

# **Oracle® Spatial and Graph**

Developer's Guide

12c Release 1 (12.1)

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Provides usage and reference information for indexing and storing spatial data and for developing spatial applications using Oracle Spatial and Graph and Oracle Locator.

Oracle Spatial and Graph Developer's Guide, 12c Release 1 (12.1)

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# Preface

*Oracle Spatial and Graph Developer's Guide* provides usage and reference information for indexing and storing spatial data and for developing spatial applications using Oracle Spatial and Graph and Oracle Locator.

Oracle Spatial and Graph requires the Enterprise Edition of Oracle Database. It is a foundation for the deployment of enterprise-wide spatial information systems, and Web-based and wireless location-based applications requiring complex spatial data management. Oracle Locator is a feature of the Standard and Enterprise Editions of Oracle Database. It offers a subset of Oracle Spatial and Graph capabilities (see [Oracle Locator](#) (page B-1) for a list of Locator features) typically required to support Internet and wireless service applications and partner-based geographic information system (GIS) solutions.

The Standard and Enterprise Editions of Oracle Database have the same basic features. However, several advanced features, such as extended data types, are available only with the Enterprise Edition, and some of these features are optional. For example, to use Oracle Database table partitioning, you must have the Enterprise Edition and the Partitioning Option.

## Audience

This guide is intended for anyone who needs to store spatial data in an Oracle database.

## Documentation Accessibility

For information about Oracle's commitment to accessibility, visit the Oracle Accessibility Program website at <http://www.oracle.com/pls/topic/lookup?ctx=acc&id=docacc>.

### Access to Oracle Support

Oracle customers that have purchased support have access to electronic support through My Oracle Support. For information, visit <http://www.oracle.com/pls/topic/lookup?ctx=acc&id=info> or visit <http://www.oracle.com/pls/topic/lookup?ctx=acc&id=trs> if you are hearing impaired.

## Related Documents

For more information, see the following documents:

- *Oracle Spatial and Graph GeoRaster Developer's Guide*

- *Oracle Spatial and Graph Topology Data Model and Network Data Model Graph Developer's Guide*
- *Oracle Database SQL Language Reference*
- *Oracle Database Administrator's Guide*
- *Oracle Database Development Guide*
- *Oracle Database Error Messages - Spatial and Graph messages are in the range of 13000 to 13499.*
- *Oracle Database Performance Tuning Guide*
- *Oracle Database SQL Tuning Guide*
- *Oracle Database Utilities*
- *Oracle Database Advanced Replication*
- *Oracle Database Data Cartridge Developer's Guide*

## Conventions

The following text conventions are used in this document:

Convention	Meaning
<b>boldface</b>	Boldface type indicates graphical user interface elements associated with an action, or terms defined in text or the glossary.
<i>italic</i>	Italic type indicates book titles, emphasis, or placeholder variables for which you supply particular values.
monospace	Monospace type indicates commands within a paragraph, URLs, code in examples, text that appears on the screen, or text that you enter.

---

# Changes in This Release for Oracle Spatial and Graph Developer's Guide

This preface contains:

- [Changes in Oracle Database 12c Release 1 \(12.1.0.2\)](#) (page xxix)
- [Changes in Oracle Database 12c Release 1 \(12.1.0.1\)](#) (page xxx)

## Changes in Oracle Database 12c Release 1 (12.1.0.2)

The following are changes in *Oracle Spatial and Graph Developer's Guide* for Oracle Database 12c Release 1 (12.1.0.2).

### Routing Engine Information Revised

The information for the Spatial and Graph routing engine (often referred to as the routing engine) has been substantially updated and reorganized. It appears in the following locations:

- [Routing Engine](#) (page 13-1) describes concepts and techniques relevant to all users of the routing engine.
- [Routing Engine Administration](#) (page E-1) is for advanced users who need to administer the routing engine. It is not intended for most routing users. (It assumes that you are already familiar with the material in [Routing Engine](#) (page 13-1).)

### Change in Behavior for SDO\_GEOM.SDO\_CLOSEST\_POINTS

For [SDO\\_GEOM.SDO\\_CLOSEST\\_POINTS](#) (page 23-14), if the distance between the two points is 0 (zero), the output geometries (`geoma` and `geom_b`) was null in the previous release. Now, the output geometries depend on whether the input geometries are two-dimensional or three-dimensional, as explained in the Usage Notes for that procedure.

### GeoRaster Not Enabled by Default

By default the GeoRaster feature is disabled after the Oracle Spatial and Graph is initially installed. To enable GeoRaster, follow these steps:

1. Connect to the database as SYS AS SYSDBA.
2. Enter the following statement:

```
EXECUTE MDSYS.enableGeoRaster;
```

For more information, see [Ensuring That GeoRaster Works Properly After an Installation or Upgrade](#) (page A-1)

## Changes in Oracle Database 12c Release 1 (12.1.0.1)

The following are changes in *Oracle Spatial and Graph Developer's Guide* for Oracle Database 12c Release 1 (12.1.0.1).

### New Features

The following features are new in this release:

- [New and Changed SDO\\_GEOM Subprograms \(Release 12.1.0.2\)](#) (page xxx)
- [NURBS Curve Support](#) (page xxx)
- [Height Information Approximated for Certain 3D Geodetic Operations](#) (page xxxi)
- [New Spatial Metadata Views \(3D Themes\\_ Scenes\\_ Viewframes\)](#) (page xxxi)
- [New and Changed Aggregate Functions](#) (page xxxi)
- [New and Changed SDO\\_CS Subprograms](#) (page xxxi)
- [New and Changed SDO\\_UTIL Subprograms](#) (page xxxii)
- [New SDO\\_GEOM\\_MBR Operator](#) (page xxxiii)
- [SPATIAL\\_VECTOR\\_ACCELERATION System Parameter \(VPA\)](#) (page xxxiii)

#### New and Changed SDO\_GEOM Subprograms (Release 12.1.0.2)

Effective with Oracle Database Release 12.1.0.2, the following new subprograms have been added to the SDO\_GEOM package, which is documented in [SDO\\_GEOM Package \(Geometry\)](#) (page 23-1):

- [SDO\\_GEOM.SDO\\_DIAMETER](#) (page 23-21)
- [SDO\\_GEOM.SDO\\_DIAMETER\\_LINE](#) (page 23-22)
- [SDO\\_GEOM.SDO\\_MAXDISTANCE](#) (page 23-31)
- [SDO\\_GEOM.SDO\\_MAXDISTANCE\\_LINE](#) (page 23-33)
- [SDO\\_GEOM.SDO\\_MBC](#) (page 23-34)
- [SDO\\_GEOM.SDO\\_MBC\\_CENTER](#) (page 23-35)
- [SDO\\_GEOM.SDO\\_MBC\\_RADIUS](#) (page 23-37)
- [SDO\\_GEOM.SDO\\_WIDTH](#) (page 23-47)
- [SDO\\_GEOM.SDO\\_WIDTH\\_LINE](#) (page 23-49)

#### NURBS Curve Support

Support for non-uniform rational B-spline (NURBS) curve geometries is included in this release. NURBS curves allow representation of free-form shapes with arbitrary shapes. NURBS representation allows control over the shape of the curve because

control points and knots guide the shape of the curve, and they allow complex shapes to be represented with little data.

For more information, see [NURBS Curve Support in Oracle Spatial and Graph](#) (page 1-27).

### **Height Information Approximated for Certain 3D Geodetic Operations**

In the previous release, height information was ignored for certain operations on three-dimensional geodetic geometries. With this release, the height is approximated and included in calculations for these operations.

For more information, see [Three-Dimensional Spatial Objects](#) (page 1-16), including [Table 1-2](#) (page 1-19).

### **New Spatial Metadata Views (3D Themes, Scenes, Viewframes)**

ALL\_SDO\_xxx and USER\_SDO\_xxx metadata views have been added for 3D themes, scenes, and viewframes. For descriptions of these views, see [Other Spatial Metadata Views](#) (page 2-49).

These views are relevant to several new functions listed under "[New and Changed SDO\\_UTIL Subprograms](#) (page xxxii)".

### **New and Changed Aggregate Functions**

The following new spatial aggregate function has been added (spatial aggregate functions are documented in [Spatial Aggregate Functions](#) (page 19-1)):

- [SDO\\_AGGR\\_SET\\_UNION](#) (page 19-7)

### **New and Changed SDO\_CS Subprograms**

The following new subprograms have been added to the SDO\_CS package, which is documented in [SDO\\_CS Package \(Coordinate System Transformation\)](#) (page 20-1):

- [SDO\\_CS.CONVERT\\_3D\\_SRID\\_TO\\_2D](#) (page 20-4)
- [SDO\\_CS.LOAD\\_EPSG\\_MATRIX](#) (page 20-26)
- [SDO\\_CS.VALIDATE\\_EPSG\\_MATRIX](#) (page 20-42)

### **New and Changed SDO\_GEOM Subprograms**

The following new subprogram has been added to the SDO\_GEOM package, which is documented in [SDO\\_GEOM Package \(Geometry\)](#) (page 23-1):

- [SDO\\_GEOM.SDO\\_SELF\\_UNION](#) (page 23-42)

### **New and Changed SDO\_PC\_PKG Subprograms**

The following new subprograms have been added to the SDO\_PC\_PKG package, which is documented in [SDO\\_PC\\_PKG Package \(Point Clouds\)](#) (page 27-1):

- [SDO\\_PC\\_PKG.CLIP\\_PC\\_FLAT](#) (page 27-3)
- [SDO\\_PC\\_PKG.CREATE\\_CONTOUR\\_GEOMETRIES](#) (page 27-6)

The following significant changes have also been made:

- For [SDO\\_PC\\_PKG.CLIP\\_PC](#) (page 27-1), the `include_custom_dims` parameter can be used to return point cloud blocks that contain custom dimensions in addition to regular dimensions.
- For [SDO\\_PC\\_PKG.INIT](#) (page 27-10), the `pc_other_attrs` parameter can be used to specify metadata for point cloud pyramiding.

### New and Changed SDO\_TIN\_PKG Subprograms

The following new subprograms have been added to the SDO\_TIN\_PKG package, which is documented in [SDO\\_TIN\\_PKG Package \(TINs\)](#) (page 29-1):

- [SDO\\_TIN\\_PKG.PROJECT\\_ORDINATES\\_ONTO\\_TIN](#) (page 29-8)
- [SDO\\_TIN\\_PKG.TO\\_DEM](#) (page 29-9)

The following significant changes have also been made:

- For [SDO\\_TIN\\_PKG.INIT](#) (page 29-5), the `tin_other_attrs` parameter can be used to specify metadata for TIN pyramiding.

### New and Changed SDO\_UTIL Subprograms

The following new subprograms have been added to the SDO\_UTIL package, which is documented in [SDO\\_UTIL Package \(Utility\)](#) (page 31-1):

- [SDO\\_UTIL.CONVERT3007TO3008](#) (page 31-16)
- [SDO\\_UTIL.GET\\_2D\\_FOOTPRINT](#) (page 31-35)
- [SDO\\_UTIL.SIMPLIFYVW](#) (page 31-52)
- [SDO\\_UTIL.THEME3D\\_GET\\_BLOCK\\_TABLE](#) (page 31-53)
- [SDO\\_UTIL.THEME3D\\_HAS\\_LOD](#) (page 31-54)
- [SDO\\_UTIL.THEME3D\\_HAS\\_TEXTURE](#) (page 31-56)
- [SDO\\_UTIL.VALIDATE\\_3DTHEME](#) (page 31-71)
- [SDO\\_UTIL.VALIDATE\\_SCENE](#) (page 31-72)
- [SDO\\_UTIL.VALIDATE\\_VIEWFRAME](#) (page 31-73)

The following significant changes have also been made:

- [SDO\\_UTIL.AFFINETRANSFORMS](#) (page 31-3) has default values for all parameters except the first (geometry). This can simplify coding when you need to specify nondefault values for only a few parameters.
- [SDO\\_UTIL.CIRCLE\\_POLYGON](#) (page 31-11) has an additional format that includes the `start_azimuth` and `end_azimuth` parameters.
- [SDO\\_UTIL.SIMPLIFY](#) (page 31-49) has the new optional parameter `remove_loops`, which enables you to ensure that a simplified line string geometry for not contain any self-crossing loops in the middle. ([SDO\\_UTIL.SIMPLIFYVW](#) (page 31-52) also has the `remove_loops` parameter.)



### New SDO\_GEOM\_MBR Operator

SDO\_GEOM\_MBR is a SQL operator that is functionally identical to the [SDO\\_GEOM.SDO\\_MBR](#) (page 23-38) function, but provides better performance.

For SDO\_GEOM\_MBR operator usage information and an example, see the [SDO\\_GEOM.SDO\\_MBR](#) (page 23-38) function reference section.

### New SDO\_POINTINPOLYGON Operator

The new [SDO\\_POINTINPOLYGON](#) (page 18-28) operator (technically a table function) takes a set of rows whose first column is a point's x-coordinate value and the second column is a point's y-coordinate value, and returns those rows that are within a specified polygon geometry.

### SPATIAL\_VECTOR\_ACCELERATION System Parameter (VPA)

To accelerate the performance of spatial operators, it is recommended that you enable the Vector Performance Accelerator (VPA) feature by setting the SPATIAL\_VECTOR\_ACCELERATION database system parameter to the value TRUE. (This feature and associated system parameter are authorized for use only by licensed Oracle Spatial and Graph users, and the default value for the parameter is FALSE.) You can set this parameter for the whole system or for a single session.

For more information, see [SPATIAL\\_VECTOR\\_ACCELERATION System Parameter](#) (page 1-31).

## Other Changes

The following other changes have been made in this book:

- The product name has been changed from Oracle Spatial to Oracle Spatial and Graph, also referred to as Spatial and Graph.
- The section previously titled "SDO\_AGGR\_UNION Example" in [Complex Spatial Queries: Examples](#) (page C-1) has been deleted. That section had recommended: "For better performance when aggregating many rows, break your aggregation into groupings so that each is always 50 geometries or fewer." However, because of enhancements to [SDO\\_AGGR\\_UNION](#) (page 19-9) effective with Release 12.1, if you are using Spatial and Graph with SPATIAL\_VECTOR\_ACCELERATION=TRUE (see [SPATIAL\\_VECTOR\\_ACCELERATION System Parameter](#) (page 1-31)), that statement and the example using nested aggregates are no longer recommended, and nested aggregates can actually be slower than a single aggregate.

However, if you are using Oracle Locator, nested aggregates or [SDO\\_AGGR\\_SET\\_UNION](#) (page 19-7) are recommended. For more information, see Section C.4 ("SDO\_AGGR\_UNION Example") in the Release 11.2 version of *Oracle Spatial Developer's Guide*.



# Part I

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## Conceptual and Usage Information

This document has the following parts:

- Part I provides conceptual and usage information about Oracle Spatial and Graph.
- [Spatial Web Services](#) (page 1) provides conceptual and usage information about Oracle Spatial and Graph web services.
- [Reference Information](#) (page 1) provides reference information about Oracle Spatial and Graph operators, functions, and procedures.
- [Supplementary Information](#) (page 1) provides supplementary information (appendixes and a glossary).

Part I is organized for efficient learning about Oracle Spatial and Graph. It covers basic concepts and techniques first, and proceeds to more advanced material, such as coordinate systems, the linear referencing system, geocoding, and extending spatial indexing. Part I contains the following chapters:

- [Spatial Concepts](#) (page 1-1)
- [Spatial Data Types and Metadata](#) (page 2-1)
- [SQL Multimedia Type Support](#) (page 3-1)
- [Loading Spatial Data](#) (page 4-1)
- [Indexing and Querying Spatial Data](#) (page 5-1)
- [Coordinate Systems \(Spatial Reference Systems\)](#) (page 6-1)
- [Linear Referencing System](#) (page 7-1)
- [Spatial Analysis and Mining](#) (page 8-1)
- [Extending Spatial Indexing Capabilities](#) (page 9-1)



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# Spatial Concepts

Oracle Spatial and Graph is an integrated set of functions, procedures, data types and data models that support spatial and graph analytics. The spatial features enable spatial data to be stored, accessed, and analyzed quickly and efficiently in an Oracle database.

Spatial data represents the essential location characteristics of real or conceptual objects as those objects relate to the real or conceptual space in which they exist.

This chapter contains the following major sections:

- [What Is Oracle Spatial and Graph?](#) (page 1-2)
- [Object-Relational Model](#) (page 1-2)
- [Introduction to Spatial Data](#) (page 1-3)
- [Geometry Types](#) (page 1-3)
- [Data Model](#) (page 1-5)
- [Query Model](#) (page 1-9)
- [Indexing of Spatial Data](#) (page 1-10)
- [Spatial Relationships and Filtering](#) (page 1-11)
- [Spatial Operators\\_ Procedures\\_ and Functions](#) (page 1-14)
- [Spatial Aggregate Functions](#) (page 1-15)
- [Three-Dimensional Spatial Objects](#) (page 1-16)
- [Geocoding](#) (page 1-26)
- [NURBS Curve Support in Oracle Spatial and Graph](#) (page 1-27)
- [Spatial and Graph Java Application Programming Interface](#) (page 1-29)
- [Predefined User Accounts Created by Spatial and Graph](#) (page 1-29)
- [Performance and Tuning Information](#) (page 1-30)
- [OGC and ISO Compliance](#) (page 1-30)
- [Spatial and Graph Release \(Version\) Number](#) (page 1-31)
- [SPATIAL\\_VECTOR\\_ACCELERATION System Parameter](#) (page 1-31)
- [Spatially Enabling a Table](#) (page 1-32)
- [Moving Spatial Metadata \(MDSYS.MOVE\\_SDO\)](#) (page 1-34)

- [Spatial Application Hardware Requirement Considerations](#) (page 1-34)
- [Spatial and Graph Error Messages](#) (page 1-34)
- [Spatial Examples](#) (page 1-35)
- [README File for Spatial and Graph and Related Features](#) (page 1-35)

## 1.1 What Is Oracle Spatial and Graph?

Oracle Spatial and Graph, often referred to as Spatial and Graph, includes advanced features for spatial data and analysis and for physical, logical, network, and social and semantic graph applications. The spatial features provide a schema and functions that facilitate the storage, retrieval, update, and query of collections of spatial features in an Oracle database. Spatial and Graph consists of the following:

- A schema (MDSYS) that prescribes the storage, syntax, and semantics of supported geometric data types
- A spatial indexing mechanism
- Operators, functions, and procedures for performing area-of-interest queries, spatial join queries, and other spatial analysis operations
- Functions and procedures for utility and tuning operations
- Topology data model for working with data about nodes, edges, and faces in a topology (described in *Oracle Spatial and Graph Topology Data Model and Network Data Model Graph Developer's Guide*).
- Network data model for representing capabilities or objects that are modeled as nodes and links (vertices and edges) in a graph (described in *Oracle Spatial and Graph Topology Data Model and Network Data Model Graph Developer's Guide*).
- GeoRaster, a feature that lets you store, index, query, analyze, and deliver GeoRaster data, that is, raster image and gridded data and its associated metadata (described in *Oracle Spatial and Graph GeoRaster Developer's Guide*).

The spatial component of a spatial feature is the geometric representation of its shape in some coordinate space. This is referred to as its **geometry**.

---

**Note:**

Do not modify any packages, tables, or other objects under the MDSYS schema. (The only exception is if you need to create a user-defined coordinate reference system, as explained in [Creating a User-Defined Coordinate Reference System](#) (page 6-55).)

---

## 1.2 Object-Relational Model

Spatial and Graph supports the **object-relational** model for representing geometries. This model stores an entire geometry in the Oracle native spatial data type for vector data, SDO\_GEOMETRY. An Oracle table can contain one or more SDO\_GEOMETRY columns. The object-relational model corresponds to a "SQL with Geometry Types" implementation of spatial feature tables in the Open GIS ODBC/SQL specification for geospatial features.

The benefits provided by the object-relational model include:

- Support for many geometry types, including arcs, circles, compound polygons, compound line strings, and optimized rectangles
- Ease of use in creating and maintaining indexes and in performing spatial queries
- Index maintenance by the Oracle database
- Geometries modeled in a single column
- Optimal performance

## 1.3 Introduction to Spatial Data

Oracle Spatial and Graph is designed to make spatial data management easier and more natural to users of location-enabled applications and geographic information system (GIS) applications. Once spatial data is stored in an Oracle database, it can be easily manipulated, retrieved, and related to all other data stored in the database.

A common example of spatial data can be seen in a road map. A road map is a two-dimensional object that contains points, lines, and polygons that can represent cities, roads, and political boundaries such as states or provinces. A road map is a visualization of geographic information. The location of cities, roads, and political boundaries that exist on the surface of the Earth are projected onto a two-dimensional display or piece of paper, preserving the relative positions and relative distances of the rendered objects.

The data that indicates the Earth location (such as longitude and latitude) of these rendered objects is the spatial data. When the map is rendered, this spatial data is used to project the locations of the objects on a two-dimensional piece of paper. A GIS is often used to store, retrieve, and render this Earth-relative spatial data.

Types of spatial data (other than GIS data) that can be stored using Spatial and Graph include data from computer-aided design (CAD) and computer-aided manufacturing (CAM) systems. Instead of operating on objects on a geographic scale, CAD/CAM systems work on a smaller scale, such as for an automobile engine or printed circuit boards.

The differences among these systems are in the size and precision of the data, not the data's complexity. The systems might all involve the same number of data points. On a geographic scale, the location of a bridge can vary by a few tenths of an inch without causing any noticeable problems to the road builders, whereas if the diameter of an engine's pistons is off by a few tenths of an inch, the engine will not run.

In addition, the complexity of data is independent of the absolute scale of the area being represented. For example, a printed circuit board is likely to have many thousands of objects etched on its surface, containing in its small area information that may be more complex than the details shown on a road builder's blueprints.

These applications all store, retrieve, update, or query some collection of features that have both nonspatial and spatial attributes. Examples of nonspatial attributes are name, soil\_type, landuse\_classification, and part\_number. The spatial attribute is a coordinate geometry, or vector-based representation of the shape of the feature.

## 1.4 Geometry Types

A **geometry** is an ordered sequence of vertices that are connected by straight line segments or circular arcs. The semantics of the geometry are determined by its type.

Spatial and Graph supports several primitive types, and geometries composed of collections of these types, including two-dimensional:

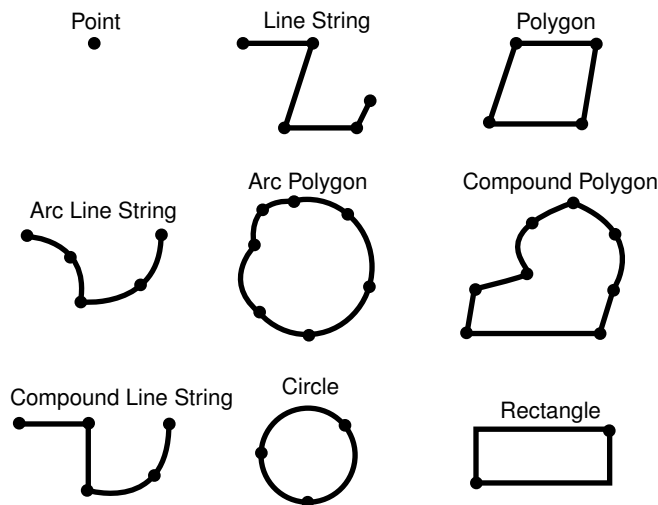
- Points and point clusters
- Line strings
- $n$ -point polygons
- Arc line strings (All arcs are generated as circular arcs.)
- Arc polygons
- Compound polygons
- Compound line strings
- Circles
- Optimized rectangles

**Two-dimensional points** are elements composed of two ordinates,  $X$  and  $Y$ , often corresponding to longitude and latitude. **Line strings** are composed of one or more pairs of points that define line segments. **Polygons** are composed of connected line strings that form a closed ring, and the area of the polygon is implied. For example, a point might represent a building location, a line string might represent a road or flight path, and a polygon might represent a state, city, zoning district, or city block.

Self-crossing polygons are not supported, although self-crossing line strings are supported. If a line string crosses itself, it does not become a polygon. A self-crossing line string does not have any implied area.

The following figure illustrates the geometric types.

**Figure 1-1 Geometric Types**



Spatial and Graph also supports the storage and indexing of three-dimensional and four-dimensional geometric types, where three or four coordinates are used to define each vertex of the object being defined. For information about support for three-dimensional geometries, see [Three-Dimensional Spatial Objects](#) (page 1-16).



## 1.5 Data Model

The spatial data model in Oracle Spatial and Graph is a hierarchical structure consisting of elements, geometries, and layers. Layers are composed of geometries, which in turn are made up of elements.

### 1.5.1 Element

An **element** is the basic building block of a geometry. The supported spatial element types are points, line strings, and polygons. For example, elements might model star constellations (point clusters), roads (line strings), and county boundaries (polygons). Each coordinate in an element is stored as an X,Y pair. The exterior ring and zero or more interior rings (holes) of a complex polygon are considered a single element.

**Point data** consists of one coordinate. **Line data** consists of two coordinates representing a line segment of the element. **Polygon data** consists of coordinate pair values, one vertex pair for each line segment of the polygon. Coordinates are defined in order around the polygon (counterclockwise for an exterior polygon ring, clockwise for an interior polygon ring).

### 1.5.2 Geometry

A **geometry** (or **geometry object**) is the representation of a spatial feature, modeled as an ordered set of primitive elements. A geometry can consist of a single element, which is an instance of one of the supported primitive types, or a homogeneous or heterogeneous collection of elements. A multipolygon, such as one used to represent a set of islands, is a homogeneous collection. A heterogeneous collection is one in which the elements are of different types, for example, a point and a polygon.

An example of a geometry might describe the buildable land in a town. This could be represented as a polygon with holes where water or zoning prevents construction.

### 1.5.3 Layer

A **layer** is a collection of geometries having the same attribute set. For example, one layer in a GIS might include topographical features, while another describes population density, and a third describes the network of roads and bridges in the area (lines and points). The geometries and associated spatial index for each layer are stored in the database in standard tables.

### 1.5.4 Coordinate System

A **coordinate system** (also called a *spatial reference system*) is a means of assigning coordinates to a location and establishing relationships between sets of such coordinates. It enables the interpretation of a set of coordinates as a representation of a position in a real world space.

Any spatial data has a coordinate system associated with it. The coordinate system can be *georeferenced* (related to a specific representation of the Earth) or not georeferenced (that is, Cartesian, and not related to a specific representation of the Earth). If the coordinate system is georeferenced, it has a default *unit of measurement* (such as meters) associated with it, but you can have Spatial and Graph automatically return results in another specified unit (such as miles). (For more information about unit of measurement support, see [Unit of Measurement Support](#) (page 2-55).)

Spatial data can be associated with a Cartesian, geodetic (geographical), projected, or local coordinate system:

- **Cartesian coordinates** are coordinates that measure the position of a point from a defined origin along axes that are perpendicular in the represented two-dimensional or three-dimensional space.

If a coordinate system is not explicitly associated with a geometry, a Cartesian coordinate system is assumed.

- **Geodetic coordinates** (sometimes called *geographic coordinates*) are angular coordinates (longitude and latitude), closely related to spherical polar coordinates, and are defined relative to a particular Earth geodetic datum. (A geodetic datum is a means of representing the figure of the Earth and is the reference for the system of geodetic coordinates.)
- **Projected coordinates** are planar Cartesian coordinates that result from performing a mathematical mapping from a point on the Earth's surface to a plane. There are many such mathematical mappings, each used for a particular purpose.
- **Local coordinates** are Cartesian coordinates in a non-Earth (non-georeferenced) coordinate system. Local coordinate systems are often used for CAD applications and local surveys.

When performing operations on geometries, Spatial and Graph uses either a Cartesian or curvilinear computational model, as appropriate for the coordinate system associated with the spatial data.

For more information about coordinate system support in Spatial and Graph, including geodetic, projected, and local coordinates and coordinate system transformation, see [Coordinate Systems \(Spatial Reference Systems\)](#) (page 6-1).

## 1.5.5 Tolerance

Tolerance is used to associate a level of precision with spatial data. **Tolerance** reflects the *distance that two points can be apart and still be considered the same* (for example, to accommodate rounding errors). The tolerance value must be a positive number greater than zero. The significance of the value depends on whether or not the spatial data is associated with a geodetic coordinate system. (Geodetic and other types of coordinate systems are described in [Coordinate System](#) (page 1-5).)

- For geodetic data (such as data identified by longitude and latitude coordinates), the tolerance value is a number of meters. For example, a tolerance value of 100 indicates a tolerance of 100 meters. The tolerance value for geodetic data must be 0.05 (5 centimeters) or greater. Spatial and Graph uses 0.05 as the tolerance value for geodetic data if you specify a smaller value with the following functions: [SDO\\_GEOM.RELATE](#) (page 23-4), [SDO\\_GEOM.SDO\\_DIFFERENCE](#) (page 23-24), [SDO\\_GEOM.SDO\\_INTERSECTION](#) (page 23-27), [SDO\\_GEOM.SDO\\_UNION](#) (page 23-44), and [SDO\\_GEOM.SDO\\_XOR](#) (page 23-50); however, the geometries must be valid at the 0.05 tolerance.
- For non-geodetic data, the tolerance value is a number of the units that are associated with the coordinate system associated with the data. For example, if the unit of measurement is miles, a tolerance value of 0.005 indicates a tolerance of 0.005 (that is, 1/200) mile (approximately 26 feet or 7.9 meters), and a tolerance value of 2 indicates a tolerance of 2 miles.

In both cases, the smaller the tolerance value, the more precision is to be associated with the data.

For geodetic and projected data, the tolerance value should be less than 10. In addition, ensure that geometries are valid at the specified tolerance.

For geometries that have 16 or more digits of precision, Spatial and Graph boolean operations (such as [SDO\\_GEOM.SDO\\_UNION](#) (page 23-44) and [SDO\\_GEOM.SDO\\_INTERSECTION](#) (page 23-27)) and the [SDO\\_GEOM.RELATE](#) (page 23-4) function might produce inconsistent results due to the loss of precision in floating point arithmetic. The number of digits of precision is calculated as in the following example: if the tolerance is set to 0.0000000005 and the coordinates have 6 digits to the left of decimal (for example, 123456.4321), the precision is 10 + 6 digits (16). In such cases, it is better to use a larger tolerance value (fewer leading zeros after the decimal) to get consistent results using spatial operations.

---

**Note:**

Floating point operations tend to lose precision when the number of digits used in the computation is more than 15, so make sure the number of digits specified for computations is less than 15. For example, if the number is 123456.789 and the tolerance is 10E-10, then this effectively means 16 (10+6) digits of precision, which is more than the recommended 15.

---

A tolerance value is specified in two cases:

- In the geometry metadata definition for a layer (see [Tolerance in the Geometry Metadata for a Layer](#) (page 1-7))
- As an input parameter to certain functions (see [Tolerance as an Input Parameter](#) (page 1-8))

For additional information about tolerance with linear referencing system (LRS) data, see [Tolerance Values with LRS Functions](#) (page 7-15).

### 1.5.5.1 Tolerance in the Geometry Metadata for a Layer

The dimensional information for a layer includes a tolerance value. Specifically, the DIMINFO column (described in [DIMINFO](#) (page 2-48)) of the xxx\_SDO\_GEOM\_METADATA views includes an SDO\_TOLERANCE value for each dimension, and the value should be the same for each dimension.

If a function accepts an optional tolerance parameter and this parameter is null or not specified, the SDO\_TOLERANCE value of the layer is used. Using the non-geodetic data from the example in [Simple Example: Inserting, Indexing, and Querying Spatial Data](#) (page 2-1), the actual distance between geometries cola\_b and cola\_d is 0.846049894. If a query uses the [SDO\\_GEOM.SDO\\_DISTANCE](#) (page 23-25) function to return the distance between cola\_b and cola\_d and does not specify a tolerance parameter value, the result depends on the SDO\_TOLERANCE value of the layer. For example:

- If the SDO\_TOLERANCE value of the layer is 0.005, this query returns .846049894.
- If the SDO\_TOLERANCE value of the layer is 0.5, this query returns 0.

The zero result occurs because Spatial and Graph first constructs an imaginary buffer of the tolerance value (0.5) around each geometry to be considered, and the buffers around cola\_b and cola\_d overlap in this case. (If the two geometries

being considered have different tolerance values, the higher value is used for the imaginary buffer.)

You can, therefore, take either of two approaches in selecting an SDO\_TOLERANCE value for a layer:

- The value can reflect the desired level of precision in queries for distances between objects. For example, if two non-geodetic geometries 0.8 units apart should be considered as separated, specify a small SDO\_TOLERANCE value such as 0.05 or smaller.
- The value can reflect the precision of the values associated with geometries in the layer. For example, if all geometries in a non-geodetic layer are defined using integers and if two objects 0.8 units apart should not be considered as separated, an SDO\_TOLERANCE value of 0.5 is appropriate. To have greater precision in any query, you must override the default by specifying the `tolerance` parameter.

With non-geodetic data, the guideline to follow for most instances of the second case (precision of the values of the geometries in the layer) is: take the highest level of precision in the geometry definitions, and use .5 at the next level as the SDO\_TOLERANCE value. For example, if geometries are defined using integers (as in the simplified example in [Simple Example: Inserting, Indexing, and Querying Spatial Data](#) (page 2-1)), the appropriate value is 0.5; however, if geometries are defined using numbers up to four decimal positions (for example, 31.2587), the appropriate value is 0.00005.

---

**Note:**

This guideline should not be used if the geometries include any polygons that are so narrow at any point that the distance between facing sides is less than the proposed tolerance value. Be sure that the tolerance value is less than the shortest distance between any two sides in any polygon.

Moreover, if you encounter "invalid geometry" errors with inserted or updated geometries, and if the geometries are in fact valid, consider increasing the precision of the tolerance value (for example, changing 0.00005 to 0.000005).

---

### 1.5.5.2 Tolerance as an Input Parameter

Many spatial functions accept a `tolerance` parameter, which (if specified) overrides the default tolerance value for the layer (explained in [Tolerance in the Geometry Metadata for a Layer](#) (page 1-7)). If the distance between two points is less than or equal to the tolerance value, Spatial and Graph considers the two points to be a single point. Thus, tolerance is usually a reflection of how accurate or precise users perceive their spatial data to be.

For example, assume that you want to know which restaurants are within 5 kilometers of your house. Assume also that Maria's Pizzeria is 5.1 kilometers from your house. If the spatial data has a geodetic coordinate system and if you ask, *Find all restaurants within 5 kilometers and use a tolerance of 100* (or greater, such as 500), Maria's Pizzeria will be included, because 5.1 kilometers (5100 meters) is within 100 meters of 5 kilometers (5000 meters). However, if you specify a tolerance less than 100 (such as 50), Maria's Pizzeria will not be included.

Tolerance values for spatial functions are typically very small, although the best value in each case depends on the kinds of applications that use or will use the data. See also

the tolerance guidelines in [Tolerance in the Geometry Metadata for a Layer](#) (page 1-7), and ensure that all input geometries are valid. (Spatial functions may not work as expected if the geometry data is not valid.)

If you explicitly want to use the tolerance value from the dimensional information array for the geometry layer, and if a subprogram has separate formats with `tolerance` (or `tol`) and `dim` parameters, use the format with `dim`. In the following example, the first statement uses the tolerance value from the dimensional information array, and the second statement specifies a numeric tolerance value (0.005):

```
-- Return the area of the cola_a geometry.

SELECT c.name, SDO_GEOM.SDO_AREA(c.shape, m.diminfo)
  FROM cola_markets c, user_sdo_geom_metadata m
 WHERE m.table_name = 'COLA_MARKETS' AND m.column_name = 'SHAPE'
 AND c.name = 'cola_a';

SELECT c.name, SDO_GEOM.SDO_AREA(c.shape, 0.005) FROM cola_markets c
 WHERE c.name = 'cola_a';
```

## 1.6 Query Model

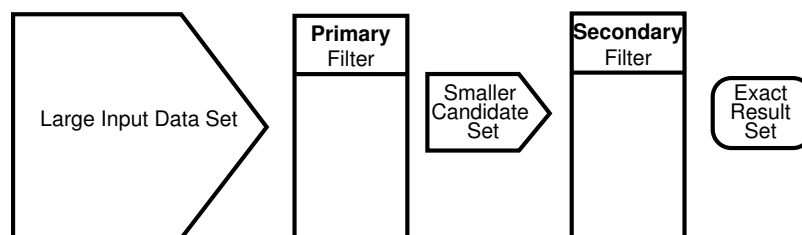
Spatial and Graph uses a **two-tier query model** to resolve spatial queries and spatial joins. The term is used to indicate that two distinct operations are performed to resolve queries. The output of the two combined operations yields the exact result set.

The two operations are referred to as *primary* and *secondary* filter operations.

- The **primary filter** permits fast selection of candidate records to pass along to the secondary filter. The primary filter compares geometry approximations to reduce computation complexity and is considered a lower-cost filter. Because the primary filter compares geometric approximations, it returns a superset of the exact result set.
- The **secondary filter** applies exact computations to geometries that result from the primary filter. The secondary filter yields an accurate answer to a spatial query. The secondary filter operation is computationally expensive, but it is only applied to the primary filter results, not the entire data set.

[Figure 1-2](#) (page 1-9) illustrates the relationship between the primary and secondary filters.

**Figure 1-2 Query Model**



As shown in [Figure 1-2](#) (page 1-9), the primary filter operation on a large input data set produces a smaller candidate set, which contains at least the exact result set and may contain more records. The secondary filter operation on the smaller candidate set produces the exact result set.

Spatial and Graph uses a spatial index to implement the primary filter. Spatial and Graph does not require the use of both the primary and secondary filters. In some

cases, just using the primary filter is sufficient. For example, a *zoom* feature in a mapping application queries for data that has any interaction with a rectangle representing visible boundaries. The primary filter very quickly returns a superset of the query. The mapping application can then apply clipping routines to display the target area.

The purpose of the primary filter is to quickly create a subset of the data and reduce the processing burden on the secondary filter. The primary filter, therefore, should be as efficient (that is, selective yet fast) as possible. This is determined by the characteristics of the spatial index on the data.

For more information about querying spatial data, see [Querying Spatial Data](#) (page 5-8).

## 1.7 Indexing of Spatial Data

The introduction of spatial indexing capabilities into the Oracle database engine is a key feature of the Spatial and Graph product. A spatial index, like any other index, provides a mechanism to limit searches, but in this case the mechanism is based on spatial criteria such as intersection and containment. A spatial index is needed to:

- Find objects within an indexed data space that interact with a given point or area of interest (window query)
- Find pairs of objects from within two indexed data spaces that interact spatially with each other (spatial join)

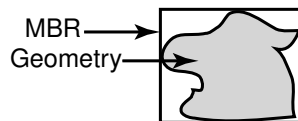
Testing of spatial indexes with many workloads and operators is ongoing, and results and recommendations will be documented as they become available.

The following sections explain the concepts and options associated with R-tree indexing.

### 1.7.1 R-Tree Indexing

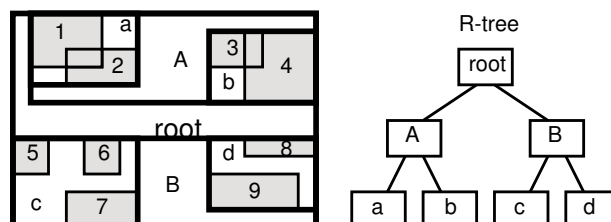
A spatial R-tree index can index spatial data of up to four dimensions. An R-tree index approximates each geometry by a single rectangle that minimally encloses the geometry (called the minimum bounding rectangle, or MBR), as shown in [Figure 1-3](#) (page 1-10).

**Figure 1-3 MBR Enclosing a Geometry**



For a layer of geometries, an R-tree index consists of a hierarchical index on the MBRs of the geometries in the layer, as shown in [Figure 1-4](#) (page 1-10).

**Figure 1-4 R-Tree Hierarchical Index on MBRs**



In [Figure 1-4](#) (page 1-10):

- 1 through 9 are geometries in a layer.
- *a*, *b*, *c*, and *d* are the leaf nodes of the R-tree index, and contain minimum bounding rectangles of geometries, along with pointers to the geometries. For example, *a* contains the MBR of geometries 1 and 2, *b* contains the MBR of geometries 3 and 4, and so on.
- *A* contains the MBR of *a* and *b*, and *B* contains the MBR of *c* and *d*.
- The root contains the MBR of *A* and *B* (that is, the entire area shown).

An R-tree index is stored in the spatial index table (SDO\_INDEX\_TABLE in the USER\_SDO\_INDEX\_METADATA view, described in [Spatial Index-Related Structures](#) (page 2-51)). The R-tree index also maintains a sequence object (SDO\_RTREE\_SEQ\_NAME in the USER\_SDO\_INDEX\_METADATA view) to ensure that simultaneous updates by concurrent users can be made to the index.

## 1.7.2 R-Tree Quality

A substantial number of insert and delete operations affecting an R-tree index may degrade the quality of the R-tree structure, which may adversely affect query performance.

The R-tree is a hierarchical tree structure with nodes at different heights of the tree. The performance of an R-tree index structure for queries is roughly proportional to the area and perimeter of the index nodes of the R-tree. The area covered at level 0 represents the area occupied by the minimum bounding rectangles of the data geometries, the area at level 1 indicates the area covered by leaf-level R-tree nodes, and so on. The original ratio of the area at the root (topmost level) to the area at level 0 can change over time based on updates to the table; and if there is a degradation in that ratio (that is, if it increases significantly), rebuilding the index may help the performance of queries.

If the performance of [SDO\\_FILTER](#) (page 18-8) operations has degraded, and if there have been a large number of insert, update, or delete operations affecting geometries, the performance degradation may be due to a degradation in the quality of the associated R-tree index.

To rebuild an R-tree index, use the [ALTER INDEX REBUILD](#) (page 17-3) statement, which is described in [SQL Statements for Indexing Spatial Data](#) (page 17-1).

## 1.8 Spatial Relationships and Filtering

Spatial and Graph uses secondary filters to determine the spatial relationship between entities in the database. The spatial relationship is based on geometry locations. The most common spatial relationships are based on topology and distance. For example, the *boundary* of an area consists of a set of curves that separates the area from the rest of the coordinate space. The *interior* of an area consists of all points in the area that are not on its boundary. Given this, two areas are said to be adjacent if they share part of a boundary but do not share any points in their interior.

The distance between two spatial objects is the minimum distance between any points in them. Two objects are said to be *within a given distance* of one another if their distance is less than the given distance.

To determine spatial relationships, Spatial and Graph has several secondary filter methods:



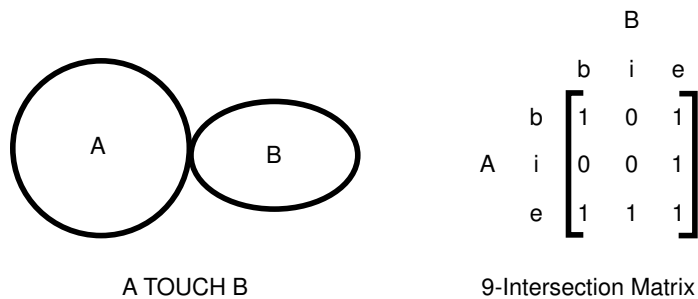
- The [SDO\\_RELATE](#) (page 18-30) operator evaluates topological criteria.
- The [SDO\\_WITHIN\\_DISTANCE](#) (page 18-36) operator determines if two spatial objects are within a specified distance of each other.
- The [SDO\\_NN](#) (page 18-17) operator identifies the nearest neighbors for a spatial object.

The syntax of these operators is given in [Spatial Operators](#) (page 18-1).

The [SDO\\_RELATE](#) (page 18-30) operator implements a nine-intersection model for categorizing binary topological relationships between points, lines, and polygons. Each spatial object has an interior, a boundary, and an exterior. The boundary consists of points or lines that separate the interior from the exterior. The boundary of a line string consists of its end points; however, if the end points overlap (that is, if they are the same point), the line string has no boundary. The boundaries of a multiline string are the end points of each of the component line strings; however, if the end points overlap, only the end points that overlap an odd number of times are boundaries. The boundary of a polygon is the line that describes its perimeter. The interior consists of points that are in the object but not on its boundary, and the exterior consists of those points that are not in the object and are not on its boundary.

Given that an object A has three components (a boundary  $A_b$ , an interior  $A_i$ , and an exterior  $A_e$ ), any pair of objects has nine possible interactions between their components. Pairs of components have an empty (0) or not empty (1) set intersection. The set of interactions between two geometries is represented by a nine-intersection matrix that specifies which pairs of components intersect and which do not. [Figure 1-5](#) (page 1-12) shows the nine-intersection matrix for two polygons that are adjacent to one another. This matrix yields the following bit mask, generated in row-major form: "101001111".

**Figure 1-5 The Nine-Intersection Model**



Some of the topological relationships identified in the seminal work by Professor Max Egenhofer (University of Maine, Orono) and colleagues have names associated with them. Spatial and Graph uses the following names:

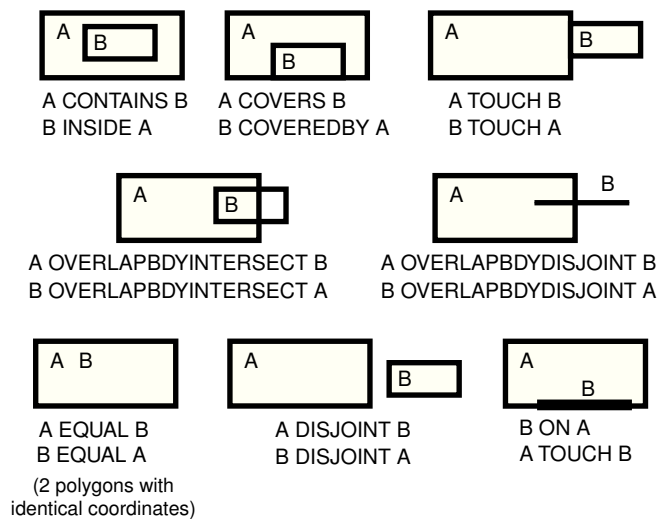
- **DISJOINT**: The boundaries and interiors do not intersect.
- **TOUCH**: The boundaries intersect but the interiors do not intersect.
- **OVERLAPBDYDISJOINT**: The interior of one object intersects the boundary and interior of the other object, but the two boundaries do not intersect. This relationship occurs, for example, when a line originates outside a polygon and ends inside that polygon.
- **OVERLAPBDYINTERSECT**: The boundaries and interiors of the two objects intersect.



- **EQUAL:** The two objects have the same boundary and interior.
- **CONTAINS:** The interior and boundary of one object is completely contained in the interior of the other object.
- **COVERS:** The boundary and interior of one object is completely contained in the interior or the boundary of the other object, their interiors intersect, and the boundary or the interior of one object and the boundary of the other object intersect.
- **INSIDE:** The opposite of CONTAINS. A INSIDE B implies B CONTAINS A.
- **COVEREDBY:** The opposite of COVERS. A COVEREDBY B implies B COVERS A.
- **ON:** The interior and boundary of one object is on the boundary of the other object. This relationship occurs, for example, when a line is on the boundary of a polygon.
- **ANYINTERACT:** The objects are non-disjoint.

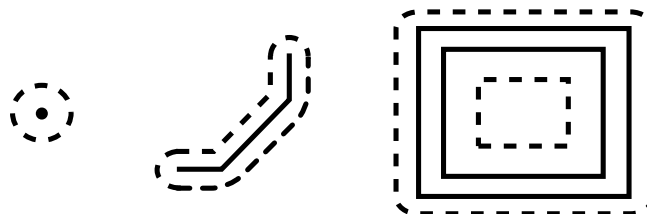
Figure 1-6 (page 1-13) illustrates these topological relationships.

**Figure 1-6 Topological Relationships**



The [SDO\\_WITHIN\\_DISTANCE](#) (page 18-36) operator determines if two spatial objects, A and B, are within a specified distance of one another. This operator first constructs a distance buffer,  $D_b$ , around the reference object B. It then checks that A and  $D_b$  are non-disjoint. The distance buffer of an object consists of all points within the given distance from that object. Figure 1-7 (page 1-13) shows the distance buffers for a point, a line, and a polygon.

**Figure 1-7 Distance Buffers for Points, Lines, and Polygons**



In the point, line, and polygon geometries shown in Figure 1-7 (page 1-13):

- The dashed lines represent distance buffers. Notice how the buffer is rounded near the corners of the objects.
- The geometry on the right is a polygon with a hole: the large rectangle is the exterior polygon ring and the small rectangle is the interior polygon ring (the hole). The dashed line outside the large rectangle is the buffer for the exterior ring, and the dashed line inside the small rectangle is the buffer for the interior ring.

The [SDO\\_NN](#) (page 18-17) operator returns a specified number of objects from a geometry column that are closest to a specified geometry (for example, the five closest restaurants to a city park). In determining how close two geometry objects are, the shortest possible distance between any two points on the surface of each object is used.

## 1.9 Spatial Operators, Procedures, and Functions

The Spatial and Graph PL/SQL application programming interface (API) includes several operators and many procedures and functions.

Spatial operators, such as [SDO\\_FILTER](#) (page 18-8) and [SDO\\_RELATE](#) (page 18-30), provide optimum performance because they use the spatial index. (Spatial operators require that the geometry column in the first parameter have a spatial index defined on it.) Spatial operators must be used in the WHERE clause of a query. The first parameter of any operator specifies the geometry column to be searched, and the second parameter specifies a query window. If the query window does not have the same coordinate system as the geometry column, Spatial and Graph performs an implicit coordinate system transformation. For detailed information about the spatial operators, see [Spatial Operators](#) (page 18-1).

Spatial procedures and functions are provided as subprograms in PL/SQL packages, such as [SDO\\_GEOM](#), [SDO\\_CS](#), and [SDO\\_LRS](#). These subprograms do not require that a spatial index be defined, and they do not use a spatial index if it is defined. These subprograms can be used in the WHERE clause or in a subquery. If two geometries are input parameters to a spatial procedure or function, both must have the same coordinate system.

---

---

**Note:**

For any numbers in string (VARCHAR2) parameters to Spatial and Graph operators and subprograms, the period (.) must be used for any decimal points regardless of the locale. Example: 'distance=3.7'

---

---

The following performance-related guidelines apply to the use of spatial operators, procedures, and functions:

- If an operator and a procedure or function perform comparable operations, and if the operator satisfies your requirements, use the operator. For example, unless you need to do otherwise, use [SDO\\_RELATE](#) (page 18-30) instead of [SDO\\_GEOM.RELATE](#) (page 23-4), and use [SDO\\_WITHIN\\_DISTANCE](#) (page 18-36) instead of [SDO\\_GEOM.WITHIN\\_DISTANCE](#) (page 23-58).
- With operators, always specify TRUE in uppercase. That is, specify = 'TRUE', and do not specify <> 'FALSE' or = 'true'.
- With operators, use the /\*+ ORDERED \*/ optimizer hint if the query window comes from a table. (You must use this hint if multiple windows come from a

table.) See the Usage Notes and Examples for specific operators for more information.

For information about using operators with topologies, see *Oracle Spatial and Graph Topology Data Model and Network Data Model Graph Developer's Guide*.

## 1.10 Spatial Aggregate Functions

SQL has long had aggregate functions, which are used to aggregate the results of a SQL query. The following example uses the SUM aggregate function to aggregate employee salaries by department:

```
SELECT SUM(salary), dept
FROM employees
GROUP BY dept;
```

Spatial aggregate functions aggregate the results of SQL queries involving geometry objects. Spatial aggregate functions return a geometry object of type SDO\_GEOMETRY. For example, the following statement returns the minimum bounding rectangle of all geometries in a table (using the definitions and data from [Simple Example: Inserting, Indexing, and Querying Spatial Data](#) (page 2-1)):

```
SELECT SDO_AGGR_MBR(shape) FROM cola_markets;
```

The following example returns the union of all geometries except cola\_d:

```
SELECT SDO_AGGR_UNION(SDOAGGRTYPE(c.shape, 0.005))
FROM cola_markets c WHERE c.name <> 'cola_d';
```

For reference information about the spatial aggregate functions and examples of their use, see [Spatial Aggregate Functions](#) (page 19-1).

---

---

### Note:

Spatial aggregate functions are supported for two-dimensional geometries only, except for [SDO\\_AGGR\\_MBR](#) (page 19-6), which is supported for both two-dimensional and three-dimensional geometries.

---

---

### 1.10.1 SDOAGGRTYPE Object Type

Many spatial aggregate functions accept an input parameter of type SDOAGGRTYPE. Oracle Spatial and Graph defines the object type SDOAGGRTYPE as:

```
CREATE TYPE sdoaggrtype AS OBJECT (
  geometry SDO_GEOMETRY,
  tolerance NUMBER);
```

---

---

### Note:

Do not use SDOAGGRTYPE as the data type for a column in a table. Use this type only in calls to spatial aggregate functions.

---

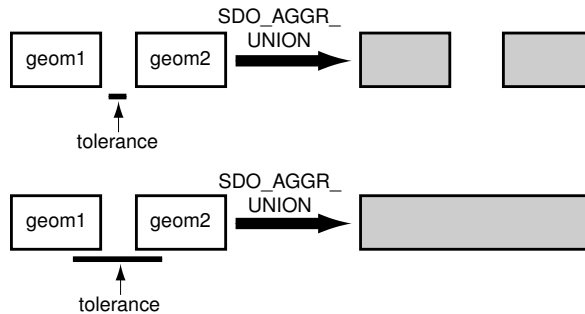
---

The tolerance value in the SDOAGGRTYPE definition should be the same as the SDO\_TOLERANCE value specified in the DIMINFO column in the xxx\_SDO\_GEOM\_METADATA views for the geometries, unless you have a specific reason for wanting a different value. For more information about tolerance, see

[Tolerance](#) (page 1-6); for information about the xxx\_SDO\_GEOM\_METADATA views, see [Geometry Metadata Views](#) (page 2-47).

The tolerance value in the SDOAGGRTYPE definition can affect the result of a spatial aggregate function. [Figure 1-8](#) (page 1-16) shows a spatial aggregate union ([SDO\\_AGGR\\_UNION](#) (page 19-9)) operation of two geometries using two different tolerance values: one smaller and one larger than the distance between the geometries.

**Figure 1-8 Tolerance in an Aggregate Union Operation**



In the first aggregate union operation in [Figure 1-8](#) (page 1-16), where the tolerance is less than the distance between the rectangles, the result is a compound geometry consisting of two rectangles. In the second aggregate union operation, where the tolerance is greater than the distance between the rectangles, the result is a single geometry.

## 1.11 Three-Dimensional Spatial Objects

Oracle Spatial and Graph supports the storage and retrieval of three-dimensional spatial data, which can include points, point clouds (collections of points), lines, polygons, surfaces, and solids. [Table 1-1](#) (page 1-16) shows the SDO\_GTYPE and element-related attributes of the SDO\_GEOMETRY type that are relevant to three-dimensional geometries. (The SDO\_GEOMETRY type is explained in [SDO\\_GEOMETRY Object Type](#) (page 2-5).)

**Table 1-1 SDO\_GEOMETRY Attributes for Three-Dimensional Geometries**

Type of 3-D Data	SDO_GTYPE	Element Type, Interpretation in SDO_ELEM_INFO
Point	3001	Does not apply. Specify all 3 dimension values in the SDO_POINT_TYPE attribute.
Line	3002	2, 1
Polygon	3003	1003, 1: planar exterior polygon 2003, 1: planar interior polygon 1003, 3: planar exterior rectangle 2003, 3: planar interior rectangle

**Table 1-1 (Cont.) SDO\_GEOMETRY Attributes for Three-Dimensional Geometries**

Type of 3-D Data	SDO_GTYPE	Element Type, Interpretation in SDO_ELEM_INFO
Surface	3003	1006, 1: surface (followed by element information for the polygons)
Collection	3004	Same considerations as for two-dimensional
Multipoint (point cloud)	3005	1, $n$ (where $n$ is the number of points)
Multiline	3006	2, 1 (same as for Line)
Multisurface	3007	Element definitions for one or more surfaces
Solid	3008	Simple solid formed by a single closed surface: one element type 1007, followed by one element type 1006 (the external surface) and optionally one or more element type 2006 (internal surfaces)  Composite solid formed by multiple adjacent simple solids: one element type 1008 (holding the count of simple solids), followed by any number of element type 1007 (each describing one simple solid)
Multisolid	3009	Element definitions for one or more simple solids (element type 1007) or composite solids (element type 1008)

The following spatial operators consider all three dimensions in their computations:

- [SDO\\_ANYINTERACT](#) (page 18-2)
- [SDO\\_FILTER](#) (page 18-8)
- [SDO\\_INSIDE](#) (page 18-11) (for solid geometries only)
- [SDO\\_NN](#) (page 18-17)
- [SDO\\_WITHIN\\_DISTANCE](#) (page 18-36)

The other operators consider only the first two dimensions. For some of preceding operators the height information is ignored when dealing with geodetic data, as explained later in this section. (Spatial operators are described in [Spatial Operators](#) (page 18-1).)

The [SDO\\_GEOM.SDO\\_VOLUME](#) (page 23-46) function applies only to solid geometries, which are by definition three-dimensional; however, this function cannot be used with geodetic data. (This function is described in [SDO\\_GEOM Package \(Geometry\)](#) (page 23-1).) For information about support for three-dimensional geometries with other SDO\_GEOM subprograms, see the usage information after [Table 23-1](#) (page 23-1).

For distance computations with three-dimensional geometries:

- If the data is geodetic (geographic 3D), the distance computations are done on the geodetic surface.
- If the data is non-geodetic (projected or local), the distance computations are valid only if the unit of measure is the same for all three dimensions.

To have any functions, procedures, or operators consider all three dimensions, you must specify `PARAMETERS ('sdo_indx_dims=3')` in the [CREATE INDEX](#) (page 17-7) statement when you create the spatial index on a spatial table containing Geographic3D data (longitude, latitude, ellipsoidal height). If you do not specify that parameter in the [CREATE INDEX](#) (page 17-7) statement, a two-dimensional index is created.

For spatial functions, procedures, and operators that consider all three dimensions, distance and length computations correctly factor in the height or elevation. For example, consider two three-dimensional points, one at the origin of a Cartesian space (0,0,0), and the other at X=3 on the Y axis and a height (Z) of 4 (3,0,4).

- If the operation considers all three dimensions, the distance between the two points is 5. (Think of the hypotenuse of a 3-4-5 right triangle.)
- If the operation considers only two dimensions, the distance between the two points is 3. (That is, the third dimension, or height, is ignored.)

However, for the following operators and subprograms, when dealing with geodetic data, the distances with three-dimensional geometries are computed between the "ground" representations (for example, the longitude/latitude extent of the footprint of a building), and the height information is approximated:

- [SDO\\_NN](#) (page 18-17) operator
- [SDO\\_WITHIN\\_DISTANCE](#) (page 18-36) operator
- [SDO\\_GEOM.SDO\\_DISTANCE](#) (page 23-25) function
- [SDO\\_GEOM.WITHIN\\_DISTANCE](#) (page 23-58) function

For a two-dimensional query window with three-dimensional data, you can use the [SDO\\_FILTER](#) (page 18-8) operator, but not any other spatial operators.

For examples of creating different types of three-dimensional spatial geometries, see [Three-Dimensional Geometry Types](#) (page 2-38). That section also includes an example showing how to update the spatial metadata and create spatial indexes for three-dimensional geometries.

For information about support for three-dimensional coordinate reference systems, see [Three-Dimensional Coordinate Reference System Support](#) (page 6-9).

Three-dimensional support does not apply to many spatial aggregate functions and PL/SQL packages and subprograms. The following are supported for two-dimensional geometries only:

- Spatial aggregate functions, except for [SDO\\_AGGR\\_MBR](#) (page 19-6), which is supported for both two-dimensional and three-dimensional geometries.
- SDO\_GEOM (geometry) subprograms, except for the following, which are supported for both two-dimensional and three-dimensional geometries:
  - [SDO\\_GEOM.RELATE](#) (page 23-4) with the ANYINTERACT mask
  - [SDO\\_GEOM.SDO\\_AREA](#) (page 23-9)
  - [SDO\\_GEOM.SDO\\_DISTANCE](#) (page 23-25)
  - [SDO\\_GEOM.SDO\\_LENGTH](#) (page 23-28)
  - [SDO\\_GEOM.SDO\\_MAX\\_MBR\\_ORDINATE](#) (page 23-30)
  - [SDO\\_GEOM.SDO\\_MBR](#) (page 23-38)
  - [SDO\\_GEOM.SDO\\_MIN\\_MBR\\_ORDINATE](#) (page 23-40)
  - [SDO\\_GEOM.SDO\\_VOLUME](#) (page 23-46)
  - [SDO\\_GEOM.VALIDATE\\_GEOMETRY\\_WITH\\_CONTEXT](#) (page 23-52)
  - [SDO\\_GEOM.VALIDATE\\_LAYER\\_WITH\\_CONTEXT](#) (page 23-56)
  - [SDO\\_GEOM.WITHIN\\_DISTANCE](#) (page 23-58)
- SDO\_SAM (spatial analysis and mining) subprograms
- [SDO\\_MIGRATE.TO\\_CURRENT](#) (page 25-1) procedure

[Table 1-2](#) (page 1-19) describes how Oracle Spatial and Graph internally performs certain *geodetic* three-dimensional calculations.

**Table 1-2 How Geodetic 3D Calculations Are Performed**

Type of Calculation	Internal Calculations Performed
ANYINTERACT	The input geometries are transformed using Gnomonic transformation; then the ANYINTERACT relationship is computed with the resulting geometries.
Area	The input geometry is projected onto a local tangent plane; then the area is computed with the resulting input geometry.
Distance or Length	The 2D precise ellipsoidal distance is computed using the longitude/latitude of the two closest points of approach; then the height or length difference is included using an approximation.
Volume	The input geometry is projected onto a local tangent plane; then the volume is computed with the resulting input geometry.

### 1.11.1 Modeling Surfaces

A surface contains an area but not a volume, and it can have two or three dimensions. A surface is often constructed by a set of planar regions.

Surfaces can be modeled as surface-type SDO\_GEOMETRY objects or, if they are very large, as SDO\_TIN objects. The surface-type in SDO\_GEOMETRY can be an arbitrary surface defining a contiguous area bounded by adjacent three-dimensional polygons.

The number of polygons in the SDO\_GEOMETRY is limited by the number of ordinates that can be in the SDO\_ORDINATES\_ARRAY. An SDO\_TIN object, on the other hand, models the surface as a network of triangles with no explicit limit on the number of triangles.

Surfaces are stored as a network of triangles, called triangulated irregular networks, or TINs. The TIN model represents a surface as a set of contiguous, non-overlapping triangles. Within each triangle the surface is represented by a plane. The triangles are made from a set of points called mass points. If mass points are carefully selected, the TIN represents an accurate representation of the model of the surface. Well-placed mass points occur where there is a major change in the shape of the surface, for example, at the peak of a mountain, the floor of a valley, or at the edge (top and bottom) of cliffs.

TINs are generally computed from a set of three-dimensional points specifying coordinate values in the longitude (x), latitude (y), and elevation (z) dimensions. Oracle TIN generation software uses the Delaunay triangulation algorithm, but it is not required that TIN data be formed using only Delaunay triangulation techniques.

The general process for working with a TIN is as follows:

1. Initialize the TIN, using the [SDO\\_TIN\\_PKG.INIT](#) (page 29-5) function.
2. Create the TIN, using the [SDO\\_TIN\\_PKG.CREATE\\_TIN](#) (page 29-3) procedure.
3. As needed for queries, clip the TIN, using the [SDO\\_TIN\\_PKG.CLIP\\_TIN](#) (page 29-1) function.
4. If necessary, use the [SDO\\_TIN\\_PKG.TO\\_GEOMETRY](#) (page 29-10) function (for example, to convert the result of a clip operation into a single SDO\_GEOMETRY object).

The PL/SQL subprograms for working with TINs are described in [SDO\\_TIN\\_PKG Package \(TINs\)](#) (page 29-1).

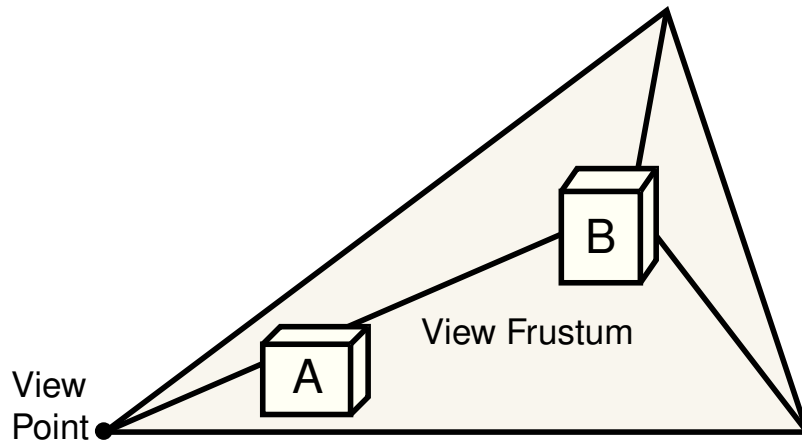
For a Java example of working with TINs, see the following files:

```
$ORACLE_HOME/md/demo/TIN/examples/java/README.txt  
$ORACLE_HOME/md/demo/TIN/examples/java/readTIN.java
```

## 1.11.2 Modeling Solids

The simplest types of solids can be represented as cuboids, such as a cube or a brick. A more complex solid is a **frustum**, which is a pyramid formed by cutting a larger pyramid (with three or more faces) by a plane parallel to the base of that pyramid. Frustums are sometimes used as query windows to spatial operators. Frustums and cubes are typically modeled as solid-type SDO\_GEOMETRY objects. [Figure 1-9](#) (page 1-21) shows a frustum as a query window, with two spatial objects at different distances from the view point.



**Figure 1-9 Frustum as Query Window for Spatial Objects**

**Point clouds**, which are large collections of points, can sometimes be used to model the shape or structure of solid and surface geometries. Most applications that use point cloud data contain queries based on location. Applications can also go outside Spatial and Graph to add visibility logic to perform queries based on both location and visibility.

Most applications that use point cloud data seek to minimize data transfer by retrieving objects based on their distance from a view point. For example, in [Figure 1-9](#) (page 1-21), object B is farther from the view point than object A, and therefore the application might retrieve object A in great detail (high resolution) and object B in less detail (low resolution). In most scenarios, the number of objects or points increases significantly as the distance from the view point increases; and if farther objects are retrieved at lower resolutions than nearer objects, the number of bytes returned by the query and the rendering time for the objects decrease significantly.

For storage of point cloud data, you can use either an SDO\_PC object or is a flat table. The approach to use depends on your hardware environment and usage patterns. An advantage of the flat format is its efficient and dynamic nature, because updates to the point data do not require reblocking.

The general process for working with a point cloud is as follows, depending on whether the point cloud data will be stored in an SDO\_PC object or in a flat table.

- To use point cloud data stored as an SDO\_PC object:
  1. Initialize the point cloud, using the [SDO\\_PC\\_PKG.INIT](#) (page 27-10) function.
  2. Create the point cloud, using the [SDO\\_PC\\_PKG.CREATE\\_PC](#) (page 27-7) procedure.
  3. As needed for queries, clip the point cloud, using the [SDO\\_PC\\_PKG.CLIP\\_PC](#) (page 27-1) function.
  4. If necessary, use the [SDO\\_PC\\_PKG.TO\\_GEOMETRY](#) (page 27-13) function (for example, to convert the result of a clip operation into a single SDO\_GEOMETRY object).
- To use point cloud data stored in a flat table:
  1. Create the table (or a view based on an appropriate table) for the point cloud data.

Each row will contain the values of the first three spatial dimensions of a point, and optionally values for nonspatial dimensions. The table or view definition must start with the following columns: VAL\_D1 NUMBER, VAL\_D2 NUMBER, VAL\_D3 NUMBER. It can also contain columns for point cloud nonspatial dimensions.

2. Populate the table with point data.
3. As needed for queries, clip the point cloud, using the [SDO\\_PC\\_PKG.CLIP\\_PC\\_FLAT](#) (page 27-3) function.

The PL/SQL subprograms for working with point clouds are described in [SDO\\_PC\\_PKG Package \(Point Clouds\)](#) (page 27-1).

For a Java example of working with point clouds, see the following files:

```
$ORACLE_HOME/md/demo/PointCloud/examples/java/README.txt  
$ORACLE_HOME/md/demo/PointCloud/examples/java/readPointCloud.java
```

### 1.11.3 Three-Dimensional Optimized Rectangles

Instead of specifying all the vertices for a three-dimensional rectangle (a polygon in the shape of rectangle in three-dimensional space), you can represent the rectangle by specifying just the two corners corresponding to the minimum ordinate values (*min-corner*) and the maximum ordinate values (*max-corner*) for the X, Y, and Z dimensions.

The orientation of a three-dimensional rectangle defined in this way is as follows:

- If the rectangle is specified as *<min-corner, max-corner>*, the normal points in the positive direction of the perpendicular third dimension.
- If the rectangle is specified as *<max-corner, min-corner>*, the normal points in the negative direction of the perpendicular third dimension.

For example, if the rectangle is in the XY plane and the order of the vertices is *<min-corner, max-corner>*, the normal is along the positive Z-axis; but if the order is *<max-corner, min-corner>*, the normal is along the negative Z-axis.

Using these orientation rules for rectangles, you can specify the order of the *min-corner* and *max-corner* vertices for a rectangle appropriately so that the following requirements are met:

- The normal for each polygon in a solid always points outward from the solid when the rectangle is part of the solid.
- An inner rectangle polygon is oriented in the reverse direction as its outer when the rectangle is part of a surface.

### 1.11.4 Using Texture Data

---

**Note:**

This section describes concepts that you will need to understand for using texture data with Spatial and Graph. However, the texture metadata is not yet fully implemented in Oracle Spatial and Graph, and a viewer is not yet supported. This section will be updated when texture support is released.

---

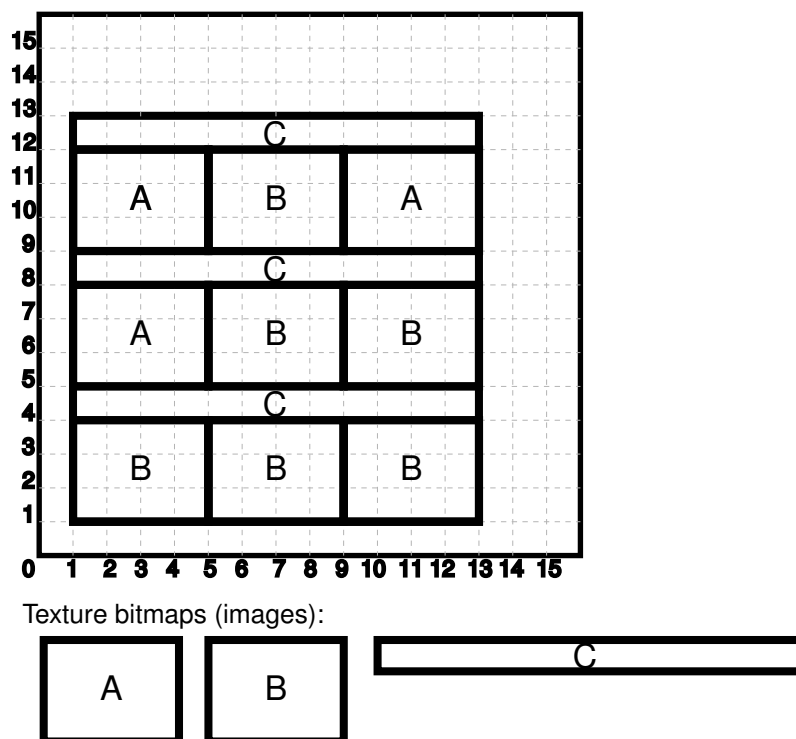
A **texture** is an image that represents one or more parts of a feature. Textures are commonly used with visualizer applications (viewers) that display objects stored as spatial geometries. For example, a viewer might display an office building (three-dimensional solid) using textures, to allow a more realistic visualization than using just colors. Textures can be used with two-dimensional and three-dimensional geometries.

In the simplest case, a rectangular geometry can be draped with a texture bitmap. However, often only a subregion of a texture bitmap is used, as in the following example cases:

- If the texture bitmap contains multiple sides of the same building, as well as the roof and roof gables. In this case, each bitmap portion is draped over one of the geometry faces.
- If the texture bitmap represents a single panel or window on the building surface, and a geometric face represents a wall with 15 such panels or windows (five on each of three floors). In this case, the single texture bitmap is tiled 15 times over the face.
- If the face is non-rectangular sub-faces, such as roof gables. In this case, only a portion (possible triangular) of the texture bitmap is used.

Figure 1-10 (page 1-23) shows a large rectangular surface that, when viewed, appears to consist of three textures, each of which is repeated multiple times in various places on the surface.

**Figure 1-10 Faces and Textures**



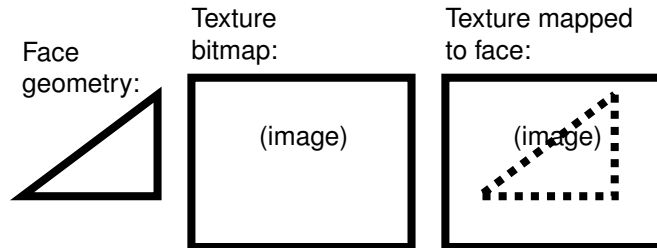
As shown in [Figure 1-10](#) (page 1-23):

- The entire image is a large surface that consists of 12 smaller rectangular faces (surface geometries), each of which can be represented by one of three images (labeled A, B, and C).

- Three texture bitmaps (labeled A, B, and C) can be used to visualize all of the faces. In this case, bitmap A is used 3 times, bitmap B is used 6 times, and bitmap C is used 3 times.

[Figure 1-11](#) (page 1-24) shows a texture bitmap mapped to a triangular face.

**Figure 1-11 Texture Mapped to a Face**



As shown in [Figure 1-11](#) (page 1-24):

- The face (surface geometry) is a triangle. (For example, a side or roof of a building may contain several occurrences of this face.)
- The texture bitmap (image) is a rectangle, shown in the box in the middle.
- A portion of the texture bitmap represents an image of the face. This portion is shown by a dashed line in the box on the right.

In your application, you will need to specify coordinates within the texture bitmap to map the appropriate portion to the face geometry.

To minimize the storage requirements for image data representing surfaces, you should store images for only the distinct textures that will be needed. The data type for storing a texture is `SDO_ORDINATE_ARRAY`, which is used in the `SDO_GEOMETRY` type definition (explained in [SDO\\_GEOMETRY Object Type](#) (page 2-5)).

For example, assume that the large surface in [Figure 1-10](#) (page 1-23) has the following definition:

```
SDO_GEOMETRY(
  2003, -- two-dimensional polygon
  NULL,
  NULL,
  SDO_ELEM_INFO_ARRAY(1,1003,1), -- one polygon (exterior polygon ring)
  SDO_ORDINATE_ARRAY(1,1. 1,13, 13,13, 1,13, 1,1)
)
```

Assume that you have a `MY_TEXTURE_COORDINATES` table with the following definition:

```
CREATE TABLE my_texture_coordinates (
  texture_coord_id NUMBER PRIMARY KEY,
  texture_name VARCHAR2(32),
  texture_coordinates SDO_ORDINATE_ARRAY);
```

[Example 1-1](#) (page 1-25) inserts three texture coordinate definitions into this table. For each texture, its coordinates reflect one of the appropriate smaller rectangles shown in [Figure 1-10](#) (page 1-23); however, you can choose any one of the appropriate rectangles for each texture. In [Example 1-1](#) (page 1-25), the `SDO_ORDINATE_ARRAY` definitions for each texture reflect a polygon near the top of [Figure 1-10](#) (page 1-23).

**Example 1-1 Inserting Texture Coordinate Definitions**

```

INSERT INTO my_texture_coordinates VALUES(
  1,
  'Texture_A',
  SDO_ORDINATE_ARRAY(1,9, 1,5, 5,12, 1,12, 1,9)
);

INSERT INTO my_texture_coordinates VALUES(
  2,
  'Texture_B',
  SDO_ORDINATE_ARRAY(5,9, 9,9, 9,12, 5,12, 5,9)
);

INSERT INTO my_texture_coordinates VALUES(
  3,
  'Texture_C',
  SDO_ORDINATE_ARRAY(1,12, 13,12, 13,13, 1,13, 1,12)
);

```

**1.11.4.1 Schema Considerations with Texture Data**

Texture bitmaps (stored as BLOBs or as URLs in VARCHAR2 format) and texture coordinate arrays (stored using type SDO\_ORDINATE\_ARRAY) can be stored in the same table as the SDO\_GEOMETRY column or in separate tables; however, especially for the texture bitmaps, it is usually better to use separate tables. Texture bitmaps are likely to be able to be shared among features (such as different office buildings), but texture coordinate definitions are less likely to be sharable among features. (For example, many office buildings may share the same general type of glass exterior, but few of the buildings have the same number of windows and floors. In designing your textures and applications, you must consider how many buildings use the same texture subregion or drape the texture in the same size of repetitive matrix.)

An exception is a texture coordinate array that drapes an entire texture bitmap over a rectangular geometric face. In this case, the texture coordinate array can be specified as (0,0, 1,0, 1,1, 0,1, 1,1), defined by vertices "lower left", "lower right", "upper right", "upper left", and closing with "lower left". Many data sets use this texture coordinate array extensively, because they have primarily rectangular faces and they store one facade for each texture bitmap.

If you used separate tables, you could link them to the surface geometries using foreign keys, as in [Example 1-2](#) (page 1-25).

**Example 1-2 Creating Tables for Texture Coordinates, Textures, and Surfaces**

```

-- One row for each texture coordinates definition.
CREATE TABLE my_texture_coordinates (
  texture_coord_id NUMBER PRIMARY KEY,
  texture_coordinates SDO_ORDINATE_ARRAY);

-- One row for each texture.
CREATE TABLE my_textures(
  texture_id NUMBER PRIMARY KEY,
  texture BLOB);

-- One row for each surface (each individual "piece" of a
-- potentially larger surface).
CREATE TABLE my_surfaces(
  surface_id NUMBER PRIMARY KEY,
  surface_geometry SDO_GEOMETRY,
  texture_id NUMBER,

```

```
texture_coord_id NUMBER,  
CONSTRAINT texture_id_fk  
    FOREIGN KEY (texture_id) REFERENCES my_textures(texture_id),  
CONSTRAINT texture_coord_id_fk  
    FOREIGN KEY (texture_coord_id) REFERENCES  
        my_texture_coordinates(texture_coord_id));
```

### 1.11.5 Validation Checks for Three-Dimensional Geometries

The [SDO\\_GEOM.VALIDATE\\_GEOMETRY\\_WITH\\_CONTEXT](#) (page 23-52) and [SDO\\_GEOM.VALIDATE\\_LAYER\\_WITH\\_CONTEXT](#) (page 23-56) subprograms can validate two-dimensional and three-dimensional geometries. For a three-dimensional geometry, these subprograms perform any necessary checks on any two-dimensional geometries (see the Usage Notes for [SDO\\_GEOM.VALIDATE\\_GEOMETRY\\_WITH\\_CONTEXT](#) (page 23-52)) within the overall three-dimensional geometry, but also several checks specific to the three-dimensional nature of the overall object.

For a simple solid (one outer surface and any number of inner surfaces), these subprograms perform the following checks:

- Closedness: The solid must be closed.
- Reachability: Each face of a solid must have a full-edge intersection with its neighboring faces, and all faces must be reachable from any face. (However, inner shells are ignored, because inner shells can, by definition, be not connected to the other shells.)
- Inner-outer disjointedness: An inner surface must not intersect the outer surface at more than a point or a line; that is, there must be no overlapping areas with inner surfaces.
- No surface patch: No additional surfaces can be defined on the surfaces that make up the solid.
- Orientation: For all surfaces, the vertices must be aligned so that the normal vector (or surface normal, or "the normal") points to the outside of (away from) the outer solid. Thus, the volume of the outer solid must be greater than zero, and the volume of any inner solid must be less than zero.

For a composite solid (one or more solids connected to each other), these subprograms perform the following checks:

- Connectedness: All solids of a composite solid must share at least one face.
- Zero-volume intersections: Any intersections of the solids in a composite solid must have a volume of zero.

For a multisolid (one or more solids, each of which is a simple or composite solid), these subprograms perform the following check:

- Disjointedness: Any two solids of a multisolid can share points or lines, but must not intersect in any other manner.

## 1.12 Geocoding

**Geocoding** is the process of converting tables of address data into standardized address, location, and possibly other data. The result of a geocoding operation includes the pair of longitude and latitude coordinates that correspond with the input

address or location. For example, if the input address is *22 Monument Square, Concord, MA 01742*, the longitude and latitude coordinates in the result of the geocoding operation may be (depending on the geocoding data provider) -71.34937 and 42.46101, respectively.

Given a geocoded address, you can perform proximity or location queries using a spatial engine, such as Oracle Spatial and Graph, or demographic analysis using tools and data from Oracle's business partners. In addition, you can use geocoded data with other spatial data such as block group, postal code, and county code for association with demographic information. Results of analyses or queries can be presented as maps, in addition to tabular formats, using third-party software integrated with Oracle Spatial and Graph.

For conceptual and usage information about the geocoding capabilities of Oracle Spatial and Graph, see [Geocoding Address Data](#) (page 11-1). For reference information about the MDSYS.SDO\_GCDR PL/SQL package, see [SDO\\_GCDR Package \(Geocoding\)](#) (page 22-1).

## 1.13 NURBS Curve Support in Oracle Spatial and Graph

Spatial and Graph supports non-uniform rational B-spline (NURBS) curve geometries. NURBS curves allow representation of free-form shapes with arbitrary shapes. NURBS representation allows control over the shape of the curve because control points and knots guide the shape of the curve, and they allow complex shapes to be represented with little data.

Support for NURBS curves in Spatial and Graph includes the following:

- WKT/WKB and GML functions for loading and storing of NURBS curve geometries in Oracle Spatial and Graph.
- Validation of NURBS curve geometries.
- Spatial indexing of NURBS curve geometries along with the SDO\_FILTER, SDO\_RELATE, and other operators. Spatial operators use an approximation of the curve for computation.

A NURBS representation requires specification of the control points and the basis functions. The basis functions, in turn, are defined using the knot vector and the degree of the curve. The control points are used to determine the shape of the NURBS curve. The knot vector does not directly control the shape of the curve, but is used to control the exact placement of end points. The knot vector is also used to create curves with kinks and corners. Non-uniform knot vectors are used for manipulating the curve.

To represent a NURBS curve, the following data must be stored: the control points, the knot vector, and the degree of the curve. The set of control points can be represented in either the Euclidean form as  $(x, y, z, w)$  where  $w$  represents the weight of the control point or in the homogeneous form as  $(wx, wy, wz, w)$ . If  $w_i=1$  for all  $i$ , the curve is non-rational. The control points are specified in the weighted Euclidean form. Basis functions can be uniform or non-uniform based on the knot vector. A non-uniform knot vector is useful for placement of end points and creating kinks or corners. A normalized knot vector must be specified, that is, the first knot in the knot vector must be zero and the last knot in the knot vector must be one. It is also required that the knot vector is "clamped" at the end points. This requirement is enforced by ensuring that the first  $d+1$  values in the knot vector are all zeros and the last  $d+1$  values are all ones, where  $d$  represents the degree of the NURBS curve.



The implementation of NURBS curves in Oracle Spatial and Graph follows the SQL/MM standards. The SQL/MM standards for NURBS curves are used to represent splines, polynomial splines, cubic splines, B-splines, and Bezier curves. In Oracle Spatial and Graph, the SDO\_GEOMETRY object type is used for NURBS representation. NURBS curves can be included in the Line, Multiline, and Collection type geometry objects. In these geometries, the simple line string and compound line string type elements can contain NURBS.

For compound line strings containing at least one NURBS segment, the last point of the previous segment is the same as the "clamped" first control point of a NURBS segment, and the last "clamped" control point of a NURBS segment is the same as the first point of the next segment. That is, the vertices will be repeated.

For geometry elements with element type value 2 representing a line string, the interpretation value of 3 is used to represent a NURBS curve; interpretation values of 1 and 2 represent linear segments and arcs. The SDO\_ELEM\_INFO\_ARRAY for a NURBS curve is stored as (*offset*, 2, 3), which represents the offset, element type, and the interpretation value.

The SDO\_ORDINATE\_ARRAY stores the degree of the curve  $d$ , the set of  $m$  control points and a knot vector of size  $n$ . So, the ordinate array is stored as a sequence of values ( $d, m, x_1, y_1, z_1, w_1, \dots, x_m, y_m, z_m, w_m, n, k_1, \dots, k_n$ ). The control points are stored in the Euclidean form as specified in the SQL/MM standards. Note that for a NURBS curve the number of knots is equal to the sum of the degree, the number of control points, and 1. Therefore,  $n = d + m + 1$ , an equation which is useful for validating NURBS curve geometries.

The following considerations apply to defining a NURBS curve:

- The degree of the curve should be greater than 1, because a curve of degree 1 represents polylines.
- The number of control points must be greater than or equal to 3, and must be greater than the degree.
- The number of knots must be equal to the (number of control points + degree + 1).
- The weight component of each control point must be positive.
- Control points are represented in "weighted Euclidean" form  $[wx, wy, (wz), w]$ .
- Knot values should be specified in non-decreasing order, and the knot vector must be a normalized knot vector  $[0, \dots, 1]$ .
- If  $d$  is the degree of the curve, there must be  $d+1$  consecutive equal knots at the beginning of the curve (value 0) and  $d+1$  consecutive equal knots at the end of the curve (value 1). This is to ensure that the curve is clamped at the end points.
- If  $d$  is the degree of the curve, there must not be more than  $d$  consecutive equal knots except at the beginning or end of the curve where  $d+1$  knots must be present.

Be sure to validate geometries with NURBS segments before creating the spatial index or performing any spatial operations on them. (This recommendation applies to all geometry types, NURBS or otherwise.)

For examples that specify NURBS curve geometries, see [NURBS Curve](#) (page 2-32).

To get a line string geometry that is an approximation of an input NURBS curve geometry, use the [SDO\\_UTIL.GETNURBSAPPROX](#) (page 31-38) function.



## 1.14 Spatial and Graph Java Application Programming Interface

Oracle Spatial and Graph provides a Java application programming interface (API) that includes the following packages:

- `oracle.spatial.geometry` provides support for the Spatial and Graph SQL SDO\_GEOMETRY data type, which is documented in this guide.
- `oracle.spatial.georaster` provides support for the core GeoRaster features, which are documented in *Oracle Spatial and Graph GeoRaster Developer's Guide*.
- `oracle.spatial.georaster.image` provides support for generating Java images from a GeoRaster object or subset of a GeoRaster object, and for processing the images. These features are documented in *Oracle Spatial and Graph GeoRaster Developer's Guide*.
- `oracle.spatial.georaster.sql` provides support for wrapping the GeoRaster PL/SQL API, which is documented in *Oracle Spatial and Graph GeoRaster Developer's Guide*.
- `oracle.spatial.network` provides support for the Oracle Spatial and Graph Network Data Model Graph, which is documented in *Oracle Spatial and Graph Topology Data Model and Network Data Model Graph Developer's Guide*.
- `oracle.spatial.network.lod` provides support for the load-on-demand (LOD) approach of network analysis in the Oracle Spatial and Graph Network Data Model Graph, which is documented in *Oracle Spatial and Graph Topology Data Model and Network Data Model Graph Developer's Guide*.
- `oracle.spatial.network.lod.config` provides support for the configuration of load-on-demand (LOD) network analysis in the Oracle Spatial and Graph Network Data Model Graph, which is documented in *Oracle Spatial and Graph Topology Data Model and Network Data Model Graph Developer's Guide*.
- `oracle.spatial.topo` provides support for the Oracle Spatial and Graph topology data model, which is documented in *Oracle Spatial and Graph Topology Data Model and Network Data Model Graph Developer's Guide*.
- `oracle.spatial.util` provides classes that perform miscellaneous operations.

For detailed reference information about the classes and interfaces in these packages, see *Oracle Spatial and Graph Java API Reference* (Javadoc).

The Spatial and Graph Java class libraries are in `.jar` files under the `<ORACLE_HOME>/md/jlib/` directory.

## 1.15 Predefined User Accounts Created by Spatial and Graph

During installation, Spatial and Graph creates user accounts that have the minimum privileges needed to perform their jobs. These accounts are created locked and expired; so if you need to use the accounts, you must unlock them. [Table 1-3](#) (page 1-30) lists the predefined user accounts created by Spatial and Graph.

**Table 1-3 Predefined User Accounts Created by Spatial and Graph**

User Account	Description
MDDATA	The schema used by Oracle Spatial and Graph for storing data used by geocoding and routing applications. This is the default schema for Oracle software that accesses geocoding and routing data.
SPATIAL_CSW_ADMIN_USR	The Catalog Services for the Web (CSW) account. It is used by the Oracle Spatial and Graph CSW cache manager to load all record type metadata and all record instances from the database into main memory for the record types that are cached.
SPATIAL_WFS_ADMIN_USR	The Web Feature Service (WFS) account. It is used by the Oracle Spatial and Graph WFS cache manager to load all feature type metadata and all feature instances from the database into main memory for the feature types that are cached.

For information about Oracle Database predefined user accounts, including how to secure these accounts, see *Oracle Database 2 Day + Security Guide*.

## 1.16 Performance and Tuning Information

Many factors can affect the performance of Oracle Spatial and Graph applications, such as the use of optimizer hints to influence the plan for query execution. This guide contains some information about performance and tuning where it is relevant to a particular topic. For example, [R-Tree Quality](#) (page 1-11) discusses R-tree quality and its possible effect on query performance, and [Spatial Operators\\_ Procedures\\_ and Functions](#) (page 1-14) explains why spatial operators provide better performance than procedures and functions.

In addition, more spatial performance and tuning information is available in one or more white papers through the Oracle Technology Network (OTN). That information is often more detailed than what is in this guide, and it is periodically updated as a result of internal testing and consultations with Spatial and Graph users. To find that information on the OTN, go to

<http://www.oracle.com/technetwork/database/options/spatialandgraph/>

Look for material relevant to spatial performance and tuning.

## 1.17 OGC and ISO Compliance

Oracle Spatial and Graph is conformant with Open Geospatial Consortium (OGC) Simple Features Specification 1.1.1 (Document 99-049), starting with Oracle Database release 10g (version 10.1.0.4). Conformance with the Geometry Types Implementation means that Oracle Spatial and Graph supports all the types, functions, and language constructs detailed in Section 3.2 of the specification.

Synonyms are created to match all OGC function names except for `X(p Point)` and `Y(p Point)`. For these functions, you must use the names `OGC_X` and `OGC_Y` instead of just `X` and `Y`.

Oracle Spatial and Graph is conformant with the following International Organization for Standardization (ISO) standards:

- ISO 13249-3 SQL Multimedia and Application Packages - Part 3: Spatial
- ISO 19101: Geographic information - Reference model (definition of terms and approach)
- ISO 19109: Geographic information - Rules for application schema (called the General Feature Model)
- ISO 19111: Geographic information - Spatial referencing by coordinates (also OGC Abstract specification for coordinate reference systems)
- ISO 19118: Geographic information - Encoding (GML 2.1 and GML 3.1.1)
- ISO 19107: Geographic information - Spatial schema (also OGC Abstract specification for Geometry)

However, standards compliance testing for Oracle Spatial and Graph is ongoing, and compliance with more recent versions of standards or with new standards might be announced at any time. For current information about compliance with standards, see <http://www.oracle.com/technetwork/database/options/spatialandgraph/documentation/>.

## 1.18 Spatial and Graph Release (Version) Number

To check which release of Spatial and Graph you are running, use the SDO\_VERSION function. For example:

```
SELECT SDO_VERSION FROM DUAL;
```

```
SDO_VERSION
```

```
-----  
12.1.0.1.0
```

## 1.19 SPATIAL\_VECTOR\_ACCELERATION System Parameter

To accelerate the performance of spatial operators, it is recommended that you enable the Vector Performance Accelerator (VPA) feature by setting the SPATIAL\_VECTOR\_ACCELERATION database system parameter to the value TRUE. (This feature and associated system parameter are authorized for use only by licensed Oracle Spatial and Graph users, and the default value for the parameter is FALSE.)

The benefits of setting the SPATIAL\_VECTOR\_ACCELERATION parameter to TRUE include:

- Improved spatial algorithms for spatial operators and functions
- Metadata caching for all spatial operators and functions, which improves their overall performance
- Metadata caching for all DML operations, which makes insert, update, and delete operations on spatial tables run faster

You can set this parameter for the whole system or for a single session. To set the value for the whole system, do either of the following:

- Enter the following statement from a suitably privileged account:

```
ALTER SYSTEM SET SPATIAL_VECTOR_ACCELERATION = TRUE;
```

- Add the following to the database initialization file (xxxinit.ora):

```
SPATIAL_VECTOR_ACCELERATION = TRUE;
```

To set the value for the current session, enter the following statement from a suitably privileged account:

```
ALTER SESSION SET SPATIAL_VECTOR_ACCELERATION = TRUE;
```

---

**See Also:**

- *Oracle Database Reference* for reference and usage information about the SPATIAL\_VECTOR\_ACCELERATION database initialization parameter
- 

## 1.20 Spatially Enabling a Table

If you have a regular Oracle table without an SDO\_GEOMETRY column, but containing location-related information (such as latitude/longitude values for points), you can *spatially enable* the table by adding an SDO\_GEOMETRY column and using existing (and future) location-related information in records to populate the SDO\_GEOMETRY column values.

The following are the basic steps for spatially enabling a regular table. They assume that the regular table has columns that contain location-related values associated with each record in the table.

1. Alter the table to add a geometry (SDO\_GEOMETRY) column.
2. Update the table to populate the SDO\_GEOMETRY objects using existing location-related data values.
3. Update the spatial metadata (USER\_SDO\_GEOM\_METADATA).
4. Create the spatial index on the table.

### **Example 1-3 Spatially Enabling a Table**

```
-- Original table without a spatial geometry column.
CREATE TABLE city_points (
  city_id NUMBER PRIMARY KEY,
  city_name VARCHAR2(25),
  latitude NUMBER,
  longitude NUMBER);

-- Original data for the table.
-- (The sample coordinates are for a random point in or near the city.)
INSERT INTO city_points (city_id, city_name, latitude, longitude)
VALUES (1, 'Boston', 42.207905, -71.015625);
INSERT INTO city_points (city_id, city_name, latitude, longitude)
VALUES (2, 'Raleigh', 35.634679, -78.618164);
INSERT INTO city_points (city_id, city_name, latitude, longitude)
VALUES (3, 'San Francisco', 37.661791, -122.453613);
INSERT INTO city_points (city_id, city_name, latitude, longitude)
VALUES (4, 'Memphis', 35.097140, -90.065918);

-- Add a spatial geometry column.
ALTER TABLE city_points ADD (shape SDO_GEOMETRY);
```

```

-- Update the table to populate geometry objects using existing
-- latitude and longitude coordinates.
UPDATE city_points SET shape =
  SDO_GEOMETRY(
    2001,
    8307,
    SDO_POINT_TYPE(LONGITUDE, LATITUDE, NULL),
    NULL,
    NULL
  );

-- Update the spatial metadata.
INSERT INTO user_sdo_geom_metadata VALUES (
  'city_points',
  'SHAPE',
  SDO_DIM_ARRAY(
    SDO_DIM_ELEMENT('Longitude',-180,180,0.5),
    SDO_DIM_ELEMENT('Latitude',-90,90,0.5)
  ),
  8307
);

-- Create the spatial index.
CREATE INDEX city_points_spatial_idx on city_points(SHAPE)
  INDEXTYPE IS MDSYS.SPATIAL_INDEX;

-- Later, add new records to the table, using original INSERT format
-- (latitude and longitude, no spatial geometry object data).
-- Then update to include spatial geometry object information.
-- Tip: For efficiency, keep track of existing and new records, and use
-- a WHERE clause to restrict the UPDATE to new records (not shown here).

INSERT INTO city_points (city_id, city_name, latitude, longitude)
  VALUES (5, 'Chicago', 41.848832, -87.648926);
INSERT INTO city_points (city_id, city_name, latitude, longitude)
  VALUES (6, 'Miami', 25.755043, -80.200195);

UPDATE city_points SET shape =
  SDO_GEOMETRY(
    2001,
    8307,
    SDO_POINT_TYPE(LONGITUDE, LATITUDE, NULL),
    NULL,
    NULL
  );

```

[Example 1-3](#) (page 1-32) creates a table (CITY\_POINTS) that initially does not contain an SDO\_GEOMETRY column but does contain latitude and longitude values for each record (a point in or near a specified city). It spatially enables the table, updating the existing records to include the SDO\_GEOMETRY information, and it also inserts new records and updates those.

Notes on [Example 1-3](#) (page 1-32):

- It does not matter that the original table has the LATITUDE and LONGITUDE values in that order, as long as the column names are specified in the correct order in the geometry constructor (SDO\_POINT in this case) in the UPDATE statement. (SDO\_GEOMETRY objects have longitude first, then latitude for points.)

- Geometry validation is not included in the example because validation is not relevant for points. However, if you spatially enable a table with other types of geometries, you should validate all initial and added geometries. (To perform validation, use [SDO\\_GEOM.VALIDATE\\_LAYER\\_WITH\\_CONTEXT](#) (page 23-56) or [SDO\\_GEOM.VALIDATE\\_GEOMETRY\\_WITH\\_CONTEXT](#) (page 23-52).)

## 1.21 Moving Spatial Metadata (MDSYS.MOVE\_SDO)

Database administrators (DBAs) can use the MDSYS.MOVE\_SDO procedure to move all Oracle Spatial and Graph metadata tables to a specified target tablespace. By default, the spatial metadata tables are created in the SYSAUX tablespace in Release 11.1 and later releases, and in the SYSTEM tablespace in releases before 11.1.

The MDSYS.MOVE\_SDO procedure has the following syntax:

```
MDSYS.MOVE_SDO(  
    target_tablespace_name IN VARCHAR2);
```

The required `target_tablespace_name` parameter specifies the name of the tablespace to which to move the spatial metadata tables.

This procedure should be used only by DBAs.

During the move operation, all other Oracle Spatial and Graph capabilities are disabled.

The following example moves the spatial metadata tables to the SYSAUX tablespace.

```
EXECUTE MDSYS.MOVE_SDO('SYSAUX');
```

## 1.22 Spatial Application Hardware Requirement Considerations

This section discusses some general guidelines that affect the amount of disk storage space and CPU power needed for applications that use Oracle Spatial and Graph. These guidelines are intended to supplement, not replace, any other guidelines you use for general application sizing.

The following characteristics of spatial applications can affect the need for storage space and CPU power:

- **Data volumes:** The amount of storage space needed for spatial objects depends on their complexity (precision of representation and number of points for each object). For example, storing one million point objects takes less space than storing one million road segments or land parcels. Complex natural features such as coastlines, seismic fault lines, rivers, and land types can require significant storage space if they are stored at a high precision.
- **Query complexity:** The CPU requirements for simple mapping queries, such as *Select all features in this rectangle*, are lower than for more complex queries, such as *Find all seismic fault lines that cross this coastline*.

## 1.23 Spatial and Graph Error Messages

Spatial and Graph error messages are documented in *Oracle Database Error Messages*.

Oracle error message documentation is only available in HTML. You can browse the error messages by range; and once you find the specific range, use your browser's "find in page" feature to locate the specific message. You can also search for a specific

error message using the error message search feature of the Oracle online documentation.

## 1.24 Spatial Examples

Oracle Spatial and Graph provides examples that you can use to reinforce your learning and to create models for coding certain operations. If you installed the demo files from the Oracle Database Examples media (see *Oracle Database Examples Installation Guide*), several examples are provided in the following directory:

`$ORACLE_HOME/md/demo/examples`

The following files in that directory are helpful for applications that use the Oracle Call Interface (OCI):

- `readgeom.c` and `readgeom.h`
- `writegeom.c` and `writegeom.h`

This guide also includes many examples in SQL and PL/SQL. One or more examples are usually provided with the reference information for each function or procedure, and several simplified examples are provided that illustrate table and index creation, combinations of functions and procedures, and advanced features:

- Inserting, indexing, and querying spatial data ([Simple Example: Inserting, Indexing, and Querying Spatial Data](#) (page 2-1))
- Coordinate systems (spatial reference systems) ([Example of Coordinate System Transformation](#) (page 6-76))
- Linear referencing system (LRS) ([Example of LRS Functions](#) (page 7-15))
- SDO\_GEOMETRY objects in function-based indexes ([SDO\\_GEOMETRY Objects in Function-Based Indexes](#) (page 9-3))
- Complex queries ( [Complex Spatial Queries: Examples](#) (page C-1))

## 1.25 README File for Spatial and Graph and Related Features

A `README.txt` file supplements the information in the following manuals: *Oracle Spatial and Graph Developer's Guide* (this manual), *Oracle Spatial and Graph GeoRaster Developer's Guide*, and *Oracle Spatial and Graph Topology Data Model and Network Data Model Graph Developer's Guide*. This file is located at:

`$ORACLE_HOME/md/doc/README.txt`





---

## Spatial Data Types and Metadata

The spatial features in Oracle Spatial and Graph consist of a set of object data types, type methods, and operators, functions, and procedures that use these types. A geometry is stored as an object, in a single row, in a column of type SDO\_GEOMETRY. Spatial index creation and maintenance is done using basic DDL (CREATE, ALTER, DROP) and DML (INSERT, UPDATE, DELETE) statements.

This chapter starts with a simple example that inserts, indexes, and queries spatial data. You may find it helpful to read this example quickly before you examine the detailed data type and metadata information later in the chapter.

This chapter contains the following major sections:

- [Simple Example: Inserting, Indexing, and Querying Spatial Data](#) (page 2-1)
- [SDO\\_GEOMETRY Object Type](#) (page 2-5)
- [SDO\\_GEOMETRY Methods](#) (page 2-12)
- [SDO\\_GEOMETRY Constructors](#) (page 2-14)
- [TIN-Related Object Types](#) (page 2-15)
- [Point Cloud-Related Object Types](#) (page 2-19)
- [Geometry Examples](#) (page 2-21)
- [Geometry Metadata Views](#) (page 2-47)
- [Other Spatial Metadata Views](#) (page 2-49)
- [Spatial Index-Related Structures](#) (page 2-51)
- [Unit of Measurement Support](#) (page 2-55)

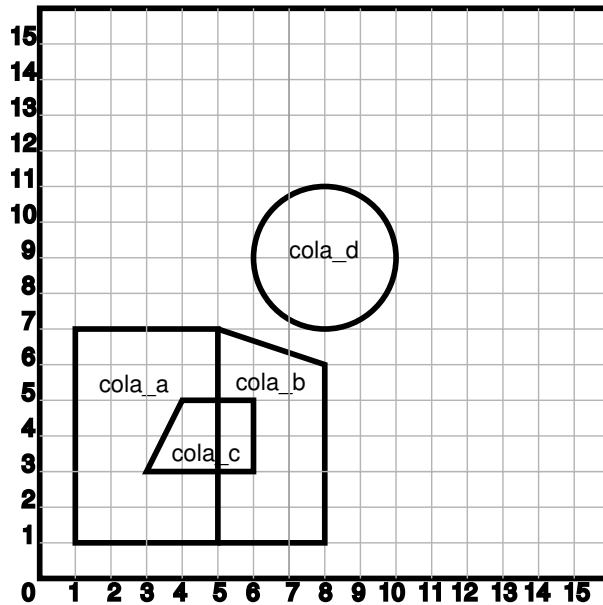
### 2.1 Simple Example: Inserting, Indexing, and Querying Spatial Data

This section presents a simple example of creating a spatial table, inserting data, creating the spatial index, and performing spatial queries. It refers to concepts that were explained in [Spatial Concepts](#) (page 1-1) and that will be explained in other sections of this chapter.

The scenario is a soft drink manufacturer that has identified geographical areas of marketing interest for several products (colas). The colas could be those produced by the company or by its competitors, or some combination. Each area of interest could represent any user-defined criterion: for example, an area where that cola has the majority market share, or where the cola is under competitive pressure, or where the cola is believed to have significant growth potential. Each area could be a neighborhood in a city, or a part of a state, province, or country.

Figure 2-1 (page 2-2) shows the areas of interest for four colas.

**Figure 2-1 Areas of Interest for the Simple Example**



Example 2-1 (page 2-2) performs the following operations:

- Creates a table (COLA\_MARKETS) to hold the spatial data
- Inserts rows for four areas of interest (cola\_a, cola\_b, cola\_c, cola\_d)
- Updates the USER\_SDO\_GEOM\_METADATA view to reflect the dimensional information for the areas
- Creates a spatial index (COLA\_SPATIAL\_IDX)
- Performs some spatial queries

Many concepts and techniques in Example 2-1 (page 2-2) are explained in detail in other sections of this chapter.

**Example 2-1 Simple Example: Inserting, Indexing, and Querying Spatial Data**

```
-- Create a table for cola (soft drink) markets in a
-- given geography (such as city or state).
-- Each row will be an area of interest for a specific
-- cola (for example, where the cola is most preferred
-- by residents, where the manufacturer believes the
-- cola has growth potential, and so on).
-- (For restrictions on spatial table and column names, see
-- TABLE_NAME (page 2-48) and COLUMN_NAME (page 2-48).)
```

```
CREATE TABLE cola_markets (
  mkt_id NUMBER PRIMARY KEY,
  name VARCHAR2(32),
  shape SDO_GEOMETRY);
```

```
-- The next INSERT statement creates an area of interest for
-- Cola A. This area happens to be a rectangle.
-- The area could represent any user-defined criterion: for
-- example, where Cola A is the preferred drink, where
-- Cola A is under competitive pressure, where Cola A
```

```

-- has strong growth potential, and so on.

INSERT INTO cola_markets VALUES(
  1,
  'cola_a',
  SDO_GEOMETRY(
    2003, -- two-dimensional polygon
    NULL,
    NULL,
    SDO_ELEM_INFO_ARRAY(1,1003,3), -- one rectangle (1003 = exterior)
    SDO_ORDINATE_ARRAY(1,1, 5,7) -- only 2 points needed to
      -- define rectangle (lower left and upper right) with
      -- Cartesian-coordinate data
  )
);

-- The next two INSERT statements create areas of interest for
-- Cola B and Cola C. These areas are simple polygons (but not
-- rectangles).

INSERT INTO cola_markets VALUES(
  2,
  'cola_b',
  SDO_GEOMETRY(
    2003, -- two-dimensional polygon
    NULL,
    NULL,
    SDO_ELEM_INFO_ARRAY(1,1003,1), -- one polygon (exterior polygon ring)
    SDO_ORDINATE_ARRAY(5,1, 8,1, 8,6, 5,7, 5,1)
  )
);

INSERT INTO cola_markets VALUES(
  3,
  'cola_c',
  SDO_GEOMETRY(
    2003, -- two-dimensional polygon
    NULL,
    NULL,
    SDO_ELEM_INFO_ARRAY(1,1003,1), -- one polygon (exterior polygon ring)
    SDO_ORDINATE_ARRAY(3,3, 6,3, 6,5, 4,5, 3,3)
  )
);

-- Now insert an area of interest for Cola D. This is a
-- circle with a radius of 2. It is completely outside the
-- first three areas of interest.

INSERT INTO cola_markets VALUES(
  4,
  'cola_d',
  SDO_GEOMETRY(
    2003, -- two-dimensional polygon
    NULL,
    NULL,
    SDO_ELEM_INFO_ARRAY(1,1003,4), -- one circle
    SDO_ORDINATE_ARRAY(8,7, 10,9, 8,11)
  )
);

```

```
-- UPDATE METADATA VIEW --
-----
-- Update the USER_SDO_GEOM_METADATA view. This is required
-- before the spatial index can be created. Do this only once for each
-- layer (that is, table-column combination; here: COLA_MARKETS and SHAPE).

INSERT INTO user_sdo_geom_metadata
  (TABLE_NAME,
   COLUMN_NAME,
   DIMINFO,
   SRID)
VALUES (
  'cola_markets',
  'shape',
  SDO_DIM_ARRAY(
    -- 20X20 grid
    SDO_DIM_ELEMENT('X', 0, 20, 0.005),
    SDO_DIM_ELEMENT('Y', 0, 20, 0.005)
  ),
  NULL -- SRID
);

-----
-- CREATE THE SPATIAL INDEX --
-----

CREATE INDEX cola_spatial_idx
  ON cola_markets(shape)
  INDEXTYPE IS MDSYS.SPATIAL_INDEX;
-- Preceding statement created an R-tree index.

-----
-- PERFORM SOME SPATIAL QUERIES --
-----

-- Return the topological intersection of two geometries.
SELECT SDO_GEOM.SDO_INTERSECTION(c_a.shape, c_c.shape, 0.005)
  FROM cola_markets c_a, cola_markets c_c
  WHERE c_a.name = 'cola_a' AND c_c.name = 'cola_c';

-- Do two geometries have any spatial relationship?
SELECT SDO_GEOM.RELATE(c_b.shape, 'anyinteract', c_d.shape, 0.005)
  FROM cola_markets c_b, cola_markets c_d
  WHERE c_b.name = 'cola_b' AND c_d.name = 'cola_d';

-- Return the areas of all cola markets.
SELECT name, SDO_GEOM.SDO_AREA(shape, 0.005) FROM cola_markets;

-- Return the area of just cola_a.
SELECT c.name, SDO_GEOM.SDO_AREA(c.shape, 0.005) FROM cola_markets c
  WHERE c.name = 'cola_a';

-- Return the distance between two geometries.
SELECT SDO_GEOM.SDO_DISTANCE(c_b.shape, c_d.shape, 0.005)
  FROM cola_markets c_b, cola_markets c_d
  WHERE c_b.name = 'cola_b' AND c_d.name = 'cola_d';

-- Is a geometry valid?
SELECT c.name, SDO_GEOM.VALIDATE_GEOMETRY_WITH_CONTEXT(c.shape, 0.005)
  FROM cola_markets c WHERE c.name = 'cola_c';

-- Is a layer valid? (First, create the results table.)
CREATE TABLE val_results (sdo_rowid ROWID, result VARCHAR2(2000));
CALL SDO_GEOM.VALIDATE_LAYER_WITH_CONTEXT('COLA_MARKETS', 'SHAPE',
```

```
'VAL_RESULTS', 2);
SELECT * from val_results;
```

## 2.2 SDO\_GEOMETRY Object Type

With Spatial and Graph, the geometric description of a spatial object is stored in a single row, in a single column of object type SDO\_GEOMETRY in a user-defined table. Any table that has a column of type SDO\_GEOMETRY must have another column, or set of columns, that defines a unique primary key for that table. Tables of this sort are sometimes referred to as spatial tables or spatial geometry tables.

Oracle Spatial and Graph defines the object type SDO\_GEOMETRY as:

```
CREATE TYPE sdo_geometry AS OBJECT (
  SDO_GTYPE NUMBER,
  SDO_SRID NUMBER,
  SDO_POINT SDO_POINT_TYPE,
  SDO_ELEM_INFO SDO_ELEM_INFO_ARRAY,
  SDO_ORDINATES SDO_ORDINATE_ARRAY);
```

Oracle Spatial and Graph also defines the SDO\_POINT\_TYPE, SDO\_ELEM\_INFO\_ARRAY, and SDO\_ORDINATE\_ARRAY types, which are used in the SDO\_GEOMETRY type definition, as follows:

```
CREATE TYPE sdo_point_type AS OBJECT (
  X NUMBER,
  Y NUMBER,
  Z NUMBER);
CREATE TYPE sdo_elem_info_array AS VARRAY (1048576) of NUMBER;
CREATE TYPE sdo_ordinate_array AS VARRAY (1048576) of NUMBER;
```

Because the maximum SDO\_ORDINATE\_ARRAY size is 1,048,576 numbers, the maximum number of vertices in an SDO\_GEOMETRY object depends on the number of dimensions per vertex: 524,288 for two dimensions, 349,525 for three dimensions, and 262,144 for four dimensions.

The sections that follow describe the semantics of each SDO\_GEOMETRY attribute, and then describe some usage considerations ([Usage Considerations](#) (page 2-12)).

The SDO\_GEOMETRY object type has methods that provide convenient access to some of the attributes. These methods are described in [SDO\\_GEOMETRY Methods](#) (page 2-12).

Some Spatial and Graph data types are described in locations other than this section:

- [Data Types for Geocoding](#) (page 11-6) describes data types for geocoding.
- *Oracle Spatial and Graph GeoRaster Developer's Guide* describes data types for Oracle Spatial and Graph GeoRaster.
- *Oracle Spatial and Graph Topology Data Model and Network Data Model Graph Developer's Guide* describes data types for the Oracle Spatial and Graph topology data model.

### 2.2.1 SDO\_GTYPE

The SDO\_GTYPE attribute indicates the type of the geometry. Valid geometry types correspond to those specified in the *Geometry Object Model for the OGIS Simple Features for SQL* specification (with the exception of Surfaces). The numeric values differ from

those given in the OGIS specification, but there is a direct correspondence between the names and semantics where applicable.

The SDO\_GTYPE value is 4 digits in the format *DLTT*, where:

- *D* identifies the number of dimensions (2, 3, or 4)
- *L* identifies the linear referencing measure dimension for a three-dimensional linear referencing system (LRS) geometry, that is, which dimension (3 or 4) contains the measure value. For a non-LRS geometry, or to accept the Spatial and Graph default of the last dimension as the measure for an LRS geometry, specify 0. For information about the linear referencing system (LRS), see [Linear Referencing System](#) (page 7-1).
- *TT* identifies the geometry type (00 through 09, with 10 through 99 reserved for future use).

[Table 2-1](#) (page 2-6) shows the valid SDO\_GTYPE values. The Geometry Type and Description values reflect the OGIS specification.

**Table 2-1 Valid SDO\_GTYPE Values**

Value	Geometry Type	Description
DL00	UNKNOWN_GEOMETRY	Spatial and Graph ignores this geometry.
DL01	POINT	Geometry contains one point.
DL02	LINE or CURVE	Geometry contains one line string that can contain straight or circular arc segments, or both. (LINE and CURVE are synonymous in this context.)
DL03	POLYGON or SURFACE	Geometry contains one polygon with or without holes, <sup>1</sup> or one surface consisting of one or more polygons. In a three-dimensional polygon, all points must be on the same plane.
DL04	COLLECTION	Geometry is a heterogeneous collection of elements. COLLECTION is a superset that includes all other types.
DL05	MULTIPOINT	Geometry has one or more points. (MULTIPOINT is a superset of POINT.)
DL06	MULTILINE or MULTICURVE	Geometry has one or more line strings. (MULTILINE and MULTICURVE are synonymous in this context, and each is a superset of both LINE and CURVE.)
DL07	MULTIPOLYGON or MULTISURFACE	Geometry can have multiple, disjoint polygons (more than one exterior boundary). or surfaces (MULTIPOLYGON is a superset of POLYGON, and MULTISURFACE is a superset of SURFACE.)
DL08	SOLID	Geometry consists of multiple surfaces and is completely enclosed in a three-dimensional space. Can be a cuboid or a frustum.
DL09	MULTISOLID	Geometry can have multiple, disjoint solids (more than one exterior boundary). (MULTISOLID is a superset of SOLID.)

<sup>1</sup> For a polygon with holes, enter the exterior boundary first, followed by any interior boundaries.

The *D* in the Value column of [Table 2-1](#) (page 2-6) is the number of dimensions: 2, 3, or 4. For example, an SDO\_GTYPE value of 2003 indicates a two-dimensional polygon. The number of dimensions reflects the number of ordinates used to represent each vertex (for example, X,Y for two-dimensional objects).

In any given layer (column), all geometries must have the same number of dimensions. For example, you cannot mix two-dimensional and three-dimensional data in the same layer.

The following methods are available for returning the individual *DLTT* components of the SDO\_GTYPE for a geometry object: `Get_Dims`, `Get_LRS_Dim`, and `Get_Gtype`. These methods are described in [SDO\\_GEOMETRY Methods](#) (page 2-12).

For more information about SDO\_GTYPE values for three-dimensional geometries, see [Table 1-1](#) (page 1-16) in [Three-Dimensional Spatial Objects](#) (page 1-16).

## 2.2.2 SDO\_SRID

The SDO\_SRID attribute can be used to identify a coordinate system (spatial reference system) to be associated with the geometry. If SDO\_SRID is null, no coordinate system is associated with the geometry. If SDO\_SRID is not null, it must contain a value from the SRID column of the SDO\_COORD\_REF\_SYS table (described in [SDO\\_COORD\\_REF\\_SYS Table](#) (page 6-27)), and this value must be inserted into the SRID column of the USER\_SDO\_GEOM\_METADATA view (described in [Geometry Metadata Views](#) (page 2-47)).

All geometries in a geometry column must have the same SDO\_SRID value if a spatial index will be built on that column.

For information about coordinate systems, see [Coordinate Systems \(Spatial Reference Systems\)](#) (page 6-1).

## 2.2.3 SDO\_POINT

The SDO\_POINT attribute is defined using the SDO\_POINT\_TYPE object type, which has the attributes X, Y, and Z, all of type NUMBER. (The SDO\_POINT\_TYPE definition is shown in [SDO\\_GEOMETRY Object Type](#) (page 2-5).) If the SDO\_ELEM\_INFO and SDO\_ORDINATES arrays are both null, and the SDO\_POINT attribute is non-null, then the X, Y, and Z values are considered to be the coordinates for a point geometry. Otherwise, the SDO\_POINT attribute is ignored by Spatial and Graph. You should store point geometries in the SDO\_POINT attribute for optimal storage; and if you have only point geometries in a layer, it is strongly recommended that you store the point geometries in the SDO\_POINT attribute.

[Point](#) (page 2-27) illustrates a point geometry and provides examples of inserting and querying point geometries.

---

### Note:

Do not use the SDO\_POINT attribute in defining a linear referencing system (LRS) point or an oriented point. For information about LRS, see [Linear Referencing System](#) (page 7-1). For information about oriented points, see [Oriented Point](#) (page 2-28).

---

## 2.2.4 SDO\_ELEM\_INFO

The SDO\_ELEM\_INFO attribute is defined using a varying length array of numbers. This attribute lets you know how to interpret the ordinates stored in the SDO\_ORDINATES attribute (described in [SDO\\_ORDINATES](#) (page 2-11)).

Each triplet set of numbers is interpreted as follows:

- SDO\_STARTING\_OFFSET -- Indicates the offset within the SDO\_ORDINATES array where the first ordinate for this element is stored. Offset values start at 1 and not at 0. Thus, the first ordinate for the first element will be at SDO\_GEOMETRY.SDO\_ORDINATES(1). If there is a second element, its first ordinate will be at SDO\_GEOMETRY.SDO\_ORDINATES(*n*), where *n* reflects the position within the SDO\_ORDINATE\_ARRAY definition (for example, 19 for the 19th number, as in [Polygon with a Hole](#) (page 2-23)).
- SDO\_ETYPE -- Indicates the type of the element. Valid values are shown in [Table 2-2](#) (page 2-9).

SDO\_ETYPE values 1, 2, 1003, and 2003 are considered *simple elements*. They are defined by a single triplet entry in the SDO\_ELEM\_INFO array. For SDO\_ETYPE values 1003 and 2003, the first digit indicates *exterior* (1) or *interior* (2):

1003: exterior polygon ring (must be specified in counterclockwise order)

2003: interior polygon ring (must be specified in clockwise order)

---

---

**Note:**

The use of 3 as an SDO\_ETYPE value for polygon ring elements in a single geometry is discouraged. You should specify 3 only if you do not know if the simple polygon is exterior or interior, and you should then upgrade the table or layer to the current format using the [SDO\\_MIGRATE.TO\\_CURRENT](#) (page 25-1) procedure, described in [SDO\\_MIGRATE Package \(Upgrading\)](#) (page 25-1).

You cannot mix 1-digit and 4-digit SDO\_ETYPE values in a single geometry.

---

---

SDO\_ETYPE values 4, 1005, 2005, 1006, and 2006 are considered *compound elements*. They contain at least one header triplet with a series of triplet values that belong to the compound element. For 4-digit SDO\_ETYPE values, the first digit indicates *exterior* (1) or *interior* (2):

1005: exterior polygon ring (must be specified in counterclockwise order)

2005: interior polygon ring (must be specified in clockwise order)

1006: exterior surface consisting of one or more polygon rings

2006: interior surface in a solid element

1007: solid element

The elements of a compound element are contiguous. The last point of a subelement in a compound element is the first point of the next subelement. The point is not repeated.

- SDO\_INTERPRETATION -- Means one of two things, depending on whether or not SDO\_ETYPE is a compound element.



If SDO\_ETYPE is a compound element (4, 1005, or 2005), this field specifies how many subsequent triplet values are part of the element.

If the SDO\_ETYPE is not a compound element (1, 2, 1003, or 2003), the interpretation attribute determines how the sequence of ordinates for this element is interpreted. For example, a line string or polygon boundary may be made up of a sequence of connected straight line segments or circular arcs.

Descriptions of valid SDO\_ETYPE and SDO\_INTERPRETATION value pairs are given in [Table 2-2](#) (page 2-9).

If a geometry consists of more than one element, then the last ordinate for an element is always one less than the starting offset for the next element. The last element in the geometry is described by the ordinates from its starting offset to the end of the SDO\_ORDINATES varying length array.

For compound elements (SDO\_ETYPE values 4, 1005, or 2005), a set of  $n$  triplets (one for each subelement) is used to describe the element. It is important to remember that subelements of a compound element are contiguous. The last point of a subelement is the first point of the next subelement. For subelements 1 through  $n-1$ , the end point of one subelement is the same as the starting point of the next subelement. The starting point for subelements 2... $n-2$  is the same as the end point of subelement 1... $n-1$ . The last ordinate of subelement  $n$  is either the starting offset minus 1 of the next element in the geometry, or the last ordinate in the SDO\_ORDINATES varying length array.

The current size of a varying length array can be determined by using the function `varray_variable.Count` in PL/SQL or `OCICollSize` in the Oracle Call Interface (OCI).

The semantics of each SDO\_ETYPE element and the relationship between the SDO\_ELEM\_INFO and SDO\_ORDINATES varying length arrays for each of these SDO\_ETYPE elements are given in [Table 2-2](#) (page 2-9).

**Table 2-2 Values and Semantics in SDO\_ELEM\_INFO**

SDO_ETYPE	SDO_INTERPRETATION	Meaning
0	(any numeric value)	Type 0 (zero) element. Used to model geometry types not supported by Oracle Spatial and Graph. For more information, see <a href="#">Type 0 (Zero) Element</a> (page 2-31).
1	1	Point type.
1	0	Orientation for an oriented point. For more information, see <a href="#">Oriented Point</a> (page 2-28).
1	$n > 1$	Point cluster with $n$ points.
2	1	Line string whose vertices are connected by straight line segments.
2	2	Line string made up of a connected sequence of circular arcs. Each circular arc is described using three coordinates: the start point of the arc, any point on the arc, and the end point of the arc. The coordinates for a point designating the end of one arc and the start of the next arc are not repeated. For example, five coordinates are used to describe a line string made up of two connected circular arcs. Points 1, 2, and 3 define the first arc, and points 3, 4, and 5 define the second arc, where point 3 is only stored once.

**Table 2-2 (Cont.) Values and Semantics in SDO\_ELEM\_INFO**

SDO_ET YPE	SDO_INTERPRET ATION	Meaning
2	3	NURBS (non-uniform rational B-spline) curve. For more information, see <a href="#">NURBS Curve Support in Oracle Spatial and Graph</a> (page 1-27).
1003 or 2003	1	Simple polygon whose vertices are connected by straight line segments. You must specify a point for each vertex; and the last point specified must be exactly the same point as the first (within the tolerance value), to close the polygon. For example, for a 4-sided polygon, specify 5 points, with point 5 the same as point 1.
1003 or 2003	2	<p>Polygon made up of a connected sequence of circular arcs that closes on itself. The end point of the last arc is the same as the start point of the first arc.</p> <p>Each circular arc is described using three coordinates: the start point of the arc, any point on the arc, and the end point of the arc. The coordinates for a point designating the end of one arc and the start of the next arc are not repeated. For example, five coordinates are used to describe a polygon made up of two connected circular arcs. Points 1, 2, and 3 define the first arc, and points 3, 4, and 5 define the second arc. The coordinates for points 1 and 5 must be the same (tolerance is not considered), and point 3 is not repeated.</p>
1003 or 2003	3	<p>Rectangle type (sometimes called <i>optimized rectangle</i>). A bounding rectangle such that only two points, the lower-left and the upper-right, are required to describe it. The rectangle type can be used with geodetic or non-geodetic data. However, with geodetic data, use this type only to create a query window (not for storing objects in the database).</p> <p>For information about using this type with geodetic data, including examples, see <a href="#">Geodetic MBRs</a> (page 6-5). For information about creating three-dimensional optimized rectangles, see <a href="#">Three-Dimensional Optimized Rectangles</a> (page 1-22).</p>
1003 or 2003	4	Circle type. Described by three distinct non-colinear points, all on the circumference of the circle.
4	$n > 1$	<p>Compound line string with some vertices connected by straight line segments and some by circular arcs. The value <math>n</math> in the Interpretation column specifies the number of contiguous subelements that make up the line string.</p> <p>The next <math>n</math> triplets in the SDO_ELEM_INFO array describe each of these subelements. The subelements can only be of SDO_ETYPE 2. The last point of a subelement is the first point of the next subelement, and must not be repeated.</p> <p>See <a href="#">Compound Line String</a> (page 2-24) and <a href="#">Figure 2-5</a> (page 2-25) for an example of a compound line string geometry.</p>

**Table 2-2 (Cont.) Values and Semantics in SDO\_ELEM\_INFO**

SDO_ET YPE	SDO_INTERPRET ATION	Meaning
1005 or 2005	$n > 1$	<p>Compound polygon with some vertices connected by straight line segments and some by circular arcs. The value <math>n</math> in the Interpretation column specifies the number of contiguous subelements that make up the polygon.</p> <p>The next <math>n</math> triplets in the SDO_ELEM_INFO array describe each of these subelements. The subelements can only be of SDO_ETYPE 2. The end point of a subelement is the start point of the next subelement, and it must not be repeated. The start and end points of the polygon must be exactly the same point (tolerance is ignored).</p> <p>See <a href="#">Compound Polygon</a> (page 2-26) for an example of a compound polygon geometry.</p>
1006 or 2006	$n > 1$	<p>Surface consisting of one or more polygons, with each edge shared by no more than two polygons. A surface contains an area but not a volume. The value <math>n</math> in the Interpretation column specifies the number of polygons that make up the surface.</p> <p>The next <math>n</math> triplets in the SDO_ELEM_INFO array describe each of these polygon subelements.</p> <p>A surface must be three-dimensional. For an explanation of three-dimensional support in Spatial and Graph, see <a href="#">Three-Dimensional Spatial Objects</a> (page 1-16).</p>
1007	$n = 1$ or 3	<p>Solid consisting of multiple surfaces that are completely enclosed in a three-dimensional space, so that the solid has an interior volume. A solid element can have one exterior surface defined by the 1006 elements and zero or more interior boundaries defined by the 2006 elements. The value <math>n</math> in the Interpretation column must be 1 or 3.</p> <p>Subsequent triplets in the SDO_ELEM_INFO array describe the exterior 1006 and optional interior 2006 surfaces that make up the solid element.</p> <p>If <math>n</math> is 3, the solid is an <i>optimized box</i>, such that only two three-dimensional points are required to define it: one with minimum values for the box in the X, Y, and Z dimensions and another with maximum values for the box in the X, Y, and Z dimensions. For example: <code>SDO_GEOMETRY( 3008 , NULL , NULL , SDO_ELEM_INFO_ARRAY( 1, 1007, 3 ) , SDO_ORDINATE_ARRAY( 1, 1, 1, 3, 3, 3 ) )</code></p> <p>For an explanation of three-dimensional support in Spatial and Graph, see <a href="#">Three-Dimensional Spatial Objects</a> (page 1-16).</p>

## 2.2.5 SDO\_ORDINATES

The SDO\_ORDINATES attribute is defined using a varying length array (1048576) of NUMBER type that stores the coordinate values that make up the boundary of a spatial object. This array must always be used in conjunction with the SDO\_ELEM\_INFO varying length array. The values in the array are ordered by dimension. For example, a polygon whose boundary has four two-dimensional points is stored as {X1, Y1, X2, Y2, X3, Y3, X4, Y4, X1, Y1}. If the points are three-dimensional,

then they are stored as {X1, Y1, Z1, X2, Y2, Z2, X3, Y3, Z3, X4, Y4, Z4, X1, Y1, Z1}. The number of dimensions associated with each point is stored as metadata in the xxx\_SDO\_GEOM\_METADATA views, described in [Geometry Metadata Views](#) (page 2-47).

The values in the SDO\_ORDINATES array must all be valid and non-null. There are no special values used to delimit elements in a multielement geometry. The start and end points for the sequence describing a specific element are determined by the STARTING\_OFFSET values for that element and the next element in the SDO\_ELEM\_INFO array, as explained in [SDO\\_ELEM\\_INFO](#) (page 2-8). The offset values start at 1. SDO\_ORDINATES(1) is the first ordinate of the first point of the first element.

## 2.2.6 Usage Considerations

You should use the SDO\_GTYPE values as shown in [SDO\\_GTYPE](#) (page 2-5); however, Spatial and Graph does not check or enforce all geometry consistency constraints. Spatial and Graph does check the following:

- For SDO\_GTYPE values *d001* and *d005*, any subelement not of SDO\_ETYPE 1 is ignored.
- For SDO\_GTYPE values *d002* and *d006*, any subelement not of SDO\_ETYPE 2 or 4 is ignored.
- For SDO\_GTYPE values *d003* and *d007*, any subelement not of SDO\_ETYPE 3 or 5 is ignored. (This includes SDO\_ETYPE variants 1003, 2003, 1005, and 2005, which are explained in [SDO\\_ELEM\\_INFO](#) (page 2-8)).

The [SDO\\_GEOM.VALIDATE\\_GEOMETRY\\_WITH\\_CONTEXT](#) (page 23-52) function can be used to evaluate the consistency of a single geometry object or of all geometry objects in a specified feature table.

## 2.3 SDO\_GEOMETRY Methods

The SDO\_GEOMETRY object type (described in [SDO\\_GEOMETRY Object Type](#) (page 2-5)) has methods (member functions) that retrieve information about a geometry object. [Table 2-3](#) (page 2-12) lists these methods.

**Table 2-3 SDO\_GEOMETRY Methods**

Name	Returns	Description
Get_Dims	NUMBER	Returns the number of dimensions of a geometry object, as specified in its SDO_GTYPE value. In Oracle Spatial and Graph, the Get_Dims and ST_CoordDim methods return the same result.
Get_GType	NUMBER	Returns the geometry type of a geometry object, as specified in its SDO_GTYPE value.
Get_LRS_Dim	NUMBER	Returns the measure dimension of an LRS geometry object, as specified in its SDO_GTYPE value.  A return value of 0 indicates that the geometry is a standard (non-LRS) geometry, or is an LRS geometry in the format before release 9.0.1 and with measure as the default (last) dimension; 3 indicates that the third dimension contains the measure information; 4 indicates that the fourth dimension contains the measure information.

**Table 2-3 (Cont.) SDO\_GEOMETRY Methods**

Name	Returns	Description
Get_WKB	BLOB	Returns the well-known binary (WKB) format of a geometry object. (The returned object does not include any SRID information.)
Get_WKT	CLOB	Returns the well-known text (WKT) format (explained in <a href="#">Well-Known Text (WKT)</a> (page 6-48)) of a geometry object. (The returned object does not include any SRID information.)
ST_CoordDim	NUMBER	Returns the coordinate dimension (as defined by the ISO/IEC SQL Multimedia standard) of a geometry object. In Oracle Spatial and Graph, the Get_Dims and ST_CoordDim methods return the same result.
ST_IsValid	NUMBER	Returns 0 if a geometry object is invalid or 1 if it is valid. (The ISO/IEC SQL Multimedia standard uses the term <i>well formed</i> for <i>valid</i> in this context.)  This method uses 0.001 as the tolerance value. (Tolerance is explained in <a href="#">Tolerance</a> (page 1-6).) To specify a different tolerance value or to learn more about why a geometry is invalid, use the <a href="#">SDO_GEOM.VALIDATE_GEOMETRY_WITH_CONTEXT</a> (page 23-52) function, which is documented in <a href="#">SDO_GEOM Package (Geometry)</a> (page 23-1).

[Example 2-2](#) (page 2-13) shows most of the SDO\_GEOMETRY methods. (The Get\_WKB method is not included because its output cannot be displayed by SQL\*Plus.)

**Example 2-2 SDO\_GEOMETRY Methods**

```
SELECT c.shape.Get_Dims()
       FROM cola_markets c WHERE c.name = 'cola_b';
```

```
C.SHAPE.GET_DIMS()
-----
                2
```

```
SELECT c.shape.Get_GType()
       FROM cola_markets c WHERE c.name = 'cola_b';
```

```
C.SHAPE.GET_GTYPE()
-----
                3
```

```
SELECT a.route_geometry.Get_LRS_Dim()
       FROM lrs_routes a WHERE a.route_id = 1;
```

```
A.ROUTE_GEOMETRY.GET_LRS_DIM()
-----
                3
```

```
SELECT c.shape.Get_WKT()
       FROM cola_markets c WHERE c.name = 'cola_b';
```

```
C.SHAPE.GET_WKT()
-----
```

```
POLYGON ((5.0 1.0, 8.0 1.0, 8.0 6.0, 5.0 7.0, 5.0 1.0))

SELECT c.shape.ST_CoordDim()
       FROM cola_markets c WHERE c.name = 'cola_b';

C.SHAPE.ST_COORDDIM()
-----
                2

SELECT c.shape.ST_IsValid()
       FROM cola_markets c WHERE c.name = 'cola_b';

C.SHAPE.ST_ISVALID()
-----
                1
```

## 2.4 SDO\_GEOMETRY Constructors

The SDO\_GEOMETRY object type (described in [SDO\\_GEOMETRY Object Type](#) (page 2-5)) has constructors that create a geometry object from a well-known text (WKT) string in CLOB or VARCHAR2 format, or from a well-known binary (WKB) object in BLOB format. The following constructor formats are available:

```
SDO_GEOMETRY(wkt CLOB, srid NUMBER DEFAULT NULL);
SDO_GEOMETRY(wkt VARCHAR2, srid NUMBER DEFAULT NULL);
SDO_GEOMETRY(wkb BLOB, srid NUMBER DEFAULT NULL);
```

If the created geometry is inserted into a table, the SRID value used with the constructor must match the SDO\_SRID value of the geometries in the table.

The following simple example constructs a point geometry using a well-known text string. (In a WKT, spaces separate ordinates of a vertex, and commas separate vertices.)

```
SELECT SDO_GEOMETRY('POINT(-79 37)') FROM DUAL;

SDO_GEOMETRY('POINT(-7937)')(SDO_GTYPE, SDO_SRID, SDO_POINT(X, Y, Z), SDO_ELEM_I
-----
SDO_GEOMETRY(2001, NULL, SDO_POINT_TYPE(-79, 37, NULL), NULL, NULL)
```

[Example 2-3](#) (page 2-14) shows SDO\_GEOMETRY constructors that create geometry objects, insert the objects into a table, and display the objects that were added to the table.

### **Example 2-3 SDO\_GEOMETRY Constructors to Create Geometries**

```
DECLARE
  cola_b_wkb BLOB;
  cola_b_wkt_clob CLOB;
  cola_b_wkt_varchar VARCHAR2(255);
  cola_b_geom SDO_GEOMETRY;

BEGIN
  -- Get cola_b geometry into CLOB, VARCHAR2, and BLOB objects,
  -- for use by the constructor.
  SELECT c.shape.Get_WKT() INTO cola_b_wkt_clob
     FROM cola_markets c WHERE c.name = 'cola_b';
  cola_b_wkt_varchar := cola_b_wkt_clob;
  SELECT c.shape.Get_WKB() INTO cola_b_wkb
     FROM cola_markets c WHERE c.name = 'cola_b';
```

```

-- Use some SDO_GEOMETRY constructors;
-- insert 3 geometries into the table; display the geometries later.
cola_b_geom := SDO_GEOMETRY(cola_b_wkt_clob);
INSERT INTO cola_markets VALUES (101, 'cola_b_from_clob', cola_b_geom);
cola_b_geom := SDO_GEOMETRY(cola_b_wkt_varchar);
INSERT INTO cola_markets VALUES (102, 'cola_b_from_varchar', cola_b_geom);
cola_b_geom := SDO_GEOMETRY(cola_b_wkb);
INSERT INTO cola_markets VALUES (103, 'cola_b_from_wkb', cola_b_geom);
END;
/

PL/SQL procedure successfully completed.

-- Display the geometries created using SDO_GEOMETRY constructors.
-- All three geometries are identical.
SELECT name, shape FROM cola_markets WHERE mkt_id > 100;

NAME
-----
SHAPE(SDO_GTYPE, SDO_SRID, SDO_POINT(X, Y, Z), SDO_ELEM_INFO, SDO_ORDINATES)
-----
cola_b_from_clob
SDO_GEOMETRY(2003, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 1003, 1), SDO_ORDINATE_ARR
AY(5, 1, 8, 1, 8, 6, 5, 7, 5, 1))

cola_b_from_varchar
SDO_GEOMETRY(2003, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 1003, 1), SDO_ORDINATE_ARR
AY(5, 1, 8, 1, 8, 6, 5, 7, 5, 1))

cola_b_from_wkb
SDO_GEOMETRY(2003, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 1003, 1), SDO_ORDINATE_ARR
AY(5, 1, 8, 1, 8, 6, 5, 7, 5, 1))

```

## 2.5 TIN-Related Object Types

This section describes the following object types related to support for triangulated irregular networks (TINs):

- SDO\_TIN
- SDO\_TIN\_BLK\_TYPE
- SDO\_TIN\_BLK

### 2.5.1 SDO\_TIN Object Type

The description of a TIN is stored in a single row, in a single column of object type SDO\_TIN in a user-defined table. The object type SDO\_TIN is defined as:

```

CREATE TYPE sdo_tin AS OBJECT
(
  base_table          VARCHAR2(70),
  base_table_col      VARCHAR2(1024),
  tin_id              NUMBER,
  blk_table           VARCHAR2(70),
  ptn_params          VARCHAR2(1024),
  tin_extent          SDO_GEOMETRY,
  tin_tol             NUMBER,
  tin_tot_dimensions  NUMBER,
  tin_domain          SDO_ORGSLC_TYPE,
  tin_break_lines     SDO_GEOMETRY,
  tin_stop_lines      SDO_GEOMETRY,

```

```
tin_void_rgns      SDO_GEOMETRY,  
tin_val_attr_tables SDO_STRING_ARRAY,  
tin_other_attrs    XMLTYPE);
```

The SDO\_TIN type has the attributes shown in [Table 2-4](#) (page 2-16).

**Table 2-4 SDO\_TIN Type Attributes**

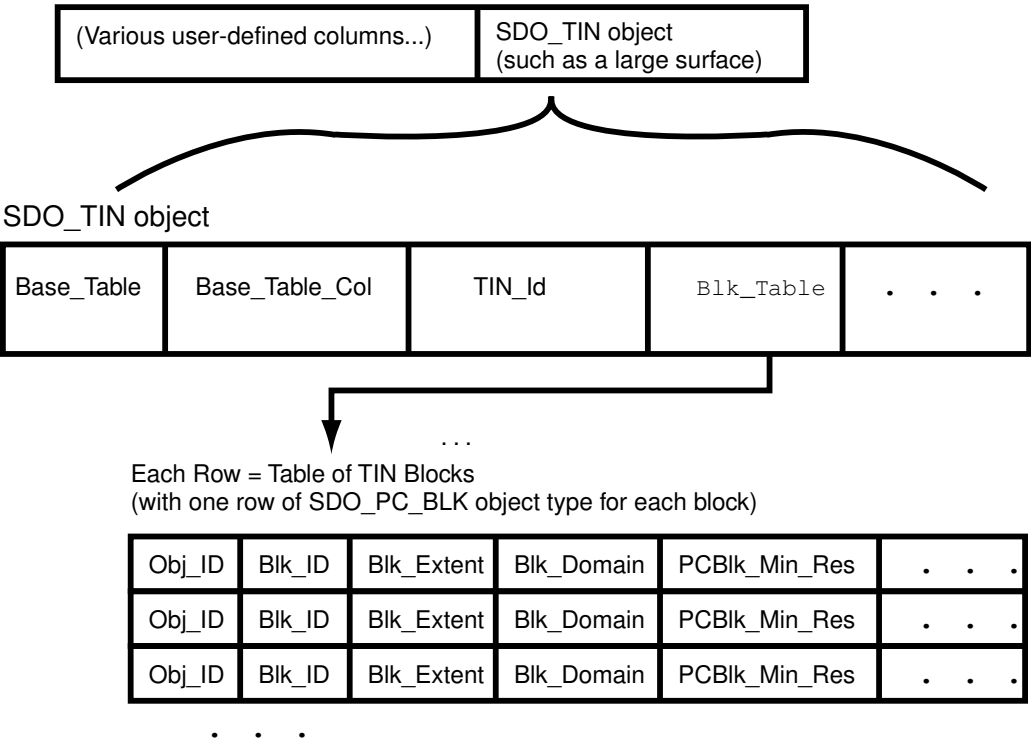
Attribute	Explanation
BASE_TABLE	Name of the base table containing a column of type SDO_TIN
BASE_TABLE_COL	Name of the column of type SDO_TIN in the base table
TIN_ID	ID number for the TIN. (This unique ID number is generated by Spatial and Graph. It is unique within the schema for base tables containing a column of type SDO_TIN.)
BLK_TABLE	Name of the table that contains information about each block in the TIN. This table contains the columns shown in <a href="#">Table 2-5</a> (page 2-17).
PTN_PARAMS	Parameters for partitioning the TIN
TIN_EXTENT	SDO_GEOMETRY object representing the spatial extent of the TIN (the minimum bounding object enclosing all objects in the TIN)
TIN_TOL	Tolerance value for objects in the TIN. (For information about spatial tolerance, see <a href="#">Tolerance</a> (page 1-6).)
TIN_TOT_DIMENSIONS	Total number of dimensions in the TIN. Includes spatial dimensions and any nonspatial dimensions, up to a maximum total of 9.
TIN_DOMAIN	(Not currently used.)
TIN_BREAK_LINES	(Not currently used.)
TIN_STOP_LINES	(Not currently used.)
TIN_VOID_RGNS	(Not currently used.).
TIN_VAL_ATTR_TABLES	SDO_STRING_ARRAY object specifying the names of any value attribute tables for the TIN. Type SDO_STRING_ARRAY is defined as VARRAY(1048576) OF VARCHAR2(32).
TIN_OTHER_ATTRS	XMLTYPE object specifying any other attributes of the TIN. (For more information, see the Usage Notes for the <a href="#">SDO_TIN_PKG.INIT</a> (page 29-5) function.)

[Figure 2-2](#) (page 2-17) shows the storage model for TIN data, in which the TIN block table (specified in the BLK\_TABLE attribute of the SDO\_TIN type) stores the blocks associated with the SDO\_TIN object.



**Figure 2-2 Storage of TIN Data**

Spatial table containing TIN data, for each row:



The TIN block table contains the columns shown in [Table 2-5](#) (page 2-17).

**Table 2-5 Columns in the TIN Block Table**

Column Name	Data Type	Purpose
BLK_ID	NUMBER	ID number of the block.
BLK_EXTENT	SDO_GEOMETRY	Spatial extent of the block.
BLK_DOMAIN	SDO_ORGSLTYPE	(Not currently used.)
PCBLK_MIN_RES	NUMBER	For point cloud data, the minimum resolution level at which the block is visible in a query. The block is retrieved only if the query window intersects the spatial extent of the block and if the minimum - maximum resolution interval of the block intersects the minimum - maximum resolution interval of the query. Usually, lower values mean farther from the view point, and higher values mean closer to the view point.

**Table 2-5 (Cont.) Columns in the TIN Block Table**

Column Name	Data Type	Purpose
PCBLK_MAX_RES	NUMBER	For point cloud data, the maximum resolution level at which the block is visible in a query. The block is retrieved only if the query window intersects the spatial extent of the block and if the minimum - maximum resolution interval of the block intersects the minimum - maximum resolution interval of the query. Usually, lower values mean farther from the view point, and higher values mean closer to the view point.
NUM_POINTS	NUMBER	For point cloud data, the total number of points in the POINTS BLOB
NUM_UNSORTED_POINTS	NUMBER	For point cloud data, the number of unsorted points in the POINTS BLOB
PT_SORT_DIM	NUMBER	For point cloud data, the number of spatial dimensions for the points (2 or 3)
POINTS	BLOB	For point cloud data, BLOB containing the points. Consists of an array of points, with the following information for each point: <ul style="list-style-type: none"> <li>• <math>d</math> 8-byte IEEE doubles, where <math>d</math> is the point cloud total number of dimensions</li> <li>• 4-byte big-endian integer for the BLK_ID value</li> <li>• 4-byte big-endian integer for the PT_ID value</li> </ul>
TR_LVL	NUMBER	(Not currently used.)
TR_RES	NUMBER	(Not currently used.)
NUM_TRIANGLES	NUMBER	Number of triangles in the TRIANGLES BLOB.
TR_SORT_DIM	NUMBER	(Not currently used.)
TRIANGLES	BLOB	BLOB containing the triangles. Consists of an array of triangles for the block: <ul style="list-style-type: none"> <li>• Each triangle is specified by three vertices.</li> <li>• Each vertex is specified by the pair (BLK_ID, PT_ID), with each value being a 4-byte big-endian integer.</li> </ul>

For each BLOB in the POINTS column of the TIN block table:

- The total size is  $(tdim+1)*8$ , where  $tdim$  is the total dimensionality of each block.
- The total size should be less than 5 MB for Oracle Database Release 11.1.0.6 or earlier; it should be less than 12 MB for Oracle Database Release 11.1.0.7 or later.

You can use an attribute name in a query on an object of SDO\_TIN. [Example 2-4](#) (page 2-19) shows part of a SELECT statement that queries the TIN\_EXTENT attribute of the TERRAIN column of a hypothetical LANDSCAPES table.

**Example 2-4 SDO\_TIN Attribute in a Query**

```
SELECT l.terrain.tin_extent FROM landscapes l WHERE ...;
```

## 2.5.2 SDO\_TIN\_BLK\_TYPE and SDO\_TIN\_BLK Object Types

When you perform a clip operation using the [SDO\\_TIN\\_PKG.CLIP\\_TIN](#) (page 29-1) function, an object of SDO\_TIN\_BLK\_TYPE is returned, which is defined as TABLE OF SDO\_TIN\_BLK.

The attributes of the SDO\_TIN\_BLK object type are the same as the columns in the TIN block table, which is described in [Table 2-5](#) (page 2-17) in [SDO\\_TIN\\_BLK\\_TYPE and SDO\\_TIN\\_BLK Object Types](#) (page 2-19).

## 2.6 Point Cloud-Related Object Types

This section describes the following object types related to support for point clouds:

- SDO\_PC
- SDO\_PC\_BLK

### 2.6.1 SDO\_PC Object Type

The description of a point cloud is stored in a single row, in a single column of object type SDO\_PC in a user-defined table. The object type SDO\_PC is defined as:

```
CREATE TYPE sdo_pc AS OBJECT
(
  base_table      VARCHAR2(70),
  base_table_col  VARCHAR2(1024),
  pc_id           NUMBER,
  blk_table       VARCHAR2(70),
  ptn_params      VARCHAR2(1024),
  pc_extent       SDO_GEOMETRY,
  pc_tol          NUMBER,
  pc_tot_dimensions NUMBER,
  pc_domain       SDO_ORGSLC_TYPE,
  pc_val_attr_tables SDO_STRING_ARRAY,
  pc_other_attrs  XMLTYPE);
```

The SDO\_PC type has the attributes shown in [Table 2-6](#) (page 2-19).

**Table 2-6 SDO\_PC Type Attributes**

Attribute	Explanation
BASE_TABLE	Name of the base table containing a column of type SDO_PC
BASE_TABLE_COL	Name of the column of type SDO_PC in the base table
PC_ID	ID number for the point cloud. (This unique ID number is generated by Spatial and Graph. It is unique within the schema for base tables containing a column of type SDO_PC.)

**Table 2-6 (Cont.) SDO\_PC Type Attributes**

Attribute	Explanation
BLK_TABLE	Name of the table that contains information about each block in the point cloud. This table contains the columns shown in <a href="#">Table 2-7</a> (page 2-20).
PTN_PARAMS	Parameters for partitioning the point cloud
PC_EXTENT	SDO_GEOMETRY object representing the spatial extent of the point cloud (the minimum bounding object enclosing all objects in the point cloud)
PC_TOL	Tolerance value for points in the point cloud. (For information about spatial tolerance, see <a href="#">Tolerance</a> (page 1-6).)
PC_TOT_DIMENSIONS	Total number of dimensions in the point cloud. Includes spatial dimensions and any nonspatial dimensions, up to a maximum total of 9.
PC_DOMAINS	(Not currently used.)
PC_VAL_ATTR_TABLES	SDO_STRING_ARRAY object specifying the names of any value attribute tables for the point cloud. Type SDO_STRING_ARRAY is defined as <code>VARRAY ( 1048576 ) OF VARCHAR2 ( 32 )</code> .
PC_OTHER_ATTRS	XMLTYPE object specifying any other attributes of the point cloud. (For more information, see the Usage Notes for the <a href="#">SDO_PC_PKG.INIT</a> (page 27-10) function.)

The point cloud block table (specified in the BLK\_TABLE attribute of the SDO\_PC type) contains the columns shown in [Table 2-7](#) (page 2-20).

**Table 2-7 Columns in the Point Cloud Block Table**

Column Name	Data Type	Purpose
OBJ_ID	NUMBER	ID number of the point cloud object.
BLK_ID	NUMBER	ID number of the block.
BLK_EXTENT	SDO_GEOMETRY	Spatial extent of the block.
BLK_DOMAIN	SDO_ORGSLTYPE	(Not currently used.)
PCBLK_MIN_RES	NUMBER	For point cloud data, the minimum resolution level at which the block is visible in a query. The block is retrieved only if the query window intersects the spatial extent of the block and if the minimum - maximum resolution interval of the block intersects the minimum - maximum resolution interval of the query. Usually, lower values mean farther from the view point, and higher values mean closer to the view point.

**Table 2-7 (Cont.) Columns in the Point Cloud Block Table**

Column Name	Data Type	Purpose
PCBLK_MAX_RES	NUMBER	For point cloud data, the maximum resolution level at which the block is visible in a query. The block is retrieved only if the query window intersects the spatial extent of the block and if the minimum - maximum resolution interval of the block intersects the minimum - maximum resolution interval of the query. Usually, lower values mean farther from the view point, and higher values mean closer to the view point.
NUM_POINTS	NUMBER	For point cloud data, the total number of points in the POINTS BLOB
NUM_UNSORTED_POINTS	NUMBER	For point cloud data, the number of unsorted points in the POINTS BLOB
PT_SORT_DIM	NUMBER	Number of the dimension (1 for the first dimension, 2 for the second dimension, and so on) on which the points are sorted.
POINTS	BLOB	BLOB containing the points. Consists of an array of points, with the following information for each point: <ul style="list-style-type: none"> <li>• <math>d</math> 8-byte IEEE doubles, where <math>d</math> is the PC_TOT_DIMENSIONS value</li> <li>• 4-byte big-endian integer for the BLK_ID value</li> <li>• 4-byte big-endian integer for the PT_ID value</li> </ul>

You can use an attribute name in a query on an object of SDO\_PC. [Example 2-5](#) (page 2-21) shows part of a SELECT statement that queries the PC\_EXTENT attribute of the OCEAN\_FLOOR column of a hypothetical OCEAN\_FLOOR\_MODEL table.

**Example 2-5 SDO\_PC Attribute in a Query**

```
SELECT o.ocean_floor.pc_extent FROM ocean_floor_model o WHERE ...;
```

## 2.6.2 SDO\_PC\_BLK\_TYPE and SDO\_PC\_BLK Object Type

When you perform a clip operation using the [SDO\\_PC\\_PKG.CLIP\\_PC](#) (page 27-1) function, an object of SDO\_PC\_BLK\_TYPE is returned, which is defined as TABLE OF SDO\_PC\_BLK.

The attributes of the SDO\_PC\_BLK object type are the same as the columns in the point cloud block table, which is described in [Table 2-7](#) (page 2-20) in [SDO\\_PC Object Type](#) (page 2-19).

## 2.7 Geometry Examples

This section contains examples of many geometry types:

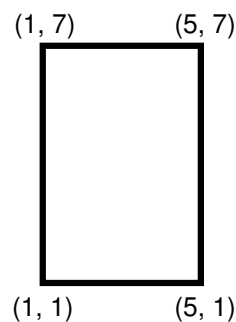
- [Rectangle](#) (page 2-22)
- [Polygon with a Hole](#) (page 2-23)
- [Compound Line String](#) (page 2-24)
- [Compound Polygon](#) (page 2-26)

- [Point](#) (page 2-27)
- [Oriented Point](#) (page 2-28)
- [Type 0 \(Zero\) Element](#) (page 2-31)
- [Several Two-Dimensional Geometry Types](#) (page 2-34)
- [Three-Dimensional Geometry Types](#) (page 2-38)

### 2.7.1 Rectangle

[Figure 2-3](#) (page 2-22) illustrates the rectangle that represents `cola_a` in the example in [Simple Example: Inserting\\_ Indexing\\_ and Querying Spatial Data](#) (page 2-1).

**Figure 2-3 Rectangle**



In the `SDO_GEOMETRY` definition of the geometry illustrated in [Figure 2-3](#) (page 2-22):

- `SDO_GTYPE` = 2003. The 2 indicates two-dimensional, and the 3 indicates a polygon.
- `SDO_SRID` = NULL.
- `SDO_POINT` = NULL.
- `SDO_ELEM_INFO` = (1, 1003, 3). The final 3 in 1,1003,3 indicates that this is a rectangle. Because it is a rectangle, only two ordinates are specified in `SDO_ORDINATES` (lower-left and upper-right).
- `SDO_ORDINATES` = (1,1, 5,7). These identify the lower-left and upper-right ordinates of the rectangle.

[Example 2-6](#) (page 2-22) shows a SQL statement that inserts the geometry illustrated in [Figure 2-3](#) (page 2-22) into the database.

**Example 2-6 SQL Statement to Insert a Rectangle**

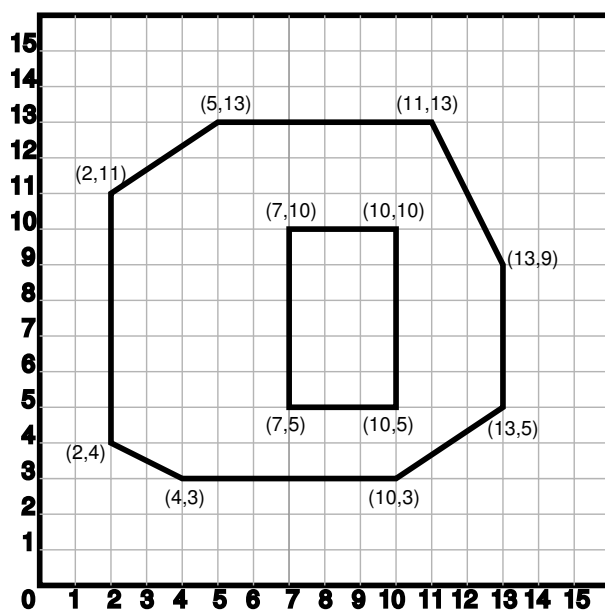
```
INSERT INTO cola_markets VALUES(  
  1,  
  'cola_a',  
  SDO_GEOMETRY(  
    2003, -- two-dimensional polygon  
    NULL,  
    NULL,  
    SDO_ELEM_INFO_ARRAY(1,1003,3), -- one rectangle (1003 = exterior)  
    SDO_ORDINATE_ARRAY(1,1, 5,7) -- only 2 points needed to  
      -- define rectangle (lower left and upper right) with  
      -- Cartesian-coordinate data
```

```
)
);
```

## 2.7.2 Polygon with a Hole

Figure 2-4 (page 2-23) illustrates a polygon consisting of two elements: an exterior polygon ring and an interior polygon ring. The inner element in this example is treated as a void (a hole).

**Figure 2-4 Polygon with a Hole**



In the SDO\_GEOMETRY definition of the geometry illustrated in Figure 2-4 (page 2-23):

- SDO\_GTYPE = 2003. The 2 indicates two-dimensional, and the 3 indicates a polygon.
- SDO\_SRID = NULL.
- SDO\_POINT = NULL.
- SDO\_ELEM\_INFO = (1,1003,1, 19,2003,1). There are two triplet elements: 1,1003,1 and 19,2003,1.  
1003 indicates that the element is an exterior polygon ring; 2003 indicates that the element is an interior polygon ring.  
19 indicates that the second element (the interior polygon ring) ordinate specification starts at the 19th number in the SDO\_ORDINATES array (that is, 7, meaning that the first point is 7,5).
- SDO\_ORDINATES = (2,4, 4,3, 10,3, 13,5, 13,9, 11,13, 5,13, 2,11, 2,4, 7,5, 7,10, 10,10, 10,5, 7,5).
- The area (SDO\_GEOM.SDO\_AREA (page 23-9) function) of the polygon is the area of the exterior polygon minus the area of the interior polygon. In this example, the area is 84 (99 - 15).

- The perimeter ([SDO\\_GEOM.SDO\\_LENGTH](#) (page 23-28) function) of the polygon is the perimeter of the exterior polygon plus the perimeter of the interior polygon. In this example, the perimeter is 52.9193065 (36.9193065 + 16).

**Example 2-7 SQL Statement to Insert a Polygon with a Hole**

[Example 2-7](#) (page 2-24) shows a SQL statement that inserts the geometry illustrated in [Figure 2-4](#) (page 2-23) into the database.

```
INSERT INTO cola_markets VALUES(
  10,
  'polygon_with_hole',
  SDO_GEOMETRY(
    2003, -- two-dimensional polygon
    NULL,
    NULL,
    SDO_ELEM_INFO_ARRAY(1,1003,1, 19,2003,1), -- polygon with hole
    SDO_ORDINATE_ARRAY(2,4, 4,3, 10,3, 13,5, 13,9, 11,13, 5,13, 2,11, 2,4,
      7,5, 7,10, 10,10, 10,5, 7,5)
  )
);
```

An example of such a "polygon with a hole" might be a land mass (such as a country or an island) with a lake inside it. Of course, an actual land mass might have many such interior polygons: each one would require a triplet element in `SDO_ELEM_INFO`, plus the necessary ordinate specification.

Exterior and interior rings cannot be nested. For example, if a country has a lake and there is an island in the lake (and perhaps a lake on the island), a separate polygon must be defined for the island; the island cannot be defined as an interior polygon ring within the interior polygon ring of the lake.

In a **multipolygon** (polygon collection), rings must be grouped by polygon, and the first ring of each polygon must be the exterior ring. For example, consider a polygon collection that contains two polygons (A and B):

- Polygon A (one interior "hole"): exterior ring A0, interior ring A1
- Polygon B (two interior "holes"): exterior ring B0, interior ring B1, interior ring B2

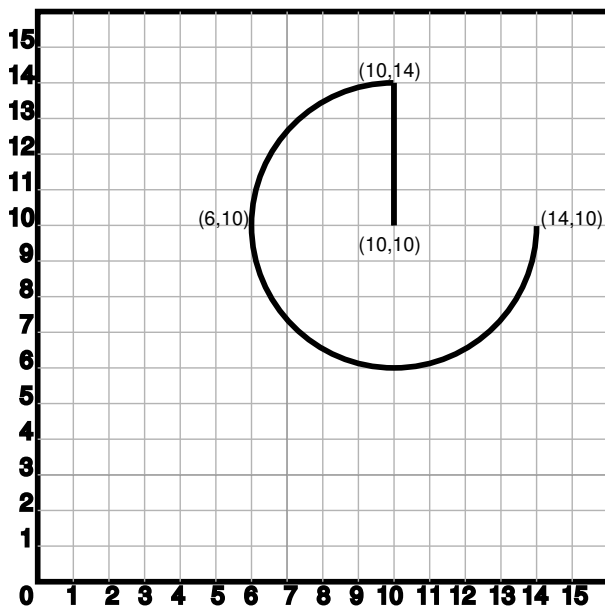
The elements in `SDO_ELEM_INFO` and `SDO_ORDINATES` must be in one of the following orders (depending on whether you specify Polygon A or Polygon B first):

- A0, A1; B0, B1, B2
- B0, B1, B2; A0, A1

## 2.7.3 Compound Line String

[Figure 2-5](#) (page 2-25) illustrates a crescent-shaped object represented as a compound line string made up of one straight line segment and one circular arc. Four points are required to represent this shape: points (10,10) and (10,14) describe the straight line segment, and points (10,14), (6,10), and (14,10) describe the circular arc.



**Figure 2-5 Compound Line String**

In the SDO\_GEOMETRY definition of the geometry illustrated in [Figure 2-5](#) (page 2-25):

- SDO\_GTYPE = 2002. The first 2 indicates two-dimensional, and the second 2 indicates one or more line segments.
- SDO\_SRID = NULL.
- SDO\_POINT = NULL.
- SDO\_ELEM\_INFO = (1,4,2, 1,2,1, 3,2,2). There are three triplet elements: 1,4,2, 1,2,1, and 3,2,2.

The first triplet indicates that this element is a compound line string made up of two subelement line strings, which are described with the next two triplets.

The second triplet indicates that the line string is made up of straight line segments and that the ordinates for this line string start at offset 1. The end point of this line string is determined by the starting offset of the second line string, 3 in this instance.

The third triplet indicates that the second line string is made up of circular arcs with ordinates starting at offset 3. The end point of this line string is determined by the starting offset of the next element or the current length of the SDO\_ORDINATES array, if this is the last element.

- SDO\_ORDINATES = (10,10, 10,14, 6,10, 14,10).

[Example 2-8](#) (page 2-25) shows a SQL statement that inserts the geometry illustrated in [Figure 2-5](#) (page 2-25) into the database.

**Example 2-8 SQL Statement to Insert a Compound Line String**

```
INSERT INTO cola_markets VALUES(
  11,
  'compound_line_string',
  SDO_GEOMETRY(
    2002,
    NULL,
```

```

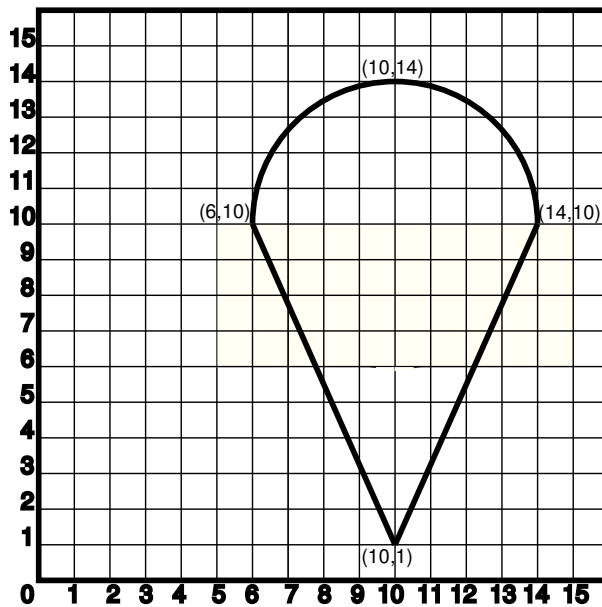
NULL,
SDO_ELEM_INFO_ARRAY(1,4,2, 1,2,1, 3,2,2), -- compound line string
SDO_ORDINATE_ARRAY(10,10, 10,14, 6,10, 14,10)
)
);

```

## 2.7.4 Compound Polygon

Figure 2-6 (page 2-26) illustrates an ice cream cone-shaped object represented as a compound polygon made up of one straight line segment and one circular arc. Five points are required to represent this shape: points (6,10), (10,1), and (14,10) describe one acute angle-shaped line string, and points (14,10), (10,14), and (6,10) describe the circular arc. The starting point of the line string and the ending point of the circular arc are the same point (6,10). The SDO\_ELEM\_INFO array contains three triplets for this compound line string. These triplets are {(1,1005,2), (1,2,1), (5,2,2)}.

**Figure 2-6 Compound Polygon**



In the SDO\_GEOMETRY definition of the geometry illustrated in Figure 2-6 (page 2-26):

- SDO\_GTYPE = 2003. The 2 indicates two-dimensional, and the 3 indicates a polygon.
- SDO\_SRID = NULL.
- SDO\_POINT = NULL.
- SDO\_ELEM\_INFO = (1,1005,2, 1,2,1, 5,2,2). There are three triplet elements: 1,1005,2, 1,2,1, and 5,2,2.

The first triplet indicates that this element is a compound polygon made up of two subelement line strings, which are described using the next two triplets.

The second triplet indicates that the first subelement line string is made up of straight line segments and that the ordinates for this line string start at offset 1. The end point of this line string is determined by the starting offset of the second line string, 5 in this instance. Because the vertices are two-dimensional, the coordinates for the end point of the first line string are at ordinates 5 and 6.

The third triplet indicates that the second subelement line string is made up of a circular arc with ordinates starting at offset 5. The end point of this line string is determined by the starting offset of the next element or the current length of the SDO\_ORDINATES array, if this is the last element.

- SDO\_ORDINATES = (6,10, 10,1, 14,10, 10,14, 6,10).

[Example 2-9](#) (page 2-27) shows a SQL statement that inserts the geometry illustrated in [Figure 2-6](#) (page 2-26) into the database.

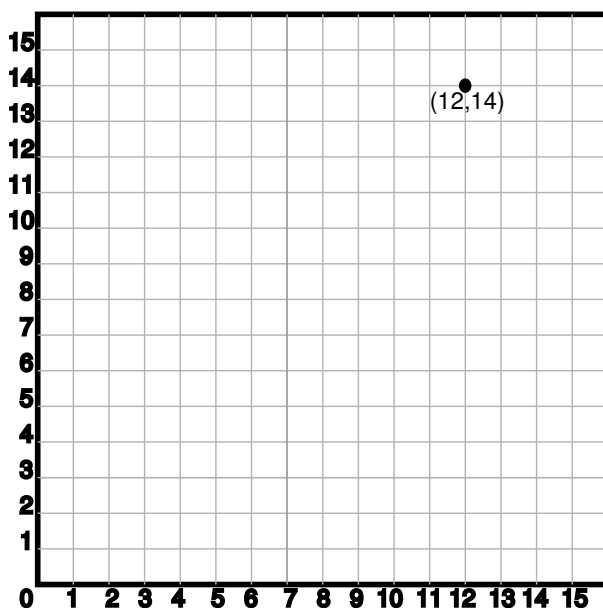
**Example 2-9 SQL Statement to Insert a Compound Polygon**

```
INSERT INTO cola_markets VALUES(
  12,
  'compound_polygon',
  SDO_GEOMETRY(
    2003, -- two-dimensional polygon
    NULL,
    NULL,
    SDO_ELEM_INFO_ARRAY(1,1005,2, 1,2,1, 5,2,2), -- compound polygon
    SDO_ORDINATE_ARRAY(6,10, 10,1, 14,10, 10,14, 6,10)
  )
);
```

## 2.7.5 Point

[Figure 2-7](#) (page 2-27) illustrates a point-only geometry at coordinates (12,14).

**Figure 2-7 Point-Only Geometry**



In the SDO\_GEOMETRY definition of the geometry illustrated in [Figure 2-7](#) (page 2-27):

- SDO\_GTYPE = 2001. The 2 indicates two-dimensional, and the 1 indicates a single point.
- SDO\_SRID = NULL.

- `SDO_POINT = SDO_POINT_TYPE(12, 14, NULL)`. The `SDO_POINT` attribute is defined using the `SDO_POINT_TYPE` object type, because this is a point-only geometry.

For more information about the `SDO_POINT` attribute, see [SDO\\_POINT](#) (page 2-7).

- `SDO_ELEM_INFO` and `SDO_ORDINATES` are both `NULL`, as required if the `SDO_POINT` attribute is specified.

[Example 2-10](#) (page 2-28) shows a SQL statement that inserts the geometry illustrated in [Figure 2-7](#) (page 2-27) into the database.

**Example 2-10 SQL Statement to Insert a Point-Only Geometry**

```
INSERT INTO cola_markets VALUES(
  90,
  'point_only',
  SDO_GEOMETRY(
    2001,
    NULL,
    SDO_POINT_TYPE(12, 14, NULL),
    NULL,
    NULL)) ;
```

You can search for point-only geometries based on the X, Y, and Z values in the `SDO_POINT_TYPE` specification. [Example 2-11](#) (page 2-28) is a query that asks for all points whose first coordinate (the X value) is 12, and it finds the point that was inserted in [Example 2-10](#) (page 2-28).

**Example 2-11 Query for Point-Only Geometry Based on a Coordinate Value**

```
SELECT * from cola_markets c WHERE c.shape.SDO_POINT.X = 12;
```

```

MKT_ID NAME
-----
90 point_only
SDO_GEOMETRY(2001, NULL, SDO_POINT_TYPE(12, 14, NULL), NULL, NULL)
SHAPE(SDO_GTYPE, SDO_SRID, SDO_POINT(X, Y, Z), SDO_ELEM_INFO, SDO_ORDINATES)
-----
```

## 2.7.6 Oriented Point

An **oriented point** is a special type of point geometry that includes coordinates representing the locations of the point and a virtual end point, to indicate an orientation vector that can be used for rotating a symbol at the point or extending a label from the point. The main use for an oriented point is in map visualization and display applications that include symbols, such as a shield symbol to indicate a highway.

To specify an oriented point:

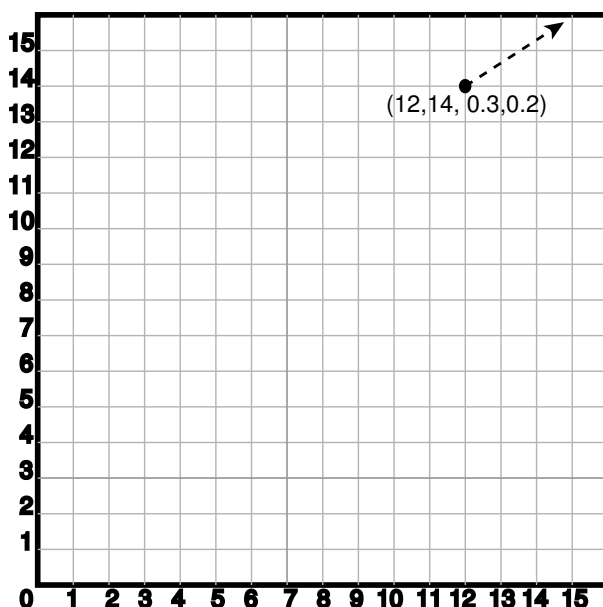
- Use an `SDO_GTYPE` value (explained in [SDO\\_GTYPE](#) (page 2-5)) for a point or multipoint geometry.
- Specify a null value for the `SDO_POINT` attribute.
- In the `SDO_ELEM_INFO` array (explained in [SDO\\_ELEM\\_INFO](#) (page 2-8)), specify an additional triplet, with the second and third values (`SDO_ETYPE` and `SDO_INTERPRETATION`) as 1 and 0. For example, a triplet of 3,1,0 indicates that the point is an oriented point, with the third number in the `SDO_ORDINATES`

array being the first coordinate, or x-axis value, of the end point reflecting the orientation vector for any symbol or label.

- In the SDO\_ORDINATES array (explained in [SDO\\_ORDINATES](#) (page 2-11)), specify the coordinates of the end point for the orientation vector from the point, with values between -1 and 1. The orientation start point is assumed to be (0,0), and it is translated to the location of the physical point to which it corresponds.

[Figure 2-8](#) (page 2-29) illustrates an oriented point geometry at coordinates (12,14), with an orientation vector of approximately 34 degrees (counterclockwise from the x-axis), reflecting the orientation coordinates 0.3,0.2. (To have an orientation that more precisely matches a specific angle, refer to the cotangent or tangent values in the tables in a trigonometry textbook.) The orientation vector in this example goes from (0,0) to (0.3,0.2) and extends onward. Assuming  $i=0.3$  and  $j=0.2$ , the angle in radians can be calculated as follows:  $\text{angle in radians} = \arctan(j/i)$ . The angle is then applied to the physical point associated with the orientation vector.

**Figure 2-8 Oriented Point Geometry**



In the SDO\_GEOMETRY definition of the geometry illustrated in [Figure 2-8](#) (page 2-29):

- SDO\_GTYPE = 2001. The 2 indicates two-dimensional, and the 1 indicates a single point.
- SDO\_SRID = NULL.
- SDO\_POINT = NULL.
- SDO\_ELEM\_INFO = (1,1,1, 3,1,0). The final 1,0 in 3,1,0 indicates that this is an oriented point.
- SDO\_ORDINATES = (12,14, 0.3,0.2). The 12,14 identifies the physical coordinates of the point; and the 0.3,0.2 identifies the x and y coordinates (assuming 12,14 as the origin) of the end point of the orientation vector. The resulting orientation vector slopes upward at about a 34-degree angle.

[Example 2-12](#) (page 2-30) shows a SQL statement that inserts the geometry illustrated in [Figure 2-8](#) (page 2-29) into the database.

**Example 2-12 SQL Statement to Insert an Oriented Point Geometry**

```
INSERT INTO cola_markets VALUES(
  91,
  'oriented_point',
  SDO_GEOMETRY(
    2001,
    NULL,
    NULL,
    SDO_ELEM_INFO_ARRAY(1,1,1, 3,1,0),
    SDO_ORDINATE_ARRAY(12,14, 0.3,0.2)));
```

The following guidelines apply to the definition of an oriented point:

- The numbers defining the orientation vector must be between -1 and 1. (In [Example 2-12](#) (page 2-30), these numbers are 0.3 and 0.2.)
- Multipoint oriented points are allowed (see [Example 2-13](#) (page 2-30)), but the orientation information must follow the point being oriented.

The following considerations apply to the dimensionality of the orientation vector for an oriented point:

- A two-dimensional point has a two-dimensional orientation vector.
- A two-dimensional point with an LRS measure (SDO\_GTYPE=3301) has a two-dimensional orientation vector.
- A three-dimensional point (SDO\_GTYPE=3001) has a three-dimensional orientation vector.
- A three-dimensional point with an LRS measure (SDO\_GTYPE=4401) has a three-dimensional orientation vector.
- A four-dimensional point (SDO\_GTYPE=4001) has a three-dimensional orientation vector.

**Example 2-13 SQL Statement to Insert an Oriented Multipoint Geometry**

[Example 2-13](#) (page 2-30) shows a SQL statement that inserts an oriented multipoint geometry into the database. The multipoint geometry contains two points, at coordinates (12,14) and (12, 10), with the two points having different orientation vectors. The statement is similar to the one in [Example 2-12](#) (page 2-30), but in [Example 2-13](#) (page 2-30) the second point has an orientation vector pointing down and to the left at 45 degrees (or, 135 degrees clockwise from the x-axis), reflecting the orientation coordinates -1,-1.

```
-- Oriented multipoint: 2 points, different orientations
INSERT INTO cola_markets VALUES(
  92,
  'oriented_multipoint',
  SDO_GEOMETRY(
    2005, -- Multipoint
    NULL,
    NULL,
    SDO_ELEM_INFO_ARRAY(1,1,1, 3,1,0, 5,1,1, 7,1,0),
    SDO_ORDINATE_ARRAY(12,14, 0.3,0.2, 12,10, -1,-1)));
```

## 2.7.7 Type 0 (Zero) Element

Type 0 (zero) elements are used to model geometry types that are not supported by Oracle Spatial and Graph, such as curves and splines. A type 0 element has an SDO\_ETYPE value of 0. (See [SDO\\_ELEM\\_INFO](#) (page 2-8) for information about the SDO\_ETYPE.) Type 0 elements are not indexed by Oracle Spatial and Graph, and they are ignored by spatial functions and procedures.

Geometries with type 0 elements must contain at least one nonzero element, that is, an element with an SDO\_ETYPE value that is not 0. The nonzero element should be an approximation of the unsupported geometry, and therefore it must have both:

- An SDO\_ETYPE value associated with a geometry type supported by Spatial and Graph
- An SDO\_INTERPRETATION value that is valid for the SDO\_ETYPE value (see [Table 2-2](#) (page 2-9))

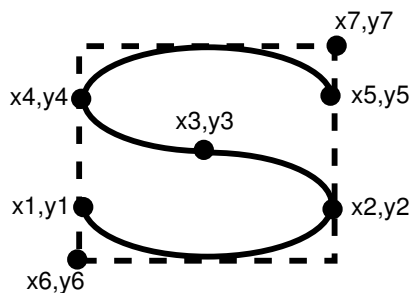
(The SDO\_INTERPRETATION value for the type 0 element can be any numeric value, and applications are responsible for determining the validity and significance of the value.)

The nonzero element is indexed by Spatial and Graph, and it will be returned by the spatial index.

The SDO\_GTYPE value for a geometry containing a type 0 element must be set to the value for the geometry type of the nonzero element.

[Figure 2-9](#) (page 2-31) shows a geometry with two elements: a curve (unsupported geometry) and a rectangle (the nonzero element) that approximates the curve. The curve looks like the letter S, and the rectangle is represented by the dashed line.

**Figure 2-9 Geometry with Type 0 (Zero) Element**



In the example shown in [Figure 2-9](#) (page 2-31):

- The SDO\_GTYPE value for the geometry is 2003 (for a two-dimensional polygon).
- The SDO\_ELEM\_INFO array contains two triplets for this compound line string. For example, the triplets might be {(1,0,57), (11,1003,3)}. That is:

Ordinate Starting Offset (SDO_STARTING_OFFSET)	Element Type (SDO_ETYPE)	Interpretation (SDO_INTERPRETATION)
1	0	57
11	1003	3

In this example:

- The type 0 element has an SDO\_ETYPE value of 0.
- The nonzero element (rectangle) has an SDO\_ETYPE value of 1003, indicating an exterior polygon ring.
- The nonzero element has an SDO\_STARTING\_OFFSET value of 11 because ordinate x6 is the eleventh ordinate in the geometry.
- The type 0 element has an SDO\_INTERPRETATION value whose significance is application-specific. In this example, the SDO\_INTERPRETATION value is 57.
- The nonzero element has an SDO\_INTERPRETATION value that is valid for the SDO\_ETYPE of 1003. In this example, the SDO\_INTERPRETATION value is 3, indicating a rectangle defined by two points (lower-left and upper-right).

**Example 2-14** (page 2-32) shows a SQL statement that inserts the geometry with a type 0 element (similar to the geometry illustrated in [Figure 2-9](#) (page 2-31)) into the database. In the SDO\_ORDINATE\_ARRAY structure, the curve is defined by points (6,6), (12,6), (9,8), (6,10), and (12,10), and the rectangle is defined by points (6,4) and (12,12).

**Example 2-14 SQL Statement to Insert a Geometry with a Type 0 Element**

```
INSERT INTO cola_markets VALUES(
  13,
  'type_zero_element_geom',
  SDO_GEOMETRY(
    2003, -- two-dimensional polygon
    NULL,
    NULL,
    SDO_ELEM_INFO_ARRAY(1,0,57, 11,1003,3), -- 1st is type 0 element
    SDO_ORDINATE_ARRAY(6,6, 12,6, 9,8, 6,10, 12,10, 6,4, 12,12)
  )
);
```

## 2.7.8 NURBS Curve

A NURBS (non-uniform rational B-spline) curve allows the representation of free-form shapes with arbitrary shapes. NURBS representation allows control over the shape of the curve because control points and knots guide the shape of the curve, and they allow complex shapes to be represented with little data. For an explanation of NURBS curves and the requirements for defining a NURBS curve geometry, see [NURBS Curve Support in Oracle Spatial and Graph](#) (page 1-27).

**Example 2-15** (page 2-33) shows a SQL statement that inserts a NURBS curve geometry into the database.

In the SDO\_GEOMETRY definition of the geometry illustrated in [Example 2-15](#) (page 2-33):

- SDO\_GTYPE = 2002. The first 2 indicates two-dimensional, and the second 2 indicates a single line string.
- SDO\_SRID = NULL. Note that geodetic NURBS curves are not permitted in Oracle Spatial and Graph.
- SDO\_POINT = NULL.
- SDO\_ELEM\_INFO\_ARRAY = (1,2,3). The SDO\_INTERPRETATION value of 3 indicates a NURBS curve.



- In the SDO\_ORDINATE\_ARRAY, 3 is the degree of the NURBS curve, 7 is the number of weighted control points, and 11 in the number of knot values.

**Example 2-15 SQL Statement to Insert a NURBS Curve Geometry**

```
CREATE TABLE nurbs_test (gid integer, geom sdo_geometry);

INSERT INTO nurbs_test values(
  1,
  SDO_GEOMETRY(
    2002,
    NULL,
    NULL,
    SDO_ELEM_INFO_ARRAY(1, 2, 3), /* Element type 2 = SDO_ETYPE_CURVE and
    Interpretation value 3 = NURBS curve */
    SDO_ORDINATE_ARRAY
      (3, /* Degree of the NURBS curve */
       7, /* Number of weighted Control Points */
       0, 0, 1, /* x1, y1, w1 where w1 denotes the weight of the control point and
       x1, y1 are weighted values. Implies the actual coordinate values have been
       multiplied by w1 */
       -0.5, 1, 1,
       0.2, 2, 1,
       0.5, 3.5, 1,
       0.8, 2, 1,
       0.9, 1, 1,
       0.3, 0, 1,
       11, /* Number of knot values = Number of control points + degree + 1 */
       0, 0, 0, 0, 0.25, 0.5, 0.75, 1.0, 1.0, 1.0, 1.0)); /* Normalized knot
vector; values start at zero and end at 1. Clamped at end points as multiplicity of
zero and one is 4, which is equal to the degree of the curve + 1 */
```

**Example 2-16 SQL Statement to Insert a NURBS Compound Curve Geometry**

[Example 2-16](#) (page 2-33) shows the insertion of a compound curve geometry that has a NURBS segment. It uses the same NURBS\_TEST table created in [Example 2-15](#) (page 2-33).

```
INSERT INTO nurbs_test VALUES(
  1,
  SDO_GEOMETRY(2002, NULL, NULL,
    SDO_ELEM_INFO_ARRAY(1, 4, 2, 1, 2, 1, 5, 2, 3),
    SDO_ORDINATE_ARRAY(-1, -1, 0, 0, 3, 7, 0, 0, 1, -0.5, 1, 1,
      0.2, 2, 1, 0.5, 3.5, 1, 0.8, 2, 1, 0.9, 1, 1, 0.3,
      0, 1, 11, 0, 0, 0, 0, 0.25, 0.5, 0.75, 1.0, 1.0, 1.0, 1.0)
  ));
```

In the SDO\_GEOMETRY definition of the geometry illustrated in [Example 2-16](#) (page 2-33):

- SDO\_GTYPE = 2002. The first 2 indicates two-dimensional, and the second 2 indicates a single line string.
- SDO\_SRID = NULL. Note that geodetic NURBS curves are not permitted in Oracle Spatial and Graph.
- SDO\_POINT = NULL.
- SDO\_ELEM\_INFO\_ARRAY = (1, 4, 2, 1, 2, 1, 5, 2, 3). The first triplet indicates a compound line string (interpretation = 4) with two elements. The next two triplets define the segments of the compound line string: the first segment is a line string

beginning at offset 1; the second segment is a NURBS segment beginning at offset 5.

- In the `SDO_ORDINATE_ARRAY`, the first 4 values define the first segment, which is a simple line string. For compound line strings containing at least one NURBS segment, the common vertices will be repeated across segments. In this example, the last point of the line string (0,0) must be equal to the first "clamped" point of the NURBS curve (0,0). The NURBS segment is defined beginning at offset 5 and the first control point is (0,0), which follows the degree (3) and the number of control points (7). The NURBS segment has 11 knot values.

## 2.7.9 Several Two-Dimensional Geometry Types

[Example 2-17](#) (page 2-34) creates a table and inserts various two-dimensional geometries, including multipoints (point clusters), multipolygons, and collections. At the end, it calls the [SDO\\_GEOM.VALIDATE\\_GEOMETRY\\_WITH\\_CONTEXT](#) (page 23-52) function to validate the inserted geometries. Note that some geometries are deliberately invalid, and their descriptions include the string `INVALID`.

### **Example 2-17** *SQL Statements to Insert Various Two-Dimensional Geometries*

```
CREATE TABLE t1 (  
  i NUMBER,  
  d VARCHAR2(50),  
  g SDO_GEOMETRY  
);  
INSERT INTO t1 (i, d, g)  
VALUES (  
  1,  
  'Point',  
  sdo_geometry (2001, null, null, sdo_elem_info_array (1,1,1),  
    sdo_ordinate_array (10,5))  
);  
INSERT INTO t1 (i, d, g)  
VALUES (  
  2,  
  'Line segment',  
  sdo_geometry (2002, null, null, sdo_elem_info_array (1,2,1),  
    sdo_ordinate_array (10,10, 20,10))  
);  
INSERT INTO t1 (i, d, g)  
VALUES (  
  3,  
  'Arc segment',  
  sdo_geometry (2002, null, null, sdo_elem_info_array (1,2,2),  
    sdo_ordinate_array (10,15, 15,20, 20,15))  
);  
INSERT INTO t1 (i, d, g)  
VALUES (  
  4,  
  'Line string',  
  sdo_geometry (2002, null, null, sdo_elem_info_array (1,2,1),  
    sdo_ordinate_array (10,25, 20,30, 25,25, 30,30))  
);  
INSERT INTO t1 (i, d, g)  
VALUES (  
  5,  
  'Arc string',  
  sdo_geometry (2002, null, null, sdo_elem_info_array (1,2,2),  
    sdo_ordinate_array (10,35, 15,40, 20,35, 25,30, 30,35))
```

```

);
INSERT INTO t1 (i, d, g)
VALUES (
    6,
    'Compound line string',
    sdo_geometry (2002, null, null,
        sdo_elem_info_array (1,4,3, 1,2,1, 3,2,2, 7,2,1),
        sdo_ordinate_array (10,45, 20,45, 23,48, 20,51, 10,51))
);
INSERT INTO t1 (i, d, g)
VALUES (
    7,
    'Closed line string',
    sdo_geometry (2002, null, null, sdo_elem_info_array (1,2,1),
        sdo_ordinate_array (10,55, 15,55, 20,60, 10,60, 10,55))
);
INSERT INTO t1 (i, d, g)
VALUES (
    8,
    'Closed arc string',
    sdo_geometry (2002, null, null, sdo_elem_info_array (1,2,2),
        sdo_ordinate_array (15,65, 10,68, 15,70, 20,68, 15,65))
);
INSERT INTO t1 (i, d, g)
VALUES (
    9,
    'Closed mixed line',
    sdo_geometry (2002, null, null, sdo_elem_info_array (1,4,2, 1,2,1, 7,2,2),
        sdo_ordinate_array (10,78, 10,75, 20,75, 20,78, 15,80, 10,78))
);
INSERT INTO t1 (i, d, g)
VALUES (
    10,
    'Self-crossing line',
    sdo_geometry (2002, null, null, sdo_elem_info_array (1,2,1),
        sdo_ordinate_array (10,85, 20,90, 20,85, 10,90, 10,85))
);
INSERT INTO t1 (i, d, g)
VALUES (
    11,
    'Polygon',
    sdo_geometry (2003, null, null, sdo_elem_info_array (1,1003,1),
        sdo_ordinate_array (10,105, 15,105, 20,110, 10,110, 10,105))
);
INSERT INTO t1 (i, d, g)
VALUES (
    12,
    'Arc polygon',
    sdo_geometry (2003, null, null, sdo_elem_info_array (1,1003,2),
        sdo_ordinate_array (15,115, 20,118, 15,120, 10,118, 15,115))
);
INSERT INTO t1 (i, d, g)
VALUES (
    13,
    'Compound polygon',
    sdo_geometry (2003, null, null, sdo_elem_info_array (1,1005,2, 1,2,1, 7,2,2),
        sdo_ordinate_array (10,128, 10,125, 20,125, 20,128, 15,130, 10,128))
);
INSERT INTO t1 (i, d, g)
VALUES (
    14,

```

```
'Rectangle',
sdo_geometry (2003, null, null, sdo_elem_info_array (1,1003,3),
sdo_ordinate_array (10,135, 20,140))
);
INSERT INTO t1 (i, d, g)
VALUES (
15,
'Circle',
sdo_geometry (2003, null, null, sdo_elem_info_array (1,1003,4),
sdo_ordinate_array (15,145, 10,150, 20,150))
);
INSERT INTO t1 (i, d, g)
VALUES (
16,
'Point cluster',
sdo_geometry (2005, null, null, sdo_elem_info_array (1,1,3),
sdo_ordinate_array (50,5, 55,7, 60,5))
);
INSERT INTO t1 (i, d, g)
VALUES (
17,
'Multipoint',
sdo_geometry (2005, null, null, sdo_elem_info_array (1,1,1, 3,1,1, 5,1,1),
sdo_ordinate_array (65,5, 70,7, 75,5))
);
INSERT INTO t1 (i, d, g)
VALUES (
18,
'Multiline',
sdo_geometry (2006, null, null, sdo_elem_info_array (1,2,1, 5,2,1),
sdo_ordinate_array (50,15, 55,15, 60,15, 65,15))
);
INSERT INTO t1 (i, d, g)
VALUES (
19,
'Multiline - crossing',
sdo_geometry (2006, null, null, sdo_elem_info_array (1,2,1, 5,2,1),
sdo_ordinate_array (50,22, 60,22, 55,20, 55,25))
);
INSERT INTO t1 (i, d, g)
VALUES (
20,
'Multiarc',
sdo_geometry (2006, null, null, sdo_elem_info_array (1,2,2, 7,2,2),
sdo_ordinate_array (50,35, 55,40, 60,35, 65,35, 70,30, 75,35))
);
INSERT INTO t1 (i, d, g)
VALUES (
21,
'Multiline - closed',
sdo_geometry (2006, null, null, sdo_elem_info_array (1,2,1, 9,2,1),
sdo_ordinate_array (50,55, 50,60, 55,58, 50,55, 56,58, 60,55, 60,60, 56,58))
);
INSERT INTO t1 (i, d, g)
VALUES (
22,
'Multiarc - touching',
sdo_geometry (2006, null, null, sdo_elem_info_array (1,2,2, 7,2,2),
sdo_ordinate_array (50,65, 50,70, 55,68, 55,68, 60,65, 60,70))
);
INSERT INTO t1 (i, d, g)
```

```

VALUES (
  23,
  'Multipolygon - disjoint',
  sdo_geometry (2007, null, null, sdo_elem_info_array (1,1003,1, 11,1003,3),
    sdo_ordinate_array (50,105, 55,105, 60,110, 50,110, 50,105, 62,108, 65,112))
);
INSERT INTO t1 (i, d, g)
VALUES (
  24,
  'Multipolygon - touching',
  sdo_geometry (2007, null, null, sdo_elem_info_array (1,1003,3, 5,1003,3),
    sdo_ordinate_array (50,115, 55,120, 55,120, 58,122))
);
INSERT INTO t1 (i, d, g)
VALUES (
  25,
  'Multipolygon - tangent * INVALID 13351',
  sdo_geometry (2007, null, null, sdo_elem_info_array (1,1003,3, 5,1003,3),
    sdo_ordinate_array (50,125, 55,130, 55,128, 60,132))
);
INSERT INTO t1 (i, d, g)
VALUES (
  26,
  'Multipolygon - multi-touch',
  sdo_geometry (2007, null, null, sdo_elem_info_array (1,1003,1, 17,1003,1),
    sdo_ordinate_array (50,95, 55,95, 53,96, 55,97, 53,98, 55,99, 50,99, 50,95,
      55,100, 55,95, 60,95, 60,100, 55,100))
);
INSERT INTO t1 (i, d, g)
VALUES (
  27,
  'Polygon with void',
  sdo_geometry (2003, null, null, sdo_elem_info_array (1,1003,3, 5,2003,3),
    sdo_ordinate_array (50,135, 60,140, 51,136, 59,139))
);
INSERT INTO t1 (i, d, g)
VALUES (
  28,
  'Polygon with void - reverse',
  sdo_geometry (2003, null, null, sdo_elem_info_array (1,2003,3, 5,1003,3),
    sdo_ordinate_array (51,146, 59,149, 50,145, 60,150))
);
INSERT INTO t1 (i, d, g)
VALUES (
  29,
  'Crescent (straight lines) * INVALID 13349',
  sdo_geometry (2003, null, null, sdo_elem_info_array (1,1003,1),
    sdo_ordinate_array (10,175, 10,165, 20,165, 15,170, 25,170, 20,165,
      30,165, 30,175, 10,175))
);
INSERT INTO t1 (i, d, g)
VALUES (
  30,
  'Crescent (arcs) * INVALID 13349',
  sdo_geometry (2003, null, null, sdo_elem_info_array (1,1003,2),
    sdo_ordinate_array (14,180, 10,184, 14,188, 18,184, 14,180, 16,182,
      14,184, 12,182, 14,180))
);
INSERT INTO t1 (i, d, g)
VALUES (
  31,

```

```
'Heterogeneous collection',
sdo_geometry (2004, null, null, sdo_elem_info_array (1,1,1, 3,2,1, 7,1003,1),
sdo_ordinate_array (10,5, 10,10, 20,10, 10,105, 15,105, 20,110, 10,110,
10,105))
);
INSERT INTO t1 (i, d, g)
VALUES (
32,
'Polygon+void+island touch',
sdo_geometry (2007, null, null,
sdo_elem_info_array (1,1003,1, 11,2003,1, 31,1003,1),
sdo_ordinate_array (50,168, 50,160, 55,160, 55,168, 50,168, 51,167,
54,167, 54,161, 51,161, 51,162, 52,163, 51,164, 51,165, 51,166, 51,167,
52,166, 52,162, 53,162, 53,166, 52,166))
);
COMMIT;
SELECT i, d, SDO_GEOM.VALIDATE_GEOMETRY_WITH_CONTEXT (g, 0.5) FROM t1;
```

## 2.7.10 Three-Dimensional Geometry Types

[Example 2-18](#) (page 2-38) creates several tables (POINTS3D, LINES3D, and POLYGONS3D), and inserts three-dimensional objects into each table as appropriate (points into POINTS3D; lines into LINES3D; and polygons, surfaces, and solids into POLYGONS3D). [Example 2-19](#) (page 2-46) then creates the metadata and spatial indexes for the tables.

For information about support for three-dimensional geometries, see [Three-Dimensional Spatial Objects](#) (page 1-16).

### **Example 2-18 SQL Statements to Insert Three-Dimensional Geometries**

```
create table points3d(id number, geometry sdo_geometry);
insert into points3d values(1, sdo_geometry(3001,null,
sdo_point_type(0,0,0), null, null));
insert into points3d values(2, sdo_geometry(3001,null,
sdo_point_type(1,1,1), null, null));
insert into points3d values(3, sdo_geometry(3001,null,
sdo_point_type(0,1,1), null, null));
insert into points3d values(4, sdo_geometry(3001,null,
sdo_point_type(0,0,1), null, null));
insert into points3d values(5, sdo_geometry(3001,null,
sdo_point_type(1,1,0), null, null));
insert into points3d values(6, sdo_geometry(3001,null,
sdo_point_type(1,0,1), null, null));
insert into points3d values(7, sdo_geometry(3001,null,
sdo_point_type(1,0,0), null, null));
insert into points3d values(8, sdo_geometry(3001,null,
sdo_point_type(0,1,0), null, null));
insert into points3d values(9, sdo_geometry(3005,null, null,
sdo_elem_info_array(1,1,1, 4,1,1),
sdo_ordinate_array(1,1,1, 0,0,0)));

create table lines3d(id number, geometry sdo_geometry);
insert into lines3d values(1, sdo_geometry(3002,null, null,
sdo_elem_info_array(1,2,1),
sdo_ordinate_array(1,1,1, 0,0,0)));
insert into lines3d values(2, sdo_geometry(3002,null, null,
sdo_elem_info_array(1,2,1),
sdo_ordinate_array(1,0,1, 0,1,0)));
insert into lines3d values(2, sdo_geometry(3002,null, null,
sdo_elem_info_array(1,2,1),
```

```

        sdo_ordinate_array(0,1,1, 1,0,0)));
insert into lines3d values(3, sdo_geometry(3002,null, null,
        sdo_elem_info_array(1,2,1),
        sdo_ordinate_array(0,1,1, 1,0,0)));
insert into lines3d values(4, sdo_geometry(3002,null, null,
        sdo_elem_info_array(1,2,1),
        sdo_ordinate_array(0,1,0, 1,0,1)));

create table polygons3d(id number, geometry sdo_geometry);

-- Simple Polygon
-- All points have to be on the same plane.
insert into polygons3d values(1,
SDO_Geometry (3003,NULL,NULL ,
  SDO_Elem_Info_Array(1,1003,1),
  SDO_Ordinate_Array(0.5,0.0,0.0,
0.5,1.0,0.0,
0.0,1.0,1.0,
0.0,0.0,1.0,
0.5,0.0,0.0
)));
insert into polygons3d values(2,
SDO_Geometry (3003,NULL,NULL ,
  SDO_Elem_Info_Array(1,1003,1),
  SDO_Ordinate_Array(6.0,6.0,6.0,
5.0,6.0,10.0,
3.0,4.0,8.0,
4.0,4.0,4.0,
6.0,6.0,6.0
)));
insert into polygons3d values(3,
SDO_Geometry (3007,NULL,NULL ,
  SDO_Elem_Info_Array(1,1003,1,16,1003,1),
  SDO_Ordinate_Array(6.0,6.0,6.0,
5.0,6.0,10.0,
3.0,4.0,8.0,
4.0,4.0,4.0,
6.0,6.0,6.0,
0.5,0.0,0.0,
0.5,1.0,0.0,
0.0,1.0,1.0,
0.0,0.0,1.0,
0.5,0.0,0.0
)));
-- Polygon with a Hole (same rules as 2D) plus all points on the same plane
insert into polygons3d values(4,
SDO_Geometry (3003,NULL,NULL ,
  SDO_Elem_Info_Array(1,1003,1,16,2003,1),
  SDO_Ordinate_Array(0.5,0.0,0.0,
0.5,1.0,0.0,
0.0,1.0,1.0,
0.0,0.0,1.0,
0.5,0.0,0.0,
0.25,0.5,0.5,
0.15,0.5,0.7,
0.15,0.6,0.7,
0.25,0.6,0.5,
0.25,0.5,0.5
)));
-- Surface with 2 3D polygons (on same plane)
insert into polygons3d values(5,

```

```
SDO_Geometry (3003,NULL,NULL ,
  SDO_Elem_Info_Array(1,1006,2,1,1003,1,16,1003,1),
  SDO_Ordinate_Array(0.5,0.0,0.0,
0.5,1.0,0.0,
0.0,1.0,0.0,
0.0,0.0,0.0,
0.5,0.0,0.0,
1.5,0.0,0.0,
2.5,1.0,0.0,
1.5,2.0,0.0,
0.5,2.0,0.0,
0.5,0.0,0.0,
1.5,0.0,0.0
));
-- Surface with 2 3D polygons (on two planes)
insert into polygons3d values(5,
SDO_Geometry(3003,NULL,NULL ,
  SDO_Elem_Info_Array(1,1006,2,1,1003,3,7,1003,3),
  SDO_Ordinate_Array(2,2,2,
4,4,2,
2,2,2,
4,2,4
));
-- Surface with 2 3D polygons
-- First polygon has one ext and one int.
insert into polygons3d values(6,
SDO_Geometry (3003,NULL,NULL ,
  SDO_Elem_Info_Array(1,1006,2,1,1003,1,16,2003,1,31,1003,1),
  SDO_Ordinate_Array(0.5,0.0,0.0,
0.5,1.0,0.0,
0.0,1.0,1.0,
0.0,0.0,1.0,
0.5,0.0,0.0,
0.25,0.5,0.5,
0.15,0.5,0.7,
0.15,0.6,0.7,
0.25,0.6,0.5,
0.25,0.5,0.5,
1.5,0.0,0.0,
2.5,1.0,0.0,
1.5,2.0,0.0,
0.5,2.0,0.0,
0.5,0.0,0.0,
1.5,0.0,0.0
));
--3D Surface with 3 3D polygons
insert into polygons3d values(7,
SDO_Geometry (3003,NULL,NULL ,
  SDO_Elem_Info_Array(1,1006,3,1,1003,1,16,1003,1,34,1003,1),
  SDO_Ordinate_Array(0.5,0.0,0.0,
0.5,1.0,0.0,
0.0,1.0,1.0,
0.0,0.0,1.0,
0.5,0.0,0.0,
1.5,0.0,0.0,
2.5,1.0,0.0,
1.5,2.0,0.0,
0.5,2.0,0.0,
0.5,0.0,0.0,
1.5,0.0,0.0,
1.5,0.0,0.0,
```



```

2.5,0.0,0.0,
2.5,1.0,0.0,
1.5,0.0,0.0
));
-- 3D surface with 3 3D polygons
insert into polygons3d values(8,
SDO_Geometry (3003,NULL,NULL ,
  SDO_Elem_Info_Array(1,1006,3,1,1003,1,16,2003,1,31,1003,1,49,1003,1),
  SDO_Ordinate_Array(0.5,0.0,0.0,
0.5,1.0,0.0,
0.0,1.0,1.0,
0.0,0.0,1.0,
0.5,0.0,0.0,
0.25,0.5,0.5,
0.15,0.5,0.7,
0.15,0.6,0.7,
0.25,0.6,0.5,
0.25,0.5,0.5,
1.5,0.0,0.0,
2.5,1.0,0.0,
1.5,2.0,0.0,
0.5,2.0,0.0,
0.5,0.0,0.0,
1.5,0.0,0.0,
0.5,1.0,0.0,
0.5,2.0,0.0,
0.0,2.0,0.0,
0.0,1.0,0.0,
0.5,1.0,0.0
));
-- Simple 3D polygon
insert into polygons3d values(9,
SDO_Geometry (3003,NULL,NULL ,
  SDO_Elem_Info_Array(1,1003,1),
  SDO_Ordinate_Array(0.0,-4.0,1.0,
4.0,-4.0,1.0,
5.0,-3.0,1.0,
5.0,0.0,1.0,
3.0,1.0,1.0,
-1.0,1.0,1.0,
-3.0,0.5,1.0,
0.0,0.0,1.0,
-6.0,-2.0,1.0,
-6.0,-3.5,1.0,
-2.0,-3.5,1.0,
0.0,-4.0,1.0
));
-- SOLID with 6 polygons
insert into polygons3d values(10,
SDO_Geometry (3008,NULL,NULL ,

SDO_Elem_Info_Array(1,1007,1,1,1006,6,1,1003,1,16,1003,1,31,1003,1,46,1003,1,61,1003,
1,76,1003,1),
  SDO_Ordinate_Array(1.0,0.0,-1.0,
1.0,1.0,-1.0,
1.0,1.0,1.0,
1.0,0.0,1.0,
1.0,0.0,-1.0,
1.0,0.0,1.0,
0.0,0.0,1.0,
0.0,0.0,-1.0,

```

```
1.0,0.0,-1.0,
1.0,0.0,1.0,
0.0,1.0,1.0,
0.0,1.0,-1.0,
0.0,0.0,-1.0,
0.0,0.0,1.0,
0.0,1.0,1.0,
1.0,1.0,-1.0,
0.0,1.0,-1.0,
0.0,1.0,1.0,
1.0,1.0,1.0,
1.0,1.0,-1.0,
1.0,1.0,1.0,
0.0,1.0,1.0,
0.0,0.0,1.0,
1.0,0.0,1.0,
1.0,1.0,1.0,
1.0,1.0,-1.0,
1.0,0.0,-1.0,
0.0,0.0,-1.0,
0.0,1.0,-1.0,
1.0,1.0,-1.0
)))
-- Simple SOLID with 6 polygons
-- All polygons are described using the optimized rectangle representation.
insert into polygons3d values(11,
SDO_Geometry (3008,NULL,NULL ,
SDO_Elem_Info_Array(1,1007,1,1,1006,6,1,1003,3,7,1003,3,13,1003,3,19,1003,3,25,1003,3,
31,1003,3),
SDO_Ordinate_Array(1.0,0.0,-1.0,
1.0,1.0,1.0,
1.0,0.0,1.0,
0.0,0.0,-1.0,
0.0,1.0,1.0,
0.0,0.0,-1.0,
0.0,1.0,-1.0,
1.0,1.0,1.0,
0.0,0.0,1.0,
1.0,1.0,1.0,
1.0,1.0,-1.0,
0.0,0.0,-1.0
)));
-- Multi-Solid
-- Both solids use optimized representation.
insert into polygons3d values(12,
SDO_Geometry (3009,NULL,NULL ,
SDO_Elem_Info_Array(1,1007,3,7,1007,3),
SDO_Ordinate_Array(-2.0,1.0,3.0,
-3.0,-1.0,0.0,
0.0,0.0,0.0,
1.0,1.0,1.0
)));
-- Multi-Solid - like multipolygon in 2D
-- disjoint solids
insert into polygons3d values(13,
SDO_Geometry (3009,NULL,NULL ,
SDO_Elem_Info_Array(1,1007,1,1,1006,6,1,1003,1,16,1003,1,31,1003,1,46,1003,1,61,1003,
1,76,1003,1,91,1007,1,91,1006,7,91,1003,1,106,1003,1,121,1003,1,136,1003,1,151,1003,1,
166,1003,1,184,1003,1),
SDO_Ordinate_Array(1.0,0.0,4.0,
1.0,1.0,4.0,
```

```
1.0,1.0,6.0,  
1.0,0.0,6.0,  
1.0,0.0,4.0,  
1.0,0.0,6.0,  
0.0,0.0,6.0,  
0.0,0.0,4.0,  
1.0,0.0,4.0,  
1.0,0.0,6.0,  
0.0,1.0,6.0,  
0.0,1.0,4.0,  
0.0,0.0,4.0,  
0.0,0.0,6.0,  
0.0,1.0,6.0,  
1.0,1.0,4.0,  
0.0,1.0,4.0,  
0.0,1.0,6.0,  
1.0,1.0,6.0,  
1.0,1.0,4.0,  
1.0,1.0,6.0,  
0.0,1.0,6.0,  
0.0,0.0,6.0,  
1.0,0.0,6.0,  
1.0,1.0,6.0,  
1.0,1.0,4.0,  
1.0,0.0,4.0,  
0.0,0.0,4.0,  
0.0,1.0,4.0,  
1.0,1.0,4.0,  
2.0,0.0,3.0,  
2.0,0.0,0.0,  
4.0,2.0,0.0,  
4.0,2.0,3.0,  
2.0,0.0,3.0,  
4.5,-2.0,3.0,  
4.5,-2.0,0.0,  
2.0,0.0,0.0,  
2.0,0.0,3.0,  
4.5,-2.0,3.0,  
4.5,-2.0,3.0,  
-2.0,-2.0,3.0,  
-2.0,-2.0,0.0,  
4.5,-2.0,0.0,  
4.5,-2.0,3.0,  
-2.0,-2.0,3.0,  
-2.0,2.0,3.0,  
-2.0,2.0,0.0,  
-2.0,-2.0,0.0,  
-2.0,-2.0,3.0,  
4.0,2.0,3.0,  
4.0,2.0,0.0,  
-2.0,2.0,0.0,  
-2.0,2.0,3.0,  
4.0,2.0,3.0,  
2.0,0.0,3.0,  
4.0,2.0,3.0,  
-2.0,2.0,3.0,  
-2.0,-2.0,3.0,  
4.5,-2.0,3.0,  
2.0,0.0,3.0,  
2.0,0.0,0.0,  
4.5,-2.0,0.0,
```

```

-2.0,-2.0,0.0,
-2.0,2.0,0.0,
4.0,2.0,0.0,
2.0,0.0,0.0
)))

-- SOLID with a hole
-- etype = 1007 exterior solid
-- etype = 2007 is interior solid
-- All polygons of etype=2007 are described as 2003's.
insert into polygons3d values(14,
SDO_Geometry (3008,NULL,NULL ,

SDO_Elem_Info_Array(1,1007,1,1,1006,7,1,1003,1,16,1003,1,31,1003,1,46,1003,1,61,1003,
1,76,1003,1,94,1003,1,112,2006,6,112,2003,1,127,2003,1,142,2003,1,157,2003,1,172,2003
,1,187,2003,1),
SDO_Ordinate_Array(2.0,0.0,3.0,
2.0,0.0,0.0,
4.0,2.0,0.0,
4.0,2.0,3.0,
2.0,0.0,3.0,
4.5,-2.0,3.0,
4.5,-2.0,0.0,
2.0,0.0,0.0,
2.0,0.0,3.0,
4.5,-2.0,3.0,
4.5,-2.0,3.0,
-2.0,-2.0,3.0,
-2.0,-2.0,0.0,
4.5,-2.0,0.0,
4.5,-2.0,3.0,
-2.0,-2.0,3.0,
-2.0,2.0,3.0,
-2.0,2.0,0.0,
-2.0,-2.0,0.0,
-2.0,-2.0,3.0,
4.0,2.0,3.0,
4.0,2.0,0.0,
-2.0,2.0,0.0,
-2.0,2.0,3.0,
4.0,2.0,3.0,
2.0,0.0,3.0,
4.0,2.0,3.0,
-2.0,2.0,3.0,
-2.0,-2.0,3.0,
4.5,-2.0,3.0,
2.0,0.0,3.0,
2.0,0.0,0.0,
4.5,-2.0,0.0,
-2.0,-2.0,0.0,
-2.0,2.0,0.0,
4.0,2.0,0.0,
2.0,0.0,0.0,
1.0,1.0,2.5,
-1.0,1.0,2.5,
-1.0,1.0,0.5,
1.0,1.0,0.5,
1.0,1.0,2.5,
-1.0,1.0,2.5,
-1.0,-1.0,2.5,
-1.0,-1.0,0.5,

```

```

-1.0,1.0,0.5,
-1.0,1.0,2.5,
-1.0,-1.0,2.5,
1.0,-1.0,2.5,
1.0,-1.0,0.5,
-1.0,-1.0,0.5,
-1.0,-1.0,2.5,
1.0,-1.0,2.5,
1.0,1.0,2.5,
1.0,1.0,0.5,
1.0,-1.0,0.5,
1.0,-1.0,2.5,
-1.0,-1.0,2.5,
-1.0,1.0,2.5,
1.0,1.0,2.5,
1.0,-1.0,2.5,
-1.0,-1.0,2.5,
1.0,1.0,0.5,
-1.0,1.0,0.5,
-1.0,-1.0,0.5,
1.0,-1.0,0.5,
1.0,1.0,0.5
)))
-- Gtype = SOLID
-- The elements make up one composite solid (non-disjoint solids) like a cube
-- on a cube on a cube.
-- This is made up of two solid elements.
-- Each solid element here is a simple solid.
insert into polygons3d values(15,
SDO_Geometry (3008,NULL,NULL ,

SDO_Elem_Info_Array(1,1008,2,1,1007,1,1,1006,6,1,1003,1,16,1003,1,31,1003,1,46,1003,1
,
61,1003,1,76,1003,1,91,1007,1,91,1006,7,91,1003,1,106,1003,1,121,1003,1,136,1003,1,15
1,1003,1,166,1003,1,184,1003,1),
SDO_Ordinate_Array(-2.0,1.0,3.0,
-2.0,1.0,0.0,
-3.0,1.0,0.0,
-3.0,1.0,3.0,
-2.0,1.0,3.0,
-3.0,1.0,3.0,
-3.0,1.0,0.0,
-3.0,-1.0,0.0,
-3.0,-1.0,3.0,
-3.0,1.0,3.0,
-3.0,-1.0,3.0,
-3.0,-1.0,0.0,
-2.0,-1.0,0.0,
-2.0,-1.0,3.0,
-3.0,-1.0,3.0,
-2.0,-1.0,3.0,
-2.0,-1.0,0.0,
-2.0,1.0,0.0,
-2.0,1.0,3.0,
-2.0,-1.0,3.0,
-2.0,-1.0,3.0,
-2.0,1.0,3.0,
-3.0,1.0,3.0,
-3.0,-1.0,3.0,
-2.0,-1.0,3.0,
-2.0,1.0,0.0,

```

```
-2.0,-1.0,0.0,  
-3.0,-1.0,0.0,  
-3.0,1.0,0.0,  
-2.0,1.0,0.0,  
2.0,0.0,3.0,  
2.0,0.0,0.0,  
4.0,2.0,0.0,  
4.0,2.0,3.0,  
2.0,0.0,3.0,  
4.5,-2.0,3.0,  
4.5,-2.0,0.0,  
2.0,0.0,0.0,  
2.0,0.0,3.0,  
4.5,-2.0,3.0,  
4.5,-2.0,3.0,  
-2.0,-2.0,3.0,  
-2.0,-2.0,0.0,  
4.5,-2.0,0.0,  
4.5,-2.0,3.0,  
-2.0,-2.0,3.0,  
-2.0,2.0,3.0,  
-2.0,2.0,0.0,  
-2.0,-2.0,0.0,  
-2.0,-2.0,3.0,  
4.0,2.0,3.0,  
4.0,2.0,0.0,  
-2.0,2.0,0.0,  
-2.0,2.0,3.0,  
4.0,2.0,3.0,  
2.0,0.0,3.0,  
4.0,2.0,3.0,  
-2.0,2.0,3.0,  
-2.0,-2.0,3.0,  
4.5,-2.0,3.0,  
2.0,0.0,3.0,  
2.0,0.0,0.0,  
4.5,-2.0,0.0,  
-2.0,-2.0,0.0,  
-2.0,2.0,0.0,  
4.0,2.0,0.0,  
2.0,0.0,0.0  
));
```

### **Example 2-19    Updating Metadata and Creating Indexes for 3-Dimensional Geometries**

[Example 2-19](#) (page 2-46) updates the USER\_SDO\_GEOM\_METADATA view with the necessary information about the tables created in [Example 2-18](#) (page 2-38) (POINTS3D, LINES3D, and POLYGONS3D), and it creates a spatial index on the geometry column (named GEOMETRY) in each table. The indexes are created with the PARAMETERS ( 'sdo\_indx\_dims=3' ) clause, to ensure that all three dimensions are considered in operations that are supported on three-dimensional geometries.

```
INSERT INTO user_sdo_geom_metadata VALUES('POINTS3D', 'GEOMETRY',  
      sdo_dim_array( sdo_dim_element('X', -100,100, 0.000005),  
      sdo_dim_element('Y', -100,100, 0.000005),  
      sdo_dim_element('Z', -100,100, 0.000005)), NULL);  
  
CREATE INDEX points3d_sidx on points3d(geometry)  
  INDEXTYPE IS mdsys.spatial_index  
  PARAMETERS ('sdo_indx_dims=3');
```

```

INSERT INTO user_sdo_geom_metadata VALUES('LINES3D', 'GEOMETRY',
      sdo_dim_array( sdo_dim_element('X', -100,100, 0.000005),
      sdo_dim_element('Y', -100,100, 0.000005),
      sdo_dim_element('Z', -100,100, 0.000005)), NULL);

CREATE INDEX lines3d_sidx on lines3d(geometry)
  INDEXTYPE IS mdsys.spatial_index
  PARAMETERS ('sdo_indx_dims=3');

INSERT INTO user_sdo_geom_metadata VALUES('POLYGONS3D', 'GEOMETRY',
      sdo_dim_array( sdo_dim_element('X', -100,100, 0.000005),
      sdo_dim_element('Y', -100,100, 0.000005),
      sdo_dim_element('Z', -100,100, 0.000005)), NULL);

CREATE INDEX polygons3d_sidx on polygons3d(geometry)
  INDEXTYPE IS mdsys.spatial_index
  PARAMETERS ('sdo_indx_dims=3');

```

## 2.8 Geometry Metadata Views

The geometry metadata describing the dimensions, lower and upper bounds, and tolerance in each dimension is stored in a global table owned by MDSYS (which users should never directly update). Each Spatial and Graph user has the following views available in the schema associated with that user:

- **USER\_SDO\_GEOM\_METADATA** contains metadata information for all spatial tables owned by the user (schema). This is the only view that you can update, and it is the one in which Spatial and Graph users must insert metadata related to spatial tables.
- **ALL\_SDO\_GEOM\_METADATA** contains metadata information for all spatial tables on which the user has SELECT permission.

Spatial and Graph users are responsible for populating these views. For each spatial column, you must insert an appropriate row into the **USER\_SDO\_GEOM\_METADATA** view. Oracle Spatial and Graph ensures that the **ALL\_SDO\_GEOM\_METADATA** view is also updated to reflect the rows that you insert into **USER\_SDO\_GEOM\_METADATA**.

Each metadata view has the following definition:

```

(
  TABLE_NAME  VARCHAR2(32),
  COLUMN_NAME  VARCHAR2(32),
  DIMINFO      SDO_DIM_ARRAY,
  SRID         NUMBER
);

```

In addition, the **ALL\_SDO\_GEOM\_METADATA** view has an **OWNER** column identifying the schema that owns the table specified in **TABLE\_NAME**.

The following considerations apply to schema, table, and column names, and to any **SDO\_DIMNAME** values, that are stored in any Oracle Spatial and Graph metadata views:

- They must contain only letters, numbers, and underscores. For example, such a name cannot contain a space ( ), an apostrophe ( '), a quotation mark ( " ), or a comma ( , ).

- All letters in the names are converted to uppercase before the names are stored in geometry metadata views or before the tables are accessed. This conversion also applies to any schema name specified with the table name.

## 2.8.1 TABLE\_NAME

The TABLE\_NAME column contains the name of a feature table, such as COLA\_MARKETS, that has a column of type SDO\_GEOMETRY.

The table name is stored in the spatial metadata views in all uppercase characters.

The table name cannot contain spaces or mixed-case letters in a quoted string when inserted into the USER\_SDO\_GEOM\_METADATA view, and it cannot be in a quoted string when used in a query (unless it is in all uppercase characters).

The spatial feature table cannot be an index-organized table if you plan to create a spatial index on the spatial column.

## 2.8.2 COLUMN\_NAME

The COLUMN\_NAME column contains the name of the column of type SDO\_GEOMETRY. For the COLA\_MARKETS table, this column is called SHAPE.

The column name is stored in the spatial metadata views in all uppercase characters.

The column name cannot contain spaces or mixed-case letters in a quoted string when inserted into the USER\_SDO\_GEOM\_METADATA view, and it cannot be in a quoted string when used in a query (unless it is in all uppercase characters).

## 2.8.3 DIMINFO

The DIMINFO column is a varying length array of an object type, ordered by dimension, and has one entry for each dimension. The SDO\_DIM\_ARRAY type is defined as follows:

```
Create Type SDO_DIM_ARRAY as VARRAY(4) of SDO_DIM_ELEMENT;
```

The SDO\_DIM\_ELEMENT type is defined as:

```
Create Type SDO_DIM_ELEMENT as OBJECT (  
    SDO_DIMNAME VARCHAR2(64),  
    SDO_LB NUMBER,  
    SDO_UB NUMBER,  
    SDO_TOLERANCE NUMBER);
```

The SDO\_DIM\_ARRAY instance is of size  $n$  if there are  $n$  dimensions. That is, DIMINFO contains 2 SDO\_DIM\_ELEMENT instances for two-dimensional geometries, 3 instances for three-dimensional geometries, and 4 instances for four-dimensional geometries. Each SDO\_DIM\_ELEMENT instance in the array must have valid (not null) values for the SDO\_LB, SDO\_UB, and SDO\_TOLERANCE attributes.

---

---

**Note:**

The number of dimensions reflected in the DIMINFO information must match the number of dimensions of each geometry object in the layer.

---

---



For an explanation of tolerance and how to determine the appropriate SDO\_TOLERANCE value, see [Tolerance](#) (page 1-6), especially [Tolerance in the Geometry Metadata for a Layer](#) (page 1-7).

Spatial and Graph assumes that the varying length array is ordered by dimension. The DIMINFO varying length array must be ordered by dimension in the same way the ordinates for the points in SDO\_ORDINATES varying length array are ordered. For example, if the SDO\_ORDINATES varying length array contains {X1, Y1, ..., Xn, Yn}, then the first DIMINFO entry must define the X dimension and the second DIMINFO entry must define the Y dimension.

[Simple Example: Inserting, Indexing, and Querying Spatial Data](#) (page 2-1) shows the use of the SDO\_GEOMETRY and SDO\_DIM\_ARRAY types. This example demonstrates how geometry objects (hypothetical market areas for colas) are represented, and how the COLA\_MARKETS feature table and the USER\_SDO\_GEOM\_METADATA view are populated with the data for those objects.

## 2.8.4 SRID

The SRID column should contain either of the following: the SRID value for the coordinate system for all geometries in the column, or NULL if no specific coordinate system should be associated with the geometries. (For information about coordinate systems, see [Coordinate Systems \(Spatial Reference Systems\)](#) (page 6-1).)

## 2.9 Other Spatial Metadata Views

Oracle Spatial and Graph uses the following other metadata views:

- USER\_SDO\_3DTHEMES and ALL\_SDO\_3DTHEMES contain information about three-dimensional themes. These views are described in [xxx\\_SDO\\_3DTHEMES Views](#) (page 2-49).
- USER\_SDO\_SCENES and ALL\_SDO\_SCENES contain information about scenes. These views are described in [xxx\\_SDO\\_SCENES Views](#) (page 2-50).
- USER\_SDO\_VIEWFRAMES and ALL\_SDO\_VIEWFRAMES contain information about viewframes. These views are described in [xxx\\_SDO\\_VIEWFRAMES Views](#) (page 2-50).

The USER\_SDO\_xxx views contain metadata information about objects owned by the user (schema), and the ALL\_SDO\_xxx views contain metadata information about objects on which the user has SELECT permission.

The ALL\_SDO\_xxx views include an OWNER column that identifies the schema of the owner of the object. The USER\_SDO\_xxx views do not include an OWNER column.

### 2.9.1 xxx\_SDO\_3DTHEMES Views

The USER\_SDO\_3DTHEMES and ALL\_SDO\_3DTHEMES views have the columns listed in [Table 2-8](#) (page 2-49).

**Table 2-8 xxx\_SDO\_3DTHEMES Views**

Column Name	Data Type	Description
OWNER	VARCHAR2(32)	Schema that owns the theme (ALL_SDO_3DTHEMES only)

**Table 2-8 (Cont.) xxx\_SDO\_3DTHEMES Views**

Column Name	Data Type	Description
NAME	VARCHAR2(32)	Unique name to be associated with the theme
DESCRIPTION	VARCHAR2(4000)	Optional descriptive text about the theme
BASE_TABLE	VARCHAR2(64)	Table or view containing the spatial geometry column
THEME_COLUMN	VARCHAR2(2048)	Name of the theme column
STYLE_COLUMN	VARCHAR2(32)	Name of the style column
THEME_TYPE	VARCHAR2(32)	Theme type
DEFINITION	CLOB	XML definition of the theme

## 2.9.2 xxx\_SDO\_SCENES Views

The USER\_SDO\_SCENES and ALL\_SDO\_SCENES views have the columns listed in [Table 2-9](#) (page 2-50).

**Table 2-9 xxx\_SDO\_SCENES Views**

Column Name	Data Type	Description
OWNER	VARCHAR2(32)	Schema that owns the scene (ALL_SDO_SCENES only)
NAME	VARCHAR2(32)	Unique name to be associated with the scene
DESCRIPTION	VARCHAR2(4000)	Optional descriptive text about the scene
DEFINITION	CLOB	XML definition of the scene

## 2.9.3 xxx\_SDO\_VIEWFRAMES Views

The USER\_SDO\_VIEWFRAMES and ALL\_SDO\_VIEWFRAMES views have the columns listed in [Table 2-10](#) (page 2-50).

**Table 2-10 xxx\_SDO\_VIEWFRAMES Views**

Column Name	Data Type	Description
OWNER	VARCHAR2(32)	Schema that owns the scene (ALL_SDO_VIEWFRAMES only)
NAME	VARCHAR2(32)	Unique name to be associated with the viewframe
DESCRIPTION	VARCHAR2(4000)	Optional descriptive text about the viewframe
SCENE_NAME	VARCHAR2(32)	Name of the scene associated with the viewframe

**Table 2-10 (Cont.) xxx\_SDO\_VIEWFRAMES Views**

Column Name	Data Type	Description
DEFINITION	CLOB	XML definition of the viewframe

## 2.10 Spatial Index-Related Structures

This section describes the structure of the tables containing the spatial index data and metadata. Concepts and usage notes for spatial indexing are explained in [Indexing of Spatial Data](#) (page 1-10). The spatial index data and metadata are stored in tables that are created and maintained by the Spatial and Graph indexing routines. These tables are created in the schema of the owner of the feature (underlying) table that has a spatial index created on a column of type SDO\_GEOMETRY.

### 2.10.1 Spatial Index Views

There are two sets of spatial index metadata views for each schema (user): `xxx_SDO_INDEX_INFO` and `xxx_SDO_INDEX_METADATA`, where `xxx` can be `USER` or `ALL`. These views are read-only to users; they are created and maintained by the Spatial and Graph indexing routines.

#### 2.10.1.1 xxx\_SDO\_INDEX\_INFO Views

The following views contain basic information about spatial indexes:

- `USER_SDO_INDEX_INFO` contains index information for all spatial tables owned by the user.
- `ALL_SDO_INDEX_INFO` contains index information for all spatial tables on which the user has `SELECT` permission.

The `USER_SDO_INDEX_INFO` and `ALL_SDO_INDEX_INFO` views contain the same columns, as shown [Table 2-11](#) (page 2-51), except that the `USER_SDO_INDEX_INFO` view does not contain the `SDO_INDEX_OWNER` column. (The columns are listed in their order in the view definition.)

**Table 2-11 Columns in the xxx\_SDO\_INDEX\_INFO Views**

Column Name	Data Type	Purpose
SDO_INDEX_OWNER	VARCHAR 2	Owner of the index ( <code>ALL_SDO_INDEX_INFO</code> view only).
INDEX_NAME	VARCHAR 2	Name of the index.
TABLE_OWNER	VARCHAR 2	Name of the owner of the table containing the column on which this index is built.
TABLE_NAME	VARCHAR 2	Name of the table containing the column on which this index is built.
COLUMN_NAME	VARCHAR 2	Name of the column on which this index is built.

**Table 2-11 (Cont.) Columns in the xxx\_SDO\_INDEX\_INFO Views**

Column Name	Data Type	Purpose
SDO_INDEX_TYPE	VARCHAR2	Contains RTREE (for an R-tree index).
SDO_INDEX_TABLE	VARCHAR2	Name of the spatial index table (described in <a href="#">Spatial Index Table Definition</a> (page 2-54)).
SDO_INDEX_STATUS	VARCHAR2	(Reserved for Oracle use.)

### 2.10.1.2 xxx\_SDO\_INDEX\_METADATA Views

The following views contain detailed information about spatial index metadata:

- USER\_SDO\_INDEX\_METADATA contains index information for all spatial tables owned by the user.
- ALL\_SDO\_INDEX\_METADATA contains index information for all spatial tables on which the user has SELECT permission.

The USER\_SDO\_INDEX\_METADATA and ALL\_SDO\_INDEX\_METADATA views contain the same columns, as shown [Table 2-12](#) (page 2-52). (The columns are listed in their order in the view definition.)

**Table 2-12 Columns in the xxx\_SDO\_INDEX\_METADATA Views**

Column Name	Data Type	Purpose
SDO_INDEX_OWNER	VARCHAR2	Owner of the index.
SDO_INDEX_TYPE	VARCHAR2	Contains RTREE (for an R-tree index).
SDO_LEVEL	NUMBER	(No longer relevant; applies to a desupported feature.)
SDO_NUMTILES	NUMBER	(No longer relevant; applies to a desupported feature.)
SDO_MAXLEVEL	NUMBER	(No longer relevant; applies to a desupported feature.)
SDO_COMMIT_INTERVAL	NUMBER	(No longer relevant; applies to a desupported feature.)
SDO_INDEX_TABLE	VARCHAR2	Name of the spatial index table (described in <a href="#">Spatial Index Table Definition</a> (page 2-54)).
SDO_INDEX_NAME	VARCHAR2	Name of the index.
SDO_INDEX_PRIMARY	NUMBER	Indicates if this is a primary or secondary index. 1 = primary, 2 = secondary.
SDO_TSNAME	VARCHAR2	Schema name of the SDO_INDEX_TABLE.
SDO_COLUMN_NAME	VARCHAR2	Name of the column on which this index is built.
SDO_RTREE_HEIGHT	NUMBER	Height of the R-tree.

**Table 2-12 (Cont.) Columns in the xxx\_SDO\_INDEX\_METADATA Views**

Column Name	Data Type	Purpose
SDO_RTREE_NUM_NODES	NUMBER	Number of nodes in the R-tree.
SDO_RTREE_DIMENSIONALITY	NUMBER	Number of dimensions used internally by Spatial and Graph. This may be different from the number of dimensions indexed, which is controlled by the <code>sdo_indx_dims</code> keyword in the <a href="#">CREATE INDEX</a> (page 17-7) or <a href="#">ALTER INDEX</a> (page 17-1) statement, and which is stored in the SDO_INDEX_DIMS column in this view. For example, for an index on geodetic data, the SDO_RTREE_DIMENSIONALITY value is 3, but the SDO_INDEX_DIMS value is 2.
SDO_RTREE_FANOUT	NUMBER	Maximum number of children in each R-tree node.
SDO_RTREE_ROOT	VARCHAR2	Rowid corresponding to the root node of the R-tree in the index table.
SDO_RTREE_SEQ_NAME	VARCHAR2	Sequence name associated with the R-tree.
SDO_FIXED_META	RAW	If applicable, this column contains the metadata portion of the SDO_GROUPCODE or SDO_CODE for a fixed-level index.
SDO_TABLESPACE	VARCHAR2	Same as in the SQL CREATE TABLE statement. Tablespace in which to create the SDOINDEX table.
SDO_INITIAL_EXTENT	VARCHAR2	Same as in the SQL CREATE TABLE statement.
SDO_NEXT_EXTENT	VARCHAR2	Same as in the SQL CREATE TABLE statement.
SDO_PCTINCREASE	NUMBER	Same as in the SQL CREATE TABLE statement.
SDO_MIN_EXTENTS	NUMBER	Same as in the SQL CREATE TABLE statement.
SDO_MAX_EXTENTS	NUMBER	Same as in the SQL CREATE TABLE statement.
SDO_INDEX_DIMS	NUMBER	Number of dimensions of the geometry objects in the column on which this index is built, as determined by the value of the <code>sdo_indx_dims</code> keyword in the <a href="#">CREATE INDEX</a> (page 17-7) or <a href="#">ALTER INDEX</a> (page 17-1) statement.
SDO_LAYER_GTYPE	VARCHAR2	Contains DEFAULT if the layer can contain both point and polygon data, or a value from the Geometry Type column in <a href="#">SDO_GTYPE</a> (page 2-5).
SDO_RTREE_PCTFREE	NUMBER	Minimum percentage of slots in each index tree node to be left empty when an R-tree index is created.
SDO_INDEX_PARTITION	VARCHAR2	For a partitioned index, name of the index partition.

**Table 2-12 (Cont.) Columns in the xxx\_SDO\_INDEX\_METADATA Views**

Column Name	Data Type	Purpose
SDO_PARTITIONED	NUMBER	Contains 0 if the index is not partitioned or 1 if the index is partitioned.
SDO_RTREE_QUALITY	NUMBER	Quality score for an index. See the information about R-tree quality in <a href="#">R-Tree Quality</a> (page 1-11).
SDO_INDEX_VERSION	NUMBER	Internal version number of the index.
SDO_INDEX_GEODETTIC	VARCHAR2	Contains TRUE if the index is geodetic and FALSE if the index is not geodetic.
SDO_INDEX_STATUS	VARCHAR2	(Reserved for Oracle use.)
SDO_NL_INDEX_TABLE	VARCHAR2	Name of a separate index table (with a name in the form MDNT_...\$) for nonleaf nodes of the index. For more information, see the description of the <code>sdo_non_leaf_tbl</code> parameter for the <a href="#">CREATE INDEX</a> (page 17-7) statement in <a href="#">SQL Statements for Indexing Spatial Data</a> (page 17-1).
SDO_DML_BATCH_SIZE	NUMBER	Number of index updates to be processed in each batch of updates after a commit operation. For more information, see the description of the <code>sdo_dml_batch_size</code> parameter for the <a href="#">CREATE INDEX</a> (page 17-7) statement in <a href="#">SQL Statements for Indexing Spatial Data</a> (page 17-1).
SDO_RTREE_EXT_XPND	NUMBER	(Reserved for future use.)
SDO_NUM_ROWS	NUMBER	Number of rows (with non-null geometries) in the base spatial table (table containing the column on which this index is built).
SDO_NUM_BLKs	NUMBER	Number of blocks in the spatial index table (SDO_INDEX_TABLE),
SDO_ROOT_MBR	SDO_GEOMETRY	Minimum bounding rectangle of the maximum extent of the spatial layer. This is greater than or equal to the MBR of the current extent, and is reset to reflect the current extent when the index is rebuilt.

## 2.10.2 Spatial Index Table Definition

For an R-tree index, a spatial index table (each SDO\_INDEX\_TABLE entry as described in [xxx\\_SDO\\_INDEX\\_METADATA Views](#) (page 2-52)) contains the columns shown in [Table 2-13](#) (page 2-55).

**Table 2-13 Columns in an R-Tree Spatial Index Data Table**

Column Name	Data Type	Purpose
NODE_ID	NUMBER	Unique ID number for this node of the tree.
NODE_LEVEL	NUMBER	Level of the node in the tree. Leaf nodes (nodes whose entries point to data items in the base table) are at level 1, their parent nodes are at level 2, and so on.
INFO	BLOB	Other information in a node. Includes an array of <child_mbr, child_rowid> pairs (maximum of fanout value, or number of children for such pairs in each R-tree node), where child_rowid is the rowid of a child node, or the rowid of a data item from the base table.

### 2.10.3 R-Tree Index Sequence Object

Each R-tree spatial index table has an associated sequence object (SDO\_RTREE\_SEQ\_NAME in the USER\_SDO\_INDEX\_METADATA view, described in [xxx\\_SDO\\_INDEX\\_METADATA Views](#) (page 2-52)). The sequence is used to ensure that simultaneous updates can be performed to the index by multiple concurrent users.

The sequence name is the index table name with the letter S replacing the letter T before the underscore (for example, the sequence object MDRS\_5C01\$ is associated with the index table MDRT\_5C01\$).

## 2.11 Unit of Measurement Support

Geometry functions that involve measurement allow an optional `unit` parameter to specify the unit of measurement for a specified distance or area, if a georeferenced coordinate system (SDO\_SRID value) is associated with the input geometry or geometries. The `unit` parameter is not valid for geometries with a null SDO\_SRID value (that is, an orthogonal Cartesian system). For information about support for coordinate systems, see [Coordinate Systems \(Spatial Reference Systems\)](#) (page 6-1).

The default unit of measure is the one associated with the georeferenced coordinate system. The unit of measure for most coordinate systems is the meter, and in these cases the default unit for distances is meter and the default unit for areas is square meter. By using the `unit` parameter, however, you can have Spatial and Graph automatically convert and return results that are more meaningful to application users, for example, displaying the distance to a restaurant in miles.

The `unit` parameter must be enclosed in single quotation marks and contain the string `unit=` and a valid UNIT\_OF\_MEAS\_NAME value from the SDO\_UNITS\_OF\_MEASURE table (described in [SDO\\_UNITS\\_OF\\_MEASURE Table](#) (page 6-41)). For example, 'unit=KM' in the following example (using data and definitions from [Example 6-17](#) (page 6-76) in [Example of Coordinate System Transformation](#) (page 6-76)) specifies kilometers as the unit of measurement:

```
SELECT c.name, SDO_GEOM.SDO_LENGTH(c.shape, m.diminfo, 'unit=KM')
FROM cola_markets_cs c, user_sdo_geom_metadata m
WHERE m.table_name = 'COLA_MARKETS_CS' AND m.column_name = 'SHAPE';
```

Spatial and Graph uses the information in the SDO\_UNITS\_OF\_MEASURE table (described in [SDO\\_UNITS\\_OF\\_MEASURE Table](#) (page 6-41)) to determine which

unit names are valid and what ratios to use in comparing or converting between different units. For convenience, you can also use the following legacy views to see the angle, area, and distance units of measure:

- MDSYS.SDO\_ANGLE\_UNITS (described in [MDSYS.SDO\\_ANGLE\\_UNITS View](#) (page 6-52))
- MDSYS.SSDO\_AREA\_UNITS (described in [MDSYS.SDO\\_AREA\\_UNITS View](#) (page 6-52))
- MDSYS.SSDO\_DIST\_UNITS (described in [MDSYS.SDO\\_DIST\\_UNITS View](#) (page 6-53))

### 2.11.1 Creating a User-Defined Unit of Measurement

If the area and distance units of measurement supplied by Oracle are not sufficient for your needs, you can create user-defined area and distance units. (You cannot create a user-defined angle unit.) To do so, you must connect to the database as a user that has been granted the DBA role, and insert a row for each desired unit to the SDO\_UNITS\_OF\_MEASURE table (described in [SDO\\_UNITS\\_OF\\_MEASURE Table](#) (page 6-41))

[Table 2-14](#) (page 2-56) lists the columns in the SDO\_UNITS\_OF\_MEASURE table and the requirements and recommendations for each if you are inserting a row for a user-defined unit of measurement.

**Table 2-14 SDO\_UNITS\_OF\_MEASURE Table Entries for User-Defined Unit**

Column Name	Description
UOM_ID	Any unit of measure ID number not currently used for an Oracle-supplied unit or another user-defined unit. Example: 1000001
UNIT_OF_MEAS_NAME	Name of the user-defined unit of measurement. Example: HALF_METER
SHORT_NAME	Optional short name (if any) of the unit of measurement.
UNIT_OF_MEAS_TYPE	Type of measure for which the unit is used. Must be either area (for an area unit) or length (for a distance unit).
TARGET_UOM_ID	Optional, but for support purposes you should enter one of the following: 10008 for an area unit (10008 = UOM_ID for SQ_METER) or 10032 for a distance unit (10032 = UOM_ID for METER).
FACTOR_B	For a value that can be expressed as a floating point number, specify how many square meters (for an area unit) or meters (for a distance unit) are equal to one of the user-defined unit. For example, for a unit defined as one-half of a standard meter, specify: .5  For a value that cannot be expressed as a simple floating point number, specify the dividend for the expression FACTOR_B/FACTOR_C that determines how many square meters (for an area unit) or meters (for a distance unit) are equal to one of the user-defined unit.
FACTOR_C	For a value that can be expressed as a floating point number, specify 1.  For a value that cannot be expressed as a simple floating point number, specify the divisor for the expression FACTOR_B/FACTOR_C that determines how many square meters (for an area unit) or meters (for a distance unit) are equal to one of the user-defined unit.



**Table 2-14 (Cont.) SDO\_UNITS\_OF\_MEASURE Table Entries for User-Defined Unit**

Column Name	Description
INFORMATION_SOURCE	Specify the following: USER_DEFINED
DATA_SOURCE	A phrase briefly describing the unit. Example: User-defined half meter
IS_LEGACY	Specify the following: FALSE.
LEGACY_CODE	(Do not use this for a user-defined unit.)

[Example 2-20](#) (page 2-57) creates a user-defined distance unit named HALF\_METER, and uses it in a query to find all customers within 400,000 half-meters (200 kilometers) of a specified store.

**Example 2-20 Creating and Using a User-Defined Unit of Measurement**

```
-- Distance unit: HALF_METER
-- FACTOR_B specifies how many meters = one of this unit.

INSERT INTO MDSYS.SDO_UNITS_OF_MEASURE
  (UOM_ID, UNIT_OF_MEAS_NAME, UNIT_OF_MEAS_TYPE, TARGET_UOM_ID,
   FACTOR_B, FACTOR_C, INFORMATION_SOURCE, DATA_SOURCE, IS_LEGACY)
VALUES
  (100001, 'HALF_METER', 'length', 100001,
   .5, 1, 'User-defined half meter', 'USER_DEFINED', 'FALSE');

. . .

-- Find all the customers within 400,000 half-meters of store_id = 101
SELECT /*+ordered*/
  c.customer_id,
  c.first_name,
  c.last_name
FROM stores s,
     customers c
WHERE s.store_id = 101
AND sdo_within_distance (c.cust_geo_location,
  s.store_geo_location,
  'distance = 400000 unit = HALF_METER') = 'TRUE';

CUSTOMER_ID FIRST_NAME                                LAST_NAME
-----
1005 Carla                                           Rodriguez
1004 Thomas                                           Williams
1003 Marian                                           Chang
1001 Alexandra                                       Nichols
```



---

## SQL Multimedia Type Support

This chapter explains the support within Oracle Spatial and Graph for the use of the ST\_xxx types specified in *ISO 13249-3, Information technology - Database languages - SQL Multimedia and Application Packages - Part 3: Spatial*. This chapter contains the following major sections:

- [ST\\_GEOMETRY and SDO\\_GEOMETRY Interoperability](#) (page 3-1)
- [Tolerance Value with SQL Multimedia Types](#) (page 3-8)
- [Avoiding Name Conflicts](#) (page 3-8)
- [Annotation Text Type and Views](#) (page 3-8)

### 3.1 ST\_GEOMETRY and SDO\_GEOMETRY Interoperability

The SQL Multimedia ST\_GEOMETRY root type, including its subtypes, and the Oracle Spatial and Graph SDO\_GEOMETRY type (described in [SDO\\_GEOMETRY Object Type](#) (page 2-5)) are essentially interoperable. The ST\_GEOMETRY subtypes are:

- ST\_CIRCULARSTRING
- ST\_COMPOUNDCURVE
- ST\_CURVE
- ST\_CURVEPOLYGON
- ST\_GEOMCOLLECTION
- ST\_LINESTRING
- ST\_MULTICURVE
- ST\_MULTILINESTRING
- ST\_MULTIPPOINT
- ST\_MULTIPOLYGON
- ST\_MULTISURFACE
- ST\_POINT
- ST\_POLYGON
- ST\_SURFACE

The ST\_GEOMETRY type has an additional constructor method (that is, in addition to the constructors defined in the ISO standard) for creating an instance of the type using an SDO\_GEOMETRY object. This constructor has the following format:

```
ST_GEOMETRY(geom SDO_GEOMETRY);
```

### **Example 3-1 Using the ST\_GEOMETRY Type for a Spatial Column**

[Example 3-1](#) (page 3-2) creates a table using the ST\_GEOMETRY type for a spatial column instead of the SDO\_GEOMETRY type, and it uses the ST\_GEOMETRY constructor to specify the SHAPE column value when inserting a row into that table.

```
CREATE TABLE cola_markets (  
    mkt_id NUMBER PRIMARY KEY,  
    name VARCHAR2(32),  
    shape ST_GEOMETRY);  
  
INSERT INTO cola_markets VALUES(  
    1,  
    'cola_a',  
    ST_GEOMETRY(  
        SDO_GEOMETRY(  
            2003, -- two-dimensional polygon  
            NULL,  
            NULL,  
            SDO_ELEM_INFO_ARRAY(1,1003,3), -- one rectangle (1003 = exterior)  
            SDO_ORDINATE_ARRAY(1,1, 5,7) -- only 2 points needed to  
                -- define rectangle (lower left and upper right) with  
                -- Cartesian-coordinate data  
        )  
    )  
);
```

If you create a table with a spatial column of type ST\_GEOMETRY, you should add its information to the USER\_SDO\_GEOM\_METADATA view and create a spatial index on the ST\_GEOMETRY column, just as you would for spatial data defined using the SDO\_GEOMETRY type. After you have performed these operations, you can use Oracle Spatial and Graph operators (described in [Spatial Operators](#) (page 18-1)) in the ST\_GEOMETRY data. In addition to the operators defined in the standard, you can use the [SDO\\_NN](#) (page 18-17) and [SDO\\_WITHIN\\_DISTANCE](#) (page 18-36) operators.

### **Example 3-2 Creating, Indexing, Storing, and Querying ST\_GEOMETRY Data**

[Example 3-2](#) (page 3-2) performs many of the same basic operations as in [Example 2-1](#) (page 2-2) in [Simple Example: Inserting, Indexing, and Querying Spatial Data](#) (page 2-1), but it uses the ST\_GEOMETRY type instead of the SDO\_GEOMETRY type for the spatial column.

```
CREATE TABLE cola_markets (  
    mkt_id NUMBER PRIMARY KEY,  
    name VARCHAR2(32),  
    shape ST_GEOMETRY);  
  
INSERT INTO cola_markets VALUES(  
    1,  
    'cola_a',  
    ST_GEOMETRY(  
        SDO_GEOMETRY(  
            2003, -- two-dimensional polygon  
            NULL,  
            NULL,  
            SDO_ELEM_INFO_ARRAY(1,1003,3), -- one rectangle (1003 = exterior)  
            SDO_ORDINATE_ARRAY(1,1, 5,7) -- only 2 points needed to  
                -- define rectangle (lower left and upper right) with  
                -- Cartesian-coordinate data  
        )  
    )  
);
```

```

        SDO_ELEM_INFO_ARRAY(1,1003,3), -- one rectangle (1003 = exterior)
        SDO_ORDINATE_ARRAY(1,1, 5,7) -- only 2 points needed to
        -- define rectangle (lower left and upper right) with
        -- Cartesian-coordinate data
    )
)
);

INSERT INTO cola_markets VALUES(
    2,
    'cola_b',
    ST_GEOMETRY(
        SDO_GEOMETRY(
            2003, -- two-dimensional polygon
            NULL,
            NULL,
            SDO_ELEM_INFO_ARRAY(1,1003,1), -- one polygon (exterior polygon ring)
            SDO_ORDINATE_ARRAY(5,1, 8,1, 8,6, 5,7, 5,1)
        )
    )
);

INSERT INTO cola_markets VALUES(
    3,
    'cola_c',
    ST_GEOMETRY(
        SDO_GEOMETRY(
            2003, -- two-dimensional polygon
            NULL,
            NULL,
            SDO_ELEM_INFO_ARRAY(1,1003,1), -- one polygon (exterior polygon ring)
            SDO_ORDINATE_ARRAY(3,3, 6,3, 6,5, 4,5, 3,3)
        )
    )
);

INSERT INTO cola_markets VALUES(
    4,
    'cola_d',
    ST_GEOMETRY(
        SDO_GEOMETRY(
            2003, -- two-dimensional polygon
            NULL,
            NULL,
            SDO_ELEM_INFO_ARRAY(1,1003,4), -- one circle
            SDO_ORDINATE_ARRAY(8,7, 10,9, 8,11)
        )
    )
);

-----
-- UPDATE METADATA VIEW --
-----

-- Update the USER_SDO_GEOM_METADATA view. This is required before
-- the spatial index can be created. Do this only once for each layer
-- (that is, table-column combination; here: cola_markets and shape).

INSERT INTO user_sdo_geom_metadata
    (TABLE_NAME,
     COLUMN_NAME,

```

```
        DIMINFO,
        SRID)
VALUES (
    'cola_markets',
    'shape',
    SDO_DIM_ARRAY( -- 20X20 grid
        SDO_DIM_ELEMENT('X', 0, 20, 0.005),
        SDO_DIM_ELEMENT('Y', 0, 20, 0.005)
    ),
    NULL -- SRID
);

-----
-- CREATE THE SPATIAL INDEX --
-----

CREATE INDEX cola_spatial_idx
ON cola_markets(shape)
INDEXTYPE IS MDSYS.SPATIAL_INDEX;

-----
-- SDO_NN and SDO_WITHIN_DISTANCE
-----

-- SDO_NN operator.

SELECT /*+ INDEX(c cola_spatial_idx) */ c.mkt_id, c.name
FROM cola_markets c
WHERE SDO_NN(c.shape, sdo_geometry(2001, NULL,
    sdo_point_type(10,7,NULL), NULL, NULL), 'sdo_num_res=2') = 'TRUE';

-- SDO_NN_DISTANCE ancillary operator

SELECT /*+ INDEX(c cola_spatial_idx) */
    c.mkt_id, c.name, SDO_NN_DISTANCE(1) dist
FROM cola_markets c
WHERE SDO_NN(c.shape, sdo_geometry(2001, NULL,
    sdo_point_type(10,7,NULL), NULL, NULL),
    'sdo_num_res=2', 1) = 'TRUE' ORDER BY dist;

-- SDO_WITHIN_DISTANCE operator (two examples)

SELECT c.name FROM cola_markets c WHERE SDO_WITHIN_DISTANCE(c.shape,
    SDO_GEOMETRY(2003, NULL, NULL, SDO_ELEM_INFO_ARRAY(1,1003,3),
    SDO_ORDINATE_ARRAY(4,6, 8,8)),
    'distance=10') = 'TRUE';

-- What geometries are within a distance of 10 from a query window
-- (here, a rectangle with lower-left, upper-right coordinates 4,6, 8,8)?
-- But exclude geoms with MBRs with both sides < 4.1, i.e., cola_c and cola_d.

SELECT c.name FROM cola_markets c WHERE SDO_WITHIN_DISTANCE(c.shape,
    SDO_GEOMETRY(2003, NULL, NULL, SDO_ELEM_INFO_ARRAY(1,1003,3),
    SDO_ORDINATE_ARRAY(4,6, 8,8)),
    'distance=10 min_resolution=4.1') = 'TRUE';

-----
-- Some ST_GEOMETRY member functions
-----

SELECT c.shape.GET_WKB()
```

```

FROM cola_markets c WHERE c.name = 'cola_b';

SELECT c.shape.GET_WKT()
FROM cola_markets c WHERE c.name = 'cola_b';

SELECT c.shape.ST_COORDDIM()
FROM cola_markets c WHERE c.name = 'cola_b';

SELECT c.shape.ST_ISVALID()
FROM cola_markets c WHERE c.name = 'cola_b';

SELECT c.shape.ST_SRID()
FROM cola_markets c WHERE c.name = 'cola_b';

SELECT c.shape.ST_SRID(8307)
FROM cola_markets c WHERE c.name = 'cola_b';

SELECT c.shape.ST_ISEMPTY()
FROM cola_markets c WHERE c.name = 'cola_b';

SELECT c.shape.ST_ENVELOPE()
FROM cola_markets c WHERE c.name = 'cola_b';

SELECT c.shape.ST_BOUNDARY()
FROM cola_markets c WHERE c.name = 'cola_b';

SELECT c.shape.ST_GEOMETRYTYPE()
FROM cola_markets c WHERE c.name = 'cola_b';

SELECT c.shape.ST_ISSIMPLE()
FROM cola_markets c WHERE c.name = 'cola_b';

SELECT c.shape.ST_DIMENSION()
FROM cola_markets c WHERE c.name = 'cola_b';

SELECT c.shape.ST_CONVEXHULL()
FROM cola_markets c WHERE c.name = 'cola_b';

SELECT c.shape.ST_CENTROID()
FROM cola_markets c WHERE c.name = 'cola_b';

SELECT c.shape.ST_GETTOLERANCE()
FROM cola_markets c WHERE c.name = 'cola_b';

-- Some member functions that require a parameter
DECLARE
  cola_a_geom ST_GEOMETRY;
  cola_b_geom ST_GEOMETRY;
  cola_c_geom ST_GEOMETRY;
  cola_d_geom ST_GEOMETRY;
  returned_geom ST_GEOMETRY;
  returned_number NUMBER;

BEGIN

-- Populate geometry variables with cola market shapes.
SELECT c.shape INTO cola_a_geom FROM cola_markets c
  WHERE c.name = 'cola_a';
SELECT c.shape INTO cola_b_geom FROM cola_markets c
  WHERE c.name = 'cola_b';
SELECT c.shape INTO cola_c_geom FROM cola_markets c

```

```
WHERE c.name = 'cola_c';
SELECT c.shape INTO cola_d_geom FROM cola_markets c
WHERE c.name = 'cola_d';

SELECT c.shape.ST_EQUALS(col_a_geom) INTO returned_number
FROM cola_markets c WHERE c.name = 'cola_b';
DBMS_OUTPUT.PUT_LINE('Is cola_b equal to cola_a?: ' || returned_number);

SELECT c.shape.ST_SYMMETRICDIFFERENCE(col_a_geom) INTO returned_geom
FROM cola_markets c WHERE c.name = 'cola_b';

SELECT c.shape.ST_DISTANCE(col_d_geom) INTO returned_number
FROM cola_markets c WHERE c.name = 'cola_b';
DBMS_OUTPUT.PUT_LINE('Distance between cola_b equal to cola_d: ' || returned_number);

SELECT c.shape.ST_INTERSECTS(col_a_geom) INTO returned_number
FROM cola_markets c WHERE c.name = 'cola_b';
DBMS_OUTPUT.PUT_LINE('Does cola_b intersect cola_a?: ' || returned_number);

SELECT c.shape.ST_CROSS(col_a_geom) INTO returned_number
FROM cola_markets c WHERE c.name = 'cola_b';
DBMS_OUTPUT.PUT_LINE('Does cola_b cross cola_a?: ' || returned_number);

SELECT c.shape.ST_DISJOINT(col_a_geom) INTO returned_number
FROM cola_markets c WHERE c.name = 'cola_b';
DBMS_OUTPUT.PUT_LINE('Is cola_b disjoint with cola_a?: ' || returned_number);

SELECT c.shape.ST_TOUCH(col_a_geom) INTO returned_number
FROM cola_markets c WHERE c.name = 'cola_b';
DBMS_OUTPUT.PUT_LINE('Does cola_b touch cola_a?: ' || returned_number);

SELECT c.shape.ST_WITHIN(col_a_geom) INTO returned_number
FROM cola_markets c WHERE c.name = 'cola_b';
DBMS_OUTPUT.PUT_LINE('Is cola_b within cola_a?: ' || returned_number);

SELECT c.shape.ST_OVERLAP(col_a_geom) INTO returned_number
FROM cola_markets c WHERE c.name = 'cola_b';
DBMS_OUTPUT.PUT_LINE('Does cola_b overlap cola_a?: ' || returned_number);

SELECT c.shape.ST_CONTAINS(col_a_geom) INTO returned_number
FROM cola_markets c WHERE c.name = 'cola_b';
DBMS_OUTPUT.PUT_LINE('Does cola_b contain cola_a?: ' || returned_number);

SELECT c.shape.ST_INTERSECTION(col_a_geom) INTO returned_geom
FROM cola_markets c WHERE c.name = 'cola_b';

SELECT c.shape.ST_DIFFERENCE(col_a_geom) INTO returned_geom
FROM cola_markets c WHERE c.name = 'cola_b';

SELECT c.shape.ST_UNION(col_a_geom) INTO returned_geom
FROM cola_markets c WHERE c.name = 'cola_b';

SELECT c.shape.ST_SYMDIFFERENCE(col_a_geom) INTO returned_geom
FROM cola_markets c WHERE c.name = 'cola_b';

SELECT c.shape.ST_TOUCHES(col_a_geom) INTO returned_number
FROM cola_markets c WHERE c.name = 'cola_b';
DBMS_OUTPUT.PUT_LINE('Does cola_b touch cola_a?: ' || returned_number);

SELECT c.shape.ST_CROSSES(col_a_geom) INTO returned_number
FROM cola_markets c WHERE c.name = 'cola_b';
```



```
DBMS_OUTPUT.PUT_LINE('Does cola_b cross cola_a?: ' || returned_number);

END;
/
```

## 3.2 ST\_xxx Functions and Spatial and Graph Counterparts

**Table 3-1** (page 3-7) lists SQL Multimedia functions and the comparable Oracle Spatial and Graph SDO\_GEOMETRY method or Spatial and Graph function, procedure, operator. Note that in some cases the Oracle Spatial and Graph counterpart has more features than the SQL Multimedia function.

**Table 3-1 ST\_xxx Functions and Spatial and Graph Counterparts**

SQL Multimedia Function	Comparable Oracle Spatial and Graph Interface
FROM_WKB	<a href="#">SDO_UTIL.FROM_WKBGEOMETRY</a> (page 31-33)
FROM_WKT	<a href="#">SDO_UTIL.FROM_WKTGEOMETRY</a> (page 31-34)
GET_WKB	SDO_GEOMETRY.Get_WKB
GET_WKT	SDO_GEOMETRY.Get_WKT
ST_BUFFER	<a href="#">SDO_GEOM.SDO_BUFFER</a> (page 23-11)
ST_CENTROID	<a href="#">SDO_GEOM.SDO_CENTROID</a> (page 23-13)
ST_CONTAINS	<a href="#">SDO_GEOM.RELATE</a> (page 23-4) with mask=CONTAINS
ST_CONVEXHULL	<a href="#">SDO_GEOM.SDO_CONVEXHULL</a> (page 23-19)
ST_COORDDIM	SDO_GEOMETRY.Get_Dims and SDO_GEOMETRY.ST_CoordDim (equivalent)
ST_CROSS	(None predefined; requires using <a href="#">SDO_GEOM.RELATE</a> (page 23-4) with a complex mask)
ST_CROSSES	(None predefined; requires using <a href="#">SDO_GEOM.RELATE</a> (page 23-4) with a complex mask)
ST_DIFFERENCE	<a href="#">SDO_GEOM.SDO_DIFFERENCE</a> (page 23-24)
ST_DIMENSION	SDO_GEOMETRY.Get_Dims
ST_DISJOINT	<a href="#">SDO_GEOM.RELATE</a> (page 23-4) with mask=DISJOINT
ST_DISTANCE	<a href="#">SDO_GEOM.SDO_DISTANCE</a> (page 23-25)
ST_ENVELOPE	<a href="#">SDO_GEOM.SDO_MBR</a> (page 23-38)
ST_EQUALS	<a href="#">SDO_GEOM.RELATE</a> (page 23-4) with mask=EQUAL
ST_GEOMETRYTYPE	SDO_GEOMETRY.Get_GType
ST_INTERSECTION	<a href="#">SDO_GEOM.SDO_INTERSECTION</a> (page 23-27)
ST_INTERSECTS	<a href="#">SDO_GEOM.RELATE</a> (page 23-4) with mask=OVERLAPBDYDISJOINT + OVERLAPBDYINTERSECT

**Table 3-1 (Cont.) ST\_xxx Functions and Spatial and Graph Counterparts**

SQL Multimedia Function	Comparable Oracle Spatial and Graph Interface
ST_ISVALID	<a href="#">SDO_GEOM.VALIDATE_GEOMETRY_WITH_CONTEXT</a> (page 23-52)
ST_OVERLAP	<a href="#">SDO_GEOM.RELATE</a> (page 23-4) with mask=CONTAINS
ST_RELATE	<a href="#">SDO_RELATE</a> (page 18-30), <a href="#">SDO_GEOM.RELATE</a> (page 23-4)
ST_SYMDIFFERENCE	<a href="#">SDO_GEOM.SDO_XOR</a> (page 23-50)
ST_SYMMETRICDIFFERENCE	<a href="#">SDO_GEOM.SDO_XOR</a> (page 23-50)
ST_TOUCH	<a href="#">SDO_GEOM.RELATE</a> (page 23-4) with mask=TOUCH
ST_TOUCHES	<a href="#">SDO_GEOM.RELATE</a> (page 23-4) with mask=TOUCH
ST_UNION	<a href="#">SDO_GEOM.SDO_UNION</a> (page 23-44)
ST_WITHIN	<a href="#">SDO_GEOM.RELATE</a> (page 23-4) with mask=COVERS +CONTAINS

### 3.3 Tolerance Value with SQL Multimedia Types

Because the SQL Multimedia standard does not define how tolerance is to be used with the ST\_ xxx, Spatial and Graph uses a default value of 0.005 in all the member methods of the ST\_GEOMETRY type. If you want to specify a different tolerance value to be used with ST\_GEOMETRY member functions, override the default by inserting the desired value into the SDO\_ST\_TOLERANCE table.

The SDO\_ST\_TOLERANCE table is a global temporary table that should have a single row specifying the tolerance to be used with ST\_GEOMETRY member methods. This table has a single column, defined as (tolerance NUMBER).

For all spatial operators that use a spatial index, Spatial and Graph uses the tolerance value specified for the spatial column in the USER\_SDO\_GEOM\_METADATA view.

### 3.4 Avoiding Name Conflicts

Some third-party vendors support their own version of ST\_ xxx types on Oracle. For example, a vendor might create its own version of the ST\_GEOMETRY type.

To avoid possible conflicts between third-party names and Oracle-supplied names, any third-party implementation of ST\_ xxx types on Oracle should use a schema prefix. For example, this will ensure that if someone specifies a column type as just ST\_GEOMETRY, the column will be created with the Oracle implementation of the ST\_GEOMETRY type.

### 3.5 Annotation Text Type and Views

Oracle Spatial and Graph supports annotation text as specified in the *OpenGIS Implementation Specification for Geographic information - Simple feature access - Part 1: Common architecture*, which defines **annotation text** as "simply placed text that can carry either geographically-related or ad-hoc data and process-related information as displayable text. This text may be used for display in editors or in simpler maps. It is

usually lacking in full cartographic quality, but may act as an approximation to such text as needed by any application."

The `ST_ANNOTATION_TEXT` object type can be used to store annotation text. This type has a constructor for inserting annotation text into a table, as explained in [Using the `ST\_ANNOTATION\_TEXT` Constructor](#) (page 3-9).

The `USER_ANNOTATION_TEXT_METADATA` and `ALL_ANNOTATION_TEXT_METADATA` views store metadata related to annotation text, as explained in [Annotation Text Metadata Views](#) (page 3-10).

### 3.5.1 Using the `ST_ANNOTATION_TEXT` Constructor

An annotation text object contains an array of objects, where each object consists of a text label, the point at which to start rendering the text label, a leader line (typically from the text label to the associated point on the map), and optionally extra attribute information. A single annotation text object may typically contain all the text labels for a map.

Each text label object has the following definition:

Name	Null?	Type
PRIVATEVALUE		VARCHAR2(4000)
PRIVATELOCATION		MDSYS.SDO_GEOMETRY
PRIVATELEADERLINE		MDSYS.SDO_GEOMETRY
PRIVATETEXTATTRIBUTES		VARCHAR2(4000)

#### **Example 3-3 Using the `ST_ANNOTATION_TEXT` Constructor**

To insert the annotation for a single point, use the `ST_ANNOTATION_TEXT` constructor. This constructor specifies the information for a single point using an array, as shown in [Example 3-3](#) (page 3-9), which creates a table with a column of type `ST_ANNOTATION_TEXT` and inserts one row, using the `ST_ANNOTATION_TEXT` constructor in the `INSERT` statement.

```
CREATE TABLE my_annotations (id NUMBER, textobj ST_ANNOTATION_TEXT);

INSERT INTO my_annotations VALUES (2,
  ST_ANNOTATION_TEXT(
    ST_ANNOTATIONTEXTELEMENT_ARRAY(
      ST_ANNOT_TEXTELEMENT_ARRAY(
        ST_ANNOTATIONTEXTELEMENT(
          'Sample Label 2',
          SDO_GEOMETRY(2001,null,sdo_point_type(10,10,null),null,null),
          SDO_GEOMETRY(2002,null,null,
            SDO_ELEM_INFO_ARRAY(1,2,1),
            SDO_ORDINATE_ARRAY(5,10, 10,10)),
          NULL)))));
```

In the `ST_ANNOTATION_TEXT` constructor in [Example 3-3](#) (page 3-9), the `ST_ANNOTATIONTEXTELEMENT` subelement specifies the following:

- The text for the label, in this case `Sample Label 2`
- A point geometry specifying where to start rendering the label, in this case location (10,10)
- A line string geometry specifying the start and end points of the leader line between the point of interest and the text label, in this case a line between locations (5,10) and (10,10)

- No text display attribute information (NULL), which means that the information TEXT\_ATTRIBUTES column of the annotation text metadata views is used (see [Table 3-2](#) (page 3-10) in [Annotation Text Metadata Views](#) (page 3-10))

### 3.5.2 Annotation Text Metadata Views

The annotation text metadata is stored in a global table owned by MDSYS (which users should never directly update). Each Spatial and Graph user has the following views available in the schema associated with that user:

- USER\_ANNOTATION\_TEXT\_METADATA contains metadata information for all annotation text in tables owned by the user (schema). This is the only view that you can update, and it is the one in which Spatial and Graph users must insert metadata related to spatial tables.
- ALL\_ANNOTATION\_TEXT\_METADATA contains metadata information for all annotation text in tables on which the user has SELECT permission.

Spatial and Graph users are responsible for populating these views. For each annotation text object, you must insert an appropriate row into the USER\_ANNOTATION\_TEXT\_METADATA view. Oracle Spatial and Graph ensures that the ALL\_ANNOTATION\_TEXT\_METADATA view is also updated to reflect the rows that you insert into USER\_ANNOTATION\_TEXT\_METADATA.

The USER\_ANNOTATION\_TEXT\_METADATA and ALL\_ANNOTATION\_TEXT\_METADATA views contain the same columns, as shown [Table 3-2](#) (page 3-10), except that the USER\_ANNOTATION\_TEXT\_METADATA view does not contain the OWNER column. (The columns are listed in their order in the view definition.)

**Table 3-2 Columns in the Annotation Text Metadata Views**

Column Name	Data Type	Purpose
OWNER	VARCHAR2(32)	Owner of the table specified in the TABLE_NAME column (ALL_ANNOTATION_TEXT_METADATA view only).
TABLE_NAME	VARCHAR2(32)	Name of the table containing the column of type ST_ANNOTATION_TEXT.
COLUMN_NAME	VARCHAR2(1024)	Name of the column of type ST_ANNOTATION_TEXT.
TEXT_EXPRESSION	VARCHAR2(4000)	A value that can be used if text is not specified for a label. As explained in the OpenGIS specification: "Text to place is first derived from the contents of VALUE in the current element, if VALUE is not null. Otherwise, text is derived from the first non-null preceding element VALUE. If all preceding elements have null VALUE fields, VALUE is derived from the TEXT_EXPRESSION in the metadata table."
TEXT_ATTRIBUTES	VARCHAR2(4000)	Default text display attributes (font family and size, horizontal and vertical spacing, and so on) for the label text style and layout, unless overridden in the PRIVATETEXTATTRIBUTES attribute of the ST_ANNOTATION_TEXT constructor (described in <a href="#">Using the ST_ANNOTATION_TEXT Constructor</a> (page 3-9)). Use the format specified in the "XML for Text Attributes" section of the OpenGIS specification.

## Loading Spatial Data

This chapter describes how to load spatial data into a database, including storing the data in a table with a column of type SDO\_GEOMETRY. After you have loaded spatial data, you can create a spatial index for it and perform queries on it, as described in [Indexing and Querying Spatial Data](#) (page 5-1).

The process of loading data can be classified into two categories:

- Bulk loading of data (see [Bulk Loading](#) (page 4-1))  
This process is used to load large volumes of data into the database and uses the SQL\*Loader utility to load the data.
- Transactional insert operations (see [Transactional Insert Operations Using SQL](#) (page 4-3))  
This process is typically used to insert relatively small amounts of data into the database using the INSERT statement in SQL.

Recommendations for loading and validating spatial data are described in [Recommendations for Loading and Validating Spatial Data](#) (page 4-4).

### 4.1 Bulk Loading

Bulk loading can import large amounts of data into an Oracle database. Bulk loading is accomplished with the SQL\*Loader utility. (For information about SQL\*Loader, see *Oracle Database Utilities*.)

#### 4.1.1 Bulk Loading SDO\_GEOMETRY Objects

[Example 4-1](#) (page 4-1) is the SQL\*Loader control file for loading four geometries. When this control file is used with SQL\*Loader, it loads the same cola market geometries that are inserted using SQL statements in [Example 2-1](#) (page 2-2) in [Simple Example: Inserting, Indexing, and Querying Spatial Data](#) (page 2-1).

**Example 4-1 Control File for a Bulk Load of Cola Market Geometries**

```
LOAD DATA
  INFILE *
  TRUNCATE
  CONTINUEIF NEXT(1:1) = '#'
  INTO TABLE COLA_MARKETS
  FIELDS TERMINATED BY '|'
  TRAILING NULLCOLS (
    mkt_id INTEGER EXTERNAL,
    name CHAR,
    shape COLUMN OBJECT
  (
    SDO_GTYPE INTEGER EXTERNAL,
    SDO_ELEM_INFO VARRAY TERMINATED BY '||'
```

```

(elements FLOAT EXTERNAL),
SDO_ORDINATES VARRAY TERMINATED BY '|'/'
(ordinates FLOAT EXTERNAL)
)
)
begindata
  1|cola_a|
#2003|1|1003|3|/
#1|1|5|7|/
  2|cola_b|
#2003|1|1003|1|/
#5|1|8|1|8|6|5|7|5|1|/
  3|cola_c|
#2003|1|1003|1|/
#3|3|6|3|6|5|4|5|3|3|/
  4|cola_d|
#2003|1|1003|4|/
#8|7|10|9|8|11|/

```

Notes on [Example 4-1](#) (page 4-1):

- The `EXTERNAL` keyword in the definition `mkt_id INTEGER EXTERNAL` means that each value to be inserted into the `MKT_ID` column (1, 2, 3, and 4 in this example) is an integer in human-readable form, not binary format.
- In the data after `begindata`, each `MKT_ID` value is preceded by one space, because the `CONTINUEIF NEXT(1:1) = '#'` specification causes the first position of each data line to be ignored unless it is the number sign (#) continuation character.

#### **Example 4-2 Control File for a Bulk Load of Polygons**

[Example 4-2](#) (page 4-2) assumes that a table named `POLY_4PT` was created as follows:

```

CREATE TABLE POLY_4PT (GID VARCHAR2(32),
                        GEOMETRY SDO_GEOMETRY);

```

Assume that the ASCII data consists of a file with delimited columns and separate rows fixed by the limits of the table with the following format:

```

geometry rows:      GID, GEOMETRY

```

The coordinates in the `GEOMETRY` column represent polygons. [Example 4-2](#) (page 4-2) shows the control file for loading the data.

```

LOAD DATA
  INFILE *
  TRUNCATE
  CONTINUEIF NEXT(1:1) = '#'
  INTO TABLE POLY_4PT
  FIELDS TERMINATED BY '|'
  TRAILING NULLCOLS (
    GID INTEGER EXTERNAL,
    GEOMETRY COLUMN OBJECT
  (
    SDO_GTYPE      INTEGER EXTERNAL,
    SDO_ELEM_INFO  VARRAY TERMINATED BY '|'/'
    (elements      FLOAT EXTERNAL),
    SDO_ORDINATES  VARRAY TERMINATED BY '|'/'
    (ordinates     FLOAT EXTERNAL)
  )
)

```

```

begindata
  1|2003|1|1003|1|/
  #-122.4215|37.7862|-122.422|37.7869|-122.421|37.789|-122.42|37.7866|
  #-122.4215|37.7862|/
  2|2003|1|1003|1|/
  #-122.4019|37.8052|-122.4027|37.8055|-122.4031|37.806|-122.4012|37.8052|
  #-122.4019|37.8052|/
  3|2003|1|1003|1|/
  #-122.426|37.803|-122.4242|37.8053|-122.42355|37.8044|-122.4235|37.8025|
  #-122.426|37.803|/

```

### 4.1.2 Bulk Loading Point-Only Data in SDO\_GEOMETRY Objects

The following example shows a control file for loading a table with point data.

**Example 4-3 Control File for a Bulk Load of Point-Only Data**

```

LOAD DATA
  INFILE *
  TRUNCATE
  CONTINUEIF NEXT(1:1) = '#'
  INTO TABLE POINT
  FIELDS TERMINATED BY '|'
  TRAILING NULLCOLS (
    GID          INTEGER EXTERNAL,
    GEOMETRY COLUMN OBJECT
  (
    SDO_GTYPE          INTEGER EXTERNAL,
    SDO_POINT COLUMN OBJECT
    (X          FLOAT EXTERNAL,
    Y          FLOAT EXTERNAL)
  )
)

BEGINDATA
  1| 2001| -122.4215| 37.7862|
  2| 2001| -122.4019| 37.8052|
  3| 2001| -122.426| 37.803|
  4| 2001| -122.4171| 37.8034|
  5| 2001| -122.416151| 37.8027228|

```

## 4.2 Transactional Insert Operations Using SQL

Oracle Spatial and Graph uses standard Oracle tables that can be accessed or loaded with standard SQL syntax. This section contains examples of transactional insertions into columns of type SDO\_GEOMETRY. This process is typically used to add relatively small amounts of data into the database.

The INSERT statement in Oracle SQL has a limit of 999 arguments. Therefore, you cannot create a variable-length array of more than 999 elements using the SDO\_GEOMETRY constructor inside a transactional INSERT statement; however, you can insert a geometry using a host variable, and the host variable can be built using the SDO\_GEOMETRY constructor with more than 999 values in the SDO\_ORDINATE\_ARRAY specification. (The host variable is an OCI, PL/SQL, or Java program variable.)

To perform transactional insertions of geometries, you can create a procedure to insert a geometry, and then invoke that procedure on each geometry to be inserted.

[Example 4-4](#) (page 4-4) creates a procedure to perform the insert operation.

**Example 4-4 Procedure to Perform a Transactional Insert Operation**

```
CREATE OR REPLACE PROCEDURE
    INSERT_GEOM(GEOM SDO_GEOMETRY)
IS
BEGIN
    INSERT INTO TEST_1 VALUES (GEOM);
    COMMIT;
END;
/
```

Using the procedure created in [Example 4-4](#) (page 4-4), you can insert data by using a PL/SQL block, such as the one in [Example 4-5](#) (page 4-4), which loads a geometry into the variable named `geom` and then invokes the `INSERT_GEOM` procedure to insert that geometry.

**Example 4-5 PL/SQL Block Invoking a Procedure to Insert a Geometry**

```
DECLARE
geom SDO_geometry :=
    SDO_geometry (2003, null, null,
        SDO_elem_info_array (1,1003,3),
        SDO_ordinate_array (-109,37,-102,40));
BEGIN
    INSERT_GEOM(geom);
    COMMIT;
END;
/
```

For additional examples with various geometry types, see the following:

- Rectangle: in [Rectangle](#) (page 2-22)
- Polygon with a hole: in [Polygon with a Hole](#) (page 2-23)
- Compound line string :in [Compound Line String](#) (page 2-24)
- Compound polygon: in [Compound Polygon](#) (page 2-26)
- Point: in [Point](#) (page 2-27)
- Oriented point: in [Oriented Point](#) (page 2-28)
- Type 0 (zero) element: in [Type 0 \(Zero\) Element](#) (page 2-31)

## 4.3 Recommendations for Loading and Validating Spatial Data

You should validate all geometry data, and fix any validation errors, before performing any spatial operations on the data.

The recommended procedure for loading and validating spatial data is as follows:

1. Load the data, using a method described in [Bulk Loading](#) (page 4-1) or [Transactional Insert Operations Using SQL](#) (page 4-3).
2. Use the [SDO\\_GEOM.VALIDATE\\_GEOMETRY\\_WITH\\_CONTEXT](#) (page 23-52) function or the [SDO\\_GEOM.VALIDATE\\_LAYER\\_WITH\\_CONTEXT](#) (page 23-56) procedure on all spatial data loaded into the database.



3. For any geometries with the wrong orientation or an invalid ETYPE or GTYPE value, use [SDO\\_MIGRATE.TO\\_CURRENT](#) (page 25-1) on these invalid geometries to fix them.
4. For any geometries that are invalid for other reasons, use [SDO\\_UTIL.RECTIFY\\_GEOMETRY](#) (page 31-46) to fix these geometries.

For detailed information about using any of these subprograms, see the usage notes in its reference information section.



---

# Indexing and Querying Spatial Data

After you have loaded spatial data (discussed in [Loading Spatial Data](#) (page 4-1)), you should create a spatial index on it to enable efficient query performance using the data. This chapter describes how to:

- Create a spatial index (see [Creating a Spatial Index](#) (page 5-1))
- Query spatial data efficiently, based on an understanding of the Oracle Spatial and Graph query model and primary and secondary filtering (see [Querying Spatial Data](#) (page 5-8))

## 5.1 Creating a Spatial Index

Once data has been loaded into the spatial tables through either bulk or transactional loading, a spatial index (that is, a spatial R-tree index) must be created on each geometry column in the tables for efficient access to the data. For example, the following statement creates a spatial index named `territory_idx` using default values for all parameters:

```
CREATE INDEX territory_idx ON territories (territory_geom)
    INDEXTYPE IS MDSYS.SPATIAL_INDEX;
```

For detailed information about options for creating a spatial index, see the documentation for the [CREATE INDEX](#) (page 17-7) statement in [SQL Statements for Indexing Spatial Data](#) (page 17-1).

If the index creation does not complete for any reason, the index is invalid and must be deleted with the [DROP INDEX](#) (page 17-12) `<index_name> [FORCE]` statement.

Within each geometry column to be indexed, all the geometries must have the same `SDO_SRID` value.

Spatial indexes can be built on two, three, or four dimensions of data. The default number of dimensions is two, but if the data has more than two dimensions, you can use the `sdo_indx_dims` parameter keyword to specify the number of dimensions on which to build the index. (For information about support for three-dimensional geometries, see [Three-Dimensional Spatial Objects](#) (page 1-16). For an explanation of support for various combinations of dimensionality in query elements, see [Data and Index Dimensionality\\_ and Spatial Queries](#) (page 5-14).)

If you are *not* using the automatic undo management feature or the PGA memory management feature, or both, of Oracle Database, see [Rollback Segments and Sort Area Size](#) (page 5-7) for information about initialization parameter values that you may need to set. Both automatic undo management and PGA memory management are enabled by default, and their use is highly recommended.

The tablespace specified with the `tablespace` keyword in the [CREATE INDEX](#) (page 17-7) statement (or the default tablespace if the `tablespace` keyword is not specified) is used to hold both the index data table and some transient tables that are

created for internal computations. If you specify `WORK_TABLESPACE` as the tablespace, the transient tables are stored in the work tablespace.

For large tables (over 1 million rows), a temporary tablespace may be needed to perform internal sorting operations. The recommended size for this temporary tablespace is  $100 \times n$  bytes, where  $n$  is the number of rows in the table, up to a maximum requirement of 1 gigabyte of temporary tablespace.

To estimate the space that will be needed to create a spatial index, use the [SDO\\_TUNE.ESTIMATE\\_RTREE\\_INDEX\\_SIZE](#) (page 30-2) function, described in [SDO\\_TUNE Package \(Tuning\)](#) (page 30-1).

This section also contains the following topics:

- [Constraining Data to a Geometry Type](#) (page 5-2)
- [Creating a Cross-Schema Index](#) (page 5-2)
- [Using Partitioned Spatial Indexes](#) (page 5-3)
- [Exchanging Partitions Including Indexes](#) (page 5-6)
- [Export and Import Considerations with Spatial Indexes and Data](#) (page 5-6)
- [Distributed Transactions and Spatial Index Consistency](#) (page 5-7)
- [Enabling Access to Spatial Index Statistics](#) (page 5-7)
- [Rollback Segments and Sort Area Size](#) (page 5-7)

### 5.1.1 Constraining Data to a Geometry Type

When you create or rebuild a spatial index, you can ensure that all geometries that are in the table or that are inserted later are of a specified geometry type. To constrain the data to a geometry type in this way, use the `layer_gtype` keyword in the `PARAMETERS` clause of the [CREATE INDEX](#) (page 17-7) or [ALTER INDEX REBUILD](#) (page 17-3) statement, and specify a value from the Geometry Type column in [SDO\\_GTYPE](#) (page 2-5). For example, to constrain spatial data in a layer to polygons:

```
CREATE INDEX cola_spatial_idx
ON cola_markets(shape)
INDEXTYPE IS MDSYS.SPATIAL_INDEX
PARAMETERS ('layer_gtype=POLYGON');
```

The geometry types in [SDO\\_GTYPE](#) (page 2-5) are considered as a hierarchy when data is checked:

- The *MULTI* forms include the regular form also. For example, specifying `'layer_gtype=MULTIPOINT'` allows the layer to include both `POINT` and `MULTIPOINT` geometries.
- `COLLECTION` allows the layer to include all types of geometries.

### 5.1.2 Creating a Cross-Schema Index

You can create a spatial index on a table that is not in your schema. Assume that user B wants to create a spatial index on column `GEOMETRY` in table `T1` under user A's schema. Follow these steps:

1. Connect to the database as a privileged user (for example, as SYSTEM), and execute the following statement:

```
GRANT create table, create sequence to B;
```

2. Connect as a privileged user or as user A (or have user A connect), and execute the following statement:

```
GRANT select, index on A.T1 to B;
```

3. Connect as user B and execute a statement such as the following:

```
CREATE INDEX t1_spatial_idx on A.T1(geometry)
  INDEXTYPE IS mdsys.spatial_index;
```

### 5.1.3 Using Partitioned Spatial Indexes

You can create a partitioned spatial index on a partitioned table. This section describes usage considerations specific to Oracle Spatial and Graph. For a detailed explanation of partitioned tables and partitioned indexes, see *Oracle Database VLDB and Partitioning Guide*.

A partitioned spatial index can provide the following benefits:

- Reduced response times for long-running queries, because partitioning reduces disk I/O operations
- Reduced response times for concurrent queries, because I/O operations run concurrently on each partition
- Easier index maintenance, because of partition-level create and rebuild operations

Indexes on partitions can be rebuilt without affecting the queries on other partitions, and storage parameters for each local index can be changed independent of other partitions.

- Parallel query on multiple partition searching

The degree of parallelism is the value from the DEGREE column in the row for the index in the USER\_INDEXES view (that is, the value specified or defaulted for the PARALLEL keyword with the [CREATE INDEX](#) (page 17-7), [ALTER INDEX](#) (page 17-1), or [ALTER INDEX REBUILD](#) (page 17-3) statement).

- Improved query processing in multiprocessor system environments

In a multiprocessor system environment, if a spatial operator is invoked on a table with partitioned spatial index and if multiple partitions are involved in the query, multiple processors can be used to evaluate the query. The number of processors used is determined by the degree of parallelism and the number of partitions used in evaluating the query.

The following restrictions apply to spatial index partitioning:

- The partition key for spatial tables must be a scalar value, and must not be a spatial column.
- Only range partitioning is supported on the underlying table. All other kinds of partitioning are not currently supported for partitioned spatial indexes.

To create a partitioned spatial index, you must specify the LOCAL keyword. (If you do not specify the LOCAL keyword, a nonpartitioned spatial index is created on the data in all table partitions.) The following example creates a partitioned spatial index:

```
CREATE INDEX counties_idx ON counties(geometry)
  INDEXTYPE IS MDSYS.SPATIAL_INDEX LOCAL;
```

In this example, the default values are used for the number and placement of index partitions, namely:

- Index partitioning is based on the underlying table partitioning. For each table partition, a corresponding index partition is created.
- Each index partition is placed in the default tablespace.

If you do specify parameters for individual partitions, the following considerations apply:

- The storage characteristics for each partition can be the same or different for each partition. If they are different, it may enable parallel I/O (if the tablespaces are on different disks) and may improve performance.
- The `sdo_idx_dims` value must be the same for all partitions.
- The `layer_gtype` parameter value (see [Constraining Data to a Geometry Type](#) (page 5-2)) used for each partition may be different.

To override the default partitioning values, use a CREATE INDEX statement with the following general format:

```
CREATE INDEX <indexname> ON <table>(<column>)
  INDEXTYPE IS MDSYS.SPATIAL_INDEX
  [PARAMETERS ('<spatial-params>, <storage-params>')] LOCAL
  [( PARTITION <index_partition>
    PARAMETERS ('<spatial-params>, <storage-params>')
  [, PARTITION <index_partition>
    PARAMETERS ('<spatial-params>, <storage-params>')]
  )]
```

Queries can operate on partitioned tables to perform the query on only one partition. For example:

```
SELECT * FROM counties PARTITION(pl)
  WHERE ...<some-spatial-predicate>;
```

Querying on a selected partition may speed up the query and also improve overall throughput when multiple queries operate on different partitions concurrently.

When queries use a partitioned spatial index, the semantics (meaning or behavior) of spatial operators and functions is the same with partitioned and nonpartitioned indexes, except in the case of [SDO\\_NN](#) (page 18-17) (nearest neighbor). With [SDO\\_NN](#) (page 18-17), the requested number of geometries is returned for each partition that is affected by the query. (See the description of the [SDO\\_NN](#) (page 18-17) operator in [Spatial Operators](#) (page 18-1) for more information.)

For example, if you request the 5 closest restaurants to a point and the spatial index has 4 partitions, [SDO\\_NN](#) (page 18-17) returns up to 20 (5\*4) geometries. In this case, you must use the ROWNUM pseudocolumn (here, WHERE ROWNUM <=5) to return the 5 closest restaurants, and the ORDER BY clause to sort the results by distance in miles. [Example 5-1](#) (page 5-5) returns the 5 nearest restaurants from a partitioned spatial index.

**Note:**

[SDO\\_NN Examples](#) (page C-3) for more examples of using the [SDO\\_NN](#) (page 18-17) operator.

For a cross-schema query when a table has a partitioned spatial index, the user must be granted SELECT or READ privilege on both the spatial table and the index table (MDRT\_xxx) for the spatial index that was created on the spatial table. For more information and an example, see "[Cross-Schema Invocation of SDO\\_JOIN](#) (page 18-16)" in the Usage Notes for the [SDO\\_JOIN](#) (page 18-12) operator in [Spatial Operators](#) (page 18-1).

**Example 5-1 SDO\_NN Query with Partitioned Spatial Index**

```
SELECT * FROM
(
  SELECT r.name, r.location, SDO_NN_DISTANCE(1) distance_in_miles
  FROM restaurants_part_table r
  WHERE SDO_NN(r.location,
    MDSYS.SDO_GEOMETRY(2001,8307,MDSYS.SDO_POINT_TYPE(-110,35,Null),Null,Null),
    'SDO_NUM_RES=5 distance=2 unit=MILE', 1) = 'TRUE'
  ORDER BY distance_in_miles
)
WHERE ROWNUM<=5;
```

**5.1.3.1 Creating a Local Partitioned Spatial Index**

If you want to create a local partitioned spatial index, Oracle recommends that you use the procedure in this section instead of using the PARALLEL keyword, to avoid having to start over if the creation of any partition's index fails for any reason (for example, because the tablespace is full). Follow these steps:

1. Create a local spatial index and specify the UNUSABLE keyword. For example:

```
CREATE INDEX sp_idx ON my_table (location)
  INDEXTYPE IS mdsys.spatial_index
  PARAMETERS ('tablespace=tb_name work_tablespace=work_tb_name')
  LOCAL UNUSABLE;
```

This statement executes quickly and creates metadata associated with the index.

2. Create scripts with ALTER INDEX REBUILD statements, but without the PARALLEL keyword. For example, if you have 100 partitions and 10 processors, create 10 scripts with 10 ALTER INDEX statements such as the following:

```
ALTER INDEX sp_idx REBUILD PARTITION ip1;
ALTER INDEX sp_idx REBUILD PARTITION ip2;
. . .
ALTER INDEX sp_idx REBUILD PARTITION ip10;
```

3. Run all the scripts at the same time, so that each processor works on the index for a single partition, but all the processors are busy working on their own set of ALTER INDEX statements.

If any of the ALTER INDEX statements fails, you do not need to rebuild any partitions for which the operation has successfully completed.

### 5.1.4 Exchanging Partitions Including Indexes

You can use the ALTER TABLE statement with the EXCHANGE PARTITION ... INCLUDING INDEXES clause to exchange a spatial table partition and its index partition with a corresponding table and its index. For information about exchanging partitions, see the description of the ALTER TABLE statement in *Oracle Database SQL Language Reference*.

This feature can help you to operate more efficiently in a number of situations, such as:

- Bringing data into a partitioned table and avoiding the cost of index re-creation.
- Managing and creating partitioned indexes. For example, the data could be divided into multiple tables. The index for each table could be built one after the other to minimize the memory and tablespace resources needed during index creation. Alternately, the indexes could be created in parallel in multiple sessions. The tables (along with the indexes) could then be exchanged with the partitions of the original data table.
- Managing offline insert operations. New data can be stored in a temporary table and periodically exchanged with a new partition (for example, in a database with historical data).

To exchange partitions including indexes with spatial data and indexes, the two spatial indexes (one on the partition, the other on the table) must have the same dimensionality (`sdo_indx_dims` value). If the indexes do not have the same dimensionality, an error is raised. The table data is exchanged, but the indexes are not exchanged and the indexes are marked as failed. To use the indexes, you must rebuild them

### 5.1.5 Export and Import Considerations with Spatial Indexes and Data

If you use the Export utility to export tables with spatial data, the behavior of the operation depends on whether or not the spatial data has been spatially indexed:

- If the spatial data has not been spatially indexed, the table data is exported. However, you must update the `USER_SDO_GEOM_METADATA` view with the appropriate information on the target system.
- If the spatial data has been spatially indexed, the table data is exported, the appropriate information is inserted into the `USER_SDO_GEOM_METADATA` view on the target system, and the spatial index is built on the target system. However, if the insertion into the `USER_SDO_GEOM_METADATA` view fails (for example, if there is already a `USER_SDO_GEOM_METADATA` entry for the spatial layer), the spatial index is not built.

If you use the Import utility to import data that has been spatially indexed, the following considerations apply:

- If the index on the exported data was created with a `TABLESPACE` clause and if the specified tablespace does not exist in the database at import time, the index is not built. (This is different from the behavior with other Oracle indexes, where the index is created in the user's default tablespace if the tablespace specified for the original index does not exist at import time.)



- If the import operation must be done by a privileged database user, and if the FROMUSER and TOUSER format is used, the TOUSER user must be granted the CREATE TABLE and CREATE SEQUENCE privileges before the import operation, as shown in the following example (and enter the password for the SYSTEM account when prompted):

```
sqlplus system
SQL> grant CREATE TABLE, CREATE SEQUENCE to CHRIS;
SQL> exit;
imp system file=spatl_data.dmp fromuser=SCOTT touser=CHRIS
```

For information about using the Export and Import utilities, see *Oracle Database Utilities*.

### 5.1.6 Distributed Transactions and Spatial Index Consistency

In a distributed transaction, different branches of the transaction can execute in different sessions. The branches can detach from their current session and migrate to another within the transaction scope. To maintain the consistency of spatial indexes in distributed transactions, you must follow the usage guidelines in this section.

When the first insert, update, or delete operation on a spatial table (one with a spatial index) is performed in a distributed transaction, all subsequent insert, update, or delete operations on the table, as well as any prepare to commit operation (the first branch to prepare a commit), in the transaction should happen *in the same session* as the first operation. The branches performing these subsequent operations will first have to connect to the session in which the first operation was performed.

For more information about distributed transactions, see *Oracle Database Administrator's Guide*.

### 5.1.7 Enabling Access to Spatial Index Statistics

The Oracle Database optimizer collects statistics that describe details about the database and its objects. Statistics are critical to the optimizer's ability to pick the best execution plan for a SQL statement. For more information about optimizer statistics, see *Oracle Database SQL Tuning Guide*.

To be able to use procedures such as DBMS\_STATS.GATHER\_INDEX\_STATS and DBMS\_STATS.GATHER\_SCHEMA\_STATS to gather index statistics related to spatial indexes, the CREATE TABLE privilege must be granted to all database users that will perform the statistics collection.

When you run ANALYZE INDEX on a spatial domain index for a different schema (user), the user performing the ANALYZE operation needs the following privileges:

- CREATE ANY TABLE to create missing temporary tables
- DROP ANY TABLE to truncate or remove existing temporary tables

If the statistics are successfully collected, a table with the name in the form MDXT\_%objID% will be created for each index for which the statistics are collected. Each such table will be populated with spatial statistics data, 512 rows by default.

### 5.1.8 Rollback Segments and Sort Area Size

This section applies *only* if you (or the database administrator) are not using the automatic undo management feature or the PGA memory management feature, or both, of Oracle Database. Automatic memory management and PGA memory

management are enabled by default, and their use is highly recommended. For explanations of these features, see:

- The section about automatic undo management and undo segments in *Oracle Database Concepts*
- The section about PGA memory management in *Oracle Database Concepts*

If you are not using automatic undo management and if the rollback segment is not large enough, an attempt to create a spatial index will fail. The rollback segment should be  $100 \times n$  bytes, where  $n$  is the number of rows of data to be indexed. For example, if the table contains 1 million (1,000,000) rows, the rollback segment size should be 100,000,000 (100 million) bytes.

To ensure an adequate rollback segment, or if you have tried to create a spatial index and received an error that a rollback segment cannot be extended, review (or have a DBA review) the size and structure of the rollback segments. Create a public rollback segment of the appropriate size, and place that rollback segment online. In addition, ensure that any small inappropriate rollback segments are placed offline during large spatial index operations.

If you are not using the PGA memory management feature, the database parameter `SORT_AREA_SIZE` affects the amount of time required to create the index. The `SORT_AREA_SIZE` value is the maximum amount, in bytes, of memory to use for a sort operation. The optimal value depends on the database size, but a good guideline is to make it at least 1 million bytes when you create a spatial index. To change the `SORT_AREA_SIZE` value, use the `ALTER SESSION` statement. For example, to change the value to 20 million bytes:

```
ALTER SESSION SET SORT_AREA_SIZE = 20000000;
```

## 5.2 Querying Spatial Data

This section describes how the structures of a spatial layer are used to resolve spatial queries and spatial joins.

Spatial and Graph uses a two-tier query model with primary and secondary filter operations to resolve spatial queries and spatial joins, as explained in [Query Model](#) (page 1-9). The term *two-tier* indicates that two distinct operations are performed to resolve queries. If both operations are performed, the exact result set is returned.

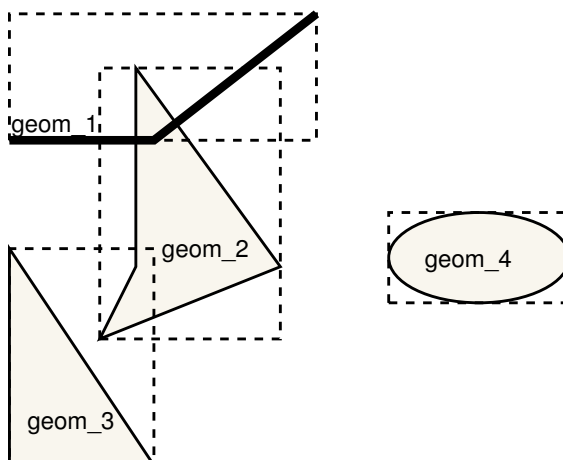
You cannot append a database link (dblink) name to the name of a spatial table in a query if a spatial index is defined on that table.

This section also contains the following topics:

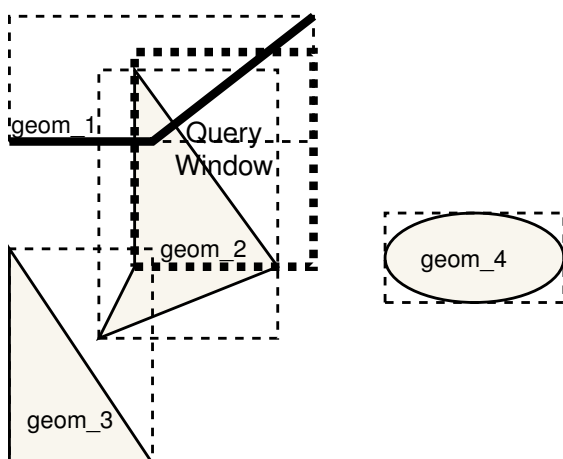
- [Spatial Query](#) (page 5-8)
- [Spatial Join](#) (page 5-13)
- [Data and Index Dimensionality\\_ and Spatial Queries](#) (page 5-14)

### 5.2.1 Spatial Query

In a spatial R-tree index, each geometry is represented by its minimum bounding rectangle (MBR), as explained in [R-Tree Indexing](#) (page 1-10). Consider the following layer containing several objects in [Figure 5-1](#) (page 5-9). Each object is labeled with its geometry name (geom\_1 for the line string, geom\_2 for the four-sided polygon, geom\_3 for the triangular polygon, and geom\_4 for the ellipse), and the MBR around each object is represented by a dashed line.

**Figure 5-1 Geometries with MBRs**

A typical spatial query is to request all objects that lie within a **query window**, that is, a defined fence or window. A dynamic query window refers to a rectangular area that is not defined in the database, but that must be defined before it is used. [Figure 5-2](#) (page 5-9) shows the same geometries as in [Figure 5-1](#) (page 5-9), but adds a query window represented by the heavy dotted-line box.

**Figure 5-2 Layer with a Query Window**

In [Figure 5-2](#) (page 5-9), the query window covers parts of geometries geom\_1 and geom\_2, as well as part of the MBR for geom\_3 but none of the actual geom\_3 geometry. The query window does not cover any part of the geom\_4 geometry or its MBR.

### 5.2.1.1 Primary Filter Operator

The [SDO\\_FILTER](#) (page 18-8) operator, described in [Spatial Operators](#) (page 18-1), implements the primary filter portion of the two-step process involved in the Oracle Spatial and Graph query processing model. The primary filter uses the index data to determine only if a set of candidate object pairs may interact. Specifically, the primary filter checks to see if the MBRs of the candidate objects interact, not whether the objects themselves interact. The [SDO\\_FILTER](#) (page 18-8) operator syntax is as follows:

```
SDO_FILTER(geometry1 SDO_GEOMETRY, geometry2 SDO_GEOMETRY, param VARCHAR2)
```

In the preceding syntax:

- `geometry1` is a column of type `SDO_GEOMETRY` in a table. This column must be spatially indexed.
- `geometry2` is an object of type `SDO_GEOMETRY`. This object may or may not come from a table. If it comes from a table, it may or may not be spatially indexed.
- `param` is an optional string of type `VARCHAR2`. It can specify either or both of the `min_resolution` and `max_resolution` keywords.

The following examples perform a primary filter operation only (with no secondary filter operation). They will return all the geometries shown in [Figure 5-2](#) (page 5-9) that have an MBR that interacts with the query window. The result of the following examples are geometries `geom_1`, `geom_2`, and `geom_3`.

The following example performs a primary filter operation without inserting the query window into a table. The window will be indexed in memory and performance will be very good.

**Example 5-2 Primary Filter with a Temporary Query Window**

```
SELECT A.Feature_ID FROM TARGET A
WHERE sdo_filter(A.shape, SDO_geometry(2003,NULL,NULL,
                                     SDO_elem_info_array(1,1003,3),
                                     SDO_ordinate_array(x1,y1, x2,y2))
               ) = 'TRUE';
```

In the preceding example, `(x1,y1)` and `(x2,y2)` are the lower-left and upper-right corners of the query window.

In the following example, a transient instance of type `SDO_GEOMETRY` was constructed for the query window instead of specifying the window parameters in the query itself.

**Example 5-3 Primary Filter with a Transient Instance of the Query Window**

```
SELECT A.Feature_ID FROM TARGET A
WHERE sdo_filter(A.shape, :theWindow) = 'TRUE';
```

The following example assumes the query window was inserted into a table called `WINDOWS`, with an ID of `WINS_1`.

**Example 5-4 Primary Filter with a Stored Query Window**

```
SELECT A.Feature_ID FROM TARGET A, WINDOWS B
WHERE B.ID = 'WINS_1' AND
      sdo_filter(A.shape, B.shape) = 'TRUE';
```

If the `B.SHAPE` column is not spatially indexed, the [SDO\\_FILTER](#) (page 18-8) operator indexes the query window in memory and performance is very good.

### 5.2.1.2 Primary and Secondary Filter Operator

The [SDO\\_RELATE](#) (page 18-30) operator, described in [Spatial Operators](#) (page 18-1), performs both the primary and secondary filter stages when processing a query. The secondary filter ensures that only candidate objects that actually interact are selected. This operator can be used only if a spatial index has been created on two dimensions of data. The syntax of the [SDO\\_RELATE](#) (page 18-30) operator is as follows:

```
SDO_RELATE(geometry1  SDO_GEOMETRY,
            geometry2  SDO_GEOMETRY,
            param       VARCHAR2)
```

In the preceding syntax:

- `geometry1` is a column of type `SDO_GEOMETRY` in a table. This column must be spatially indexed.
- `geometry2` is an object of type `SDO_GEOMETRY`. This object may or may not come from a table. If it comes from a table, it may or may not be spatially indexed.
- `param` is a quoted string with the `mask` keyword and a valid mask value, and optionally either or both of the `min_resolution` and `max_resolution` keywords, as explained in the documentation for the [SDO\\_RELATE](#) (page 18-30) operator in [Spatial Operators](#) (page 18-1).

The following examples perform both primary and secondary filter operations. They return all the geometries in [Figure 5-2](#) (page 5-9) that lie within or overlap the query window. The result of these examples is objects `geom_1` and `geom_2`.

The following example performs both primary and secondary filter operations without inserting the query window into a table. The window will be indexed in memory and performance will be very good.

#### **Example 5-5 Secondary Filter Using a Temporary Query Window**

```
SELECT A.Feature_ID FROM TARGET A
WHERE sdo_relate(A.shape, SDO_geometry(2003,NULL,NULL,
                                     SDO_elem_info_array(1,1003,3),
                                     SDO_ordinate_array(x1,y1, x2,y2)),
               'mask=anyinteract') = 'TRUE';
```

In the preceding example, `(x1,y1)` and `(x2,y2)` are the lower-left and upper-right corners of the query window.

The following example assumes the query window was inserted into a table called `WINDOWS`, with an ID value of `WINS_1`.

#### **Example 5-6 Secondary Filter Using a Stored Query Window**

```
SELECT A.Feature_ID FROM TARGET A, WINDOWS B
WHERE B.ID = 'WINS_1' AND
      sdo_relate(A.shape, B.shape,
               'mask=anyinteract') = 'TRUE';
```

If the `B.SHAPE` column is not spatially indexed, the [SDO\\_RELATE](#) (page 18-30) operator indexes the query window in memory and performance is very good.

### **5.2.1.3 Within-Distance Operator**

The [SDO\\_WITHIN\\_DISTANCE](#) (page 18-36) operator, described in [Spatial Operators](#) (page 18-1), is used to determine the set of objects in a table that are within *n* distance units from a reference object. This operator can be used only if a spatial index has been created on two dimensions of data. The reference object may be a transient or persistent instance of `SDO_GEOMETRY`, such as a temporary query window or a permanent geometry stored in the database. The syntax of the operator is as follows:

```
SDO_WITHIN_DISTANCE(geometry1 SDO_GEOMETRY,
                    aGeom      SDO_GEOMETRY,
                    params      VARCHAR2);
```

In the preceding syntax:

- `geometry1` is a column of type `SDO_GEOMETRY` in a table. This column must be spatially indexed.

- aGeom is an instance of type SDO\_GEOMETRY.
- params is a quoted string of keyword value pairs that determines the behavior of the operator. See the [SDO\\_WITHIN\\_DISTANCE](#) (page 18-36) operator in [Spatial Operators](#) (page 18-1) for a list of parameters.

The following example selects any objects within 1.35 distance units from the query window:

```
SELECT A.Feature_ID
FROM TARGET A
WHERE SDO_WITHIN_DISTANCE( A.shape, :theWindow, 'distance=1.35') = 'TRUE';
```

The distance units are based on the geometry coordinate system in use. If you are using a geodetic coordinate system, the units are meters. If no coordinate system is used, the units are the same as for the stored data.

The [SDO\\_WITHIN\\_DISTANCE](#) (page 18-36) operator is not suitable for performing spatial joins. That is, a query such as *Find all parks that are within 10 distance units from coastlines* will not be processed as an index-based spatial join of the COASTLINES and PARKS tables. Instead, it will be processed as a nested loop query in which each COASTLINES instance is in turn a reference object that is buffered, indexed, and evaluated against the PARKS table. Thus, the [SDO\\_WITHIN\\_DISTANCE](#) (page 18-36) operation is performed *n* times if there are *n* rows in the COASTLINES table.

For non-geodetic data, there is an efficient way to accomplish a spatial join that involves buffering all geometries of a layer. This method does not use the [SDO\\_WITHIN\\_DISTANCE](#) (page 18-36) operator. First, create a new table COSINE\_BUFS as follows:

```
CREATE TABLE cosine_bufs UNRECOVERABLE AS
  SELECT SDO_BUFFER (A.SHAPE, B.DIMINFO, 1.35)
  FROM COSINE A, USER_SDO_GEOM_METADATA B
  WHERE TABLE_NAME='COSINES' AND COLUMN_NAME='SHAPE';
```

Next, create a spatial index on the SHAPE column of COSINE\_BUFS. Then you can perform the following query:

```
SELECT /*+ ordered */ a.gid, b.gid
FROM TABLE(SDO_JOIN( 'PARKS', 'SHAPE',
                      'COSINE_BUFS', 'SHAPE',
                      'mask=ANYINTERACT')) c,
      parks a,
      cosine_bufs b
WHERE c.rowid1 = a.rowid AND c.rowid2 = b.rowid;
```

#### 5.2.1.4 Nearest Neighbor Operator

The [SDO\\_NN](#) (page 18-17) operator, described in [Spatial Operators](#) (page 18-1), is used to identify the nearest neighbors for a geometry. This operator can be used only if a spatial index has been created on two dimensions of data. The syntax of the operator is as follows:

```
SDO_NN(geometry1  SDO_GEOMETRY,
        geometry2  SDO_GEOMETRY,
        param       VARCHAR2
        [, number   NUMBER]);
```

In the preceding syntax:

- `geometry1` is a column of type `SDO_GEOMETRY` in a table. This column must be spatially indexed.
- `geometry2` is an instance of type `SDO_GEOMETRY`.
- `param` is a quoted string of keyword-value pairs that can determine the behavior of the operator, such as how many nearest neighbor geometries are returned. See the [SDO\\_NN](#) (page 18-17) operator in [Spatial Operators](#) (page 18-1) for information about this parameter.
- `number` is the same number used in the call to [SDO\\_NN\\_DISTANCE](#) (page 18-21). Use this only if the [SDO\\_NN\\_DISTANCE](#) (page 18-21) ancillary operator is included in the call to [SDO\\_NN](#) (page 18-17). See the [SDO\\_NN](#) (page 18-17) operator in [Spatial Operators](#) (page 18-1) for information about this parameter.

The following example finds the two objects from the `SHAPE` column in the `COLA_MARKETS` table that are closest to a specified point (10,7). (Note the use of the optimizer hint in the `SELECT` statement, as explained in the Usage Notes for the [SDO\\_NN](#) (page 18-17) operator in [Spatial Operators](#) (page 18-1).)

```
SELECT /*+ INDEX(cola_markets cola_spatial_idx) */
  c.mkt_id, c.name FROM cola_markets c WHERE SDO_NN(c.shape,
  SDO_geometry(2001, NULL, SDO_point_type(10,7,NULL), NULL,
  NULL), 'sdo_num_res=2') = 'TRUE';
```

### 5.2.1.5 Spatial Functions

Spatial and Graph also supplies functions for determining relationships between geometries, finding information about single geometries, changing geometries, and combining geometries. These functions all take into account two dimensions of source data. If the output value of these functions is a geometry, the resulting geometry will have the same dimensionality as the input geometry, but only the first two dimensions will accurately reflect the result of the operation.

## 5.2.2 Spatial Join

A **spatial join** is the same as a regular join except that the predicate involves a spatial operator. In Spatial and Graph, a spatial join takes place when you compare all geometries of one layer to all geometries of another layer. This is unlike a query window, which compares a single geometry to all geometries of a layer.

Spatial joins can be used to answer questions such as *Which highways cross national parks?*

The following table structures illustrate how the join would be accomplished for this example:

```
PARKS(      GID VARCHAR2(32), SHAPE SDO_GEOMETRY)
HIGHWAYS(   GID VARCHAR2(32), SHAPE SDO_GEOMETRY)
```

To perform a spatial join, use the [SDO\\_JOIN](#) (page 18-12) operator, which is described in [Spatial Operators](#) (page 18-1). The following spatial join query, to list the `GID` column values of highways and parks where a highway interacts with a park, performs a primary filter operation only (`'mask=FILTER'`), and thus it returns only approximate results:

```
SELECT /*+ ordered */ a.gid, b.gid
  FROM TABLE(SDO_JOIN('PARKS', 'SHAPE',
                        'HIGHWAYS', 'SHAPE',
                        'mask=FILTER')) c,
```

```
parks a,
highways b
WHERE c.rowid1 = a.rowid AND c.rowid2 = b.rowid;
```

The following spatial join query requests the same information as in the preceding example, but it performs both primary and secondary filter operations ('mask=ANYINTERACT'), and thus it returns exact results:

```
SELECT /* ordered */ a.gid, b.gid
FROM TABLE(SDO_JOIN('PARKS', 'SHAPE',
                     'HIGHWAYS', 'SHAPE',
                     'mask=ANYINTERACT')) c,
parks a,
highways b
WHERE c.rowid1 = a.rowid AND c.rowid2 = b.rowid;
```

### 5.2.3 Data and Index Dimensionality, and Spatial Queries

The elements of a spatial query can, in theory, have the following dimensionality:

- The base table geometries (or geometry1 in spatial operator formats) can have two, three, or more dimensions.
- The spatial index created on the base table (or geometry1) can be two-dimensional or three-dimensional.
- The query window (or geometry2 in spatial operator formats) can have two, three, or more dimensions.

Some combinations of dimensionality among the three elements are supported and some are not. [Table 5-1](#) (page 5-14) explains what happens with the possible combinations involving two and three dimensions.

**Table 5-1 Data and Index Dimensionality, and Query Support**

Base Table (geometry1) Dimensionality	Spatial Index Dimensionality	Query Window (geometry2) Dimensionality	Query Result
2-dimensional	2-dimensional	2-dimensional	Performs a two-dimensional query.
2-dimensional	2-dimensional	3-dimensional	Supported if the query window has an appropriate SDO_GTYPE value less than 3008.
2-dimensional	3-dimensional	2-dimensional	Not supported: 3D index not permitted on 2D data.
2-dimensional	3-dimensional	3-dimensional	Not supported: 3D index not permitted on 2D data.
3-dimensional	2-dimensional	2-dimensional	Ignores the third (Z) dimension in each base geometry and performs a two-dimensional query.
3-dimensional	2-dimensional	3-dimensional	Supported if the query window has an appropriate SDO_GTYPE value less than 3008.



**Table 5-1 (Cont.) Data and Index Dimensionality, and Query Support**

<b>Base Table (geometry1) Dimensionality</b>	<b>Spatial Index Dimensionality</b>	<b>Query Window (geometry2) Dimensionality</b>	<b>Query Result</b>
3-dimensional	3-dimensional	2-dimensional	Converts the 2D query window to a 3D window with zero Z values and performs a three-dimensional query.
3-dimensional	3-dimensional	3-dimensional	Performs a three-dimensional query.



---

# Coordinate Systems (Spatial Reference Systems)

This chapter describes in greater detail the Oracle Spatial and Graph coordinate system support, which was introduced in [Coordinate System](#) (page 1-5). You can store and manipulate SDO\_GEOMETRY objects in a variety of coordinate systems.

For reference information about coordinate system transformation functions and procedures in the MDSYS.SDO\_CS package, see [SDO\\_CS Package \(Coordinate System Transformation\)](#) (page 20-1).

This chapter contains the following major sections:

- [Terms and Concepts](#) (page 6-1)
- [Geodetic Coordinate Support](#) (page 6-2)
- [Local Coordinate Support](#) (page 6-8)
- [EPSG Model and Spatial and Graph](#) (page 6-8)
- [Three-Dimensional Coordinate Reference System Support](#) (page 6-9)
- [TFM\\_PLAN Object Type](#) (page 6-19)
- [Coordinate Systems Data Structures](#) (page 6-20)
- [Legacy Tables and Views](#) (page 6-47)
- [Creating a User-Defined Coordinate Reference System](#) (page 6-55)
- [Notes and Restrictions with Coordinate Systems Support](#) (page 6-73)
- [U.S. National Grid Support](#) (page 6-74)
- [Google Maps Considerations](#) (page 6-74)
- [Example of Coordinate System Transformation](#) (page 6-76)

## 6.1 Terms and Concepts

This section explains important terms and concepts related to coordinate system support in Oracle Spatial and Graph.

### 6.1.1 Coordinate System (Spatial Reference System)

A **coordinate system** (also called a *spatial reference system*) is a means of assigning coordinates to a location and establishing relationships between sets of such coordinates. It enables the interpretation of a set of coordinates as a representation of a position in a real world space.

The term **coordinate reference system** has the same meaning as coordinate system for Spatial and Graph, and the terms are used interchangeably. European Petroleum Survey Group (EPSG) specifications and documentation typically use the term coordinate reference system. (EPSG has its own meaning for the term *coordinate system*, as noted in [SDO\\_COORD\\_SYS Table](#) (page 6-29).)

### 6.1.2 Cartesian Coordinates

**Cartesian coordinates** are coordinates that measure the position of a point from a defined origin along axes that are perpendicular in the represented two-dimensional or three-dimensional space.

### 6.1.3 Geodetic Coordinates (Geographic Coordinates)

**Geodetic coordinates** (sometimes called *geographic coordinates*) are angular coordinates (longitude and latitude), closely related to spherical polar coordinates, and are defined relative to a particular Earth geodetic datum (described in [Geodetic Datum](#) (page 6-2)). For more information about geodetic coordinate support, see [Geodetic Coordinate Support](#) (page 6-2).

### 6.1.4 Projected Coordinates

**Projected coordinates** are planar Cartesian coordinates that result from performing a mathematical mapping from a point on the Earth's surface to a plane. There are many such mathematical mappings, each used for a particular purpose.

### 6.1.5 Local Coordinates

**Local coordinates** are Cartesian coordinates in a non-Earth (non-georeferenced) coordinate system. [Local Coordinate Support](#) (page 6-8) describes local coordinate support in Spatial and Graph.

### 6.1.6 Geodetic Datum

A **geodetic datum** (or **datum**) is a means of shifting and rotating an ellipsoid to represent the figure of the Earth, usually as an oblate spheroid, that approximates the surface of the Earth locally or globally, and is the reference for the system of geodetic coordinates.

Each geodetic coordinate system is based on a datum.

### 6.1.7 Transformation

**Transformation** is the conversion of coordinates from one coordinate system to another coordinate system.

If the coordinate system is georeferenced, transformation can involve datum transformation: the conversion of geodetic coordinates from one geodetic datum to another geodetic datum, usually involving changes in the shape, orientation, and center position of the reference ellipsoid.

## 6.2 Geodetic Coordinate Support

Effective with Oracle9i, Spatial and Graph provides a rational and complete treatment of geodetic coordinates. Before Oracle9i, spatial computations were based solely on flat (Cartesian) coordinates, regardless of the coordinate system specified for the layer of geometries. Consequently, computations for data in geodetic coordinate systems

were inaccurate, because they always treated the coordinates as if they were on a flat surface, and they did not consider the curvature of the surface.

Effective with release 9.2, ellipsoidal surface computations consider the curvatures of the Earth in the specified geodetic coordinate system and return correct, accurate results. In other words, spatial queries return the right answers all the time.

### 6.2.1 Geodesy and Two-Dimensional Geometry

A two-dimensional geometry is a surface geometry, but the important question is: What is the *surface*? A flat surface (plane) is accurately represented by Cartesian coordinates. However, Cartesian coordinates are not adequate for representing the surface of a solid. A commonly used surface for spatial geometry is the surface of the Earth, and the laws of geometry there are different than they are in a plane. For example, on the Earth's surface there are no parallel lines: lines are geodesics, and all geodesics intersect. Thus, closed curved surface problems cannot be done accurately with Cartesian geometry.

Spatial and Graph provides accurate results regardless of the coordinate system or the size of the area involved, without requiring that the data be projected to a flat surface. The results are accurate regardless of where on the Earth's surface the query is focused, even in "special" areas such as the poles. Thus, you can store coordinates in any datum and projections that you choose, and you can perform accurate queries regardless of the coordinate system.

### 6.2.2 Choosing a Geodetic or Projected Coordinate System

For applications that deal with the Earth's surface, the data can be represented using a geodetic coordinate system or a projected plane coordinate system. In deciding which approach to take with the data, consider any needs related to accuracy and performance:

- Accuracy

For many spatial applications, the area is sufficiently small to allow adequate computations on Cartesian coordinates in a local projection. For example, the New Hampshire State Plane local projection provides adequate accuracy for most spatial applications that use data for that state.

However, Cartesian computations on a plane projection will never give accurate results for a large area such as Canada or Scandinavia. For example, a query asking if Stockholm, Sweden and Helsinki, Finland are within a specified distance may return an incorrect result if the specified distance is close to the actual measured distance. Computations involving large areas or requiring very precise accuracy must account for the curvature of the Earth's surface.

- Performance

Spherical computations use more computing resources than Cartesian computations. Some operations using geodetic coordinates may take longer to complete than the same operations using Cartesian coordinates.

It is important that you choose the correct type of coordinate system, because it affects the point at which anomalies related to floating point arithmetic are likely to appear.

### 6.2.3 Choosing Non-Ellipsoidal or Ellipsoidal Height

This section discusses guidelines for choosing the appropriate type of height for three-dimensional data: non-ellipsoidal or ellipsoidal. Although ellipsoidal height is widely

used and is the default for many GPS applications, and although ellipsoidal computations incur less performance overhead in many cases, there are applications for which a non-ellipsoidal height may be preferable or even necessary.

Also, after any initial decision, you can change the reference height type, because transformations between different height datums are supported.

### 6.2.3.1 Non-Ellipsoidal Height

Non-ellipsoidal height is measured from some point other than the reference ellipsoid. Some common non-ellipsoidal measurements of height are from ground level, mean sea level (MSL), or the reference geoid.

- **Ground level:** Measuring height from the ground level is conceptually the simplest approach, and it is common in very local or informal applications. For example, when modeling a single building or a cluster of buildings, ground level may be adequate.

Moreover, if you ever need to integrate local ground height with a global height datum, you can achieve this with a transformation (EPSG method 9616) adding a local constant reference height. If you need to model local terrain undulations, you can achieve this with a transformation using an offset matrix (EPSG method 9635), just as you can between the geoid and the ellipsoid.

- **Mean sea level (MSL):** MSL is a common variation of sea level that provides conceptual simplicity, ignoring local variations and changes over time in sea level. It can also be extrapolated to areas covered by land.

Height relative to MSL is useful for a variety of applications, such as those dealing with flooding risk, gravitational potential, and how thin the air is. MSL is commonly used for the heights of aircraft in flight.

- **Geoid:** The geoid, the equipotential surface closest to MSL, provides the most precise measurements of height in terms of gravitational pull, factoring in such things as climate and tectonic changes. The geoid can deviate from MSL by approximately 2 meters (plus or minus).

If an application is affected more by purely gravitational effects than by actual local sea level, you may want to use the geoid as the reference rather than MSL. To perform transformations between MSL, geoid, or ellipsoid, you can use EPSG method 9635 and the appropriate time-stamped offset matrix.

Because most non-ellipsoidal height references are irregular and undulating surfaces, transformations between them are more complicated than with ellipsoidal heights. One approach is to use an offset grid file to define the transformation. This approach is implemented in EPSG method 9635. The grid file has to be acquired (often available publicly from government websites). Moreover, because most such non-ellipsoidal height datums (including the geoid, sea level, and local terrain) change over time, the timestamp of an offset matrix may matter, even if not by much. (Of course, the same principle applies to ellipsoids as well, since they are not static in the long term. After all, they are intended to approximate the changing geoid, MSL, or terrain.)

Regarding performance and memory usage with EPSG method 9635, at runtime the grid must be loaded before the transformation of a dataset. This load operation temporarily increases the footprint in main memory and incurs one-time loading overhead. If an entire dataset is transformed, the overhead can be relatively insignificant; however, if frequent transformations are performed on single geometries, the cumulative overhead can become significant.

### 6.2.3.2 Ellipsoidal Height

Ellipsoidal height is measured from a point on the reference ellipsoid. The ellipsoid is a convenient and relatively faithful approximation of the Earth. Although using an ellipsoid is more complex than using a sphere to represent the Earth, using an ellipsoid is, for most applications, simpler than using a geoid or local heights (although with some sacrifice in precision). Moreover, geoidal and sea-level heights are often not well suited for mathematical analysis, because the undulating and irregular shapes would make certain computations prohibitively complex and expensive.

GPS applications often assume ellipsoidal height as a reference and use it as the default. Because the ellipsoid is chosen to match the geoid (and similar sea level), ellipsoidal height tends not to deviate far from MSL height. For example, the geoid diverges from the NAD83 ellipsoid by only up to 50 meters. Other ellipsoids may be chosen to match a particular country even more closely.

Even if different parties use different ellipsoids, a WKT can conveniently describe such differences. A simple datum transformation can efficiently and accurately perform transformations between ellipsoids. Because no offset matrix is involved, no loading overhead is required. Thus, interoperability is simplified with ellipsoidal height, although future requirements or analysis might necessitate the use of MSL, a geoid, or other non-ellipsoidal height datums.

## 6.2.4 Geodetic MBRs

To create a query window for certain operations on geodetic data, use an MBR (minimum bounding rectangle) by specifying an SDO\_ETYPE value of 1003 or 2003 (optimized rectangle) and an SDO\_INTERPRETATION value of 3, as described in [Table 2-2](#) (page 2-9) in [SDO\\_ELEM\\_INFO](#) (page 2-8). A geodetic MBR can be used with the following operators: [SDO\\_FILTER](#) (page 18-8), [SDO\\_RELATE](#) (page 18-30) with the ANYINTERACT mask, [SDO\\_ANYINTERACT](#) (page 18-2), and [SDO\\_WITHIN\\_DISTANCE](#) (page 18-36).

[Example 6-1](#) (page 6-5) requests the names of all cola markets that are likely to interact spatially with a geodetic MBR.

### **Example 6-1 Using a Geodetic MBR**

```
SELECT c.name FROM cola_markets_cs c WHERE
  SDO_FILTER(c.shape,
    SDO_GEOMETRY(
      2003,
      8307,      -- SRID for WGS 84 longitude/latitude
      NULL,
      SDO_ELEM_INFO_ARRAY(1,1003,3),
      SDO_ORDINATE_ARRAY(6,5, 10,10))
  ) = 'TRUE';
```

[Example 6-1](#) (page 6-5) produces the following output (assuming the data as defined in [Example 6-17](#) (page 6-76) in [Example of Coordinate System Transformation](#) (page 6-76)):

```
NAME
-----
cola_c
cola_b
cola_d
```

The following considerations apply to the use of geodetic MBRs:

- Do not use a geodetic MBR with spatial objects stored in the database. Use it only to construct a query window.
- The lower-left Y coordinate (minY) must be less than the upper-right Y coordinate (maxY). If the lower-left X coordinate (minX) is greater than the upper-right X coordinate (maxX), the window is assumed to cross the date line meridian (that is, the meridian "opposite" the prime meridian, or both 180 and -180 longitude). For example, an MBR of (-10,10, -100, 20) with longitude/latitude data goes three-fourths of the way around the Earth (crossing the date line meridian), and goes from latitude lines 10 to 20.
- When Spatial and Graph constructs the MBR internally for the query, lines along latitude lines are densified by adding points at one-degree intervals. This might affect results for objects within a few meters of the edge of the MBR (especially objects in the middle latitudes in both hemispheres).
- When an optimized rectangle spans more than 119 degrees in longitude, it is internally divided into three rectangles; and as a result, these three rectangles share an edge that is the common boundary between them. If you validate the geometry of such an optimized rectangle, error code 13351 is returned because the internal rectangles have a shared edge. You can use such an optimized rectangle for queries with only the following: [SDO\\_ANYINTERACT](#) (page 18-2) operator, [SDO\\_RELATE](#) (page 18-30) operator with the ANYINTERACT mask, or [SDO\\_GEOM.RELATE](#) (page 23-4) function with the ANYINTERACT mask. (Any other queries on such an optimized rectangle may return incorrect results.)

The following additional examples show special or unusual cases, to illustrate how a geodetic MBR is interpreted with longitude/latitude data:

- (10,0, -110,20) crosses the date line meridian and goes most of the way around the world, and goes from the equator to latitude 20.
- (10,-90, 40,90) is a band from the South Pole to the North Pole between longitudes 10 and 40.
- (10,-90, 40,50) is a band from the South Pole to latitude 50 between longitudes 10 and 40.
- (-180,-10, 180,5) is a band that wraps the equator from 10 degrees south to 5 degrees north.
- (-180,-90, 180,90) is the whole Earth.
- (-180,-90, 180,50) is the whole Earth below latitude 50.
- (-180,50, 180,90) is the whole Earth above latitude 50.

## 6.2.5 Other Considerations and Requirements with Geodetic Data

The following geometries are not permitted if a geodetic coordinate system is used or if any transformation is being performed (even if the transformation is from one projected coordinate system to another projected coordinate system):

- Circles
- Circular arcs



Geodetic coordinate system support is provided only for geometries that consist of points or geodesics (lines on the ellipsoid). If you have geometries containing circles or circular arcs in a projected coordinate system, you can densify them using the [SDO\\_GEOM.SDO\\_ARC\\_DENSIFY](#) (page 23-7) function (documented in [SDO\\_GEOM Package \(Geometry\)](#) (page 23-1)) before transforming them to geodetic coordinates, and then perform spatial operations on the resulting geometries.

The following size limits apply with geodetic data:

- No polygon element can have an area larger than or equal to one-half the surface of the Earth. Moreover, if the result of a union of two polygons is greater than one-half the surface of the Earth, the operation will not produce a correct result. For example, if A union B results in a polygon that is greater than one-half of the area of the Earth, the operations A difference B, A intersection B, and A XOR B are not supported, and only a relate operation with the ANYINTERACT mask is supported between those two polygons.
- In a line, the distance between two adjacent coordinates cannot be greater than or equal to one-half the perimeter (a great circle) of the Earth.

If you need to work with larger elements, first break these elements into multiple smaller elements and work with them. For example, you cannot create a geometry representing the entire ocean surface of the Earth; however, you can create multiple geometries, each representing part of the overall ocean surface. To work with a line string that is greater than or equal to one-half the perimeter of the Earth, you can add one or more intermediate points on the line so that all adjacent coordinates are less than one-half the perimeter of the Earth.

Tolerance is specified as meters for geodetic layers. If you use tolerance values that are typical for non-geodetic data, these values are interpreted as meters for geodetic data. For example, if you specify a tolerance value of 0.05 for geodetic data, this is interpreted as precise to 5 centimeters. If this value is more precise than your applications need, performance may be affected because of the internal computational steps taken to implement the specified precision. (For more information about tolerance, see [Tolerance](#) (page 1-6).)

For geodetic layers, you must specify the dimensional extents in the index metadata as -180,180 for longitude and -90,90 for latitude. The following statement (from [Example 6-17](#) (page 6-76) in [Example of Coordinate System Transformation](#) (page 6-76)) specifies these extents (with a 10-meter tolerance value in each dimension) for a geodetic data layer:

```
INSERT INTO user_sdo_geom_metadata
  (TABLE_NAME,
   COLUMN_NAME,
   DIMINFO,
   SRID)
VALUES (
  'cola_markets_cs',
  'shape',
  SDO_DIM_ARRAY(
    SDO_DIM_ELEMENT('Longitude', -180, 180, 10), -- 10 meters tolerance
    SDO_DIM_ELEMENT('Latitude', -90, 90, 10) -- 10 meters tolerance
  ),
  8307 -- SRID for 'Longitude / Latitude (WGS 84)' coordinate system
);
```

See [Notes and Restrictions with Coordinate Systems Support](#) (page 6-73) for additional notes and restrictions relating to geodetic data.

## 6.3 Local Coordinate Support

Spatial and Graph provides a level of support for local coordinate systems. Local coordinate systems are often used in CAD systems, and they can also be used in local surveys where the relationship between the surveyed site and the rest of the world is not important.

Several local coordinate systems are predefined and included with Spatial and Graph in the SDO\_COORD\_REF\_SYS table (described in [SDO\\_COORD\\_REF\\_SYS Table](#) (page 6-27)). These supplied local coordinate systems, whose names start with *Non-Earth*, define non-Earth Cartesian coordinate systems based on different units of measurement (*Meter, Millimeter, Inch*, and so on).

In the current release, you cannot perform coordinate system transformation between local and Earth-based coordinate systems; and when transforming a geometry or layer of geometries between local coordinate systems, you can only to convert coordinates in a local coordinate system from one unit of measurement to another (for example, inches to millimeters). However, you can perform all other spatial operations (for example, using [SDO\\_RELATE](#) (page 18-30), [SDO\\_WITHIN\\_DISTANCE](#) (page 18-36), and other operators) with local coordinate systems.

## 6.4 EPSG Model and Spatial and Graph

The Oracle Spatial and Graph coordinate system support is based on, but is not always identical to, the European Petroleum Survey Group (EPSG) data model and dataset. These are described in detail at <http://www.epsg.org>, and the download for the EPSG geodetic parameter dataset includes a "Readme" that contains an entity-relationship (E-R) diagram. The approach taken by Oracle Spatial and Graph provides the benefits of standardization, expanded support, and flexibility:

- The EPSG model is a comprehensive and widely accepted standard for data representation, so users familiar with it can more easily understand Spatial and Graph storage and operations.
- Support is provided for more coordinate systems and their associated datums, ellipsoids, and projections. For example, some of the EPSG geographic and projected coordinate systems had no counterpart among coordinate systems supported for previous Spatial and Graph releases. Their addition results in an expanded set of supported coordinate systems.
- Data transformations are more flexible. Instead of there being only one possible Oracle-defined transformation path between a given source and target coordinate system, you can specify alternative paths to be used for a specific area of applicability (that is, use case) or as the systemwide default.

The rest of this section describes this flexibility.

For data transformations (that is, transforming data from one coordinate system to another), you can now control which transformation rules are to be applied. In previous releases, and in the current release by default, Spatial and Graph performs transformations based only on the specified source and target coordinate systems, using predetermined intermediate transformation steps. The assumption behind that default approach is that there is a single correct or preferable transformation chain.

By default, then, Spatial and Graph applies certain transformation methods for each supported transformation between specific pairs of source and target coordinate systems. For example, there are over 500 supported transformations from specific

coordinate systems to the WGS 84 (longitude/latitude) coordinate system, which has the EPSG SRID value of 4326. As one example, for a transformation from SRID 4605 to SRID 4326, Spatial and Graph can use the transformation method with the COORD\_OP\_ID value 1445, as indicated in the SDO\_COORD\_OPS table (described in [SDO\\_COORD\\_OPS Table](#) (page 6-25)), which contains one row for each transformation operation between coordinate systems.

However, you can override the default transformation by specifying a different method (from the set of Oracle-supplied methods) for the transformation for any given source and target SRID combination. You can specify a transformation as the new systemwide default, or you can associate the transformation with a named use case that can be specified when transforming a layer of spatial geometries. (A **use case** is simply a name given to a usage scenario or area of applicability, such as *Project XYZ* or *Mike's Favorite Transformations*; there is no relationship between use cases and database users or schemas.)

To specify a transformation as either the systemwide default or associated with a use case, use the [SDO\\_CS.ADD\\_PREFERENCE\\_FOR\\_OP](#) (page 20-3) procedure. To remove a previously specified preference, use the [SDO\\_CS.REVOKE\\_PREFERENCE\\_FOR\\_OP](#) (page 20-30) procedure.

When it performs a coordinate system transformation, Spatial and Graph follows these general steps to determine the specific transformation to use:

1. If a use case has been specified, the transformation associated with that use case is applied.
2. If no use case has been specified and if a user-defined systemwide transformation has been created for the specified source and target coordinate system pair, that transformation is applied.
3. If no use case has been specified and if no user-defined transformation exists for the specified source and target coordinate system pair, the behavior depends on whether or not EPSG rules have been created, such as by the [SDO\\_CS.CREATE\\_OBVIOUS\\_EPSG\\_RULES](#) (page 20-12) procedure:
  - If the EPSG rules have been created and if an EPSG rule is defined for this transformation, the EPSG transformation is applied.
  - If the EPSG rules have not been created, or if they have been created but no EPSG rule is defined for this transformation, the Oracle Spatial and Graph default transformation is applied.

To return the version number of the EPSG dataset used by Spatial and Graph, use the [SDO\\_CS.GET\\_EPSG\\_DATA\\_VERSION](#) (page 20-26) function.

## 6.5 Three-Dimensional Coordinate Reference System Support

The Oracle Spatial and Graph support for three-dimensional coordinate reference systems complies with the EPSG model (described in [EPSG Model and Spatial and Graph](#) (page 6-8)), which provides the following types of coordinate reference systems:

- Geographic 2D
- Projected 2D
- Geographic 3D, which consists of Geographic 2D plus ellipsoidal height, with longitude, latitude, and height based on the same ellipsoid and datum

- Compound, which consists of either Geographic 2D plus gravity-related height or Projected 2D plus gravity-related height

Thus, there are two categories of three-dimensional coordinate reference systems: those based on ellipsoidal height (geographic 3D, described in [Geographic 3D Coordinate Reference Systems](#) (page 6-10)) and those based on gravity-related height (compound, described in [Compound Coordinate Reference Systems](#) (page 6-10)).

Three-dimensional computations are more accurate than their two-dimensional equivalents, particularly when they are chained: For example, datum transformations internally always are performed in three dimensions, regardless of the dimensionality of the source and target CRS and geometries. When two-dimensional geometries are involved, one or more of the following can occur:

1. When the input or output geometries and CRS are two-dimensional, the (unspecified) input height defaults to zero (above the ellipsoid, depending on the CRS) for any internal three-dimensional computations. This is a potential source of inaccuracy, unless the height was intended to be exactly zero. (Data can be two-dimensional because height values were originally either unavailable or not considered important; this is different from representing data in two dimensions because heights are known to be exactly zero.
2. The transformation might then internally result in a non-zero height. Since the two-dimensional target CRS cannot accommodate the height value, the height value must be truncated, resulting in further inaccuracy.
3. If further transformations are chained, the repeated truncation of height values can result in increasing inaccuracies. Note that an inaccurate input height can affect not only the output height of a transformation, but also the longitude and latitude.

However, if the source and target CRS are three-dimensional, there is no repeated truncation of heights. Consequently, accuracy is increased, particularly for transformation chains.

For an introduction to support in Spatial and Graph for three-dimensional geometries, see [Three-Dimensional Spatial Objects](#) (page 1-16).

## 6.5.1 Geographic 3D Coordinate Reference Systems

A geographic three-dimensional coordinate reference system is based on longitude and latitude, plus ellipsoidal height. The **ellipsoidal height** is the height relative to a reference ellipsoid, which is an approximation of the real Earth. All three dimensions of the CRS are based on the same ellipsoid.

Using ellipsoidal heights enables Spatial and Graph to perform internal operations with great mathematical regularity and efficiency. Compound coordinate reference systems, on the other hand, require more complex transformations, often based on offset matrixes. Some of these matrixes have to be downloaded and configured. Furthermore, they might have a significant footprint, on disk and in main memory.

The supported geographic 3D coordinate reference systems are listed in the SDO\_CRS\_GEOGRAPHIC3D view, described in [SDO\\_CRS\\_GEOGRAPHIC3D View](#) (page 6-32).

## 6.5.2 Compound Coordinate Reference Systems

A compound three-dimensional coordinate reference system is based on a geographic or projected two-dimensional system, plus gravity-related height. **Gravity-related**

height is the height as influenced by the Earth's gravitational force, where the base height (zero) is often an equipotential surface, and might be defined as above or below "sea level."

Gravity-related height is a more complex representation than ellipsoidal height, because of gravitational irregularities such as the following:

- Orthometric height

Orthometric height is also referred to as the height above the geoid. The geoid is an equipotential surface that most closely (but not exactly) matches mean sea level. An equipotential surface is a surface on which each point is at the same gravitational potential level. Such a surface tends to undulate slightly, because the Earth has regions of varying density. There are multiple equipotential surfaces, and these might not be parallel to each other due to the irregular density of the Earth.

- Height relative to mean sea level, to sea level at a specific location, or to a vertical network warped to fit multiple tidal stations (for example, NGVD 29)

Sea level is close to, but not identical to, the geoid. The sea level at a given location is often defined based on the "average sea level" at a specific port.

The supported compound coordinate reference systems are listed in the `SDO_CRS_COMPOUND` view, described in [SDO\\_CRS\\_COMPOUND View](#) (page 6-30).

You can create a customized compound coordinate reference system, which combines a horizontal CRS with a vertical CRS. (The *horizontal* CRS contains two dimensions, such as X and Y or longitude and latitude, and the *vertical* CRS contains the third dimension, such as Z or height or altitude.) [Creating a Compound CRS](#) (page 6-67) explains how to create a compound CRS.

### 6.5.3 Three-Dimensional Transformations

Spatial and Graph supports three-dimensional coordinate transformations for `SDO_GEOMETRY` objects directly, and indirectly for point clouds and TINs. (For example, a point cloud must be transformed to a table with an `SDO_GEOMETRY` column.) The supported transformations include the following:

- Three-dimensional datum transformations
- Transformations between ellipsoidal and gravity-related height

For three-dimensional datum transformations, the datum transformation between the two ellipsoids is essentially the same as for two-dimensional coordinate reference systems, except that the third dimension is considered instead of ignored. Because height values are not ignored, the accuracy of the results increases, especially for transformation chains.

For transformations between ellipsoidal and gravity-related height, computations are complicated by the fact that equipotential and other gravity-related surfaces tend to undulate, compared to any ellipsoid and to each other. Transformations might be based on higher-degree polynomial functions or bilinear interpolation. In either case, a significant parameter matrix is required to define the transformation.

For transforming between gravity-related and ellipsoidal height, the process usually involves a transformation, based on an offset matrix, between geoidal and ellipsoidal height. Depending on the source or target definition of the offset matrix, a common datum transformation might have to be appended or prefixed.

**Example 6-2 Three-Dimensional Datum Transformation**

**Example 6-2** (page 6-12) shows a three-dimensional datum transformation.

```
set numwidth 9

CREATE TABLE source_geoms (
  mkt_id NUMBER PRIMARY KEY,
  name VARCHAR2(32),
  GEOMETRY SDO_GEOMETRY);

INSERT INTO source_geoms VALUES(
  1,
  'reference geom',
  SDO_GEOMETRY(
    3001,
    4985,
    SDO_POINT_TYPE(
      4.0,
      55.0,
      1.0),
    NULL,
    NULL));

INSERT INTO USER_SDO_GEOM_METADATA VALUES (
  'source_geoms',
  'GEOMETRY',
  SDO_DIM_ARRAY(
    SDO_DIM_ELEMENT('Longitude', -180, 180, 10),
    SDO_DIM_ELEMENT('Latitude', -90, 90, 10),
    SDO_DIM_ELEMENT('Height', -1000,1000, 10)),
  4985);

commit;

-----

CALL SDO_CS.TRANSFORM_LAYER(
  'source_geoms',
  'GEOMETRY',
  'GEO_CS_4979',
  4979);

INSERT INTO USER_SDO_GEOM_METADATA VALUES (
  'GEO_CS_4979',
  'GEOMETRY',
  SDO_DIM_ARRAY(
    SDO_DIM_ELEMENT('Longitude', -180, 180, 10),
    SDO_DIM_ELEMENT('Latitude', -90, 90, 10),
    SDO_DIM_ELEMENT('Height', -1000,1000, 10)),
  4979);

set lines 210;

-----

CALL SDO_CS.TRANSFORM_LAYER(
  'GEO_CS_4979',
  'GEOMETRY',
  'source_geoms2',
  4985);
```

```

INSERT INTO USER_SDO_GEOM_METADATA VALUES (
  'source_geoms2',
  'GEOMETRY',
  SDO_DIM_ARRAY(
    SDO_DIM_ELEMENT('Longitude', -180, 180, 10),
    SDO_DIM_ELEMENT('Latitude', -90, 90, 10),
    SDO_DIM_ELEMENT('Height', -1000,1000, 10)),
  4985);

```

```

-----
DELETE FROM USER_SDO_GEOM_METADATA WHERE table_name = 'GEO_CS_4979';
DELETE FROM USER_SDO_GEOM_METADATA WHERE table_name = 'SOURCE_GEOMS';
DELETE FROM USER_SDO_GEOM_METADATA WHERE table_name = 'SOURCE_GEOMS2';

```

```

drop table GEO_CS_4979;
drop table source_geoms;
drop table source_geoms2;

```

As a result of the transformation in [Example 6-2](#) (page 6-12), (4, 55, 1) is transformed to (4.0001539, 55.0000249, 4.218).

### **Example 6-3 Transformation Between Geoidal And Ellipsoidal Height**

[Example 6-3](#) (page 6-13) configures a transformation between geoidal and ellipsoidal height, using a Hawaii offset grid. Note that without the initial creation of a rule (using the [SDO\\_CS.CREATE\\_PREF\\_CONCATENATED\\_OP](#) (page 20-13) procedure), the grid would not be used.

```

-- Create Sample operation:
insert into mdsys.sdo_coord_ops (
  COORD_OP_ID,
  COORD_OP_NAME,
  COORD_OP_TYPE,
  SOURCE_SRID,
  TARGET_SRID,
  COORD_TFM_VERSION,
  COORD_OP_VARIANT,
  COORD_OP_METHOD_ID,
  UOM_ID_SOURCE_OFFSETS,
  UOM_ID_TARGET_OFFSETS,
  INFORMATION_SOURCE,
  DATA_SOURCE,
  SHOW_OPERATION,
  IS_LEGACY,
  LEGACY_CODE,
  REVERSE_OP,
  IS_IMPLEMENTED_FORWARD,
  IS_IMPLEMENTED_REVERSE)
values (
  1000000005,
  'Test Bi-linear Interpolation',
  'CONVERSION',
  null,
  null,
  null,
  null,
  null,
  9635,
  null,
  null,
  'Oracle',
  'Oracle',

```

```
1,
'FALSE',
null,
1,
1,
1);

--Create sample parameters, pointing to the offset file
--(in this case reusing values from an existing operation):
insert into mdsys.sdo_coord_op_param_vals (
    coord_op_id,
    COORD_OP_METHOD_ID,
    PARAMETER_ID,
    PARAMETER_VALUE,
    PARAM_VALUE_FILE_REF,
    PARAM_VALUE_FILE,
    PARAM_VALUE_XML,
    UOM_ID) (
select
    1000000005,
    9635,
    8666,
    PARAMETER_VALUE,
    PARAM_VALUE_FILE_REF,
    PARAM_VALUE_FILE,
    PARAM_VALUE_XML,
    UOM_ID
from
    mdsys.sdo_coord_op_param_vals
where
    coord_op_id = 999998 and
    parameter_id = 8666);

--Create a rule to use this operation between SRIDs 7406 and 4359:
call sdo_cs.create_pref_concatenated_op(
    300,
    'CONCATENATED OPERATION',
    TFM_PLAN(SDO_TFM_CHAIN(7406, 1000000005, 4359)),
    NULL);

-- Now, actually perform the transformation:
set numformat 999999.99999999

-- Create the source table
CREATE TABLE source_geoms (
    mkt_id NUMBER PRIMARY KEY,
    name VARCHAR2(32),
    GEOMETRY SDO_GEOMETRY);

INSERT INTO source_geoms VALUES(
    1,
    'reference geom',
    SDO_GEOMETRY(
    3001,
    7406,
    SDO_POINT_TYPE(
        -161,
        18,
        0),
    NULL,
```



```

NULL));

INSERT INTO USER_SDO_GEOM_METADATA VALUES (
  'source_geoms',
  'GEOMETRY',
  SDO_DIM_ARRAY(
    SDO_DIM_ELEMENT('Longitude', -180, 180, 10),
    SDO_DIM_ELEMENT('Latitude',   -90,  90, 10),
    SDO_DIM_ELEMENT('Height',     -100, 100, 10)),
  7406);

commit;

SELECT GEOMETRY "Source" FROM source_geoms;

```

```

-----

--Perform the transformation:
CALL SDO_CS.TRANSFORM_LAYER(
  'source_geoms',
  'GEOMETRY',
  'GEO_CS_4359',
  4359);

INSERT INTO USER_SDO_GEOM_METADATA VALUES (
  'GEO_CS_4359',
  'GEOMETRY',
  SDO_DIM_ARRAY(
    SDO_DIM_ELEMENT('Longitude', -180, 180, 10),
    SDO_DIM_ELEMENT('Latitude',   -90,  90, 10),
    SDO_DIM_ELEMENT('Height',     -100, 100, 10)),
  4359);

set lines 210;

SELECT GEOMETRY "Target" FROM GEO_CS_4359;

```

```

-----

--Transform back:
CALL SDO_CS.TRANSFORM_LAYER(
  'GEO_CS_4359',
  'GEOMETRY',
  'source_geoms2',
  7406);

INSERT INTO USER_SDO_GEOM_METADATA VALUES (
  'source_geoms2',
  'GEOMETRY',
  SDO_DIM_ARRAY(
    SDO_DIM_ELEMENT('Longitude', -180, 180, 10),
    SDO_DIM_ELEMENT('Latitude',   -90,  90, 10),
    SDO_DIM_ELEMENT('Height',     -100, 100, 10)),
  7406);

SELECT GEOMETRY "Source2" FROM source_geoms2;

```

```

-----

--Clean up (regarding the transformation):
DELETE FROM USER_SDO_GEOM_METADATA WHERE table_name = 'GEO_CS_4359';

```

```
DELETE FROM USER_SDO_GEOM_METADATA WHERE table_name = 'SOURCE_GEOMS';
DELETE FROM USER_SDO_GEOM_METADATA WHERE table_name = 'SOURCE_GEOMS2';

drop table GEO_CS_4359;
drop table source_geoms;
drop table source_geoms2;

--Clean up (regarding the rule):
CALL sdo_cs.delete_op(300);

delete from mdsys.sdo_coord_op_param_vals where coord_op_id = 1000000005;

delete from mdsys.sdo_coord_ops where coord_op_id = 1000000005;

COMMIT;
```

With the configuration in [Example 6-3](#) (page 6-13):

- Without the rule, (-161.00000000, 18.00000000, .00000000) is transformed to (-161.00127699, 18.00043360, 62.03196364), based simply on a datum transformation.
- With the rule, (-161.00000000, 18.00000000, .00000000) is transformed to (-161.00000000, 18.00000000, 6.33070000).

## 6.5.4 Cross-Dimensionality Transformations

You cannot directly perform a cross-dimensionality transformation (for example, from a two-dimensional geometry to a three-dimensional geometry) using the [SDO\\_CS.TRANSFORM](#) (page 20-33) function or the [SDO\\_CS.TRANSFORM\\_LAYER](#) (page 20-35) procedure. However, you can use the [SDO\\_CS.MAKE\\_3D](#) (page 20-28) function to convert a two-dimensional geometry to a three-dimensional geometry, or the [SDO\\_CS.MAKE\\_2D](#) (page 20-27) function to convert a three-dimensional geometry to a two-dimensional geometry; and you can use the resulting geometry to perform a transformation into a geometry with the desired number of dimensions.

For example, transforming a two-dimensional geometry into a three-dimensional geometry involves using the [SDO\\_CS.MAKE\\_3D](#) (page 20-28) function. This function does not itself perform any coordinate transformation, but simply adds a height value and sets the target SRID. You must choose an appropriate target SRID, which should be the three-dimensional equivalent of the source SRID. For example, three-dimensional WGS 84 (4327) is the equivalent of two-dimensional WGS 84 (4326). If necessary, modify height values of vertices in the returned geometry.

There are many options for how to use the [SDO\\_CS.MAKE\\_3D](#) (page 20-28) function, but the simplest is the following:

1. Transform from the two-dimensional source SRID to two-dimensional WGS 84 (4326).
2. Call [SDO\\_CS.MAKE\\_3D](#) (page 20-28) to convert the geometry to three-dimensional WGS 84 (4327).
3. Transform from three-dimensional WGS 84 (4327) to the three-dimensional target SRID.

[Example 6-4](#) (page 6-17) transforms a two-dimensional point from SRID 27700 to two-dimensional SRID 4326, converts the result of the transformation to a three-

dimensional point with SRID 4327, and transforms the converted point to three-dimensional SRID 4327.

#### Example 6-4 Cross-Dimensionality Transformation

```
SELECT
  SDO_CS.TRANSFORM(
    SDO_CS.MAKE_3D(
      SDO_CS.TRANSFORM(
        SDO_GEOMETRY(
          2001,
          27700,
          SDO_POINT_TYPE(577274.984, 69740.4923, NULL),
          NULL,
          NULL),
          4326),
        height => 0,
        target_srid => 4327),
    4327) "27700 > 4326 > 4327 > 4327"
FROM DUAL;
```

```
27700 > 4326 > 4327 > 4327(SDO_GTYPE, SDO_SRID, SDO_POINT(X, Y, Z), SDO_ELEM_INF
-----
SDO_GEOMETRY(3001, 4327, SDO_POINT_TYPE(.498364058, 50.5006366, 0), NULL, NULL)
```

### 6.5.5 3D Equivalent for WGS 84?

There are two possible answers to the question *What is 3D equivalent for the WGS 84 coordinate system?* (that is, 2D Oracle SRID 8308 or EPSG SRID 4326):

- 4979 (in many or most cases), or
- It depends on what you mean by *height* (for example, above ground level, above or below sea level, or something else).

There are many different height datums. Height can be relative to:

- The ellipsoid, which requires the use of a coordinate system of type GEOGRAPHIC3d, for which SRID values 4327, 43229, and 4979 are predefined in Oracle Spatial and Graph.
- A non-ellipsoidal height datum, which requires the use of a coordinate system of type COMPOUND, for which a custom SRID must usually be defined. The non-ellipsoidal height may be specified in relation to the geoid, to some local or mean sea level (or a network of local sea levels), or to some other definition of *height* (such as above ground surface).

To define a compound coordinate system (see [Compound Coordinate Reference Systems](#) (page 6-10)) based on the two dimensions of the WGS 84 coordinate system, you must first select a predefined or custom vertical coordinate reference system (see [Creating a Vertical CRS](#) (page 6-66)). To find the available vertical coordinate reference systems, enter the following statement:

```
SELECT srid, COORD_REF_SYS_NAME from sdo_coord_ref_sys
WHERE COORD_REF_SYS_KIND = 'VERTICAL' order by srid;
```

```
SRID COORD_REF_SYS_NAME
-----
3855 EGM2008 geoid height
3886 Fao 1979 height
4440 NZVD2009 height
```

```
4458 Dunedin-Bluff 1960 height
5600 NGPF height
5601 IGN 1966 height
5602 Moorea SAU 1981 height
. . .
5795 Guadeloupe 1951 height
5796 Lagos 1955 height
5797 AIOC95 height
5798 EGM84 geoid height
5799 DVR90 height
```

123 rows selected.

After selecting a vertical coordinate reference system, create the compound SRID by entering a statement in the following form:

```
INSERT INTO sdo_coord_ref_system (
  SRID,
  COORD_REF_SYS_NAME,
  COORD_REF_SYS_KIND,
  COORD_SYS_ID,
  DATUM_ID,
  GEOG_CRS_DATUM_ID,
  SOURCE_GEOG_SRID,
  PROJECTION_CONV_ID,
  CMPD_HORIZ_SRID,
  CMPD_VERT_SRID,
  INFORMATION_SOURCE,
  DATA_SOURCE,
  IS_LEGACY,
  LEGACY_CODE,
  LEGACY_WKTEXT,
  LEGACY_CS_BOUNDS,
  IS_VALID,
  SUPPORTS_SDO_GEOMETRY)
values (
  custom-SRID,
  'custom-name',
  'COMPOUND',
  NULL,
  NULL,
  6326,
  NULL,
  NULL,
  4326,
  vertical-SRID,
  'custom-information-source',
  'custom-data-source',
  'FALSE',
  NULL,
  NULL,
  NULL,
  'TRUE',
  'TRUE');
```

You can check the definition, based on the generated WKT, by entering a statement in the following form:

```
SELECT wkttext3d FROM cs_srs WHERE srid = custom-SRID;

WKTEXT3D
```

```

-----
COMPDCS[
  "NTF (Paris) + NGF IGN69",
  GEOGCS["NTF (Paris)",
    DATUM["Nouvelle Triangulation Francaise (Paris)",
      SPHEROID[
        "Clarke 1880 (IGN)",
        6378249.2,
        293.4660212936293951,
        AUTHORITY["EPSG", "7011"]],
      TOWGS84[-168.0, -60.0, 320.0, 0.0, 0.0, 0.0, 0.0],
      AUTHORITY["EPSG", "6807"]],
    PRIMEM["Paris", 2.337229, AUTHORITY["EPSG", "8903"]],
    UNIT["grad", 0.015707963267949, AUTHORITY["EPSG", "9105"]],
    AXIS["Lat", NORTH],
    AXIS["Long", EAST],
    AUTHORITY["EPSG", "4807"]],
  VERT_CS["NGF IGN69",
    VERT_DATUM["Nivellement general de la France - IGN69", 2005,
      AUTHORITY["EPSG", "5119"]],
    UNIT["metre", 1.0, AUTHORITY["EPSG", "9001"]],
    AXIS["H", UP],
    AUTHORITY["EPSG", "5720"]],
  AUTHORITY["EPSG", "7400"]]

```

When transforming between different height datums, you might use a VERTCON matrix. For example, between the WGS 84 ellipsoid and geoid, there is an offset matrix that allows height transformation. For more information, see the following:

- [Example 6-3](#) (page 6-13) in [Three-Dimensional Transformations](#) (page 6-11)
- [Creating a Transformation Operation](#) (page 6-68)
- [Using British Grid Transformation OSTN02/OSGM02 \(EPSG Method 9633\)](#) (page 6-71)

## 6.6 TFM\_PLAN Object Type

The object type TFM\_PLAN is used by several SDO\_CS package subprograms to specify a transformation plan. For example, to create a concatenated operation that consists of two operations specified by a parameter of type TFM\_PLAN, use the [SDO\\_CS.CREATE\\_CONCATENATED\\_OP](#) (page 20-12) procedure.

Oracle Spatial and Graph defines the object type TFM\_PLAN as:

```

CREATE TYPE tfm_plan AS OBJECT (
  THE_PLAN SDO_TFM_CHAIN);

```

The SDO\_TFM\_CHAIN type is defined as VARRAY(1048576) OF NUMBER.

Within the SDO\_TFM\_CHAIN array:

- The first element specifies the SRID of the source coordinate system.
- Each pair of elements after the first element specifies an operation ID and the SRID of a target coordinate system.

## 6.7 Coordinate Systems Data Structures

The coordinate systems functions and procedures use information provided in the tables and views supplied with Oracle Spatial and Graph. The tables and views are part of the MDSYS schema; however, public synonyms are defined, so you do not need to specify *MDSYS*. before the table or view name. The definitions and data in these tables and views are based on the EPSG data model and dataset, as explained in [EPSG Model and Spatial and Graph](#) (page 6-8).

The coordinate system tables fit into several general categories:

- Coordinate system general information: SDO\_COORD\_SYS, SDO\_COORD\_REF\_SYS
- Elements or aspects of a coordinate system definition: SDO\_DATUMS, SDO\_ELLIPSOIDS, SDO\_PRIME\_MERIDIANS
- Datum transformation support: SDO\_COORD\_OPS, SDO\_COORD\_OP\_METHODS, SDO\_COORD\_OP\_PARAM\_USE, SDO\_COORD\_OP\_PARAM\_VALS, SDO\_COORD\_OP\_PARAMS, SDO\_COORD\_OP\_PATHS, SDO\_PREFERRED\_OPS\_SYSTEM, SDO\_PREFERRED\_OPS\_USER
- Others related to coordinate system definition: SDO\_COORD\_AXES, SDO\_COORD\_AXIS\_NAMES, SDO\_UNITS\_OF\_MEASURE

Several views are provided that are identical to or subsets of coordinate system tables:

- SDO\_COORD\_REF\_SYSTEM, which contains the same columns as the SDO\_COORD\_REF\_SYS table. Use the SDO\_COORD\_REF\_SYSTEM view instead of the COORD\_REF\_SYS table for any insert, update, or delete operations.
- Subsets of SDO\_DATUMS, selected according to the value in the DATUM\_TYPE column: SDO\_DATUM\_ENGINEERING, SDO\_DATUM\_GEODETTIC, SDO\_DATUM\_VERTICAL.
- Subsets of SDO\_COORD\_REF\_SYS, selected according to the value in the COORD\_REF\_SYS\_KIND column: SDO\_CRS\_COMPOUND, SDO\_CRS\_ENGINEERING, SDO\_CRS\_GEOCENTRIC, SDO\_CRS\_GEOGRAPHIC2D, SDO\_CRS\_GEOGRAPHIC3D, SDO\_CRS\_PROJECTED, SDO\_CRS\_VERTICAL.

Most of the rest of this section explains these tables and views, in alphabetical order. (Many column descriptions are adapted or taken from EPSG descriptions.)

[Relationships Among Coordinate System Tables and Views](#) (page 6-42) describes relationships among the tables and views, and it lists EPSG table names and their corresponding Oracle Spatial and Graph names. [Finding Information About EPSG-Based Coordinate Systems](#) (page 6-43) describes how to find information about EPSG-based coordinate systems, and it provides several examples.

In addition to the tables and views in this section, Spatial and Graph provides several legacy tables whose definitions and data match those of certain Spatial and Graph system tables used in previous releases. [Legacy Tables and Views](#) (page 6-47) describes the legacy tables.

**Note:**

You should not modify or delete any Oracle-supplied information in any of the tables or views that are used for coordinate system support.

If you want to create a user-defined coordinate system, see [Creating a User-Defined Coordinate Reference System](#) (page 6-55).

### 6.7.1 SDO\_COORD\_AXES Table

The SDO\_COORD\_AXES table contains one row for each coordinate system axis definition. This table contains the columns shown in [Table 6-1](#) (page 6-21).

**Table 6-1 SDO\_COORD\_AXES Table**

Column Name	Data Type	Description
COORD_SYS_ID	NUMBER(10)	ID number of the coordinate system to which this axis applies.
COORD_AXIS_NAME_ID	NUMBER(10)	ID number of a coordinate system axis name. Matches a value in the COORD_AXIS_NAME_ID column of the SDO_COORD_AXIS_NAMES table (described in <a href="#">SDO_COORD_AXIS_NAMES Table</a> (page 6-21)). Example: 9901 (for Geodetic latitude)
COORD_AXIS_ORIENTATION	VARCHAR2(24)	The direction of orientation for the coordinate system axis. Example: east
COORD_AXIS_ABBREVIATION	VARCHAR2(24)	The abbreviation for the coordinate system axis orientation. Example: E
UOM_ID	NUMBER(10)	ID number of the unit of measurement associated with the axis. Matches a value in the UOM_ID column of the SDO_UNITS_OF_MEASURE table (described in <a href="#">SDO_UNITS_OF_MEASURE Table</a> (page 6-41)).
ORDER	NUMBER(5)	Position of this axis within the coordinate system (1, 2, or 3).

### 6.7.2 SDO\_COORD\_AXIS\_NAMES Table

The SDO\_COORD\_AXIS\_NAMES table contains one row for each axis that can be used in a coordinate system definition. This table contains the columns shown in [Table 6-2](#) (page 6-21).

**Table 6-2 SDO\_COORD\_AXIS\_NAMES Table**

Column Name	Data Type	Description
COORD_AXIS_NAME_ID	NUMBER(10)	ID number of the coordinate axis name. Example: 9926
COORD_AXIS_NAME	VARCHAR2(80)	Name of the coordinate axis. Example: Spherical latitude

### 6.7.3 SDO\_COORD\_OP\_METHODS Table

The SDO\_COORD\_OP\_METHODS table contains one row for each coordinate systems transformation method. This table contains the columns shown in [Table 6-3](#) (page 6-22).

**Table 6-3 SDO\_COORD\_OP\_METHODS Table**

Column Name	Data Type	Description
COORD_OP_METHOD_ID	NUMBER(10)	ID number of the coordinate system transformation method. Example: 9613
COORD_OP_METHOD_NAME	VARCHAR2(50)	Name of the method. Example: NADCON
LEGACY_NAME	VARCHAR2(50)	Name for this transformation method in the legacy WKT strings. This name might differ syntactically from the name used by EPSG.
REVERSE_OP	NUMBER(1)	Contains 1 if reversal of the transformation (from the current target coordinate system to the source coordinate system) can be achieved by reversing the sign of each parameter value; contains 0 if a separate operation must be defined for reversal of the transformation.
INFORMATION_SOURCE	VARCHAR2(254)	Origin of this information. Example: US Coast and geodetic Survey - <a href="http://www.ngs.noaa.gov">http://www.ngs.noaa.gov</a>
DATA_SOURCE	VARCHAR2(40)	Organization providing the data for this record. Example: EPSG
IS_IMPLEMENTED_FORWARD	NUMBER(1)	Contains 1 if the forward operation is implemented; contains 0 if the forward operation is not implemented.
IS_IMPLEMENTED_REVERSE	NUMBER(1)	Contains 1 if the reverse operation is implemented; contains 0 if the reverse operation is not implemented.

### 6.7.4 SDO\_COORD\_OP\_PARAM\_USE Table

The SDO\_COORD\_OP\_PARAM\_USE table contains one row for each combination of transformation method and transformation operation parameter that is available for use. This table contains the columns shown in [Table 6-4](#) (page 6-22).

**Table 6-4 SDO\_COORD\_OP\_PARAM\_USE Table**

Column Name	Data Type	Description
COORD_OP_METHOD_ID	NUMBER(10)	ID number of the coordinate system transformation method. Matches a value in the COORD_OP_METHOD_ID column of the COORD_OP_METHODS table (described in <a href="#">SDO_COORD_OP_METHODS Table</a> (page 6-22)).



**Table 6-4 (Cont.) SDO\_COORD\_OP\_PARAM\_USE Table**

Column Name	Data Type	Description
PARAMETER_ID	NUMBER(10)	ID number of the parameter for transformation operations. Matches a value in the PARAMETER_ID column of the SDO_COORD_OP_PARAMS table (described in <a href="#">SDO_COORD_OP_PARAMS Table</a> (page 6-24)).
LEGACY_PARAM_NAME	VARCHAR2(80)	Open GeoSpatial Consortium (OGC) name for the parameter.
SORT_ORDER	NUMBER(5)	A number indicating the position of this parameter in the sequence of parameters for this method. Example: 2 for the second parameter
PARAM_SIGN_REVERSAL	VARCHAR2(3)	Yes if reversal of the transformation (from the current target coordinate system to the source coordinate system) can be achieved by reversing the sign of each parameter value; No if a separate operation must be defined for reversal of the transformation.

### 6.7.5 SDO\_COORD\_OP\_PARAM\_VALS Table

The SDO\_COORD\_OP\_PARAM\_VALS table contains information about parameter values for each coordinate system transformation method. This table contains the columns shown in [Table 6-5](#) (page 6-23).

**Table 6-5 SDO\_COORD\_OP\_PARAM\_VALS Table**

Column Name	Data Type	Description
COORD_OP_ID	NUMBER(10)	ID number of the coordinate transformation operation. Matches a value in the COORD_OP_ID column of the SDO_COORD_OPS table (described in <a href="#">SDO_COORD_OPS Table</a> (page 6-25)).
COORD_OP_METHOD_ID	NUMBER(10)	Coordinate operation method ID. Must match a COORD_OP_METHOD_ID value in the SDO_COORD_OP_METHODS table (see <a href="#">SDO_COORD_OP_METHODS Table</a> (page 6-22)).
PARAMETER_ID	NUMBER(10)	ID number of the parameter for transformation operations. Matches a value in the PARAMETER_ID column of the SDO_COORD_OP_PARAMS table (described in <a href="#">SDO_COORD_OP_PARAMS Table</a> (page 6-24)).
PARAMETER_VALUE	FLOAT(49)	Value of the parameter for this operation.
PARAM_VALUE_FILE_REF	VARCHAR2(254)	Name of the file (as specified in the original EPSG database) containing the value data, if a single value for the parameter is not sufficient.

**Table 6-5 (Cont.) SDO\_COORD\_OP\_PARAM\_VALS Table**

Column Name	Data Type	Description
PARAM_VALUE_FILE	CLOB	The ASCII content of the file specified in the PARAM_VALUE_FILE_REF column. Used only for grid file parameters (for NADCON, NTv2, and height transformations "Geographic3D to Geographic2D+GravityRelatedHeight").
PARAM_VALUE_XML	XMLTYPE	An XML representation of the content of the file specified in the PARAM_VALUE_FILE_REF column. (Optional, and currently only used for documentation.)
UOM_ID	NUMBER(10)	ID number of the unit of measurement associated with the operation. Matches a value in the UOM_ID column of the SDO_UNITS_OF_MEASURE table (described in <a href="#">SDO_UNITS_OF_MEASURE Table</a> (page 6-41)).

## 6.7.6 SDO\_COORD\_OP\_PARAMS Table

The SDO\_COORD\_OP\_PARAMS table contains one row for each available parameter for transformation operations. This table contains the columns shown in [Table 6-6](#) (page 6-24).

**Table 6-6 SDO\_COORD\_OP\_PARAMS Table**

Column Name	Data Type	Description
PARAMETER_ID	NUMBER(10)	ID number of the parameter. Example: 8608
PARAMETER_NAME	VARCHAR2(80)	Name of the operation. Example: X-axis rotation
INFORMATION_SOURCE	VARCHAR2(254)	Origin of this information. Example: EPSG guidance note number 7.
DATA_SOURCE	VARCHAR2(40)	Organization providing the data for this record. Example: EPSG

## 6.7.7 SDO\_COORD\_OP\_PATHS Table

The SDO\_COORD\_OP\_PATHS table contains one row for each atomic step in a concatenated operation. This table contains the columns shown in [Table 6-7](#) (page 6-24).

**Table 6-7 SDO\_COORD\_OP\_PATHS Table**

Column Name	Data Type	Description
CONCAT_OPERATION_ID	NUMBER(10)	ID number of the concatenation operation. Must match a COORD_OP_ID value in the SDO_COORD_OPS table (described in <a href="#">SDO_COORD_OPS Table</a> (page 6-25)) for which the COORD_OP_TYPE value is CONCATENATION.

**Table 6-7 (Cont.) SDO\_COORD\_OP\_PATHS Table**

Column Name	Data Type	Description
SINGLE_OPERATION_ID	NUMBER(10)	ID number of the single coordinate operation for this step (atomic operation) in a concatenated operation. Must match a COORD_OP_ID value in the SDO_COORD_OPS table (described in <a href="#">SDO_COORD_OPS Table</a> (page 6-25)).
SINGLE_OP_SOURCE_ID	NUMBER(10)	ID number of source coordinate reference system for the single coordinate operation for this step. Must match an SRID value in the SDO_COORD_REF_SYS table (described in <a href="#">SDO_COORD_REF_SYS Table</a> (page 6-27)).
SINGLE_OP_TARGET_ID	NUMBER(10)	ID number of target coordinate reference system for the single coordinate operation for this step. Must match an SRID value in the SDO_COORD_REF_SYS table (described in <a href="#">SDO_COORD_REF_SYS Table</a> (page 6-27)).
OP_PATH_STEP	NUMBER(5)	Sequence number of this step (atomic operation) within this concatenated operation.

### 6.7.8 SDO\_COORD\_OPS Table

The SDO\_COORD\_OPS table contains one row for each transformation operation between coordinate systems. This table contains the columns shown in [Table 6-8](#) (page 6-25).

**Table 6-8 SDO\_COORD\_OPS Table**

Column Name	Data Type	Description
COORD_OP_ID	NUMBER(10)	ID number of the coordinate transformation operation. Example: 101
COORD_OP_NAME	VARCHAR2(80)	Name of the operation. Example: ED50 to WGS 84 (14)
COORD_OP_TYPE	VARCHAR2(24)	Type of operation. One of the following: CONCATENATED OPERATION, CONVERSION, or TRANSFORMATION
SOURCE_SRID	NUMBER(10)	SRID of the coordinate system from which to perform the transformation. Example: 4230
TARGET_SRID	NUMBER(10)	SRID of the coordinate system into which to perform the transformation. Example: 4326
COORD_TFM_VERSION	VARCHAR2(24)	Name assigned by EPSG to the coordinate transformation. Example: 5Nat-NSea90
COORD_OP_VARIANT	NUMBER(5)	A variant of the more generic method specified in COORD_OP_METHOD_ID. Example: 14

**Table 6-8 (Cont.) SDO\_COORD\_OPS Table**

Column Name	Data Type	Description
COORD_OP_METHOD_ID	NUMBER(10)	Coordinate operation method ID. Must match a COORD_OP_METHOD_ID value in the SDO_COORD_OP_METHODS table (see <a href="#">SDO_COORD_OP_METHODS Table</a> (page 6-22)). Several operations can use a method. Example: 9617
UOM_ID_SOURCE_OFFSETS	NUMBER(10)	ID number of the unit of measurement for offsets in the source coordinate system. Matches a value in the UOM_ID column of the SDO_UNITS_OF_MEASURE table (described in <a href="#">SDO_UNITS_OF_MEASURE Table</a> (page 6-41)).
UOM_ID_TARGET_OFFSETS	NUMBER(10)	ID number of the unit of measurement for offsets in the target coordinate system. Matches a value in the UOM_ID column of the SDO_UNITS_OF_MEASURE table (described in <a href="#">SDO_UNITS_OF_MEASURE Table</a> (page 6-41)).
INFORMATION_SOURCE	VARCHAR2(254)	Origin of this information. Example: Institut de Geomatica; Barcelona
DATA_SOURCE	VARCHAR2(40)	Organization providing the data for this record. Example: EPSG
SHOW_OPERATION	NUMBER(3)	(Not currently used.)
IS_LEGACY	VARCHAR2(5)	TRUE if the operation was included in Oracle Spatial before release 10.2; FALSE if the operation was new in Oracle Spatial release 10.2.
LEGACY_CODE	NUMBER(10)	For any EPSG coordinate transformation operation that has a semantically identical legacy (in Oracle Spatial before release 10.2) counterpart, the COORD_OP_ID value of the legacy coordinate transformation operation.
REVERSE_OP	NUMBER(1)	Contains 1 if reversal of the transformation (from the current target coordinate system to the source coordinate system) is defined as achievable by reversing the sign of each parameter value; contains 0 if a separate operation must be defined for reversal of the transformation. If REVERSE_OP contains 1, the operations that are actually implemented are indicated by the values for IS_IMPLEMENTED_FORWARD and IS_IMPLEMENTED_REVERSE.
IS_IMPLEMENTED_FORWARD	NUMBER(1)	Contains 1 if the forward operation is implemented; contains 0 if the forward operation is not implemented.
IS_IMPLEMENTED_REVERSE	NUMBER(1)	Contains 1 if the reverse operation is implemented; contains 0 if the reverse operation is not implemented.

### 6.7.9 SDO\_COORD\_REF\_SYS Table

The SDO\_COORD\_REF\_SYS table contains one row for each coordinate reference system. This table contains the columns shown in [Table 6-9](#) (page 6-27). (The SDO\_COORD\_REF\_SYS table is roughly patterned after the EPSG Coordinate Reference System table.)

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**Note:**

If you need to perform an insert, update, or delete operation, you *must* perform it on the SDO\_COORD\_REF\_SYSTEM view, which contains the same columns as the SDO\_COORD\_REF\_SYS table. The SDO\_COORD\_REF\_SYSTEM view is described in [SDO\\_COORD\\_REF\\_SYSTEM View](#) (page 6-29).

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**Table 6-9 SDO\_COORD\_REF\_SYS Table**

Column Name	Data Type	Description
SRID	NUMBER(10)	ID number of the coordinate reference system. Example: 8307
COORD_REF_SYS_NAME	VARCHAR2(80)	Name of the coordinate reference system. Example: Longitude / Latitude (WGS 84)
COORD_REF_SYS_KIND	VARCHAR2(24)	Category for the coordinate system. Example: GEOGRAPHIC2D
COORD_SYS_ID	NUMBER(10)	ID number of the coordinate system used for the coordinate reference system. Must match a COORD_SYS_ID value in the SDO_COORD_SYS table (see <a href="#">SDO_COORD_SYS Table</a> (page 6-29)).
DATUM_ID	NUMBER(10)	ID number of the datum used for the coordinate reference system. Null for a projected coordinate system. For a geodetic coordinate system, must match a DATUM_ID value in the SDO_DATUMS table (see <a href="#">SDO_DATUMS Table</a> (page 6-37)). Example: 10115
GEOG_CRS_DATUM_ID	NUMBER(10)	ID number of the datum used for the coordinate reference system. For a projected coordinate system, must match the DATUM_ID value (in the SDO_DATUMS table, described in <a href="#">SDO_DATUMS Table</a> (page 6-37)) of the geodetic coordinate system on which the projected coordinate system is based. For a geodetic coordinate system, must match the DATUM_ID value. Example: 10115
SOURCE_GEOG_SRID	NUMBER(10)	For a projected coordinate reference system, the ID number for the associated geodetic coordinate system.

**Table 6-9 (Cont.) SDO\_COORD\_REF\_SYS Table**

Column Name	Data Type	Description
PROJECTION_CO NV_ID	NUMBER(10)	For a projected coordinate reference system, the COORD_OP_ID value of the conversion operation used to convert the projected coordinated system to and from the source geographic coordinate system.
CMPD_HORIZ_S RID	NUMBER(10)	(EPSG-assigned value; not used by Oracle Spatial and Graph. The EPSG description is: "For compound CRS only, the code of the horizontal component of the Compound CRS.")
CMPD_VERT_SRI D	NUMBER(10)	(EPSG-assigned value; not used by Oracle Spatial and Graph. The EPSG description is: "For compound CRS only, the code of the vertical component of the Compound CRS.")
INFORMATION_ SOURCE	VARCHAR2(254)	Provider of the definition for the coordinate system (Oracle for all rows supplied by Oracle).
DATA_SOURCE	VARCHAR2(40)	Organization that supplied the data for this record (if not Oracle).
IS_LEGACY	VARCHAR2(5)	TRUE if the coordinate system definition was included in Oracle Spatial before release 10.2; FALSE if the coordinate system definition was new in Oracle Spatial release 10.2.
LEGACY_CODE	NUMBER(10)	For any EPSG coordinate reference system that has a semantically identical legacy (in Oracle Spatial before release 10.2) counterpart, the SRID value of the legacy coordinate system.
LEGACY_WKTEX T	VARCHAR2(2046)	If IS_LEGACY is TRUE, contains the well-known text description of the coordinate system. Example: GEOGCS [ "Longitude / Latitude (WGS 84)", DATUM [ "WGS 84", SPHEROID [ "WGS 84", 6378137, 298.257223563]], PRIMEM [ "Greenwich", 0.000000 ], UNIT [ "Decimal Degree", 0.01745329251994330 ] ]
LEGACY_CS_BO UNDS	SDO_GEOMETRY	For a legacy coordinate system, the dimensional boundary (if any).
IS_VALID	VARCHAR2(5)	TRUE if the EPSG record for the coordinate reference system is completely defined; FALSE if the EPSG record for the coordinate reference system is not completely defined.
SUPPORTS_SDO_ GEOMETRY	VARCHAR2(5)	TRUE if the COORD_REF_SYS_KIND column contains ENGINEERING, GEOGRAPHIC2D, or PROJECTED CRS; FALSE if the COORD_REF_SYS_KIND column contains any other value.

See also the information about the following views that are defined based on the value of the COORD\_REF\_SYS\_KIND column:

- SDO\_CRS\_COMPOUND ([SDO\\_CRS\\_COMPOUND View](#) (page 6-30))
- SDO\_CRS\_ENGINEERING ([SDO\\_CRS\\_ENGINEERING View](#) (page 6-30))
- SDO\_CRS\_GEOCENTRIC ([SDO\\_CRS\\_GEOCENTRIC View](#) (page 6-31))
- SDO\_CRS\_GEOGRAPHIC2D ([SDO\\_CRS\\_GEOGRAPHIC2D View](#) (page 6-31))
- SDO\_CRS\_GEOGRAPHIC3D ([SDO\\_CRS\\_GEOGRAPHIC3D View](#) (page 6-32))
- SDO\_CRS\_PROJECTED ([SDO\\_CRS\\_PROJECTED View](#) (page 6-33))
- SDO\_CRS\_VERTICAL ([SDO\\_CRS\\_VERTICAL View](#) (page 6-33))

### 6.7.10 SDO\_COORD\_REF\_SYSTEM View

The SDO\_COORD\_REF\_SYSTEM view contains the same columns as the SDO\_COORD\_REF\_SYS table, which is described in [SDO\\_COORD\\_REF\\_SYS Table](#) (page 6-27). However, the SDO\_COORD\_REF\_SYSTEM view has a trigger defined on it, so that any insert, update, or delete operations performed on the view cause all relevant Spatial and Graph system tables to have the appropriate operations performed on them.

Therefore, if you need to perform an insert, update, or delete operation, you *must* perform it on the SDO\_COORD\_REF\_SYSTEM view, *not* the SDO\_COORD\_REF\_SYS table.

### 6.7.11 SDO\_COORD\_SYS Table

The SDO\_COORD\_SYS table contains rows with information about coordinate systems. This table contains the columns shown in [Table 6-10](#) (page 6-29). (The SDO\_COORD\_SYS table is roughly patterned after the EPSG Coordinate System table, where a coordinate system is described as "a pair of reusable axes.")

**Table 6-10 SDO\_COORD\_SYS Table**

Column Name	Data Type	Description
COORD_SYS_ID	NUMBER(10)	ID number of the coordinate system. Example: 6405
COORD_SYS_NAME	VARCHAR2(254)	Name of the coordinate system. Example: Ellipsoidal 2D CS. Axes: latitude, longitude. Orientations: north, east. UoM: dec deg
COORD_SYS_TYPE	VARCHAR2(24)	Type of coordinate system. Example: ellipsoidal
DIMENSION	NUMBER(5)	Number of dimensions represented by the coordinate system.
INFORMATION_SOURCE	VARCHAR2(254)	Origin of this information.
DATA_SOURCE	VARCHAR2(50)	Organization providing the data for this record.

## 6.7.12 SDO\_CRS\_COMPOUND View

The SDO\_CRS\_COMPOUND view contains selected information from the SDO\_COORD\_REF\_SYS table (described in [SDO\\_COORD\\_REF\\_SYS Table](#) (page 6-27)) where the COORD\_REF\_SYS\_KIND column value is COMPOUND. (For an explanation of compound coordinate reference systems, see [Compound Coordinate Reference Systems](#) (page 6-10).) This view contains the columns shown in [Table 6-11](#) (page 6-30).

**Table 6-11 SDO\_CRS\_COMPOUND View**

Column Name	Data Type	Description
SRID	NUMBER(10)	ID number of the coordinate reference system.
COORD_REF_SYS_NAME	VARCHAR2(80)	Name of the coordinate reference system.
CMPD_HORIZ_SRID	NUMBER(10)	(EPSG-assigned value; not used by Oracle Spatial and Graph. The EPSG description is: "For compound CRS only, the code of the horizontal component of the Compound CRS.")
CMPD_VERT_SRID	NUMBER(10)	(EPSG-assigned value; not used by Oracle Spatial and Graph. The EPSG description is: "For compound CRS only, the code of the vertical component of the Compound CRS.")
INFORMATION_SOURCE	VARCHAR2(254)	Provider of the definition for the coordinate system (Oracle for all rows supplied by Oracle).
DATA_SOURCE	VARCHAR2(40)	Organization that supplied the data for this record (if not Oracle).

## 6.7.13 SDO\_CRS\_ENGINEERING View

The SDO\_CRS\_ENGINEERING view contains selected information from the SDO\_COORD\_REF\_SYS table (described in [SDO\\_COORD\\_REF\\_SYS Table](#) (page 6-27)) where the COORD\_REF\_SYS\_KIND column value is ENGINEERING. This view contains the columns shown in [Table 6-12](#) (page 6-30).

**Table 6-12 SDO\_CRS\_ENGINEERING View**

Column Name	Data Type	Description
SRID	NUMBER(10)	ID number of the coordinate reference system.
COORD_REF_SYS_NAME	VARCHAR2(80)	Name of the coordinate reference system.
COORD_SYS_ID	NUMBER(10)	ID number of the coordinate system used for the coordinate reference system. Must match a COORD_SYS_ID value in the SDO_COORD_SYS table (see <a href="#">SDO_COORD_SYS Table</a> (page 6-29)).



**Table 6-12 (Cont.) SDO\_CRS\_ENGINEERING View**

Column Name	Data Type	Description
DATUM_ID	NUMBER(10)	ID number of the datum used for the coordinate reference system. Must match a DATUM_ID value in the SDO_DATUMS table (see <a href="#">SDO_DATUMS Table</a> (page 6-37)).
INFORMATION_SOURCE	VARCHAR2(254)	Provider of the definition for the coordinate system (Oracle for all rows supplied by Oracle).
DATA_SOURCE	VARCHAR2(40)	Organization that supplied the data for this record (if not Oracle).

#### 6.7.14 SDO\_CRS\_GEOCENTRIC View

The SDO\_CRS\_GEOCENTRIC view contains selected information from the SDO\_COORD\_REF\_SYS table (described in [SDO\\_COORD\\_REF\\_SYS Table](#) (page 6-27)) where the COORD\_REF\_SYS\_KIND column value is GEOCENTRIC. This view contains the columns shown in [Table 6-13](#) (page 6-31).

**Table 6-13 SDO\_CRS\_GEOCENTRIC View**

Column Name	Data Type	Description
SRID	NUMBER(10)	ID number of the coordinate reference system.
COORD_REF_SYS_NAME	VARCHAR2(80)	Name of the coordinate reference system.
COORD_SYS_ID	NUMBER(10)	ID number of the coordinate system used for the coordinate reference system. Must match a COORD_SYS_ID value in the SDO_COORD_SYS table (see <a href="#">SDO_COORD_SYS Table</a> (page 6-29)).
DATUM_ID	NUMBER(10)	ID number of the datum used for the coordinate reference system. Must match a DATUM_ID value in the SDO_DATUMS table (see <a href="#">SDO_DATUMS Table</a> (page 6-37)).
INFORMATION_SOURCE	VARCHAR2(254)	Provider of the definition for the coordinate system (Oracle for all rows supplied by Oracle).
DATA_SOURCE	VARCHAR2(40)	Organization that supplied the data for this record (if not Oracle).

#### 6.7.15 SDO\_CRS\_GEOGRAPHIC2D View

The SDO\_CRS\_GEOGRAPHIC2D view contains selected information from the SDO\_COORD\_REF\_SYS table (described in [SDO\\_COORD\\_REF\\_SYS Table](#) (page 6-27)) where the COORD\_REF\_SYS\_KIND column value is GEOGRAPHIC2D. This view contains the columns shown in [Table 6-14](#) (page 6-32).

**Table 6-14 SDO\_CRS\_GEOGRAPHIC2D View**

Column Name	Data Type	Description
SRID	NUMBER(10)	ID number of the coordinate reference system.
COORD_REF_SYS_NAME	VARCHAR2(80)	Name of the coordinate reference system.
COORD_SYS_ID	NUMBER(10)	ID number of the coordinate system used for the coordinate reference system. Must match a COORD_SYS_ID value in the SDO_COORD_SYS table (see <a href="#">SDO_COORD_SYS Table</a> (page 6-29)).
DATUM_ID	NUMBER(10)	ID number of the datum used for the coordinate reference system. Must match a DATUM_ID value in the SDO_DATUMS table (see <a href="#">SDO_DATUMS Table</a> (page 6-37)).
INFORMATION_SOURCE	VARCHAR2(254)	Provider of the definition for the coordinate system (Oracle for all rows supplied by Oracle).
DATA_SOURCE	VARCHAR2(40)	Organization that supplied the data for this record (if not Oracle).

### 6.7.16 SDO\_CRS\_GEOGRAPHIC3D View

The SDO\_CRS\_GEOGRAPHIC3D view contains selected information from the SDO\_COORD\_REF\_SYS table (described in [SDO\\_COORD\\_REF\\_SYS Table](#) (page 6-27)) where the COORD\_REF\_SYS\_KIND column value is GEOGRAPHIC3D. (For an explanation of geographic 3D coordinate reference systems, see [Geographic 3D Coordinate Reference Systems](#) (page 6-10).) This view contains the columns shown in [Table 6-15](#) (page 6-32).

**Table 6-15 SDO\_CRS\_GEOGRAPHIC3D View**

Column Name	Data Type	Description
SRID	NUMBER(10)	ID number of the coordinate reference system.
COORD_REF_SYS_NAME	VARCHAR2(80)	Name of the coordinate reference system.
COORD_SYS_ID	NUMBER(10)	ID number of the coordinate system used for the coordinate reference system. Must match a COORD_SYS_ID value in the SDO_COORD_SYS table (see <a href="#">SDO_COORD_SYS Table</a> (page 6-29)).
DATUM_ID	NUMBER(10)	ID number of the datum used for the coordinate reference system. Must match a DATUM_ID value in the SDO_DATUMS table (see <a href="#">SDO_DATUMS Table</a> (page 6-37)).
INFORMATION_SOURCE	VARCHAR2(254)	Provider of the definition for the coordinate system (Oracle for all rows supplied by Oracle).
DATA_SOURCE	VARCHAR2(40)	Organization that supplied the data for this record (if not Oracle).

### 6.7.17 SDO\_CRS\_PROJECTED View

The SDO\_CRS\_PROJECTED view contains selected information from the SDO\_COORD\_REF\_SYS table (described in [SDO\\_COORD\\_REF\\_SYS Table](#) (page 6-27)) where the COORD\_REF\_SYS\_KIND column value is PROJECTED. This view contains the columns shown in [Table 6-16](#) (page 6-33).

**Table 6-16 SDO\_CRS\_PROJECTED View**

Column Name	Data Type	Description
SRID	NUMBER(10)	ID number of the coordinate reference system.
COORD_REF_SYS_NAME	VARCHAR2(80)	Name of the coordinate reference system.
COORD_SYS_ID	NUMBER(10)	ID number of the coordinate system used for the coordinate reference system. Must match a COORD_SYS_ID value in the SDO_COORD_SYS table (see <a href="#">SDO_COORD_SYS Table</a> (page 6-29)).
SOURCE_GEOG_SRID	NUMBER(10)	ID number for the associated geodetic coordinate system.
PROJECTION_CONV_ID	NUMBER(10)	COORD_OP_ID value of the conversion operation used to convert the projected coordinated system to and from the source geographic coordinate system.
INFORMATION_SOURCE	VARCHAR2(254)	Provider of the definition for the coordinate system (Oracle for all rows supplied by Oracle).
DATA_SOURCE	VARCHAR2(40)	Organization that supplied the data for this record (if not Oracle).

### 6.7.18 SDO\_CRS\_VERTICAL View

The SDO\_CRS\_VERTICAL view contains selected information from the SDO\_COORD\_REF\_SYS table (described in [SDO\\_COORD\\_REF\\_SYS Table](#) (page 6-27)) where the COORD\_REF\_SYS\_KIND column value is VERTICAL. This view contains the columns shown in [Table 6-17](#) (page 6-33).

**Table 6-17 SDO\_CRS\_VERTICAL View**

Column Name	Data Type	Description
SRID	NUMBER(10)	ID number of the coordinate reference system.
COORD_REF_SYS_NAME	VARCHAR2(80)	Name of the coordinate reference system.
COORD_SYS_ID	NUMBER(10)	ID number of the coordinate system used for the coordinate reference system. Must match a COORD_SYS_ID value in the SDO_COORD_SYS table (see <a href="#">SDO_COORD_SYS Table</a> (page 6-29)).

**Table 6-17 (Cont.) SDO\_CRS\_VERTICAL View**

Column Name	Data Type	Description
DATUM_ID	NUMBER(10)	ID number of the datum used for the coordinate reference system. Must match a DATUM_ID value in the SDO_DATUMS table (see <a href="#">SDO_DATUMS Table</a> (page 6-37)).
INFORMATION_SOURCE	VARCHAR2(254)	Provider of the definition for the coordinate system (Oracle for all rows supplied by Oracle).
DATA_SOURCE	VARCHAR2(40)	Organization that supplied the data for this record (if not Oracle).

### 6.7.19 SDO\_DATUM\_ENGINEERING View

The SDO\_DATUM\_ENGINEERING view contains selected information from the SDO\_DATUMS table (described in [SDO\\_DATUMS Table](#) (page 6-37)) where the DATUM\_TYPE column value is ENGINEERING. This view contains the columns shown in [Table 6-18](#) (page 6-34).

**Table 6-18 SDO\_DATUM\_ENGINEERING View**

Column Name	Data Type	Description
DATUM_ID	NUMBER(10)	ID number of the datum.
DATUM_NAME	VARCHAR2(80)	Name of the datum.
ELLIPSOID_ID	NUMBER(10)	ID number of the ellipsoid used in the datum definition. Must match an ELLIPSOID_ID value in the SDO_ELLIPSOIDS table (see <a href="#">SDO_ELLIPSOIDS Table</a> (page 6-38)). Example: 8045
PRIME_MERIDIAN_ID	NUMBER(10)	ID number of the prime meridian used in the datum definition. Must match a PRIME_MERIDIAN_ID value in the SDO_PRIME_MERIDIANS table (see <a href="#">SDO_PRIME_MERIDIANS Table</a> (page 6-40)). Example: 8950
INFORMATION_SOURCE	VARCHAR2(254)	Provider of the definition of the datum. Example: Ordnance Survey of Great Britain.
DATA_SOURCE	VARCHAR2(40)	Organization that supplied the data for this record (if not Oracle).
SHIFT_X	NUMBER	Number of meters to shift the ellipsoid center relative to the center of the WGS 84 ellipsoid on the x-axis.
SHIFT_Y	NUMBER	Number of meters to shift the ellipsoid center relative to the center of the WGS 84 ellipsoid on the y-axis.
SHIFT_Z	NUMBER	Number of meters to shift the ellipsoid center relative to the center of the WGS 84 ellipsoid on the z-axis.

**Table 6-18 (Cont.) SDO\_DATUM\_ENGINEERING View**

Column Name	Data Type	Description
ROTATE_X	NUMBER	Number of arc-seconds of rotation about the x-axis.
ROTATE_Y	NUMBER	Number of arc-seconds of rotation about the y-axis.
ROTATE_Z	NUMBER	Number of arc-seconds of rotation about the z-axis.
SCALE_ADJUST	NUMBER	A value to be used in adjusting the X, Y, and Z values after any shifting and rotation, according to the formula: $1.0 + (\text{SCALE\_ADJUST} * 10^{-6})$

### 6.7.20 SDO\_DATUM\_GEODETTIC View

The SDO\_DATUM\_GEODETTIC view contains selected information from the SDO\_DATUMS table (described in [SDO\\_DATUMS Table](#) (page 6-37)) where the DATUM\_TYPE column value is GEODETTIC. This view contains the columns shown in [Table 6-19](#) (page 6-35).

**Table 6-19 SDO\_DATUM\_GEODETTIC View**

Column Name	Data Type	Description
DATUM_ID	NUMBER(10)	ID number of the datum.
DATUM_NAME	VARCHAR2(80)	Name of the datum.
ELLIPSOID_ID	NUMBER(10)	ID number of the ellipsoid used in the datum definition. Must match an ELLIPSOID_ID value in the SDO_ELLIPSOIDS table (see <a href="#">SDO_ELLIPSOIDS Table</a> (page 6-38)). Example: 8045
PRIME_MERIDIAN_ID	NUMBER(10)	ID number of the prime meridian used in the datum definition. Must match a PRIME_MERIDIAN_ID value in the SDO_PRIME_MERIDIANS table (see <a href="#">SDO_PRIME_MERIDIANS Table</a> (page 6-40)). Example: 8950
INFORMATION_SOURCE	VARCHAR2(254)	Provider of the definition of the datum. Example: Ordnance Survey of Great Britain.
DATA_SOURCE	VARCHAR2(40)	Organization that supplied the data for this record (if not Oracle).
SHIFT_X	NUMBER	Number of meters to shift the ellipsoid center relative to the center of the WGS 84 ellipsoid on the x-axis.
SHIFT_Y	NUMBER	Number of meters to shift the ellipsoid center relative to the center of the WGS 84 ellipsoid on the y-axis.
SHIFT_Z	NUMBER	Number of meters to shift the ellipsoid center relative to the center of the WGS 84 ellipsoid on the z-axis.

**Table 6-19 (Cont.) SDO\_DATUM\_GEODETTIC View**

Column Name	Data Type	Description
ROTATE_X	NUMBER	Number of arc-seconds of rotation about the x-axis.
ROTATE_Y	NUMBER	Number of arc-seconds of rotation about the y-axis.
ROTATE_Z	NUMBER	Number of arc-seconds of rotation about the z-axis.
SCALE_ADJUST	NUMBER	A value to be used in adjusting the X, Y, and Z values after any shifting and rotation, according to the formula: $1.0 + (\text{SCALE\_ADJUST} * 10^{-6})$

## 6.7.21 SDO\_DATUM\_VERTICAL View

The SDO\_DATUM\_VERTICAL view contains selected information from the SDO\_DATUMS table (described in [SDO\\_DATUMS Table](#) (page 6-37)) where the DATUM\_TYPE column value is VERTICAL. This view contains the columns shown in [Table 6-20](#) (page 6-36).

**Table 6-20 SDO\_DATUM\_VERTICAL View**

Column Name	Data Type	Description
DATUM_ID	NUMBER(10)	ID number of the datum.
DATUM_NAME	VARCHAR2(80)	Name of the datum.
ELLIPSOID_ID	NUMBER(10)	ID number of the ellipsoid used in the datum definition. Must match an ELLIPSOID_ID value in the SDO_ELLIPSOIDS table (see <a href="#">SDO_ELLIPSOIDS Table</a> (page 6-38)). Example: 8045
PRIME_MERIDIAN_ID	NUMBER(10)	ID number of the prime meridian used in the datum definition. Must match a PRIME_MERIDIAN_ID value in the SDO_PRIME_MERIDIANS table (see <a href="#">SDO_PRIME_MERIDIANS Table</a> (page 6-40)). Example: 8950
INFORMATION_SOURCE	VARCHAR2(254)	Provider of the definition of the datum. Example: Ordnance Survey of Great Britain.
DATA_SOURCE	VARCHAR2(40)	Organization that supplied the data for this record (if not Oracle).
SHIFT_X	NUMBER	Number of meters to shift the ellipsoid center relative to the center of the WGS 84 ellipsoid on the x-axis.
SHIFT_Y	NUMBER	Number of meters to shift the ellipsoid center relative to the center of the WGS 84 ellipsoid on the y-axis.
SHIFT_Z	NUMBER	Number of meters to shift the ellipsoid center relative to the center of the WGS 84 ellipsoid on the z-axis.

**Table 6-20 (Cont.) SDO\_DATUM\_VERTICAL View**

Column Name	Data Type	Description
ROTATE_X	NUMBER	Number of arc-seconds of rotation about the x-axis.
ROTATE_Y	NUMBER	Number of arc-seconds of rotation about the y-axis.
ROTATE_Z	NUMBER	Number of arc-seconds of rotation about the z-axis.
SCALE_ADJUST	NUMBER	A value to be used in adjusting the X, Y, and Z values after any shifting and rotation, according to the formula: $1.0 + (\text{SCALE\_ADJUST} * 10^{-6})$

### 6.7.22 SDO\_DATUMS Table

The SDO\_DATUMS table contains one row for each datum. This table contains the columns shown in [Table 6-21](#) (page 6-37).

**Table 6-21 SDO\_DATUMS Table**

Column Name	Data Type	Description
DATUM_ID	NUMBER(10)	ID number of the datum. Example: 10115
DATUM_NAME	VARCHAR2(80)	Name of the datum. Example: WGS 84
DATUM_TYPE	VARCHAR2(24)	Type of the datum. Example: GEODETIC
ELLIPSOID_ID	NUMBER(10)	ID number of the ellipsoid used in the datum definition. Must match an ELLIPSOID_ID value in the SDO_ELLIPSOIDS table (see <a href="#">SDO_ELLIPSOIDS Table</a> (page 6-38)). Example: 8045
PRIME_MERIDIAN_ID	NUMBER(10)	ID number of the prime meridian used in the datum definition. Must match a PRIME_MERIDIAN_ID value in the SDO_PRIME_MERIDIANS table (see <a href="#">SDO_PRIME_MERIDIANS Table</a> (page 6-40)). Example: 8950
INFORMATION_SOURCE	VARCHAR2(254)	Provider of the definition of the datum. Example: Ordnance Survey of Great Britain.
DATA_SOURCE	VARCHAR2(40)	Organization that supplied the data for this record (if not Oracle). Example: EPSG
SHIFT_X	NUMBER	Number of meters to shift the ellipsoid center relative to the center of the WGS 84 ellipsoid on the x-axis.
SHIFT_Y	NUMBER	Number of meters to shift the ellipsoid center relative to the center of the WGS 84 ellipsoid on the y-axis.
SHIFT_Z	NUMBER	Number of meters to shift the ellipsoid center relative to the center of the WGS 84 ellipsoid on the z-axis.

**Table 6-21 (Cont.) SDO\_DATUMS Table**

Column Name	Data Type	Description
ROTATE_X	NUMBER	Number of arc-seconds of rotation about the x-axis.
ROTATE_Y	NUMBER	Number of arc-seconds of rotation about the y-axis.
ROTATE_Z	NUMBER	Number of arc-seconds of rotation about the z-axis.
SCALE_ADJUST	NUMBER	A value to be used in adjusting the X, Y, and Z values after any shifting and rotation, according to the formula: $1.0 + (\text{SCALE\_ADJUST} * 10^{-6})$
IS_LEGACY	VARCHAR2(5)	TRUE if the datum definition was included in Oracle Spatial before release 10.2; FALSE if the datum definition was new in Oracle Spatial release 10.2.
LEGACY_CODE	NUMBER(10)	For any EPSG datum that has a semantically identical legacy (in Oracle Spatial before release 10.2) counterpart, the DATUM_ID value of the legacy datum.

See also the information about the following views that are defined based on the value of the DATUM\_TYPE column: SDO\_DATUM\_ENGINEERING ([SDO\\_DATUM\\_ENGINEERING View](#) (page 6-34)), SDO\_DATUM\_GEODETTIC ([SDO\\_DATUM\\_GEODETTIC View](#) (page 6-35)), and SDO\_DATUM\_VERTICAL ([SDO\\_DATUM\\_VERTICAL View](#) (page 6-36)).

### 6.7.23 SDO\_ELLIPSOIDS Table

The SDO\_ELLIPSOIDS table contains one row for each ellipsoid. This table contains the columns shown in [Table 6-22](#) (page 6-38).

**Table 6-22 SDO\_ELLIPSOIDS Table**

Column Name	Data Type	Description
ELLIPSOID_ID	NUMBER	ID number of the ellipsoid (spheroid). Example: 8045
ELLIPSOID_NAME	VARCHAR2(80)	Name of the ellipsoid. Example: WGS 84
SEMI_MAJOR_AXIS	NUMBER	Radius in meters along the semi-major axis (one-half of the long axis of the ellipsoid).
UOM_ID	NUMBER	ID number of the unit of measurement for the ellipsoid. Matches a value in the UOM_ID column of the SDO_UNITS_OF_MEASURE table (described in <a href="#">SDO_UNITS_OF_MEASURE Table</a> (page 6-41)). Example: 9001
INV_FLATTENING	NUMBER	Inverse flattening of the ellipsoid. That is, $1/f$ , where $f = (a-b)/a$ , and $a$ is the semi-major axis and $b$ is the semi-minor axis.



**Table 6-22 (Cont.) SDO\_ELLIPSOIDS Table**

Column Name	Data Type	Description
SEMI_MINOR_AXIS	NUMBER	Radius in meters along the semi-minor axis (one-half of the short axis of the ellipsoid).
INFORMATION_SOURCE	VARCHAR2(254)	Origin of this information. Example: Kort og Matrikelstyrelsen (KMS), Copenhagen.
DATA_SOURCE	VARCHAR2(40)	Organization that supplied the data for this record (if not Oracle). Example: EPSG
IS_LEGACY	VARCHAR2(5)	TRUE if the ellipsoid definition was included in Oracle Spatial before release 10.2; FALSE if the ellipsoid definition was new in Oracle Spatial release 10.2.
LEGACY_CODE	NUMBER	For any EPSG ellipsoid that has a semantically identical legacy (in Oracle Spatial before release 10.2) counterpart, the ELLIPSOID_ID value of the legacy ellipsoid.

### 6.7.24 SDO\_PREFERRED\_OPS\_SYSTEM Table

The SDO\_PREFERRED\_OPS\_SYSTEM table contains one row for each specification of the user-defined default preferred coordinate transformation operation for a source and target SRID combination. If you insert a row into the SDO\_PREFERRED\_OPS\_SYSTEM table, you are overriding the Oracle default operation for transformations between the specified source and target coordinate systems. The [SDO\\_CS.CREATE\\_OBVIOUS\\_EPSG\\_RULES](#) (page 20-12) procedure inserts many rows into this table. The [SDO\\_CS.DELETE\\_ALL\\_EPSG\\_RULES](#) (page 20-15) procedure deletes all rows from this table if the `use_case` parameter is null. This table contains the columns shown in [Table 6-23](#) (page 6-39).

**Table 6-23 SDO\_PREFERRED\_OPS\_SYSTEM Table**

Column Name	Data Type	Description
SOURCE_SRID	NUMBER(10)	ID number of the coordinate system (spatial reference system) from which to perform coordinate transformation, using the operation specified by COORD_OP_ID as the default preferred method for transforming to the specified target SRID.
COORD_OP_ID	NUMBER(10)	ID number of the coordinate transformation operation. Matches a value in the COORD_OP_ID column of the SDO_COORD_OPS table (described in <a href="#">SDO_COORD_OPS Table</a> (page 6-25)).
TARGET_SRID	NUMBER(10)	ID number of coordinate system (spatial reference system) into which to perform coordinate transformation using the operation specified by COORD_OP_ID.

## 6.7.25 SDO\_PREFERRED\_OPS\_USER Table

The SDO\_PREFERRED\_OPS\_USER table contains one row for each specification of a user-defined source and target SRID and coordinate transformation operation. If you insert a row into the SDO\_PREFERRED\_OPS\_USER table, you create a custom transformation between the source and target coordinate systems, and you can specify the name (the USE\_CASE column value) of the transformation operation as the use\_case parameter value with several SDO\_CS functions and procedures. If you specify a use case with the [SDO\\_CS.DELETE\\_ALL\\_EPSG\\_RULES](#) (page 20-15) procedure, rows associated with that use case are deleted from this table. This table contains the columns shown in [Table 6-24](#) (page 6-40).

**Table 6-24 SDO\_PREFERRED\_OPS\_USER Table**

Column Name	Data Type	Description
USE_CASE	VARCHAR2(32)	Name of this specification of a source and target SRID and coordinate transformation operation.
SOURCE_SRID	NUMBER(10)	ID number of the coordinate system (spatial reference system) from which to perform the transformation.
COORD_OP_ID	NUMBER(10)	ID number of the coordinate transformation operation. Matches a value in the COORD_OP_ID column of the SDO_COORD_OPS table (described in <a href="#">SDO_COORD_OPS Table</a> (page 6-25)).
TARGET_SRID	NUMBER(10)	ID number of the coordinate system (spatial reference system) into which to perform the transformation.

## 6.7.26 SDO\_PRIME\_MERIDIANS Table

The SDO\_PRIME\_MERIDIANS table contains one row for each prime meridian that can be used in a datum specification. This table contains the columns shown in [Table 6-25](#) (page 6-40).

**Table 6-25 SDO\_PRIME\_MERIDIANS Table**

Column Name	Data Type	Description
PRIME_MERIDIAN_ID	NUMBER(10)	ID number of the prime meridian. Example: 8907
PRIME_MERIDIAN_NAME	VARCHAR2(80)	Name of the prime meridian. Example: Bern
GREENWICH_LONITUDE	FLOAT(49)	Longitude of the prime meridian as an offset from the Greenwich meridian. Example: 7.26225
UOM_ID	NUMBER(10)	ID number of the unit of measurement for the prime meridian. Matches a value in the UOM_ID column of the SDO_UNITS_OF_MEASURE table (described in <a href="#">SDO_UNITS_OF_MEASURE Table</a> (page 6-41)). Example: 9110 for sexagesimal degree

**Table 6-25 (Cont.) SDO\_PRIME\_MERIDIANS Table**

Column Name	Data Type	Description
INFORMATION_SOURCE	VARCHAR2(254)	Origin of this information. Example: Bundesamt fur Landestopographie
DATA_SOURCE	VARCHAR2(254)	Organization that supplied the data for this record (if not Oracle). Example: EPSG

### 6.7.27 SDO\_UNITS\_OF\_MEASURE Table

The SDO\_UNITS\_OF\_MEASURE table contains one row for each unit of measurement. This table contains the columns shown in [Table 6-26](#) (page 6-41).

**Table 6-26 SDO\_UNITS\_OF\_MEASURE Table**

Column Name	Data Type	Description
UOM_ID	NUMBER(10)	ID number of the unit of measurement. Example: 10032
UNIT_OF_MEASURE_NAME	VARCHAR2(2083)	Name of the unit of measurement; can also be a URL or URI. Example: Meter
SHORT_NAME	VARCHAR2(80)	Short name (if any) of the unit of measurement. Example: METER
UNIT_OF_MEASURE_TYPE	VARCHAR2(50)	Type of measure for which the unit is used: angle for angle unit, area for area unit, length for distance unit, scale for scale unit, or volume for volume unit.
TARGET_UOM_ID	NUMBER(10)	ID number of a target unit of measurement. Corresponds to the TARGET_UOM_CODE column in the EPSG Unit of Measure table, which has the following description: "Other UOM of the same type into which the current UOM can be converted using the formula (POSC); POSC factors A and D always equal zero for EPSG supplied units of measure."
FACTOR_B	NUMBER	Corresponds to the FACTOR_B column in the EPSG Unit of Measure table, which has the following description: "A quantity in the target UOM (y) is obtained from a quantity in the current UOM (x) through the conversion: $y = (B/C) \cdot x$ " In a user-defined unit of measurement, FACTOR_B is usually the number of square meters or meters equal to one of the unit. For information about user-defined units, see <a href="#">Creating a User-Defined Unit of Measurement</a> (page 2-56).
FACTOR_C	NUMBER	Corresponds to the FACTOR_C column in the EPSG Unit of Measure table. For FACTOR_C in a user-defined unit of measurement, see <a href="#">Creating a User-Defined Unit of Measurement</a> (page 2-56).

**Table 6-26 (Cont.) SDO\_UNITS\_OF\_MEASURE Table**

Column Name	Data Type	Description
INFORMATION_SOURCE	VARCHAR2(254)	Origin of this information. Example: ISO 1000.
DATA_SOURCE	VARCHAR2(40)	Organization providing the data for this record. Example: EPSG
IS_LEGACY	VARCHAR2(5)	TRUE if the unit of measurement definition was included in Oracle Spatial before release 10.2; FALSE if the unit of measurement definition was new in Oracle Spatial release 10.2.
LEGACY_CODE	NUMBER(10)	For any EPSG unit of measure that has a semantically identical legacy (in Oracle Spatial before release 10.2) counterpart, the UOM_ID value of the legacy unit of measure.

## 6.7.28 Relationships Among Coordinate System Tables and Views

Because the definitions in Spatial and Graph system tables and views are based on the EPSG data model and dataset, the EPSG entity-relationship (E-R) diagram provides a good overview of the relationships among the Spatial and Graph coordinate system data structures. The EPSG E-R diagram is included in the following document:

[http://www.ihsenergy.com/epsg/geod\\_arch.html](http://www.ihsenergy.com/epsg/geod_arch.html)

However, Oracle Spatial and Graph does not use the following from the EPSG E-R diagram:

- Area of Use (yellow box in the upper center of the diagram)
- Deprecation, Alias, and others represented by pink boxes in the lower right corner of the diagram

In addition, Spatial and Graph changes the names of some tables to conform to its own naming conventions, and it does not use some tables, as shown in [Table 6-27](#) (page 6-42)

**Table 6-27 EPSG Table Names and Oracle Spatial and Graph Names**

EPSG Name	Oracle Name
Coordinate System	SDO_COORD_SYS
Coordinate Axis	SDO_COORD_AXES
Coordinate Reference System	SDO_COORD_REF_SYSTEM
Area Of Use	(Not used)
Datum	SDO_DATUMS
Prime Meridian	SDO_PRIME_MERIDIANS
Ellipsoid	SDO_ELLIPSOIDS
Unit Of Measure	SDO_UNITS_OF_MEASURE

**Table 6-27 (Cont.) EPSG Table Names and Oracle Spatial and Graph Names**

EPSG Name	Oracle Name
Coordinate Operation	SDO_COORD_OPS
Coord. Operation Parameter ValueCoord	SDO_COORD_OP_PARAM_VALS
Operation Parameter UsageCoord.	SDO_COORD_OP_PARAM_USE
Operation Parameter	SDO_COORD_OP_PARAMS
Coordinate Operation Path	SDO_COORD_OP_PATHS
Coordinate Operation Method	SDO_COORD_OP_METHODS
Change	(Not used)
Deprecation	(Not used)
Supersession	(Not used)
Naming System	(Not used)
Alias	(Not used)
Any Entity	(Not used)

## 6.7.29 Finding Information About EPSG-Based Coordinate Systems

This section explains how to query the Spatial and Graph coordinate systems data structures for information about geodetic and projected EPSG-based coordinate systems.

### 6.7.29.1 Geodetic Coordinate Systems

A human-readable summary of a CRS is the WKT string. For example:

```
SQL> select wktext from cs_srs where srid = 4326;
```

WKTEXT

```
-----
GEOGCS [ "WGS 84", DATUM [ "World Geodetic System 1984 (EPSG ID 6326)", SPHEROID
[ "WGS 84 (EPSG ID 7030)", 6378137, 298.257223563]], PRIMEM [ "Greenwich", 0.0000
00 ], UNIT [ "Decimal Degree", 0.01745329251994328]]
```

EPSG WKTs have been automatically generated by Spatial and Graph, for backward compatibility. Note that EPSG WKTs also contain numeric ID values (such as EPSG ID 6326 in the preceding example) for convenience. However, for more detailed information you should access the EPSG data stored in the coordinate systems data structures. The following example returns information about the ellipsoid, datum shift, rotation, and scale adjustment for SRID 4123:

```
SQL> select
  ell.semi_major_axis,
  ell.inv_flattening,
  ell.semi_minor_axis,
  ell.uom_id,
  dat.shift_x,
  dat.shift_y,
```

```
dat.shift_z,  
dat.rotate_x,  
dat.rotate_y,  
dat.rotate_z,  
dat.scale_adjust  
from  
  sdo_coord_ref_system crs,  
  sdo_datums dat,  
  sdo_ellipsoids ell  
where  
  crs.srid = 4123 and  
  dat.datum_id = crs.datum_id and  
  ell.ellipsoid_id = dat.ellipsoid_id;
```

SEMI_MAJOR_AXIS	INV_FLATTENING	SEMI_MINOR_AXIS	UOM_ID	SHIFT_X	SHIFT_Y
SHIFT_Z	ROTATE_X	ROTATE_Y	ROTATE_Z	SCALE_ADJUST	
-----					
6378388	297	6356911.95	9001	-90.7	-106.1
-119.2	4.09	.218	-1.05	1.37	

In the preceding example, the UOM\_ID represents the unit of measure for SEMI\_MAJOR\_AXIS (a) and SEMI\_MINOR\_AXIS (b). INV\_FLATTENING is  $a/(a-b)$  and has no associated unit. Shifts are in meters, rotation angles are given in arc seconds, and scale adjustment in parts per million.

To interpret the UOM\_ID, you can query the units table, as shown in the following example:

```
SQL> select UNIT_OF_MEAS_NAME from sdo_units_of_measure where UOM_ID = 9001;
```

```
UNIT_OF_MEAS_NAME
```

```
-----  
metre
```

Conversion factors for units of length are given relative to meters, as shown in the following example:

```
SQL> select UNIT_OF_MEAS_NAME, FACTOR_B/FACTOR_C from sdo_units_of_measure where  
UOM_ID = 9002;
```

```
UNIT_OF_MEAS_NAME
```

```
-----  
FACTOR_B/FACTOR_C
```

```
-----  
foot
```

```
.3048
```

Conversion factors for units of angle are given relative to radians, as shown in the following example:

```
SQL> select UNIT_OF_MEAS_NAME, FACTOR_B/FACTOR_C from sdo_units_of_measure where  
UOM_ID = 9102;
```

```
UNIT_OF_MEAS_NAME
```

```
-----  
FACTOR_B/FACTOR_C
```

```
-----  
degree
```

```
.017453293
```

### 6.7.29.2 Projected Coordinate Systems

As mentioned in [Geodetic Coordinate Systems](#) (page 6-43), the WKT is a human-readable summary of a CRS, but the actual EPSG data is stored in the Spatial and Graph coordinate systems data structures. The following example shows the WKT string for a projected coordinate system:

```
SQL> select wktext from cs_srs where srid = 32040;
```

WKTEXT

[illegible]

To determine the base geographic CRS for a projected CRS, you can query the `SDO_COORD_REF_SYSTEM` table, as in the following example:

```
SQL> select SOURCE_GEOG_SRID from sdo_coord_ref_system where srid = 32040;
```

SOURCE\_GEOG\_SRID

4267

The following example returns the projection method for the projected CRS 32040:

```
SQL> select
    m.coord_op_method_name
from
    sdo_coord_ref_sys crs,
    sdo_coord_ops ops,
    sdo_coord_op_methods m
where
    crs.srid = 32040 and
    ops.coord_op_id = crs.projection_conv_id and
    m.coord_op_method_id = ops.coord_op_method_id;
```

COORD OP METHOD NAME

Lambert Conic Conformal (2SP)

The following example returns the projection parameters for the projected CRS 32040:

```
SQL> select
  params.parameter_name || ' = ' ||
  vals.parameter_value || ' ' ||
  uom.unit_of_meas_name "Projection parameters"
from
  sdo_coord_ref_sys crs,
  sdo_coord_op_param_vals vals,
  sdo_units_of_measure uom,
  sdo_coord_op_params params
where
  crs.srid = 32040 and
```

```
vals.coord_op_id = crs.projection_conv_id and
uom.uom_id = vals.uom_id and
params.parameter_id = vals.parameter_id;
```

Projection parameters

```
-----
Latitude of false origin = 27.5 sexagesimal DMS
Longitude of false origin = -99 sexagesimal DMS
Latitude of 1st standard parallel = 28.23 sexagesimal DMS
Latitude of 2nd standard parallel = 30.17 sexagesimal DMS
Easting at false origin = 2000000 US survey foot
Northing at false origin = 0 US survey foot
```

The following example is essentially the same query as the preceding example, but it also converts the values to the base unit:

```
SQL> select
  params.parameter_name || ' = ' ||
  vals.parameter_value || ' ' ||
  uom.unit_of_meas_name || ' = ' ||
  sdo_cs.transform_to_base_unit(vals.parameter_value, vals.uom_id) || ' ' ||
  decode(
    uom.unit_of_meas_type,
    'area', 'square meters',
    'angle', 'radians',
    'length', 'meters',
    'scale', '', '') "Projection parameters"
from
  sdo_coord_ref_sys crs,
  sdo_coord_op_param_vals vals,
  sdo_units_of_measure uom,
  sdo_coord_op_params params
where
  crs.srid = 32040 and
  vals.coord_op_id = crs.projection_conv_id and
  uom.uom_id = vals.uom_id and
  params.parameter_id = vals.parameter_id;
```

Projection parameters

```
-----
Latitude of false origin = 27.5 sexagesimal DMS = .
485783308471754564814814814814815 radians
Longitude of false origin = -99 sexagesimal DMS = -1.7278759594743845 radians
Latitude of 1st standard parallel = 28.23 sexagesimal DMS = .
495382619357723367592592592592593 radians
Latitude of 2nd standard parallel = 30.17 sexagesimal DMS = .
528543875145615595370370370370371 radians
Easting at false origin = 2000000 US survey foot =
609601.219202438404876809753619507239014 meters
Northing at false origin = 0 US survey foot = 0 meters
```

The following example returns the projection unit of measure for the projected CRS 32040. (The projection unit might be different from the length unit used for the projection parameters.)

```
SQL> select
  axes.coord_axis_abbreviation || ': ' ||
  uom.unit_of_meas_name "Projection units"
from
```



```

sdo_coord_ref_sys crs,
sdo_coord_axes axes,
sdo_units_of_measure uom
where
crs.srid = 32040 and
axes.coord_sys_id = crs.coord_sys_id and
uom.uom_id = axes.uom_id;

```

Projection units

```

-----
X: US survey foot
Y: US survey foot

```

## 6.8 Legacy Tables and Views

In releases of Spatial and Graph before 10.2, the coordinate systems functions and procedures used information provided in the following tables, some of which have new names or are now views instead of tables:

- MDSYS.CS\_SRS (see [MDSYS.CS\\_SRS Table](#) (page 6-48)) defined the valid coordinate systems. It associates each coordinate system with its well-known text description, which is in conformance with the standard published by the Open Geospatial Consortium (<http://www.opengeospatial.org>).
- MDSYS.SDO\_ANGLE\_UNITS (see [MDSYS.SDO\\_ANGLE\\_UNITS View](#) (page 6-52)) defines the valid angle units.
- MDSYS.SDO\_AREA\_UNITS (see [MDSYS.SDO\\_AREA\\_UNITS View](#) (page 6-52)) defines the valid area units.
- MDSYS.SDO\_DIST\_UNITS (see [MDSYS.SDO\\_DIST\\_UNITS View](#) (page 6-53)) defines the valid distance units.
- MDSYS.SDO\_DATUMS\_OLD\_FORMAT and MDSYS.SDO\_DATUMS\_OLD\_SNAPSHOT (see [MDSYS.SDO\\_DATUMS\\_OLD\\_FORMAT and SDO\\_DATUMS\\_OLD\\_SNAPSHOT Tables](#) (page 6-53)) are based on the MDSYS.SDO\_DATUMS table before release 10.2, which defined valid datums.
- MDSYS.SDO\_ELLIPSOIDS\_OLD\_FORMAT and MDSYS.SDO\_ELLIPSOIDS\_OLD\_SNAPSHOT (see [MDSYS.SDO\\_ELLIPSOIDS\\_OLD\\_FORMAT and SDO\\_ELLIPSOIDS\\_OLD\\_SNAPSHOT Tables](#) (page 6-54)) are based on the MDSYS.SDO\_ELLIPSOIDS table before release 10.2, which defined valid ellipsoids.
- MDSYS.SDO\_PROJECTIONS\_OLD\_FORMAT and MDSYS.SDO\_PROJECTIONS\_OLD\_SNAPSHOT (see [MDSYS.SDO\\_PROJECTIONS\\_OLD\\_FORMAT and SDO\\_PROJECTIONS\\_OLD\\_SNAPSHOT Tables](#) (page 6-55)) are based on the MDSYS.SDO\_PROJECTIONS table before release 10.2, which defined the valid map projections.

**Note:**

You should not modify or delete any Oracle-supplied information in these legacy tables.

If you refer to a legacy table in a SQL statement, you must include the *MDSYS*. before the table name.

## 6.8.1 MDSYS.CS\_SRS Table

The MDSYS.CS\_SRS reference table contains over 4000 rows, one for each valid coordinate system. This table contains the columns shown in [Table 6-28](#) (page 6-48).

**Table 6-28 MDSYS.CS\_SRS Table**

Column Name	Data Type	Description
CS_NAME	VARCHAR2(68)	A well-known name, often mnemonic, by which a user can refer to the coordinate system.
SRID	NUMBER(38)	The unique ID number (Spatial Reference ID) for a coordinate system. Currently, SRID values 1-999999 are reserved for use by Oracle Spatial and Graph, and values 1000000 (1 million) and higher are available for user-defined coordinate systems.
AUTH_SRID	NUMBER(38)	An optional ID number that can be used to indicate how the entry was derived; it might be a foreign key into another coordinate table, for example.
AUTH_NAME	VARCHAR2(256)	An authority name for the coordinate system. Contains Oracle in the supplied table. Users can specify any value in any rows that they add.
WKTEXT	VARCHAR2(2046)	The well-known text (WKT) description of the SRS, as defined by the Open Geospatial Consortium. For more information, see <a href="#">Well-Known Text (WKT)</a> (page 6-48).
CS_BOUNDS	SDO_GEOMETRY	An optional SDO_GEOMETRY object that is a polygon with WGS 84 longitude and latitude vertices, representing the spheroidal polygon description of the zone of validity for a projected coordinate system. Must be null for a geographic or non-Earth coordinate system. Is null in all supplied rows.

### 6.8.1.1 Well-Known Text (WKT)

The WKTEXT column of the MDSYS.CS\_SRS table contains the well-known text (WKT) description of the SRS, as defined by the Open Geospatial Consortium. The following is the WKT EBNF syntax.

```

<coordinate system> ::=
    <horz cs> | <local cs>

<horz cs> ::=
    <geographic cs> | <projected cs>

<projected cs> ::=

```

```

    PROJCS [ "<name>", <geographic cs>, <projection>,
              {<parameter>,*} <linear unit> ]

<projection> ::=
    PROJECTION [ "<name>" ]

<parameter> ::=
    PARAMETER [ "<name>", <number> ]

<geographic cs> ::=
    GEOGCS [ "<name>", <datum>, <prime meridian>, <angular unit> ]

<datum> ::=
    DATUM [ "<name>", <spheroid>
            {, <shift-x>, <shift-y>, <shift-z>
              , <rot-x>, <rot-y>, <rot-z>, <scale_adjust>}
            ]

<spheroid> ::=
    SPHEROID [ "<name>", <semi major axis>, <inverse flattening> ]

<prime meridian> ::=
    PRIMEM [ "<name>", <longitude> ]

<longitude> ::=
    <number>

<semi-major axis> ::=
    <number>

<inverse flattening> ::=
    <number>

<angular unit> ::= <unit>

<linear unit> ::= <unit>

<unit> ::=
    UNIT [ "<name>", <conversion factor> ]

<local cs> ::=
    LOCAL_CS [ "<name>", <local datum>, <linear unit>,
               <axis> {, <axis>}* ]

<local datum> ::=
    LOCAL_DATUM [ "<name>", <datum type>
                  {, <shift-x>, <shift-y>, <shift-z>
                    , <rot-x>, <rot-y>, <rot-z>, <scale_adjust>}
                  ]

<datum type> ::=
    <number>

<axis> ::=
    AXIS [ "<name>", NORTH | SOUTH | EAST |
           WEST | UP | DOWN | OTHER ]

```

Each <parameter> specification is one of the following:

- Standard\_Parallel\_1 (in decimal degrees)

- Standard\_Parallel\_2 (in decimal degrees)
- Central\_Meridian (in decimal degrees)
- Latitude\_of\_Origin (in decimal degrees)
- Azimuth (in decimal degrees)
- False\_Easting (in the unit of the coordinate system; for example, meters)
- False\_Northing (in the unit of the coordinate system; for example, meters)
- Perspective\_Point\_Height (in the unit of the coordinate system; for example, meters)
- Landsat\_Number (must be 1, 2, 3, 4, or 5)
- Path\_Number
- Scale\_Factor

---

**Note:**

If the WKT uses European rather than US-American notation for datum rotation parameters, or if the transformation results do not seem correct, see [US-American and European Notations for Datum Parameters](#) (page 6-51).

---

The default value for each <parameter> specification is 0 (zero). That is, if a specification is needed for a projection but no value is specified in the WKT, Spatial and Graph uses a value of 0.

The prime meridian (PRIMEM) is specified in decimal degrees of longitude.

An example of the WKT for a geodetic (geographic) coordinate system is:

```
'GEOGCS [ "Longitude / Latitude (Old Hawaiian)", DATUM [ "Old Hawaiian", SPHEROID [ "Clarke 1866", 6378206.400000, 294.978698]], PRIMEM [ "Greenwich", 0.000000 ], UNIT [ "Decimal Degree", 0.01745329251994330]]'
```

The WKT definition of the coordinate system is hierarchically nested. The Old Hawaiian geographic coordinate system (GEOGCS) is composed of a named datum (DATUM), a prime meridian (PRIMEM), and a unit definition (UNIT). The datum is in turn composed of a named spheroid and its parameters of semi-major axis and inverse flattening.

An example of the WKT for a projected coordinate system (a Wyoming State Plane) is:

```
'PROJCS[ "Wyoming 4901, Eastern Zone (1983, meters)", GEOGCS [ "GRS 80", DATUM [ "GRS 80", SPHEROID [ "GRS 80", 6378137.000000, 298.257222]], PRIMEM [ "Greenwich", 0.000000 ], UNIT [ "Decimal Degree", 0.01745329251994330]], PROJECTION [ "Transverse Mercator"], PARAMETER [ "Scale_Factor", 0.999938], PARAMETER [ "Central_Meridian", -105.166667], PARAMETER [ "Latitude_Of_Origin", 40.500000], PARAMETER [ "False_Easting", 200000.000000], UNIT [ "Meter", 1.000000000000]]'
```

The projected coordinate system contains a nested geographic coordinate system as its basis, as well as parameters that control the projection.

Oracle Spatial and Graph supports all common geodetic datums and map projections.

An example of the WKT for a local coordinate system is:

```
LOCAL_CS [ "Non-Earth (Meter)", LOCAL_DATUM ["Local Datum", 0], UNIT ["Meter", 1.0],
  AXIS ["X", EAST], AXIS["Y", NORTH]]
```

For more information about local coordinate systems, see [Local Coordinate Support](#) (page 6-8).

You can use the [SDO\\_CS.VALIDATE\\_WKT](#) (page 20-43) function, described in [SDO\\_CS Package \(Coordinate System Transformation\)](#) (page 20-1), to validate the WKT of any coordinate system defined in the MDSYS.CS\_SRS table.

### 6.8.1.2 US-American and European Notations for Datum Parameters

The datum-related WKT parameters are a list of up to seven Bursa Wolf transformation parameters. Rotation parameters specify arc seconds, and shift parameters specify meters.

Two different notations, US-American and European, are used for the three rotation parameters that are in general use, and these two notations use opposite signs. Spatial and Graph uses and expects the US-American notation. Therefore, if your WKT uses the European notation, you must convert it to the US-American notation by inverting the signs of the rotation parameters.

If you do not know if a parameter set uses the US-American or European notation, perform the following test:

1. Select a single point for which you know the correct result.
2. Perform the transformation using the current WKT.
3. If the computed result does not match the known correct result, invert signs of the rotation parameters, perform the transformation, and check if the computed result matches the known correct result.

### 6.8.1.3 Procedures for Updating the Well-Known Text

If you insert or delete a row in the SDO\_COORD\_REF\_SYSTEM view (described in [SDO\\_COORD\\_REF\\_SYSTEM View](#) (page 6-29)), Spatial and Graph automatically updates the WKTEXT column in the MDSYS.CS\_SRS table. (The format of the WKTEXT column is described in [Well-Known Text \(WKT\)](#) (page 6-48).) However, if you update an existing row in the SDO\_COORD\_REF\_SYSTEM view, the well-known text (WKT) value is not automatically updated.

In addition, information relating to coordinate reference systems is also stored in several other system tables, including SDO\_DATUMS (described in [SDO\\_DATUMS Table](#) (page 6-37)), SDO\_ELLIPSOIDS (described in [SDO\\_ELLIPSOIDS Table](#) (page 6-38)), and SDO\_PRIME\_MERIDIANS (described in [SDO\\_PRIME\\_MERIDIANS Table](#) (page 6-40)). If you add, delete, or modify information in these tables, the WKTEXT values in the MDSYS.CS\_SRS table are not automatically updated. For example, if you update an ellipsoid flattening value in the SDO\_ELLIPSOIDS table, the well-known text string for the associated coordinate system is not updated.

However, you can manually update the WKTEXT values in the in the MDSYS.CS\_SRS table by using any of several procedures whose names start with [UPDATE\\_WKTS\\_FOR](#) (for example, [SDO\\_CS.UPDATE\\_WKTS\\_FOR\\_ALL\\_EPSG\\_CRS](#) (page 20-37) and [SDO\\_CS.UPDATE\\_WKTS\\_FOR\\_EPSG\\_DATUM](#) (page 20-38)). If the display of SERVEROUTPUT information is enabled, these procedures display a message identifying the SRID value for each row in the MDSYS.CS\_SRS table whose WKTEXT value is being updated. These procedures are described in [SDO\\_CS Package \(Coordinate System Transformation\)](#) (page 20-1).

## 6.8.2 MDSYS.SDO\_ANGLE\_UNITS View

The MDSYS.SDO\_ANGLE\_UNITS reference view contains one row for each valid angle UNIT specification in the well-known text (WKT) description in the coordinate system definition. The WKT is described in [Well-Known Text \(WKT\)](#) (page 6-48).

The MDSYS.SDO\_ANGLE\_UNITS view is based on the SDO\_UNITS\_OF MEASURE table (described in [SDO\\_UNITS\\_OF MEASURE Table](#) (page 6-41)), and it contains the columns shown in [Table 6-29](#) (page 6-52).

**Table 6-29 MDSYS.SDO\_ANGLE\_UNITS View**

Column Name	Data Type	Description
SDO_UNIT	VARCHAR2(32)	Name of the angle unit (often a shortened form of the UNIT_NAME value). Use the SDO_UNIT value with the <code>from_unit</code> and <code>to_unit</code> parameters of the <a href="#">SDO_UTIL.CONVERT_UNIT</a> (page 31-15) function.
UNIT_NAME	VARCHAR2(100)	Name of the angle unit. Specify a value from this column in the UNIT specification of the WKT for any user-defined coordinate system. Examples: <code>Decimal Degree</code> , <code>Radian</code> , <code>Decimal Second</code> , <code>Decimal Minute</code> , <code>Gon</code> , <code>Grad</code> .
CONVERSION_FACTOR	NUMBER	The ratio of the specified unit to one radian. For example, the ratio of <code>Decimal Degree</code> to <code>Radian</code> is 0.017453293.

## 6.8.3 MDSYS.SDO\_AREA\_UNITS View

The MDSYS.SDO\_AREA\_UNITS reference view contains one row for each valid area UNIT specification in the well-known text (WKT) description in the coordinate system definition. The WKT is described in [Well-Known Text \(WKT\)](#) (page 6-48).

The MDSYS.SDO\_AREA\_UNITS view is based on the SDO\_UNITS\_OF MEASURE table (described in [SDO\\_UNITS\\_OF MEASURE Table](#) (page 6-41)), and it contains the columns shown in [Table 6-30](#) (page 6-52).

**Table 6-30 SDO\_AREA\_UNITS View**

Column Name	Data Type	Purpose
SDO_UNIT	VARCHAR2	Values are taken from the <code>SHORT_NAME</code> column of the SDO_UNITS_OF MEASURE table.
UNIT_NAME	VARCHAR2	Values are taken from the <code>UNIT_OF_MEAS_NAME</code> column of the SDO_UNITS_OF MEASURE table.
CONVERSION_FACTOR	NUMBER	Ratio of the unit to 1 square meter. For example, the conversion factor for a square meter is 1.0, and the conversion factor for a square mile is 2589988.

## 6.8.4 MDSYS.SDO\_DATUMS\_OLD\_FORMAT and SDO\_DATUMS\_OLD\_SNAPSHOT Tables

The MDSYS.SDO\_DATUMS\_OLD\_FORMAT and MDSYS.SDO\_DATUMS\_OLD\_SNAPSHOT reference tables contain one row for each valid DATUM specification in the well-known text (WKT) description in the coordinate system definition. (The WKT is described in [Well-Known Text \(WKT\)](#) (page 6-48).)

- MDSYS.SDO\_DATUMS\_OLD\_FORMAT contains the new data in the old format (that is, EPSG-based datum specifications in a table using the format from before release 10.2).
- MDSYS.SDO\_DATUMS\_OLD\_SNAPSHOT contains the old data in the old format (that is, datum specifications and table format from before release 10.2).

These tables contain the columns shown in the following table.

**Table 6-31 MDSYS.SDO\_DATUMS\_OLD\_FORMAT and SDO\_DATUMS\_OLD\_SNAPSHOT Tables**

Column Name	Data Type	Description
NAME	VARCHAR2(80) for OLD_FORMAT VARCHAR2(64) for OLD_SNAPSHOT	Name of the datum. Specify a value (Oracle-supplied or user-defined) from this column in the DATUM specification of the WKT for any user-defined coordinate system. Examples: Adindan, Afgooeye, Ain el Abd 1970, Anna 1 Astro 1965, Arc 1950, Arc 1960, Ascension Island 1958.
SHIFT_X	NUMBER	Number of meters to shift the ellipsoid center relative to the center of the WGS 84 ellipsoid on the x-axis.
SHIFT_Y	NUMBER	Number of meters to shift the ellipsoid center relative to the center of the WGS 84 ellipsoid on the y-axis.
SHIFT_Z	NUMBER	Number of meters to shift the ellipsoid center relative to the center of the WGS 84 ellipsoid on the z-axis.
ROTATE_X	NUMBER	Number of arc-seconds of rotation about the x-axis.
ROTATE_Y	NUMBER	Number of arc-seconds of rotation about the y-axis.
ROTATE_Z	NUMBER	Number of arc-seconds of rotation about the z-axis.
SCALE_ADJUST	NUMBER	A value to be used in adjusting the X, Y, and Z values after any shifting and rotation, according to the formula: $1.0 + (\text{SCALE\_ADJUST} * 10^{-6})$

To see the names of the datums in these tables, enter an appropriate SELECT statement. For example:

```
SELECT name FROM MDSYS.SDO_DATUMS_OLD_FORMAT ORDER BY name;
```

## 6.8.5 MDSYS.SDO\_DIST\_UNITS View

The MDSYS.SDO\_DIST\_UNITS reference view contains one row for each valid distance UNIT specification in the well-known text (WKT) description in the

coordinate system definition. The WKT is described in [Well-Known Text \(WKT\)](#) (page 6-48).

The MDSYS.SDO\_DIST\_UNITS view is based on the SDO\_UNITS\_OF\_MEASURE table (described in [SDO\\_UNITS\\_OF\\_MEASURE Table](#) (page 6-41)), and it contains the columns shown in [Table 6-32](#) (page 6-54).

**Table 6-32 MDSYS.SDO\_DIST\_UNITS View**

Column Name	Data Type	Description
SDO_UNIT	VARCHAR2	Values are taken from the SHORT_NAME column of the SDO_UNITS_OF_MEASURE table.
UNIT_NAME	VARCHAR2	Values are taken from the UNIT_OF_MEAS_NAME column of the SDO_UNITS_OF_MEASURE table.
CONVERSION_FACTOR	NUMBER	Ratio of the unit to 1 meter. For example, the conversion factor for a meter is 1.0, and the conversion factor for a mile is 1609.344.

### 6.8.6 MDSYS.SDO\_ELLIPSOIDS\_OLD\_FORMAT and SDO\_ELLIPSOIDS\_OLD\_SNAPSHOT Tables

The MDSYS.SDO\_ELLIPSOIDS\_OLD\_FORMAT and MDSYS.SDO\_ELLIPSOIDS\_OLD\_SNAPSHOT reference tables contain one row for each valid SPHEROID specification in the well-known text (WKT) description in the coordinate system definition. (The WKT is described in [Well-Known Text \(WKT\)](#) (page 6-48).)

- MDSYS.SDO\_ELLIPSOIDS\_OLD\_FORMAT contains the new data in the old format (that is, EPSG-based ellipsoid specifications in a table using the format from before release 10.2).
- MDSYS.SDO\_ELLIPSOIDS\_OLD\_SNAPSHOT contains the old data in the old format (that is, ellipsoid specifications and table format from before release 10.2).

These tables contain the columns shown in the following table.

**Table 6-33 MDSYS.SDO\_ELLIPSOIDS\_OLD\_FORMAT and SDO\_ELLIPSOIDS\_OLD\_SNAPSHOT Tables**

Column Name	Data Type	Description
NAME	VARCHAR2(80) for OLD_FORMAT VARCHAR2(64) for OLD_SNAPSHOT	Name of the ellipsoid (spheroid). Specify a value from this column in the SPHEROID specification of the WKT for any user-defined coordinate system. Examples: Clarke 1866, WGS 72, Australian, Krassovsky, International 1924.
SEMI_MAJOR_AXIS	NUMBER	Radius in meters along the semi-major axis (one-half of the long axis of the ellipsoid).
INVERSE_FLATTENING	NUMBER	Inverse flattening of the ellipsoid. That is, $1/f$ , where $f = (a-b)/a$ , and $a$ is the semi-major axis and $b$ is the semi-minor axis.



To see the names of the ellipsoids in these tables, enter an appropriate SELECT statement. For example:

```
SELECT name FROM MDSYS.SDO_ELLIPSOIDS_OLD_FORMAT ORDER BY name;
```

### 6.8.7 MDSYS.SDO\_PROJECTIONS\_OLD\_FORMAT and SDO\_PROJECTIONS\_OLD\_SNAPSHOT Tables

The MDSYS.SDO\_PROJECTIONS\_OLD\_FORMAT and MDSYS.SDO\_PROJECTIONS\_OLD\_SNAPSHOT reference tables contain one row for each valid PROJECTION specification in the well-known text (WKT) description in the coordinate system definition. (The WKT is described in [Well-Known Text \(WKT\)](#) (page 6-48).)

- MDSYS.SDO\_PROJECTIONS\_OLD\_FORMAT contains the new data in the old format (that is, EPSG-based projection specifications in a table using the format from before release 10.2).
- MDSYS.SDO\_PROJECTIONS\_OLD\_SNAPSHOT contains the old data in the old format (that is, projection specifications and table format from before release 10.2).

These tables contains the column shown in the following table.

**Table 6-34 MDSYS.SDO\_PROJECTIONS\_OLD\_FORMAT and SDO\_PROJECTIONS\_OLD\_SNAPSHOT Tables**

Column Name	Data Type	Description
NAME	VARCHAR2(80) for OLD_FORMAT VARCHAR2(64) for OLD_SNAPSHOT	Name of the map projection. Specify a value from this column in the PROJECTION specification of the WKT for any user-defined coordinate system. Examples: Geographic (Lat/Long), Universal Transverse Mercator, State Plane Coordinates, Albers Conical Equal Area.

To see the names of the projections in these tables, enter an appropriate SELECT statement. For example:

```
SELECT name FROM MDSYS.SDO_PROJECTIONS_OLD_FORMAT ORDER BY name;
```

## 6.9 Creating a User-Defined Coordinate Reference System

If the coordinate systems supplied by Oracle are not sufficient for your needs, you can create user-defined coordinate reference systems.

---

#### Note:

As mentioned in [Coordinate System \(Spatial Reference System\)](#) (page 6-1), the terms *coordinate system* and *coordinate reference system* (CRS) are often used interchangeably, although coordinate reference systems must be Earth-based.

---

The exact steps for creating a user-defined CRS depend on whether it is geodetic or projected. In both cases, supply information about the coordinate system (coordinate axes, axis names, unit of measurement, and so on). For a geodetic CRS, supply information about the datum (ellipsoid, prime meridian, and so on), as explained in

[Creating a Geodetic CRS](#) (page 6-56). For a projected CRS, supply information about the source (geodetic) CRS and the projection (operation and parameters), as explained in [Creating a Projected CRS](#) (page 6-57).

For any user-defined coordinate system, the SRID value should be 1000000 (1 million) or higher.

## 6.9.1 Creating a Geodetic CRS

If the necessary unit of measurement, coordinate axes, SDO\_COORD\_SYS table row, ellipsoid, prime meridian, and datum are already defined, insert a row into the SDO\_COORD\_REF\_SYSTEM view (described in [SDO\\_COORD\\_REF\\_SYSTEM View](#) (page 6-29)) to define the new geodetic CRS.

**Example 6-5** (page 6-56) inserts the definition for a hypothetical geodetic CRS named My Own NAD27 (which, except for its SRID and name, is the same as the NAD27 CRS supplied by Oracle).

If the necessary information for the definition does not already exist, follow these steps, as needed, to define the information before you insert the row into the SDO\_COORD\_REF\_SYSTEM view:

1. If the unit of measurement is not already defined in the SDO\_UNITS\_OF\_MEASURE table (described in [SDO\\_UNITS\\_OF\\_MEASURE Table](#) (page 6-41)), insert a row into that table to define the new unit of measurement.
2. If the coordinate axes are not already defined in the SDO\_COORD\_AXES table (described in [SDO\\_COORD\\_AXES Table](#) (page 6-21)), insert one row into that table for each new coordinate axis.
3. If an appropriate entry for the coordinate system does not already exist in the SDO\_COORD\_SYS table (described in [SDO\\_COORD\\_SYS Table](#) (page 6-29)), insert a row into that table. **Example 6-6** (page 6-57) inserts the definition for a fictitious coordinate system.
4. If the ellipsoid is not already defined in the SDO\_ELLIPSOIDS table (described in [SDO\\_ELLIPSOIDS Table](#) (page 6-38)), insert a row into that table to define the new ellipsoid.
5. If the prime meridian is not already defined in the SDO\_PRIME\_MERIDIANS table (described in [SDO\\_PRIME\\_MERIDIANS Table](#) (page 6-40)), insert a row into that table to define the new prime meridian.
6. If the datum is not already defined in the SDO\_DATUMS table (described in [SDO\\_DATUMS Table](#) (page 6-37)), insert a row into that table to define the new datum.

### **Example 6-5    Creating a User-Defined Geodetic Coordinate Reference System**

```
INSERT INTO SDO_COORD_REF_SYSTEM (  
    SRID,  
    COORD_REF_SYS_NAME,  
    COORD_REF_SYS_KIND,  
    COORD_SYS_ID,  
    DATUM_ID,  
    GEOG_CRS_DATUM_ID,  
    SOURCE_GEOG_SRID,  
    PROJECTION_CONV_ID,  
    CMPD_HORIZ_SRID,
```

```

        CMPD_VERT_SRID,
        INFORMATION_SOURCE,
        DATA_SOURCE,
        IS_LEGACY,
        LEGACY_CODE,
        LEGACY_WKTEXT,
        LEGACY_CS_BOUNDS,
        IS_VALID,
        SUPPORTS_SDO_GEOMETRY)
VALUES (
    9994267,
    'My Own NAD27',
    'GEOGRAPHIC2D',
    6422,
    6267,
    6267,
    NULL,
    NULL,
    NULL,
    NULL,
    NULL,
    'EPSG',
    'FALSE',
    NULL,
    NULL,
    NULL,
    'TRUE',
    'TRUE');

```

#### **Example 6-6 Inserting a Row into the SDO\_COORD\_SYS Table**

```

INSERT INTO SDO_COORD_SYS (
    COORD_SYS_ID,
    COORD_SYS_NAME,
    COORD_SYS_TYPE,
    DIMENSION,
    INFORMATION_SOURCE,
    DATA_SOURCE)
VALUES (
    9876543,
    'My custom CS. Axes: lat, long. Orientations: north, east. UoM: deg',
    'ellipsoidal',
    2,
    'Myself',
    'Myself');

```

## **6.9.2 Creating a Projected CRS**

If the necessary unit of measurement, coordinate axes, SDO\_COORD\_SYS table row, source coordinate system, projection operation, and projection parameters are already defined, insert a row into the SDO\_COORD\_REF\_SYSTEM view (described in [SDO\\_COORD\\_REF\\_SYSTEM View](#) (page 6-29)) to define the new projected CRS.

**Example 6-7** (page 6-58) inserts the definition for a hypothetical projected CRS named *My Own NAD27 / Cuba Norte* (which, except for its SRID and name, is the same as the *NAD27 / Cuba Norte* CRS supplied by Oracle).

If the necessary information for the definition does not already exist, follow these steps, as needed, to define the information before you insert the row into the SDO\_COORD\_REF\_SYSTEM view:

1. If the unit of measurement is not already defined in the SDO\_UNITS\_OF\_MEASURE table (described in [SDO\\_UNITS\\_OF\\_MEASURE Table](#) (page 6-41)), insert a row into that table to define the new unit of measurement.
2. If the coordinate axes are not already defined in the SDO\_COORD\_AXES table (described in [SDO\\_COORD\\_AXES Table](#) (page 6-21)), insert one row into that table for each new coordinate axis.
3. If an appropriate entry for the coordinate system does not already exist in SDO\_COORD\_SYS table (described in [SDO\\_COORD\\_SYS Table](#) (page 6-29)), insert a row into that table. (See [Example 6-6](#) (page 6-57) in [Creating a Geodetic CRS](#) (page 6-56)).
4. If the projection operation is not already defined in the SDO\_COORD\_OPS table (described in [SDO\\_COORD\\_OPS Table](#) (page 6-25)), insert a row into that table to define the new projection operation. [Example 6-8](#) (page 6-59) shows the statement used to insert information about coordinate operation ID 18061, which is supplied by Oracle.
5. If the parameters for the projection operation are not already defined in the SDO\_COORD\_OP\_PARAM\_VALS table (described in [SDO\\_COORD\\_OP\\_PARAM\\_VALS Table](#) (page 6-23)), insert one row into that table for each new parameter. [Example 6-9](#) (page 6-59) shows the statement used to insert information about parameters with ID values 8801, 8802, 8805, 8806, and 8807, which are supplied by Oracle.

**Example 6-7 Creating a User-Defined Projected Coordinate Reference System**

```
INSERT INTO SDO_COORD_REF_SYSTEM (  
    SRID,  
    COORD_REF_SYS_NAME,  
    COORD_REF_SYS_KIND,  
    COORD_SYS_ID,  
    DATUM_ID,  
    GEOG_CRS_DATUM_ID,  
    SOURCE_GEOG_SRID,  
    PROJECTION_CONV_ID,  
    CMPD_HORIZ_SRID,  
    CMPD_VERT_SRID,  
    INFORMATION_SOURCE,  
    DATA_SOURCE,  
    IS_LEGACY,  
    LEGACY_CODE,  
    LEGACY_WKTEXT,  
    LEGACY_CS_BOUNDS,  
    IS_VALID,  
    SUPPORTS_SDO_GEOMETRY)  
VALUES (  
    9992085,  
    'My Own NAD27 / Cuba Norte',  
    'PROJECTED',  
    4532,  
    NULL,  
    6267,  
    4267,  
    18061,  
    NULL,  
    NULL,  
    'Institut Cubano di Hidrografia (ICH)',
```

```
'EPSG',
'FALSE',
NULL,
NULL,
NULL,
'TRUE',
'TRUE');
```

**Example 6-8 Inserting a Row into the SDO\_COORD\_OPS Table**

```
INSERT INTO SDO_COORD_OPS (
    COORD_OP_ID,
    COORD_OP_NAME,
    COORD_OP_TYPE,
    SOURCE_SRID,
    TARGET_SRID,
    COORD_TFM_VERSION,
    COORD_OP_VARIANT,
    COORD_OP_METHOD_ID,
    UOM_ID_SOURCE_OFFSETS,
    UOM_ID_TARGET_OFFSETS,
    INFORMATION_SOURCE,
    DATA_SOURCE,
    SHOW_OPERATION,
    IS_LEGACY,
    LEGACY_CODE,
    REVERSE_OP,
    IS_IMPLEMENTED_FORWARD,
    IS_IMPLEMENTED_REVERSE)
VALUES (
    18061,
    'Cuba Norte',
    'CONVERSION',
    NULL,
    NULL,
    NULL,
    NULL,
    9801,
    NULL,
    NULL,
    NULL,
    'EPSG',
    1,
    'FALSE',
    NULL,
    1,
    1,
    1);
```

**Example 6-9 Inserting a Row into the SDO\_COORD\_OP\_PARAM\_VALS Table**

```
INSERT INTO SDO_COORD_OP_PARAM_VALS (
    COORD_OP_ID,
    COORD_OP_METHOD_ID,
    PARAMETER_ID,
    PARAMETER_VALUE,
    PARAM_VALUE_FILE_REF,
    UOM_ID)
VALUES (
    18061,
    9801,
    8801,
```

```

        22.21,
        NULL,
        9110);

INSERT INTO SDO_COORD_OP_PARAM_VALS (
    COORD_OP_ID,
    COORD_OP_METHOD_ID,
    PARAMETER_ID,
    PARAMETER_VALUE,
    PARAM_VALUE_FILE_REF,
    UOM_ID)
VALUES (
    18061,
    9801,
    8802,
    -81,
    NULL,
    9110);

INSERT INTO SDO_COORD_OP_PARAM_VALS (
    COORD_OP_ID,
    COORD_OP_METHOD_ID,
    PARAMETER_ID,
    PARAMETER_VALUE,
    PARAM_VALUE_FILE_REF,
    UOM_ID)
VALUES (
    18061,
    9801,
    8805,
    .99993602,
    NULL,
    9201);

INSERT INTO SDO_COORD_OP_PARAM_VALS (
    COORD_OP_ID,
    COORD_OP_METHOD_ID,
    PARAMETER_ID,
    PARAMETER_VALUE,
    PARAM_VALUE_FILE_REF,
    UOM_ID)
VALUES (
    18061,
    9801,
    8806,
    500000,
    NULL,
    9001);

INSERT INTO SDO_COORD_OP_PARAM_VALS (
    COORD_OP_ID,
    COORD_OP_METHOD_ID,
    PARAMETER_ID,
    PARAMETER_VALUE,
    PARAM_VALUE_FILE_REF,
    UOM_ID)
VALUES (
    18061,
    9801,
    8807,
    280296.016,
    NULL,
    9001);

```

```
NULL,
9001);
```

### Example 6-10 Creating a User-Defined Projected CRS: Extended Example

```
-- Create an EPSG equivalent for the following CRS:
--
-- CS_NAME:      VDOT_LAMBERT
-- SRID:         51000000
-- AUTH_SRID:    51000000
-- AUTH_NAME:    VDOT Custom Lambert Conformal Conic
-- WKTEXT:
--
-- PROJCS[
--   "VDOT_Lambert",
--   GEOGCS[
--     "GCS_North_American_1983",
--     DATUM[
--       "D_North_American_1983",
--       SPHEROID["GRS_1980", 6378137.0, 298.257222101]],
--       PRIMEM["Greenwich", 0.0],
--       UNIT["Decimal Degree",0.0174532925199433]],
--     PROJECTION["Lambert_Conformal_Conic"],
--     PARAMETER["False_Easting", 0.0],
--     PARAMETER["False_Northing", 0.0],
--     PARAMETER["Central_Meridian", -79.5],
--     PARAMETER["Standard_Parallel_1", 37.0],
--     PARAMETER["Standard_Parallel_2", 39.5],
--     PARAMETER["Scale_Factor", 1.0],
--     PARAMETER["Latitude_Of_Origin", 36.0],
--     UNIT["Meter", 1.0]]
--
-- First, the base geographic CRS (GCS_North_American_1983) already exists in EPSG.
-- It is 4269:
-- Next, find the EPSG equivalent for PROJECTION["Lambert_Conformal_Conic"]:
select
  coord_op_method_id,
  legacy_name
from
  sdo_coord_op_methods
where
  not legacy_name is null
order by
  coord_op_method_id;

-- Result:
-- COORD_OP_METHOD_ID  LEGACY_NAME
-- -----
--          9802  Lambert Conformal Conic
--          9803  Lambert Conformal Conic (Belgium 1972)
--          9805  Mercator
--          9806  Cassini
--          9807  Transverse Mercator
--          9829  Polar Stereographic
--
-- 6 rows selected.
--
-- It is EPSG method 9802. Create a projection operation 510000001, based on it:

insert into MDSYS.SDO_COORD_OPS (
  COORD_OP_ID,
```

```
        COORD_OP_NAME,
        COORD_OP_TYPE,
        SOURCE_SRID,
        TARGET_SRID,
        COORD_TFM_VERSION,
        COORD_OP_VARIANT,
        COORD_OP_METHOD_ID,
        UOM_ID_SOURCE_OFFSETS,
        UOM_ID_TARGET_OFFSETS,
        INFORMATION_SOURCE,
        DATA_SOURCE,
        SHOW_OPERATION,
        IS_LEGACY,
        LEGACY_CODE,
        REVERSE_OP,
        IS_IMPLEMENTED_FORWARD,
        IS_IMPLEMENTED_REVERSE)
VALUES (
    510000001,
    'VDOT_Lambert',
    'CONVERSION',
    NULL,
    NULL,
    NULL,
    NULL,
    9802,
    NULL,
    NULL,
    NULL,
    NULL,
    1,
    'FALSE',
    NULL,
    1,
    1,
    1);

-- Now, set the parameters. See which are required:

select
    use.parameter_id || ': ' ||
    use.legacy_param_name
from
    sdo_coord_op_param_use use
where
    use.coord_op_method_id = 9802;

-- result:
-- 8821: Latitude_Of_Origin
-- 8822: Central_Meridian
-- 8823: Standard_Parallel_1
-- 8824: Standard_Parallel_2
-- 8826: False_Easting
-- 8827: False_Northing
--
-- 6 rows selected.

-- Also check the most common units we will need:

select
    UOM_ID || ': ' ||
```



```

UNIT_OF_MEAS_NAME
from
  sdo_units_of_measure
where
  uom_id in (9001, 9101, 9102, 9201)
order by
  uom_id;

-- result:
-- 9001: metre
-- 9101: radian
-- 9102: degree
-- 9201: unity

-- Now, configure the projection parameters:

-- 8821: Latitude_Of-Origin

insert into MDSYS.SDO_COORD_OP_PARAM_VALS (
  COORD_OP_ID,
  COORD_OP_METHOD_ID,
  PARAMETER_ID,
  PARAMETER_VALUE,
  PARAM_VALUE_FILE_REF,
  UOM_ID)
VALUES (
  510000001,
  9802,
  8821,
  36.0,
  NULL,
  9102);

-- 8822: Central_Meridian

insert into MDSYS.SDO_COORD_OP_PARAM_VALS (
  COORD_OP_ID,
  COORD_OP_METHOD_ID,
  PARAMETER_ID,
  PARAMETER_VALUE,
  PARAM_VALUE_FILE_REF,
  UOM_ID)
VALUES (
  510000001,
  9802,
  8822,
  -79.5,
  NULL,
  9102);

-- 8823: Standard_Parallel_1

insert into MDSYS.SDO_COORD_OP_PARAM_VALS (
  COORD_OP_ID,
  COORD_OP_METHOD_ID,
  PARAMETER_ID,
  PARAMETER_VALUE,
  PARAM_VALUE_FILE_REF,
  UOM_ID)
VALUES (
  510000001,

```

```

        9802,
        8823,
        37.0,
        NULL,
        9102);

-- 8824: Standard_Parallel_2

insert into MDSYS.SDO_COORD_OP_PARAM_VALS (
    COORD_OP_ID,
    COORD_OP_METHOD_ID,
    PARAMETER_ID,
    PARAMETER_VALUE,
    PARAM_VALUE_FILE_REF,
    UOM_ID)
VALUES (
    510000001,
    9802,
    8824,
    39.5,
    NULL,
    9102);

-- 8826: False_Easting

insert into MDSYS.SDO_COORD_OP_PARAM_VALS (
    COORD_OP_ID,
    COORD_OP_METHOD_ID,
    PARAMETER_ID,
    PARAMETER_VALUE,
    PARAM_VALUE_FILE_REF,
    UOM_ID)
VALUES (
    510000001,
    9802,
    8826,
    0.0,
    NULL,
    9001);

-- 8827: False_Northing

insert into MDSYS.SDO_COORD_OP_PARAM_VALS (
    COORD_OP_ID,
    COORD_OP_METHOD_ID,
    PARAMETER_ID,
    PARAMETER_VALUE,
    PARAM_VALUE_FILE_REF,
    UOM_ID)
VALUES (
    510000001,
    9802,
    8827,
    0.0,
    NULL,
    9001);

-- Now, create the actual projected CRS.Look at the GEOG_CRS_DATUM_ID
-- and COORD_SYS_ID first. The GEOG_CRS_DATUM_ID is the datum of
-- the base geog_crs (4269):

```

```

select datum_id from sdo_coord_ref_sys where srid = 4269;

--   DATUM_ID
--   -----
--       6269

-- And the COORD_SYS_ID is the Cartesian CS used for the projected CRS.
-- We can use 4400, if meters will be the unit:

select COORD_SYS_NAME from sdo_coord_sys where COORD_SYS_ID = 4400;

-- Cartesian 2D CS. Axes: easting, northing (E,N). Orientations: east, north.
-- UoM: m.

-- Now create the projected CRS:

insert into MDSYS.SDO_COORD_REF_SYSTEM (
    SRID,
    COORD_REF_SYS_NAME,
    COORD_REF_SYS_KIND,
    COORD_SYS_ID,
    DATUM_ID,
    SOURCE_GEOG_SRID,
    PROJECTION_CONV_ID,
    CMPD_HORIZ_SRID,
    CMPD_VERT_SRID,
    INFORMATION_SOURCE,
    DATA_SOURCE,
    IS_LEGACY,
    LEGACY_CODE,
    LEGACY_WKTEXT,
    LEGACY_CS_BOUNDS,
    GEOG_CRS_DATUM_ID)
VALUES (
    51000000,
    'VDOT_LAMBERT',
    'PROJECTED',
    4400,
    NULL,
    4269,
    510000001,
    NULL,
    NULL,
    NULL,
    NULL,
    'FALSE',
    NULL,
    NULL,
    NULL,
    6269);

-- To see the result:

select srid, wktext from cs_srs where srid = 51000000;

-- 51000000
-- PROJCS[
--   "VDOT_LAMBERT",
--   GEOGCS [
--     "NAD83",
--     DATUM [

```

**Example 6-10** (page 6-61) provides an extended, annotated example of creating a user-defined projected coordinate system

A vertical CRS has only one dimension, usually height. On its own, a vertical CRS is of little use, but it can be combined with a two-dimensional CRS (geodetic or projected), to result in a compound CRS. [Example 6-11](#) (page 6-66) shows the statement that created the vertical CRS with SRID 5701, which is included with Spatial and Graph. This definition refers to an existing (one-dimensional) coordinate system (ID 6499; see [SDO\\_COORD\\_SYS Table](#) (page 6-29)) and vertical datum (ID 5101; see [SDO\\_DATUMS Table](#) (page 6-37)).

```

INSERT INTO MDSYS.SDO_COORD_REF_SYSTEM (
    SRID,
    COORD_REF_SYS_NAME,
    COORD_REF_SYS_KIND,
    COORD_SYS_ID,
    DATUM_ID,
    SOURCE_GEOG_SRID,
    PROJECTION_CONV_ID,
    CMPD_HORIZ_SRID,
    CMPD_VERT_SRID,
    INFORMATION_SOURCE,
    DATA_SOURCE,
    IS_LEGACY,
    LEGACY_CODE,
    LEGACY_WKTEXT,
    LEGACY_CS_BOUNDS)
VALUES (
    5701,
    'Newlyn',
    'VERTICAL',
    6499,
    5101,
    NULL,
    NULL,
    NULL,
    NULL,
    NULL,
    'EPSG',
    'FALSE',
    NULL,

```

```
NULL,
NULL);
```

A vertical CRS might define some undulating equipotential surface. The shape of that surface, and its offset from some ellipsoid, is not actually defined in the vertical CRS record itself (other than textually). Instead, that definition is included in an operation between the vertical CRS and another CRS. Consequently, you can define several alternative operations between the same pair of geoidal and WGS 84-ellipsoidal heights. For example, there are geoid offset matrixes GEOID90, GEOID93, GEOID96, GEOID99, GEOID03, GEOID06, and others, and for each of these variants there can be a separate operation. [Creating a Transformation Operation](#) (page 6-68) describes such an operation.

## 6.9.4 Creating a Compound CRS

A compound CRS combines an existing horizontal (two-dimensional) CRS and a vertical (one-dimensional) CRS. The horizontal CRS can be geodetic or projected. [Example 6-12](#) (page 6-67) shows the statement that created the compound CRS with SRID 7405, which is included with Spatial and Graph. This definition refers to an existing projected CRS and vertical CRS (IDs 27700 and 5701, respectively; see [SDO\\_COORD\\_REF\\_SYS Table](#) (page 6-27)).

### **Example 6-12 Creating a Compound Coordinate Reference System**

```
INSERT INTO MDSYS.SDO_COORD_REF_SYSTEM (
    SRID,
    COORD_REF_SYS_NAME,
    COORD_REF_SYS_KIND,
    COORD_SYS_ID,
    DATUM_ID,
    SOURCE_GEOG_SRID,
    PROJECTION_CONV_ID,
    CMPD_HORIZ_SRID,
    CMPD_VERT_SRID,
    INFORMATION_SOURCE,
    DATA_SOURCE,
    IS_LEGACY,
    LEGACY_CODE,
    LEGACY_WKTEXT,
    LEGACY_CS_BOUNDS)
VALUES (
    7405,
    'OSGB36 / British National Grid + ODN',
    'COMPOUND',
    NULL,
    NULL,
    NULL,
    NULL,
    27700,
    5701,
    NULL,
    'EPSG',
    'FALSE',
    NULL,
    NULL,
    NULL);
```

## 6.9.5 Creating a Geographic 3D CRS

A geographic 3D CRS is the combination of a geographic 2D CRS with ellipsoidal height. [Example 6-13](#) (page 6-68) shows the statement that created the geographic 3D CRS with SRID 4327, which is included with Spatial and Graph. This definition refers to an existing projected coordinate system (ID 6401; see [SDO\\_COORD\\_SYS Table](#) (page 6-29)) and datum (ID 6326; see [SDO\\_DATUMS Table](#) (page 6-37)).

### **Example 6-13** *Creating a Geographic 3D Coordinate Reference System*

```
INSERT INTO MDSYS.SDO_COORD_REF_SYSTEM (
    SRID,
    COORD_REF_SYS_NAME,
    COORD_REF_SYS_KIND,
    COORD_SYS_ID,
    DATUM_ID,
    GEOG_CRS_DATUM_ID,
    SOURCE_GEOG_SRID,
    PROJECTION_CONV_ID,
    CMPD_HORIZ_SRID,
    CMPD_VERT_SRID,
    INFORMATION_SOURCE,
    DATA_SOURCE,
    IS_LEGACY,
    LEGACY_CODE,
    LEGACY_WKTEXT,
    LEGACY_CS_BOUNDS,
    IS_VALID,
    SUPPORTS_SDO_GEOMETRY)
VALUES (
    4327,
    'WGS 84 (geographic 3D)',
    'GEOGRAPHIC3D',
    6401,
    6326,
    6326,
    NULL,
    NULL,
    NULL,
    NULL,
    'NIMA TR8350.2 January 2000 revision. http://164.214.2.59/GandG/tr8350_2.html',
    'EPSG',
    'FALSE',
    NULL,
    NULL,
    NULL,
    'TRUE',
    'TRUE');
```

## 6.9.6 Creating a Transformation Operation

[Creating a Projected CRS](#) (page 6-57) described the creation of a projection operation, for the purpose of then creating a projected CRS. A similar requirement can arise when using a compound CRS based on orthometric height: you may want to transform from and to ellipsoidal height. The offset between the two heights is undulating and irregular.

By default, Spatial and Graph transforms between ellipsoidal and orthometric height using an identity transformation. (Between different ellipsoids, the default would instead be a datum transformation.) The identity transformation is a reasonable

approximation; however, a more accurate approach involves an EPSG type 9635 operation, involving an offset matrix. [Example 6-14](#) (page 6-69) is a declaration of such an operation:

**Example 6-14 Creating a Transformation Operation**

```
INSERT INTO MDSYS.SDO_COORD_OPS (
  COORD_OP_ID,
  COORD_OP_NAME,
  COORD_OP_TYPE,
  SOURCE_SRID,
  TARGET_SRID,
  COORD_TFM_VERSION,
  COORD_OP_VARIANT,
  COORD_OP_METHOD_ID,
  UOM_ID_SOURCE_OFFSETS,
  UOM_ID_TARGET_OFFSETS,
  INFORMATION_SOURCE,
  DATA_SOURCE,
  SHOW_OPERATION,
  IS_LEGACY,
  LEGACY_CODE,
  REVERSE_OP,
  IS_IMPLEMENTED_FORWARD,
  IS_IMPLEMENTED_REVERSE)
VALUES (
  999998,
  'Test operation, based on GEOID03 model, using Hawaii grid',
  'TRANSFORMATION',
  NULL,
  NULL,
  NULL,
  NULL,
  9635,
  NULL,
  NULL,
  'NGS',
  'NGS',
  1,
  'FALSE',
  NULL,
  1,
  1,
  1) ;

INSERT INTO MDSYS.SDO_COORD_OP_PARAM_VALS (
  COORD_OP_ID,
  COORD_OP_METHOD_ID,
  PARAMETER_ID,
  PARAMETER_VALUE,
  PARAM_VALUE_FILE_REF,
  UOM_ID)
VALUES (
  999998,
  9635,
  8666,
  NULL,
  'g2003h01.asc',
  NULL) ;
```

The second INSERT statement in [Example 6-14](#) (page 6-69) specifies the file name `g2003h01.asc`, but not yet its actual CLOB content with the offset matrix. As with NADCON and NTV2 matrixes, geoid matrixes have to be loaded into the `PARAM_VALUE_FILE` column. Due to space and copyright considerations, Oracle does not supply most of these matrixes; however, they are usually available for download on the Web. Good sources are the relevant government websites, and you can search by file name (such as `g2003h01` in this example). Although some of these files are available in both binary format (such as `.gsb`) and ASCII format (such as `.gsa` or `.asc`), only the ASCII variant can be used with Spatial and Graph. The existing EPSG operations include file names in standard use.

**Example 6-15 Loading Offset Matrixes**

```
DECLARE
  ORCL_HOME_DIR VARCHAR2(128);
  ORCL_WORK_DIR VARCHAR2(128);
  Src_loc        BFILE;
  Dest_loc        CLOB;
  CURSOR PARAM_FILES IS
    SELECT
      COORD_OP_ID,
      PARAMETER_ID,
      PARAM_VALUE_FILE_REF
    FROM
      MDSYS.SDO_COORD_OP_PARAM_VALS
    WHERE
      PARAMETER_ID IN (8656, 8657, 8658, 8666);
  PARAM_FILE PARAM_FILES%ROWTYPE;
  ACTUAL_FILE_NAME VARCHAR2(128);
  platform NUMBER;
BEGIN
  EXECUTE IMMEDIATE 'CREATE OR REPLACE DIRECTORY work_dir AS
  'define_your_source_directory_here''';

  FOR PARAM_FILE IN PARAM_FILES LOOP
    CASE UPPER(PARAM_FILE.PARAM_VALUE_FILE_REF)
      /* NTV2, fill in your files here */
      WHEN 'NTV2_0.GSB' THEN ACTUAL_FILE_NAME := 'ntv20.gsa';
      /* GEOID03, fill in your files here */
      WHEN 'G2003H01.ASC' THEN ACTUAL_FILE_NAME := 'g2003h01.asc';
      ELSE
        ACTUAL_FILE_NAME := NULL;
    END CASE;

    IF(NOT (ACTUAL_FILE_NAME IS NULL)) THEN
      BEGIN
        dbms_output.put_line('Loading file ' || actual_file_name || '...');
        Src_loc := BFILENAME('WORK_DIR', ACTUAL_FILE_NAME);
        DBMS_LOB.OPEN(Src_loc, DBMS_LOB.LOB_READONLY);

        END;

      UPDATE
        MDSYS.SDO_COORD_OP_PARAM_VALS
      SET
        PARAM_VALUE_FILE = EMPTY_CLOB()
      WHERE
        COORD_OP_ID = PARAM_FILE.COORD_OP_ID AND
        PARAMETER_ID = PARAM_FILE.PARAMETER_ID
      RETURNING
        PARAM_VALUE_FILE INTO Dest_loc;

      DBMS_LOB.OPEN(Dest_loc, DBMS_LOB.LOB_READWRITE);
```



```

        DBMS_LOB.LOADFROMFILE(Dest_loc, Src_loc, DBMS_LOB.LOBMAXSIZE);
        DBMS_LOB.CLOSE(Dest_loc);
        DBMS_LOB.CLOSE(Src_loc);
        DBMS_LOB.FILECLOSE(Src_loc);
    END IF;
END LOOP;
END;
/

```

[Example 6-15](#) (page 6-70) is a script for loading a set of such matrixes. It loads specified physical files (such as `ntv20.gsa`) into database CLOBs, based on the official file name reference (such as `NTV2_0.GSB`).

## 6.9.7 Using British Grid Transformation OSTN02/OSGM02 (EPSG Method 9633)

To use British Grid Transformation OSTN02/OSGM02 (EPSG method 9633) in a projected coordinate reference system, you must first insert a modified version of the `OSTN02_OSGM02_GB.txt` grid file into the `PARAM_VALUE_FILE` column (type CLOB) of the `SDO_COORD_OP_PARAM_VALS` table (described in [SDO\\_COORD\\_OP\\_PARAM\\_VALS Table](#) (page 6-23)). The `OSTN02_OSGM02_GB.txt` file contains the offset matrix on which EPSG transformation method 9633 is based.

Follow these steps:

1. Download the following file: <http://www.ordnancesurvey.co.uk/docs/gps/ostn02-osgm02-files.zip>
2. From this .zip file, extract the following file: `OSTN02_OSGM02_GB.txt`
3. Edit your copy of `OSTN02_OSGM02_GB.txt`, and insert the following lines before the first line of the current file:

```

SDO Header
x: 0.0 - 700000.0
y: 0.0 - 1250000.0
x-intervals: 1000.0
y-intervals: 1000.0
End of SDO Header

```

The is, after the editing operation, the contents of the file will look like this:

```

SDO Header
x: 0.0 - 700000.0
y: 0.0 - 1250000.0
x-intervals: 1000.0
y-intervals: 1000.0
End of SDO Header
1,0,0,0.000,0.000,0.000,0
2,1000,0,0.000,0.000,0.000,0
3,2000,0,0.000,0.000,0.000,0
4,3000,0,0.000,0.000,0.000,0
5,4000,0,0.000,0.000,0.000,0
.
.
.
876949,698000,1250000,0.000,0.000,0.000,0
876950,699000,1250000,0.000,0.000,0.000,0
876951,700000,1250000,0.000,0.000,0.000,0

```

4. Save the edited file, perhaps using a different name (for example, `my_OSTN02_OSGM02_GB.txt`).

5. In the SDO\_COORD\_OP\_PARAM\_VALS table, for each operation of EPSG method 9633 that has PARAM\_VALUE\_FILE\_REF value OSTN02\_OSGM02\_GB.TXT, update the PARAM\_VALUE\_FILE column to be the contents of the saved file (for example, the contents of my\_OSTN02\_OSGM02\_GB.txt). You can use coding similar to that in [Example 6-16](#) (page 6-72).

**Example 6-16 Using British Grid Transformation OSTN02/OSGM02 (EPSG Method 9633)**

```

DECLARE
  ORCL_HOME_DIR VARCHAR2(128);
  ORCL_WORK_DIR VARCHAR2(128);
  Src_loc        BFILE;
  Dest_loc        CLOB;
  CURSOR PARAM_FILES IS
    SELECT
      COORD_OP_ID,
      PARAMETER_ID,
      PARAM_VALUE_FILE_REF
    FROM
      MDSYS.SDO_COORD_OP_PARAM_VALS
    WHERE
      PARAMETER_ID IN (8656, 8657, 8658, 8664, 8666)
    order by
      COORD_OP_ID,
      PARAMETER_ID;
  PARAM_FILE PARAM_FILES%ROWTYPE;
  ACTUAL_FILE_NAME VARCHAR2(128);
  platform NUMBER;
BEGIN
  EXECUTE IMMEDIATE 'CREATE OR REPLACE DIRECTORY work_dir AS ''' || system.geor_dir
  || '''';

  FOR PARAM_FILE IN PARAM_FILES LOOP
    CASE UPPER(PARAM_FILE.PARAM_VALUE_FILE_REF)
      /* NTV2 */
      WHEN 'NTV2_0.GSB' THEN ACTUAL_FILE_NAME := 'ntv20.gsa';
      /* GEOID03 */
      WHEN 'G2003H01.ASC' THEN ACTUAL_FILE_NAME := 'g2003h01.asc';
      /* British Ordnance Survey (9633) */
      WHEN 'OSTN02_OSGM02_GB.TXT'
        THEN ACTUAL_FILE_NAME := 'my_OSTN02_OSGM02_GB.txt';
      ELSE
        ACTUAL_FILE_NAME := NULL;
    END CASE;

    IF(NOT (ACTUAL_FILE_NAME IS NULL)) THEN
      BEGIN
        dbms_output.put_line('Loading file ' || actual_file_name || '...');
        Src_loc := BFILENAME('WORK_DIR', ACTUAL_FILE_NAME);
        DBMS_LOB.OPEN(Src_loc, DBMS_LOB.LOB_READONLY);
      END;

      UPDATE
        MDSYS.SDO_COORD_OP_PARAM_VALS
      SET
        PARAM_VALUE_FILE = EMPTY_CLOB()
      WHERE
        COORD_OP_ID = PARAM_FILE.COORD_OP_ID AND
        PARAMETER_ID = PARAM_FILE.PARAMETER_ID
      RETURNING
        PARAM_VALUE_FILE INTO Dest_loc;
    
```

```

        DBMS_LOB.OPEN(Dest_loc, DBMS_LOB.LOB_READWRITE);
        DBMS_LOB.LOADFROMFILE(Dest_loc, Src_loc, DBMS_LOB.LOBMAXSIZE);
        DBMS_LOB.CLOSE(Dest_loc);
        DBMS_LOB.CLOSE(Src_loc);
        DBMS_LOB.FILECLOSE(Src_loc);
    END IF;
END LOOP;
END;
/

```

Note that adding "header" information to a grid file is required only for British Grid Transformation OSTN02/OSGM02. It is not required for NADCON, NTv2, or VERTCON matrixes, because they already have headers of varying formats.

See also the following for related information:

- [Creating a Projected CRS](#) (page 6-57)
- [Creating a Transformation Operation](#) (page 6-68)

## 6.10 Notes and Restrictions with Coordinate Systems Support

The following notes and restrictions apply to coordinate systems support in the current release of Oracle Spatial and Graph.

If you have geodetic data, see [Geodetic Coordinate Support](#) (page 6-2) for additional considerations, guidelines, and restrictions.

### 6.10.1 Different Coordinate Systems for Geometries with Operators and Functions

For spatial operators (described in [Spatial Operators](#) (page 18-1)) that take two geometries as input parameters, if the geometries are based on different coordinate systems, the query window (the second geometry) is transformed to the coordinate system of the first geometry before the operation is performed. This transformation is a temporary internal operation performed by Spatial and Graph; it does not affect any stored query-window geometry.

For SDO\_GEOM package geometry functions (described in [SDO\\_GEOM Package \(Geometry\)](#) (page 23-1)) that take two geometries as input parameters, both geometries must be based on the same coordinate system.

### 6.10.2 3D LRS Functions Not Supported with Geodetic Data

In the current release, the 3D formats of LRS functions (explained in [3D Formats of LRS Functions](#) (page 7-7)) are not supported with geodetic data.

### 6.10.3 Functions Supported by Approximations with Geodetic Data

In the current release, the following functions are supported by approximations with geodetic data:

- [SDO\\_GEOM.SDO\\_BUFFER](#) (page 23-11)
- [SDO\\_GEOM.SDO\\_CENTROID](#) (page 23-13)
- [SDO\\_GEOM.SDO\\_CONVEXHULL](#) (page 23-19)

When these functions are used on data with geodetic coordinates, they internally perform the operations in an implicitly generated local-tangent-plane Cartesian

coordinate system and then transform the results to the geodetic coordinate system. For [SDO\\_GEOM.SDO\\_BUFFER](#) (page 23-11), generated arcs are approximated by line segments before the back-transform.

## 6.10.4 Unknown CRS and NaC Coordinate Reference Systems

The following coordinate reference systems are provided for Oracle internal use and for other possible special uses:

- `unknown CRS` (SRID 999999) means that the coordinate system is unknown, and its space could be geodetic or Cartesian. Contrast this with specifying a null coordinate reference system, which indicates an unknown coordinate system with a Cartesian space.
- `NaC` (SRID 999998) means *Not-a-CRS*. Its name is patterned after the `NaN` (*Not-a-Number*) value in Java. It is intended for potential use with nonspatial geometries.

The following restrictions apply to geometries based on the `unknown CRS` and `NaC` coordinate reference systems:

- You cannot perform coordinate system transformations on these geometries.
- Operations that require a coordinate system will return a null value when performed on these geometries. These operations include finding the area or perimeter of a geometry, creating a buffer, densifying an arc, and computing the aggregate centroid.

## 6.11 U.S. National Grid Support

The U.S. National Grid is a point coordinate representation using a single alphanumeric coordinate (for example, 18SUJ2348316806479498). This approach contrasts with the use of numeric coordinates to represent the location of a point, as is done with Oracle Spatial and Graph and with EPSG. A good description of the U.S. National Grid is available at <http://www.ngs.noaa.gov/TOOLS/usng.html>.

To support the U.S. National Grid in Spatial and Graph, the `SDO_GEOMETRY` type cannot be used because it is based on numeric coordinates. Instead, a point in U.S. National Grid format is represented as a single string of type `VARCHAR2`. To allow conversion between the `SDO_GEOMETRY` format and the U.S. National grid format, the `SDO_CS` package (documented in [SDO\\_CS Package \(Coordinate System Transformation\)](#) (page 20-1)) contains the following functions:

- [SDO\\_CS.FROM\\_USNG](#) (page 20-25)
- [SDO\\_CS.TO\\_USNG](#) (page 20-32)

## 6.12 Google Maps Considerations

Google Maps uses spherical math in its projections, as opposed to the ellipsoidal math used by Oracle Spatial and Graph. This difference can lead to inconsistencies in applications, such as when overlaying a map based on Google Maps with a map based on an Oracle Spatial and Graph ellipsoidal projection. For example, an Oracle Spatial and Graph transformation from the ellipsoidal SRID 8307 to the spherical SRID 3785 accounts, by default, for the different ellipsoidal shapes, whereas Google Maps does not consider ellipsoidal shapes.

If you want Oracle Spatial and Graph to accommodate the Google Maps results, consider the following options:

- Use the spherical SRID 4055 instead of the ellipsoidal SRID 8307. This may be the simplest approach; however, if you need to accommodate SRID 8307-based data (such as from a third-party tool) as if it were spherical, you must use another option.
- Use SRID 3857 instead of SRID 3785. This more convenient than the next two options, because using SRID 3857 does not require that you declare an EPSG rule or that you specify the `USE_SPHERICAL` use case name in order to produce Google-compatible results.
- Declare an EPSG rule between the ellipsoidal and spherical coordinate systems. For example, declare an EPSG rule between SRIDs 8307 and 3785, ignoring the ellipsoidal shape of SRID 8307, as in the following example:

```
CALL sdo_cs.create_pref_concatenated_op(
  302,
  'CONCATENATED OPERATION',
  TFM_PLAN(SDO_TFM_CHAIN(8307, 1000000000, 4055, 19847, 3785)),
  NULL);
```

In this example, operation 1000000000 represents *no-operation*, causing the datum transformation between ellipsoid and sphere to be ignored.

With this approach, you must declare a rule for each desired SRID pair (ellipsoidal and spherical).

- Specify a use case name of `USE_SPHERICAL` with the [SDO\\_CS.TRANSFORM](#) (page 20-33) function or the [SDO\\_CS.TRANSFORM\\_LAYER](#) (page 20-35) procedure, as in the following examples:

```
SELECT
  SDO_CS.TRANSFORM(
    sdo_geometry(
      2001,
      4326,
      sdo_point_type(1, 1, null),
      null,
      null),
    'USE_SPHERICAL',
    3785)
FROM DUAL;
```

```
CALL SDO_CS.TRANSFORM_LAYER(
  'source_geoms',
  'GEOMETRY',
  'GEO_CS_3785_SPHERICAL',
  'USE_SPHERICAL',
  3785);
```

If you specify a `use_case` parameter value of `USE_SPHERICAL` in such cases, the transformation defaults to using spherical math instead of ellipsoidal math, thereby accommodating Google Maps and some other third-party tools that use spherical math.

If you use this approach (specifying `'USE_SPHERICAL'`) but you have also declared an EPSG rule requiring that ellipsoidal math be used in transformations between two specified SRIDs, then the declared EPSG rule takes precedence and ellipsoidal math is used for transformations between those two SRIDs.

## 6.13 Example of Coordinate System Transformation

This section presents a simplified example that uses coordinate system transformation functions and procedures. It refers to concepts that are explained in this chapter and uses functions documented in [SDO\\_CS Package \(Coordinate System Transformation\)](#) (page 20-1).

### **Example 6-17 Simplified Example of Coordinate System Transformation**

[Example 6-17](#) (page 6-76) uses mostly the same geometry data (cola markets) as in [Simple Example: Inserting, Indexing, and Querying Spatial Data](#) (page 2-1), except that instead of null SDO\_SRID values, the SDO\_SRID value 8307 is used. That is, the geometries are defined as using the coordinate system whose SRID is 8307 and whose well-known name is "Longitude / Latitude (WGS 84)". This is probably the most widely used coordinate system, and it is the one used for global positioning system (GPS) devices. The geometries are then transformed using the coordinate system whose SRID is 8199 and whose well-known name is "Longitude / Latitude (Arc 1950)".

[Example 6-17](#) (page 6-76) uses the geometries illustrated in [Simple Example: Inserting, Indexing, and Querying Spatial Data](#) (page 2-1), except that cola\_d is a rectangle (here, a square) instead of a circle, because arcs are not supported with geodetic coordinate systems.

[Example 6-17](#) (page 6-76) does the following:

- Creates a table (COLA\_MARKETS\_CS) to hold the spatial data
- Inserts rows for four areas of interest (cola\_a, cola\_b, cola\_c, cola\_d), using the SDO\_SRID value 8307
- Updates the USER\_SDO\_GEOM\_METADATA view to reflect the dimension of the areas, using the SDO\_SRID value 8307
- Creates a spatial index (COLA\_SPATIAL\_IDX\_CS)
- Performs some transformation operations (single geometry and entire layer)

```
-- Create a table for cola (soft drink) markets in a
-- given geography (such as city or state).
```

```
CREATE TABLE cola_markets_cs (
  mkt_id NUMBER PRIMARY KEY,
  name VARCHAR2(32),
  shape SDO_GEOMETRY);
```

```
-- The next INSERT statement creates an area of interest for
-- Cola A. This area happens to be a rectangle.
-- The area could represent any user-defined criterion: for
-- example, where Cola A is the preferred drink, where
-- Cola A is under competitive pressure, where Cola A
-- has strong growth potential, and so on.
```

```
INSERT INTO cola_markets_cs VALUES(
  1,
  'cola_a',
  SDO_GEOMETRY(
    2003, -- two-dimensional polygon
    8307, -- SRID for 'Longitude / Latitude (WGS 84)' coordinate system
    NULL,
```

```

        SDO_ELEM_INFO_ARRAY(1,1003,1), -- polygon
        SDO_ORDINATE_ARRAY(1,1, 5,1, 5,7, 1,7, 1,1) -- All vertices must
            -- be defined for rectangle with geodetic data.
    )
);

-- The next two INSERT statements create areas of interest for
-- Cola B and Cola C. These areas are simple polygons (but not
-- rectangles).

INSERT INTO cola_markets_cs VALUES(
    2,
    'cola_b',
    SDO_GEOMETRY(
        2003, -- two-dimensional polygon
        8307,
        NULL,
        SDO_ELEM_INFO_ARRAY(1,1003,1), -- one polygon (exterior polygon ring)
        SDO_ORDINATE_ARRAY(5,1, 8,1, 8,6, 5,7, 5,1)
    )
);

INSERT INTO cola_markets_cs VALUES(
    3,
    'cola_c',
    SDO_GEOMETRY(
        2003, -- two-dimensional polygon
        8307,
        NULL,
        SDO_ELEM_INFO_ARRAY(1,1003,1), --one polygon (exterior polygon ring)
        SDO_ORDINATE_ARRAY(3,3, 6,3, 6,5, 4,5, 3,3)
    )
);

-- Insert a rectangle (here, square) instead of a circle as in the original,
-- because arcs are not supported with geodetic coordinate systems.
INSERT INTO cola_markets_cs VALUES(
    4,
    'cola_d',
    SDO_GEOMETRY(
        2003, -- two-dimensional polygon
        8307, -- SRID for 'Longitude / Latitude (WGS 84)' coordinate system
        NULL,
        SDO_ELEM_INFO_ARRAY(1,1003,1), -- polygon
        SDO_ORDINATE_ARRAY(10,9, 11,9, 11,10, 10,10, 10,9) -- All vertices must
            -- be defined for rectangle with geodetic data.
    )
);

-----
-- UPDATE METADATA VIEW --
-----

-- Update the USER_SDO_GEOM_METADATA view. This is required
-- before the spatial index can be created. Do this only once for each
-- layer (table-column combination; here: cola_markets_cs and shape).

INSERT INTO user_sdo_geom_metadata
    (TABLE_NAME,
     COLUMN_NAME,
     DIMINFO,
     SRID)

```

```
VALUES (
  'cola_markets_cs',
  'shape',
  SDO_DIM_ARRAY(
    SDO_DIM_ELEMENT('Longitude', -180, 180, 10), -- 10 meters tolerance
    SDO_DIM_ELEMENT('Latitude', -90, 90, 10) -- 10 meters tolerance
  ),
  8307 -- SRID for 'Longitude / Latitude (WGS 84)' coordinate system
);

-----
-- CREATE THE SPATIAL INDEX --
-----

CREATE INDEX cola_spatial_idx_cs
ON cola_markets_cs(shape)
INDEXTYPE IS MDSYS.SPATIAL_INDEX;

-----

-- TEST COORDINATE SYSTEM TRANSFORMATION --
-----

-- Return the transformation of cola_c using to_srid 8199
-- ('Longitude / Latitude (Arc 1950)')
SELECT c.name, SDO_CS.TRANSFORM(c.shape, 8199)
  FROM cola_markets_cs c WHERE c.name = 'cola_c';

-- Same as preceding, but using to_sname parameter.
SELECT c.name, SDO_CS.TRANSFORM(c.shape, 'Longitude / Latitude (Arc 1950)')
  FROM cola_markets_cs c WHERE c.name = 'cola_c';

-- Transform the entire SHAPE layer and put results in the table
-- named cola_markets_cs_8199, which the procedure will create.
CALL SDO_CS.TRANSFORM_LAYER('COLA_MARKETS_CS','SHAPE','COLA_MARKETS_CS_8199',8199);

-- Select all from the old (existing) table.
SELECT * from cola_markets_cs;

-- Select all from the new (layer transformed) table.
SELECT * from cola_markets_cs_8199;

-- Show metadata for the new (layer transformed) table.
DESCRIBE cola_markets_cs_8199;

-- Use a geodetic MBR with SDO_FILTER.
SELECT c.name FROM cola_markets_cs c WHERE
  SDO_FILTER(c.shape,
    SDO_GEOMETRY(
      2003,
      8307, -- SRID for WGS 84 longitude/latitude
      NULL,
      SDO_ELEM_INFO_ARRAY(1,1003,3),
      SDO_ORDINATE_ARRAY(6,5, 10,10))
    ) = 'TRUE';
```

[Example 6-18](#) (page 6-79) shows the output of the SELECT statements in [Example 6-17](#) (page 6-76). Notice the slight differences between the coordinates in the original geometries (SRID 8307) and the transformed coordinates (SRID 8199) -- for example, (1, 1, 5, 1, 5, 7, 1, 7, 1, 1) and (1.00078604, 1.00274579, 5.00069354, 1.00274488, 5.0006986, 7.00323528, 1.00079179, 7.00324162, 1.00078604, 1.00274579) for cola\_a.



**Example 6-18 Output of SELECT Statements in Coordinate System Transformation Example**

```

SQL> -- Return the transformation of cola_c using to_srid 8199
SQL> -- ('Longitude / Latitude (Arc 1950)')
SQL> SELECT c.name, SDO_CS.TRANSFORM(c.shape, 8199)
      2   FROM cola_markets_cs c WHERE c.name = 'cola_c';

NAME
-----
SDO_CS.TRANSFORM(C.SHAPE,8199)(SDO_GTYPE, SDO_SRID, SDO_POINT(X, Y, Z), SDO_ELEM
-----
cola_c
SDO_GEOMETRY(2003, 8199, NULL, SDO_ELEM_INFO_ARRAY(1, 1003, 1), SDO_ORDINATE_ARR
AY(3.00074114, 3.00291482, 6.00067068, 3.00291287, 6.0006723, 5.00307625, 4.0007
1961, 5.00307838, 3.00074114, 3.00291482))

SQL>
SQL> -- Same as preceding, but using to_sname parameter.
SQL> SELECT c.name, SDO_CS.TRANSFORM(c.shape, 'Longitude / Latitude (Arc 1950)')
      2   FROM cola_markets_cs c WHERE c.name = 'cola_c';

NAME
-----
SDO_CS.TRANSFORM(C.SHAPE,'LONGITUDE/LATITUDE(ARC1950)')(SDO_GTYPE, SDO_SRID, SDO
-----
cola_c
SDO_GEOMETRY(2003, 8199, NULL, SDO_ELEM_INFO_ARRAY(1, 1003, 1), SDO_ORDINATE_ARR
AY(3.00074114, 3.00291482, 6.00067068, 3.00291287, 6.0006723, 5.00307625, 4.0007
1961, 5.00307838, 3.00074114, 3.00291482))

SQL>
SQL> -- Transform the entire SHAPE layer and put results in the table
SQL> -- named cola_markets_cs_8199, which the procedure will create.
SQL> CALL SDO_CS.TRANSFORM_LAYER('COLA_MARKETS_CS','SHAPE','COLA_MARKETS_CS_8199',
8199);

Call completed.

SQL>
SQL> -- Select all from the old (existing) table.
SQL> SELECT * from cola_markets_cs;

MKT_ID NAME
-----
SHAPE(SDO_GTYPE, SDO_SRID, SDO_POINT(X, Y, Z), SDO_ELEM_INFO, SDO_ORDINATES)
-----
      1 cola_a
SDO_GEOMETRY(2003, 8307, NULL, SDO_ELEM_INFO_ARRAY(1, 1003, 1), SDO_ORDINATE_ARR
AY(1, 1, 5, 1, 5, 7, 1, 7, 1, 1))

      2 cola_b
SDO_GEOMETRY(2003, 8307, NULL, SDO_ELEM_INFO_ARRAY(1, 1003, 1), SDO_ORDINATE_ARR
AY(5, 1, 8, 1, 8, 6, 5, 7, 5, 1))

      3 cola_c

MKT_ID NAME
-----
SHAPE(SDO_GTYPE, SDO_SRID, SDO_POINT(X, Y, Z), SDO_ELEM_INFO, SDO_ORDINATES)
-----

```

```
SDO_GEOMETRY(2003, 8307, NULL, SDO_ELEM_INFO_ARRAY(1, 1003, 1), SDO_ORDINATE_ARRAY(3, 3, 6, 3, 6, 5, 4, 5, 3, 3))
```

```
4 cola_d
SDO_GEOMETRY(2003, 8307, NULL, SDO_ELEM_INFO_ARRAY(1, 1003, 1), SDO_ORDINATE_ARRAY(10, 9, 11, 9, 11, 10, 10, 10, 10, 9))
```

```
SQL>
SQL> -- Select all from the new (layer transformed) table.
SQL> SELECT * from cola_markets_cs_8199;
```

```
SDO_ROWID
-----
GEOMETRY(SDO_GTYPE, SDO_SRID, SDO_POINT(X, Y, Z), SDO_ELEM_INFO, SDO_ORDINATES)
-----
AABZzAABAAOa6AAA
SDO_GEOMETRY(2003, 8199, NULL, SDO_ELEM_INFO_ARRAY(1, 1003, 1), SDO_ORDINATE_ARRAY(1.00078604, 1.00274579, 5.00069354, 1.00274488, 5.0006986, 7.00323528, 1.00079179, 7.00324162, 1.00078604, 1.00274579))
```

```
AABZzAABAAOa6AAB
SDO_GEOMETRY(2003, 8199, NULL, SDO_ELEM_INFO_ARRAY(1, 1003, 1), SDO_ORDINATE_ARRAY(5.00069354, 1.00274488, 8.00062191, 1.00274427, 8.00062522, 6.00315345, 5.0006986, 7.00323528, 5.00069354, 1.00274488))
```

```
SDO_ROWID
-----
GEOMETRY(SDO_GTYPE, SDO_SRID, SDO_POINT(X, Y, Z), SDO_ELEM_INFO, SDO_ORDINATES)
-----
AABZzAABAAOa6AAC
SDO_GEOMETRY(2003, 8199, NULL, SDO_ELEM_INFO_ARRAY(1, 1003, 1), SDO_ORDINATE_ARRAY(3.00074114, 3.00291482, 6.00067068, 3.00291287, 6.0006723, 5.00307625, 4.00071961, 5.00307838, 3.00074114, 3.00291482))
```

```
AABZzAABAAOa6AAD
SDO_GEOMETRY(2003, 8199, NULL, SDO_ELEM_INFO_ARRAY(1, 1003, 1), SDO_ORDINATE_ARRAY(10.0005802, 9.00337775, 11.0005553, 9.00337621, 11.0005569, 10.0034478, 10.0005802, 9.00337775, 11.0005553, 9.00337621))
```

```
SDO_ROWID
-----
GEOMETRY(SDO_GTYPE, SDO_SRID, SDO_POINT(X, Y, Z), SDO_ELEM_INFO, SDO_ORDINATES)
-----
05819, 10.0034495, 10.0005802, 9.00337775))
```

```
SQL>
SQL> -- Show metadata for the new (layer transformed) table.
SQL> DESCRIBE cola_markets_cs_8199;
```

Name	Null?	Type
SDO_ROWID		ROWID
GEOMETRY		SDO_GEOMETRY

```
SQL>
SQL> -- Use a geodetic MBR with SDO_FILTER
SQL> SELECT c.name FROM cola_markets_cs c WHERE
2     SDO_FILTER(c.shape,
3         SDO_GEOMETRY(
4             2003,
```

```
5          8307,    -- SRID for WGS 84 longitude/latitude
6          NULL,
7          SDO_ELEM_INFO_ARRAY(1,1003,3),
8          SDO_ORDINATE_ARRAY(6,5, 10,10))
9      ) = 'TRUE';
```

NAME

-----

cola\_c

cola\_b

cola\_d



---

# Linear Referencing System

Linear referencing is a natural and convenient means to associate attributes or events to locations or portions of a linear feature. It has been widely used in transportation applications (such as for highways, railroads, and transit routes) and utilities applications (such as for gas and oil pipelines). The major advantage of linear referencing is its capability of locating attributes and events along a linear feature with only one parameter (usually known as *measure*) instead of two (such as *longitude/latitude* or *x/y* in Cartesian space). Sections of a linear feature can be referenced and created dynamically by indicating the start and end locations along the feature without explicitly storing them.

The linear referencing system (LRS) application programming interface (API) in Oracle Spatial and Graph provides server-side LRS capabilities at the cartographic level. The linear measure information is directly integrated into the Oracle Spatial and Graph geometry structure. The Oracle Spatial and Graph LRS API provides support for dynamic segmentation, and it serves as a groundwork for third-party or middle-tier application development for virtually any linear referencing methods and models in any coordinate system.

For an example of LRS, see [Example of LRS Functions](#) (page 7-15). However, you may want to read the rest of this chapter first, to understand the concepts that the example illustrates.

For reference information about LRS functions and procedures, see [SDO\\_LRS Package \(Linear Referencing System\)](#) (page 24-1).

This chapter contains the following major sections:

- [Terms and Concepts](#) (page 7-1)
- [LRS Data Model](#) (page 7-6)
- [Indexing of LRS Data](#) (page 7-7)
- [3D Formats of LRS Functions](#) (page 7-7)
- [LRS Operations](#) (page 7-8)
- [Tolerance Values with LRS Functions](#) (page 7-15)
- [Example of LRS Functions](#) (page 7-15)

## 7.1 Terms and Concepts

This section explains important terms and concepts related to linear referencing support in Oracle Spatial and Graph.

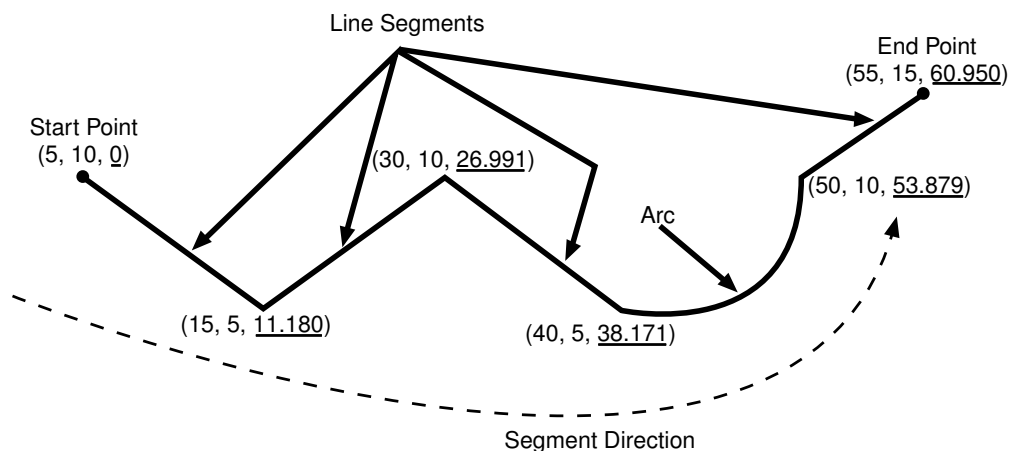
## 7.1.1 Geometric Segments (LRS Segments)

**Geometric segments** are basic LRS elements in Oracle Spatial and Graph. A geometric segment can be any of the following:

- Line string: an ordered, nonbranching, and continuous geometry (for example, a simple road)
- Multiline string: nonconnected line strings (for example, a highway with a gap caused by a lake or a bypass road)
- Polygon (for example, a racetrack or a scenic tour route that starts and ends at the same point)

A geometric segment must contain at least start and end measures for its start and end points. Measures of points of interest (such as highway exits) on the geometric segments can also be assigned. These measures are either assigned by users or derived from existing geometric segments. [Figure 7-1](#) (page 7-2) shows a geometric segment with four line segments and one arc. Points on the geometric segment are represented by triplets (x, y, m), where x and y describe the location and m denotes the measure (with each measure value underlined in [Figure 7-1](#) (page 7-2)).

**Figure 7-1 Geometric Segment**



## 7.1.2 Shape Points

**Shape points** are points that are specified when an LRS segment is constructed, and that are assigned measure information. In Oracle Spatial and Graph, a line segment is represented by its start and end points, and an arc is represented by three points: start, middle, and end points of the arc. You must specify these points as shape points, but you can also specify other points as shape points if you need measure information stored for these points (for example, an exit in the middle of a straight part of the highway).

Thus, shape points can serve one or both of the following purposes: to indicate the direction of the segment (for example, a turn or curve), and to identify a point of interest for which measure information is to be stored.

Shape points might not directly relate to mileposts or reference posts in LRS; they are used as internal reference points. The measure information of shape points is automatically populated when you define the LRS segment using the

[SDO\\_LRS.DEFINE\\_GEOM\\_SEGMENT](#) (page 24-18) procedure, which is described in [SDO\\_LRS Package \(Linear Referencing System\)](#) (page 24-1).

### 7.1.3 Direction of a Geometric Segment

The **direction** of a geometric segment is indicated from the start point of the geometric segment to the end point. The direction is determined by the order of the vertices (from start point to end point) in the geometry definition. Measures of points on a geometric segment always either increase or decrease along the direction of the geometric segment.

### 7.1.4 Measure (Linear Measure)

The **measure** of a point along a geometric segment is the linear distance (in the measure dimension) to the point measured from the start point (for increasing values) or end point (for decreasing values) of the geometric segment. The measure information does not necessarily have to be of the same scale as the distance. However, the linear mapping relationship between measure and distance is always preserved.

Some LRS functions use *offset* instead of measure to represent measured distance along linear features. Although some other linear referencing systems might use offset to mean what the Oracle Spatial and Graph LRS refers to as measure, offset has a different meaning in Oracle Spatial and Graph from measure, as explained in [Offset](#) (page 7-3).

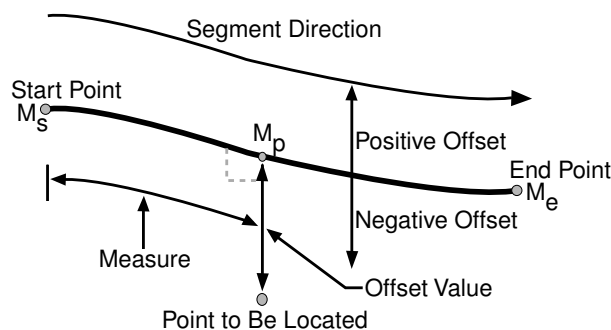
### 7.1.5 Offset

The **offset** of a point along a geometric segment is the perpendicular distance between the point and the geometric segment. Offsets are positive if the points are on the left side along the segment direction and are negative if they are on the right side. Points are on a geometric segment if their offsets to the segment are zero.

The unit of measurement for an offset is the same as for the coordinate system associated with the geometric segment. For geodetic data, the default unit of measurement is meters.

[Figure 7-2](#) (page 7-3) shows how a point can be located along a geometric segment with measure and offset information. By assigning an offset together with a measure, it is possible to locate not only points that are on the geometric segment, but also points that are perpendicular to the geometric segment.

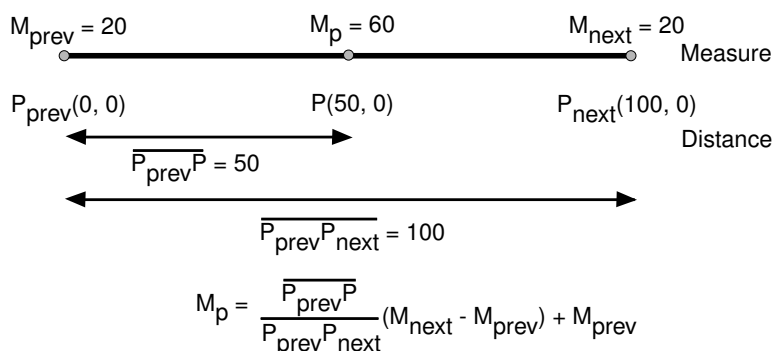
**Figure 7-2 Describing a Point Along a Segment with a Measure and an Offset**



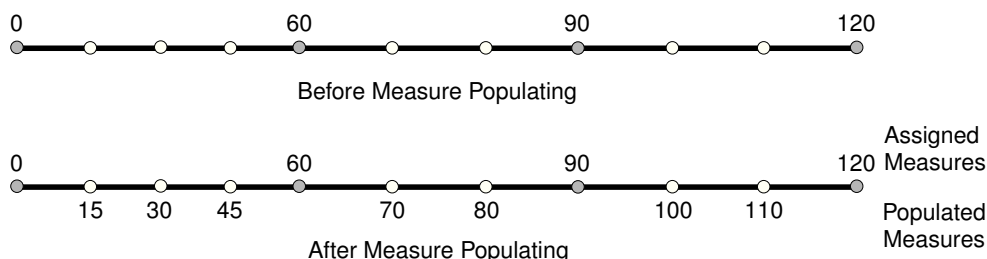
## 7.1.6 Measure Populating

Any unassigned measures of a geometric segment are automatically populated based upon their distance distribution. This is done before any LRS operations for geometric segments with unknown measures (NULL in Oracle Spatial and Graph). The resulting geometric segments from any LRS operations return the measure information associated with geometric segments. The measure of a point on the geometric segment can be obtained based upon a linear mapping relationship between its previous and next known measures or locations. See the algorithm representation in [Figure 7-3](#) (page 7-4) and the example in [Figure 7-4](#) (page 7-4).

**Figure 7-3 Measures, Distances, and Their Mapping Relationship**



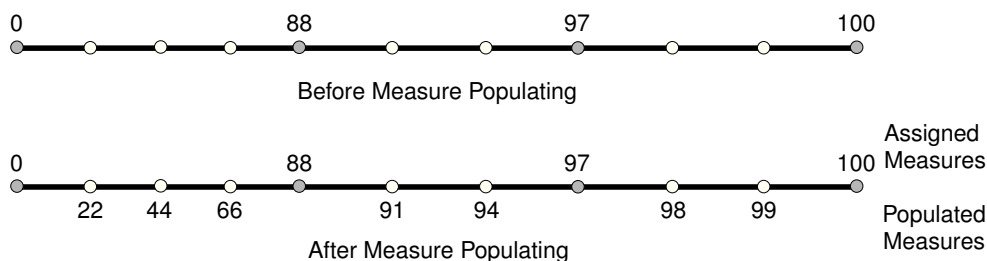
**Figure 7-4 Measure Populating of a Geometric Segment**



Measures are evenly spaced between assigned measures. However, the assigned measures for points of interest on a geometric segment do not need to be evenly spaced. This could eliminate the problem of error accumulation and account for inaccuracy of data source.

Moreover, the assigned measures do not even need to reflect actual distances (for example, they can reflect estimated driving time); they can be any valid values within the measure range. [Figure 7-5](#) (page 7-4) shows the measure population that results when assigned measure values are not proportional and reflect widely varying gaps.

**Figure 7-5 Measure Populating with Disproportional Assigned Measures**





In all cases, measure populating is done in an incremental fashion along the segment direction. This improves the performance of current and subsequent LRS operations.

### 7.1.7 Measure Range of a Geometric Segment

The start and end measures of a geometric segment define the linear **measure range** of the geometric segment. Any valid LRS measures of a geometric segment must fall within its linear measure range.

### 7.1.8 Projection

The **projection** of a point along a geometric segment is the point on the geometric segment with the minimum distance to the specified point. The measure information of the resulting point is also returned in the point geometry.

### 7.1.9 LRS Point

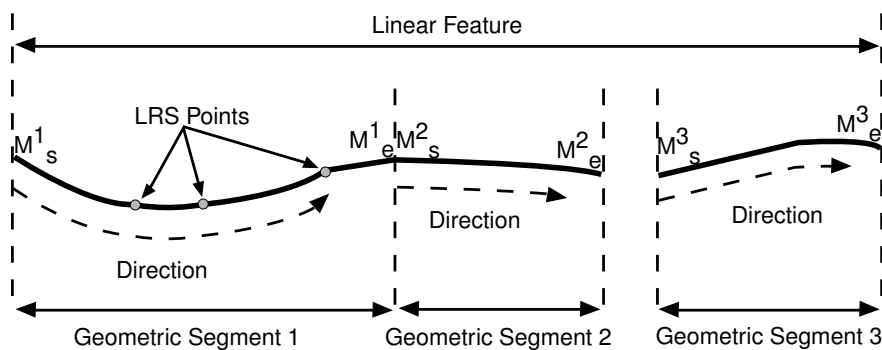
**LRS points** are points with linear measure information along a geometric segment. A valid LRS point is a point geometry with measure information.

All LRS point data must be stored in the SDO\_ELEM\_INFO\_ARRAY and SDO\_ORDINATE\_ARRAY, and cannot be stored in the SDO\_POINT field in the SDO\_GEOMETRY definition of the point.

### 7.1.10 Linear Features

**Linear features** are any spatial objects that can be treated as a logical set of linear segments. Examples of linear features are highways in transportation applications and pipelines in utility industry applications. The relationship of linear features, geometric segments, and LRS points is shown in [Figure 7-6](#) (page 7-5), where a single linear feature consists of three geometric segments, and three LRS points are shown on the first segment.

**Figure 7-6 Linear Feature, Geometric Segments, and LRS Points**



### 7.1.11 Measures with Multiline Strings and Polygons with Holes

With a multiline string or polygon with hole LRS geometry, the [SDO\\_LRS.DEFINE\\_GEOM\\_SEGMENT](#) (page 24-18) procedure and [SDO\\_LRS.CONVERT\\_TO\\_LRS\\_GEOM](#) (page 24-11) function by default assign the same measure value to the end point of one segment and the start point (separated by a gap) of the next segment, although you can later assign different measure values to points. Thus, by default there will duplicate measure values in different segments for such geometries. In such cases, LRS subprograms use the first point with a specified measure, except when doing so would result in an invalid geometry.

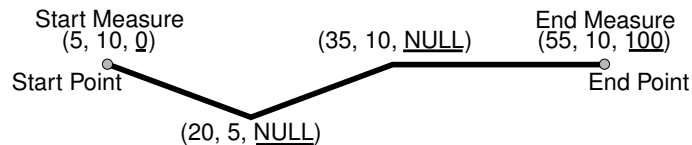
For example, assume that in a multiline string LRS geometry, the first segment is from measures 0 through 100 and the second segment is from measures 100 through 150. If you use the [SDO\\_LRS.LOCATE\\_PT](#) (page 24-40) function to find the point at measure 100, the returned point will be at measure 100 in the first segment. If you use the [SDO\\_LRS.CLIP\\_GEOM\\_SEGMENT](#) (page 24-5), [SDO\\_LRS.DYNAMIC\\_SEGMENT](#) (page 24-20), or [SDO\\_LRS.OFFSET\\_GEOM\\_SEGMENT](#) (page 24-45) function to return the geometry object between measures 75 and 125, the result is a multiline string geometry consisting of two segments. If you use the same function to return the geometry object between measures 100 and 125, the point at measure 100 in the first segment is ignored, and the result is a line string along the second segment from measures 100 through 125.

## 7.2 LRS Data Model

The Oracle Spatial and Graph LRS data model incorporates measure information into its geometry representation at the point level. The measure information is directly integrated into the Oracle Spatial and Graph model. To accomplish this, an additional *measure* dimension must be added to the Oracle Spatial and Graph metadata.

Oracle Spatial and Graph LRS support affects the spatial metadata and data (the geometries). [Example 7-1](#) (page 7-6) shows how a measure dimension can be added to two-dimensional geometries in the spatial metadata. The measure dimension must be the last element of the SDO\_DIM\_ARRAY in a spatial object definition (shown in bold in [Example 7-1](#) (page 7-6)).

**Figure 7-7 Creating a Geometric Segment**



In [Figure 7-7](#) (page 7-6), the geometric segment has the following definition (with measure values underlined):

```
SDO_GEOMETRY(3302, NULL, NULL,
             SDO_ELEM_INFO_ARRAY(1,2,1),
             SDO_ORDINATE_ARRAY(5,10,0, 20,5,NULL, 35,10,NULL, 55,10,100))
```

Whenever a geometric segment is defined, its start and end measures must be defined or derived from some existing geometric segment. The unsigned measures of all shape points on a geometric segment will be automatically populated.

The SDO\_GTYPE of any point geometry used with an LRS function must be 3301.

### **Example 7-1 Including LRS Measure Dimension in Spatial Metadata**

```
INSERT INTO user_sdo_geom_metadata
(TABLE_NAME,
 COLUMN_NAME,
 DIMINFO,
 SRID)
VALUES (
'LRS_ROUTES',
'GEOMETRY',
SDO_DIM_ARRAY (
SDO_DIM_ELEMENT('X', 0, 20, 0.005),
SDO_DIM_ELEMENT('Y', 0, 20, 0.005),
```

```
SDO_DIM_ELEMENT('M', 0, 100, 0.005)),
NULL);
```

After adding the new measure dimension, geometries with measure information such as geometric segments and LRS points can be represented. An example of creating a geometric segment with three line segments is shown in [Figure 7-7](#) (page 7-6).

## 7.3 Indexing of LRS Data

If LRS data has four dimensions (three plus the M dimension) and if you need to index all three non-measure dimensions, you must use a spatial R-tree index to index the data, and you must specify `PARAMETERS('sdo_indx_dims=3')` in the [CREATE INDEX](#) (page 17-7) statement to ensure that the first three dimensions are indexed. Note, however, that if you specify an `sdo_indx_dims` value of 3 or higher, only those operators listed in [Three-Dimensional Spatial Objects](#) (page 1-16) as considering all three dimensions can be used on the indexed geometries; the other operators described in [Spatial Operators](#) (page 18-1) cannot be used. (The default value for the `sdo_indx_dims` keyword is 2, which would cause only the first two dimensions to be indexed.) For example, if the dimensions are X, Y, Z, and M, specify `sdo_indx_dims=3` to index the X, Y, and Z dimensions, but not the measure (M) dimension. Do not include the measure dimension in a spatial index, because this causes additional processing overhead and produces no benefit.

Information about the [CREATE INDEX](#) (page 17-7) statement and its parameters and keywords is in [SQL Statements for Indexing Spatial Data](#) (page 17-1).

## 7.4 3D Formats of LRS Functions

Most LRS functions have formats that end in `_3D`: for example, `DEFINE_GEOM_SEGMENT_3D`, `CLIP_GEOM_SEGMENT_3D`, `FIND_MEASURE_3D`, and `LOCATE_PT_3D`. If a function has a `3D` format, it is identified in the Usage Notes for the function in [SDO\\_LRS Package \(Linear Referencing System\)](#) (page 24-1).

The `3D` formats are supported only for line string and multiline string geometries. The `3D` formats should be used only when the geometry object has four dimensions and the fourth dimension is the measure (for example, X, Y, Z, and M), and only when you want the function to consider the first three dimensions (for example, X, Y, and Z). If the standard format of a function (that is, without the `_3D`) is used on a geometry with four dimensions, the function considers only the first two dimensions (for example, X and Y).

For example, the following format considers the X, Y, and Z dimensions of the specified GEOM object in performing the clip operation:

```
SELECT SDO_LRS.CLIP_GEOM_SEGMENT_3D(a.geom, m.diminfo, 5, 10)
FROM routes r, user_sdo_geom_metadata m
WHERE m.table_name = 'ROUTES' AND m.column_name = 'GEOM'
AND r.route_id = 1;
```

However, the following format considers only the X and Y dimensions, and ignores the Z dimension, of the specified GEOM object in performing the clip operation:

```
SELECT SDO_LRS.CLIP_GEOM_SEGMENT(a.geom, m.diminfo, 5, 10)
FROM routes r, user_sdo_geom_metadata m
WHERE m.table_name = 'ROUTES' AND m.column_name = 'GEOM'
AND r.route_id = 1;
```

The parameters for the standard and 3D formats of any function are the same, and the Usage Notes apply to both formats.

The 3D formats are not supported with the following:

- Geodetic data
- Polygons, arcs, or circles

## 7.5 LRS Operations

This section describes several linear referencing operations supported by the Oracle Spatial and Graph LRS API.

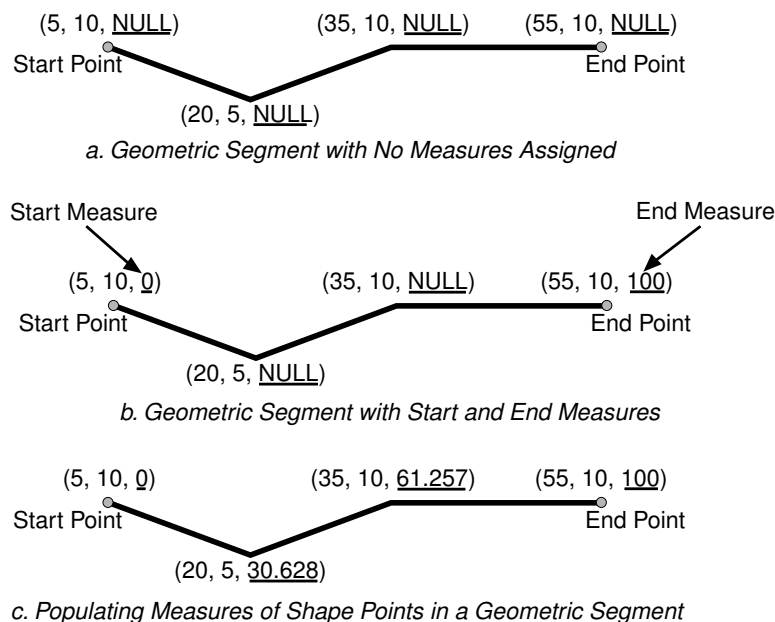
### 7.5.1 Defining a Geometric Segment

There are two ways to create a geometric segment with measure information:

- Construct a geometric segment and assign measures explicitly.
- Define a geometric segment with specified start and end, and any other measures, in an ascending or descending order. Measures of shape points with unknown (unassigned) measures (null values) in the geometric segment will be automatically populated according to their locations and distance distribution.

Figure 7-8 (page 7-8) shows different ways of defining a geometric segment:

**Figure 7-8 Defining a Geometric Segment**



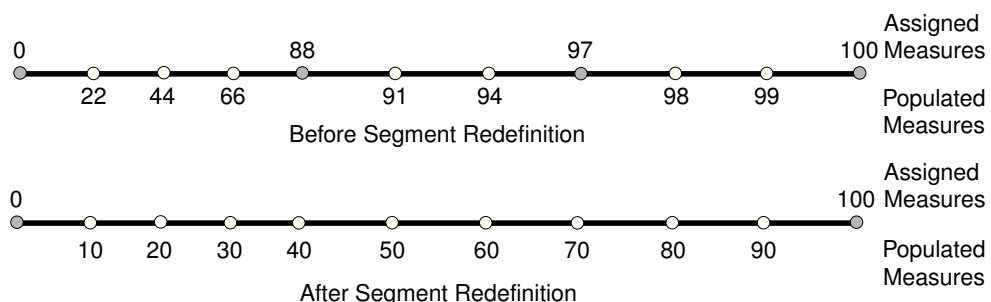
An LRS segment must be defined (or must already exist) before any LRS operations can proceed. That is, the start, end, and any other assigned measures must be present to derive the location from a specified measure. The measure information of intermediate shape points will automatically be populated if measure values are not assigned.

## 7.5.2 Redefining a Geometric Segment

You can redefine a geometric segment to replace the existing measures of all shape points between the start and end point with automatically calculated measures. Redefining a segment can be useful if errors have been made in one or more explicit measure assignments, and you want to start over with proportionally assigned measures.

Figure 7-9 (page 7-9) shows the redefinition of a segment where the existing (before) assigned measure values are not proportional and reflect widely varying gaps.

**Figure 7-9 Redefining a Geometric Segment**

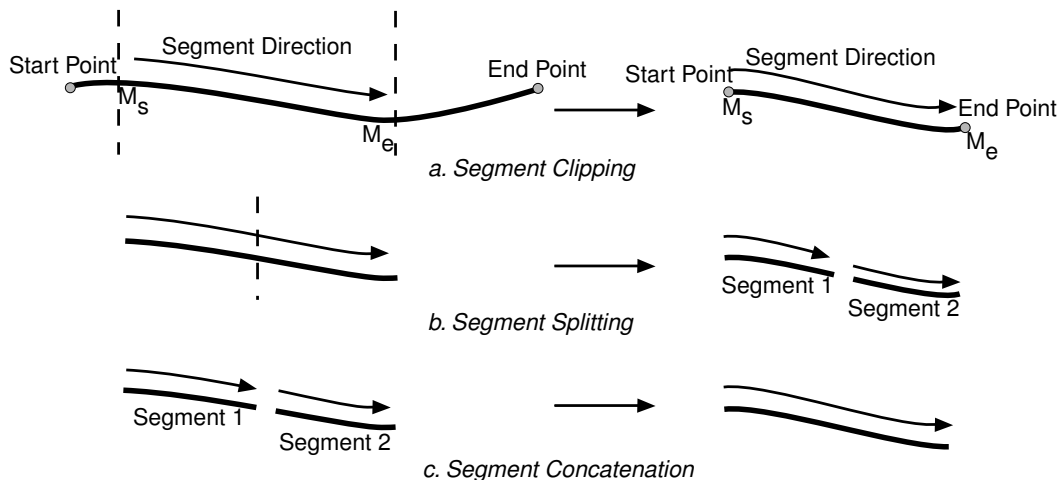


After the segment redefinition in Figure 7-9 (page 7-9), the populated measures reflect proportional distances along the segment.

## 7.5.3 Clipping a Geometric Segment

You can clip a geometric segment to create a new geometric segment out of an existing geometric segment, as shown in Figure 7-10 (page 7-9), part a.

**Figure 7-10 Clipping, Splitting, and Concatenating Geometric Segments**



In Figure 7-10 (page 7-9), part a, a segment is created from part of a larger segment. The new segment has its own start and end points, and the direction is the same as in the original larger segment.

## 7.5.4 Splitting a Geometric Segment

You can create two new geometric segments by splitting a geometric segment, as shown in [Figure 7-10](#) (page 7-9), part b. The direction of each new segment is the same as in the original segment.

---

### Note:

In [Figure 7-10](#) (page 7-9) and several figures that follow, small gaps between segments are used in illustrations of segment splitting and concatenation. Each gap simply reinforces the fact that two different segments are involved. However, the two segments (such as segment 1 and segment 2 in [Figure 7-10](#) (page 7-9), parts b and c) are actually connected. The tolerance (see [Tolerance](#) (page 1-6)) is considered in determining whether or not segments are connected.

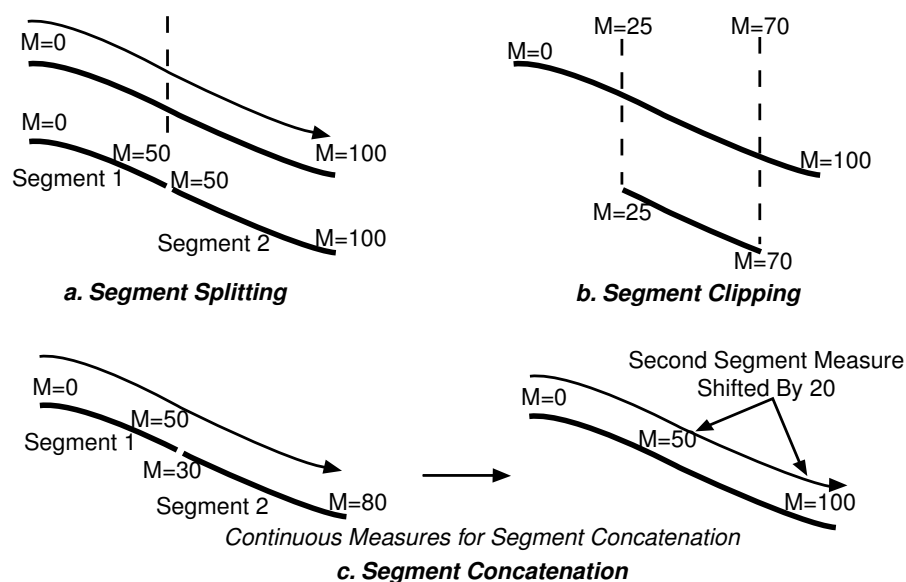
---

## 7.5.5 Concatenating Geometric Segments

You can create a new geometric segment by concatenating two geometric segments, as shown in [Figure 7-10](#) (page 7-9), part c. The geometric segments do not need to be spatially connected, although they are connected in the illustration in [Figure 7-10](#) (page 7-9), part c. (If the segments are not spatially connected, the concatenated result is a multiline string.) The measures of the second geometric segment are shifted so that the end measure of the first segment is the same as the start measure of the second segment. The direction of the segment resulting from the concatenation is the same as in the two original segments.

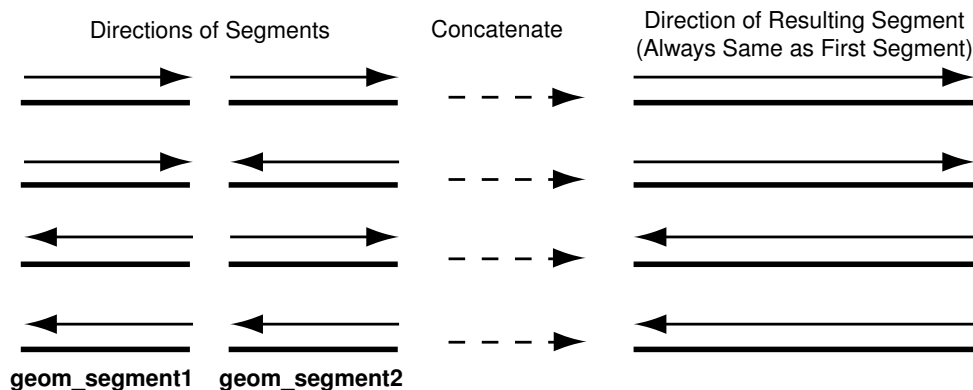
Measure assignments for the clipping, splitting, and concatenating operations in [Figure 7-10](#) (page 7-9) are shown in [Figure 7-11](#) (page 7-10). Measure information and segment direction are preserved in a consistent manner. The assignment is done automatically when the operations have completed.

**Figure 7-11 Measure Assignment in Geometric Segment Operations**



The direction of the geometric segment resulting from concatenation is always the direction of the first segment (`geom_segment1` in the call to the [SDO\\_LRS.CONCATENATE\\_GEOM\\_SEGMENTS](#) (page 24-6) function), as shown in [Figure 7-12](#) (page 7-11).

**Figure 7-12 Segment Direction with Concatenation**

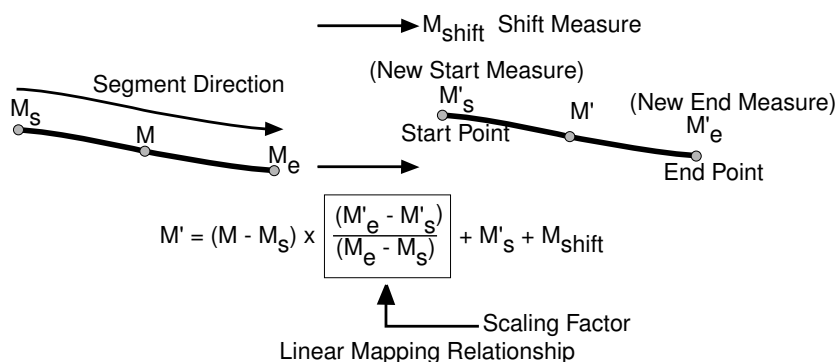


In addition to explicitly concatenating two connected segments using the [SDO\\_LRS.CONCATENATE\\_GEOM\\_SEGMENTS](#) (page 24-6) function, you can perform aggregate concatenation: that is, you can concatenate all connected geometric segments in a column (layer) using the [SDO\\_AGGR\\_LRS\\_CONCAT](#) (page 19-4) spatial aggregate function. (See the description and example of the [SDO\\_AGGR\\_LRS\\_CONCAT](#) (page 19-4) spatial aggregate function in [Spatial Aggregate Functions](#) (page 19-1).)

## 7.5.6 Scaling a Geometric Segment

You can create a new geometric segment by performing a linear scaling operation on a geometric segment. [Figure 7-13](#) (page 7-11) shows the mapping relationship for geometric segment scaling.

**Figure 7-13 Scaling a Geometric Segment**



In general, scaling a geometric segment only involves rearranging measures of the newly created geometric segment. However, if the scaling factor is negative, the order of the shape points needs to be reversed so that measures will increase along the geometric segment's direction (which is defined by the order of the shape points).

A scale operation can perform any combination of the following operations:

- Translating (shifting) measure information. (For example, add the same value to  $M_s$  and  $M_e$  to get  $M'_s$  and  $M'_e$ .)

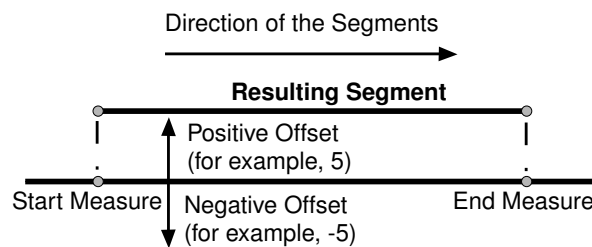
- Reversing measure information. (Let  $M's = M'e$ ,  $M'e = M's$ , and  $Mshift = 0$ .)
- Performing simple scaling of measure information. (Let  $Mshift = 0$ .)

For examples of these operations, see the Usage Notes and Examples for the [SDO\\_LRS.SCALE\\_GEOM\\_SEGMENT](#) (page 24-56), [SDO\\_LRS.TRANSLATE\\_MEASURE](#) (page 24-62), [SDO\\_LRS.REVERSE\\_GEOMETRY](#) (page 24-53), and [SDO\\_LRS.REDEFINE\\_GEOM\\_SEGMENT](#) (page 24-50) subprograms in [SDO\\_LRS Package \(Linear Referencing System\)](#) (page 24-1).

## 7.5.7 Offsetting a Geometric Segment

You can create a new geometric segment by performing an offsetting operation on a geometric segment. [Figure 7-14](#) (page 7-12) shows the mapping relationship for geometric segment offsetting.

**Figure 7-14 Offsetting a Geometric Segment**



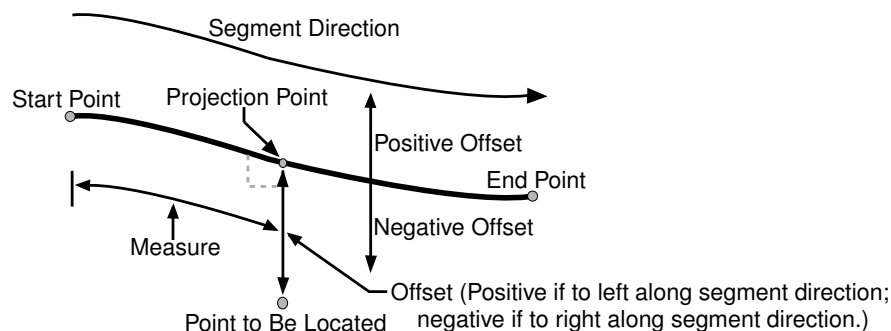
In the offsetting operation shown in [Figure 7-14](#) (page 7-12), the resulting geometric segment is offset by 5 units from the specified start and end measures of the original segment.

For more information, see the Usage Notes and Examples for the [SDO\\_LRS.OFFSET\\_GEOM\\_SEGMENT](#) (page 24-45) function in [SDO\\_LRS Package \(Linear Referencing System\)](#) (page 24-1).

## 7.5.8 Locating a Point on a Geometric Segment

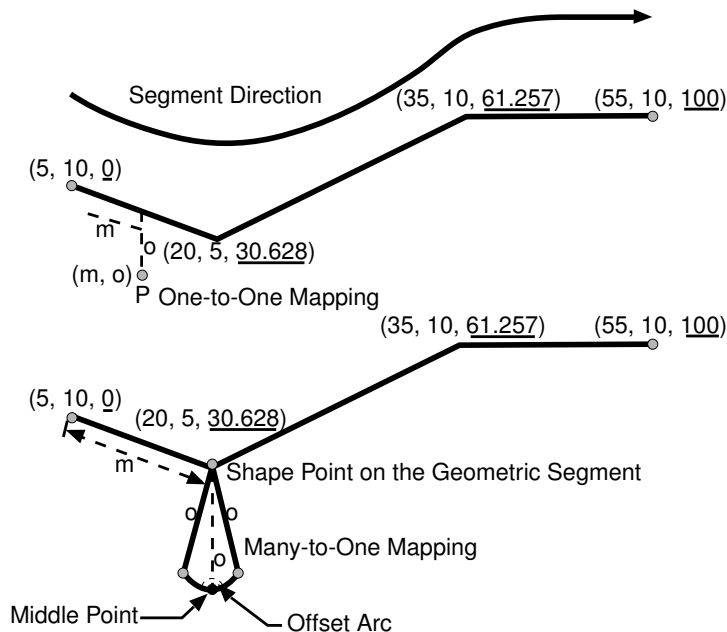
You can find the position of a point described by a measure and an offset on a geometric segment (see [Figure 7-15](#) (page 7-12)).

**Figure 7-15 Locating a Point Along a Segment with a Measure and an Offset**



There is always a unique location with a specific measure on a geometric segment. Ambiguity arises when offsets are given and the points described by the measures fall on shape points of the geometric segment (see [Figure 7-16](#) (page 7-13)).



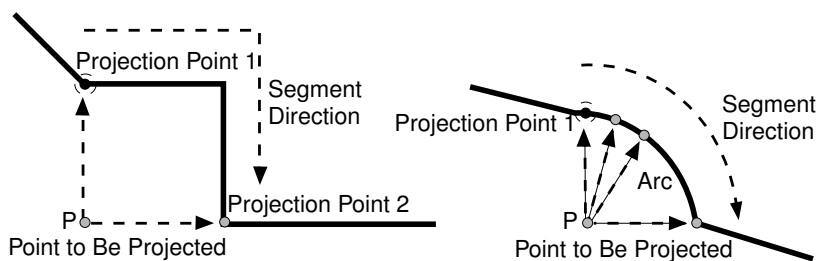
**Figure 7-16 Ambiguity in Location Referencing with Offsets**

As shown in [Figure 7-16](#) (page 7-13), an offset arc of a shape point on a geometric segment is an arc on which all points have the same minimum distance to the shape point. As a result, all points on the offset arc are represented by the same (measure, offset) pair. To resolve this one-to-many mapping problem, the middle point on the offset arc is returned.

### 7.5.9 Projecting a Point onto a Geometric Segment

You can find the projection point of a point with respect to a geometric segment. The point to be projected can be on or off the segment. If the point is on the segment, the point and its projection point are the same.

Projection is a reverse operation of the point-locating operation shown in [Figure 7-15](#) (page 7-12). Similar to a point-locating operation, all points on the offset arc of a shape point will have the same projection point (that is, the shape point itself), measure, and offset (see [Figure 7-16](#) (page 7-13)). If there are multiple projection points for a point, the first one from the start point is returned (Projection Point 1 in both illustrations in [Figure 7-17](#) (page 7-13)).

**Figure 7-17 Multiple Projection Points**

### 7.5.10 Converting LRS Geometries

You can convert geometries from standard line string format to LRS format, and the reverse. The main use of conversion functions will probably occur if you have a large amount of existing line string data, in which case conversion is a convenient

alternative to creating all of the LRS segments manually. However, if you need to convert LRS segments to standard line strings for certain applications, that capability is provided also.

Functions are provided to convert:

- Individual line strings or points

For conversion from standard format to LRS format, a measure dimension (named *M* by default) is added, and measure information is provided for each point. For conversion from LRS format to standard format, the measure dimension and information are removed. In both cases, the dimensional information (DIMINFO) metadata in the USER\_SDO\_GEOM\_METADATA view is not affected.

- Layers (all geometries in a column)

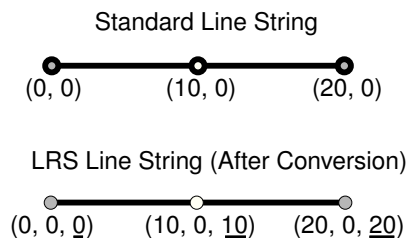
For conversion from standard format to LRS format, a measure dimension (named *M* by default) is added, but no measure information is provided for each point. For conversion from LRS format to standard format, the measure dimension and information are removed. In both cases, the dimensional information (DIMINFO) metadata in the USER\_SDO\_GEOM\_METADATA view is modified as needed.

- Dimensional information (DIMINFO)

The dimensional information (DIMINFO) metadata in the USER\_SDO\_GEOM\_METADATA view is modified as needed. For example, converting a standard dimensional array with X and Y dimensions (SDO\_DIM\_ELEMENT) to an LRS dimensional array causes an M dimension (SDO\_DIM\_ELEMENT) to be added.

Figure 7-18 (page 7-14) shows the addition of measure information when a standard line string is converted to an LRS line string (using the [SDO\\_LRS.CONVERT\\_TO\\_LRS\\_GEOM](#) (page 24-11) function). The measure dimension values are underlined in Figure 7-18 (page 7-14).

**Figure 7-18 Conversion from Standard to LRS Line String**



For conversions of point geometries, the SDO\_POINT attribute (described in [SDO\\_POINT](#) (page 2-7)) in the returned geometry is affected as follows:

- If a standard point is converted to an LRS point, the SDO\_POINT attribute information in the input geometry is used to set the SDO\_ELEM\_INFO and SDO\_ORDINATES attributes (described in [SDO\\_ELEM\\_INFO](#) (page 2-8) and [SDO\\_ORDINATES](#) (page 2-11)) in the resulting geometry, and the SDO\_POINT attribute in the resulting geometry is set to null.
- If an LRS point is converted to a standard point, the information in the SDO\_ELEM\_INFO and SDO\_ORDINATES attributes (described in [SDO\\_ELEM\\_INFO](#) (page 2-8) and [SDO\\_ORDINATES](#) (page 2-11)) in the input geometry is used to set the SDO\_POINT attribute information in the resulting

geometry, and the SDO\_ELEM\_INFO and SDO\_ORDINATES attributes in the resulting geometry are set to null.

The conversion functions are listed in [Table 24-3](#) (page 24-4) in [SDO\\_LRS Package \(Linear Referencing System\)](#) (page 24-1). See also the reference information in [SDO\\_LRS Package \(Linear Referencing System\)](#) (page 24-1) about each conversion function.

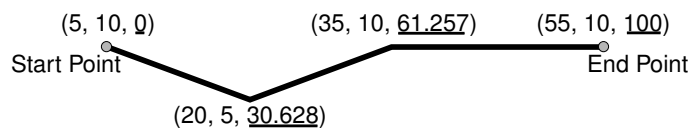
## 7.6 Tolerance Values with LRS Functions

Many LRS functions require that you specify a tolerance value or one or more dimensional arrays. Thus, you can control whether to specify a single tolerance value for all non-measure dimensions or to use the tolerance associated with each non-measure dimension in the dimensional array or arrays. The tolerance is applied only to the geometry portion of the data, not to the measure dimension. The tolerance value for geodetic data is in meters, and for non-geodetic data it is in the unit of measurement associated with the data. (For a detailed discussion of tolerance, see [Tolerance](#) (page 1-6).)

Be sure that the tolerance value used is appropriate to the data and your purpose. If the results of LRS functions seem imprecise or incorrect, you may need to specify a smaller tolerance value.

For clip operations (see [Clipping a Geometric Segment](#) (page 7-9)) and offset operations (see [Offsetting a Geometric Segment](#) (page 7-12)), if the returned segment has any shape points within the tolerance value of the input geometric segment from what would otherwise be the start point or end point of the returned segment, the shape point is used as the start point or end point of the returned segment. This is done to ensure that the resulting geometry does not contain any redundant vertices, which would cause the geometry to be invalid. For example, assume that the tolerance associated with the geometric segment (non-geodetic data) in [Figure 7-19](#) (page 7-15) is 0.5.

**Figure 7-19 Segment for Clip Operation Affected by Tolerance**

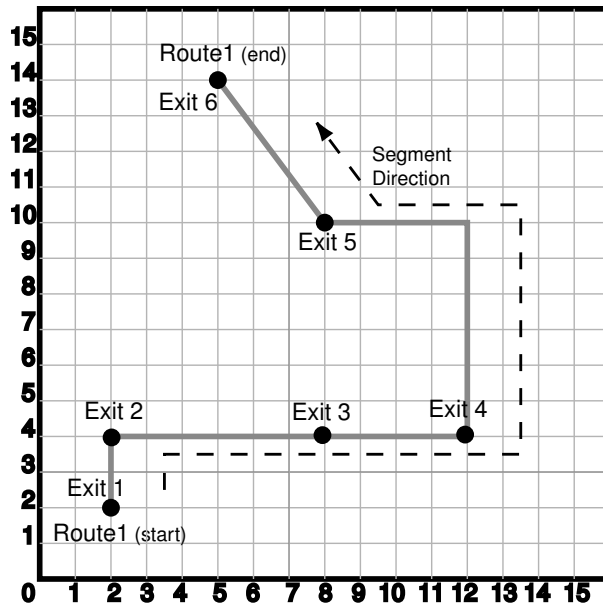


If you request a clip operation to return the segment between measure values 0 (the start point) and 61.5 in [Figure 7-19](#) (page 7-15), and if the distance between the points associated with measure values 61.5 and 61.257 is less than the 0.5 tolerance value, the end point of the returned segment is (35, 10, 61.257).

## 7.7 Example of LRS Functions

This section presents a simplified example that uses LRS functions. It refers to concepts that are explained in this chapter and uses functions documented in [SDO\\_LRS Package \(Linear Referencing System\)](#) (page 24-1).

This example uses the road that is illustrated in [Figure 7-20](#) (page 7-16).

**Figure 7-20 Simplified LRS Example: Highway**

In Figure 7-20 (page 7-16), the highway (Route 1) starts at point 2,2 and ends at point 5,14, follows the path shown, and has six entrance-exit points (Exit 1 through Exit 6). For simplicity, each unit on the graph represents one unit of measure, and thus the measure from start to end is 27 (the segment from Exit 5 to Exit 6 being the hypotenuse of a 3-4-5 right triangle).

Each row in Table 7-1 (page 7-16) lists an actual highway-related feature and the LRS feature that corresponds to it or that can be used to represent it.

**Table 7-1 Highway Features and LRS Counterparts**

Highway Feature	LRS Feature
Named route, road, or street	LRS segment, or linear feature (logical set of segments)
Mile or kilometer marker	Measure
Accident reporting and location tracking	<a href="#">SDO_LRS.LOCATE_PT</a> (page 24-40) function
Construction zone (portion of a road)	<a href="#">SDO_LRS.CLIP_GEOM_SEGMENT</a> (page 24-5) function
Road extension (adding at the beginning or end) or combination (designating or renaming two roads that meet as one road)	<a href="#">SDO_LRS.CONCATENATE_GEOM_SEGMENTS</a> (page 24-6) function
Road reconstruction or splitting (resulting in two named roads from one named road)	<a href="#">SDO_LRS.SPLIT_GEOM_SEGMENT</a> (page 24-60) procedure
Finding the closest point on the road to a point off the road (such as a building)	<a href="#">SDO_LRS.PROJECT_PT</a> (page 24-48) function
Guard rail or fence alongside a road	<a href="#">SDO_LRS.OFFSET_GEOM_SEGMENT</a> (page 24-45) function

[Example 7-2](#) (page 7-17) does the following:

- Creates a table to hold the segment depicted in [Figure 7-20](#) (page 7-16)
- Inserts the definition of the highway depicted in [Figure 7-20](#) (page 7-16) into the table
- Inserts the necessary metadata into the USER\_SDO\_GEOM\_METADATA view
- Uses PL/SQL and SQL statements to define the segment and perform operations on it

**Example 7-2 Simplified Example: Highway**

```
-- Create a table for routes (highways).
CREATE TABLE lrs_routes (
  route_id NUMBER PRIMARY KEY,
  route_name VARCHAR2(32),
  route_geometry SDO_GEOMETRY);

-- Populate table with just one route for this example.
INSERT INTO lrs_routes VALUES(
  1,
  'Route1',
  SDO_GEOMETRY(
    3302, -- line string, 3 dimensions: X,Y,M
    NULL,
    NULL,
    SDO_ELEM_INFO_ARRAY(1,2,1), -- one line string, straight segments
    SDO_ORDINATE_ARRAY(
      2,2,0, -- Start point - Exit1; 0 is measure from start.
      2,4,2, -- Exit2; 2 is measure from start.
      8,4,8, -- Exit3; 8 is measure from start.
      12,4,12, -- Exit4; 12 is measure from start.
      12,10,NULL, -- Not an exit; measure automatically calculated and filled.
      8,10,22, -- Exit5; 22 is measure from start.
      5,14,27) -- End point (Exit6); 27 is measure from start.
    )
  );

-- Update the spatial metadata.
INSERT INTO user_sdo_geom_metadata
  (TABLE_NAME,
   COLUMN_NAME,
   DIMINFO,
   SRID)
VALUES (
  'lrs_routes',
  'route_geometry',
  SDO_DIM_ARRAY( -- 20X20 grid
    SDO_DIM_ELEMENT('X', 0, 20, 0.005),
    SDO_DIM_ELEMENT('Y', 0, 20, 0.005),
    SDO_DIM_ELEMENT('M', 0, 20, 0.005) -- Measure dimension
  ),
  NULL -- SRID
);

-- Create the spatial index.
CREATE INDEX lrs_routes_idx ON lrs_routes(route_geometry)
  INDEXTYPE IS MDSYS.SPATIAL_INDEX;

-- Test the LRS procedures.
```

```

DECLARE
geom_segment SDO_GEOMETRY;
line_string SDO_GEOMETRY;
dim_array SDO_DIM_ARRAY;
result_geom_1 SDO_GEOMETRY;
result_geom_2 SDO_GEOMETRY;
result_geom_3 SDO_GEOMETRY;

BEGIN

SELECT a.route_geometry into geom_segment FROM lrs_routes a
  WHERE a.route_name = 'Route1';
SELECT m.diminfo into dim_array from
  user_sdo_geom_metadata m
  WHERE m.table_name = 'LRS_ROUTES' AND m.column_name = 'ROUTE_GEOMETRY';

-- Define the LRS segment for Route1. This will populate any null measures.
-- No need to specify start and end measures, because they are already defined
-- in the geometry.
SDO_LRS.DEFINE_GEOM_SEGMENT (geom_segment, dim_array);

SELECT a.route_geometry INTO line_string FROM lrs_routes a
  WHERE a.route_name = 'Route1';

-- Split Route1 into two segments.
SDO_LRS.SPLIT_GEOM_SEGMENT(line_string,dim_array,5,result_geom_1,result_geom_2);

-- Concatenate the segments that were just split.
result_geom_3 := SDO_LRS.CONCATENATE_GEOM_SEGMENTS(result_geom_1, dim_array,
result_geom_2, dim_array);

-- Update and insert geometries into table, to display later.
UPDATE lrs_routes a SET a.route_geometry = geom_segment
  WHERE a.route_id = 1;

INSERT INTO lrs_routes VALUES(
  11,
  'result_geom_1',
  result_geom_1
);
INSERT INTO lrs_routes VALUES(
  12,
  'result_geom_2',
  result_geom_2
);
INSERT INTO lrs_routes VALUES(
  13,
  'result_geom_3',
  result_geom_3
);

END;
/

-- First, display the data in the LRS table.
SELECT route_id, route_name, route_geometry FROM lrs_routes;

-- Are result_geom_1 and result_geom2 connected?
SELECT SDO_LRS.CONNECTED_GEOM_SEGMENTS(a.route_geometry,
  b.route_geometry, 0.005)
  FROM lrs_routes a, lrs_routes b

```

```

WHERE a.route_id = 11 AND b.route_id = 12;

-- Is the Route1 segment valid?
SELECT SDO_LRS.VALID_GEOM_SEGMENT(route_geometry)
FROM lrs_routes WHERE route_id = 1;

-- Is 50 a valid measure on Route1? (Should return FALSE; highest Route1 measure is
27.)
SELECT SDO_LRS.VALID_MEASURE(route_geometry, 50)
FROM lrs_routes WHERE route_id = 1;

-- Is the Route1 segment defined?
SELECT SDO_LRS.IS_GEOM_SEGMENT_DEFINED(route_geometry)
FROM lrs_routes WHERE route_id = 1;

-- How long is Route1?
SELECT SDO_LRS.GEOM_SEGMENT_LENGTH(route_geometry)
FROM lrs_routes WHERE route_id = 1;

-- What is the start measure of Route1?
SELECT SDO_LRS.GEOM_SEGMENT_START_MEASURE(route_geometry)
FROM lrs_routes WHERE route_id = 1;

-- What is the end measure of Route1?
SELECT SDO_LRS.GEOM_SEGMENT_END_MEASURE(route_geometry)
FROM lrs_routes WHERE route_id = 1;

-- What is the start point of Route1?
SELECT SDO_LRS.GEOM_SEGMENT_START_PT(route_geometry)
FROM lrs_routes WHERE route_id = 1;

-- What is the end point of Route1?
SELECT SDO_LRS.GEOM_SEGMENT_END_PT(route_geometry)
FROM lrs_routes WHERE route_id = 1;

-- Translate (shift measure values) (+10).
-- First, display the original segment; then, translate.
SELECT a.route_geometry FROM lrs_routes a WHERE a.route_id = 1;
SELECT SDO_LRS.TRANSLATE_MEASURE(a.route_geometry, m.diminfo, 10)
FROM lrs_routes a, user_sdo_geom_metadata m
WHERE m.table_name = 'LRS_ROUTES' AND m.column_name = 'ROUTE_GEOMETRY'
AND a.route_id = 1;

-- Redefine geometric segment to "convert" miles to kilometers
DECLARE
geom_segment SDO_GEOMETRY;
dim_array SDO_DIM_ARRAY;

BEGIN

SELECT a.route_geometry into geom_segment FROM lrs_routes a
WHERE a.route_name = 'Route1';
SELECT m.diminfo into dim_array from
user_sdo_geom_metadata m
WHERE m.table_name = 'LRS_ROUTES' AND m.column_name = 'ROUTE_GEOMETRY';

-- "Convert" mile measures to kilometers (27 * 1.609 = 43.443).
SDO_LRS.REDEFINE_GEOM_SEGMENT (geom_segment,
dim_array,
0, -- Zero starting measure: LRS segment starts at start of route.
43.443); -- End of LRS segment. 27 miles = 43.443 kilometers.

```

```
-- Update and insert geometries into table, to display later.
UPDATE lrs_routes a SET a.route_geometry = geom_segment
  WHERE a.route_id = 1;

END;/
-- Display the redefined segment, with all measures "converted."
SELECT a.route_geometry FROM lrs_routes a WHERE a.route_id = 1;

-- Clip a piece of Routel.
SELECT  SDO_LRS.CLIP_GEOM_SEGMENT(route_geometry, 5, 10)
  FROM lrs_routes WHERE route_id = 1;

-- Point (9,3,NULL) is off the road; should return (9,4,9).
SELECT  SDO_LRS.PROJECT_PT(route_geometry,
  SDO_GEOMETRY(3301, NULL, NULL,
    SDO_ELEM_INFO_ARRAY(1, 1, 1),
    SDO_ORDINATE_ARRAY(9, 3, NULL)) )
  FROM lrs_routes WHERE route_id = 1;

-- Return the measure of the projected point.
SELECT  SDO_LRS.GET_MEASURE(
  SDO_LRS.PROJECT_PT(a.route_geometry, m.diminfo,
    SDO_GEOMETRY(3301, NULL, NULL,
      SDO_ELEM_INFO_ARRAY(1, 1, 1),
      SDO_ORDINATE_ARRAY(9, 3, NULL)) ),
  m.diminfo )
  FROM lrs_routes a, user_sdo_geom_metadata m
 WHERE m.table_name = 'LRS_ROUTES' AND m.column_name = 'ROUTE_GEOMETRY'
    AND a.route_id = 1;

-- Is point (9,3,NULL) a valid LRS point? (Should return TRUE.)
SELECT  SDO_LRS.VALID_LRS_PT(
  SDO_GEOMETRY(3301, NULL, NULL,
    SDO_ELEM_INFO_ARRAY(1, 1, 1),
    SDO_ORDINATE_ARRAY(9, 3, NULL)),
  m.diminfo)
  FROM lrs_routes a, user_sdo_geom_metadata m
 WHERE m.table_name = 'LRS_ROUTES' AND m.column_name = 'ROUTE_GEOMETRY'
    AND a.route_id = 1;

-- Locate the point on Routel at measure 9, offset 0.
SELECT  SDO_LRS.LOCATE_PT(route_geometry, 9, 0)
  FROM lrs_routes WHERE route_id = 1;
```

[Example 7-3](#) (page 7-20) shows the output of the SELECT statements in [Example 7-2](#) (page 7-17).

### **Example 7-3 Simplified Example: Output of SELECT Statements**

```
SQL> -- First, display the data in the LRS table.
SQL> SELECT route_id, route_name, route_geometry FROM lrs_routes;

  ROUTE_ID ROUTE_NAME
-----
ROUTE_GEOMETRY(SDO_GTYPE, SDO_SRID, SDO_POINT(X, Y, Z), SDO_ELEM_INFO, SDO_ORDIN
-----
          1 Routel
SDO_GEOMETRY(3302, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 2, 1), SDO_ORDINATE_ARRAY(
2, 2, 0, 2, 4, 2, 8, 4, 8, 12, 4, 12, 12, 10, 18, 8, 10, 22, 5, 14, 27))

11 result_geom_1
```



```
SDO_GEOMETRY(3302, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 2, 1), SDO_ORDINATE_ARRAY(
2, 2, 0, 2, 4, 2, 5, 4, 5))
```

```
12 result_geom_2
```

```
ROUTE_ID ROUTE_NAME
```

```
-----
ROUTE_GEOMETRY(SDO_GTYPE, SDO_SRID, SDO_POINT(X, Y, Z), SDO_ELEM_INFO, SDO_ORDINATE_ARRAY(
```

```
SDO_GEOMETRY(3302, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 2, 1), SDO_ORDINATE_ARRAY(
5, 4, 5, 8, 4, 8, 12, 4, 12, 12, 10, 18, 8, 10, 22, 5, 14, 27))
```

```
13 result_geom_3
```

```
SDO_GEOMETRY(3302, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 2, 1), SDO_ORDINATE_ARRAY(
2, 2, 0, 2, 4, 2, 5, 4, 5, 8, 4, 8, 12, 4, 12, 12, 10, 18, 8, 10, 22, 5, 14, 27)
)
```

```
SQL> -- Are result_geom_1 and result_geom2 connected?
```

```
SQL> SELECT SDO_LRS.CONNECTED_GEOM_SEGMENTS(a.route_geometry,
2          b.route_geometry, 0.005)
3 FROM lrs_routes a, lrs_routes b
4 WHERE a.route_id = 11 AND b.route_id = 12;
```

```
SDO_LRS.CONNECTED_GEOM_SEGMENTS(A.ROUTE_GEOMETRY,B.ROUTE_GEOMETRY,0.005)
```

```
-----
TRUE
```

```
SQL> -- Is the Route1 segment valid?
```

```
SQL> SELECT SDO_LRS.VALID_GEOM_SEGMENT(route_geometry)
2 FROM lrs_routes WHERE route_id = 1;
```

```
SDO_LRS.VALID_GEOM_SEGMENT(ROUTE_GEOMETRY)
```

```
-----
TRUE
```

```
SQL> -- Is 50 a valid measure on Route1? (Should return FALSE; highest Route1
measure is 27.)
```

```
SQL> SELECT SDO_LRS.VALID_MEASURE(route_geometry, 50)
2 FROM lrs_routes WHERE route_id = 1;
```

```
SDO_LRS.VALID_MEASURE(ROUTE_GEOMETRY,50)
```

```
-----
FALSE
```

```
SQL> -- Is the Route1 segment defined?
```

```
SQL> SELECT SDO_LRS.IS_GEOM_SEGMENT_DEFINED(route_geometry)
2 FROM lrs_routes WHERE route_id = 1;
```

```
SDO_LRS.IS_GEOM_SEGMENT_DEFINED(ROUTE_GEOMETRY)
```

```
-----
TRUE
```

```
SQL> -- How long is Route1?
```

```
SQL> SELECT SDO_LRS.GEOM_SEGMENT_LENGTH(route_geometry)
2 FROM lrs_routes WHERE route_id = 1;
```

```
SDO_LRS.GEOM_SEGMENT_LENGTH(ROUTE_GEOMETRY)
```

```
-----
27
```

```
SQL> -- What is the start measure of Route1?
```

```

SQL> SELECT  SDO_LRS.GEOM_SEGMENT_START_MEASURE(route_geometry)
      2      FROM lrs_routes WHERE route_id = 1;

SDO_LRS.GEOM_SEGMENT_START_MEASURE(ROUTE_GEOMETRY)
-----
0

SQL> -- What is the end measure of Route1?
SQL> SELECT  SDO_LRS.GEOM_SEGMENT_END_MEASURE(route_geometry)
      2      FROM lrs_routes WHERE route_id = 1;

SDO_LRS.GEOM_SEGMENT_END_MEASURE(ROUTE_GEOMETRY)
-----
27

SQL> -- What is the start point of Route1?
SQL> SELECT  SDO_LRS.GEOM_SEGMENT_START_PT(route_geometry)
      2      FROM lrs_routes WHERE route_id = 1;

SDO_LRS.GEOM_SEGMENT_START_PT(ROUTE_GEOMETRY)(SDO_GTYPE, SDO_SRID, SDO_POINT(X,
-----
SDO_GEOMETRY(3301, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 1, 1), SDO_ORDINATE_ARRAY(
2, 2, 0))

SQL> -- What is the end point of Route1?
SQL> SELECT  SDO_LRS.GEOM_SEGMENT_END_PT(route_geometry)
      2      FROM lrs_routes WHERE route_id = 1;

SDO_LRS.GEOM_SEGMENT_END_PT(ROUTE_GEOMETRY)(SDO_GTYPE, SDO_SRID, SDO_POINT(X, Y,
-----
SDO_GEOMETRY(3301, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 1, 1), SDO_ORDINATE_ARRAY(
5, 14, 27))

SQL> -- Translate (shift measure values) (+10).
SQL> -- First, display the original segment; then, translate.
SQL> SELECT a.route_geometry FROM lrs_routes a WHERE a.route_id = 1;

ROUTE_GEOMETRY(SDO_GTYPE, SDO_SRID, SDO_POINT(X, Y, Z), SDO_ELEM_INFO, SDO_ORDIN
-----
SDO_GEOMETRY(3302, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 2, 1), SDO_ORDINATE_ARRAY(
2, 2, 0, 2, 4, 2, 8, 4, 8, 12, 4, 12, 12, 10, 18, 8, 10, 22, 5, 14, 27))

SQL> SELECT SDO_LRS.TRANSLATE_MEASURE(a.route_geometry, m.diminfo, 10)
      2      FROM lrs_routes a, user_sdo_geom_metadata m
      3      WHERE m.table_name = 'LRS_ROUTES' AND m.column_name = 'ROUTE_GEOMETRY'
      4      AND a.route_id = 1;

SDO_LRS.TRANSLATE_MEASURE(A.ROUTE_GEOMETRY,M.DIMINFO,10)(SDO_GTYPE, SDO_SRID, SD
-----
SDO_GEOMETRY(3302, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 2, 1), SDO_ORDINATE_ARRAY(
2, 2, 10, 2, 4, 12, 8, 4, 18, 12, 4, 22, 12, 10, 28, 8, 10, 32, 5, 14, 37))

SQL> -- Redefine geometric segment to "convert" miles to kilometers
SQL> DECLARE
      2      geom_segment SDO_GEOMETRY;
      3      dim_array SDO_DIM_ARRAY;
      4
      5      BEGIN
      6
      7      SELECT a.route_geometry into geom_segment FROM lrs_routes a

```

```

8   WHERE a.route_name = 'Route1';
9   SELECT m.diminfo into dim_array from
10  user_sdo_geom_metadata m
11  WHERE m.table_name = 'LRS_ROUTES' AND m.column_name = 'ROUTE_GEOMETRY';
12
13  -- "Convert" mile measures to kilometers (27 * 1.609 = 43.443).
14  SDO_LRS.REDEFINE_GEOM_SEGMENT (geom_segment,
15    dim_array,
16    0, -- Zero starting measure: LRS segment starts at start of route.
17    43.443); -- End of LRS segment. 27 miles = 43.443 kilometers.
18
19  -- Update and insert geometries into table, to display later.
20  UPDATE lrs_routes a SET a.route_geometry = geom_segment
21    WHERE a.route_id = 1;
22
23  END;
24  /

```

PL/SQL procedure successfully completed.

```

SQL> -- Display the redefined segment, with all measures "converted."
SQL> SELECT a.route_geometry FROM lrs_routes a WHERE a.route_id = 1;

```

```

ROUTE_GEOMETRY(SDO_GTYPE, SDO_SRID, SDO_POINT(X, Y, Z), SDO_ELEM_INFO, SDO_ORDIN
-----
SDO_GEOMETRY(3302, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 2, 1), SDO_ORDINATE_ARRAY(
2, 2, 0, 2, 4, 3.218, 8, 4, 12.872, 12, 4, 19.308, 12, 10, 28.962, 8, 10, 35.398
, 5, 14, 43.443))

```

```

SQL> -- Clip a piece of Route1.

```

```

SQL> SELECT SDO_LRS.CLIP_GEOM_SEGMENT(route_geometry, 5, 10)
2   FROM lrs_routes WHERE route_id = 1;

```

```

SDO_LRS.CLIP_GEOM_SEGMENT(ROUTE_GEOMETRY,5,10)(SDO_GTYPE, SDO_SRID, SDO_POINT(X,
-----
SDO_GEOMETRY(3302, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 2, 1), SDO_ORDINATE_ARRAY(
5, 4, 5, 8, 4, 8, 10, 4, 10))

```

```

SQL> -- Point (9,3,NULL) is off the road; should return (9,4,9).

```

```

SQL> SELECT SDO_LRS.PROJECT_PT(route_geometry,
2   SDO_GEOMETRY(3301, NULL, NULL,
3   SDO_ELEM_INFO_ARRAY(1, 1, 1),
4   SDO_ORDINATE_ARRAY(9, 3, NULL)) )
5   FROM lrs_routes WHERE route_id = 1;

```

```

SDO_LRS.PROJECT_PT(ROUTE_GEOMETRY,SDO_GEOMETRY(3301,NULL,NULL,SDO_EL
-----
SDO_GEOMETRY(3301, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 1, 1), SDO_ORDINATE_ARRAY(
9, 4, 9))

```

```

SQL> -- Return the measure of the projected point.

```

```

SQL> SELECT SDO_LRS.GET_MEASURE(
2   SDO_LRS.PROJECT_PT(a.route_geometry, m.diminfo,
3   SDO_GEOMETRY(3301, NULL, NULL,
4   SDO_ELEM_INFO_ARRAY(1, 1, 1),
5   SDO_ORDINATE_ARRAY(9, 3, NULL)) ),
6   m.diminfo )
7   FROM lrs_routes a, user_sdo_geom_metadata m
8   WHERE m.table_name = 'LRS_ROUTES' AND m.column_name = 'ROUTE_GEOMETRY'
9   AND a.route_id = 1;

```

```
SDO_LRS.GET_MEASURE(SDO_LRS.PROJECT_PT(A.ROUTE_GEOMETRY,M.DIMINFO,SDO_GEOM
```

9

```
SQL> -- Is point (9,3,NULL) a valid LRS point? (Should return TRUE.)
```

```
SQL> SELECT  SDO_LRS.VALID_LRS_PT(
2   SDO_GEOMETRY(3301, NULL, NULL,
3   SDO_ELEM_INFO_ARRAY(1, 1, 1),
4   SDO_ORDINATE_ARRAY(9, 3, NULL)),
5   m.diminfo)
6   FROM lrs_routes a, user_sdo_geom_metadata m
7   WHERE m.table_name = 'LRS_ROUTES' AND m.column_name = 'ROUTE_GEOMETRY'
8   AND a.route_id = 1;
```

```
SDO_LRS.VALID_LRS_PT(SDO_GEOMETRY(3301,NULL,NULL,SDO_ELEM_INFO_ARRAY
```

```
-----
TRUE
```

```
SQL> -- Locate the point on Route1 at measure 9, offset 0.
```

```
SQL> SELECT  SDO_LRS.LOCATE_PT(route_geometry, 9, 0)
2   FROM lrs_routes WHERE route_id = 1;
```

```
SDO_LRS.LOCATE_PT(ROUTE_GEOMETRY,9,0)(SDO_GTYPE, SDO_SRID, SDO_POINT(X, Y, Z), S
```

```
-----
SDO_GEOMETRY(3301, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 1, 1), SDO_ORDINATE_ARRAY(
9, 4, 9))
```

---

# Spatial Analysis and Mining

This chapter describes the Oracle Spatial and Graph features that enable the use of spatial data in data mining applications.

---

**Note:**

To use the features described in this chapter, you must understand the main concepts and techniques explained in the documentation for Oracle Data Mining, a component of the Oracle Advanced Analytics Option.

---

For reference information about spatial analysis and mining functions and procedures in the SDO\_SAM package, see [SDO\\_SAM Package \(Spatial Analysis and Mining\)](#) (page 28-1).

---

**Note:**

SDO\_SAM subprograms are supported for two-dimensional geometries only. They are not supported for three-dimensional geometries.

---

This chapter contains the following major sections:

- [Spatial Information and Data Mining Applications](#) (page 8-1)
- [Spatial Binning for Detection of Regional Patterns](#) (page 8-3)
- [Materializing Spatial Correlation](#) (page 8-4)
- [Colocation Mining](#) (page 8-4)
- [Spatial Clustering](#) (page 8-5)
- [Location Prospecting](#) (page 8-5)

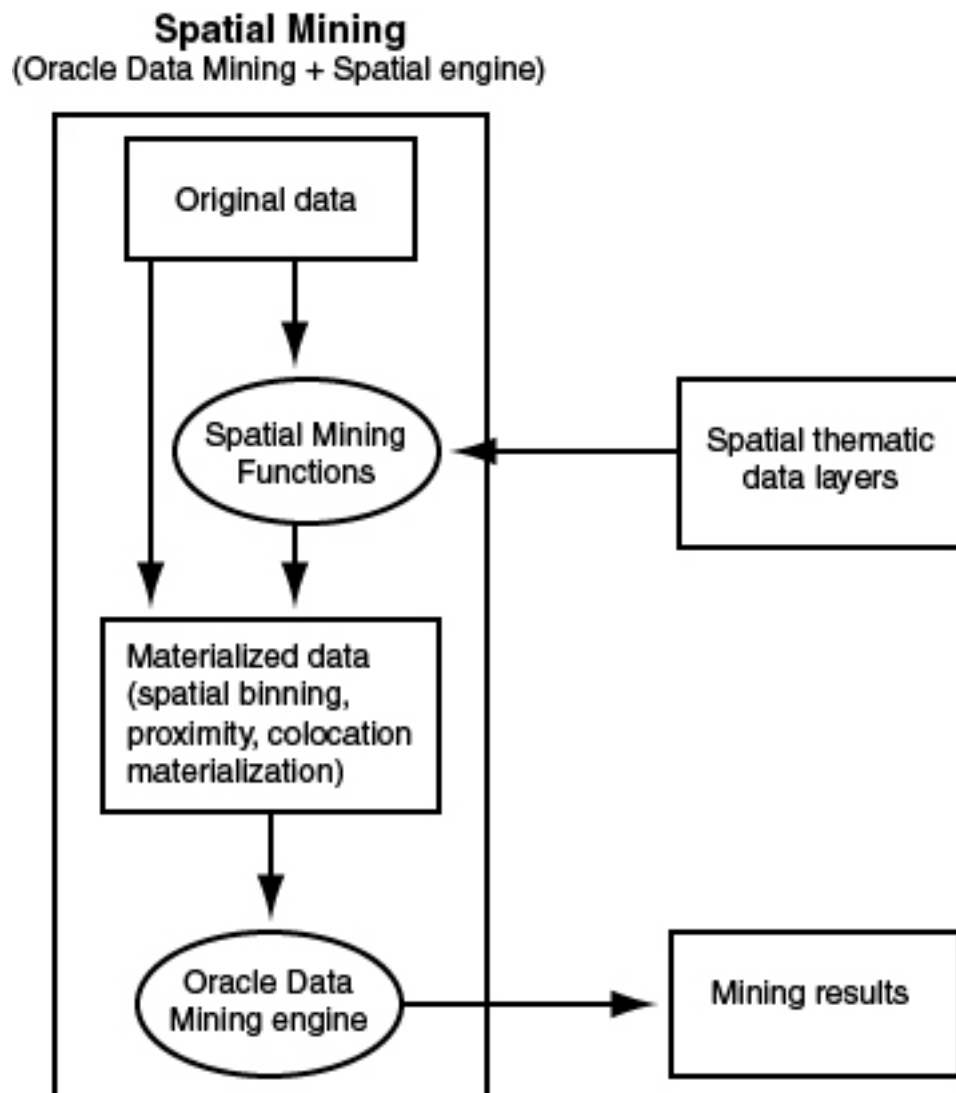
## 8.1 Spatial Information and Data Mining Applications

Oracle Data Mining allows automatic discovery of knowledge from a database. Its techniques include discovering hidden associations between different data attributes, classification of data based on some samples, and clustering to identify intrinsic patterns. Spatial data can be materialized for inclusion in data mining applications. Thus, Oracle Data Mining might enable you to discover that sales prospects with addresses located in specific areas (neighborhoods, cities, or regions) are more likely to watch a particular television program or to respond favorably to a particular advertising solicitation. (The addresses are geocoded into longitude/latitude points and stored in an Oracle Spatial and Graph geometry object.)

In many applications, data at a specific location is influenced by data in the neighborhood. For example, the value of a house is largely determined by the value of other houses in the neighborhood. This phenomenon is called *spatial correlation* (or, neighborhood influence), and is discussed further in [Materializing Spatial Correlation](#) (page 8-4). The spatial analysis and mining features in Oracle Spatial and Graph let you exploit spatial correlation by using the location attributes of data items in several ways: for binning (discretizing) data into regions (such as categorizing data into northern, southern, eastern, and western regions), for materializing the influence of neighborhood (such as number of customers within a two-mile radius of each store), and for identifying colocated data items (such as video rental stores and pizza restaurants).

To perform spatial data mining, you materialize spatial predicates and relationships for a set of spatial data using thematic layers. Each layer contains data about a specific kind of spatial data (that is, having a specific "theme"), for example, parks and recreation areas, or demographic income data. The spatial materialization could be performed as a preprocessing step before the application of data mining techniques, or it could be performed as an intermediate step in spatial mining, as shown in [Figure 8-1](#) (page 8-2).

**Figure 8-1 Spatial Mining and Oracle Data Mining**



Notes on [Figure 8-1](#) (page 8-2):

- The original data, which included spatial and nonspatial data, is processed to produce materialized data.
- Spatial data in the original data is processed by spatial mining functions to produce materialized data. The processing includes such operations as spatial binning, proximity, and colocation materialization.
- The Oracle Data Mining engine processes materialized data (spatial and nonspatial) to generate mining results.

The following are examples of the kinds of data mining applications that could benefit from including spatial information in their processing:

- Business prospecting: Determine if colocation of a business with another franchise (such as colocation of a Pizza Hut restaurant with a Blockbuster video store) might improve its sales.
- Store prospecting: Find a good store location that is within 50 miles of a major city and inside a state with no sales tax. (Although 50 miles is probably too far to drive to avoid a sales tax, many customers may live near the edge of the 50-mile radius and thus be near the state with no sales tax.)
- Hospital prospecting: Identify the best locations for opening new hospitals based on the population of patients who live in each neighborhood.
- Spatial region-based classification or personalization: Determine if southeastern United States customers in a certain age or income category are more likely to prefer "soft" or "hard" rock music.
- Automobile insurance: Given a customer's home or work location, determine if it is in an area with high or low rates of accident claims or auto thefts.
- Property analysis: Use colocation rules to find hidden associations between proximity to a highway and either the price of a house or the sales volume of a store.
- Property assessment: In assessing the value of a house, examine the values of similar houses in a neighborhood, and derive an estimate based on variations and spatial correlation.

## 8.2 Spatial Binning for Detection of Regional Patterns

**Spatial binning** (spatial discretization) discretizes the location values into a small number of groups associated with geographical areas. The assignment of a location to a group can be done by any of the following methods:

- Reverse geocoding the longitude/latitude coordinates to obtain an address that specifies (for United States locations) the ZIP code, city, state, and country
- Checking a spatial bin table to determine which bin this specific location belongs in

You can then apply Oracle Data Mining techniques to the discretized locations to identify interesting regional patterns or association rules. For example, you might discover that customers in area A prefer regular soda, while customers in area B prefer diet soda.

The following functions and procedures, documented in [SDO\\_SAM Package \(Spatial Analysis and Mining\)](#) (page 28-1), perform operations related to spatial binning:

- [SDO\\_SAM.BIN\\_GEOMETRY](#) (page 28-5)
- [SDO\\_SAM.BIN\\_LAYER](#) (page 28-6)

## 8.3 Materializing Spatial Correlation

**Spatial correlation** (or, *neighborhood influence*) refers to the phenomenon of the location of a specific object in an area affecting some nonspatial attribute of the object. For example, the value (nonspatial attribute) of a house at a given address (geocoded to give a spatial attribute) is largely determined by the value of other houses in the neighborhood.

To use spatial correlation in a data mining application, you materialize the spatial correlation by adding attributes (columns) in a data mining table. You use associated thematic tables to add the appropriate attributes. You then perform mining tasks on the data mining table using Oracle Data Mining functions.

The following functions and procedures, documented in [SDO\\_SAM Package \(Spatial Analysis and Mining\)](#) (page 28-1), perform operations related to materializing spatial correlation:

- [SDO\\_SAM.SIMPLIFY\\_GEOMETRY](#) (page 28-9)
- [SDO\\_SAM.SIMPLIFY\\_LAYER](#) (page 28-10)
- [SDO\\_SAM.AGGREGATES\\_FOR\\_GEOMETRY](#) (page 28-2)
- [SDO\\_SAM.AGGREGATES\\_FOR\\_LAYER](#) (page 28-4)

## 8.4 Colocation Mining

**Colocation** is the presence of two or more spatial objects at the same location or at significantly close distances from each other. Colocation patterns can indicate interesting associations among spatial data objects with respect to their nonspatial attributes. For example, a data mining application could discover that sales at franchises of a specific pizza restaurant chain were higher at restaurants collocated with video stores than at restaurants not collocated with video stores.

Two types of colocation mining are supported:

- Colocation of items in a data mining table. Given a data layer, this approach identifies the colocation of multiple features. For example, predator and prey species could be collocated in animal habitats, and high-sales pizza restaurants could be collocated with high-sales video stores. You can use a reference-feature approach (using one feature as a reference and the other features as thematic attributes, and materializing all neighbors for the reference feature) or a buffer-based approach (materializing all items that are within all windows of a specified size).
- Colocation with thematic layers. Given several data layers, this approach identifies colocation across the layers. For example, given a lakes layer and a vegetation layer, lakes could be collocated with areas of high vegetation. You materialize the data, add categorical and numerical spatial relationships to the data mining table, and apply the Oracle Data Mining Association-Rule mechanisms.



The following functions and procedures, documented in [SDO\\_SAM Package \(Spatial Analysis and Mining\)](#) (page 28-1), perform operations related to colocation mining:

- [SDO\\_SAM.COLOCATED\\_REFERENCE\\_FEATURES](#) (page 28-7)
- [SDO\\_SAM.BIN\\_GEOMETRY](#) (page 28-5)

## 8.5 Spatial Clustering

Spatial clustering returns cluster geometries for a layer of data. An example of spatial clustering is the clustering of crime location data.

The [SDO\\_SAM.SPATIAL\\_CLUSTERS](#) (page 28-11) function, documented in [SDO\\_SAM Package \(Spatial Analysis and Mining\)](#) (page 28-1), performs spatial clustering. This function requires a spatial R-tree index on the geometry column of the layer, and it returns a set of SDO\_REGION objects where the geometry column specifies the boundary of each cluster and the `geometry_key` value is set to null.

You can use the [SDO\\_SAM.BIN\\_GEOMETRY](#) (page 28-5) function, with the returned spatial clusters in the bin table, to identify the cluster to which a geometry belongs.

## 8.6 Location Prospecting

Location prospecting can be performed by using thematic layers to compute aggregates for a layer, and choosing the locations that have the maximum values for computed aggregates.

The following functions, documented in [SDO\\_SAM Package \(Spatial Analysis and Mining\)](#) (page 28-1), perform operations related to location prospecting:

- [SDO\\_SAM.AGGREGATES\\_FOR\\_GEOMETRY](#) (page 28-2)
- [SDO\\_SAM.AGGREGATES\\_FOR\\_LAYER](#) (page 28-4)
- [SDO\\_SAM.TILED\\_AGGREGATES](#) (page 28-12)



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## Extending Spatial Indexing Capabilities

This chapter shows how to create and use spatial indexes on objects other than a geometry column. In other chapters, the focus is on indexing and querying spatial data that is stored in a single column of type SDO\_GEOMETRY. This chapter shows how to:

- Embed an SDO\_GEOMETRY object in a user-defined object type, and index the geometry attribute of that type (see [SDO\\_GEOMETRY Objects in User-Defined Type Definitions](#) (page 9-1))
- Create and use a function-based index where the function returns an SDO\_GEOMETRY object (see [SDO\\_GEOMETRY Objects in Function-Based Indexes](#) (page 9-3))

The techniques in this chapter are intended for experienced and knowledgeable application developers. You should be familiar with the Spatial and Graph concepts and techniques described in other chapters. You should also be familiar with, or able to learn about, relevant Oracle database features, such as user-defined data types and function-based indexing.

### 9.1 SDO\_GEOMETRY Objects in User-Defined Type Definitions

The SDO\_GEOMETRY type can be embedded in a user-defined data type definition. The procedure is very similar to that for using the SDO\_GEOMETRY type for a spatial data column:

1. Create the user-defined data type.
2. Create a table with a column based on that data type.
3. Insert data into the table.
4. Update the USER\_SDO\_GEOM\_METADATA view.
5. Create the spatial index on the geometry attribute.
6. Perform queries on the data.

For example, assume that you want to follow the cola markets scenario in the simplified example in [Simple Example: Inserting, Indexing, and Querying Spatial Data](#) (page 2-1), but want to incorporate the market name attribute and the geometry attribute in a single type. First, create the user-defined data type, as in the following example that creates an object type named MARKET\_TYPE:

```
CREATE OR REPLACE TYPE market_type AS OBJECT
  (name VARCHAR2(32), shape SDO_GEOMETRY);
/
```

Create a table that includes a column based on the user-defined type. The following example creates a table named COLA\_MARKETS\_2 that will contain the same information as the COLA\_MARKETS table used in the example in [Simple Example: Inserting, Indexing, and Querying Spatial Data](#) (page 2-1).

```
CREATE TABLE cola_markets_2 (  
  mkt_id NUMBER PRIMARY KEY,  
  market MARKET_TYPE);
```

Insert data into the table, using the object type name as a constructor. For example:

```
INSERT INTO cola_markets_2 VALUES(  
  1,  
  MARKET_TYPE('cola_a',  
    SDO_GEOMETRY(  
      2003, -- two-dimensional polygon  
      NULL,  
      NULL,  
      SDO_ELEM_INFO_ARRAY(1,1003,3), -- one rectangle (1003 = exterior)  
      SDO_ORDINATE_ARRAY(1,1, 5,7) -- only 2 points needed to  
        -- define rectangle (lower left and upper right)  
    )  
  )  
);
```

Update the USER\_SDO\_GEOM\_METADATA view, using dot-notation to specify the column name and spatial attribute. The following example specifies MARKET.SHAPE as the COLUMN\_NAME (explained in [COLUMN\\_NAME](#) (page 2-48)) in the metadata view.

```
INSERT INTO user_sdo_geom_metadata  
  (TABLE_NAME,  
   COLUMN_NAME,  
   DIMINFO,  
   SRID)  
VALUES (  
  'cola_markets_2',  
  'market.shape',  
  SDO_DIM_ARRAY(  
    SDO_DIM_ELEMENT('X', 0, 20, 0.005),  
    SDO_DIM_ELEMENT('Y', 0, 20, 0.005)  
  ),  
  NULL -- SRID  
);
```

Create the spatial index, specifying the column name and spatial attribute using dot-notation. For example.

```
CREATE INDEX cola_spatial_idx_2  
ON cola_markets_2(market.shape)  
INDEXTYPE IS MDSYS.SPATIAL_INDEX;
```

Perform queries on the data, using dot-notation to refer to attributes of the user-defined type. The following simple query returns information associated with the cola market named cola\_a.

```
SELECT c.mkt_id, c.market.name, c.market.shape  
FROM cola_markets_2 c  
WHERE c.market.name = 'cola_a';
```

The following query returns information associated with all geometries that have any spatial interaction with a specified query window, namely, the rectangle with lower-left coordinates (4,6) and upper-right coordinates (8,8).

```
SELECT c.mkt_id, c.market.name, c.market.shape
FROM cola_markets_2 c
WHERE SDO_RELATE(c.market.shape,
                 SDO_GEOMETRY(2003, NULL, NULL,
                              SDO_ELEM_INFO_ARRAY(1,1003,3),
                              SDO_ORDINATE_ARRAY(4,6, 8,8)),
                 'mask=anyinteract' = 'TRUE');
```

## 9.2 SDO\_GEOMETRY Objects in Function-Based Indexes

A function-based spatial index facilitates queries that use locational information (of type SDO\_GEOMETRY) returned by a function or expression. In this case, the spatial index is created based on the precomputed values returned by the function or expression.

If you are not already familiar with function-based indexes, see the following for detailed explanations of their benefits, options, and requirements, as well as usage examples:

- *Oracle Database Development Guide*
- *Oracle Database Administrator's Guide*

The procedure for using an SDO\_GEOMETRY object in a function-based index is as follows:

1. Create the function that returns an SDO\_GEOMETRY object.  
The function must be declared as DETERMINISTIC.
2. If the spatial data table does not already exist, create it, and insert data into the table.
3. Update the USER\_SDO\_GEOM\_METADATA view.
4. Create the spatial index.  
For a function-based spatial index, the number of parameters must not exceed 32.
5. Perform queries on the data.

The rest of this section describes two examples of using function-based indexes. In both examples, a function is created that returns an SDO\_GEOMETRY object, and a spatial index is created on that function. In the first example, the input parameters to the function are a standard Oracle data type (NUMBER). In the second example, the input to the function is a user-defined object type.

### 9.2.1 Example: Function with Standard Types

In the following example, the input parameters to the function used for the function-based index are standard numeric values (longitude and latitude).

Assume that you want to create a function that returns the longitude and latitude of a point and to use that function in a spatial index. First, create the function, as in the following example that creates a function named GET\_LONG\_LAT\_PT:

```
-- Create a function to return a point geometry (SDO_GTYPE = 2001) with
-- input of 2 numbers: longitude and latitude (SDO_SRID = 8307, for
-- "Longitude / Latitude (WGS 84)", probably the most widely used
-- coordinate system, and the one used for GPS devices.
-- Specify DETERMINISTIC for the function.

create or replace function get_long_lat_pt(longitude in number,
                                           latitude in number)
return SDO_GEOMETRY deterministic is
begin
    return sdo_geometry(2001, 8307,
        sdo_point_type(longitude, latitude, NULL), NULL, NULL);
end;
/
```

If the spatial data table does not already exist, create the table and add data to it, as in the following example that creates a table named LONG\_LAT\_TABLE:

```
create table LONG_LAT_TABLE
(lon number, lat number, name varchar2(32));

insert into LONG_LAT_TABLE values (10,10, 'Place1');
insert into LONG_LAT_TABLE values (20,20, 'Place2');
insert into LONG_LAT_TABLE values (30,30, 'Place3');
```

Update the USER\_SDO\_GEOM\_METADATA view, using dot-notation to specify the schema name and function name. The following example specifies SCOTT.GET\_LONG\_LAT\_PT(LON,LAT) as the COLUMN\_NAME (explained in [COLUMN\\_NAME](#) (page 2-48)) in the metadata view.

```
-- Set up the metadata entry for this table.
-- The column name sets up the function on top
-- of the two columns used in this function,
-- along with the owner of the function.
insert into user_sdo_geom_metadata values('LONG_LAT_TABLE',
    'scott.get_long_lat_pt(lon,lat)',
    sdo_dim_array(
        sdo_dim_element('Longitude', -180, 180, 0.005),
        sdo_dim_element('Latitude', -90, 90, 0.005)), 8307);
```

Create the spatial index, specifying the function name with parameters. For example:

```
create index LONG_LAT_TABLE_IDX on
    LONG_LAT_TABLE(get_long_lat_pt(lon,lat))
indextype is mdsys.spatial_index;
```

Perform queries on the data. The following example specifies the user-defined function in a call to the [SDO\\_FILTER](#) (page 18-8) operator.

```
select name from LONG_LAT_TABLE a
where sdo_filter(
    get_long_lat_pt(a.lon,a.lat),
    sdo_geometry(2001, 8307, sdo_point_type(10,10,NULL), NULL, NULL)
)='TRUE';

NAME
-----
Place1
```

## 9.2.2 Example: Function with a User-Defined Object Type

In the following example, the input parameter to the function used for the function-based index is an object of a user-defined type that includes the longitude and latitude.

Assume that you want to create a function that returns the longitude and latitude of a point and to create a spatial index on that function. First, create the user-defined data type, as in the following example that creates an object type named LONG\_LAT and its member function GetGeometry:

```
create type long_lat as object (
    longitude number,
    latitude number,
    member function GetGeometry(SELF in long_lat)
RETURN SDO_GEOMETRY DETERMINISTIC)
/

create or replace type body long_lat as
    member function GetGeometry(self in long_lat)
    return SDO_GEOMETRY is
    begin
        return sdo_geometry(2001, 8307,
            sdo_point_type(longitude, latitude, NULL), NULL,NULL);
    end;
end;
/
```

If the spatial data table does not already exist, create the table and add data to it, as in the following example that creates a table named TEST\_LONG\_LAT:

```
create table test_long_lat
(location long_lat, name varchar2(32));

insert into test_long_lat values (long_lat(10,10), 'Place1');
insert into test_long_lat values (long_lat(20,20), 'Place2');
insert into test_long_lat values (long_lat(30,30), 'Place3');
```

Update the USER\_SDO\_GEOM\_METADATA view, using dot-notation to specify the schema name, table name, and function name and parameter value. The following example specifies SCOTT.LONG\_LAT.GetGeometry(LOCATION) as the COLUMN\_NAME (explained in [COLUMN\\_NAME](#) (page 2-48)) in the metadata view.

```
insert into user_sdo_geom_metadata values('test_long_lat',
    'scott.long_lat.GetGeometry(location)',
    sdo_dim_array(
        sdo_dim_element('Longitude', -180, 180, 0.005),
        sdo_dim_element('Latitude', -90, 90, 0.005)), 8307);
```

Create the spatial index, specifying the column name and function name using dot-notation. For example:

```
create index test_long_lat_idx on test_long_lat(location.GetGeometry())
indextype is mdsys.spatial_index;
```

Perform queries on the data. The following query performs a primary filter operation, asking for the names of geometries that are likely to interact spatially with point (10,10).

```
SELECT a.name FROM test_long_lat a
WHERE SDO_FILTER(a.location.GetGeometry(),
                SDO_GEOMETRY(2001, 8307,
                            SDO_POINT_TYPE(10,10,NULL), NULL, NULL)
                ) = 'TRUE';
```



# Part II

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## Spatial Web Services

This document has the following parts:

- [Conceptual and Usage Information](#) (page 1) provides conceptual and usage information about Oracle Spatial and Graph.
- Part II provides conceptual and usage information about Oracle Spatial and Graph web services.
- [Reference Information](#) (page 1) provides reference information about Oracle Spatial and Graph operators, functions, and procedures.
- [Supplementary Information](#) (page 1) provides supplementary information (appendixes and a glossary).

Part II contains the following chapters:

- [Introduction to Spatial Web Services](#) (page 10-1)
- [Geocoding Address Data](#) (page 11-1)
- [Business Directory \(Yellow Pages\) Support](#) (page 12-1)
- [Routing Engine](#) (page 13-1)
- [OpenLS Support](#) (page 14-1)
- [Web Feature Service \(WFS\) Support](#) (page 15-1)
- [Catalog Services for the Web \(CSW\) Support](#) (page 16-1)



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## Introduction to Spatial Web Services

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This chapter introduces the Oracle Spatial and Graph support for spatial web services. A web service enables developers of Oracle Spatial and Graph applications to provide feature data and metadata to their application users over the web.

This chapter contains the following major sections:

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**Note:**

If you are using Spatial and Graph Web Feature Service (WFS) or Catalog Services for the Web (CSW) support, and if you have data from a previous release that was indexed using one or more SYS.XMLTABLEINDEX indexes, you must drop the associated indexes **before** the upgrade and re-create the indexes after the upgrade.

For more information, see [Index Maintenance Before and After an Upgrade \(WFS and CSW\)](#) (page A-2).

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- [Types of Spatial Web Services](#) (page 10-1)
- [Types of Users of Spatial Web Services](#) (page 10-2)
- [Setting Up the Client for Spatial Web Services](#) (page 10-2)
- [Demo Files for Sample Java Client](#) (page 10-5)

### 10.1 Types of Spatial Web Services

Oracle Spatial and Graph provides the following types of web services:

- Geocoding, which enables users to associate spatial locations (longitude and latitude coordinates) with postal addresses. Geocoding support is explained in [Geocoding Address Data](#) (page 11-1).
- Yellow Pages, which enables users to find businesses by name or category based on their relationship to a location. Yellow Pages support is explained in [Business Directory \(Yellow Pages\) Support](#) (page 12-1).
- Routing, which provides driving information and instructions for individual or multiple routes. Routing support is explained in [Routing Engine](#) (page 13-1).
- OpenLS, which provides location-based services based on the Open Location Services Initiative (OpenLS) specification for geocoding, mapping, routing, and yellow pages. OpenLS support is explained in [OpenLS Support](#) (page 14-1).

- Web Feature Services (WFS), which enables users to find features (roads, rivers, and so on) based on their relationship to a location or a nonspatial attribute. WFS support is explained in [Web Feature Service \(WFS\) Support](#) (page 15-1).
- Catalog Services for the Web (CSW), which describes the Oracle Spatial and Graph implementation of the Open GIS Consortium specification for catalog services. According to this specification: "Catalogue services support the ability to publish and search collections of descriptive information (metadata) for data, services, and related information objects." CSW support is explained in [Catalog Services for the Web \(CSW\) Support](#) (page 16-1).

## 10.2 Types of Users of Spatial Web Services

In the general business sense of the word "user," implementing any spatial web services application involves the following kinds of people:

- Administrators set up the web services infrastructure. Administrators might create database users, grant privileges and access rights to new and existing database users, and do other operations that affect multiple database users. For web feature services, administrators register feature tables, publish feature types, and unlock certain accounts.

For example, an administrator might set up the infrastructure to enable access to spatial features, such as roads and rivers.

- Application developers create and manage the spatial data and metadata. They create spatial data tables, create spatial indexes, insert rows into the `USER_SDO_GEOM_METADATA` view, and use spatial functions and procedures to implement the application logic.

For example, an application developer might create tables of roads and rivers, and implement application logic that enables end users to find roads and rivers based on spatial query criteria.

- End users access the services through their web browsers.

For example, an end user might ask for all roads that are within one mile of a specific river or that intersect (cross) that river.

From the perspective of an administrator, application developers and end users are all "users" because database users must be created to accommodate their needs.

Application developers will connect to the database as users with sufficient privileges to create and manage spatial tables and to use Oracle Spatial and Graph functions and procedures. End users will access the database through a database user with limited access privileges, typically read-only access to data or limited write access.

The chapters about Spatial and Graph web services are written for administrators and application developers, not for end users.

## 10.3 Deploying and Configuring Spatial Web Services

This topic describes actions that apply to deploying and configuring spatial web services, and particularly WFS, WCS, and CSW. These services are implemented as Java web applications and can be deployed to run on WebLogic 12.1.3 or later. The required Java version is JDK 1.8 or later. They are packaged in the `sdows.ear.zip` file.

- WFS, CSW, and CSW are packaged in the `sdows.ear.zip` file.

- The Geocoder service is packaged in the `geocoder.ear.zip` file.
- The Routing Engine is packaged in the `routeserver.ear.zip` file.

In addition to the “general” instructions in this topic, see the chapter about each specific spatial web service that you plan to use for any additional deployment and configuration tasks.

Deploying any Oracle Spatial and Graph web services includes the following major tasks.

1. Preparing WebLogic Server (Version 12.1.3 or Later)
2. Creating a Domain on WebLogic Server
3. Unpacking the `sdows.ear.zip` File (WFS, WCS, CSW)
4. Deploying Spatial Web Services on WebLogic Server and Editing the `web.xml` File
5. Ensuring the Web Service Web Project is in the Active State
6. Configuring Each Spatial Web Service

### Preparing WebLogic Server (Version 12.1.3 or Later)

Before you deploy the web service engine, it is recommended that you create a managed server in WebLogic Server.

For the Web Service Engine to be successfully deployed on a managed server, a WebLogic domain must be created.

### Creating a Domain on WebLogic Server

You must ensure that a domain exists for web services on WebLogic Server. To create a spatial domain, follow these steps.

1. Log in to the WebLogic Server console.
2. Select **Create a New WebLogic Domain**, and click **Next**.
3. Select **Domain Source: Generate a Domain Configured Automatically**, and click **Next**.
4. Configure the Administrator Username and Password, and click **Next**.
5. For **Server Start Mode**, select **Development** or **Production**.
6. For **JDK**, select one of the available JDKs.
7. For **Customize Environment** and **Service Settings**, either accept the default values or specify any customizations.
8. On the Create WebLogic Domain page, click **Create**, then **Next**.
9. On the Creating Domain page, click **Done**.

For more information about creating and configuring a domain, see the WebLogic Server documentation.

### Unpacking the sdows.ear.zip File (WFS, WCS, CSW)

Before anyone can use Spatial and Graph WFS, WCS, and CSW services, you, as an administrator with the DBA role, must ensure that the `sdows.ear.zip` file, found in `$ORACLE_HOME/md/jlib`, is unzipped into a desired directory before deployment. The resulting path should end with an `sdows.ear` directory, which is sometimes referred to as the `sdows exploded` directory.

### Deploying Spatial Web Services on WebLogic Server and Editing the web.xml File

Spatial web services should be deployed as an exploded directory because log files are generated inside this directory.

For backward compatibility for WFS service only (because WCS 2.0.1 and CSW 2.0.2 are newly added services as of Release 12.2), if you prefer `SpatialWS-SpatialWS-context-root` (or any other preferred root name), then in the `web.xml` file, for the `<env-entry-name>oracle/spatial/ws/publish_url_as/contextPath</env-entry-name>` element, specify the desired value in its `<env-entry-value>` element. In this case, also modify these other files to reflect a root other than the default `oraclespatial: application.xml, context.xml, weblogic.xml, wfs.wsdl` and `csw202.wsdl`.

Similarly, if you need to change the servlet path for WFS, WCS, or CSW, all relevant `<env-entry-name>` and `<env-entry-type>` elements in the `web.xml` file must specify the desired values. For example:

```
<env-entry-name>oracle/spatial/ws/publish_url_as/servletPath/wfs</env-entry-name>
<env-entry-type>java.lang.String</env-entry-type>
```

```
<env-entry-name>oracle/spatial/ws/publish_url_as/servletPath/csw</env-entry-name>
<env-entry-type>java.lang.String</env-entry-type>
```

```
<env-entry-name>oracle/spatial/ws/publish_url_as/servletPath/wcs</env-entry-name>
<env-entry-type>java.lang.String</env-entry-type>
```

If a proxy server is used as an intermediary for requests from clients, the following `env-entry` elements in the `web.xml` file should be edited.

- `oracle/spatial/ws/publish_url_as/host`
- `oracle/spatial/ws/publish_url_as/port`
- `oracle/spatial/ws/publish_url_as/protocol`
- `oracle/spatial/ws/publish_url_as/contextPath`
- `oracle/spatial/ws/publish_url_as/servletPath/ws`
- `oracle/spatial/ws/publish_url_as/servletPath/wfs`
- `oracle/spatial/ws/publish_url_as/servletPath/csw`
- `oracle/spatial/ws/publish_url_as/servletPath/wcs`
- `oracle/spatial/ws/publish_url_as/xmlservletPath/ws`
- `oracle/spatial/ws/publish_url_as/xmlservletPath/wfs`
- `oracle/spatial/ws/publish_url_as/xmlservletPath/csw`

- `oracle/spatial/ws/publish_url_as/xmlservletPath/wcs`

To deploy a spatial web service on WebLogic Server, follow these steps.

1. Log in to the WLS console
2. Click **Deployments**, then **Install**.
3. Ensure that **Path** is set to the application deployment (Exploded Archive) directory.
4. Select `sdows.ear` (a directory), and click **Next**.
5. Ensure that the **Install this deployment as an application** targeting style is selected, and click **Next**.
6. In the list of potential servers to which to deploy the WFS Engine, select the name of the managed server that you created, select **I will make the deployment accessible from the following location**, enter the **Exploded Archive (Application deployment) Directory**, and click **Next**.
7. Ensure that the deployment name is `sdows`, and click **Finish**.

### Ensuring the Web Service Web Project is in the Active State

After completing the necessary steps for a spatial web service, check on the Deployments page that the application is in the **Active** state.

If it is in the **Prepared** state, click **Start** to start the application.

### Configuring Each Spatial Web Service

The next step is to configure each spatial web service that you will use (such as WFS, WCS, or CSW) independently. You must perform specific tasks that depend on which web services you will be supporting for use in your environment. You will probably need to create and grant privileges to database users. You may need to download and load special data (such as for geocoding), modify configuration files or create data sources in WebLogic Server.

See the chapter for each relevant spatial web service for instructions specific to that service.

## 10.4 Demo Files for Sample Java Client

To help you get started with spatial web services, Oracle supplies a `.jar` file (`wsclient.jar`) with the source code and related files for setting up a sample Java client. To use this file, follow these steps:

1. Find `wsclient.jar` under the Spatial and Graph demo directory.
2. Expand (unzip) `wsclient.jar` into a directory of your choice.  
The top-level directory for all the files in the `.jar` file is named `src`.
3. In the `src` directory, read the file named `Readme.txt` and follow its instructions.  
The `Readme.txt` file contains detailed explanations and guidelines.





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## Geocoding Address Data

Geocoding is the process of associating spatial locations (longitude and latitude coordinates) with postal addresses. This chapter includes the following major sections:

- [Concepts for Geocoding](#) (page 11-1)
- [Data Types for Geocoding](#) (page 11-6)
- [Using the Geocoding Capabilities](#) (page 11-10)
- [Geocoding from a Place Name](#) (page 11-10)
- [Data Structures for Geocoding](#) (page 11-11)
- [Using the Geocoding Service \(XML API\)](#) (page 11-33)

### 11.1 Concepts for Geocoding

This section describes concepts that you must understand before you use the Spatial and Graph geocoding capabilities.

#### 11.1.1 Address Representation

Addresses to be geocoded can be represented either as formatted addresses or unformatted addresses.

A **formatted address** is described by a set of attributes for various parts of the address, which can include some or all of those shown in [Table 11-1](#) (page 11-1).

**Table 11-1** *Attributes for Formal Address Representation*

Address Attribute	Description
Name	Place name (optional).
Intersecting street	Intersecting street name (optional).
Street	Street address, including the house or building number, street name, street type (Street, Road, Blvd, and so on), and possibly other information.  In the current release, the first four characters of the street name must match a street name in the geocoding data for there to be a potential street name match.
Settlement	The lowest-level administrative area to which the address belongs. In most cases it is the city. In some European countries, the settlement can be an area within a large city, in which case the large city is the municipality.

**Table 11-1 (Cont.) Attributes for Formal Address Representation**

Address Attribute	Description
Municipality	The administrative area above settlement. Municipality is not used for United States addresses. In European countries where cities contain settlements, the municipality is the city.
Region	The administrative area above municipality (if applicable), or above settlement if municipality does not apply. In the United States, the region is the state; in some other countries, the region is the province.
Postal code	Postal code (optional if administrative area information is provided). In the United States, the postal code is the 5-digit ZIP code.
Postal add-on code	String appended to the postal code. In the United States, the postal add-on code is typically the last four numbers of a 9-digit ZIP code specified in "5-4" format.
Country	The country name or ISO country code.

Formatted addresses are specified using the SDO\_GEO\_ADDR data type, which is described in [SDO\\_GEO\\_ADDR Type](#) (page 11-6).

An **unformatted address** is described using lines with information in the postal address format for the relevant country. The address lines must contain information essential for geocoding, and they might also contain information that is not needed for geocoding (something that is common in unprocessed postal addresses). An unformatted address is stored as an array of strings. For example, an address might consist of the following strings: '22 Monument Square' and 'Concord, MA 01742'.

Unformatted addresses are specified using the SDO\_KEYWORDARRAY data type, which is described in [SDO\\_KEYWORDARRAY Type](#) (page 11-9).

## 11.1.2 Match Modes

The match mode for a geocoding operation determines how closely the attributes of an input address must match the data being used for the geocoding. Input addresses can include different ways of representing the same thing (such as *Street* and the abbreviation *St*), and they can include minor errors (such as the wrong postal code, even though the street address and city are correct and the street address is unique within the city).

You can require an exact match between the input address and the data used for geocoding, or you can relax the requirements for some attributes so that geocoding can be performed despite certain discrepancies or errors in the input addresses. [Table 11-2](#) (page 11-3) lists the match modes and their meanings. Use a value from this table with the `MatchMode` attribute of the SDO\_GEO\_ADDR data type (described in [SDO\\_GEO\\_ADDR Type](#) (page 11-6)) and for the `match_mode` parameter of a geocoding function or procedure.

**Table 11-2 Match Modes for Geocoding Operations**

Match Mode	Description
EXACT	All attributes of the input address must match the data used for geocoding. However, if the house or building number, base name (street name), street type, street prefix, and street suffix do not all match the geocoding data, a location in the first match found in the following is returned: postal code, city or town (settlement) within the state, and state. For example, if the street name is incorrect but a valid postal code is specified, a location in the postal code is returned.
RELAX_STREET_TYPE	The street type can be different from the data used for geocoding. For example, if <i>Main St</i> is in the data used for geocoding, <i>Main Street</i> would also match that, as would <i>Main Blvd</i> if there was no <i>Main Blvd</i> and no other street type named <i>Main</i> in the relevant area.
RELAX_POI_NAME	The name of the point of interest does not have to match the data used for geocoding. For example, if <i>Jones State Park</i> is in the data used for geocoding, <i>Jones State Pk</i> and <i>Jones Park</i> would also match as long as there were no ambiguities or other matches in the data.
RELAX_HOUSE_NUMBER	The house or building number and street type can be different from the data used for geocoding. For example, if <i>123 Main St</i> is in the data used for geocoding, <i>123 Main Lane</i> and <i>124 Main St</i> would also match as long as there were no ambiguities or other matches in the data.
RELAX_BASE_NAME	The base name of the street, the house or building number, and the street type can be different from the data used for geocoding. For example, if <i>Pleasant Valley</i> is the base name of a street in the data used for geocoding, <i>Pleasant Vale</i> would also match as long as there were no ambiguities or other matches in the data.
RELAX_POSTAL_CODE	The postal code (if provided), base name, house or building number, and street type can be different from the data used for geocoding.
RELAX_BUILTUP_AREA	The address can be outside the city specified as long as it is within the same county. Also includes the characteristics of RELAX_POSTAL_CODE.
RELAX_ALL	Equivalent to RELAX_BUILTUP_AREA.
DEFAULT	Equivalent to RELAX_POSTAL_CODE.

### 11.1.3 Match Codes

The match code is a number indicating which input address attributes matched the data used for geocoding. The match code is stored in the `MatchCode` attribute of the output `SDO_GEO_ADDR` object (described in [SDO\\_GEO\\_ADDR Type](#) (page 11-6)).

[Table 11-3](#) (page 11-4) lists the possible match code values.

**Table 11-3 Match Codes for Geocoding Operations**

Match Code	Description
1	Exact match: the city name, postal code, street base name, street type (and suffix or prefix or both, if applicable), and house or building number match the data used for geocoding.
2	The city name, postal code, street base name, and house or building number match the data used for geocoding, but the street type, suffix, or prefix does not match.
3	The city name, postal code, and street base name match the data used for geocoding, but the house or building number does not match.
4	The city name and postal code match the data used for geocoding, but the street address does not match.
10	The city name matches the data used for geocoding, but the postal code does not match.
11	The postal code matches the data used for geocoding, but the city name does not match.
12	The region matches the data in the geocoder schema, but the city name and postal code do not match.

#### 11.1.4 Error Messages for Output Geocoded Addresses

---

**Note:**

You are encouraged to use the `MatchVector` attribute (see [Match Vector for Output Geocoded Addresses](#) (page 11-5)) instead of the `ErrorMessage` attribute, which is described in this section.

---

For an output geocoded address, the `ErrorMessage` attribute of the `SDO_GEO_ADDR` object (described in [SDO\\_GEO\\_ADDR Type](#) (page 11-6)) contains a string that indicates which address attributes have been matched against the data used for geocoding. Before the geocoding operation begins, the string is set to the value `??????????281C??`; and the value is modified to reflect which attributes have been matched.

[Table 11-4](#) (page 11-4) lists the character positions in the string and the address attribute corresponding to each position. It also lists the character value that the position is set to if the attribute is matched.

**Table 11-4 Geocoded Address Error Message Interpretation**

Position	Attribute	Value If Matched
1-2	(Reserved for future use)	??
3	Address point	X
4	POI name	O

**Table 11-4 (Cont.) Geocoded Address Error Message Interpretation**

Position	Attribute	Value If Matched
5	House or building number	#
6	Street prefix	E
7	Street base name	N
8	Street suffix	U
9	Street type	T
10	Secondary unit	S
11	Built-up area or city	B
12-13	(Reserved)	(Ignore any values in these positions.)
14	Region	1
15	Country	C
16	Postal code	P
17	Postal add-on code	A

### 11.1.5 Match Vector for Output Geocoded Addresses

For an output geocoded address, the `MatchVector` attribute of the `SDO_GEO_ADDR` object (described in [SDO\\_GEO\\_ADDR Type](#) (page 11-6)) contains a string that indicates how each address attribute has been matched against the data used for geocoding. It gives more accurate and detailed information about the match status of each address attribute than the `ErrorMessage` attribute (described in [Error Messages for Output Geocoded Addresses](#) (page 11-4)). Before the geocoding operation begins, the string is set to the value `????????????????`. Each character of this string indicates the match status of an address attribute.

[Table 11-5](#) (page 11-5) lists the character positions in the string and the address attribute corresponding to each position. Following the table is an explanation of what the value in each character position represents.

**Table 11-5 Geocoded Address Match Vector Interpretation**

Position	Attribute
1-2	(Reserved for future use)
3	Address point
4	POI name
5	House or building number
6	Street prefix
7	Street base name

**Table 11-5 (Cont.) Geocoded Address Match Vector Interpretation**

Position	Attribute
8	Street suffix
9	Street type
10	Secondary unit
11	Built-up area or city
14	Region
15	Country
16	Postal code
17	Postal add-on code

Each character position in [Table 11-5](#) (page 11-5) can have one of the following possible numeric values:

- 0: The input attribute is not null and is matched with a non-null value.
- 1: The input attribute is null and is matched with a null value.
- 2: The input attribute is not null and is replaced by a different non-null value.
- 3: The input attribute is not null and is replaced by a null value.
- 4: The input attribute is null and is replaced by a non-null value.

## 11.2 Data Types for Geocoding

This section describes the data types specific to geocoding functions and procedures.

### 11.2.1 SDO\_GEO\_ADDR Type

The SDO\_GEO\_ADDR object type is used to describe an address. When a geocoded address is output by an SDO\_GCDR function or procedure, it is stored as an object of type SDO\_GEO\_ADDR.

[Table 11-6](#) (page 11-6) lists the attributes of the SDO\_GEO\_ADDR type. Not all attributes will be relevant in any given case. The attributes used for a returned geocoded address depend on the geographical context of the input address, especially the country.

**Table 11-6 SDO\_GEO\_ADDR Type Attributes**

Attribute	Data Type	Description
Id	NUMBER	(Not used.)
AddressLines	SDO_KEYWORDARRAY	Address lines. (The SDO_KEYWORDARRAY type is described in <a href="#">SDO_KEYWORDARRAY Type</a> (page 11-9).)

**Table 11-6 (Cont.) SDO\_GEO\_ADDR Type Attributes**

Attribute	Data Type	Description
PlaceName	VARCHAR2(200)	Point of interest (POI) name. Example: <i>CALIFORNIA PACIFIC MEDICAL CTR</i>
StreetName	VARCHAR2(200)	Street name, including street type. Example: <i>MAIN ST</i>
IntersectStreet	VARCHAR2(200)	Intersecting street.
SecUnit	VARCHAR2(200)	Secondary unit, such as an apartment number or building number.
Settlement	VARCHAR2(200)	Lowest-level administrative area to which the address belongs. (See <a href="#">Table 11-1</a> (page 11-1).)
Municipality	VARCHAR2(200)	Administrative area above settlement. (See <a href="#">Table 11-1</a> (page 11-1).)
Region	VARCHAR2(200)	Administrative area above municipality (if applicable), or above settlement if municipality does not apply. (See <a href="#">Table 11-1</a> (page 11-1).)
Country	VARCHAR2(100)	Country name or ISO country code.
PostalCode	VARCHAR2(20)	Postal code (optional if administrative area information is provided). In the United States, the postal code is the 5-digit ZIP code.
PostalAddOnCode	VARCHAR2(20)	String appended to the postal code. In the United States, the postal add-on code is typically the last four numbers of a 9-digit ZIP code specified in "5-4" format.
FullPostalCode	VARCHAR2(20)	Full postal code, including the postal code and postal add-on code.
POBox	VARCHAR2(100)	Post Office box number.
HouseNumber	VARCHAR2(100)	House or building number. Example: <i>123</i> in <i>123 MAIN ST</i>
BaseName	VARCHAR2(200)	Base name of the street. Example: <i>MAIN</i> in <i>123 MAIN ST</i>
StreetType	VARCHAR2(20)	Type of the street. Example: <i>ST</i> in <i>123 MAIN ST</i>
StreetTypeBefore	VARCHAR2(1)	(Not used.)
StreetTypeAttached	VARCHAR2(1)	(Not used.)
StreetPrefix	VARCHAR2(20)	Prefix for the street. Example: <i>S</i> in <i>123 S MAIN ST</i>
StreetSuffix	VARCHAR2(20)	Suffix for the street. Example: <i>NE</i> in <i>123 MAIN ST NE</i>

**Table 11-6 (Cont.) SDO\_GEO\_ADDR Type Attributes**

Attribute	Data Type	Description
Side	VARCHAR2(1)	Side of the street (L for left or R for right) that the house is on when you are traveling along the road segment following its orientation (that is, from its start node toward its end node). The house numbers may be increasing or decreasing.
Percent	NUMBER	Number from 0 to 1 (multiply by 100 to get a percentage value) indicating how far along the street you are when traveling following the road segment orientation.
EdgeID	NUMBER	Edge ID of the road segment.
ErrorMessage	VARCHAR2(20)	Error message (see <a href="#">Error Messages for Output Geocoded Addresses</a> (page 11-4)). Note: You are encouraged to use the MatchVector attribute instead of the ErrorMessage attribute.
MatchCode	NUMBER	Match code (see <a href="#">Match Codes</a> (page 11-3)).
MatchMode	VARCHAR2(30)	Match mode (see <a href="#">Match Modes</a> (page 11-2)).
Longitude	NUMBER	Longitude coordinate value.
Latitude	NUMBER	Latitude coordinate value.
MatchVector	VARCHAR2(20)	A string that indicates how each address attribute has been matched against the data used for geocoding (see <a href="#">Match Vector for Output Geocoded Addresses</a> (page 11-5)).

You can return the entire SDO\_GEO\_ADDR object, or you can specify an attribute using standard "dot" notation. [Example 11-1](#) (page 11-8) contains statements that geocode the address of the San Francisco City Hall; the first statement returns the entire SDO\_GEO\_ADDR object, and the remaining statements return some specific attributes.

**Example 11-1 Geocoding, Returning Address Object and Specific Attributes**

```

SELECT SDO_GCDR.GEOCODE('SCOTT',
  SDO_KEYWORDARRAY('1 Carlton B Goodlett Pl', 'San Francisco, CA 94102'),
  'US', 'RELAX_BASE_NAME') FROM DUAL;

SDO_GCDR.GEOCODE('SCOTT',SDO_KEYWORDARRAY('1CARLTONBGODLETTPL','SANFRANCISCO
-----
SDO_GEO_ADDR(0, SDO_KEYWORDARRAY(), NULL, 'CARLTON B GOODLETT PL', NULL, NULL, '
SAN FRANCISCO', NULL, 'CA', 'US', '94102', NULL, '94102', NULL, '1', 'CARLTON B
GOODLETT', 'PL', 'F', 'F', NULL, NULL, 'L', .01, 23614360, '????#ENUT?B281CP?',
1, 'RELAX_BASE_NAME', -122.41815, 37.7784183, '????0101010??000?')

SELECT SDO_GCDR.GEOCODE('SCOTT',
  SDO_KEYWORDARRAY('1 Carlton B Goodlett Pl', 'San Francisco, CA 94102'),
  'US', 'RELAX_BASE_NAME').StreetType FROM DUAL;

SDO_GCDR.GEOCODE('SCOTT',SDO_KEYWORDARRAY('1CARLTONBGODLETTPL','SANFRANCISCO
-----

```



```

PL

SELECT SDO_GCDR.GEOCODE('SCOTT',
      SDO_KEYWORDARRAY('1 Carlton B Goodlett Pl', 'San Francisco, CA 94102'),
      'US', 'RELAX_BASE_NAME').Side FROM DUAL;

S
-
L

SELECT SDO_GCDR.GEOCODE('SCOTT',
      SDO_KEYWORDARRAY('1 Carlton B Goodlett Pl', 'San Francisco, CA 94102'),
      'US', 'RELAX_BASE_NAME').Percent FROM DUAL;

SDO_GCDR.GEOCODE('SCOTT',SDO_KEYWORDARRAY('1CARLTONBGODLETTPL','SANFRANCISCO
-----
                                           .01

SELECT SDO_GCDR.GEOCODE('SCOTT',
      SDO_KEYWORDARRAY('1 Carlton B Goodlett Pl', 'San Francisco, CA 94102'),
      'US', 'RELAX_BASE_NAME').EdgeID FROM DUAL;

SDO_GCDR.GEOCODE('SCOTT',SDO_KEYWORDARRAY('1CARLTONBGODLETTPL','SANFRANCISCO
-----
                                           23614360

SELECT SDO_GCDR.GEOCODE('SCOTT',
      SDO_KEYWORDARRAY('1 Carlton B Goodlett Pl', 'San Francisco, CA 94102'),
      'US', 'RELAX_BASE_NAME').MatchCode FROM DUAL;

SDO_GCDR.GEOCODE('SCOTT',SDO_KEYWORDARRAY('1CARLTONBGODLETTPL','SANFRANCISCO
-----
                                           1

SELECT SDO_GCDR.GEOCODE('SCOTT',
      SDO_KEYWORDARRAY('1 Carlton B Goodlett Pl', 'San Francisco, CA 94102'),
      'US', 'RELAX_BASE_NAME').MatchVector FROM DUAL;

SDO_GCDR.GEOCODE('SC
-----
????0101010??000?

```

## 11.2.2 SDO\_ADDR\_ARRAY Type

The SDO\_ADDR\_ARRAY type is a VARRAY of SDO\_GEO\_ADDR objects (described in [SDO\\_GEO\\_ADDR Type](#) (page 11-6)) used to store geocoded address results. Multiple address objects can be returned when multiple addresses are matched as a result of a geocoding operation.

The SDO\_ADDR\_ARRAY type is defined as follows:

```
CREATE TYPE sdo_addr_array AS VARRAY(1000) OF sdo_geo_addr;
```

## 11.2.3 SDO\_KEYWORDARRAY Type

The SDO\_KEYWORDARRAY type is a VARRAY of VARCHAR2 strings used to store address lines for unformatted addresses. (Formatted and unformatted addresses are described in [Address Representation](#) (page 11-1).)

The SDO\_KEYWORDARRAY type is defined as follows:

```
CREATE TYPE sdo_keywordarray AS VARRAY(10000) OF VARCHAR2(9000);
```

## 11.3 Using the Geocoding Capabilities

To use the Oracle Spatial and Graph geocoding capabilities, you must use data provided by a geocoding vendor, and the data must be in the format supported by the Oracle Spatial and Graph geocoding feature. For information about geocoding, go to:

database/options

To geocode an address using the geocoding data, use the SDO\_GCDR PL/SQL package subprograms, which are documented in [SDO\\_GCDR Package \(Geocoding\)](#) (page 22-1):

- The [SDO\\_GCDR.GEOCODE](#) (page 22-2) function geocodes an unformatted address to return an SDO\_GEO\_ADDR object.
- The [SDO\\_GCDR.GEOCODE\\_ADDR](#) (page 22-3) function geocodes an input address using attributes in an SDO\_GEO\_ADDR object, and returns the first matched address as an SDO\_GEO\_ADDR object.
- The [SDO\\_GCDR.GEOCODE\\_ADDR\\_ALL](#) (page 22-4) function geocodes an input address using attributes in an SDO\_GEO\_ADDR object, and returns matching addresses as an SDO\_ADDR\_ARRAY object.
- The [SDO\\_GCDR.GEOCODE\\_AS\\_GEOMETRY](#) (page 22-7) function geocodes an unformatted address to return an SDO\_GEOMETRY object.
- The [SDO\\_GCDR.GEOCODE\\_ALL](#) (page 22-5) function geocodes all addresses associated with an unformatted address and returns the result as an SDO\_ADDR\_ARRAY object (an array of address objects).
- The [SDO\\_GCDR.REVERSE\\_GEOCODE](#) (page 22-8) function reverse geocodes a location, specified by its spatial geometry object and country, and returns the result as an SDO\_GEO\_ADDR object.

## 11.4 Geocoding from a Place Name

If you know a place name (point of interest) but not its locality details, you can create a PL/SQL function to construct an SDO\_GEO\_ADDR object from placename and country input parameters, as shown in [Example 11-2](#) (page 11-10), which creates a function named `create_addr_from_placename`. The SELECT statement in this example uses the [SDO\\_GCDR.GEOCODE\\_ADDR](#) (page 22-3) function to geocode the address constructed using the `create_addr_from_placename` function.

### **Example 11-2 Geocoding from a Place Name and Country**

```
create or replace function create_addr_from_placename(  
  placename varchar2,  
  country varchar2)  
  return sdo_geo_addr  
  deterministic  
as  
  addr sdo_geo_addr ;  
begin  
  addr := sdo_geo_addr() ;  
  addr.country := country ;  
  addr.placename := placename ;  
  addr.matchmode := 'default' ;  
  return addr ;
```

```

end;
/

SELECT sdo_gcdr.geocode_addr('SCOTT',
  create_addr_from_placename('CALIFORNIA PACIFIC MEDICAL CTR', 'US'))
FROM DUAL;

```

### **Example 11-3 Geocoding from a Place Name, Country, and Other Fields**

If you know at least some of the locality information, such as settlement, region, and postal code, you can get better performance if you can provide such information.

[Example 11-3](#) (page 11-11) provides an alternate version of the `create_addr_from_placename` function that accepts additional parameters. To call this version of the function, specify actual values for the placename and country parameters, and specify an actual value or a null value for each of the other input parameters.

```

create or replace function create_addr_from_placename(
  placename varchar2,
  city varchar2,
  state varchar2,
  postalcode varchar2,
  country varchar2)
return sdo_geo_addr
deterministic
as
  addr sdo_geo_addr ;
begin
  addr := sdo_geo_addr() ;
  addr.settlement := city ;
  addr.region := state ;
  addr.postalcode := postalcode ;
  addr.country := country ;
  addr.placename := placename ;
  addr.matchmode := 'default' ;
  return addr ;
end;
/

SELECT sdo_gcdr.geocode_addr('SCOTT',
  create_addr_from_placename('CALIFORNIA PACIFIC MEDICAL CTR',
    'san francisco', 'ca', null, 'US')) FROM DUAL;

```

## **11.5 Data Structures for Geocoding**

Oracle uses the following tables for geocoding:

- GC\_PARSER\_PROFILES
- GC\_PARSER\_PROFILEAFS
- GC\_COUNTRY\_PROFILE
- GC\_AREA\_<suffix>
- GC\_POSTAL\_CODE\_<suffix>
- GC\_ROAD\_SEGMENT\_<suffix>
- GC\_ROAD\_<suffix>

- GC\_POI\_<suffix>
- GC\_INTERSECTION\_<suffix>

The GC\_PARSER\_PROFILES and GC\_PARSER\_PROFILEAFS tables store address format definitions of all supported counties. These tables are used by the internal address parser in parsing postal addresses into addressing fields. The data for these two tables is provided by your data provider or by Oracle. (If these tables are not supplied by your data provider, you will need to install and populate them as explained in [Installing the Profile Tables](#) (page 11-33).) The remaining tables store geocoding data provided by data vendors.

Each user that owns the tables containing geocoding data (that is, each user that can be specified with the `username` parameter in a call to an SDO\_GCDR subprogram) must have one GC\_PARSER\_PROFILES table, one GC\_PARSER\_PROFILEAFS table, and one GC\_COUNTRY\_PROFILE table. Each such user can have multiple sets of the other tables (GC\_XXX\_<suffix>). Each set of tables whose names end with the same suffix stores geocoding data of a country. For example, the following set of tables can be used to store geocoding data of the United States:

- GC\_AREA\_US
- GC\_POSTAL\_CODE\_US
- GC\_ROAD\_SEGMENT\_US
- GC\_ROAD\_US
- GC\_POI\_US
- GC\_INTERSECTION\_US

Geocoding data of one country cannot be stored in more than one set of those tables. The table suffix is defined by data vendors and is specified in the GC\_TABLE\_SUFFIX column in the GC\_COUNTRY\_PROFILE table (described in [GC\\_COUNTRY\\_PROFILE Table](#) (page 11-15)).

The following sections describe the vendor-supplied tables that store geocoding data, in alphabetical order by table name.

[Indexes on Tables for Geocoding](#) (page 11-32) describes the indexes that you must create in order to use these tables for geocoding.

### 11.5.1 GC\_ADDRESS\_POINT\_<suffix> Table and Index

The GC\_ADDRESS\_POINT\_<suffix> table (for example, GC\_ADDRESS\_POINT\_US) stores the geographic (latitude, longitude) coordinates for addresses in the country or group of countries associated with the table-name suffix. This table is *not* required for geocoding (although it is required for point-based geocoding); however, it enables the geocoder to provide more accurate location results. It is automatically used when present in the schema. This table contains one row for each address stored in the table, and it contains the columns shown in [Table 11-7](#) (page 11-12).

**Table 11-7 GC\_ADDRESS\_POINT\_<suffix> Table**

Column Name	Data Type	Description
ADDRESS_POINT_ID	NUMBER(10)	ID number of the address point. (Required)

**Table 11-7 (Cont.) GC\_ADDRESS\_POINT\_<suffix> Table**

Column Name	Data Type	Description
ROAD_ID	NUMBER	ID number of the road on which the address point is located. (Required)
ROAD_SEGMENT_ID	NUMBER(10)	ID number of the road segment on the road on which the address point is located. (Required)
SIDE	VARCHAR2(1)	Side of the road on which the address point is located. Possible values: L (left) or R (right). (Required)
LANG_CODE	VARCHAR2(3)	3-letter ISO national language code for the language associated with the address point. (Required)
HOUSE_NUMBER	VARCHAR2(60 CHAR)	House number of the address point; may contain non-numeric characters. (Required)
PERCENT	NUMBER	Decimal fraction of the length of the road segment on which the address point is located. It is computed by dividing the distance from the segment start point to the address point by the length of the road segment. (Required).
ADDR_LONG	NUMBER(10)	Longitude coordinate value of the address point. (Required)
ADDR_LAT	NUMBER(10)	Latitude coordinate value of the address point. (Required)
COUNTRY_CODE_2	VARCHAR2(2)	2-letter ISO country code of the country to which the address point belongs. (Required)
PARTITION_ID	NUMBER	Partition key used for partitioning geocoder data by geographic boundaries. If the data is not partitioned, set the value to 1. (Required)

If you use the GC\_ADDRESS\_POINT\_<suffix> table, you must create an index on the table using a statement in the following form:

```
CREATE INDEX idx_<suffix>_addrpt_addr ON gc_address_point_<suffix> (road_segment_id, road_id, house_number, side);
```

### 11.5.2 GC\_AREA\_<suffix> Table

The GC\_AREA\_<suffix> table (for example, CG\_AREA\_US) stores administration area information for the country associated with the table name suffix. This table contains one row for each administration area, and it contains the columns shown in [Table 11-8](#) (page 11-13).

**Table 11-8 GC\_AREA\_<suffix> Table**

Column Name	Data Type	Description
AREA_ID	NUMBER(10)	Area ID number. (Required)
AREA_NAME	VARCHAR2(64)	Area name. (Required)

**Table 11-8 (Cont.) GC\_AREA\_<suffix> Table**

Column Name	Data Type	Description
LANG_CODE	VARCHAR2(3)	3-letter ISO national language code for the language associated with the area. (Required)
ADMIN_LEVEL	NUMBER(1)	Administration hierarchy level for the area. (Required)
LEVEL1_AREA_ID	NUMBER(10)	ID of the level-1 area to which the area belongs. In the administration hierarchy, the level-1 area is the country. (Required)
LEVEL2_AREA_ID	NUMBER(10)	ID of the level-2 area to which the area belongs, if applicable. You must specify an area ID for each level in the administration hierarchy to which this area belongs. (Optional)
LEVEL3_AREA_ID	NUMBER(10)	ID of the level-3 area to which the area belongs, if applicable. You must specify an area ID for each level in the administration hierarchy to which this area belongs. (Optional)
LEVEL4_AREA_ID	NUMBER(10)	ID of the level-4 area to which the area belongs, if applicable. You must specify an area ID for each level in the administration hierarchy to which this area belongs. (Optional)
LEVEL5_AREA_ID	NUMBER(10)	ID of the level-5 area to which the area belongs, if applicable. You must specify an area ID for each level in the administration hierarchy to which this area belongs. (Optional)
LEVEL6_AREA_ID	NUMBER(10)	ID of the level-6 area to which the area belongs, if applicable. You must specify an area ID for each level in the administration hierarchy to which this area belongs. (Optional)
LEVEL7_AREA_ID	NUMBER(10)	ID of the level-7 area to which the area belongs, if applicable. You must specify an area ID for each level in the administration hierarchy to which this area belongs. (Optional)
CENTER_LONG	NUMBER	Longitude value of the center of the area. The center is set to the closest road segment to the center longitude and latitude values. Oracle recommends that these two attributes be set properly. If these values are not set, the longitude and latitude coordinates of the geocoded result of an area will be (0,0). (Optional)
CENTER_LAT	NUMBER	Latitude value of the center of the area. (See the explanation for the CENTER_LONG column.) (Optional)
ROAD_SEGMENT_ID	NUMBER(10)	ID of the road segment to which the area center is set. This value must be set correctly if the geocoder is intended to work with the Oracle Spatial and Graph routing engine (described in <a href="#">Routing Engine</a> (page 13-1)); otherwise, it can be set to any nonzero value, but it cannot be null. (Required)

**Table 11-8 (Cont.) GC\_AREA\_<suffix> Table**

Column Name	Data Type	Description
POSTAL_CODE	VARCHAR2(16) )	Postal code for the center of the area. Oracle recommends that this attribute be set correctly. If this value is null, the postal code attribute of the geocoded result of an area will be null. (Optional)
COUNTRY_CODE_2	VARCHAR2(2)	2- letter ISO country code of the country to which the area belongs. (Required)
PARTITION_ID	NUMBER	Partition key used for partitioning geocoder data by geographic boundaries. If the data is not partitioned, set the value to 1. (Required)
REAL_NAME	VARCHAR2(64) )	The real name of the area, as spelled using the local language. This column is useful for area names that are not in English. For example, the German name of city MUNICH is MÜNCHEN. It is allowed to be spelled as MUNCHEN, but its REAL_NAME value should be MÜNCHEN. In the area table for Germany, areas with name MÜNCHEN and MUNCHEN both refer to the same area, and they both have the same real name MÜNCHEN. If the area name does not have any non-English characters, set REAL_NAME to be the same as AREA_NAME. (Required)
IS_ALIAS	VARCHAR2(1)	Contains T if this area is an alias of another area that is an officially recognized administrative area; contains F if this area is not an alias of another area that is an officially recognized administrative area. For example, Manhattan is not an officially recognized administrative area, but it is used by the public to refer to a part of New York City. In this case, Manhattan is an alias of New York City. (Required)
NUM_STREETS	NUMBER	The number of streets inside this area. (Optional)

### 11.5.3 GC\_COUNTRY\_PROFILE Table

The GC\_COUNTRY\_PROFILE table stores country profile information used by the geocoder. This information includes administrative-area hierarchy definitions, the national languages, and the table-name suffix used by the data tables and their indexes. This table contains one row for each supported country, and it contains the columns shown in [Table 11-9](#) (page 11-15).

**Table 11-9 GC\_COUNTRY\_PROFILE Table**

Column Name	Data Type	Description
COUNTRY_NAME	VARCHAR2(60) )	Country name. (Required)
COUNTRY_CODE_3	VARCHAR2(3)	3- letter ISO country code. (Required)
COUNTRY_CODE_2	VARCHAR2(2)	2- letter ISO country code. (Required)

**Table 11-9 (Cont.) GC\_COUNTRY\_PROFILE Table**

Column Name	Data Type	Description
LANG_CODE_1	VARCHAR2(3)	3-letter ISO national language code. Some countries might have multiple national languages, in which case LANG_CODE_2 and perhaps other LANG_CODE_ <i>n</i> columns should contain values. (Required)
LANG_CODE_2	VARCHAR2(3)	3-letter ISO national language code. (Optional)
LANG_CODE_3	VARCHAR2(3)	3-letter ISO national language code. (Optional)
LANG_CODE_4	VARCHAR2(3)	3-letter ISO national language code. (Optional)
NUMBER_ADMIN_LEVELS	NUMBER(1)	Number of administration hierarchy levels. A country can have up to 7 administration area levels, numbered from 1 to 7 (largest to smallest). The top level area (country) is level 1. For the United States, the administration hierarchy is as follows: level 1 = country, level 2 = state, level 3 = county, level 4 = city. (Required)
SETTLEMENT_LEVEL	NUMBER(1)	Administration hierarchy level for a settlement, which is the lowest area level used in addressing. In the United States, this is the city level; in Europe, this is generally a subdivision of a city (level 5). (Required)
MUNICIPALITY_LEVEL	NUMBER(1)	Administration hierarchy level for a municipality, which is the second-lowest area level used in addressing. In the United States, this is the county (level 3); in Europe, this is generally a city (level 4). (Optional)
REGION_LEVEL	NUMBER(1)	Administrative level for the region, which is above the municipality level. In the United States, this is the state or third-lowest area level used in addressing (level 2); in Europe, this is a recognized subdivision of the country (level 2 or level 3). (Optional)
SETTLEMENT_IS_OPTIONAL	VARCHAR2(1)	Contains T if settlement information is optional in the address data; contains F if settlement information is not optional (that is, is required) in the address data. (Required)
MUNICIPALITY_IS_OPTIONAL	VARCHAR2(1)	Contains T if municipality information is optional in the address data; contains F if municipality information is not optional (that is, is required) in the address data. (Required)
REGION_IS_OPTIONAL	VARCHAR2(1)	Contains T if region information is optional in the address data; contains F if region information is not optional (that is, is required) in the address data. (Required)
POSTCODE_IN_SETTLEMENT	VARCHAR(1)	Contains T if each postal code must be completely within a settlement area; contains F if a postal code can include areas from multiple settlements. (Required)



**Table 11-9 (Cont.) GC\_COUNTRY\_PROFILE Table**

Column Name	Data Type	Description
SETTLEMENT_A S_CITY	VARCHAR(1)	Contains T if a city name can identify both a municipality and a settlement; contains F if a city name can identify only a settlement. For example, in the United Kingdom, London can be both the name of a municipality area and the name of a settlement area, which is inside the municipality of London. This is common in large cities in some European countries, such as the UK and Belgium. (Required)
CACHED_ADMI N_AREA_LEVEL	NUMBER	(Reserved for future use.)
GC_TABLE_SUFF IX	VARCHAR2(5)	Table name suffix identifying the country for the GC_* data tables. For example, if the value of GC_TABLE_SUFFIX is US, the names of tables with geocoding data for this country end with _US (for example, CG_AREA_US). (Required)
CENTER_LONG	NUMBER	Longitude value of the center of the area. (Optional)
CENTER_LAT	NUMBER	Latitude value of the center of the area. (Optional)
SEPARATE_PREF IX	VARCHAR2(1)	Contains T if the street name prefix is a separate word from the street name; contains F if the street name prefix is in the same word with the street name. For example, in an American street address of 123 N Main St, the prefix is N, and it is separate from the street name, which is Main. (Optional; not currently used by Oracle)
SEPARATE_SUFF IX	VARCHAR2(1)	Contains T if the street name suffix is a separate word from the street name; contains F if the street name suffix is in the same word with the street name. For example, in an American street address of 123 Main St NW, the suffix is NW, and it is separate from the street name, which is Main, and from the street type, which is St. (Optional; not currently used by Oracle)
SEPARATE_STYP E	VARCHAR2(1)	Contains T if the street type is a separate word from the street name; contains F if the street type is in the same word with the street name. For example, in a German street address of 123 Beethovenstrass, the type is strass, and it is in the same word with the street name, which is Beethoven. (Optional; not currently used by Oracle)
AREA_ID	NUMBER	Not currently used by Oracle. (Optional)
VERSION	VARCHAR2(10) )	Version of the data. The first version should be 1.0. (Required)

#### 11.5.4 GC\_INTERSECTION\_<suffix> Table

The GC\_INTERSECTION\_<suffix> table (for example, GC\_INTERSECTION\_US) stores information on road intersections for the country or group of countries

associated with the table-name suffix. An intersection occurs when roads meet or cross each other. This table contains the columns shown in [Table 11-10](#) (page 11-18).

**Table 11-10 GC\_INTERSECTION\_<suffix> Table**

Column Name	Data Type	Description
ROAD_ID_1	NUMBER	ID number of the first road on which the intersection is located. (Required)
ROAD_SEGMENT_ID_1	NUMBER	ID number of the road segment on the first road on which the intersection is located. (Required)
ROAD_ID_2	NUMBER	ID number of the second road on which the intersection is located. (Required)
ROAD_SEGMENT_ID_2	NUMBER	ID number of the road segment on the second road on which the intersection is located. (Required)
INTS_LONG	NUMBER	Longitude coordinate value of the intersection. (Required)
INTS_LAT	NUMBER	Latitude coordinate value of the intersection. (Required)
HOUSE_NUMBER	NUMBER	The leading numerical part of the house number at the intersection. (See the explanation of house numbers after <a href="#">Table 11-16</a> (page 11-30) in <a href="#">GC_ROAD_SEGMENT_&lt;suffix&gt; Table</a> (page 11-30).) (Required)
HOUSE_NUMBER_2	VARCHAR2(10)	The second part of the house number at the intersection. (See the explanation of house numbers after <a href="#">Table 11-16</a> (page 11-30) in <a href="#">GC_ROAD_SEGMENT_&lt;suffix&gt; Table</a> (page 11-30).) (Required)
SIDE	VARCHAR2(1)	Side of the street on which the house at the intersection is located. Possible values: L (left) or R (right). (Required)
COUNTRY_CODE_2	VARCHAR2(2)	2- letter ISO country code of the country to which the house at the intersection belongs. (Required)
PARTITION_ID	NUMBER	Partition key used for partitioning geocoder data by geographic boundaries. If the data is not partitioned, set the value to 1. (Required)

### 11.5.5 GC\_PARSER\_PROFILES Table

The GC\_PARSER\_PROFILES table stores information about keywords typically found in postal addresses. The geocoder uses keywords to identify address fields, such as house number, road name, city name, state name, and postal code. A keyword can be the type of street (such as road, street, drive, or avenue) or the prefix or suffix of a street (such as north, south, east, or west). This table contains the columns shown in [Table 11-11](#) (page 11-19).

**Table 11-11 GC\_PARSER\_PROFILES Table**

Column Name	Data Type	Description
COUNTRY_CODE	VARCHAR2(2)	2- letter ISO country code of the country for the keyword. (Required)
KEYWORDS	SDO_KEYWORDARRAY	<p>A single array of keywords for a specific address field. The array may contain a single word, or a group of words and abbreviations that can be used with the same meaning; for example, <i>United States of America</i>, <i>USA</i>, and <i>United States</i> all refer to the US. The first word of this array should be the official full name of the keyword, if there is any. The US uses over 400 keywords in parsing addresses. The following are some examples of keyword arrays and keywords from the US data set; however, only a single SDO_KEYWORDARRAY object is stored in each row:</p> <p>SDO_KEYWORDARRAY( 'UNITED STATES OF AMERICA','US', 'USA', 'UNITED STATES', 'U.S.A.', 'U.S.')</p> <p>SDO_KEYWORDARRAY('AVENUE','AV', 'AVE', 'AVEN', 'AVENU', 'AVN', 'AVNUE', 'AV.', 'AVE.')</p> <p>SDO_KEYWORDARRAY('40TH', 'FORTIETH')</p> <p>SDO_KEYWORDARRAY('NEW YORK','NY')</p> <p>SDO_KEYWORDARRAY('LIBRARY')</p>
OUTPUT_KEYWORD	VARCHAR2(2000)	<p>A keyword used in the geocoder data to represent an address field. It must be the same as one of the keywords used in the keyword array. The output keyword is used to match the addresses stored in the geocoding data tables to the user's input, for example, if the output keyword AV is used for street type Avenue in the GC_ROAD_US table, wherever a user enters an address containing any of the keywords (<i>AVENUE</i>, <i>AV</i>, <i>AVE</i>, <i>AVEN</i>, <i>AVENU</i>, <i>AVN</i>, <i>AVNUE</i>, <i>AV.</i>, <i>AVE.</i>), the keyword will be interpreted and matched to the output keyword AV to help find the address in the database. The following are some examples of output keywords; however, only a single output keyword is stored in each row:</p> <p>US</p> <p>AV</p> <p>40TH</p> <p>NY</p> <p>LIBRARY</p>

**Table 11-11 (Cont.) GC\_PARSER\_PROFILES Table**

Column Name	Data Type	Description
SECTION_LABEL	VARCHAR2(30)	<p>A label used to identify the type of keyword represented in the KEYWORDS and OUTPUT_KEYWORD columns. There are the multiple different section labels; however, only a single section label for each row is used in identifying the type of keywords:</p> <p>COUNTRY_NAME: Identifies keywords that are used to represent country names.</p> <p>LOCALITY_KEYWORD_DICTIONARY: Identifies keywords that are used to replace words in a locality (city, state, province, and so on) with a standardized form of the word. For example, <i>Saint</i> is replaced by <i>St</i>; and by doing so, the city names <i>Saint Thomas</i> and <i>St. Thomas</i> will be standardized to <i>St Thomas</i>, which is stored in the database.</p> <p>PLACE_NAME_KEYWORD: Identifies a point of interest (POI) name keyword, such as for a restaurant or a hotel.</p> <p>REGION_LIST: Identifies keywords that are known names of regions, such as <i>NY</i>, <i>New York</i>, <i>NH</i>, and <i>New Hampshire</i>. The regions identified must be administrative areas that belong to the third-lowest area level or third-smallest area used in addressing. In the US this is the state level (the lowest area level or smallest area is the city level).</p> <p>SECOND_UNIT_KEYWORD: Identifies keywords used in second-unit descriptions, such as <i>Floor</i>, <i>#</i>, <i>Suite</i>, and <i>Apartment</i>.</p> <p>STREET_KEYWORD_DICTIONARY: Identifies keywords used to replace non-street-type keywords in street names (such as <i>40TH</i> and <i>Fortieth</i>) with a standardized form.</p> <p>STREET_PREFIX_KEYWORD: Identifies street name prefix keywords, such as <i>South</i>, <i>North</i>, <i>West</i>, and <i>East</i>.</p> <p>STREET_TYPE_KEYWORD: Identifies street type keywords, such as <i>Road</i>, <i>Street</i>, and <i>Drive</i>.</p> <p>IN_LINE_STREET_TYPE_KEYWORD: Identifies street type keywords that are attached to street names, such as <i>strasse</i> in the German street name <i>Steinstrasse</i>.</p>
POSITION	VARCHAR2(1)	<p>The position of the keyword relative to a street name. It indicates whether the keyword can precede (P) or follow (F) the actual street name, or both (B). Thus, P, F, and B are the only valid entries. In the US, most street type keywords follow the street names, for example, the street type <i>Bld</i> in <i>Hollywood Blvd</i>. In France, however, street type keywords usually precede the street names, for example, the street type <i>Avenue</i> in <i>Avenue De Paris</i>.</p>

**Table 11-11 (Cont.) GC\_PARSER\_PROFILES Table**

Column Name	Data Type	Description
SEPARATENES S	VARCHAR2(1)	Indicates whether the keyword is separate from a street name. Keywords are either separable (S) or non-separable (N). Thus, S and N are the only valid entries. In the US, all street-type keywords are separate words from the street name, for example, the street type Blvd in <i>Hollywood Blvd</i> . In Germany, however, the street-type keywords are not separate from the street name, for example, the street type strasse in <i>Augustenstrasse</i> .

### 11.5.6 GC\_PARSER\_PROFILEAFS Table

The GC\_PARSER\_PROFILEAFS table stores the XML definition of postal-address formats. An XML string describes each address format for a specific country. In the Oracle Geocoder 10g and earlier, the J2EE geocoder uses a country\_name.ppr file instead of this table. The content of the country\_name.ppr file is equivalent to the content of the ADDRESS\_FORMAT\_STRING attribute. This table contains the columns shown in [Table 11-12](#) (page 11-21).

**Table 11-12 GC\_PARSER\_PROFILEAFS Table**

Column Name	Data Type	Description
COUNTRY_CODE	VARCHAR2(2)	2- letter ISO country code of the country. (Required)
ADDRESS_FORMAT_STRING	CLOB	XML string describing the address format for the country specified in the COUNTRY_CODE column. ( <a href="#">Example 11-4</a> (page 11-21) shows the XML definition for the US address format, and <a href="#">ADDRESS_FORMAT_STRING Description</a> (page 11-23) explains the elements used in the US address format definition.).

[Example 11-4](#) (page 11-21) shows the ADDRESS\_FORMAT\_STRING definition for the US address format.

#### **Example 11-4 XML Definition for the US Address Format**

```
<address_format unit_separator="," replace_hyphen="true">
  <address_line>
    <place_name />
  </address_line>
  <address_line>
    <street_address>
      <house_number>
        <format form="0*" effective="0-1" output="$" />
        <format form="0*1*" effective="0-1" output="$">
          <exception form="0*TH" />
          <exception form="0*ST" />
          <exception form="0*2ND" />
          <exception form="0*3RD" />
        </format>
        <format form="0*10*" effective="0-1" output="$" />
        <format form="0*-0*" effective="0-1" output="$" />
      </house_number>
    </street_address>
  </address_line>
</address_format>
```

```
        <format form="0*.0*" effective="0-1" output="$" />
        <format form="0* 0*/0*" effective="0-1" output="$" />
    </house_number>
    <street_name>
        <prefix />
        <base_name />
        <suffix />
        <street_type />
        <special_format>
            <format form="1* HWY 0*" effective="7-8" addon_effective="0-1" addon_output="$
HWY"/>
            <format form="1* HIGHWAY 0*" effective="11-12" addon_effective="0-1"
addon_output="$ HWY"/>
            <format form="1* HWY-0*" effective="7-8" addon_effective="0-1" addon_output="$
HWY"/>
            <format form="1* HIGHWAY-0*" effective="11-12" addon_effective="0-1"
addon_output="$ HWY"/>
            <format form="HWY 0*" effective="4-5" addon_output="HWY" />
            <format form="HIGHWAY 0*" effective="8-9" addon_output="HWY" />
            <format form="ROUTE 0*" effective="6-7" addon_output="RT" />
            <format form="I 0*" effective="2-3" addon_output="I" />
            <format form="11 0*" effective="3-4" addon_effective="0-1" />
            <format form="I0*" effective="1-2" addon_output="I" />
            <format form="I-0*" effective="2-3" addon_output="I" />
            <format form="11-0*" effective="3-4" addon_effective="0-1" />
            <format form="ROUTE-0*" effective="6-7" addon_output="RT" />
            <format form="US0*" effective="2-3" addon_output="US" />
            <format form="HWY-0*" effective="2-3" addon_output="US" />
            <format form="HIGHWAY-0*" effective="8-9" addon_output="HWY" />
        </special_format>
    </street_name>
    <second_unit>
        <special_format>
            <format form="# 0*" effective="2-3" output="APT $" />
            <format form="#0*" effective="1-2" output="APT $" />
        </special_format>
    </second_unit>
</street_address>
</address_line>
<address_line>
    <po_box>
        <format form="PO BOX 0*" effective="7-8" />
        <format form="P.O. BOX 0*" effective="9-10" />
        <format form="PO 0*" effective="3-4" />
        <format form="P.O. 0*" effective="5-6" />
        <format form="POBOX 0*" effective="6-7" />
    </po_box>
</address_line>
<address_line>
    <city optional="no" />
    <region optional="no" order="1" />
    <postal_code>
        <format form="00000" effective="0-4" />
        <format form="00000-0000" effective="0-4" addon_effective="6-9" />
        <format form="00000 0000" effective="0-4" addon_effective="6-9" />
    </postal_code>
</address_line>
</address_format>
```

### 11.5.6.1 ADDRESS\_FORMAT\_STRING Description

The ADDRESS\_FORMAT\_STRING column of the GC\_PARSER\_PROFILEAFS table describes the format of address fields and their positioning in valid postal addresses. The address format string is organized by address lines, because postal addresses are typically written in multiple address lines.

The address parser uses the format description defined in the XML address format, combined with the keyword definition for each address field defined in the GC\_PARSER\_PROFILES table, to parse the input address and identify individual address fields.

#### <address\_format> Element

The <address\_format> element includes the unit\_separator and replace\_hyphen attributes. The unit\_separator attribute is used to separate fields in the stored data. By default it is a comma (unit\_separator=", "). The replace\_hyphen attribute specifies whether to replace all hyphens in the user's input with a space. By default it is set to true (replace\_hyphen="true"), that is, it is expected that all names in the data tables will contain a space instead of a hyphen.

If replace\_hyphen="true", administrative-area names in the data tables containing hyphens will not be matched during geocoding if replace\_hyphen="true"; however, these area names with hyphens can be placed in the REAL\_NAME column of the GC\_AREA table to be returned as the administrative-area name in the geocoded result. Road names in the NAME column of the GC\_ROAD table containing hyphens will, however, be matched during geocoding, but the matching performance will be degraded.

#### <address\_line> Elements

Each <address\_line> element in the XML address format string describes the format of an address line. Each <address\_line> element can have one or more child elements describing the individual address fields, such as street address, city, state (region or province), and postal code. These address field elements are listed in the order that the address fields appear in valid postal addresses. The optional attribute of the address field element is set to "no" if the address field is mandatory. By default, address field elements are optional.

#### <format> Elements

The format descriptions for house number, special street name, post box, and postal code elements are specified with a single or multiple <format> elements. Each <format> element specifies a valid layout and range of values for a particular address field. The following example illustrates the format used to define a special street name:

```
<format
  form="1* HWY 0*"
  effective="7-8"
  output="$"
  addon_effective="0-1"
  addon_output="$ HIGHWAY" />
```

The form attribute uses a regular expression-like string to describe the format: 1 stands for any alphabetic letter; 0 stands for any numerical digit; 2 stands for any alphabetic letter or any numerical digit; 1\* specifies a string consisting of all alphabetic letters; 0\* specifies a string consisting of all numerical digits; 2\* specifies a string consisting of any combination of numerical digits and alphabetic letters. All other symbols represent themselves.

Any string matching the pattern specified by the `form` attribute is considered to be a valid string for its (parent) address field. A valid string can then be broken down into segments specified by the attributes `effective` and `addon_effective`. The `effective` attribute specifies the more important, primary piece of the address string; the `addon_effective` attribute specifies the secondary piece of the address string.

- The `effective` attribute specifies a substring of the full pattern using the start and end positions for the end descriptor of the `form` attribute. In the preceding example, `effective="7-8"` retrieves the substring (counting from position 0) starting at position 7 and ending at position 8, which is the substring defined by `0*`, at the end of the `form` attribute.
- The `addon_effective` attribute specifies a substring of the full pattern using the start and end positions for the start descriptor of the `form` attribute. In the preceding example, `addon_effective="0-1"` retrieves the substring, (counting from position 0) starting at position 0 and ending at position 1, which is the substring defined by `1*`, at the beginning of the `form` attribute.

The `output` and `addon_output` attributes specify the output form of the address string for segments specified by the `effective` and `addon_effective` attributes, respectively. These output forms are used during address matching. The symbol `$` stands for the matched string, and other symbols represent themselves. In the preceding example:

- In `output="$"`, the `$` stands for the substring that was matched in the `effective` attribute.
- In `addon_output="$ HIGHWAY"`, the `$ HIGHWAY` stands for the substring that was matched in the `addon_effective` attribute, followed by a space, followed by the word *HIGHWAY*.

Using the `<format>` element in the preceding example, with `form="1* HWY 0*"`, the input string *'STATE HWY 580'* will have `effective=580`, `output=580`, `addon_effective=STATE`, and `addon_output=STATE HIGHWAY`.

The `<format>` element may also contain an `<exception>` element. The `<exception>` element specifies a string that has a valid form, but must be excluded from the address field. For example, in a `<house_number>` element with valid numbers `0*1*` (that is, any numeric digits followed by any alphabetic letters), specifying `<exception form="0*TH" />` means that any house number with (or without) numeric digits and ending with "TH" must be excluded.

### 11.5.7 GC\_POI\_<suffix> Table

The `GC_POI_<suffix>` table (for example, `GC_POI_US`) stores point of interest (POI) information for the country or group of countries associated with the table name suffix. POIs include features such as airports, monuments, and parks. This table contains one or more rows for each point of interest. (For example, it can contain multiple rows for a POI if the POI is associated with multiple settlements.) The `GC_POI_<suffix>` table contains the columns shown in [Table 11-13](#) (page 11-24).

**Table 11-13 GC\_POI\_<suffix> Table**

Column Name	Data Type	Description
POI_ID	NUMBER	ID number of the POI. (Required)



**Table 11-13 (Cont.) GC\_POI\_<suffix> Table**

Column Name	Data Type	Description
POI_NAME	VARCHAR2(64) )	Name of the POI. (Required)
LANG_CODE	VARCHAR2(3)	3-letter ISO national language code for the language for the POI name. (Required)
FEATURE_CODE	NUMBER	Feature code for the POI, if the data vendor classifies POIs by category. (Optional)
HOUSE_NUMBER	VARCHAR2(10) )	House number of the POI; may contain non-numeric characters. (Required)
STREET_NAME	VARCHAR2(80) )	Road name of the POI. (Required)
SETTLEMENT_ID	NUMBER(10)	ID number of the settlement to which the POI belongs. (Required if the POI is associated with a settlement)
MUNICIPALITY_ID	NUMBER(10)	ID number of the municipality to which the POI belongs. (Required if the POI is associated with a municipality)
REGION_ID	NUMBER(10)	ID number of the region to which the POI belongs. (Required if the POI is associated with a region)
SETTLEMENT_NAME	VARCHAR2(64) )	Name of the settlement to which the POI belongs. (Required if the POI is associated with a settlement)
MUNICIPALITY_NAME	VARCHAR2(64) )	Name of the municipality to which the POI belongs. (Required if the POI is associated with a municipality)
REGION_NAME	VARCHAR2(64) )	Name of the region to which the POI belongs. (Required if the POI is associated with a region)
POSTAL_CODE	VARCHAR2(16) )	Postal code of the POI. (Required)
VANITY_CITY	VARCHAR2(35) )	Name of the city popularly associated with the POI, if it is different from the actual city containing the POI. For example, the London Heathrow Airport is actually located in a town named Hayes, which is part of greater London, but people tend to associate the airport only with London. In this case, the VANITY_CITY value is London. (Optional)
ROAD_SEGMENT_ID	NUMBER	ID of the road segment on which the POI is located. (Required)
SIDE	VARCHAR2(1)	Side of the street on which the POI is located. Possible values: L (left) or R (right). (Required)
PERCENT	NUMBER	Percentage value at which the POI is located on the road. It is computed by dividing the distance from the street segment start point to the POI by the length of the street segment. (Required)

**Table 11-13 (Cont.) GC\_POI\_<suffix> Table**

Column Name	Data Type	Description
TELEPHONE_NUMBER	VARCHAR2(20)	Telephone number of the POI. (Optional)
LOC_LONG	NUMBER	Longitude coordinate value of the POI. (Required)
LOC_LAT	NUMBER	Latitude coordinate value of the POI. (Required)
COUNTRY_CODE_2	VARCHAR2(2)	2-letter ISO country code of the country to which the POI belongs. (Required)
PARTITION_ID	NUMBER	Partition key used for partitioning geocoder data by geographic boundaries. If the data is not partitioned, set the value to 1. (Required)

### 11.5.8 GC\_POSTAL\_CODE\_<suffix> Table

The GC\_POSTAL\_CODE\_<suffix> table (for example, GC\_POSTAL\_CODE\_US) stores postal code information for the country or group of countries associated with the table-name suffix, if postal codes are used in the address format. This table contains one or more rows for each postal code; it may contain multiple rows for a postal code when the postal code is associated with multiple settlements. The GC\_POSTAL\_CODE\_<suffix> table contains the columns shown in [Table 11-14](#) (page 11-26).

**Table 11-14 GC\_POSTAL\_CODE\_<suffix> Table**

Column Name	Data Type	Description
POSTAL_CODE	VARCHAR2(16)	Postal code for the postal code area. (Required)
SETTLEMENT_NAME	VARCHAR2(64)	Name of the settlement to which the postal code belongs. (Required if the postal code is associated with a settlement)
MUNICIPALITY_NAME	VARCHAR2(64)	Name of the municipality to which the postal code belongs. (Required if the postal code is associated with a municipality)
REGION_NAME	VARCHAR2(64)	Name of the region to which the postal code belongs. (Required if the postal code is associated with a region)
LANG_CODE	VARCHAR2(3)	3-letter ISO national language code for the language associated with the area. (Required)
SETTLEMENT_ID	NUMBER(10)	ID number of the settlement to which the postal code belongs. (Required if the postal code is associated with a settlement)
MUNICIPALITY_ID	NUMBER(10)	ID number of the municipality to which the postal code belongs. (Required if the postal code is associated with a municipality)

**Table 11-14 (Cont.) GC\_POSTAL\_CODE\_<suffix> Table**

Column Name	Data Type	Description
REGION_ID	NUMBER(10)	ID number of the region to which the postal code belongs. (Required if the postal code is associated with a region)
CENTER_LONG	NUMBER	Longitude value of the center of the postal-code area. The center (longitude, latitude) value is set to the start- or end-point of the closest road segment to the center, depending on which point is closer. Oracle recommends that the CENTER_LONG and CENTER_LAT values be correctly set. If these values are not set, the longitude, latitude values of the geocoded result for an area will be (0,0). (Optional)
CENTER_LAT	NUMBER	Latitude value of the center of the area. (See the explanation for the CENTER_LONG column.) (Optional)
ROAD_SEGMENTS_ID	NUMBER(10)	ID of the road segment to which the area center is set. This value must be set correctly if the geocoder is intended to work with the Oracle Spatial and Graph routing engine (described in <a href="#">Routing Engine</a> (page 13-1)); otherwise, it can be set to any nonzero value, but it cannot be null. (Required)
COUNTRY_CODE_2	VARCHAR2(2)	2- letter ISO country code of the country to which the area belongs. (Required)
PARTITION_ID	NUMBER	Partition key used for partitioning geocoder data by geographic boundaries. If the data is not partitioned, set the value to 1. (Required)
NUM_STREETS	NUMBER	The number of streets inside this postal code area. (Optional)

### 11.5.9 GC\_ROAD\_<suffix> Table

The GC\_ROAD\_<suffix> table (for example, GC\_ROAD\_US) stores road information for the country associated with the table name suffix. A road is a collection of road segments with the same name in the same settlement area; a road segment is defined in [GC\\_ROAD\\_SEGMENT\\_<suffix> Table](#) (page 11-30). The GC\_ROAD\_<suffix> table contains one or more rows for each road. (For example, it can contain multiple rows for a road if the road is associated with multiple settlements.) The GC\_ROAD\_<suffix> table contains the columns shown in [Table 11-15](#) (page 11-27).

**Table 11-15 GC\_ROAD\_<suffix> Table**

Column Name	Data Type	Description
ROAD_ID	NUMBER	ID number of the road. (Required)
SETTLEMENT_ID	NUMBER(10)	ID number of the settlement to which the road belongs. (Required if the road is associated with a settlement)

**Table 11-15 (Cont.) GC\_ROAD\_<suffix> Table**

Column Name	Data Type	Description
MUNICIPALITY_ID	NUMBER(10)	ID number of the municipality to which the road belongs. (Required if the road is associated with a municipality)
PARENT_AREA_ID	NUMBER(10)	ID number of the parent area of the municipality to which the road belongs. (Required if the road is associated with a parent area)
LANG_CODE	VARCHAR2(3)	3-letter ISO national language code for the language for the road name. (Required)
NAME	VARCHAR2(64)	Name of the road, including the type (if any), the prefix (if any), and the suffix (if any). For example, N Main St as NAME. (Required)
BASE_NAME	VARCHAR2(64)	Name of the road, excluding the type (if any), the prefix (if any), and the suffix (if any). For example, N Main St as NAME, with Main as BASE_NAME. (Required)
PREFIX	VARCHAR2(32)	Prefix of the road name. For example, N Main St as NAME, with N as PREFIX. (Required if the road name has a prefix)
SUFFIX	VARCHAR2(32)	Suffix of the road name. For example, Main St NW as NAME, with NW as SUFFIX. (Required if the road name has a suffix)
STYPE_BEFORE	VARCHAR2(32)	Street type that precedes the base name. For example, Avenue Victor Hugo as NAME, with Avenue as STYPE_BEFORE and Victor Hugo as BASE_NAME. (Required if the road type precedes the base name)
STYPE_AFTER	VARCHAR2(32)	Street type that follows the base name. For example, Main St as NAME, with St as STYPE_AFTER and Main as BASE_NAME. (Required if the road type follows the base name)
STYPE_ATTACHED	VARCHAR2(1)	Contains T if the street type is in the same word with the street name; contains F if the street type is a separate word from the street name. For example, in a German street address of 123 Beethovenstrass, the street type is strass, and it is in the same word with the street name, which is Beethoven. (Required)
START_HN	NUMBER(5)	The lowest house number on the road. It is returned when a specified house number is lower than this value.

**Table 11-15 (Cont.) GC\_ROAD\_<suffix> Table**

Column Name	Data Type	Description
CENTER_HN	NUMBER(5)	Leading numerical part of the center house number. The center house number is the left side house number at the start point of the center road segment, which is located in the center of the whole road. (See the explanation of house numbers after <a href="#">Table 11-16</a> (page 11-30) in <a href="#">GC_ROAD_SEGMENT_&lt;suffix&gt; Table</a> (page 11-30).) It is returned when no house number is specified in an input address. (Required)
END_HN	NUMBER(5)	The highest house number on the road. It is returned when a specified house number is higher than this value.
START_HN_SIDE	VARCHAR2(1)	Side of the road of the lowest house number: L for left or R for right.
CENTER_HN_SIDE	VARCHAR2(1)	Side of the road of the center house number: L for left or R for right. The center house number is the left side house number at the start point of the center road segment, which is located in the center of the whole road. (See the explanation of house numbers after <a href="#">Table 11-16</a> (page 11-30) in <a href="#">GC_ROAD_SEGMENT_&lt;suffix&gt; Table</a> (page 11-30).) (Required if there are houses on the road)
END_HN_SIDE	VARCHAR2(1)	Side of the road of the highest house number: L for left or R for right.
START_LONG	NUMBER	Longitude value of the lowest house number.
START_LAT	NUMBER	Latitude value of the lowest house number.
CENTER_LONG	NUMBER	Longitude value of the center house number. The center house number is the left side house number at the start point of the center road segment, which is located in the center of the whole road. (See the explanation of house numbers after <a href="#">Table 11-16</a> (page 11-30) in <a href="#">GC_ROAD_SEGMENT_&lt;suffix&gt; Table</a> (page 11-30).) (Required)
CENTER_LAT	NUMBER	Latitude value of the center house number. (See also the explanation of the CENTER_LONG column.) (Required)
END_LONG	NUMBER	Longitude value of the highest house number.
END_LAT	NUMBER	Latitude value of the highest house number.
START_ROAD_SEGMENT_ID	NUMBER(5)	ID number of the road segment at the start of the road.
CENTER_ROAD_SEGMENT_ID	NUMBER(5)	ID number of the road segment at the center point of the road. (Required)
END_ROAD_SEGMENT_ID	NUMBER(5)	ID number of the road segment at the end of the road.

**Table 11-15 (Cont.) GC\_ROAD\_<suffix> Table**

Column Name	Data Type	Description
POSTAL_CODE	VARCHAR2(16)	Postal code for the road. (Required)
COUNTRY_CODE_2	VARCHAR2(2)	2- letter ISO country code of the country to which the road belongs. (Required)
PARTITION_ID	NUMBER	Partition key used for partitioning geocoder data by geographic boundaries. If the data is not partitioned, set the value to 1. (Required)
CENTER_HN2	VARCHAR2(10)	The second part of the center house number. (See the explanation of house numbers after <a href="#">Table 11-16</a> (page 11-30) in <a href="#">GC_ROAD_SEGMENT_&lt;suffix&gt; Table</a> (page 11-30).) (Required)

### 11.5.10 GC\_ROAD\_SEGMENT\_<suffix> Table

The GC\_ROAD\_SEGMENT\_<suffix> table (for example, GC\_ROAD\_SEGMENT\_US) stores road segment information for the country associated with the table name suffix. A road segment is the portion of a road between two continuous intersections along the road; an intersection occurs when roads meet or cross each other. A road segment can also be the portion of a road between the start (or end) of the road and its closest intersection along the road, or it can be the entire length of a road if there are no intersections along the road. The GC\_ROAD\_SEGMENT\_<suffix> table contains one row for each road segment, and it contains the columns shown in [Table 11-16](#) (page 11-30).

**Table 11-16 GC\_ROAD\_SEGMENT\_<suffix> Table**

Column Name	Data Type	Description
ROAD_SEGMENT_ID	NUMBER	ID number of the road segment. (Required)
ROAD_ID	NUMBER	ID number of the road containing this road segment. (Required)
L_ADDR_FORMAT	VARCHAR2(1)	Left side address format. Specify N if there are one or more house numbers on the left side of the road segment; leave null if there is no house number on the left side of the road segment. (Required)
R_ADDR_FORMAT	VARCHAR2(1)	Right side address format. Specify N if there are one or more house numbers on the right side of the road segment; leave null if there is no house number on the right side of the road segment. (Required)
L_ADDR_SCHEME	VARCHAR2(1)	Numbering scheme for house numbers on the left side of the road segment: O (all odd numbers), E (all even numbers), or M (mixture of odd and even numbers). (Required)

**Table 11-16 (Cont.) GC\_ROAD\_SEGMENT\_<suffix> Table**

Column Name	Data Type	Description
R_ADDR_SCHEME	VARCHAR2(1)	Numbering scheme for house numbers on the right side of the road segment: O (all odd numbers), E (all even numbers), or M (mixture of odd and even numbers). (Required)
START_HN	NUMBER(5)	The lowest house number on this road segment. (Required)
END_HN	NUMBER(5)	The highest house number on this road segment. (Required)
L_START_HN	NUMBER(5)	The leading numerical part of the left side starting house number. (See the explanation of house numbers after this table.) (Required)
L_END_HN	NUMBER(5)	The leading numerical part of the left side ending house number. (See the explanation of house numbers after this table.) (Required)
R_START_HN	NUMBER(5)	The leading numerical part of the right side starting house number. (See the explanation of house numbers after this table.) (Required)
R_END_HN	NUMBER(5)	The leading numerical part of the right side ending house number. (See the explanation of house numbers after this table.) (Required)
POSTAL_CODE	VARCHAR2(16) )	Postal code for the road segment. If the left side and right side of the road segment belong to two different postal codes, create two rows for the road segment with identical values in all columns except for POSTAL_CODE. (Required)
GEOMETRY	SDO_GEOMETRY	Spatial geometry object representing the road segment. (Required)
COUNTRY_CODE_2	VARCHAR2(2)	2- letter ISO country code of the country to which the road segment belongs. (Required)
PARTITION_ID	NUMBER	Partition key used for partitioning geocoder data by geographic boundaries. If the data is not partitioned, set the value to 1. (Required)
L_START_HN2	VARCHAR2(10) )	The second part of the left side starting house number. (See the explanation of house numbers after this table.) (Required if the left side starting house number has a second part)
L_END_HN2	VARCHAR2(10) )	The second part of the left side ending house number. (See the explanation of house numbers after this table.) (Required if the left side ending house number has a second part)

**Table 11-16 (Cont.) GC\_ROAD\_SEGMENT\_<suffix> Table**

Column Name	Data Type	Description
R_START_HN2	VARCHAR2(10) )	The second part of the right side starting house number. (See the explanation of house numbers after this table.) (Required if the right side starting house number has a second part)
R_END_HN2	VARCHAR2(10) )	The second part of the right side ending house number. (See the explanation of house numbers after this table.) (Required if the right side ending house number has a second part)

A house number is a descriptive part of an address that helps identify the location of a establishment along a road segment. A house number is divided into two parts: the leading numerical part and the second part, which is the rest of the house number. The leading numerical part is the numerical part of the house number that starts from the beginning of the complete house number string and ends just before the first non-numeric character (if present). If the house number contains non-numeric characters, the second part of the house number is the portion from the first non-numeric character through the last character of the string. For example, if the house number is 123, the leading numerical part is 123 and the second part is null; however, if the house number is 123A23, the leading numerical part is 123 and the second part is A23.

The starting house number is the house number at the start point of a road segment; the start point of the road segment is the first shape point of the road segment geometry. The ending house number is the house number at the end point of a road segment; the end point of the road segment is the last shape point of the road segment geometry. The left and right side starting house numbers do not need to be lower than the left and right side ending house numbers. The house number attributes in the data tables follow these conventions in locating establishments along road segments.

### 11.5.11 Indexes on Tables for Geocoding

To use the vendor-supplied tables for geocoding, indexes must be created on many of the tables, and the names of these indexes must follow certain requirements.

**Example 11-5** (page 11-32) lists the format of CREATE INDEX statements that create the required indexes. In each statement, you must use the index name, table name, column names, and (if multiple columns are indexed) sequence of column names as shown in **Example 11-5** (page 11-32), except that you must replace all occurrences of <suffix> with the appropriate string (for example, US for the United States). Note that the first index in the example is a spatial index. Optionally, you can also include other valid keywords and clauses in the CREATE INDEX statements.

#### **Example 11-5 Required Indexes on Tables for Geocoding**

```
CREATE INDEX idx_<suffix>_road_geom ON gc_road_segment_<suffix> (geometry) INDEXTYPE IS
mdsys.spatial_index;
CREATE INDEX idx_<suffix>_road_seg_rid ON gc_road_segment_<suffix> (road_id, start_hn, end_hn);
CREATE INDEX idx_<suffix>_road_id ON gc_road_<suffix> (road_id);
CREATE INDEX idx_<suffix>_road_setbn ON gc_road_<suffix> (settlement_id, base_name);
CREATE INDEX idx_<suffix>_road_munbn ON gc_road_<suffix> (municipality_id, base_name);
CREATE INDEX idx_<suffix>_road_parbn ON gc_road_<suffix> (parent_area_id, country_code_2, base_name);
CREATE INDEX idx_<suffix>_road_setbnsd ON gc_road_<suffix> (settlement_id, soundex(base_name));
CREATE INDEX idx_<suffix>_road_munbnsd ON gc_road_<suffix> (municipality_id, soundex(base_name));
```



```

CREATE INDEX idx_<suffix>_road_parbnsd ON gc_road_<suffix> (parent_area_id, country_code_2,
soundex(base_name));
CREATE INDEX idx_<suffix>_inters ON gc_intersection_<suffix> (country_code_2, road_id_1, road_id_2);
CREATE INDEX idx_<suffix>_area_name_id ON gc_area_<suffix> (country_code_2, area_name, admin_level);
CREATE INDEX idx_<suffix>_area_id_name ON gc_area_<suffix> (area_id, area_name, country_code_2);
CREATE INDEX idx_<suffix>_poi_name ON gc_poi_<suffix> (country_code_2, name);
CREATE INDEX idx_<suffix>_poi_setnm ON gc_poi_<suffix> (country_code_2, settlement_id, name);
CREATE INDEX idx_<suffix>_poi_munnm ON gc_poi_<suffix> (country_code_2, municipality_id, name);
CREATE INDEX idx_<suffix>_poi_regnm ON gc_poi_<suffix> (country_code_2, region_id, name);
CREATE INDEX idx_<suffix>_postcode ON gc_postal_code_<suffix> (country_code_2, postal_code);
CREATE INDEX idx_<suffix>_addrpt_addr ON gc_address_point_<suffix> (road_segment_id, road_id,
house_number, side);

```

## 11.6 Installing the Profile Tables

The Oracle Geocoder profile tables are typically supplied by a data provider. Use the data provider's profile tables for geocoding whenever they are available. For users building their own geocoder schema, Oracle provides sample GC\_COUNTRY\_PROFILE, GC\_PARSER\_PROFILES, and GC\_PARSER\_PROFILEAFS tables; however, you should install these Oracle-supplied profile tables *only* if profile tables are *not* supplied with the data tables.

The Oracle-supplied tables contain parser profiles for a limited number of countries. If profiles for your country or group of countries of interest are not included, you will need to manually add them; and for a quick start, you can copy the parser profiles of a country with a similar address format to your country of interest, and edit these profiles where necessary. If your parser profiles of interest are included in the Oracle-supplied tables, you can use them directly or update them if necessary. No sample country profiles are provided, so you will need to add your own.

To install and query the Oracle-supplied profile tables, perform the following steps:

1. Log on to your database as the geocoder user. The geocoder user is the user under whose schema the geocoder schema will be loaded.
2. Create the GC\_COUNTRY\_PROFILE, GC\_PARSER\_PROFILES, and GC\_PARSER\_PROFILEAFS tables by executing the [SDO\\_GCDR.CREATE\\_PROFILE\\_TABLES](#) (page 22-1) procedure:

```
SQL> EXECUTE SDO_GCDR.CREATE_PROFILE_TABLES;
```

3. Populate the GC\_PARSER\_PROFILES and GC\_PARSER\_PROFILEAFS tables by running the `sdogcprs.sql` script in the `$ORACLE_HOME/md/admin/` directory. For example:

```
SQL> @$ORACLE_HOME/md/admin/sdogcprs.sql
```

4. Query the profile tables to determine if parser profiles for your country of interest are supplied, by checking if its country code is included in the output of the following statements:

```

SQL> SELECT DISTINCT(country_code) FROM gc_parser_profiles ORDER BY country_code;
SQL> SELECT DISTINCT(country_code) FROM gc_parser_profileafs ORDER BY
country_code;

```

## 11.7 Using the Geocoding Service (XML API)

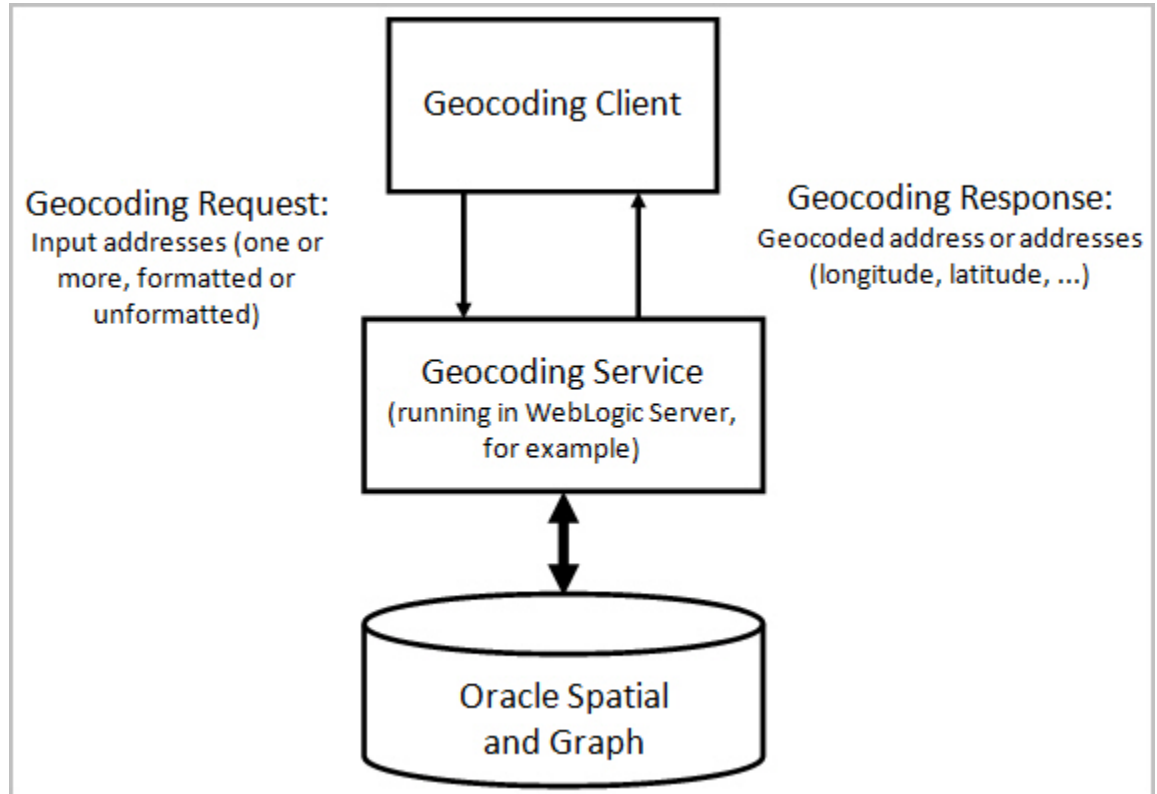
In addition to the SQL API, Oracle Spatial and Graph also provides an XML API for a geocoding service that enables you to geocode addresses. A Java geocoder application

engine performs international address standardization, geocoding, and POI matching, by querying geocoder data stored in the Oracle database. The support for unparsed addresses adds flexibility and convenience to customer applications.

This geocoding service is implemented as a Java 2 Enterprise Edition (J2EE) Web application that you can deploy in a WebLogic Server environment.

[Figure 11-1](#) (page 11-34) shows the basic flow of action with the geocoding service: a client locates a remote geocoding service instance, sends a geocoding request, and processes the response returned by the geocoding service instance.

**Figure 11-1 Basic Flow of Action with the Spatial Geocoding Service**



As shown in [Figure 11-1](#) (page 11-34):

1. The client sends an XML geocoding request, containing one or more input addresses to be geocoded, to the geocoding service using the HTTP protocol.
2. The geocoding service parses the input request and looks up the input address in the database.
3. The geocoding service sends the geocoded result in XML format to the client using the HTTP protocol.

After you load the geocoder schema into the database, you must configure the J2EE geocoder before it can be used, as explained in [Deploying and Configuring the J2EE Geocoder](#) (page 11-35)

## 11.7.1 Deploying and Configuring the J2EE Geocoder

The J2EE geocoder processes geocoding requests and generates responses. To enable this geocoding service, a `geocoder.ear.zip` file must be deployed using Oracle WebLogic Server. To deploy and configure the geocoding service, follow these steps.

1. Deploy the geocoder using Oracle WebLogic Server:
  - a. Unzip the `geocoder.ear.zip` file found in your `$ORACLE_HOME/md/jlib` directory into a suitable directory. Your resulting directory structure should be: `$geocoder.ear/web.war/...`
  - b. Log on to the WebLogic Server console (for example, `http://<hostname>:7001/console`); and from **Deployments** install the `geocoder.ear` file, accepting the **Name** `geocoder` for the deployment and choosing the **Location** option. Make the deployment accessible from the following location.
2. Launch the geocoder welcome page in a web browser using the URL `http://<hostname>:<port>/geocoder`. On the welcome page, select the **Administration** link and enter the administrator (`weblogic`) user name and password.

---

### Note:

If you are *not* using the default WebLogic administrator user name (`weblogic`), you will need to edit the `weblogic.xml` file located in the `$geocoder.ear/web.war/WEB-INF/` directory. Replace `<principal-name>weblogic</principal-name>` with your WebLogic Server administrator user name, for example, `<principal-name>my_weblogic_admin</principal-name>`.

If the welcome page was not displayed, ensure that the newly deployed geocoding service was successfully started. (It is assumed that you are running WebLogic Server 12.1 or later with an Oracle Database 12.2 or later `geocoder.ear.zip` file.)

---

3. Modify the geocoder configuration file (`geocodercfg.xml`). Uncomment at least one `<geocoder>` element, and change the `<database>` element attributes of that `<geocoder>` element to reflect the configuration of your database. For information about this file, see [Configuring the geocodercfg.xml File](#) (page 11-36).
4. Save the changes to the file, and restart the geocoder.
5. Test the database connection by going to the welcome page at URL `http://<hostname>:<port>/geocoder` and running the XML geocoding request page. (This demo requires geocoder data for the United States.)

Examples are available to demonstrate various capabilities of the geocoding service. Reviewing the examples at URL `http://<hostname>:<port>/geocoder/gcxmlreq_exp_af.html` is a good way to learn the XML API, which is described in [Geocoding Request XML Schema Definition and Example](#) (page 11-36).

### 11.7.1.1 Configuring the geocodercfg.xml File

You will need to edit the `<database>` element in the default `geocodercfg.xml` file that is included with Spatial and Graph, to specify the database and schema where the geocoding data is loaded.

In this file, each `<geocoder>` element defines the geocoder for the database in which the geocoder schema resides. The `<database>` element defines the database connection for the geocoder. In Oracle 11g or later, there are two ways to define a database connection: by providing the JDBC database connection parameters, or by providing the JNDI name (`container_ds`) of a predefined container data source.

[Example 11-6](#) (page 11-36) illustrates two different ways in which a `<database>` element can be defined. The first definition specifies a JDBC connection; the second definition uses the JNDI name of a predefined container data source.

#### **Example 11-6   <database> Element Definitions**

```
<database name="gcdatabase"
         host="gisserver.example.com"
         port="1521"
         sid="orcl"
         mode="thin"
         user="geocoder_us"
         password="geocoder_us"
         load_db_parser_profiles="true" />

<database container_ds="jdbc/gc_europe"
         load_db_parser_profiles="true" />
```

The attributes of the `<database>` element are as follows

- `name` is a descriptive name for the database connection; it is not used to connect to the database.
- `host`, `port`, and `sid` identify the database.
- `mode` identifies the type of JDBC driver to use for the connection.
- `user` and `password` are the user name and password for the database user under whose schema the geocoding data is stored.
- `load_db_parser_profiles` specifies whether to load the address parser profiles from the specified database connection. If `true`, the address parser profiles are loaded from the geocoder schema; otherwise, the parser profiles are loaded from the application at `../applications/geocoder/web/WEB-INF/parser_profiles/<country-name>.ppr` (for example, `usa.ppr`). Before Oracle 11g, parser profiles were loaded from the application only. This parameter should be set to `true`.
- `container_ds` specifies the JNDI name for a predefined data source.

## 11.7.2 Geocoding Request XML Schema Definition and Example

For a geocoding request (HTTP GET or POST method), it is assumed the request has a parameter named `xml_request` whose value is a string containing the XML document for the request. The input XML document describes the input addresses that need to be geocoded. One XML request can contain one or more input addresses. Several internationalized address formats are available for describing the input

addresses. (The input XML API also supports reverse geocoding, that is, a longitude/latitude point to a street address.)

The XML schema definition (XSD) for a geocoding request is as follows:

```
<?xml version="1.0" encoding="UTF-8"?>
<!-- Schema for an XML geocoding request that takes one or more input_locations and
supports reverse geocoding using the input_location's attributes -->
<xsd:schema xmlns:xsd="http://www.w3.org/2001/XMLSchema"
elementFormDefault="qualified">
  <xsd:complexType name="address_lineType">
    <xsd:attribute name="value" type="xsd:string" use="required"/>
  </xsd:complexType>
  <xsd:complexType name="address_listType">
    <xsd:sequence>
      <xsd:element name="input_location" type="input_locationType"
        maxOccurs="unbounded"/>
    </xsd:sequence>
  </xsd:complexType>
  <xsd:complexType name="gdf_formType">
    <xsd:attribute name="name" type="xsd:string"/>
    <xsd:attribute name="street" type="xsd:string"/>
    <xsd:attribute name="intersecting_street" type="xsd:string"/>
    <xsd:attribute name="builtup_area" type="xsd:string"/>
    <xsd:attribute name="order8_area" type="xsd:string"/>
    <xsd:attribute name="order2_area" type="xsd:string"/>
    <xsd:attribute name="order1_area" type="xsd:string"/>
    <xsd:attribute name="country" type="xsd:string"/>
    <xsd:attribute name="postal_code" type="xsd:string"/>
    <xsd:attribute name="postal_addon_code" type="xsd:string"/>
  </xsd:complexType>
  <xsd:complexType name="gen_formType">
    <xsd:attribute name="name" type="xsd:string"/>
    <xsd:attribute name="street" type="xsd:string"/>
    <xsd:attribute name="intersecting_street" type="xsd:string"/>
    <xsd:attribute name="sub_area" type="xsd:string"/>
    <xsd:attribute name="city" type="xsd:string"/>
    <xsd:attribute name="region" type="xsd:string"/>
    <xsd:attribute name="country" type="xsd:string"/>
    <xsd:attribute name="postal_code" type="xsd:string"/>
    <xsd:attribute name="postal_addon_code" type="xsd:string"/>
  </xsd:complexType>
  <xsd:element name="geocode_request">
    <xsd:complexType>
      <xsd:sequence>
        <xsd:element name="address_list" type="address_listType"/>
      </xsd:sequence>
      <xsd:attribute name="vendor" type="xsd:string"/>
    </xsd:complexType>
  </xsd:element>
  <xsd:complexType name="input_addressType">
    <xsd:choice>
      <xsd:element name="us_form1" type="us_form1Type"/>
      <xsd:element name="us_form2" type="us_form2Type"/>
      <xsd:element name="gdf_form" type="gdf_formType"/>
      <xsd:element name="gen_form" type="gen_formType"/>
      <xsd:element name="unformatted" type="unformattedType"/>
    </xsd:choice>
    <xsd:attribute name="match_mode" default="relax_postal_code">
      <xsd:simpleType>
        <xsd:restriction base="xsd:NMTOKEN">
          <xsd:enumeration value="exact"/>
        </xsd:restriction>
      </xsd:simpleType>
    </xsd:attribute>
  </xsd:complexType>
</xsd:schema>
```

```

        <xsd:enumeration value="relax_street_type"/>
        <xsd:enumeration value="relax_poi_name"/>
        <xsd:enumeration value="relax_house_number"/>
        <xsd:enumeration value="relax_base_name"/>
        <xsd:enumeration value="relax_postal_code"/>
        <xsd:enumeration value="relax_builtup_area"/>
        <xsd:enumeration value="relax_all"/>
        <xsd:enumeration value="DEFAULT"/>
    </xsd:restriction>
</xsd:simpleType>
</xsd:attribute>
</xsd:complexType>
<xsd:complexType name="input_locationType">
    <xsd:sequence>
        <xsd:element name="input_address" type="input_addressType"
            minOccurs="0"/>
    </xsd:sequence>
    <xsd:attribute name="id" type="xsd:string"/>
    <xsd:attribute name="country" type="xsd:string"/>
    <xsd:attribute name="longitude" type="xsd:string"/>
    <xsd:attribute name="latitude" type="xsd:string"/>
    <xsd:attribute name="x" type="xsd:string"/>
    <xsd:attribute name="y" type="xsd:string"/>
    <xsd:attribute name="srid" type="xsd:string"/>
    <xsd:attribute name="multimatch_number" type="xsd:string" default="1000"/>
</xsd:complexType>
<xsd:complexType name="unformattedType">
    <xsd:sequence>
        <xsd:element name="address_line" type="address_lineType"
            maxOccurs="unbounded"/>
    </xsd:sequence>
    <xsd:attribute name="country" type="xsd:string"/>
</xsd:complexType>
<xsd:complexType name="us_form1Type">
    <xsd:attribute name="name" type="xsd:string"/>
    <xsd:attribute name="street" type="xsd:string"/>
    <xsd:attribute name="intersecting_street" type="xsd:string"/>
    <xsd:attribute name="lastline" type="xsd:string"/>
</xsd:complexType>
<xsd:complexType name="us_form2Type">
    <xsd:attribute name="name" type="xsd:string"/>
    <xsd:attribute name="street" type="xsd:string"/>
    <xsd:attribute name="intersecting_street" type="xsd:string"/>
    <xsd:attribute name="city" type="xsd:string"/>
    <xsd:attribute name="state" type="xsd:string"/>
    <xsd:attribute name="zip_code" type="xsd:string"/>
</xsd:complexType>
</xsd:schema>

```

[Example 11-7](#) (page 11-38) is a request to geocode several three addresses (representing two different actual physical addresses), using different address formats and an unformatted address.

#### **Example 11-7 Geocoding Request (XML API)**

```

<?xml version="1.0" encoding="UTF-8"?>
<geocode_request xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xsi:noNamespaceSchemaLocation="../geocode_request.xsd">
    <address_list>
        <input_location id="1">
            <input_address>
                <us_form2 name="Oracle" street="500 Oracle Parkway" city="Redwood City"

```

```

        state="CA" zip_code="94021"/>
      </input_address>
    </input_location>
    <input_location id="2">
      <input_address>
        <gdf_form street="1 Oracle Drive" builtup_area="Nashua" order1_area="NH"
          postal_code="03062" country="US"/>
      </input_address>
    </input_location>
    <input_location id="3">
      <input_address>
        <gen_form street="1 Oracle Drive" city="Nashua" region="NH" postal_code="03062" country="US"/>
      </input_address>
    </input_location>
    <input_location id="4">
      <input_address>
        <unformatted country="UNITED STATES">
          <address_line value="Oracle NEDC"/>
          <address_line value="1 Oracle drive "/>
          <address_line value="Nashua "/>
          <address_line value="NH"/>
        </unformatted>
      </input_address>
    </input_location>
  </address_list>
</geocode_request>

```

### 11.7.3 Geocoding Response XML Schema Definition and Example

A geocoding response contains one or more standardized addresses including longitude/latitude points, the matching code, and possibly multiple match and no match indication and an error message.

The XML schema definition (XSD) for a geocoding response is as follows:

```

<?xml version="1.0" encoding="UTF-8"?>
<!-- Schema for an XML geocoding response -->
<xsd:schema xmlns:xsd="http://www.w3.org/2001/XMLSchema"
  elementFormDefault="qualified">
  <xsd:complexType name="geocodeType">
    <xsd:sequence>
      <xsd:element name="match" type="matchType" minOccurs="0"
        maxOccurs="unbounded"/>
    </xsd:sequence>
    <xsd:attribute name="id" type="xsd:string" use="required"/>
    <xsd:attribute name="match_count" type="xsd:string"/>
  </xsd:complexType>
  <xsd:element name="geocode_response">
    <xsd:complexType>
      <xsd:sequence>
        <xsd:element name="geocode" type="geocodeType" maxOccurs="unbounded"/>
      </xsd:sequence>
    </xsd:complexType>
  </xsd:element>
  <xsd:complexType name="matchType">
    <xsd:sequence>
      <xsd:element name="output_address" type="output_addressType"/>
    </xsd:sequence>
    <xsd:attribute name="sequence" type="xsd:string" use="required"/>
    <xsd:attribute name="longitude" type="xsd:string" use="required"/>
    <xsd:attribute name="latitude" type="xsd:string" use="required"/>
  </xsd:complexType>

```

```

<xsd:attribute name="match_code" use="required">
  <xsd:simpleType>
    <xsd:restriction base="xsd:NMTOKEN">
      <xsd:enumeration value="0"/>
      <xsd:enumeration value="1"/>
      <xsd:enumeration value="2"/>
      <xsd:enumeration value="3"/>
      <xsd:enumeration value="4"/>
      <xsd:enumeration value="10"/>
      <xsd:enumeration value="11"/>
    </xsd:restriction>
  </xsd:simpleType>
</xsd:attribute>
<xsd:attribute name="error_message" type="xsd:string"/>
</xsd:complexType>
<xsd:complexType name="output_addressType">
  <xsd:attribute name="name" type="xsd:string"/>
  <xsd:attribute name="house_number" type="xsd:string"/>
  <xsd:attribute name="street" type="xsd:string"/>
  <xsd:attribute name="builtup_area" type="xsd:string"/>
  <xsd:attribute name="order1_area" type="xsd:string"/>
  <xsd:attribute name="order8_area" type="xsd:string"/>
  <xsd:attribute name="country" type="xsd:string"/>
  <xsd:attribute name="postal_code" type="xsd:string"/>
  <xsd:attribute name="postal_addon_code" type="xsd:string"/>
  <xsd:attribute name="side" type="xsd:string"/>
  <xsd:attribute name="percent" type="xsd:string"/>
  <xsd:attribute name="edge_id" type="xsd:string"/>
</xsd:complexType>
</xsd:schema>

```

[Example 11-8](#) (page 11-40) is the response to the request in [Example 11-7](#) (page 11-38) in [Geocoding Request XML Schema Definition](#) and [Example](#) (page 11-36).

### Example 11-8 Geocoding Response (XML API)

```

<?xml version="1.0" encoding="UTF-8"?>
<geocode_response xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xsi:noNamespaceSchemaLocation="../geocode_response.xsd">
  <geocode id="1" match_count="1">
    <match sequence="0"
      longitude="-122.26193971893862" latitude="37.53195483966782"
      match_code="10" error_message="####ENUT?B281C??">
      <output_address name="" house_number="500" street="ORACLE PKY"
        builtup_area="REDWOOD CITY" order1_area="CA" order8_area=""
        country="US" postal_code="94065" postal_addon_code="" side="L"
        percent="0.33166666666666667" edge_id="28503563"/>
    </match>
  </geocode>
  <geocode id="2" match_count="1">
    <match sequence="0"
      longitude="-71.45937299307225" latitude="42.70784494226865"
      match_code="1" error_message="####ENUT?B281CP?">
      <output_address name="" house_number="1" street="ORACLE DR"
        builtup_area="NASHUA" order1_area="NH" order8_area=""
        country="US" postal_code="03062" postal_addon_code="" side="L"
        percent="0.01" edge_id="22325991"/>
    </match>
  </geocode>
  <geocode id="3" match_count="1">
    <match sequence="0"
      longitude="-71.45937299307225" latitude="42.70784494226865"

```



```
        match_code="1" error_message="####ENUT?B281CP?">
      <output_address name="" house_number="1" street="ORACLE DR"
        buildup_area="NASHUA" order1_area="NH" order8_area=""
        country="US" postal_code="03062" postal_addon_code="" side="L"
        percent="0.01" edge_id="22325991"/>
    </match>
  </geocode>
  <geocode id="4" match_count="1">
    <match sequence="0"
      longitude="-71.45937299307225" latitude="42.70784494226865"
      match_code="1" error_message="####ENUT?B281CP?">
      <output_address name="" house_number="1" street="ORACLE DR"
        buildup_area="NASHUA" order1_area="NH" order8_area=""
        country="US" postal_code="03062" postal_addon_code="" side="L"
        percent="0.01" edge_id="22325991"/>
    </match>
  </geocode>
</geocode_response>
```



---

## Business Directory (Yellow Pages) Support

This chapter describes Oracle Spatial and Graph support for OpenLS business directory (Yellow Pages, or YP) services. It includes the following major sections:

- [Business Directory Concepts](#) (page 12-1)
- [Using the Business Directory Capabilities](#) (page 12-1)
- [Data Structures for Business Directory Support](#) (page 12-2)

### 12.1 Business Directory Concepts

Business directory services provide lists of businesses in a given area and matching a specified name or category.

Business directory data comes from third-party providers of such data. These providers probably have different business categories, and even different hierarchical structures. A unifying pattern in the various approaches is that businesses are categorized by subject and location. The location component is well understood; for example, for the United States, either a ZIP code or the combination of a city and state, and optionally a specific address, can be used to determine the location from which to start searching.

The categorization of businesses, on the other hand, is not uniformly implemented. Some providers offer a flat list of categories, user-selected by simple substring matching. Others offer a 3-level or 4-level hierarchical organization of subcategories, often with a fanout (maximum number of child categories at a level) of 20 to 50, and sometimes more than 100. A user might start the hierarchy traversal at the root of the hierarchy (by default). Alternatively, a user might enter a keyword that is matched to an appropriate starting point within the hierarchy. Such keyword matching might go beyond simple substring matching and result in more intelligent choices.

### 12.2 Using the Business Directory Capabilities

To use the Oracle Spatial business directory capabilities, you must use data provided by a business directory (YP) vendor, and the data must be in the format supported by the Oracle Spatial and Graph OpenLS support (see [OPENLS\\_DIR\\_BUSINESSES Table](#) (page 12-2)).

To submit users' directory services requests and to return the responses, use the OpenLS web services API, which is introduced in [OpenLS Application Programming Interfaces](#) (page 14-2). For information about directory services requests and responses, with examples, see [OpenLS Service Support and Examples](#) (page 14-2).

## 12.3 Data Structures for Business Directory Support

After you acquire the business directory data and invoke the appropriate procedure to load it into the database, the procedure populates the following tables, all owned by the MDSYS schema, which are used for business directory support:

- OPENLS\_DIR\_BUSINESSES
- OPENLS\_DIR\_BUSINESS\_CHAINS
- OPENLS\_DIR\_CATEGORIES
- OPENLS\_DIR\_CATEGORIZATIONS
- OPENLS\_DIR\_CATEGORY\_TYPES
- OPENLS\_DIR\_SYNONYMS

In some tables, some rows have null values for some columns, because the information does not apply in this instance or because the data provider did not supply a value.

The following sections describe these tables, in alphabetical order by table name.

### 12.3.1 OPENLS\_DIR\_BUSINESSES Table

The OPENLS\_DIR\_BUSINESSES table stores information about each business (that is, each business that has an address). If the business is part of a larger business chain, the CHAIN\_ID column is a foreign key to the CHAIN\_ID column in the OPENLS\_DIR\_BUSINESS\_CHAINS table (described in [OPENLS\\_DIR\\_BUSINESS\\_CHAINS Table](#) (page 12-3)).

The OPENLS\_DIR\_BUSINESSES table contains one row for each business, and it contains the columns shown in [Table 12-1](#) (page 12-2).

**Table 12-1 OPENLS\_DIR\_BUSINESSES Table**

Column Name	Data Type	Description
BUSINESS_ID	NUMBER	Business ID number. (Required)
BUSINESS_NAME	VARCHAR2(128)	Area name. (Required)
CHAIN_ID	NUMBER	ID number of the business chain (in the OPENLS_DIR_BUSINESS_CHAIN table), if the business is part of a chain.
DESCRIPTION	VARCHAR2(1024)	Description of the business.
PHONE	VARCHAR2(64)	Phone number, in an appropriate format for the location.
COUNTRY	VARCHAR2(64)	Country code or name. (Required)
COUNTRY_SUBDIVISION	VARCHAR2(128)	Subdivision of the country, if applicable.

**Table 12-1 (Cont.) OPENLS\_DIR\_BUSINESSES Table**

Column Name	Data Type	Description
COUNTRY_SECONDARY_SUBDIVISION	VARCHAR2(128)	Subdivision within COUNTRY_SUBDIVISION, if applicable.
MUNICIPALITY	VARCHAR2(128)	Municipality name.
MUNICIPALITY_SUBDIVISION	VARCHAR2(128)	Subdivision within MUNICIPALITY, if applicable.
POSTAL_CODE	VARCHAR2(32)	Postal code (for example, 5-digit ZIP code in the United States and Canada). (Required)
POSTAL_CODE_EXT	VARCHAR2(32)	Postal code extension (for example, 4-digit extension if the 5-4 ZIP code format is used).
STREET	VARCHAR2(128)	Street address, including house or unit number. (Required)
INTERSECTING_STREET	VARCHAR2(128)	Name of the street (if any) that intersects STREET at this address.
BUILDING	VARCHAR2(128)	Name of the building that includes this address.
PARAMETERS	XMLTYPE	XML document with additional information about the business.
GEOM	SDO_GEOMETRY	Point geometry representing the address of the business.

### 12.3.2 OPENLS\_DIR\_BUSINESS\_CHAINS Table

The OPENLS\_DIR\_BUSINESS\_CHAINS table stores information about each business chain. A business chain is a business that has multiple associated businesses; for example, a restaurant chain has multiple restaurants that have the same name and offer basically the same menu. If the business is part of a business chain, the row for that business in the OPENLS\_DIR\_BUSINESSES table (described in [OPENLS\\_DIR\\_BUSINESSES Table](#) (page 12-2)) contains a CHAIN\_ID column value that matches a value in the CHAIN\_ID column in the OPENLS\_DIR\_BUSINESS\_CHAINS table.

The OPENLS\_DIR\_BUSINESS\_CHAINS table contains one row for each business chain, and it contains the columns shown in [Table 12-2](#) (page 12-3).

**Table 12-2 OPENLS\_DIR\_BUSINESS\_CHAINS Table**

Column Name	Data Type	Description
CHAIN_ID	NUMBER	Business chain ID number. (Required)
CHAIN_NAME	VARCHAR2(128)	Business chain name.

### 12.3.3 OPENLS\_DIR\_CATEGORIES Table

The OPENLS\_DIR\_CATEGORIES table stores information about each category into which a business can be placed. If the data provider uses a category hierarchy, this table contains rows for categories at all levels of the hierarchy, using the PARENT\_ID column to indicate the parent category of a child category. For example, a Restaurants category might be the parent of several child categories, one of which might be Chinese.

The OPENLS\_DIR\_CATEGORIES table contains one row for each category, and it contains the columns shown in [Table 12-3](#) (page 12-4).

**Table 12-3 OPENLS\_DIR\_CATEGORIES Table**

Column Name	Data Type	Description
CATEGORY_ID	VARCHAR2(32)	Category ID string. (Required)
CATEGORY_TYP E_ID	NUMBER	Category type ID number. Must match a value in the CATEGORY_TYPE_ID column of the OPENLS_DIR_CATEGORY_TYPES table (described in <a href="#">OPENLS_DIR_CATEGORY_TYPES Table</a> (page 12-5)). (Required)
CATEGORY_NA ME	VARCHAR2(128)	Category name. (Required)
PARENT_ID	VARCHAR2(32)	CATEGORY_ID value of the parent category, if any, for this category.
PARAMETERS	XMLTYPE	XML document with additional information about the category.

### 12.3.4 OPENLS\_DIR\_CATEGORIZATIONS Table

The OPENLS\_DIR\_CATEGORIZATIONS table stores information about associations of businesses with categories. Each business can be in multiple categories; and the categories for a business can be independent of each other or in a parent-child relationship, or both. For example, a store that sells books and music CDs might be in the categories for Bookstores, Music, and its child category Music Stores, in which case there will be three rows for that business in this table.

The OPENLS\_DIR\_CATEGORIZATIONS table contains one row for each association of a business with a category, and it contains the columns shown in [Table 12-4](#) (page 12-4).

**Table 12-4 OPENLS\_DIR\_CATEGORIZATIONS Table**

Column Name	Data Type	Description
BUSINESS_ID	NUMBER	Business ID. Must match a value in the BUSINESS_ID column of the OPENLS_DIR_BUSINESSES table (described in <a href="#">OPENLS_DIR_BUSINESSES Table</a> (page 12-2)). (Required)

**Table 12-4 (Cont.) OPENLS\_DIR\_CATEGORIZATIONS Table**

Column Name	Data Type	Description
CATEGORY_ID	VARCHAR2(32)	Category ID string. The CATEGORY_ID and CATEGORY_TYPE_ID values must match corresponding column values in a single row in the OPENLS_DIR_CATEGORIES table (described in <a href="#">OPENLS_DIR_CATEGORIES Table</a> (page 12-4)). (Required)
CATEGORY_TYPE_ID	NUMBER	Category type ID number. The CATEGORY_ID and CATEGORY_TYPE_ID values must match corresponding column values in a single row in the OPENLS_DIR_CATEGORIES table (described in <a href="#">OPENLS_DIR_CATEGORIES Table</a> (page 12-4)). (Required)
CATEGORIZATION_TYPE	VARCHAR2(8)	EXPLICIT (the default) or IMPLICIT.
USER_SPECIFIC_CATEGORIZATION	VARCHAR2(32)	User-specified categorization, if any.
PARAMETERS	XMLTYPE	XML document with additional information about the association of the business with the category.

### 12.3.5 OPENLS\_DIR\_CATEGORY\_TYPES Table

The OPENLS\_DIR\_CATEGORY\_TYPES table stores information about category types. This table contains the columns shown in [Table 12-5](#) (page 12-5).

**Table 12-5 OPENLS\_DIR\_CATEGORY\_TYPES Table**

Column Name	Data Type	Description
CATEGORY_TYPE_ID	NUMBER	Category type ID number. (Required)
CATEGORY_TYPE_NAME	VARCHAR2(128)	Name of the category type. (Required)
PARAMETERS	XMLTYPE	XML document with additional information about the category type.

### 12.3.6 OPENLS\_DIR\_SYNONYMS Table

The OPENLS\_DIR\_SYNONYMS table stores information about synonyms for categories. Synonyms can be created to expand the number of terms (strings) associated with a category, so that users get more complete and meaningful results from a search.

The OPENLS\_DIR\_SYNONYMS table contains one row for each synonym definition, and it contains the columns shown in [Table 12-6](#) (page 12-6).

**Table 12-6 OPENLS\_DIR\_SYNONYMS Table**

Column Name	Data Type	Description
STANDARD_NAME	VARCHAR2(128)	Standard name of a category, as the user might enter it.
CATEGORY	VARCHAR2(128)	Category name, as it appears in the OPENLS_DIR_CATEGORIES table (described in <a href="#">OPENLS_DIR_CATEGORIES Table</a> (page 12-4)).
AKA	VARCHAR2(128)	.Additional or alternate name for the category. ("AKA" stands for "also known as.")



---

## Routing Engine

The Spatial and Graph routing engine (often referred to as the routing engine) enables you to host an XML-based web service that provides the following features:

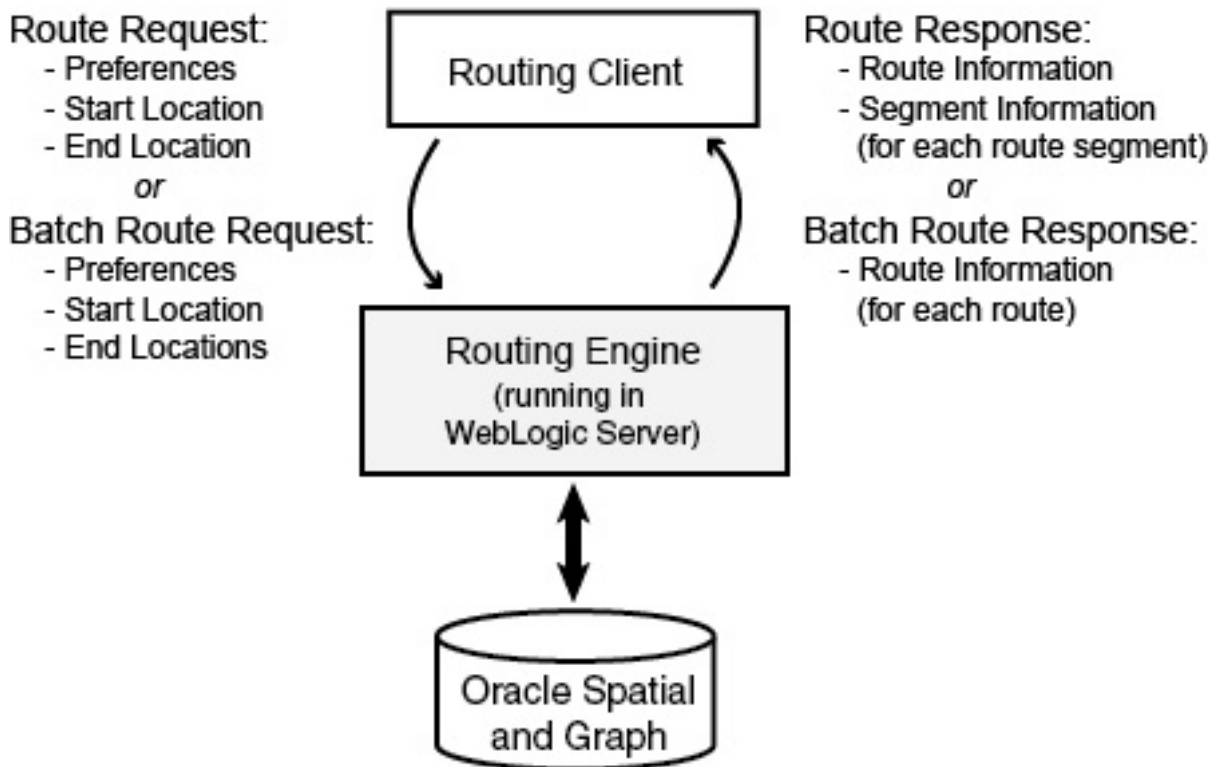
- Simple route requests return route information between the two locations.
- Simple multi-address route requests return route information between three or more locations. The ordering of the locations in the response is user specified and is not optimized.
- Traveling salesperson (TSP) route requests are a form of multi-address route request and also return route information between three or more locations. The ordering of some or all of the locations in the response can be reordered to optimize the overall route.
- Batched route requests are a batch of one or more simple or multi-address route requests. This can be a mix of simple, simple multi-address and TSP requests. Each individual request looks like a single request but is encapsulated in a `<batch_route_request>` element. The routing engine differentiates batched requests from batch mode requests when it finds a `<route_request>` element embedded in the `<batch_route_request>` element.
- Batch mode route requests return multiple responses, each with the same start location but different end locations.

For all requests, the start, intermediate, and end locations are identified by addresses, pre-geocoded addresses, or longitude/latitude coordinates.

Multi-address routes are explained in [Routing](#) (page 13-2).

The Oracle Routing engine is implemented as a Java 2 Enterprise Edition (J2EE) Web application that can be deployed in an application server such as Oracle WebLogic Server.

[Figure 13-1](#) (page 13-2) shows the basic flow of action with the routing engine: a client locates a remote routing engine instance, sends a route request, and processes the route response returned by the routing engine instance.

**Figure 13-1 Basic Flow of Action with the Spatial and Graph Routing Engine**

This chapter contains the following major sections:

- [Routing](#) (page 13-2)
- [Deploying the Routing Engine](#) (page 13-6)
- [Routing Engine XML API](#) (page 13-8)
- [Data Structures Used by the Routing Engine](#) (page 13-54)

This chapter does not include information about administering the routing engine. That information, which is for advanced users with specialized needs, is in [Routing Engine Administration](#) (page E-1).

## 13.1 Routing

Routes are computed between location elements. There are three types of location elements: `<start_location>`, `<location>` (intermediate locations or waypoints), and `<end_location>`. A location element can be specified as an address that is geocoded; as a pre-geocoded address, edge id/percentage pair; or as a latitude/longitude pair that is reverse geocoded.

This section includes the following topics:

- [Simple Route Request](#) (page 13-3)
- [Simple Multi-address Route Request](#) (page 13-3)
- [Traveling Salesperson \(TSP\) Route Request](#) (page 13-4)
- [Batched Route Request](#) (page 13-5)

- [Batch Mode Route Request](#) (page 13-5)

### 13.1.1 Simple Route Request

Simple route requests must contain both a `<start_location>` and `<end_location>` element. The response for a simple route request is a single route from the start location to the end location.

Several attributes in a simple route request control how the route is computed and what is returned in the route response. These attributes are discussed in [Routing Engine XML API](#) (page 13-8).

### 13.1.2 Simple Multi-address Route Request

Simple multi-address route requests must contain at least three locations, including a required `<start_location>` element. Multi-address route requests must also contain one or more `<location>` elements, and optionally an `<end_location>` element.

The result of a simple multi-address route request is a single route from the start location, through each intermediate location, to the end location. This single route consists of multiple subroutes. **Subroutes** are the routes between each of the individual locations.

In a simple multi-address route request, the `optimize_route` attribute must be absent or set to `FALSE`. In simple multi-address route requests, all locations are fixed. There is no attempt to optimize the order in which the locations are visited. The locations in the route are visited in the order in which they were specified in the request.

Simple multi-address route requests use the `route_type` attribute to classify the route as an open or closed tour:

- Open tour: The route ends at the final intermediate location or a specified end location.
- Closed tour: The route returns to the start location.

If a simple multi-address closed tour route is requested, the `<start_location>` element specification also used as the end location during route computation. If an `<end_location>` element is specified in a simple multi-address closed tour route request, an error is returned.

#### Example: Simple Multi-address Open Tour Route Request

Assume you want to drive from your workplace to customer A, then to customer B, and then to customer C.

- The route request has your workplace as the start location, customers A and B as intermediate locations, and customer C as the end location.
- The returned route has three subroutes: (1) workplace to customer A, (2) customer A to customer B, and (3) customer B to customer C.
- Each subroute probably has multiple segments, each one associated with a specific driving direction step.

#### Example: Simple Multi-address Closed Tour Route Request

Assume you want to drive from your workplace to customer A, then to customer B, then to customer C, and then back to your workplace.

- The route request has your workplace as the start location, and customers A, B, and C as intermediate locations. Your workplace is also used as the end location. An `<end_location>` element should not be specified in the route request. The routing engine adds the subroute from customer C to the workplace automatically when it sees a request for a closed tour.
- The returned route has four subroutes: (1) workplace to customer A, (2) customer A to customer B, (3) customer B to customer C, and (4) customer C back to the workplace.
- Each subroute probably has multiple segments, each one associated with a specific driving direction step.

Simple multi-address requests can contain several attributes specific to each subroute. These attributes include `return_subroutes`, `return_subroute_edge_ids`, and `return_subroute_geometry`. These attributes are explained in [Route Request XML Schema Definition](#) (page 13-37).

### 13.1.3 Traveling Salesperson (TSP) Route Request

A **traveling salesperson (TSP) route** request must have at least three locations. Unlike simple multi-address route requests, the `<start_location>` element is optional.

TSP route requests are multi-address requests that have the `optimize_route` attribute present and set to TRUE. TSP route requests attempt to reorder the unfixed locations in the request to optimize the overall route.

All the locations in a TSP request are classified as unfixed or fixed:

- **Unfixed** location: If a location is specified with the `<location>` element, it is considered an unfixed location and is subject to reordering during route computation.
- **Fixed** location: If the location is specified with a `<start_location>` or `<end_location>` element, it is considered a fixed location and is not subject to reordering during route computation.

If intermediate locations need to be fixed, a simple multi-address route request should be used instead of a TSP route request.

TSP route requests use the `route_type` attribute to classify the route as an open or closed tour.:

- **Open** tour: The route does not return to the start location.
- **Closed** tour: The route returns to the start location.

If a TSP closed tour route is requested, the `<start_location>` element must be specified. This start location is also used as the end location during route computation. If an `<end_location>` element is specified in a TSP closed tour route request, an error is returned. By definition, TSP closed tour routes use a single fixed start and end location but the intermediate locations are still subject to reordering.

#### Example: TSP Open Tour Route Request

To drive from your workplace, visiting customers A, B, and C:

- The route has the workplace as a fixed start location.

- The route has customers A, B, and C as unfixed intermediate locations. These locations are reordered to optimize the overall route.
- The returned route is an optimized open tour route from the workplace to the first reordered location, through the second reordered location, to the final location.

#### **Example: TSP Closed Tour Route Request**

To drive from your workplace, visiting customers A, B, and C, and then returning to your workplace:

- The route has the workplace as a fixed start location. The workplace is also used as a fixed end location. An `<end_location>` element should not be specified in the route request. The routing engine adds the subroute from last unfixed location to the workplace automatically when it sees a request for a closed tour.
- The route has customers A, B, and C as unfixed intermediate locations. These locations are reordered to optimize the overall route.
- The returned route is an optimized closed tour route from the workplace to the first reordered location, through the second and third reordered locations, and finally back to the start location.

TSP route requests can contain several attributes specific to each subroute. These attributes include `return_subroutes`, `return_subroute_edge_ids`, and `return_subroute_geometry`. These attributes are explained in [Route Request XML Schema Definition](#) (page 13-37).

### **13.1.4 Batched Route Request**

**Batched route requests** are a hybrid of batch mode requests (explained in [Batch Mode Route Request](#) (page 13-5)) and individual route requests. Batched route requests are a way to process multiple simple, simple multi-address, and TSP route requests in one request to the routing engine. Batching of batch mode requests is not allowed.

Like a batch mode request, the outermost element of a batched route request is `<batch_route_request>`. Unlike a batch mode request, batched route requests have one or more `<route_request>` elements nested inside the batch request.

In a batched route request, all attributes associated with the encompassing `<batch_route_request>` element are ignored. Instead, the attributes associated with the nested `<route_request>` elements are used when processing each individual route. This allows users to mix simple, simple multi-address, and TSP requests in a single batched individual route request.

The batched route request is useful for submitting multiple variations of a single route request with differing attributes and comparing the results, for example, for comparing the fastest route with the shortest route.

The individual route requests in a batched route request can use any of the attributes from simple route requests. They can also use any of the subroute-specific attributes of simple multi-address and TSP route requests.

All of the individual route requests in a batched route request are standalone; they have no effect on any other route request in the batch.

### **13.1.5 Batch Mode Route Request**

A **batch mode route request** contains one `<start_location>` element and one or more `<end_location>` elements.

The result of a batch mode route request contains multiple routes. Each route is from the start location to one of the end locations. Each route in a batch mode request is completely separate from all the other routes except for the shared start location.

Batch mode route requests may contain several batch mode specific attributes. These attributes include `cutoff_distance` and `sort_by_distance`. These attributes are explained in [Route Request XML Schema Definition](#) (page 13-37).

## 13.2 Deploying the Routing Engine

Deploying the routing engine involves the following major tasks:

- [Preparing WebLogic Server](#) (page 13-6)
- [Unpacking the routeserver.ear File](#) (page 13-6)
- [Editing the web.xml File](#) (page 13-7)
- [Deploying the Routing Engine on WebLogic Server](#) (page 13-8)

### 13.2.1 Preparing WebLogic Server

Before you deploy the routing engine, a *Managed Server* should be created in WebLogic Server (WLS). The managed server should have at least four gigabytes of memory in the heap. The more memory that is allocated to the heap, the more local partitions can be kept in the cache. Being able to keep more partitions in the cache is the single best way to improve the performance of the routing engine.

For the routing engine to be successfully deployed on a managed server, the server must have a data source associated with it. This data source provides a pool of connections to the database schema that contains the road network data and user data.

It is recommended that a WLS *Work Manager* be created and associated with the managed server. A work manager stores constraints on the number of requests that can run concurrently on the managed server. It also stores a constraint on the number of requests that can be queued before the managed server starts rejecting requests.

### 13.2.2 Unpacking the routeserver.ear File

To unpack the `routeserver.ear.zip` file, follow these steps.

In examples in these steps, the following values are used:

- The WebLogic Server Home (`$WLS_HOME`) is `/scratch/software/Oracle/Middleware/user_projects/domains/spatial/`.
- The application deployment directory is `$WLS_HOME/applications/`.

However, use the values appropriate for your environment if they are different.

1. Copy `routeserver.ear.zip` to the application deployment directory:

```
cp routeserver.ear.zip $WLS_HOME/applications/
```

2. Unzip `routeserver.ear.zip`:

```
cd $WLS_HOME/applications/  
unzip routeserver.ear.zip
```

### 13.2.3 Editing the web.xml File

This section describes changes to parameter values in the `web.xml` file that you must make for the routing engine to deploy properly. (There are also additional parameters that you can change to alter how the routing engine operates.)

- Change the `container_ds` parameter to be the JNDI Name of the data source associated with the managed server. For example: `JNDI/NorthAmericanDS`
- Change the `routeserver_network_name` parameter to the name of the Network Data Model (NDM) network built on the routing engine road network data. For example: `NorthAmericanNetwork`
- If the WLS Managed Server has a Work Manager associated with it, change the `wl-dispatch-policy` parameter value to the name of the Work Manager. For example: `NorthAmericanWM`
- Check to be sure the `geocoder_type` parameter is set to `httpclient` or `None`. (`thinclient` is no longer supported.)
  - If set to `httpclient`, then also set `geocoder_http_url` to the URL of the Geocoder servlet. For example: `http://localhost:8888/geocoder/gcserver`
  - If an HTTP proxy is being used, then also specify `geocoder_http_proxy_host` and `geocoder_http_proxy_port`. If no proxy exists, these two parameters can be ignored
- If necessary, change the `logfile_name` parameter value. By default, the `logfile_name` parameter is set to `log/RouteServer.log`. This default relative path includes a subdirectory named `log`, relative to where the routing engine is installed. The `logfile_name` parameter can also be set to an absolute path, for example: `/scratch/logs/RouteServer.log`.
- Change the `partition_cache_size` parameter. The default value for this parameter is 70, but it will probably need to be changed depending on the amount of memory allocated to the heap on the managed server. The following formula can be used to get a good starting point for a cache size.

```
partition_cache_size = (NodesPerGigabyte /
AvgNodesPartition) * UsableMemory
```

Where:

- `NodesPerGigabyte` is the number of nodes per gigabyte. (This value should not change. In the data sets as of December 2013, this value is 15000000, that is, 1.5 million.)
- `AvgNodesPartition` is the average number of nodes per local partition. This does not include the highway partition 0. The memory for the highway partition is accounted for in the 1 gigabyte subtracted from the allocated heap size. For the North American data set, the `AvgNodesPartition` value is around 26000. You can check the actual average nodes per partition by using the following query:

```
SELECT AVG(COUNT(node_id))
FROM node
```

```
WHERE partition_id>0  
GROUP BY partition_id;
```

- UsableMemory is the managed server allocated heap size in Gigabytes minus 1 Gigabyte.

This formula generates a safe number for the `partition_cache_size` parameter. Depending on the types of user information being used and the average number of concurrent requests being processed, it may be possible to add another 15% to 20% to this number. Use the WLS console to monitor the heap usage before changing this number.

The heap can then be monitored while the routing engine is running to tune this number up or down. However, setting this value too high may cause the managed server to run out of memory.

### 13.2.4 Deploying the Routing Engine on WebLogic Server

To deploy the routing engine on WebLogic Server, follow these steps:

1. Log into the WLS console.
2. Click **Deployments > Install**.
3. Make sure that **Path** is set to the application deployment directory (as explained in [Unpacking the routeserver.ear File](#) (page 13-6)).
4. Select **routeserver.ear** (a directory) and click **Next**.
5. Ensure that the **Install this deployment as an application** targeting style is selected, and click **Next**.
6. In the list of potential servers to which to deploy the routing engine, select the name of the managed server that you created, and click **Next**.
7. Ensure that the deployment name is **routeserver**, and click **Finish**.

After the routing engine is deployed, you can test the deployment with a set of routing engine test queries. For example, if the managed server was set up to run on port 7003, the routing engine servlet can be tested from `http://localhost:7003/routeserver/`.

These queries can run a variety of different types of route requests. These queries contain North American addresses, but the addresses can easily be manipulated on the web page for other data sets.

## 13.3 Routing Engine XML API

This section explains how to submit route requests in XML format to the routing engine, and it describes the XML Schema Definitions (XSDs) for the route requests (input) and responses (output). XML is widely used for transmitting structured documents using the HTTP protocol. If an HTTP request (GET or POST method) is used, it is assumed the request has a parameter named `xml_request` whose value is a string containing the XML document for the request.

A request to the routing engine servlet has the following format:

```
http://hostname:port/route-server-servlet-path?xml_request=xml-request
```

In this format:



- *hostname* is the network path of the server on which the routing engine is running.
- *port* is the port on which the application server listens.
- *route-server-servlet-path* is the routing engine servlet path (for example, `routeserver/servlet/RouteServerServlet`).
- *xml-request* is the URL-encoded XML request submitted using the HTML GET or POST method.

The input XML is required for all requests. The output will be an XML document.

In a simple *route* request, you must specify a route ID, and you can specify one or more of the following attributes:

- *route\_preference*: fastest or shortest (default)
- *road\_preference*: highway (default) or local
- *return\_driving\_directions* (whether to return driving directions): true or false (default)
- *return\_hierarchical\_directions* (whether to return hierarchical directions): true or false (default)
- *return\_locations* (return geocoded results for the start and end locations of the route and any subroutes): true or false (default)
- *return\_subroutes* (whether to return subroutes): true (default if a multi-address route, ignored for a single-address route) or false
- *return\_route\_geometry* (whether to return the line string coordinates for the route): true or false (default)
- *return\_subroute\_geometry* (whether to return the line string coordinates for each subroute): true or false (default for multi-address routes)
- *return\_segment\_geometry* (whether to return the line string coordinates for each maneuver in the route): true or false (default)
- *return\_detailed\_geometry*: true (default; returns detailed geometries) or false (returns generalized geometries)
- *language*: language used to generate driving directions (ENGLISH (default), FRENCH, GERMAN, ITALIAN, or SPANISH)
- *distance\_unit*: kilometer, mile (default), or meter
- *length\_unit*: us for feet (default) or metric for meters
- *time\_unit*: hour, minute (default), or second
- *weight\_unit*: us for tons (default) or metric for metric tons
- *pre\_geocoded\_locations* (whether the start and end locations are input locations (address specifications or points) or previously geocoded locations): true (previously geocoded locations) or false (default; input locations)
- *driving\_directions\_detail*: high, medium (default) or low
- *optimize\_route*: true or false (default)

- `route_type`: open (default) or closed
- `vehicle_type`: auto (default) or truck
- `truck_type`: delivery, public, resident, or trailer; (no default)
- `truck_height`: floating-point number in `length_units`
- `truck_length`: floating-point number in `length_units`
- `truck_per_axle_weight`: floating-point number in `weight_units`
- `truck_weight`: floating-point number in `weight_units`
- `truck_width`: floating-point number in `length_units`

*Batched route* requests are groups of one or more simple (single, multi-address, or TSP) requests encapsulated in a `<batch_route_request>` element. All attributes associated with the `<batch_route_request>` element are ignored. Because all encapsulated requests are simple requests, they use the preceding listed attributes.

In a *batch mode route* request, you must specify a request ID, a start location, and one or more end locations. Each location must have an ID attribute. Most of the attributes used for simple requests have no meaning for batch mode. You can use one or more of the following attributes in a batch mode route request, but using an attribute not in this list will cause an exception to be raised.

- `route_preference`: fastest or shortest (default)
- `road_preference`: highway (default) or local
- `distance_unit`: kilometer, km, mile (default), or meter
- `time_unit`: hour, minute (default), or second
- `sort_by_distance` (whether to sort the returned routes in ascending order by distance of the end location from the start location): true or false (default)
- `cutoff_distance` (returning only routes where the end location is less than or equal to a specified number of distance units from the start location): (number; default = no limit)
- `pre_geocoded_locations` (whether the start and end locations are input locations (address specifications or points) or previously geocoded locations): true (previously geocoded locations) or false (default; input locations)

This section includes the following topics:

- [Route Request and Response Examples](#) (page 13-11)
- [Route Request XML Schema Definition](#) (page 13-37)
- [Route Response XML Schema Definition](#) (page 13-44)
- [Batch Mode Route Request and Response Examples](#) (page 13-48)
- [Batch Route Request XML Schema Definition](#) (page 13-50)
- [Batch Route Response XML Schema](#) (page 13-53)

### 13.3.1 Route Request and Response Examples

This section contains XML examples of route requests and the responses generated by those requests. One request uses specified addresses, another uses points specified by longitude and latitude coordinates, and another uses previously geocoded locations. For reference information about the available elements and attributes, see [Route Request XML Schema Definition](#) (page 13-37) for requests and [Route Response XML Schema Definition](#) (page 13-44) for responses.

#### **Example 13-1 Route Request with Specified Addresses**

[Example 13-1](#) (page 13-11) shows a simple request for the fastest route, preferably using highways, between two offices at specified addresses (in Waltham, Massachusetts and Nashua, New Hampshire) in a 5.67 metric ton delivery truck. The response contains driving directions for each segment using kilometers for distances and minutes for times. This request also returns the geocode information for the start and end location.

```
<?xml version="1.0" standalone="yes"?>
<route_request
  id="8"
  route_preference="fastest"
  road_preference="highway"
  vehicle_type="truck"
  truck_type="delivery"
  truck_weight="5.67"
  return_driving_directions="true"
  return_locations="true"
  distance_unit="km"
  time_unit="minute"
  weight_unit="metric">
  <start_location>
    <input_location id="1">
      <input_address>
        <us_form1
          street="1000 Winter St"
          lastline="Waltham, MA" />
        </input_address>
      </input_location></start_location>
    <end_location>
      <input_location id="2">
        <input_address>
          <us_form1
            street="1 Oracle Dr"
            lastline="Nashua, NH" />
          </input_address>
        </input_location>
      </end_location>
    </route_request>
```

#### **Example 13-2 Response for Route Request with Specified Addresses**

[Example 13-2](#) (page 13-11) shows the response generated by the request in [Example 13-1](#) (page 13-11). (The output is reformatted for readability.)

```
<!-- Oracle Routeserver version 12.1.0.1.0 (data version 11.1.0.7.1) -->
<route_response>
  <route id="8" step_count="12"
    distance="46.07216796875" distance_unit="km"
    time="31.133371988932293" time_unit="minute"
```

```
        start_location="1" end_location="2">
<start_location>
  <location id="1"
    longitude="-71.25962" latitude="42.39741"
    house_number="399" street="WINTER ST"
    city="WALTHAM" state="MA" country="US"
    driving_side="R"
    postal_code="02451"
    edge_id="906810462" percent="0.0"/>
</start_location>
<segment sequence="1"
  instruction="Start out on Winter St (Going Southwest)"
  distance="0.0" time="0.0"/>
<segment sequence="2"
  instruction="Turn RIGHT onto Wyman St (Going North)"
  distance="0.3453199939727783" time="0.3597083270549774"/>
<segment sequence="3"
  instruction="Take RAMP toward Peabody"
  distance="0.43125000953674314" time="0.3478285253047943"/>
<segment sequence="4"
  instruction="Merge onto I-95 N/RT-128 N (Going North)"
  distance="9.598520091056823" time="6.1528975268205"/>
<segment sequence="5"
  instruction="Continue on toward Burlington"
  distance="0.0" time="0.0"/>
<segment sequence="6"
  instruction="Stay STRAIGHT to go onto RAMP (Going East)"
  distance="0.22952000427246094" time="0.23908333778381347"/>
<segment sequence="7"
  instruction="Continue on toward Lowell"
  distance="0.5157099990844727" time="0.5371979157129924"/>
<segment sequence="8"
  instruction="Stay STRAIGHT to go onto US-3 N (Going Northwest)"
  distance="33.26371000862122" time="21.322891048093638"/>
<segment sequence="9"
  instruction="Take EXIT 1 toward S. Nashua"
  distance="0.6134100036621094" time="0.5454034169514974"/>
<segment sequence="10"
  instruction="Continue on toward So. Nashua"
  distance="0.27333999633789063" time="0.41415150960286456"/>
<segment sequence="11"
  instruction="Turn LEFT onto Spit Brook Rd (Going West)"
  distance="0.8013799934387207" time="1.2142121195793152"/>
<segment sequence="12"
  instruction="Turn RIGHT onto Oracle Dr (Going North)"
  distance="0.0" time="0.0"/>
<end_location>
  <location id="2"
    longitude="-71.45937" latitude="42.70783"
    house_number="1" street="ORACLE DR"
    city="NASHUA" state="NH" country="US"
    driving_side="R"
    postal_code="03062"
    edge_id="22325991" percent="0.0"/>
</end_location>
</route>
</route_response>
```

### Example 13-3 Route Request with Locations Specified as Longitude/Latitude Points

[Example 13-3](#) (page 13-13) shows a request for a closed tour TSP shortest route, preferably using highways, between four locations specified as longitude/latitude points. (The points are associated with four locations in San Francisco, California: the World Trade Center, Golden Gate Park, 3001 Larkin Street, and 100 Flower Street.) The route starts and ends at a fixed location at the World Trade Center, but the other three locations are subject to reordering to produce an optimal route. The information from the geocoder is returned for all location in the route. The geometry is displayed at the subroute level, and edge IDs are displayed with the driving directions at the segment level.

```
<?xml version="1.0" standalone="yes"?>
<route_request id="8"
    route_preference="shortest"
    route_type="closed"
    optimize_route="true"
    road_preference="highway"
    return_locations="true"
    return_driving_directions="true"
    return_subroutes="true"
    return_route_geometry="false"
    return_subroute_geometry="true"
    return_segment_geometry="false"
    return_segment_edge_ids="true"
  >
  <start_location>
    <input_location id="1" longitude="-122.39436" latitude="37.79579"/>
  </start_location>
  <location>
    <input_location id="2" longitude="-122.45412" latitude="37.7714" />;
  </location>
  <location>
    <input_location id="3" longitude="-122.422" latitude="37.80551" />
  </location>
  <location>
    <input_location id="4" longitude="-122.40459" latitude="37.74211" />
  </location>
</route_request>
```

### Example 13-4 Response for Route Request with Locations Specified as Longitude/Latitude Points

[Example 13-4](#) (page 13-13) shows the response generated by the request in [Example 13-3](#) (page 13-13). (The output is reformatted for readability.)

```
<!-- Oracle Routeserver version 12.1.0.2.0 (data version 11.1.0.7.1) -->
<route_response>
  <route id="8" step_count="88"
    distance="15.105344411681319" distance_unit="mile"
    time="35.63843688964844" time_unit="minute"
    start_location="1" end_location="1">
    <subroute id="1" step_count="5"
      distance="1.8589950065634127" distance_unit="mile"
      time="4.305604044596354" time_unit="minute"
      start_location="1" end_location="3">
      <subroute_geometry>
        <LineString><coordinates>
          -122.39436,37.79579 -122.39436,37.79579 -122.39454,37.79601
          -122.39467,37.79614 -122.39486,37.79633 -122.39499,37.79647
```

```
-122.39529,37.79678 -122.39558,37.79709 -122.39592,37.79747
-122.3963,37.7979 -122.39646,37.79808 -122.3969,37.79858
-122.39741,37.79916 -122.39755,37.79929 -122.39776,37.79918
-122.39793,37.79907 -122.39811,37.79899 -122.39821,37.79896
-122.39836,37.79892 -122.39867,37.79889 -122.39986,37.79874
-122.40104,37.7986 -122.40223,37.79845 -122.40302,37.79835
-122.40308,37.79834 -122.40349,37.79828 -122.40384,37.79824
-122.40466,37.79813 -122.40545,37.79802 -122.40549,37.79802
-122.4062,37.79794 -122.40622,37.79794 -122.40664,37.79789
-122.40707,37.79816 -122.40789,37.79872 -122.40846,37.7991
-122.40898,37.7995 -122.41017,37.80031 -122.41038,37.80045
-122.41078,37.80073 -122.41089,37.8008 -122.41094,37.80084
-122.41136,37.80112 -122.41143,37.80118 -122.41248,37.80188
-122.41254,37.80193 -122.41289,37.80218 -122.41367,37.80274
-122.41488,37.80355 -122.41547,37.80396 -122.41607,37.80441
-122.41657,37.80475 -122.41681,37.80492 -122.4172,37.80519
-122.4178,37.8056 -122.41837,37.80598 -122.41873,37.80593
-122.42035,37.80573 -122.422,37.80551
-122.42199999992847,37.805509999663826
</coordinates></LineString>
</subroute_geometry>
<start_location>
  <location id="1"
    longitude="-122.39436" latitude="37.79579"
    house_number="" street="HERB CAEN WAY"
    city="SAN FRANCISCO" state="CA" country="US"
    driving_side="R"
    postal_code="94111"
    edge_id="724791174" percent="1.0"/>
</start_location>
<segment sequence="1"
  instruction="Start out on The Embarcadero (Going Northwest)"
  distance="0.29822904401544625" time="0.49993750055631003">
  <segment_edge_ids><edge_ids>
    724791174, 724791175, 733049363, 915793201, 915793202, 830932896,
    112011102, 112011103, 830934259, 830934260, 726169597, 112011105,
    37830229
  </edge_ids></segment_edge_ids>
</segment>
<segment sequence="2"
  instruction="Turn LEFT onto Broadway (Going Southwest)"
  distance="0.5093705394140182" time="1.2420151789983114">
  <segment_edge_ids><edge_ids>
    -24571168, -724946174, -724946173, -23598782, -23621077, -23598783,
    -23598784, -23598786, -23598787, -23598788, -23598789, -23598791,
    -23598792
  </edge_ids></segment_edge_ids>
</segment>
<segment sequence="3"
  instruction="Turn SLIGHT RIGHT onto Columbus Ave (Going Northwest)"
  distance="0.8505250718279074" time="2.07386361459891">
  <segment_edge_ids><edge_ids>
    23601001, 23601002, 23601003, 23601004, 830239101, 830239102,
    799420615, 23601006, 23601007, 23601008, 23737804, 23601009,
    23601010, 23601011, 23737805, 23601012, 754219681, 754219682,
    23622414, 754224948, 754224949
  </edge_ids></segment_edge_ids>
</segment>
<segment sequence="4"
  instruction="Turn SLIGHT LEFT onto North Point St (Going West)"
  distance="0.20086994241069608" time="0.48978787660598755">
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    <segment_edge_ids><edge_ids>
      -23612405, -23612406, -23612407
    </edge_ids></segment_edge_ids>
  </segment>
  <segment sequence="5"
    instruction="Turn LEFT onto Larkin St (Going South)"
    distance="2.3560371803568745E-8" time="5.744803956986288">
    <segment_edge_ids><edge_ids>
      -23609029
    </edge_ids></segment_edge_ids>
  </segment>
  <end_location>
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      house_number="2999" street="LARKIN ST" city="SAN FRANCISCO"
      state="CA" country="US"
      driving_side="R"
      postal_code="94109"
      edge_id="23609029" percent="0.9999996412873026"/>
  </end_location>
</subroute>
<subroute id="2" step_count="32"
  distance="4.0150478493172495" distance_unit="mile"
  time="9.790025838216145" time_unit="minute"
  start_location="3" end_location="2">
  <subroute_geometry>
    <LineString><coordinates>
      -122.42199999992847,37.805509999663826 -122.422,37.80551
      -122.42364,37.8053 -122.42345,37.80436 -122.42327,37.80342
      -122.42482,37.80322 -122.42496,37.8032 -122.42545,37.80314
      -122.42656,37.803 -122.42638,37.80207 -122.4262,37.80111
      -122.42782,37.8009 -122.42947,37.80069 -122.43111,37.80048
      -122.43276,37.80026 -122.43439,37.80006 -122.43605,37.79985
      -122.43597,37.79943 -122.43588,37.79896 -122.43751,37.79874
      -122.43742,37.79828 -122.43733,37.79781 -122.43895,37.79759
      -122.43877,37.79667 -122.44041,37.79645 -122.44025,37.79554
      -122.4419,37.7953 -122.44173,37.79439 -122.44153,37.79343
      -122.44308,37.79323 -122.44317,37.79322 -122.44328,37.79321
      -122.44476,37.79302 -122.44487,37.79301 -122.44496,37.793
      -122.44643,37.7928 -122.4463,37.79188 -122.44614,37.79099
      -122.44595,37.79011 -122.44577,37.78924 -122.44559,37.78836
      -122.44697,37.78818 -122.44688,37.78775 -122.44687,37.78769
      -122.44678,37.78726 -122.44676,37.78705 -122.44671,37.78679
      -122.44675,37.78651 -122.4468,37.78635 -122.44689,37.78618
      -122.44697,37.78603 -122.44749,37.7855 -122.44766,37.78538
      -122.44792,37.78513 -122.448,37.78507 -122.44814,37.78496
      -122.44929,37.78468 -122.45012,37.78448 -122.45015,37.78432
      -122.4502,37.78418 -122.45034,37.78396 -122.45041,37.78383
      -122.45043,37.78369 -122.45012,37.78218 -122.45112,37.78205
      -122.45109,37.78192 -122.45082,37.78064 -122.45186,37.78049
      -122.45287,37.78037 -122.45385,37.78023 -122.45374,37.77943
      -122.45367,37.77905 -122.45349,37.77817 -122.45339,37.77781
      -122.45332,37.77763 -122.45318,37.77685 -122.45303,37.77596
      -122.45299,37.77574 -122.45283,37.77499 -122.45297,37.77497
      -122.45287,37.77443 -122.45279,37.77404 -122.45262,37.7731
      -122.45241,37.77215 -122.45276,37.77206 -122.45301,37.77195
      -122.45346,37.77172 -122.45387,37.77153 -122.45398,37.77148
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    </coordinates></LineString>
  </subroute_geometry>
</start_location>

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  house_number="2999" street="LARKIN ST" city="SAN FRANCISCO"
  state="CA" country="US"
  driving_side="R"
  postal_code="94109"
  edge_id="23609029" percent="0.9999996412873026"/>
</start_location>
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  instruction="Start out on Larkin St (Going North)"
  distance="2.3560371803568745E-8" time="5.7448039569862884E-8">
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  </edge_ids></segment_edge_ids>
</segment>
<segment sequence="2"
  instruction="Turn LEFT onto North Point St (Going West)"
  distance="0.09072267445473188" time="0.22121211687723796">
  <segment_edge_ids><edge_ids>
    -23612408
  </edge_ids></segment_edge_ids>
</segment>
<segment sequence="3"
  instruction="Turn LEFT onto Polk St (Going South)"
  distance="0.1314981638707435" time="0.3206363519032796">
  <segment_edge_ids><edge_ids>
    -23614397, -23614396
  </edge_ids></segment_edge_ids>
</segment>
<segment sequence="4"
  instruction="Turn RIGHT onto Francisco St (Going West)"
  distance="0.1819921735430389" time="0.443757571776708">
  <segment_edge_ids><edge_ids>
    -23604420, -120906034, -916007650, -916007649
  </edge_ids></segment_edge_ids>
</segment>
<segment sequence="5"
  instruction="Turn LEFT onto Franklin St (Going South)"
  distance="0.13209470069661014" time="0.32209091186523436">
  <segment_edge_ids><edge_ids>
    -23604500, -23604499
  </edge_ids></segment_edge_ids>
</segment>
<segment sequence="6"
  instruction="Turn RIGHT onto Lombard St (Going West)"
  distance="0.544926363604202"
  time="1.3287121295928954">
  <segment_edge_ids><edge_ids>
    -23609690, -23609691, -23609692, -23609693, -23609694,
    -23609695
  </edge_ids></segment_edge_ids>
</segment>
<segment sequence="7"
  instruction="Turn LEFT onto Fillmore St (Going South)"
  distance="0.06220717119887626"
  time="0.15168182055155435">
  <segment_edge_ids><edge_ids>
    -23604040, -23604039
  </edge_ids></segment_edge_ids>
</segment>
<segment sequence="8"
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instruction="Turn RIGHT onto Greenwich St (Going West)"
distance="0.09030634551112576"
time="0.22019697825113932">
<segment_edge_ids><edge_ids>
  -23605619
</edge_ids></segment_edge_ids>
</segment>
<segment sequence="9"
  instruction="Turn LEFT onto Steiner St (Going South)"
  distance="0.06502205890116725" t
  time="0.15854545434316">
<segment_edge_ids><edge_ids>
  -23618095, -23618094
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  instruction="Turn RIGHT onto Filbert St (Going West)"
  distance="0.08977195129603127"
  time="0.21889394124348957">
<segment_edge_ids><edge_ids>
  -23603994
</edge_ids></segment_edge_ids>
</segment>
<segment sequence="11"
  instruction="Turn LEFT onto Pierce St (Going South)"
  distance="0.06433853285001388"
  time="0.15687878926595053">
<segment_edge_ids><edge_ids>
  -23614117
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</segment>
<segment sequence="12"
  instruction="Turn RIGHT onto Union St (Going West)"
  distance="0.09084695019464499"
  time="0.22151514689127605">
<segment_edge_ids><edge_ids>
  -23619255
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</segment>
<segment sequence="13"
  instruction="Turn LEFT onto Scott St (Going South)"
  distance="0.06349965975356134"
  time="0.1548333269755045">
<segment_edge_ids><edge_ids>
  -23616716
</edge_ids></segment_edge_ids>
</segment>
<segment sequence="14"
  instruction="Turn RIGHT onto Green St (Going West)"
  distance="0.09162990537119692"
  time="0.2234242598215739">
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  -23605539
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</segment>
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  instruction="Turn LEFT onto Divisadero St (Going South)"
  distance="0.13081463781959013"
  time="0.3189696947733561">
<segment_edge_ids><edge_ids>
  -23602190, -23602189
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</edge_ids></segment_edge_ids>
</segment>
<segment sequence="16"
  instruction="Turn RIGHT onto Broadway (Going West)"
  distance="0.2711613656927398"
  time="0.6611817995707194">
  <segment_edge_ids><edge_ids>
    -829713884, -829713883, -829713879, -829713878,
    -829713874, -829713887,-829713886
  </edge_ids></segment_edge_ids>
</segment>
<segment sequence="17"
  instruction="Turn LEFT onto Lyon St (Going South)"
  distance="0.3103461147339876"
<segment sequence="16"
  instruction="Turn RIGHT onto Broadway (Going West)"
  distance="0.2711613656927398"
  time="0.6611817995707194">
  <segment_edge_ids><edge_ids>
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    -829713874, -829713887,-829713886
  </edge_ids></segment_edge_ids>
</segment>
<segment sequence="17"
  instruction="Turn LEFT onto Lyon St (Going South)"
  distance="0.3103461147339876"
  time="0.7567272663116456">
  <segment_edge_ids><edge_ids>
    -28479560, -23609965, -23609964, -23609963, -23609962
  </edge_ids></segment_edge_ids>
</segment>
<segment sequence="18"
  instruction="Turn RIGHT onto Sacramento St (Going West)"
  distance="0.07639346451339481"
  time="0.18627273241678874">
  <segment_edge_ids><edge_ids>
    -23615823
  </edge_ids></segment_edge_ids>
</segment>
<segment sequence="19"
  instruction="Turn LEFT onto Presidio Ave (Going South)"
  distance="0.09716025402078811"
  time="0.23690908749898273">
  <segment_edge_ids><edge_ids>
    -754763527, -754763526,-23747787
  </edge_ids></segment_edge_ids>
</segment>
<segment sequence="20"
  instruction="Turn SLIGHT RIGHT onto RAMP (Going South)"
  distance="0.054849932668282114"
  time="0.1337424119313558">
  <segment_edge_ids><edge_ids>
    -23747788
  </edge_ids></segment_edge_ids>
</segment>
<segment sequence="21"
  instruction="Turn SLIGHT RIGHT onto Masonic Ave (Going Southwest)"
  distance="0.09798048860074304"
  time="0.23890908559163412">
  <segment_edge_ids><edge_ids>
    -723450070, -723450073
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        </edge_ids></segment_edge_ids>
    </segment>
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        time="0.7567272663116456">
        <segment_edge_ids><edge_ids>
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        </edge_ids></segment_edge_ids>
    </segment>
    <segment sequence="18"
        instruction="Turn RIGHT onto Sacramento St (Going West)"
        distance="0.07639346451339481"
        time="0.18627273241678874">
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        distance="0.09716025402078811"
        time="0.23690908749898273">
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        distance="0.054849932668282114"
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    </segment>
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<location id="2"
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    city="SAN FRANCISCO" state="CA" country="US"
    driving_side="R"
    postal_code="94118"
    edge_id="728011751" percent="0.5203619908971352"/>
</end_location>
</subroute>
<subroute id="3" step_count="36"
    distance="4.848880093441248" distance_unit="mile"
    time="11.788133748372395" time_unit="minute"
    start_location="2" end_location="4">
    <subroute_geometry>
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            -122.4552,37.77097 -122.45533,37.77086 -122.45501,37.77098
            -122.4547,37.77107 -122.45447,37.77116 -122.45424,37.77124
            -122.45396,37.77135 -122.45384,37.7714 -122.45382,37.77141
            -122.45369,37.77143 -122.45358,37.77144 -122.45347,37.77143

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-122.4529,37.77133 -122.45222,37.77123 -122.45205,37.77031
-122.45043,37.77051 -122.45021,37.76958 -122.44967,37.76964
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-122.44672,37.76907 -122.44593,37.76917 -122.44555,37.76733
-122.44473,37.76743 -122.44467,37.76702 -122.44456,37.76645
-122.44451,37.76631 -122.44418,37.76596 -122.44361,37.76539
-122.44347,37.76536 -122.44273,37.76532 -122.44246,37.7653
-122.44232,37.76529 -122.44192,37.76527 -122.44202,37.76513
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-122.43528,37.76346 -122.43523,37.76312 -122.43519,37.76283
-122.43516,37.76264 -122.43515,37.76258 -122.43511,37.76207
-122.43504,37.76128 -122.435,37.76089 -122.43388,37.76095
-122.43278,37.76101 -122.43057,37.76115 -122.43048,37.76036
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-122.42566,37.75822 -122.42347,37.75836 -122.42126,37.75851
-122.42047,37.75854 -122.42028,37.75695 -122.41999,37.75696
-122.4197,37.75698 -122.41892,37.75702 -122.41874,37.75545
-122.41766,37.75553 -122.41659,37.75557 -122.41549,37.75563
-122.41533,37.75405 -122.41425,37.75412 -122.41385,37.75414
-122.41312,37.75417 -122.41204,37.75424 -122.41109,37.75428
-122.4102,37.75433 -122.41004,37.75276 -122.40913,37.75282
-122.40818,37.75287 -122.40733,37.75292 -122.40713,37.75133
-122.40617,37.75138 -122.40614,37.75103 -122.40613,37.75096
-122.40611,37.75088 -122.40602,37.75067 -122.40599,37.75051
-122.40578,37.75013 -122.40565,37.74987 -122.40529,37.74937
-122.40518,37.74924 -122.40506,37.74913 -122.40483,37.74896
-122.4045,37.74873 -122.40441,37.74867 -122.40437,37.74864
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-122.40397,37.74719 -122.4043,37.74633 -122.40434,37.74618
-122.40434,37.74603 -122.40431,37.74594 -122.4042,37.74554
-122.40416,37.7453 -122.40417,37.74515 -122.40431,37.74464
-122.40445,37.74427 -122.40461,37.74393 -122.40479,37.74362
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    city="SAN FRANCISCO" state="CA" country="US"
    driving_side="R"
    postal_code="94118"
    edge_id="728011751" percent="0.5203619908971352"/>
</start_location>
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  instruction="Start out on John F Kennedy Dr (Going West)"
  distance="0.02898340160626114"
  time="0.07067119280497233">
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    -728011751, -728011750
  </edge_ids></segment_edge_ids>
</segment>
<segment sequence="2"
  instruction="Stay STRAIGHT to go onto Kezar Dr (Going Southwest)"
  distance="0.04787796125753919"
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time="0.11674242814381917">
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  -23747756
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  instruction="Turn SHARP LEFT onto John F Kennedy Dr (Going East)"
  distance="0.08222829797036355"
  time="0.20049999952316283">
<segment_edge_ids><edge_ids>
  23747762, 728012586, 724789094
</edge_ids></segment_edge_ids>
</segment>
<segment sequence="4"
  instruction="Stay STRAIGHT to go onto Oak St (Going Northeast)"
  distance="0.09773193475050901"
  time="0.2383030315240224">
<segment_edge_ids><edge_ids>
  724764533, 724764534, -23738012
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</segment>
<segment sequence="5"
  instruction="Turn RIGHT onto Shrader St (Going South)"
  distance="0.06425775409315192"
  time="0.15668182373046874">
<segment_edge_ids><edge_ids>
  -23617167
</edge_ids></segment_edge_ids>
</segment>
<segment sequence="6"
  instruction="Turn LEFT onto Page St (Going East)"
  distance="0.08957932247692126"
  time="0.21842424074808756">
<segment_edge_ids><edge_ids>
  23613434
</edge_ids></segment_edge_ids>
</segment>
<segment sequence="7"
  instruction="Turn RIGHT onto Cole St (Going South)"
  distance="0.06538868039329745"
  time="0.1594394048055013">
<segment_edge_ids><edge_ids>
  -23600911
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</segment>
<segment sequence="8"
  instruction="Turn LEFT onto Haight St (Going East)"
  distance="0.02978934855322748"
  time="0.07263635794321696">
<segment_edge_ids><edge_ids>
  23605814
</edge_ids></segment_edge_ids>
</segment>
<segment sequence="9"
  instruction="Turn RIGHT onto Belvedere St (Going South)"
  distance="0.06471136481056884"
  time="0.1577878793080648">
<segment_edge_ids><edge_ids>
  -23598189
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</segment>
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<segment sequence="10"
  instruction="Turn LEFT onto Waller St (Going East)"
  distance="0.1948176204828599"
  time="0.4750302950541178">
  <segment_edge_ids><edge_ids>
    23620205, 23620204, 23620203, 23620202
  </edge_ids></segment_edge_ids>
</segment>
<segment sequence="11"
  instruction="Turn RIGHT onto Delmar St (Going South)"
  distance="0.12885726410065712"
  time="0.3141969680786133">
  <segment_edge_ids><edge_ids>
    -23602039
  </edge_ids></segment_edge_ids>
</segment>
<segment sequence="12"
  instruction="Turn LEFT onto Frederick St (Going East)"
  distance="0.04533026592197986"
  time="0.11053029696146648">
  <segment_edge_ids><edge_ids>
    23604508
  </edge_ids></segment_edge_ids>
</segment>
<segment sequence="13"
  instruction="Turn RIGHT onto Masonic Ave (Going South)"
  distance="0.2072702425733493"
  time="0.5053939501444499">
  <segment_edge_ids><edge_ids>
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    -814886921
  </edge_ids></segment_edge_ids>
</segment>
<segment sequence="14"
  instruction="Stay STRAIGHT to go onto Roosevelt Way (Going East)"
  distance="0.04439197258915798"
  time="0.1082424263159434">
  <segment_edge_ids><edge_ids>
    -814886920, -799371986, -799371985
  </edge_ids></segment_edge_ids>
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  instruction="Turn RIGHT onto Levant St (Going Southwest)"
  distance="0.03410178286259032"
  time="0.0831515113512675">
  <segment_edge_ids><edge_ids>
    -799371984, -799371983
  </edge_ids></segment_edge_ids>
</segment>
<segment sequence="16"
  instruction="Turn LEFT onto States St (Going Southeast)"
  distance="0.4172186714314114"
  time="1.0173182010650634">
  <segment_edge_ids><edge_ids>
    -829568337, -936352352, -936352351, -932495104,
    932495103, 799475779
  </edge_ids></segment_edge_ids>
</segment>
<segment sequence="17"
  instruction="Turn RIGHT onto Castro St (Going South)"
  distance="0.1783259826221157"
```

```

time="0.4348181843757629">
  <segment_edge_ids><edge_ids>
    -754012004, -833349280, -833349279, -905543898,
    -905543897, -753950604, -753950603
  </edge_ids></segment_edge_ids>
</segment>
<segment sequence="18"
  instruction="Turn LEFT onto 18th St (Going East)"
  distance="0.24272664830496957"
  time="0.5918484846750895">
  <segment_edge_ids><edge_ids>
    23594648, 23594647, 23594646
  </edge_ids></segment_edge_ids>
</segment>
<segment sequence="19"
  instruction="Turn RIGHT onto Sanchez St (Going South)"
  distance="0.10895420615626991"
  time="0.26566667556762696">
  <segment_edge_ids><edge_ids>
    -23616290, -23616291
  </edge_ids></segment_edge_ids>
</segment>
<segment sequence="20"
  instruction="Turn LEFT onto 19th St (Going East)"
  distance="0.11787733607670552"
  time="0.2874242464701335">
  <segment_edge_ids><edge_ids>
    23594737
  </edge_ids></segment_edge_ids>
</segment>
<segment sequence="21"
  instruction="Turn RIGHT onto Church St (Going South)"
  distance="0.115211584951289"
  time="0.2809242566426595">
  <segment_edge_ids><edge_ids>
    -23600503, -23600504
  </edge_ids></segment_edge_ids>
</segment>
<segment sequence="22"
  instruction="Turn LEFT onto 20th St (Going East)"
  distance="0.4155409305719238"
  time="1.0132273137569427">
  <segment_edge_ids><edge_ids>
    732180611, 732180612, 23747712, 23594835,
    23594834, 23594833
  </edge_ids></segment_edge_ids>
</segment>
<segment sequence="23"
  instruction="Turn RIGHT onto Lexington St (Going South)"
  distance="0.11038339612853318"
  time="0.5921333312988282">
  <segment_edge_ids><edge_ids>
    -23609398
  </edge_ids></segment_edge_ids>
</segment>
<segment sequence="24"
  instruction="Turn LEFT onto 21st St (Going East)"
  distance="0.07448580061634548"
  time="0.18162120978037516">
  <segment_edge_ids><edge_ids>
    23594883, 23594882, 23594881

```

```
</edge_ids></segment_edge_ids>
</segment>
<segment sequence="25"
  instruction="Turn RIGHT onto Mission St (Going South)"
  distance="0.10895420141545431"
  time="0.26566665967305503">
  <segment_edge_ids><edge_ids>
    -23611414
  </edge_ids></segment_edge_ids>
</segment>
<segment sequence="26"
  instruction="Turn LEFT onto 22nd St (Going East)"
  distance="0.17805878047745186"
  time="0.4341666539510091">
  <segment_edge_ids><edge_ids>
    23594956, 23594955, 23594954
  </edge_ids></segment_edge_ids>
</segment>
<segment sequence="27"
  instruction="Turn RIGHT onto Shotwell St (Going South)"
  distance="0.10955073824132096"
  time="0.2671212196350098">
  <segment_edge_ids><edge_ids>
    -23617156
  </edge_ids></segment_edge_ids>
</segment>
<segment sequence="28"
  instruction="Turn LEFT onto 23rd St (Going East)"
  distance="0.28101037926858485"
  time="0.6851969718933105">
  <segment_edge_ids><edge_ids>
    23595024, 799561724, 799561725, 23595022,
    23595021, 23595020
  </edge_ids></segment_edge_ids>
</segment>
<segment sequence="29"
  instruction="Turn RIGHT onto Florida St (Going South)"
  distance="0.10886099698092727"
  time="0.26543939908345543">
  <segment_edge_ids><edge_ids>
    -23604143
  </edge_ids></segment_edge_ids>
</segment>
<segment sequence="30"
  instruction="Turn LEFT onto 24th St (Going East)"
  distance="0.14851177530603368"
  time="0.3621212085088094">
  <segment_edge_ids><edge_ids>
    23595090, 23595089, 23595088
  </edge_ids></segment_edge_ids>
</segment>
<segment sequence="31"
  instruction="Turn RIGHT onto Hampshire St (Going South)"
  distance="0.11043310832082466"
  time="0.26927274068196616">
  <segment_edge_ids><edge_ids>
    -23605909
  </edge_ids></segment_edge_ids>
</segment>
<segment sequence="32"
  instruction="Turn LEFT onto 25th St (Going East)"
```



```

distance="0.05257565439032596"
time="0.1281969706217448">
<segment_edge_ids><edge_ids>
  23595179
</edge_ids></segment_edge_ids>
</segment>
<segment sequence="33"
  instruction="Turn RIGHT onto Potrero Ave (Going South)"
  distance="0.050077673617465915"
  time="0.1221060593922933">
<segment_edge_ids><edge_ids>
  -724773368, -724773367
</edge_ids></segment_edge_ids>
</segment>
<segment sequence="34"
  instruction="Take RAMP toward Bayshore Blvd"
  distance="0.03984341188503202"
  time="0.09715151786804199">
<segment_edge_ids><edge_ids>
  -915517048
</edge_ids></segment_edge_ids>
</segment>
<segment sequence="35"
  instruction="Stay STRAIGHT to go onto Bayshore Blvd(Going Southeast)"
  distance="0.5910582184784158"
  time="1.0831619163354238">
<segment_edge_ids><edge_ids>
  -915517047, -120885637, -830210066, -776735343,
  -776735342, -756632225, -756632224, -127815508,
  -23621037, -23621038, -23621034, -756635722,
  -756635721, -23597820, -756635724, -756635723
</edge_ids></segment_edge_ids>
</segment>
<segment sequence="36"
  instruction="Turn LEFT onto Flower St (Going East)"
  distance="0.06390356064909457"
  time="0.15581818421681723">
<segment_edge_ids><edge_ids>
  -23604154, -23604155
</edge_ids></segment_edge_ids>
</segment>
<end_location>
<location id="4"
  longitude="-122.40459" latitude="37.74211"
  house_number="99" street="FLOWER ST" city="SAN FRANCISCO"
  state="CA" country="US"
  driving_side="R"
  postal_code="94124"
  edge_id="23604155" percent="0.0"/>
</end_location>
</subroute>
<subroute id="4" step_count="15"
  distance="4.382421462359411" distance_unit="mile"
  time="9.754673258463542" time_unit="minute"
  start_location="4" end_location="1">
<subroute_geometry>
<LineString><coordinates>
  -122.40459,37.74211 -122.40459,37.74211 -122.40431,37.74253
  -122.40366,37.74342 -122.40322,37.74381 -122.40289,37.74515
  -122.40268,37.74635 -122.40295,37.74675 -122.40311,37.747
  -122.40327,37.74723 -122.40332,37.74737 -122.40342,37.74753

```

```
-122.40348,37.74767 -122.40354,37.74787 -122.40365,37.74821
-122.40367,37.74839 -122.40366,37.74857 -122.40358,37.74883
-122.40353,37.74897 -122.40343,37.74916 -122.40336,37.74926
-122.40329,37.74932 -122.4032,37.74936 -122.40306,37.7494
-122.40283,37.74944 -122.40283,37.74994 -122.40281,37.75019
-122.4028,37.75044 -122.40276,37.7505 -122.40266,37.75057
-122.40221,37.7506 -122.40231,37.75197 -122.40242,37.75326
-122.40254,37.75452 -122.40163,37.75458 -122.40178,37.75614
-122.40187,37.75714 -122.40198,37.75826 -122.40199,37.75842
-122.4021,37.75969 -122.40222,37.76095 -122.40235,37.76223
-122.40248,37.76352 -122.40254,37.76478 -122.40268,37.7661
-122.40282,37.76738 -122.40295,37.76865 -122.40306,37.76983
-122.40351,37.76981 -122.40363,37.76989 -122.40378,37.76999
-122.40382,37.77002 -122.40386,37.77004 -122.4036,37.77025
-122.40285,37.77086 -122.40226,37.77134 -122.40203,37.77153
-122.40166,37.77183 -122.40131,37.77211 -122.40113,37.77226
-122.39968,37.7734 -122.39956,37.7735 -122.39943,37.77361
-122.39723,37.77535 -122.39539,37.77679 -122.39499,37.77711
-122.39457,37.77743 -122.3943,37.77764 -122.3939,37.77795
-122.39356,37.77823 -122.39344,37.77832 -122.3933,37.77843
-122.39275,37.77886 -122.39259,37.77899 -122.39256,37.77902
-122.39239,37.77915 -122.39222,37.77929 -122.39203,37.77944
-122.39141,37.77994 -122.39108,37.7802 -122.39052,37.78062
-122.38974,37.78123 -122.38923,37.78161 -122.38911,37.78166
-122.38896,37.78173 -122.38863,37.78179 -122.38841,37.78181
-122.38814,37.7818 -122.38813,37.78195 -122.38811,37.7823
-122.38811,37.78254 -122.3881,37.78266 -122.38806,37.78316
-122.38802,37.78335 -122.38791,37.78477 -122.38789,37.78504
-122.3878,37.7861 -122.3878,37.78615 -122.38771,37.78707
-122.3877,37.78722 -122.38769,37.78747 -122.3877,37.78766
-122.38772,37.78791 -122.38779,37.78835 -122.38788,37.7888
-122.38794,37.78896 -122.38816,37.78937 -122.38838,37.78965
-122.38859,37.78984 -122.38935,37.79047 -122.38978,37.79082
-122.38992,37.79095 -122.39013,37.7912 -122.39028,37.79141
-122.39041,37.79166 -122.39049,37.79181 -122.39061,37.79205
-122.39071,37.79226 -122.39093,37.79252 -122.39117,37.79276
-122.3915,37.79303 -122.392,37.79344 -122.39233,37.79374
-122.39246,37.79387 -122.39257,37.79397 -122.39275,37.79414
-122.39303,37.7944 -122.39319,37.79455 -122.39335,37.79471
-122.39357,37.79494 -122.39374,37.79511 -122.39382,37.79518
-122.39407,37.79546 -122.39436,37.79579
</coordinates></LineString>
</subroute_geometry>
<start_location>
  <location id="4"
    longitude="-122.40459" latitude="37.74211"
    house_number="99" street="FLOWER ST" city="SAN FRANCISCO"
    state="CA" country="US"
    driving_side="R"
    postal_code="94124"
    edge_id="23604155" percent="0.0"/>
</start_location>
<segment sequence="1"
  instruction="Start out on Flower St (Going East)"
  distance="0.0"
  time="0.0">
  <segment_edge_ids><edge_ids>
    -23604155
  </edge_ids></segment_edge_ids>
</segment>
<segment sequence="2"
```

```

        instruction="Turn LEFT onto Loomis St (Going Northeast)"
        distance="0.1399739006534103"
        time="0.341303030649821">
        <segment_edge_ids><edge_ids>
            23609757, 23609756
        </edge_ids></segment_edge_ids>
    </segment>
    <segment sequence="3"
        instruction="Turn SLIGHT LEFT onto Barneveld Ave (Going North)"
        distance="0.1780836365735976"
        time="0.43422727584838866">
        <segment_edge_ids><edge_ids>
            23597607
        </edge_ids></segment_edge_ids>
    </segment>
    <segment sequence="4"
        instruction="Turn SLIGHT LEFT onto Jerrold Ave (Going Northwest)"
        distance="0.06884359716369064"
        time="0.16786363919576008">
        <segment_edge_ids><edge_ids>
            127821131
        </edge_ids></segment_edge_ids>
    </segment>
    <segment sequence="5"
        instruction="Stay STRAIGHT to go onto RAMP (Going Northwest)"
        distance="0.04681538329577495"
        time="0.11415150960286459">
        <segment_edge_ids><edge_ids>
            127821133
        </edge_ids></segment_edge_ids>
    </segment>
    <segment sequence="6"
        instruction="Stay STRAIGHT to go onto Cesar Chavez (Going North)"
        distance="0.1321568397517706"
        time="0.22154166897137959">
        <segment_edge_ids><edge_ids>
            23621025, 830210057, 830210058, 120885622
        </edge_ids></segment_edge_ids>
    </segment>
    <segment sequence="7"
        instruction="Turn LEFT onto Vermont St (Going North)"
        distance="0.06916050646352936"
        time="0.16863636970520018">
        <segment_edge_ids><edge_ids>
            754243248, 754243249
        </edge_ids></segment_edge_ids>
    </segment>
    <segment sequence="8"
        instruction="Turn SLIGHT RIGHT onto 26th St (Going East)"
        distance="0.036668115529443365"
        time="0.08940908908843995">
        <segment_edge_ids><edge_ids>
            23595258
        </edge_ids></segment_edge_ids>
    </segment>
    <segment sequence="9"
        instruction="Turn LEFT onto Kansas St (Going North)"
        distance="0.27153420476451817"
        time="0.6620909055074056">
        <segment_edge_ids><edge_ids>
            23608261, 23608260, 23608259

```

```
</edge_ids></segment_edge_ids>
</segment>
<segment sequence="10"
  instruction="Turn RIGHT onto 23rd St (Going East)"
  distance="0.049897472846428766"
  time="0.12166666984558105">
  <segment_edge_ids><edge_ids>
    23595010
  </edge_ids></segment_edge_ids>
</segment>
<segment sequence="11"
  instruction="Turn LEFT onto Rhode Island St (Going North)"
  distance="1.0569688657972653"
  time="2.5772424399852754">
  <segment_edge_ids><edge_ids>
    933038005, 933038006, 933038001, 933038002,
    23615271, 23615270, 23615269, 23615268,
    23615267, 23615266, 23615265, 23615264,
    23615263
  </edge_ids></segment_edge_ids>
</segment>
<segment sequence="12"
  instruction="Turn LEFT onto Division St (Going West)"
  distance="0.043919717429223945"
  time="0.10709091226259868">
  <segment_edge_ids><edge_ids>
    -23602204, 829577422, 829577423
  </edge_ids></segment_edge_ids>
</segment>
<segment sequence="13"
  instruction="Stay STRAIGHT to go onto RAMP (Going Northwest)"
  distance="0.0055987076548075785"
  time="0.013651515046755472">
  <segment_edge_ids><edge_ids>
    24552756
  </edge_ids></segment_edge_ids>
</segment>
<segment sequence="14"
  instruction="Turn RIGHT onto Townsend St (Going Northeast)"
  distance="1.192965882328057"
  time="2.9088484485944113">
  <segment_edge_ids><edge_ids>
    916742043, 916742044, 916742041, 916742042,
    916637669, 916637670, 916637671, 916637672,
    23618959, 724706739, 724706740, 915025718,
    915025719, 915025717, 23618956, 915025720,
    915025721, 23618954, 916135978, 916135979,
    916135980, 916135981, 916135982, 799424055,
    23618951, 23618950, 799362044, 799362045,
    724686775, -23841533
  </edge_ids></segment_edge_ids>
</segment>
<segment sequence="15"
  instruction="Turn LEFT onto The Embarcadero (Going North)"
  distance="1.0898340975809355"
  time="1.8269479304552079">
  <segment_edge_ids><edge_ids>
    807424014, 807424015, 733049265, 830425790,
    830425791, 112011086, 799424653, 799424654,
    724665449, 830416191, 830416192, 120886507,
    120886508, 112011094, 112011097, 725001298,
```

```

            830434313, 830434314, 724945050, 724945051,
            830222369, 830222370, 23841522, 825450115,
            825450116, 127810052, 724791171, 724791172,
            799417573, 799417574, 724791173, 724791174
        </edge_ids></segment_edge_ids>
    </segment>
</end_location>
<location id="1"
    longitude="-122.39436" latitude="37.79579"
    house_number="" street="HERB CAEN WAY" city="SAN FRANCISCO"
    state="CA" country="US"
    driving_side="R" postal_code="94111"
    edge_id="724791174"percent="1.0"/>
</end_location>
</subroute>
</route>
</route_response>

```

**Example 13-5 Batched Route Request with Locations Specified as Addresses, Pre-geocoded Locations, and Longitude/Latitude Points**

Example 13-5 (page 13-29) shows a batched request for the a route between the same two points as an auto requesting the fastest route, an auto requesting the shortest route, a truck requesting the fastest route, and a truck requesting the shortest route. The locations in all the requests are the same, but they are specified in a mix of input addresses, pre-geocoded locations, and longitude/latitude points.

```

<?xml version="1.0" standalone="yes"?>
<batch_route_request id="1">
<route_request id="1"
    route_preference="fastest"
    road_preference="highway"
    return_locations="true"
    return_driving_directions="true"
    vehicle_type="auto"
    distance_unit="mile"
    time_unit="minute"
    >
<start_location>
    <input_location id="1">
        <input_address>
            <us_form1
                street="875 ALMA ST"
                lastline="94301"/>
        </input_address>
    </input_location>
</start_location>
<end_location>
    <input_location id="2">
        <input_address>
            <us_form1
                street="660 BLOSSOM HILL RD"
                lastline="95123" />
        </input_address>
    </input_location>
</end_location>
</route_request>
<route_request id="2"
    route_preference="shortest"
    road_preference="highway"
    pre_geocoded_locations="true"

```

```
        return_locations="true"
        return_driving_directions="true"
        vehicle_type="auto"
        distance_unit="mile"
        time_unit="minute"
    >
<start_location>
  <pre_geocoded_location id="1">
    <edge_id>23694266</edge_id>
    <percent>0.0</percent>
    <side>R</side>
  </pre_geocoded_location>
</start_location>
<end_location>
  <pre_geocoded_location id="2">
    <edge_id>812218080</edge_id>
    <percent>0.0</percent>
    <side>R</side>
  </pre_geocoded_location>
</end_location>
</route_request>
<route_request id="3"
  route_preference="fastest"
  road_preference="highway"
  return_locations="true"
  return_driving_directions="true"
  vehicle_type="truck"
  truck_height="13.6"
  truck_length="75"
  truck_weight="30"
  distance_unit="mile"
  time_unit="minute"
  >
<start_location>
  <input_location id="1"
    longitude="-122.15901"
    latitude="37.4403" />
</start_location>
<end_location>
  <input_location id="2"
    longitude="-121.83459"
    latitude="37.25125" />
</end_location>
</route_request>
<route_request id="4"
  route_preference="shortest"
  road_preference="highway"
  pre_geocoded_locations="true"
  vehicle_type="truck"
  truck_height="13.6"
  truck_length="75"
  truck_weight="30"
  return_driving_directions="true"
  distance_unit="mile"
  time_unit="minute"
  >
<start_location>
  <pre_geocoded_location id="1">
    <edge_id>23694266</edge_id>
    <percent>0.0</percent>
    <side>R</side>
```

```

    </pre_geocoded_location>
  </start_location>
<end_location>
  <pre_geocoded_location id="2">
    <edge_id>812218080</edge_id>
    <percent>0.0</percent>
    <side>R</side>
  </pre_geocoded_location>
</end_location>
</route_request>
</batch_route_request>

```

**Example 13-6 Response for Batched Route Request with Locations Specified as Addresses, Pre-geocoded Locations, and Longitude/Latitude Points**

[Example 13-6](#) (page 13-31) shows the response to the request in [Example 13-5](#) (page 13-29). (The output is reformatted for readability.)

```

<!-- Oracle Routeserver version 12.1.0.2.0 (data version 11.1.0.7.1) -->
<batch_route_response>
<route_response>
  <route id="1" step_count="15"
    distance="26.103862121729946" distance_unit="mile"
    time="26.6184814453125" time_unit="minute"
    start_location="1" end_location="2">
    <start_location>
      <location id="1"
        longitude="-122.15901" latitude="37.4403"
        house_number="898" street="ALMA ST" city="PALO ALTO"
        state="CA" country="US"
        driving_side="R"
        postal_code="94301"
        edge_id="23694266" percent="0.0"/>
    </start_location>
    <segment sequence="1"
      instruction="Start out on Alma St (Going Southeast)"
      distance="1.3587211956625542"
      time="2.504421416918437"/>
    <segment sequence="2"
      instruction="Take RAMP toward Oregon Expwy"
      distance="0.12862735113732848"
      time="0.215624996026357"/>
    <segment sequence="3"
      instruction="Stay STRAIGHT to go onto Oregon Expy (Going Northeast)"
      distance="1.3840054698278719"
      time="2.3200833360354105"/>
    <segment sequence="4"
      instruction="Take RAMP toward San Jose"
      distance="0.2647486517044605"
      time="0.44381250540415446"/>
    <segment sequence="5"
      instruction="Stay STRAIGHT to go onto US-101 S (Going Southeast)"
      distance="11.747225529883993"
      time="10.16387637803952"/>
    <segment sequence="6"
      instruction="Take RAMP toward Guadalupe Pkwy"
      distance="0.40232399596959373"
      time="0.6744375069936116"/>
    <segment sequence="7"
      instruction="Stay STRAIGHT to go onto CA-87 S (Going Southeast)"
      distance="2.6388802347934055"
      time="2.2831989218791326"/>

```

```
<segment sequence="8"
  instruction="Stay STRAIGHT to go onto CA-87 S (Going Southeast)"
  distance="5.839967669586142"
  time="5.052827918032805"/>
<segment sequence="9"
  instruction="Stay STRAIGHT to go onto RAMP (Going South)"
  distance="0.1527496425121632"
  time="0.15757692654927571"/>
<segment sequence="10"
  instruction="Continue on toward Gilroy"
  distance="0.8405766344600814"
  time="0.8671410039067269"/>
<segment sequence="11"
  instruction="Stay STRAIGHT to go onto CA-85 S (Going East)"
  distance="0.3956813619067624"
  time="0.34234946966171265"/>
<segment sequence="12"
  instruction="Take RAMP toward Blossom Hill Road"
  distance="0.22891319287702547"
  time="0.38373958468437197"/>
<segment sequence="13"
  instruction="Turn LEFT onto Blossom Hill Rd (Going East)"
  distance="0.49810476095097306"
  time="0.8349999914566676"/>
<segment sequence="14"
  instruction="Turn LEFT onto Snell Ave (Going North)"
  distance="0.011060709151221367"
  time="0.01854166587193807"/>
<segment sequence="15"
  instruction="Turn LEFT onto Blossom Hill Rd (Going West)"
  distance="0.21227241518009607"
  time="0.35584374765555066"/>
<end_location>
  <location id="2"
    longitude="-121.83459" latitude="37.25125"
    house_number="499" street="BLOSSOM HILL RD" city="SAN JOSE"
    state="CA" country="US"
    driving_side="R"
    postal_code="95123"
    edge_id="812218080" percent="0.0"/>
  </end_location>
</route>
</route_response>
<route_response>
  <route id="2" step_count="18"
    distance="24.879477393121235" distance_unit="mile"
    time="39.014546712239586" time_unit="minute"
    start_location="1" end_location="2">
    <start_location>
      <location id="1"
        longitude="" latitude=""
        house_number="" street="" city=""
        state="" country=""
        driving_side="N"
        postal_code=""
        edge_id="23694266" percent="0.0"/>
    </start_location>
    <segment sequence="1"
      instruction="Start out on Alma St (Going Southeast)"
      distance="0.2592928618616754"
      time="0.6322424242893855"/>
```



```
<segment sequence="2"
  instruction="Turn LEFT onto Kingsley Ave (Going Northeast)"
  distance="0.08879637204118493"
  time="0.2165151596069336"/>
<segment sequence="3"
  instruction="Turn SLIGHT RIGHT onto Embarcadero Rd (Going East)"
  distance="0.6481327160471586"
  time="1.5803636133670806"/>
<segment sequence="4"
  instruction="Turn RIGHT onto Middlefield Rd (Going Southeast)"
  distance="2.96746411421623"
  time="7.235666685303053"/>
<segment sequence="5"
  instruction="Stay STRAIGHT to go onto Old Middlefield Way (Going East)"
  distance="0.8495432761786168"
  time="1.789845637480418"/>
<segment sequence="6"
  instruction="Stay STRAIGHT to go onto RAMP (Going East)"
  distance="0.22642142849860966"
  time="0.37956250508626305"/>
<segment sequence="7"
  instruction="Stay STRAIGHT to go onto US-101 S (Going Southeast)"
  distance="9.176685525492026"
  time="7.939806487659613"/>
<segment sequence="8"
  instruction="Take RAMP toward Brokaw Road"
  distance="0.20942024511139234"
  time="0.3510625004768372"/>
<segment sequence="9"
  instruction="Stay STRAIGHT to go onto Old Bayshore Hwy (Going East)"
  distance="0.1670850676627406"
  time="0.2800937493642171"/>
<segment sequence="10"
  instruction="Turn SLIGHT RIGHT onto N 1st St (Going Southeast)"
  distance="1.9476604686858663"
  time="3.9989981204271317"/>
<segment sequence="11"
  instruction="Turn LEFT onto Jackson St (Going Northeast)"
  distance="0.07099981550357595"
  time="0.17312120993932087"/>
<segment sequence="12"
  instruction="Turn RIGHT onto 2nd St (Going Southeast)"
  distance="2.3224258991749434"
  time="5.6628484646479285"/>
<segment sequence="13"
  instruction="Stay STRAIGHT to go onto S 1st St (Going Southeast)"
  distance="0.18884608205270126"
  time="0.31657291650772096"/>
<segment sequence="14"
  instruction="Stay STRAIGHT to go onto Monterey Rd (Going Southeast)"
  distance="3.887951286200716"
  time="5.287046383817991"/>
<segment sequence="15"
  instruction="Turn SLIGHT RIGHT onto RAMP (Going South)"
  distance="0.0414465897894999"
  time="0.1010606050491333"/>
<segment sequence="16"
  instruction="Turn RIGHT onto Skyway Dr (Going Southwest)"
  distance="0.34504443027423093"
  time="0.5849081456661225"/>
<segment sequence="17"
```

```
        instruction="Turn LEFT onto Snell Ave (Going East)"
        distance="1.279357478030909"
        time="2.1446562389532726"/>
<segment sequence="18"
  instruction="Turn RIGHT onto Blossom Hill Rd (Going West)"
  distance="0.20292052293456395"
  time="0.34016666412353513"/>
<end_location>
  <location id="2"
    longitude="" latitude=""
    house_number="" street="" city=""
    state="" country=""
    driving_side="N"
    postal_code=""
    edge_id="812218080" percent="0.0"/>
  </end_location>
</route>
</route_response>
<route_response>
  <route id="3" step_count="14"
    distance="25.906590792580626" distance_unit="mile"
    time="29.140561930338542" time_unit="minute"
    start_location="1" end_location="2">
    <start_location>
      <location id="1"
        longitude="-122.15901" latitude="37.4403"
        house_number="900" street="ALMA ST" city="PALO ALTO"
        state="CA" country="US"
        driving_side="R"
        postal_code="94301"
        edge_id="23694267" percent="1.0"/>
      </start_location>
      <segment sequence="1"
        instruction="Start out on Alma St (Going Northwest)"
        distance="0.0"
        time="0.0"/>
      <segment sequence="2"
        instruction="Turn RIGHT onto Channing Ave(Going Northeast)"
        distance="2.1771018293093087"
        time="5.30849996805191"/>
      <segment sequence="3"
        instruction="Turn RIGHT onto W Bayshore Rd (Going Southwest)"
        distance="0.12998197519156232"
        time="0.31693938573201497"/>
      <segment sequence="4"
        instruction="Turn LEFT onto Embarcadero Rd (Going Northeast)"
        distance="0.006878766976215882"
        time="0.016772727171579998"/>
      <segment sequence="5"
        instruction="Take RAMP toward San Jose"
        distance="0.4222705568230516"
        time="0.707875007390976"/>
      <segment sequence="6"
        instruction="Stay STRAIGHT to go onto US-101 S (Going Southeast)"
        distance="11.747225529883993"
        time="10.16387637803952"/>
      <segment sequence="7"
        instruction="Take RAMP toward Guadalupe Pkwy"
        distance="0.40232399596959373"
        time="0.6744375069936116"/>
      <segment sequence="8"
```

```

        instruction="Stay STRAIGHT to go onto CA-87 S (Going Southeast)"
        distance="2.6388802347934055"
        time="2.2831989218791326"/>
<segment sequence="9"
  instruction="Stay STRAIGHT to go onto CA-87 S (Going Southeast)"
  distance="4.708519202974121"
  time="4.073881677289804"/>
<segment sequence="10"
  instruction="Take EXIT 1D toward Capitol Expwy Auto Mall"
  distance="0.23860684637032842"
  time="0.3948361724615097"/>
<segment sequence="11"
  instruction="Turn LEFT onto W Capitol Expy (Going East)"
  distance="1.2198347095111897"
  time="1.4871818164984385"/>
<segment sequence="12"
  instruction="Turn SLIGHT RIGHT onto RAMP (Going East)"
  distance="0.029621573459855412"
  time="0.049656248092651366"/>
<segment sequence="13"
  instruction="Turn SLIGHT RIGHT onto Snell Ave (Going Southeast)"
  distance="1.9824209209108623"
  time="3.3232395708560944"/>
<segment sequence="14"
  instruction="Turn RIGHT onto Blossom Hill Rd (Going West)"
  distance="0.20292052293456395"
  time="0.34016666412353513"/>
<end_location>
  <location id="2"
    longitude="-121.83459" latitude="37.25125"
    house_number="499" street="BLOSSOM HILL RD" city="SAN JOSE"
    state="CA" country="US"
    driving_side="R"
    postal_code="95123"
    edge_id="812218080" percent="0.0"/>
  </end_location>
</route>
</route_response>
<route_response>
  <route id="4" step_count="28"
    distance="25.43010499518424" distance_unit="mile"
    time="41.812373860677084" time_unit="minute"
    start_location="1" end_location="2">
    <segment sequence="1"
      instruction="Start out on Alma St (Going Southeast)"
      distance="2.512197865475656"
      time="4.438056838512421"/>
    <segment sequence="2"
      instruction="Turn RIGHT onto W Meadow Dr (Going Southwest)"
      distance="0.259249367249032"
      time="0.6321363727251689"/>
    <segment sequence="3"
      instruction="Turn LEFT onto El Camino Way (Going Southeast)"
      distance="0.19732181646496028"
      time="0.48113636175791424"/>
    <segment sequence="4"
      instruction="Stay STRAIGHT to go onto RAMP (Going Southwest)"
      distance="0.009935996875112263"
      time="0.02422727147738139"/>
    <segment sequence="5"
      instruction="Turn LEFT onto El Camino Real (Going Southeast)"

```

```
distance="0.7259305251035061"
time="1.2169166604677837"/>
<segment sequence="6"
  instruction="Stay STRAIGHT to go onto El Camino Real (Going Southeast)"
  distance="10.18052570327847"
  time="17.06616668154796"/>
<segment sequence="7"
  instruction="Turn RIGHT onto Madison St (Going Southeast)"
  distance="0.1341639244777912"
  time="0.32713637351989744"/>
<segment sequence="8"
  instruction="Turn LEFT onto Harrison St (Going East)"
  distance="0.06893059350020074"
  time="0.16807576020558676"/>
<segment sequence="9"
  instruction="Turn RIGHT onto Monroe St (Going Southeast)"
  distance="0.0705648403396469"
  time="0.1720606009165446"/>
<segment sequence="10"
  instruction="Turn LEFT onto Fremont St (Going East)"
  distance="0.07203753203577691"
  time="0.17565151850382488"/>
<segment sequence="11"
  instruction="Turn RIGHT onto Jackson St (Going Southeast)"
  distance="0.2098303612161659"
  time="0.5116363684336345"/>
<segment sequence="12"
  instruction="Turn LEFT onto Homestead Rd (Going East)"
  distance="0.13950164667868017"
  time="0.3401515007019043"/>
<segment sequence="13"
  instruction="Turn RIGHT onto Washington St (Going Southeast)"
  distance="0.14307462872056173"
  time="0.3488636334737142"/>
<segment sequence="14"
  instruction="Turn LEFT onto Santa Clara St (Going East)"
  distance="0.06947120055412777"
  time="0.16939393679300943"/>
<segment sequence="15"
  instruction="Turn RIGHT onto Lafayette St (Going Southeast)"
  distance="0.06759460559205673"
  time="0.16481818358103434"/>
<segment sequence="16"
  instruction="Turn LEFT onto Market St (Going East)"
  distance="0.17456658015544202"
  time="0.4256515165170034"/>
<segment sequence="17"
  instruction="Turn RIGHT onto The Alameda (Going Southeast)"
  distance="2.317572876182314"
  time="4.207776539524397"/>
<segment sequence="18"
  instruction="Stay STRAIGHT to go onto W Santa Clara St (Going East)"
  distance="0.03303921082684557"
  time="0.05538541873296102"/>
<segment sequence="19"
  instruction="Stay STRAIGHT to go onto CA-82 (Going East)"
  distance="0.05555210434715647"
  time="0.09312500158945719"/>
<segment sequence="20"
  instruction="Stay STRAIGHT to go onto W Santa Clara St (Going East)"
  distance="0.17006772690279195"
```

```

        time="0.33163256843884786"/>
<segment sequence="21"
  instruction="Turn RIGHT onto Delmas Ave (Going Southeast)"
  distance="0.49640216162493195"
  time="1.2103939274946849"/>
<segment sequence="22"
  instruction="Take CA-87 RAMP toward Guadalupe Pky"
  distance="0.1178586975602079"
  time="0.197572918732961"/>
<segment sequence="23"
  instruction="Stay STRAIGHT to go onto CA-87 S (Going Southeast)"
  distance="3.628403629205081"
  time="3.139349430302779"/>
<segment sequence="24"
  instruction="Take EXIT 1D toward Capitol Expwy Auto Mall"
  distance="0.23860684637032842"
  time="0.3948361724615097"/>
<segment sequence="25"
  instruction="Turn LEFT onto W Capitol Expy (Going East)"
  distance="0.9895544609762458"
  time="1.2064318120479585"/>
<segment sequence="26"
  instruction="Turn SLIGHT RIGHT onto Rosenbaum Ave (Going East)"
  distance="0.49535202237807563"
  time="1.2078333616256713"/>
<segment sequence="27"
  instruction="Turn RIGHT onto Snell Ave (Going Southeast)"
  distance="1.649872606747162"
  time="2.7657708187898"/>
<segment sequence="28"
  instruction="Turn RIGHT onto Blossom Hill Rd (Going West)"
  distance="0.20292052293456395"
  time="0.34016666412353513"/>
</route>
</route_response>
</batch_route_response>

```

### 13.3.2 Route Request XML Schema Definition

The following is the XML Schema Definition for a route request. The main elements and attributes of the Schema Definition are explained in sections that follow.

```

<xsd:schema xmlns:xsd="http://www.w3.org/2001/XMLSchema"
  elementFormDefault="qualified">
  <xsd:include schemaLocation="geocoder_request.xsd"/>
  <xsd:simpleType name="positiveDecimal">
    <xsd:restriction base="xsd:decimal">
      <xsd:minExclusive value="0"/>
    </xsd:restriction>
  </xsd:simpleType>

  <xsd:simpleType name="distanceUnit">
    <xsd:restriction base="xsd:string">
      <xsd:enumeration value="mile"/>
      <xsd:enumeration value="km"/>
      <xsd:enumeration value="kilometer"/>
      <xsd:enumeration value="meter"/>
    </xsd:restriction>
  </xsd:simpleType>

  <xsd:simpleType name="timeUnit">

```

```
<xsd:restriction base="xsd:string">
  <xsd:enumeration value="minute"/>
  <xsd:enumeration value="hour"/>
  <xsd:enumeration value="second"/>
</xsd:restriction>
</xsd:simpleType>

<xsd:simpleType name="unitType">
  <xsd:restriction base="xsd:string">
    <xsd:enumeration value="us"/>
    <xsd:enumeration value="metric"/>
  </xsd:restriction>
</xsd:simpleType>

<xsd:simpleType name="edgePercentage">
  <xsd:restriction base="xsd:decimal">
    <xsd:minInclusive value="0.0"/>
    <xsd:maxInclusive value="1.0"/>
  </xsd:restriction>
</xsd:simpleType>

<xsd:simpleType name="roadPreference">
  <xsd:restriction base="xsd:string">
    <xsd:enumeration value="highway"/>
    <xsd:enumeration value="local"/>
  </xsd:restriction>
</xsd:simpleType>

<xsd:simpleType name="routePreference">
  <xsd:restriction base="xsd:string">
    <xsd:enumeration value="shortest"/>
    <xsd:enumeration value="fastest"/>
    <xsd:enumeration value="traffic"/>
  </xsd:restriction>
</xsd:simpleType>

<xsd:simpleType name="truckType">
  <xsd:restriction base="xsd:string">
    <xsd:enumeration value="delivery"/>
    <xsd:enumeration value="public"/>
    <xsd:enumeration value="resident"/>
    <xsd:enumeration value="trailer"/>
  </xsd:restriction>
</xsd:simpleType>

<xsd:simpleType name="vehicleType">
  <xsd:restriction base="xsd:string">
    <xsd:enumeration value="auto"/>
    <xsd:enumeration value="truck"/>
  </xsd:restriction>
</xsd:simpleType>

<xsd:complexType name="pregeocodedType">
  <xsd:all>
    <xsd:element name="edge_id" type="xsd:long" />
    <xsd:element name="percent" type="edgePercentage"/>
    <xsd:element name="side">
      <xsd:simpleType>
        <xsd:restriction base="xsd:string">
          <xsd:enumeration value="L"/>
          <xsd:enumeration value="R"/>
        </xsd:restriction>
      </xsd:simpleType>
    </xsd:element>
  </xsd:all>
</xsd:complexType>
```

```

        </xsd:element>
    </xsd:all>
</xsd:complexType>

<xsd:complexType name="routerInputLocation">
    <xsd:choice>
        <xsd:element name="router_input_location" type="input_locationType"/>
        <xsd:element name="router_pregeocoded_location" type="pregeocodedType"/>
    </xsd:choice>
</xsd:complexType>
<xsd:element name="batch_route_request" type="batchRouteRequest" />
<xsd:complexType name="batchRouteRequest">
    <xsd:sequence>
        <xsd:element name="route_request" type="routeRequest"
            minOccurs="1" maxOccurs="unbounded"/>
    </xsd:sequence>
    <xsd:attribute name="id" type="xsd:nonNegativeInteger" use="required"/>
</xsd:complexType>

<xsd:element name="route_request" type="routeRequest" />
<xsd:complexType name="routeRequest">
    <xsd:sequence>
        <xsd:element name="start_location" type="routerInputLocation"
            minOccurs="0" maxOccurs="1"/>
        <xsd:element name="location" type="routerInputLocation"
            minOccurs="0" maxOccurs="unbounded"/>
        <xsd:element name="end_location" type="routerInputLocation"
            minOccurs="0" maxOccurs="1"/>
    </xsd:sequence>
    <xsd:attribute name="id" type="xsd:nonNegativeInteger" use="required"/>
    <xsd:attribute name="pre_geocoded_locations" type="xsd:boolean"
        use="optional"/>
    <xsd:attribute name="route_preference" type="routePreference"
        use="optional"/>
    <xsd:attribute name="road_preference" type="roadPreference"
        use="optional"/>
    <xsd:attribute name="start_date" type="xsd:date"
        use="optional"/>
    <xsd:attribute name="start_time" type="xsd:time"
        use="optional"/>
    <xsd:attribute name="date_format" type="xsd:date"
        use="optional"/>
    <xsd:attribute name="time_format" type="xsd:time"
        use="optional"/>
    <xsd:attribute name="output_time_format" type="xsd:date"
        use="optional"/>

    <xsd:attribute name="optimize_route" type="xsd:boolean" use="optional"/>
    <xsd:attribute name="route_type" use="optional">
        <xsd:simpleType>
            <xsd:restriction base="xsd:string">
                <xsd:enumeration value="open"/>
                <xsd:enumeration value="closed"/>
            </xsd:restriction>
        </xsd:simpleType>
    </xsd:attribute>
    <xsd:attribute name="driving_directions_detail" use="optional">
        <xsd:simpleType>
            <xsd:restriction base="xsd:string">
                <xsd:enumeration value="medium"/>
                <xsd:enumeration value="high"/>
            </xsd:restriction>
        </xsd:simpleType>
    </xsd:attribute>

```

```
        <xsd:enumeration value="low"/>
    </xsd:restriction>
</xsd:simpleType>
</xsd:attribute>
<xsd:attribute name="language" use="optional">
    <xsd:simpleType>
        <xsd:restriction base="xsd:string">
            <xsd:enumeration value="English"/>
            <xsd:enumeration value="French"/>
            <xsd:enumeration value="German"/>
            <xsd:enumeration value="Italian"/>
            <xsd:enumeration value="Portuguese"/>
            <xsd:enumeration value="Spanish"/>
        </xsd:restriction>
    </xsd:simpleType>
</xsd:attribute>
<xsd:attribute name="distance_unit" type="distanceUnit" use="optional"/>
<xsd:attribute name="length_unit" type="unitType" use="optional"/>
<xsd:attribute name="time_unit" type="timeUnit" use="optional"/>
<xsd:attribute name="weight_unit" type="unitType" use="optional"/>
<xsd:attribute name="return_locations" type="xsd:boolean"
    use="optional"/>
<xsd:attribute name="return_subroutes" type="xsd:boolean"
    use="optional"/>
<xsd:attribute name="return_route_time" type="xsd:boolean"
    use="optional"/>
<xsd:attribute name="return_subroute_time" type="xsd:boolean"
    use="optional"/>

<xsd:attribute name="return_driving_directions" type="xsd:boolean"
    use="optional"/>
<xsd:attribute name="return_hierarchical_directions" type="xsd:boolean"
    use="optional"/>
<xsd:attribute name="return_route_geometry" type="xsd:boolean"
    use="optional"/>
<xsd:attribute name="return_subroute_geometry" type="xsd:boolean"
    use="optional"/>
<xsd:attribute name="return_segment_geometry" type="xsd:boolean"
    use="optional"/>
<xsd:attribute name="return_detailed_geometry" type="xsd:boolean"
    use="optional"/>
<xsd:attribute name="return_route_edge_ids" type="xsd:boolean"
    use="optional"/>
<xsd:attribute name="return_subroute_edge_ids" type="xsd:boolean"
    use="optional"/>
<xsd:attribute name="return_segment_edge_ids" type="xsd:boolean"
    use="optional"/>
<xsd:attribute name="vehicle_type" type="vehicleType" use="optional"/>
<xsd:attribute name="truck_type" type="truckType" use="optional"/>
<xsd:attribute name="truck_height" type="positiveDecimal"
    use="optional"/>
<xsd:attribute name="truck_length" type="positiveDecimal"
    use="optional"/>
<xsd:attribute name="truck_per_axle_weight" type="positiveDecimal"
    use="optional"/>
<xsd:attribute name="truck_weight" type="positiveDecimal"
    use="optional"/>
<xsd:attribute name="truck_width" type="positiveDecimal" use="optional"/>
</xsd:complexType>
```



### 13.3.2.1 route\_request Element

The `<route_request>` element has the following definition:

```
<xsd:element name="route_request" type="routeRequest" />
```

The root element of a route request is always named `route_request`.

The `<start_location>` child element specifies the start location for the route, as an address specification, a geocoded address, or longitude/latitude coordinates. Depending on the route request, there can be 0 or 1 `<start_location>` elements. A simple route request requires a `<start_location>` element, whereas an open tour TSP request does not.

The `<location>` child element specifies a location for a segment, as an address specification, a geocoded address, or longitude/latitude coordinates. In a simple route request there are no `<location>` elements; if there are one or more `<location>` elements, it is a multi-address route.

The `<end_location>` child element specifies the end location for the route, as an address specification, a geocoded address, or longitude/latitude coordinates. Depending on the route request, there can be 0 or 1 `<end_location>` elements. A simple route request requires an `<end_location>` element, whereas a closed tour multi-address or TSP tour must not contain an `<end_location>` element.

In a route request:

- If `<start_location>` is an address specification or longitude/latitude coordinates, each `<end_location>` and `<location>` element can be either an address specification or longitude/latitude coordinate; however, it cannot be a pre-geocoded address.
- If `<start_location>` is a pre-geocoded address, `<end_location>` and any `<location>` specifications must also be pre-geocoded addresses.

In a batched route request, each of the individual route requests must follow the preceding rules. However, within the batch, because the individual requests are independent, you can mix address, pre-geocoded, and longitude/latitude locations, as long as they are consistent within an individual request.

### 13.3.2.2 route\_request Attributes

The root element `<route_request>` has a number of attributes, most of them optional. The attributes are defined as follows.

`vendor` is an optional attribute whose default value identifies the routing provider as Oracle.

`id` is a required attribute that specifies an identification number to be associated with the request.

`route_preference` is an optional attribute that specifies whether you want the route with the lowest estimated driving time (FASTEST) or the route with the shortest driving distance (SHORTEST, the default).

`road_preference` is an optional attribute that allows the routing process to have a preference for highways (HIGHWAY, the default) or local roads (LOCAL).

`return_driving_directions` is an optional attribute that specifies whether driving directions for the route are returned. TRUE returns driving directions; FALSE (the default) does not return driving directions.

`return_hierarchical_driving_directions` is an optional attribute that specifies whether driving directions for the route are returned in an expandable and collapsible hierarchy. `TRUE` returns driving directions in an expandable and collapsible hierarchy; `FALSE` (the default) returns driving directions in a list with no hierarchy.

`return_locations` is an optional attribute that specifies whether to return the geocode information for all the locations in the route. `TRUE` returns the geocode information; `FALSE` (the default) does not.

`return_subroutes` is an optional attribute that specifies whether to return the subroutes in a multi-address route. `TRUE` (the default for multi-address routes) returns subroutes; `FALSE` does not return subroutes. (This attribute is ignored for simple routes.)

`return_route_geometry` is an optional attribute that specifies whether to return the coordinates of the line string that represents the route. `TRUE` returns the coordinates; `FALSE` (the default) does not return the coordinates.

`return_subroute_geometry` is an optional attribute that specifies whether to return the coordinates of the line strings that represent the subroutes within a route. `TRUE` returns the coordinates; `FALSE` (the default for multi-address routes) does not return the coordinates. (This attribute is ignored for simple routes.)

`return_segment_geometry` is an optional attribute that specifies whether to return the coordinates of the line strings that represent maneuvers of a route. `TRUE` returns the coordinates; `FALSE` (the default) does not return the coordinates. If `return_segment_geometry` is `TRUE`, driving directions for the route are returned regardless of the value of the `return_driving_directions` attribute.

`return_detailed_geometry` is an optional attribute that indicates the level of detail to be included in returned geometries. `TRUE` (the default) returns detailed geometries; `FALSE` returns generalized geometries (usually with fewer coordinates).

`return_route_edge_ids` is an optional attribute that specifies whether to return the edge ID values of the edges in the route. `TRUE` returns the edge ID values; `FALSE` (the default) does not return the edge ID values.

`return_subroute_edge_ids` is an optional attribute that specifies whether to return the edge ID values of the edges in the subroutes. `TRUE` returns the edge ID values; `FALSE` (the default for multi-address routes) does not return the edge ID values. (This attribute is ignored for simple routes.)

`return_segment_edge_ids` is an optional attribute that specifies whether to return the edge ID values of the edges of all maneuvers in the route. `TRUE` returns the edge ID values; `FALSE` (the default) does not return the edge ID values. If `return_segment_edge_ids` is `TRUE`, driving directions for the route are returned regardless of the value of the `return_driving_directions` attribute.

`language` is an optional attribute that overrides the default language used to generate the driving directions. The default language for is set in the `web.xml` file; you can use this attribute to override the default on a per-request basis. The following attribute values are supported: `ENGLISH`, `FRENCH`, `GERMAN`, `ITALIAN`, and `SPANISH`.

`distance_unit` is an optional attribute that specifies the unit of measure for distance values that are returned: `KILOMETER` or `KM` for kilometer, `MILE` (the default) for mile, or `METER` for meter.

`length_unit` is an optional attribute that specifies the length measurement system used for input length values: `US` for feet (the default) or `METRIC` for meters. This attribute is used to specify the height, length, and/or width of trucks.

`time_unit` is an optional attribute that specifies the unit for time values that are returned: HOUR for hour, MINUTE (the default) for minute, or SECOND for second.

`weight_unit` is an optional attribute that specifies the weight measurement system used for input weight values: US for tons (the default) or METRIC for metric tons. This attribute is used to specify the weight of trucks.

`pre_geocoded_locations` is an optional attribute that indicates how locations are specified. TRUE means that both are previously geocoded locations specified using the `<pre_geocoded_location>` element; FALSE (the default) means that both are addresses or longitude/latitude pairs specified using the `<input_location>` element.

`driving_directions_detail` is an optional attribute that influences the level of detail and the number of separate steps in driving instructions. The available values are HIGH (most details and steps), MEDIUM (the default), and LOW (fewest details and steps). For example, LOW might treat a segment as a single step even if it involves slight maneuvers to the right or left. The effect of a value for this attribute on the length of returned driving directions will vary, depending on the exact names of elements and maneuvers. This attribute is ignored if you do not specify TRUE for `return_driving_directions` or `return_hierarchical_driving_directions`.

`optimize_route` is an optional attribute that specifies whether a multi-address route request should have its unfixed locations reordered to optimize the overall route. TRUE reorders the locations to optimize the overall route (Traveling Salesperson); FALSE (the default) does not reorder the locations (multi-address). Since multi-address requests are not optimized, all locations are returned in the order specified in the request. In multi-address and TSP open tour requests, the START\_LOCATION and END\_LOCATION are optional. If they are specified they are fixed locations and are not subject to reordering in TSP requests. In multi-address and TSP requests, one or more intermediate locations (LOCATION) must be specified, and they are unfixed locations and are subject to reordering in a TSP request.

`route_type` is an optional attribute that specifies whether a multi-address route is an OPEN (the default) or CLOSED tour. An open tour routes from the START\_LOCATION, or first LOCATION, to the END\_LOCATION, or last LOCATION. In a closed tour the START\_LOCATION is required and is used as both the starting and ending location. If an END\_LOCATION is specified for a closed tour, an exception is raised.

`vehicle_type` is an optional attribute that specifies that the type of vehicle is an AUTO (the default) or a TRUCK. For the truck description subattributes to be used, the vehicle type must be set to TRUCK; if the vehicle type is AUTO, these subattributes are ignored.

`truck_type` is an optional attribute and a subattribute to `vehicle_type` being set to TRUCK. This attribute describes a specific type of truck, allowing it to potentially override more generalized truck rules. The following attribute values are supported: DELIVERY, PUBLIC, RESIDENT, and TRAILER. The DELIVERY, PUBLIC, and RESIDENT truck types provide exceptions to truck rules for trucks of these types. Garbage and public utility trucks are examples of PUBLIC trucks. The RESIDENT truck type describes trucks that are local to a neighborhood. The TRAILER truck type describes extra restrictions that semi-trailer trucks are subject to are that the other trucks are not.

`truck_height` is an optional attribute and a subattribute to `vehicle_type` being set to TRUCK. This attribute specifies, as a floating-point number, the height of a truck

in `length_units`. This height is used to check against any height restrictions that may exist on an edge being considered as part of a route.

`truck_length` is an optional attribute and a subattribute to `vehicle_type` being set to `TRUCK`. This attribute specifies, as a floating-point number, the length of a truck in `length_units`. This length is used to check against any length restrictions that may exist on an edge being considered as part of a route.

`truck_per_axle_weight` is an optional attribute and a subattribute to `vehicle_type` being set to `TRUCK`. This attribute specifies, as a floating-point number, the per axle weight of a truck in `weight_units`. This weight is used to check against any per axle weight restrictions that may exist on an edge being considered as part of a route.

`truck_weight` is an optional attribute and a subattribute to `vehicle_type` being set to `TRUCK`. This attribute specifies, as a floating-point number, the weight of a truck in `weight_units`. This weight is used to check against weight restrictions that may exist on an edge being considered as part of a route.

`truck_width` is an optional attribute and a subattribute to `vehicle_type` being set to `TRUCK`. This attribute specifies, as a floating-point number, the width of a truck in `length_units`. This width is used to check against width restrictions that may exist on an edge being considered as part of a route.

### 13.3.2.3 input\_location Element

The `<input_location>` element specifies an address in a format that satisfies the Oracle Spatial and Graph geocoding request XML Schema, which is described in [Geocoding Request XML Schema Definition and Example](#) (page 11-36). You can specify the input location using either a longitude/latitude pair or the `<input_address>` element. [Example 13-1](#) (page 13-11) in [Route Request and Response Examples](#) (page 13-11) shows the start and end addresses specified using the `<input_location>` element and its child element `<input_address>`.

To use the `<input_location>` element, you must ensure that the value of the `pre_geocoded_locations` attribute is `FALSE` (the default) in the `<route_request>` element. You can use longitude/latitude pairs and `<input_address>` elements together in a request.

### 13.3.2.4 pre\_geocoded\_location Element

The `<pre_geocoded_location>` element specifies a geocoded location in terms of how far along a street (an edge) the address is and on which side of the street. [Example 13-5](#) (page 13-29) in [Route Request and Response Examples](#) (page 13-11) shows the start and end addresses specified using the `<pre_geocoded_location>` element.

To use the `<pre_geocoded_location>` element, you must specify `pre_geocoded_locations="TRUE"` in the `<route_request>` element, and you must use the `<pre_geocoded_location>` element to specify all locations.

## 13.3.3 Route Response XML Schema Definition

The following is the XML Schema definition for a route response:

```
<!-- XML Schema definition for Route Response from the routing engine -->
<xsd:schema xmlns:xsd="http://www.w3.org/2001/XMLSchema"
  xmlns:gml="http://www.opengis.net/gml"
  elementFormDefault="qualified">
```

```
<xsd:simpleType name="nonNegativeDecimal">
  <xsd:restriction base="xsd:decimal">
    <xsd:minInclusive value="0"/>
  </xsd:restriction>
</xsd:simpleType>

<xsd:simpleType name="positiveDecimal">
  <xsd:restriction base="xsd:decimal">
    <xsd:minExclusive value="0"/>
  </xsd:restriction>
</xsd:simpleType>

<xsd:simpleType name="distanceUnit">
  <xsd:restriction base="xsd:string">
    <xsd:enumeration value="mile"/>
    <xsd:enumeration value="km"/>
    <xsd:enumeration value="kilometer"/>
    <xsd:enumeration value="meter"/>
  </xsd:restriction>
</xsd:simpleType>

<xsd:simpleType name="timeUnit">
  <xsd:restriction base="xsd:string">
    <xsd:enumeration value="minute"/>
    <xsd:enumeration value="hour"/>
    <xsd:enumeration value="second"/>
  </xsd:restriction>
</xsd:simpleType>

<xsd:simpleType name="edgeIdElement">
  <xsd:restriction base="xsd:string">
    <xsd:pattern value="[-0-9,]+" />
  </xsd:restriction>
</xsd:simpleType>

<xsd:simpleType name="edgeIdList">
  <xsd:list itemType="edgeIdElement" />
</xsd:simpleType>

<xsd:simpleType name="emptyString">
  <xsd:restriction base="string">
    <xsd:maxLength value="0"/>
  </xsd:restriction>
</xsd:simpleType>

<xsd:simpleType name="latitude">
  <xsd:restriction base="decimal">
    <xsd:minInclusive value="-90.0" />
    <xsd:maxInclusive value="90.0" />
  </xsd:restriction>
</xsd:simpleType>

<xsd:simpleType name="longitude">
  <xsd:restriction base="decimal">
    <xsd:minInclusive value="-180.0"/>
    <xsd:maxInclusive value="180.0"/>
  </xsd:restriction>
</xsd:simpleType>

<xsd:complexType name="geometry">
  <xsd:sequence>
```

```
<xsd:element ref="gml:LineString"/>
</xsd:sequence>
</xsd:complexType>

<xsd:complexType name="outputLocation">
  <xsd:attribute name="id" type="xsd:positiveInteger" use="required"/>
  <xsd:attribute name="longitude" use="required">
    <xsd:simpleType>
      <xsd:union memberTypes="longitude emptyString" />
    </xsd:simpleType>
  </xsd:attribute>
  <xsd:attribute name="latitude" use="required">
    <xsd:simpleType>
      <xsd:union memberTypes="latitude emptyString" />
    </xsd:simpleType>
  </xsd:attribute>
  <xsd:attribute name="house_number" type="xsd:string" use="required"/>
  <xsd:attribute name="street" type="xsd:string" use="required"/>
  <xsd:attribute name="city" type="xsd:string" use="required"/>
  <xsd:attribute name="state" type="xsd:string" use="required"/>
  <xsd:attribute name="country" type="xsd:string" use="required"/>
  <xsd:attribute name="driving_side" use="required">
    <xsd:simpleType>
      <xsd:restriction base="xsd:string">
        <xsd:enumeration value="L"/>
        <xsd:enumeration value="N"/>
        <xsd:enumeration value="R"/>
      </xsd:restriction>
    </xsd:simpleType>
  </xsd:attribute>
  <xsd:attribute name="postal_code" type="xsd:string" use="required"/>
  <xsd:attribute name="edge_id" type="xsd:long" use="required"/>
  <xsd:attribute name="percent" type="edgePercentage" use="required"/>
</xsd:complexType>

<xsd:complexType name="segmentType">
  <xsd:sequence>
    <xsd:element name="segment_geometry" type="geometry"
      minOccurs="0" maxOccurs="1"/>
    <xsd:element name="segment_edge_ids" type="edgeIdList"
      minOccurs="0" maxOccurs="1"/>
  </xsd:sequence>
  <xsd:attribute name="sequence" type="xsd:positiveInteger" use="required"/>
  <xsd:attribute name="instruction" type="xsd:string" use="required"/>
  <xsd:attribute name="distance" type="nonNegativeDecimal" use="required"/>
  <xsd:attribute name="time" type="nonNegativeDecimal" use="required"/>
</xsd:complexType>

<xsd:element name="route_response">
  <xsd:complexType>
    <xsd:sequence>
      <xsd:element name="route" minOccurs="1" maxOccurs="1">
        <xsd:simpleType>
          <xsd:union memberTypes="multiRouteType routeType"/>
        </xsd:simpleType>
      </xsd:element>
    </xsd:sequence>
  </xsd:complexType>
</xsd:element>

<xsd:complexType name="multiRouteType">
```

```

<xsd:sequence>
  <xsd:element name="route_geometry" type="geometry"
    minOccurs="0" maxOccurs="1"/>
  <xsd:element name="route_edge_ids" type="edgeIdList"
    minOccurs="0" maxOccurs="1"/>
  <xsd:element name="start_location" type="outputLocation"
    minOccurs="0" maxOccurs="1"/>
  <xsd:element name="end_location" type="outputLocation"
    minOccurs="0" maxOccurs="1"/>
  <xsd:element name="subroute" minOccurs="1" maxOccurs="unbounded">
    <xsd:complexType>
      <xsd:sequence>
        <xsd:element name="subroute_geometry" type="geometry"
          minOccurs="0" maxOccurs="1"/>
        <xsd:element name="subroute_edge_ids" type="edgeIdList"
          minOccurs="0" maxOccurs="1"/>
        <xsd:element name="start_location" type="outputLocation"
          minOccurs="0" maxOccurs="1"/>
        <xsd:element name="segment" type="segmentType"
          minOccurs="0" maxOccurs="unbounded"/>
        <xsd:element name="end_location" type="outputLocation"
          minOccurs="0" maxOccurs="1"/>
      </xsd:sequence>
      <xsd:attribute name="id" type="xsd:nonNegativeInteger"
        use="required"/>
      <xsd:attribute name="step_count" type="xsd:nonNegativeInteger"
        use="required"/>
      <xsd:attribute name="distance" type="nonNegativeDecimal"
        use="required"/>
      <xsd:attribute name="distance_unit" type="distanceUnit"
        use="required"/>
      <xsd:attribute name="time" type="nonNegativeDecimal" use="required"/>
      <xsd:attribute name="time_unit" type="timeUnit" use="required"/>
      <xsd:attribute name="start_location" type="xsd:positiveInteger"
        use="required"/>
      <xsd:attribute name="end_location" type="xsd:positiveInteger"
        use="required"/>
    </xsd:complexType>
  </xsd:element>
</xsd:sequence>
</xsd:complexType>

<xsd:complexType name="routeType">
  <xsd:sequence>
    <xsd:element name="route_geometry" type="geometry"
      minOccurs="0" maxOccurs="1"/>
    <xsd:element name="route_edge_ids" type="edgeIdList"
      minOccurs="0" maxOccurs="1"/>
    <xsd:element name="start_location" type="outputLocation"
      minOccurs="0" maxOccurs="1"/>
    <xsd:element name="segment" type="segmentType"
      minOccurs="0" maxOccurs="unbounded"/>
    <xsd:element name="end_location" type="outputLocation"
      minOccurs="0" maxOccurs="1"/>
  </xsd:sequence>
  <xsd:attribute name="id" type="xsd:nonNegativeInteger" use="required"/>
  <xsd:attribute name="step_count" type="xsd:nonNegativeInteger"
    use="required"/>
  <xsd:attribute name="distance" type="nonNegativeDecimal" use="required"/>
  <xsd:attribute name="distance_unit" type="distanceUnit" use="required"/>
  <xsd:attribute name="time" type="nonNegativeDecimal" use="required"/>

```

```
<xsd:attribute name="time_unit" type="timeUnit" use="required"/>
<xsd:attribute name="start_location" type="xsd:positiveInteger"
  use="required"/>
<xsd:attribute name="end_location" type="xsd:positiveInteger"
  use="required"/>
</xsd:complexType>
</xsd:schema>
```

### 13.3.4 Batch Mode Route Request and Response Examples

This section contains XML examples of batch mode route requests and the responses generated by those requests. One request uses specified addresses, and the other request uses previously geocoded locations. For reference information about the available elements and attributes, see [Batch Route Request XML Schema Definition](#) (page 13-50) for requests and [Batch Route Response XML Schema](#) (page 13-53) for responses.

#### **Example 13-7 Batch Route Request with Specified Addresses**

[Example 13-7](#) (page 13-48) shows a batch route request using specified addresses. The request is for the fastest routes, preferably using highways, between an office in Waltham, Massachusetts and three end locations (an Oracle office in Nashua, New Hampshire; the town offices in Concord, Massachusetts; and Boston City Hall), using miles for distances and minutes for times. The request calls for the returned routes to be sorted by distance between the start and end location, and for no routes over 35 miles to be returned.

```
<?xml version="1.0" standalone="yes"?>
<batch_route_request
  id="8"
  route_preference="fastest"
  road_preference="highway"
  return_driving_directions="false"
  sort_by_distance = "true"
  cutoff_distance="35"
  distance_unit="mile"
  time_unit="minute">
  <start_location>
    <input_location id="1">
      <input_address>
        <us_form1
          street="399 Winter St"
          lastline="Waltham, MA" />
        </input_address>
      </input_location>
    </start_location>
    <end_location>
      <input_location id="10">
        <input_address>
          <us_form1
            street="1 Oracle Dr"
            lastline="Nashua, NH" />
          </input_address>
        </input_location>
      </end_location>
      <end_location>
        <input_location id="11">
          <input_address>
            <us_form1
              street="2 Monument Sq"
              lastline="Concord, MA" />
            </input_address>
          </input_location>
        </end_location>
      </end_location>
    </batch_route_request>
```



```

        </input_address>
      </input_location>
    </end_location>
  <end_location>
    <input_location id="12">
      <input_address>
        <us_form1
          street="1 City Hall Plaza"
          lastline="Boston, MA" />
      </input_address>
    </input_location>
  </end_location>
</batch_route_request>

```

### Example 13-8 Batch Route Response with Specified Addresses

[Example 13-8](#) (page 13-49) shows the response generated by the request in [Example 13-7](#) (page 13-48). (The output is reformatted for readability.) Note that because `sort_by_distance = "true"` was specified in the request, the routes returned are not in order by route IDs (11, 12, 10), but instead by route distances.

```

<!-- Oracle Routeserver version 12.1.0.2.0 (data version 11.1.0.7.1) -->
<batch_route_response id="8">
  <route id="11" step_count="0"
    distance="7.796855460254458" distance_unit="mile"
    time="11.343014526367188" time_unit="minute"/>
  <route id="12" step_count="0"
    distance="17.201688768020258" distance_unit="mile"
    time="21.577909342447917" time_unit="minute"/>
  <route id="10" step_count="0"
    distance="28.628700657894736" distance_unit="mile"
    time="31.133371988932293" time_unit="minute"/>
</batch_route_response>

```

### Example 13-9 Batch Route Request with Previously Geocoded Locations

[Example 13-9](#) (page 13-49) shows a batch route request using previously geocoded locations. The request is for the fastest routes, preferably using highways, between one location and three other locations, using miles for distances and minutes for times. The request calls for the returned routes to be sorted by distance between the start and end location, and for no routes over 28.5 miles to be returned.

```

<?xml version="1.0" standalone="yes"?>
<batch_route_request id="8"
  route_preference="fastest"
  road_preference="highway"
  return_driving_directions="false"
  distance_unit="mile"
  time_unit="minute"
  pre_geocoded_locations="true"
  cutoff_distance="28.5"
  sort_by_distance="true">
  <start_location>
    <pre_geocoded_location id="1">
      <edge_id>906810462</edge_id>
      <percent>0.0</percent>
      <side>R</side>
    </pre_geocoded_location>
  </start_location>
  <end_location>
    <pre_geocoded_location id="11">
      <edge_id>22325991</edge_id>

```

```
        <percent>0.0</percent>
        <side>R</side>
      </pre_geocoded_location>
    </end_location>
  <end_location>
    <pre_geocoded_location id="12">
      <edge_id>22027853</edge_id>
      <percent>0.0</percent>
      <side>R</side>
    </pre_geocoded_location>
  </end_location>
</end_location>
<pre_geocoded_location id="13">
  <edge_id>31102851</edge_id>
  <percent>0.0</percent>
  <side>R</side>
</pre_geocoded_location>
</end_location>
</batch_route_request>
```

#### **Example 13-10 Batch Route Response with Previously Geocoded Locations**

[Example 13-10](#) (page 13-50) shows the response to the request in [Example 13-9](#) (page 13-49). Only two routes are returned, because the third route is longer than the specified cutoff distance of 28.5 miles. (The output is reformatted for readability.)

```
<!-- Oracle Routeserver version 12.1.0.2.0 (data version 11.1.0.7.1) -->
<batch_route_response id="8">
  <route id="11" step_count="0"
    distance="7.796855460254458" distance_unit="mile"
    time="11.343014526367188" time_unit="minute"/>
  <route id="12" step_count="0"
    distance="17.201688768020258" distance_unit="mile"
    time="21.577909342447917" time_unit="minute"/>
</batch_route_response>
```

### **13.3.5 Batch Route Request XML Schema Definition**

The following is the XML Schema definition for a batch route request. The main elements and attributes of the XML Schema Definition are explained in sections that follow.

```
<?xml version="1.0" encoding="UTF-8"?>
<!-- XML Schema definition for a Batch Route Request to the routing engine -->
<xsd:schema xmlns:xsd="http://www.w3.org/2001/XMLSchema"
  elementFormDefault="qualified">
  <xsd:include schemaLocation "geocoder_request.xsd" />

  <xsd:simpleType name="positiveDecimal">
    <xsd:restriction base="xsd:decimal">
      <xsd:minExclusive value="0"/>
    </xsd:restriction>
  </xsd:simpleType>

  <xsd:simpleType name="distanceUnit">
    <xsd:restriction base="xsd:string">
      <xsd:enumeration value="mile"/>
      <xsd:enumeration value="km"/>
      <xsd:enumeration value="kilometer"/>
      <xsd:enumeration value="meter"/>
    </xsd:restriction>
  </xsd:simpleType>
```

```

</xsd:simpleType>

<xsd:simpleType name="timeUnit">
  <xsd:restriction base="xsd:string">
    <xsd:enumeration value="minute"/>
    <xsd:enumeration value="hour"/>
    <xsd:enumeration value="second"/>
  </xsd:restriction>
</xsd:simpleType>

<xsd:simpleType name="unitType">
  <xsd:restriction base="xsd:string">
    <xsd:enumeration value="us"/>
    <xsd:enumeration value="metric"/>
  </xsd:restriction>
</xsd:simpleType>

<xsd:simpleType name="roadPreference">
  <xsd:restriction base="xsd:string">
    <xsd:enumeration value="highway"/>
    <xsd:enumeration value="local"/>
  </xsd:restriction>
</xsd:simpleType>

<xsd:simpleType name="routePreference">
  <xsd:restriction base="xsd:string">
    <xsd:enumeration value="shortest"/>
    <xsd:enumeration value="fastest"/>
  </xsd:restriction>
</xsd:simpleType>

<xsd:simpleType name="truckType">
  <xsd:restriction base="xsd:string">
    <xsd:enumeration value="delivery"/>
    <xsd:enumeration value="public"/>
    <xsd:enumeration value="resident"/>
    <xsd:enumeration value="trailer"/>
  </xsd:restriction>
</xsd:simpleType>

<xsd:simpleType name="vehicleType">
  <xsd:restriction base="xsd:string">
    <xsd:enumeration value="auto"/>
    <xsd:enumeration value="truck"/>
  </xsd:restriction>
</xsd:simpleType>

<xsd:complexType name="routerInputLocation">
  <xsd:choice>
    <xsd:element name="router_input_location" type="input_locationType"/>
    <xsd:element name="router_pregeocoded_location" type="pregeocodedType"/>
  </xsd:choice>
</xsd:complexType>

<xsd:element name="batch_route_request" type="batch_route_requestType" />

<xsd:complexType name="batch_route_requestType">
  <xsd:sequence>
    <xsd:element name="start_location" type="routerInputLocation"
      minOccurs="1" maxOccurs="1"/>
    <xsd:element name="end_location" type="routerInputLocation"

```

```
        minOccurs="1" maxOccurs="unbounded"/>
</xsd:sequence>
<xsd:attribute name="id" type="xsd:nonNegativeInteger" use="required"/>
<xsd:attribute name="pre_geocoded_locations" type="xsd:boolean"
    use="optional"/>
<xsd:attribute name="route_preference" type="routePreference"
    use="optional"/>
<xsd:attribute name="road_preference" type="roadPreference"
    use="optional"/>
<xsd:attribute name="distance_unit" type="distanceUnit" use="optional"/>
<xsd:attribute name="length_unit" type="unitType" use="optional"/>
<xsd:attribute name="time_unit" type="timeUnit" use="optional"/>
<xsd:attribute name="weight_unit" type="unitType" use="optional"/>
<xsd:attribute name="vehicle_type" type="vehicleType" use="optional"/>
<xsd:attribute name="truck_type" type="truckType" use="optional"/>
<xsd:attribute name="truck_height" type="positiveDecimal" use="optional"/>
<xsd:attribute name="truck_length" type="positiveDecimal" use="optional"/>
<xsd:attribute name="truck_per_axle_weight" type="positiveDecimal"
    use="optional"/>
<xsd:attribute name="truck_weight" type="positiveDecimal" use="optional"/>
<xsd:attribute name="truck_width" type="positiveDecimal" use="optional"/>
<xsd:attribute name="cutoff_distance" type="positiveDecimal"
    use="optional"/>
<xsd:attribute name="sort_by_distance" type="xsd:boolean" use="optional"/>
</xsd:complexType>
</xsd:schema>
```

### 13.3.5.1 batch\_route\_request Element

The root element of a batch mode route request is always named `batch_route_request`.

The `<start_location>` child element specifies the start location for the route, as an address specification, a pre-geocoded address, or longitude/latitude point.

Each of the one or more `<end_location>` child elements specifies the end location for the route, as an address specification, a geocoded address, or longitude/latitude point.

The `<location>` child element is never used in batch mode route requests.

### 13.3.5.2 batch\_route\_request Attributes

The root element `<batch_route_request>` has a number of attributes, most of them optional. The attributes are defined in this section.

The `<batch_route_request>` element shares a number of attributes with the `<route_request>` element. These attributes share the same meaning as their counterpart `<route_request>` attributes, which are explained in [batch\\_route\\_request Attributes](#) (page 13-52). In addition, the `sort_by_distance` and `cutoff_distance` attributes do not apply to single route requests.

`sort_by_distance` is an optional attribute that specifies whether you want the routes returned in ascending order by distance of the end location from the start location. `TRUE` sorts the returned routes by distance; `FALSE` (the default) does not sort the returned routes by distance.

`cutoff_distance` is an optional attribute that causes routes to be returned only where the end location is less than or equal to a specified distance from the start location. By default, all routes are returned.

**Note:**

If any route is within the batch generates a `<router_error>` element in the response (see [Batch Route Response XML Schema](#) (page 13-53)), the route is removed from the response and not shown.

### 13.3.6 Batch Route Response XML Schema

The following is the XML Schema definition for a batch route response:

```
<?xml version="1.0" encoding="UTF-8"?>
<!-- XML Schema definition for a Batch Mode Route Request -->
<xsd:schema xmlns:xsd="http://www.w3.org/2001/XMLSchema"
  elementFormDefault="qualified">

  <xsd:simpleType name="nonNegativeDecimal">
    <xsd:restriction base="xsd:decimal">
      <xsd:minInclusive value="0"/>
    </xsd:restriction>
  </xsd:simpleType>

  <xsd:simpleType name="distanceUnit">
    <xsd:restriction base="xsd:string">
      <xsd:enumeration value="mile"/>
      <xsd:enumeration value="km"/>
      <xsd:enumeration value="kilometer"/>
      <xsd:enumeration value="meter"/>
    </xsd:restriction>
  </xsd:simpleType>

  <xsd:simpleType name="timeUnit">
    <xsd:restriction base="xsd:string">
      <xsd:enumeration value="minute"/>
      <xsd:enumeration value="hour"/>
      <xsd:enumeration value="second"/>
    </xsd:restriction>
  </xsd:simpleType>

  <xsd:element name="batch_route_response">
    <xsd:complexType>
      <xsd:sequence>
        <xsd:element name="route" maxOccurs="unbounded">
          <xsd:complexType>
            <xsd:attribute name="id" type="xsd:nonNegativeInteger"
              use="required"/>
            <xsd:attribute name="step_count" type="xsd:nonNegativeInteger"
              fixed="0" use="required"/>
            <xsd:attribute name="distance" type="nonNegativeDecimal"
              use="required"/>
            <xsd:attribute name="distance_unit" type="distanceUnit"
              use="required"/>
            <xsd:attribute name="time" type="nonNegativeDecimal"
              use="required"/>
            <xsd:attribute name="time_unit" type="timeUnit" use="required"/>
          </xsd:complexType>
        </xsd:element>
      </xsd:sequence>
      <xsd:attribute name="id" type="xsd:nonNegativeInteger" use="required"/>
    </xsd:complexType>
  </xsd:element>
</xsd:schema>
```

```
</xsd:element>  
</xsd:schema>
```

## 13.4 Data Structures Used by the Routing Engine

Older versions of the routing engine (before Release 12.1) must have the following tables in their schema:

- EDGE
- NODE
- PARTITION
- SIGN\_POST

The EDGE and NODE tables store edge and node information about the street network used by the routing engine. To understand how edges and nodes are used to represent street segments, intersections, and other entities in a street network, you must be familiar with the Oracle Spatial and Graph Network Data Model Graph, which is described in *Oracle Spatial and Graph Topology Data Model and Network Data Model Graph Developer's Guide*.

The following sections describe the tables used by the routing engine, in alphabetical order by table name:

- [EDGE Table](#) (page 13-54)
- [NODE Table](#) (page 13-55)
- [PARTITION Table](#) (page 13-56)
- [SIGN\\_POST Table](#) (page 13-56)

### 13.4.1 EDGE Table

The EDGE table contains one row for each directed edge in a street network. Each street segment (a part of a road between two nodes) is an undirected edge that corresponds to one or more directed edges in the EDGE table. The EDGE table contains the columns shown in [Table 13-1](#) (page 13-54).

**Table 13-1** *EDGE Table*

Column Name	Data Type	Description
EDGE_ID	NUMBER	Edge ID number. (Primary key.)
START_NODE_ID	NUMBER	Node ID number of the start node of this edge.
END_NODE_ID	NUMBER	Node ID number of the end node of this edge.
PARTITION_ID	NUMBER	Partition ID number of the network partition that contains this edge.

**Table 13-1 (Cont.) EDGE Table**

Column Name	Data Type	Description
FUNC_CLASS	NUMBER	Functional road class: a number from 1 through 5, with 1 indicating a large, high-speed, high-volume road, and each successive class generally smaller in size, speed, and volume. Class 2 roads have consistent speeds and are used to get traffic to and from class 1 roads. Class 3 roads have high volume and are used to connect class 2 roads. Class 4 roads move volumes of traffic between neighborhoods (for example, a busy main road in a city). Class 5 roads are all other roads (for example, a small, low-volume street in a neighborhood).
LENGTH	NUMBER	Length of this edge, in meters.
SPEED_LIMIT	NUMBER	Assigned speed limit for this edge, in meters per second.
GEOMETRY	SDO_GEOMETRY	Line string geometry representing this edge, with the coordinates ordered from the start node to the end node.
NAME	VARCHAR2(128)	Name of this edge.
DIVIDER	VARCHAR2(1)	A value of N indicates that the edge is not divided; other values indicate whether, where, and how turns are allowed on the divided edge. (The routing engine currently considers only whether the edge is divided or not.)

### 13.4.2 NODE Table

The NODE table contains one row for each node that is the start node or end node of one or more edges in the street network. A node often corresponds to an intersection (the intersection of two edges); however, a node can be independent of any intersection (for example, the end of a "dead end" or "no outlet" street). The NODE table contains the columns shown in [Table 13-2](#) (page 13-55).

**Table 13-2 NODE Table**

Column Name	Data Type	Description
NODE_ID	NUMBER	Node ID number.(Primary key.)
GEOMETRY	SDO_GEOMETRY	Point geometry representing this node.
PARTITION_ID	NUMBER	Partition ID number of the network partition that contains this node.

### 13.4.3 PARTITION Table

The PARTITION table is generated by the routing engine based on the contents of the EDGE and NODE tables. The PARTITION table contains the columns shown in [Table 13-3](#) (page 13-56).

**Table 13-3 PARTITION Table**

Column Name	Data Type	Description
PARTITION_ID	NUMBER	Partition ID number.(Primary key.)
SUBNETWORK	BLOB	Part of the network included in this partition.
NUM_NODES	NUMBER	Number of nodes in this partition.
NUM_NON_BOUNDARY_EDGES	NUMBER	Number of edges in this partition that are edges that are completely contained within the partition.
NUM_OUTGOING_BOUNDARY_EDGES	NUMBER	Number of edges in this partition that start in this partition and terminate in another partition. (An edge cannot be in more that two partitions; for example, an edge cannot start in one partition, go through a second partition, and end in a third partition.)
NUM_INCOMING_BOUNDARY_EDGES	NUMBER	Number of edges in this partition that start in another partition and terminate in this partition. (An edge cannot be in more that two partitions; for example, an edge cannot start in one partition, go through a second partition, and end in a third partition.)

### 13.4.4 SIGN\_POST Table

The SIGN\_POST table stores sign information that is used to generate driving directions. For example, a sign might indicate that Exit 33A on US Route 3 South goes toward Winchester. A SIGN\_POST row might correspond to a physical sign at an exit ramp on a highway, but it does not need to correspond to a physical sign. The SIGN\_POST table contains the columns shown in [Table 13-4](#) (page 13-56).

**Table 13-4 SIGN\_POST Table**

Column Name	Data Type	Description
FROM_EDGE_ID	NUMBER	Edge ID number of the edge to which this sign applies (for example, the street segment containing the exit ramp).(Primary key.)
TO_EDGE_ID	NUMBER	Edge ID number of the edge to which this sign points (for example, the street segment to which the exit ramp leads).
RAMP	VARCHAR2(64)	Ramp text (for example, US-3 SOUTH).
EXIT	VARCHAR2(8)	Exit number (for example, 33A).
TOWARD	VARCHAR2(64)	Text indicating where the exit is heading (for example, WINCHESTER).



**Table 13-4 (Cont.) SIGN\_POST Table**

Column Name	Data Type	Description
LANGUAGE_CO DE	CHAR (3 CHAR)	A three-letter language code indicating the language used on the sign. Examples ENG, FRE, and SPA for English, French, and Spanish.

## 13.5 User Data Structures Used by the Routing Engine

The routing engine uses user data as well as routing engine data. Some user data, such as turn restriction user data, must be present in the routing engine schema. Other user data, such as trucking user data, is optional.

---

### Note:

Effective with Release 12.1, the routing engine running against Release 12.1 or later data expects turn restriction user data to be present. However, the routing engine can also be run against earlier data versions; but if this is done, a much more limited version of the turn restriction data from the PARTITION table is used.

---

This section explains tables used for the following types of user data:

- [Turn Restriction User Data](#) (page 13-57)
- [Trucking User Data](#) (page 13-59)

### 13.5.1 Turn Restriction User Data

Turn restrictions are described in the following tables:

- [ROUTER\\_CONDITION Table](#) (page 13-57)
- [ROUTER\\_NAV\\_STRAND Table](#) (page 13-58)
- [ROUTER\\_TURN\\_RESTRICTION\\_DATA Table](#) (page 13-58)

An edge (or a link) is an undirected edge that corresponds to one or more directed edges in the EDGE table (explained in [EDGE Table](#) (page 13-54)). Turn restrictions are applied to a navigation strand (**nav\_strand**) that is a group of two or more edges. A simple turn restriction would be applied to a two-edge nav\_strand: the edge where the turn would have started and the edge where the turn would have ended. A nav\_strand can have more than two edges to describe very complex restricted maneuvers.

#### 13.5.1.1 ROUTER\_CONDITION Table

The ROUTER\_CONDITION table contains the raw data used to build the turn restriction user data for simple conditions. This table is not used during the routing process. Instead it is used to build the ROUTER\_TURN\_RESTRICTION\_DATA user data table. It is part of routing engine data set so the turn restriction user data can be rebuilt if the routing engine data is repartitioned. The ROUTER\_CONDITION table contains the columns shown in [Table 13-5](#) (page 13-58).

**Table 13-5 ROUTER\_CONDITION Table**

Column Name	Data Type	Description
NAV_STRAND_ID	NUMBER	A unique ID number for a nav_strand.
APPLIES_TO	NUMBER	A number representing a list of vehicles to which the turn restriction applies.

**13.5.1.2 ROUTER\_NAV\_STRAND Table**

The ROUTER\_NAV\_STRAND table contains the raw data used to build the turn restriction user data for complex maneuvers. This table is not used during the routing process. Instead, it is used to build the ROUTER\_TURN\_RESTRICTION\_DATA user data table. It is part of routing engine data set, so the turn restriction user data can be rebuilt if the routing engine data is repartitioned. The ROUTER\_NAV\_STRAND table contains the columns shown in [Table 13-6](#) (page 13-58).

**Table 13-6 ROUTER\_NAV\_STRAND Table**

Column Name	Data Type	Description
NAV_STRAND_ID	NUMBER	A unique ID number for a nav_strand that contains this edge.
SEQ_NUM	NUMBER	The edge ID's position within the nav_strand.
LINK_ID	NUMBER	Link (edge) ID of an edge that is part of this nav_strand.
NODE_ID	NUMBER	Node id of the node that connects the first and second link id in the nav_strand. This is zero for all other links in the nav_strand.
APPLIES_TO	NUMBER	A number representing a list of vehicles to which the turn restriction applies.

**13.5.1.3 ROUTER\_TURN\_RESTRICTION\_DATA Table**

The ROUTER\_TURN\_RESTRICTION\_DATA table contains the user data that describes turn restrictions. This table is used to enforce turn restrictions during the routing process. This table is partitioned to match the partitioning of the EDGE table. When a particular routing engine data partition is brought into the cache, the turn restriction User Data partition of the same number is also brought into the cache.

The ROUTER\_TURN\_RESTRICTION\_DATA table contains the columns shown in [Table 13-7](#) (page 13-58).

**Table 13-7 ROUTER\_TURN\_RESTRICTION\_DATA Table**

Column Name	Data Type	Description
PARTITION_ID	NUMBER	The routing engine data partition ID with which this turn restriction user data is associated.
NUM_EDGES	NUMBER	Number of edges with turn restrictions on them.

**Table 13-7 (Cont.) ROUTER\_TURN\_RESTRICTION\_DATA Table**

Column Name	Data Type	Description
TURN_RESTRICTION_DATA	BLOB	BLOB containing the nav_strand information describing the turn restriction and the edges to which the turn restriction applies.

## 13.5.2 Trucking User Data

Trucking information is described in the following tables:

- [ROUTER\\_TRANSPORT Table](#) (page 13-59)
- [ROUTER\\_TRUCKING\\_DATA Table](#) (page 13-59)

### 13.5.2.1 ROUTER\_TRANSPORT Table

The ROUTER\_TRANSPORT table contains the raw data used to build the trucking user data. This table is not used during the routing process. Instead, it is used to build the [ROUTER\\_TRUCKING\\_DATA Table](#) (page 13-59) (a user data table). It is part of routing engine data set so that the trucking user data can be rebuilt if the routing engine data is repartitioned.

When the ROUTER\_TRANSPORT table is first imported into the routing engine schema, you must execute the SDO\_ROUTER\_PARTITION.CREATE\_TRUCKING\_DATA procedure (see [CREATE\\_TRUCKING\\_DATA Procedure](#) (page E-15)) to produce the ROUTER\_TRUCKING\_DATA partitioned user data table.

The ROUTER\_TRANSPORT table contains the columns shown in [Table 13-8](#) (page 13-59).

**Table 13-8 ROUTER\_TRANSPORT Table**

Column Name	Data Type	Description
EDGE_ID	NUMBER	Edge ID number of the edge to which the restriction applies.
MAINTYPE	NUMBER(2)	Type of truck restriction: height, length, per axle weight, weight, width or legal.
SUBTYPE	NUMBER(2)	Subtype used to extend or provide exceptions to the main type of restriction. For example, a delivery subtype might allow delivery trucks access where other trucks are forbidden.
VALUE	NUMBER(6,2)	A value associated with the main type: for example a value of 20 associated with a weight main type to indicate that any truck in excess of 20 metric tons will not be allowed access to the edge.

### 13.5.2.2 ROUTER\_TRUCKING\_DATA Table

The ROUTER\_TRUCKING\_DATA contains the user data that describes truck restrictions. This table is used to enforce truck restrictions during the routing process. This table is partitioned to match the partitioning of the EDGE table. When a

particular routing engine data partition is brought into the cache, the truck restriction User Data partition of the same number is also brought into the cache if the vehicle being routed is a truck.

The ROUTER\_TRUCKING\_DATA table contains the columns shown in [Table 13-9](#) (page 13-60).

**Table 13-9 ROUTER\_TRUCKING\_DATA Table**

Column Name	Data Type	Description
PARTITION_ID	NUMBER	ID of the routing engine data partition with which this trucking data is associated.
NUM_EDGES	NUMBER	Number of edges in this partition with trucking restrictions.
TRUCKING_DATA	BLOB	Trucking restrictions for this partition in BLOB format.

---

## OpenLS Support

This chapter describes the Oracle Spatial and Graph support for web services based on the Open Location Services Initiative (OpenLS) of the Open GeoSpatial Consortium (OGC), versions 1.0 and 1.1. For a description of OpenLS, see <http://www.opengeospatial.org/standards/ols>, which includes links for downloads and schemas.

This chapter includes the following major sections:

- [Supported OpenLS Services](#) (page 14-1)
- [OpenLS Application Programming Interfaces](#) (page 14-2)
- [OpenLS Service Support and Examples](#) (page 14-2)

---

**Note:**

Before you use OpenLS, be sure that you understand the concepts described in [Introduction to Spatial Web Services](#) (page 10-1), and that you have performed any necessary configuration work as described in that chapter.

---

### 14.1 Supported OpenLS Services

Spatial and Graph supports the following OGC OpenLS services:

- Location Utility Service (geocoding)
- Presentation Service (mapping)
- Route Service (driving directions)
- Directory Service (YP, or "Yellow Pages")

Spatial and Graph does not currently support the OGC OpenLS Gateway Service (mobile positioning).

For all supported services except Directory Service (YP, or Yellow Pages), you must first perform certain operations, which might include acquiring and loading third-party data, as well as configuring and deploying underlying technology on which the Spatial and Graph OpenLS service is based. [Table 14-1](#) (page 14-2) lists the Spatial and Graph OpenLS services, and the chapter or manual that documents the requirements and underlying technologies.

**Table 14-1 Spatial and Graph OpenLS Services Dependencies**

Spatial and Graph OpenLS Service	Depends On	Documented In
Geocoding	Geocoding metadata and data	<a href="#">Geocoding Address Data</a> (page 11-1)
Mapping	Oracle MapViewer	<i>Oracle Fusion Middleware User's Guide for Oracle MapViewer</i>
Driving directions	Routing engine	<a href="#">Routing Engine</a> (page 13-1)
Business directory (YP, or Yellow Pages)	Data from an external provider	<a href="#">Business Directory (Yellow Pages) Support</a> (page 12-1)

## 14.2 OpenLS Application Programming Interfaces

Two application programming interfaces (APIs) are provided using Spatial and Graph OpenLS services: a web services API and a PL/SQL API.

The web services API uses the same SOAP envelope as Web feature services (described in [Web Feature Service \(WFS\) Support](#) (page 15-1)). You enable authentication and authorization using WSS and proxy authentication and user management.

The PL/SQL API is a convenient alternative to web services. Authentication and authorization are enabled through the database connection that you use to call a PL/SQL subprogram to submit an OpenLS request and return the result. The PL/SQL API is implemented in the SDO\_OLS package, which is documented in [SDO\\_OLS Package \(OpenLS\)](#) (page 26-1).

## 14.3 OpenLS Service Support and Examples

This section describes the support provided for geocoding, mapping, routing, and directory service (YP). It also contains examples of OpenLS web services API requests and responses.

### 14.3.1 OpenLS Geocoding

An OpenLS geocoding <Request> element includes the `methodName` attribute with a value of either `GeocodeRequest` or `ReverseGeocodeRequest`, and corresponding a top-level element named <GeocodeRequest> or <ReverseGeocodeRequest>.

If the `methodName` attribute value is `GeocodeRequest`, the <GeocodeRequest> element contains an <Address> element that can specify a free-form address, a street address, or an intersection address, with zero or more <Place> elements and an optional <PostalCode> element. The <Address> element has the required attribute `countryCode`, and several optional attributes.

If the `methodName` attribute value is `ReverseGeocodeRequest`, the <ReverseGeocodeRequest> element contains a <Position> element for identifying the location to be reverse geocoded, and an optional <ReverseGeocodePreference> element for specifying the information to be returned (default = a street address).

[Example 14-1](#) (page 14-3) is a request to geocode two addresses in San Francisco, California.

#### **Example 14-1 OpenLS Geocoding Request**

```
<XLS
  xmlns=http://www.opengis.net/xls
  xmlns:gml=http://www.opengis.net/gml
  xmlns:xsi=http://www.w3.org/2001/XMLSchema-instance
  xsi:schemaLocation="http://www.opengis.net/xls ..."
  version="1.0">
  <RequestHeader clientName="someName" clientPassword="password"/>
  <Request
    maximumResponses="10"
    methodName="GeocodeRequest"
    requestID="123"
    version="1.0">
    <GeocodeRequest>
      <Address countryCode="US">
        <StreetAddress>
          <Building number="400"/>
          <Street>Post Street</Street>
        </StreetAddress>
        <Place type="CountrySubdivision">CA</Place>
        <Place type="Municipality">San Francisco</Place>
        <PostalCode>94102</PostalCode>
      </Address>
      <Address countryCode="US">
        <StreetAddress>
          <Building number="233"/>
          <Street>Winston Drive</Street>
        </StreetAddress>
        <Place type="CountrySubdivision">CA</Place>
        <Place type="Municipality">San Francisco</Place>
        <PostalCode>94132</PostalCode>
      </Address>
    </GeocodeRequest>
  </Request>
</XLS>
```

#### **Example 14-2 OpenLS Geocoding Response**

[Example 14-2](#) (page 14-3) is the response to the request in [Example 14-1](#) (page 14-3). The longitude and latitude coordinates are returned for the two addresses (-122.4083257 37.788208 for the first, -122.4753965 37.7269066 for the second).

```
<xls:XLS
  xmlns:xls=http://www.opengis.net/xls
  xmlns:gml=http://www.opengis.net/gml
  xmlns:xsi=http://www.w3.org/2001/XMLSchema-instance
  version="1.0">
  <xls:ResponseHeader/>
  <xls:Response requestID="123" version="1.0">
    <xls:GeocodeResponse xmlns:xls="http://www.opengis.net/xls">
      <xls:GeocodeResponseList
        xmlns:xls=http://www.opengis.net/xls
        numberOfGeocodedAddresses="1">
        <xls:GeocodedAddress>
          <gml:Point xmlns:gml="http://www.opengis.net/gml">
            <gml:pos dimension="2" srsName="4326">-122.4083257 37.788208</gml:pos>
          </gml:Point>
```

```
<xls:Address countryCode="US">
  <xls:StreetAddress>
    <xls:Building number="400"/>
    <xls:Street>POST ST</xls:Street>
  </xls:StreetAddress>
  <xls:Place type="CountrySubdivision">CA</xls:Place>
  <xls:Place type="Municipality">SAN FRANCISCO</xls:Place>
  <xls:PostalCode>94102</xls:PostalCode>
</xls:Address>
</xls:GeocodedAddress>
</xls:GeocodeResponseList>
<xls:GeocodeResponseList
  xmlns:xls=http://www.opengis.net/xls
  numberOfGeocodedAddresses="1">
  <xls:GeocodedAddress>
    <gml:Point xmlns:gml="http://www.opengis.net/gml">
      <gml:pos dimension="2" srsName="4326">-122.4753965 37.7269066</gml:pos>
    </gml:Point>
    <xls:Address countryCode="US">
      <xls:StreetAddress>
        <xls:Building number="233"/>
        <xls:Street>WINSTON DR</xls:Street>
      </xls:StreetAddress>
      <xls:Place type="CountrySubdivision">CA</xls:Place>
      <xls:Place type="Municipality">SAN FRANCISCO</xls:Place>
      <xls:PostalCode>94132</xls:PostalCode>
    </xls:Address>
  </xls:GeocodedAddress>
</xls:GeocodeResponseList>
</xls:GeocodeResponse>
</xls:Response>
</xls:XLS>
```

### 14.3.2 OpenLS Mapping

An OpenLS mapping `<Request>` element includes the `methodName` attribute with a value of `PortrayMapRequest`, and a top-level element named `<PortrayMapRequest>`.

The `<PortrayMapRequest>` element contains an `<Output>` element that specifies the output of the map to be generated, including the center point of the map.

The `<PortrayMapRequest>` element can contain a `<Basemap>` element specifying a MapViewer base map and one or more themes, and zero or more `<Overlay>` elements, each specifying information to be overlaid on the base map.

[Example 14-3](#) (page 14-4) is a request to portray a map image. The image is to be centered at a specified longitude/latitude point, to use a base map and two MapViewer themes, and identify three points on the map.

#### **Example 14-3** OpenLS Mapping Request

```
<XLS
  xmlns=http://www.opengis.net/xls
  xmlns:gml=http://www.opengis.net/gml
  xmlns:xsi=http://www.w3.org/2001/XMLSchema-instance
  xsi:schemaLocation="http://www.opengis.net/xls ..."
  version="1.1">
  <RequestHeader clientName="someName" clientPassword="password"/>
  <Request
    maximumResponses="1"
    methodName="PortrayMapRequest"
```



```

requestID="456"
version="1.1">
<PortrayMapRequest>
  <Output
    BGcolor="#a6cae0"
    content="URL"
    format="GIF_URL"
    height="600"
    transparent="false"
    width="800">
    <CenterContext SRS="8307">
      <CenterPoint srsName="8307">
        <gml:pos>-122.2615 37.5266</gml:pos>
      </CenterPoint>
      <Radius unit="M">50000</Radius>
    </CenterContext>
  </Output>
  <Basemap filter="Include">
    <Layer name="mvdemo.demo_map.THEME_DEMO_COUNTIES"/>
    <Layer name="mvdemo.demo_map.THEME_DEMO_HIGHWAYS"/>
  </Basemap>
  <Overlay zorder="1">
    <POI
      ID="123"
      description="description"
      phoneNumber="1234"
      POIName="Books at Post Str (point)">
      <gml:Point srsName="4326">
        <gml:pos>-122.4083257 37.788208</gml:pos>
      </gml:Point>
    </POI>
  </Overlay>
  <Overlay zorder="2">
    <POI
      ID="456"
      description="description"
      phoneNumber="1234"
      POIName="Books at Winston Dr (address)">
      <Address countryCode="US">
        <StreetAddress>
          <Building number="233"/>
          <Street>Winston Drive</Street>
        </StreetAddress>
        <Place type="CountrySubdivision">CA</Place>
        <Place type="CountrySecondarySubdivision"/>
        <Place type="Municipality">San Francisco</Place>
        <Place type="MunicipalitySubdivision"/>
        <PostalCode>94132</PostalCode>
      </Address>
    </POI>
  </Overlay>
  <Overlay zorder="3">
    <Position levelOfConf="1">
      <gml:Point gid="a boat (point)" srsName="4326">
        <gml:pos>-122.8053965 37.388208</gml:pos>
      </gml:Point>
    </Position>
  </Overlay>
</PortrayMapRequest>
</Request>
</XLS>

```

**Example 14-4 OpenLS Mapping Response**

[Example 14-4](#) (page 14-6) is the response to the request in [Example 14-3](#) (page 14-4).; however, in an actual response, the line `<xls:URL>Actual URL` replaced with constant string for test`</xls:URL>` would contain the actual URL of the map image.

```
<xls:XLS
  xmlns:xls=http://www.opengis.net/xls
  xmlns:gml=http://www.opengis.net/gml
  xmlns:xsi=http://www.w3.org/2001/XMLSchema-instance
  xsi:schemaLocation="http://www.opengis.net/xls ..."
  version="1.1">
  <xls:ResponseHeader/>
  <xls:Response numberOfResponses="1" requestID="456" version="1.1">
    <xls:PortrayMapResponse>
      <xls:Map>
        <xls:Content format="GIF_URL" height="600" width="800">
          <xls:URL>Actual URL replaced with constant string for test</xls:URL>
        </xls:Content>
        <xls:BBoxContext srsName="4326">
          <gml:pos>-122.86037685607968 37.07744235794024</gml:pos>
          <gml:pos>-121.66262314392031 37.97575764205976</gml:pos>
        </xls:BBoxContext>
      </xls:Map>
    </xls:PortrayMapResponse>
  </xls:Response>
</xls:XLS>
```

### 14.3.3 OpenLS Routing

An OpenLS routing `<Request>` element includes the `methodName` attribute with a value of `DetermineRouteRequest`, and a top-level element named `<DetermineRouteRequest>`.

The `<DetermineRouteRequest>` element contains a `<RoutePlan>` element that specifies the route preference and points to be included (and optionally avoided) in the route, with at least the start and end points.

The `<DetermineRouteRequest>` element can also contain zero or more of the following elements: `<RouteGeometryRequest>` to return the line string geometry representing the route, `<RouteMapRequest>` to request a map image of the route, and `<RouteInstructionsRequest>` to request driving directions for the route.

[Example 14-5](#) (page 14-6) is a request for the route geometry and map image for the fastest route between an address in Cambridge, Massachusetts and an address in Nashua, New Hampshire.

**Example 14-5 OpenLS Routing Request**

```
<XLS
  xmlns=http://www.opengis.net/xls
  xmlns:gml=http://www.opengis.net/gml
  xmlns:xsi=http://www.w3.org/2001/XMLSchema-instance
  xsi:schemaLocation="http://www.opengis.net/xls ..."
  version="1.1">
  <RequestHeader clientName="someName" clientPassword="password"/>
  <Request
    maximumResponses="10"
    methodName="DetermineRouteRequest"
    requestID="12345"
    version="1.0">
```

```

<DetermineRouteRequest>
  <RoutePlan>
    <RoutePreference>Fastest</RoutePreference>
    <WayPointList>
      <StartPoint>
        <POI description="Borders" ID="1" phoneNumber="12345" POIName="Borders">
          <Address countryCode="US">
            <StreetAddress>
              <Building number="100"/>
              <Street>Cambridgeside Pl</Street>
            </StreetAddress>
            <Place type="CountrySubdivision">MA</Place>
            <Place type="Municipality">Cambridge</Place>
            <PostalCode>02141</PostalCode>
          </Address>
        </POI>
      </StartPoint>
      <EndPoint>
        <Address countryCode="US">
          <StreetAddress>
            <Building number="1"/>
            <Street>Oracle Dr</Street>
          </StreetAddress>
          <Place type="CountrySubdivision">New Hampshire</Place>
          <Place type="Municipality">Nashua</Place>
          <PostalCode>03062</PostalCode>
        </Address>
      </EndPoint>
    </WayPointList>
    <AvoidList/>
  </RoutePlan>
  <RouteGeometryRequest maxPoints="100" provideStartingPortion="true" scale="1">
    <BoundingBox>
      <gml:pos/>
      <gml:pos/>
    </BoundingBox>
  </RouteGeometryRequest>
  <RouteMapRequest>
    <Output BGcolor="" format="" height="600" transparent="false" width="800"/>
  </RouteMapRequest>
</DetermineRouteRequest>
</Request>
</XLS>

```

#### Example 14-6 OpenLS Routing Response

[Example 14-6](#) (page 14-7) is part of the response to the request in [Example 14-5](#) (page 14-6). [Example 14-6](#) (page 14-7) shows the total estimated driving time, the total distance, the lower-left and upper-right longitude/latitude coordinates of the minimum bounding rectangle that encloses the route, and the longitude/latitude coordinates of the first few points along the line geometry representing the route.

```

<xls:XLS
  xmlns:xls=http://www.opengis.net/xls
  xmlns:gml=http://www.opengis.net/gml
  xmlns:xsi=http://www.w3.org/2001/XMLSchema-instance
  xsi:schemaLocation="http://www.opengis.net/xls ..."
  version="1.1">
  <xls:ResponseHeader/>
  <xls:Response numberOfResponses="1" requestID="12345" version="1.0">
    <xls:DetermineRouteResponse>

```

```
<xls:RouteSummary>
  <xls:TotalTime>P0DT0H42M26S</xls:TotalTime>
  <xls:TotalDistance uom="M" value="61528.7"/>
  <xls:BoundingBox srsName="4326">
    <gml:pos dimension="2" srsName="4326">-71.45937289088023 42.36694</gml:pos>
    <gml:pos dimension="2" srsName="4326">-71.06754 42.70824</gml:pos>
  </xls:BoundingBox>
</xls:RouteSummary>
<xls:RouteGeometry>
  <gml:LineString srsName="4326">
    <gml:pos
      xmlns:gml=http://www.opengis.net/gml
      dimension="2"
      srsName="4326">-71.07444,42.36792</gml:pos>
    <gml:pos
      xmlns:gml=http://www.opengis.net/gml
      dimension="2"
      srsName="4326">-71.07162,42.37082</gml:pos>
    <gml:pos
      xmlns:gml=http://www.opengis.net/gml
      dimension="2"
      srsName="4326">-71.06954,42.37333</gml:pos>
  </gml:LineString>
</xls:RouteGeometry>
. . .
```

### 14.3.4 OpenLS Directory Service (YP)

An OpenLS directory service `<Request>` element includes the `methodName` attribute with a value of `DirectoryRequest`, and a top-level element named `<DirectoryRequest>`.

The `<DirectoryRequest>` element contains a `<POILocation>` element that specifies the location of a point of interest, that is, the center point from which to compute distances of returned businesses.

The `<DirectoryRequest>` element also contains a `<POIProperties>` element that specifies one or more `<POIProperty>` elements, each of which contains a `name` attribute identifying a property and a `value` attribute identifying the value for the property. The `name` attribute can specify any of the following strings: `ID`, `POIName`, `PhoneNumber`, `Keyword`, `NAICS_type`, `NAICS_subType`, `NAICS_category`, `SIC_type`, `SIC_subType`, `SIC_category`, `SIC_code`, or other.

[Example 14-7](#) (page 14-8) is a request for information about business that have either or both of two specified SIC (Standard Industrial Classification) codes. For this example, the two SIC codes (1234567890 and 1234567891) are fictitious, and they are being used with a limited test data set in which these codes have been applied to categories (*Book stores* and *Cafes & Cafeterias*) that do not have these SIC codes in the real world.

#### **Example 14-7 OpenLS Directory Service (YP) Request**

```
<XLS
  xmlns=http://www.opengis.net/xls
  xmlns:gml=http://www.opengis.net/gml
  xmlns:xsi=http://www.w3.org/2001/XMLSchema-instance
  xsi:schemaLocation="http://www.opengis.net/xls ..."
  version="1.0">
  <RequestHeader clientName="someName" clientPassword="password"/>
  <Request
    requestID="123"
    maximumResponses="100"
    version="1.1"
```

```

        methodName="DirectoryRequest">
        <DirectoryRequest>
            <POILocation>
                <Address countryCode="US">
                </Address>
            </POILocation>
            <POIProperties>
                <POIProperty name="SIC_code" value="1234567890"/>
                <POIProperty name="SIC_code" value="1234567891"/>
            </POIProperties>
        </DirectoryRequest>
    </Request>
</XLS>

```

#### Example 14-8 OpenLS Directory Service (YP) Response

Example 14-8 (page 14-9) is the response to the request in Example 14-7 (page 14-8). The response contains information about two businesses for which either or both of the specific SIC codes apply.

```

<xls:XLS
  xmlns:xls=http://www.opengis.net/xls
  xmlns:gml=http://www.opengis.net/gml
  xmlns:xsi=http://www.w3.org/2001/XMLSchema-instance
  version="1.0">
  <xls:ResponseHeader/>
  <xls:Response requestID="123" version="1.1">
    <DirectoryResponse xmlns="http://www.opengis.net/xls">
      <xls:POIContext xmlns:xls="http://www.opengis.net/xls">
        <xls:POI
          ID="1"
          POIName="Borders Books & More"
          phoneNumber="415-731-0665"
          description="Books & more">
          <POIAttributeList xmlns="http://www.opengis.net/xls">
            <xls:SIC
              xmlns:xls=http://www.opengis.net/xls
              category="Book stores"
              code="1234567890"
              subType=""
              type=""/>
            <xls:SIC
              xmlns:xls=http://www.opengis.net/xls
              category="Cafes & Cafeterias"
              code="1234567891"
              subType="" type=""/>
          </POIAttributeList>
          <gml:Point xmlns:gml="http://www.opengis.net/gml">
            <gml:pos dimension="2" srsName="4326">-122.4753965 37.7269066</gml:pos>
          </gml:Point>
          <xls:Address countryCode="US">
            <xls:StreetAddress>
              <xls:Building number="233"/>
              <xls:Street>Winston Drive</xls:Street>
            </xls:StreetAddress>
            <xls:Place type="CountrySubdivision">CA</xls:Place>
            <xls:Place type="CountrySecondarySubdivision"/>
            <xls:Place type="Municipality">San Francisco</xls:Place>
            <xls:Place type="MunicipalitySubdivision"/>
            <xls:PostalCode>94132</xls:PostalCode>
          </xls:Address>
        </xls:POI>

```

```
</xls:POIContext>
<xls:POIContext xmlns:xls="http://www.opengis.net/xls">
  <xls:POI
    ID="2"
    POIName="Borders Books & More"
    phoneNumber="415-399-1633"
    description="Books & more">
    <POIAttributeList xmlns="http://www.opengis.net/xls">
      <xls:SIC
        xmlns:xls=http://www.opengis.net/xls
        category="Book stores"
        code="1234567890"
        subType=""
        type="" />
      <xls:SIC
        xmlns:xls=http://www.opengis.net/xls
        category="Cafes & Cafeterias"
        code="1234567891"
        subType=""
        type="" />
    </POIAttributeList>
    <gml:Point xmlns:gml="http://www.opengis.net/gml">
      <gml:pos dimension="2" srsName="4326">-122.4083257 37.788208</gml:pos>
    </gml:Point>
    <xls:Address countryCode="US">
      <xls:StreetIntersection>
        <xls:Street>Post St</xls:Street>
        <xls:IntersectingStreet>Powell St</xls:IntersectingStreet>
      </xls:StreetIntersection>
      <xls:Place type="CountrySubdivision">CA</xls:Place>
      <xls:Place type="CountrySecondarySubdivision"/>
      <xls:Place type="Municipality">San Francisco</xls:Place>
      <xls:Place type="MunicipalitySubdivision"/>
      <xls:PostalCode>94102</xls:PostalCode>
    </xls:Address>
  </xls:POI>
</xls:POIContext>
</DirectoryResponse>
</xls:Response>
</xls:XLS>
```

---

## Web Feature Service (WFS) Support

This chapter describes Web Feature Service (WFS) support in Oracle Spatial and Graph. It includes the following major sections:

- [WFS Engine](#) (page 15-1)
- [Managing Feature Types](#) (page 15-2)
- [Request and Response XML Examples](#) (page 15-4)
- [Java API for WFS Administration](#) (page 15-13)
- [Using WFS with Oracle Workspace Manager](#) (page 15-24)

---

**Note:**

Before you use WFS, be sure that you understand the concepts described in [Introduction to Spatial Web Services](#) (page 10-1), and that you have performed any necessary configuration work as described in that chapter.

If you have data from a previous release that was indexed using one or more SYS.XMLTABLEINDEX indexes, you must drop the associated indexes before the upgrade and re-create the indexes after the upgrade, as described in [Index Maintenance Before and After an Upgrade \(WFS and CSW\)](#) (page A-2).

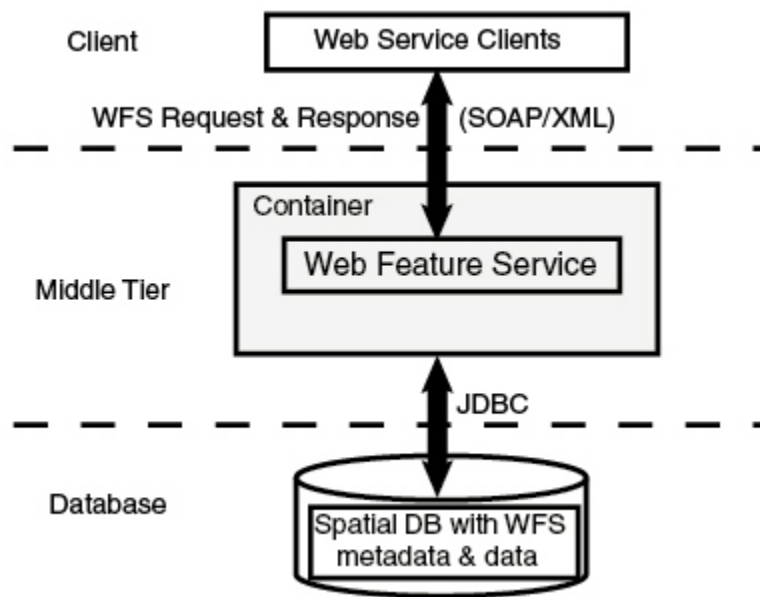
---

### 15.1 WFS Engine

This section describes the Web Feature Service engine, including its relationship to clients and to the database server. WFS is implemented as a Java web application and can be deployed in WebLogic 12.1.3 or later. The required Java version is JDK 1.8 or later.

WFS has a metadata layer, which stores in the database the metadata needed to reply to the WFS requests. The metadata includes spatial columns, which can be queried and processed using Oracle Spatial and Graph interfaces. The metadata also stores the association of nonspatial and spatial attributes of features, as well as the services that the Web Feature Service provides to its clients.

[Figure 15-1](#) (page 15-2) shows the WFS architecture.

**Figure 15-1 Web Feature Service Architecture**

As shown in [Figure 15-1](#) (page 15-2):

- WFS is part of the middle tier, and includes a feature cache.
- WFS can communicate with a web service client using WFS requests and responses in SOAP/XML format.
- WFS performs spatial data and metadata access through JDBC calls to the database.
- The database includes Oracle Spatial and Graph with WFS metadata and data, and with PL/SQL packages for administrative operations (see [SDO\\_WFS\\_PROCESS Package \(WFS Processing\)](#) (page 33-1) and [SDO\\_WFS\\_LOCK Package \(WFS\)](#) (page 32-1)).

User identities and user labels are managed in LDAP, which works with the middle tier to perform authentication.

## 15.2 Managing Feature Types

WFS supports relational and document-based feature types:

- **Relational** feature types expose the content of database tables as feature instances. Relational feature types are well suited for those who use Oracle Spatial and Graph to manage their geospatial data and use Oracle Database to manage other business data. The Spatial and Graph WFS implementation provides ways to access the data, especially in service-oriented architecture (SOA) systems implemented using web services.

Use PL/SQL application programming interfaces (APIs) to manage relational feature types. The PL/SQL packages [SDO\\_WFS\\_LOCK](#) and [SDO\\_WFS\\_PROCESS](#) (described in [SDO\\_WFS\\_LOCK Package \(WFS\)](#) (page 32-1) and [SDO\\_WFS\\_PROCESS Package \(WFS Processing\)](#) (page 33-1), respectively) enable you to manage relational feature types.

- **Document-based** feature types expose XML schema-based XML content as feature instances. Document-based feature types are well suited for those who use XML as



their main data source and who might not currently use Oracle Spatial and Graph with such data. For this data, the Spatial and Graph WFS implementation extracts the geometry components and stores them using the SDO\_GEOMETRY type; it stores the remaining XML components in Oracle XDB and builds appropriate XMLIndex indexes for them.

Use Java APIs (described in [Java API for WFS Administration](#) (page 15-13)) to manage document-based feature types.

These APIs enable you to perform operations that include:

- Publishing feature types
- Dropping (unpublishing) feature types
- Granting to users and revoking from users privileges of WFS metadata and feature types
- For relational feature types: lock-enabling and lock-disabling feature tables (with lock-enabling on by default for document-based feature types)

## 15.2.1 Capabilities Documents

A capabilities document describes an instance of a capability. The document specifies a feature type (such as roads or rivers) and the type of operations supported (such as insert and delete).

A capabilities document is generated by the WFS server in response to a GetCapabilities request. The WFS server uses a capabilities template, and adds information about the feature type and operations to this template to create the capabilities document.

The client can use the HTTP GET method to access this capabilities document using either the SOAP interface or the XML interface:

- For the SOAP interface, use `oracle.spatial.ws.servlet.WFSServlet`, which can be accessed at an address in the following format:

```
http://machine-name:port/SpatialWS-SpatialWS-context-root/wfsservlet?
request=GetCapabilities&service=WFS&version=1.0.0
```

- For the XML interface, use `oracle.spatial.ws.servlet.WFSXMLServlet`, which can be accessed at an address in the following format:

```
http://machine-name:port/SpatialWS-SpatialWS-context-root/xmlwfsservlet?
request=GetCapabilities&service=WFS&version=1.0.0
```

In the preceding formats:

- *machine-name* is the name of the system where the application server or OC4J server is running.
- *port* is the port number where the application server or OC4J server is running.
- *SpatialWS-SpatialWS-context-root* is the default root where the Spatial and Graph web services application is mounted.
- *wfsservlet* is the servlet-mapping url-pattern for `oracle.spatial.ws.servlet.WFSServlet`, as specified by default in the `web.xml` file.

- `xmfwfservlet` is the `servlet-mapping url-pattern` for `oracle.spatial.ws.servlet.WFSXMLServlet`, as specified by default in the `web.xml` file.

## 15.3 Request and Response XML Examples

This section presents some feature requests to the WFS engine, and the response to each request, for each of the following operations:

- `GetCapabilities`
- `DescribeFeatureType`
- `GetFeature`
- `GetFeatureWithLock`
- `LockFeature`
- `Transaction`, with a subelement specifying the transaction type:
  - `Insert`
  - `Update`
  - `Delete`

The XML request and response formats are similar for both relational and document-based features. Several examples in this section refer to relational features based on the `COLA_MARKETS_CS` table used in [Example 6-17](#) (page 6-76) in [Example of Coordinate System Transformation](#) (page 6-76), where the `MKT_ID` column contains the unique numeric ID of each feature, the `NAME` column contains each feature's name (`cola_a`, `cola_b`, `cola_c`, or `cola_d`), and the `SHAPE` column contains the geometry associated with each feature.

### **Example 15-1** *GetCapabilities Request*

[Example 15-1](#) (page 15-4) is a request to get the capabilities of the WFS server named WFS at a specified namespace URL. This request will return a capabilities document, as explained in [Capabilities Documents](#) (page 15-3)

```
<?xml version="1.0" ?>
<GetCapabilities
  service="WFS"
  version="1.0.0"
  xmlns="http://www.opengis.net/wfs" />
```

### **Example 15-2** *GetCapabilities Response*

[Example 15-2](#) (page 15-4) is an excerpt of the response from the request in [Example 15-1](#) (page 15-4).

```
<WFS_Capabilities xmlns="http://www.opengis.net/wfs" version="1.0.0"
xmlns:ogc="http://www.opengis.net/ogc" xmlns:myns="http://www.example.com/myns">
  <Service>
    <Name> Oracle WFS </Name>
    <Title> Oracle Web Feature Service </Title>
    <Abstract> Web Feature Service maintained by Oracle </Abstract>
    <OnlineResource>http://localhost:8888/SpatialWS-SpatialWS-context-root/
wfservlet</OnlineResource>
  </Service>
```

```

<Capability>
  <Request>
    <GetCapabilities>
      <DCPType>
        <HTTP>
          <Get onlineResource="http://localhost:8888/SpatialWS-SpatialWS-context-
root/wfsservlet" />
        </HTTP>
      </DCPType>
      <DCPType>
        <HTTP>
          <Post onlineResource="http://localhost:8888/SpatialWS-SpatialWS-context-
root/SpatialWSSoapHttpPort" />
        </HTTP>
      </DCPType>
    </GetCapabilities>
    <DescribeFeatureType>
      <SchemaDescriptionLanguage>
        <XMLSCHEMA/>
      </SchemaDescriptionLanguage>
      <DCPType>
        <HTTP>
          <Post onlineResource="http://localhost:8888/SpatialWS-SpatialWS-context-
root/SpatialWSSoapHttpPort" />
        </HTTP>
      </DCPType>
    </DescribeFeatureType>
    <GetFeature>
      <ResultFormat>
        <GML2/>
      </ResultFormat>
      <DCPType>
        <HTTP>
          <Post onlineResource="http://localhost:8888/SpatialWS-SpatialWS-context-
root/SpatialWSSoapHttpPort" />
        </HTTP>
      </DCPType>
    </GetFeature>
    <GetFeatureWithLock>
      <ResultFormat>
        <GML2/>
      </ResultFormat>
      <DCPType>
        <HTTP>
          <Post onlineResource="http://localhost:8888/SpatialWS-SpatialWS-context-
root/SpatialWSSoapHttpPort" />
        </HTTP>
      </DCPType>
    </GetFeatureWithLock>
    <Transaction>
      <DCPType>
        <HTTP>
          <Post onlineResource="http://localhost:8888/SpatialWS-SpatialWS-context-
root/SpatialWSSoapHttpPort" />
        </HTTP>
      </DCPType>
    </Transaction>
    <LockFeature>
      <DCPType>
        <HTTP>
          <Post onlineResource="http://localhost:8888/SpatialWS-SpatialWS-context-

```

```
root/SpatialWSSoapHttpPort"/>
  </HTTP>
  </DCPType>
  </LockFeature>
</Request>
</Capability>
<FeatureTypeList>
  <Operations>
    <Insert/>
    <Update/>
    <Delete/>
    <Query/>
    <Lock/>
  </Operations>
  <FeatureType xmlns:myns="http://www.example.com/myns">
    <Name> myns:COLA</Name>
    <Title> LIST OF COLA MARKETS </Title>
    <SRS> SDO:8307</SRS>
  </FeatureType>
  <FeatureType xmlns:myns="http://www.example.com/myns">
    <Name> myns:COLAVIEW1 </Name>
    <Title> LIST OF COLA MARKET VIEW </Title>
    <SRS> SDO:8307</SRS>
  </FeatureType>
  <FeatureType xmlns:wfs="http://www.opengis.net/wfs">
    <Name xmlns:myns="http://www.example.com/myns1">myns:SampleFeature</Name>
    <Title>SAMPLE FEATURE</Title>
    <SRS>EPSG:32615</SRS>
  </FeatureType>
</FeatureTypeList>
<ogc:Filter_Capabilities xmlns:ogc="http://www.opengis.net/ogc">
  <ogc:Spatial_Capabilities>
    <ogc:Spatial_Operators>
      <ogc:BBOX/>
      <ogc:Equals/>
      <ogc:Disjoint/>
      <ogc:Intersect/>
      <ogc:Touches/>
      <ogc:Crosses/>
      <ogc:Within/>
      <ogc:Contains/>
      <ogc:Overlaps/>
      <ogc:Beyond/>
      <ogc:DWithin/>
    </ogc:Spatial_Operators>
  </ogc:Spatial_Capabilities>
  <ogc:Scalar_Capabilities>
    <ogc:Logical_Operators/>
    <ogc:Comparison_Operators>
      <ogc:Simple_Comparisons/>
      <ogc:Like/>
      <ogc:Between/>
      <ogc:NullCheck/>
    </ogc:Comparison_Operators>
    <ogc:Arithmetic_Operators>
      <ogc:Simple_Arithmetic/>
    </ogc:Arithmetic_Operators>
  </ogc:Scalar_Capabilities>
</ogc:Filter_Capabilities>
</WFS_Capabilities>
```

**Example 15-3 DescribeFeatureType Request**

[Example 15-3](#) (page 15-6) is a request to describe the feature type named COLA.

```
<?xml version="1.0" ?>
<wfs:DescribeFeatureType
  service="WFS"
  version="1.0.0"
  xmlns:wfs="http://www.opengis.net/wfs"
  xmlns:myns="http://www.example.com/myns"
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xmlns:xsd="http://www.w3.org/2001/XMLSchema"
  xsi:schemaLocation="http://www.opengis.net/wfs ../wfs/1.0.0/WFS-basic.xsd">
  <wfs:TypeName>myns:COLA</wfs:TypeName>
</wfs:DescribeFeatureType>
```

#### **Example 15-4 DescribeFeatureType Response**

[Example 15-4](#) (page 15-7) is the response from the request in [Example 15-3](#) (page 15-6). The response is an XML schema definition (XSD).

```
<xsd:schema targetNamespace="http://www.example.com/myns" xmlns:wfs="http://
www.opengis.net/wfs" xmlns:myns="http://www.example.com/myns" xmlns:gml="http://
www.opengis.net/gml" elementFormDefault="qualified" version="1.0.0"
xmlns:xsd="http://www.w3.org/2001/XMLSchema">
  <xsd:import namespace="http://www.opengis.net/gml" schemaLocation="http://
localhost:8888/examples/servlets/xsds/feature.xsd"/>
  <xsd:element name="COLA" type="myns:COLAType" substitutionGroup="gml:_Feature"/>
  <xsd:complexType name="COLAType">
    <xsd:complexContent>
      <xsd:extension base="gml:AbstractFeatureType">
        <xsd:sequence>
          <xsd:element name="MKT_ID" type="xsd:double"/>
          <xsd:element name="NAME" nillable="true">
            <xsd:simpleType>
              <xsd:restriction base="xsd:string">
                <xsd:maxLength value="32"/>
              </xsd:restriction>
            </xsd:simpleType>
          </xsd:element>
          <xsd:element name="SHAPE" type="gml:PolygonMemberType"
nillable="true"/>
        </xsd:sequence>
        <xsd:attribute name="fid" type="xsd:double"/>
      </xsd:extension>
    </xsd:complexContent>
  </xsd:complexType>
</xsd:schema>
```

#### **Example 15-5 GetFeature Request**

[Example 15-5](#) (page 15-7) is a request to get the MKT\_ID, NAME, and SHAPE properties of the feature or features of type COLA where the MKT\_ID value is greater than 2 and the NAME value is equal to cola\_c, or where the MKT\_ID value is greater than 3 and the NAME value is equal to cola\_d.

Note that for GetFeature and GetFeatureWithLock, the <Query> and <PropertyName> elements, which list the property names to be selected, can be any top-level element of the queried feature type, in which case its entire content (which may be nested) is returned in the query response. XPath's of arbitrary depth are not supported in <PropertyName> elements directly under the <Query> element; however, they are supported in <PropertyName> elements in a <Filter> element under the <Query> element, as shown in [Example 15-5](#) (page 15-7) and [Example 15-7](#) (page 15-9)

```
<?xml version="1.0" ?>
<wfs:GetFeature
  service="WFS"
  version="1.0.0"
  xmlns:wfs="http://www.opengis.net/wfs"
  xmlns:ogc="http://www.opengis.net/ogc"
  xmlns:myns="http://www.example.com/myns"
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xsi:schemaLocation="http://www.opengis.net/wfs ../wfs/1.0.0/WFS-basic.xsd">
  <wfs:Query typeName="myns:COLA">
    <ogc:PropertyName>myns:MKT_ID</ogc:PropertyName>
    <ogc:PropertyName>myns:NAME</ogc:PropertyName>
    <ogc:PropertyName>myns:SHAPE</ogc:PropertyName>
    <ogc:Filter>
      <ogc:And>
        <ogc:And>
          <ogc:PropertyIsGreaterThan>
            <ogc:PropertyName>myns:COLA/myns:MKT_ID</ogc:PropertyName>
            <ogc:Literal> 2 </ogc:Literal>
          </ogc:PropertyIsGreaterThan>
          <ogc:PropertyIsEqualTo>
            <ogc:PropertyName>myns:COLA/myns:NAME</ogc:PropertyName>
            <ogc:Literal>cola_c</ogc:Literal>
          </ogc:PropertyIsEqualTo>
        </ogc:And>
        <ogc:Or>
          <ogc:PropertyIsEqualTo>
            <ogc:PropertyName>myns:COLA/myns:MKT_ID</ogc:PropertyName>
            <ogc:Literal>3</ogc:Literal>
          </ogc:PropertyIsEqualTo>
          <ogc:PropertyIsEqualTo>
            <ogc:PropertyName>myns:COLA/myns:NAME</ogc:PropertyName>
            <ogc:Literal>cola_d</ogc:Literal>
          </ogc:PropertyIsEqualTo>
        </ogc:Or>
      </ogc:And>
    </ogc:Filter>
  </wfs:Query>
</wfs:GetFeature>
```

### **Example 15-6   GetFeature Response**

**Example 15-6** (page 15-8) is the response from the request in [Example 15-5](#) (page 15-7).

```
<?xml version = '1.0' encoding = 'UTF-8'?>
<wfs:FeatureCollection xsi:schemaLocation="http://www.example.com/myns http://
localhost:8888/wfsservlet?featureTypeId=1 http://www.opengis.net/wfs ../wfs/1.0.0/
WFS-basic.xsd" xmlns:wfs="http://www.opengis.net/wfs" xmlns:xsi="http://www.w3.org/
2001/XMLSchema-instance">
  <gml:boundedBy xmlns:gml="http://www.opengis.net/gml">
    <gml:Box srsName="SDO:8307">
      <gml:coordinates>3.0,3.0 6.0,5.0</gml:coordinates>
    </gml:Box>
  </gml:boundedBy>
  <gml:featureMember xmlns:gml="http://www.opengis.net/gml">
    <myns:COLA fid="3" xmlns:myns="http://www.example.com/myns">
      <myns:MKT_ID>3</myns:MKT_ID>
      <myns:NAME>cola_c</myns:NAME>
      <myns:SHAPE>
        <gml:Polygon srsName="SDO:8307" xmlns:gml="http://www.opengis.net/gml">
          <gml:outerBoundaryIs>
            <gml:LinearRing>
```

```

        <gml:coordinates decimal="." cs="," ts=" ">3.0,3.0 6.0,3.0
6.0,5.0 4.0,5.0 3.0,3.0 </gml:coordinates>
    </gml:LinearRing>
</gml:outerBoundaryIs>
</gml:Polygon>
</myns:SHAPE>
</myns:COLA>
</gml:FeatureMember>
</wfs:FeatureCollection>

```

### Example 15-7 GetFeatureWithLock Request

[Example 15-7](#) (page 15-9) is a request to get the MKT\_ID, NAME, and SHAPE properties of the feature of type COLA where the MKT\_ID value is greater than 2 and the NAME value is equal to cola\_c, or where the MKT\_ID value is equal to 3, and to lock that feature.

```

<?xml version="1.0" ?>
<wfs:GetFeatureWithLock
  service="WFS"
  version="1.0.0"
  expiry="5"
  xmlns:wfs="http://www.opengis.net/wfs"
  xmlns:ogc="http://www.opengis.net/ogc"
  xmlns:gml="http://www.opengis.net/gml"
  xmlns:myns="http://www.example.com/myns"
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" >
  <wfs:Query typeName="myns:COLA">
    <ogc:PropertyName>myns:MKT_ID</ogc:PropertyName>
    <ogc:PropertyName>myns:NAME</ogc:PropertyName>
    <ogc:PropertyName>myns:SHAPE</ogc:PropertyName>
    <ogc:Filter>
      <ogc:PropertyIsEqualTo>
        <ogc:PropertyName>myns:COLA/myns:MKT_ID</ogc:PropertyName>
        <ogc:Literal> 3 </ogc:Literal>
      </ogc:PropertyIsEqualTo>
    </ogc:Filter>
  </wfs:Query>
</wfs:GetFeatureWithLock>

```

### Example 15-8 GetFeatureWithLock Response

[Example 15-8](#) (page 15-9) is the response from the request in [Example 15-7](#) (page 15-9).

```

<wfs:FeatureCollection xmlns:wfs="http://www.opengis.net/wfs" lockId="1"
xsi:schemaLocation="http://www.example.com/myns http://localhost:8888/SpatialWS-
SpatialWS-context-root/wfsservlet?featureTypeId=1 " xmlns:xsi="http://www.w3.org/
2001/XMLSchema-instance">
  <gml:boundedBy xmlns:gml="http://www.opengis.net/gml">
    <gml:Box srsName="SDO:8307">
      <gml:coordinates>3.0,3.0 6.0,5.0</gml:coordinates>
    </gml:Box>
  </gml:boundedBy>
  <gml:featureMember xmlns:gml="http://www.opengis.net/gml">
    <myns:COLA xmlns:myns="http://www.example.com/myns" fid="3">
      <myns:MKT_ID>3</myns:MKT_ID>
      <myns:NAME>cola_c</myns:NAME>
      <myns:SHAPE>
        <gml:Polygon srsName="SDO:8307">
          <gml:outerBoundaryIs>
            <gml:LinearRing>
              <gml:coordinates decimal="." cs="," ts=" ">3.0,3.0 6.0,3.0

```

```
6.0,5.0 4.0,5.0 3.0,3.0 </gml:coordinates>
    </gml:LinearRing>
  </gml:outerBoundaryIs>
</gml:Polygon>
</myns:SHAPE>
</myns:COLA>
</gml:featureMember>
</wfs:FeatureCollection>
```

### **Example 15-9 LockFeature Request**

[Example 15-9](#) (page 15-10) is a request to lock the feature where the MKT\_ID value is equal to 2.

```
<?xml version="1.0" ?>
<wfs:LockFeature
  service="WFS"
  version="1.0.0"
  expiry="5"
  xmlns:wfs="http://www.opengis.net/wfs"
  xmlns:ogc="http://www.opengis.net/ogc"
  xmlns:gml="http://www.opengis.net/gml"
  xmlns:myns="http://www.example.com/myns"
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" >
  <wfs:Lock typeName="myns:COLA">
    <ogc:Filter>
      <ogc:PropertyIsEqualTo>
        <ogc:PropertyName>myns:COLA/myns:MKT_ID</ogc:PropertyName>
        <ogc:Literal> 2 </ogc:Literal>
      </ogc:PropertyIsEqualTo>
    </ogc:Filter>
  </wfs:Lock>
</wfs:LockFeature>
```

### **Example 15-10 LockFeature Response**

[Example 15-10](#) (page 15-10) is the response from the request in [Example 15-9](#) (page 15-10).

```
<wfs:WFS_LockFeatureResponse xmlns:wfs="http://www.opengis.net/wfs">
  <wfs:LockId>2</wfs:LockId>
</wfs:WFS_LockFeatureResponse>
```

### **Example 15-11 Insert Request**

[Example 15-11](#) (page 15-10) is a request to insert a feature, with MKT\_ID = 5 and NAME = cola\_e, into the table associated with the WFS service named WFS.

```
<?xml version="1.0"?>
<wfs:Transaction version="1.0.0" handle="TX01" service="WFS" xmlns="http://www.e
example.com/myns" xmlns:myns="http://www.example.com/myns" xmlns:gml="http://ww
w.opengis.net/gml" xmlns:ogc="http://www.opengis.net/ogc" xmlns:wfs="http://www.
opengis.net/wfs" xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" >
  <wfs:Insert handle="INSERT01" >
    <myns:COLA fid="5" xmlns:myns="http://www.example.com/myns">
      <myns:MKT_ID>5</myns:MKT_ID>
      <myns:NAME>cola_e</myns:NAME>
      <myns:SHAPE>
        <gml:Polygon srsName="SDO:8307" xmlns:gml="http://www.opengis.net/gml">
          <gml:outerBoundaryIs>
            <gml:LinearRing>
              <gml:coordinates decimal="." cs="," ts=" ">1.0,3.0 6.0,3.0
6.0,5.0 4.0,5.0 1.0,3.0 </gml:coordinates>
```



```

        </gml:LinearRing>
      </gml:outerBoundaryIs>
    </gml:Polygon>
  </myns:SHAPE>
</myns:COLA>
</wfs:Insert>
</wfs:Transaction>

```

### Example 15-12 Insert Response

[Example 15-12](#) (page 15-11) is the response from the request in [Example 15-11](#) (page 15-10).

```

<?xml version = '1.0' encoding = 'UTF-8'?>
<wfs:WFS_TransactionResponse version="1.0.0" xmlns:wfs="http://www.opengis.net/wfs">
  <wfs:InsertResult handle="INSERT01">
    <ogc:FeatureId fid="5" xmlns:ogc="http://www.opengis.net/ogc"/>
  </wfs:InsertResult>
  <wfs:TransactionResult handle="TX01">
    <wfs:Status>
      <wfs:SUCCESS/>
    </wfs:Status>
  </wfs:TransactionResult>
</wfs:WFS_TransactionResponse>

```

### Example 15-13 Update Request

[Example 15-13](#) (page 15-11) is a request to update the feature, where MKT\_ID is greater than 2 and less than 4 and where NAME is not null, in the table associated with the WFS service named WFS. This request specifies that the NAME value of the specified feature is to be set to cola\_cl.

```

<?xml version="1.0"?>
<wfs:Transaction version="1.0.0" handle="TX01" service="WFS" xmlns="http://
www.example.com/myns"
  xmlns:myns="http://www.example.com/myns" xmlns:gml="http://www.opengis.net/gml"
  xmlns:ogc="http://www.opengis.net/ogc" xmlns:wfs="http://www.
  opengis.net/wfs" xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" >
  <wfs:Update handle="UPDATE1" typeName="myns:COLA" >
    <wfs:Property>
      <wfs:Name>myns:COLA/myns:NAME</wfs:Name>
      <wfs:Value>cola_cl</wfs:Value>
    </wfs:Property>
    <ogc:Filter>
      <ogc:And>
        <ogc:And>
          <ogc:PropertyIsGreaterThan>
            <ogc:PropertyName>myns:COLA/myns:MKT_ID</ogc:PropertyName>
            <ogc:Literal> 2 </ogc:Literal>
          </ogc:PropertyIsGreaterThan>
          <ogc:PropertyIsLessThan>
            <ogc:PropertyName>myns:COLA/myns:MKT_ID</ogc:PropertyName>
            <ogc:Literal> 4 </ogc:Literal>
          </ogc:PropertyIsLessThan>
        </ogc:And>
        <ogc:Not>
          <ogc:PropertyIsNull>
            <ogc:PropertyName>myns:COLA/myns:NAME</ogc:PropertyName>
          </ogc:PropertyIsNull>
        </ogc:Not>
      </ogc:And>
    </ogc:Filter>
  </wfs:Update>
</wfs:Transaction>

```

```
</wfs:Update>
</wfs:Transaction>
```

#### **Example 15-14 Update Response**

[Example 15-14](#) (page 15-12) is the response from the request in [Example 15-13](#) (page 15-11).

```
<?xml version = '1.0' encoding = 'UTF-8'?>
<wfs:WFS_TransactionResponse version="1.0.0" xmlns:wfs="http://www.opengis.net/wfs">
  <wfs:TransactionResult handle="TX01">
    <wfs:Status>
      <wfs:SUCCESS/>
    </wfs:Status>
  </wfs:TransactionResult>
</wfs:WFS_TransactionResponse>
```

#### **Example 15-15 Delete Request**

[Example 15-15](#) (page 15-12) is a request to delete the feature, where MKT\_ID is greater than 3 and NAME is equal to cola\_e and is not null, in the table associated with the WFS service named WFS.

```
<?xml version="1.0"?>
<wfs:Transaction version="1.0.0" handle="TX01" service="WFS" xmlns="http://
www.example.com/myns"
xmlns:myns="http://www.example.com/myns" xmlns:gml="http://www.opengis.net/gml"
xmlns:ogc="http://www.opengis.net/ogc" xmlns:wfs="http://www.
opengis.net/wfs" xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" >
<wfs:Delete handle="DELETE1" typeName="myns:COLA" >
<ogc:Filter>
  <ogc:And>
    <ogc:And>
      <ogc:PropertyIsGreaterThan>
        <ogc:PropertyName>myns:COLA/myns:MKT_ID</ogc:PropertyName>
        <ogc:Literal> 3 </ogc:Literal>
      </ogc:PropertyIsGreaterThan>
      <ogc:PropertyIsEqualTo>
        <ogc:PropertyName>myns:COLA/myns:NAME</ogc:PropertyName>
        <ogc:Literal> cola_e </ogc:Literal>
      </ogc:PropertyIsEqualTo>
    </ogc:And>
    <ogc:Not>
      <ogc:PropertyIsNull>
        <ogc:PropertyName>myns:COLA/myns:NAME</ogc:PropertyName>
      </ogc:PropertyIsNull>
    </ogc:Not>
  </ogc:And>
</ogc:Filter>
</wfs:Delete>
</wfs:Transaction>
```

#### **Example 15-16 Delete Response**

[Example 15-16](#) (page 15-12) is the response from the request in [Example 15-15](#) (page 15-12).

```
<?xml version = '1.0' encoding = 'UTF-8'?>
<wfs:WFS_TransactionResponse version="1.0.0" xmlns:wfs="http://www.opengis.net/wfs">
  <wfs:TransactionResult handle="TX01">
    <wfs:Status>
      <wfs:SUCCESS/>
    </wfs:Status>
  </wfs:TransactionResult>
</wfs:WFS_TransactionResponse>
```

```

        </wfs:Status>
    </wfs:TransactionResult>
</wfs:WFS_TransactionResponse>

```

## 15.4 Java API for WFS Administration

In addition to the PL/SQL APIs in the SDO\_WFS\_PROCESS and SDO\_WFS\_LOCK packages, you can use a Java API to publish and drop feature types, and to grant and revoke access to feature types and WFS metadata tables.

This section provides basic reference information about the methods in the `oracle.spatial.wfs.WFSAdmin` class. The methods are presented in alphabetical order.

### 15.4.1 createXMLTableIndex method

The `createXMLTableIndex` method creates an index of XDB.XMLINDEX on document-based feature type instances. This method has the following format:

```

public static void createXMLTableIndex(
    OracleConnection conn,
    String ftNSUrl,
    String ftName) throws SQLException;

```

`conn` is an Oracle Database connection for a user that has been granted the DBA role.

`ftNSUrl` is the URL of the namespace of the feature type.

`ftName` is the name of the feature type.

### 15.4.2 dropFeatureType method

The `dropFeatureType` method deletes a feature type from the WFS repository. This method has the following format:

```

public static void dropFeatureType(
    OracleConnection conn,
    String ftNSUrl,
    String ftName) throws SQLException;

```

`conn` is an Oracle Database connection for a user that has been granted the DBA role.

`ftNSUrl` is the URL of the namespace of the feature type.

`ftName` is the name of the feature type.

### 15.4.3 dropXMLTableIndex method

The `dropXMLTableIndex` method drops an index of type XDB.XMLINDEX that was created on document-based feature type instances. This method has the following format:

```

public static void dropXMLTableIndex(
    OracleConnection conn,
    String ftNSUrl,
    String ftName) throws SQLException;

```

`conn` is an Oracle Database connection for a user that has been granted the DBA role.

`ftNSUrl` is the URL of the namespace of the feature type.

`ftName` is the name of the feature type.

### 15.4.4 getIsXMLTableIndexCreated method

The `getIsXMLTableIndexCreated` method returns a Boolean `TRUE` if an index of type `XDB.XMLINDEX` has been created on a document-based feature type, or a Boolean `FALSE` if such an index has not been created. This method has the following format:

```
public static boolean getIsXMLTableIndexCreated(  
    OracleConnection conn,  
    String ftNSUrl,  
    String ftName) throws SQLException;
```

`conn` is an Oracle Database connection for a user that has been granted the DBA role.

`ftNSUrl` is the URL of the namespace of the feature type.

`ftName` is the name of the feature type.

### 15.4.5 grantFeatureTypeToUser method

The `grantFeatureTypeToUser` method grants access to a feature type to a database user. This method has the following format:

```
public static void grantFeatureTypeToUser(  
    OracleConnection conn,  
    String typeNS,  
    String typeName,  
    String usrName) throws SQLException;
```

`conn` is an Oracle Database connection for a user that has been granted the DBA role.

`typeNS` is the URL of the namespace of the feature type.

`typeName` is the name of the feature type.

`usrName` is the name of the database user.

### 15.4.6 grantMDAccessToUser method

The `grantMDAccessToUser` method grants access to the WFS metadata to a database user. This method has the following format:

```
public static void grantMDAccessToUser(  
    OracleConnection conn,  
    String usrName) throws SQLException;
```

`conn` is an Oracle Database connection for a user that has been granted the DBA role.

`usrName` is the name of the database user.

### 15.4.7 publishFeatureType method

The `publishFeatureType` method publishes a document-based feature type; that is, it registers metadata related to the feature type. This method has the following formats:

```
public static void publishFeatureType(OracleConnection conn,  
    XMLType featureTypeMD) throws SQLException , WFSException;
```

```

public static void publishFeatureType(OracleConnection conn,
    XMLType schemaDocXt,
    XMLType featureDescXt,
    ArrayList<String> docIdPaths,
    String primarySpatialPath,
    String featureMemberNS,
    String featureMemberName,
    String ftNSUrl,
    String ftName,
    ArrayList<PathInfo> spatialPaths,
    ArrayList<PathInfo> mandatoryPaths,
    ArrayList<PathInfo> tsPaths,
    ArrayList<GeomMetaInfo> sdoMetaInfo,
    String srsNS,
    String srsNSAlias) throws SQLException;

public static void publishFeatureType(OracleConnection conn,
    XMLType schemaDocXt,
    XMLType featureDescXt,
    ArrayList<String> docIdPaths,
    String primarySpatialPath,
    String featureMemberNS,
    String featureMemberName,
    String ftNSUrl,
    String ftName,
    ArrayList<PathInfo> spatialPaths,
    ArrayList<PathInfo> mandatoryPaths,
    ArrayList<PathInfo> tsPaths,
    ArrayList<GeomMetaInfo> sdoMetaInfo,
    String srsNS,
    String srsNSAlias,
    String ftXSDRefId) throws SQLException;

public static void publishFeatureType(OracleConnection conn,
    XMLType schemaDocXt,
    XMLType featureDescXt,
    ArrayList<String> docIdPaths,
    String primarySpatialPath,
    String featureMemberNS,
    String featureMemberName,
    String ftNSUrl,
    String ftName,
    ArrayList<PathInfo> spatialPaths,
    ArrayList<PathInfo> mandatoryPaths,
    ArrayList<PathInfo> tsPaths,
    ArrayList<GeomMetaInfo> sdoMetaInfo,
    String srsNS,
    String srsNSAlias,
    String ftXSDRefId,
    boolean genSpatialIndex,
    boolean lockEnable) throws SQLException;

public static void publishFeatureType(OracleConnection conn,
    XMLType schemaDocXt,
    XMLType featureDescXt,
    ArrayList<String> docIdPaths,
    String primarySpatialPath,
    String featureMemberNS,
    String featureMemberName,
    String ftNSUrl,
    String ftName,

```

```
        ArrayList<PathInfo> spatialPaths,
        ArrayList<PathInfo> mandatoryPaths,
        ArrayList<PathInfo> tsPaths,
        ArrayList<GeomMetaInfo> sdoMetaInfo,
        String srsNS,
        String srsNSAlias,
        String ftXSDRefId,
        boolean genSpatialIndex,
        boolean lockEnable,
        ArrayList<PathInfo> numPaths,
        ArrayList<PathInfo> idxPaths,
        ArrayList<String[]> idxPathTypes,
        boolean genXMLIndex) throws SQLException;

    public static void publishFeatureType(OracleConnection conn,
        XMLType schemaDocXt,
        XMLType featureDescXt,
        ArrayList<String> docIdPaths,
        String primarySpatialPath,
        String featureMemberNS,
        String featureMemberName,
        String ftNSUrl,
        String ftName,
        ArrayList<PathInfo> spatialPaths,
        ArrayList<PathInfo> mandatoryPaths,
        ArrayList<PathInfo> tsPaths,
        ArrayList<GeomMetaInfo> sdoMetaInfo,
        String srsNS,
        String srsNSAlias,
        String ftXSDRefId,
        boolean genSpatialIndex,
        boolean lockEnable,
        ArrayList<PathInfo> numPaths,
        ArrayList<PathInfo> idxPaths,
        ArrayList<String[]> idxPathTypes,
        boolean genXMLIndex,
        String featureCollectionNS,
        String featureCollectionName,
        boolean isGML3) throws SQLException;

    public static void publishFeatureType(OracleConnection conn,
        XMLType schemaDocXt,
        XMLType featureDescXt,
        ArrayList<String> docIdPaths,
        String primarySpatialPath,
        String featureMemberNS,
        String featureMemberName,
        String ftNSUrl,
        String ftName,
        ArrayList<PathInfo> spatialPaths,
        ArrayList<PathInfo> mandatoryPaths,
        ArrayList<PathInfo> tsPaths,
        ArrayList<GeomMetaInfo> sdoMetaInfo,
        String srsNS,
        String srsNSAlias,
        String ftXSDRefId,
        boolean genSpatialIndex,
        boolean lockEnable,
        ArrayList<PathInfo> numPaths,
        ArrayList<PathInfo> idxPaths,
        ArrayList<String[]> idxPathTypes,
```

```

        boolean genXMLIndex,
        String featureCollectionNS,
        String featureCollectionName,
        boolean isGML3,
        CollectionPathInfo collPathInfo) throws SQLException;

    public static void publishFeatureType(OracleConnection conn,
        XMLType schemaDocXt,
        XMLType featureDescXt,
        ArrayList<String> docIdPaths,
        String primarySpatialPath,
        String featureMemberNS,
        String featureMemberName,
        String ftNSUrl,
        String ftName,
        ArrayList<PathInfo> spatialPaths,
        ArrayList<PathInfo> mandatoryPaths,
        ArrayList<PathInfo> tsPaths,
        ArrayList<GeomMetaInfo> sdoMetaInfo,
        String srsNS,
        String srsNSAlias,
        String ftXSDRefId,
        boolean genSpatialIndex,
        boolean lockEnable,
        ArrayList<PathInfo> numPaths,
        ArrayList<PathInfo> idxPaths,
        ArrayList<String[]> idxPathTypes,
        boolean genXMLIndex,
        String featureCollectionNS,
        String featureCollectionName,
        boolean isGML3,
        CollectionPathInfo collPathInfo,
        boolean hasMultipleSRSNS) throws SQLException;

```

`conn` is an Oracle Database connection for a user that has been granted the DBA role.

`featureTypeMD` is the feature type path registration metadata. This metadata must conform to the `featureTypeMd` element definition as specified in the `wstype_md.xsd` file. An example of feature type path registration metadata XML is provided in `ft_metadata.xml`. These files are included in the `ws_client.jar` demo file (described in [Demo Files for Sample Java Client](#) (page 10-5)) under the `src/data/` path. For information about using the example to publish a feature type, see the `Readme.txt` file, which is included in `ws_client.jar` under the `src/` path.

`schemaDocXt` is the XML schema definition (XSD) of the feature type.

`featureDescXt` is the XML schema definition (XSD) of the feature type description, to be included in the Capabilities document.

`docIdPaths` is a list of document ID path elements where each element is a String.

`primarySpatialPath` is the primary spatial path that will be used to compute the bounding box in the result.

`featureMemberNS` is the namespace of the feature member.

`featureMemberName` is the name of the feature member.

`ftNSUrl` is the URL of the namespace of the feature type.

`ftName` is the name of the feature type.

`spatialPaths` is a list of spatial paths in the feature type. It is an `ArrayList` of class `oracle.spatial.ws.PathInfo`, which is described in [Related Classes for publishFeatureType](#) (page 15-19).

`mandatoryPaths` is a list of mandatory paths in the feature type. It is an `ArrayList` of class `oracle.spatial.ws.PathInfo`, which is described in [Related Classes for publishFeatureType](#) (page 15-19).

`tsPaths` is a list of time-related paths in the feature type (for example, `date`, `dateTime`, `gYear`, `gMonth`, `gDay`, `gMonthDay`, and `gYearMonth`). It is an `ArrayList` of class `oracle.spatial.ws.PathInfo`, which is described in [Related Classes for publishFeatureType](#) (page 15-19).

`sdoMetaInfo` is the spatial metadata information for spatial paths. It is an `ArrayList` of class `oracle.spatial.ws.GeomMetaInfo`, which is described in [Related Classes for publishFeatureType](#) (page 15-19).

`srsNS` is the user-defined namespace of the spatial reference system (coordinate system) associated with the data in the spatial paths. This namespace (if specified) is also used to generate the `srsName` attribute in the `<boundedBy>` element of the `FeatureCollection` result generated for the `GetFeature` request.

`srsNSAlias` is the namespace alias of the spatial reference system (coordinate system) associated with the data in the spatial paths.

`ftXSDRefId` is the group feature type XML schema definition file name (as a string), for cases where multiple feature types are defined in a single XSD file. This parameter is used to store the group XSD definition once in the WFS metadata, and then refer to it from multiple feature types whose schema definitions are present in the group feature type XSD file.

`genSpatialIndex` is a Boolean value: `TRUE` causes a spatial index to be created on the feature type at type creation time; `FALSE` does not cause a spatial index to be created.

`lockEnable` is a Boolean value: `TRUE` causes the feature type table (the underlying system-generated table where instances of this feature type are stored) to be lock-enabled at type creation time; `FALSE` does not cause the feature type table to be lock-enabled. If `lockEnable` is `TRUE`, this will WFS-transaction lock enable the WFS data table for the feature type. (This data table is automatically generated when the feature type is published.)

`numPaths` is a list of numeric (`NUMBER`, `INTEGER`, and so on) related paths in the feature type. It is an `ArrayList` of class `oracle.spatial.ws.PathInfo`, which is described in [Related Classes for publishFeatureType](#) (page 15-19).

`idxPaths` is the index path list. It is list of paths on which to create an index of type `XDB.XMLINDEX` when that index is created. It is an `ArrayList` of class `oracle.spatial.ws.PathInfo`, which is described in [Related Classes for publishFeatureType](#) (page 15-19).

`idxPathTypes` specifies information about each index path, where each element of `string[3]` contains the following: `string[0]` is the type name, `string[1]` is the type format (such as the type length), and `string[2]` specifies whether a `Btree` or unique index, or no index, should be created (`WFSAdmin.BTREE`, `WFSAdmin.UNIQUE`, or `null`).

`genXMLIndex` is a Boolean value: `TRUE` causes an index of type `XDB.XMLINDEX` to be created on the document-based feature type; `FALSE` does not cause an index of type `XDB.XMLINDEX` to be created on the document-based feature type. If you choose not to create the index now, you can create it later using the `createXMLTableIndex` method (described in [createXMLTableIndex method](#) (page 15-13)).



featureCollectionNS is the namespace of the feature collection.

featureCollectionName is the name of the feature collection.

isGML3 is a Boolean value: TRUE means that the geometries inside instances of this feature type are GML3.1.1 compliant; FALSE means that the geometries inside instances of this feature type are GML 2.1.2 compliant.

collPathInfo is spatial collection path information.

hasMultipleSRSNS is a Boolean value: TRUE means that this feature type refers to multiple user-defined spatial reference system namespaces; FALSE means that this feature type does not refer to multiple user-defined spatial reference system namespaces.

#### 15.4.7.1 Related Classes for publishFeatureType

This section describes some classes used in the definition of parameters of the [publishFeatureType method](#) (page 15-14).

oracle.spatial.ws.PathElement is a Java class that contains a pair of String objects: the PathElement namespace and the PathElement name. This class includes the `getValue()` method, which returns a string format of the PathElement object. This class has the following format:

```
public class PathElement {
    // Set namespace and name information for a PathElement.
    public void set(String ns, String name);
    //Get a string value for the PathElement object.
    public String getValue() ;
}
```

oracle.spatial.ws.Path is a Java class that contains an ordered list of PathElement objects that constitute the path. For example, if an XPath is `myns:A/myns:B`, then `myns:A` and `myns:B` are PathElement objects. This class includes the `getValue()` method, which returns a string format of the Path object. This class has the following format:

```
public class Path {
    //Add a PathElement.
    public void add(PathElement p) ;
    //Get a string Value for the Path object.
    public String getValue() ;
}
```

oracle.spatial.ws.PathInfo is a container class that contains information about a path or list of paths, including their association and metadata information. This class has the following format:

```
public class PathInfo {

    // Set number of occurrences for the Path. Default value is 1. Number of
    // occurrences > 1 in case of arrays.
    public void setNumOfOccurrences(int i) ;

    // Get number of occurrences for the Path.
    public int getNumOfOccurrences();

    // Add a path, in case PathInfo has multiple paths associated via a
    // choice association
    public void addPath(Path p) ;
}
```

```
// Add path type information. This is relevant for time-related Paths
// (for example, date, dateTime, gDay, gMonth, gYear, gMonthDay,
// gYearMonth, duration, or time).
    public void addPathType(String t) ;

// Add a PathInfo type. This can be PathInfo.CHOICE or
// PathInfo.DEFAULT or PathInfo.COLLECTION.
// PathInfo.CHOICE - means that the list of paths in this PathInfo are
// related to each other via choice association. For example, we may have
// a list of Spatial Paths, which are associated with one another via choice.
// So, only one of these path can occur in a feature instance/document.
// PathInfo.COLLECTION - means the list of paths in this PathInfo are part
// of a collection (currently spatial collections are
// supported) which will be indexed.
// Default value is PathInfo.DEFAULT for one Path or a finite array Paths.
// @param t PathInfo type information. PathInfo.CHOICE or
// PathInfo.DEFAULT or PathInfo.COLLECTION
    public void addPathInfoType(int t) ;

// Returns a string representation for PathInfo content.
    public String getPathContent() ;

// Returns Path type information (for example, date, dateTime, gDay, gMonth,
// gYear, gMonthDay, gYearMonth, duration, or time).
    public String getPathType() ;

// Returns a string representation for PathInfo path content.
// param i The index of the path in the PathInfo whose path content needs to
// be returned
// @return a string representation for PathInfo path content
    public String getCollectionPathContent(int i);

// Returns number of paths in the PathInfo.
// @return number of paths in the PathInfo which is of type PathInfo.COLLECTION
// if PathInfo is not of type PathInfo.COLLECTION returns -1
    public int getCollectionPathContentSize();
}
```

`oracle.spatial.ws.CollectionPathInfo` is a container class that contains information about a collection of `PathInfo` objects. Each `PathInfo` object in this collection, represents a group of spatial paths that will be indexed and searched on. This class will be used to register paths referring to spatial collection-based content in feature and record types. This class has the following format:

```
public class CollectionPathInfo {

    /**
     * Add a PathInfo.
     * @param p PathInfo to be added
     * @param g geometry related metadata for PathInfo to be added
     */
    public void addPathInfo(PathInfo p, GeomMetaInfo g) ;

    /**
     * Get a PathInfo.
     * @param i index of the PathInfo to be retrieved
     */
    public PathInfo getPathInfo(int i) ;

    /**
     * Get geometry related metadata for a certain PathInfo.
     * @param i index of the PathInfo whose geomMetaInfo is to be retrieved
     */
}
```

```

    */
    public GeomMetaInfo getGeomMetaInfo(int i) ;

    /**
     * Get all PathInfo objects in this CollectionPathInfo.
     */
    public ArrayList<PathInfo> getPathInfos() ;
}

```

`oracle.spatial.ws.GeomMetaInfo` is a class that contains dimension-related information corresponding to a spatial path in a feature type. This information includes the dimension name, the lower and upper bounds, the tolerance, and the coordinate system (SRID). This class has the following format:

```

public class GeomMetaInfo {

    // Default constructor. Creates a GeomMetaInfo object with number of
    // dimensions equal to 2.
    public GeomMetaInfo() ;

    // Creates a GeomMetaInfo object of a specified number of dimensions.
    // Parameter numOfDimensions is the number of dimensions represented
    // in the GeomMetaInfo object.
    // Note: max number of dimensions supported is 4.
    public GeomMetaInfo(int numOfDimensions) throws
        ArrayIndexOutOfBoundsException ;

    //Set Dimension Name.
    // Parameter index represents the dimension index which needs to be set.
    // Parameter val is dimension name value.
    public void setDimName(int index, String val) throws
        ArrayIndexOutOfBoundsException ;

    // Set Dimension Lower Bound.
    // Parameter index represents the dimension index which needs to be set.
    // Parameter val is dimension lower bound value.
    public void setLB(int index, double val) throws
        ArrayIndexOutOfBoundsException ;

    // Set Dimension Upper Bound
    // Parameter index represents the dimension index which needs to be set.
    // Parameter val is dimension upper bound value
    public void setUB(int index, double val) throws
        ArrayIndexOutOfBoundsException ;

    // Set Dimension tolerance value.
    // Parameter index represents the dimension index which needs to be set.
    // Parameter val is dimension tolerance value.
    public void setTolerance(int index, double val) throws
        ArrayIndexOutOfBoundsException ;

    // Set Coordinate Reference System Identifier
    public void setSRID (int val) ;

    // Get dimension Name.
    // Parameter index represents the dimension index whose name needs to be
    // returned. This method returns the dimension name for the given index.
    public String getDimName(int index) throws
        ArrayIndexOutOfBoundsException ;

    // Get dimension lower bound.

```

```
// Parameter index represents the dimension index whose lower bound needs
// to be returned.
// This method returns the lower bound for the given index.
    public double getLB(int index) throws ArrayIndexOutOfBoundsException ;

// Get dimension upper bound.
// Parameter index represents the dimension index whose upper bound needs
// to be returned.
// This method returns the upper bound for the given index.
    public double getUB(int index) throws ArrayIndexOutOfBoundsException ;

// Get dimension tolerance.
// Parameter index represents the dimension index whose tolerance needs
// to be returned.
// This method returns the tolerance value for the given index.
    public double getTolerance(int index) throws
        ArrayIndexOutOfBoundsException ;

// Get coordinate system (spatial reference system) identifier.
    public int getSRID () ;

// Get number of dimensions represented by this GeomMetaInfo object.
    public int getNumOfDimensions() ;

// Sets the spatial index dimension parameter. By default it is 2.
// return Coordinate Reference System Identifier value
    public int setSpatialIndexDimension(int d) ;

// Get the spatial index dimension parameter.
// return number of dimensions
    public int getSpatialIndexDimension() ;

// Sets the user spatial srs namespace referred by this GeomMetaInfo object.
// Needs to be specified if multiple srs namespace are referred within the same
//feature or record type.
    public void setSRSNS(String s) ;

// Gets the user defined spatial srs namespace referred by this
// GeomMetaInfo object.
    public String getSRSNS() ;

// Sets the user defined spatial srs namespace alias referred by this
// GeomMetaInfo object.
    public void setSRSNSAlias (String s) ;

// Gets the user defined spatial srs namespace alias referred by this
// GeomMetaInfo object.
    public String getSRSNSAlias () ;
}
```

### 15.4.8 revokeFeatureTypeFromUser method

The `revokeFeatureTypeFromUser` method revokes access to a feature type from a database user. This method has the following format:

```
public static void revokeFeatureTypeFromUser(
    OracleConnection conn,
    String typeNS,
    String typeName,
    String usrName) throws SQLException;
```

`conn` is an Oracle Database connection for a user that has been granted the DBA role.

`typeNS` is the URL of the namespace of the feature type.

`typeName` is the name of the feature type.

`usrName` is the name of the database user.

### 15.4.9 revokeMDAccessFromUser method

The `revokeMDAccessFromUser` method revokes access to the WFS metadata from a database user. This method has the following format:

```
public static void revokeMDAccessFromUser(
    OracleConnection conn,
    String usrName) throws SQLException;
```

`conn` is an Oracle Database connection for a user that has been granted the DBA role.

`usrName` is the name of the database user.

### 15.4.10 setXMLTableIndexInfo method

The `setXMLTableIndexInfo` method updates the `XMLTableIndex` index information for a document-based feature type, with the option of creating the index. This method has the following format:

---

#### Note:

If the `XMLTableIndex` index already exists, you must drop it (using the [dropXMLTableIndex method](#) (page 15-13)) before you call the `setXMLTableIndexInfo` method.

---

```
public static void setXMLTableIndexInfo(OracleConnection conn,
    String ftNSUrl,
    String ftName,
    ArrayList<PathInfo> idxPaths,
    ArrayList<String[]> idxPathTypes,
    boolean genXMLIndex) throws SQLException , WFSException;
```

`conn` is an Oracle Database connection for a user that has been granted the DBA role.

`ftNSUrl` is the URL of the namespace of the feature type.

`ftName` is the name of the feature type.

`idxPaths` is the index path list. It is list of paths on which to create an index of type `XDB.XMLINDEX` when that index is created. It is an `ArrayList` of class `oracle.spatial.ws.PathInfo`, which is described in [Related Classes for publishFeatureType](#) (page 15-19).

`idxPathTypes` specifies information about each index path, where each element of `string[3]` contains the following: `string[0]` is the type name, `string[1]` is the type format (such as the type length), and `string[2]` specifies whether a Btree or unique index, or no index, should be created (`WFSAdmin.BTREE`, `WFSAdmin.UNIQUE`, or `null`).

`genXMLIndex` is a Boolean value: `TRUE` causes an index of type `XDB.XMLINDEX` to be created on the document-based feature type; `FALSE` does not cause an index of type `XDB.XMLINDEX` to be created on the document-based feature type. If you choose not

to create the index now, you can create it later using the `createXMLTableIndex` method (described in [createXMLTableIndex method](#) (page 15-13)).

## 15.5 Using WFS with Oracle Workspace Manager

You can use Oracle Workspace Manager to version-enable a WFS table with relational features. To do so, first register the WFS table using the [SDO\\_WFS\\_LOCK.RegisterFeatureTable](#) (page 32-2) procedure; then execute the `DBMS_WM.EnableVersioning` procedure. (For information about Workspace Manager, including reference documentation for the `DBMS_WM` PL/SQL package, see *Oracle Database Workspace Manager Developer's Guide*.)

You can create workspaces and perform transactional WFS changes to these workspaces by using the WFS-T (Web Feature Services transaction) interfaces. However, to use interfaces other than WFS-T, you must use a SQL\*Plus session for which database transactions are enabled on the WFS tables. These database transactions include the following:

- Update and delete operations on WFS tables
- Workspace maintenance operations, such as refreshing a workspace or merging workspaces

To enable database transactions on the WFS tables, call the [SDO\\_WFS\\_LOCK.EnableDBTxns](#) (page 32-1) procedure (documented in [SDO\\_WFS\\_LOCK Package \(WFS\)](#) (page 32-1)). After you execute this procedure, database transactions are permitted on the WFS tables and WFS-T semantics are maintained for WFS transactions, until the end of the session.

---

## Catalog Services for the Web (CSW) Support

This chapter describes the Oracle Spatial and Graph implementation of the Open GIS Consortium specification for catalog services. According to this specification: "Catalogue services support the ability to publish and search collections of descriptive information (metadata) for data, services, and related information objects. Metadata in catalogues represent resource characteristics that can be queried and presented for evaluation and further processing by both humans and software. Catalogue services are required to support the discovery and binding to registered information resources within an information community."

The Oracle Spatial and Graph implementation will be referred to as Catalog Services for the Web, or CSW

This chapter includes the following major sections:

- [CSW Engine and Architecture](#) (page 16-1)
- [CSW APIs and Configuration](#) (page 16-2)
- [Request and Response XML Examples](#) (page 16-5)
- [Java API for CSW Administration](#) (page 16-14)

---

### Note:

Before you use CSW, be sure that you understand the concepts described in [Introduction to Spatial Web Services](#) (page 10-1), and that you have performed any necessary configuration work as described in that chapter.

If you have data from a previous release that was indexed using one or more SYS.XMLTABLEINDEX indexes, you must drop the associated indexes before the upgrade and re-create the indexes after the upgrade, as described in [Index Maintenance Before and After an Upgrade \(WFS and CSW\)](#) (page A-2).

---

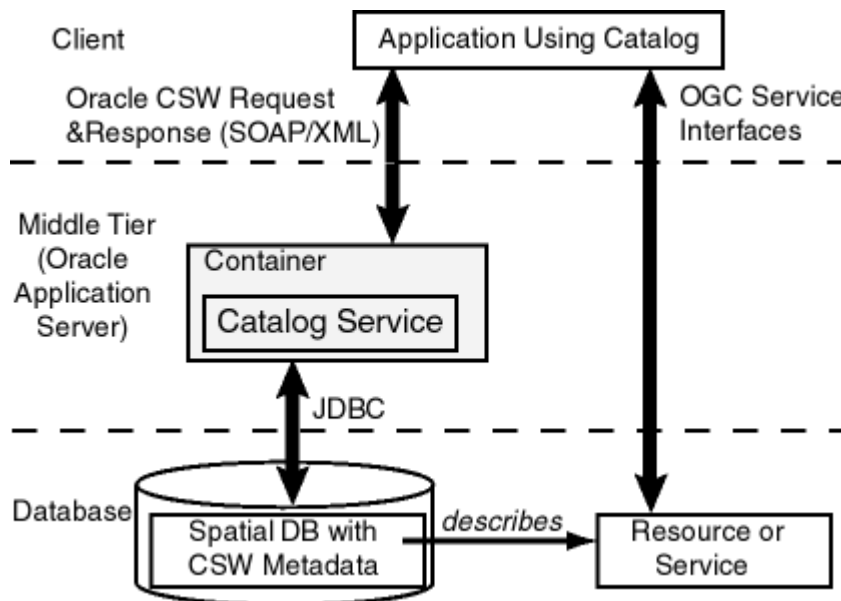
## 16.1 CSW Engine and Architecture

This section describes CSW, including its relationship to clients and to the database server. CSW is implemented as a Java web application and can be deployed in WebLogic 12.1.3 or later. The required Java version is JDK 1.8 or later.

CSW has a metadata layer, which stores in the database the metadata needed to reply to catalog requests. The metadata includes spatial columns, which can be queried and processed using Oracle Spatial and Graph interfaces. The metadata also stores the association of nonspatial and spatial attributes of records, as well as the services that the catalog service provides to its clients.

[Figure 16-1](#) (page 16-2) shows the CSW architecture.

**Figure 16-1 CSW Architecture**



As shown in [Figure 16-1](#) (page 16-2):

- CSW is part of a container in the middle tier.
- CSW can communicate with a web service client using CSW requests and responses in SOAP/XML/KVP format.
- CSW performs spatial data and metadata access through JDBC calls to the database.
- The database includes Oracle Spatial and Graph with CSW metadata and data.

## 16.2 CSW APIs and Configuration

The CSW APIs enable you to perform operations that include:

- Specifying information about record type domains and record view transformations
- Publishing record types
- Dropping (unpublishing) record types
- Granting to users and revoking from users privileges on CSW record types

[SDO\\_CSW\\_PROCESS Package \(CSW Processing\)](#) (page 21-1) describes the PL/SQL API (SDO\_CSW\_PROCESS package), [Request and Response XML Examples](#) (page 16-5) provides examples of XML requests and responses, and [Java API for CSW Administration](#) (page 16-14) describes the Java API.

### 16.2.1 Capabilities Documents (CSW)

A client can get information about the server's capabilities. A capabilities document is generated by the CSW server in response to a GetCapabilities request. The capabilities



document contains information extracted from CSW metadata stored in an Oracle database, including a record type and the type of operations supported.

The client can use HTTP GET, POST, and SOAP protocols to access this capabilities document. The following example uses the HTTP protocol:

```
http://<machine-name:port>/oraclespatial/csw?
request=GetCapabilities&service=CSW&acceptversion=2.0.0&outputFormat=text/xml
```

In the preceding formats:

- *machine-name* is the name of the system where the application server is running.
- *port* is the port number where the application server is running.
- *oraclespatial* is the default root where the Oracle Spatial and Graph web services application is mounted.

## 16.2.2 Spatial Path Extractor Function (extractSDO)

If you need CSW to process any spatial content that is not in GML format, you must create a user-defined function named `extractSDO` to extract the spatial path information. This function must be implemented for each record type that has spatial content in non-GML format and on which you want to create a spatial index. (This function is not needed if all spatial content for a record type is in GML format.)

This function must be registered, as explained in [Registering and Unregistering the extractSDO Function](#) (page 16-4), so that the Oracle Spatial and Graph CSW server can find and invoke this function when it needs to extract spatial path content that is not in GML format.

The `extractSDO` function has the following format:

```
extractSDO(
    xmlData IN XMLType,    srsNs IN VARCHAR2,    spPathsSRSNSList IN
MDSYS.STRINGLISTLIST); ) RETURN MDSYS.SDO_GEOM_PATH_INFO;
```

### Parameters

#### xmlData

Data of the record instance from which spatial path information needs to be extracted.

#### srsNs

User-defined namespace of the spatial reference system (coordinate system) associated with the spatial data for the feature type. This namespace (if specified) is also used to generate the `srsName` attribute in the `<boundedBy>` element of the `FeatureCollection` result generated for the `GetFeature` request.

#### spPathsSRSNSList

If a record type has multiple user-defined spatial reference system namespaces associated with different spatial paths, this parameter specifies the list of spatial reference system namespace information corresponding to the different spatial paths specified during type registration. It is an object of type `MDSYS.STRINGLISTLIST`, which is defined as `VARARRAY(1000000) OF MDSYS.STRINGLIST`, and where `MDSYS.STRINGLIST` is defined as `VARARRAY(1000000) OF VARCHAR2(4000)`. If a record type does not have multiple user-defined spatial reference system namespaces associated with different spatial columns, this parameter should be null.

In each MDSYS.STRINGLIST object, the first element is the spatial reference system namespace, and second element is the spatial reference system namespace alias (if any).

### Usage Notes

This function parses the non-GML spatial content and returns an object of type MDSYS.SDO\_GEOM\_PATH\_INFO, which is defined as follows:

```
(path      MDSYS.STRINGLIST,  
 geom      SDO_GEOMETRY,  
 arrindex  NUMBER)
```

The path attribute specifies path to the spatial content that is to be extracted and stored in the geom attribute. It is an object of MDSYS.STRINGLIST, which is defined as: VARRAY(1000000) OF VARCHAR2(4000). The path attribute has the following pattern: MDSYS.STRINGLIST('pe\_namespace1', 'pe\_name1', 'pe\_namespace2', 'pe\_name2', ...); where:

- pe\_namespace1 is the namespace of the first path element.
- pe\_name1 is the name of the first path element.
- pe\_namespace2 is the namespace of the second path element.
- pe\_name2 is the name of the second path element.
- and so on, for any remaining namespace and name pairs.

In the path, /typeNameNSAlias:typeName/pe\_namespace1\_Alias:pe\_name1/pe\_namespace2\_Alias:pe\_name2... is an XPath representation of spatial content, in non-GML format, that will be extracted by the user-defined function extractSDO:

- typeNameNSAlias is an alias to record type name namespace.
- typeName is the type name of the record type.
- pe\_namespace1\_Alias is a namespace alias for namespace pe\_namespace1
- pe\_namespace2\_Alias is a namespace alias for namespace pe\_namespace2.

The geom attribute is the spatial content (corresponding to the path parameter) extracted as an SDO\_GEOMETRY object. The extracted geometry can then be indexed using a spatial index.

The arrindex attribute is not currently used, and should be set to 1. (It is reserved for future use as an array index of paths.)

#### 16.2.2.1 Registering and Unregistering the extractSDO Function

After you create the extractSDO function, you must register it to enable it to be used for processing spatial path content in record types that is not in GML format. To register the function, call the [SDO\\_CSW\\_PROCESS.InsertPluginMap](#) (page 21-7) procedure. For example:

```
BEGIN  
  SDO_CSW_PROCESS.insertPluginMap('http://www.opengis.net/cat/csw',  
    'Record', 'csw_admin_usr.csw_RT_1_package');  
END;  
/
```

If you no longer want the `extractSDO` function to be used for processing spatial path content that is not in GML format, you can unregister the function by calling the [SDO\\_CSW\\_PROCESS.DeletePluginMap](#) (page 21-3) procedure. For example:

```
BEGIN
  SDO_CSW_PROCESS.deletePluginMap('http://www.opengis.net/cat/csw',
    'Record');
END;
/
```

## 16.3 Request and Response XML Examples

This section presents some record requests to the CSW engine, and the response to each request, for each of the following operations:

- GetCapabilities
- DescribeRecord
- GetRecords
- GetDomain
- GetRecordById
- Transaction, with a subelement specifying the transaction type:
  - Insert
  - Update
  - Delete

### **Example 16-1** *GetCapabilities Request*

[Example 16-1](#) (page 16-5) is a request to get the capabilities of the CSW server named CSW at a specified namespace URL. This request will return a capabilities document, as explained in [Capabilities Documents](#) (page 16-2)

```
<csw:GetCapabilities service="CSW" xmlns:csw="http://www.opengis.net/cat/csw"
xmlns:ows="http://www.opengis.net/ows">
  <ows:AcceptVersions>
    <ows:Version>2.0.0</ows:Version>
  </ows:AcceptVersions>
  <ows:AcceptFormats>
    <ows:OutputFormat>text/xml</ows:OutputFormat>
  </ows:AcceptFormats>
</csw:GetCapabilities>
```

### **Example 16-2** *GetCapabilities Response*

[Example 16-2](#) (page 16-5) is an excerpt of the response from the request in [Example 16-1](#) (page 16-5).

```
<Capabilities xmlns="http://www.opengis.net/cat/csw" version="2.0.0" updateSequence="0"
xmlns:ows="http://www.opengis.net/ows" xmlns:ogc="http://www.opengis.net/ogc" xmlns:csw="http://
www.opengis.net/cat/csw" xmlns:xlink="http://www.w3.org/1999/xlink" xmlns:ns0="http://
www.opengis.net/cat/csw" xmlns:ns1="http://www.opengis.net/cat/csw">
  <ows:ServiceIdentification xmlns:ows="http://www.opengis.net/ows">
    <ows:ServiceType>CSW</ows:ServiceType>
    <ows:ServiceTypeVersion>2.0.0</ows:ServiceTypeVersion>
    <ows:Title>Company CSW</ows:Title>
```

```
<ows:Abstract>
  A catalogue service that conforms to the HTTP protocol
  binding of the OpenGIS Catalogue Service specification
  version 2.0.0.
</ows:Abstract>
<ows:Keywords>
  <ows:Keyword>CSW</ows:Keyword>
  <ows:Keyword>Company Name</ows:Keyword>
  <ows:Keyword>geospatial</ows:Keyword>
  <ows:Keyword>catalogue</ows:Keyword>
</ows:Keywords>
<ows:Fees>NONE</ows:Fees>
<ows:AccessConstraints>NONE</ows:AccessConstraints>
</ows:ServiceIdentification>
<ows:ServiceProvider xmlns:ows="http://www.opengis.net/ows">
  <ows:ProviderName>Company Name</ows:ProviderName>
  <ows:ProviderSite xmlns:ans1:href="http://www.oracle.com" xmlns:ans1="http://www.w3.org/1999/xlink"/>
  <ows:ServiceContact>
    <ows:IndividualName> Contact Person Name</ows:IndividualName>
    <ows:PositionName>Staff</ows:PositionName>
    <ows:ContactInfo>
      <ows:Phone>
        <ows:Voice>999-999-9999</ows:Voice>
        <ows:Facsimile>999-999-9999</ows:Facsimile>
      </ows:Phone>
      <ows:Address>
        <ows:DeliveryPoint>1 Street Name</ows:DeliveryPoint>
        <ows:City>CityName</ows:City>
        <ows:AdministrativeArea>StateName</ows:AdministrativeArea>
        <ows:PostalCode>09999</ows:PostalCode>
        <ows:Country>USA</ows:Country>
        <ows:ElectronicMailAddress>
          contact.person@example.com
        </ows:ElectronicMailAddress>
      </ows:Address>
      <ows:OnlineResource xmlns:ans1:href="mailto:contact.person@example.com" xmlns:ans1="http://
www.w3.org/1999/xlink"/>
    </ows:ContactInfo>
  </ows:ServiceContact>
</ows:ServiceProvider>
<ows:OperationsMetadata xmlns:ows="http://www.opengis.net/ows">
  <ows:Operation name="GetCapabilities">
    <ows:DCP>
      <ows:HTTP>
        <ows:Get xmlns:ans1:href="http://localhost:8888/SpatialWS-SpatialWS-context-root/cswservlet"
xmlns:ans1="http://www.w3.org/1999/xlink"/>
        <ows:Post xmlns:ans1:href="http://localhost:8888/SpatialWS-SpatialWS-context-root/
SpatialWSSoapHttpPort" xmlns:ans1="http://www.w3.org/1999/xlink"/>
      </ows:HTTP>
    </ows:DCP>
  </ows:Operation>
  <ows:Operation name="DescribeRecord">
    <ows:DCP>
      <ows:HTTP>
        <ows:Post xmlns:ans1:href="http://localhost:8888/SpatialWS-SpatialWS-context-root/
SpatialWSSoapHttpPort" xmlns:ans1="http://www.w3.org/1999/xlink"/>
      </ows:HTTP>
    </ows:DCP>
    <ows:Parameter name="typeName"><ows:Value>ns0:SampleRecord</ows:Value><ows:Value>ns1:Record</
ows:Value></ows:Parameter>
    <ows:Parameter name="outputFormat">
```

```

    <ows:Value>text/xml</ows:Value>
  </ows:Parameter>
  <ows:Parameter name="schemaLanguage">
    <ows:Value>XMLSCHEMA</ows:Value>
  </ows:Parameter>
</ows:Operation>
<ows:Operation name="GetRecords">
  <ows:DCP>
    <ows:HTTP>
      <ows:Post ans1:href="http://localhost:8888/SpatialWS-SpatialWS-context-root/
SpatialWSSoapHttpPort" xmlns:ans1="http://www.w3.org/1999/xlink"/>
    </ows:HTTP>
  </ows:DCP>
  <ows:Parameter name="TypeName"><ows:Value>ns0:SampleRecord</ows:Value><ows:Value>ns1:Record</
ows:Value></ows:Parameter>
  <ows:Parameter name="outputFormat">
    <ows:Value>text/xml </ows:Value>
  </ows:Parameter>
  <ows:Parameter name="outputSchema">
    <ows:Value>OGCCORE</ows:Value>
  </ows:Parameter>
  <ows:Parameter name="resultType">
    <ows:Value>hits</ows:Value>
    <ows:Value>results</ows:Value>
    <ows:Value>validate</ows:Value>
  </ows:Parameter>
  <ows:Parameter name="ElementSetName">
    <ows:Value>brief</ows:Value>
    <ows:Value>summary</ows:Value>
    <ows:Value>full</ows:Value>
  </ows:Parameter>
  <ows:Parameter name="CONSTRAINTLANGUAGE">
    <ows:Value>Filter</ows:Value>
  </ows:Parameter>
</ows:Operation>
<ows:Operation name="GetRecordById">
  <ows:DCP>
    <ows:HTTP>
      <ows:Post ans1:href="http://localhost:8888/SpatialWS-SpatialWS-context-root/
SpatialWSSoapHttpPort" xmlns:ans1="http://www.w3.org/1999/xlink"/>
    </ows:HTTP>
  </ows:DCP>
  <ows:Parameter name="ElementSetName">
    <ows:Value>brief</ows:Value>
    <ows:Value>summary</ows:Value>
    <ows:Value>full</ows:Value>
  </ows:Parameter>
</ows:Operation>
<ows:Operation name="GetDomain">
  <ows:DCP>
    <ows:HTTP>
      <ows:Post ans1:href="http://localhost:8888/SpatialWS-SpatialWS-context-root/
SpatialWSSoapHttpPort" xmlns:ans1="http://www.w3.org/1999/xlink"/>
    </ows:HTTP>
  </ows:DCP>
  <ows:Parameter name="ParameterName">
    <ows:Value>GetRecords.resultType</ows:Value>
    <ows:Value>GetRecords.outputFormat</ows:Value>
    <ows:Value>GetRecords.outputRecType</ows:Value>
    <ows:Value>GetRecords.typeNames</ows:Value>
    <ows:Value>GetRecords.ElementSetName</ows:Value>

```

```
<ows:Value>GetRecords.ElementName</ows:Value>
<ows:Value>GetRecords.CONSTRAINTLANGUAGE</ows:Value>
<ows:Value>GetRecordById.ElementSetName</ows:Value>
<ows:Value>DescribeRecord.typeName</ows:Value>
<ows:Value>DescribeRecord.schemaLanguage</ows:Value>
</ows:Parameter>
</ows:Operation>
<ows:Operation name="Transaction">
  <ows:DCP>
    <ows:HTTP>
      <ows:Post ans1:href="http://localhost:8888/SpatialWS-SpatialWS-context-root/
SpatialWSSoapHttpPort" xmlns:ans1="http://www.w3.org/1999/xlink"/>
    </ows:HTTP>
  </ows:DCP>
</ows:Operation>
<ows:Parameter name="service">
  <ows:Value>CSW</ows:Value>
</ows:Parameter>
<ows:Parameter name="version">
  <ows:Value>2.0.0</ows:Value>
</ows:Parameter>
<ows:ExtendedCapabilities>
  <ogc:Filter_Capabilities xmlns:ogc="http://www.opengis.net/ogc">
    <ogc:Spatial_Capabilities>
      <ogc:Spatial_Operators>
        <ogc:BBOX/>
        <ogc:Equals/>
        <ogc:Disjoint/>
        <ogc:Intersect/>
        <ogc:Touches/>
        <ogc:Crosses/>
        <ogc:Within/>
        <ogc:Contains/>
        <ogc:Overlaps/>
        <ogc:Beyond/>
        <ogc:DWithin/>
      </ogc:Spatial_Operators>
    </ogc:Spatial_Capabilities>
    <ogc:Scalar_Capabilities>
      <ogc:Logical_Operators/>
      <ogc:Comparison_Operators>
        <ogc:Simple_Comparisons/>
        <ogc:Like/>
        <ogc:Between/>
        <ogc:NullCheck/>
      </ogc:Comparison_Operators>
      <ogc:Arithmetic_Operators>
        <ogc:Simple_Arithmetic/>
      </ogc:Arithmetic_Operators>
    </ogc:Scalar_Capabilities>
  </ogc:Filter_Capabilities>
</ows:ExtendedCapabilities>
</ows:OperationsMetadata>
</Capabilities>
```

### **Example 16-3 DescribeRecord Request**

[Example 16-3](#) (page 16-8) is a request to describe the record with the type name Record for a specified namespace.

```
<csw:DescribeRecord service="CSW"
  version="2.0.0"
```

```

xmlns:csw="http://www.opengis.net/cat/csw" >
  <csw:TypeName targetNamespace="http://www.opengis.net/cat/csw">Record</
csw:TypeName>
</csw:DescribeRecord>

```

#### Example 16-4 DescribeRecord Response

[Example 16-4](#) (page 16-9) is the response from the request in [Example 16-3](#) (page 16-8). The response is an XML schema definition (XSD). See the `<documentation>` elements in the response for explanatory comments.

```

<xsd:schema targetNamespace="http://www.opengis.net/cat/csw"
elementFormDefault="qualified" version="2.0.0" id="csw-record" xmlns:csw="http://
www.opengis.net/cat/csw" xmlns:dc="http://www.purl.org/dc/elements/1.1/"
xmlns:dct="http://www.purl.org/dc/terms/" xmlns:ows="http://www.opengis.net/ows"
xmlns:xsd="http://www.w3.org/2001/XMLSchema">
  <xsd:annotation>
    <xsd:appinfo>
      <dc:identifier xmlns:dc="http://www.purl.org/dc/elements/1.1/">
        http://schemas.opengis.net/csw/2.0.0/record
      </dc:identifier>
    </xsd:appinfo>
    <xsd:documentation xml:lang="en">
      This schema defines the basic record types that are common to all CSW
      implementations. An application profile may extend AbstractRecordType to
      represent model-specific content.
    </xsd:documentation>
  </xsd:annotation>
  <xsd:import namespace="http://www.purl.org/dc/terms/" schemaLocation="./
recdctterms.xsd"/>
  <xsd:import namespace="http://www.purl.org/dc/elements/1.1/" schemaLocation="./
recdcmes.xsd"/>
  <xsd:import namespace="http://www.opengis.net/ows" schemaLocation="./
owsboundingbox.xsd"/>
  <xsd:element name="AbstractRecord" type="csw:AbstractRecordType" abstract="true"
id="AbstractRecord"/>
  <xsd:complexType name="AbstractRecordType" abstract="true"
id="AbstractRecordType"/>
  <xsd:element name="DCMIRecord" type="csw:DCMIRecordType"
substitutionGroup="csw:AbstractRecord"/>
  <xsd:complexType name="DCMIRecordType">
    <xsd:annotation>
      <xsd:documentation xml:lang="en">
        This type encapsulates all of the standard DCMI metadata terms,
        including the Dublin Core refinements; these terms may be mapped to the
        profile-specific information model.
      </xsd:documentation>
    </xsd:annotation>
    <xsd:complexContent>
      <xsd:extension base="csw:AbstractRecordType">
        <xsd:sequence>
          <xsd:group ref="dct:DCMI-terms"/>
        </xsd:sequence>
      </xsd:extension>
    </xsd:complexContent>
  </xsd:complexType>
  <xsd:element name="BriefRecord" type="csw:BriefRecordType"
substitutionGroup="csw:AbstractRecord"/>
  <xsd:complexType name="BriefRecordType">
    <xsd:annotation>
      <xsd:documentation xml:lang="en">
        This type defines a brief representation of the common record format.

```

```
        It extends AbstractRecordType to include only the dc:identifier and
        dc:type properties.
    </xsd:documentation>
</xsd:annotation>
<xsd:complexContent>
    <xsd:extension base="csw:AbstractRecordType">
        <xsd:sequence>
            <xsd:element ref="dc:identifier"/>
            <xsd:element ref="dc:type" minOccurs="0"/>
        </xsd:sequence>
    </xsd:extension>
</xsd:complexContent>
</xsd:complexType>
<xsd:element name="SummaryRecord" type="csw:SummaryRecordType"
substitutionGroup="csw:AbstractRecord"/>
<xsd:complexType name="SummaryRecordType">
    <xsd:annotation>
        <xsd:documentation xml:lang="en">
            This type defines a summary representation of the common record format.
            It extends AbstractRecordType to include the core properties.
        </xsd:documentation>
    </xsd:annotation>
    <xsd:complexContent>
        <xsd:extension base="csw:AbstractRecordType">
            <xsd:sequence>
                <xsd:choice maxOccurs="unbounded">
                    <xsd:element ref="dc:identifier"/>
                    <xsd:element ref="dc:type"/>
                    <xsd:element ref="dc:title"/>
                    <xsd:element ref="dc:subject"/>
                    <xsd:element ref="dc:format"/>
                    <xsd:element ref="dc:relation"/>
                    <xsd:element ref="dct:modified"/>
                    <xsd:element ref="dct:abstract"/>
                    <xsd:element ref="dct:spatial"/>
                </xsd:choice>
            </xsd:sequence>
        </xsd:extension>
    </xsd:complexContent>
</xsd:complexType>
<xsd:element name="Record" type="csw:RecordType"
substitutionGroup="csw:AbstractRecord"/>
<xsd:complexType name="RecordType">
    <xsd:annotation>
        <xsd:documentation xml:lang="en">
            This type extends DCMIRecordType to add ows:BoundingBox; it may be used
            to specify a bounding envelope for the catalogued resource.
        </xsd:documentation>
    </xsd:annotation>
    <xsd:complexContent>
        <xsd:extension base="csw:DCMIRecordType">
            <xsd:sequence>
                <xsd:element ref="ows:BoundingBox" minOccurs="0"/>
            </xsd:sequence>
        </xsd:extension>
    </xsd:complexContent>
</xsd:complexType>
</xsd:schema>
```



**Example 16-5 GetRecords Request**

[Example 16-5](#) (page 16-11) is a request to get records where the contributor is equal to Raja.

Note that Spatial Catalog Service supports only synchronous processing of GetRecords requests.

```
<?xml version="1.0" ?>
<csw:GetRecords
  service="CSW"
  version="2.0.0"
  xmlns:csw="http://www.opengis.net/cat/csw"
  xmlns:ogc="http://www.opengis.net/ogc"
  xmlns:dc="http://www.purl.org/dc/elements/1.1/"
  xmlns:dct="http://www.purl.org/dc/terms/"
  outputFormat="text/xml"
  resultType="results"
  outputSchema="csw:Record">
<csw:Query typeNames="csw:Record">
<csw:ElementName>/csw:Record/dc:identifier</csw:ElementName>
<csw:ElementName>/csw:Record/dc:contributor</csw:ElementName>
<csw:Constraint version="2.0.0" >
  <ogc:Filter>
    <ogc:PropertyIsEqualTo>
      <ogc:PropertyName>/csw:Record/dc:contributor</ogc:PropertyName>
      <ogc:Literal>Raja</ogc:Literal>
    </ogc:PropertyIsEqualTo>
  </ogc:Filter>
</csw:Constraint>
</csw:Query>
</csw:GetRecords>
```

**Example 16-6 GetRecords Response**

[Example 16-6](#) (page 16-11) is the response from the request in [Example 16-5](#) (page 16-11).

```
<csw:GetRecordsResponse xmlns:csw="http://www.opengis.net/cat/csw" xmlns:dc="http://
www.purl.org/dc/elements/1.1/" xmlns:dct="http://www.purl.org/dc/terms/"
xsi:schemaLocation="http://www.opengis.net/cat/csw http://localhost:8888/SpatialWS-
SpatialWS-context-root/cswservlet?recordTypeId=1 " version="2.0.0" xmlns:xsi="http://
www.w3.org/2001/XMLSchema-instance">
  <csw:RequestId>4</csw:RequestId>
  <csw:SearchStatus status="complete"/>
  <csw:SearchResults recordSchema="http://www.opengis.net/cat/csw"
numberOfRecordsMatched="1" numberOfRecordsReturned="1" nextRecord="0"
expires="2007-02-09T16:32:35.29Z">
    <csw:Record xmlns:dc="http://www.purl.org/dc/elements/1.1/" xmlns:ows="http://
www.opengis.net/ows" xmlns:dct="http://www.purl.org/dc/terms/">
      <dc:contributor xmlns:dc="http://www.purl.org/dc/elements/1.1/"
scheme="http://www.example.com">Raja</dc:contributor>
      <dc:identifier xmlns:dc="http://www.purl.org/dc/elements/1.1/">REC-1</
dc:identifier>
    </csw:Record>
  </csw:SearchResults>
</csw:GetRecordsResponse>
```

**Example 16-7 GetDomain Request**

[Example 16-7](#) (page 16-11) is a request to get domain information related to a record type.

```
<csw:GetDomain service="CSW"
  version="2.0.0"
  xmlns:csw="http://www.opengis.net/cat/csw" >
  <csw:ParameterName>GetRecords.resultType</csw:ParameterName>
</csw:GetDomain>
```

### **Example 16-8 GetDomain Response**

[Example 16-8](#) (page 16-12) is the response from the request in [Example 16-7](#) (page 16-11).

```
<csw:GetDomainResponse xmlns:csw="http://www.opengis.net/cat/csw" xmlns:dc="http://
www.purl.org/dc/elements/1.1/" xmlns:dct="http://www.purl.org/dc/terms/">
  <csw:DomainValues type="csw:SampleRecord">
    <csw:ParameterName>GetRecords.resultType</csw:ParameterName>
    <csw:ListOfValues>
      <csw:Value>hits</csw:Value>
      <csw:Value>results</csw:Value>
      <csw:Value>validate</csw:Value>
    </csw:ListOfValues>
  </csw:DomainValues>
  <csw:DomainValues type="csw:Record">
    <csw:ParameterName>GetRecords.resultType</csw:ParameterName>
    <csw:ListOfValues>
      <csw:Value>hits</csw:Value>
      <csw:Value>results</csw:Value>
      <csw:Value>validate</csw:Value>
    </csw:ListOfValues>
  </csw:DomainValues>
</csw:GetDomainResponse>
```

### **Example 16-9 GetRecordById Request**

[Example 16-9](#) (page 16-12) is a request to get the record with the record ID value REC-1.

```
<?xml version="1.0" ?>
<csw:GetRecordById
  service="CSW"
  version="2.0.0"
  xmlns:csw="http://www.opengis.net/cat/csw"
  xmlns:ogc="http://www.opengis.net/ogc" >
<csw:Id> REC-1 </csw:Id>
<csw:ElementSetName>brief</csw:ElementSetName>
</csw:GetRecordById>
```

### **Example 16-10 GetRecordById Response**

[Example 16-10](#) (page 16-12) is the response from the request in [Example 16-9](#) (page 16-12).

```
<csw:GetRecordByIdResponse xmlns:csw="http://www.opengis.net/cat/csw"
xmlns:dc="http://www.purl.org/dc/elements/1.1/" xmlns:dct="http://www.purl.org/dc/
terms/" xsi:schemaLocation="http://www.opengis.net/cat/csw http://localhost:8888/
SpatialWS-SpatialWS-context-root/cswservlet?recordTypeId=2 http://
www.opengis.net/cat/csw http://localhost:8888/SpatialWS-SpatialWS-context-root/
cswservlet?recordTypeId=1 " xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance">
  <csw:BriefRecord xmlns:dc="http://www.purl.org/dc/elements/1.1/"
xmlns:ows="http://www.opengis.net/ows" xmlns:dct="http://www.purl.org/dc/terms/">
    <dc:identifier xmlns:dc="http://www.purl.org/dc/elements/1.1/">REC-1</
dc:identifier>
  </csw:BriefRecord>
</csw:GetRecordByIdResponse>
```

**Example 16-11 Insert Request**

[Example 16-11](#) (page 16-13) is a request to insert a record for contributor John. The record has an ID value of REC-2, and has the spatial attribute of the specified bounding box (optimized rectangle: lower-left and upper-right coordinates).

```
<csw:Transaction service="CSW"
  version="2.0.0"
  xmlns:csw="http://www.opengis.net/cat/csw" >
  <csw:Insert>
    <Record xmlns="http://www.opengis.net/cat/csw" xmlns:dc="http://www.purl.org/dc/
elements/1.1/" xmlns:dct="http://www.purl.org/dc/terms/" xmlns:ows="http://
www.opengis.net/ows" >
      <dc:contributor scheme="http://www.example.com">John</dc:contributor>
      <dc:identifier >REC-2</dc:identifier>
      <ows:WGS84BoundingBox crs="urn:opengis:crs:OGC:2:84" dimensions="2">
        <ows:LowerCorner>12 12</ows:LowerCorner>
        <ows:UpperCorner>102 102</ows:UpperCorner>
      </ows:WGS84BoundingBox>
    </Record>
  </csw:Insert>
</csw:Transaction>
```

**Example 16-12 Insert Response**

[Example 16-12](#) (page 16-13) is the response from the request in [Example 16-11](#) (page 16-13).

```
<csw:TransactionResponse xmlns:csw="http://www.opengis.net/cat/csw" xmlns:dc="http://
www.purl.org/dc/elements/1.1/" xmlns:dct="http://www.purl.org/dc/terms/"
xsi:schemaLocation="http://www.opengis.net/cat/csw http://localhost:8888/SpatialWS-
SpatialWS-context-root/cswservlet?recordTypeId=1 " xmlns:xsi="http://www.w3.org/2001/
XMLSchema-instance">
  <csw:TransactionSummary>
    <csw:totalInserted>1</csw:totalInserted>
  </csw:TransactionSummary>
</csw:TransactionResponse>
```

**Example 16-13 Update Request**

[Example 16-13](#) (page 16-13) is a request to update the contributor value to Jane in the record where the current contributor value is John (that is, change the value from John to Jane).

```
<csw:Transaction service="CSW"
  version="2.0.0"
  xmlns:csw="http://www.opengis.net/cat/csw"
  xmlns:ogc="http://www.opengis.net/ogc"
  xmlns:dc="http://www.purl.org/dc/elements/1.1/">
  <csw:Update>
    <csw:RecordProperty>
      <csw:Name>/csw:Record/dc:contributor</csw:Name>
      <csw:Value>Jane</csw:Value>
    </csw:RecordProperty>

    <csw:Constraint version="2.0.0">
      <ogc:Filter>
        <ogc:PropertyIsEqualTo>
          <ogc:PropertyName>/csw:Record/dc:contributor</ogc:PropertyName>
          <ogc:Literal>John</ogc:Literal>
        </ogc:PropertyIsEqualTo>
      </ogc:Filter>
    </csw:Constraint>
  </csw:Update>
```

```
</csw:Constraint>

</csw:Update>
</csw:Transaction>
```

#### **Example 16-14 Update Response**

[Example 16-14](#) (page 16-14) is the response from the request in [Example 16-13](#) (page 16-13).

```
<csw:TransactionResponse xmlns:csw="http://www.opengis.net/cat/csw" xmlns:dc="http://
www.purl.org/dc/elements/1.1/" xmlns:dct="http://www.purl.org/dc/terms/">
  <csw:TransactionSummary>
    <csw:totalUpdated>1</csw:totalUpdated>
  </csw:TransactionSummary>
</csw:TransactionResponse>
```

#### **Example 16-15 Delete Request**

[Example 16-15](#) (page 16-14) is a request to delete the record where the contributor value is equal to Jane.

```
<csw:Transaction service="CSW"
  version="2.0.0"
  xmlns:csw="http://www.opengis.net/cat/csw"
  xmlns:dc="http://www.purl.org/dc/elements/1.1/"
  xmlns:ogc="http://www.opengis.net/ogc">
  <csw:Delete typeName="csw:Record">
    <csw:Constraint version="2.0.0">
      <ogc:Filter>
        <ogc:PropertyIsEqualTo>
          <ogc:PropertyName>/csw:Record/dc:contributor</ogc:PropertyName>
          <ogc:Literal>Jane</ogc:Literal>
        </ogc:PropertyIsEqualTo>
      </ogc:Filter>
    </csw:Constraint>
  </csw:Delete>
</csw:Transaction>
```

#### **Example 16-16 Delete Response**

[Example 16-16](#) (page 16-14) is the response from the request in [Example 16-15](#) (page 16-14).

```
<csw:TransactionResponse xmlns:csw="http://www.opengis.net/cat/csw" xmlns:dc="http://
www.purl.org/dc/elements/1.1/" xmlns:dct="http://www.purl.org/dc/terms/">
  <csw:TransactionSummary>
    <csw:totalDeleted>1</csw:totalDeleted>
  </csw:TransactionSummary>
</csw:TransactionResponse>
```

## 16.4 Java API for CSW Administration

In addition to the PL/SQL APIs in the SDO\_CSW\_PROCESS package, you can use a Java API to publish and drop record types, and to grant and revoke access to record types and CSW metadata tables.

This section provides basic reference information about the methods in the `oracle.spatial.csw.CSWAdmin` class. The methods are presented in alphabetical order.

### 16.4.1 createXMLTableIndex method

The `createXMLTableIndex` method creates an index of XDB.XMLINDEX on record type instances. This method has the following format:

```
public static void createXMLTableIndex(
    OracleConnection conn,
    String typeNS,
    String typeName) throws SQLException;
```

`conn` is an Oracle Database connection for a user that has been granted the DBA role.

`typeNS` is the URL of the namespace of the record type.

`typeName` is the name of the record type.

### 16.4.2 deleteDomainInfo method

The `deleteDomainInfo` method deletes domain information related to the record type. This method has the following format:

```
public static void deleteDomainInfo(
    OracleConnection conn,
    int recordTypeId,
    String parameterName) throws SQLException;
```

`conn` is an Oracle Database connection for a user that has been granted the DBA role.

`recordTypeId` is the ID of the record type.

`parameterName` is the name of the domain parameter to be deleted.

### 16.4.3 deleteRecordViewMap method

The `deleteRecordViewMap` method deletes information related to record view transformation. This method has the following format:

```
public static void deleteRecordViewMap(
    OracleConnection conn,
    String recordTypeNS,
    String viewSrcName,
    String targetTypeName,
    String mapType) throws SQLException;
```

`conn` is an Oracle Database connection for a user that has been granted the DBA role.

`recordTypeNS` is the URL of the namespace of the record type.

`viewSrcName` is the name of the source of the record type.

`targetTypeName` is the name of the destination of the record type.

`mapType` is the map type (brief, summary, and so on).

### 16.4.4 disableVersioning method

The `disableVersioning` method disables versioning for a record type. This method has the following format:

```
public static void disableVersioning(
    OracleConnection conn,
```

```
String rtNSUrl,  
String rtName) throws SQLException;
```

conn is an Oracle Database connection for a user that has been granted the DBA role.

rtNSUrl is the URL of the namespace of the record type.

rtName is the name of the record type.

### 16.4.5 dropRecordType method

The dropRecordType method deletes a record type from the CSW repository. This method has the following format:

```
public static void dropRecordType(  
    OracleConnection conn,  
    String rtNSUrl,  
    String rtName) throws SQLException;
```

conn is an Oracle Database connection for a user that has been granted the DBA role.

rtNSUrl is the URL of the namespace of the record type.

rtName is the name of the record type.

### 16.4.6 dropXMLTableIndex method

The dropXMLTableIndex method drops an index of type XDB.XMLINDEX that was created on record type instances. This method has the following format:

```
public static void dropXMLTableIndex(  
    OracleConnection conn,  
    String typeNS,  
    String typeName) throws SQLException;
```

conn is an Oracle Database connection for a user that has been granted the DBA role.

typeNS is the URL of the namespace of the record type.

typeName is the name of the record type.

### 16.4.7 enableVersioning method

The enableVersioning method enables versioning for a record type. This method has the following format:

```
public static void enableVersioning(  
    OracleConnection conn,  
    String rtNSUrl,  
    String rtName) throws SQLException;
```

conn is an Oracle Database connection for a user that has been granted the DBA role.

rtNSUrl is the URL of the namespace of the record type.

rtName is the name of the record type.

### 16.4.8 getIsXMLTableIndexCreated method

The getIsXMLTableIndexCreated method returns a Boolean TRUE if an index of type XDB.XMLINDEX has been created on a record type, or a Boolean FALSE if such an index has not been created. This method has the following format:

```
public static boolean getIsXMLTableIndexCreated(
    OracleConnection conn,
    String typeNS,
    String typeName) throws SQLException;
```

`conn` is an Oracle Database connection for a user that has been granted the DBA role.

`typeNS` is the URL of the namespace of the record type.

`typeName` is the name of the record type.

### 16.4.9 getRecordTypeId method

The `getRecordTypeId` method returns the record type ID for a specified combination of namespace and record type. This method has the following format:

```
public static boolean getRecordTypeId(
    OracleConnection conn,
    String typeNamespace,
    String typeName) throws SQLException;
```

`conn` is an Oracle Database connection for a user that has been granted the DBA role.

`typeNamespace` is the URL of the namespace of the record type.

`typeName` is the name of the record type.

### 16.4.10 grantMDAccessToUser method

The `grantMDAccessToUser` method grants access to the CSW metadata to a database user. This method has the following format:

```
public static void grantMDAccessToUser(
    OracleConnection conn,
    String usrName) throws SQLException;
```

`conn` is an Oracle Database connection for a user that has been granted the DBA role.

`usrName` is the name of the database user.

### 16.4.11 grantRecordTypeToUser method

The `grantRecordTypeToUser` method grants access to a record type to a database user. This method has the following format:

```
public static void grantRecordTypeToUser(
    OracleConnection conn,
    String typeNS,
    String typeName,
    String usrName) throws SQLException;
```

`conn` is an Oracle Database connection for a user that has been granted the DBA role.

`typeNS` is the URL of the namespace of the record type.

`typeName` is the name of the record type.

`usrName` is the name of the database user.

## 16.4.12 publishRecordType method

The `publishRecordType` method publishes a record type; that is, it registers metadata related to the record type. This method has the following formats:

```
public static void publishRecordType(OracleConnection conn,
    XMLType recordTypeMD) throws SQLException , CSWException;

public static void publishRecordType(OracleConnection conn,
    String typeNS,
    String typeName,
    ArrayList<String> idPaths,
    ArrayList<PathInfo> spatialPaths,
    ArrayList<PathInfo> tsPaths,
    XMLType schemaDoc,
    XMLType briefXSLPattern,
    XMLType summaryXSLPattern,
    XMLType dcmiXSLPattern,
    ArrayList<String> srsPaths,
    String idExtractorType,
    ArrayList<GeomMetaInfo> sdoMetaInfo,
    String srsNS, String srsNSAlias) throws SQLException ;

public static void publishRecordType(OracleConnection conn,
    String typeNS,
    String typeName,
    ArrayList<String> idPaths,
    ArrayList<PathInfo> spatialPaths,
    ArrayList<PathInfo> tsPaths,
    XMLType schemaDoc,
    XMLType briefXSLPattern,
    XMLType summaryXSLPattern,
    XMLType dcmiXSLPattern,
    ArrayList<String> srsPaths,
    String idExtractorType,
    ArrayList<GeomMetaInfo> sdoMetaInfo,
    String srsNS, String srsNSAlias,
    String rtXSDRefId,
    boolean genSpatialIndex,
    boolean setDomainInfo,
    Hashtable<String, ArrayList<String>> domainInfo,
    boolean setRecordViewMap,
    ArrayList<ArrayList<Object>> recordViewMap) throws SQLException ;

public static void publishRecordType(OracleConnection conn,
    String typeNS,
    String typeName,
    ArrayList<String> idPaths,
    ArrayList<PathInfo> spatialPaths,
    ArrayList<PathInfo> tsPaths,
    XMLType schemaDoc,
    XMLType briefXSLPattern,
    XMLType summaryXSLPattern,
    XMLType dcmiXSLPattern,
    ArrayList<String> srsPaths,
    String idExtractorType,
    ArrayList<GeomMetaInfo> sdoMetaInfo,
    String srsNS, String srsNSAlias,
    String rtXSDRefId,
    boolean genSpatialIndex,
```



```

        boolean setDomainInfo,
        Hashtable<String, ArrayList<String>> domainInfo,
        boolean setRecordViewMap,
        ArrayList<ArrayList<Object>> recordViewMap,
        ArrayList<PathInfo> numPaths,
        ArrayList<PathInfo> idxPaths,
        ArrayList<String[]> idxPathTypes,
        boolean genXMLIndex) throws SQLException ;

public static void publishRecordType(OracleConnection conn,
        String typeNS,
        String typeName,
        ArrayList<String> idPaths,
        ArrayList<PathInfo> spatialPaths,
        ArrayList<PathInfo> tsPaths,
        XMLType schemaDoc,
        XMLType briefXSLPattern,
        XMLType summaryXSLPattern,
        XMLType dcmlXSLPattern,
        ArrayList<String> srsPaths,
        String idExtractorType, ArrayList<GeomMetaInfo> sdoMetaInfo,
        String srsNS, String srsNSAlias,
        String rtXSDRefId,
        boolean genSpatialIndex,
        boolean setDomainInfo,
        Hashtable<String, ArrayList<String>> domainInfo,
        boolean setRecordViewMap,
        ArrayList<ArrayList<Object>> recordViewMap,
        ArrayList<PathInfo> numPaths,
        ArrayList<PathInfo> idxPaths,
        ArrayList<String[]> idxPathTypes,
        boolean genXMLIndex,
        boolean isGML3) throws SQLException ;

public static void publishRecordType(OracleConnection conn,
        String typeNS,
        String typeName,
        ArrayList<String> idPaths,
        ArrayList<PathInfo> spatialPaths,
        ArrayList<PathInfo> tsPaths,
        XMLType schemaDoc,
        XMLType briefXSLPattern,
        XMLType summaryXSLPattern,
        XMLType dcmlXSLPattern,
        ArrayList<String> srsPaths,
        String idExtractorType,
        ArrayList<GeomMetaInfo> sdoMetaInfo,
        String srsNS, String srsNSAlias,
        String rtXSDRefId,
        boolean genSpatialIndex,
        boolean setDomainInfo,
        Hashtable<String, ArrayList<String>> domainInfo,
        boolean setRecordViewMap,
        ArrayList<ArrayList<Object>> recordViewMap,
        ArrayList<PathInfo> numPaths,
        ArrayList<PathInfo> idxPaths,
        ArrayList<String[]> idxPathTypes,
        boolean genXMLIndex,
        boolean isGML3,
        CollectionPathInfo collPathInfo) throws SQLException;

```

```
public static void publishRecordType(OracleConnection conn,
    String typeNS,
    String typeName,
    ArrayList<String> idPaths,
    ArrayList<PathInfo> spatialPaths,
    ArrayList<PathInfo> tsPaths,
    XMLType schemaDoc,
    XMLType briefXSLPattern,
    XMLType summaryXSLPattern,
    XMLType dcmlXSLPattern,
    ArrayList<String> srsPaths,
    String idExtractorType,
    ArrayList<GeomMetaInfo> sdoMetaInfo,
    String srsNS, String srsNSAlias,
    String rtXSDRefId,
    boolean genSpatialIndex,
    boolean setDomainInfo,
    Hashtable<String, ArrayList<String>> domainInfo,
    boolean setRecordViewMap,
    ArrayList<ArrayList<Object>> recordViewMap,
    ArrayList<PathInfo> numPaths,
    ArrayList<PathInfo> idxPaths,
    ArrayList<String[]> idxPathTypes,
    boolean genXMLIndex,
    boolean isGML3,
    CollectionPathInfo collPathInfo,
    boolean hasMultipleSRSSNS) throws SQLException;
```

`conn` is an Oracle Database connection for a user that has been granted the DBA role.

`recordTypeMd` is the record type registration metadata. This metadata must conform to the `recordTypeMd` element definition as specified in the `wstype_md.xsd` file.

Examples of record type path registration metadata XML are provided in `rt_metadata1.xml` and `rt_metadata2.xml`. These files are included in the `ws_client.jar` demo file (described in [Demo Files for Sample Java Client](#) (page 10-5)) under the `src/data/` path. For information about using the examples to publish record types, see the `Readme.txt` file, which is included in `ws_client.jar` under the `src/` path.

`typeNS` is the URL of the namespace of the record type.

`typeName` is the name of the record type.

`idPaths` is a list of record ID path elements where each element is a `String`.

`spatialPaths` is a list of spatial paths in the record type. It is an `ArrayList` of class `oracle.spatial.ws.PathInfo`, which is described in [Related Classes for publishRecordType](#) (page 16-22).

`tsPaths` is a list of time-related paths in the record type (for example, `date`, `dateTime`, `gYear`, `gMonth`, `gDay`, `gMonthDay`, and `gYearMonth`). It is an `ArrayList` of class `oracle.spatial.ws.PathInfo`, which is described in [Related Classes for publishRecordType](#) (page 16-22).

`schemaDoc` is the XML schema definition (XSD) of the record type.

`briefXSLPattern` is the XSLT mapping for transforming the record structure from full to brief format.

`summaryXSLPattern` is the XSLT mapping for transforming the record structure from summary to brief format.

`dcmiXSLPattern` is the XSLT mapping for transforming the record structure from dcmi to brief format.

`srsPaths` is a list of paths representing spatial reference system information.

`idExtractorType` is Identifier extractor method information (XPATH, USER\_FUNC, or NONE). XPATH means that the record identifier will be extracted using an XPath as specified in the `idPaths` parameter. USER\_FUNC means that the record identifier will be extracted by a user-defined function invocation, as specified in the `idPaths` parameter, to which the entire record document instance will be passed. NONE means that the record identifier will be a system-generated identifier.

`sdoMetaInfo` is the spatial metadata information for spatial paths. It is an `ArrayList` of class `oracle.spatial.ws.GeomMetaInfo`, which is described in [Related Classes for publishRecordType](#) (page 16-22).

`srsNS` is the user-defined namespace of the spatial reference system (coordinate system) associated with the data in the spatial paths.

`srsNSAlias` is the namespace alias of the spatial reference system (coordinate system) associated with the data in the spatial paths.

`rtXSDRefId` is the group record type XML schema definition file name (as a string), for cases where multiple record types are defined in a single XSD file. This parameter is used to store the group XSD definition once in the CSW metadata, and then refer to it from multiple record types whose schema definitions are present in the group record type XSD file.

`genSpatialIndex` is a Boolean value: TRUE causes a spatial index to be created on the record type at type creation time; FALSE does not cause a spatial index to be created.

`setDomainInfo` is a Boolean value: TRUE causes domain information for this record type to be set at type creation time; FALSE does not cause domain information for this record type to be set.

`domainInfo` is domain information.

`setRecordViewMap` is a Boolean value: TRUE causes the record view transformation map to be set at type creation time; FALSE does not cause the record view transformation map to be set.

`recordViewMap` is the record view transformation map information (brief to full, summary to full, and dcmi to full). It is of type `ArrayList<ArrayList<Object>>` where the content of each `ArrayList<Object>` is: `Object[0] = (String) recordTypeNS`, `Object[1] = (String) viewSrcName`, `Object[2] = (String) targetTypeNS`, `Object[3] = (oracle.xdb.XMLType) mapInfo`, `Object[4] = (String) mapType`

`numPaths` is a list of numeric (NUMBER, INTEGER, and so on) related paths in the record type. It is an `ArrayList` of class `oracle.spatial.ws.PathInfo`, which is described in [Related Classes for publishRecordType](#) (page 16-22).

`idxPaths` is the index path list. It is list of paths on which to create an index of type XDB.XMLINDEX when that index is created. It is an `ArrayList` of class `oracle.spatial.ws.PathInfo`, which is described in [Related Classes for publishRecordType](#) (page 16-22).

`idxPathTypes` specifies information about each index path, where each element of `string[3]` contains the following: `string[0]` is the type name, `string[1]` is the type format (such as the type length), and `string[2]` specifies whether a Btree or unique index, or no index, should be created (`CSWAdmin.BTREE`, `CSWAdmin.UNIQUE`, or null).

`genXMLIndex` is a Boolean value: `TRUE` causes an index of type `XDB.XMLINDEX` to be created on the document-based record type; `FALSE` does not cause an index of type `XDB.XMLINDEX` to be created on the document-based record type. If you choose not to create the index now, you can create it later using the `createXMLTableIndex` method (described in [createXMLTableIndex method](#) (page 16-15)).

`isGML3` is a Boolean value: `TRUE` means that the geometries inside instances of this record type are GML3.1.1 compliant; `FALSE` means that the geometries inside instances of this record type are GML 2.1.2 compliant.

`collPathInfo` is spatial collection path information.

`hasMultipleSRSNS` is a Boolean value: `TRUE` means that this record type refers to multiple user-defined spatial reference system namespaces; `FALSE` means that this record type does not refer to multiple user-defined spatial reference system namespaces.

#### 16.4.12.1 Related Classes for `publishRecordType`

This section describes some classes used in the definition of parameters of the [publishRecordType method](#) (page 16-18).

`oracle.spatial.ws.PathElement` is a Java class that contains a pair of String objects: the `PathElement` namespace and the `PathElement` name. This class includes the `getValue()` method, which returns a string format of the `PathElement` object. This class has the following format:

```
public class PathElement {
    // Set namespace and name information for a PathElement.
    public void set(String ns, String name);
    //Get a string value for the PathElement object.
    public String getValue() ;
}
```

`oracle.spatial.ws.Path` is a Java class that contains an ordered list of `PathElement` objects that constitute the path. For example, if an XPath is `myns:A/myns:B`, then `myns:A` and `myns:B` are `PathElement` objects. This class includes the `getValue()` method, which returns a string format of the `Path` object. This class has the following format:

```
public class Path {
    //Add a PathElement.
    public void add(PathElement p) ;
    //Get a string Value for the Path object.
    public String getValue() ;
}
```

`oracle.spatial.ws.PathInfo` is a container class that contains information about a path or list of paths, including their association and metadata information. This class has the following format:

```
public class PathInfo {

    // Set number of occurrences for the Path. Default value is 1. Number of
    // occurrences > 1 in case of arrays.
    public void setNumOfOccurrences(int i) ;

    // Get number of occurrences for the Path.
    public int getNumOfOccurrences();

    // Add a path, in case PathInfo has multiple paths associated via a
```

```

// choice association
    public void addPath(Path p) ;

// Add path type information. This is relevant for time-related Paths
// (for example, date, dateTime, gDay, gMonth, gYear, gMonthDay,
// gYearMonth, duration, or time).
    public void addPathType(String t) ;

// Add a PathInfo type. This can be PathInfo.CHOICE or
// PathInfo.DEFAULT or PathInfo.COLLECTION.
// PathInfo.CHOICE - means that the list of paths in this PathInfo are
// related to each other via choice association. For example, we may have
// a list of Spatial Paths, which are associated with one another via choice.
// So, only one of these path can occur in a feature instance/document.
// PathInfo.COLLECTION - means the list of paths in this PathInfo are part
// of a collection (currently spatial collections are
// supported) which will be indexed.
// Default value is PathInfo.DEFAULT for one Path or a finite array Paths.
// @param t PathInfo type information. PathInfo.CHOICE or
// PathInfo.DEFAULT or PathInfo.COLLECTION
    public void addPathInfoType(int t) ;

// Returns a string representation for PathInfo content.
    public String getPathContent() ;

// Returns Path type information (for example, date, dateTime, gDay, gMonth,
// gYear, gMonthDay, gYearMonth, duration, or time).
    public String getPathType() ;

// Returns a string representation for PathInfo path content.
// param i The index of the path in the PathInfo whose path content needs to
// be returned
// @return a string representation for PathInfo path content
    public String getCollectionPathContent(int i);

// Returns number of paths in the PathInfo.
// @return number of paths in the PathInfo which is of type PathInfo.COLLECTION
// if PathInfo is not of type PathInfo.COLLECTION returns -1
    public int getCollectionPathContentSize();
}

```

`oracle.spatial.ws.CollectionPathInfo` is a container class that contains information about a collection of `PathInfo` objects. Each `PathInfo` object in this collection, represents a group of spatial paths that will be indexed and searched on. This class will be used to register paths referring to spatial collection-based content in feature and record types. This class has the following format:

```

public class CollectionPathInfo {

    /**
     * Add a PathInfo.
     * @param p PathInfo to be added
     * @param g geometry related metadata for PathInfo to be added
     */
    public void addPathInfo(PathInfo p, GeomMetaInfo g) ;

    /**
     * Get a PathInfo.
     * @param i index of the PathInfo to be retrieved
     */
    public PathInfo getPathInfo(int i) ;
}

```

```
/**
 * Get geometry related metadata for a certain PathInfo.
 * @param i index of the PathInfo whose geomMetaInfo is to be retrieved
 */
    public GeomMetaInfo getGeomMetaInfo(int i) ;

/**
 * Get all PathInfo objects in this CollectionPathInfo.
 */
    public ArrayList<PathInfo> getPathInfos() ;
}
```

oracle.spatial.ws.GeomMetaInfo is a class that contains dimension-related information corresponding to a spatial path in a record type. This information includes the dimension name, the lower and upper bounds, the tolerance, and the coordinate system (SRID). This class has the following format:

```
public class GeomMetaInfo {

    // Default constructor. Creates a GeomMetaInfo object with number of
    // dimensions equal to 2.
    public GeomMetaInfo() ;

    // Creates a GeomMetaInfo object of a specified number of dimensions.
    // Parameter numOfDimensions is the number of dimensions represented
    // in the GeomMetaInfo object.
    // Note: max number of dimensions supported is 4.
    public GeomMetaInfo(int numOfDimensions) throws
        ArrayIndexOutOfBoundsException ;

    //Set Dimension Name.
    // Parameter index represents the dimension index which needs to be set.
    // Parameter val is dimension name value.
    public void setDimName(int index, String val) throws
        ArrayIndexOutOfBoundsException ;

    // Set Dimension Lower Bound.
    // Parameter index represents the dimension index which needs to be set.
    // Parameter val is dimension lower bound value.
    public void setLB(int index, double val) throws
        ArrayIndexOutOfBoundsException ;

    // Set Dimension Upper Bound
    // Parameter index represents the dimension index which needs to be set.
    // Parameter val is dimension upper bound value
    public void setUB(int index, double val) throws
        ArrayIndexOutOfBoundsException ;

    // Set Dimension tolerance value.
    // Parameter index represents the dimension index which needs to be set.
    // Parameter val is dimension tolerance value.
    public void setTolerance(int index, double val) throws
        ArrayIndexOutOfBoundsException ;

    // Set Coordinate Reference System Identifier
    public void setSRID (int val) ;

    // Get dimension Name.
    // Parameter index represents the dimension index whose name needs to be
    // returned. This method returns the dimension name for the given index.
    public String getDimName(int index) throws
```

```

        ArrayIndexOutOfBoundsException ;

// Get dimension lower bound.
// Parameter index represents the dimension index whose lower bound needs
// to be returned.
// This method returns the lower bound for the given index.
    public double getLB(int index) throws ArrayIndexOutOfBoundsException ;

// Get dimension upper bound.
// Parameter index represents the dimension index whose upper bound needs
// to be returned.
// This method returns the upper bound for the given index.
    public double getUB(int index) throws ArrayIndexOutOfBoundsException ;

// Get dimension tolerance.
// Parameter index represents the dimension index whose tolerance needs
// to be returned.
// This method returns the tolerance value for the given index.
    public double getTolerance(int index) throws
        ArrayIndexOutOfBoundsException ;

// Get coordinate system (spatial reference system) identifier.
    public int getSRID () ;

// Get number of dimensions represented by this GeomMetaInfo object.
    public int getNumOfDimensions() ;

// Sets the spatial index dimension parameter. By default it is 2.
// return Coordinate Reference System Identifier value
    public int setSpatialIndexDimension(int d) ;

// Get the spatial index dimension parameter.
// return number of dimensions
    public int getSpatialIndexDimension() ;

// Sets the user spatial srs namespace referred to by this GeomMetaInfo object.
// Needs to be specified if multiple srs namespace are referred to within
// the same feature or record type.
    public void setSRSNS(String s) ;

// Gets the user defined spatial srs namespace referred to by
// this GeomMetaInfo object.
    public String getSRSNS() ;

// Sets the user defined spatial srs namespace alias referred to
// by this GeomMetaInfo object.
    public void setSRSNSAlias (String s) ;

// Gets the user defined spatial srs namespace alias
// referred to by this GeomMetaInfo object.
    public String getSRSNSAlias () ;
}

```

### 16.4.13 registerTypePluginMap method

The `registerTypePluginMap` method registers a plugin for processing and extracting spatial content for a record type. This method has the following format:

```

public static boolean registerTypePluginMap(
    OracleConnection conn,
    String typeNamespace,

```

```
String typeName,  
String packageName) throws SQLException;
```

conn is an Oracle Database connection for a user that has been granted the DBA role.

typeNS is the URL of the namespace of the record type.

typeName is the name of the record type.

packageName is the name of the PL/SQL package object for the plugin (for example, `scott.my_plugin_pkg`).

#### 16.4.14 revokeMDAccessFromUser method

The `revokeMDAccessFromUser` method revokes access to the CSW metadata from a database user. This method has the following format:

```
public static void revokeMDAccessFromUser(  
    OracleConnection conn,  
    String usrName) throws SQLException;
```

conn is an Oracle Database connection for a user that has been granted the DBA role.

usrName is the name of the database user.

#### 16.4.15 revokeRecordTypeFromUser method

The `revokeRecordTypeFromUser` method revokes access to a record type from a database user. This method has the following format:

```
public static void revokeRecordTypeFromUser(  
    OracleConnection conn,  
    String typeNS,  
    String typeName,  
    String usrName) throws SQLException;
```

conn is an Oracle Database connection for a user that has been granted the DBA role.

typeNS is the URL of the namespace of the record type.

typeName is the name of the record type.

usrName is the name of the database user.

#### 16.4.16 setCapabilitiesInfo method

The `setCapabilitiesInfo` method populates the capabilities related information. (For information about capabilities documents, see [Capabilities Documents](#) (page 16-2).) This method has the following format:

```
public static void setCapabilitiesInfo(OracleConnection conn,  
    XMLType capabilitiesTemplate) throws SQLException;
```

conn is an Oracle Database connection for a user that has been granted the DBA role.

capabilitiesTemplate is the Catalog services capabilities document.

#### 16.4.17 setDomainInfo method

The `setDomainInfo` method sets domain information related to the record type. This method has the following format:



```
public static void setDomainInfo(OracleConnection conn,
    int recordTypeId,
    String propertyName,
    String parameterName,
    ArrayList<String> values) throws SQLException;
```

conn is an Oracle Database connection for a user that has been granted the DBA role.

recordTypeId is the ID of the record type.

propertyName is the name of a domain property.

parameterName is the name of a domain parameter.

values specifies values for the domain parameter.

### 16.4.18 setRecordViewMap method

The setRecordViewMap method populates information related to record view transformation (for example, from BriefRecord to Record). This method has the following format:

```
public static void setRecordViewMap(OracleConnection conn,
    String recordTypeNS,
    String viewSrcName,
    String targetTypeNS,
    oracle.xdb.XMLType mapInfo,
    String mapType) throws SQLException;
```

conn is an Oracle Database connection for a user that has been granted the DBA role.

recordTypeNS is the URL of the namespace of the record type.

viewSrcName is the name of the source of the record type.

targetTypeNS is the name of the destination of the record type.

mapInfo is the XSLT definition of the mapping.

mapType is the map type (brief, summary, and so on).

### 16.4.19 setXMLTableIndexInfo method

The setXMLTableIndexInfo method updates the XMLTableIndex index information for a record type, with the option of creating the index. This method has the following format:

---

#### Note:

If the XMLTableIndex index already exists, you must drop it (using the [dropRecordType method](#) (page 16-16)) before you call the setXMLTableIndexInfo method.

---

```
public static void setXMLTableIndexInfo(OracleConnection conn,
    String typeNS,
    String ftName,
    ArrayList<PathInfo> idxPaths,
    ArrayList<String[]> idxPathTypes,
    boolean genXMLIndex) throws SQLException , CSWException;
```

conn is an Oracle Database connection for a user that has been granted the DBA role.

`typeNS` is the URL of the namespace of the record type.

`ftName` is the name of the record type.

`idxPaths` is the index path list. It is list of paths on which to create an index of type `XMLTABLEINDEX` when that index is created. It is an `ArrayList` of class `oracle.spatial.ws.PathInfo`, which is described in [Related Classes for publishRecordType](#) (page 16-22).

`idxPathTypes` specifies information about each index path, where each element of `string[3]` contains the following: `string[0]` is the type name, `string[1]` is the type format (such as the type length), and `string[2]` specifies whether a Btree or unique index, or no index, should be created (`CSWAdmin.BTREE`, `CSWAdmin.UNIQUE`, or `null`).

`genXMLIndex` is a Boolean value: `TRUE` causes an index of type `XDB.XMLINDEX` to be created on the record type; `FALSE` does not cause an index of type `XDB.XMLINDEX` to be created on the record type. If you choose not to create the index now, you can create it later using the `createXMLTableIndex` method (described in [createXMLTableIndex method](#) (page 16-15)).

# Part III

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## Reference Information

This document has the following parts:

- [Conceptual and Usage Information](#) (page 1) provides conceptual and usage information about Oracle Spatial and Graph.
- [Spatial Web Services](#) (page 1) provides conceptual and usage information about Oracle Spatial and Graph web services.
- Part III provides reference information about Oracle Spatial and Graph operators, functions, and procedures.
- [Supplementary Information](#) (page 1) provides supplementary information (appendixes and a glossary).

Part III contains the following chapters with reference information:

- [SQL Statements for Indexing Spatial Data](#) (page 17-1)
- [Spatial Operators](#) (page 18-1)
- [Spatial Aggregate Functions](#) (page 19-1)
- [SDO\\_CS Package \(Coordinate System Transformation\)](#) (page 20-1)
- [SDO\\_CSW\\_PROCESS Package \(CSW Processing\)](#) (page 21-1)
- [SDO\\_GCDR Package \(Geocoding\)](#) (page 22-1)
- [SDO\\_GEOM Package \(Geometry\)](#) (page 23-1)
- [SDO\\_LRS Package \(Linear Referencing System\)](#) (page 24-1)
- [SDO\\_MIGRATE Package \(Upgrading\)](#) (page 25-1)
- [SDO\\_OLS Package \(OpenLS\)](#) (page 26-1)
- [SDO\\_PC\\_PKG Package \(Point Clouds\)](#) (page 27-1)
- [SDO\\_SAM Package \(Spatial Analysis and Mining\)](#) (page 28-1)
- [SDO\\_TIN\\_PKG Package \(TINs\)](#) (page 29-1)
- [SDO\\_TUNE Package \(Tuning\)](#) (page 30-1)
- [SDO\\_UTIL Package \(Utility\)](#) (page 31-1)
- [SDO\\_WFS\\_LOCK Package \(WFS\)](#) (page 32-1)
- [SDO\\_WFS\\_PROCESS Package \(WFS Processing\)](#) (page 33-1)

To understand the examples in the reference chapters, you must understand the conceptual and data type information in [Spatial Data Types and Metadata](#) (page 2-1), especially [SDO\\_GEOMETRY Object Type](#) (page 2-5).

# SQL Statements for Indexing Spatial Data

This chapter describes the SQL statements used when working with the spatial object data type. The statements are listed in the following table.

**Table 17-1 Spatial Index Creation and Usage Statements**

Statement	Description
<a href="#">ALTER INDEX</a> (page 17-1)	Alters specific parameters for a spatial index.
<a href="#">ALTER INDEX REBUILD</a> (page 17-3)	Rebuilds a spatial index or a specified partition of a partitioned index.
<a href="#">ALTER INDEX RENAME TO</a> (page 17-6)	Changes the name of a spatial index or a partition of a spatial index.
<a href="#">CREATE INDEX</a> (page 17-7)	Creates a spatial index on a column of type SDO_GEOMETRY.
<a href="#">DROP INDEX</a> (page 17-12)	Deletes a spatial index.

This chapter focuses on using these SQL statements with spatial indexes. For complete reference information about any statement, see *Oracle Database SQL Language Reference*.

Bold italic text is often used in the **Keywords and Parameters** sections in this chapter to identify a grouping of keywords, followed by specific keywords in the group. For example, *INDEX\_PARAMS* identifies the start of a group of index-related keywords.

## 17.1 ALTER INDEX

### Purpose

Alters specific parameters for a spatial index.

### Syntax

```
ALTER INDEX [schema.]index PARAMETERS ('index_params [physical_storage_params]' )
    [{ NOPARALLEL | PARALLEL [ integer ] }];
```

### Keywords and Parameters

Value	Description
<i>INDEX_PARAMS</i>	Changes the characteristics of the spatial index.

Value	Description
sdo_indx_dims	Specifies the number of dimensions to be indexed. For example, a value of 2 causes only the first two dimensions to be indexed. Must be less than or equal to the number of actual dimensions. For usage information related to three-dimensional geometries, see <a href="#">Three-Dimensional Spatial Objects</a> (page 1-16). Data type is NUMBER. Default = 2.
sdo_rtr_pctfree	Specifies the minimum percentage of slots in each index tree node to be left empty when the index is created. Slots that are left empty can be filled later when new data is inserted into the table. The value can range from 0 to 50. The default value is best for most applications; however, a value of 0 is recommended if no updates will be performed to the geometry column. Data type is NUMBER. Default = 10.
<b><i>PHYSICAL_STORAGE_PARAMS</i></b>	Determines the storage parameters used for altering the spatial index data table. A spatial index data table is a standard Oracle table with a prescribed format. Not all physical storage parameters that are allowed in the STORAGE clause of a CREATE TABLE statement are supported. The following is a list of the supported subset.
tablespace	Specifies the tablespace in which the index data table is created. This parameter is the same as TABLESPACE in the STORAGE clause of a CREATE TABLE statement.
initial	Is the same as INITIAL in the STORAGE clause of a CREATE TABLE statement.
next	Is the same as NEXT in the STORAGE clause of a CREATE TABLE statement.
minextents	Is the same as MINEXTENTS in the STORAGE clause of a CREATE TABLE statement.
maxextents	Is the same as MAXEXTENTS in the STORAGE clause of a CREATE TABLE statement.
pctincrease	Is the same as PCTINCREASE in the STORAGE clause of a CREATE TABLE statement.
<b><i>{ NOPARALLEL   PARALLEL [ integer ] }</i></b>	Controls whether serial (NOPARALLEL) execution or parallel (PARALLEL) execution is used for subsequent queries and DML operations that use the index. For parallel execution you can specify an integer value of degree of parallelism. See the Usage Notes for the <a href="#">CREATE INDEX</a> (page 17-7) statement for guidelines and restrictions that apply to the use of the PARALLEL keyword. Default = NOPARALLEL. (If PARALLEL is specified without an integer value, the Oracle database calculates the optimum degree of parallelism.)

**Prerequisites**

- You must have EXECUTE privileges on the index type and its implementation type.
- The spatial index to be altered is not marked in-progress.

**Usage Notes**

Use this statement to change the parameters of an existing index.

See the Usage Notes for the [CREATE INDEX](#) (page 17-7) statement for usage information about many of the other available parameters.

**Examples**

The following example modifies the tablespace for partition IP2 of the spatial index named BGI.

```
ALTER INDEX bgi MODIFY PARTITION ip2
  PARAMETERS ('tablespace=TBS_3');
```

**Related Topics**

- [ALTER INDEX REBUILD](#) (page 17-3)
- [ALTER INDEX RENAME TO](#) (page 17-6)
- [CREATE INDEX](#) (page 17-7)
- ALTER TABLE (clauses for partition maintenance) in *Oracle Database SQL Language Reference*

## 17.2 ALTER INDEX REBUILD

**Syntax**

```
ALTER INDEX [schema.]index REBUILD
  [PARAMETERS ('rebuild_params [physical_storage_params]' ) ]
  [{ NOPARALLEL | PARALLEL [ integer ] }];
```

or

```
ALTER INDEX [schema.]index REBUILD ONLINE
  [PARAMETERS ('rebuild_params [physical_storage_params]' ) ]
  [{ NOPARALLEL | PARALLEL [ integer ] }];
```

or

```
ALTER INDEX [schema.]index REBUILD PARTITION partition
  [PARAMETERS ('rebuild_params [physical_storage_params]' ) ];
```

**Purpose**

Rebuilds a spatial index or a specified partition of a partitioned index.

## Keywords and Parameters

Value	Description
<b><i>REBUILD_PARAMS</i></b>	Specifies in a command string the index parameters to use in rebuilding the spatial index.
index_status=cleanup	For an online rebuild operation (ALTER INDEX REBUILD ONLINE), performs cleanup operations on tables associated with the older version of the index.
layer_gtype	Checks to ensure that all geometries are of a specified geometry type. The value must be from the Geometry Type column in <a href="#">SDO_GTYPE</a> (page 2-5) (except that UNKNOWN_GEOMETRY is not allowed). In addition, specifying POINT allows for optimized processing of point data. Data type is VARCHAR2.
sdo_dml_batch_size	Specifies the number of index updates to be processed in each batch of updates after a commit operation. The default value is 1000. For example, if you insert 3500 rows into the spatial table and then perform a commit operation, the updates to the spatial index table are performed in four batches of insert operations (1000, 1000, 1000, and 500). See the Usage Notes for the <a href="#">CREATE INDEX</a> (page 17-7) statement for more information. Data type is NUMBER. Default = 1000.
sdo_indx_dims	Specifies the number of dimensions to be indexed. For example, a value of 2 causes only the first two dimensions to be indexed. Must be less than or equal to the number of actual dimensions. For usage information related to three-dimensional geometries, see <a href="#">Three-Dimensional Spatial Objects</a> (page 1-16). Data type is NUMBER. Default = 2.
sdo_max_memory	Specifies the amount of maximum memory that can be allocated to perform a spatial index build or rebuild operation. Can be from 64000 (about 64 KB) to 200000000 (about 200 MB). If the specified number of bytes cannot be allocated, 64000 (about 64 KB) is allocated. Specifying a value greater than the default can significantly improve index creation performance; however, do not specify more than 20 percent of available memory. Data type is NUMBER. Default = 10000000 (about 10 MB).
sdo_rtr_pctfree	Specifies the minimum percentage of slots in each index tree node to be left empty when the index is created. Slots that are left empty can be filled later when new data is inserted into the table. The value can range from 0 to 50. Data type is NUMBER. Default = 10.
<b><i>PHYSICAL_STORAGE_PARAMS</i></b>	Determines the storage parameters used for rebuilding the spatial index data table. A spatial index data table is a regular Oracle table with a prescribed format. Not all physical storage parameters that are allowed in the STORAGE clause of a CREATE TABLE statement are supported. The following is a list of the supported subset.



Value	Description
tablespace	Specifies the tablespace in which the index data table is created. Same as TABLESPACE in the STORAGE clause of a CREATE TABLE statement.
initial	Is the same as INITIAL in the STORAGE clause of a CREATE TABLE statement.
next	Is the same as NEXT in the STORAGE clause of a CREATE TABLE statement.
minextents	Is the same as MINEXTENTS in the STORAGE clause of a CREATE TABLE statement.
maxextents	Is the same as MAXEXTENTS in the STORAGE clause of a CREATE TABLE statement.
pctincrease	Is the same as PCTINCREASE in the STORAGE clause of a CREATE TABLE statement.
<i>{ NOPARALLEL   PARALLEL [ integer ] }</i>	Controls whether serial (NOPARALLEL) execution or parallel (PARALLEL) execution is used for the rebuilding of the index and for subsequent queries and DML operations that use the index. For parallel execution you can specify an integer value of degree of parallelism. See the Usage Notes for the <a href="#">CREATE INDEX</a> (page 17-7) statement for guidelines and restrictions that apply to the use of the PARALLEL keyword. Default = NOPARALLEL. (If PARALLEL is specified without an integer value, the Oracle database calculates the optimum degree of parallelism.)

### Prerequisites

- You must have EXECUTE privileges on the index type and its implementation type.
- The spatial index to be altered is not marked in-progress.

### Usage Notes

An ALTER INDEX REBUILD 'rebuild\_params' statement rebuilds the index using supplied parameters. Spatial index creation involves creating and inserting index data, for each row in the underlying table column being spatially indexed, into a table with a prescribed format. All rows in the underlying table are processed before the insertion of index data is committed, and this requires adequate rollback segment space.

The ONLINE keyword rebuilds the index without blocking the index; that is, queries can use the spatial index while it is being rebuilt. However, after all queries issued during the rebuild operation have completed, you must clean up the old index information (in the MDRT tables) by entering a SQL statement in the following form:

```
ALTER INDEX [schema.]index REBUILD ONLINE PARAMETERS ('index_status=cleanup');
```

The following limitations apply to the use of the ONLINE keyword:

- Only query operations are permitted while the index is being rebuilt. Insert, update, and delete operations that would affect the index are blocked while the index is being rebuilt; and an online rebuild is blocked while any insert, update, or delete operations that would affect the index are being performed.
- You cannot use the ONLINE keyword for a rebuild operation if the index was created using the 'sdo\_non\_leaf\_tbl=TRUE' parameter.
- You cannot use the ONLINE keyword for a partitioned spatial index.

Effective with Release 12.1, the ALTER INDEX REBUILD statement reuses any previous parameters from the index creation. If new or changed parameters are passed, new parameters are merged with the previous ones, and changed parameters override the previous ones.

For more information about using the `layer_gtype` keyword to constrain data in a layer to a geometry type, see [Constraining Data to a Geometry Type](#) (page 5-2).

With a partitioned spatial index, you must use a separate ALTER INDEX REBUILD statement for each partition to be rebuilt.

If you want to use a *local* partitioned spatial index, follow the procedure in [Creating a Local Partitioned Spatial Index](#) (page 5-5).

See also the Usage Notes for the [CREATE INDEX](#) (page 17-7) statement for usage information about many of the available parameters and about the use of the PARALLEL keyword.

### Examples

The following example rebuilds OLDINDEX and specifies the tablespace in which to create the index data table.

```
ALTER INDEX oldindex REBUILD PARAMETERS('tablespace=TBS_3');
```

### Related Topics

- [CREATE INDEX](#) (page 17-7)
- [DROP INDEX](#) (page 17-12)
- ALTER TABLE and ALTER INDEX (clauses for partition maintenance) in *Oracle Database SQL Language Reference*

## 17.3 ALTER INDEX RENAME TO

### Syntax

```
ALTER INDEX [schema.]index RENAME TO <new_index_name>;
```

```
ALTER INDEX [schema.]index PARTITION partition RENAME TO <new_partition_name>;
```

### Purpose

Changes the name of a spatial index or a partition of a spatial index.

### Keywords and Parameters

Value	Description
<code>new_index_name</code>	Specifies the new name of the index.
<code>new_partition_name</code>	Specifies the new name of the partition.

### Prerequisites

- You must have EXECUTE privileges on the index type and its implementation type.
- The spatial index to be altered is not marked in-progress.

### Usage Notes

None.

### Examples

The following example renames OLDINDEX to NEWINDEX.

```
ALTER INDEX oldindex RENAME TO newindex;
```

### Related Topics

- [CREATE INDEX](#) (page 17-7)
- [DROP INDEX](#) (page 17-12)

## 17.4 CREATE INDEX

### Syntax

```
CREATE INDEX [schema.]index ON [schema.]table (column)
    INDEXTYPE IS MDSYS.SPATIAL_INDEX
    [PARAMETERS ('index_params [physical_storage_params]' )]
    [{ NOPARALLEL | PARALLEL [ integer ] }];
```

### Purpose

Creates a spatial index on a column of type SDO\_GEOMETRY.

### Keywords and Parameters

Value	Description
<code>INDEX_PARAMS</code>	Determines the characteristics of the spatial index.
<code>layer_gtype</code>	Checks to ensure that all geometries are of a specified geometry type. The value must be from the Geometry Type column in <a href="#">SDO_GTYPE</a> (page 2-5) (except that UNKNOWN_GEOMETRY is not allowed). In addition, specifying POINT allows for optimized processing of point data. Data type is VARCHAR2.

Value	Description
sdo_dml_batch_size	Specifies the number of index updates to be processed in each batch of updates after a commit operation. The default value is 1000. For example, if you insert 3500 rows into the spatial table and then perform a commit operation, the updates to the spatial index table are performed in four batches of insert operations (1000, 1000, 1000, and 500). See the Usage Notes for more information. Data type is NUMBER. Default = 1000.
sdo_indx_dims	Specifies the number of dimensions to be indexed. For example, a value of 2 causes only the first two dimensions to be indexed. Must be less than or equal to the number of actual dimensions. For usage information related to three-dimensional geometries, see <a href="#">Three-Dimensional Spatial Objects</a> (page 1-16). Data type is NUMBER. Default = 2.
sdo_max_memory	Specifies the amount of maximum memory that can be allocated to perform a spatial index build or rebuild operation. Can be from 64000 (about 64 KB) to 200000000 (about 200 MB). If the specified number of bytes cannot be allocated, 64000 (about 64 KB) is allocated. Specifying a value greater than the default can significantly improve index creation performance; however, do not specify more than 20 percent of available memory. Data type is NUMBER. Default = 10000000 (about 10 MB).
sdo_non_leaf_tbl	'sdo_non_leaf_tbl=TRUE' creates a separate index table (with a name in the form MDNT_...\$) for nonleaf nodes of the index, in addition to creating an index table (with a name in the form MDRT_...\$) for leaf nodes. 'sdo_non_leaf_tbl=FALSE' creates a single table (with a name in the form MDRT_...\$) for both leaf nodes and nonleaf nodes of the index. See the Usage Notes for more information. Data type is VARCHAR2. Default = FALSE
sdo_rtr_pctfree	Specifies the minimum percentage of slots in each index tree node to be left empty when the index is created. Slots that are left empty can be filled later when new data is inserted into the table. The value can range from 0 to 50. Data type is NUMBER. Default = 10.
<b>PHYSICAL_STORAGE_PARAMS</b>	Determines the storage parameters used for creating the spatial index data table. A spatial index data table is a regular Oracle table with a prescribed format. Not all physical storage parameters that are allowed in the STORAGE clause of a CREATE TABLE statement are supported. The following is a list of the supported subset.
tablespace	Specifies the tablespace in which the index data table is created. Same as TABLESPACE in the STORAGE clause of a CREATE TABLE statement.
initial	Is the same as INITIAL in the STORAGE clause of a CREATE TABLE statement.

Value	Description
next	Is the same as NEXT in the STORAGE clause of a CREATE TABLE statement.
minextents	Is the same as MINEXTENTS in the STORAGE clause of a CREATE TABLE statement.
maxextents	Is the same as MAXEXTENTS in the STORAGE clause of a CREATE TABLE statement.
pctincrease	Is the same as PCTINCREASE in the STORAGE clause of a CREATE TABLE statement.
work_tablespace	Specifies the tablespace for temporary tables used in creating the index. (Applies only to creating spatial R-tree indexes, and not to other types of indexes.) Specifying a work tablespace reduces fragmentation in the index tablespace, but it requires storage space of two times the size of the final index; however, after the index is created you can drop or reuse the work tablespace.
securefile	'securefile=TRUE' causes SecureFiles Intelligent Compression to be used; 'securefile=FALSE' causes SecureFiles Intelligent Compression not to be used. See the compression parameter explanation for more information. Data type is VARCHAR2. Default = 'securefile=FALSE'
compression	'compression=<OFF LOW MEDIUM HIGH>' controls the level of spatial index node compression. To specify any value other than OFF, you must also specify 'securefile=TRUE', and you must have a license for the Oracle Advanced Compression Option and implement SecureFiles Intelligent Compression. See the Usage Notes for more information. Data type is VARCHAR2. Default = 'compression=OFF'
{ <i>NOPARALLEL</i>   <i>PARALLEL</i> [ <i>integer</i> ] }	Controls whether serial (NOPARALLEL) execution or parallel (PARALLEL) execution is used for the creation of the index and for subsequent queries and DML operations that use the index. For parallel execution you can specify an integer value of degree of parallelism. See the Usage Notes for more information about parallel index creation. Default = NOPARALLEL. (If PARALLEL is specified without an integer value, the Oracle database calculates the optimum degree of parallelism.)

### Prerequisites

- All current SQL CREATE INDEX prerequisites apply.
- You must have EXECUTE privilege on the index type and its implementation type.
- The USER\_SDO\_GEOM\_METADATA view must contain an entry with the dimensions and coordinate boundary information for the table column to be spatially indexed.

## Usage Notes

For information about spatial indexes, see [Indexing of Spatial Data](#) (page 1-10).

Before you create a spatial index, be sure that the rollback segment size and the `SORT_AREA_SIZE` parameter value are adequate, as described in [Creating a Spatial Index](#) (page 5-1).

If an R-tree index is used on linear referencing system (LRS) data and if the LRS data has four dimensions (three plus the M dimension), the `sdo_indx_dims` parameter must be used and must specify 3 (the number of dimensions minus one), to avoid the default `sdo_indx_dims` value of 2, which would index only the X and Y dimensions. For example, if the dimensions are X, Y, Z, and M, specify `sdo_indx_dims=3` to index the X, Y, and Z dimensions, but not the measure (M) dimension. (The LRS data model, including the measure dimension, is explained in [LRS Data Model](#) (page 7-6).)

A partitioned spatial index can be created on a partitioned table. See [Using Partitioned Spatial Indexes](#) (page 5-3) for more information about partitioned spatial indexes, including benefits and restrictions.

If you want to use a *local* partitioned spatial index, follow the procedure in [Creating a Local Partitioned Spatial Index](#) (page 5-5).

A spatial index cannot be created on an index-organized table.

You can specify the `PARALLEL` keyword to cause the index creation to be parallelized. For example:

```
CREATE INDEX cola_spatial_idx ON cola_markets(shape)
  INDEXTYPE IS MDSYS.SPATIAL_INDEX PARALLEL;
```

For information about using the `PARALLEL` keyword, see the description of the `parallel_clause` in the section on the `CREATE INDEX` statement in *Oracle Database SQL Language Reference*. In addition, the following notes apply to the use of the `PARALLEL` keyword for creating or rebuilding (using the [ALTER INDEX REBUILD](#) (page 17-3) statement) spatial indexes:

- The performance cost and benefits from parallel execution for creating or rebuilding an index depend on system resources and load. If the CPUs or disk controllers are already heavily loaded, you should not specify the `PARALLEL` keyword.
- Specifying `PARALLEL` for creating or rebuilding an index on tables with simple geometries, such as point data, usually results in less performance improvement than on tables with complex geometries.

Other options available for regular indexes (such as `ASC` and `DESC`) are not applicable for spatial indexes.

Spatial index creation involves creating and inserting index data, for each row in the underlying table column being spatially indexed, into a table with a prescribed format. All rows in the underlying table are processed before the insertion of index data is committed, and this requires adequate rollback segment space.

If a tablespace name is provided in the parameters clause, the user (underlying table owner) must have appropriate privileges for that tablespace.

For more information about using the `layer_gtype` keyword to constrain data in a layer to a geometry type, see [Constraining Data to a Geometry Type](#) (page 5-2).

The `sdo_dml_batch_size` parameter can improve application performance, because Spatial and Graph can preallocate system resources to perform multiple index

updates more efficiently than successive single index updates; however, to gain the performance benefit, you must not perform commit operations after each insert operation or at intervals less than or equal to the `sdo_dml_batch_size` value. You should not specify a value greater than 10000 (ten thousand), because the cost of the additional memory and other resources required will probably outweigh any marginal performance increase resulting from such a value.

Specifying `'sdo_non_leaf_tbl=TRUE'` can help query performance with large data sets if the entire R-tree table may not fit in the KEEP buffer pool. In this case, you must also cause Oracle to buffer the MDNT\_...\$ table in the KEEP buffer pool, for example, by using ALTER TABLE and specifying STORAGE (BUFFER\_POOL KEEP). For partitioned indexes, the same `sdo_non_leaf_tbl` value must be used for all partitions. Any physical storage parameters, except for `tablespace`, are applied only to the MDRT\_...\$ table. The MDNT\_...\$ table uses only the `tablespace` parameter, if specified, and default values for all other physical storage parameters.

The `compression` parameter with a value of LOW, MEDIUM, or HIGH causes the SecureFiles Intelligent Compression feature to be used. The higher the compression, the higher the latency incurred.

- `'compression=HIGH'` incurs more work, but compresses the data better.
- `'compression=LOW'` uses a lightweight compression algorithm that removes most of the CPU cost that is typical with file compression. Compressed SecureFiles, thus providing a very efficient choice for SecureFiles LOB storage. SecureFiles LOBs compressed at LOW generally consume less storage and CPU time than BasicFiles LOBs, and help applications run faster because of a reduction in disk I/O.

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**Note:**

When using `compression` with any value other than OFF, set the `DB_BLOCK_CHECKING` database parameter to FALSE or OFF. Using any other `DB_BLOCK_CHECKING` database parameter value in conjunction with a `compression` value other than OFF could adversely affect spatial index DML (insert, update, or delete) operations.

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If you are creating a function-based spatial index, the number of parameters must not exceed 32. For information about using function-based spatial indexes, see [SDO\\_GEOMETRY Objects in Function-Based Indexes](#) (page 9-3).

To determine if a [CREATE INDEX](#) (page 17-7) statement for a spatial index has failed, check to see if the `DOMIDX_OPSTATUS` column in the `USER_INDEXES` view is set to FAILED. This is different from the case of regular indexes, where you check to see if the `STATUS` column in the `USER_INDEXES` view is set to FAILED.

If the [CREATE INDEX](#) (page 17-7) statement fails because of an invalid geometry, the ROWID of the failed geometry is returned in an error message along with the reason for the failure.

If the [CREATE INDEX](#) (page 17-7) statement fails for any reason, then the [DROP INDEX](#) (page 17-12) statement must be used to clean up the partially built index and associated metadata. If [DROP INDEX](#) (page 17-12) does not work, add the `FORCE` parameter and try again.

## Examples

The following example creates a spatial R-tree index named COLA\_SPATIAL\_IDX.

```
CREATE INDEX cola_spatial_idx ON cola_markets(shape)
  INDEXTYPE IS MDSYS.SPATIAL_INDEX;
```

**Related Topics**

- [ALTER INDEX](#) (page 17-1)
- [DROP INDEX](#) (page 17-12)

## 17.5 DROP INDEX

**Syntax**

```
DROP INDEX [schema.]index [FORCE];
```

**Purpose**

Deletes a spatial index.

**Keywords and Parameters**

Value	Description
FORCE	Causes the spatial index to be deleted from the system tables even if the index is marked in-progress or some other error condition occurs.

**Prerequisites**

You must have EXECUTE privileges on the index type and its implementation type.

**Usage Notes**

Use [DROP INDEX](#) (page 17-12) indexname FORCE to clean up after a failure in the [CREATE INDEX](#) (page 17-7) statement.

**Examples**

The following example deletes a spatial index named OLDINDEX and forces the deletion to be performed even if the index is marked in-process or an error occurs.

```
DROP INDEX oldindex FORCE;
```

**Related Topics**

- [CREATE INDEX](#) (page 17-7)



## Spatial Operators

This chapter describes the operators that you can use when working with the spatial object data type. For an overview of spatial operators, including how they differ from spatial procedures and functions, see [Spatial Operators\\_ Procedures\\_ and Functions](#) (page 1-14). The following table lists the main operators.

**Table 18-1 Main Spatial Operators**

Operator	Description
<a href="#">SDO_FILTER</a> (page 18-8)	Specifies which geometries may interact with a given geometry.
<a href="#">SDO_JOIN</a> (page 18-12)	Performs a spatial join based on one or more topological relationships.
<a href="#">SDO_NN</a> (page 18-17)	Determines the nearest neighbor geometries to a geometry.
<a href="#">SDO_NN_DISTANCE</a> (page 18-21)	Returns the distance of an object returned by the <a href="#">SDO_NN</a> (page 18-17) operator.
<a href="#">SDO_POINTINPOLYGON</a> (page 18-28)	Takes a set of rows whose first column is a point's x-coordinate value and the second column is a point's y-coordinate value, and returns those rows that are within a specified polygon geometry.
<a href="#">SDO_RELATE</a> (page 18-30)	Determines whether or not two geometries interact in a specified way. (See also <a href="#">Table 18-2</a> (page 18-1) for convenient alternative operators for performing specific mask value operations.)
<a href="#">SDO_WITHIN_DISTANCE</a> (page 18-36)	Determines if two geometries are within a specified distance from one another.

[Table 18-2](#) (page 18-1) lists operators, provided for convenience, that perform an [SDO\\_RELATE](#) (page 18-30) operation of a specific mask type.

**Table 18-2 Convenience Operators for SDO\_RELATE Operations**

Operator	Description
<a href="#">SDO_ANYINTERACT</a> (page 18-2)	Checks if any geometries in a table have the ANYINTERACT topological relationship with a specified geometry.
<a href="#">SDO_CONTAINS</a> (page 18-4)	Checks if any geometries in a table have the CONTAINS topological relationship with a specified geometry.
<a href="#">SDO_COVEREDBY</a> (page 18-5)	Checks if any geometries in a table have the COVEREDBY topological relationship with a specified geometry.

**Table 18-2 (Cont.) Convenience Operators for SDO\_RELATE Operations**

Operator	Description
<a href="#">SDO_COVERS</a> (page 18-6)	Checks if any geometries in a table have the COVERS topological relationship with a specified geometry.
<a href="#">SDO_EQUAL</a> (page 18-7)	Checks if any geometries in a table have the EQUAL topological relationship with a specified geometry.
<a href="#">SDO_INSIDE</a> (page 18-11)	Checks if any geometries in a table have the INSIDE topological relationship with a specified geometry.
<a href="#">SDO_ON</a> (page 18-23)	Checks if any geometries in a table have the ON topological relationship with a specified geometry.
<a href="#">SDO_OVERLAPBDYDISJOINT</a> (page 18-24)	Checks if any geometries in a table have the OVERLAPBDYDISJOINT topological relationship with a specified geometry.
<a href="#">SDO_OVERLAPBDYINTERSECT</a> (page 18-25)	Checks if any geometries in a table have the OVERLAPBDYINTERSECT topological relationship with a specified geometry.
<a href="#">SDO_OVERLAPS</a> (page 18-27)	Checks if any geometries in a table overlap (that is, have the OVERLAPBDYDISJOINT or OVERLAPBDYINTERSECT topological relationship with) a specified geometry.
<a href="#">SDO_TOUCH</a> (page 18-35)	Checks if any geometries in a table have the TOUCH topological relationship with a specified geometry.

**Note:**

For any numbers in string (VARCHAR2) parameters to Spatial and Graph operators and subprograms, the period (.) must be used for any decimal points regardless of the locale. Example: 'distance=3.7'

The rest of this chapter provides reference information on the operators, listed in alphabetical order.

For information about using operators with topologies, see *Oracle Spatial and Graph Topology Data Model and Network Data Model Graph Developer's Guide*.

## 18.1 SDO\_ANYINTERACT

**Format**

```
SDO_ANYINTERACT(geometry1, geometry2);
```

**Description**

Checks if any geometries in a table have the ANYINTERACT topological relationship with a specified geometry. Equivalent to specifying the [SDO\\_RELATE](#) (page 18-30) operator with 'mask=ANYINTERACT'.

See the section on the [SDO\\_RELATE](#) (page 18-30) operator in this chapter for information about the operations performed by this operator and for usage requirements.

### Keywords and Parameters

Value	Description
geometry1	Specifies a geometry column in a table. The column must be spatially indexed. Data type is SDO_GEOMETRY.
geometry2	Specifies either a geometry from a table or a transient instance of a geometry. (Specified using a bind variable or SDO_GEOMETRY constructor.) Data type is SDO_GEOMETRY.

### Returns

The expression `SDO_ANYINTERACT(geometry1,geometry2) = 'TRUE'` evaluates to TRUE for object pairs that have the ANYINTERACT topological relationship, and FALSE otherwise.

### Usage Notes

See the Usage Notes for the [SDO\\_RELATE](#) (page 18-30) operator in this chapter.

For an explanation of the topological relationships and the nine-intersection model used by Spatial and Graph, see [Spatial Relationships and Filtering](#) (page 1-11).

For information about 3D support with spatial operators (which operators do and do not consider all three dimensions in their computations), see [Three-Dimensional Spatial Objects](#) (page 1-16).

### Examples

The following example finds geometries that have the ANYINTERACT relationship with a query window (here, a rectangle with lower-left, upper-right coordinates 4,6, 8,8). (The example uses the definitions and data described in [Simple Example: Inserting, Indexing, and Querying Spatial Data](#) (page 2-1) and illustrated in [Figure 2-1](#) (page 2-2).)

```
SELECT c.mkt_id, c.name
FROM cola_markets c
WHERE SDO_ANYINTERACT(c.shape,
    SDO_GEOMETRY(2003, NULL, NULL,
        SDO_ELEM_INFO_ARRAY(1,1003,3),
        SDO_ORDINATE_ARRAY(4,6, 8,8))
    ) = 'TRUE';
```

```

MKT_ID NAME
-----
      2 cola_b
      1 cola_a
      4 cola_d
```

## 18.2 SDO\_CONTAINS

### Format

```
SDO_CONTAINS(geometry1, geometry2);
```

### Description

Checks if any geometries in a table have the CONTAINS topological relationship with a specified geometry. Equivalent to specifying the [SDO\\_RELATE](#) (page 18-30) operator with 'mask=CONTAINS'.

See the section on the [SDO\\_RELATE](#) (page 18-30) operator in this chapter for information about the operations performed by this operator and for usage requirements.

### Keywords and Parameters

Value	Description
geometry1	Specifies a geometry column in a table. The column must be spatially indexed. Data type is SDO_GEOMETRY.
geometry2	Specifies either a geometry from a table or a transient instance of a geometry. (Specified using a bind variable or SDO_GEOMETRY constructor.) Data type is SDO_GEOMETRY.

### Returns

The expression `SDO_CONTAINS(geometry1,geometry2) = 'TRUE'` evaluates to TRUE for object pairs that have the CONTAINS topological relationship, and FALSE otherwise.

### Usage Notes

See the Usage Notes for the [SDO\\_RELATE](#) (page 18-30) operator in this chapter.

For an explanation of the topological relationships and the nine-intersection model used by Spatial and Graph, see [Spatial Relationships and Filtering](#) (page 1-11).

For information about 3D support with spatial operators (which operators do and do not consider all three dimensions in their computations), see [Three-Dimensional Spatial Objects](#) (page 1-16).

### Examples

The following example finds geometries that have the CONTAINS relationship with a query window (here, a rectangle with lower-left, upper-right coordinates 2,2, 4,6). (The example uses the definitions and data described in [Simple Example: Inserting, Indexing, and Querying Spatial Data](#) (page 2-1) and illustrated in [Figure 2-1](#) (page 2-2).) In this example, only `cola_a` contains the query window geometry.

```
SELECT c.mkt_id, c.name
FROM cola_markets c
WHERE SDO_CONTAINS(c.shape,
                   SDO_GEOMETRY(2003, NULL, NULL,
```

```
SDO_ELEM_INFO_ARRAY(1,1003,3),
SDO_ORDINATE_ARRAY(2,2, 4,6))
) = 'TRUE';
```

```
MKT_ID NAME
-----
1 cola_a
```

## 18.3 SDO\_COVEREDBY

### Format

```
SDO_COVEREDBY(geometry1, geometry2);
```

### Description

Checks if any geometries in a table have the COVEREDBY topological relationship with a specified geometry. Equivalent to specifying the [SDO\\_RELATE](#) (page 18-30) operator with 'mask=COVEREDBY'.

See the section on the [SDO\\_RELATE](#) (page 18-30) operator in this chapter for information about the operations performed by this operator and for usage requirements.

### Keywords and Parameters

Value	Description
geometry1	Specifies a geometry column in a table. The column must be spatially indexed. Data type is SDO_GEOMETRY.
geometry2	Specifies either a geometry from a table or a transient instance of a geometry. (Specified using a bind variable or SDO_GEOMETRY constructor.) Data type is SDO_GEOMETRY.

### Returns

The expression SDO\_COVEREDBY(geometry1,geometry2) = 'TRUE' evaluates to TRUE for object pairs that have the COVEREDBY topological relationship, and FALSE otherwise.

### Usage Notes

See the Usage Notes for the [SDO\\_RELATE](#) (page 18-30) operator in this chapter.

For an explanation of the topological relationships and the nine-intersection model used by Spatial and Graph, see [Spatial Relationships and Filtering](#) (page 1-11).

For information about 3D support with spatial operators (which operators do and do not consider all three dimensions in their computations), see [Three-Dimensional Spatial Objects](#) (page 1-16).

### Examples

The following example finds geometries that have the COVEREDBY relationship with a query window (here, a rectangle with lower-left, upper-right coordinates 1,1, 5,8). (The example uses the definitions and data described in [Simple Example: Inserting\\_](#)

[Indexing and Querying Spatial Data](#) (page 2-1) and illustrated in [Figure 2-1](#) (page 2-2). In this example, only cola\_a is covered by the query window geometry.

```
SELECT c.mkt_id, c.name
FROM cola_markets c
WHERE SDO_COVEREDBY(c.shape,
    SDO_GEOMETRY(2003, NULL, NULL,
        SDO_ELEM_INFO_ARRAY(1,1003,3),
        SDO_ORDINATE_ARRAY(1,1, 5,8))
    ) = 'TRUE';

MKT_ID NAME
-----
1 cola_a
```

18.4 SDO\_COVERS

Format

```
SDO_COVERS(geometry1, geometry2);
```

Description

Checks if any geometries in a table have the COVERS topological relationship with a specified geometry. Equivalent to specifying the [SDO\\_RELATE](#) (page 18-30) operator with 'mask=COVERS'.

See the section on the [SDO\\_RELATE](#) (page 18-30) operator in this chapter for information about the operations performed by this operator and for usage requirements.

Keywords and Parameters

Value	Description
geometry1	Specifies a geometry column in a table. The column must be spatially indexed. Data type is SDO_GEOMETRY.
geometry2	Specifies either a geometry from a table or a transient instance of a geometry. (Specified using a bind variable or SDO_GEOMETRY constructor.) Data type is SDO_GEOMETRY.

Returns

The expression SDO\_COVERS(geometry1,geometry2) = 'TRUE' evaluates to TRUE for object pairs that have the COVERS topological relationship, and FALSE otherwise.

Usage Notes

See the Usage Notes for the [SDO\\_RELATE](#) (page 18-30) operator in this chapter.

For an explanation of the topological relationships and the nine-intersection model used by Spatial and Graph, see [Spatial Relationships and Filtering](#) (page 1-11).

For information about 3D support with spatial operators (which operators do and do not consider all three dimensions in their computations), see [Three-Dimensional Spatial Objects](#) (page 1-16).

### Examples

The following example finds geometries that have the COVERS relationship with a query window (here, a rectangle with lower-left, upper-right coordinates 1,1, 4,6). (The example uses the definitions and data described in [Simple Example: Inserting\\_ Indexing\\_ and Querying Spatial Data](#) (page 2-1) and illustrated in [Figure 2-1](#) (page 2-2).) In this example, only cola\_a covers the query window geometry.

```
SELECT c.mkt_id, c.name
FROM cola_markets c
WHERE SDO_COVERS(c.shape,
  SDO_GEOMETRY(2003, NULL, NULL,
    SDO_ELEM_INFO_ARRAY(1,1003,3),
    SDO_ORDINATE_ARRAY(1,1, 4,6))
  ) = 'TRUE';
```

MKT_ID	NAME
1	cola_a

## 18.5 SDO\_EQUAL

### Format

```
SDO_EQUAL(geometry1, geometry2);
```

### Description

Checks if any geometries in a table have the EQUAL topological relationship with a specified geometry. Equivalent to specifying the [SDO\\_RELATE](#) (page 18-30) operator with 'mask=EQUAL'.

See the section on the [SDO\\_RELATE](#) (page 18-30) operator in this chapter for information about the operations performed by this operator and for usage requirements.

### Keywords and Parameters

Value	Description
geometry1	Specifies a geometry column in a table. The column must be spatially indexed. Data type is SDO_GEOMETRY.
geometry2	Specifies either a geometry from a table or a transient instance of a geometry. (Specified using a bind variable or SDO_GEOMETRY constructor.) Data type is SDO_GEOMETRY.

### Returns

The expression `SDO_EQUAL(geometry1, geometry2) = 'TRUE'` evaluates to TRUE for object pairs that have the EQUAL topological relationship, and FALSE otherwise.

### Usage Notes

See the Usage Notes for the [SDO\\_RELATE](#) (page 18-30) operator in this chapter.

For an explanation of the topological relationships and the nine-intersection model used by Spatial and Graph, see [Spatial Relationships and Filtering](#) (page 1-11).

For information about 3D support with spatial operators (which operators do and do not consider all three dimensions in their computations), see [Three-Dimensional Spatial Objects](#) (page 1-16).

Examples

The following example finds geometries that have the EQUAL relationship with a query window (here, a rectangle with lower-left, upper-right coordinates 1,1, 5,7). (The example uses the definitions and data described in [Simple Example: Inserting, Indexing, and Querying Spatial Data](#) (page 2-1) and illustrated in [Figure 2-1](#) (page 2-2).) In this example, cola\_a (and only cola\_a) has the same boundary and interior as the query window geometry.

```
SELECT c.mkt_id, c.name
FROM cola_markets c
WHERE SDO_EQUAL(c.shape,
               SDO_GEOMETRY(2003, NULL, NULL,
                           SDO_ELEM_INFO_ARRAY(1,1003,3),
                           SDO_ORDINATE_ARRAY(1,1, 5,7))
               ) = 'TRUE';

MKT_ID NAME
-----
1 cola_a
```

18.6 SDO\_FILTER

Format

```
SDO_FILTER(geometry1, geometry2, param);
```

Description

Uses the spatial index to identify either the set of spatial objects that are likely to interact spatially with a given object (such as an area of interest), or pairs of spatial objects that are likely to interact spatially. Objects interact spatially if they are not disjoint.

This operator performs only a primary filter operation. The secondary filtering operation, performed by the [SDO\\_RELATE](#) (page 18-30) operator, can be used to determine with certainty if objects interact spatially.

Keywords and Parameters

Value	Description
geometry1	Specifies a geometry column in a table. The column must be spatially indexed. Data type is SDO_GEOMETRY.
geometry2	Specifies either a geometry from a table or a transient instance of a geometry. (Specified using a bind variable or SDO_GEOMETRY constructor.) Data type is SDO_GEOMETRY.



Value	Description
param	<p>Optionally specifies either or both of the <code>min_resolution</code> and <code>max_resolution</code> keywords. Data type is VARCHAR2.</p> <p>The <code>min_resolution</code> keyword includes only geometries for which at least one side of the geometry's MBR is equal to or greater than the specified value. For example, <code>min_resolution=10</code> includes only geometries for which the width or the height (or both) of the geometry's MBR is at least 10. (This keyword can be used to exclude geometries that are too small to be of interest.)</p> <p>The <code>max_resolution</code> keyword includes only geometries for which at least one side of the geometry's MBR is less than or equal to the specified value. For example, <code>max_resolution=10</code> includes only geometries for which the width or the height (or both) of the geometry's MBR is less than or equal to 10. (This keyword can be used to exclude geometries that are too large to be of interest.)</p>

### Returns

The expression `SDO_FILTER(geometry1,geometry2) = 'TRUE'` evaluates to TRUE for object pairs that are non-disjoint, and FALSE otherwise.

### Usage Notes

The `SDO_FILTER` operator must always be used in a WHERE clause and the condition that includes the operator should be an expression of the form `SDO_FILTER(arg1, arg2) = 'TRUE'`. (The expression must not equate to any value other than 'TRUE'.)

`geometry2` can come from a table or be a transient `SDO_GEOMETRY` object, such as a bind variable or `SDO_GEOMETRY` constructor.

- If the `geometry2` column is not spatially indexed, the operator indexes the query window in memory and performance is very good.
- If two or more geometries from `geometry2` are passed to the operator, the `ORDERED` optimizer hint must be specified, and the table in `geometry2` must be specified first in the FROM clause.

If `geometry1` and `geometry2` are based on different coordinate systems, `geometry2` is temporarily transformed to the coordinate system of `geometry1` for the operation to be performed, as described in [Different Coordinate Systems for Geometries with Operators and Functions](#) (page 6-73).

---

#### Note:

If the `DBMS_RLS.ADD_POLICY` procedure has been used to add a fine-grained access control policy to a table or view, and if the specified policy function uses a spatial operator, the operator must be `SDO_FILTER`. No other spatial operators are supported in that context.

---

For information about 3D support with spatial operators (which operators do and do not consider all three dimensions in their computations), see [Three-Dimensional Spatial Objects](#) (page 1-16).

## Examples

The following example selects the geometries that are likely to interact with a query window (here, a rectangle with lower-left, upper-right coordinates 4,6, 8,8). (The example uses the definitions and data described in [Simple Example: Inserting\\_ Indexing\\_ and Querying Spatial Data](#) (page 2-1) and illustrated in [Figure 2-1](#) (page 2-2).)

```
SELECT c.mkt_id, c.name
FROM cola_markets c
WHERE SDO_FILTER(c.shape,
  SDO_GEOMETRY(2003, NULL, NULL,
    SDO_ELEM_INFO_ARRAY(1,1003,3),
    SDO_ORDINATE_ARRAY(4,6, 8,8))
) = 'TRUE';

MKT_ID NAME
-----
      2 cola_b
      1 cola_a
      4 cola_d
```

The following example is the same as the preceding example, except that it includes only geometries where at least one side of the geometry's MBR is equal to or greater than 4.1. In this case, only `cola_a` and `cola_b` are returned, because their MBRs have at least one side with a length greater than or equal to 4.1. The circle `cola_d` is excluded, because its MBR is a square whose sides have a length of 4.

```
SELECT c.mkt_id, c.name
FROM cola_markets c
WHERE SDO_FILTER(c.shape,
  SDO_GEOMETRY(2003, NULL, NULL,
    SDO_ELEM_INFO_ARRAY(1,1003,3),
    SDO_ORDINATE_ARRAY(4,6, 8,8)),
'min_resolution=4.1'
) = 'TRUE';

MKT_ID NAME
-----
      2 cola_b
      1 cola_a
```

The following example selects the GID values from the POLYGONS table where the GEOMETRY column objects are likely to interact spatially with the GEOMETRY column object in the QUERY\_POLYS table that has a GID value of 1.

```
SELECT A.gid
FROM Polygons A, query_polys B
WHERE B.gid = 1
AND SDO_FILTER(A.Geometry, B.Geometry) = 'TRUE';
```

The following example selects the GID values from the POLYGONS table where the GEOMETRY column object is likely to interact spatially with the geometry stored in the aGeom variable.

```
Select A.Gid
FROM Polygons A
WHERE SDO_FILTER(A.Geometry, :aGeom) = 'TRUE';
```

The following example selects the GID values from the POLYGONS table where the GEOMETRY column object is likely to interact spatially with the specified rectangle having the lower-left coordinates (x1,y1) and the upper-right coordinates (x2, y2).

```
Select A.Gid
  FROM Polygons A
 WHERE SDO_FILTER(A.Geometry, sdo_geometry(2003,NULL,NULL,
                                     sdo_elem_info_array(1,1003,3),
                                     sdo_ordinate_array(x1,y1,x2,y2))
        ) = 'TRUE';
```

The following example selects the GID values from the POLYGONS table where the GEOMETRY column object is likely to interact spatially with any GEOMETRY column object in the QUERY\_POLYS table. In this example, the ORDERED optimizer hint is used and the QUERY\_POLYS (geometry2) table is specified first in the FROM clause, because multiple geometries from geometry2 are involved (see the Usage Notes).

```
SELECT /*+ ORDERED */
      A.gid
  FROM query_polys B, polygons A
 WHERE SDO_FILTER(A.Geometry, B.Geometry) = 'TRUE';
```

### Related Topics

- [SDO\\_RELATE](#) (page 18-30)

## 18.7 SDO\_INSIDE

### Format

```
SDO_INSIDE(geometry1, geometry2);
```

### Description

Checks if any geometries in a table have the INSIDE topological relationship with a specified geometry. Equivalent to specifying the [SDO\\_RELATE](#) (page 18-30) operator with 'mask=INSIDE'.

See the section on the [SDO\\_RELATE](#) (page 18-30) operator in this chapter for information about the operations performed by this operator and for usage requirements.

### Keywords and Parameters

Value	Description
geometry1	Specifies a geometry column in a table. The column must be spatially indexed. Data type is SDO_GEOMETRY.
geometry2	Specifies either a geometry from a table or a transient instance of a geometry. (Specified using a bind variable or SDO_GEOMETRY constructor.) Data type is SDO_GEOMETRY.

### Returns

The expression SDO\_INSIDE(geometry1,geometry2) = 'TRUE' evaluates to TRUE for object pairs that have the INSIDE topological relationship, and FALSE otherwise.

Usage Notes

See the Usage Notes for the [SDO\\_RELATE](#) (page 18-30) operator in this chapter.

For an explanation of the topological relationships and the nine-intersection model used by Spatial and Graph, see [Spatial Relationships and Filtering](#) (page 1-11).

For information about 3D support with spatial operators (which operators do and do not consider all three dimensions in their computations), see [Three-Dimensional Spatial Objects](#) (page 1-16).

Examples

The following example finds geometries that have the INSIDE relationship with a query window (here, a rectangle with lower-left, upper-right coordinates 5,6, 12,12). (The example uses the definitions and data described in [Simple Example: Inserting, Indexing, and Querying Spatial Data](#) (page 2-1) and illustrated in [Figure 2-1](#) (page 2-2).) In this example, only cola\_d (the circle) is inside the query window geometry.

```
SELECT c.mkt_id, c.name
FROM cola_markets c
WHERE SDO_INSIDE(c.shape,
                SDO_GEOMETRY(2003, NULL, NULL,
                SDO_ELEM_INFO_ARRAY(1,1003,3),
                SDO_ORDINATE_ARRAY(5,6, 12,12))
        ) = 'TRUE';

MKT_ID NAME
-----
      4 cola_d
```

18.8 SDO\_JOIN

Format

```
SDO_JOIN(table_name1, column_name1, table_name2, column_name2,
params,preserve_join_order, table1_partition, table2_partition) RETURN SDO_ROWIDSET;
```

Description

Performs a spatial join based on one or more topological relationships.

Keywords and Parameters

Value	Description
table_name1	Name of the first table to be used in the spatial join operation. The table must have a column of type SDO_GEOMETRY. Data type is VARCHAR2.
column_name1	Name of the spatial column of type SDO_GEOMETRY in table_name1. A spatial R-tree index must be defined on this column. Data type is VARCHAR2.

Value	Description
table_name2	Name of the second table to be used in the spatial join operation. (It can be the same as or different from table_name1. If table_name2 is the same as table_name1, see <a href="#">"Optimizing Self-Joins"</a> (page 18-15) in this section.) The table must have a column of type SDO_GEOMETRY. Data type is VARCHAR2.
column_name2	Name of the spatial column of type SDO_GEOMETRY in table_name2. A spatial R-tree index must be defined on this column. Data type is VARCHAR2.
params	Optional parameter string of keywords and values; available only if mask=ANYINTERACT. Determines the behavior of the operator. See <a href="#">Table 18-3</a> (page 18-14) in the Usage Notes for information about the available keywords. Data type is VARCHAR2. Default is NULL.
preserve_join_order	Optional parameter to specify if the join order is guaranteed to be preserved during processing of the operator. If the value is 0 (the default), the order of the tables might be changed; if the value is 1, the order of the tables is not changed. Data type is NUMBER. Default is 0.
table1_partition	Name of the table partition in table_name1. Must be specified if the table has a partitioned spatial index; must be null if the table does not have a partitioned spatial index. (For information about using partitioned spatial indexes, see <a href="#">Using Partitioned Spatial Indexes</a> (page 5-3).) Data type is VARCHAR2. Default is null.
table2_partition	Name of the table partition in table_name2. Must be specified if the table has a partitioned spatial index; must be null if the table does not have a partitioned spatial index. (For information about using partitioned spatial indexes, see <a href="#">Using Partitioned Spatial Indexes</a> (page 5-3).) Data type is VARCHAR2. Default is null.

## Returns

SDO\_JOIN returns an object of SDO\_ROWIDSET, which consists of a table of objects of SDO\_ROWIDPAIR. Oracle Spatial and Graph defines the type SDO\_ROWIDSET as:

```
CREATE TYPE sdo_rowidset as TABLE OF sdo_rowidpair;
```

Oracle Spatial and Graph defines the object type SDO\_ROWIDPAIR as:

```
CREATE TYPE sdo_rowidpair AS OBJECT
  (rowid1 VARCHAR2(24),
   rowid2 VARCHAR2(24));
```

In the SDO\_ROWIDPAIR definition, rowid1 refers to a rowid from table\_name1, and rowid2 refers to a rowid from table\_name2.

## Usage Notes

SDO\_JOIN is technically not an operator, but a table function. (For an explanation of table functions, see *Oracle Database PL/SQL Language Reference*.) However, it is presented in the chapter with spatial operators because its usage is similar to that of

the operators, and because it is not part of a package with other functions and procedures.

This table function is recommended when you need to perform full table joins.

The geometries in `column_name1` and `column_name2` must have the same SRID (coordinate system) value and the same number of dimensions.

For best performance, use the `/*+ ORDERED */` optimizer hint, and specify the SDO\_JOIN table function first in the FROM clause.

If a table is version-enabled (using the Workspace Manager feature), you must specify the `<table_name>_LT` table created by Workspace Manager. For example, if the COLA\_MARKETS table is version-enabled and you want to perform a spatial join operation on that table, specify COLA\_MARKETS\_LT (not COLA\_MARKETS) with the SDO\_JOIN table function. (However, for all other spatial functions, procedures, and operators, do not use the `<table_name>_LT` name.)

[Table 18-3](#) (page 18-14) shows the keywords for the `params` parameter.

**Table 18-3** *params Keywords for the SDO\_JOIN Operator*

Keyword	Description
mask	<p>The topological relationship of interest. Valid values are 'mask=&lt;value&gt;' where &lt;value&gt; is one or more of the mask values valid for the <a href="#">SDO_RELATE</a> (page 18-30) operator (TOUCH, OVERLAPBDYDISJOINT, OVERLAPBDYINTERSECT, EQUAL, INSIDE, COVEREDBY, CONTAINS, COVERS, ANYINTERACT, ON), or FILTER, which checks if the MBRs (the filter-level approximations) intersect. Multiple masks are combined with the logical Boolean operator OR (for example, 'mask=inside+touch'); however, FILTER cannot be combined with any other mask.</p> <p>If this parameter is null or contains an empty string, mask=FILTER is assumed.</p>
distance	<p>Specifies a numeric distance value that is added to the tolerance value (explained in <a href="#">Tolerance</a> (page 1-6)) before the relationship checks are performed. For example, if the tolerance is 10 meters and you specify 'distance=100 unit=meter', two objects are considered to have spatial interaction if they are within 110 meters of each other. If you specify distance but not unit, the unit of measurement associated with the data is assumed.</p>
unit	<p>Specifies a unit of measurement to be associated with the distance value (for example, 'distance=100 unit=meter'). See <a href="#">Unit of Measurement Support</a> (page 2-55) for more information about unit of measurement specification. If you specify unit, you must also specify distance. Data type is VARCHAR2. Default = unit of measurement associated with the data. For geodetic data, the default is meters.</p>

Before you call SDO\_JOIN, you must commit any previous DML statements in your session. Otherwise, the following error will be returned: `ORA-13236: internal error in R-tree processing: [SDO_Join in active txns not supported]`

For information about 3D support with spatial operators (which operators do and do not consider all three dimensions in their computations), see [Three-Dimensional Spatial Objects](#) (page 1-16).

### Optimizing Self-Joins

If you are performing a self-join (that is, if `table_name1` and `table_name2` specify the same table), you can improve the performance by optimizing the self-join.

If `SDO_JOIN` is called without a mask (for example, `ANYINTERACT`) or distance specification, it compares only the index structure of the two geometry columns being joined. This can quickly identify geometry pairs that are "likely" to interact. If `SDO_JOIN` is called with a mask or distance specification, after the index is used to identify geometry pairs that are likely to interact, geometry coordinates are also compared to see if the geometry pairs actually do interact. Coordinate comparison is the most expensive part of the `SDO_JOIN` operation.

In a self-join, where the same geometry column is compared to itself, each geometry pair is returned twice in the result set. For example:

- For the geometry pair with ID values (1,2), the pair (2,1) is also returned. The undesired effect in `SDO_JOIN` is that the coordinates of the same geometry pair are compared twice, instead of once.
- ID pairs that are equal are returned twice. For example, a table with 50,000 rows will return ID pair (1,1) twice, ID pair (2,2) twice, and so on. This is also an undesired effect.

When calling `SDO_JOIN` in a self-join scenario, you can eliminate the undesired effects by eliminating duplicate comparison of geometry pairs and all coordinate comparisons where the ID values of the pairs match. This optimization uses `SDO_JOIN` for the primary filter only, and calls the [SDO\\_GEOM.RELATE](#) (page 23-4) function to compare geometry coordinates. The following statement accomplishes this optimization by adding "`AND b.rowid < c.rowid`" as a predicate to the `WHERE` clause.

```
SQL> set autotrace trace explain
SQL> SELECT /*+ ordered use_nl (a,b) use_nl (a,c) */ b.id, c.id
      FROM TABLE(sdo_join('GEOD_STATES','GEOM','GEOD_STATES','GEOM')) a,
      GEOD_STATES b,
      GEOD_STATES c
     WHERE a.rowid1 = b.rowid
           AND a.rowid2 = c.rowid
           AND b.rowid < c.rowid
           AND SDO_GEOM.RELATE (b.geom, 'ANYINTERACT', c.geom, .05) = 'TRUE'
```

Execution Plan

Plan hash value: 1412731386

Id	Operation	Name	Rows	Bytes	Cost (%CPU)	Time
0	SELECT STATEMENT		1	1124	12787 (1)	00:02:34
1	NESTED LOOPS		1	1124	12787 (1)	00:02:34
2	NESTED LOOPS		4574	2514K	8206 (1)	00:01:39
3	COLLECTION ITERATOR PICKLER FETCH	SDO_JOIN				
* 4	TABLE ACCESS BY USER ROWID	GEOD_STATES	1	561	1 (0)	00:00:01
* 5	TABLE ACCESS BY USER ROWID	GEOD_STATES	1	561	1 (0)	00:00:01

Predicate Information (identified by operation id):

```
4 - access(CHARTOROWID(VALUE(KOKBF$)))
5 - access(CHARTOROWID(VALUE(KOKBF$)))
   filter("B".ROWID<"C".ROWID AND
          "SDO_GEOM"."RELATE"("B"."GEOM",'ANYINTERACT',"C"."GEOM",.05)='TRUE')
```

```
SQL> set autotrace off
```

In the preceding example, It is very important that `AND b.rowid < c.rowid` be before the call to [SDO\\_GEOM.RELATE](#) (page 23-4) in the WHERE clause. This will omit the undesired scenarios for the invocation of the [SDO\\_GEOM.RELATE](#) (page 23-4) function. Also, note that the example uses the `ORDERED` and `USE_NL` hints, and that the execution plan does not contain `TABLE ACCESS FULL` or `HASH JOIN`.

### Cross-Schema Invocation of SDO\_JOIN

You can invoke the `SDO_JOIN` table function on an indexed table that is not in your schema, if you have been granted `SELECT` access to both the spatial table and to the index table for the spatial index that was created on the spatial table. To find the name of the index table for a spatial index, query the `SDO_INDEX_TABLE` column in the `USER_SDO_INDEX_METADATA` view. For example, the following statement returns the name of the index table for the `COLA_MARKETS_IDX` spatial index:

```
SELECT sdo_index_table FROM user_sdo_index_metadata
WHERE sdo_index_name = 'COLA_SPATIAL_IDX';
```

Assume that user A owns spatial table T1 (with index table `MDRT_F9AA$`), and that user B owns spatial table T2 and wants to join geometries from both T1 and T2. Assume also that the geometry column in both tables is named `GEOMETRY`.

User A or a suitably privileged user must connect as user A and execute the following statements:

```
GRANT select on T1 to B;
GRANT select on MDRT_F9AA$ to B;
```

User B can now connect and execute an `SDO_JOIN` query, such as the following:

```
SELECT COUNT(*) FROM
  (SELECT * FROM
    TABLE(SDO_JOIN('A.T1', 'GEOMETRY',
                    'B.T2', 'GEOMETRY',
                    'mask=anyinteract')) );
```

### Examples

The following example joins the `COLA_MARKETS` table with itself to find, for each geometry, all other geometries that have any spatial interaction with it. (The example uses the definitions and data from [Simple Example: Inserting\\_ Indexing\\_ and Querying Spatial Data](#) (page 2-1).) In this example, `rowid1` and `rowid2` correspond to the names of the attributes in the `SDO_ROWIDPAIR` type definition. Note that in the output, `cola_d` (the circle in [Figure 2-1](#) (page 2-2)) interacts only with itself, and not with any of the other geometries.

```
SELECT /*+ ordered */ a.name, b.name
FROM TABLE(SDO_JOIN('COLA_MARKETS', 'SHAPE',
                     'COLA_MARKETS', 'SHAPE',
                     'mask=ANYINTERACT')) c,
      cola_markets a,
      cola_markets b
```



```
WHERE c.rowid1 = a.rowid AND c.rowid2 = b.rowid
ORDER BY a.name;
```

NAME	NAME
cola_a	cola_c
cola_a	cola_b
cola_a	cola_a
cola_b	cola_c
cola_b	cola_b
cola_b	cola_a
cola_c	cola_c
cola_c	cola_b
cola_c	cola_a
cola_d	cola_d

10 rows selected.

### Related Topics

- [SDO\\_RELATE](#) (page 18-30)

## 18.9 SDO\_NN

### Format

```
SDO_NN(geometry1, geometry2, param [, number]);
```

### Description

Uses the spatial index to identify the nearest neighbors for a geometry.

### Keywords and Parameters

Value	Description
geometry1	Specifies a geometry column in a table. The column must be spatially indexed. Data type is SDO_GEOMETRY.
geometry2	Specifies either a geometry from a table or a transient instance of a geometry. The nearest neighbor or neighbors to geometry2 will be returned from geometry1. (geometry2 is specified using a bind variable or SDO_GEOMETRY constructor.) Data type is SDO_GEOMETRY.
param	Determines the behavior of the operator. The available keywords are listed in <a href="#">Table 18-4</a> (page 18-18). If you do not specify this parameter, the operator returns all rows in increasing distance order from geometry2. Data type is VARCHAR2.
number	If the <a href="#">SDO_NN_DISTANCE</a> (page 18-21) ancillary operator is included in the call to SDO_NN, specifies the same number used in the call to <a href="#">SDO_NN_DISTANCE</a> (page 18-21). Data type is NUMBER.

[Table 18-4](#) (page 18-18) lists the keywords for the param parameter.

**Table 18-4 Keywords for the SDO\_NN Param Parameter**

Keyword	Description
distance	Specifies the number of distance units after which to stop searching for nearest neighbors. If you do not also specify the <code>unit</code> keyword, the default is the unit of measurement associated with the data. Data type is NUMBER. For example: 'distance=10 unit=mile'
sdo_batch_size	Specifies the number of rows to be evaluated at a time when the SDO_NN expression may need to be evaluated multiple times in order to return the desired number of results that satisfy the WHERE clause. Available only when an R-tree index is used. If you specify <code>sdo_batch_size=0</code> (or if you omit the <code>param</code> parameter completely), Spatial and Graph calculates a batch size suited to the result set size. See the Usage Notes and Examples for more information. Data type is NUMBER. For example: 'sdo_batch_size=10'
sdo_num_res	Specifies the number of results (nearest neighbors) to be returned. If neither <code>sdo_batch_size</code> nor <code>sdo_num_res</code> is specified, this is equivalent to specifying <code>sdo_batch_size=0</code> . See the Usage Notes and Examples for more information. Data type is NUMBER. For example: 'sdo_num_res=5'
unit	If the <code>distance</code> keyword or the <a href="#">SDO_NN_DISTANCE</a> (page 18-21) ancillary operator is included in the call to SDO_NN, specifies the unit of measurement: a quoted string with <code>unit=</code> and an SDO_UNIT value from the MDSYS.SDO_DIST_UNITS table. See <a href="#">Unit of Measurement Support</a> (page 2-55) for more information about unit of measurement specification. Data type is VARCHAR2. Default = unit of measurement associated with the data. For geodetic data, the default is meters. For example: 'unit=KM'

## Returns

This operator returns the `sdo_num_res` number of objects from `geometry1` that are nearest to `geometry2` in the query. In determining how near two geometry objects are, the shortest possible distance between any two points on the surface of each object is used.

## Usage Notes

The operator is disabled if the table does not have a spatial index or if the number of dimensions for the query window does not match the number of dimensions specified when the index was created.

The operator must always be used in a WHERE clause, and the condition that includes the operator should be an expression of the form `SDO_NN(arg1, arg2, '<some_parameter>') = 'TRUE'`. (The expression must not equate to any value other than 'TRUE'.)

The operator can be used in the following ways:

- If all geometries in the layer are candidates, use the `sdo_num_res` keyword to specify the number of geometries returned.

The `sdo_num_res` keyword is especially useful when you are concerned only with proximity (for example, the three closest banks, regardless of bank name).

- If any geometries in the table might be nearer than the geometries specified in the WHERE clause, use the `sdo_batch_size` keyword and use the WHERE clause (including the ROWNUM pseudocolumn) to limit the number of geometries returned.

The `sdo_batch_size` keyword is especially useful when you need to consider one or more columns from the *same* table as the nearest neighbor search column in the WHERE clause (for example, the three closest banks whose name contains *MegaBank*).

- You can also specify both the `sdo_num_res` and `sdo_batch_size` keywords, as explained later in these Usage Notes.

As an example of the `sdo_batch_size` keyword, assume that a RESTAURANTS table contains different types of restaurants, and you want to find the two nearest Italian restaurants to your hotel but only if they are within two miles. The query might look like the following:

```
SELECT r.name FROM restaurants r WHERE
  SDO_NN(r.geometry, :my_hotel,
    'sdo_batch_size=10 distance=2 unit=mile')= 'TRUE'
  AND r.cuisine = 'Italian' AND ROWNUM <=2;
```

In this example, the ROWNUM <=2 clause is necessary to limit the number of results returned to no more than 2 where CUISINE is Italian. However, if the `sdo_batch_size` keyword is not specified in this example, and if `sdo_num_res=2` is specified instead of ROWNUM <=2, only the two nearest restaurants within two miles are considered, regardless of their CUISINE value; and if the CUISINE value of these two rows is not Italian, the query may return no rows.

The `sdo_batch_size` value can affect the performance of nearest neighbor queries. A good general guideline is to specify the number of candidate rows likely to satisfy the WHERE clause. Using the preceding example of a query for Italian restaurants, if approximately 20 percent of the restaurants nearest to the hotel are Italian and if you want 2 restaurants, an `sdo_batch_size` value of 10 will probably result in the best performance. On the other hand, if only approximately 5 percent of the restaurants nearest to the hotel are Italian and if you want 2 restaurants, an `sdo_batch_size` value of 40 would be better.

You can specify `sdo_batch_size=0`, which causes Spatial and Graph to calculate a batch size that is suitable for the result set size. However, the calculated batch size may not be optimal, and the calculation incurs some processing overhead; if you can determine a good `sdo_batch_size` value for a query, the performance will probably be better than if you specify `sdo_batch_size=0`.

Specify the number parameter only if you are using the [SDO\\_NN\\_DISTANCE](#) (page 18-21) ancillary operator in the call to SDO\_NN. See the information about the [SDO\\_NN\\_DISTANCE](#) (page 18-21) operator in this chapter.

If two or more objects from `geometry1` are an equal distance from `geometry2`, any of the objects can be returned on any call to the function. For example, if `item_a`, `item_b`, and `item_c` are nearest to and equally distant from `geometry2`, and if `sdo_num_res=2`, two of those three objects are returned, but they can be any two of the three.

If the SDO\_NN operator uses a partitioned spatial index (see [Using Partitioned Spatial Indexes](#) (page 5-3)), the requested number of geometries is returned for *each* partition

that contains candidate rows based on the query criteria. For example, if you request the 5 nearest restaurants to a point and the spatial index has 4 partitions, the operator returns up to 20 (5\*4) geometries. In this case, you must use the ROWNUM pseudocolumn (here, WHERE ROWNUM <=5) to return the 5 nearest restaurants.

If geometry1 and geometry2 are based on different coordinate systems, geometry2 is temporarily transformed to the coordinate system of geometry1 for the operation to be performed, as described in [Different Coordinate Systems for Geometries with Operators and Functions](#) (page 6-73).

SDO\_NN is not supported for spatial joins.

In some situations the SDO\_NN operator will not use the spatial index unless an optimizer hint forces the index to be used. This can occur when a query involves a join; and if the optimizer hint is not used in such situations, an internal error occurs. To prevent such errors, you should always specify an optimizer hint to use the spatial index with the SDO\_NN operator, regardless of how simple or complex the query is. For example, the following excerpt from a query specifies to use the COLA\_SPATIAL\_IDX index that is defined on the COLA\_MARKETS table:

```
SELECT /*+ INDEX(c cola_spatial_idx) */
      c.mkt_id, c.name, ... FROM cola_markets c, ...;
```

However, if the column predicate in the WHERE clause specifies any nonspatial column in the table for geometry1 that has an associated index, be sure that this index is not used by specifying the NO\_INDEX hint for that index. For example, if there was an index named COLA\_NAME\_IDX defined on the NAME column, you would need to specify the hints in the preceding example as follows:

```
SELECT /*+ INDEX(c cola_spatial_idx) NO_INDEX(c cola_name_idx) */
      c.mkt_id, c.name, ... FROM cola_markets c, ...;
```

(Note, however, that there is no index named COLA\_NAME\_IDX in the example in [Simple Example: Inserting, Indexing, and Querying Spatial Data](#) (page 2-1).)

If you join two or more tables with the SDO\_NN operator and the sdo\_num\_res keyword, specify the LEADING hint for the outer table, USE\_NL hint to have a nested loops join, and the INDEX hint for the inner table (the table with the spatial index). For example:

```
SELECT /*+ LEADING(b) USE_NL(b a) INDEX(a cola_spatial_idx) */ a.gid
      FROM cola_qry b, cola_markets a
      WHERE SDO_NN(a.shape, b.shape, 'sdo_num_res=1')='TRUE';
```

However, if you join two or more tables with the SDO\_NN operator, the sdo\_batch\_size keyword, and the ROWNUM clause, the best way to implement the logic is to use a PL/SQL block. For example:

```
BEGIN
  FOR item IN ( SELECT b.shape FROM cola_qry b)
  LOOP
    SELECT /*+ INDEX(a cola_spatial_idx) */ a.gid INTO local_gid
    FROM cola_markets a
    WHERE SDO_NN(a.shape, item.shape, 'sdo_batch_size=10')='TRUE'
      and a.name like 'cola%' and ROWNUM <2;
  END LOOP;
END;
```

For detailed information about using optimizer hints, see *Oracle Database SQL Tuning Guide*.

For information about 3D support with spatial operators (which operators do and do not consider all three dimensions in their computations), see [Three-Dimensional Spatial Objects](#) (page 1-16).

### Examples

The following example finds the two objects from the SHAPE column in the COLA\_MARKETS table that are nearest to a specified point (10,7). (The example uses the definitions and data described in [Simple Example: Inserting\\_ Indexing\\_ and Querying Spatial Data](#) (page 2-1) and illustrated in [Figure 2-1](#) (page 2-2).)

```
SELECT /*+ INDEX(c cola_spatial_idx) */
       c.mkt_id, c.name FROM cola_markets c WHERE SDO_NN(c.shape,
       sdo_geometry(2001, NULL, sdo_point_type(10,7,NULL), NULL,
       NULL), 'sdo_num_res=2') = 'TRUE';
```

MKT_ID	NAME
2	cola_b
4	cola_d

The following example uses the `sdo_batch_size` keyword to find the two objects (`ROWNUM <= 2`), with a NAME value less than 'cola\_d', from the SHAPE column in the COLA\_MARKETS table that are nearest to a specified point (10,7). The value of 3 for `sdo_batch_size` represents a best guess at the number of nearest geometries that need to be evaluated before the WHERE clause condition is satisfied. (The example uses the definitions and data from [Simple Example: Inserting\\_ Indexing\\_ and Querying Spatial Data](#) (page 2-1).)

```
SELECT /*+ INDEX(c cola_spatial_idx) */ c.mkt_id, c.name
       FROM cola_markets c
       WHERE SDO_NN(c.shape, sdo_geometry(2001, NULL,
       sdo_point_type(10,7,NULL), NULL, NULL),
       'sdo_batch_size=3') = 'TRUE'
       AND c.name < 'cola_d' AND ROWNUM <= 2;
```

MKT_ID	NAME
2	cola_b
3	cola_c

See also the more complex SDO\_NN examples in [SDO\\_NN Examples](#) (page C-3).

### Related Topics

- [SDO\\_NN\\_DISTANCE](#) (page 18-21)

## 18.10 SDO\_NN\_DISTANCE

### Format

```
SDO_NN_DISTANCE(number);
```

### Description

Returns the distance of an object returned by the [SDO\\_NN](#) (page 18-17) operator. Valid only within a call to the [SDO\\_NN](#) (page 18-17) operator.

Keywords and Parameters

Value	Description
number	Specifies a number that must be the same as the last parameter passed to the <a href="#">SDO_NN</a> (page 18-17) operator. Data type is NUMBER.

Returns

This operator returns the distance of an object returned by the [SDO\\_NN](#) (page 18-17) operator. In determining how near two geometry objects are, the shortest possible distance between any two points on the surface of each object is used.

Usage Notes

SDO\_NN\_DISTANCE is an ancillary operator to the [SDO\\_NN](#) (page 18-17) operator. It returns the distance between the specified geometry and a nearest neighbor object. This distance is passed as ancillary data to the [SDO\\_NN](#) (page 18-17) operator. (For an explanation of how operators can use ancillary data, see the section on ancillary data in *Oracle Database Data Cartridge Developer's Guide*.)

You can choose any arbitrary number for the number parameter. The only requirement is that it must match the last parameter in the call to the [SDO\\_NN](#) (page 18-17) operator.

Use a bind variable to store and operate on the distance value.

Examples

The following example finds the two objects from the SHAPE column in the COLA\_MARKETS table that are nearest to a specified point (10,7), and it finds the distance between each object and the point. (The example uses the definitions and data described in [Simple Example: Inserting, Indexing, and Querying Spatial Data](#) (page 2-1) and illustrated in [Figure 2-1](#) (page 2-2).)

```
SELECT  /*+ INDEX(c cola_spatial_idx) */
        c.mkt_id, c.name, SDO_NN_DISTANCE(1) dist
FROM    cola_markets c
WHERE   SDO_NN(c.shape, sdo_geometry(2001, NULL,
        sdo_point_type(10,7,NULL), NULL, NULL),
        'sdo_num_res=2', 1) = 'TRUE' ORDER BY dist;
```

MKT_ID	NAME	DIST
4	cola_d	.828427125
2	cola_b	2.23606798

Note the following about this example:

- 1 is used as the number parameter for SDO\_NN\_DISTANCE, and 1 is also specified as the last parameter to [SDO\\_NN](#) (page 18-17) (after 'sdo\_num\_res=2').
- The column alias dist holds the distance between the object and the point. (For geodetic data, the distance unit is meters; for non-geodetic data, the distance unit is the unit associated with the data.)

The following example uses the `sdo_batch_size` keyword in selecting the two closest Italian restaurants to your hotel from a `YELLOW_PAGES` table that contains different types of businesses:

```
SELECT * FROM
  (SELECT /*+ FIRST_ROWS */ y.name FROM YELLOW_PAGES y
   WHERE SDO_NN(y.geometry, :my_hotel, 'sdo_batch_size=100', 1) = 'TRUE'
   AND y.business = 'Italian Restaurant'
   ORDER BY SDO_NN_DISTANCE(1))
 WHERE ROWNUM <=10;
```

In the preceding query, the `FIRST_ROWS` hint enables the optimizer to improve performance by pushing the `ORDER BY` operation into the spatial index. `:my_hotel` can be either a bind variable or a literal value.

The `FIRST_ROWS` hint is also available to a local partitioned spatial index. In the preceding example, if the `YELLOW_PAGES` table is partitioned by name, the query will be executed as follows:

1. For each partition, the `ORDER BY` operation is processed using the spatial index until 10 rows are found.
2. After all partitions are completed, all rows found in the preceding step are sorted, and the top 10 rows are returned.

### Related Topics

- [SDO\\_NN](#) (page 18-17)

## 18.11 SDO\_ON

### Format

```
SDO_ON(geometry1, geometry2);
```

### Description

Checks if any geometries in a table have the ON topological relationship with a specified geometry. Equivalent to specifying the [SDO\\_RELATE](#) (page 18-30) operator with `'mask=ON'`.

See the section on the [SDO\\_RELATE](#) (page 18-30) operator in this chapter for information about the operations performed by this operator and for usage requirements.

### Keywords and Parameters

Value	Description
geometry1	Specifies a geometry column in a table. The column must be spatially indexed. Data type is <code>SDO_GEOMETRY</code> .
geometry2	Specifies either a geometry from a table or a transient instance of a geometry. (Specified using a bind variable or <code>SDO_GEOMETRY</code> constructor.) Data type is <code>SDO_GEOMETRY</code> .

Returns

The expression SDO\_ON(geometry1,geometry2) = 'TRUE' evaluates to TRUE for object pairs that have the ON topological relationship, and FALSE otherwise.

Usage Notes

See the Usage Notes for the [SDO\\_RELATE](#) (page 18-30) operator in this chapter.

For an explanation of the topological relationships and the nine-intersection model used by Spatial and Graph, see [Spatial Relationships and Filtering](#) (page 1-11).

For information about 3D support with spatial operators (which operators do and do not consider all three dimensions in their computations), see [Three-Dimensional Spatial Objects](#) (page 1-16).

Examples

The following example finds geometries that have the ON relationship with a query window (here, a rectangle with lower-left, upper-right coordinates 4,6, 8,8). (The example uses the definitions and data described in [Simple Example: Inserting\\_ Indexing\\_ and Querying Spatial Data](#) (page 2-1) and illustrated in [Figure 2-1](#) (page 2-2).) This example returns no rows because there are no line string geometries in the SHAPE column.

```
SELECT c.mkt_id, c.name
FROM cola_markets c
WHERE SDO_ON(c.shape,
             SDO_GEOMETRY(2003, NULL, NULL,
                           SDO_ELEM_INFO_ARRAY(1,1003,3),
                           SDO_ORDINATE_ARRAY(4,6, 8,8))
             ) = 'TRUE';
```

no rows selected

# 18.12 SDO\_OVERLAPBDYDISJOINT

Format

```
SDO_OVERLAPBDYDISJOINT(geometry1, geometry2);
```

Description

Checks if any geometries in a table have the OVERLAPBDYDISJOINT topological relationship with a specified geometry. Equivalent to specifying the [SDO\\_RELATE](#) (page 18-30) operator with 'mask=OVERLAPBDYDISJOINT'.

See the section on the [SDO\\_RELATE](#) (page 18-30) operator in this chapter for information about the operations performed by this operator and for usage requirements.

Keywords and Parameters

Value	Description
geometry1	Specifies a geometry column in a table. The column must be spatially indexed. Data type is SDO_GEOMETRY.



Value	Description
geometry2	Specifies either a geometry from a table or a transient instance of a geometry. (Specified using a bind variable or SDO_GEOMETRY constructor.) Data type is SDO_GEOMETRY.

### Returns

The expression `SDO_OVERLAPBDYDISJOINT(geometry1,geometry2) = 'TRUE'` evaluates to TRUE for object pairs that have the OVERLAPBDYDISJOINT topological relationship, and FALSE otherwise.

### Usage Notes

See the Usage Notes for the [SDO\\_RELATE](#) (page 18-30) operator in this chapter.

For an explanation of the topological relationships and the nine-intersection model used by Spatial and Graph, see [Spatial Relationships and Filtering](#) (page 1-11).

For information about 3D support with spatial operators (which operators do and do not consider all three dimensions in their computations), see [Three-Dimensional Spatial Objects](#) (page 1-16).

### Examples

The following example finds geometries that have the OVERLAPBDYDISJOINT relationship with a line string geometry (here, a horizontal line from 0,6 to 2,6). (The example uses the definitions and data described in [Simple Example: Inserting\\_ Indexing\\_ and Querying Spatial Data](#) (page 2-1) and illustrated in [Figure 2-1](#) (page 2-2).) In this example, only cola\_a has the OVERLAPBDYDISJOINT relationship with the line string geometry.

```
SELECT c.mkt_id, c.name
FROM cola_markets c
WHERE SDO_OVERLAPBDYDISJOINT(c.shape,
    SDO_GEOMETRY(2002, NULL, NULL,
        SDO_ELEM_INFO_ARRAY(1,2,1),
        SDO_ORDINATE_ARRAY(0,6, 2,6))
    ) = 'TRUE';

MKT_ID NAME
-----
1 cola_a
```

## 18.13 SDO\_OVERLAPBDYINTERSECT

### Format

```
SDO_OVERLAPBDYINTERSECT(geometry1, geometry2);
```

### Description

Checks if any geometries in a table have the OVERLAPBDYINTERSECT topological relationship with a specified geometry. Equivalent to specifying the [SDO\\_RELATE](#) (page 18-30) operator with 'mask=OVERLAPBDYINTERSECT'.

See the section on the [SDO\\_RELATE](#) (page 18-30) operator in this chapter for information about the operations performed by this operator and for usage requirements.

**Keywords and Parameters**

Value	Description
geometry1	Specifies a geometry column in a table. The column must be spatially indexed. Data type is SDO_GEOMETRY.
geometry2	Specifies either a geometry from a table or a transient instance of a geometry. (Specified using a bind variable or SDO_GEOMETRY constructor.) Data type is SDO_GEOMETRY.

**Returns**

The expression SDO\_OVERLAPBDYINTERSECT(geometry1,geometry2) = 'TRUE' evaluates to TRUE for object pairs that have the OVERLAPBDYINTERSECT topological relationship, and FALSE otherwise.

**Usage Notes**

See the Usage Notes for the [SDO\\_RELATE](#) (page 18-30) operator in this chapter.

For an explanation of the topological relationships and the nine-intersection model used by Spatial and Graph, see [Spatial Relationships and Filtering](#) (page 1-11).

For information about 3D support with spatial operators (which operators do and do not consider all three dimensions in their computations), see [Three-Dimensional Spatial Objects](#) (page 1-16).

**Examples**

The following example finds geometries that have the OVERLAPBDYINTERSECT relationship with a query window (here, a rectangle with lower-left, upper-right coordinates 4,6, 8,8). (The example uses the definitions and data described in [Simple Example: Inserting, Indexing, and Querying Spatial Data](#) (page 2-1) and illustrated in [Figure 2-1](#) (page 2-2).) In this example, cola\_a, cola\_b, and cola\_d have the OVERLAPBDYINTERSECT relationship with the query window geometry.

```

SELECT c.mkt_id, c.name
  FROM cola_markets c
 WHERE SDO_OVERLAPBDYINTERSECT(c.shape,
                                SDO_GEOMETRY(2003, NULL, NULL,
                                SDO_ELEM_INFO_ARRAY(1,1003,3),
                                SDO_ORDINATE_ARRAY(4,6, 8,8))
                                ) = 'TRUE' ;

MKT_ID NAME
-----
      2 cola_b
      1 cola_a
      4 cola_d

```

## 18.14 SDO\_OVERLAPS

### Format

```
SDO_OVERLAPS(geometry1, geometry2);
```

### Description

Checks if any geometries in a table overlap (that is, have the OVERLAPBDYDISJOINT or OVERLAPBDYINTERSECT topological relationship with) a specified geometry. Equivalent to specifying the [SDO\\_RELATE](#) (page 18-30) operator with 'mask=OVERLAPBDYDISJOINT+OVERLAPBDYINTERSECT'.

See the section on the [SDO\\_RELATE](#) (page 18-30) operator in this chapter for information about the operations performed by this operator and for usage requirements.

For information about 3D support with Spatial and Graph operators (which operators do and do not consider all three dimensions in their computations), see [Three-Dimensional Spatial Objects](#) (page 1-16).

### Keywords and Parameters

Value	Description
geometry1	Specifies a geometry column in a table. The column must be spatially indexed. Data type is SDO_GEOMETRY.
geometry2	Specifies either a geometry from a table or a transient instance of a geometry. (Specified using a bind variable or SDO_GEOMETRY constructor.) Data type is SDO_GEOMETRY.

### Returns

The expression SDO\_OVERLAPS(geometry1,geometry2) = 'TRUE' evaluates to TRUE for object pairs that have the OVERLAPBDYDISJOINT or OVERLAPBDYINTERSECT topological relationship, and FALSE otherwise.

### Usage Notes

See the Usage Notes for the [SDO\\_RELATE](#) (page 18-30) operator in this chapter.

For an explanation of the topological relationships and the nine-intersection model used by Spatial and Graph, see [Spatial Relationships and Filtering](#) (page 1-11).

### Examples

The following example finds geometries that overlap a query window (here, a rectangle with lower-left, upper-right coordinates 4,6, 8,8). (The example uses the definitions and data described in [Simple Example: Inserting, Indexing, and Querying Spatial Data](#) (page 2-1) and illustrated in [Figure 2-1](#) (page 2-2).) In this example, three of the geometries in the SHAPE column overlap the query window geometry.

```
SELECT c.mkt_id, c.name
FROM cola_markets c
WHERE SDO_OVERLAPS(c.shape,
```

```
SDO_GEOMETRY(2003, NULL, NULL,
  SDO_ELEM_INFO_ARRAY(1,1003,3),
  SDO_ORDINATE_ARRAY(4,6, 8,8))
) = 'TRUE';
```

```
MKT_ID NAME
-----
2 cola_b
1 cola_a
4 cola_d
```

18.15 SDO\_POINTINPOLYGON

Format

```
SDO_POINTINPOLYGON(cur, geom_obj, tol, params) RETURN ANYDATASET;
```

Description

Takes a set of rows whose first column is a point's x-coordinate value and the second column is a point's y-coordinate value, and returns those rows that are within a specified polygon geometry.

Keywords and Parameters

Value	Description
cur	A REF cursor: the first two columns in the SELECT of the SQL for ref_cursor must be an X and Y point coordinates pair from a user table. The two columns must be of type NUMBER. (Any other columns can be number, character and date types). Data type is SYS_REFCURSOR.
geom_obj	Spatial polygon geometry object: either a polygon geometry from a table or a transient instance of a polygon geometry, against which all of the selected points from cur will be checked. Data type is SDO_GEOMETRY.
tol	Tolerance value (see <a href="#">Tolerance</a> (page 1-6)). Must be greater than 0.0. Data type is NUMBER.
params	Optional parameter string of keywords and values. Determines the behavior of the operator. See <a href="#">Table 18-5</a> (page 18-29) in the Usage Notes for information about the available keywords. Data type is VARCHAR2. Default is NULL.

Returns

SDO\_POINTINPOLYGON returns an object of ANYDATASET TYPE, which is described in *Oracle Database PL/SQL Packages and Types Reference*. The ANYDATASET output columns are those specified by the cur parameter.

Usage Notes

SDO\_POINTINPOLYGON is technically not an operator, but a table function. (For an explanation of table functions, see *Oracle Database PL/SQL Language Reference*.) However, it is presented in the chapter with spatial operators because its usage is

similar to that of the operators, and because it is not part of a package with other functions and procedures.

The SQL statement used in the `cur` parameter can have any number of predicates in the WHERE clause. This feature can be used to filter the data on other attributes before passing the resulting rows into the SDO\_POINTINPOLYGON operator.

The output columns are identical to the input columns, but the only rows returned are those matching the selection criteria.

Table 18-5 (page 18-29) shows the keywords for the `params` parameter.

**Table 18-5** *params Keywords for the SDO\_POINTINPOLYGON Operator*

Keyword	Description
mask	The topological relationship of interest. Valid values are 'mask=<value>' where <value> is one or more of the following: ANYINTERACT, TOUCH, ON, INSIDE, and DISJOINT. (TOUCH and ON are synonymous in this context.)  If this parameter is null or contains an empty string, mask=ANYINTERACT is assumed.
sdo_batch_size	Specifies the maximum number of rows that are processed in a batch. The default value is 4000 and the maximum value is 32768. Data type is NUMBER.  For example: 'sdo_batch_size=5000'

To use parallel query servers, you must do either of the following:

- Specify the `/*+ PARALLEL(<table alias>, <n>) */` optimizer hint, where <table alias> is the specified table alias and <n> is the degree-of-parallelism.
- Enable parallel query execution by entering the following command from a suitably privileged account:

```
ALTER SESSION FORCE PARALLEL QUERY;
```

## Examples

The following example creates a new table named COLA\_MARKET\_POINTS based on the data from the COLA\_MARKETS table, which is described in [Simple Example: Inserting, Indexing, and Querying Spatial Data](#) (page 2-1) and illustrated in [Figure 2-1](#) (page 2-2). The example then selects a point within each geometry where the MKT\_ID column value is greater than 1. (It uses the [SDO\\_UTIL.INTERIOR\\_POINT](#) (page 31-43) function to get a point that is guaranteed to be inside each geometry that matches the query criteria.)

```
-- Create a new table with a different name based on the data from the
-- COLA_MARKETS table. This table has four columns: X, Y, MKT_ID, and NAME.

CREATE TABLE cola_market_points AS
SELECT a.point.sdo_point.x X, a.point.sdo_point.y Y, MKT_ID, NAME
FROM (
SELECT mkt_id, name, sdo_util.interior_point(shape) point FROM cola_markets) a;

-- Limit to MKT_ID > 1. Also, use the PARALLEL hint.
SELECT /*+ PARALLEL(a, 4) */ *
FROM TABLE(sdo_PointInPolygon(
```

```
CURSOR(select * from cola_market_points where mkt_id > 1),
SDO_GEOMETRY(
  2003,
  NULL,
  NULL,
  MDSYS.SDO_ELEM_INFO_ARRAY(1, 1003, 1),
  MDSYS.SDO_ORDINATE_ARRAY(1, 1, 8, 1, 8, 6, 5, 7, 1, 1)),
0.05)) a;
```

X	Y	MKT_ID	NAME
6.3125	2.875	2	cola_b
4.6875	3.875	3	cola_c

The following example uses a bind variable in the WHERE clause, and it specifies a params string. It assumes the existence of a table named PIP\_DATA.

```
DECLARE
my_cursor SYS_REFCURSOR;
my_pip_cursor SYS_REFCURSOR;
stmt varchar2(2000);
cnt number;
BEGIN
  stmt := 'SELECT count(*) FROM ' ||
    ' TABLE (Sdo_PointInPolygon(' ||
    ' CURSOR(select * from pip_data where x < :x1),' ||
    ' :g1, :tol, ''mask=DISJOINT sdo_batch_size=6000'')) ' ;
  open my_cursor for stmt
  using 100, -- :x1
    SDO_GEOMETRY( 2003, NULL, NULL,
      SDO_ELEM_INFO_ARRAY(1, 1003, 1),
      SDO_ORDINATE_ARRAY(10, 10, 70,10, 70, 70, 50,70,
        40,50, 20,70, 10,70, 10,10)), -- :g1
    0.05; -- :tol
  FETCH my_cursor into cnt;
  dbms_output.put_line(to_char(cnt));
END;
/
```

### Related Topics

- [SDO\\_UTIL.INTERIOR\\_POINT](#) (page 31-43)

## 18.16 SDO\_RELATE

### Format

```
SDO_RELATE(geometry1, geometry2, param);
```

### Description

Uses the spatial index to identify either the spatial objects that have a particular spatial interaction with a given object such as an area of interest, or pairs of spatial objects that have a particular spatial interaction.

This operator performs both primary and secondary filter operations.

## Keywords and Parameters

Value	Description
geometry1	Specifies a geometry column in a table. The column must be spatially indexed. Data type is SDO_GEOMETRY.
geometry2	Specifies either a geometry from a table or a transient instance of a geometry. (Specified using a bind variable or SDO_GEOMETRY constructor.) Data type is SDO_GEOMETRY.
param	<p>Specifies the mask keyword, and optionally either or both of the min_resolution and max_resolution keywords. The data type for this parameter is VARCHAR2.</p> <p>The mask keyword specifies the topological relationship of interest. This is a required parameter. Valid mask keyword values are one or more of the following in the nine-intersection pattern: TOUCH, OVERLAPBDYDISJOINT, OVERLAPBDYINTERSECT, EQUAL, INSIDE, COVEREDBY, CONTAINS, COVERS, ANYINTERACT, ON. Multiple masks are combined with the logical Boolean operator OR, for example, 'mask=inside+touch'. See <a href="#">Spatial Relationships and Filtering</a> (page 1-11) for an explanation of the nine-intersection relationship pattern.</p> <p>The min_resolution keyword includes only geometries for which at least one side of the geometry's MBR is equal to or greater than the specified value. For example, min_resolution=10 includes only geometries for which the width or the height (or both) of the geometry's MBR is at least 10. (This keyword can be used to exclude geometries that are too small to be of interest.)</p> <p>The max_resolution keyword includes only geometries for which at least one side of the geometry's MBR is less than or equal to the specified value. For example, max_resolution=10 includes only geometries for which the width or the height (or both) of the geometry's MBR is less than or equal to 10. (This keyword can be used to exclude geometries that are too large to be of interest.)</p> <p>For backward compatibility, any additional keywords for the param parameter that were supported before release 10.1 will still work; however, the use of those keywords is discouraged and is not supported for new uses of the operator.</p>

## Returns

The expression SDO\_RELATE(geometry1,geometry2, 'mask = <some\_mask\_val>') = 'TRUE' evaluates to TRUE for object pairs that have the topological relationship specified by <some\_mask\_val>, and FALSE otherwise.

## Usage Notes

The operator is disabled if the table does not have a spatial index or if the number of dimensions for the query window does not match the number of dimensions specified when the index was created.

The operator must always be used in a WHERE clause, and the condition that includes the operator should be an expression of the form SDO\_RELATE(arg1, arg2, 'mask = <some\_mask\_val>') = 'TRUE'. (The expression must not equate to any value other than 'TRUE'.)

geometry2 can come from a table or be a transient SDO\_GEOMETRY object, such as a bind variable or SDO\_GEOMETRY constructor.

- If the geometry2 column is not spatially indexed, the operator indexes the query window in memory and performance is very good.
- If two or more geometries from geometry2 are passed to the operator, the ORDERED optimizer hint must be specified, and the table in geometry2 must be specified first in the FROM clause.

If geometry1 and geometry2 are based on different coordinate systems, geometry2 is temporarily transformed to the coordinate system of geometry1 for the operation to be performed, as described in [Different Coordinate Systems for Geometries with Operators and Functions](#) (page 6-73).

Unlike with the [SDO\\_GEOM.RELATE](#) (page 23-4) function, DISJOINT and DETERMINE masks are not allowed in the relationship mask with the SDO\_RELATE operator. This is because SDO\_RELATE uses the spatial index to find candidates that may interact, and the information to satisfy DISJOINT or DETERMINE is not present in the index.

Multiple masks can be combined using the logical Boolean operator OR, for example, 'mask=touch+coveredby'. Effective with Release 12.1, if you set the SPATIAL\_VECTOR\_ACCELERATION system parameter to TRUE (highly recommended, as explained in [SPATIAL\\_VECTOR\\_ACCELERATION System Parameter](#) (page 1-31)), you do not need to use UNION ALL with such masks. However, if you are *not* setting SPATIAL\_VECTOR\_ACCELERATION to TRUE, better performance may result if the spatial query specifies each mask individually and uses the UNION ALL syntax to combine the results. This is due to internal optimizations that Spatial and Graph can apply under certain conditions when masks are specified singly rather than grouped within the same SDO\_RELATE operator call. (There are two exceptions, inside+coveredby and contains+covers, where the combination performs better than the UNION ALL alternative.)

For example, consider the following query using the logical Boolean operator OR to group multiple masks:

```
SELECT a.gid
FROM polygons a, query_polys B
WHERE B.gid = 1
AND SDO_RELATE(A.Geometry, B.Geometry,
               'mask=touch+coveredby') = 'TRUE';
```

If SPATIAL\_VECTOR\_ACCELERATION is TRUE, then preceding query is simplest and has the best performance. However, if SPATIAL\_VECTOR\_ACCELERATION is FALSE, the preceding query may result in better performance if it is expressed as follows, using UNION ALL to combine results of multiple SDO\_RELATE operator calls, each with a single mask:

```
SELECT a.gid
FROM polygons a, query_polys B
WHERE B.gid = 1
AND SDO_RELATE(A.Geometry, B.Geometry,
               'mask=touch') = 'TRUE'
UNION ALL
SELECT a.gid
FROM polygons a, query_polys B
WHERE B.gid = 1
AND SDO_RELATE(A.Geometry, B.Geometry,
               'mask=coveredby') = 'TRUE';
```



The following considerations apply to relationships between lines and a multipoint geometry (points in a point cluster). Assume the example of a line and a multipoint geometry (for example, SDO\_GTYPE = 2005) consisting of three points.

- If none of the points has any interaction with the line, the relationship between the line and the point cluster is DISJOINT.
- If one of the points is on the interior of the line and the other two points are disjoint, the relationship between the line and the point cluster is OVERLAPBDYDISJOINT.
- If one of the points is on the boundary of the line (that is, if it is on the start point or end point of the line) and the other two points are disjoint, the relationship between the line and the point cluster is TOUCH.
- If one of the points is on the boundary of the line (that is, if it is on the start point or end point of the line), another point is on the interior of the line, and the third point is disjoint, the relationship between the line and the point cluster is OVERLAPBDYDISJOINT (not OVERLAPBDYINTERSECT).

For information about 3D support with spatial operators (which operators do and do not consider all three dimensions in their computations), see [Three-Dimensional Spatial Objects](#) (page 1-16).

### Examples

The following examples are similar to those for the [SDO\\_FILTER](#) (page 18-8) operator; however, they identify a specific type of interaction (using the mask keyword), and they determine with certainty (not mere likelihood) if the spatial interaction occurs.

The following example selects the geometries that have any interaction with a query window (here, a rectangle with lower-left, upper-right coordinates 4,6, 8,8). (The example uses the definitions and data described in [Simple Example: Inserting, Indexing, and Querying Spatial Data](#) (page 2-1) and illustrated in [Figure 2-1](#) (page 2-2).)

```
SELECT c.mkt_id, c.name
FROM cola_markets c
WHERE SDO_RELATE(c.shape,
  SDO_GEOMETRY(2003, NULL, NULL,
    SDO_ELEM_INFO_ARRAY(1,1003,3),
    SDO_ORDINATE_ARRAY(4,6, 8,8)),
  'mask=anyinteract') = 'TRUE';
```

```
MKT_ID NAME
```

```
-----
      2 cola_b
      1 cola_a
      4 cola_d
```

The following example is the same as the preceding example, except that it includes only geometries where at least one side of the geometry's MBR is equal to or greater than 4.1. In this case, only cola\_a and cola\_b are returned, because their MBRs have at least one side with a length greater than or equal to 4.1. The circle cola\_d is excluded, because its MBR is a square whose sides have a length of 4.

```
SELECT c.mkt_id, c.name
FROM cola_markets c
WHERE SDO_RELATE(c.shape,
  SDO_GEOMETRY(2003, NULL, NULL,
```

```
SDO_ELEM_INFO_ARRAY(1,1003,3),
SDO_ORDINATE_ARRAY(4,6, 8,8)),
'mask=anyinteract min_resolution=4.1') = 'TRUE';
```

```
MKT_ID NAME
-----
      2 cola_b
      1 cola_a
```

The following example selects the GID values from the POLYGONS table where the GEOMETRY column objects have any spatial interaction with the GEOMETRY column object in the QUERY\_POLYS table that has a GID value of 1.

```
SELECT A.gid
FROM Polygons A, query_polys B
WHERE B.gid = 1
AND SDO_RELATE(A.Geometry, B.Geometry,
               'mask=ANYINTERACT') = 'TRUE';
```

The following example selects the GID values from the POLYGONS table where a GEOMETRY column object has any spatial interaction with the geometry stored in the aGeom variable.

```
SELECT A.Gid
FROM Polygons A
WHERE SDO_RELATE(A.Geometry, :aGeom, 'mask=ANYINTERACT') = 'TRUE';
```

The following example selects the GID values from the POLYGONS table where a GEOMETRY column object has any spatial interaction with the specified rectangle having the lower-left coordinates (x1,y1) and the upper-right coordinates (x2, y2).

```
SELECT A.Gid
FROM Polygons A
WHERE SDO_RELATE(A.Geometry, sdo_geometry(2003,NULL,NULL,
                                           sdo_elem_info_array(1,1003,3),
                                           sdo_ordinate_array(x1,y1,x2,y2)),
               'mask=ANYINTERACT') = 'TRUE';
```

The following example selects the GID values from the POLYGONS table where the GEOMETRY column object has any spatial interaction with any GEOMETRY column object in the QUERY\_POLYS table. In this example, the ORDERED optimizer hint is used and QUERY\_POLYS (geometry2) table is specified first in the FROM clause, because multiple geometries from geometry2 are involved (see the Usage Notes).

```
SELECT /*+ ORDERED */
      A.gid
FROM query_polys B, polygons A
WHERE SDO_RELATE(A.Geometry, B.Geometry, 'mask=ANYINTERACT') = 'TRUE';
```

### Related Topics

- [SDO\\_FILTER](#) (page 18-8)
- [SDO\\_JOIN](#) (page 18-12)
- [SDO\\_WITHIN\\_DISTANCE](#) (page 18-36)
- [SDO\\_GEOM.RELATE](#) (page 23-4) function

## 18.17 SDO\_TOUCH

### Format

```
SDO_TOUCH(geometry1, geometry2);
```

### Description

Checks if any geometries in a table have the TOUCH topological relationship with a specified geometry. Equivalent to specifying the [SDO\\_RELATE](#) (page 18-30) operator with 'mask=TOUCH'.

See the section on the [SDO\\_RELATE](#) (page 18-30) operator in this chapter for information about the operations performed by this operator and for usage requirements.

### Keywords and Parameters

Value	Description
geometry1	Specifies a geometry column in a table. The column must be spatially indexed. Data type is SDO_GEOMETRY.
geometry2	Specifies either a geometry from a table or a transient instance of a geometry. (Specified using a bind variable or SDO_GEOMETRY constructor.) Data type is SDO_GEOMETRY.

### Returns

The expression `SDO_TOUCH(geometry1,geometry2) = 'TRUE'` evaluates to TRUE for object pairs that have the TOUCH topological relationship, and FALSE otherwise.

### Usage Notes

See the Usage Notes for the [SDO\\_RELATE](#) (page 18-30) operator in this chapter.

For an explanation of the topological relationships and the nine-intersection model used by Spatial and Graph, see [Spatial Relationships and Filtering](#) (page 1-11).

For information about 3D support with spatial operators (which operators do and do not consider all three dimensions in their computations), see [Three-Dimensional Spatial Objects](#) (page 1-16).

### Examples

The following example finds geometries that have the TOUCH relationship with a query window (here, a rectangle with lower-left, upper-right coordinates 1,1, 5,7). (The example uses the definitions and data in [Simple Example: Inserting, Indexing, and Querying Spatial Data](#) (page 2-1) and illustrated in [Figure 2-1](#) (page 2-2).) In this example, only `cola_b` has the TOUCH relationship with the query window geometry.

```
SELECT c.mkt_id, c.name
FROM cola_markets c
WHERE SDO_TOUCH(c.shape,
                SDO_GEOMETRY(2003, NULL, NULL,
```

```
        SDO_ELEM_INFO_ARRAY(1,1003,3),
        SDO_ORDINATE_ARRAY(1,1, 5,7))
    ) = 'TRUE';
FROM cola_markets c

MKT_ID NAME
-----
2 cola_b
```

18.18 SDO\_WITHIN\_DISTANCE

Format

```
SDO_WITHIN_DISTANCE(geometry1, aGeom, params);
```

Description

Uses the spatial index to identify the set of spatial objects that are within some specified distance of a given object, such as an area of interest or point of interest.

Keywords and Parameters

Value	Description
geometry1	Specifies a geometry column in a table. The column has the set of geometry objects that will be operated on to determine if they are within the specified distance of the given object (aGeom). The column must be spatially indexed. Data type is SDO_GEOMETRY.
aGeom	Specifies the object to be checked for distance against the geometry objects in geometry1. Specify either a geometry from a table (using a bind variable) or a transient instance of a geometry (using the SDO_GEOMETRY constructor). Data type is SDO_GEOMETRY.
params	A quoted string containing one or more keywords (with values) that determine the behavior of the operator. The remaining items (distance, max_resolution, min_resolution, querytype, and unit) are potential keywords for the params parameter. Data type is VARCHAR2.
distance	Specifies the distance value. If a coordinate system is associated with the geometry, the distance unit is assumed to be the unit associated with the coordinate system. This is a required keyword. Data type is NUMBER.
max_resolution	Includes only geometries for which at least one side of the geometry's MBR is less than or equal to the specified value. For example, max_resolution=10 includes only geometries for which the width or the height (or both) of the geometry's MBR is less than or equal to 10. (This keyword can be used to exclude geometries that are too large to be of interest.)
min_resolution	Includes only geometries for which at least one side of the geometry's MBR is equal to or greater than the specified value. For example, min_resolution=10 includes only geometries for which the width or the height (or both) of the geometry's MBR is at least 10. (This keyword can be used to exclude geometries that are too small to be of interest.)

Value	Description
querytype	Set 'querytype=FILTER' to perform only a primary filter operation. If querytype is not specified, both primary and secondary filter operations are performed (default). Data type is VARCHAR2.
unit	Specifies the unit of measurement: a quoted string with unit= and an SDO_UNIT value from the MDSYS.SDO_DIST_UNITS table (for example, 'unit=KM'). See <a href="#">Unit of Measurement Support</a> (page 2-55) for more information about unit of measurement specification. Data type is NUMBER. Default = unit of measurement associated with the data. For geodetic data, the default is meters.

### Returns

The expression SDO\_WITHIN\_DISTANCE(arg1, arg2, arg3) = 'TRUE' evaluates to TRUE for object pairs that are within the specified distance, and FALSE otherwise.

### Usage Notes

The distance between two extended objects (nonpoint objects such as lines and polygons) is defined as the minimum distance between these two objects. The distance between two adjacent polygons is zero.

The operator is disabled if the table does not have a spatial index or if the number of dimensions for the query window does not match the number of dimensions specified when the index was created.

The operator must always be used in a WHERE clause and the condition that includes the operator should be an expression of the form:

```
SDO_WITHIN_DISTANCE(arg1, arg2, 'distance = <some_dist_val>') = 'TRUE'
```

(The expression must not equate to any value other than 'TRUE'.)

The geometry column must have a spatial index built on it. If the data is geodetic, the spatial index must be an R-tree index.

SDO\_WITHIN\_DISTANCE is not supported for spatial joins. See [Within-Distance Operator](#) (page 5-11) for a discussion on how to perform a spatial join within-distance operation.

For information about 3D support with spatial operators (which operators do and do not consider all three dimensions in their computations), see [Three-Dimensional Spatial Objects](#) (page 1-16).

### Examples

The following example selects the geometries that are within a distance of 10 from a query window (here, a rectangle with lower-left, upper-right coordinates 4,6, 8,8). (The example uses the definitions and data described in [Simple Example: Inserting, Indexing, and Querying Spatial Data](#) (page 2-1) and illustrated in [Figure 2-1](#) (page 2-2). In this case, all geometries shown in that figure are returned.)

```
SELECT c.name FROM cola_markets c WHERE SDO_WITHIN_DISTANCE(c.shape,
  SDO_GEOMETRY(2003, NULL, NULL, SDO_ELEM_INFO_ARRAY(1,1003,3),
    SDO_ORDINATE_ARRAY(4,6, 8,8)),
  'distance=10') = 'TRUE';
```

```
NAME
-----
cola_b
cola_a
cola_c
cola_d
```

The following example is the same as the preceding example, except that it includes only geometries where at least one side of the geometry's MBR is equal to or greater than 4.1. In this case, only `cola_a` and `cola_b` are returned, because their MBRs have at least one side with a length greater than or equal to 4.1. The trapezoid `cola_c` is excluded, because its MBR has sides with lengths of 3 and 2; and the circle `cola_d` is excluded, because its MBR is a square whose sides have a length of 4.

```
SELECT c.name FROM cola_markets c WHERE SDO_WITHIN_DISTANCE(c.shape,
    SDO_GEOMETRY(2003, NULL, NULL, SDO_ELEM_INFO_ARRAY(1,1003,3),
    SDO_ORDINATE_ARRAY(4,6, 8,8)),
    'distance=10 min_resolution=4.1') = 'TRUE';
```

```
NAME
-----
cola_b
cola_a
```

The following example selects the `GID` values from the `POLYGONS` table where the `GEOMETRY` column object is within 10 distance units of the geometry stored in the `aGeom` variable.

```
SELECT A.GID
FROM POLYGONS A
WHERE
    SDO_WITHIN_DISTANCE(A.Geometry, :aGeom, 'distance = 10') = 'TRUE';
```

The following example selects the `GID` values from the `POLYGONS` table where the `GEOMETRY` column object is within 10 distance units of the specified rectangle having the lower-left coordinates (`x1,y1`) and the upper-right coordinates (`x2, y2`).

```
SELECT A.GID
FROM POLYGONS A
WHERE
    SDO_WITHIN_DISTANCE(A.Geometry, sdo_geometry(2003,NULL,NULL,
        sdo_elem_info_array(1,1003,3),
        sdo_ordinate_array(x1,y1,x2,y2)),
        'distance = 10') = 'TRUE';
```

The following example selects the `GID` values from the `POLYGONS` table where the `GID` value in the `QUERY_POINTS` table is 1 and a `POLYGONS.GEOMETRY` object is within 10 distance units of the `QUERY_POINTS.GEOMETRY` object.

```
SELECT A.GID
FROM POLYGONS A, Query_Points B
WHERE B.GID = 1 AND
    SDO_WITHIN_DISTANCE(A.Geometry, B.Geometry, 'distance = 10') = 'TRUE';
```

See also the more complex `SDO_WITHIN_DISTANCE` examples in [SDO\\_WITHIN\\_DISTANCE Examples](#) (page C-1).

**Related Topics**

- [SDO\\_FILTER](#) (page 18-8)
- [SDO\\_RELATE](#) (page 18-30)





## Spatial Aggregate Functions

This chapter contains reference and usage information for the spatial aggregate functions, which are listed in [Table 19-1](#) (page 19-1).

**Table 19-1 Spatial Aggregate Functions**

Method	Description
<a href="#">SDO_AGGR_CENTROID</a> (page 19-2)	Returns a geometry object that is the centroid ("center of gravity") of the specified geometry objects.
<a href="#">SDO_AGGR_CONCAT_LINES</a> (page 19-3)	Returns a geometry that concatenates the specified line or multiline geometries.
<a href="#">SDO_AGGR_CONVEXHULL</a> (page 19-4)	Returns a geometry object that is the convex hull of the specified geometry objects.
<a href="#">SDO_AGGR_LRS_CONCAT</a> (page 19-4)	Returns an LRS geometry object that concatenates specified LRS geometry objects.
<a href="#">SDO_AGGR_MBR</a> (page 19-6)	Returns the minimum bounding rectangle of the specified geometries.
<a href="#">SDO_AGGR_SET_UNION</a> (page 19-7)	Returns the aggregate union of all the geometry objects from an input VARRAY of SDO_GEOMETRY objects or a REF cursor.
<a href="#">SDO_AGGR_UNION</a> (page 19-9)	Returns a geometry object that is the topological union ( <i>OR</i> operation) of the specified geometry objects.

See the usage information about spatial aggregate functions in [Spatial Aggregate Functions](#) (page 1-15).

Most of these aggregate functions accept a parameter of type SDOAGGRTYPE, which is described in [SDOAGGRTYPE Object Type](#) (page 1-15).

---

**Note:**

Spatial aggregate functions are supported for two-dimensional geometries only, except for [SDO\\_AGGR\\_MBR](#) (page 19-6), which is supported for both two-dimensional and three-dimensional geometries.

---

## 19.1 SDO\_AGGR\_CENTROID

### Format

```
SDO_AGGR_CENTROID(  
    AggregateGeometry SDOAGGRTYPE  
    ) RETURN SDO_GEOMETRY;
```

### Description

Returns a geometry object that is the centroid ("center of gravity") of the specified geometry objects.

### Parameters

#### AggregateGeometry

An object of type SDOAGGRTYPE (see [SDOAGGRTYPE Object Type](#) (page 1-15)) that specifies the geometry column and dimensional array.

### Usage Notes

The behavior of the function depends on whether the geometry objects are all polygons, all points, or a mixture of polygons and points:

- If the geometry objects are all polygons, the centroid of all the objects is returned.
- If the geometry objects are all points, the centroid of all the objects is returned.
- If the geometry objects are a mixture of polygons and points (specifically, if they include at least one polygon and at least one point), any points are ignored, and the centroid of all the polygons is returned.

The result is weighted by the area of each polygon in the geometry objects. If the geometry objects are a mixture of polygons and points, the points are not used in the calculation of the centroid. If the geometry objects are all points, the points have equal weight.

See also the information about the [SDO\\_GEOM.SDO\\_CENTROID](#) (page 23-13) function in [SDO\\_GEOM Package \(Geometry\)](#) (page 23-1).

### Examples

The following example returns the centroid of the geometry objects in the COLA\_MARKETS table. (The example uses the definitions and data from [Simple Example: Inserting, Indexing, and Querying Spatial Data](#) (page 2-1).)

```
SELECT SDO_AGGR_CENTROID(SDOAGGRTYPE(shape, 0.005))  
FROM cola_markets;  
  
SDO_AGGR_CENTROID(SDOAGGRTYPE(SHAPE,0.005))(SDO_GTYPE, SDO_SRID, SDO_POINT  
-----  
SDO_GEOMETRY(2001, NULL, SDO_POINT_TYPE(5.21295938, 5.00744233, NULL), NULL, NUL  
L)
```

## 19.2 SDO\_AGGR\_CONCAT\_LINES

### Format

```
SDO_AGGR_CONCAT_LINES(
    geom SDO_GEOMETRY
) RETURN SDO_GEOMETRY;
```

### Description

Returns a geometry that concatenates the specified line or multiline geometries.

### Parameters

#### geom

Geometry objects.

### Usage Notes

Each input geometry must be a two-dimensional line or multiline geometry (that is, the SDO\_GTYPE value must be 2002 or 2006). This function is not supported for LRS geometries. To perform an aggregate concatenation of LRS geometric segments, use the [SDO\\_AGGR\\_LRS\\_CONCAT](#) (page 19-4) spatial aggregate function.

The input geometries must be line strings whose vertices are connected by straight line segments. Circular arcs and compound line strings are not supported.

If any input geometry is a multiline geometry, the elements of the geometry must be disjoint. If they are not disjoint, this function may return incorrect results.

The topological relationship between the geometries in each pair of geometries to be concatenated must be DISJOINT or TOUCH; and if the relationship is TOUCH, the geometries must intersect only at two end points.

You can use the [SDO\\_UTIL.CONCAT\\_LINES](#) (page 31-14) function (described in [SDO\\_UTIL Package \(Utility\)](#) (page 31-1)) to concatenate two line or multiline geometries.

An exception is raised if any input geometries are not line or multiline geometries, or if not all input geometries are based on the same coordinate system.

### Examples

The following example inserts two line geometries in the COLA\_MARKETS table, and then returns the aggregate concatenation of these geometries. (The example uses the data definitions from [Simple Example: Inserting\\_ Indexing\\_ and Querying Spatial Data](#) (page 2-1).)

```
-- First, insert two line geometries.
INSERT INTO cola_markets VALUES(1001, 'line_1', SDO_GEOMETRY(2002, NULL, NULL,
    SDO_ELEM_INFO_ARRAY(1,2,1), SDO_ORDINATE_ARRAY(1,1, 5,1)));
INSERT INTO cola_markets VALUES(1002, 'line_2', SDO_GEOMETRY(2002, NULL, NULL,
    SDO_ELEM_INFO_ARRAY(1,2,1), SDO_ORDINATE_ARRAY(5,1, 8,1)));
-- Perform aggregate concatenation of all line geometries in layer.
SELECT SDO_AGGR_CONCAT_LINES(c.shape) FROM cola_markets c
    WHERE c.mkt_id > 1000;
```

```
SDO_AGGR_CONCAT_LINES(C.SHAPE)(SDO_GTYPE, SDO_SRID, SDO_POINT(X, Y, Z), SDO_ELEM
```

```
-----  
SDO_GEOMETRY(2002, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 2, 1), SDO_ORDINATE_ARRAY(  
1, 1, 5, 1, 8, 1))
```

## 19.3 SDO\_AGGR\_CONVEXHULL

### Format

```
SDO_AGGR_CONVEXHULL(  
    AggregateGeometry SDOAGGRTYPE  
    ) RETURN SDO_GEOMETRY;
```

### Description

Returns a geometry object that is the convex hull of the specified geometry objects.

### Parameters

#### AggregateGeometry

An object of type SDOAGGRTYPE (see [SDOAGGRTYPE Object Type](#) (page 1-15)) that specifies the geometry column and dimensional array.

### Usage Notes

See also the information about the [SDO\\_GEOM.SDO\\_CONVEXHULL](#) (page 23-19) function in [SDO\\_GEOM Package \(Geometry\)](#) (page 23-1).

### Examples

The following example returns the convex hull of the geometry objects in the COLA\_MARKETS table. (The example uses the definitions and data from [Simple Example: Inserting, Indexing, and Querying Spatial Data](#) (page 2-1).)

```
SELECT SDO_AGGR_CONVEXHULL(SDOAGGRTYPE(shape, 0.005))  
    FROM cola_markets;  
  
SDO_AGGR_CONVEXHULL(SDOAGGRTYPE(SHAPE,0.005))(SDO_GTYPE, SDO_SRID, SDO_POI  
-----  
SDO_GEOMETRY(2003, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 1003, 1), SDO_ORDINATE_ARR  
AY(8, 1, 10, 7, 10, 11, 8, 11, 6, 11, 1, 7, 1, 1, 8, 1))
```

## 19.4 SDO\_AGGR\_LRS\_CONCAT

### Format

```
SDO_AGGR_LRS_CONCAT(  
    AggregateGeometry SDOAGGRTYPE  
    ) RETURN SDO_GEOMETRY;
```

### Description

Returns an LRS geometry that concatenates specified LRS geometries.

### Parameters

## AggregateGeometry

An object of type SDOAGGRTYPE (see [SDOAGGRTYPE Object Type](#) (page 1-15)) that specifies the geometry column and dimensional array.

## Usage Notes

This function performs an aggregate concatenation of any number of LRS geometries. If you want to control the order in which the geometries are concatenated, you must use a subquery with the NO\_MERGE optimizer hint and the ORDER BY clause. (See the examples.)

The direction of the resulting segment is the same as the direction of the first geometry in the concatenation.

A 3D format of this function (SDO\_AGGR\_LRS\_CONCAT\_3D) is available. For information about 3D formats of LRS functions, see [3D Formats of LRS Functions](#) (page 7-7).

For information about the Spatial and Graph linear referencing system, see [Linear Referencing System](#) (page 7-1).

## Examples

The following example adds an LRS geometry to the LRS\_ROUTES table, and then performs two queries that concatenate the LRS geometries in the table. The first query does not control the order of concatenation, and the second query controls the order of concatenation. Notice the difference in direction of the two segments: the segment resulting from the second query has decreasing measure values because the first segment in the concatenation (Route0) has decreasing measure values. (This example uses the definitions from the example in [Example of LRS Functions](#) (page 7-15).)

```
-- Add a segment with route_id less than 1 (here, zero).
INSERT INTO lrs_routes VALUES(
  0,
  'Route0',
  SDO_GEOMETRY(
    3302, -- Line string; 3 dimensions (X,Y,M); 3rd is measure dimension.
    NULL,
    NULL,
    SDO_ELEM_INFO_ARRAY(1,2,1), -- One line string, straight segments
    SDO_ORDINATE_ARRAY(
      5,14,5, -- Starting point - 5 is measure from start.
      10,14,0 -- Ending point - 0 measure (decreasing measure)
    )
  );

1 row created.

-- Concatenate all routes (no ordering specified).
SELECT SDO_AGGR_LRS_CONCAT(SDOAGGRTYPE(route_geometry, 0.005))
  FROM lrs_routes;

SDO_AGGR_LRS_CONCAT(SDOAGGRTYPE(ROUTE_GEOMETRY,0.005))(SDO_GTYPE, SDO_SRID
-----
SDO_GEOMETRY(3302, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 2, 1), SDO_ORDINATE_ARRAY(
2, 2, 0, 2, 4, 2, 8, 4, 8, 12, 4, 12, 12, 10, 18, 8, 10, 22, 5, 14, 27, 10, 14,
32))

-- Aggregate concatenation using subquery for ordering.
SELECT
```

```
SDO_AGGR_LRS_CONCAT(SDOAGGRTYPE(route_geometry, 0.005))
FROM (
    SELECT /*+ NO_MERGE */ route_geometry
    FROM lrs_routes
    ORDER BY route_id);

SDO_AGGR_LRS_CONCAT(SDOAGGRTYPE(ROUTE_GEOMETRY,0.005))(SDO_GTYPE, SDO_SRID
-----
SDO_GEOMETRY(3302, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 2, 1), SDO_ORDINATE_ARRAY(
2, 2, 32, 2, 4, 30, 8, 4, 24, 12, 4, 20, 12, 10, 14, 8, 10, 10, 5, 14, 5, 10, 14
, 0))
```

## 19.5 SDO\_AGGR\_MBR

### Format

```
SDO_AGGR_MBR(
    geom SDO_GEOMETRY
) RETURN SDO_GEOMETRY;
```

### Description

Returns the minimum bounding rectangle (MBR) of the specified geometries, that is, a single rectangle that minimally encloses the geometries.

### Parameters

#### geom

Geometry objects.

### Usage Notes

This function does not return an MBR geometry if a proper MBR cannot be constructed. Specifically:

- If the input geometries are all null, the function returns a null geometry.
- If all data in the input geometries is on a single point, the function returns the point.
- If all data in the input geometries consists of points on a straight line, the function returns a two-point line.

The [SDO\\_TUNE.EXTENT\\_OF](#) (page 30-4) function, documented in [SDO\\_TUNE Package \(Tuning\)](#) (page 30-1), also returns the MBR of geometries. The [SDO\\_TUNE.EXTENT\\_OF](#) (page 30-4) function has better performance than the [SDO\\_AGGR\\_MBR](#) function if a spatial index is defined on the geometry column; however, the [SDO\\_TUNE.EXTENT\\_OF](#) (page 30-4) function is limited to two-dimensional geometries, whereas the [SDO\\_AGGR\\_MBR](#) function is not. In addition, the [SDO\\_TUNE.EXTENT\\_OF](#) (page 30-4) function computes the extent for all geometries in a table; by contrast, the [SDO\\_AGGR\\_MBR](#) function can operate on subsets of rows.

## Examples

The following example returns the minimum bounding rectangle of the geometry objects in the COLA\_MARKETS table. (The example uses the definitions and data from [Simple Example: Inserting, Indexing, and Querying Spatial Data](#) (page 2-1).)

```
SELECT SDO_AGGR_MBR(shape) FROM cola_markets;

SDO_AGGR_MBR(C.SHAPE)(SDO_GTYPE, SDO_SRID, SDO_POINT(X, Y, Z), SDO_ELEM_INFO, SD
-----
SDO_GEOMETRY(2003, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 1003, 3), SDO_ORDINATE_ARR
AY(1, 1, 10, 11))
```

## 19.6 SDO\_AGGR\_SET\_UNION

### Format (as Function in SDO\_AGGR Package)

```
SDO_AGGR.SDO_AGGR_SET_UNION(
    geometry SDO_GEOMETRY_ARRAY,
    tol      NUMBER
) RETURN SDO_GEOMETRY;
```

or

```
SDO_AGGR.SDO_AGGR_SET_UNION(
    cur SYS_REFCURSOR,
    tol NUMBER
) RETURN SDO_GEOMETRY;
```

### Format (as Spatial Aggregate Function [Deprecated])

```
SDO_AGGR_SET_UNION(
    geometry SDO_GEOMETRY_ARRAY,
    tol      NUMBER
) RETURN SDO_GEOMETRY;
```

### Description

Returns the aggregate union of all the geometry objects from an input VARRAY of SDO\_GEOMETRY objects or a REF cursor.

### Parameters

#### geometry

An array of geometry objects of object type SDO\_GEOMETRY\_ARRAY, which is defined as VARRAY OF SDO\_GEOMETRY.

#### cur

A REF cursor that returns a set of the geometry objects for which to return the aggregate union of all the geometry objects.

#### tol

Tolerance value (see [Tolerance](#) (page 1-6)).

## Usage Notes

---

### Note:

Effective with Oracle Database Release 12c (12.1), the format as a spatial aggregate function is deprecated, and will be removed in an upcoming major release.

You should instead use one of the formats for the SDO\_AGGR.SDO\_AGGR\_SET\_UNION function.

---

SDO\_AGGR\_SET\_UNION provides faster performance than [SDO\\_AGGR\\_UNION](#) (page 19-9) but less flexibility, and SDO\_AGGR\_SET\_UNION should be considered when performance is especially important and when it satisfies your functional needs.

[SDO\\_AGGR\\_UNION](#) (page 19-9) is a SQL aggregate function, and therefore it is very flexible and can be used with complex SQL GROUP BY clauses. However, SDO\_AGGR\_SET\_UNION can be much faster than SDO\_AGGR\_UNION. SDO\_AGGR\_SET\_UNION is useful when the geometries to be grouped can easily be gathered into a collection, such as a VARRAY of SDO\_GEOMETRY objects).

SDO\_AGGR\_SET\_UNION:

- *Cannot* aggregate a set of *overlapping* polygons. For overlapping polygons, use [SDO\\_AGGR\\_UNION](#) (page 19-9).
- *Can* effectively aggregate a set of *non-overlapping* polygons, including polygons that touch.
- Can aggregate sets of lines and points, even if they overlap.

## Examples

The following example creates a generic routine to build a geometry set to pass to SDO\_AGGR\_SET\_UNION. It takes as input a table name, column name, and optional predicate to apply, and returns an SDO\_GEOMETRY\_ARRAY ready to use with SDO\_AGGR\_SET\_UNION. The first SELECT statement after the get\_geom\_set function creation calls the SDO\_AGGR.SDO\_AGGR\_UNION PL/SQL function, the second SELECT statement calls the deprecated spatial aggregate function, and the third SELECT statement calls the SDO\_AGGR.SDO\_AGGR\_UNION PL/SQL function using the format that specifies a cursor. All the SELECT statements return the same result. (The example uses the definitions and data from [Simple Example: Inserting Indexing and Querying Spatial Data](#) (page 2-1).)

```
CREATE OR REPLACE FUNCTION get_geom_set (table_name VARCHAR2,
                                         column_name VARCHAR2,
                                         predicate VARCHAR2 := NULL)
RETURN SDO_GEOMETRY_ARRAY DETERMINISTIC AS

type          cursor_type is REF CURSOR;
query_crs     cursor_type ;
g             SDO_GEOMETRY;
GeometryArr   SDO_GEOMETRY_ARRAY;
where_clause   VARCHAR2(2000);
BEGIN
  IF predicate IS NULL
  THEN
    where_clause := NULL;
```



```

ELSE
    where_clause := ' WHERE ';
END IF;

GeometryArr := SDO_GEOMETRY_ARRAY();
OPEN query_crs FOR ' SELECT ' || column_name ||
    ' FROM ' || table_name ||
    where_clause || predicate;

LOOP
    FETCH query_crs into g;
    EXIT when query_crs%NOTFOUND ;
    GeometryArr.extend;
    GeometryArr(GeometryArr.count) := g;
END LOOP;
RETURN GeometryArr;
END;
/

-- Call SDO_AGGR_SET_UNION function in SDO_AGGR PL/SQL package.
SELECT sdo_aggr.sdo_aggr_set_union (get_geom_set ('COLA_MARKETS', 'SHAPE',
    'name <> 'cola_c''), .0005 ) FROM dual;

SDO_AGGR.SDO_AGGR_SET_UNION(GET_GEOM_SET('COLA_MARKETS','SHAPE','NAME<>'COLA_C'
-----
SDO_GEOMETRY(2007, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 1003, 2, 11, 1003, 1), SDO
_ORDINATE_ARRAY(8, 11, 6, 9, 8, 7, 10, 9, 8, 11, 1, 7, 1, 1, 5, 1, 8, 1, 8, 6, 5
, 7, 1, 7))

-- CALL SDO_AGGR_SET_UNION spatial aggregate function (deprecated format).
SELECT sdo_aggr_set_union (get_geom_set ('COLA_MARKETS', 'SHAPE',
    'name <> 'cola_c''), .0005 ) FROM dual;

SDO_AGGR.SDO_AGGR_SET_UNION(GET_GEOM_SET('COLA_MARKETS','SHAPE','NAME<>'COLA_C'
-----
SDO_GEOMETRY(2007, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 1003, 2, 11, 1003, 1), SDO
_ORDINATE_ARRAY(8, 11, 6, 9, 8, 7, 10, 9, 8, 11, 1, 7, 1, 1, 5, 1, 8, 1, 8, 6, 5
, 7, 1, 7))

-- Call SDO_AGGR_SET_UNION function in SDO_AGGR PL/SQL package; specify
-- a cursor as input.
SELECT sdo_aggr.sdo_aggr_set_union
    (CURSOR(SELECT shape FROM COLA_MARKETS WHERE name <> 'cola_c'), .0005 )
FROM dual;

SDO_AGGR.SDO_AGGR_SET_UNION(CURSOR(SELECT SHAPE FROM COLA_MARKETS WHERE NAME<>'COLA_C'
-----
SDO_GEOMETRY(2007, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 1003, 2, 11, 1003, 1), SDO
_ORDINATE_ARRAY(8, 11, 6, 9, 8, 7, 10, 9, 8, 11, 1, 7, 1, 1, 5, 1, 8, 1, 8, 6, 5
, 7, 1, 7))

```

## 19.7 SDO\_AGGR\_UNION

### Format

```

SDO_AGGR_UNION(
    AggregateGeometry SDOAGGRTYPE
) RETURN SDO_GEOMETRY;

```

**Description**

Returns a geometry object that is the topological union (OR operation) of the specified geometry objects.

**Parameters****AggregateGeometry**

An object of type SDOAGGRTYPE (see [SDOAGGRTYPE Object Type](#) (page 1-15)) that specifies the geometry column and dimensional array.

**Usage Notes**

Do not use SDO\_AGGR\_UNION to merge line string or multiline string geometries; instead, use the [SDO\\_AGGR\\_CONCAT\\_LINES](#) (page 19-3) spatial aggregate function.

See also the information about the [SDO\\_GEOM.SDO\\_UNION](#) (page 23-44) function in [SDO\\_GEOM Package \(Geometry\)](#) (page 23-1).

**Examples**

The following example returns the union of all geometries except cola\_d (in this case, cola\_a, cola\_b, and cola\_c). (The example uses the definitions and data from [Simple Example: Inserting\\_ Indexing\\_ and Querying Spatial Data](#) (page 2-1).)

```
SELECT SDO_AGGR_UNION(
  SDOAGGRTYPE(c.shape, 0.005))
FROM cola_markets c
WHERE c.name <> 'cola_d';

SDO_AGGR_UNION(SDOAGGRTYPE(C.SHAPE,0.005))(SDO_GTYPE, SDO_SRID, SDO_POINT(
-----
SDO_GEOMETRY(2007, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 1003, 2, 11, 1003, 1), SDO
_ORDINATE_ARRAY(8, 11, 6, 9, 8, 7, 10, 9, 8, 11, 1, 7, 1, 1, 5, 1, 8, 1, 8, 6, 5
, 7, 1, 7))
```

## SDO\_CS Package (Coordinate System Transformation)

The MDSYS.SDO\_CS package contains subprograms for working with coordinate systems. You can perform explicit coordinate transformations on a single geometry or an entire layer of geometries (that is, all geometries in a specified column in a table).

To use the subprograms in this chapter, you must understand the conceptual information about coordinate systems in [Coordinate System](#) (page 1-5) and [Coordinate Systems \(Spatial Reference Systems\)](#) (page 6-1).

[Table 20-1](#) (page 20-1) lists the coordinate system transformation subprograms.

**Table 20-1 Subprograms for Coordinate System Transformation**

Subprogram	Description
<a href="#">SDO_CS.ADD_PREFERENCE_FOR_OP</a> (page 20-3)	Adds a preference for an operation between a source coordinate system and a target coordinate system.
<a href="#">SDO_CS.CONVERT_3D_SRID_TO_2D</a> (page 20-4)	Converts a three-dimensional SRID value into a two-dimensional SRID value.
<a href="#">SDO_CS.CONVERT_NADCON_TO_XML</a> (page 20-6)	Converts a NADCON (North American Datum Conversion) grid in ASCII format to an Oracle Spatial and Graph XML representation.
<a href="#">SDO_CS.CONVERT_NTV2_TO_XML</a> (page 20-7)	Converts an NTv2 (National Transformation Version 2) grid in ASCII format to an Oracle Spatial and Graph XML representation.
<a href="#">SDO_CS.CONVERT_XML_TO_NADCON</a> (page 20-9)	Converts an Oracle Spatial and Graph XML representation of a NADCON (North American Datum Conversion) grid to NADCON ASCII format.
<a href="#">SDO_CS.CONVERT_XML_TO_NTV2</a> (page 20-10)	Converts an Oracle Spatial and Graph XML representation of an NTv2 (National Transformation Version 2) grid to NTv2 ASCII format.
<a href="#">SDO_CS.CREATE_CONCATENATE_D_OP</a> (page 20-12)	Creates a concatenated operation.
<a href="#">SDO_CS.CREATE_OBVIOUS_EPSG_RULES</a> (page 20-12)	Creates a basic set of EPSG rules to be applied in certain transformations.
<a href="#">SDO_CS.CREATE_PREF_CONCATENATED_OP</a> (page 20-13)	Creates a concatenated operation, associating it with a transformation plan and making it preferred either systemwide or for a specified use case.
<a href="#">SDO_CS.DELETE_ALL_EPSG_RULES</a> (page 20-15)	Deletes the basic set of EPSG rules to be applied in certain transformations.

**Table 20-1 (Cont.) Subprograms for Coordinate System Transformation**

Subprogram	Description
<a href="#">SDO_CS.DELETE_OP</a> (page 20-15)	Deletes a concatenated operation.
<a href="#">SDO_CS.DETERMINE_CHAIN</a> (page 20-16)	Returns the query chain, based on the system rule set, to be used in transformations from one coordinate reference system to another coordinate reference system.
<a href="#">SDO_CS.DETERMINE_DEFAULT_CHAIN</a> (page 20-17)	Returns the default chain of SRID values in transformations from one coordinate reference system to another coordinate reference system.
<a href="#">SDO_CS.FIND_GEOG_CRS</a> (page 20-18)	Returns the SRID values of geodetic (geographic) coordinate reference systems that have the same well-known text (WKT) numeric values as the coordinate reference system with the specified reference SRID value.
<a href="#">SDO_CS.FIND_PROJ_CRS</a> (page 20-20)	Returns the SRID values of projected coordinate reference systems that have the same well-known text (WKT) numeric values as the coordinate reference system with the specified reference SRID value.
<a href="#">SDO_CS.FIND_SRID</a> (page 20-21)	Finds an SRID value for a coordinate system that matches information that you specify.
<a href="#">SDO_CS.FROM_OGC_SIMPLEFEATURE_SRS</a> (page 20-24)	Converts a well-known text string from the Open Geospatial Consortium simple feature format without the TOWGS84 keyword to the format that includes the TOWGS84 keyword.
<a href="#">SDO_CS.FROM_USNG</a> (page 20-25)	Converts a point represented in U.S. National Grid format to a spatial point geometry object.
<a href="#">SDO_CS.GET_EPSG_DATA_VERSION</a> (page 20-26)	Gets the version number of the EPSG dataset used by Spatial and Graph.
<a href="#">SDO_CS.MAKE_2D</a> (page 20-27)	Converts a three-dimensional (or more dimensions) geometry into a two-dimensional geometry.
<a href="#">SDO_CS.MAKE_3D</a> (page 20-28)	Converts a two-dimensional geometry into a three-dimensional geometry.
<a href="#">SDO_CS.MAP_EPSG_SRID_TO_ORACLE</a> (page 20-29)	Returns the Oracle Spatial and Graph SRID values corresponding to the specified EPSG SRID value.
<a href="#">SDO_CS.MAP_ORACLE_SRID_TO_EPSG</a> (page 20-30)	Returns the EPSG SRID value corresponding to the specified Oracle Spatial and Graph SRID value.
<a href="#">SDO_CS.REVOKE_PREFERENCE_FOR_OP</a> (page 20-30)	Revokes a preference for an operation between a source coordinate system and a target coordinate system.
<a href="#">SDO_CS.TO_OGC_SIMPLEFEATURE_SRS</a> (page 20-31)	Converts a well-known text string from the Open Geospatial Consortium simple feature format that includes the TOWGS84 keyword to the format without the TOWGS84 keyword.

**Table 20-1 (Cont.) Subprograms for Coordinate System Transformation**

Subprogram	Description
<a href="#">SDO_CS.TRANSFORM</a> (page 20-33)	Transforms a geometry representation using a coordinate system (specified by SRID or name).
<a href="#">SDO_CS.TRANSFORM_LAYER</a> (page 20-35)	Transforms an entire layer of geometries (that is, all geometries in a specified column in a table).
<a href="#">SDO_CS.UPDATE_WKTS_FOR_ALL_EPSG_CRS</a> (page 20-37)	Updates the well-known text (WKT) description for all EPSG coordinate reference systems.
<a href="#">SDO_CS.UPDATE_WKTS_FOR_EPSG_CRS</a> (page 20-38)	Updates the well-known text (WKT) description for the EPSG coordinate reference system associated with a specified SRID.
<a href="#">SDO_CS.UPDATE_WKTS_FOR_EPSG_DATUM</a> (page 20-38)	Updates the well-known text (WKT) description for all EPSG coordinate reference systems associated with a specified datum.
<a href="#">SDO_CS.UPDATE_WKTS_FOR_EPSG_ELLIPS</a> (page 20-39)	Updates the well-known text (WKT) description for all EPSG coordinate reference systems associated with a specified ellipsoid.
<a href="#">SDO_CS.UPDATE_WKTS_FOR_EPSG_OP</a> (page 20-40)	Updates the well-known text (WKT) description for all EPSG coordinate reference systems associated with a specified coordinate transformation operation.
<a href="#">SDO_CS.UPDATE_WKTS_FOR_EPSG_PARAM</a> (page 20-40)	Updates the well-known text (WKT) description for all EPSG coordinate reference systems associated with a specified coordinate transformation operation and parameter for transformation operations.
<a href="#">SDO_CS.UPDATE_WKTS_FOR_EPSG_PM</a> (page 20-41)	Updates the well-known text (WKT) description for all EPSG coordinate reference systems associated with a specified prime meridian.
<a href="#">SDO_CS.VALIDATE_WKT</a> (page 20-43)	Validates the well-known text (WKT) description associated with a specified SRID.

The rest of this chapter provides reference information on the subprograms, listed in alphabetical order.

## 20.1 SDO\_CS.ADD\_PREFERENCE\_FOR\_OP

### Format

```
SDO_CS.ADD_PREFERENCE_FOR_OP(
    op_id          IN NUMBER,
    source_crs     IN NUMBER DEFAULT NULL,
    target_crs     IN NUMBER DEFAULT NULL,
    use_case       IN VARCHAR2 DEFAULT NULL);
```

### Description

Adds a preference for an operation between a source coordinate system and a target coordinate system.

### Parameters

**op\_id**

ID number of the operation. Must be a value in the COORD\_OP\_ID column of the SDO\_COORD\_OPS table (described in [SDO\\_COORD\\_OPS Table](#) (page 6-25)).

**source\_crs**

The SRID of the source coordinate reference system. Must be null or a value in the SRID column of the SDO\_COORD\_REF\_SYS table (described in [SDO\\_COORD\\_REF\\_SYS Table](#) (page 6-27)).

**target\_crs**

The SRID of the target coordinate reference system. Must be null or a value in the SRID column of the SDO\_COORD\_REF\_SYS table (described in [SDO\\_COORD\\_REF\\_SYS Table](#) (page 6-27)).

**use\_case**

Name of the use case to be associated with this preference. Must be null or a value from the USE\_CASE column of the SDO\_PREFERRED\_OPS\_USER table (described in [SDO\\_PREFERRED\\_OPS\\_USER Table](#) (page 6-40)).

### Usage Notes

If `use_case` is null, the transformation plan associated with the operation is a systemwide preference, and a row is added (or two rows are added if a reverse operation exists) to the SDO\_PREFERRED\_OPS\_SYSTEM table (described in [SDO\\_PREFERRED\\_OPS\\_SYSTEM Table](#) (page 6-39)). If `use_case` is not null, the transformation plan associated with the operation is a preference associated with the specified use case, and a row is added (or two rows are added if a reverse operation exists) to the SDO\_PREFERRED\_OPS\_USER table (described in [SDO\\_PREFERRED\\_OPS\\_USER Table](#) (page 6-40)).

To create a concatenated operation and make it preferred either systemwide or for a specified use case, you can use the [SDO\\_CS.CREATE\\_PREF\\_CONCATENATED\\_OP](#) (page 20-13) convenience procedure.

To revoke a preference for an operation between a source coordinate system and a target coordinate system, use the [SDO\\_CS.REVOKE\\_PREFERENCE\\_FOR\\_OP](#) (page 20-30) procedure.

### Examples

The following example adds a preference for operation 19977 to be used in transformations from SRID 4301 to SRID 4326 when use case `use_case_B` is specified for the transformation.

```
EXECUTE SDO_CS.ADD_PREFERENCE_FOR_OP(19977, 4301, 4326, 'use_case_B');
```

## 20.2 SDO\_CS.CONVERT\_3D\_SRID\_TO\_2D

### Format

```
SDO_CS.CONVERT_3D_SRID_TO_2D(  
    srid3d IN NUMBER) RETURN NUMBER;
```

## Description

Converts a three-dimensional SRID value into a two-dimensional SRID value.

## Parameters

### srid\_3d

The SRID of a three-dimensional coordinate reference system. Must be a value in the SRID column of the SDO\_COORD\_REF\_SYS table (described in [SDO\\_COORD\\_REF\\_SYS Table](#) (page 6-27)).

## Usage Notes

This function returns the SRID value of a functionally equivalent two-dimensional coordinate reference system that corresponds to the input coordinate reference system.

- If a compound 3D SRID is input, there is only one corresponding two-dimensional SRID, and it is returned.
- If a Geographic 3D SRID is input, there may be multiple possible corresponding two-dimensional SRIDs, and one of them is returned.
- If a two-dimensional SRID is input, it is returned.

For information about three-dimensional coordinate reference system support, see [Three-Dimensional Coordinate Reference System Support](#) (page 6-9).

## Examples

The following example returns an equivalent two-dimensional SRID for each coordinate reference system listed in the SDO\_COORD\_REF\_SYS table (described in [SDO\\_COORD\\_REF\\_SYS Table](#) (page 6-27)). For 2D SRID values in that table, the function returns the existing value.

```
SELECT
  crs.srid "nD SRID",
  crs.coord_ref_sys_kind "nD Type",
  sdo_cs.convert_3d_srid_to_2d(crs.srid) "2D SRID",
  (SELECT
    coord_ref_sys_kind
  FROM
    sdo_coord_ref_sys crs2
  WHERE
    crs2.srid = sdo_cs.convert_3d_srid_to_2d(crs.srid)
  ) "2D Type"
FROM sdo_coord_ref_sys crs
ORDER BY crs.coord_ref_sys_kind, crs.srid;
```

nD SRID	nD Type	2D SRID	2D Type
4097	COMPOUND	4093	PROJECTED
4098	COMPOUND	4094	PROJECTED
4099	COMPOUND	4095	PROJECTED
...	...	...	...
7400	COMPOUND	4807	GEOGRAPHIC2D
...	...	...	...
5800	ENGINEERING	5800	ENGINEERING
...	...	...	...
4000	GEOCENTRIC	...	...
...	...	...	...

4326	GEOGRAPHIC2D	4326	GEOGRAPHIC2D
...	...	...	...
4327	GEOGRAPHIC3D	4326	GEOGRAPHIC2D
...	...	...	...
27700	PROJECTED	27700	PROJECTED
...	...	...	...
3855	VERTICAL	3855	VERTICAL
...	...	...	...

## 20.3 SDO\_CS.CONVERT\_NADCON\_TO\_XML

### Format

```
SDO_CS.CONVERT_NADCON_TO_XML(  
    laa_clob  IN CLOB,  
    loa_clob  IN CLOB,  
    xml_grid  OUT XMLTYPE );
```

### Description

Converts a NADCON (North American Datum Conversion) grid in ASCII format to an Oracle Spatial and Graph XML representation.

### Parameters

#### laa\_clob

Latitude values of the NADCON grid in a CLOB object.

#### loa\_clob

Longitude values of the NADCON grid in a CLOB object.

#### xml\_grid

Output XML document containing the Oracle Spatial and Graph XML representation of the NADCON grid.

### Usage Notes

To convert an Oracle Spatial and Graph XML representation to a NADCON grid, use the [SDO\\_CS.CONVERT\\_XML\\_TO\\_NADCON](#) (page 20-9) procedure.

### Examples

The following example converts a NADCON grid in ASCII format to an Oracle Spatial and Graph XML representation, converts the resulting XML representation back to a NADCON ASCII representation, and displays the resulting ASCII representation. (Only part of the output is shown.)

```
set lines 32000  
set long 2000000000  
  
DECLARE  
    laa      CLOB;  
    loa      CLOB;  
    xml      XMLTYPE;  
    laa_file BFILE;  
    loa_file BFILE;  
BEGIN  
    laa_file := BFILENAME('MY_WORK_DIR', 'samplenadcon.laa');
```



```

loa_file := BFILENAME('MY_WORK_DIR', 'samplenadcon.loa');
DBMS_LOB.OPEN(laa_file, DBMS_LOB.LOB_READONLY);
DBMS_LOB.OPEN(loa_file, DBMS_LOB.LOB_READONLY);

DBMS_LOB.CREATETEMPORARY(laa, TRUE, DBMS_LOB.SESSION);
DBMS_LOB.CREATETEMPORARY(loa, TRUE, DBMS_LOB.SESSION);
DBMS_LOB.OPEN(laa, DBMS_LOB.LOB_READWRITE);
DBMS_LOB.OPEN(loa, DBMS_LOB.LOB_READWRITE);
DBMS_LOB.LOADFROMFILE(laa, loa_file, DBMS_LOB.LOBMAXSIZE);
DBMS_LOB.LOADFROMFILE(loa, loa_file, DBMS_LOB.LOBMAXSIZE);
DBMS_LOB.CLOSE(laa);
DBMS_LOB.CLOSE(loa);
DBMS_LOB.CLOSE(laa_file);
DBMS_LOB.CLOSE(loa_file);

SDO_CS.convert_NADCON_to_XML(laa, loa, xml);
SDO_CS.convert_XML_to_NADCON(xml, laa, loa);
DBMS_OUTPUT.PUT_LINE(SUBSTR(laa, 1, 32000));
DBMS_OUTPUT.PUT_LINE(SUBSTR(loa, 1, 32000));
END;
/
NADCON EXTRACTED REGION                                NADGRD
33 49 1 -107.00000      .25000  25.00000      .25000      .00000
.006731      .006444      .006208      .006036      .005935      .005904
.005932      .006002      .006092      .006174      .006218      .006198
.006087      .005867      .005522      .005045      .004432      .003688
.002818      .001836      .000759      -.000385      -.001559      -.002704
. . .
NADCON EXTRACTED REGION                                NADGRD
33 49 1 -107.00000      .25000  25.00000      .25000      .00000
.008509      .007147      .005756      .004331      .002879      .001410
-.000060      -.001507      -.002904      -.004222      -.005431      -.006498
-.007395      -.008095      -.008579      -.008832      -.008848      -.008632
-.008200      -.007577      -.006800      -.005911      -.004957      -.003974
. . .

```

## 20.4 SDO\_CS.CONVERT\_NTV2\_TO\_XML

### Format

```

SDO_CS.CONVERT_NTV2_TO_XML(
    ntv2_clob IN CLOB,
    xml_grid  OUT XMLTYPE );

```

### Description

Converts an NTv2 (National Transformation Version 2) grid in ASCII format to an Oracle Spatial and Graph XML representation.

### Parameters

#### ntv2\_clob

NTv2 grid values in a CLOB object.

#### xml\_grid

Output XML document containing the Oracle Spatial and Graph XML representation of the NTv2 grid.

## Usage Notes

To convert an Oracle Spatial and Graph XML representation to an NTV2 grid, use the [SDO\\_CS.CONVERT\\_XML\\_TO\\_NTV2](#) (page 20-10) procedure.

## Examples

The following example converts an NTV2 grid in ASCII format to an Oracle Spatial and Graph XML representation, converts the resulting XML representation back to an NTV2 ASCII representation, and displays the resulting ASCII representation. (Only part of the output is shown.)

```
set lines 32000
set long 2000000000

DECLARE
    ntv2      CLOB;
    xml       XMLTYPE;
    ntv2_file BFILE;
BEGIN
    ntv2_file := BFILENAME('MY_WORK_DIR', 'samplentv2.gsa');
    DBMS_LOB.OPEN(ntv2_file, DBMS_LOB.LOB_READONLY);

    DBMS_LOB.CREATETEMPORARY(ntv2, TRUE, DBMS_LOB.SESSION);
    DBMS_LOB.OPEN(ntv2, DBMS_LOB.LOB_READWRITE);
    DBMS_LOB.LOADFROMFILE(ntv2, ntv2_file, DBMS_LOB.LOBMAXSIZE);
    DBMS_LOB.CLOSE(ntv2);
    DBMS_LOB.CLOSE(ntv2_file);

    SDO_CS.convert_NTV2_to_XML(ntv2, xml);
    SDO_CS.convert_XML_to_NTV2(xml, ntv2);
    DBMS_OUTPUT.PUT_LINE(SUBSTR(ntv2, 1, 32000));
END;
/
NUM_OREC 11
NUM_SREC 11
NUM_FILE 2
GS_TYPE SECONDS
VERSION NTV2.0
DATUM_F NAD27
DATUM_T NAD83
MAJOR_F 6378206.400
MINOR_F 6356583.800
MAJOR_T 6378137.000
MINOR_T 6356752.314
SUB_NAMEALbanff
PARENT NONE
CREATED 95-06-29
UPDATED 95-07-04
S_LAT 183900.000000
N_LAT 184500.000000
E_LONG 415800.000000
W_LONG 416100.000000
LAT_INC 30.000000
LONG_INC 30.000000
GS_COUNT 231
0.084020 3.737300 0.005000 0.008000
0.083029 3.738740 0.017000 0.011000
0.082038 3.740180 0.029000 0.015000
. . .
```

## 20.5 SDO\_CS.CONVERT\_XML\_TO\_NADCON

### Format

```
SDO_CS.CONVERT_XML_TO_NADCON(
    xml_grid  IN XMLTYPE,
    laa_clob  OUT CLOB,
    loa_clob  OUT CLOB);
```

### Description

Converts an Oracle Spatial and Graph XML representation of a NADCON (North American Datum Conversion) grid to NADCON ASCII format.

### Parameters

#### xml\_grid

XML document containing the Oracle Spatial and Graph XML representation of the NADCON grid.

#### laa\_clob

Output CLOB object containing the latitude values of the NADCON grid.

#### loa\_clob

Output CLOB object containing the longitude values of the NADCON grid.

### Usage Notes

To convert a NADCON grid in ASCII format to an Oracle Spatial and Graph XML representation, use the [SDO\\_CS.CONVERT\\_NADCON\\_TO\\_XML](#) (page 20-6) procedure.

### Examples

The following example converts a NADCON grid in ASCII format to an Oracle Spatial and Graph XML representation, converts the resulting XML representation back to a NADCON ASCII representation, and displays the resulting ASCII representation. (Only part of the output is shown.)

```
set lines 32000
set long 2000000000

DECLARE
    laa      CLOB;
    loa      CLOB;
    xml      XMLTYPE;
    laa_file BFILE;
    loa_file BFILE;
BEGIN
    laa_file := BFILENAME('MY_WORK_DIR', 'samplenadcon.laa');
    loa_file := BFILENAME('MY_WORK_DIR', 'samplenadcon.loa');
    DBMS_LOB.OPEN(laa_file, DBMS_LOB.LOB_READONLY);
    DBMS_LOB.OPEN(loa_file, DBMS_LOB.LOB_READONLY);

    DBMS_LOB.CREATETEMPORARY(laa, TRUE, DBMS_LOB.SESSION);
    DBMS_LOB.CREATETEMPORARY(loa, TRUE, DBMS_LOB.SESSION);
    DBMS_LOB.OPEN(laa, DBMS_LOB.LOB_READWRITE);
```

```

DBMS_LOB.OPEN(laa, DBMS_LOB.LOB_READWRITE);
DBMS_LOB.LOADFROMFILE(laa, laa_file, DBMS_LOB.LOBMAXSIZE);
DBMS_LOB.LOADFROMFILE(laa, laa_file, DBMS_LOB.LOBMAXSIZE);
DBMS_LOB.CLOSE(laa);
DBMS_LOB.CLOSE(laa);
DBMS_LOB.CLOSE(laa_file);
DBMS_LOB.CLOSE(laa_file);

SDO_CS.convert_NADCON_to_XML(laa, laa, xml);
SDO_CS.convert_XML_to_NADCON(xml, laa, laa);
DBMS_OUTPUT.PUT_LINE(SUBSTR(laa, 1, 32000));
DBMS_OUTPUT.PUT_LINE(SUBSTR(laa, 1, 32000));
END;
/
NADCON EXTRACTED REGION                                NADGRD
33 49 1 -107.00000      .25000    25.00000      .25000      .00000
      .006731      .006444      .006208      .006036      .005935      .005904
      .005932      .006002      .006092      .006174      .006218      .006198
      .006087      .005867      .005522      .005045      .004432      .003688
      .002818      .001836      .000759      -.000385      -.001559      -.002704
. . .
NADCON EXTRACTED REGION                                NADGRD
33 49 1 -107.00000      .25000    25.00000      .25000      .00000
      .008509      .007147      .005756      .004331      .002879      .001410
      -.000060      -.001507      -.002904      -.004222      -.005431      -.006498
      -.007395      -.008095      -.008579      -.008832      -.008848      -.008632
      -.008200      -.007577      -.006800      -.005911      -.004957      -.003974
. . .

```

## 20.6 SDO\_CS.CONVERT\_XML\_TO\_NTV2

### Format

```

SDO_CS.CONVERT_XML_TO_NTV2(
    xml_grid IN XMLTYPE,
    ntv2_clob OUT CLOB);

```

### Description

Converts an Oracle Spatial and Graph XML representation of an NTv2 (National Transformation Version 2) grid to NTv2 ASCII format.

### Parameters

#### xml\_grid

XML document containing the Oracle Spatial and Graph XML representation of the NTv2 grid.

#### ntv2\_clob

Output CLOB object containing the values for the NTv2 grid.

### Usage Notes

To convert an NTv2 grid in ASCII format to an Oracle Spatial and Graph XML representation, use the [SDO\\_CS.CONVERT\\_NTV2\\_TO\\_XML](#) (page 20-7) procedure.

## Examples

The following example converts an NTV2 grid in ASCII format to an Oracle Spatial and Graph XML representation, converts the resulting XML representation back to an NTV2 ASCII representation, and displays the resulting ASCII representation. (Only part of the output is shown.)

```

set lines 32000
set long 2000000000

DECLARE
    ntv2      CLOB;
    xml       XMLTYPE;
    ntv2_file BFILE;
BEGIN
    ntv2_file := BFILENAME('MY_WORK_DIR', 'samplentv2.gsa');
    DBMS_LOB.OPEN(ntv2_file, DBMS_LOB.LOB_READONLY);

    DBMS_LOB.CREATETEMPORARY(ntv2, TRUE, DBMS_LOB.SESSION);
    DBMS_LOB.OPEN(ntv2, DBMS_LOB.LOB_READWRITE);
    DBMS_LOB.LOADFROMFILE(ntv2, ntv2_file, DBMS_LOB.LOBMAXSIZE);
    DBMS_LOB.CLOSE(ntv2);
    DBMS_LOB.CLOSE(ntv2_file);

    SDO_CS.convert_NTV2_to_XML(ntv2, xml);
    SDO_CS.convert_XML_to_NTV2(xml, ntv2);
    DBMS_OUTPUT.PUT_LINE(SUBSTR(ntv2, 1, 32000));
END;
/
NUM_OREC 11
NUM_SREC 11
NUM_FILE 2
GS_TYPE SECONDS
VERSION NTV2.0
DATUM_F NAD27
DATUM_T NAD83
MAJOR_F 6378206.400
MINOR_F 6356583.800
MAJOR_T 6378137.000
MINOR_T 6356752.314
SUB_NAMEALbanff
PARENT NONE
CREATED 95-06-29
UPDATED 95-07-04
S_LAT 183900.000000
N_LAT 184500.000000
E_LONG 415800.000000
W_LONG 416100.000000
LAT_INC 30.000000
LONG_INC 30.000000
GS_COUNT 231
0.084020 3.737300 0.005000 0.008000
0.083029 3.738740 0.017000 0.011000
0.082038 3.740180 0.029000 0.015000
. . .

```

## 20.7 SDO\_CS.CREATE\_CONCATENATED\_OP

### Format

```
SDO_CS.CREATE_CONCATENATED_OP(  
    op_id      IN NUMBER,  
    op_name    IN VARCHAR2,  
    use_plan   IN TFM_PLAN);
```

### Description

Creates a concatenated operation.

### Parameters

#### **op\_id**

ID number of the concatenated operation.

#### **op\_name**

Name to be associated with the concatenated operation.

#### **use\_plan**

Transformation plan. The TFM\_PLAN object type is explained in [TFM\\_PLAN Object Type](#) (page 6-19).

### Usage Notes

A concatenated operation is the concatenation (chaining) of two or more atomic operations.

To create a concatenated operation and make it preferred either systemwide or for a specified use case, you can use the [SDO\\_CS.CREATE\\_PREF\\_CONCATENATED\\_OP](#) (page 20-13) convenience procedure.

### Examples

The following example creates a concatenation operation with the operation ID 2999 and the name CONCATENATED\_OPERATION\_2999.

```
DECLARE  
BEGIN  
SDO_CS.CREATE_CONCATENATED_OP(  
    2999,  
    'CONCATENATED_OPERATION_2999',  
    TFM_PLAN(SDO_TFM_CHAIN(4242, 19910, 24200, 10000000000, 24200)));  
END;  
/
```

## 20.8 SDO\_CS.CREATE\_OBVIOUS\_EPSG\_RULES

### Format

```
SDO_CS.CREATE_OBVIOUS_EPSG_RULES(  
    use_case   IN VARCHAR2 DEFAULT NULL);
```

**Description**

Creates a basic set of EPSG rules to be applied in certain transformations.

**Parameters****use\_case**

Name of the use case to be associated with the application of the EPSG rules that are created. Must be a value from the USE\_CASE column of the SDO\_PREFERRED\_OPS\_USER table (described in [SDO\\_PREFERRED\\_OPS\\_USER Table](#) (page 6-40)).

**Usage Notes**

This procedure creates rules to implement the main EPSG-defined transformations between specific coordinate reference systems. For transformations between some coordinate reference systems, EPSG has specified rules that should be applied. For any given transformation from one coordinate reference system to another, the EPSG rule might be different from the default Oracle Spatial and Graph rule. If you execute this procedure, the EPSG rules are applied in any such cases. If you do not execute this procedure, the default Spatial and Graph rules are used in such cases.

This procedure inserts many rows into the SDO\_PREFERRED\_OPS\_SYSTEM table (see [SDO\\_PREFERRED\\_OPS\\_SYSTEM Table](#) (page 6-39)).

To delete the EPSG rules created by this procedure, and thus cause the default Spatial and Graph rules to be used in all cases, use the [SDO\\_CS.DELETE\\_ALL\\_EPSG\\_RULES](#) (page 20-15) procedure.

**Examples**

The following example creates a basic set of EPSG rules to be applied in certain transformations.

```
EXECUTE SDO_CS.CREATE_OBVIOUS_EPSG_RULES;
```

## 20.9 SDO\_CS.CREATE\_PREF\_CONCATENATED\_OP

**Format**

```
SDO_CS.CREATE_PREF_CONCATENATED_OP(
    op_id      IN NUMBER,
    op_name    IN VARCHAR2,
    use_plan   IN TFM_PLAN,
    use_case   IN VARCHAR2 DEFAULT NULL);
```

**Description**

Creates a concatenated operation, associating it with a transformation plan and making it preferred either systemwide or for a specified use case.

**Parameters****op\_id**

ID number of the concatenated operation to be created.

**op\_name**

Name to be associated with the concatenated operation.

**use\_plan**

Transformation plan. The TFM\_PLAN object type is explained in [TFM\\_PLAN Object Type](#) (page 6-19).

**use\_case**

Use case to which this preferred concatenated operation applies. Must be a null or a value from the USE\_CASE column of the SDO\_PREFERRED\_OPS\_USER table (described in [SDO\\_PREFERRED\\_OPS\\_USER Table](#) (page 6-40)).

**Usage Notes**

This convenience procedure combines the operations of the [SDO\\_CS.CREATE\\_CONCATENATED\\_OP](#) (page 20-12) and [SDO\\_CS.ADD\\_PREFERENCE\\_FOR\\_OP](#) (page 20-3) procedures.

A concatenated operation is the concatenation (chaining) of two or more atomic operations.

If `use_case` is null, the transformation plan associated with the operation is a systemwide preference, and a row is added (or two rows are added if a reverse operation exists) to the SDO\_PREFERRED\_OPS\_SYSTEM table (described in [SDO\\_PREFERRED\\_OPS\\_SYSTEM Table](#) (page 6-39)). If `use_case` is not null, the transformation plan associated with the operation is a preference associated with the specified use case, and a row is added (or two rows are added if a reverse operation exists) to the SDO\_PREFERRED\_OPS\_USER table (described in [SDO\\_PREFERRED\\_OPS\\_USER Table](#) (page 6-40)).

To create a concatenation without making it preferred either systemwide or for a specified use case, use the [SDO\\_CS.CREATE\\_CONCATENATED\\_OP](#) (page 20-12) procedure

To delete a concatenated operation, use the [SDO\\_CS.DELETE\\_OP](#) (page 20-15) procedure.

**Examples**

The following example creates a concatenation operation with the operation ID 300 and the name MY\_CONCATENATION\_OPERATION, and causes Spatial and Graph to use the specified transformation plan in all cases (because `use_case` is null) when this operation is used.

```
DECLARE
BEGIN
SDO_CS.CREATE_PREF_CONCATENATED_OP(
  300,
  'MY_CONCATENATED_OPERATION',
  TFM_PLAN(SDO_TFM_CHAIN(4242, 19910, 24200, 10000000000, 24200)),
  NULL);
END;
/
```



## 20.10 SDO\_CS.DELETE\_ALL\_EPSG\_RULES

### Format

```
SDO_CS.DELETE_ALL_EPSG_RULES(  
    use_case IN VARCHAR2 DEFAULT NULL);
```

### Description

Deletes the basic set of EPSG rules to be applied in certain transformations.

### Parameters

#### use\_case

Name of the use case to be associated with the application of the EPSG rules that are created. Must match the value that was used for the use\_case parameter value (either null or a specified value) when the [SDO\\_CS.CREATE\\_OBVIOUS\\_EPSG\\_RULES](#) (page 20-12) procedure was called.

### Usage Notes

This procedure deletes the EPSG rules that were previously created by the [SDO\\_CS.CREATE\\_OBVIOUS\\_EPSG\\_RULES](#) (page 20-12) procedure, and thus causes the default Spatial and Graph rules to be used in all cases. (See the Usage Notes for the [SDO\\_CS.CREATE\\_OBVIOUS\\_EPSG\\_RULES](#) (page 20-12) procedure for more information.)

If use\_case is null, this procedure deletes all rows from the SDO\_PREFERRED\_OPS\_SYSTEM table (see [SDO\\_PREFERRED\\_OPS\\_SYSTEM Table](#) (page 6-39)). If use\_case is not null, this procedure deletes the rows associated with the specified use case from the SDO\_PREFERRED\_OPS\_USER table (see [SDO\\_PREFERRED\\_OPS\\_USER Table](#) (page 6-40)).

### Examples

The following example deletes the basic set of EPSG rules to be applied in certain transformations.

```
EXECUTE SDO_CS.DELETE_ALL_EPSG_RULES;
```

## 20.11 SDO\_CS.DELETE\_OP

### Format

```
SDO_CS.DELETE_OP(  
    op_id IN NUMBER);
```

### Description

Deletes a concatenated operation.

### Parameters

#### op\_id

ID number of the operation to be deleted.

### Usage Notes

To create a concatenated operation and make it preferred systemwide or only for a specified use case, use the [SDO\\_CS.CREATE\\_CONCATENATED\\_OP](#) (page 20-12) procedure.

### Examples

The following example deletes the operation with the ID number 300.

```
EXECUTE SDO_CS.DELETE_OP(300);
```

## 20.12 SDO\_CS.DETERMINE\_CHAIN

### Format

```
SDO_CS.DETERMINE_CHAIN(  
    transient_rule_set IN SDO_TRANSIENT_RULE_SET,  
    use_case           IN VARCHAR2,  
    source_srid        IN NUMBER,  
    target_srid        IN NUMBER) RETURN TFM_PLAN;
```

### Description

Returns the query chain, based on the system rule set, to be used in transformations from one coordinate reference system to another coordinate reference system.

### Parameters

#### **transient\_rule\_set**

Rule set to be used for the transformation. If you specify a null value, the Oracle system rule set is used.

#### **use\_case**

Use case for which to determine the query chain. Must be a null value or a value from the USE\_CASE column of the SDO\_PREFERRED\_OPS\_USER table (described in [SDO\\_PREFERRED\\_OPS\\_USER Table](#) (page 6-40)).

#### **source\_srid**

The SRID of the source coordinate reference system. Must be a value in the SRID column of the SDO\_COORD\_REF\_SYS table (described in [SDO\\_COORD\\_REF\\_SYS Table](#) (page 6-27)).

#### **target\_srid**

The SRID of the target coordinate reference system. Must be a value in the SRID column of the SDO\_COORD\_REF\_SYS table (described in [SDO\\_COORD\\_REF\\_SYS Table](#) (page 6-27)).

### Usage Notes

This function returns an object of type TFM\_PLAN, which is explained in [TFM\\_PLAN Object Type](#) (page 6-19).

The transient\_rule\_set parameter is of type SDO\_TRANSIENT\_RULE\_SET, which has the following definition:

```
CREATE TYPE sdo_transient_rule_set AS OBJECT (  
    source_srid NUMBER,
```

```
target_srid  NUMBER,
tfm          NUMBER);
```

### Examples

The following example returns the query chain based on the system rule set.

```
SELECT MDSYS.SDO_CS.DETERMINE_CHAIN(NULL, NULL, 4804, 4257) FROM DUAL;
```

```
MDSYS.SDO_CS.DETERMINE_CHAIN(NULL, NULL, 4804, 4257) (THE_PLAN)
```

```
-----
TFM_PLAN(SDO_TFM_CHAIN(4804, -2, 4257))
```

The next example creates a preferred concatenated operation (with operation ID 300) with a specified chain for transformations from SRID 4804 to SRID 4257, and then calls the DETERMINE\_CHAIN function, returning a different result. (The operation created in this example is not meaningful or useful, and it was created only for illustration.)

```
CALL SDO_CS.CREATE_PREF_CONCATENATED_OP(
    300,
```

```
    'CONCATENATED OPERATION',
```

```
    TFM_PLAN(
```

```
        SDO_TFM_CHAIN(
```

```
            4804,
```

```
            1000000001, 4804,
```

```
            1000000002, 4804,
```

```
            1000000001, 4804,
```

```
            1000000001, 4804,
```

```
            1000000002, 4804,
```

```
            1000000002, 4804,
```

```
            1000000001, 4804,
```

```
            1000000001, 4804,
```

```
            1000000001, 4804,
```

```
            1000000002, 4804,
```

```
            1000000002, 4804,
```

```
            1000000002, 4257)),
```

```
    NULL);
```

```
SELECT MDSYS.SDO_CS.DETERMINE_CHAIN(NULL, NULL, 4804, 4257) FROM DUAL;
```

```
MDSYS.SDO_CS.DETERMINE_CHAIN(NULL, NULL, 4804, 4257) (THE_PLAN)
```

```
-----
TFM_PLAN(SDO_TFM_CHAIN(4804, 300, 4257))
```

## 20.13 SDO\_CS.DETERMINE\_DEFAULT\_CHAIN

### Format

```
SDO_CS.DETERMINE_DEFAULT_CHAIN(
    source_srid  IN NUMBER,
    target_srid  IN NUMBER) RETURN SDO_SRID_CHAIN;
```

### Description

Returns the default chain of SRID values in transformations from one coordinate reference system to another coordinate reference system.

### Parameters

**source\_srid**

The SRID of the source coordinate reference system. Must be a value in the SRID column of the SDO\_COORD\_REF\_SYS table (described in [SDO\\_COORD\\_REF\\_SYS Table](#) (page 6-27)).

**target\_srid**

The SRID of the target coordinate reference system. Must be a value in the SRID column of the SDO\_COORD\_REF\_SYS table (described in [SDO\\_COORD\\_REF\\_SYS Table](#) (page 6-27)).

**Usage Notes**

This function returns an object of type SDO\_SRID\_CHAIN, which is defined as VARRAY(1048576) OF NUMBER.

**Examples**

The following example returns the default chain of SRID values in transformations from SRID 4804 to SRID 4257.

```
SELECT MDSYS.SDO_CS.DETERMINE_DEFAULT_CHAIN(4804, 4257) FROM DUAL;

MDSYS.SDO_CS.DETERMINE_DEFAULT_CHAIN(4804,4257)
-----
SDO_SRID_CHAIN(NULL, 4804, 4257, NULL)
```

## 20.14 SDO\_CS.FIND\_GEOG\_CRS

**Format**

```
SDO_CS.FIND_GEOG_CRS(
    reference_srid IN NUMBER,
    is_legacy      IN VARCHAR2,
    max_rel_num_difference IN NUMBER DEFAULT 0.000001) RETURN SDO_SRID_LIST;
```

**Description**

Returns the SRID values of geodetic (geographic) coordinate reference systems that have the same well-known text (WKT) numeric values as the coordinate reference system with the specified reference SRID value.

**Parameters****reference\_srid**

The SRID of the coordinate reference system for which to find all other geodetic coordinate reference systems that have the same WKT numeric values. Must be a value in the SRID column of the SDO\_COORD\_REF\_SYS table (described in [SDO\\_COORD\\_REF\\_SYS Table](#) (page 6-27)).

**is\_legacy**

TRUE limits the results to geodetic coordinate reference systems for which the IS\_LEGACY column value is TRUE in the SDO\_COORD\_REF\_SYS table (described in [SDO\\_COORD\\_REF\\_SYS Table](#) (page 6-27)); FALSE limits the results to geodetic coordinate reference systems for which the IS\_LEGACY column value is FALSE in the SDO\_COORD\_REF\_SYS table. If you specify a null value for this parameter, the

IS\_LEGACY column value in the SDO\_COORD\_REF\_SYS table is ignored in determining the results.

#### **max\_rel\_num\_difference**

A numeric value indicating how closely WKT values must match in order for a projected coordinate reference system to be considered a match. The default value is 0.000001. The value for each numeric WKT item is compared with its corresponding value in the WKT for the reference SRID or in the specified list of parameters to this function; and if the difference in all cases is less than or equal to the max\_rel\_num\_difference value, the SRID for that coordinate reference system is included in the results.

#### **Usage Notes**

This function returns an object of type SDO\_SRID\_LIST, which is defined as VARRAY(1048576) OF NUMBER.

The well-known text (WKT) format is described in [Well-Known Text \(WKT\)](#) (page 6-48).

#### **Examples**

The following examples show the effect of the is\_legacy parameter value on the results. The first example returns the SRID values of all geodetic legacy coordinate reference systems that have the same WKT numeric values as the coordinate reference system with the SRID value of 8307.

```
SELECT SDO_CS.FIND_GEOG_CRS(
    8307,
    'TRUE') FROM DUAL;

SDO_CS.FIND_GEOG_CRS(8307, 'TRUE')
-----
SDO_SRID_LIST(8192, 8265, 8307, 8311, 8320, 524288, 2000002, 2000006, 2000012, 2
000015, 2000023, 2000028)
```

The next example returns the SRID values of all geodetic non-legacy coordinate reference systems that have the same WKT numeric values as the coordinate reference system with the SRID value of 8307.

```
SELECT SDO_CS.FIND_GEOG_CRS(
    8307,
    'FALSE') FROM DUAL;

SDO_CS.FIND_GEOG_CRS(8307, 'FALSE')
-----
SDO_SRID_LIST(4019, 4030, 4031, 4032, 4033, 4041, 4121, 4122, 4126, 4130, 4133,
4140, 4141, 4148, 4151, 4152, 4163, 4166, 4167, 4170, 4171, 4172, 4173, 4176, 41
80, 4189, 4190, 4258, 4269, 4283, 4318, 4319, 4326, 4610, 4612, 4617, 4619, 4624
, 4627, 4640, 4659, 4661, 4667, 4669, 4670)
```

The next example returns the SRID values of all geodetic coordinate reference systems (legacy and non-legacy) that have the same WKT numeric values as the coordinate reference system with the SRID value of 8307.

```
SELECT SDO_CS.FIND_GEOG_CRS(
    8307,
    NULL) FROM DUAL;

SDO_CS.FIND_GEOG_CRS(8307, NULL)
```

```
-----  
SDO_SRID_LIST(4019, 4030, 4031, 4032, 4033, 4041, 4121, 4122, 4126, 4130, 4133,  
4140, 4141, 4148, 4151, 4152, 4163, 4166, 4167, 4170, 4171, 4172, 4173, 4176, 41  
80, 4189, 4190, 4258, 4269, 4283, 4318, 4319, 4326, 4610, 4612, 4617, 4619, 4624  
, 4627, 4640, 4659, 4661, 4667, 4669, 4670, 8192, 8265, 8307, 8311, 8320, 524288  
, 2000002, 2000006, 2000012, 2000015, 2000023, 2000028)
```

## 20.15 SDO\_CS.FIND\_PROJ\_CRS

### Format

```
SDO_CS.FIND_PROJ_CRS(  
    reference_srid          IN NUMBER,  
    is_legacy               IN VARCHAR2,  
    max_rel_num_difference  IN NUMBER DEFAULT 0.000001) RETURN SDO_SRID_LIST;
```

### Description

Returns the SRID values of projected coordinate reference systems that have the same well-known text (WKT) numeric values as the coordinate reference system with the specified reference SRID value.

### Parameters

#### reference\_srid

The SRID of the coordinate reference system for which to find all other projected coordinate reference systems that have the same WKT numeric values. Must be a value in the SRID column of the SDO\_COORD\_REF\_SYS table (described in [SDO\\_COORD\\_REF\\_SYS Table](#) (page 6-27)).

#### is\_legacy

TRUE limits the results to projected coordinate reference systems for which the IS\_LEGACY column value is TRUE in the SDO\_COORD\_REF\_SYS table (described in [SDO\\_COORD\\_REF\\_SYS Table](#) (page 6-27)); FALSE limits the results to projected coordinate reference systems for which the IS\_LEGACY column value is FALSE in the SDO\_COORD\_REF\_SYS table. If you specify a null value for this parameter, the IS\_LEGACY column value in the SDO\_COORD\_REF\_SYS table is ignored in determining the results.

#### max\_rel\_num\_difference

A numeric value indicating how closely WKT values must match in order for a coordinate reference system to be considered a match. The default value is 0.000001. The value for each numeric WKT item is compared with its corresponding value in the WKT for the reference SRID or in the specified list of parameters to this function; and if the difference in all cases is less than or equal to the max\_rel\_num\_difference value, the SRID for that coordinate reference system is included in the results.

### Usage Notes

This function returns an object of type SDO\_SRID\_LIST, which is defined as VARRAY(1048576) OF NUMBER.

The well-known text (WKT) format is described in [Well-Known Text \(WKT\)](#) (page 6-48).

## Examples

The following examples show the effect of the `is_legacy` parameter value on the results. The first example returns the SRID values of all projected legacy coordinate reference systems that have the same WKT numeric values as the coordinate reference system with the SRID value of 2007. The returned result list is empty, because there are no legacy projected legacy coordinate reference systems that meet the search criteria.

```
SELECT SDO_CS.FIND_PROJ_CRS(
    2007,
    'TRUE') FROM DUAL;
```

```
SDO_CS.FIND_PROJ_CRS(2007, 'TRUE')
```

```
-----
SDO_SRID_LIST()
```

The next example returns the SRID values of all projected non-legacy coordinate reference systems that have the same WKT numeric values as the coordinate reference system with the SRID value of 2007.

```
SELECT SDO_CS.FIND_PROJ_CRS(
    2007,
    'FALSE') FROM DUAL;
```

```
SDO_CS.FIND_PROJ_CRS(2007, 'FALSE')
```

```
-----
SDO_SRID_LIST(2000, 2001, 2002, 2003, 2004, 2005, 2006, 2007, 21291)
```

The next example returns the SRID values of all projected coordinate reference systems (legacy and non-legacy) that have the same WKT numeric values as the coordinate reference system with the SRID value of 2007. The returned result list is the same as for the preceding example.

```
SELECT SDO_CS.FIND_PROJ_CRS(
    2007,
    NULL) FROM DUAL;
```

```
SDO_CS.FIND_PROJ_CRS(2007, NULL)
```

```
-----
SDO_SRID_LIST(2000, 2001, 2002, 2003, 2004, 2005, 2006, 2007, 21291)
```

## 20.16 SDO\_CS.FIND\_SRID

### Format

```
SDO_CS.FIND_SRID(
    srid                OUT NUMBER,
    epsg_srid_geog      IN NUMBER DEFAULT NULL,
    epsg_srid_proj      IN NUMBER DEFAULT NULL,
    datum_id            IN NUMBER DEFAULT NULL,
    pm_id               IN NUMBER DEFAULT NULL,
    proj_method_id      IN NUMBER DEFAULT NULL,
    coord_ref_sys_kind  IN VARCHAR2 DEFAULT NULL,
    semi_major_axis     IN NUMBER DEFAULT NULL,
    semi_minor_axis     IN NUMBER DEFAULT NULL,
    inv_flattening      IN NUMBER DEFAULT NULL,
    params              IN EPSG_PARAMS DEFAULT NULL);
```

or

```
SDO_CS.FIND_SRID(  
    srid                OUT NUMBER,  
    epsg_srid_geog      IN NUMBER DEFAULT NULL,  
    epsg_srid_proj      IN NUMBER DEFAULT NULL,  
    datum_id           IN NUMBER DEFAULT NULL,  
    pm_id              IN NUMBER DEFAULT NULL,  
    proj_method_id      IN NUMBER DEFAULT NULL,  
    proj_op_id          IN NUMBER DEFAULT NULL,  
    coord_ref_sys_kind  IN VARCHAR2 DEFAULT NULL,  
    semi_major_axis     IN NUMBER DEFAULT NULL,  
    semi_minor_axis     IN NUMBER DEFAULT NULL,  
    inv_flattening      IN NUMBER DEFAULT NULL,  
    params              IN EPSG_PARAMS DEFAULT NULL,  
    max_rel_num_difference IN NUMBER DEFAULT 0.000001);
```

### Description

Finds an SRID value for a coordinate system that matches information that you specify.

### Parameters

#### **srid**

Output parameter; will contain either a numeric SRID value or a null value, as explained in the Usage Notes.

#### **epsg\_srid\_geog**

EPSG SRID value of a geographic coordinate system. Depending on the value of the `coord_ref_sys_kind` parameter, this procedure will either verify the existence of a coordinate system with this geographic SRID value, or will find an SRID value of a projected coordinate system based on a coordinate system with this SRID value.

#### **epsg\_srid\_proj**

EPSG SRID value of a projected coordinate system.

#### **datum\_id**

Datum ID value. Depending on the value of the `coord_ref_sys_kind` parameter, this procedure will look for the SRID of a geographic or projected coordinate system based on this datum.

#### **ellipsoid\_id**

Ellipsoid ID value. Depending on the value of the `coord_ref_sys_kind` parameter, this procedure will look for the SRID of a geographic or projected coordinate system based on this ellipsoid.

#### **pm\_id**

Prime meridian ID value. Depending on the value of the `coord_ref_sys_kind` parameter, this procedure will look for the SRID of a geographic or projected coordinate system based on this prime meridian.

#### **proj\_method\_id**

Projection method ID value. This procedure will look for the SRID of a projected coordinate system based on this projection method.



**proj\_op\_id**

Projection operation ID value. This procedure will look for the SRID of a projected coordinate system based on this projection operation. A projection operation is a projection method combined with specific projection parameters.

**coord\_ref\_sys\_kind**

The kind or category of coordinate system. Must be a string value in the COORD\_REF\_SYS\_KIND column of the SDO\_COORD\_REF\_SYS table (described in [SDO\\_COORD\\_REF\\_SYS Table](#) (page 6-27)). Examples: GEOGRAPHIC2D and PROJECTED

**semi\_major\_axis**

Semi-major axis ID value. Depending on the value of the coord\_ref\_sys\_kind parameter, this procedure will look for the SRID of a geographic or projected coordinate system based on this semi-major axis.

**semi\_minor\_axis**

Semi-minor axis ID value. Depending on the value of the coord\_ref\_sys\_kind parameter, this procedure will look for the SRID of a geographic or projected coordinate system based on this semi-minor axis.

**inv\_flattening**

Inverse flattening (unit "unity"). Depending on the value of the coord\_ref\_sys\_kind parameter, this procedure will look for the SRID of a geographic or projected coordinate system based on this inverse flattening.

**params**

Projection parameters. The parameters depend on the projection method. The EPSG\_PARAMS type is defined as VARRAY(1048576) OF EPSG\_PARAM, and the EPSG\_PARAM type is defined as (id NUMBER, val NUMBER, uom NUMBER). The format includes attributes for the parameter ID, value, and unit of measure ID, as shown in the following example:

```
epsg_params(
  epsg_param(8801,      0.0,    9102),
  epsg_param(8802,      9.0,    9102),
  epsg_param(8805,      0.9996, 9201),
  epsg_param(8806, 500000.0,    9001),
  epsg_param(8807,      0.0,    9001));
```

**max\_rel\_num\_difference**

A numeric value indicating how closely WKT values must match in order for a coordinate reference system to be considered a match. The default value is 0.000001. The value for each numeric WKT item is compared with its corresponding value in the WKT for the reference SRID or in the specified list of parameters to this procedure; and if the difference in all cases is less than or equal to the max\_rel\_num\_difference value, the SRID for that coordinate reference system is included in the results.

**Usage Notes**

This procedure places the result of its operation in the srid output parameter. The result is either a numeric SRID value or a null value.

This procedure has the following major uses:

- To check if a coordinate system with a specific SRID value exists. In this case, you specify a value for `epsg_srid_geog` or `epsg_srid_proj` (depending on whether the coordinate system is geographic or projected) and enough parameters for a valid PL/SQL statement. If the resulting `srid` parameter value is the same number as the value that you specified, the coordinate system with that SRID value exists; however, if the resulting `srid` parameter value is null, no coordinate system with that SRID value exists.
- To find the SRID value of a coordinate system based on information that you specify about it.

If multiple coordinate systems match the criteria specified in the input parameters, only one SRID value is returned in the `srid` parameter. This could be any one of the potential matching SRID values, and it is not guaranteed to be the same value in subsequent executions of this procedure with the same input parameters.

### Examples

The following example finds an SRID value for a projected coordinate system that uses datum ID 6267 in its definition.

```
DECLARE
    returned_srid NUMBER;
BEGIN
    SDO_CS.FIND_SRID (
        srid           => returned_srid,
        epsg_srid_geog => null,
        epsg_srid_proj => null,
        datum_id       => 6267,
        ellips_id       => null,
        pm_id           => null,
        proj_method_id  => null,
        proj_op_id      => null,
        coord_ref_sys_kind => 'PROJECTED');
    DBMS_OUTPUT.PUT_LINE('SRID = ' || returned_srid);
END;
/
SRID = 4267
```

## 20.17 SDO\_CS.FROM\_OGC\_SIMPLEFEATURE\_SRS

### Format

```
SDO_CS.FROM_OGC_SIMPLEFEATURE_SRS(
    wkt IN VARCHAR2) RETURN VARCHAR2;
```

### Description

Converts a well-known text string from the Open Geospatial Consortium simple feature format without the TOWGS84 keyword to the format that includes the TOWGS84 keyword.

### Parameters

#### **wkt**

Well-known text string.

## Usage Notes

To convert a well-known text string from the Open Geospatial Consortium simple feature format that includes the TOWGS84 keyword to the format without the TOWGS84 keyword, use the [SDO\\_CS.TO\\_OGC\\_SIMPLEFEATURE\\_SRS](#) (page 20-31) function.

## Examples

The following example converts a well-known text string from the Open Geospatial Consortium simple feature format without the TOWGS84 keyword to the format that includes the TOWGS84 keyword.

```
SELECT sdo_cs.from_OGC_SimpleFeature_SRS('GEOGCS [ "Longitude / Latitude (DHDN)",
    DATUM [ "", SPHEROID [ "Bessel 1841", 6377397.155, 299.1528128],
    582.000000, 105.000000, 414.000000, -1.040000, -0.350000, 3.080000, 8.300000 ],
    PRIMEM [ "Greenwich", 0.000000 ], UNIT [ "Decimal Degree", 0.01745329251994330]]')
FROM DUAL;

MDSYS.SDO_CS.FROM_OGC_SIMPLEFEATURE_SRS('GEOGCS[ "LONGITUDE/LATITUDE(DHDN)", DATUM
-----
GEOGCS [ "Longitude / Latitude (DHDN)", DATUM [ "", SPHEROID [ "Bessel 1841", 6377
397.155, 299.1528128], TOWGS84[ 582.000000, 105.000000, 414.000000, -1.040000, -
0.350000, 3.080000, 8.300000]], PRIMEM [ "Greenwich", 0.000000 ], UNIT [ "Decimal
Degree", 0.01745329251994330]]')
```

# 20.18 SDO\_CS.FROM\_USNG

## Format

```
SDO_CS.FROM_USNG(
    usng    IN VARCHAR2,
    srid    IN NUMBER,
    datum   IN VARCHAR2 DEFAULT 'NAD83') RETURN SDO_GEOMETRY;
```

## Description

Converts a point represented in U.S. National Grid format to a spatial point geometry object.

## Parameters

### usng

Well-known text string.

### srid

The SRID of the coordinate system to be used for the conversion (that is, the SRID to be used in the returned geometry). Must be a value in the SRID column of the SDO\_COORD\_REF\_SYS table (described in [SDO\\_COORD\\_REF\\_SYS Table](#) (page 6-27)).

### datum

The name of the datum on which the U.S. National Grid coordinate for the point is based. Must be either a value in the DATUM\_NAME column of the SDO\_DATUMS table (described in [SDO\\_DATUMS Table](#) (page 6-37)) or null. The default value is NAD83.

**Usage Notes**

For information about Oracle Spatial and Graph support for the U.S. National Grid, see [U.S. National Grid Support](#) (page 6-74).

To convert a spatial point geometry to a point represented in U.S. National Grid format, use the [SDO\\_CS.TO\\_USNG](#) (page 20-32) function.

**Examples**

The following example converts a point represented in U.S. National Grid format to a spatial geometry point object with longitude/latitude coordinates.

```
-- Convert US National Grid point to SDO_GEOMETRY point using SRID 4326
-- (WGS 84, longitude/latitude).
SELECT SDO_CS.FROM_USNG(
    '18SUJ2348316806479498',
    4326) FROM DUAL;

WGS84(SDO_GTYPE, SDO_SRID, SDO_POINT(X, Y, Z), SDO_ELEM_INFO, SDO_ORDINATES)
-----
SDO_GEOMETRY(2001, 4326, SDO_POINT_TYPE(-77.03524, 38.8894673, NULL), NULL, NULL)
```

## 20.19 SDO\_CS.GET\_EPSG\_DATA\_VERSION

**Format**

```
SDO_CS.GET_EPSG_DATA_VERSION() RETURN VARCHAR2;
```

**Description**

Gets the version number of the EPSG dataset used by Spatial and Graph.

**Parameters**

None.

**Usage Notes**

The EPSG dataset is available from the European Petroleum Survey Group, and is distributed in a Microsoft Access 97 database and as SQL scripts.

**Examples**

The following example gets the version number of the EPSG dataset used by Spatial and Graph.

```
SELECT SDO_CS.GET_EPSG_DATA_VERSION FROM DUAL;

GET_EPSG_DATA_VERSION
-----
7.5
```

## 20.20 SDO\_CS.LOAD\_EPSG\_MATRIX

**Format**

```
SDO_CS.LOAD_EPSG_MATRIX(
    op_id          IN NUMBER,
```

```
parameter_id IN NUMBER,
directory    IN VARCHAR2,
file_name    IN VARCHAR2);
```

### Description

Loads an EPSG matrix of NADCON, NTv2, or VERTCON format.

### Parameters

#### op\_id

EPSG operation ID to which the matrix belongs.

#### parameter\_id

EPSG parameter id identifying the matrix, if an operation has more than one matrix, such as NADCON.

#### directory

Name of the matrix file directory.

#### file\_name

Matrix file name.

### Usage Notes

To validate an EPSG matrix, use the [SDO\\_CS.VALIDATE\\_EPSG\\_MATRIX](#) (page 20-42) function.

### Examples

The following example loads an NTv2 matrix for operation 1703 ("NAD27 to WGS 84 (32)"). For an NTv2 operation, a single matrix is sufficient, assigned to parameter ID 8656.

```
CREATE OR REPLACE DIRECTORY work_dir AS '...';

EXECUTE sdo_cs.load_epsg_matrix(
    1703,
    8656,
    'WORK_DIR',
    'ntv2file.asc');
```

## 20.21 SDO\_CS.MAKE\_2D

### Format

```
SDO_CS.MAKE_2D(
    geom3d      IN SDO_GEOMETRY,
    target_srid IN NUMBER DEFAULT NULL) RETURN SDO_GEOMETRY;
```

### Description

Converts a three-dimensional (or more dimensions) geometry into a two-dimensional geometry.

### Parameters

**geom3d**

Geometry object with more than two dimensions.

**target\_srid**

The SRID of the target coordinate reference system. Must be null or a value in the SRID column of the SDO\_COORD\_REF\_SYS table (described in [SDO\\_COORD\\_REF\\_SYS Table](#) (page 6-27)). If this parameter is null, a default SRID is used based on the SRID of the input geometry.

**Usage Notes**

This function returns a two-dimensional geometry object that removes the third (height) dimension value (and other dimension values if the input geometry has more than three dimensions) from each vertex in the input geometry.

For information about three-dimensional coordinate reference system support, see [Three-Dimensional Coordinate Reference System Support](#) (page 6-9).

**Examples**

The following example converts a three-dimensional geometry to a two-dimensional geometry by removing all the third (height) dimension values. (It uses as its input geometry the output geometry from the example for the [SDO\\_CS.MAKE\\_3D](#) (page 20-28) function.)

```
SELECT SDO_CS.MAKE_2D(SDO_GEOMETRY(3003, 8307, NULL,
  SDO_ELEM_INFO_ARRAY(1, 1003, 1),
  SDO_ORDINATE_ARRAY(1, 1, 10, 5, 1, 10, 5, 7, 10, 1, 7, 10, 1, 1, 10)))
FROM DUAL;

SDO_CS.MAKE_2D(SDO_GEOMETRY(3003,8307,NULL,SDO_ELEM_INFO_ARRAY(1,1003,1),SDO_ORD
-----
SDO_GEOMETRY(2003, 8307, NULL, SDO_ELEM_INFO_ARRAY(1, 1003, 1), SDO_ORDINATE_ARR
AY(1, 1, 5, 1, 5, 7, 1, 7, 1, 1))
```

## 20.22 SDO\_CS.MAKE\_3D

**Format**

```
SDO_CS.MAKE_3D(
  geom2d      IN SDO_GEOMETRY,
  height      IN NUMBER DEFAULT 0,
  target_srid IN NUMBER DEFAULT NULL) RETURN SDO_GEOMETRY;
```

**Description**

Converts a two-dimensional geometry into a three-dimensional geometry.

**Parameters****geom2d**

Two-dimensional geometry object.

**height**

Height value to be used in the third dimension for all vertices in the returned geometry. If this parameter is null or not specified, a height of 0 (zero) is used for all vertices.

**target\_srid**

The SRID of the target coordinate reference system. Must be null or a value in the SRID column of the SDO\_COORD\_REF\_SYS table (described in [SDO\\_COORD\\_REF\\_SYS Table](#) (page 6-27)).

**Usage Notes**

For information about using this function to simulate a cross-dimensionality transformation, see [Cross-Dimensionality Transformations](#) (page 6-16).

For information about three-dimensional coordinate reference system support, see [Three-Dimensional Coordinate Reference System Support](#) (page 6-9).

**Examples**

The following example converts the cola\_a two-dimensional geometry to a three-dimensional geometry. (This example uses the definitions from the example in [Example of Coordinate System Transformation](#) (page 6-76)).

```
SELECT SDO_CS.MAKE_3D(c.shape, 10, 8307) FROM cola_markets_cs c
WHERE c.name = 'cola_a';

SDO_CS.MAKE_3D(C.SHAPE,10,8307)(SDO_GTYPE, SDO_SRID, SDO_POINT(X, Y, Z), SDO_ELE
-----
SDO_GEOMETRY(3003, 8307, NULL, SDO_ELEM_INFO_ARRAY(1, 1003, 1), SDO_ORDINATE_ARR
AY(1, 1, 10, 5, 1, 10, 5, 7, 10, 1, 7, 10, 1, 1, 10))
```

## 20.23 SDO\_CS.MAP\_EPSG\_SRID\_TO\_ORACLE

**Format**

```
SDO_CS.MAP_EPSG_SRID_TO_ORACLE(
    epsg_srid IN NUMBER) RETURN NUMBER;
```

**Description**

Returns the Oracle Spatial and Graph SRID value corresponding to the specified EPSG SRID value.

**Parameters****epsg\_srid**

The SRID of the EPSG coordinate reference system, as indicated in the COORD\_REF\_SYS\_CODE field in the EPSG Coordinate Reference System table.

**Usage Notes**

This function returns a value that matches a value in the SRID column of the SDO\_COORD\_REF\_SYS table (see [SDO\\_COORD\\_REF\\_SYS Table](#) (page 6-27)).

To return the EPSG SRID value corresponding to the specified Oracle Spatial and Graph SRID value, use the [SDO\\_CS.MAP\\_ORACLE\\_SRID\\_TO\\_EPSG](#) (page 20-30) function.

### Examples

The following example returns the Oracle Spatial and Graph SRID value corresponding to EPSG SRID 23038.

```
SELECT SDO_CS.MAP_EPSG_SRID_TO_ORACLE(23038) FROM DUAL;

SDO_CS.MAP_EPSG_SRID_TO_ORACLE(23038)
-----
                        82361
```

## 20.24 SDO\_CS.MAP\_ORACLE\_SRID\_TO\_EPSG

### Format

```
SDO_CS.MAP_ORACLE_SRID_TO_EPSG(
    legacy_srid IN NUMBER) RETURN NUMBER;
```

### Description

Returns the EPSG SRID value corresponding to the specified Oracle Spatial and Graph SRID value.

### Parameters

#### legacy\_srid

Oracle Spatial and Graph SRID value. Must match a value in the LEGACY\_CODE column of the SDO\_COORD\_REF\_SYS table (see [SDO\\_COORD\\_REF\\_SYS Table](#) (page 6-27)).

### Usage Notes

This function returns the SRID of an EPSG coordinate reference system. The EPSG SRID value for a coordinate reference system is indicated in the COORD\_REF\_SYS\_CODE field in the EPSG Coordinate Reference System table.

To return the Oracle Spatial and Graph SRID value corresponding to a specified EPSG SRID value, use the [SDO\\_CS.MAP\\_EPSG\\_SRID\\_TO\\_ORACLE](#) (page 20-29) function.

### Examples

The following example returns the EPSG SRID value corresponding to Oracle Spatial and Graph SRID 82361.

```
SELECT SDO_CS.MAP_ORACLE_SRID_TO_EPSG(82361) FROM DUAL;

SDO_CS.MAP_ORACLE_SRID_TO_EPSG(82361)
-----
                        23038
```

## 20.25 SDO\_CS.REVOKE\_PREFERENCE\_FOR\_OP

### Format

```
SDO_CS.REVOKE_PREFERENCE_FOR_OP(
    op_id      IN NUMBER,
    source_crs IN NUMBER DEFAULT NULL,
```



```
target_crs IN NUMBER DEFAULT NULL,
use_case   IN VARCHAR2 DEFAULT NULL);
```

### Description

Revokes a preference for an operation between a source coordinate system and a target coordinate system.

### Parameters

#### op\_id

ID number of the operation. Must match an `op_id` value that was specified in a call to the [SDO\\_CS.ADD\\_PREFERENCE\\_FOR\\_OP](#) (page 20-3) procedure.

#### source\_crs

The SRID of the source coordinate reference system. Must match the `source_crs` value in a `source_crs`, `target_crs`, and `use_case` combination that was specified in a call to the [SDO\\_CS.ADD\\_PREFERENCE\\_FOR\\_OP](#) (page 20-3) procedure.

#### target\_crs

The SRID of the target coordinate reference system. Must match the `target_crs` value in a `source_crs`, `target_crs`, and `use_case` combination that was specified in a call to the [SDO\\_CS.ADD\\_PREFERENCE\\_FOR\\_OP](#) (page 20-3) procedure.

#### use\_case

Name of the use case associated with the preference. Must match the `use_case` value in a `source_crs`, `target_crs`, and `use_case` combination that was specified in a call to the [SDO\\_CS.ADD\\_PREFERENCE\\_FOR\\_OP](#) (page 20-3) procedure.

### Usage Notes

This procedure reverses the effect of the [SDO\\_CS.ADD\\_PREFERENCE\\_FOR\\_OP](#) (page 20-3) procedure.

If `use_case` is null, this procedure deletes one or more rows from the `SDO_PREFERRED_OPS_SYSTEM` table (described in [SDO\\_PREFERRED\\_OPS\\_SYSTEM Table](#) (page 6-39)). If `use_case` is not null, this procedure deletes one or more rows from the `SDO_PREFERRED_OPS_USER` table (described in [SDO\\_PREFERRED\\_OPS\\_USER Table](#) (page 6-40)).

### Examples

The following example revokes a preference for operation ID 19777 to be used in transformations from SRID 4301 to SRID 4326 when use case `use_case_B` is specified for the transformation.

```
EXECUTE SDO_CS.REVOKE_PREFERENCE_FOR_OP(19777, 4301, 4326, 'use_case_B');
```

## 20.26 SDO\_CS.TO\_OGC\_SIMPLEFEATURE\_SRS

### Format

```
SDO_CS.TO_OGC_SIMPLEFEATURE_SRS(
    wkt IN VARCHAR2) RETURN VARCHAR2;
```

### Description

Converts a well-known text string from the Open Geospatial Consortium simple feature format that includes the TOWGS84 keyword to the format without the TOWGS84 keyword.

### Parameters

**wkt**

Well-known text string.

### Usage Notes

To convert a well-known text string from the Open Geospatial Consortium simple feature format without the TOWGS84 keyword to the format that includes the TOWGS84 keyword, use the [SDO\\_CS.FROM\\_OGC\\_SIMPLEFEATURE\\_SRS](#) (page 20-24) procedure.

### Examples

The following example converts a well-known text string from the Open Geospatial Consortium simple feature format that includes the TOWGS84 keyword to the format without the TOWGS84 keyword.

```
SELECT sdo_cs.to_OGC_SimpleFeature_SRS('GEOGCS [ "Longitude / Latitude (DHDN)",
    DATUM [ "", SPHEROID [ "Bessel 1841", 6377397.155, 299.1528128],
    TOWGS84 [ 582.000000, 105.000000, 414.000000, -1.040000, -0.350000, 3.080000,
        8.300000 ] ],
    PRIMEM [ "Greenwich", 0.000000 ], UNIT [ "Decimal Degree", 0.01745329251994330]]')
FROM DUAL;
```

```
MDSYS.SDO_CS.TO_OGC_SIMPLEFEATURE_SRS('GEOGCS[ "LONGITUDE/LATITUDE(DHDN)",DATUM[ "
-----
GEOGCS [ "Longitude / Latitude (DHDN)", DATUM [ "", SPHEROID [ "Bessel 1841", 6377
397.155, 299.1528128], 582.000000, 105.000000, 414.000000, -1.040000, -0.350000,
3.080000, 8.300000 ], PRIMEM [ "Greenwich", 0.000000 ], UNIT [ "Decimal Degree",
0.01745329251994330]]')
```

## 20.27 SDO\_CS.TO\_USNG

### Format

```
SDO_CS.TO_USNG(
    geom                IN SDO_GEOMETRY,
    accuracy_in_meters IN NUMBER,
    datum               IN VARCHAR2 DEFAULT 'NAD83') RETURN VARCHAR2;
```

### Description

Converts a spatial point geometry object to a point represented in U.S. National Grid format.

### Parameters

**geom**

Point geometry whose representation is to be converted to a point represented in U.S. National Grid format. The input geometry must have a valid non-null SRID, that is, a

value in the SRID column of the SDO\_COORD\_REF\_SYS table (described in [SDO\\_COORD\\_REF\\_SYS Table](#) (page 6-27)).

#### **accuracy\_in\_meters**

Accuracy of the point location in meters. Should be 1 raised to a negative or positive power of 10 (for example, 0.001, 0.01, 0.1, 1, 10, 100, or 1000). Any other specified values are adjusted internally by Spatial and Graph, and the result might not be what you expect.

#### **datum**

The name of the datum on which the U.S. National Grid coordinate for the point is to be based. Must be either NAD83 or NAD27. The default value is NAD83.

### **Usage Notes**

For information about Oracle Spatial and Graph support for the U.S. National Grid, see [U.S. National Grid Support](#) (page 6-74).

The `accuracy_in_meters` value affects the number of digits used to represent the accuracy in the returned U.S. National Grid string. For example, if you specify 0.000001, the string will contain many digits; however, depending on the source of the data, the digits might not accurately reflect geographical reality. Consider the following scenarios. If you create a U.S. National Grid string from a UTM geometry, you can get perfect accuracy, because no inherently inaccurate transformation is involved. However, transforming from a Lambert projection to the U.S. National Grid format involves an inverse Lambert projection and a forward UTM projection, each of which has some inherent inaccuracy. If you request the resulting U.S. National Grid string with 1 millimeter (0.001) accuracy, the string will contain all the digits, but the millimeter-level digit will probably be geographically inaccurate.

To convert a point represented in U.S. National Grid format to a spatial point geometry, use the [SDO\\_CS.FROM\\_USNG](#) (page 20-25) function.

### **Examples**

The following example converts a spatial geometry point object with longitude/latitude coordinates to a point represented in U.S. National Grid format using an accuracy of 0.001 meter (1 millimeter).

```
-- Convert longitude/latitude (WGS 84) point to US National Grid.
SELECT SDO_CS.TO_USNG(
  SDO_GEOMETRY(2001, 4326,
    SDO_POINT_TYPE(-77.0352402158258, 38.8894673086544, NULL),
    NULL, NULL),
  0.001) FROM DUAL;

SDO_CS.TO_USNG(SDO_GEOMETRY(2001,4326,SDO_POINT_TYPE(-77.0352402158258,38.889467
-----
18SUJ2348316806479498
```

## **20.28 SDO\_CS.TRANSFORM**

### **Format**

```
SDO_CS.TRANSFORM(
  geom      IN SDO_GEOMETRY,
  to_srid   IN NUMBER
) RETURN SDO_GEOMETRY;
```

or

```
SDO_CS.TRANSFORM(  
    geom      IN SDO_GEOMETRY,  
    to_sname  IN VARCHAR2  
    ) RETURN SDO_GEOMETRY;
```

or

```
SDO_CS.TRANSFORM(  
    geom      IN SDO_GEOMETRY,  
    use_case  IN VARCHAR2,  
    to_srid   IN NUMBER  
    ) RETURN SDO_GEOMETRY;
```

or

```
SDO_CS.TRANSFORM(  
    geom      IN SDO_GEOMETRY,  
    use_plan  IN TFM_PLAN  
    ) RETURN SDO_GEOMETRY;
```

### Description

Transforms a geometry representation using a coordinate system (specified by SRID or name).

You can also associate a use case or a transformation plan with the transformation.

### Parameters

#### **geom**

Geometry whose representation is to be transformed using another coordinate system. The input geometry must have a valid non-null SRID, that is, a value in the SRID column of the SDO\_COORD\_REF\_SYS table (described in [SDO\\_COORD\\_REF\\_SYS Table](#) (page 6-27)).

#### **to\_srid**

The SRID of the coordinate system to be used for the transformation. It must be a value in the SRID column of the SDO\_COORD\_REF\_SYS table (described in [SDO\\_COORD\\_REF\\_SYS Table](#) (page 6-27)).

#### **to\_sname**

The name of the coordinate system to be used for the transformation. It must be a value (specified exactly) in the COORD\_REF\_SYS\_NAME column of the SDO\_COORD\_REF\_SYS table (described in [SDO\\_COORD\\_REF\\_SYS Table](#) (page 6-27)).

#### **use\_case**

The name of the use case to be associated with the transformation. If you specify the string USE\_SPHERICAL, the transformation uses spherical math instead of ellipsoidal math, thereby accommodating Google Maps and some other third-party tools that use projections based on spherical math. Use cases are explained in [EPSG Model and Spatial and Graph](#) (page 6-8). For considerations related to Google Maps, see [Google Maps Considerations](#) (page 6-74).

**use\_plan**

Transformation plan. The TFM\_PLAN object type is explained in [TFM\\_PLAN Object Type](#) (page 6-19).

**Usage Notes**

Transformation can be done only between two different georeferenced coordinate systems or between two different local coordinate systems.

Transformation of circles and arcs is not supported, regardless of the type of coordinate systems involved.

An exception is raised if geom, to\_srid, or to\_sname is invalid. For geom to be valid for this function, its definition must include an SRID value matching a value in the SRID column of the SDO\_COORD\_REF\_SYS table (described in [SDO\\_COORD\\_REF\\_SYS Table](#) (page 6-27)).

**Examples**

The following example transforms the cola\_c geometry to a representation that uses SRID value 8199. (This example uses the definitions from the example in [Example of Coordinate System Transformation](#) (page 6-76).)

```
-- Return the transformation of cola_c using to_srid 8199
-- ('Longitude / Latitude (Arc 1950)')
SELECT c.name, SDO_CS.TRANSFORM(c.shape, 8199)
  FROM cola_markets_cs c WHERE c.name = 'cola_c';

NAME
-----
SDO_CS.TRANSFORM(C.SHAPE,8199)(SDO_GTYPE, SDO_SRID, SDO_POINT(X, Y, Z), SDO_ELEM
-----
cola_c
SDO_GEOMETRY(2003, 8199, NULL, SDO_ELEM_INFO_ARRAY(1, 1003, 1), SDO_ORDINATE_ARR
AY(3.00074114, 3.00291482, 6.00067068, 3.00291287, 6.0006723, 5.00307625, 4.0007
1961, 5.00307838, 3.00074114, 3.00291482))

-- Same as preceding, but using to_sname parameter.
SELECT c.name, SDO_CS.TRANSFORM(c.shape, 'Longitude / Latitude (Arc 1950)')
  FROM cola_markets_cs c WHERE c.name = 'cola_c';

NAME
-----
SDO_CS.TRANSFORM(C.SHAPE,'LONGITUDE/LATITUDE(ARC1950)')(SDO_GTYPE, SDO_SRID, SDO
-----
cola_c
SDO_GEOMETRY(2003, 8199, NULL, SDO_ELEM_INFO_ARRAY(1, 1003, 1), SDO_ORDINATE_ARR
AY(3.00074114, 3.00291482, 6.00067068, 3.00291287, 6.0006723, 5.00307625, 4.0007
1961, 5.00307838, 3.00074114, 3.00291482))
```

## 20.29 SDO\_CS.TRANSFORM\_LAYER

**Format**

```
SDO_CS.TRANSFORM_LAYER(
  table_in  IN VARCHAR2,
  column_in IN VARCHAR2,
  table_out IN VARCHAR2,
  to_srid   IN NUMBER);
```

or

```
SDO_CS.TRANSFORM_LAYER(  
    table_in  IN VARCHAR2,  
    column_in IN VARCHAR2,  
    table_out IN VARCHAR2,  
    use_plan  IN TFM_PLAN);
```

or

```
SDO_CS.TRANSFORM_LAYER(  
    table_in  IN VARCHAR2,  
    column_in IN VARCHAR2,  
    table_out IN VARCHAR2,  
    use_case  IN VARCHAR2,  
    to_srid   IN NUMBER);
```

## Description

Transforms an entire layer of geometries (that is, all geometries in a specified column in a table).

## Parameters

### **table\_in**

Table containing the layer (`column_in`) whose geometries are to be transformed.

### **column\_in**

Column in `table_in` that contains the geometries to be transformed.

### **table\_out**

Table that will be created and that will contain the results of the transformation. See the Usage Notes for information about the format of this table.

### **to\_srid**

The SRID of the coordinate system to be used for the transformation. `to_srid` must be a value in the `SRID` column of the `SDO_COORD_REF_SYS` table (described in [SDO\\_COORD\\_REF\\_SYS Table](#) (page 6-27)).

### **use\_plan**

Transformation plan. The `TFM_PLAN` object type is explained in [TFM\\_PLAN Object Type](#) (page 6-19).

### **use\_case**

Name of the use case whose transformation rules are to be applied in performing the transformation. Use cases are explained in [EPSG Model and Spatial and Graph](#) (page 6-8).

## Usage Notes

Transformation can be done only between two different georeferenced coordinate systems or between two different local coordinate systems.

An exception is raised if any of the following occurs:

- `table_in` does not exist, or `column_in` does not exist in the table.
- The geometries in `column_in` have a null or invalid `SDO_SRID` value.

- `table_out` already exists.
- `to_srid` is invalid.

The `table_out` table is created by the procedure and is filled with one row for each transformed geometry. This table has the columns shown in [Table 20-2](#) (page 20-37).

**Table 20-2 Table to Hold Transformed Layer**

Column Name	Data Type	Description
SDO_ROWID	ROWID	Oracle ROWID (row address identifier). For more information about the ROWID data type, see <i>Oracle Database SQL Language Reference</i> .
GEOMETRY	SDO_GEOMETRY	Geometry object with coordinate values in the specified ( <code>to_srid</code> parameter) coordinate system.

### Examples

The following example transforms the geometries in the `shape` column in the `COLA_MARKETS_CS` table to a representation that uses SRID value 8199. The transformed geometries are stored in the newly created table named `COLA_MARKETS_CS_8199`. (This example uses the definitions from the example in [Example of Coordinate System Transformation](#) (page 6-76).)

```
-- Transform the entire SHAPE layer and put results in the table
-- named cola_markets_cs_8199, which the procedure will create.
CALL SDO_CS.TRANSFORM_LAYER('COLA_MARKETS_CS','SHAPE','COLA_MARKETS_CS_8199',8199);
```

The example in [Example of Coordinate System Transformation](#) (page 6-76) includes a display of the geometry object coordinates in both tables (`COLA_MARKETS_CS` and `COLA_MARKETS_CS_8199`).

## 20.30 SDO\_CS.UPDATE\_WKTS\_FOR\_ALL\_EPSG\_CRS

### Format

```
SDO_CS.UPDATE_WKTS_FOR_ALL_EPSG_CRS();
```

### Description

Updates the well-known text (WKT) description for all EPSG coordinate reference systems.

### Parameters

None.

### Usage Notes

For information about using procedures to update well-known text (WKT) description, see [Procedures for Updating the Well-Known Text](#) (page 6-51).

### Examples

The following example updates the WKT description for all EPSG coordinate reference systems.

```
EXECUTE SDO_CS.UPDATE_WKTS_FOR_ALL_EPSG_CRS;  
Updating SRID 4001...  
Updating SRID 4002...  
Updating SRID 4003...  
...  
Updating SRID 69036405...  
Updating SRID 69046405...
```

## 20.31 SDO\_CS.UPDATE\_WKTS\_FOR\_EPSG\_CRS

### Format

```
SDO_CS.UPDATE_WKTS_FOR_EPSG_CRS(  
    srid IN NUMBER);
```

### Description

Updates the well-known text (WKT) description for the EPSG coordinate reference system associated with a specified SRID.

### Parameters

#### srid

The SRID of the coordinate system whose well-known text (WKT) description is to be updated. An entry for the specified value must exist in the SDO\_COORD\_REF\_SYS table (described in [SDO\\_COORD\\_REF\\_SYS Table](#) (page 6-27)).

### Usage Notes

This procedure updates the WKT descriptions for the specified SRID and all dependent SRIDs. For example, for SRID 4326 (WGS84 geodetic system), all EPSG coordinate systems that use this geodetic system will also be updated.

For information about using procedures to update well-known text (WKT) descriptions, see [Procedures for Updating the Well-Known Text](#) (page 6-51).

### Examples

The following example updates the WKT description for the EPSG coordinate reference system associated with SRID 4326.

```
EXECUTE SDO_CS.UPDATE_WKTS_FOR_EPSG_CRS(4326);
```

## 20.32 SDO\_CS.UPDATE\_WKTS\_FOR\_EPSG\_DATUM

### Format

```
SDO_CS.UPDATE_WKTS_FOR_EPSG_DATUM(  
    datum_id IN NUMBER);
```

### Description

Updates the well-known text (WKT) description for all EPSG coordinate reference systems associated with a specified datum.

### Parameters



**datum\_id**

The ID of the datum. Must match a value in the DATUM\_ID column of the SDO\_DATUMS table (described in [SDO\\_DATUMS Table](#) (page 6-37)).

**Usage Notes**

For information about using procedures to update well-known text (WKT) description, see [Procedures for Updating the Well-Known Text](#) (page 6-51).

**Examples**

The following example updates the WKT description for all EPSG coordinate reference systems associated with datum 5100.

```
EXECUTE SDO_CS.UPDATE_WKTS_FOR_EPSG_DATUM(5100);  
Updating SRID 5714...  
Updating SRID 5715...
```

## 20.33 SDO\_CS.UPDATE\_WKTS\_FOR\_EPSG\_ELLIPS

**Format**

```
SDO_CS.UPDATE_WKTS_FOR_EPSG_ELLIPS(  
    ellipsoid_id IN NUMBER);
```

**Description**

Updates the well-known text (WKT) description for all EPSG coordinate reference systems associated with a specified ellipsoid.

**Parameters****ellipsoid\_id**

The ID of the ellipsoid. Must match a value in the ELLIPSOID\_ID column of the SDO\_ELLIPSOIDS table (described in [SDO\\_ELLIPSOIDS Table](#) (page 6-38)).

**Usage Notes**

For information about using procedures to update well-known text (WKT) description, see [Procedures for Updating the Well-Known Text](#) (page 6-51).

**Examples**

The following example updates the WKT description for all EPSG coordinate reference systems associated with ellipsoid 7100.

```
EXECUTE SDO_CS.UPDATE_WKTS_FOR_EPSG_ELLIPS(7001);  
Updating SRID 4001...  
Updating SRID 4188...  
Updating SRID 29901...  
Updating SRID 61886405...  
Updating SRID 4277...  
Updating SRID 27700...  
Updating SRID 62776405...  
Updating SRID 4278...  
Updating SRID 62786405...  
Updating SRID 4279...  
Updating SRID 62796405...
```

## 20.34 SDO\_CS.UPDATE\_WKTS\_FOR\_EPSG\_OP

### Format

```
SDO_CS.UPDATE_WKTS_FOR_EPSG_OP(  
    coord_op_id IN NUMBER);
```

### Description

Updates the well-known text (WKT) description for all EPSG coordinate reference systems associated with a specified coordinate transformation operation.

### Parameters

#### coord\_op\_id

The ID of the SRID of the coordinate transformation operation. Must match a value in the COORD\_OP\_ID column of the SDO\_COORD\_OP\_PARAM\_VALS table (described in [SDO\\_COORD\\_OP\\_PARAM\\_VALS Table](#) (page 6-23)).

### Usage Notes

For information about using procedures to update well-known text (WKT) description, see [Procedures for Updating the Well-Known Text](#) (page 6-51).

### Examples

The following example updates the WKT description for all EPSG coordinate reference systems associated with coordinate transformation operation 2000067.

```
EXECUTE SDO_CS.UPDATE_WKTS_FOR_EPSG_OP(2000067);  
Updating SRID 20000671...
```

## 20.35 SDO\_CS.UPDATE\_WKTS\_FOR\_EPSG\_PARAM

### Format

```
SDO_CS.UPDATE_WKTS_FOR_EPSG_PARAM(  
    coord_op_id IN NUMBER,  
    parameter_id IN NUMBER);
```

### Description

Updates the well-known text (WKT) description for all EPSG coordinate reference systems associated with a specified coordinate transformation operation and parameter for transformation operations.

### Parameters

#### coord\_op\_id

The ID of the SRID of the coordinate transformation operation. Must match a value in the COORD\_OP\_ID column of the SDO\_COORD\_OP\_PARAM\_VALS table (described in [SDO\\_COORD\\_OP\\_PARAM\\_VALS Table](#) (page 6-23)).

**parameter\_id**

The ID of the SRID of the parameter for transformation operations. Must match a value in the PARAMETER\_ID column of the SDO\_COORD\_OP\_PARAM\_VALS table (described in [SDO\\_COORD\\_OP\\_PARAM\\_VALS Table](#) (page 6-23)) where the COORD\_OP\_ID column value is equal to the coord\_op\_id parameter value.

**Usage Notes**

For information about using procedures to update well-known text (WKT) description, see [Procedures for Updating the Well-Known Text](#) (page 6-51).

**Examples**

The following example updates the WKT description for all EPSG coordinate reference systems associated with coordinate transformation operation 9601 and parameter 8602.

```
EXECUTE SDO_CS.UPDATE_WKTS_FOR_EPSG_PARAM(9601, 8602);
```

## 20.36 SDO\_CS.UPDATE\_WKTS\_FOR\_EPSG\_PM

**Format**

```
SDO_CS.UPDATE_WKTS_FOR_EPSG_PM(  
    prime_meridian_id IN NUMBER);
```

**Description**

Updates the well-known text (WKT) description for all EPSG coordinate reference systems associated with a specified prime meridian.

**Parameters****prime\_meridian\_id**

The ID of the prime meridian. Must match a value in the PRIME\_MERIDIAN\_ID column in the SDO\_PRIME\_MERIDIANS table (described in [SDO\\_PRIME\\_MERIDIANS Table](#) (page 6-40)).

**Usage Notes**

For information about using procedures to update well-known text (WKT) description, see [Procedures for Updating the Well-Known Text](#) (page 6-51).

**Examples**

The following example updates the WKT description for all EPSG coordinate reference systems associated with prime meridian 8902.

```
EXECUTE SDO_CS.UPDATE_WKTS_FOR_EPSG_PM(8902);  
Updating SRID 4803...  
Updating SRID 20790...  
Updating SRID 20791...  
Updating SRID 68036405...  
Updating SRID 4904...  
Updating SRID 2963...  
Updating SRID 69046405...
```

## 20.37 SDO\_CS.VALIDATE\_EPSG\_MATRIX

### Format

```
SDO_CS.VALIDATE_EPSG_MATRIX(  
    method_id    IN NUMBER,  
    parameter_id IN NUMBER,  
    matrix        IN CLOB  
    ) RETURN VARCHAR2;
```

### Description

Validates an EPSG matrix of NADCON, NTv2, or VERTCON format.

### Parameters

#### **method\_id**

EPSG method ID to which the matrix refers.

#### **parameter\_id**

EPSG parameter id identifying the matrix, if an operation has more than one matrix, such as NADCON.

#### **matrix**

Matrix CLOB (loaded, using [SDO\\_CS.LOAD\\_EPSG\\_MATRIX](#) (page 20-26) or manually).

### Usage Notes

You can load an EPSG matrix using the [SDO\\_CS.LOAD\\_EPSG\\_MATRIX](#) (page 20-26) procedure.

### Examples

The following example loads an NTv2 matrix for operation 1703 ("NAD27 to WGS 84 (32)"). For an NTv2 operation, a single matrix is sufficient, assigned to parameter ID 8656.

```
SQL> select  
    m.coord_op_method_name "Method",  
    vals.parameter_id "Parameter",  
    sdo_cs.validate_epsg_matrix(m.coord_op_method_id, vals.parameter_id,  
    vals.param_value_file) "Valid",  
    count(*) "##"  
from  
    sdo_coord_op_param_vals vals,  
    sdo_coord_op_methods m  
where  
    m.coord_op_method_id = vals.coord_op_method_id and  
    not(vals.param_value_file is null)  
group by  
    m.coord_op_method_name,  
    vals.parameter_id,  
    sdo_cs.validate_epsg_matrix(m.coord_op_method_id, vals.parameter_id,  
    vals.param_value_file)  
order by  
    m.coord_op_method_name,
```

```

vals.parameter_id,
sdo_cs.validate_epsg_matrix(m.coord_op_method_id, vals.parameter_id,
vals.param_value_file);

```

Method	Parameter Valid	#
Geographic3D to Geographic2D+GravityRelatedHeight	8666 TRUE	2
Geographic3D to GravityRelatedHeight (OSGM02)	8666 TRUE	14
NADCON	8657 TRUE	104
NADCON	8658 TRUE	104
NTv2	8656 TRUE	4
Ordnance Survey National Transformation	8664 TRUE	3

6 rows selected.

## 20.38 SDO\_CS.VALIDATE\_WKT

### Format

```

SDO_CS.VALIDATE_WKT(
    srid IN NUMBER
) RETURN VARCHAR2;

```

### Description

Validates the well-known text (WKT) description associated with a specified SRID.

### Parameters

#### srid

The SRID of the coordinate system whose well-known text (WKT) description is to be validated. An entry for the specified value must exist in the SDO\_COORD\_REF\_SYS table (described in [SDO\\_COORD\\_REF\\_SYS Table](#) (page 6-27)).

### Usage Notes

This function returns the string 'TRUE' if the WKT description is valid. If the WKT description is invalid, this function returns a string in the format 'FALSE (<position-number>)', where <position-number> is the number of the character position in the WKT description where the first error occurs.

The WKT description is checked to see if it satisfies the requirements described in [Well-Known Text \(WKT\)](#) (page 6-48).

### Examples

The following example validates the WKT description of the coordinate system associated with SRID 81989000. The results show that the cause of the invalidity (or the first cause of the invalidity) starts at character position 181 in the WKT description. (SRID 81989000 is not associated with any established coordinate system. Rather, it is for a deliberately invalid coordinate system that was inserted into a test version of the MDSYS.CS\_SRS table, and it is not included in the MDSYS.CS\_SRS table that is shipped with Oracle Spatial and Graph.)

```
SELECT SDO_CS.VALIDATE_WKT(81989000) FROM DUAL;
```

```
SDO_CS.VALIDATE_WKT(81989000)
```

-----  
FALSE (181)

## SDO\_CSW\_PROCESS Package (CSW Processing)

The MDSYS.SDO\_CSW\_PROCESS package contains subprograms for various processing operations related to support for Catalog Services for the Web (CSW).

To use the subprograms in this chapter, you must understand the conceptual and usage information about Catalog Services for the Web in [Catalog Services for the Web \(CSW\) Support](#) (page 16-1).

[Table 21-1](#) (page 21-1) lists the CSW processing subprograms.

**Table 21-1 Subprograms for CSW Processing Operations**

Subprogram	Description
<a href="#">SDO_CSW_PROCESS.DeleteCapabilitiesInfo</a> (page 21-2)	Deletes the capabilities information that had been set by the <a href="#">SDO_CSW_PROCESS.InsertCapabilitiesInfo</a> (page 21-5) procedure.
<a href="#">SDO_CSW_PROCESS.DeleteDomainInfo</a> (page 21-2)	Deletes domain information related to a record type.
<a href="#">SDO_CSW_PROCESS.DeletePluginMap</a> (page 21-3)	Unregisters a plugin for processing and extracting spatial content for a record type.
<a href="#">SDO_CSW_PROCESS.DeleteRecordViewMap</a> (page 21-4)	Deletes information related to record view transformation.
<a href="#">SDO_CSW_PROCESS.GetRecordTypeId</a> (page 21-4)	Gets the record type ID for a type (specified by namespace and type name).
<a href="#">SDO_CSW_PROCESS.InsertCapabilitiesInfo</a> (page 21-5)	Inserts the capabilities template information.
<a href="#">SDO_CSW_PROCESS.InsertDomainInfo</a> (page 21-6)	Inserts domain information related to a record type.
<a href="#">SDO_CSW_PROCESS.InsertPluginMap</a> (page 21-7)	Registers a plugin for processing and extracting spatial content for a record type.
<a href="#">SDO_CSW_PROCESS.InsertRecordViewMap</a> (page 21-7)	Inserts information related to record view transformation.
<a href="#">SDO_CSW_PROCESS.InsertRtDataUpdated</a> (page 21-9)	Inserts a notification that the data for a record type was updated in the database.
<a href="#">SDO_CSW_PROCESS.InsertRtMDUUpdated</a> (page 21-10)	Inserts a notification that the metadata for a record type was updated in the database.

The rest of this chapter provides reference information on the subprograms, listed in alphabetical order.

## 21.1 SDO\_CSW\_PROCESS.DeleteCapabilitiesInfo

### Format

```
SDO_CSW_PROCESS.DeleteCapabilitiesInfo();
```

### Description

Deletes the capabilities information that had been set by the [SDO\\_CSW\\_PROCESS.InsertCapabilitiesInfo](#) (page 21-5) procedure.

### Parameters

None.

### Usage Notes

For information about support for Catalog Services for the Web, see [Catalog Services for the Web \(CSW\) Support](#) (page 16-1).

### Examples

The following example deletes the capabilities information that had been set by the [SDO\\_CSW\\_PROCESS.InsertCapabilitiesInfo](#) (page 21-5) procedure.

```
BEGIN
    SDO_CSW_PROCESS.DeleteCapabilitiesInfo;
END;
/
```

## 21.2 SDO\_CSW\_PROCESS.DeleteDomainInfo

### Format

```
SDO_CSW_PROCESS.DeleteDomainInfo(
    recordTypeId IN NUMBER,
    propertyName IN VARCHAR2,
    parameterName IN VARCHAR2);
```

### Description

Deletes domain information related to a record type.

### Parameters

#### **recordTypeId**

ID of the record type.

#### **propertyName**

Name of the property.

#### **parameterName**

Name of domain parameter to be deleted.



### Usage Notes

For information about support for Catalog Services for the Web, see [Catalog Services for the Web \(CSW\) Support](#) (page 16-1).

### Examples

The following example deletes domain information about the `resultType` parameter for a specified record type.

```
DECLARE
    rtId NUMBER;
BEGIN
    rtId :=
        sdo_csw_process.getRecordTypeId('http://www.opengis.net/cat/csw', 'Record');
    sdo_csw_process.deleteDomainInfo(rtId, null, 'GetRecords.resultType');
END;
/
```

## 21.3 SDO\_CSW\_PROCESS.DeletePluginMap

### Format

```
SDO_CSW_PROCESS.DeletePluginMap(
    rtnsUrl IN VARCHAR2,
    rtName  IN VARCHAR2);
```

### Description

Unregisters a plugin for processing and extracting non-GML spatial content for a record type.

### Parameters

#### **rtnsUrl**

Uniform resource locator of namespace of the record type.

#### **rtName**

Name of the record type.

### Usage Notes

To register a plugin, which is a user-defined implementation of the `extractSDO` function, use the [SDO\\_CSW\\_PROCESS.InsertPluginMap](#) (page 21-7) procedure.

For information about creating and using the `extractSDO` function, see [Spatial Path Extractor Function \(extractSDO\)](#) (page 16-3).

For information about support for Catalog Services for the Web, see [Catalog Services for the Web \(CSW\) Support](#) (page 16-1).

### Examples

The following example unregisters a plugin.

```
BEGIN
    SDO_CSW_PROCESS.deletePluginMap('http://www.opengis.net/cat/csw',
    'Record');
```

```
END;  
/
```

## 21.4 SDO\_CSW\_PROCESS.DeleteRecordViewMap

### Format

```
SDO_CSW_PROCESS.DeleteRecordViewMap(  
    recordTypeNs    IN VARCHAR2,  
    viewSrcName     IN VARCHAR2,  
    targetTypeNs    IN VARCHAR2);
```

### Description

Deletes information related to record view transformation.

### Parameters

#### **recordTypeNs**

URL of the namespace of the record type.

#### **viewSrcName**

Name of the source record type (for example, BriefRecord, DCMIRRecord, Record, or SummaryRecord).

#### **targetTypeNs**

Name of the destination record type (for example, BriefRecord, DCMIRRecord, Record, or SummaryRecord).

### Usage Notes

For information about support for Catalog Services for the Web, see [Catalog Services for the Web \(CSW\) Support](#) (page 16-1).

### Examples

The following example deletes information related to record view transformation from source record type BriefRecord and destination record type Record.

```
BEGIN  
    SDO_CSW_PROCESS.deleteRecordViewMap('http://www.opengis.net/cat/csw',  
        'BriefRecord',  
        'Record');  
END;  
/
```

## 21.5 SDO\_CSW\_PROCESS.GetRecordTypeId

### Format

```
SDO_CSW_PROCESS.GetRecordTypeId(  
    rtNsUrl IN VARCHAR2,  
    rtName  IN VARCHAR2) RETURN NUMBER;
```

### Description

Gets the record type ID for a type (specified by namespace and type name).

**Parameters****rtnsUrl**

Uniform resource locator (URL) of the namespace of the record type.

**rtName**

Name of the record type.

**Usage Notes**

For information about support for Catalog Services for the Web, see [Catalog Services for the Web \(CSW\) Support](#) (page 16-1).

**Examples**

The following example gets the record type ID of a record type named Record.

```
DECLARE
    rtId NUMBER;
BEGIN
    rtId := SDO_CSW_PROCESS.getRecordTypeId('http://www.opengis.net/cat/csw',
        'Record');
END;
/
```

## 21.6 SDO\_CSW\_PROCESS.InsertCapabilitiesInfo

**Format**

```
SDO_CSW_PROCESS.InsertCapabilitiesInfo(
    capabilitiesInfo IN XMLTYPE);
```

**Description**

Inserts the capabilities template information.

**Parameters****capabilitiesInfo**

XML document for the capabilities template, which is used at runtime to generate capabilities documents.

**Usage Notes**

At runtime, the capabilities document is dynamically generated by binding feature type information from the CSW metadata with the capabilities template. For information about capabilities documents, see [Capabilities Documents](#) (page 16-2).

For information about support for Catalog Services for the Web, see [Catalog Services for the Web \(CSW\) Support](#) (page 16-1).

**Examples**

The following example inserts the capabilities template information.

```
BEGIN
    SDO_CSW_PROCESS.insertCapabilitiesInfo(
        xmltype(bfilename('CSWUSERDIR', 'cswloadcapabilities.xml')),
```

```
        nls_charset_id('AL32UTF8')));  
END;  
/
```

## 21.7 SDO\_CSW\_PROCESS.InsertDomainInfo

### Format

```
SDO_CSW_PROCESS.InsertDomainInfo(  
    recordTypeId  IN NUMBER,  
    propertyName  IN VARCHAR2,  
    parameterName IN VARCHAR2,  
    pValue        IN MDSYS.STRINGLIST);
```

### Description

Inserts domain information related to a record type.

### Parameters

#### **recordTypeId**

ID of the record type

#### **propertyName**

Name of a domain property.

#### **parameterName**

Name of a domain parameter

#### **pValue**

An array of strings containing parameter values for parameterName. The MDSYS.STRINGLIST type is defined as VARRAY(1000000) OF VARCHAR2(4000).

### Usage Notes

For information about support for Catalog Services for the Web, see [Catalog Services for the Web \(CSW\) Support](#) (page 16-1).

### Examples

The following example inserts domain information for the record type named Record.

```
DECLARE  
    rtId NUMBER;  
BEGIN  
    rtId := SDO_CSW_PROCESS.getRecordTypeId(  
        'http://www.opengis.net/cat/csw', 'Record');  
    SDO_CSW_PROCESS.insertDomainInfo(rtId,  
        null,  
        'GetRecords.resultType',  
        MDSYS.STRINGLIST('hits', 'results', 'validate'));  
END;  
/
```

## 21.8 SDO\_CSW\_PROCESS.InsertPluginMap

### Format

```
SDO_CSW_PROCESS.InsertPluginMap(
    rtnsUrl          IN VARCHAR2,
    rtName           IN VARCHAR2,
    pluginPackageName IN VARCHAR2);
```

### Description

Registers a plugin for processing and extracting non-GML spatial content for a record type.

### Parameters

#### rtnsUrl

Uniform resource locator of the namespace of the record type.

#### rtName

Name of the record type.

#### pluginPackageName

Name of the PL/SQL package object for the plugin.

### Usage Notes

The plugin must contain the user-defined implementation of the `extractSDO` function. A plugin is needed if the records are not in GML format. For detailed information about creating and using the `extractSDO` function, see [Spatial Path Extractor Function \(extractSDO\)](#) (page 16-3).

You must grant EXECUTE access on the plugin package (`pluginPackageName` parameter) to user MDSYS and to the CSW administrative user.

For information about support for Catalog Services for the Web, see [Catalog Services for the Web \(CSW\) Support](#) (page 16-1).

### Examples

The following example registers a plugin.

```
BEGIN
    SDO_CSW_PROCESS.insertPluginMap('http://www.opengis.net/cat/csw',
    'Record', 'csw_admin_usr.csw_RT_1_package');
END;
```

## 21.9 SDO\_CSW\_PROCESS.InsertRecordViewMap

### Format

```
SDO_CSW_PROCESS.InsertRecordViewMap(
    recordTypeNs  IN VARCHAR2,
    viewSrcName   IN VARCHAR2,
    targetTypeNs  IN VARCHAR2,
```

```
mapInfo      IN XMLTYPE,  
mapType      IN VARCHAR2);
```

### Description

Inserts information related to record view transformation.

### Parameters

#### **recordTypeNs**

URL of the namespace of the record type.

#### **viewSrcName**

Name of the source record type (for example, BriefRecord, DCMIRRecord, Record, or SummaryRecord).

#### **targetTypeName**

Name of the destination of the record type (for example, BriefRecord, DCMIRRecord, Record, or SummaryRecord).

#### **mapInfo**

XSLT definition of the mapping. (See the comments in the example at the end of this section for a transformation from BriefRecord type to Record type.)

#### **mapType**

Map type (brief, summary, and so on)

### Usage Notes

For information about support for Catalog Services for the Web, see [Catalog Services for the Web \(CSW\) Support](#) (page 16-1).

### Examples

The following example inserts information related to transformation from BriefRecord type to Record type.

```
create or replace directory CSWUSERDIR as  
'dir_path_where_mapinfo.xml_file_is_located' ;  
  
/*  
// Content of mapinfo.xml could be that which transforms  
// all <csw:BriefRecord> node to <csw:Record> node, where csw is  
// the namespace alias for "http://www.opengis.net/cat/csw"  
  
<?xml version="1.0" encoding="UTF-8"?>  
<xsl:stylesheet version="1.0" xmlns:xsl="http://www.w3.org/1999/XSL/Transform"  
xmlns:csw="http://www.opengis.net/cat/csw">  
<xsl:output method="xml" version="1.0" encoding="UTF-8" indent="yes" />  
  
<xsl:template match="/">  
  <csw:Record xmlns:csw="http://www.opengis.net/cat/csw" xmlns:dc="http://  
www.purl.org/dc/elements/1.1/" xmlns:ows="http://www.opengis.net/ows"  
xmlns:dct="http://www.purl.org/dc/terms/">  
    <xsl:apply-templates select="@*|node()" />  
  </csw:Record>  
</xsl:template>
```

```

<xsl:template match="csw:BriefRecord">
  <xsl:apply-templates select="@*|node()"/>
</xsl:template>

<xsl:template match="@*|node()">
  <xsl:copy>
    <xsl:apply-templates select="@*|node()"/>
  </xsl:copy>
</xsl:template>

</xsl:stylesheet>
*/

DECLARE
  rtId NUMBER;
BEGIN
  SDO_CSW_PROCESS.insertRecordViewMap('http://www.opengis.net/cat/csw',
    'BriefRecord',
    'Record',
    xmltype(bfilename('CSWUSERDIR', 'mapinfo.xml'), nls_charset_id('AL32UTF8')),
    'brief');
END;
/

```

## 21.10 SDO\_CSW\_PROCESS.InsertRtDataUpdated

### Format

```

SDO_CSW_PROCESS.InsertRtDataUpdated(
  ns          IN VARCHAR2,
  name        IN VARCHAR2,
  updatedRowList IN ROWPOINTERLIST,
  updateTs    IN TIMESTAMP);

```

### Description

Inserts a notification that the data for a record type was updated in the database.

### Parameters

#### ns

Namespace of the record type.

#### name

Name of the record type.

#### updatedRowList

List of rowids of rows that have been updated.

#### updateTS

Timestamp value indicating when the data was updated.

### Usage Notes

This procedure is used for CSW cache data synchronization. It queries the MDSYS.CSW\_RECORD\_TYPES\$ system table.

For information about support for Catalog Services for the Web, see [Catalog Services for the Web \(CSW\) Support](#) (page 16-1).

### Examples

The following example inserts a notification for a specified record type that the data was updated for the rows associated with specific rowids.

```
BEGIN
updatedRowIdList:= . . . -- list of rowIds that have been updated
-- in the table referred to by the dataPointer column of the
-- mdsys.CSW_Record_Types$ table for the row whose
-- typeNameNS column value is 'http://www.opengis.net/cat/csw' and
-- typeName column value is 'Record'
. . .
SDO_CSW_PROCESS.insertRtDataUpdated('http://www.opengis.net/cat/csw',
    'Record', updatedRowIdList, sysdate);
. . .
END;
/
```

## 21.11 SDO\_CSW\_PROCESS.InsertRtMDUpdated

### Format

```
SDO_CSW_PROCESS.InsertRtMDUpdated(
    ns          IN VARCHAR2,
    name        IN VARCHAR2,
    updateTs    IN TIMESTAMP);
```

### Description

Inserts a notification that the metadata for a record type was updated in the database.

### Parameters

#### ns

Namespace of the record type.

#### name

Name of the record type.

#### updateTS

Date and time when the metadata was updated.

### Usage Notes

This procedure is used for WFS cache metadata synchronization.

For information about support for Catalog Services for the Web, see [Catalog Services for the Web \(CSW\) Support](#) (page 16-1).

### Examples

The following example inserts a notification that the metadata for the Record record type was updated in the database.



```
BEGIN
  SDO_CSW_PROCESS.insertRtMDUpdated('http://www.opengis.net/cat/csw',
    'Record', sysdate);
END;
```



## SDO\_GCDR Package (Geocoding)

The MDSYS.SDO\_GCDR package contains subprograms for geocoding address data.

To use the subprograms in this chapter, you must understand the conceptual and usage information about geocoding in [Geocoding Address Data](#) (page 11-1).

[Table 22-1](#) (page 22-1) lists the geocoding subprograms.

**Table 22-1 Subprograms for Geocoding Address Data**

Subprogram	Description
<a href="#">SDO_GCDR.CREATE_PROFILE_TABLES</a> (page 22-1)	Creates the CG_COUNTRY_PROFILE, GC_PARSER_PROFILES, and GC_PARSER_PROFILEAFS tables in the caller's schema.
<a href="#">SDO_GCDR.GEOCODE</a> (page 22-2)	Geocodes an unformatted address and returns an SDO_GEO_ADDR object.
<a href="#">SDO_GCDR.GEOCODE_ADDR</a> (page 22-3)	Geocodes an input address using attributes in an SDO_GEO_ADDR object, and returns the first matched address as an SDO_GEO_ADDR object.
<a href="#">SDO_GCDR.GEOCODE_ADDR_ALL</a> (page 22-4)	Geocodes an input address using attributes in an SDO_GEO_ADDR object, and returns matching addresses as an SDO_ADDR_ARRAY object.
<a href="#">SDO_GCDR.GEOCODE_ALL</a> (page 22-5)	Geocodes all addresses associated with an unformatted address and returns the result as an SDO_ADDR_ARRAY object.
<a href="#">SDO_GCDR.GEOCODE_AS_GEOMETRY</a> (page 22-7)	Geocodes an unformatted address and returns an SDO_GEOMETRY object.
<a href="#">SDO_GCDR.REVERSE_GEOCODE</a> (page 22-8)	Reverse geocodes a location, specified by its spatial geometry object and country, and returns an SDO_GEO_ADDR object.

The rest of this chapter provides reference information on the subprograms, listed in alphabetical order.

### 22.1 SDO\_GCDR.CREATE\_PROFILE\_TABLES

#### Format

```
SDO_GCDR.CREATE_PROFILE_TABLES;
```

**Description**

Creates the CG\_COUNTRY\_PROFILE, GC\_PARSER\_PROFILES, and GC\_PARSER\_PROFILEAFS tables in the caller's schema.

**Parameters**

None.

**Usage Notes**

Use this procedure only if your geocoding data provider does not supply the GC\_PARSER\_PROFILES and GC\_PARSER\_PROFILEAFS tables. See [Installing the Profile Tables](#) (page 11-33) for more information.

**Examples**

The following example creates the GC\_PARSER\_PROFILES and GC\_PARSER\_PROFILEAFS tables in the caller's schema.

```
EXECUTE SDO_GCDR.CREATE_PROFILE_TABLES;
```

## 22.2 SDO\_GCDR.GEOCODE

**Format**

```
SDO_GCDR.GEOCODE(  
    username    IN VARCHAR2,  
    addr_lines  IN SDO_KEYWORDARRAY,  
    country     IN VARCHAR2,  
    match_mode  IN VARCHAR2  
) RETURN SDO_GEO_ADDR;
```

**Description**

Geocodes an unformatted address and returns the result as an SDO\_GEO\_ADDR object.

**Parameters****username**

Name of the user that owns the tables containing the geocoding data.

**addr\_lines**

An array of quoted strings representing the unformatted address to be geocoded. The SDO\_KEYWORDARRAY type is described in [SDO\\_KEYWORDARRAY Type](#) (page 11-9).

**country**

Country name or ISO country code.

**match\_mode**

Match mode for the geocoding operation. Match modes are explained in [Match Modes](#) (page 11-2).

### Usage Notes

This function returns an object of type SDO\_GEO\_ADDR, which is described in [SDO\\_GEO\\_ADDR Type](#) (page 11-6). It performs the same operation as the [SDO\\_GCDR.GEOCODE\\_AS\\_GEOMETRY](#) (page 22-7) function; however, that function returns an SDO\_GEOMETRY object.

### Examples

The following example geocodes the address of City Hall in San Francisco, California, using the RELAX\_BASE\_NAME match mode. It returns the longitude and latitude coordinates of this address as -122.41815 and 37.7784183, respectively.

```
SELECT SDO_GCDR.GEOCODE('SCOTT', SDO_KEYWORDARRAY('1 Carlton B Goodlett Pl',
    'San Francisco, CA 94102'), 'US', 'RELAX_BASE_NAME') FROM DUAL;

SDO_GCDR.GEOCODE('SCOTT',SDO_KEYWORDARRAY('1CARLTONBGODLETTPL','SANFRANCISCO
-----
SDO_GEO_ADDR(0, SDO_KEYWORDARRAY(), NULL, 'CARLTON B GOODLETT PL', NULL, NULL, '
SAN FRANCISCO', NULL, 'CA', 'US', '94102', NULL, '94102', NULL, '1', 'CARLTON B
GOODLETT', 'PL', 'F', 'F', NULL, NULL, 'L', .01, 23614360, '???#ENUT?B281CP?',
1, 'RELAX_BASE_NAME', -122.41815, 37.7784183, '???0101010??000?')
```

## 22.3 SDO\_GCDR.GEOCODE\_ADDR

### Format

```
SDO_GCDR.GEOCODE_ADDR(
    gc_username IN VARCHAR2,
    address      IN SDO_GEO_ADDR
) RETURN SDO_GEO_ADDR;
```

### Description

Geocodes an input address using attributes in an SDO\_GEO\_ADDR object, and returns the first matched address as an SDO\_GEO\_ADDR object.

### Parameters

#### gc\_username

Name of the user that owns the tables containing the geocoding data.

#### address

An SDO\_GEO\_ADDR object with one or more attributes set. The SDO\_GEO\_ADDR type is described in [SDO\\_GEO\\_ADDR Type](#) (page 11-6).

### Usage Notes

This function enables you to specify as many attributes in the input SDO\_GEO\_ADDR object as you can or want to set. It finds the first matching address, and returns an SDO\_GEO\_ADDR object with all possible attributes set.

Unlike the [SDO\\_GCDR.GEOCODE](#) (page 22-2) function, which geocodes input addresses specified by unformatted address lines, the SDO\_GCDR.GEOCODE\_ADDR function input addresses specified by individual addressing fields defined in SDO\_GEO\_ADDR objects. When you use unformatted address lines, you rely on the geocoding software to parse the input address and decompose it into individual address fields. This process usually works well, but it can produce undesirable results

if the input addresses are not well formatted. By contrast, when you specify parts of the input address as SDO\_GEO\_ADDR object attributes, you can reduce the chance of geocoding errors and produce more desirable results.

For examples of the SDO\_GCDR.GEOCODE\_ADDR function, see [Example 11-2](#) (page 11-10) and [Example 11-3](#) (page 11-11) in [Geocoding from a Place Name](#) (page 11-10).

See also the [SDO\\_GCDR.GEOCODE\\_ADDR\\_ALL](#) (page 22-4) function, which performs the same operation as this function, but which can return more than one address.

### Examples

The following example returns the geocoded result for a point of interest named CALIFORNIA PACIFIC MEDICAL CTR. The example uses a user-defined function named `create_addr_from_placename` (as defined in [Example 11-2](#) (page 11-10) in [Geocoding from a Place Name](#) (page 11-10)) to construct the input SDO\_GEO\_ADDR object.

```
SELECT sdo_gcdr.geocode_addr('SCOTT',
    create_addr_from_placename('CALIFORNIA PACIFIC MEDICAL CTR', 'US'))
FROM DUAL;

SDO_GCDR.GEOCODE_ADDR('SCOTT',CREATE_ADDR_FROM_PLACENAME('CALIFORNIAPACIFICME
-----
SDO_GEO_ADDR(0, SDO_KEYWORDARRAY(), 'CALIFORNIA PACIFIC MEDICAL CTR-SF', 'BUCHAN
AN ST', NULL, NULL, 'SAN FRANCISCO', NULL, 'CA', 'US', '94115', NULL, '94115', N
ULL, '2333', NULL, NULL, 'F', 'F', NULL, NULL, 'L', 0, 23599031, '?????????B281
CP?', 4, 'DEFAULT', -122.43097, 37.79138, '????4141114??404?')
```

## 22.4 SDO\_GCDR.GEOCODE\_ADDR\_ALL

### Format

```
SDO_GCDR.GEOCODE_ADDR_ALL(
    gc_username  IN VARCHAR2,
    address      IN SDO_GEO_ADDR,
    max_res_num  IN NUMBER DEFAULT 4000
) RETURN SDO_ADDR_ARRAY;
```

### Description

Geocodes an input address using attributes in an SDO\_GEO\_ADDR object, and returns matching addresses as an SDO\_ADDR\_ARRAY object (described in [SDO\\_ADDR\\_ARRAY Type](#) (page 11-9)).

### Parameters

#### **gc\_username**

Name of the user that owns the tables containing the geocoding data.

#### **address**

An SDO\_GEO\_ADDR object with one or more attributes set. The SDO\_GEO\_ADDR type is described in [SDO\\_GEO\\_ADDR Type](#) (page 11-6).

**max\_res\_num**

Maximum number of results to return in the SDO\_ADDR\_ARRAY object. The default value is 4000.

**Usage Notes**

This function enables you to specify as many attributes in the input SDO\_GEO\_ADDR object as you can or want to set. It finds matching addresses (up to 4000 or the limit specified in the max\_res\_num parameter), and returns an SDO\_ADDR\_ARRAY object in which each geocoded result has all possible attributes set.

This function performs the same operation as the [SDO\\_GCDR.GEOCODE\\_ADDR](#) (page 22-3) function, except that it can return more than one address. See the Usage Notes for the [SDO\\_GCDR.GEOCODE\\_ADDR](#) (page 22-3) function for more information.

**Examples**

The following example returns up to three geocoded results for a point of interest named CALIFORNIA PACIFIC MEDICAL CTR. (In this case only one result is returned, because the geocoding data contains only one address matching that point of interest.) The example uses a user-defined function named create\_addr\_from\_placename (as defined in [Example 11-2](#) (page 11-10) in [Geocoding from a Place Name](#) (page 11-10)) to construct the input SDO\_GEO\_ADDR object.

```
SELECT sdo_gcdr.geocode_addr_all('SCOTT',
    create_addr_from_placename('CALIFORNIA PACIFIC MEDICAL CTR', 'US'), 3)
FROM DUAL;

SDO_GCDR.GEOCODE_ADDR_ALL('SCOTT',CREATE_ADDR_FROM_PLACENAME('CALIFORNIAPACIF
-----
SDO_ADDR_ARRAY(SDO_GEO_ADDR(0, SDO_KEYWORDARRAY(), 'CALIFORNIA PACIFIC MEDICAL C
TR-SF', 'BUCHANAN ST', NULL, NULL, 'SAN FRANCISCO', NULL, 'CA', 'US', '94115', N
ULL, '94115', NULL, '2333', NULL, NULL, 'F', 'F', NULL, NULL, 'L', 0, 23599031,
'?????????B281CP?', 4, 'DEFAULT', -122.43097, 37.79138, '???4141114??404?'))
```

## 22.5 SDO\_GCDR.GEOCODE\_ALL

**Format**

```
SDO_GCDR.GEOCODE_ALL(
    gc_username    IN VARCHAR2,
    addr_lines     IN SDO_KEYWORDARRAY,
    country        IN VARCHAR2,
    match_mode     IN VARCHAR2
) RETURN SDO_ADDR_ARRAY;
```

**Description**

Geocodes all addresses associated with an unformatted address and returns the result as an SDO\_ADDR\_ARRAY object.

**Parameters****gc\_username**

Name of the user that owns the tables containing the geocoding data.

**addr\_lines**

An array of quoted strings representing the unformatted address to be geocoded. The SDO\_KEYWORDARRAY type is described in [SDO\\_KEYWORDARRAY Type](#) (page 11-9).

**country**

Country name or ISO country code.

**match\_mode**

Match mode for the geocoding operation. Match modes are explained in [Match Modes](#) (page 11-2).

**Usage Notes**

This function returns an object of type SDO\_ADDR\_ARRAY, which is described in [SDO\\_ADDR\\_ARRAY Type](#) (page 11-9). It performs the same operation as the [SDO\\_GCDR.GEOCODE](#) (page 22-2) function; however, it can return results for multiple addresses, in which case the returned SDO\_ADDR\_ARRAY object contains multiple SDO\_GEO\_ADDR objects. If your application needs to select one of the addresses for some further operations, you can use the information about each returned address to help you make that selection.

Each SDO\_GEO\_ADDR object in the returned SDO\_ADDR\_ARRAY array represents the center point of each street segment that matches the criteria in the `addr_lines` parameter. For example, if Main Street extends into two postal codes, or if there are two separate streets named Main Street in two separate postal codes, and if you specify Main Street and a city and state for this function, the returned SDO\_ADDR\_ARRAY array contains two SDO\_GEO\_ADDR objects, each reflecting the center point of Main Street in a particular postal code. The house or building number in each SDO\_GEO\_ADDR object is the house or building number located at the center point of the street segment, even if the input address contains no house or building number or a nonexistent number.

**Examples**

The following example returns an array of geocoded results, each result reflecting the center point of Clay Street in all postal codes in San Francisco, California, in which the street extends. The resulting array includes four SDO\_GEO\_ADDR objects, each reflecting the house at the center point of the Clay Street segment in each of the four postal codes (94108, 94115, 94118, and 94109) into which Clay Street extends.

```
SELECT SDO_GCDR.GEOCODE_ALL('SCOTT',
    SDO_KEYWORDARRAY('Clay St', 'San Francisco, CA'),
    'US', 'DEFAULT') FROM DUAL;

SDO_GCDR.GEOCODE_ALL('SCOTT',SDO_KEYWORDARRAY('CLAYST','SANFRANCISCO,CA'),'US
-----
SDO_ADDR_ARRAY(SDO_GEO_ADDR(1, SDO_KEYWORDARRAY(), NULL, 'CLAY ST', NULL, NULL,
'SAN FRANCISCO', NULL, 'CA', 'US', '94109', NULL, '94109', NULL, '1698', 'CLAY',
'ST', 'F', 'F', NULL, NULL, 'L', 0, 23600700, '???#ENUT?B281CP?', 1, 'DEFAULT',
-122.42093, 37.79236, '???4101010??004?'), SDO_GEO_ADDR(1, SDO_KEYWORDARRAY(),
NULL, 'CLAY ST', NULL, NULL, 'SAN FRANCISCO', NULL, 'CA', 'US', '94111', NULL,
'94111', NULL, '398', 'CLAY', 'ST', 'F', 'F', NULL, NULL, 'L', 0, 23600678, '??
??#ENUT?B281CP?', 1, 'DEFAULT', -122.40027, 37.79499, '???4101010??004?'), SDO_
GEO_ADDR(1, SDO_KEYWORDARRAY(), NULL, 'CLAY ST', NULL, NULL, 'SAN FRANCISCO', NU
LL, 'CA', 'US', '94108', NULL, '94108', NULL, '978', 'CLAY', 'ST', 'F', 'F', NUL
L, NULL, 'L', 0, 23600689, '???#ENUT?B281CP?', 1, 'DEFAULT', -122.40904, 37.793
85, '???4101010??004?'), SDO_GEO_ADDR(1, SDO_KEYWORDARRAY(), NULL, 'CLAY ST', N
```



```

ULL, NULL, 'SAN FRANCISCO', NULL, 'CA', 'US', '94115', NULL, '94115', NULL, '279
8', 'CLAY', 'ST', 'F', 'F', NULL, NULL, 'L', 0, 23600709, '????#ENUT?B281CP?', 1
, 'DEFAULT', -122.43909, 37.79007, '????4101010??004?'), SDO_GEO_ADDR(1, SDO_KEY
WORDARRAY(), NULL, 'CLAY ST', NULL, NULL, 'SAN FRANCISCO', NULL, 'CA', 'US', '94
118', NULL, '94118', NULL, '3698', 'CLAY', 'ST', 'F', 'F', NULL, NULL, 'L', 0, 2
3600718, '????#ENUT?B281CP?', 1, 'DEFAULT', -122.45372, 37.78822, '????4101010??
004?'))

```

## 22.6 SDO\_GCDR.GEOCODE\_AS\_GEOMETRY

### Format

```

SDO_GCDR.GEOCODE_AS_GEOMETRY(
    username      IN VARCHAR2,
    addr_lines    IN SDO_KEYWORDARRAY,
    country       IN VARCHAR2
) RETURN SDO_GEOMETRY;

```

### Description

Geocodes an unformatted address and returns the result as an SDO\_GEOMETRY object.

### Parameters

#### username

Name of the user that owns the tables containing the geocoding data.

#### addr\_lines

An array of quoted strings representing the unformatted address to be geocoded. The SDO\_KEYWORDARRAY type is described in [SDO\\_KEYWORDARRAY Type](#) (page 11-9).

#### country

Country name or ISO country code.

### Usage Notes

This function returns an object of type SDO\_GEOMETRY. It performs the same operation as the [SDO\\_GCDR.GEOCODE](#) (page 22-2) function; however, that function returns an SDO\_GEO\_ADDR object.

This function uses a match mode of 'DEFAULT' for the geocoding operation. Match modes are explained in [Match Modes](#) (page 11-2).

### Examples

The following example geocodes the address of City Hall in San Francisco, California. It returns an SDO\_GEOMETRY object in which the longitude and latitude coordinates of this address are -122.41815 and 37.7784183, respectively.

```

SELECT SDO_GCDR.GEOCODE_AS_GEOMETRY('SCOTT',
    SDO_KEYWORDARRAY('1 Carlton B Goodlett Pl', 'San Francisco, CA 94102'),
    'US') FROM DUAL;

```

```

SDO_GCDR.GEOCODE_AS_GEOMETRY('SCOTT',SDO_KEYWORDARRAY('1CARLTONBGODLETTPL','
-----

```

```
SDO_GEOMETRY(2001, 8307, SDO_POINT_TYPE(-122.41815, 37.7784183, NULL), NULL, NULL)
```

## 22.7 SDO\_GCDR.REVERSE\_GEOCODE

### Format

```
SDO_GCDR.REVERSE_GEOCODE(  
    username IN VARCHAR2,  
    location IN SDO_GEOMETRY,  
    country IN VARCHAR2  
) RETURN SDO_GEO_ADDR;
```

### Description

Reverse geocodes a location, specified by its spatial geometry object and country, and returns the result as an SDO\_GEO\_ADDR object.

### Parameters

#### username

Name of the user that owns the tables containing the geocoding data.

#### location

An SDO\_GEOMETRY object that specifies the point location to be reverse geocoded.

#### country

Country name or ISO country code.

### Usage Notes

This function returns an object of type SDO\_GEO\_ADDR, which is described in [SDO\\_GEO\\_ADDR Type](#) (page 11-6).

A spatial index must be created on the table GC\_ROAD\_SEGMENT\_<table-suffix>.

### Examples

The following example reverse geocodes a point with the longitude and latitude values (-122.41815, 37.7784183). For this example, a spatial index was created on the GEOMETRY column in the GC\_ROAD\_SEGMENT\_US table.

```
SELECT SDO_GCDR.REVERSE_GEOCODE('SCOTT',  
    SDO_GEOMETRY(2001, 8307,  
        SDO_POINT_TYPE(-122.41815, 37.7784183, NULL), NULL, NULL),  
    'US') FROM DUAL;
```

```
SDO_GCDR.REVERSE_GEOCODE('SCOTT',SDO_GEOMETRY(2001,8307,SDO_POINT_TYPE(-122.4  
-----  
SDO_GEO_ADDR(0, SDO_KEYWORDARRAY(), NULL, 'POLK ST', NULL, NULL, 'SAN FRANCISCO'  
, NULL, 'CA', 'US', '94102', NULL, '94102', NULL, '200', 'POLK', 'ST', 'F', 'F',  
NULL, NULL, 'R', .00966633, 23614360, '', 1, 'DEFAULT', -122.41815, 37.7784177,  
'????4141414??404?')
```

## SDO\_GEOM Package (Geometry)

This chapter contains descriptions of the geometry-related PL/SQL subprograms in the SDO\_GEOM package, which can be grouped into the following categories:

- Relationship (True/False) between two objects: RELATE, WITHIN\_DISTANCE
- Validation: VALIDATE\_GEOMETRY\_WITH\_CONTEXT, VALIDATE\_LAYER\_WITH\_CONTEXT, SDO\_SELF\_UNION
- Single-object operations: SDO\_ALPHA\_SHAPE, SDO\_ARC\_DENSIFY, SDO\_AREA, SDO\_BUFFER, SDO\_CENTROID, SDO\_CONVEXHULL, SDO\_CONCAVEHULL, SDO\_CONCAVEHULL\_BOUNDARY, SDO\_DIAMETER, SDO\_DIAMETER\_LINE, SDO\_LENGTH, SDO\_MBC, SDO\_MBC\_CENTER, SDO\_MBC\_RADIUS, SDO\_MAX\_MBR\_ORDINATE, SDO\_MIN\_MBR\_ORDINATE, SDO\_MBR, SDO\_POINTONSURFACE, SDO\_TRIANGULATE, SDO\_VOLUME, SDO\_WIDTH, SDO\_WIDTH\_LINE
- Two-object operations: SDO\_CLOSEST\_POINTS, SDO\_DISTANCE, SDO\_DIFFERENCE, SDO\_INTERSECTION, SDO\_MAXDISTANCE, SDO\_MAXDISTANCE\_LINE, SDO\_UNION, SDO\_XOR

The geometry subprograms are listed [Table 23-1](#) (page 23-1), and some usage information follows the table.

**Table 23-1 Geometry Subprograms**

Subprogram	Description
<a href="#">SDO_GEOM.RELATE</a> (page 23-4)	Determines how two objects interact.
<a href="#">SDO_GEOM.SDO_ALPHA_SHAPE</a> (page 23-6)	Returns the alpha shape geometry of the input geometry, based on a specified radius value.
<a href="#">SDO_GEOM.SDO_ARC_DENSIFY</a> (page 23-7)	Changes each circular arc into an approximation consisting of straight lines, and each circle into a polygon consisting of a series of straight lines that approximate the circle.
<a href="#">SDO_GEOM.SDO_AREA</a> (page 23-9)	Computes the area of a two-dimensional polygon.
<a href="#">SDO_GEOM.SDO_BUFFER</a> (page 23-11)	Generates a buffer polygon around or inside a geometry.
<a href="#">SDO_GEOM.SDO_CENTROID</a> (page 23-13)	Returns the centroid of a polygon.
<a href="#">SDO_GEOM.SDO_CLOSEST_POINTS</a> (page 23-14)	Computes the minimum distance between two geometries and the points (one on each geometry) that are the minimum distance apart.

---

**Table 23-1 (Cont.) Geometry Subprograms**

Subprogram	Description
<a href="#">SDO_GEOM.SDO_CONCAVEHULL</a> (page 23-17)	Returns a polygon-type object that represents the concave hull of a geometry object.
<a href="#">SDO_GEOM.SDO_CONCAVEHULL_BOUNDARY</a> (page 23-18)	Returns a polygon-type object that represents the concave hull of a geometry object, based on boundary points rather than the alpha shape.
<a href="#">SDO_GEOM.SDO_CONVEXHULL</a> (page 23-19)	Returns a polygon-type object that represents the convex hull of a geometry object.
<a href="#">SDO_GEOM.SDO_DIAMETER</a> (page 23-21)	Returns the length of the diameter of a geometry object.
<a href="#">SDO_GEOM.SDO_DIFFERENCE</a> (page 23-24)	Returns a geometry object that is the topological difference (MINUS operation) of two geometry objects.
<a href="#">SDO_GEOM.SDO_DISTANCE</a> (page 23-25)	Computes the minimum distance between two geometry objects.
<a href="#">SDO_GEOM.SDO_INTERSECTION</a> (page 23-27)	Returns a geometry object that is the topological intersection (AND operation) of two geometry objects.
<a href="#">SDO_GEOM.SDO_LENGTH</a> (page 23-28)	Computes the length or perimeter of a geometry.
<a href="#">SDO_GEOM.SDO_MAX_MBR_ORDINATE</a> (page 23-30)	Returns the maximum value for the specified ordinate (dimension) of the minimum bounding rectangle of a geometry object.
<a href="#">SDO_GEOM.SDO_MAXDISTANCE</a> (page 23-31)	Computes the maximum distance between two geometry objects.
<a href="#">SDO_GEOM.SDO_MBC</a> (page 23-34)	Returns the minimum bounding circle of a geometry.
<a href="#">SDO_GEOM.SDO_MBC_CENTER</a> (page 23-35)	Returns the center of the minimum bounding rectangle of a geometry.
<a href="#">SDO_GEOM.SDO_MBC_RADIUS</a> (page 23-37)	Returns the length of the radius of the minimum bounding rectangle of a geometry.
<a href="#">SDO_GEOM.SDO_MBR</a> (page 23-38)	Returns the minimum bounding rectangle of a geometry.
<a href="#">SDO_GEOM.SDO_MIN_MBR_ORDINATE</a> (page 23-40)	Returns the minimum value for the specified ordinate (dimension) of the minimum bounding rectangle of a geometry object.
<a href="#">SDO_GEOM.SDO_POINTONSURFACE</a> (page 23-41)	Returns a point that is guaranteed to be on the surface of a polygon.
<a href="#">SDO_GEOM.SDO_SELF_UNION</a> (page 23-42)	Returns a valid geometry object that is the topological self union of one geometry object, which can be invalid.

**Table 23-1 (Cont.) Geometry Subprograms**

Subprogram	Description
<a href="#">SDO_GEOM.SDO_TRIANGULATE</a> (page 23-43)	Returns a collection of triangles resulting from Delaunay triangulation of the input geometry.
<a href="#">SDO_GEOM.SDO_UNION</a> (page 23-44)	Returns a geometry object that is the topological union (OR operation) of two geometry objects.
<a href="#">SDO_GEOM.SDO_VOLUME</a> (page 23-46)	Computes the volume of a three-dimensional solid geometry.
<a href="#">SDO_GEOM.SDO_XOR</a> (page 23-50)	Returns a geometry object that is the topological symmetric difference (XOR operation) of two geometry objects.
<a href="#">SDO_GEOM.VALIDATE_GEOMETRY_WITH_CONTEXT</a> (page 23-52)	Determines if a geometry is valid, and returns context information if the geometry is invalid.
<a href="#">SDO_GEOM.VALIDATE_LAYER_WITH_CONTEXT</a> (page 23-56)	Determines if all geometries stored in a column are valid, and returns context information about any invalid geometries.
<a href="#">SDO_GEOM.WITHIN_DISTANCE</a> (page 23-58)	Determines if two geometries are within a specified distance from one another.

The following usage information applies to the geometry subprograms. (See also the Usage Notes under the reference information for each subprogram.)

- Certain combinations of input parameters and operations can return a null value, that is, an empty geometry. For example, requesting the intersection of two disjoint geometry objects returns a null value.
- A null value (empty geometry) as an input parameter to a geometry function (for example, [SDO\\_GEOM.RELATE](#) (page 23-4)) produces an error.
- Certain operations can return a geometry of a different type than one or both input geometries. For example, the intersection of a line and an overlapping polygon returns a line; the intersection of two lines returns a point; and the intersection of two tangent polygons returns a line.
- SDO\_GEOM subprograms are supported for two-dimensional geometries only, except for the following, which are supported for both two-dimensional and three-dimensional geometries:
  - [SDO\\_GEOM.RELATE](#) (page 23-4) with (A) the ANYINTERACT mask, or (B) the INSIDE mask (3D support for solid geometries only)
  - [SDO\\_GEOM.SDO\\_AREA](#) (page 23-9)
  - [SDO\\_GEOM.SDO\\_DISTANCE](#) (page 23-25)
  - [SDO\\_GEOM.SDO\\_LENGTH](#) (page 23-28)
  - [SDO\\_GEOM.SDO\\_MAX\\_MBR\\_ORDINATE](#) (page 23-30)
  - [SDO\\_GEOM.SDO\\_MBR](#) (page 23-38)

- [SDO\\_GEOM.SDO\\_MIN\\_MBR\\_ORDINATE](#) (page 23-40)
- [SDO\\_GEOM.SDO\\_VOLUME](#) (page 23-46)
- [SDO\\_GEOM.VALIDATE\\_GEOMETRY\\_WITH\\_CONTEXT](#) (page 23-52)
- [SDO\\_GEOM.VALIDATE\\_LAYER\\_WITH\\_CONTEXT](#) (page 23-56)
- [SDO\\_GEOM.WITHIN\\_DISTANCE](#) (page 23-58)

## 23.1 SDO\_GEOM.RELATE

### Format

```
SDO_GEOM.RELATE(  
    geom1    IN SDO_GEOMETRY,  
    dim1     IN SDO_DIM_ARRAY,  
    mask     IN VARCHAR2,  
    geom2    IN SDO_GEOMETRY,  
    dim2     IN SDO_DIM_ARRAY  
) RETURN VARCHAR2;
```

or

```
SDO_GEOM.RELATE(  
    geom1    IN SDO_GEOMETRY,  
    mask     IN VARCHAR2,  
    geom2    IN SDO_GEOMETRY,  
    tol      IN NUMBER  
) RETURN VARCHAR2;
```

### Description

Examines two geometry objects to determine their spatial relationship.

### Parameters

#### **geom1**

Geometry object.

#### **dim1**

Dimensional information array corresponding to `geom1`, usually selected from one of the `xxx_SDO_GEOM_METADATA` views (described in [Geometry Metadata Views](#) (page 2-47)).

#### **mask**

Specifies a list of relationships to check. See the list of keywords in the Usage Notes.

#### **geom2**

Geometry object.

#### **dim2**

Dimensional information array corresponding to `geom2`, usually selected from one of the `xxx_SDO_GEOM_METADATA` views (described in [Geometry Metadata Views](#) (page 2-47)).

#### **tol**

Tolerance value (see [Tolerance](#) (page 1-6)).

## Usage Notes

For better performance, use the [SDO\\_RELATE](#) (page 18-30) operator or one of its convenience operator formats (all described in [Spatial Operators](#) (page 18-1)) instead of the `SDO_GEOM.RELATE` function, unless you need to use the function. For example, the DETERMINE mask keyword does not apply with the [SDO\\_RELATE](#) (page 18-30) operator. For more information about performance considerations with operators and functions, see [Spatial Operators\\_ Procedures\\_ and Functions](#) (page 1-14).

The `SDO_GEOM.RELATE` function can return the following types of answers:

- If you pass a mask listing one or more relationships, the function returns the specified mask value if one or more of the relationships are true for the pair of geometries. If all relationships are false, the procedure returns FALSE.
- If you pass the DETERMINE keyword in mask, the function returns the one relationship keyword that best matches the geometries.
- If you pass the ANYINTERACT keyword in mask, the function returns TRUE if the two geometries are not disjoint.

The following mask relationships can be tested:

- ANYINTERACT: Returns TRUE if the objects are not disjoint.
- CONTAINS: Returns CONTAINS if the second object is entirely within the first object and the object boundaries do not touch; otherwise, returns FALSE.
- COVEREDBY: Returns COVEREDBY if the first object is entirely within the second object and the object boundaries touch at one or more points; otherwise, returns FALSE.
- COVERS: Returns COVERS if the second object is entirely within the first object and the boundaries touch in one or more places; otherwise, returns FALSE.
- DISJOINT: Returns DISJOINT if the objects have no common boundary or interior points; otherwise, returns FALSE.
- EQUAL: Returns EQUAL if the objects share every point of their boundaries and interior, including any holes in the objects; otherwise, returns FALSE.
- INSIDE: Returns INSIDE if the first object is entirely within the second object and the object boundaries do not touch; otherwise, returns FALSE.
- ON: Returns ON if the boundary and interior of a line (the first object) is completely on the boundary of a polygon (the second object); otherwise, returns FALSE.
- OVERLAPBDYDISJOINT: Returns OVERLAPBDYDISJOINT if the objects overlap, but their boundaries do not interact; otherwise, returns FALSE.
- OVERLAPBDYINTERSECT: Returns OVERLAPBDYINTERSECT if the objects overlap, and their boundaries intersect in one or more places; otherwise, returns FALSE.
- TOUCH: Returns TOUCH if the two objects share a common boundary point, but no interior points; otherwise, returns FALSE.

Values for mask can be combined using the logical Boolean operator OR. For example, 'INSIDE + TOUCH' returns INSIDE+TOUCH if the relationship between the geometries

is `INSIDE` or `TOUCH` or both `INSIDE` and `TOUCH`; it returns `FALSE` if the relationship between the geometries is neither `INSIDE` nor `TOUCH`.

An exception is raised if `geom1` and `geom2` are based on different coordinate systems.

### Examples

The following example finds the relationship between each geometry in the `SHAPE` column and the `cola_b` geometry. (The example uses the definitions and data from [Simple Example: Inserting, Indexing, and Querying Spatial Data](#) (page 2-1). The output is reformatted for readability.)

```
SELECT c.name,
       SDO_GEOM.RELATE(c.shape, 'determine', c_b.shape, 0.005) relationship
FROM cola_markets c, cola_markets c_b WHERE c_b.name = 'cola_b';
```

NAME	RELATIONSHIP	
		cola_a TOUCH
cola_b	EQUAL	
cola_c	OVERLAPBDYINTERSECT	
cola_d	DISJOINT	

### Related Topics

- [SDO\\_RELATE](#) (page 18-30) operator

## 23.2 SDO\_GEOM.SDO\_ALPHA\_SHAPE

### Format

```
SDO_GEOM.SDO_ALPHA_SHAPE(  
  geom    IN SDO_GEOMETRY,  
  tol     IN NUMBER,  
  radius  IN NUMBER DEFAULT NULL,  
  flag    IN BINARY_INTEGER DEFAULT 0  
) RETURN SDO_GEOMETRY;
```

### Description

Returns the alpha shape geometry of the input geometry, based on a specified radius value.

### Parameters

#### **geom**

Geometry object.

#### **tol**

Tolerance value (see [Tolerance](#) (page 1-6)).

#### **radius**

Radius to be used in calculating the alpha shape. If this parameter is null, the alpha shape is the convex hull of the input geometry.

#### **flag**

Determines whether isolated points and edges are included: 0 (the default) includes isolated points and edges, so that the alpha shape is returned; 1 does not include



isolated points and edges, so that only the polygon portion of the alpha shape is returned.

### Usage Notes

The **alpha shape** is a generalization of the convex hull (see <http://www.cs.sunysb.edu/~algorithm/implement/alphashapes/implement.shtml>). This function takes all coordinates from the input geometry, uses them to compute Delaunay triangulations and the alpha shape.

If you specify a value for the `radius` parameter, you may first want to call the [SDO\\_GEOM.SDO\\_CONCAVEHULL](#) (page 23-17) function using the format with the `radius` output parameter.

An exception is raised if `geom` is of point type, has fewer than three points or vertices, or consists of multiple points all in a straight line, or if `radius` is less than 0.

With geodetic data, this function is supported by approximations, as explained in [Functions Supported by Approximations with Geodetic Data](#) (page 6-73).

### Examples

The following example returns a geometry object that is the alpha shape of `cola_c`, which is also the convex hull of `cola_c` because the default value for the `radius` parameter (null) is used. (This simplified example uses a polygon as the input geometry; this function is normally used with a large set of point data. The example uses the definitions and data from [Simple Example: Inserting\\_ Indexing\\_ and Querying Spatial Data](#) (page 2-1).)

```
SELECT c.name, SDO_GEOM.SDO_ALPHA_SHAPE(c.shape, 0.005)
   FROM cola_markets c WHERE c.name = 'cola_c';

SDO_GEOM.SDO_ALPHA_SHAPE(C.SHAPE,0.005)(SDO_GTYPE, SDO_SRID, SDO_POINT(X, Y, Z),
-----
cola_c
SDO_GEOMETRY(2003, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 1003, 1), SDO_ORDINATE_ARR
AY(4, 5, 3, 3, 6, 3, 6, 5, 4, 5))
```

### Related Topics

[SDO\\_GEOM.SDO\\_CONCAVEHULL](#) (page 23-17)

[SDO\\_GEOM.SDO\\_CONVEXHULL](#) (page 23-19)

## 23.3 SDO\_GEOM.SDO\_ARC\_DENSIFY

### Format

```
SDO_GEOM.SDO_ARC_DENSIFY(
  geom      IN SDO_GEOMETRY,
  dim       IN SDO_DIM_ARRAY
  params    IN VARCHAR2
) RETURN SDO_GEOMETRY;
```

or

```
SDO_GEOM.SDO_ARC_DENSIFY(
  geom      IN SDO_GEOMETRY,
  tol       IN NUMBER
```

```

    params IN VARCHAR2
  ) RETURN SDO_GEOMETRY;

```

### Description

Returns a geometry in which each circular arc in the input geometry is changed into an approximation of the circular arc consisting of straight lines, and each circle is changed into a polygon consisting of a series of straight lines that approximate the circle.

### Parameters

#### geom

Geometry object.

#### dim

Dimensional information array corresponding to `geom`, usually selected from one of the `xxx_SDO_GEOM_METADATA` views (described in [Geometry Metadata Views](#) (page 2-47)).

#### tol

Tolerance value (see [Tolerance](#) (page 1-6)).

#### params

A quoted string containing an arc tolerance value and optionally a unit value. See the Usage Notes for an explanation of the format and meaning.

### Usage Notes

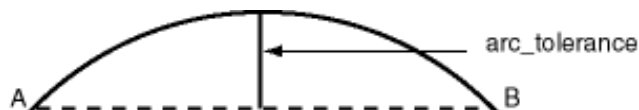
If you have geometries in a projected coordinate system that contain circles or circular arcs, you can use this function to densify them into regular polygons. You can then use the resulting straight-line polygon geometries for any spatial operations, or you can transform them to any projected or geodetic coordinate system.

The `params` parameter is a quoted string that can contain the `arc_tolerance` keyword, as well as the `unit` keyword to identify the unit of measurement associated with the `arc_tolerance` value. For example:

```
'arc_tolerance=0.05 unit=km'
```

The `arc_tolerance` keyword specifies, for each arc in the geometry, the maximum length of the perpendicular line between the surface of the arc and the straight line between the start and end points of the arc. [Figure 23-1](#) (page 23-8) shows a line whose length is the `arc_tolerance` value for the arc between points A and B.

**Figure 23-1 Arc Tolerance**



The `arc_tolerance` keyword value must be greater than the tolerance value associated with the geometry. (The default value for `arc_tolerance` is 20 times the tolerance value.) As you increase the `arc_tolerance` keyword value, the resulting polygon has fewer sides and a smaller area; as you decrease the `arc_tolerance` keyword value, the resulting polygon has more sides and a larger area (but never larger than the original geometry).

If the `unit` keyword is specified, the value must be an `SDO_UNIT` value from the `MDSYS.SDO_DIST_UNITS` table (for example, `'unit=KM'`). If the `unit` keyword is not specified, the unit of measurement associated with the geometry is used. See [Unit of Measurement Support](#) (page 2-55) for more information about unit of measurement specification.

### Examples

The following example returns the geometry that results from the arc densification of `cola_d`, which is a circle. (The example uses the definitions and data from [Simple Example: Inserting, Indexing, and Querying Spatial Data](#) (page 2-1).)

```
-- Arc densification of the circle cola_d
SELECT c.name, SDO_GEOM.SDO_ARC_DENSIFY(c.shape, m.diminfo,
                                         'arc_tolerance=0.05')
FROM cola_markets c, user_sdo_geom_metadata m
WHERE m.table_name = 'COLA_MARKETS' AND m.column_name = 'SHAPE'
AND c.name = 'cola_d';

NAME
-----
SDO_GEOM.SDO_ARC_DENSIFY(C.SHAPE,M.DIMINFO,'ARC_TOLERANCE=0.05')(SDO_GTYPE, SDO_
-----
cola_d
SDO_GEOMETRY(2003, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 1003, 1), SDO_ORDINATE_ARR
AY(8, 7, 8.76536686, 7.15224093, 9.41421356, 7.58578644, 9.84775907, 8.23463314,
10, 9, 9.84775907, 9.76536686, 9.41421356, 10.4142136, 8.76536686, 10.8477591,
8, 11, 7.23463314, 10.8477591, 6.58578644, 10.4142136, 6.15224093, 9.76536686, 6
, 9, 6.15224093, 8.23463314, 6.58578644, 7.58578644, 7.23463314, 7.15224093, 8,
7))
```

### Related Topics

- [Other Considerations and Requirements with Geodetic Data](#) (page 6-6)

## 23.4 SDO\_GEOM.SDO\_AREA

### Format

```
SDO_GEOM.SDO_AREA(
    geom IN SDO_GEOMETRY,
    dim IN SDO_DIM_ARRAY
    [, unit IN VARCHAR2]
) RETURN NUMBER;
```

or

```
SDO_GEOM.SDO_AREA(
    geom IN SDO_GEOMETRY,
    tol IN NUMBER
    [, unit IN VARCHAR2]
) RETURN NUMBER;
```

### Description

Returns the area of a two-dimensional polygon.

### Parameters

**geom**

Geometry object.

**dim**

Dimensional information array corresponding to `geom`, usually selected from one of the `xxx_SDO_GEOM_METADATA` views (described in [Geometry Metadata Views](#) (page 2-47)).

**unit**

Unit of measurement: a quoted string with `unit=` and an `SDO_UNIT` value from the `MDSYS.SDO_AREA_UNITS` table (for example, `'unit=SQ_KM'`). See [Unit of Measurement Support](#) (page 2-55) for more information about unit of measurement specification.

If this parameter is not specified, the unit of measurement associated with the data is assumed. For geodetic data, the default unit of measurement is square meters.

**tol**

Tolerance value (see [Tolerance](#) (page 1-6)).

**Usage Notes**

This function works with any polygon, including polygons with holes.

Lines that close to form a ring have no area.

**Examples**

The following example returns the areas of geometry objects stored in the `COLA_MARKETS` table. The first statement returns the areas of all objects; the second returns just the area of `cola_a`. (The example uses the definitions and data from [Simple Example: Inserting\\_ Indexing\\_ and Querying Spatial Data](#) (page 2-1).)

```
-- Return the areas of all cola markets.
SELECT name, SDO_GEOM.SDO_AREA(shape, 0.005) FROM cola_markets;

NAME                                SDO_GEOM.SDO_AREA(SHAPE,0.005)
-----
cola_a                                24
cola_b                               16.5
cola_c                                5
cola_d                               12.5663706

-- Return the area of just cola_a.
SELECT c.name, SDO_GEOM.SDO_AREA(c.shape, 0.005) FROM cola_markets c
       WHERE c.name = 'cola_a';

NAME                                SDO_GEOM.SDO_AREA(C.SHAPE,0.005)
-----
cola_a                                24
```

**Related Topics**

None.

## 23.5 SDO\_GEOM.SDO\_BUFFER

### Format

```
SDO_GEOM.SDO_BUFFER(  
  geom    IN SDO_GEOMETRY,  
  dim     IN SDO_DIM_ARRAY,  
  dist    IN NUMBER  
  [, params IN VARCHAR2]  
) RETURN SDO_GEOMETRY;
```

or

```
SDO_GEOM.SDO_BUFFER(  
  geom    IN SDO_GEOMETRY,  
  dist    IN NUMBER,  
  tol     IN NUMBER  
  [, params IN VARCHAR2]  
) RETURN SDO_GEOMETRY;
```

### Description

Generates a buffer polygon around or inside a geometry object.

### Parameters

#### geom

Geometry object.

#### dim

Dimensional information array corresponding to `geom`, usually selected from one of the `xxx_SDO_GEOM_METADATA` views (described in [Geometry Metadata Views](#) (page 2-47)).

#### dist

Distance value. If the value is positive, the buffer is generated around the geometry; if the value is negative (valid only for polygons), the buffer is generated inside the geometry. The absolute value of this parameter must be greater than the tolerance value, as specified in the dimensional array (`dim` parameter) or in the `tol` parameter.

#### tol

Tolerance value (see [Tolerance](#) (page 1-6)).

#### params

A quoted string that can contain one or both of the following keywords:

- `unit` and an `SDO_UNIT` value from the `MDSYS.SDO_DIST_UNITS` table. It identifies the unit of measurement associated with the `dist` parameter value, and also with the arc tolerance value if the `arc_tolerance` keyword is specified. See [Unit of Measurement Support](#) (page 2-55) for more information about unit of measurement specification.
- `arc_tolerance` and an arc tolerance value. See the Usage Notes for the [SDO\\_GEOM.SDO\\_ARC\\_DENSIFY](#) (page 23-7) function in this chapter for more information about the `arc_tolerance` keyword.

For example: 'unit=km arc\_tolerance=0.05'

If the input geometry is geodetic data and if `arc_tolerance` is not specified, the default value is the tolerance value multiplied by 20. Spatial and Graph uses the `arc_tolerance` value to perform arc densification in computing the result. If the input geometry is Cartesian or projected data, `arc_tolerance` has no effect and should not be specified.

If this parameter is not specified for a Cartesian or projected geometry, or if the `arc_tolerance` keyword is specified for a geodetic geometry but the `unit` keyword is not specified, the unit of measurement associated with the data is assumed.

### Usage Notes

This function returns a geometry object representing the buffer polygon.

This function creates a rounded buffer around a point, line, or polygon, or inside a polygon. The buffer within a void is also rounded, and is the same distance from the inner boundary as the outer buffer is from the outer boundary. See [Figure 1-7](#) (page 1-13) for an illustration.

If the buffer polygon geometry is in a projected coordinate system, it will contain arcs; and if you want to transform that geometry to a geodetic coordinate system, you must first densify it using the [SDO\\_GEOM.SDO\\_ARC\\_DENSIFY](#) (page 23-7) function, and then transform the densified geometry.

If the input geometry has more than 50 ordinates, and the buffer width is less than 0.1 percent (0.001) of the root-mean-square spacing between consecutive coordinates, then the original geometry is returned unchanged.

With geodetic data, this function is supported by approximations, as explained in [Functions Supported by Approximations with Geodetic Data](#) (page 6-73).

With geodetic data, this function should be used only for relatively small geometries: geometries for which the local tangent plane projection that is used for internal computations does not introduce significant distortions or errors. This limits the applicable domain of source geometries, whether line strings or polygons, to approximately the area of Texas (United States), France, or Manchuria province (China).

### Examples

The following example returns a polygon representing a buffer of 1 around `cola_a`. Note the rounded corners (for example, at .292893219,.292893219) in the returned polygon. (The example uses the non-geodetic definitions and data from [Simple Example: Inserting\\_ Indexing\\_ and Querying Spatial Data](#) (page 2-1).)

```
-- Generate a buffer of 1 unit around a geometry.
SELECT c.name, SDO_GEOM.SDO_BUFFER(c.shape, m.diminfo, 1)
  FROM cola_markets c, user_sdo_geom_metadata m
  WHERE m.table_name = 'COLA_MARKETS' AND m.column_name = 'SHAPE'
     AND c.name = 'cola_a';

NAME
-----
SDO_GEOM.SDO_BUFFER(C.SHAPE,M.DIMINFO,1)(SDO_GTYPE, SDO_SRID, SDO_POINT(X, Y, Z)
-----
cola_a
SDO_GEOMETRY(2003, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 1005, 8, 1, 2, 2, 5, 2, 1,
7, 2, 2, 11, 2, 1, 13, 2, 2, 17, 2, 1, 19, 2, 2, 23, 2, 1), SDO_ORDINATE_ARRAY(
```

```
0, 1, .292893219, .292893219, 1, 0, 5, 0, 5.70710678, .292893219, 6, 1, 6, 7, 5.
70710678, 7.70710678, 5, 8, 1, 8, .292893219, 7.70710678, 0, 7, 0, 1))
```

The following example returns a polygon representing a buffer of 1 around cola\_a using the geodetic definitions and data from [Example of Coordinate System Transformation](#) (page 6-76).

```
-- Generate a buffer of 1 kilometer around a geometry.
SELECT c.name, SDO_GEOM.SDO_BUFFER(c.shape, m.diminfo, 1,
                                   'unit=km arc_tolerance=0.05')
FROM cola_markets c, user_sdo_geom_metadata m
WHERE m.table_name = 'COLA_MARKETS'
AND m.column_name = 'SHAPE' AND c.name = 'cola_a';

NAME
-----
SDO_GEOM.SDO_BUFFER(C.SHAPE,M.DIMINFO,1,'UNIT=KMARC_TOLERANCE=0.05')(SDO_GTYPE,
-----
cola_a
SDO_GEOMETRY(2003, 8307, NULL, SDO_ELEM_INFO_ARRAY(1, 1003, 1), SDO_ORDINATE_ARR
AY(.991023822, 1.00002073, .992223711, .995486419, .99551726, .99217077, 1.00001
929, .990964898, 4.99998067, .990964929, 5.00448268, .9921708, 5.00777624, .9954
86449, 5.00897618, 1.00002076, 5.00904194, 6.99997941, 5.00784065, 7.00450033, 5
.00454112, 7.00781357, 5.00002479, 7.009034, .999975166, 7.00903403, .995458814,
7.00781359, .992159303, 7.00450036, .990958058, 6.99997944, .991023822, 1.00002
073))
```

### Related Topics

- [SDO\\_GEOM.SDO\\_UNION](#) (page 23-44)
- [SDO\\_GEOM.SDO\\_INTERSECTION](#) (page 23-27)
- [SDO\\_GEOM.SDO\\_XOR](#) (page 23-50)

## 23.6 SDO\_GEOM.SDO\_CENTROID

### Format

```
SDO_GEOM.SDO_CENTROID(
  geom1 IN SDO_GEOMETRY,
  dim1 IN SDO_DIM_ARRAY
) RETURN SDO_GEOMETRY;
```

or

```
SDO_GEOM.SDO_CENTROID(
  geom1 IN SDO_GEOMETRY,
  tol IN NUMBER
) RETURN SDO_GEOMETRY;
```

### Description

Returns a point geometry that is the centroid of a polygon, multipolygon, point, or point cluster. (The centroid is also known as the "center of gravity.")

For an input geometry consisting of multiple objects, the result is weighted by the area of each polygon in the geometry objects. If the geometry objects are a mixture of polygons and points, the points are not used in the calculation of the centroid. If the geometry objects are all points, the points have equal weight.

### Parameters

**geom1**

Geometry object.

**dim1**

Dimensional information array corresponding to `geom`, usually selected from one of the `xxx_SDO_GEOM_METADATA` views (described in [Geometry Metadata Views](#) (page 2-47)).

**tol**

Tolerance value (see [Tolerance](#) (page 1-6)).

### Usage Notes

The function returns a null value if `geom1` is not a polygon, multipolygon, point, or point cluster, as identified by the `SDO_GTYPE` value in the `SDO_GEOMETRY` object.

If `geom1` is a point, the function returns the point (the input geometry).

With geodetic data, this function is supported by approximations, as explained in [Functions Supported by Approximations with Geodetic Data](#) (page 6-73).

Depending on the shape and complexity of the input geometry, the returned point might not be on the surface of the input geometry.

### Examples

The following example returns a geometry object that is the centroid of `cola_c`. (The example uses the definitions and data from [Simple Example: Inserting, Indexing, and Querying Spatial Data](#) (page 2-1).)

```
-- Return the centroid of a geometry.
SELECT c.name, SDO_GEOM.SDO_CENTROID(c.shape, m.diminfo)
  FROM cola_markets c, user_sdo_geom_metadata m
 WHERE m.table_name = 'COLA_MARKETS' AND m.column_name = 'SHAPE'
 AND c.name = 'cola_c';

NAME
-----
SDO_GEOM.SDO_CENTROID(C.SHAPE,M.DIMINFO)(SDO_GTYPE, SDO_SRID, SDO_POINT(X, Y, Z)
-----
cola_c
SDO_GEOMETRY(2001, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 1, 1), SDO_ORDINATE_ARRAY(
4.73333333, 3.93333333))
```

### Related Topics

None.

## 23.7 SDO\_GEOM.SDO\_CLOSEST\_POINTS

### Format

```
SDO_GEOM.SDO_CLOSEST_POINTS(
  geom1      IN SDO_GEOMETRY,
  geom2      IN SDO_GEOMETRY,
  tolerance  IN NUMBER,
  unit       IN VARCHAR2,
```



```
dist      OUT NUMBER,  
geoma     OUT SDO_GEOMETRY,  
geomb     OUT SDO_GEOMETRY);
```

### Description

Computes the minimum distance between two geometries and the points (one on each geometry) that are the minimum distance apart.

### Parameters

#### **geom1**

Geometry object.

#### **geom2**

Geometry object.

#### **tolerance**

Tolerance value (see [Tolerance](#) (page 1-6)).

#### **unit**

Unit of measurement: a quoted string with `unit=` and an SDO\_UNIT value from the MDSYS.SDO\_DIST\_UNITS table (for example, 'unit=KM'). See [Unit of Measurement Support](#) (page 2-55) for more information about unit of measurement specification.

If this parameter is not specified, the unit of measurement associated with the data is assumed.

#### **dist**

Output parameter containing the minimum distance between geom1 and geom2. Specifically, the distance between geoma and geomb.

#### **geoma**

Output parameter containing the point geometry object on the boundary of geom1 that is closest to the closest point on the boundary of geom2.

#### **geomb**

Output parameter containing the point geometry object on the boundary of geom2 that is closest to the closest point on the boundary of geom1.

### Usage Notes

This procedure uses output parameters to store the computed minimum distance and the point on each input geometry associated with the minimum distance.

If the distance between the two points is 0 (zero), the output geometries (geoma and geomb) will be as follows:

- For two-dimensional (2D) geometries, if one of the input geometries is a point geometry, each output geometry is that point; otherwise, each output geometry is the first point in the first element of the intersection of the input geometries.
- For three-dimensional (3D) geometries, if one of the input geometries is a point geometry, each output geometry is that point; otherwise, the output geometries are null.

An exception is raised if geom1 and geom2 are based on different coordinate systems.

If the input data is three-dimensional and geodetic, a 3D SRID must be used for the geometries; otherwise, the results will be incorrect.

### Examples

The following example computes the minimum distance between geometries `cola_c` and `cola_d`, as well as the one point on each input geometry associated with the minimum distance. It also inserts the two output point geometries into the table and then selects these point geometries. The minimum distance between the two input geometries is 2.47213595499958, the closest point on `cola_c` is at (6,5), and the closest point on `cola_d` is at (7.10557281, 7.21114562). (The example uses the definitions and data from [Simple Example: Inserting\\_ Indexing\\_ and Querying Spatial Data](#) (page 2-1).)

```
DECLARE
  cola_c_geom SDO_GEOMETRY;
  cola_d_geom SDO_GEOMETRY;
  dist NUMBER;
  geoma SDO_GEOMETRY;
  geomb SDO_GEOMETRY;

BEGIN

  -- Populate geometry variables with cola market shapes.
  SELECT c.shape into cola_c_geom FROM cola_markets c
    WHERE c.name = 'cola_c';
  SELECT c.shape into cola_d_geom FROM cola_markets c
    WHERE c.name = 'cola_d';

  SDO_GEOM.SDO_CLOSEST_POINTS(cole_c_geom, cola_d_geom, 0.005, NULL,
    dist, geoma, geomb);

  INSERT INTO cola_markets VALUES(9901, 'geoma', geoma);
  INSERT INTO cola_markets VALUES(9902, 'geomb', geomb);

  DBMS_OUTPUT.PUT_LINE('dist output parameter value = ' || dist);
END;
/
dist output parameter value = 2.47213595499958

PL/SQL procedure successfully completed.

SELECT c.shape FROM cola_markets c WHERE c.name = 'geoma';

SHAPE(SDO_GTYPE, SDO_SRID, SDO_POINT(X, Y, Z), SDO_ELEM_INFO, SDO_ORDINATES)
-----
SDO_GEOMETRY(2001, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 1, 1), SDO_ORDINATE_ARRAY(
6, 5))

SELECT c.shape FROM cola_markets c WHERE c.name = 'geomb';

SHAPE(SDO_GTYPE, SDO_SRID, SDO_POINT(X, Y, Z), SDO_ELEM_INFO, SDO_ORDINATES)
-----
SDO_GEOMETRY(2001, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 1, 1), SDO_ORDINATE_ARRAY(
7.10557281, 7.21114562))
```

### Related Topics

None.

## 23.8 SDO\_GEOM.SDO\_CONCAVEHULL

### Format

```
SDO_GEOM.SDO_CONCAVEHULL(  
    geom IN SDO_GEOMETRY,  
    tol IN NUMBER  
) RETURN SDO_GEOMETRY;
```

or

```
SDO_GEOM.SDO_CONCAVEHULL(  
    geom IN SDO_GEOMETRY,  
    tol IN NUMBER,  
    radius OUT NUMBER  
) RETURN SDO_GEOMETRY;
```

### Description

Returns a polygon-type object that represents the concave hull of a geometry object.

### Parameters

#### geom

Geometry object.

#### tol

Tolerance value (see [Tolerance](#) (page 1-6)).

#### radius

Output parameter to hold the radius of the circumcircle of the triangles created internally (using Delaunay triangulations) in computing the concave hull.

### Usage Notes

The **concave hull** is a polygon that represents the area of the input geometry, such as a collection of points. With complex input geometries, the concave hull is typically significantly smaller in area than the convex hull.

This function takes all coordinates from the input geometry, uses them to compute Delaunay triangulations, and computes a concave hull. It returns only an exterior ring; any interior rings are discarded.

This function uses the alpha shape in computing the concave hull. By contrast, the [SDO\\_GEOM.SDO\\_CONCAVEHULL\\_BOUNDARY](#) (page 23-18) function uses exterior boundary points.

The format with the `radius` parameter returns a radius value that can be useful if you plan to call the [SDO\\_GEOM.SDO\\_ALPHA\\_SHAPE](#) (page 23-6) function.

An exception is raised if `geom` has fewer than three points or vertices, or consists of multiple points all in a straight line.

With geodetic data, this function is supported by approximations, as explained in [Functions Supported by Approximations with Geodetic Data](#) (page 6-73).

### Examples

The following example returns a geometry object that is the concave hull of cola\_c. (The example uses the definitions and data from [Simple Example: Inserting\\_ Indexing\\_ and Querying Spatial Data](#) (page 2-1).

```
-- Return the concave hull of a polygon.
SELECT c.name, SDO_GEOM.SDO_CONCAVEHULL(c.shape, 0.005)
  FROM cola_markets c WHERE c.name = 'cola_c';

NAME
-----
SDO_GEOM.SDO_CONCAVEHULL(C.SHAPE,0.005)(SDO_GTYPE, SDO_SRID, SDO_POINT(X, Y, Z),
-----
cola_c
SDO_GEOMETRY(2003, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 1003, 1), SDO_ORDINATE_ARR
AY(6, 3, 6, 5, 4, 5, 3, 3, 6, 3))
```

### Related Topics

[SDO\\_GEOM.SDO\\_ALPHA\\_SHAPE](#) (page 23-6)

[SDO\\_GEOM.SDO\\_CONCAVEHULL\\_BOUNDARY](#) (page 23-18)

[SDO\\_GEOM.SDO\\_CONVEXHULL](#) (page 23-19)

## 23.9 SDO\_GEOM.SDO\_CONCAVEHULL\_BOUNDARY

### Format

```
SDO_GEOM.SDO_CONCAVEHULL_BOUNDARY(
  geom    IN SDO_GEOMETRY,
  tol     IN NUMBER,
  length  IN NUMBER DEFAULT NULL
) RETURN SDO_GEOMETRY;
```

### Description

Returns a polygon-type object that represents the concave hull of a geometry object, based on boundary points rather than the alpha shape.

### Parameters

#### geom

Geometry object.

#### tol

Tolerance value (see [Tolerance](#) (page 1-6)).

#### length

A value to control the size of the concave hull: specifically, computation of the concave hull is stopped when the longest edge in the concave hull is shorter than the length value. Thus, the larger the length value, the larger the concave hull will probably be. If you do not specify this parameter, computation continues as described in the Usage Notes.

## Usage Notes

The **concave hull** is a polygon that represents the area of the input geometry, such as a collection of points. With complex input geometries, the concave hull is typically significantly smaller in area than the convex hull.

Like the [SDO\\_GEOM.SDO\\_CONCAVEHULL](#) (page 23-17) function, this function takes all coordinates from the input geometry, and uses them to compute Delaunay triangulations. But after that, it computes a convex hull, puts all boundary edges into a priority queue based on the lengths of these edges, and then removes edges one by one as long as the shape is still a single connected polygon (unless stopped by a specified length parameter value). If an edge is removed during the computation, the other two edges of its triangle will be on the boundary.

An exception is raised if geom has fewer than three points or vertices, or consists of multiple points all in a straight line.

With geodetic data, this function is supported by approximations, as explained in [Functions Supported by Approximations with Geodetic Data](#) (page 6-73).

## Examples

The following example returns a geometry object that is the concave hull of cola\_c. (The example uses the definitions and data from [Simple Example: Inserting Indexing and Querying Spatial Data](#) (page 2-1).)

```
-- Return the concave hull of a polygon.
SELECT c.name, SDO_GEOM.SDO_CONCAVEHULL_BOUNDARY(c.shape, 0.005)
   FROM cola_markets c WHERE c.name = 'cola_c';

NAME
-----
SDO_GEOM.SDO_CONCAVEHULL_BOUNDARY(C.SHAPE,0.005)(SDO_GTYPE, SDO_SRID, SDO_POINT(
-----
cola_c
SDO_GEOMETRY(2003, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 1003, 1), SDO_ORDINATE_ARR
AY(6, 3, 6, 5, 4, 5, 3, 3, 6, 3))
```

## Related Topics

[SDO\\_GEOM.SDO\\_ALPHA\\_SHAPE](#) (page 23-6)

[SDO\\_GEOM.SDO\\_CONCAVEHULL](#) (page 23-17)

[SDO\\_GEOM.SDO\\_CONVEXHULL](#) (page 23-19)

# 23.10 SDO\_GEOM.SDO\_CONVEXHULL

## Format

```
SDO_GEOM.SDO_CONVEXHULL(
  geom1 IN SDO_GEOMETRY,
  dim1 IN SDO_DIM_ARRAY
) RETURN SDO_GEOMETRY;
```

or

```
SDO_GEOM.SDO_CONVEXHULL(
  geom1 IN SDO_GEOMETRY,
  tol IN NUMBER
) RETURN SDO_GEOMETRY;
```

## Description

Returns a polygon-type object that represents the convex hull of a geometry object.

## Parameters

### geom1

Geometry object.

### dim1

Dimensional information array corresponding to `geom1`, usually selected from one of the `xxx_SDO_GEOM_METADATA` views (described in [Geometry Metadata Views](#) (page 2-47)).

### tol

Tolerance value (see [Tolerance](#) (page 1-6)).

## Usage Notes

The **convex hull** is a simple convex polygon that completely encloses the geometry object. Spatial and Graph uses as few straight-line sides as possible to create the smallest polygon that completely encloses the specified object. A convex hull is a convenient way to get an approximation of a complex geometry object.

If the geometry (`geom1`) contains any arc elements, the function calculates the minimum bounding rectangle (MBR) for each arc element and uses these MBRs in calculating the convex hull of the geometry. If the geometry object (`geom1`) is a circle, the function returns a square that minimally encloses the circle.

The function returns a null value if `geom1` is of point type, has fewer than three points or vertices, or consists of multiple points all in a straight line.

With geodetic data, this function is supported by approximations, as explained in [Functions Supported by Approximations with Geodetic Data](#) (page 6-73).

## Examples

The following example returns a geometry object that is the convex hull of `cola_c`. (The example uses the definitions and data from [Simple Example: Inserting Indexing and Querying Spatial Data](#) (page 2-1). This specific example, however, does not produce useful output—the returned polygon has the same vertices as the input polygon—because the input polygon is already a simple convex polygon.)

```
-- Return the convex hull of a polygon.
SELECT c.name, SDO_GEOM.SDO_CONVEXHULL(c.shape, m.diminfo)
  FROM cola_markets c, user_sdo_geom_metadata m
 WHERE m.table_name = 'COLA_MARKETS' AND m.column_name = 'SHAPE'
 AND c.name = 'cola_c';

NAME
-----
SDO_GEOM.SDO_CONVEXHULL(C.SHAPE,M.DIMINFO)(SDO_GTYPE, SDO_SRID, SDO_POINT(X, Y,
-----
cola_c
SDO_GEOMETRY(2003, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 1003, 1), SDO_ORDINATE_ARR
AY(6, 3, 6, 5, 4, 5, 3, 3, 6, 3))
```

**Related Topics**

[SDO\\_GEOM.SDO\\_CONCAVEHULL](#) (page 23-17)

**23.11 SDO\_GEOM.SDO\_DIAMETER****Note:**

This feature is available starting with Oracle Database 12c Release 1 (12.1.0.2).

**Format**

```
SDO_GEOM.SDO_DIAMETER(
    geom IN SDO_GEOMETRY,
    dim  IN SDO_DIM_ARRAY
    [, unit IN VARCHAR2]
) RETURN NUMBER;
```

or

```
SDO_GEOM.SDO_DIAMETER(
    geom IN SDO_GEOMETRY,
    tol  IN NUMBER
    [, unit IN VARCHAR2]
) RETURN NUMBER;
```

**Description**

Returns the length of the diameter of a geometry object.

**Parameters****geom**

Geometry object.

**dim**

Dimensional information array corresponding to *geom*, usually selected from one of the xxx\_SDO\_GEOM\_METADATA views (described in [Geometry Metadata Views](#) (page 2-47)).

**tol**

Tolerance value (see [Tolerance](#) (page 1-6)).

**unit**

Unit of measurement: a quoted string with *unit=* and an SDO\_UNIT value from the MDSYS.SDO\_DIST\_UNITS table (for example, 'unit=KM'). See [Unit of Measurement Support](#) (page 2-55) for more information about unit of measurement specification.

If this parameter is not specified, the unit of measurement associated with the data is assumed. For geodetic data, the default unit of measurement is meters.

**Usage Notes**

This function can be used for circle and non-circle geometry objects. The input geometry does not need to contain any curves.

The returned diameter length is the maximum distance between any two points in the geometry object. (For a formal definition of *diameter*, see a college-level mathematics textbook or other appropriate reference source.)

The input geometry can have no more than two dimensions.

If a point geometry is specified, the function returns 0 (zero).

### Examples

The following example returns the diameter length of all geometry objects stored in the COLA\_MARKETS table. (The example uses the definitions and data from [Simple Example: Inserting, Indexing, and Querying Spatial Data](#) (page 2-1).)

```
SELECT name, SDO_GEOM.SDO_DIAMETER(shape, 0.005) Diameter
FROM cola_markets;
```

NAME	DIAMETER
cola_a	7.21110255
cola_b	6.70820393
cola_c	3.60555128
cola_d	4

### Related Topics

[SDO\\_GEOM.SDO\\_DIAMETER\\_LINE](#) (page 23-22)

[SDO\\_GEOM.SDO\\_WIDTH](#) (page 23-47)

## 23.12 SDO\_GEOM.SDO\_DIAMETER\_LINE

---

---

### Note:

This feature is available starting with Oracle Database 12c Release 1 (12.1.0.2).

---

---

### Format

```
SDO_GEOM.SDO_DIAMETER_LINE(
  geom IN SDO_GEOMETRY,
  dim  IN SDO_DIM_ARRAY
) RETURN NUMBER;
```

or

```
SDO_GEOM.SDO_DIAMETER_LINE(
  geom IN SDO_GEOMETRY,
  tol  IN NUMBER
) RETURN NUMBER;
```

### Description

Returns a line string geometry reflecting the length of the diameter of a geometry object.

### Parameters



**geom**

Geometry object.

**dim**

Dimensional information array corresponding to `geom`, usually selected from one of the `xxx_SDO_GEOM_METADATA` views (described in [Geometry Metadata Views](#) (page 2-47)).

**tol**

Tolerance value (see [Tolerance](#) (page 1-6)).

**Usage Notes**

This function can be used for circle and non-circle geometry objects. The input geometry does not need to contain any curves.

The returned diameter length is the maximum distance between any two points in the geometry object. (For a formal definition of *diameter*, see a college-level mathematics textbook or other appropriate reference source.)

The input geometry can have no more than two dimensions.

If a point geometry is specified, the function returns 0 (zero).

**Examples**

The following example returns line strings reflecting diameter length of each geometry object stored in the `COLA_MARKETS` table. (The example uses the definitions and data from [Simple Example: Inserting, Indexing, and Querying Spatial Data](#) (page 2-1).)

```
SELECT name, SDO_GEOM.SDO_DIAMETER_LINE(shape, 0.005)
  FROM cola_markets;

NAME
-----
SDO_GEOM.SDO_DIAMETER_LINE(SHAPE,0.005)(SDO_GTYPE, SDO_SRID, SDO_POINT(X, Y, Z),
-----
cola_a
SDO_GEOMETRY(2002, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 2, 1), SDO_ORDINATE_ARRAY(
1, 1, 5, 7))

cola_b
SDO_GEOMETRY(2002, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 2, 1), SDO_ORDINATE_ARRAY(
8, 1, 5, 7))

cola_c
SDO_GEOMETRY(2002, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 2, 1), SDO_ORDINATE_ARRAY(
3, 3, 6, 5))

cola_d
SDO_GEOMETRY(2002, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 2, 1), SDO_ORDINATE_ARRAY(
8, 7, 8, 11))
```

**Related Topics**

[SDO\\_GEOM.SDO\\_DIAMETER](#) (page 23-21)

[SDO\\_GEOM.SDO\\_WIDTH](#) (page 23-47)

## 23.13 SDO\_GEOM.SDO\_DIFFERENCE

### Format

```
SDO_GEOM.SDO_DIFFERENCE(  
    geom1 IN SDO_GEOMETRY,  
    dim1  IN SDO_DIM_ARRAY,  
    geom2 IN SDO_GEOMETRY,  
    dim2  IN SDO_DIM_ARRAY  
) RETURN SDO_GEOMETRY;
```

or

```
SDO_GEOM.SDO_DIFFERENCE(  
    geom1 IN SDO_GEOMETRY,  
    geom2 IN SDO_GEOMETRY,  
    tol   IN NUMBER  
) RETURN SDO_GEOMETRY;
```

### Description

Returns a geometry object that is the topological difference (MINUS operation) of two geometry objects.

### Parameters

#### **geom1**

Geometry object.

#### **dim1**

Dimensional information array corresponding to `geom1`, usually selected from one of the `xxx_SDO_GEOM_METADATA` views (described in [Geometry Metadata Views](#) (page 2-47)).

#### **geom2**

Geometry object.

#### **dim2**

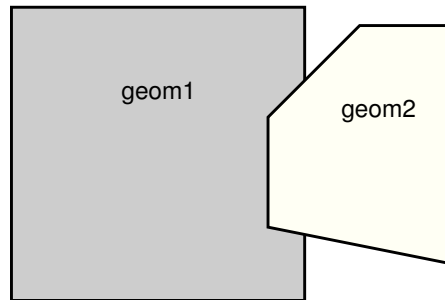
Dimensional information array corresponding to `geom2`, usually selected from one of the `xxx_SDO_GEOM_METADATA` views (described in [Geometry Metadata Views](#) (page 2-47)).

#### **tol**

Tolerance value (see [Tolerance](#) (page 1-6)).

### Usage Notes

In [Figure 23-2](#) (page 23-25), the shaded area represents the polygon returned when `SDO_DIFFERENCE` is used with a square (`geom1`) and another polygon (`geom2`).

**Figure 23-2 SDO\_GEOM.SDO\_DIFFERENCE**

An exception is raised if geom1 and geom2 are based on different coordinate systems.

### Examples

The following example returns a geometry object that is the topological difference (MINUS operation) of cola\_a and cola\_c. (The example uses the definitions and data from [Simple Example: Inserting, Indexing, and Querying Spatial Data](#) (page 2-1).)

```
-- Return the topological difference of two geometries.
SELECT SDO_GEOM.SDO_DIFFERENCE(c_a.shape, m.diminfo, c_c.shape, m.diminfo)
  FROM cola_markets c_a, cola_markets c_c, user_sdo_geom_metadata m
 WHERE m.table_name = 'COLA_MARKETS' AND m.column_name = 'SHAPE'
 AND c_a.name = 'cola_a' AND c_c.name = 'cola_c';

SDO_GEOM.SDO_DIFFERENCE(C_A.SHAPE,M.DIMINFO,C_C.SHAPE,M.DIMINFO)(SDO_GTYPE, SDO_
-----
SDO_GEOMETRY(2003, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 1003, 1), SDO_ORDINATE_ARR
AY(1, 7, 1, 1, 5, 1, 5, 3, 3, 3, 4, 5, 5, 5, 5, 7, 1, 7))
```

Note that in the returned polygon, the SDO\_ORDINATE\_ARRAY starts and ends at the same point (1, 7).

### Related Topics

- [SDO\\_GEOM.SDO\\_INTERSECTION](#) (page 23-27)
- [SDO\\_GEOM.SDO\\_UNION](#) (page 23-44)
- [SDO\\_GEOM.SDO\\_XOR](#) (page 23-50)

## 23.14 SDO\_GEOM.SDO\_DISTANCE

### Format

```
SDO_GEOM.SDO_DISTANCE(
  geom1 IN SDO_GEOMETRY,
  dim1  IN SDO_DIM_ARRAY,
  geom2 IN SDO_GEOMETRY,
  dim2  IN SDO_DIM_ARRAY
  [, unit IN VARCHAR2]
) RETURN NUMBER;
```

or

```
SDO_GEOM.SDO_DISTANCE(
  geom1 IN SDO_GEOMETRY,
```

```
geom2 IN SDO_GEOMETRY,  
tol IN NUMBER  
[, unit IN VARCHAR2]  
) RETURN NUMBER;
```

### Description

Computes the minimum distance between two geometry objects, which is the distance between the closest pair of points or segments of the two objects.

### Parameters

#### **geom1**

Geometry object whose distance from geom2 is to be computed.

#### **dim1**

Dimensional information array corresponding to geom1, usually selected from one of the xxx\_SDO\_GEOM\_METADATA views (described in [Geometry Metadata Views](#) (page 2-47)).

#### **geom2**

Geometry object whose distance from geom1 is to be computed.

#### **dim2**

Dimensional information array corresponding to geom2, usually selected from one of the xxx\_SDO\_GEOM\_METADATA views (described in [Geometry Metadata Views](#) (page 2-47)).

#### **unit**

Unit of measurement: a quoted string with unit= and an SDO\_UNIT value from the MDSYS.SDO\_DIST\_UNITS table (for example, 'unit=KM'). See [Unit of Measurement Support](#) (page 2-55) for more information about unit of measurement specification.

If this parameter is not specified, the unit of measurement associated with the data is assumed.

#### **tol**

Tolerance value (see [Tolerance](#) (page 1-6)).

### Usage Notes

An exception is raised if geom1 and geom2 are based on different coordinate systems.

If the input data is three-dimensional and geodetic, a 3D SRID must be used for the geometries; otherwise, the results will be incorrect.

### Examples

The following example returns the shortest distance between cola\_b and cola\_d. (The example uses the definitions and data from [Simple Example: Inserting\\_ Indexing\\_ and Querying Spatial Data](#) (page 2-1).)

```
-- Return the distance between two geometries.  
SELECT SDO_GEOM.SDO_DISTANCE(c_b.shape, c_d.shape, 0.005)  
FROM cola_markets c_b, cola_markets c_d  
WHERE c_b.name = 'cola_b' AND c_d.name = 'cola_d';  
  
SDO_GEOM.SDO_DISTANCE(C_B.SHAPE,C_D.SHAPE,0.005)
```

-----  
 .846049894

### Related Topics

- [SDO\\_GEOM.SDO\\_MAXDISTANCE](#) (page 23-31)
- [SDO\\_GEOM.WITHIN\\_DISTANCE](#) (page 23-58)

## 23.15 SDO\_GEOM.SDO\_INTERSECTION

### Format

```
SDO_GEOM.SDO_INTERSECTION(
  geom1  IN SDO_GEOMETRY,
  dim1   IN SDO_DIM_ARRAY,
  geom2  IN SDO_GEOMETRY,
  dim2   IN SDO_DIM_ARRAY
) RETURN SDO_GEOMETRY;
```

or

```
SDO_GEOM.SDO_INTERSECTION(
  geom1  IN SDO_GEOMETRY,
  geom2  IN SDO_GEOMETRY,
  tol    IN NUMBER
) RETURN SDO_GEOMETRY;
```

### Description

Returns a geometry object that is the topological intersection (AND operation) of two geometry objects.

### Parameters

#### **geom1**

Geometry object.

#### **dim1**

Dimensional information array corresponding to `geom1`, usually selected from one of the `xxx_SDO_GEOM_METADATA` views (described in [Geometry Metadata Views](#) (page 2-47)).

#### **geom2**

Geometry object.

#### **dim2**

Dimensional information array corresponding to `geom2`, usually selected from one of the `xxx_SDO_GEOM_METADATA` views (described in [Geometry Metadata Views](#) (page 2-47)).

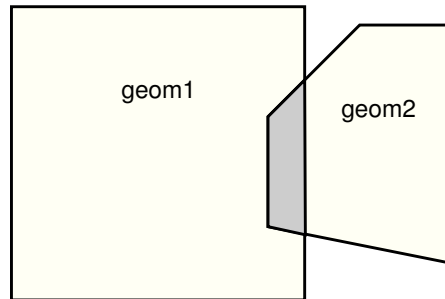
#### **tol**

Tolerance value (see [Tolerance](#) (page 1-6)).

### Usage Notes

In [Figure 23-3](#) (page 23-28), the shaded area represents the polygon returned when SDO\_INTERSECTION is used with a square (geom1) and another polygon (geom2).

**Figure 23-3 SDO\_GEOM.SDO\_INTERSECTION**



An exception is raised if geom1 and geom2 are based on different coordinate systems.

### Examples

The following example returns a geometry object that is the topological intersection (AND operation) of cola\_a and cola\_c. (The example uses the definitions and data from [Simple Example: Inserting, Indexing, and Querying Spatial Data](#) (page 2-1).)

```
-- Return the topological intersection of two geometries.
SELECT SDO_GEOM.SDO_INTERSECTION(c_a.shape, c_c.shape, 0.005)
FROM cola_markets c_a, cola_markets c_c
WHERE c_a.name = 'cola_a' AND c_c.name = 'cola_c';

SDO_GEOM.SDO_INTERSECTION(C_A.SHAPE,C_C.SHAPE,0.005)(SDO_GTYPE, SDO_SRID, SDO_PO
-----
SDO_GEOMETRY(2003, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 1003, 1), SDO_ORDINATE_ARR
AY(4, 5, 3, 3, 5, 3, 5, 5, 4, 5))
```

Note that in the returned polygon, the SDO\_ORDINATE\_ARRAY starts and ends at the same point (4, 5).

### Related Topics

- [SDO\\_GEOM.SDO\\_DIFFERENCE](#) (page 23-24)
- [SDO\\_GEOM.SDO\\_UNION](#) (page 23-44)
- [SDO\\_GEOM.SDO\\_XOR](#) (page 23-50)

## 23.16 SDO\_GEOM.SDO\_LENGTH

### Format

```
SDO_GEOM.SDO_LENGTH(
  geom IN SDO_GEOMETRY,
  dim IN SDO_DIM_ARRAY
  [, unit IN VARCHAR2]
  [, count_shared_edges IN NUMBER]
) RETURN NUMBER;
```

or

```

SDO_GEOM.SDO_LENGTH(
    geom    IN SDO_GEOMETRY,
    tol     IN NUMBER
    [, unit  IN VARCHAR2]
    [, count_shared_edges IN NUMBER]
) RETURN NUMBER;

```

## Description

Returns the length or perimeter of a geometry object.

## Parameters

### geom

Geometry object.

### dim

Dimensional information array corresponding to `geom`, usually selected from one of the `xxx_SDO_GEOM_METADATA` views (described in [Geometry Metadata Views](#) (page 2-47)).

### tol

Tolerance value (see [Tolerance](#) (page 1-6)).

### unit

Unit of measurement: a quoted string with `unit=` and an `SDO_UNIT` value from the `MDSYS.SDO_DIST_UNITS` table (for example, 'unit=KM'). See [Unit of Measurement Support](#) (page 2-55) for more information about unit of measurement specification.

If this parameter is not specified, the unit of measurement associated with the data is assumed. For geodetic data, the default unit of measurement is meters.

### count\_shared\_edges

For three-dimensional geometries only: the number of times to count the length of shared parts of edges if the input geometry contains any edges that are fully or partially shared. If specified, must be 1 (count each once) or 2 (count each twice). The default is 1.

This parameter is ignored for two-dimensional input geometries.

## Usage Notes

If the input polygon contains one or more holes, this function calculates the perimeters of the exterior boundary and all holes. It returns the sum of all perimeters.

## Examples

The following example returns the perimeters of geometry objects stored in the `COLA_MARKETS` table. The first statement returns the perimeters of all objects; the second returns just the perimeter of `cola_a`. (The example uses the definitions and data from [Simple Example: Inserting, Indexing, and Querying Spatial Data](#) (page 2-1).)

```

-- Return the perimeters of all cola markets.
SELECT c.name, SDO_GEOM.SDO_LENGTH(c.shape, m.diminfo)
  FROM cola_markets c, user_sdo_geom_metadata m
 WHERE m.table_name = 'COLA_MARKETS' AND m.column_name = 'SHAPE';

```

```
NAME                                SDO_GEOM.SDO_LENGTH(C.SHAPE,M.DIMINFO)
-----
cola_a                                20
cola_b                               17.1622777
cola_c                               9.23606798
cola_d                               12.5663706
```

```
-- Return the perimeter of just cola_a.
SELECT c.name, SDO_GEOM.SDO_LENGTH(c.shape, m.diminfo)
  FROM cola_markets c, user_sdo_geom_metadata m
 WHERE m.table_name = 'COLA_MARKETS' AND m.column_name = 'SHAPE'
 AND c.name = 'cola_a';
```

```
NAME                                SDO_GEOM.SDO_LENGTH(C.SHAPE,M.DIMINFO)
-----
cola_a                                20
```

**Related Topics**

None.

**23.17 SDO\_GEOM.SDO\_MAX\_MBR\_ORDINATE**

**Format**

```
SDO_GEOM.SDO_MAX_MBR_ORDINATE(
  geom          IN SDO_GEOMETRY,
  ordinate_pos  IN NUMBER
) RETURN NUMBER;
```

or

```
SDO_GEOM.SDO_MAX_MBR_ORDINATE(
  geom          IN SDO_GEOMETRY,
  dim           IN SDO_DIM_ARRAY,
  ordinate_pos  IN NUMBER
) RETURN NUMBER;
```

**Description**

Returns the maximum value for the specified ordinate (dimension) of the minimum bounding rectangle of a geometry object.

**Parameters**

**geom**  
Geometry object.

**dim**  
Dimensional information array corresponding to *geom*, usually selected from one of the xxx\_SDO\_GEOM\_METADATA views (described in [Geometry Metadata Views](#) (page 2-47)).

**ordinate\_pos**  
Position of the ordinate (dimension) in the definition of the geometry object: 1 for the first ordinate, 2 for the second ordinate, and so on. For example, if *geom* has X, Y ordinates, 1 identifies the X ordinate and 2 identifies the Y ordinate.



## Usage Notes

None.

## Examples

The following example returns the maximum X (first) ordinate value of the minimum bounding rectangle of the `cola_d` geometry in the `COLA_MARKETS` table. (The example uses the definitions and data from [Simple Example: Inserting, Indexing, and Querying Spatial Data](#) (page 2-1). The minimum bounding rectangle of `cola_d` is returned in the example for the [SDO\\_GEOM.SDO\\_MBR](#) (page 23-38) function.)

```
SELECT SDO_GEOM.SDO_MAX_MBR_ORDINATE(c.shape, m.diminfo, 1)
FROM cola_markets c, user_sdo_geom_metadata m
WHERE m.table_name = 'COLA_MARKETS' AND m.column_name = 'SHAPE'
AND c.name = 'cola_d';

SDO_GEOM.SDO_MAX_MBR_ORDINATE(C.SHAPE,M.DIMINFO,1)
-----
10
```

## Related Topics

- [SDO\\_GEOM.SDO\\_MBR](#) (page 23-38)
- [SDO\\_GEOM.SDO\\_MIN\\_MBR\\_ORDINATE](#) (page 23-40)

## 23.18 SDO\_GEOM.SDO\_MAXDISTANCE

---

---

### Note:

This feature is available starting with Oracle Database 12c Release 1 (12.1.0.2).

---

---

## Format

```
SDO_GEOM.SDO_MAXDISTANCE(
  geom1 IN SDO_GEOMETRY,
  dim1 IN SDO_DIM_ARRAY,
  geom2 IN SDO_GEOMETRY,
  dim2 IN SDO_DIM_ARRAY
  [, unit IN VARCHAR2]
) RETURN NUMBER;
```

or

```
SDO_GEOM.SDO_MAXDISTANCE(
  geom1 IN SDO_GEOMETRY,
  geom2 IN SDO_GEOMETRY,
  tol IN NUMBER
  [, unit IN VARCHAR2]
) RETURN NUMBER;
```

## Description

Computes the maximum distance between two geometry objects. The maximum distance between two geometry objects is the distance between the farthest pair of points or segments of the two objects.

## Parameters

### **geom1**

Geometry object whose distance from geom2 is to be computed.

### **dim1**

Dimensional information array corresponding to geom1, usually selected from one of the xxx\_SDO\_GEOM\_METADATA views (described in [Geometry Metadata Views](#) (page 2-47)).

### **geom2**

Geometry object whose distance from geom1 is to be computed.

### **dim2**

Dimensional information array corresponding to geom2, usually selected from one of the xxx\_SDO\_GEOM\_METADATA views (described in [Geometry Metadata Views](#) (page 2-47)).

### **unit**

Unit of measurement: a quoted string with unit= and an SDO\_UNIT value from the MDSYS.SDO\_DIST\_UNITS table (for example, 'unit=KM'). See [Unit of Measurement Support](#) (page 2-55) for more information about unit of measurement specification.

If this parameter is not specified, the unit of measurement associated with the data is assumed.

### **tol**

Tolerance value (see [Tolerance](#) (page 1-6)).

## Usage Notes

An exception is raised if geom1 and geom2 are based on different coordinate systems.

The input geometries can have no more than two dimensions.

## Examples

The following example returns the maximum distance between cola\_b and cola\_d. (The example uses the definitions and data from [Simple Example: Inserting Indexing and Querying Spatial Data](#) (page 2-1).)

```
SELECT SDO_GEOM.SDO_MAXDISTANCE(c_b.shape, c_d.shape, 0.005)
FROM cola_markets c_b, cola_markets c_d
WHERE c_b.name = 'cola_b' AND c_d.name = 'cola_d';

SDO_GEOM.SDO_MAXDISTANCE(C_B.SHAPE,C_D.SHAPE,0.005)
-----
10.5440037
```

## Related Topics

- [SDO\\_GEOM.SDO\\_MAXDISTANCE\\_LINE](#) (page 23-33)
- [SDO\\_GEOM.SDO\\_DISTANCE](#) (page 23-25)
- [SDO\\_GEOM.WITHIN\\_DISTANCE](#) (page 23-58)

## 23.19 SDO\_GEOM.SDO\_MAXDISTANCE\_LINE

---

### Note:

This feature is available starting with Oracle Database 12c Release 1 (12.1.0.2).

---

### Format

```
SDO_GEOM.SDO_MAXDISTANCE_LINE(
  geom1 IN SDO_GEOMETRY,
  dim1  IN SDO_DIM_ARRAY,
  geom2 IN SDO_GEOMETRY,
  dim2  IN SDO_DIM_ARRAY
) RETURN SDO_GEOMETRY;
```

or

```
SDO_GEOM.SDO_MAXDISTANCE_LINE(
  geom1 IN SDO_GEOMETRY,
  geom2 IN SDO_GEOMETRY,
  tol   IN NUMBER
) RETURN SDO_GEOMETRY;
```

### Description

Computes the maximum distance between two geometry objects, and returns the line string geometry reflecting the maximum distance. The maximum distance between two geometry objects is the distance between the farthest pair of points or segments of the two objects. The returned geometry is a straight line between this farthest pair of points or segments.

### Parameters

#### geom1

Geometry object whose distance from geom2 is to be computed.

#### dim1

Dimensional information array corresponding to geom1, usually selected from one of the xxx\_SDO\_GEOM\_METADATA views (described in [Geometry Metadata Views](#) (page 2-47)).

#### geom2

Geometry object whose distance from geom1 is to be computed.

#### dim2

Dimensional information array corresponding to geom2, usually selected from one of the xxx\_SDO\_GEOM\_METADATA views (described in [Geometry Metadata Views](#) (page 2-47)).

#### tol

Tolerance value (see [Tolerance](#) (page 1-6)).

### Usage Notes

An exception is raised if geom1 and geom2 are based on different coordinate systems.  
The input geometries can have no more than two dimensions.

### Examples

The following example returns the line string reflecting the maximum distance between cola\_b and cola\_d. (The example uses the definitions and data from [Simple Example: Inserting, Indexing, and Querying Spatial Data](#) (page 2-1).)

```
SELECT SDO_GEOM.SDO_MAXDISTANCE_LINE(c_b.shape, c_d.shape, 0.005)
FROM cola_markets c_b, cola_markets c_d
WHERE c_b.name = 'cola_b' AND c_d.name = 'cola_d';

SDO_GEOM.SDO_MAXDISTANCE_LINE(C_B.SHAPE,C_D.SHAPE,0.005)(SDO_GTYPE, SDO_SRID, SD
-----
SDO_GEOMETRY(2002, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 2, 1), SDO_ORDINATE_ARRAY(
5, 1, 8.70224688, 10.8726584))
```

### Related Topics

- [SDO\\_GEOM.SDO\\_MAXDISTANCE](#) (page 23-31)
- [SDO\\_GEOM.SDO\\_DISTANCE](#) (page 23-25)
- [SDO\\_GEOM.WITHIN\\_DISTANCE](#) (page 23-58)

## 23.20 SDO\_GEOM.SDO\_MBC

---

---

### Note:

This feature is available starting with Oracle Database 12c Release 1 (12.1.0.2).

---

---

### Format

```
SDO_GEOM.SDO_MBC(
    geom          IN SDO_GEOMETRY,
    dim           IN SDO_DIM_ARRAY,
    arc_tolerance IN NUMBER DEFAULT NULL
) RETURN SDO_GEOMETRY;
```

or

```
SDO_GEOM.SDO_MBC(
    geom          IN SDO_GEOMETRY,
    tol           IN NUMBER,
    arc_tolerance IN NUMBER DEFAULT NULL
) RETURN SDO_GEOMETRY;
```

### Description

Returns a circle object that represents the minimum bounding circle (MBC) of a geometry object.

### Parameters

**geom**

Geometry object.

**dim**

Dimensional information array corresponding to `geom`, usually selected from one of the `xxx_SDO_GEOM_METADATA` views (described in [Geometry Metadata Views](#) (page 2-47)).

**tol**

Tolerance value (see [Tolerance](#) (page 1-6)).

**arc\_tolerance**

Arc tolerance value (see the explanation of the `arc_tolerance` keyword in the Usage Notes for [SDO\\_GEOM.SDO\\_ARC\\_DENSIFY](#) (page 23-7)). This parameter is mainly used for densifying geodetic arcs.

**Usage Notes**

The **minimum bounding circle** is the circle that minimally encloses the geometry.

If the geometry (`geom`) contains any arc elements, the function calculates the minimum bounding rectangle (MBR) for each arc element and uses these MBRs in calculating the minimum bounding circle of the geometry. Thus, for example, if the input geometry is a circle, the computed MBC will be larger than the input geometry.

**Examples**

The following example returns a geometry object that is the minimum bounding circle of `cola_a`. (The example uses the definitions and data from [Simple Example: Inserting, Indexing, and Querying Spatial Data](#) (page 2-1).)

```
-- Return the MBC of cola_a.
SELECT c.name, SDO_GEOM.SDO_MBC(c.shape, 0.005) FROM cola_markets c
   WHERE c.name = 'cola_a';

NAME
-----
SDO_GEOM.SDO_MBC(C.SHAPE,0.005)(SDO_GTYPE, SDO_SRID, SDO_POINT(X, Y, Z), SDO_ELE
-----
cola_a
SDO_GEOMETRY(2003, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 1003, 4), SDO_ORDINATE_ARR
AY(3, .394448725, 6.60555128, 4, 3, 7.60555128))
```

**Related Topics**

[SDO\\_GEOM.SDO\\_MBC\\_CENTER](#) (page 23-35)

[SDO\\_GEOM.SDO\\_MBC\\_RADIUS](#) (page 23-37)

[SDO\\_GEOM.SDO\\_MBR](#) (page 23-38)

## 23.21 SDO\_GEOM.SDO\_MBC\_CENTER

**Note:**

This feature is available starting with Oracle Database 12c Release 1 (12.1.0.2).

### Format

```
SDO_GEOM.SDO_MBC_CENTER(  
    geom    IN SDO_GEOMETRY,  
    dim     IN SDO_DIM_ARRAY  
) RETURN SDO_GEOMETRY;
```

or

```
SDO_GEOM.SDO_MBC_CENTER(  
    geom    IN SDO_GEOMETRY,  
    tol     IN NUMBER  
) RETURN SDO_GEOMETRY;
```

### Description

Returns the center of the minimum bounding circle (MBC) of a geometry object.

### Parameters

#### **geom**

Geometry object.

#### **dim**

Dimensional information array corresponding to *geom*, usually selected from one of the *xxx\_SDO\_GEOM\_METADATA* views (described in [Geometry Metadata Views](#) (page 2-47)).

#### **tol**

Tolerance value (see [Tolerance](#) (page 1-6)).

### Usage Notes

The **minimum bounding circle** is the circle that minimally encloses the geometry.

If the geometry (*geom*) contains any arc elements, the function calculates the minimum bounding rectangle (MBR) for each arc element and uses these MBRs in calculating the minimum bounding circle of the geometry.

### Examples

The following example returns a point geometry object that is the center of the minimum bounding circle of *cola\_a*. (The example uses the definitions and data from [Simple Example: Inserting\\_ Indexing\\_ and Querying Spatial Data](#) (page 2-1).)

```
-- Return the MBC center of cola_a.  
SQL> SELECT c.name, SDO_GEOM.SDO_MBC_CENTER(c.shape, 0.005) FROM cola_markets c  
      2      WHERE c.name = 'cola_a';  
  
NAME  
-----  
SDO_GEOM.SDO_MBC_CENTER(C.SHAPE,0.005)(SDO_GTYPE, SDO_SRID, SDO_POINT(X, Y, Z),  
-----  
cola_a  
SDO_GEOMETRY(2001, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 1, 1), SDO_ORDINATE_ARRAY(  
3, 4))
```

**Related Topics**[SDO\\_GEOM.SDO\\_MBC](#) (page 23-34)[SDO\\_GEOM.SDO\\_MBC\\_RADIUS](#) (page 23-37)[SDO\\_GEOM.SDO\\_MBR](#) (page 23-38)

## 23.22 SDO\_GEOM.SDO\_MBC\_RADIUS

---

**Note:**

This feature is available starting with Oracle Database 12c Release 1 (12.1.0.2).

---

**Format**

```
SDO_GEOM.SDO_MBC_RADIUS(  
    geom IN SDO_GEOMETRY,  
    dim  IN SDO_DIM_ARRAY,  
    unit IN VARCHAR2 DEFAULT NULL  
) RETURN NUMBER;
```

or

```
SDO_GEOM.SDO_MBC_RADIUS(  
    geom IN SDO_GEOMETRY,  
    tol  IN NUMBER,  
    unit IN VARCHAR2 DEFAULT NULL  
) RETURN NUMBER;
```

**Description**

Returns the length of the radius of the minimum bounding circle (MBC) of a geometry object.

**Parameters****geom**

Geometry object.

**dim**

Dimensional information array corresponding to `geom`, usually selected from one of the `xxx_SDO_GEOM_METADATA` views (described in [Geometry Metadata Views](#) (page 2-47)).

**tol**

Tolerance value (see [Tolerance](#) (page 1-6)).

**unit**

Unit of measurement: a quoted string with `unit=` and an `SDO_UNIT` value from the `MDSYS.SDO_DIST_UNITS` table (for example, 'unit=KM'). See [Unit of Measurement Support](#) (page 2-55) for more information about unit of measurement specification.

If this parameter is not specified, the unit of measurement associated with the data is assumed. For geodetic data, the default unit of measurement is meters.

### Usage Notes

The **minimum bounding circle** is the circle that minimally encloses the geometry.

If the geometry (*geom*) contains any arc elements, the function calculates the minimum bounding rectangle (MBR) for each arc element and uses these MBRs in calculating the minimum bounding circle of the geometry. Thus, for example, if the input geometry is a circle, the length of the radius of the computed MBC will be greater than that of the input geometry.

### Examples

The following example returns the length of the radius of the minimum bounding circle of `cola_a`. (The example uses the definitions and data from [Simple Example: Inserting, Indexing, and Querying Spatial Data](#) (page 2-1).)

```
-- Return the MBC radius of cola_a.
SELECT c.name, SDO_GEOM.SDO_MBC_RADIUS(c.shape, 0.005) FROM cola_markets c
WHERE c.name = 'cola_a';
```

NAME	SDO_GEOM.SDO_MBC_RADIUS(C.SHAPE,0.005)
cola_a	3.60555128

### Related Topics

[SDO\\_GEOM.SDO\\_MBC](#) (page 23-34)

[SDO\\_GEOM.SDO\\_MBC\\_CENTER](#) (page 23-35)

[SDO\\_GEOM.SDO\\_MBR](#) (page 23-38)

## 23.23 SDO\_GEOM.SDO\_MBR

### Format

```
SDO_GEOM.SDO_MBR(  
  geom IN SDO_GEOMETRY  
  [, dim IN SDO_DIM_ARRAY]  
) RETURN SDO_GEOMETRY;
```

### Description

Returns the minimum bounding rectangle of a geometry object, that is, a single rectangle that minimally encloses the geometry.

---

**Note:**

SDO\_GEOM\_MBR is a SQL operator that is functionally identical to this function, but provides better performance. See [SDO\\_GEOM\\_MBR Operator Alternative for Better Performance](#) (page 23-39) under Usage Notes for more information.

---

### Parameters

**geom**

Geometry object.



**dim**

Dimensional information array corresponding to `geom`, usually selected from one of the `xxx_SDO_GEOM_METADATA` views (described in [Geometry Metadata Views](#) (page 2-47)).

**Usage Notes**

This function does not return an MBR geometry if a proper MBR cannot be constructed. Specifically:

- If the input geometry is null, the function returns a null geometry.
- If the input geometry is a point, the function returns the point.
- If the input geometry consists of points all on a straight line, the function returns a two-point line.
- If the input geometry has three dimensions but all Z dimension values are the same, the function returns a three-dimensional line.

**SDO\_GEOM\_MBR Operator Alternative for Better Performance**

`SDO_GEOM_MBR` is a SQL operator that is functionally identical to the `SDO_GEOM.SDO_MBR` function, but provides better performance.

The `SDO_GEOM_MBR` operator must be used within a SQL query, such as:

```
SELECT sdo_geom_mbr(geom) INTO g FROM DUAL;
```

You can also use multiple `SDO_GEOM_MBR` operators in the same query. For example:

```
SELECT sdo_geom_mbr(geom1), sdo_geom_mbr(geom2) INTO g1, g2 FROM DUAL;
```

See also the example of the `SDO_GEOM_MBR` operator under Examples.

**Examples**

The following example returns the minimum bounding rectangle of the `cola_d` geometry in the `COLA_MARKETS` table. (The example uses the definitions and data from [Simple Example: Inserting, Indexing, and Querying Spatial Data](#) (page 2-1). Because `cola_d` is a circle, the minimum bounding rectangle in this case is a square.)

```
-- Return the minimum bounding rectangle of cola_d (a circle).
SELECT SDO_GEOM.SDO_MBR(c.shape, m.diminfo)
  FROM cola_markets c, user_sdo_geom_metadata m
 WHERE m.table_name = 'COLA_MARKETS' AND m.column_name = 'SHAPE'
 AND c.name = 'cola_d';
```

```
SDO_GEOM.SDO_MBR(C.SHAPE,M.DIMINFO)(SDO_GTYPE, SDO_SRID, SDO_POINT(X, Y, Z), SDO_
-----
SDO_GEOMETRY(2003, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 1003, 3), SDO_ORDINATE_ARR
AY(6, 7, 10, 11))
```

The following example is functionally identical to the preceding one, except that it uses the `SDO_GEOM_MBR` operator.

```
-- Return the minimum bounding rectangle of cola_d (a circle).
SELECT SDO_GEOM_MBR(c.shape)
  FROM cola_markets c WHERE c.name = 'cola_d';
```

```
SDO_GEOM_MBR(C.SHAPE)(SDO_GTYPE, SDO_SRID, SDO_POINT(X, Y, Z), SDO_ELEM_INFO, SD
-----
SDO_GEOMETRY(2003, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 1003, 3), SDO_ORDINATE_ARR
AY(6, 7, 10, 11))
```

### Related Topics

- [SDO\\_GEOM.SDO\\_MAX\\_MBR\\_ORDINATE](#) (page 23-30)
- [SDO\\_GEOM.SDO\\_MIN\\_MBR\\_ORDINATE](#) (page 23-40)

## 23.24 SDO\_GEOM.SDO\_MIN\_MBR\_ORDINATE

### Format

```
SDO_GEOM.SDO_MIN_MBR_ORDINATE(  
    geom            IN SDO_GEOMETRY,  
    ordinate_pos    IN NUMBER  
) RETURN NUMBER;
```

or

```
SDO_GEOM.SDO_MIN_MBR_ORDINATE(  
    geom            IN SDO_GEOMETRY,  
    dim             IN SDO_DIM_ARRAY,  
    ordinate_pos    IN NUMBER  
) RETURN NUMBER;
```

### Description

Returns the minimum value for the specified ordinate (dimension) of the minimum bounding rectangle of a geometry object.

### Parameters

#### **geom**

Geometry object.

#### **dim**

Dimensional information array corresponding to `geom`, usually selected from one of the `xxx_SDO_GEOM_METADATA` views (described in [Geometry Metadata Views](#) (page 2-47)).

#### **ordinate\_pos**

Position of the ordinate (dimension) in the definition of the geometry object: 1 for the first ordinate, 2 for the second ordinate, and so on. For example, if `geom` has X, Y ordinates, 1 identifies the X ordinate and 2 identifies the Y ordinate.

### Usage Notes

None.

### Examples

The following example returns the minimum X (first) ordinate value of the minimum bounding rectangle of the `cola_d` geometry in the `COLA_MARKETS` table. (The example uses the definitions and data from [Simple Example: Inserting, Indexing, and](#)

[Querying Spatial Data](#) (page 2-1). The minimum bounding rectangle of `cola_d` is returned in the example for the [SDO\\_GEOM.SDO\\_MBR](#) (page 23-38) function.)

```
SELECT SDO_GEOM.SDO_MIN_MBR_ORDINATE(c.shape, m.diminfo, 1)
      FROM cola_markets c, user_sdo_geom_metadata m
      WHERE m.table_name = 'COLA_MARKETS' AND m.column_name = 'SHAPE'
      AND c.name = 'cola_d';
```

```
SDO_GEOM.SDO_MIN_MBR_ORDINATE(C.SHAPE,M.DIMINFO,1)
```

6

### Related Topics

- [SDO\\_GEOM.SDO\\_MAX\\_MBR\\_ORDINATE](#) (page 23-30)
- [SDO\\_GEOM.SDO\\_MBR](#) (page 23-38)

## 23.25 SDO\_GEOM.SDO\_POINTONSURFACE

### Format

```
SDO_GEOM.SDO_POINTONSURFACE(
    geom1 IN SDO_GEOMETRY,
    dim1 IN SDO_DIM_ARRAY
) RETURN SDO_GEOMETRY;
```

or

```
SDO_GEOM.SDO_POINTONSURFACE(
    geom1 IN SDO_GEOMETRY,
    tol IN NUMBER
) RETURN SDO_GEOMETRY;
```

### Description

Returns a point that is guaranteed to be on the surface of a polygon geometry object.

### Parameters

#### **geom1**

Polygon geometry object.

#### **dim1**

Dimensional information array corresponding to `geom1`, usually selected from one of the `xxx_SDO_GEOM_METADATA` views (described in [Geometry Metadata Views](#) (page 2-47)).

#### **tol**

Tolerance value (see [Tolerance](#) (page 1-6)).

### Usage Notes

This function returns a point geometry object representing a point that is guaranteed to be on the surface of `geom1`; however, it is not guaranteed to be an interior point. (That is, it can be on the boundary or edge of `geom1`.)

The returned point can be any point on the surface. You should not make any assumptions about where on the surface the returned point is, or about whether the point is the same or different when the function is called multiple times with the same input parameter values.

In most cases this function is less useful than the [SDO\\_UTIL.INTERIOR\\_POINT](#) (page 31-43) function, which returns a point that is guaranteed to be an interior point.

### Examples

The following example returns a geometry object that is a point on the surface of cola\_a. (The example uses the definitions and data from [Simple Example: Inserting, Indexing, and Querying Spatial Data](#) (page 2-1).)

```
-- Return a point on the surface of a geometry.
SELECT SDO_GEOM.SDO_POINTONSURFACE(c.shape, m.diminfo)
  FROM cola_markets c, user_sdo_geom_metadata m
 WHERE m.table_name = 'COLA_MARKETS' AND m.column_name = 'SHAPE'
 AND c.name = 'cola_a';

SDO_GEOM.SDO_POINTONSURFACE(C.SHAPE,M.DIMINFO)(SDO_GTYPE, SDO_SRID, SDO_POINT(X,
-----
SDO_GEOMETRY(2001, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 1, 1), SDO_ORDINATE_ARRAY(
1, 1))
```

### Related Topics

None.

## 23.26 SDO\_GEOM.SDO\_SELF\_UNION

### Format

```
SDO_GEOM.SDO_SELF_UNION(
  geom1  IN SDO_GEOMETRY,
  dim1   IN SDO_DIM_ARRAY,
) RETURN SDO_GEOMETRY;
```

or

```
SDO_GEOM.SDO_SELF_UNION(
  geom1  IN SDO_GEOMETRY,
  tol    IN NUMBER
) RETURN SDO_GEOMETRY;
```

### Description

Returns a valid geometry object that is the topological self union of one geometry object, which can be invalid.

### Parameters

#### geom1

Geometry object.

**dim1**

Dimensional information array corresponding to `geom1`, usually selected from one of the `xxx_SDO_GEOM_METADATA` views (described in [Geometry Metadata Views](#) (page 2-47)).

**tol**

Tolerance value (see [Tolerance](#) (page 1-6)).

**Usage Notes**

This function can be used to fix the following problems that can make a geometry invalid:

- Polygon boundary intersecting itself
- Incorrect orientation of exterior or interior rings (or both) of a polygon

**Examples**

The following example returns a valid geometry object that is the topological self union of an invalid polygon.

```
-- Return the topological self union of an invalid geometry.
SELECT SDO_GEOM.SDO_SELF_UNION(
    SDO_GEOMETRY(2003, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 1003, 1),
        SDO_ORDINATE_ARRAY(1, 1, 1, 4, 4, 4, 4, 1, 1, 1)),
    0.00005)
FROM dual;

SDO_GEOM.SDO_SELF_UNION(SDO_GEOMETRY(2003,NULL,NULL,SDO_ELEM_INFO_ARRAY(1,1003,1
-----
SDO_GEOMETRY(2003, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 1003, 1),
SDO_ORDINATE_ARRAY(1, 4, 1, 1, 4, 1, 4, 4, 1, 4))
```

**Related Topics**

- [SDO\\_GEOM.SDO\\_UNION](#) (page 23-44)
- [SDO\\_GEOM.VALIDATE\\_GEOMETRY\\_WITH\\_CONTEXT](#) (page 23-52)
- [SDO\\_GEOM.VALIDATE\\_LAYER\\_WITH\\_CONTEXT](#) (page 23-56)
- [SDO\\_UTIL.RECTIFY\\_GEOMETRY](#) (page 31-46)

## 23.27 SDO\_GEOM.SDO\_TRIANGULATE

**Format**

```
SDO_GEOM.SDO_TRIANGULATE(
    geom IN SDO_GEOMETRY,
    tol IN NUMBER
) RETURN SDO_GEOMETRY;
```

**Description**

Returns a geometry with triangular elements that result from Delaunay triangulation of the input geometry.

### Parameters

**geom**

Geometry object.

**tol**

Tolerance value (see [Tolerance](#) (page 1-6)).

### Usage Notes

This function takes all coordinates from the input geometry, uses them to compute Delaunay triangulations, and returns a geometry object, each element of which is a triangle.

An exception is raised if `geom` has fewer than three points or vertices, or consists of multiple points all in a straight line.

With geodetic data, this function is supported by approximations, as explained in [Functions Supported by Approximations with Geodetic Data](#) (page 6-73).

### Examples

The following example returns a geometry object that consists of triangular elements (two in this case) comprising the `cola_c` polygon geometry. (The example uses the definitions and data from [Simple Example: Inserting\\_ Indexing\\_ and Querying Spatial Data](#) (page 2-1).

```
-- Return triangles comprising a specified polygon.
SELECT c.name, SDO_GEOM.SDO_TRIANGULATE(c.shape, 0.005)
  FROM cola_markets c WHERE c.name = 'cola_c';

NAME
-----
SDO_GEOM.SDO_TRIANGULATE(C.SHAPE,0.005)(SDO_GTYPE, SDO_SRID, SDO_POINT(X, Y, Z),
-----
cola_c
SDO_GEOMETRY(2007, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 1003, 1, 9, 1003, 1), SDO_
ORDINATE_ARRAY(3, 3, 6, 3, 4, 5, 3, 3, 4, 5, 6, 3, 6, 5, 4, 5))
```

### Related Topics

[SDO\\_GEOM.SDO\\_ALPHA\\_SHAPE](#) (page 23-6)

## 23.28 SDO\_GEOM.SDO\_UNION

### Format

```
SDO_GEOM.SDO_UNION(
  geom1 IN SDO_GEOMETRY,
  dim1  IN SDO_DIM_ARRAY,
  geom2 IN SDO_GEOMETRY,
  dim2  IN SDO_DIM_ARRAY
) RETURN SDO_GEOMETRY;
```

or

```
SDO_GEOM.SDO_UNION(
  geom1 IN SDO_GEOMETRY,
  geom2 IN SDO_GEOMETRY,
```

```

    tol    IN NUMBER
  ) RETURN SDO_GEOMETRY;

```

### Description

Returns a geometry object that is the topological union (OR operation) of two geometry objects.

### Parameters

#### geom1

Geometry object.

#### dim1

Dimensional information array corresponding to `geom1`, usually selected from one of the `xxx_SDO_GEOM_METADATA` views (described in [Geometry Metadata Views](#) (page 2-47)).

#### geom2

Geometry object.

#### dim2

Dimensional information array corresponding to `geom2`, usually selected from one of the `xxx_SDO_GEOM_METADATA` views (described in [Geometry Metadata Views](#) (page 2-47)).

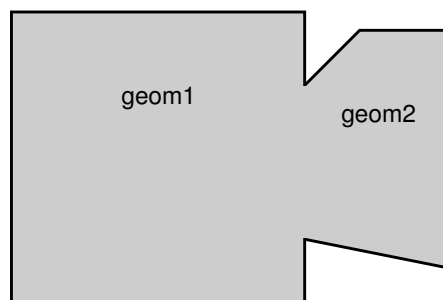
#### tol

Tolerance value (see [Tolerance](#) (page 1-6)).

### Usage Notes

In [Figure 23-4](#) (page 23-45), the shaded area represents the polygon returned when `SDO_UNION` is used with a square (`geom1`) and another polygon (`geom2`).

**Figure 23-4** *SDO\_GEOM.SDO\_UNION*



If it is sufficient to append one geometry to another geometry without performing a topological union operation, and if both geometries are disjoint, using the [SDO\\_UTIL.APPEND](#) (page 31-8) function (described in [SDO\\_UTIL Package \(Utility\)](#) (page 31-1)) is faster than using the `SDO_UNION` function.

An exception is raised if `geom1` and `geom2` are based on different coordinate systems.

### Examples

The following example returns a geometry object that is the topological union (OR operation) of `cola_a` and `cola_c`. (The example uses the definitions and data from [Simple Example: Inserting\\_ Indexing\\_ and Querying Spatial Data](#) (page 2-1).)

```
-- Return the topological union of two geometries.
SELECT SDO_GEOM.SDO_UNION(c_a.shape, m.diminfo, c_c.shape, m.diminfo)
  FROM cola_markets c_a, cola_markets c_c, user_sdo_geom_metadata m
 WHERE m.table_name = 'COLA_MARKETS' AND m.column_name = 'SHAPE'
    AND c_a.name = 'cola_a' AND c_c.name = 'cola_c';

SDO_GEOM.SDO_UNION(C_A.SHAPE,M.DIMINFO,C_C.SHAPE,M.DIMINFO)(SDO_GTYPE, SDO_SRID,
-----
SDO_GEOMETRY(2003, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 1003, 1), SDO_ORDINATE_ARR
AY(5, 5, 5, 7, 1, 7, 1, 1, 5, 1, 5, 3, 6, 3, 6, 5, 5, 5))
```

Note that in the returned polygon, the `SDO_ORDINATE_ARRAY` starts and ends at the same point (5, 5).

### Related Topics

- [SDO\\_GEOM.SDO\\_DIFFERENCE](#) (page 23-24)
- [SDO\\_GEOM.SDO\\_INTERSECTION](#) (page 23-27)
- [SDO\\_GEOM.SDO\\_XOR](#) (page 23-50)
- [SDO\\_GEOM.SDO\\_SELF\\_UNION](#) (page 23-42)

## 23.29 SDO\_GEOM.SDO\_VOLUME

### Format

```
SDO_GEOM.SDO_VOLUME(  
  geom  IN SDO_GEOMETRY,  
  tol   IN NUMBER  
  [, unit IN VARCHAR2]  
) RETURN NUMBER;
```

### Description

Returns the volume of a three-dimensional solid.

### Parameters

#### **geom**

Geometry object.

#### **tol**

Tolerance value (see [Tolerance](#) (page 1-6)).

#### **unit**

Unit of measurement: a quoted string with `unit=` and volume unit (for example, `'unit=CUBIC_FOOT'` or `'unit=CUBIC_METER'`). For a list of volume units, enter the following query:



```
SELECT short_name FROM mdsys.sdo_units_of_measure WHERE unit_of_meas_type =
'volume';
```

See [Unit of Measurement Support](#) (page 2-55) for more information about unit of measurement specification.

If this parameter is not specified, the unit of measurement associated with the data is assumed.

**Usage Notes**

This function works with any solid, including solids with holes.

This function is not supported with geodetic data.

For information about support for three-dimensional geometries, see [Three-Dimensional Spatial Objects](#) (page 1-16).

**Examples**

The following example returns the volume of a solid geometry object.

```
-- Return the volume of a solid geometry.
SELECT p.id, SDO_GEOM.SDO_VOLUME(p.geometry, 0.005) FROM polygons3d p
WHERE p.id = 12;
```

ID	SDO_GEOM.SDO_VOLUME(P.GEOMETRY,0.005)
12	6

**Related Topics**

None.

23.30 SDO\_GEOM.SDO\_WIDTH

**Note:**

This feature is available starting with Oracle Database 12c Release 1 (12.1.0.2).

**Format**

```
SDO_GEOM.SDO_WIDTH(
  geom IN SDO_GEOMETRY,
  dim IN SDO_DIM_ARRAY
  [, unit IN VARCHAR2]
) RETURN NUMBER;
```

or

```
SDO_GEOM.SDO_WIDTH(
  geom IN SDO_GEOMETRY,
  tol IN NUMBER
  [, unit IN VARCHAR2]
) RETURN NUMBER;
```

**Description**

Returns the width of a geometry object.

## Parameters

### **geom**

Geometry object.

### **dim**

Dimensional information array corresponding to `geom`, usually selected from one of the `xxx_SDO_GEOM_METADATA` views (described in [Geometry Metadata Views](#) (page 2-47)).

### **tol**

Tolerance value (see [Tolerance](#) (page 1-6)).

### **unit**

Unit of measurement: a quoted string with `unit=` and an `SDO_UNIT` value from the `MDSYS.SDO_DIST_UNITS` table (for example, `'unit=KM'`). See [Unit of Measurement Support](#) (page 2-55) for more information about unit of measurement specification.

If this parameter is not specified, the unit of measurement associated with the data is assumed. For geodetic data, the default unit of measurement is meters.

## Usage Notes

For a convex polygon, the width is the minimum distance between parallel lines of support.

For a non-convex geometry, this function determines its convex geometry and returns the width of that convex geometry.

The input geometry can have no more than two dimensions.

If a point geometry is specified, the function returns 0 (zero).

## Examples

The following example returns the width of all geometry objects stored in the `COLA_MARKETS` table. (The example uses the definitions and data from [Simple Example: Inserting\\_ Indexing\\_ and Querying Spatial Data](#) (page 2-1).)

```
SELECT name, SDO_GEOM.SDO_WIDTH(shape, 0.005) Width
FROM cola_markets;
```

NAME	WIDTH
cola_a	4
cola_b	3
cola_c	2
cola_d	4

## Related Topics

[SDO\\_GEOM.SDO\\_WIDTH\\_LINE](#) (page 23-49)

[SDO\\_GEOM.SDO\\_DIAMETER](#) (page 23-21)

## 23.31 SDO\_GEOM.SDO\_WIDTH\_LINE

---

---

### Note:

This feature is available starting with Oracle Database 12c Release 1 (12.1.0.2).

---

---

### Format

```
SDO_GEOM.SDO_WIDTH(_LINE
    geom IN SDO_GEOMETRY,
    dim  IN SDO_DIM_ARRAY
) RETURN NUMBER;
```

or

```
SDO_GEOM.SDO_WIDTH_LINE(
    geom IN SDO_GEOMETRY,
    tol  IN NUMBER
) RETURN NUMBER;
```

### Description

Returns a line string geometry reflecting the width of a geometry object.

### Parameters

#### geom

Geometry object.

#### dim

Dimensional information array corresponding to `geom`, usually selected from one of the `xxx_SDO_GEOM_METADATA` views (described in [Geometry Metadata Views](#) (page 2-47)).

#### tol

Tolerance value (see [Tolerance](#) (page 1-6)).

### Usage Notes

For a convex polygon, the width is the minimum distance between parallel lines of support.

For a non-convex geometry, this function determines its convex geometry and returns the width of that convex geometry.

The input geometry can have no more than two dimensions.

If a point geometry is specified, the function returns 0 (zero).

### Examples

The following example returns line strings reflecting width of each geometry object stored in the `COLA_MARKETS` table. (The example uses the definitions and data from [Simple Example: Inserting, Indexing, and Querying Spatial Data](#) (page 2-1).)

```
SELECT name, SDO_GEOM.SDO_WIDTH_LINE(shape, 0.005)
FROM cola_markets;
```

NAME

-----  
SDO\_GEOM.SDO\_WIDTH\_LINE(SHAPE,0.005)(SDO\_GTYPE, SDO\_SRID, SDO\_POINT(X, Y, Z), SD  
-----

cola\_a

```
SDO_GEOMETRY(2002, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 2, 1), SDO_ORDINATE_ARRAY(
5, 7, 1, 7))
```

cola\_b

```
SDO_GEOMETRY(2002, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 2, 1), SDO_ORDINATE_ARRAY(
8, 7, 5, 7))
```

cola\_c

```
SDO_GEOMETRY(2002, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 2, 1), SDO_ORDINATE_ARRAY(
3, 5, 3, 3))
```

cola\_d

```
SDO_GEOMETRY(2002, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 2, 1), SDO_ORDINATE_ARRAY(
10, 11, 6, 11))
```

### Related Topics

[SDO\\_GEOM.SDO\\_WIDTH](#) (page 23-47)

[SDO\\_GEOM.SDO\\_DIAMETER\\_LINE](#) (page 23-22)

## 23.32 SDO\_GEOM.SDO\_XOR

### Format

```
SDO_GEOM.SDO_XOR(
  geom1  IN SDO_XOR,
  dim1   IN SDO_DIM_ARRAY,
  geom2  IN SDO_GEOMETRY,
  dim2   IN SDO_DIM_ARRAY
) RETURN SDO_GEOMETRY;
```

or

```
SDO_GEOM.SDO_XOR(
  geom1  IN SDO_GEOMETRY,
  geom2  IN SDO_GEOMETRY,
  tol    IN NUMBER
) RETURN SDO_GEOMETRY;
```

### Description

Returns a geometry object that is the topological symmetric difference (XOR operation) of two geometry objects.

### Parameters

#### geom1

Geometry object.

**dim1**

Dimensional information array corresponding to `geom1`, usually selected from one of the `xxx_SDO_GEOM_METADATA` views (described in [Geometry Metadata Views](#) (page 2-47)).

**geom2**

Geometry object.

**dim2**

Dimensional information array corresponding to `geom2`, usually selected from one of the `xxx_SDO_GEOM_METADATA` views (described in [Geometry Metadata Views](#) (page 2-47)).

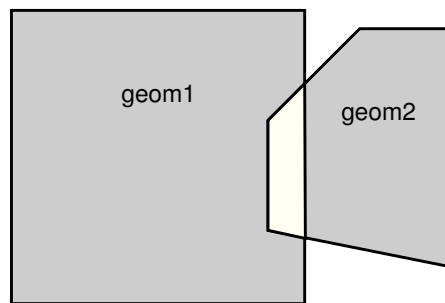
**tol**

Tolerance value (see [Tolerance](#) (page 1-6)).

**Usage Notes**

In [Figure 23-5](#) (page 23-51), the shaded area represents the polygon returned when `SDO_XOR` is used with a square (`geom1`) and another polygon (`geom2`).

**Figure 23-5 SDO\_GEOM.SDO\_XOR**



An exception is raised if `geom1` and `geom2` are based on different coordinate systems.

**Examples**

The following example returns a geometry object that is the topological symmetric difference (XOR operation) of `cola_a` and `cola_c`. (The example uses the definitions and data from [Simple Example: Inserting, Indexing, and Querying Spatial Data](#) (page 2-1).)

```
-- Return the topological symmetric difference of two geometries.
SELECT SDO_GEOM.SDO_XOR(c_a.shape, m.diminfo, c_c.shape, m.diminfo)
  FROM cola_markets c_a, cola_markets c_c, user_sdo_geom_metadata m
 WHERE m.table_name = 'COLA_MARKETS' AND m.column_name = 'SHAPE'
    AND c_a.name = 'cola_a' AND c_c.name = 'cola_c';

SDO_GEOM.SDO_XOR(C_A.SHAPE,M.DIMINFO,C_C.SHAPE,M.DIMINFO)(SDO_GTYPE, SDO_SRID, S
-----
SDO_GEOMETRY(2007, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 1003, 1, 19, 1003, 1), SDO
_ORDINATE_ARRAY(1, 7, 1, 1, 5, 1, 5, 3, 3, 3, 4, 5, 5, 5, 5, 7, 1, 7, 5, 5, 5, 3
, 6, 3, 6, 5, 5, 5))
```

Note that the returned polygon is a multipolygon (`SDO_GTYPE = 2007`), and the `SDO_ORDINATE_ARRAY` describes two polygons: one starting and ending at (1, 7) and the other starting and ending at (5, 5).

**Related Topics**

- [SDO\\_GEOM.SDO\\_DIFFERENCE](#) (page 23-24)
- [SDO\\_GEOM.SDO\\_INTERSECTION](#) (page 23-27)
- [SDO\\_GEOM.SDO\\_UNION](#) (page 23-44)

## 23.33 SDO\_GEOM.VALIDATE\_GEOMETRY\_WITH\_CONTEXT

**Format**

```
SDO_GEOM.VALIDATE_GEOMETRY_WITH_CONTEXT(  
    theGeometry IN SDO_GEOMETRY,  
    theDimInfo  IN SDO_DIM_ARRAY,  
    conditional IN VARCHAR2 DEFAULT 'TRUE' ,  
    flag10g     IN VARCHAR2 DEFAULT 'FALSE'  
) RETURN VARCHAR2;
```

or

```
SDO_GEOM.VALIDATE_GEOMETRY_WITH_CONTEXT(  
    theGeometry IN SDO_GEOMETRY,  
    tolerance   IN NUMBER,  
    conditional IN VARCHAR2 DEFAULT 'TRUE' ,  
    flag10g     IN VARCHAR2 DEFAULT 'FALSE'  
) RETURN VARCHAR2;
```

**Description**

Performs a consistency check for valid geometry types and returns context information if the geometry is invalid. The function checks the representation of the geometry from the tables against the element definitions.

**Parameters****theGeometry**

Geometry object.

**theDimInfo**

Dimensional information array corresponding to theGeometry, usually selected from one of the xxx\_SDO\_GEOM\_METADATA views (described in [Geometry Metadata Views](#) (page 2-47)).

**tolerance**

Tolerance value (see [Tolerance](#) (page 1-6)).

**conditional**

Conditional flag; relevant only for a three-dimensional composite surface or composite solid. A string value of TRUE (the default) causes validation to fail if two outer rings are on the same plane and share an edge; a string value of FALSE does not cause validation to fail if two outer rings are on the same plane and share an edge.

**flag10g**

Oracle Database 10g compatibility flag. A string value of TRUE causes only validation checks specific to two-dimensional geometries to be performed, and no 3D-specific validation checks to be performed. A string value of FALSE (the default) performs all

validation checks that are relevant for the geometry. (See the Usage Notes for more information about the `flaglog` parameter.)

### Usage Notes

You should validate all geometry data, and fix any validation errors, before performing any spatial operations on the data, as explained in [Recommendations for Loading and Validating Spatial Data](#) (page 4-4).

If the geometry is valid, this function returns TRUE. (For a user-defined geometry, that is, a geometry with an SDO\_GTYPE value of 2000, this function returns the string NULL.)

If the geometry is not valid, this function returns the following:

- An Oracle error message number based on the specific reason the geometry is invalid, or FALSE if the geometry fails for some other reason
- The context of the error (the coordinate, edge, or ring that causes the geometry to be invalid). (See "[Context of Errors: Details](#)" (page 23-54)" in this section.)

This function checks for type consistency and geometry consistency.

For type consistency, the function checks for the following:

- The SDO\_GTYPE is valid.
- The SDO\_ETYPE values are consistent with the SDO\_GTYPE value. For example, if the SDO\_GTYPE is 2003, there should be at least one element of type POLYGON in the geometry.
- The SDO\_ELEM\_INFO\_ARRAY has valid triplet values.

For geometry consistency, the function checks for the following, as appropriate for the specific geometry type:

- Polygons have at least four points, which includes the point that closes the polygon. (The last point is the same as the first.)
- Polygons are not self-crossing.
- No two vertices on a line or polygon are the same.
- Polygons are oriented correctly. (Exterior ring boundaries must be oriented counterclockwise, and interior ring boundaries must be oriented clockwise.)
- The interior of a polygon is connected.
- Line strings have at least two points.
- SDO\_ETYPE 1-digit and 4-digit values are not mixed (that is, both used) in defining polygon ring elements.
- Points on an arc are not colinear (that is, are not on a straight line) and are not the same point.
- Geometries are within the specified bounds of the applicable DIMINFO column value (from the USER\_SDO\_GEOM\_METADATA view).

- LRS geometries (see [Linear Referencing System](#) (page 7-1)) have three or four dimensions and a valid measure dimension position (3 or 4, depending on the number of dimensions).

For COLLECTION type geometries, some of the preceding checks mentioned above are not performed. Specifically, interior ring checks and polygon-polygon overlap checks are not performed for polygon elements of the COLLECTION type geometry.

For multipoint geometries, this function checks for duplicate vertices with three-dimensional geometries, but not with two-dimensional geometries.

For three-dimensional geometries, this function also performs the checks described in [Validation Checks for Three-Dimensional Geometries](#) (page 1-26).

In checking for geometry consistency, the function considers the geometry's tolerance value in determining if lines touch or if points are the same.

If the function format with `tolerance` is used, no checking is done to validate that the geometry is within the coordinate system bounds as stored in the DIMINFO field of the USER\_SDO\_GEOM\_METADATA view. If this check is required for your usage, use the function format with `theDimInfo`.

Setting the `flag10g` parameter value to `TRUE` causes the validation logic for Oracle Spatial Release 10.2 to be used, irrespective of the dimensionality of the geometry. This can be useful for allowing three-dimensional geometries that contain geometries in pre-Release 11.1 format to pass the validation check when they would otherwise fail. For example, a three-dimensional line is not valid if it contains circular arcs; and setting `flag10g` to `TRUE` will allow such geometries to avoid being considered invalid solely because of the circular arcs. (You should later make these geometries valid according to the criteria for the current release, such as by densifying the circular arcs.)

You can use this function in a PL/SQL procedure as an alternative to using the [SDO\\_GEOM.VALIDATE\\_LAYER\\_WITH\\_CONTEXT](#) (page 23-56) procedure. See the Usage Notes for [SDO\\_GEOM.VALIDATE\\_LAYER\\_WITH\\_CONTEXT](#) (page 23-56) for more information.

#### Context of Errors: Details

If a geometry is invalid, the result can include information about a combination of the following: coordinates, elements, rings, and edges.

- **Coordinates:** A coordinate refers to a vertex in a geometry. In a two-dimensional geometry, a vertex is two numbers (X and Y, or Longitude and Latitude). In a three-dimensional geometry, a vertex is defined using three numbers; and in a four-dimensional geometry, a vertex is defined using four numbers. (You can use the [SDO\\_UTIL.GETVERTICES](#) (page 31-40) function to return the coordinates in a geometry.)

If you receive a geometry validation error such as 13356 (adjacent points in a geometry are redundant), you can call the [SDO\\_UTIL.GETVERTICES](#) (page 31-40) function, specifying a rownum stopping condition to include the coordinate one greater than the coordinate indicated with the error. The last two coordinates shown in the output are the redundant coordinates. These coordinates may be exactly the same, or they may be within the user-specified tolerance and thus are considered the same point. You can remove redundant coordinates by using the [SDO\\_UTIL.REMOVE\\_DUPLICATE\\_VERTICES](#) (page 31-47) function.

- **Elements:** An element is a point, a line string, or an exterior polygon with zero or more corresponding interior polygons. (That is, a polygon element includes the exterior ring and all interior rings associated with that exterior ring.) If a geometry



is a multi-element geometry (for example, multiple points, lines, or polygons), the first element is element 1, the second element is element 2, and so on.

- **Rings:** A ring is only used with polygon elements. Exterior rings in a polygon are considered polygon elements, and an exterior ring can include zero or more interior rings (or holes). Each interior ring has its own ring designation, but Ring 1 is associated with the exterior polygon itself. For example, Element 1, Ring 1 refers to the first exterior polygon in a geometry; Element 1, Ring 2 refers to the first interior polygon of the first exterior polygon; and Element 1, Ring 3 refers to the second interior polygon. If the geometry is a multipolygon, Element 2, Ring 1 is used to refer to the second exterior polygon. If there are interior polygons associated with it, Element 2, Ring 2 refers to the first interior polygon of the second exterior polygon.
- **Edges:** An edge refers to a line segment between two coordinates. Edge 1 refers to the segment between coordinate 1 and coordinate 2, Edge 2 refers to the line segment between coordinates 2 and 3, and so on. The most common place to see edge errors when validating geometries is with self-intersecting polygons. (The Open Geospatial Consortium simple features specification does not allow a polygon to self-intersect.) In such cases, Oracle reports error 13349 (polygon boundary crosses itself), including the Element, Ring, and Edge numbers where self-intersection occurs.

If error 13351 (shared edge) is returned for an optimized rectangle that spans more than 119 degrees in longitude, some queries on this rectangle will return correct results, as explained in [Geodetic MBRs](#) (page 6-5).

## Examples

The following example validates a geometry (deliberately created as invalid) named `cola_invalid_geom`.

```
-- Validate; provide context if invalid
SELECT c.name, SDO_GEOM.VALIDATE_GEOMETRY_WITH_CONTEXT(c.shape, 0.005)
FROM cola_markets c WHERE c.name = 'cola_invalid_geom';
```

NAME

-----  
SDO\_GEOM.VALIDATE\_GEOMETRY\_WITH\_CONTEXT(C.SHAPE,0.005)

-----  
cola\_invalid\_geom  
13349 [Element <1>] [Ring <1>][Edge <1>][Edge <3>]

In the output for this example, 13349 indicates the error `ORA-13349: polygon boundary crosses itself`. The first ring of the first element has edges that intersect. The edges that intersect are edge 1 (the first and second vertices) and edge 3 (the third and fourth vertices).

## Related Topics

- [SDO\\_GEOM.VALIDATE\\_LAYER\\_WITH\\_CONTEXT](#) (page 23-56)
- [SDO\\_GEOM.SDO\\_SELF\\_UNION](#) (page 23-42)

## 23.34 SDO\_GEOM.VALIDATE\_LAYER\_WITH\_CONTEXT

### Format

```
SDO_GEOM.VALIDATE_LAYER_WITH_CONTEXT(  
  geom_table      IN VARCHAR2,  
  geom_column     IN VARCHAR2,  
  result_table    IN VARCHAR2,  
  commit_interval IN NUMBER DEFAULT -1,  
  conditional     IN VARCHAR2 DEFAULT 'TRUE' ,  
  flag10g        IN VARCHAR2 DEFAULT 'FALSE',  
  geom_schema     IN VARCHAR2 DEFAULT NULL);
```

### Description

Examines a geometry column to determine if the stored geometries follow the defined rules for geometry objects, and returns context information about any invalid geometries.

### Parameters

#### **geom\_table**

Spatial geometry table. Can be specified in *schema.table* format (for example, *scott.shapes*), unless the *geom\_schema* parameter is specified.

#### **geom\_column**

Geometry object column to be examined.

#### **result\_table**

Result table to hold the validation results. A row is added to *result\_table* for each invalid geometry. If there are no invalid geometries, one or more (depending on the *commit\_interval* value) rows with a result of DONE are added.

#### **commit\_interval**

Number of geometries to validate before Spatial and Graph performs an internal commit operation and writes a row with a result of DONE to *result\_table* (if no rows for invalid geometries have been written since the last commit operation). If *commit\_interval* is not specified, no internal commit operations are performed during the validation.

The *commit\_interval* option is helpful if you want to look at the contents of *result\_table* while the validation is in progress.

#### **conditional**

Conditional flag; relevant only for a three-dimensional composite surface or composite solid. A string value of TRUE (the default) causes validation to fail if two outer rings are on the same plane and share an edge; a string value of FALSE does not cause validation to fail if two outer rings are on the same plane and share an edge.

#### **flag10g**

Oracle Database 10g compatibility flag. A string value of TRUE causes only validation checks specific to two-dimensional geometries to be performed, and no 3D-specific validation checks to be performed. A string value of FALSE (the default) performs all validation checks that are relevant for the geometries. (See the Usage Notes for the

[SDO\\_GEOM.VALIDATE\\_GEOMETRY\\_WITH\\_CONTEXT](#) (page 23-52) function for more information about the `flag10g` parameter.)

### **geom\_schema**

Specifies the schema of the `geom_table` table, if it differs from the current schema. If `geom_schema` is specified, the `geom_table` parameter cannot be specified in *schema.table* format.

### **Usage Notes**

You should validate all geometry data, and fix any validation errors, before performing any spatial operations on the data, as explained in [Recommendations for Loading and Validating Spatial Data](#) (page 4-4).

This procedure loads the result table with validation results.

An empty result table (`result_table` parameter) should be created before calling this procedure. The format of the result table is: (`sdo_rowid` ROWID, `result` VARCHAR2(2000)). If `result_table` is not empty, it is automatically truncated by the procedure before any rows are added.

The result table contains one row for each invalid geometry. A row is not written if a geometry is valid, except as follows:

- If `commit_interval` is not specified (or if the `commit_interval` value is greater than the number of geometries in the layer) and no invalid geometries are found, a single row with a `RESULT` value of `DONE` is written.
- If `commit_interval` is specified and if no invalid geometries are found between an internal commit and the previous internal commit (or start of validation for the first internal commit), a single row with the primary key of the last geometry validated and a `RESULT` value of `DONE` is written. (If there have been no invalid geometries since the last internal commit operation, this row replaces the previous row that had a result of `DONE`.)

In each row for an invalid geometry, the `SDO_ROWID` column contains the ROWID value of the row containing the invalid geometry, and the `RESULT` column contains an Oracle error message number and the context of the error (the coordinate, edge, or ring that causes the geometry to be invalid). You can then look up the error message for more information about the cause of the failure.

This procedure performs the following checks on each geometry in the layer (`geom_column`):

- All type consistency and geometry consistency checks that are performed by the [SDO\\_GEOM.VALIDATE\\_GEOMETRY\\_WITH\\_CONTEXT](#) (page 23-52) function (see the Usage Notes for that function).
- The geometry's SRID value (coordinate system) is the same as the one specified in the applicable `DIMINFO` column value (from the `USER_SDO_GEOM_METADATA` view, which is described in [Geometry Metadata Views](#) (page 2-47)).

### **Examples**

The following example validates the geometry objects stored in the `SHAPE` column of the `COLA_MARKETS` table. The example includes the creation of the result table. For this example, a deliberately invalid geometry was inserted into the table before the validation was performed.

```
-- Is a layer valid? (First, create the result table.)
CREATE TABLE val_results (sdo_rowid ROWID, result varchar2(1000));
-- (Next statement must be on one command line.)
CALL SDO_GEOM.VALIDATE_LAYER_WITH_CONTEXT('COLA_MARKETS', 'SHAPE', 'VAL_RESULTS');

Call completed.

SQL> SELECT * from val_results;

SDO_ROWID
-----
RESULT
-----

Rows Processed <12>

AAABXNAABAAK+YAAC
13349 [Element <1>] [Ring <1>][Edge <1>][Edge <3>]
```

### Related Topics

- [SDO\\_GEOM.VALIDATE\\_GEOMETRY\\_WITH\\_CONTEXT](#) (page 23-52)
- [SDO\\_GEOM.SDO\\_SELF\\_UNION](#) (page 23-42)

## 23.35 SDO\_GEOM.WITHIN\_DISTANCE

### Format

```
SDO_GEOM.WITHIN_DISTANCE(
  geom1 IN SDO_GEOMETRY,
  dim1 IN SDO_DIM_ARRAY,
  dist IN NUMBER,
  geom2 IN SDO_GEOMETRY,
  dim2 IN SDO_DIM_ARRAY
  [, units IN VARCHAR2]
) RETURN VARCHAR2;
```

or

```
SDO_GEOM.WITHIN_DISTANCE(
  geom1 IN SDO_GEOMETRY,
  dist IN NUMBER,
  geom2 IN SDO_GEOMETRY,
  tol IN NUMBER
  [, units IN VARCHAR2]
) RETURN VARCHAR2;
```

### Description

Determines if two spatial objects are within some specified distance from each other.

### Parameters

#### **geom1**

Geometry object.

**dim1**

Dimensional information array corresponding to `geom1`, usually selected from one of the `xxx_SDO_GEOM_METADATA` views (described in [Geometry Metadata Views](#) (page 2-47)).

**dist**

Distance value.

**geom2**

Geometry object.

**dim2**

Dimensional information array corresponding to `geom2`, usually selected from one of the `xxx_SDO_GEOM_METADATA` views (described in [Geometry Metadata Views](#) (page 2-47)).

**tol**

Tolerance value (see [Tolerance](#) (page 1-6)).

**units**

Unit of measurement: a quoted string with `unit=` and an `SDO_UNIT` value from the `MDSYS.SDO_AREA_UNITS` table (for example, `'unit=KM'`). See [Unit of Measurement Support](#) (page 2-55) for more information about unit of measurement specification.

If this parameter is not specified, the unit of measurement associated with the data is assumed. For geodetic data, the default unit of measurement is meters.

**Usage Notes**

For better performance, use the [SDO\\_WITHIN\\_DISTANCE](#) (page 18-36) operator (described in [Spatial Operators](#) (page 18-1)) instead of the `SDO_GEOM.WITHIN_DISTANCE` function. For more information about performance considerations with operators and functions, see [Spatial Operators\\_ Procedures\\_ and Functions](#) (page 1-14).

This function returns `TRUE` for object pairs that are within the specified distance, and `FALSE` otherwise.

The distance between two extended objects (for example, nonpoint objects such as lines and polygons) is defined as the minimum distance between these two objects. Thus the distance between two adjacent polygons is zero.

An exception is raised if `geom1` and `geom2` are based on different coordinate systems.

**Examples**

The following example checks if `cola_b` and `cola_d` are within 1 unit apart at the shortest distance between them. (The example uses the definitions and data from [Simple Example: Inserting\\_ Indexing\\_ and Querying Spatial Data](#) (page 2-1)).

```
-- Are two geometries within 1 unit of distance apart?
SELECT SDO_GEOM.WITHIN_DISTANCE(c_b.shape, m.diminfo, 1,
                                c_d.shape, m.diminfo)
FROM cola_markets c_b, cola_markets c_d, user_sdo_geom_metadata m
WHERE m.table_name = 'COLA_MARKETS' AND m.column_name = 'SHAPE'
AND c_b.name = 'cola_b' AND c_d.name = 'cola_d';

SDO_GEOM.WITHIN_DISTANCE(C_B.SHAPE,M.DIMINFO,1,C_D.SHAPE,M.DIMINFO)
```

-----  
TRUE

### **Related Topics**

- [SDO\\_GEOM.SDO\\_DISTANCE](#) (page 23-25)

## SDO\_LRS Package (Linear Referencing System)

The MDSYS.SDO\_LRS package contains subprograms that create, modify, query, and convert linear referencing elements. These subprograms do not change the state of the database. Most LRS subprograms are functions.

To use the subprograms in this chapter, you must understand the linear referencing system (LRS) concepts and techniques described in [Linear Referencing System](#) (page 7-1).

The following table lists subprograms related to creating and editing geometric segments.

**Table 24-1 Subprograms for Creating and Editing Geometric Segments**

Subprogram	Description
<a href="#">SDO_LRS.DEFINE_GEOM_SEGMENT</a> (page 24-18)	Defines a geometric segment.
<a href="#">SDO_LRS.REDEFINE_GEOM_SEGMENT</a> (page 24-50)	Populates the measures of all shape points of a geometric segment based on the start and end measures, overriding any previously assigned measures between the start point and end point.
<a href="#">SDO_LRS.CLIP_GEOM_SEGMENT</a> (page 24-5)	Clips a geometric segment (synonym of <a href="#">SDO_LRS.DYNAMIC_SEGMENT</a> (page 24-20)).
<a href="#">SDO_LRS.DYNAMIC_SEGMENT</a> (page 24-20)	Clips a geometric segment (synonym of <a href="#">SDO_LRS.CLIP_GEOM_SEGMENT</a> (page 24-5)).
<a href="#">SDO_LRS.CONCATENATE_GEOM_SEGMENTS</a> (page 24-6)	Concatenates two geometric segments into one segment.
<a href="#">SDO_LRS.LRS_INTERSECTION</a> (page 24-41)	Returns an LRS geometry object that is the topological intersection (AND operation) of two geometry objects where one or both are LRS geometries.
<a href="#">SDO_LRS.OFFSET_GEOM_SEGMENT</a> (page 24-45)	Returns the geometric segment at a specified offset from a geometric segment.
<a href="#">SDO_LRS.SPLIT_GEOM_SEGMENT</a> (page 24-60)	Splits a geometric segment into two segments.

**Table 24-1 (Cont.) Subprograms for Creating and Editing Geometric Segments**

Subprogram	Description
<a href="#">SDO_LRS.RESET_MEASURE</a> (page 24-52)	Sets all measures of a geometric segment, including the start and end measures, to null values, overriding any previously assigned measures.
<a href="#">SDO_LRS.SCALE_GEOM_SEGMENT</a> (page 24-56)	Returns the geometry object resulting from a measure scaling operation on a geometric segment.
<a href="#">SDO_LRS.SET_PT_MEASURE</a> (page 24-58)	Sets the measure value of a specified point.
<a href="#">SDO_LRS.REVERSE_MEASURE</a> (page 24-55)	Returns a new geometric segment by reversing the measure values, but not the direction, of the original geometric segment.
<a href="#">SDO_LRS.TRANSLATE_MEASURE</a> (page 24-62)	Returns a new geometric segment by translating the original geometric segment (that is, shifting the start and end measures by a specified value).
<a href="#">SDO_LRS.REVERSE_GEOMETRY</a> (page 24-53)	Returns a new geometric segment by reversing the measure values and the direction of the original geometric segment.

The following table lists subprograms related to querying geometric segments.

**Table 24-2 Subprograms for Querying and Validating Geometric Segments**

Subprogram	Description
<a href="#">SDO_LRS.VALID_GEOM_SEGMENT</a> (page 24-63)	Checks if a geometric segment is valid.
<a href="#">SDO_LRS.VALID_LRS_PT</a> (page 24-64)	Checks if an LRS point is valid.
<a href="#">SDO_LRS.VALID_MEASURE</a> (page 24-65)	Checks if a measure falls within the measure range of a geometric segment.
<a href="#">SDO_LRS.CONNECTED_GEOM_SEGMENTS</a> (page 24-8)	Checks if two geometric segments are spatially connected.
<a href="#">SDO_LRS.GEOM_SEGMENT_LENGTH</a> (page 24-26)	Returns the length of a geometric segment.
<a href="#">SDO_LRS.GEOM_SEGMENT_START_PT</a> (page 24-28)	Returns the start point of a geometric segment.
<a href="#">SDO_LRS.GEOM_SEGMENT_END_PT</a> (page 24-25)	Returns the end point of a geometric segment.
<a href="#">SDO_LRS.GEOM_SEGMENT_START_MEASURE</a> (page 24-27)	Returns the start measure of a geometric segment.
<a href="#">SDO_LRS.GEOM_SEGMENT_END_MEASURE</a> (page 24-25)	Returns the end measure of a geometric segment.



**Table 24-2 (Cont.) Subprograms for Querying and Validating Geometric Segments**

Subprogram	Description
<a href="#">SDO_LRS.GET_MEASURE</a> (page 24-29)	Returns the measure of an LRS point.
<a href="#">SDO_LRS.GET_NEXT_SHAPE_PT</a> (page 24-30)	Returns the next shape point on a geometric segment after a specified measure value or LRS point.
<a href="#">SDO_LRS.GET_NEXT_SHAPE_PT_MEASURE</a> (page 24-31)	Returns the measure value of the next shape point on a geometric segment after a specified measure value or LRS point.
<a href="#">SDO_LRS.GET_PREV_SHAPE_PT</a> (page 24-33)	Returns the previous shape point on a geometric segment before a specified measure value or LRS point.
<a href="#">SDO_LRS.GET_PREV_SHAPE_PT_MEASURE</a> (page 24-34)	Returns the measure value of the previous shape point on a geometric segment before a specified measure value or LRS point.
<a href="#">SDO_LRS.IS_GEOM_SEGMENT_DEFINED</a> (page 24-36)	Checks if an LRS segment is defined correctly.
<a href="#">SDO_LRS.IS_MEASURE DECREASING</a> (page 24-37)	Checks if the measure values along an LRS segment are decreasing (that is, descending in numerical value).
<a href="#">SDO_LRS.IS_MEASURE INCREASING</a> (page 24-38)	Checks if the measure values along an LRS segment are increasing (that is, ascending in numerical value).
<a href="#">SDO_LRS.IS_SHAPE_PT_MEASURE</a> (page 24-39)	Checks if a specified measure value is associated with a shape point on a geometric segment.
<a href="#">SDO_LRS.MEASURE_RANGE</a> (page 24-43)	Returns the measure range of a geometric segment, that is, the difference between the start measure and end measure.
<a href="#">SDO_LRS.MEASURE_TO_PERCENTAGE</a> (page 24-44)	Returns the percentage (0 to 100) that a specified measure is of the measure range of a geometric segment.
<a href="#">SDO_LRS.PERCENTAGE_TO_MEASURE</a> (page 24-47)	Returns the measure value of a specified percentage (0 to 100) of the measure range of a geometric segment.
<a href="#">SDO_LRS.LOCATE_PT</a> (page 24-40)	Returns the point located at a specified distance from the start of a geometric segment.
<a href="#">SDO_LRS.PROJECT_PT</a> (page 24-48)	Returns the projection point of a specified point. The projection point is on the geometric segment.
<a href="#">SDO_LRS.FIND_LRS_DIM_POS</a> (page 24-21)	Returns the position of the measure dimension within the SDO_DIM_ARRAY structure for a specified SDO_GEOMETRY column.

---

**Table 24-2 (Cont.) Subprograms for Querying and Validating Geometric Segments**

Subprogram	Description
<a href="#">SDO_LRS.FIND_MEASURE</a> (page 24-22)	Returns the measure of the closest point on a segment to a specified projection point.
<a href="#">SDO_LRS.FIND_OFFSET</a> (page 24-23)	Returns the signed offset (shortest distance) from a point to a geometric segment.
<a href="#">SDO_LRS.VALIDATE_LRS_GEOMETRY</a> (page 24-66)	Checks if an LRS geometry is valid.

The following table lists subprograms related to converting geometric segments.

**Table 24-3 Subprograms for Converting Geometric Segments**

Subprogram	Description
<a href="#">SDO_LRS.CONVERT_TO_LRS_DIM_ARRAY</a> (page 24-9)	Converts a standard dimensional array to an LRS dimensional array by creating a measure dimension.
<a href="#">SDO_LRS.CONVERT_TO_LRS_GEOM</a> (page 24-11)	Converts a standard SDO_GEOMETRY line string to an LRS geometric segment by adding measure information.
<a href="#">SDO_LRS.CONVERT_TO_LRS_LAYER</a> (page 24-13)	Converts all geometry objects in a column of type SDO_GEOMETRY from standard line string geometries without measure information to LRS geometric segments with measure information, and updates the metadata.
<a href="#">SDO_LRS.CONVERT_TO_STD_DIM_ARRAY</a> (page 24-15)	Converts an LRS dimensional array to a standard dimensional array by removing the measure dimension.
<a href="#">SDO_LRS.CONVERT_TO_STD_GEOM</a> (page 24-16)	Converts an LRS geometric segment to a standard SDO_GEOMETRY line string by removing measure information.
<a href="#">SDO_LRS.CONVERT_TO_STD_LAYER</a> (page 24-17)	Converts all geometry objects in a column of type SDO_GEOMETRY from LRS geometric segments with measure information to standard line string geometries without measure information, and updates the metadata.

For more information about conversion subprograms, see [Converting LRS Geometries](#) (page 7-13).

The rest of this chapter provides reference information on the subprograms, listed in alphabetical order.

## 24.1 SDO\_LRS.CLIP\_GEOM\_SEGMENT

### Format

```
SDO_LRS.CLIP_GEOM_SEGMENT(
    geom_segment IN SDO_GEOMETRY,
    start_measure IN NUMBER,
    end_measure   IN NUMBER,
    tolerance     IN NUMBER DEFAULT 1.0e-8
) RETURN SDO_GEOMETRY;
```

or

```
SDO_LRS.CLIP_GEOM_SEGMENT(
    geom_segment IN SDO_GEOMETRY,
    dim_array    IN SDO_DIM_ARRAY,
    start_measure IN NUMBER,
    end_measure   IN NUMBER
) RETURN SDO_GEOMETRY;
```

### Description

Returns the geometry object resulting from a clip operation on a geometric segment.

---

---

#### Note:

SDO\_LRS.CLIP\_GEOM\_SEGMENT and [SDO\\_LRS.DYNAMIC\\_SEGMENT](#) (page 24-20) are synonyms: both functions have the same parameters, behavior, and return value.

---

---

### Parameters

#### geom\_segment

Cartographic representation of a linear feature.

#### dim\_array

Dimensional information array corresponding to `geom_segment`, usually selected from one of the `xxx_SDO_GEOM_METADATA` views (described in [Geometry Metadata Views](#) (page 2-47)).

#### start\_measure

Start measure of the geometric segment.

#### end\_measure

End measure of the geometric segment.

#### tolerance

Tolerance value (see [Tolerance](#) (page 1-6) and [Tolerance Values with LRS Functions](#) (page 7-15)). The default value is 0.00000001.

### Usage Notes

An exception is raised if `geom_segment`, `start_measure`, or `end_measure` is invalid.

`start_measure` and `end_measure` can be any points on the geometric segment. They do not have to be in any specific order. For example, `start_measure` and `end_measure` can be 5 and 10, respectively, or 10 and 5, respectively.

The direction and measures of the resulting geometric segment are preserved (that is, they reflect the original segment).

The *\_3D* format of this function (`SDO_LRS.CLIP_GEOM_SEGMENT_3D`) is available. For information about *\_3D* formats of LRS functions, see [3D Formats of LRS Functions](#) (page 7-7).

For more information about clipping geometric segments, see [Clipping a Geometric Segment](#) (page 7-9).

### Examples

The following example clips the geometric segment representing Route 1, returning the segment from measures 5 through 10. This segment might represent a construction zone. (This example uses the definitions from the example in [Example of LRS Functions](#) (page 7-15).)

```
SELECT  SDO_LRS.CLIP_GEOM_SEGMENT(route_geometry, 5, 10)
        FROM lrs_routes WHERE route_id = 1;

SDO_LRS.CLIP_GEOM_SEGMENT(ROUTE_GEOMETRY,5,10)(SDO_GTYPE, SDO_SRID, SDO_POINT(X,
-----
SDO_GEOMETRY(3302, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 2, 1), SDO_ORDINATE_ARRAY(
5, 4, 5, 8, 4, 8, 10, 4, 10))
```

## 24.2 SDO\_LRS.CONCATENATE\_GEOM\_SEGMENTS

### Format

```
SDO_LRS.CONCATENATE_GEOM_SEGMENTS(
    geom_segment_1  IN SDO_GEOMETRY,
    geom_segment_2  IN SDO_GEOMETRY,
    tolerance        IN NUMBER DEFAULT 1.0e-8
) RETURN SDO_GEOMETRY;
```

or

```
SDO_LRS.CONCATENATE_GEOM_SEGMENTS(
    geom_segment_1  IN SDO_GEOMETRY,
    dim_array_1     IN SDO_DIM_ARRAY,
    geom_segment_2  IN SDO_GEOMETRY,
    dim_array_2     IN SDO_DIM_ARRAY
) RETURN SDO_GEOMETRY;
```

### Description

Returns the geometry object resulting from the concatenation of two geometric segments.

### Parameters

#### **geom\_segment\_1**

First geometric segment to be concatenated.

**dim\_array\_1**

Dimensional information array corresponding to `geom_segment_1`, usually selected from one of the `xxx_SDO_GEOM_METADATA` views (described in [Geometry Metadata Views](#) (page 2-47)).

**geom\_segment\_2**

Second geometric segment to be concatenated.

**dim\_array\_2**

Dimensional information array corresponding to `geom_segment_2`, usually selected from one of the `xxx_SDO_GEOM_METADATA` views (described in [Geometry Metadata Views](#) (page 2-47)).

**tolerance**

Tolerance value (see [Tolerance](#) (page 1-6) and [Tolerance Values with LRS Functions](#) (page 7-15)). The default value is 0.00000001.

**Usage Notes**

An exception is raised if `geom_segment_1` or `geom_segment_2` has an invalid geometry type or dimensionality, or if `geom_segment_1` and `geom_segment_2` are based on different coordinate systems.

The direction of the first geometric segment is preserved, and all measures of the second segment are shifted so that its start measure is the same as the end measure of the first segment.

The geometry type of `geom_segment_1` and `geom_segment_2` must be line or multiline. Neither can be a polygon.

The `_3D` format of this function (`SDO_LRS.CONCATENATE_GEOM_SEGMENTS_3D`) is available. For information about `_3D` formats of LRS functions, see [3D Formats of LRS Functions](#) (page 7-7).

For more information about concatenating geometric segments, see [Concatenating Geometric Segments](#) (page 7-10).

**Examples**

The following example defines the geometric segment, splits it into two segments, then concatenates those segments. (This example uses the definitions from the example in [Example of LRS Functions](#) (page 7-15). The definitions of `result_geom_1`, `result_geom_2`, and `result_geom_3` are displayed in [Example 7-3](#) (page 7-20).)

```
DECLARE
geom_segment SDO_GEOMETRY;
line_string SDO_GEOMETRY;
dim_array SDO_DIM_ARRAY;
result_geom_1 SDO_GEOMETRY;
result_geom_2 SDO_GEOMETRY;
result_geom_3 SDO_GEOMETRY;

BEGIN

SELECT a.route_geometry into geom_segment FROM lrs_routes a
WHERE a.route_name = 'Route1';
SELECT m.diminfo into dim_array from
user_sdo_geom_metadata m
```

```
WHERE m.table_name = 'LRS_ROUTES' AND m.column_name = 'ROUTE_GEOMETRY';

-- Define the LRS segment for Route1.
SDO_LRS.DEFINE_GEOM_SEGMENT (geom_segment,
    dim_array,
    0,    -- Zero starting measure: LRS segment starts at start of route.
    27); -- End of LRS segment is at measure 27.

SELECT a.route_geometry INTO line_string FROM lrs_routes a
    WHERE a.route_name = 'Route1';

-- Split Route1 into two segments.
SDO_LRS.SPLIT_GEOM_SEGMENT(line_string,dim_array,5,result_geom_1,result_geom_2);

-- Concatenate the segments that were just split.
result_geom_3 := SDO_LRS.CONCATENATE_GEOM_SEGMENTS(result_geom_1, dim_array,
result_geom_2, dim_array);

-- Insert geometries into table, to display later.
INSERT INTO lrs_routes VALUES(
    11,
    'result_geom_1',
    result_geom_1
);
INSERT INTO lrs_routes VALUES(
    12,
    'result_geom_2',
    result_geom_2
);
INSERT INTO lrs_routes VALUES(
    13,
    'result_geom_3',
    result_geom_3
);

END;
/
```

## 24.3 SDO\_LRS.CONNECTED\_GEOM\_SEGMENTS

### Format

```
SDO_LRS.CONNECTED_GEOM_SEGMENTS(
    geom_segment_1  IN SDO_GEOMETRY,
    geom_segment_2  IN SDO_GEOMETRY,
    tolerance        IN NUMBER DEFAULT 1.0e-8
) RETURN VARCHAR2;
```

or

```
SDO_LRS.CONNECTED_GEOM_SEGMENTS(
    geom_segment_1  IN SDO_GEOMETRY,
    dim_array_1     IN SDO_DIM_ARRAY,
    geom_segment_2  IN SDO_GEOMETRY,
    dim_array_2     IN SDO_DIM_ARRAY
) RETURN VARCHAR2;
```

### Description

Checks if two geometric segments are spatially connected.

**Parameters****geom\_segment\_1**

First of two geometric segments to be checked.

**dim\_array\_1**

Dimensional information array corresponding to `geom_segment_1`, usually selected from one of the `xxx_SDO_GEOM_METADATA` views (described in [Geometry Metadata Views](#) (page 2-47)).

**geom\_segment\_2**

Second of two geometric segments to be checked.

**dim\_array\_2**

Dimensional information array corresponding to `geom_segment_2`, usually selected from one of the `xxx_SDO_GEOM_METADATA` views (described in [Geometry Metadata Views](#) (page 2-47)).

**tolerance**

Tolerance value (see [Tolerance](#) (page 1-6) and [Tolerance Values with LRS Functions](#) (page 7-15)). The default value is 0.00000001.

**Usage Notes**

This function returns TRUE if the geometric segments are spatially connected and FALSE if the geometric segments are not spatially connected.

An exception is raised if `geom_segment_1` or `geom_segment_2` has an invalid geometry type or dimensionality, or if `geom_segment_1` and `geom_segment_2` are based on different coordinate systems.

The `_3D` format of this function (`SDO_LRS.CONNECTED_GEOM_SEGMENTS_3D`) is available. For information about `_3D` formats of LRS functions, see [3D Formats of LRS Functions](#) (page 7-7).

**Examples**

The following example checks if two geometric segments (results of a previous split operation) are spatially connected.

```
-- Are result_geom_1 and result_geom2 connected?
SELECT  SDO_LRS.CONNECTED_GEOM_SEGMENTS(a.route_geometry,
      b.route_geometry, 0.005)
FROM    lrs_routes a, lrs_routes b
WHERE   a.route_id = 11 AND b.route_id = 12;

SDO_LRS.CONNECTED_GEOM_SEGMENTS(A.ROUTE_GEOMETRY,B.ROUTE_GEOMETRY,0.005)
-----
TRUE
```

## 24.4 SDO\_LRS.CONVERT\_TO\_LRS\_DIM\_ARRAY

**Format**

```
SDO_LRS.CONVERT_TO_LRS_DIM_ARRAY(
    dim_array      IN SDO_DIM_ARRAY
    [, lower_bound IN NUMBER,
    upper_bound    IN NUMBER,
```

```
tolerance      IN NUMBER]
) RETURN SDO_DIM_ARRAY;
```

or

```
SDO_LRS.CONVERT_TO_LRS_DIM_ARRAY(
  dim_array      IN SDO_DIM_ARRAY,
  dim_name       IN VARCHAR2
  [, lower_bound IN NUMBER,
  upper_bound    IN NUMBER,
  tolerance      IN NUMBER]
) RETURN SDO_DIM_ARRAY;
```

or

```
SDO_LRS.CONVERT_TO_LRS_DIM_ARRAY(
  dim_array      IN SDO_DIM_ARRAY,
  dim_name       IN VARCHAR2,
  dim_pos        IN INTEGER
  [, lower_bound IN NUMBER,
  upper_bound    IN NUMBER,
  tolerance      IN NUMBER]
) RETURN SDO_DIM_ARRAY;
```

## Description

Converts a standard dimensional array to an LRS dimensional array by creating a measure dimension.

## Parameters

### **dim\_array**

Dimensional information array corresponding to the layer (column of geometries) to be converted, usually selected from one of the xxx\_SDO\_GEOM\_METADATA views (described in [Geometry Metadata Views](#) (page 2-47)).

### **dim\_name**

Name of the measure dimension (M, if not otherwise specified).

### **dim\_pos**

Position of the measure dimension (the last SDO\_DIM\_ELEMENT object position in the SDO\_DIM\_ARRAY, if not otherwise specified).

### **lower\_bound**

Lower bound (SDO\_LB value in the SDO\_DIM\_ELEMENT definition) of the ordinate in the measure dimension.

### **upper\_bound**

Upper bound (SDO\_UB value in the SDO\_DIM\_ELEMENT definition) of the ordinate in the measure dimension.

### **tolerance**

Tolerance value (see [Tolerance](#) (page 1-6) and [Tolerance Values with LRS Functions](#) (page 7-15)). The default value is 0.00000001.



## Usage Notes

This function converts a standard dimensional array to an LRS dimensional array by creating a measure dimension. Specifically, it adds an SDO\_DIM\_ELEMENT object at the end of the current SDO\_DIM\_ELEMENT objects in the SDO\_DIM\_ARRAY for the dimensional array (unless another `dim_pos` is specified), and sets the SDO\_DIMNAME value in this added SDO\_DIM\_ELEMENT to M (unless another `dim_name` is specified). It sets the other values in the added SDO\_DIM\_ELEMENT according to the values of the `upper_bound`, `lower_bound`, and `tolerance` parameter values.

If `dim_array` already contains dimensional information, the `dim_array` is returned.

The `_3D` format of this function (`SDO_LRS.CONVERT_TO_LRS_DIM_ARRAY_3D`) is available. For information about `_3D` formats of LRS functions, see [3D Formats of LRS Functions](#) (page 7-7).

For more information about conversion functions, see [Converting LRS Geometries](#) (page 7-13).

## Examples

The following example converts the dimensional array for the LRS\_ROUTES table to LRS format. (This example uses the definitions from the example in [Example of LRS Functions](#) (page 7-15).)

```
SELECT SDO_LRS.CONVERT_TO_LRS_DIM_ARRAY(m.diminfo)
FROM user_sdo_geom_metadata m
WHERE m.table_name = 'LRS_ROUTES' AND m.column_name = 'ROUTE_GEOMETRY';

SDO_LRS.CONVERT_TO_LRS_DIM_ARRAY(M.DIMINFO)(SDO_DIMNAME, SDO_LB, SDO_UB, SDO_TOL
-----
SDO_DIM_ARRAY(SDO_DIM_ELEMENT('X', 0, 20, .005), SDO_DIM_ELEMENT('Y', 0, 20, .00
5), SDO_DIM_ELEMENT('M', 0, 20, .005))
```

# 24.5 SDO\_LRS.CONVERT\_TO\_LRS\_GEOM

## Format

```
SDO_LRS.CONVERT_TO_LRS_GEOM(
    standard_geom    IN SDO_GEOMETRY
    [, start_measure IN NUMBER,
    end_measure      IN NUMBER]
) RETURN SDO_GEOMETRY;
```

or

```
SDO_LRS.CONVERT_TO_LRS_GEOM(
    standard_geom    IN SDO_GEOMETRY,
    dim_array        IN SDO_DIM_ARRAY
    [, start_measure IN NUMBER,
    end_measure      IN NUMBER]
) RETURN SDO_GEOMETRY;
```

or

```
SDO_LRS.CONVERT_TO_LRS_GEOM(
    standard_geom    IN SDO_GEOMETRY,
    m_pos            IN INTEGER
    [, start_measure IN NUMBER,
```

```
        end_measure      IN NUMBER]
    ) RETURN SDO_GEOMETRY;
```

### Description

Converts a standard SDO\_GEOMETRY line string to an LRS geometric segment by adding measure information.

### Parameters

#### **standard\_geom**

Line string geometry that does not contain measure information.

#### **dim\_array**

Dimensional information array corresponding to `standard_geom`, usually selected from one of the `xxx_SDO_GEOM_METADATA` views (described in [Geometry Metadata Views](#) (page 2-47)).

#### **m\_pos**

Position of the measure dimension. If specified, must be 3 or 4. By default, the measure dimension is the last dimension in the SDO\_DIM\_ARRAY.

#### **start\_measure**

Distance measured from the start point of a geometric segment to the start point of the linear feature. The default is 0.

#### **end\_measure**

Distance measured from the end point of a geometric segment to the start point of the linear feature. The default is the cartographic length (for example, 75 if the cartographic length is 75 and the unit of measure is miles).

### Usage Notes

This function returns an LRS geometric segment with measure information, with measure information provided for all shape points.

An exception is raised if `standard_geom` has an invalid geometry type or dimensionality, if `m_pos` is less than 3 or greater than 4, or if `start_measure` or `end_measure` is out of range.

The `_3D` format of this function (`SDO_LRS.CONVERT_TO_LRS_GEOM_3D`) is available; however, the `m_pos` parameter is not available for `SDO_LRS.CONVERT_TO_LRS_GEOM_3D`. For information about `_3D` formats of LRS functions, see [3D Formats of LRS Functions](#) (page 7-7).

For more information about conversion functions, see [Converting LRS Geometries](#) (page 7-13).

### Examples

The following example converts the geometric segment representing Route 1 to LRS format. (This example uses the definitions from the example in [Example of LRS Functions](#) (page 7-15).)

```
SELECT SDO_LRS.CONVERT_TO_LRS_GEOM(a.route_geometry, m.diminfo)
FROM   lrs_routes a, user_sdo_geom_metadata m
WHERE  m.table_name = 'LRS_ROUTES' AND m.column_name = 'ROUTE_GEOMETRY'
AND    a.route_id = 1;
```

```
SDO_LRS.CONVERT_TO_LRS_GEOM(A.ROUTE_GEOMETRY,M.DIMINFO)(SDO_GTYPE, SDO_SRID, SDO
-----
SDO_GEOMETRY(3302, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 2, 1), SDO_ORDINATE_ARRAY(
2, 2, 0, 2, 4, 2, 8, 4, 8, 12, 4, 12, 12, 10, NULL, 8, 10, 22, 5, 14, 27))
```

## 24.6 SDO\_LRS.CONVERT\_TO\_LRS\_LAYER

### Format

```
SDO_LRS.CONVERT_TO_LRS_LAYER(
    table_name      IN VARCHAR2,
    column_name     IN VARCHAR2
    [, lower_bound  IN NUMBER,
    upper_bound     IN NUMBER,
    tolerance       IN NUMBER]
) RETURN VARCHAR2;
```

or

```
SDO_LRS.CONVERT_TO_LRS_LAYER(
    table_name      IN VARCHAR2,
    column_name     IN VARCHAR2,
    dim_name        IN VARCHAR2,
    dim_pos         IN INTEGER
    [, lower_bound  IN NUMBER,
    upper_bound     IN NUMBER,
    tolerance       IN NUMBER]
) RETURN VARCHAR2;
```

### Description

Converts all geometry objects in a column of type SDO\_GEOMETRY (that is, converts a layer) from standard line string geometries without measure information to LRS geometric segments with measure information, and updates the metadata in the USER\_SDO\_GEOM\_METADATA view.

### Parameters

#### **table\_name**

Table containing the column with the SDO\_GEOMETRY objects.

#### **column\_name**

Column in table\_name containing the SDO\_GEOMETRY objects.

#### **dim\_name**

Name of the measure dimension. If this parameter is null, M is assumed.

#### **dim\_pos**

Position of the measure dimension within the SDO\_DIM\_ARRAY structure for the specified SDO\_GEOMETRY column. If this parameter is null, the number corresponding to the last position is assumed.

#### **lower\_bound**

Lower bound (SDO\_LB value in the SDO\_DIM\_ELEMENT definition) of the ordinate in the measure dimension.

**upper\_bound**

Upper bound (SDO\_UB value in the SDO\_DIM\_ELEMENT definition) of the ordinate in the measure dimension.

**tolerance**

Tolerance value (see [Tolerance](#) (page 1-6) and [Tolerance Values with LRS Functions](#) (page 7-15)). The default value is 0.00000001.

**Usage Notes**

This function returns TRUE if the conversion was successful or if the layer already contains measure information, and the function returns an exception if the conversion was not successful.

An exception is raised if the existing dimensional information for the table is invalid.

The measure values are assigned based on a start measure of zero and an end measure of the cartographic length.

If a spatial index already exists on `column_name`, you must delete (drop) the index before converting the layer and create a new index after converting the layer. For information about deleting and creating indexes, see the [DROP INDEX](#) (page 17-12) and [CREATE INDEX](#) (page 17-7) statements in [SQL Statements for Indexing Spatial Data](#) (page 17-1).

The `_3D` format of this function (SDO\_LRS.CONVERT\_TO\_LRS\_LAYER\_3D) is available. For information about `_3D` formats of LRS functions, see [3D Formats of LRS Functions](#) (page 7-7).

For more information about conversion functions, see [Converting LRS Geometries](#) (page 7-13).

**Examples**

The following example converts the geometric segments in the ROUTE\_GEOMETRY column of the LRS\_ROUTES table to LRS format. (This example uses the definitions from the example in [Example of LRS Functions](#) (page 7-15).) The SELECT statement shows that dimensional information has been added (that is, SDO\_DIM\_ELEMENT('M', NULL, NULL, NULL) is included in the definition).

```
BEGIN
  IF (SDO_LRS.CONVERT_TO_LRS_LAYER('LRS_ROUTES', 'ROUTE_GEOMETRY') = 'TRUE')
    THEN
      DBMS_OUTPUT.PUT_LINE('Conversion from STD_LAYER to LRS_LAYER succeeded.');
```

ELSE

```
      DBMS_OUTPUT.PUT_LINE('Conversion from STD_LAYER to LRS_LAYER failed.');
```

END IF;

```
END;
```

.

/

Conversion from STD\_LAYER to LRS\_LAYER succeeded.

PL/SQL procedure successfully completed.

```
SQL> SELECT diminfo FROM user_sdo_geom_metadata WHERE table_name = 'LRS_ROUTES' AND
column_name = 'ROUTE_GEOMETRY';
```

```
DIMINFO(SDO_DIMNAME, SDO_LB, SDO_UB, SDO_TOLERANCE)
```

-----

```
SDO_DIM_ARRAY(SDO_DIM_ELEMENT('X', 0, 20, .005), SDO_DIM_ELEMENT('Y', 0, 20, .005), SDO_DIM_ELEMENT('M', NULL, NULL, NULL))
```

## 24.7 SDO\_LRS.CONVERT\_TO\_STD\_DIM\_ARRAY

### Format

```
SDO_LRS.CONVERT_TO_STD_DIM_ARRAY(  
    dim_array IN SDO_DIM_ARRAY  
    [, m_pos IN INTEGER]  
    ) RETURN SDO_DIM_ARRAY;
```

### Description

Converts an LRS dimensional array to a standard dimensional array by removing the measure dimension.

### Parameters

#### dim\_array

Dimensional information array corresponding to the layer (column of geometries) to be converted, usually selected from one of the xxx\_SDO\_GEOM\_METADATA views (described in [Geometry Metadata Views](#) (page 2-47)).

#### m\_pos

Position of the measure dimension. If specified, must be 3 or 4. By default, the measure dimension is the last dimension in the SDO\_DIM\_ARRAY.

### Usage Notes

This function converts an LRS dimensional array to a standard dimensional array by removing the measure dimension. Specifically, it removes the SDO\_DIM\_ELEMENT object at the end of the current SDO\_DIM\_ELEMENT objects in the SDO\_DIM\_ARRAY for the dim\_array.

An exception is raised if m\_pos is invalid (less than 3 or greater than 4).

If dim\_array is already a standard dimensional array (that is, does not contain dimensional information), the dim\_array is returned.

The \_3D format of this function (SDO\_LRS.CONVERT\_TO\_STD\_DIM\_ARRAY\_3D) is available. For information about \_3D formats of LRS functions, see [3D Formats of LRS Functions](#) (page 7-7).

For more information about conversion functions, see [Converting LRS Geometries](#) (page 7-13).

### Examples

The following example converts the dimensional array for the LRS\_ROUTES table to standard format. (This example uses the definitions from the example in [Example of LRS Functions](#) (page 7-15).)

```
SELECT SDO_LRS.CONVERT_TO_STD_DIM_ARRAY(m.diminfo)  
FROM user_sdo_geom_metadata m  
WHERE m.table_name = 'LRS_ROUTES' AND m.column_name = 'ROUTE_GEOMETRY';  
  
SDO_LRS.CONVERT_TO_STD_DIM_ARRAY(M.DIMINFO)(SDO_DIMNAME, SDO_LB, SDO_UB, SDO_TOL  
-----
```

```
SDO_DIM_ARRAY(SDO_DIM_ELEMENT('X', 0, 20, .005), SDO_DIM_ELEMENT('Y', 0, 20, .005))
```

## 24.8 SDO\_LRS.CONVERT\_TO\_STD\_GEOM

### Format

```
SDO_LRS.CONVERT_TO_STD_GEOM(  
    lrs_geom IN SDO_GEOMETRY  
    [, dim_array IN SDO_DIM_ARRAY]  
    ) RETURN SDO_GEOMETRY;
```

### Description

Converts an LRS geometric segment to a standard SDO\_GEOMETRY line string by removing measure information.

### Parameters

#### **lrs\_geom**

LRS geometry that contains measure information.

#### **dim\_array**

Dimensional information array corresponding to `lrs_geom`, usually selected from one of the `xxx_SDO_GEOM_METADATA` views (described in [Geometry Metadata Views](#) (page 2-47)).

### Usage Notes

This function returns an SDO\_GEOMETRY object in which all measure information is removed.

The `_3D` format of this function (`SDO_LRS.CONVERT_TO_STD_GEOM_3D`) is available. For information about `_3D` formats of LRS functions, see [3D Formats of LRS Functions](#) (page 7-7).

For more information about conversion functions, see [Converting LRS Geometries](#) (page 7-13).

### Examples

The following example converts the geometric segment representing Route 1 to standard format. (This example uses the definitions from the example in [Example of LRS Functions](#) (page 7-15).)

```
SELECT SDO_LRS.CONVERT_TO_STD_GEOM(a.route_geometry, m.diminfo)  
FROM lrs_routes a, user_sdo_geom_metadata m  
WHERE m.table_name = 'LRS_ROUTES' AND m.column_name = 'ROUTE_GEOMETRY'  
AND a.route_id = 1;  
  
SDO_LRS.CONVERT_TO_STD_GEOM(A.ROUTE_GEOMETRY,M.DIMINFO)(SDO_GTYPE, SDO_SRID, SDO  
-----  
SDO_GEOMETRY(2002, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 2, 1), SDO_ORDINATE_ARRAY(  
2, 2, 2, 4, 8, 4, 12, 4, 12, 10, 8, 10, 5, 14))
```

## 24.9 SDO\_LRS.CONVERT\_TO\_STD\_LAYER

### Format

```
SDO_LRS.CONVERT_TO_STD_LAYER(
    table_name  IN VARCHAR2,
    column_name IN VARCHAR2
) RETURN VARCHAR2;
```

### Description

Converts all geometry objects in a column of type SDO\_GEOMETRY (that is, converts a layer) from LRS geometric segments with measure information to standard line string geometries without measure information, and updates the metadata in the USER\_SDO\_GEOM\_METADATA view.

### Parameters

#### table\_name

Table containing the column with the SDO\_GEOMETRY objects.

#### column\_name

Column in table\_name containing the SDO\_GEOMETRY objects.

### Usage Notes

This function returns TRUE if the conversion was successful or if the layer already is a standard layer (that is, contains geometries without measure information), and the function returns an exception if the conversion was not successful.

If a spatial index already exists on column\_name, you must delete (drop) the index before converting the layer and create a new index after converting the layer. For information about deleting and creating indexes, see the [DROP INDEX](#) (page 17-12) and [CREATE INDEX](#) (page 17-7) statements in [SQL Statements for Indexing Spatial Data](#) (page 17-1).

The \_3D format of this function (SDO\_LRS.CONVERT\_TO\_STD\_LAYER\_3D) is available. For information about \_3D formats of LRS functions, see [3D Formats of LRS Functions](#) (page 7-7).

For more information about conversion functions, see [Converting LRS Geometries](#) (page 7-13).

### Examples

The following example converts the geometric segments in the ROUTE\_GEOMETRY column of the LRS\_ROUTES table to standard format. (This example uses the definitions from the example in [Example of LRS Functions](#) (page 7-15).) The SELECT statement shows that dimensional information has been removed (that is, no SDO\_DIM\_ELEMENT('M', NULL, NULL, NULL) is included in the definition).

```
BEGIN
  IF (SDO_LRS.CONVERT_TO_STD_LAYER('LRS_ROUTES', 'ROUTE_GEOMETRY') = 'TRUE')
  THEN
    DBMS_OUTPUT.PUT_LINE('Conversion from LRS_LAYER to STD_LAYER succeeded.');
```

```
  ELSE
    DBMS_OUTPUT.PUT_LINE('Conversion from LRS_LAYER to STD_LAYER failed.');
```

```
END IF;
END;
.
/
Conversion from LRS_LAYER to STD_LAYER succeeded.

PL/SQL procedure successfully completed.

SELECT diminfo FROM user_sdo_geom_metadata
  WHERE table_name = 'LRS_ROUTES' AND column_name = 'ROUTE_GEOMETRY';

DIMINFO(SDO_DIMNAME, SDO_LB, SDO_UB, SDO_TOLERANCE)
-----
SDO_DIM_ARRAY(SDO_DIM_ELEMENT('X', 0, 20, .005), SDO_DIM_ELEMENT('Y', 0, 20, .005))
```

## 24.10 SDO\_LRS.DEFINE\_GEOM\_SEGMENT

### Format

```
SDO_LRS.DEFINE_GEOM_SEGMENT(
  geom_segment      IN OUT SDO_GEOMETRY
  [, start_measure  IN NUMBER,
  end_measure       IN NUMBER]);
```

or

```
SDO_LRS.DEFINE_GEOM_SEGMENT(
  geom_segment      IN OUT SDO_GEOMETRY,
  dim_array         IN SDO_DIM_ARRAY
  [, start_measure  IN NUMBER,
  end_measure       IN NUMBER]);
```

### Description

Defines a geometric segment by assigning start and end measures to a geometric segment, and assigns values to any null measures.

### Parameters

#### **geom\_segment**

Cartographic representation of a linear feature.

#### **dim\_array**

Dimensional information array corresponding to `geom_segment`, usually selected from one of the `xxx_SDO_GEOM_METADATA` views (described in [Geometry Metadata Views](#) (page 2-47)).

#### **start\_measure**

Distance measured from the start point of a geometric segment to the start point of the linear feature. The default is the existing value (if any) in the measure dimension; otherwise, the default is 0.

#### **end\_measure**

Distance measured from the end point of a geometric segment to the start point of the linear feature. The default is the existing value (if any) in the measure dimension; otherwise, the default is the cartographic length of the segment.



## Usage Notes

An exception is raised if `geom_segment` has an invalid geometry type or dimensionality, or if `start_measure` or `end_measure` is out of range.

All unassigned measures of the geometric segment will be populated automatically.

To store the resulting geometric segment (`geom_segment`) in the database, you must execute an UPDATE or INSERT statement, as appropriate.

The `_3D` format of this procedure (`SDO_LRS.DEFINE_GEOM_SEGMENT_3D`) is available. For information about `_3D` formats of LRS functions and procedures, see [3D Formats of LRS Functions](#) (page 7-7).

For more information about defining a geometric segment, see [Defining a Geometric Segment](#) (page 7-8).

## Examples

The following example defines the geometric segment, splits it into two segments, then concatenates those segments. (This example uses the definitions from the example in [Example of LRS Functions](#) (page 7-15). The definitions of `result_geom_1`, `result_geom_2`, and `result_geom_3` are displayed in [Example 7-3](#) (page 7-20).)

```
DECLARE
geom_segment SDO_GEOMETRY;
line_string SDO_GEOMETRY;
dim_array SDO_DIM_ARRAY;
result_geom_1 SDO_GEOMETRY;
result_geom_2 SDO_GEOMETRY;
result_geom_3 SDO_GEOMETRY;

BEGIN

SELECT a.route_geometry into geom_segment FROM lrs_routes a
  WHERE a.route_name = 'Route1';
SELECT m.diminfo into dim_array from
  user_sdo_geom_metadata m
  WHERE m.table_name = 'LRS_ROUTES' AND m.column_name = 'ROUTE_GEOMETRY';

-- Define the LRS segment for Route1. This will populate any null measures.
SDO_LRS.DEFINE_GEOM_SEGMENT (geom_segment,
  dim_array,
  0, -- Zero starting measure: LRS segment starts at start of route.
  27); -- End of LRS segment is at measure 27.

SELECT a.route_geometry INTO line_string FROM lrs_routes a
  WHERE a.route_name = 'Route1';

-- Split Route1 into two segments.
SDO_LRS.SPLIT_GEOM_SEGMENT(line_string,dim_array,5,result_geom_1,result_geom_2);

-- Concatenate the segments that were just split.
result_geom_3 := SDO_LRS.CONCATENATE_GEOM_SEGMENTS(result_geom_1, dim_array,
result_geom_2, dim_array);

-- Update and insert geometries into table, to display later.
UPDATE lrs_routes a SET a.route_geometry = geom_segment
  WHERE a.route_id = 1;

INSERT INTO lrs_routes VALUES(
```

```
11,  
  'result_geom_1',  
  result_geom_1  
);  
INSERT INTO lrs_routes VALUES(  
  12,  
  'result_geom_2',  
  result_geom_2  
);  
INSERT INTO lrs_routes VALUES(  
  13,  
  'result_geom_3',  
  result_geom_3  
);  
  
END;  
/
```

## 24.11 SDO\_LRS.DYNAMIC\_SEGMENT

### Format

```
SDO_LRS.DYNAMIC_SEGMENT(  
  geom_segment IN SDO_GEOMETRY,  
  start_measure IN NUMBER,  
  end_measure IN NUMBER,  
  tolerance IN NUMBER DEFAULT 1.0e-8  
) RETURN SDO_GEOMETRY;
```

or

```
SDO_LRS.DYNAMIC_SEGMENT(  
  geom_segment IN SDO_GEOMETRY,  
  dim_array IN SDO_DIM_ARRAY,  
  start_measure IN NUMBER,  
  end_measure IN NUMBER  
) RETURN SDO_GEOMETRY;
```

### Description

Returns the geometry object resulting from a clip operation on a geometric segment.

---

---

**Note:**

[SDO\\_LRS.CLIP\\_GEOM\\_SEGMENT](#) (page 24-5) and [SDO\\_LRS.DYNAMIC\\_SEGMENT](#) are synonyms: both functions have the same parameters, behavior, and return value.

---

---

### Parameters

**geom\_segment**

Cartographic representation of a linear feature.

**dim\_array**

Dimensional information array corresponding to `geom_segment`, usually selected from one of the `xxx_SDO_GEOM_METADATA` views (described in [Geometry Metadata Views](#) (page 2-47)).

**start\_measure**

Start measure of the geometric segment.

**end\_measure**

End measure of the geometric segment.

**tolerance**

Tolerance value (see [Tolerance](#) (page 1-6) and [Tolerance Values with LRS Functions](#) (page 7-15)). The default value is 0.00000001.

**Usage Notes**

An exception is raised if `geom_segment`, `start_measure`, or `end_measure` is invalid.

The direction and measures of the resulting geometric segment are preserved.

For more information about clipping a geometric segment, see [Clipping a Geometric Segment](#) (page 7-9).

**Examples**

The following example clips the geometric segment representing Route 1, returning the segment from measures 5 through 10. This segment might represent a construction zone. (This example uses the definitions from the example in [Example of LRS Functions](#) (page 7-15).)

```
SELECT  SDO_LRS.DYNAMIC_SEGMENT(route_geometry, 5, 10)
        FROM lrs_routes WHERE route_id = 1;

SDO_LRS.DYNAMIC_SEGMENT(ROUTE_GEOMETRY,5,10)(SDO_GTYPE, SDO_SRID, SDO_POINT(X, Y
-----
SDO_GEOMETRY(3302, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 2, 1), SDO_ORDINATE_ARRAY(
5, 4, 5, 8, 4, 8, 10, 4, 10))
```

## 24.12 SDO\_LRS.FIND\_LRS\_DIM\_POS

**Format**

```
SDO_LRS.FIND_LRS_DIM_POS(
    table_name IN VARCHAR2,
    column_name IN VARCHAR2
) RETURN INTEGER;
```

**Description**

Returns the position of the measure dimension within the `SDO_DIM_ARRAY` structure for a specified `SDO_GEOMETRY` column.

**Parameters****table\_name**

Table containing the column with the `SDO_GEOMETRY` objects.

**column\_name**

Column in `table_name` containing the `SDO_GEOMETRY` objects.

**Usage Notes**

None.

**Examples**

The following example returns the position of the measure dimension within the SDO\_DIM\_ARRAY structure for geometries in the ROUTE\_GEOMETRY column of the LRS\_ROUTES table. (This example uses the definitions from the example in [Example of LRS Functions](#) (page 7-15).)

```
SELECT SDO_LRS.FIND_LRS_DIM_POS('LRS_ROUTES', 'ROUTE_GEOMETRY') FROM DUAL;
```

```
SDO_LRS.FIND_LRS_DIM_POS('LRS_ROUTES', 'ROUTE_GEOMETRY')
```

-----  
3

## 24.13 SDO\_LRS.FIND\_MEASURE

**Format**

```
SDO_LRS.FIND_MEASURE(  
    geom_segment IN SDO_GEOMETRY,  
    point        IN SDO_GEOMETRY  
) RETURN NUMBER;
```

or

```
SDO_LRS.FIND_MEASURE(  
    geom_segment IN SDO_GEOMETRY,  
    dim_array    IN SDO_DIM_ARRAY,  
    point        IN SDO_GEOMETRY  
) RETURN NUMBER;
```

**Description**

Returns the measure of the closest point on a segment to a specified projection point.

**Parameters****geom\_segment**

Cartographic representation of a linear feature. This function returns the measure of the point on this segment that is closest to the projection point.

**dim\_array**

Dimensional information array corresponding to `geom_segment`, usually selected from one of the `xxx_SDO_GEOM_METADATA` views (described in [Geometry Metadata Views](#) (page 2-47)).

**point**

Projection point. This function returns the measure of the point on `geom_segment` that is closest to the projection point.

**Usage Notes**

This function returns the measure of the point on `geom_segment` that is closest to the projection point. For example, if the projection point represents a shopping mall, the

function could be used to find how far from the start of the highway is the point on the highway that is closest to the shopping mall.

An exception is raised if `geom_segment` has an invalid geometry type or dimensionality, or if `geom_segment` and `point` are based on different coordinate systems.

The `_3D` format of this function (`SDO_LRS.FIND_MEASURE_3D`) is available. For information about `_3D` formats of LRS functions, see [3D Formats of LRS Functions](#) (page 7-7).

### Examples

The following example finds the measure for the point on the geometric segment representing Route 1 that is closest to the point (10, 7). (This example uses the definitions from the example in [Example of LRS Functions](#) (page 7-15).)

```
-- Find measure for point on segment closest to 10,7.
-- Should return 15 (for point 12,7).
SELECT SDO_LRS.FIND_MEASURE(a.route_geometry, m.diminfo,
    SDO_GEOMETRY(3001, NULL, NULL,
        SDO_ELEM_INFO_ARRAY(1, 1, 1),
        SDO_ORDINATE_ARRAY(10, 7, NULL)) )
FROM lrs_routes a, user_sdo_geom_metadata m
WHERE m.table_name = 'LRS_ROUTES' AND m.column_name = 'ROUTE_GEOMETRY'
    AND a.route_id = 1;

SDO_LRS.FIND_MEASURE(A.ROUTE_GEOMETRY,M.DIMINFO,SDO_GEOMETRY(3001,NULL,NUL
```

-----  
15

## 24.14 SDO\_LRS.FIND\_OFFSET

### Format

```
SDO_LRS.FIND_OFFSET(
    geom_segment IN SDO_GEOMETRY,
    point         IN SDO_GEOMETRY,
    tolerance     IN NUMBER DEFAULT 1.0e-8
) RETURN NUMBER;
```

or

```
SDO_LRS.FIND_OFFSET(
    geom_segment IN SDO_GEOMETRY,
    dim_array    IN SDO_DIM_ARRAY,
    point        IN SDO_GEOMETRY
    [, point_dim_array IN SDO_GEOMETRY]
) RETURN NUMBER;
```

### Description

Returns the signed offset (shortest distance) from a point to a geometric segment.

### Parameters

#### **geom\_segment**

Geometric segment to be checked for distance from `point`.

**point**

Point whose shortest distance from `geom_segment` is to be returned.

**tolerance**

Tolerance value (see [Tolerance](#) (page 1-6) and [Tolerance Values with LRS Functions](#) (page 7-15)). The default value is 0.00000001.

**dim\_array**

Dimensional information array corresponding to `geom_segment`, usually selected from one of the `xxx_SDO_GEOM_METADATA` views (described in [Geometry Metadata Views](#) (page 2-47)).

**point\_dim\_array**

Dimensional information array corresponding to `point`, usually selected from one of the `xxx_SDO_GEOM_METADATA` views (described in [Geometry Metadata Views](#) (page 2-47)).

**Usage Notes**

This function calls the [SDO\\_LRS.PROJECT\\_PT](#) (page 24-48) function format that includes the `offset` output parameter: it passes in the geometric segment and point information, and it returns the [SDO\\_LRS.PROJECT\\_PT](#) (page 24-48) `offset` parameter value. Thus, to find the offset of a point from a geometric segment, you can use either this function or the [SDO\\_LRS.PROJECT\\_PT](#) (page 24-48) function with the `offset` parameter.

An exception is raised if `geom_segment` or `point` has an invalid geometry type or dimensionality, or if `geom_segment` and `point` are based on different coordinate systems.

For more information about offsets to a geometric segment, see [Offset](#) (page 7-3).

**Examples**

The following example returns the offset of point (9,3,NULL) from the geometric segment representing Route 1. (This example uses the definitions from the example in [Example of LRS Functions](#) (page 7-15).) As you can see from [Figure 7-20](#) (page 7-16) in [Example of LRS Functions](#) (page 7-15), the point at (9,3,NULL) is on the right side along the segment, and therefore the offset has a negative value, as explained in [Offset](#) (page 7-3). The point at (9,3,NULL) is one distance unit away from the point at (9,4,NULL), which is on the segment.

```
-- Find the offset of point (9,3,NULL) from the road; should return -1.
SELECT SDO_LRS.FIND_OFFSET(route_geometry,
    SDO_GEOMETRY(3301, NULL, NULL,
        SDO_ELEM_INFO_ARRAY(1, 1, 1),
        SDO_ORDINATE_ARRAY(9, 3, NULL)) )
FROM lrs_routes WHERE route_id = 1;

SDO_LRS.FIND_OFFSET(ROUTE_GEOMETRY,SDO_GEOMETRY(3301,NULL,NULL,SDO_ELEM_INFO_ARR
-----
```

-1

## 24.15 SDO\_LRS.GEOM\_SEGMENT\_END\_MEASURE

### Format

```
SDO_LRS.GEOM_SEGMENT_END_MEASURE(  
    geom_segment IN SDO_GEOMETRY  
    [, dim_array IN SDO_DIM_ARRAY]  
) RETURN NUMBER;
```

### Description

Returns the end measure of a geometric segment.

### Parameters

#### **geom\_segment**

Geometric segment whose end measure is to be returned.

#### **dim\_array**

Dimensional information array corresponding to `geom_segment`, usually selected from one of the `xxx_SDO_GEOM_METADATA` views (described in [Geometry Metadata Views](#) (page 2-47)).

### Usage Notes

This function returns the end measure of `geom_segment`.

An exception is raised if `geom_segment` has an invalid geometry type or dimensionality.

The `_3D` format of this function (`SDO_LRS.GEOM_SEGMENT_END_MEASURE_3D`) is available. For information about `_3D` formats of LRS functions, see [3D Formats of LRS Functions](#) (page 7-7).

### Examples

The following example returns the end measure of the geometric segment representing Route 1. (This example uses the definitions from the example in [Example of LRS Functions](#) (page 7-15).)

```
SELECT  SDO_LRS.GEOM_SEGMENT_END_MEASURE(route_geometry)  
FROM    lrs_routes WHERE route_id = 1;
```

```
SDO_LRS.GEOM_SEGMENT_END_MEASURE(ROUTE_GEOMETRY)  
-----
```

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## 24.16 SDO\_LRS.GEOM\_SEGMENT\_END\_PT

### Format

```
SDO_LRS.GEOM_SEGMENT_END_PT(  
    geom_segment IN SDO_GEOMETRY  
    [, dim_array IN SDO_DIM_ARRAY]  
) RETURN SDO_GEOMETRY;
```

**Description**

Returns the end point of a geometric segment.

**Parameters****geom\_segment**

Geometric segment whose end point is to be returned.

**dim\_array**

Dimensional information array corresponding to `geom_segment`, usually selected from one of the `xxx_SDO_GEOM_METADATA` views (described in [Geometry Metadata Views](#) (page 2-47)).

**Usage Notes**

This function returns the end point of `geom_segment`.

An exception is raised if `geom_segment` has an invalid geometry type or dimensionality.

The `_3D` format of this function (`SDO_LRS.GEOM_SEGMENT_END_PT_3D`) is available. For information about `_3D` formats of LRS functions, see [3D Formats of LRS Functions](#) (page 7-7).

**Examples**

The following example returns the end point of the geometric segment representing Route 1. (This example uses the definitions from the example in [Example of LRS Functions](#) (page 7-15).)

```
SELECT  SDO_LRS.GEOM_SEGMENT_END_PT(route_geometry)
        FROM lrs_routes WHERE route_id = 1;

SDO_LRS.GEOM_SEGMENT_END_PT(ROUTE_GEOMETRY)(SDO_GTYPE, SDO_SRID, SDO_POINT(X, Y,
-----
SDO_GEOMETRY(3301, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 1, 1), SDO_ORDINATE_ARRAY(
5, 14, 27))
```

## 24.17 SDO\_LRS.GEOM\_SEGMENT\_LENGTH

**Format**

```
SDO_LRS.GEOM_SEGMENT_LENGTH(
    geom_segment IN SDO_GEOMETRY
    [, dim_array IN SDO_DIM_ARRAY]
) RETURN NUMBER;
```

**Description**

Returns the length of a geometric segment.

**Parameters****geom\_segment**

Geometric segment whose length is to be calculated.



**dim\_array**

Dimensional information array corresponding to `geom_segment`, usually selected from one of the `xxx_SDO_GEOM_METADATA` views (described in [Geometry Metadata Views](#) (page 2-47)).

**Usage Notes**

This function returns the length of `geom_segment`. The length is the geometric length, which is not the same as the total of the measure unit values. To determine how long a segment is in terms of measure units, subtract the result of an [SDO\\_LRS.GEOM\\_SEGMENT\\_START\\_MEASURE](#) (page 24-27) operation from the result of an [SDO\\_LRS.GEOM\\_SEGMENT\\_END\\_MEASURE](#) (page 24-25) operation.

An exception is raised if `geom_segment` has an invalid geometry type or dimensionality.

The `_3D` format of this function (`SDO_LRS.GEOM_SEGMENT_LENGTH_3D`) is available. For information about `_3D` formats of LRS functions, see [3D Formats of LRS Functions](#) (page 7-7).

**Examples**

The following example returns the length of the geometric segment representing Route 1. (This example uses the definitions from the example in [Example of LRS Functions](#) (page 7-15).)

```
SELECT SDO_LRS.GEOM_SEGMENT_LENGTH(route_geometry)
FROM lrs_routes WHERE route_id = 1;
```

```
SDO_LRS.GEOM_SEGMENT_LENGTH(ROUTE_GEOMETRY)
```

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## 24.18 SDO\_LRS.GEOM\_SEGMENT\_START\_MEASURE

**Format**

```
SDO_LRS.GEOM_SEGMENT_START_MEASURE(
    geom_segment IN SDO_GEOMETRY
    [, dim_array IN SDO_DIM_ARRAY]
) RETURN NUMBER;
```

**Description**

Returns the start measure of a geometric segment.

**Parameters****geom\_segment**

Geometric segment whose start measure is to be returned.

**dim\_array**

Dimensional information array corresponding to `geom_segment`, usually selected from one of the `xxx_SDO_GEOM_METADATA` views (described in [Geometry Metadata Views](#) (page 2-47)).

### Usage Notes

This function returns the start measure of `geom_segment`.

An exception is raised if `geom_segment` has an invalid geometry type or dimensionality.

The `_3D` format of this function

(`SDO_LRS.GEOM_SEGMENT_START_MEASURE_3D`) is available. For information about `_3D` formats of LRS functions, see [3D Formats of LRS Functions](#) (page 7-7).

### Examples

The following example returns the start measure of the geometric segment representing Route 1. (This example uses the definitions from the example in [Example of LRS Functions](#) (page 7-15).)

```
SELECT  SDO_LRS.GEOM_SEGMENT_START_MEASURE(route_geometry)
        FROM lrs_routes WHERE route_id = 1;
```

```
SDO_LRS.GEOM_SEGMENT_START_MEASURE(ROUTE_GEOMETRY)
-----
0
```

## 24.19 SDO\_LRS.GEOM\_SEGMENT\_START\_PT

### Format

```
SDO_LRS.GEOM_SEGMENT_START_PT(
    geom_segment IN SDO_GEOMETRY
    [, dim_array IN SDO_DIM_ARRAY]
) RETURN SDO_GEOMETRY;
```

### Description

Returns the start point of a geometric segment.

### Parameters

#### **geom\_segment**

Geometric segment whose start point is to be returned.

#### **dim\_array**

Dimensional information array corresponding to `geom_segment`, usually selected from one of the `xxx_SDO_GEOM_METADATA` views (described in [Geometry Metadata Views](#) (page 2-47)).

### Usage Notes

This function returns the start point of `geom_segment`.

An exception is raised if `geom_segment` has an invalid geometry type or dimensionality.

The `_3D` format of this function (`SDO_LRS.GEOM_SEGMENT_START_PT_3D`) is available. For information about `_3D` formats of LRS functions, see [3D Formats of LRS Functions](#) (page 7-7).

## Examples

The following example returns the start point of the geometric segment representing Route 1. (This example uses the definitions from the example in [Example of LRS Functions](#) (page 7-15).)

```
SELECT SDO_LRS.GEOM_SEGMENT_START_PT(route_geometry)
FROM lrs_routes WHERE route_id = 1;

SDO_LRS.GEOM_SEGMENT_START_PT(ROUTE_GEOMETRY)(SDO_GTYPE, SDO_SRID, SDO_POINT(X,
-----
SDO_GEOMETRY(3301, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 1, 1), SDO_ORDINATE_ARRAY(
2, 2, 0))
```

## 24.20 SDO\_LRS.GET\_MEASURE

### Format

```
SDO_LRS.GET_MEASURE(
    point          IN SDO_GEOMETRY
    [, dim_array IN SDO_DIM_ARRAY]
) RETURN NUMBER;
```

### Description

Returns the measure of an LRS point.

### Parameters

#### point

Point whose measure is to be returned.

#### dim\_array

Dimensional information array corresponding to `point`, usually selected from one of the `xxx_SDO_GEOM_METADATA` views (described in [Geometry Metadata Views](#) (page 2-47)).

### Usage Notes

This function returns the measure of an LRS point.

If `point` is not valid, an "invalid LRS point" exception is raised.

Contrast this function with [SDO\\_LRS.PROJECT\\_PT](#) (page 24-48), which accepts as input a point that is not necessarily on the geometric segment, but which returns a point that is on the geometric segment, as opposed to a measure value. As the following example shows, the `SDO_LRS.GET_MEASURE` function can be used to return the measure of the projected point returned by [SDO\\_LRS.PROJECT\\_PT](#) (page 24-48).

The `_3D` format of this function (`SDO_LRS.GET_MEASURE_3D`) is available. For information about `_3D` formats of LRS functions, see [3D Formats of LRS Functions](#) (page 7-7).

## Examples

The following example returns the measure of a projected point. In this case, the point resulting from the projection is 9 units from the start of the segment.

```
SELECT SDO_LRS.GET_MEASURE(  
    SDO_LRS.PROJECT_PT(a.route_geometry, m.diminfo,  
        SDO_GEOMETRY(3001, NULL, NULL,  
            SDO_ELEM_INFO_ARRAY(1, 1, 1),  
            SDO_ORDINATE_ARRAY(9, 3, NULL)) ),  
    m.diminfo )  
FROM lrs_routes a, user_sdo_geom_metadata m  
WHERE m.table_name = 'LRS_ROUTES' AND m.column_name = 'ROUTE_GEOMETRY'  
    AND a.route_id = 1;  
  
SDO_LRS.GET_MEASURE(SDO_LRS.PROJECT_PT(A.ROUTE_GEOMETRY,M.DIMINFO,SDO_GEOM
```

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## 24.21 SDO\_LRS.GET\_NEXT\_SHAPE\_PT

### Format

```
SDO_LRS.GET_NEXT_SHAPE_PT(  
    geom_segment IN SDO_GEOMETRY,  
    measure      IN NUMBER  
    ) RETURN SDO_GEOMETRY;
```

or

```
SDO_LRS.GET_NEXT_SHAPE_PT(  
    geom_segment IN SDO_GEOMETRY,  
    dim_array    IN SDO_DIM_ARRAY,  
    measure      IN NUMBER  
    ) RETURN SDO_GEOMETRY;
```

or

```
SDO_LRS.GET_NEXT_SHAPE_PT(  
    geom_segment IN SDO_GEOMETRY,  
    point        IN SDO_GEOMETRY  
    ) RETURN SDO_GEOMETRY;
```

or

```
SDO_LRS.GET_NEXT_SHAPE_PT(  
    geom_segment IN SDO_GEOMETRY,  
    dim_array    IN SDO_DIM_ARRAY,  
    point        IN SDO_GEOMETRY  
    ) RETURN SDO_GEOMETRY;
```

### Description

Returns the next shape point on a geometric segment after a specified measure value or LRS point.

### Parameters

#### **geom\_segment**

Geometric segment.

#### **measure**

Measure value on the geometric segment for which to return the next shape point.

**point**

Point for which to return the next shape point. If `point` is not on `geom_segment`, the point on the geometric segment closest to the specified point is computed, and the next shape point after that point is returned.

**dim\_array**

Dimensional information array corresponding to `geom_segment`, usually selected from one of the `xxx_SDO_GEOM_METADATA` views (described in [Geometry Metadata Views](#) (page 2-47)).

**Usage Notes**

If `measure` or `point` identifies the end point of the geometric segment, a null value is returned.

An exception is raised if `measure` is not a valid value for `geom_segment` or if `point` is not a valid LRS point.

Contrast this function with [SDO\\_LRS.GET\\_PREV\\_SHAPE\\_PT](#) (page 24-33), which returns the previous shape point on a geometric segment before a specified measure value or LRS point.

The `_3D` format of this function (`SDO_LRS.GET_NEXT_SHAPE_PT_3D`) is available. For information about `_3D` formats of LRS functions, see [3D Formats of LRS Functions](#) (page 7-7).

**Examples**

The following example returns the next shape point after measure 14 on the geometric segment representing Route 1. (This example uses the definitions from the example in [Example of LRS Functions](#) (page 7-15).)

```
SELECT SDO_LRS.GET_NEXT_SHAPE_PT(a.route_geometry, 14)
       FROM lrs_routes a WHERE a.route_id = 1;

SDO_LRS.GET_NEXT_SHAPE_PT(A.ROUTE_GEOMETRY,14)(SDO_GTYPE, SDO_SRID, SDO_POINT(X,
-----
SDO_GEOMETRY(3301, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 1, 1), SDO_ORDINATE_ARRAY(
12, 10, 18))
```

## 24.22 SDO\_LRS.GET\_NEXT\_SHAPE\_PT\_MEASURE

**Format**

```
SDO_LRS.GET_NEXT_SHAPE_PT_MEASURE(
    geom_segment IN SDO_GEOMETRY,
    measure      IN NUMBER
) RETURN NUMBER;
```

or

```
SDO_LRS.GET_NEXT_SHAPE_PT_MEASURE(
    geom_segment IN SDO_GEOMETRY,
    dim_array    IN SDO_DIM_ARRAY,
    measure      IN NUMBER
) RETURN NUMBER;
```

or

```
SDO_LRS.GET_NEXT_SHAPE_PT_MEASURE(  
    geom_segment IN SDO_GEOMETRY,  
    point        IN SDO_GEOMETRY  
) RETURN NUMBER;
```

or

```
SDO_LRS.GET_NEXT_SHAPE_PT_MEASURE(  
    geom_segment IN SDO_GEOMETRY,  
    dim_array    IN SDO_DIM_ARRAY,  
    point        IN SDO_GEOMETRY  
) RETURN NUMBER;
```

### Description

Returns the measure value of the next shape point on a geometric segment after a specified measure value or LRS point.

### Parameters

#### **geom\_segment**

Geometric segment.

#### **measure**

Measure value on the geometric segment for which to return the measure value of the next shape point.

#### **point**

Point for which to return the measure value of the next shape point. If `point` is not on `geom_segment`, the point on the geometric segment closest to the specified point is computed, and the measure value of the next shape point after that point is returned.

#### **dim\_array**

Dimensional information array corresponding to `geom_segment`, usually selected from one of the `xxx_SDO_GEOM_METADATA` views (described in [Geometry Metadata Views](#) (page 2-47)).

### Usage Notes

If `measure` or `point` identifies the end point of the geometric segment, a null value is returned.

An exception is raised if `measure` is not a valid value for `geom_segment` or if `point` is not a valid LRS point.

Contrast this function with [SDO\\_LRS.GET\\_PREV\\_SHAPE\\_PT\\_MEASURE](#) (page 24-34), which returns the measure value of the previous shape point on a geometric segment before a specified measure value or LRS point.

The `_3D` format of this function (`SDO_LRS.GET_NEXT_SHAPE_PT_MEASURE_3D`) is available. For information about `_3D` formats of LRS functions, see [3D Formats of LRS Functions](#) (page 7-7).

### Examples

The following example returns the measure value of the next shape point after measure 14 on the geometric segment representing Route 1. (This example uses the definitions from the example in [Example of LRS Functions](#) (page 7-15).)

```
SELECT SDO_LRS.GET_NEXT_SHAPE_PT_MEASURE(a.route_geometry, 14)
       FROM lrs_routes a WHERE a.route_id = 1;
```

```
SDO_LRS.GET_NEXT_SHAPE_PT_MEASURE(A.ROUTE_GEOMETRY,14)
```

-----  
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## 24.23 SDO\_LRS.GET\_PREV\_SHAPE\_PT

### Format

```
SDO_LRS.GET_PREV_SHAPE_PT(
    geom_segment IN SDO_GEOMETRY,
    measure      IN NUMBER
) RETURN SDO_GEOMETRY;
```

or

```
SDO_LRS.GET_PREV_SHAPE_PT(
    geom_segment IN SDO_GEOMETRY,
    dim_array    IN SDO_DIM_ARRAY,
    measure      IN NUMBER
) RETURN SDO_GEOMETRY;
```

or

```
SDO_LRS.GET_PREV_SHAPE_PT(
    geom_segment IN SDO_GEOMETRY,
    point        IN SDO_GEOMETRY
) RETURN SDO_GEOMETRY;
```

or

```
SDO_LRS.GET_PREV_SHAPE_PT(
    geom_segment IN SDO_GEOMETRY,
    dim_array    IN SDO_DIM_ARRAY,
    point        IN SDO_GEOMETRY
) RETURN SDO_GEOMETRY;
```

### Description

Returns the previous shape point on a geometric segment before a specified measure value or LRS point.

### Parameters

#### **geom\_segment**

Geometric segment.

#### **measure**

Measure value on the geometric segment for which to return the previous shape point.

**point**

Point for which to return the previous shape point. If `point` is not on `geom_segment`, the point on the geometric segment closest to the specified point is computed, and the closest shape point before that point is returned.

**dim\_array**

Dimensional information array corresponding to `geom_segment`, usually selected from one of the `xxx_SDO_GEOM_METADATA` views (described in [Geometry Metadata Views](#) (page 2-47)).

**Usage Notes**

If `measure` or `point` identifies the start point of the geometric segment, a null value is returned.

An exception is raised if `measure` is not a valid value for `geom_segment` or if `point` is not a valid LRS point.

Contrast this function with [SDO\\_LRS.GET\\_NEXT\\_SHAPE\\_PT](#) (page 24-30), which returns the next shape point on a geometric segment after a specified measure value or LRS point.

The `_3D` format of this function (`SDO_LRS.GET_PREV_SHAPE_PT_3D`) is available. For information about `_3D` formats of LRS functions, see [3D Formats of LRS Functions](#) (page 7-7).

**Examples**

The following example returns the closest shape point to measure 14 and before measure 14 on the geometric segment representing Route 1. (This example uses the definitions from the example in [Example of LRS Functions](#) (page 7-15).)

```
SELECT SDO_LRS.GET_PREV_SHAPE_PT(a.route_geometry, 14)
FROM lrs_routes a WHERE a.route_id = 1;

SDO_LRS.GET_PREV_SHAPE_PT(A.ROUTE_GEOMETRY,14)(SDO_GTYPE, SDO_SRID, SDO_POINT(X,
-----
SDO_GEOMETRY(3301, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 1, 1), SDO_ORDINATE_ARRAY(
12, 4, 12))
```

## 24.24 SDO\_LRS.GET\_PREV\_SHAPE\_PT\_MEASURE

**Format**

```
SDO_LRS.GET_PREV_SHAPE_PT_MEASURE(
    geom_segment IN SDO_GEOMETRY,
    measure      IN NUMBER
) RETURN NUMBER;
```

or

```
SDO_LRS.GET_PREV_SHAPE_PT_MEASURE(
    geom_segment IN SDO_GEOMETRY,
    dim_array    IN SDO_DIM_ARRAY,
    measure      IN NUMBER
) RETURN NUMBER;
```

or



```
SDO_LRS.GET_PREV_SHAPE_PT_MEASURE(  
    geom_segment IN SDO_GEOMETRY,  
    point        IN SDO_GEOMETRY  
) RETURN NUMBER;
```

or

```
SDO_LRS.GET_PREV_SHAPE_PT_MEASURE(  
    geom_segment IN SDO_GEOMETRY,  
    dim_array    IN SDO_DIM_ARRAY,  
    point        IN SDO_GEOMETRY  
) RETURN NUMBER;
```

## Description

Returns the measure value of the previous shape point on a geometric segment before a specified measure value or LRS point.

## Parameters

### **geom\_segment**

Geometric segment.

### **measure**

Measure value on the geometric segment for which to return the measure value of the previous shape point.

### **point**

Point for which to return the measure value of the previous shape point. If `point` is not on `geom_segment`, the point on the geometric segment closest to the specified point is computed, and the measure value of the closest shape point before that point is returned.

### **dim\_array**

Dimensional information array corresponding to `geom_segment`, usually selected from one of the `xxx_SDO_GEOM_METADATA` views (described in [Geometry Metadata Views](#) (page 2-47)).

## Usage Notes

If `measure` or `point` identifies the start point of the geometric segment, a null value is returned.

An exception is raised if `measure` is not a valid value for `geom_segment` or if `point` is not a valid LRS point.

Contrast this function with [SDO\\_LRS.GET\\_NEXT\\_SHAPE\\_PT\\_MEASURE](#) (page 24-31), which returns the measure value of the next shape point on a geometric segment after a specified measure value or LRS point.

The `_3D` format of this function (`SDO_LRS.GET_PREV_SHAPE_PT_MEASURE_3D`) is available. For information about `_3D` formats of LRS functions, see [3D Formats of LRS Functions](#) (page 7-7).

## Examples

The following example returns the measure value of the closest shape point to measure 14 and before measure 14 on the geometric segment representing Route 1.

(This example uses the definitions from the example in [Example of LRS Functions](#) (page 7-15).)

```
SELECT SDO_LRS.GET_PREV_SHAPE_PT_MEASURE(a.route_geometry, 14)
       FROM lrs_routes a WHERE a.route_id = 1;
```

```
SDO_LRS.GET_PREV_SHAPE_PT_MEASURE(A.ROUTE_GEOMETRY,14)
```

-----  
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## 24.25 SDO\_LRS.IS\_GEOM\_SEGMENT\_DEFINED

### Format

```
SDO_LRS.IS_GEOM_SEGMENT_DEFINED(  
    geom_segment IN SDO_GEOMETRY  
    [, dim_array IN SDO_DIM_ARRAY]  
) RETURN VARCHAR2;
```

### Description

Checks if an LRS segment is defined correctly.

### Parameters

#### **geom\_segment**

Geometric segment to be checked.

#### **dim\_array**

Dimensional information array corresponding to `geom_segment`, usually selected from one of the `xxx_SDO_GEOM_METADATA` views (described in [Geometry Metadata Views](#) (page 2-47)).

### Usage Notes

This function returns TRUE if `geom_segment` is defined correctly and FALSE if `geom_segment` is not defined correctly.

The start and end measures of `geom_segment` must be defined (cannot be null), and any measures assigned must be in an ascending or descending order along the segment direction.

The `_3D` format of this function (`SDO_LRS.IS_GEOM_SEGMENT_DEFINED_3D`) is available. For information about `_3D` formats of LRS functions, see [3D Formats of LRS Functions](#) (page 7-7).

See also the [SDO\\_LRS.VALID\\_GEOM\\_SEGMENT](#) (page 24-63) function.

### Examples

The following example checks if the geometric segment representing Route 1 is defined. (This example uses the definitions from the example in [Example of LRS Functions](#) (page 7-15).)

```
SELECT SDO_LRS.IS_GEOM_SEGMENT_DEFINED(route_geometry)
       FROM lrs_routes WHERE route_id = 1;
```

```
SDO_LRS.IS_GEOM_SEGMENT_DEFINED(ROUTE_GEOMETRY)
```

-----  
TRUE

## 24.26 SDO\_LRS.IS\_MEASURE\_DECREASING

### Format

```
SDO_LRS.IS_MEASURE_DECREASING(  
    geom_segment IN SDO_GEOMETRY  
    [, dim_array IN SDO_DIM_ARRAY]  
    ) RETURN VARCHAR2;
```

### Description

Checks if the measure values along an LRS segment are decreasing (that is, descending in numerical value).

### Parameters

#### **geom\_segment**

Geometric segment to be checked.

#### **dim\_array**

Dimensional information array corresponding to `geom_segment`, usually selected from one of the `xxx_SDO_GEOM_METADATA` views (described in [Geometry Metadata Views](#) (page 2-47)).

### Usage Notes

This function returns TRUE if the measure values along an LRS segment are decreasing and FALSE if the measure values along an LRS segment are not decreasing.

The start and end measures of `geom_segment` must be defined (cannot be null).

The `_3D` format of this function (`SDO_LRS.IS_MEASURE_DECREASING_3D`) is available. For information about `_3D` formats of LRS functions, see [3D Formats of LRS Functions](#) (page 7-7).

See also the [SDO\\_LRS.IS\\_MEASURE\\_INCREASING](#) (page 24-38) function.

### Examples

The following example checks if the measure values along the geometric segment representing Route 1 are decreasing. (This example uses the definitions from the example in [Example of LRS Functions](#) (page 7-15).)

```
SELECT SDO_LRS.IS_MEASURE_DECREASING(a.route_geometry, m.diminfo)  
FROM lrs_routes a, user_sdo_geom_metadata m  
WHERE m.table_name = 'LRS_ROUTES' AND m.column_name = 'ROUTE_GEOMETRY'  
AND a.route_id = 1;
```

```
SDO_LRS.IS_MEASURE_DECREASING(A.ROUTE_GEOMETRY,M.DIMINFO)
```

-----  
FALSE

## 24.27 SDO\_LRS.IS\_MEASURE\_INCREASING

### Format

```
SDO_LRS.IS_MEASURE_INCREASING(  
    geom_segment IN SDO_GEOMETRY  
    [, dim_array IN SDO_DIM_ARRAY]  
) RETURN VARCHAR2;
```

### Description

Checks if the measure values along an LRS segment are increasing (that is, ascending in numerical value).

### Parameters

#### **geom\_segment**

Geometric segment to be checked.

#### **dim\_array**

Dimensional information array corresponding to `geom_segment`, usually selected from one of the `xxx_SDO_GEOM_METADATA` views (described in [Geometry Metadata Views](#) (page 2-47)).

### Usage Notes

This function returns TRUE if the measure values along an LRS segment are increasing and FALSE if the measure values along an LRS segment are not increasing.

The start and end measures of `geom_segment` must be defined (cannot be null).

The `_3D` format of this function (`SDO_LRS.IS_MEASURE_INCREASING_3D`) is available. For information about `_3D` formats of LRS functions, see [3D Formats of LRS Functions](#) (page 7-7).

See also the [SDO\\_LRS.IS\\_MEASURE\\_DECREASING](#) (page 24-37) function.

### Examples

The following example checks if the measure values along the geometric segment representing Route 1 are increasing. (This example uses the definitions from the example in [Example of LRS Functions](#) (page 7-15).)

```
SELECT SDO_LRS.IS_MEASURE_INCREASING(a.route_geometry, m.diminfo)  
FROM lrs_routes a, user_sdo_geom_metadata m  
WHERE m.table_name = 'LRS_ROUTES' AND m.column_name = 'ROUTE_GEOMETRY'  
AND a.route_id = 1;
```

```
SDO_LRS.IS_MEASURE_INCREASING(A.ROUTE_GEOMETRY,M.DIMINFO)
```

```
-----  
TRUE
```

## 24.28 SDO\_LRS.IS\_SHAPE\_PT\_MEASURE

### Format

```
SDO_LRS.IS_SHAPE_PT_MEASURE(
    geom_segment IN SDO_GEOMETRY,
    measure      IN NUMBER
) RETURN VARCHAR2;
```

or

```
SDO_LRS.IS_SHAPE_PT_MEASURE(
    geom_segment IN SDO_GEOMETRY,
    dim_array    IN SDO_DIM_ARRAY,
    measure      IN NUMBER
) RETURN VARCHAR2;
```

### Description

Checks if a specified measure value is associated with a shape point on a geometric segment.

### Parameters

#### **geom\_segment**

Geometric segment to be checked.

#### **measure**

Measure value on the geometric segment to check if it is a shape point.

#### **dim\_array**

Dimensional information array corresponding to `geom_segment`, usually selected from one of the `xxx_SDO_GEOM_METADATA` views (described in [Geometry Metadata Views](#) (page 2-47)).

### Usage Notes

This function returns TRUE if the specified measure value is associated with a shape point and FALSE if the measure value is not associated with a shape point.

An exception is raised if `measure` is not a valid value for `geom_segment`.

The `_3D` format of this function (`SDO_LRS.IS_SHAPE_PT_MEASURE_3D`) is available. For information about `_3D` formats of LRS functions, see [3D Formats of LRS Functions](#) (page 7-7).

### Examples

The following example checks if measure 14 on the geometric segment representing Route 1 is a shape point. (This example uses the definitions from the example in [Example of LRS Functions](#) (page 7-15).)

```
SELECT SDO_LRS.IS_SHAPE_PT_MEASURE(a.route_geometry, 14)
FROM lrs_routes a WHERE a.route_id = 1;

SDO_LRS.IS_SHAPE_PT_MEASURE(A.ROUTE_GEOMETRY,14)
```

-----  
FALSE

## 24.29 SDO\_LRS.LOCATE\_PT

### Format

```
SDO_LRS.LOCATE_PT(  
    geom_segment IN SDO_GEOMETRY,  
    measure      IN NUMBER  
    [, offset    IN NUMBER]  
) RETURN SDO_GEOMETRY;
```

or

```
SDO_LRS.LOCATE_PT(  
    geom_segment IN SDO_GEOMETRY,  
    dim_array    IN SDO_DIM_ARRAY,  
    measure      IN NUMBER  
    [, offset    IN NUMBER]  
) RETURN SDO_GEOMETRY;
```

### Description

Returns the point located at a specified distance from the start of a geometric segment.

### Parameters

#### **geom\_segment**

Geometric segment to be checked to see if it falls within the measure range of `measure`.

#### **dim\_array**

Dimensional information array corresponding to `geom_segment`, usually selected from one of the `xxx_SDO_GEOM_METADATA` views (described in [Geometry Metadata Views](#) (page 2-47)).

#### **measure**

Distance to measure from the start point of `geom_segment`.

#### **offset**

Distance to measure perpendicularly from the point that is located at `measure` units from the start point of `geom_segment`. The default is 0 (that is, the point is on `geom_segment`).

### Usage Notes

This function returns the referenced point. For example, on a highway, the point might represent the location of an accident.

The unit of measurement for `offset` is the same as for the coordinate system associated with `geom_segment`. For geodetic data, the default unit of measurement is meters.

With geodetic data using the WGS 84 coordinate system, this function can be used to return the longitude and latitude coordinates of any point on or offset from the segment.

An exception is raised if `geom_segment` has an invalid geometry type or dimensionality, or if the location is out of range.

The `_3D` format of this function (`SDO_LRS.LOCATE_PT_3D`) is available; however, the `offset` parameter is not available for `SDO_LRS.LOCATE_PT_3D`. For information about `_3D` formats of LRS functions, see [3D Formats of LRS Functions](#) (page 7-7).

For more information about locating a point on a geometric segment, see [Locating a Point on a Geometric Segment](#) (page 7-12).

### Examples

The following example creates a table for automobile accident data, inserts a record for an accident at the point at measure 9 and on (that is, offset 0) the geometric segment representing Route 1, and displays the data. (The accident table is deliberately oversimplified. This example also uses the route definition from the example in [Example of LRS Functions](#) (page 7-15).)

```
-- Create a table for accidents.
CREATE TABLE accidents (
  accident_id NUMBER PRIMARY KEY,
  route_id NUMBER,
  accident_geometry SDO_GEOMETRY);

-- Insert an accident record.
DECLARE
geom_segment SDO_GEOMETRY;

BEGIN

SELECT  SDO_LRS.LOCATE_PT(a.route_geometry, 9, 0) into geom_segment
  FROM lrs_routes a WHERE a.route_name = 'Route1';

INSERT INTO accidents VALUES(1, 1, geom_segment);

END;
/

SELECT * from accidents;

ACCIDENT_ID  ROUTE_ID
-----
ACCIDENT_GEOMETRY(SDO_GTYPE, SDO_SRID, SDO_POINT(X, Y, Z), SDO_ELEM_INFO, SDO_OR
-----
              1          1
SDO_GEOMETRY(3301, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 1, 1), SDO_ORDINATE_ARRAY(
9, 4, 9))
```

## 24.30 SDO\_LRS.LRS\_INTERSECTION

### Format

```
SDO_LRS.LRS_INTERSECTION(
  geom_1      IN SDO_GEOMETRY,
  dim_array_1 IN SDO_DIM_ARRAY,
  geom_2      IN SDO_GEOMETRY,
  dim_array_2 IN SDO_DIM_ARRAY
) RETURN SDO_GEOMETRY;
```

or

```
SDO_LRS.LRS_INTERSECTION(  
    geom_1      IN SDO_GEOMETRY,  
    geom_2      IN SDO_GEOMETRY,  
    tolerance IN NUMBER  
) RETURN SDO_GEOMETRY;
```

### Description

Returns an LRS geometry object that is the topological intersection (AND operation) of two geometry objects where one or both are LRS geometries.

### Parameters

#### **geom\_1**

Geometry object.

#### **dim\_array\_1**

Dimensional information array corresponding to `geom_1`, usually selected from one of the `xxx_SDO_GEOM_METADATA` views (described in [Geometry Metadata Views](#) (page 2-47)).

#### **geom\_2**

Geometry object.

#### **dim\_array\_2**

Dimensional information array corresponding to `geom_2`, usually selected from one of the `xxx_SDO_GEOM_METADATA` views (described in [Geometry Metadata Views](#) (page 2-47)).

#### **tolerance**

Tolerance value (see [Tolerance](#) (page 1-6)).

### Usage Notes

This function performs essentially the same intersection operation as the [SDO\\_GEOM.SDO\\_INTERSECTION](#) (page 23-27) function (described in [SDO\\_GEOM Package \(Geometry\)](#) (page 23-1)), except that `SDO_LRS.LRS_INTERSECTION` is designed to return a valid LRS geometry (point, line string, or multiline string) where one or both of the geometry-related input parameters are LRS geometries. (If neither input geometry is an LRS geometry, this function operates the same as the [SDO\\_GEOM.SDO\\_INTERSECTION](#) (page 23-27) function.).

The returned geometry is an LRS line string, multiline string, or point geometry that includes measure dimension information. The measure values reflect those in the first LRS geometry specified as an input parameter.

The first LRS geometry specified as an input parameter must not be a polygon; it must be a line string, multiline string, or point.

If an LRS line string (geometric segment) intersects a line string (LRS or standard), the result is an LRS point; if an LRS line string intersects a polygon, the result is an LRS line string.

An exception is raised if `geom_1` and `geom_2` are based on different coordinate systems.



## Examples

The following example shows an LRS geometric segment (illustrated in the highway example in [Example of LRS Functions](#) (page 7-15)) intersected by a vertical line from (8,2) to (8,6). The result is an LRS point geometry, in which the measure value (8) reflects the measure for that point (designated as Exit 3) in the geom\_1 geometry. (This example uses the definitions from the example in [Example of LRS Functions](#) (page 7-15).)

```
-- Intersection of LRS segment and standard line segment
SELECT SDO_LRS.LRS_INTERSECTION(route_geometry,
    SDO_GEOMETRY(2002, NULL, NULL, SDO_ELEM_INFO_ARRAY(1,2,1),
        SDO_ORDINATE_ARRAY(8,2, 8,6)), 0.005)
FROM lrs_routes WHERE route_id = 1;

SDO_LRS.LRS_INTERSECTION(ROUTE_GEOMETRY,SDO_GEOMETRY(2002,NULL,NULL,SDO_ELEM_INF
-----
SDO_GEOMETRY(3301, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 1, 1), SDO_ORDINATE_ARRAY(
8, 4, 8))
```

The following example shows an LRS geometric segment (illustrated in [Figure 7-20](#) (page 7-16) in [Example of LRS Functions](#) (page 7-15)) intersected by a vertical line from (12,2) to (12,6). The result is an LRS line string geometry, in which the measure values (12 and 14) reflect measures for points (the first of which is designated as Exit 4) in the geom\_1 geometry. (This example uses the definitions from the example in [Example of LRS Functions](#) (page 7-15).)

```
SELECT SDO_LRS.LRS_INTERSECTION(route_geometry,
    SDO_GEOMETRY(2002, NULL, NULL, SDO_ELEM_INFO_ARRAY(1,2,1),
        SDO_ORDINATE_ARRAY(12,2, 12,6)), 0.005)
FROM lrs_routes WHERE route_id = 1;

SDO_LRS.LRS_INTERSECTION(ROUTE_GEOMETRY,SDO_GEOMETRY(2002,NULL,NULL,SDO_ELEM_INF
-----
SDO_GEOMETRY(3302, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 2, 1), SDO_ORDINATE_ARRAY(
12, 4, 12, 12, 6, 14))
```

## 24.31 SDO\_LRS.MEASURE\_RANGE

### Format

```
SDO_LRS.MEASURE_RANGE(
    geom_segment IN SDO_GEOMETRY
    [, dim_array IN SDO_DIM_ARRAY]
) RETURN NUMBER;
```

### Description

Returns the measure range of a geometric segment, that is, the difference between the start measure and end measure.

### Parameters

#### geom\_segment

Cartographic representation of a linear feature.

**dim\_array**

Dimensional information array corresponding to `geom_segment`, usually selected from one of the `xxx_SDO_GEOM_METADATA` views (described in [Geometry Metadata Views](#) (page 2-47)).

**Usage Notes**

This function subtracts the start measure of `geom_segment` from the end measure of `geom_segment`.

The `_3D` format of this function (`SDO_LRS.MEASURE_RANGE_3D`) is available. For information about `_3D` formats of LRS functions, see [3D Formats of LRS Functions](#) (page 7-7).

**Examples**

The following example returns the measure range of the geometric segment representing Route 1. (This example uses the definitions from the example in [Example of LRS Functions](#) (page 7-15).)

```
SELECT SDO_LRS.MEASURE_RANGE(route_geometry)
FROM lrs_routes WHERE route_id = 1;

SDO_LRS.MEASURE_RANGE(ROUTE_GEOMETRY)
-----
```

27

## 24.32 SDO\_LRS.MEASURE\_TO\_PERCENTAGE

**Format**

```
SDO_LRS.MEASURE_TO_PERCENTAGE(
    geom_segment IN SDO_GEOMETRY,
    measure      IN NUMBER
) RETURN NUMBER;
```

or

```
SDO_LRS.MEASURE_TO_PERCENTAGE(
    geom_segment IN SDO_GEOMETRY,
    dim_array    IN SDO_DIM_ARRAY,
    measure      IN NUMBER
) RETURN NUMBER;
```

**Description**

Returns the percentage (0 to 100) that a specified measure is of the measure range of a geometric segment.

**Parameters****geom\_segment**

Cartographic representation of a linear feature.

**dim\_array**

Dimensional information array corresponding to `geom_segment`, usually selected from one of the `xxx_SDO_GEOM_METADATA` views (described in [Geometry Metadata Views](#) (page 2-47)).

**measure**

Measure value. This function returns the percentage that this measure value is of the measure range.

**Usage Notes**

This function returns a number (0 to 100) that is the percentage of the measure range that the specified measure represents. (The measure range is the end measure minus the start measure.) For example, if the measure range of `geom_segment` is 50 and `measure` is 20, the function returns 40 (because  $20/50 = 40\%$ ).

This function performs the reverse of the [SDO\\_LRS.PERCENTAGE\\_TO\\_MEASURE](#) (page 24-47) function, which returns the measure that corresponds to a percentage value.

An exception is raised if `geom_segment` or `measure` is invalid.

**Examples**

The following example returns the percentage that 5 is of the measure range of the geometric segment representing Route 1. (This example uses the definitions from the example in [Example of LRS Functions](#) (page 7-15).) The measure range of this segment is 27, and 5 is approximately 18.5 percent of 27.

```
SELECT SDO_LRS.MEASURE_TO_PERCENTAGE(a.route_geometry, m.diminfo, 5)
FROM lrs_routes a, user_sdo_geom_metadata m
WHERE m.table_name = 'LRS_ROUTES' AND m.column_name = 'ROUTE_GEOMETRY'
AND a.route_id = 1;
```

```
SDO_LRS.MEASURE_TO_PERCENTAGE(A.ROUTE_GEOMETRY,M.DIMINFO,5)
-----
18.5185185
```

## 24.33 SDO\_LRS.OFFSET\_GEOM\_SEGMENT

**Format**

```
SDO_LRS.OFFSET_GEOM_SEGMENT(
    geom_segment IN SDO_GEOMETRY,
    start_measure IN NUMBER,
    end_measure   IN NUMBER,
    offset         IN NUMBER,
    tolerance      IN NUMBER DEFAULT 1.0e-8
    [, unit        IN VARCHAR2]
) RETURN SDO_GEOMETRY;
```

or

```
SDO_LRS.OFFSET_GEOM_SEGMENT(
    geom_segment IN SDO_GEOMETRY,
    dim_array     IN SDO_DIM_ARRAY,
    start_measure IN NUMBER,
    end_measure   IN NUMBER,
    offset        IN NUMBER
```

```
[, unit          IN VARCHAR2]
) RETURN SDO_GEOMETRY;
```

### Description

Returns the geometric segment at a specified offset from a geometric segment.

### Parameters

#### **geom\_segment**

Cartographic representation of a linear feature.

#### **dim\_array**

Dimensional information array corresponding to `geom_segment`, usually selected from one of the `xxx_SDO_GEOM_METADATA` views (described in [Geometry Metadata Views](#) (page 2-47)).

#### **start\_measure**

Start measure of `geom_segment` at which to start the offset operation.

#### **end\_measure**

End measure of `geom_segment` at which to start the offset operation.

#### **offset**

Distance to measure perpendicularly from the points along `geom_segment`. Positive offset values are to the left of `geom_segment`; negative offset values are to the right of `geom_segment`.

#### **tolerance**

Tolerance value (see [Tolerance](#) (page 1-6) and [Tolerance Values with LRS Functions](#) (page 7-15)). The default value is 0.00000001.

#### **unit**

Unit of measurement specification: a quoted string with one or both of the following keywords:

- `unit` and an `SDO_UNIT` value from the `MDSYS.SDO_DIST_UNITS` table. See [Unit of Measurement Support](#) (page 2-55) for more information about unit of measurement specification.
- `arc_tolerance` and an arc tolerance value. See the Usage Notes for the `SDO_GEOM.SDO_ARC_DENSIFY` (page 23-7) function in [SDO\\_GEOM Package \(Geometry\)](#) (page 23-1) for more information about the `arc_tolerance` keyword.

For example: 'unit=km arc\_tolerance=0.05'

If the input geometry is geodetic data, this parameter is required, and `arc_tolerance` must be specified. If the input geometry is Cartesian or projected data, `arc_tolerance` has no effect and should not be specified.

If this parameter is not specified for a Cartesian or projected geometry, or if the `arc_tolerance` keyword is specified for a geodetic geometry but the `unit` keyword is not specified, the unit of measurement associated with the data is assumed.

### Usage Notes

start\_measure and end\_measure can be any points on the geometric segment. They do not have to be in any specific order. For example, start\_measure and end\_measure can be 5 and 10, respectively, or 10 and 5, respectively.

The direction and measures of the resulting geometric segment are preserved (that is, they reflect the original segment).

The geometry type of geom\_segment must be line or multiline. For example, it cannot be a polygon.

An exception is raised if geom\_segment, start\_measure, or end\_measure is invalid.

### Examples

The following example returns the geometric segment 2 distance units to the left (positive offset 2) of the segment from measures 5 through 10 of Route 1. Note in SDO\_ORDINATE\_ARRAY of the returned segment that the Y values (6) are 2 greater than the Y values (4) of the relevant part of the original segment. (This example uses the definitions from the example in [Example of LRS Functions](#) (page 7-15).)

```
-- Create a segment offset 2 to the left from measures 5 through 10.
-- First, display the original segment; then, offset.
SELECT a.route_geometry FROM lrs_routes a WHERE a.route_id = 1;

ROUTE_GEOMETRY(SDO_GTYPE, SDO_SRID, SDO_POINT(X, Y, Z), SDO_ELEM_INFO, SDO_ORDINATE_ARRAY)
-----
SDO_GEOMETRY(3302, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 2, 1), SDO_ORDINATE_ARRAY(
2, 2, 0, 2, 4, 2, 8, 4, 8, 12, 4, 12, 12, 10, 18, 8, 10, 22, 5, 14, 27))

SELECT SDO_LRS.OFFSET_GEOM_SEGMENT(a.route_geometry, m.diminfo, 5, 10, 2)
FROM lrs_routes a, user_sdo_geom_metadata m
WHERE m.table_name = 'LRS_ROUTES' AND m.column_name = 'ROUTE_GEOMETRY'
AND a.route_id = 1;

SDO_LRS.OFFSET_GEOM_SEGMENT(A.ROUTE_GEOMETRY,M.DIMINFO,5,10,2)(SDO_GTYPE, SDO_SRID,
-----
SDO_GEOMETRY(3302, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 2, 1), SDO_ORDINATE_ARRAY(
5, 6, 5, 10, 6, 10))
```

## 24.34 SDO\_LRS.PERCENTAGE\_TO\_MEASURE

### Format

```
SDO_LRS.PERCENTAGE_TO_MEASURE(
    geom_segment IN SDO_GEOMETRY,
    percentage   IN NUMBER
) RETURN NUMBER;
```

or

```
SDO_LRS.PERCENTAGE_TO_MEASURE(
    geom_segment IN SDO_GEOMETRY,
    dim_array    IN SDO_DIM_ARRAY,
    percentage   IN NUMBER
) RETURN NUMBER;
```

**Description**

Returns the measure value of a specified percentage (0 to 100) of the measure range of a geometric segment.

**Parameters****geom\_segment**

Cartographic representation of a linear feature.

**dim\_array**

Dimensional information array corresponding to `geom_segment`, usually selected from one of the `xxx_SDO_GEOM_METADATA` views (described in [Geometry Metadata Views](#) (page 2-47)).

**percentage**

Percentage value. Must be from 0 to 100. This function returns the measure value corresponding to this percentage of the measure range.

**Usage Notes**

This function returns the measure value corresponding to the specified percentage of the measure range. (The measure range is the end measure minus the start measure.) For example, if the measure range of `geom_segment` is 50 and `percentage` is 40, the function returns 20 (because 40% of 50 = 20).

This function performs the reverse of the [SDO\\_LRS.MEASURE\\_TO\\_PERCENTAGE](#) (page 24-44) function, which returns the percentage value that corresponds to a measure.

An exception is raised if `geom_segment` has an invalid geometry type or dimensionality, or if `percentage` is less than 0 or greater than 100.

**Examples**

The following example returns the measure that is 50 percent of the measure range of the geometric segment representing Route 1. (This example uses the definitions from the example in [Example of LRS Functions](#) (page 7-15).) The measure range of this segment is 27, and 50 percent of 27 is 13.5.

```
SELECT SDO_LRS.PERCENTAGE_TO_MEASURE(a.route_geometry, m.diminfo, 50)
FROM lrs_routes a, user_sdo_geom_metadata m
WHERE m.table_name = 'LRS_ROUTES' AND m.column_name = 'ROUTE_GEOMETRY'
AND a.route_id = 1;
```

```
SDO_LRS.PERCENTAGE_TO_MEASURE(A.ROUTE_GEOMETRY,M.DIMINFO,50)
```

-----  
13.5

## 24.35 SDO\_LRS.PROJECT\_PT

**Format**

```
SDO_LRS.PROJECT_PT(
    geom_segment IN SDO_GEOMETRY,
    point        IN SDO_GEOMETRY,
    tolerance    IN NUMBER DEFAULT 1.0e-8
```

```
[, offset    OUT NUMBER]
) RETURN SDO_GEOMETRY;
```

or

```
SDO_LRS.PROJECT_PT(
    geom_segment IN SDO_GEOMETRY,
    dim_array    IN SDO_DIM_ARRAY,
    point        IN SDO_GEOMETRY
    [, point_dim_array IN SDO_DIM_ARRAY]
) RETURN SDO_GEOMETRY;
```

or

```
SDO_LRS.PROJECT_PT(
    geom_segment IN SDO_GEOMETRY,
    dim_array    IN SDO_DIM_ARRAY,
    point        IN SDO_GEOMETRY,
    point_dim_array IN SDO_DIM_ARRAY
    [, offset    OUT NUMBER]
) RETURN SDO_GEOMETRY;
```

## Description

Returns the projection point of a specified point. The projection point is on the geometric segment.

## Parameters

### **geom\_segment**

Geometric segment to be checked.

### **dim\_array**

Dimensional information array corresponding to `geom_segment`, usually selected from one of the `xxx_SDO_GEOM_METADATA` views (described in [Geometry Metadata Views](#) (page 2-47)).

### **point**

Point to be projected.

### **tolerance**

Tolerance value (see [Tolerance](#) (page 1-6) and [Tolerance Values with LRS Functions](#) (page 7-15)). The default value is 0.00000001.

### **point\_dim\_array**

Dimensional information array corresponding to `point`, usually selected from one of the `xxx_SDO_GEOM_METADATA` views (described in [Geometry Metadata Views](#) (page 2-47)).

### **offset**

Offset (shortest distance) from the point to the geometric segment.

## Usage Notes

This function returns the projection point (including its measure) of a specified point (`point`). The projection point is on the geometric segment.

If multiple projection points exist, the first projection point encountered from the start point is returned.

If you specify the output parameter *offset*, the function stores the signed offset (shortest distance) from the point to the geometric segment. For more information about the offset to a geometric segment, see [Offset](#) (page 7-3).

An exception is raised if *geom\_segment* or *point* has an invalid geometry type or dimensionality, or if *geom\_segment* and *point* are based on different coordinate systems.

The *\_3D* format of this function (SDO\_LRS.PROJECT\_PT\_3D) is available. For information about *\_3D* formats of LRS functions, see [3D Formats of LRS Functions](#) (page 7-7).

For more information about projecting a point onto a geometric segment, see [Projecting a Point onto a Geometric Segment](#) (page 7-13).

### Examples

The following example returns the point (9,4,9) on the geometric segment representing Route 1 that is closest to the specified point (9,3,NULL). (This example uses the definitions from the example in [Example of LRS Functions](#) (page 7-15).)

```
-- Point 9,3,NULL is off the road; should return 9,4,9.
SELECT  SDO_LRS.PROJECT_PT(route_geometry,
    SDO_GEOMETRY(3301, NULL, NULL,
        SDO_ELEM_INFO_ARRAY(1, 1, 1),
        SDO_ORDINATE_ARRAY(9, 3, NULL)) )
FROM lrs_routes WHERE route_id = 1;

SDO_LRS.PROJECT_PT(ROUTE_GEOMETRY,SDO_GEOMETRY(3301,NULL,NULL,SDO_EL
-----
SDO_GEOMETRY(3301, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 1, 1), SDO_ORDINATE_ARRAY(
9, 4, 9))
```

## 24.36 SDO\_LRS.REDEFINE\_GEOM\_SEGMENT

### Format

```
SDO_LRS.REDEFINE_GEOM_SEGMENT(
    geom_segment      IN OUT SDO_GEOMETRY
    [, start_measure  IN NUMBER,
    end_measure       IN NUMBER]);
```

or

```
SDO_LRS.REDEFINE_GEOM_SEGMENT(
    geom_segment      IN OUT SDO_GEOMETRY,
    dim_array         IN SDO_DIM_ARRAY
    [, start_measure  IN NUMBER,
    end_measure       IN NUMBER]);
```

### Description

Populates the measures of all shape points based on the start and end measures of a geometric segment, overriding any previously assigned measures between the start point and end point.

### Parameters



**geom\_segment**

Cartographic representation of a linear feature.

**dim\_array**

Dimensional information array corresponding to `geom_segment`, usually selected from one of the `xxx_SDO_GEOM_METADATA` views (described in [Geometry Metadata Views](#) (page 2-47)).

**start\_measure**

Distance measured from the start point of a geometric segment to the start point of the linear feature. The default is the existing value (if any) in the measure dimension; otherwise, the default is 0.

**end\_measure**

Distance measured from the end point of a geometric segment to the start point of the linear feature. The default is the existing value (if any) in the measure dimension; otherwise, the default is the cartographic length of the segment.

**Usage Notes**

An exception is raised if `geom_segment` has an invalid geometry type or dimensionality, or if `start_measure` or `end_measure` is out of range.

The `_3D` format of this procedure (`SDO_LRS.REDEFINE_GEOM_SEGMENT_3D`) is available. For information about `_3D` formats of LRS functions and procedures, see [3D Formats of LRS Functions](#) (page 7-7).

For more information about redefining a geometric segment, see [Redefining a Geometric Segment](#) (page 7-9).

**Examples**

The following example redefines a geometric segment, effectively converting miles to kilometers in the measure values. (This example uses the definitions from the example in [Example of LRS Functions](#) (page 7-15).)

```
-- First, display the original segment; then, redefine.
SELECT a.route_geometry FROM lrs_routes a WHERE a.route_id = 1;

ROUTE_GEOMETRY(SDO_GTYPE, SDO_SRID, SDO_POINT(X, Y, Z), SDO_ELEM_INFO, SDO_ORDIN
-----
SDO_GEOMETRY(3302, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 2, 1), SDO_ORDINATE_ARRAY(
2, 2, 0, 2, 4, 2, 8, 4, 8, 12, 4, 12, 12, 10, 18, 8, 10, 22, 5, 14, 27))

-- Redefine geometric segment to "convert" miles to kilometers.
DECLARE
geom_segment SDO_GEOMETRY;
dim_array SDO_DIM_ARRAY;

BEGIN

SELECT a.route_geometry into geom_segment FROM lrs_routes a
  WHERE a.route_name = 'Route1';
SELECT m.diminfo into dim_array from
  user_sdo_geom_metadata m
  WHERE m.table_name = 'LRS_ROUTES' AND m.column_name = 'ROUTE_GEOMETRY';

-- "Convert" mile measures to kilometers (27 * 1.609 = 43.443).
SDO_LRS.REDEFINE_GEOM_SEGMENT (geom_segment,
```

```
dim_array,
0,      -- Zero starting measure: LRS segment starts at start of route.
43.443); -- End of LRS segment. 27 miles = 43.443 kilometers.

-- Update and insert geometries into table, to display later.
UPDATE lrs_routes a SET a.route_geometry = geom_segment
  WHERE a.route_id = 1;

END;
/

PL/SQL procedure successfully completed.

-- Display the redefined segment, with all measures "converted."
SELECT a.route_geometry FROM lrs_routes a WHERE a.route_id = 1;

ROUTE_GEOMETRY(SDO_GTYPE, SDO_SRID, SDO_POINT(X, Y, Z), SDO_ELEM_INFO, SDO_ORDIN
-----
SDO_GEOMETRY(3302, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 2, 1), SDO_ORDINATE_ARRAY(
2, 2, 0, 2, 4, 3.218, 8, 4, 12.872, 12, 4, 19.308, 12, 10, 28.962, 8, 10, 35.398
, 5, 14, 43.443))
```

## 24.37 SDO\_LRS.RESET\_MEASURE

### Format

```
SDO_LRS.RESET_MEASURE(
  geom_segment IN OUT SDO_GEOMETRY
  [, dim_array IN SDO_DIM_ARRAY]);
```

### Description

Sets all measures of a geometric segment, including the start and end measures, to null values, overriding any previously assigned measures.

### Parameters

#### **geom\_segment**

Cartographic representation of a linear feature.

#### **dim\_array**

Dimensional information array corresponding to `geom_segment`, usually selected from one of the `xxx_SDO_GEOM_METADATA` views (described in [Geometry Metadata Views](#) (page 2-47)).

### Usage Notes

An exception is raised if `geom_segment` has an invalid geometry type or dimensionality.

### Examples

The following example sets all measures of a geometric segment to null values. (This example uses the definitions from the example in [Example of LRS Functions](#) (page 7-15).)

```
-- First, display the original segment; then, redefine.
SELECT a.route_geometry FROM lrs_routes a WHERE a.route_id = 1;
```

```

ROUTE_GEOMETRY(SDO_GTYPE, SDO_SRID, SDO_POINT(X, Y, Z), SDO_ELEM_INFO, SDO_ORDIN
-----
SDO_GEOMETRY(3302, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 2, 1), SDO_ORDINATE_ARRAY(
2, 2, 0, 2, 4, 2, 8, 4, 8, 12, 4, 12, 12, 10, 18, 8, 10, 22, 5, 14, 27))

-- Reset geometric segment measures.
DECLARE
geom_segment SDO_GEOMETRY;

BEGIN

SELECT a.route_geometry into geom_segment FROM lrs_routes a
WHERE a.route_name = 'Route1';

SDO_LRS.RESET_MEASURE (geom_segment);

-- Update and insert geometries into table, to display later.
UPDATE lrs_routes a SET a.route_geometry = geom_segment
WHERE a.route_id = 1;

END;
/

PL/SQL procedure successfully completed.

-- Display the segment, with all measures set to null.
SELECT a.route_geometry FROM lrs_routes a WHERE a.route_id = 1;

ROUTE_GEOMETRY(SDO_GTYPE, SDO_SRID, SDO_POINT(X, Y, Z), SDO_ELEM_INFO, SDO_ORDIN
-----
SDO_GEOMETRY(3302, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 2, 1), SDO_ORDINATE_ARRAY(
2, 2, NULL, 2, 4, NULL, 8, 4, NULL, 12, 4, NULL, 12, 10, NULL, 8, 10, NULL, 5, 1
4, NULL))

```

## 24.38 SDO\_LRS.REVERSE\_GEOMETRY

### Format

```

SDO_LRS.REVERSE_GEOMETRY(
    geom          IN SDO_GEOMETRY
    [, dim_array  IN SDO_DIM_ARRAY]
) RETURN SDO_GEOMETRY;

```

### Description

Returns a new geometric segment by reversing the measure values and the direction of the original geometric segment.

### Parameters

#### geom

Cartographic representation of a linear feature.

#### dim\_array

Dimensional information array corresponding to `geom`, usually selected from one of the `xxx_SDO_GEOM_METADATA` views (described in [Geometry Metadata Views](#) (page 2-47)).

## Usage Notes

This function:

- Reverses the measure values of geom  
That is, the start measure of geom is the end measure of the returned geometric segment, the end measure of geom is the start measure of the returned geometric segment, and all other measures are adjusted accordingly.
- Reverses the direction of geom

Compare this function with [SDO\\_LRS.REVERSE\\_MEASURE](#) (page 24-55), which reverses only the measure values (not the direction) of a geometric segment.

To reverse the vertices of a non-LRS line string geometry, use the [SDO\\_UTIL.REVERSE\\_LINESTRING](#) (page 31-48) function, which is described in [SDO\\_UTIL Package \(Utility\)](#) (page 31-1).

An exception is raised if geom has an invalid geometry type or dimensionality. The geometry type must be a line or multiline, and the dimensionality must be 3 (two dimensions plus the measure dimension).

The *\_3D* format of this function (SDO\_LRS.REVERSE\_GEOMETRY\_3D) is available. For information about *\_3D* formats of LRS functions, see [3D Formats of LRS Functions](#) (page 7-7).

## Examples

The following example reverses the measure values and the direction of the geometric segment representing Route 1. (This example uses the definitions from the example in [Example of LRS Functions](#) (page 7-15).)

```
-- Reverse direction and measures (for example, to prepare for
-- concatenating with another road).
-- First, display the original segment; then, reverse.
SELECT a.route_geometry FROM lrs_routes a WHERE a.route_id = 1;

ROUTE_GEOMETRY(SDO_GTYPE, SDO_SRID, SDO_POINT(X, Y, Z), SDO_ELEM_INFO, SDO_ORDIN
-----
SDO_GEOMETRY(3302, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 2, 1), SDO_ORDINATE_ARRAY(
2, 2, 0, 2, 4, 2, 8, 4, 8, 12, 4, 12, 12, 10, 18, 8, 10, 22, 5, 14, 27))

SELECT  SDO_LRS.REVERSE_GEOMETRY(a.route_geometry, m.diminfo)
        FROM lrs_routes a, user_sdo_geom_metadata m
        WHERE m.table_name = 'LRS_ROUTES' AND m.column_name = 'ROUTE_GEOMETRY'
              AND a.route_id = 1;

SDO_LRS.REVERSE_GEOMETRY(A.ROUTE_GEOMETRY,M.DIMINFO)(SDO_GTYPE, SDO_SRID, SDO_PO
-----
SDO_GEOMETRY(3302, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 2, 1), SDO_ORDINATE_ARRAY(
5, 14, 27, 8, 10, 22, 12, 10, 18, 12, 4, 12, 8, 4, 8, 2, 4, 2, 2, 2, 0))
```

Note in the returned segment that the M values (measures) now go in descending order from 27 to 0, and the segment start and end points have the opposite X and Y values as in the original segment (5,14 and 2,2 here, as opposed to 2,2 and 5,14 in the original).

## 24.39 SDO\_LRS.REVERSE\_MEASURE

### Format

```
SDO_LRS.REVERSE_MEASURE(  
    geom_segment IN SDO_GEOMETRY  
    [, dim_array IN SDO_DIM_ARRAY]  
) RETURN SDO_GEOMETRY;
```

### Description

Returns a new geometric segment by reversing the measure values, but not the direction, of the original geometric segment.

### Parameters

#### **geom\_segment**

Cartographic representation of a linear feature.

#### **dim\_array**

Dimensional information array corresponding to `geom_segment`, usually selected from one of the `xxx_SDO_GEOM_METADATA` views (described in [Geometry Metadata Views](#) (page 2-47)).

### Usage Notes

This function:

- Reverses the measure values of `geom_segment`  
That is, the start measure of `geom_segment` is the end measure of the returned geometric segment, the end measure of `geom_segment` is the start measure of the returned geometric segment, and all other measures are adjusted accordingly.
- Does not affect the direction of `geom_segment`

Compare this function with [SDO\\_LRS.REVERSE\\_GEOMETRY](#) (page 24-53), which reverses both the direction and the measure values of a geometric segment.

An exception is raised if `geom_segment` has an invalid geometry type or dimensionality.

The `_3D` format of this function (`SDO_LRS.REVERSE_MEASURE_3D`) is available. For information about `_3D` formats of LRS functions, see [3D Formats of LRS Functions](#) (page 7-7).

---

---

#### **Note:**

The behavior of the `SDO_LRS.REVERSE_MEASURE` function changed after release 8.1.7. In release 8.1.7, `REVERSE_MEASURE` reversed both the measures and the segment direction. However, if you want to have this same behavior with subsequent releases, you must use the [SDO\\_LRS.REVERSE\\_GEOMETRY](#) (page 24-53) function.

---

---

### Examples

The following example reverses the measure values of the geometric segment representing Route 1, but does not affect the direction. (This example uses the definitions from the example in [Example of LRS Functions](#) (page 7-15).)

```
-- First, display the original segment; then, reverse.
SELECT a.route_geometry FROM lrs_routes a WHERE a.route_id = 1;

ROUTE_GEOMETRY(SDO_GTYPE, SDO_SRID, SDO_POINT(X, Y, Z), SDO_ELEM_INFO, SDO_ORDIN
-----
SDO_GEOMETRY(3302, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 2, 1), SDO_ORDINATE_ARRAY(
2, 2, 0, 2, 4, 2, 8, 4, 8, 12, 4, 12, 12, 10, 18, 8, 10, 22, 5, 14, 27))

SELECT SDO_LRS.REVERSE_MEASURE(a.route_geometry, m.diminfo)
  FROM lrs_routes a, user_sdo_geom_metadata m
  WHERE m.table_name = 'LRS_ROUTES' AND m.column_name = 'ROUTE_GEOMETRY'
     AND a.route_id = 1;

SDO_LRS.REVERSE_MEASURE(A.ROUTE_GEOMETRY,M.DIMINFO)(SDO_GTYPE, SDO_SRID, SDO_POI
-----
SDO_GEOMETRY(3302, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 2, 1), SDO_ORDINATE_ARRAY(
2, 2, 27, 2, 4, 25, 8, 4, 19, 12, 4, 15, 12, 10, 9, 8, 10, 5, 5, 14, 0))
```

Note in the returned segment that the M values (measures) now go in descending order from 27 to 0, but the segment start and end points have the same X and Y values as in the original segment (2,2 and 5,14).

## 24.40 SDO\_LRS.SCALE\_GEOM\_SEGMENT

### Format

```
SDO_LRS.SCALE_GEOM_SEGMENT(
  geom_segment  IN SDO_GEOMETRY,
  start_measure IN NUMBER,
  end_measure   IN NUMBER,
  shift_measure IN NUMBER,
  tolerance     IN NUMBER DEFAULT 1.0e-8
) RETURN SDO_GEOMETRY;
```

or

```
SDO_LRS.SCALE_GEOM_SEGMENT(
  geom_segment  IN SDO_GEOMETRY,
  dim_array     IN SDO_DIM_ARRAY,
  start_measure IN NUMBER,
  end_measure   IN NUMBER,
  shift_measure IN NUMBER,
) RETURN SDO_GEOMETRY;
```

### Description

Returns the geometry object resulting from a measure scaling operation on a geometric segment.

### Parameters

**geom\_segment**

Cartographic representation of a linear feature.

**dim\_array**

Dimensional information array corresponding to `geom_segment`, usually selected from one of the `xxx_SDO_GEOM_METADATA` views (described in [Geometry Metadata Views](#) (page 2-47)).

**start\_measure**

Start measure of the geometric segment.

**end\_measure**

End measure of the geometric segment.

**shift\_measure**

Amount to be added to each measure value after the initial scaling. A value of 0 (zero) means that nothing is added (no shifting of measure values).

**tolerance**

Tolerance value (see [Tolerance](#) (page 1-6) and [Tolerance Values with LRS Functions](#) (page 7-15)). The default value is 0.00000001.

**Usage Notes**

This function performs the following actions:

1. It redistributes the measure values of the LRS geometric segment, using between `start_measure` for the start point and `end_measure` for the end point, and adjusting (scaling) the measure values in between accordingly.
2. If `shift_measure` is not 0 (zero), it translates (shifts) each measure value computed in step 1 by adding the `shift_measure` value.

The action of this function is sometimes referred to as "stretching" the measure values. The function affects only the measure values; the other coordinates of the geometry are not changed.

An exception is raised if `geom_segment`, `start_measure`, or `end_measure` is invalid.

The direction of the resulting geometric segment is preserved (that is, it reflects the original segment).

For more information about scaling geometric segments, see [Scaling a Geometric Segment](#) (page 7-11).

**Examples**

The following example scales the geometric segment representing Route 1, returning a segment in which the start measure is specified as 100, the end measure is specified as 200, with a shift measure value of 10. Consequently, after all measure values are scaled according to the start and end measure values, 10 is added to all measure values. Thus, for example, the start point measure is 110 and the end point measure is 210 in the returned geometry. (This example uses the definitions from the example in [Example of LRS Functions](#) (page 7-15).)

```
SQL> SELECT SDO_LRS.SCALE_GEOM_SEGMENT(route_geometry, 100, 200, 10)
        FROM lrs_routes WHERE route_id = 1;
```

```
SDO_LRS.SCALE_GEOM_SEGMENT(ROUTE_GEOMETRY,100,200,10)(SDO_GTYPE, SDO_SRID, SDO_P
-----
SDO_GEOMETRY(3302, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 2, 1), SDO_ORDINATE_ARRAY(
2, 2, 110, 2, 4, 117.407407, 8, 4, 139.62963, 12, 4, 154.444444, 12, 10, 176.666
667, 8, 10, 191.481481, 5, 14, 210))
```

## 24.41 SDO\_LRS.SET\_PT\_MEASURE

### Format

```
SDO_LRS.SET_PT_MEASURE(
    geom_segment IN OUT SDO_GEOMETRY,
    point        IN SDO_GEOMETRY,
    measure      IN NUMBER) RETURN VARCHAR2;
```

or

```
SDO_LRS.SET_PT_MEASURE(
    geom_segment IN OUT SDO_GEOMETRY,
    dim_array    IN SDO_DIM_ARRAY,
    point        IN SDO_GEOMETRY,
    pt_dim_array IN SDO_DIM_ARRAY,
    measure      IN NUMBER) RETURN VARCHAR2;
```

or

```
SDO_LRS.SET_PT_MEASURE(
    point  IN OUT SDO_GEOMETRY,
    measure IN NUMBER) RETURN VARCHAR2;
```

or

```
SDO_LRS.SET_PT_MEASURE(
    point      IN OUT SDO_GEOMETRY,
    dim_array  IN SDO_DIM_ARRAY,
    measure    IN NUMBER) RETURN VARCHAR2;
```

### Description

Sets the measure value of a specified point.

### Parameters

#### **geom\_segment**

Geometric segment containing the point.

#### **dim\_array**

Dimensional information array corresponding to `geom_segment` (in the second format) or `point` (in the fourth format), usually selected from one of the `xxx_SDO_GEOM_METADATA` views (described in [Geometry Metadata Views](#) (page 2-47)).

#### **point**

Point for which the measure value is to be set.



**pt\_dim\_array**

Dimensional information array corresponding to point (in the second format), usually selected from one of the xxx\_SDO\_GEOM\_METADATA views (described in [Geometry Metadata Views](#) (page 2-47)).

**measure**

Measure value to be assigned to the specified point.

**Usage Notes**

The function returns TRUE if the measure value was successfully set, and FALSE if the measure value was not set.

If both `geom_segment` and `point` are specified, the behavior of the procedure depends on whether or not `point` is a shape point on `geom_segment`:

- If `point` is a shape point on `geom_segment`, the measure value of `point` is set.
- If `point` is not a shape point on `geom_segment`, the shape point on `geom_segment` that is nearest to `point` is found, and the measure value of that shape point is set.

The `_3D` format of this function (`SDO_LRS.SET_PT_MEASURE_3D`) is available; however, only the formats that include the `geom_segment` parameter are available for `SDO_LRS.SET_PT_MEASURE_3D`. For information about `_3D` formats of LRS functions, see [3D Formats of LRS Functions](#) (page 7-7).

An exception is raised if `geom_segment` or `point` is invalid.

**Examples**

The following example sets the measure value of point (8,10) to 20. (This example uses the definitions from the example in [Example of LRS Functions](#) (page 7-15).)

```
-- Set the measure value of point 8,10 to 20 (originally 22).
DECLARE
  geom_segment SDO_GEOMETRY;
  dim_array SDO_DIM_ARRAY;
  result VARCHAR2(32);

BEGIN

  SELECT a.route_geometry into geom_segment FROM lrs_routes a
    WHERE a.route_name = 'Route1';
  SELECT m.diminfo into dim_array from
    user_sdo_geom_metadata m
    WHERE m.table_name = 'LRS_ROUTES' AND m.column_name = 'ROUTE_GEOMETRY';

  -- Set the measure value of point 8,10 to 20 (originally 22).
  result := SDO_LRS.SET_PT_MEASURE (geom_segment,
    SDO_GEOMETRY(3301, NULL, NULL,
      SDO_ELEM_INFO_ARRAY(1, 1, 1),
      SDO_ORDINATE_ARRAY(8, 10, 22)),
    20);

  -- Display the result.
  DBMS_OUTPUT.PUT_LINE('Returned value = ' || result);

END;
/
```

Returned value = TRUE

PL/SQL procedure successfully completed.

## 24.42 SDO\_LRS.SPLIT\_GEOM\_SEGMENT

### Format

```
SDO_LRS.SPLIT_GEOM_SEGMENT(  
    geom_segment IN SDO_GEOMETRY,  
    split_measure IN NUMBER,  
    segment_1    OUT SDO_GEOMETRY,  
    segment_2    OUT SDO_GEOMETRY);
```

or

```
SDO_LRS.SPLIT_GEOM_SEGMENT(  
    geom_segment IN SDO_GEOMETRY,  
    dim_array    IN SDO_DIM_ARRAY,  
    split_measure IN NUMBER,  
    segment_1    OUT SDO_GEOMETRY,  
    segment_2    OUT SDO_GEOMETRY);
```

### Description

Splits a geometric segment into two geometric segments.

### Parameters

#### **geom\_segment**

Geometric segment to be split.

#### **dim\_array**

Dimensional information array corresponding to `geom_segment`, usually selected from one of the `xxx_SDO_GEOM_METADATA` views (described in [Geometry Metadata Views](#) (page 2-47)).

#### **split\_measure**

Distance measured from the start point of a geometric segment to the split point.

#### **segment\_1**

First geometric segment: from the start point of `geom_segment` to the split point.

#### **segment\_2**

Second geometric segment: from the split point to the end point of `geom_segment`.

### Usage Notes

An exception is raised if `geom_segment` or `split_measure` is invalid.

The directions and measures of the resulting geometric segments are preserved.

The `_3D` format of this procedure (`SDO_LRS.SPLIT_GEOM_SEGMENT_3D`) is available. For information about `_3D` formats of LRS functions and procedures, see [3D Formats of LRS Functions](#) (page 7-7).

For more information about splitting a geometric segment, see [Splitting a Geometric Segment](#) (page 7-10).

### Examples

The following example defines the geometric segment, splits it into two segments, then concatenates those segments. (This example uses the definitions from the example in [Example of LRS Functions](#) (page 7-15). The definitions of result\_geom\_1, result\_geom\_2, and result\_geom\_3 are displayed in [Example 7-3](#) (page 7-20).)

```
DECLARE
geom_segment SDO_GEOMETRY;
line_string SDO_GEOMETRY;
dim_array SDO_DIM_ARRAY;
result_geom_1 SDO_GEOMETRY;
result_geom_2 SDO_GEOMETRY;
result_geom_3 SDO_GEOMETRY;

BEGIN

SELECT a.route_geometry into geom_segment FROM lrs_routes a
  WHERE a.route_name = 'Route1';
SELECT m.diminfo into dim_array from
  user_sdo_geom_metadata m
  WHERE m.table_name = 'LRS_ROUTES' AND m.column_name = 'ROUTE_GEOMETRY';

-- Define the LRS segment for Route1.
SDO_LRS.DEFINE_GEOM_SEGMENT (geom_segment,
  dim_array,
  0,    -- Zero starting measure: LRS segment starts at start of route.
  27);  -- End of LRS segment is at measure 27.

SELECT a.route_geometry INTO line_string FROM lrs_routes a
  WHERE a.route_name = 'Route1';

-- Split Route1 into two segments.
SDO_LRS.SPLIT_GEOM_SEGMENT(line_string,dim_array,5,result_geom_1,result_geom_2);

-- Concatenate the segments that were just split.
result_geom_3 := SDO_LRS.CONCATENATE_GEOM_SEGMENTS(result_geom_1, dim_array,
result_geom_2, dim_array);

-- Insert geometries into table, to display later.
INSERT INTO lrs_routes VALUES(
  11,
  'result_geom_1',
  result_geom_1
);
INSERT INTO lrs_routes VALUES(
  12,
  'result_geom_2',
  result_geom_2
);
INSERT INTO lrs_routes VALUES(
  13,
  'result_geom_3',
  result_geom_3
);
```

```
END;  
/
```

## 24.43 SDO\_LRS.TRANSLATE\_MEASURE

### Format

```
SDO_LRS.TRANSLATE_MEASURE(  
    geom_segment IN SDO_GEOMETRY,  
    translate_m   IN NUMBER  
) RETURN SDO_GEOMETRY;
```

or

```
SDO_LRS.TRANSLATE_MEASURE(  
    geom_segment IN SDO_GEOMETRY,  
    dim_array     IN SDO_DIM_ARRAY,  
    translate_m   IN NUMBER  
) RETURN SDO_GEOMETRY;
```

### Description

Returns a new geometric segment by translating the original geometric segment (that is, shifting the start and end measures by a specified value).

### Parameters

#### **geom\_segment**

Cartographic representation of a linear feature.

#### **dim\_array**

Dimensional information array corresponding to `geom_segment`, usually selected from one of the `xxx_SDO_GEOM_METADATA` views (described in [Geometry Metadata Views](#) (page 2-47)).

#### **translate\_m**

Distance measured from the start point of a geometric segment to the start point of the linear feature.

### Usage Notes

This function adds `translate_m` to the start and end measures of `geom_segment`. For example, if `geom_segment` has a start measure of 50 and an end measure of 100, and if `translate_m` is 10, the returned geometric segment has a start measure of 60 and an end measure of 110, as shown in the following figure.

**Figure 24-1 Translating a Geometric Segment**



An exception is raised if `geom_segment` has an invalid geometry type or dimensionality.

The *\_3D* format of this function (SDO\_LRS.TRANSLATE\_MEASURE\_3D) is available. For information about *\_3D* formats of LRS functions, see [3D Formats of LRS Functions](#) (page 7-7).

### Examples

The following example translates (shifts) by 10 the geometric segment representing Route 1. (This example uses the definitions from the example in [Example of LRS Functions](#) (page 7-15).)

```
SELECT SDO_LRS.TRANSLATE_MEASURE(a.route_geometry, m.diminfo, 10)
FROM lrs_routes a, user_sdo_geom_metadata m
WHERE m.table_name = 'LRS_ROUTES' AND m.column_name = 'ROUTE_GEOMETRY'
AND a.route_id = 1;

SDO_LRS.TRANSLATE_MEASURE(A.ROUTE_GEOMETRY,M.DIMINFO,10)(SDO_GTYPE, SDO_SRID, SD
-----
SDO_GEOMETRY(3302, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 2, 1), SDO_ORDINATE_ARRAY(
2, 2, 10, 2, 4, 12, 8, 4, 18, 12, 4, 22, 12, 10, 28, 8, 10, 32, 5, 14, 37))
```

## 24.44 SDO\_LRS.VALID\_GEOM\_SEGMENT

### Format

```
SDO_LRS.VALID_GEOM_SEGMENT(
    geom_segment IN SDO_GEOMETRY
    [, dim_array IN SDO_DIM_ARRAY]
) RETURN VARCHAR2;
```

### Description

Checks if a geometry object is a valid geometric segment.

### Parameters

#### geom\_segment

Geometric segment to be checked for validity.

#### dim\_array

Dimensional information array corresponding to *geom\_segment*, usually selected from one of the xxx\_SDO\_GEOM\_METADATA views (described in [Geometry Metadata Views](#) (page 2-47)).

### Usage Notes

This function returns TRUE if *geom\_segment* is valid and FALSE if *geom\_segment* is not valid.

Measure information is assumed to be stored in the last element of the SDO\_DIM\_ARRAY in the Oracle Spatial and Graph metadata.

This function only checks for geometry type and number of dimensions of the geometric segment. To further validate measure information, use the [SDO\\_LRS.IS\\_GEOM\\_SEGMENT\\_DEFINED](#) (page 24-36) function.

The *\_3D* format of this function (SDO\_LRS.VALID\_GEOM\_SEGMENT\_3D) is available. For information about *\_3D* formats of LRS functions, see [3D Formats of LRS Functions](#) (page 7-7).

### Examples

The following example checks if the geometric segment representing Route 1 is valid. (This example uses the definitions from the example in [Example of LRS Functions](#) (page 7-15).)

```
SELECT  SDO_LRS.VALID_GEOM_SEGMENT(route_geometry)
        FROM lrs_routes WHERE route_id = 1;
```

```
SDO_LRS.VALID_GEOM_SEGMENT(ROUTE_GEOMETRY)
```

```
-----
TRUE
```

## 24.45 SDO\_LRS.VALID\_LRS\_PT

### Format

```
SDO_LRS.VALID_LRS_PT(
    point          IN SDO_GEOMETRY
    [, dim_array IN SDO_DIM_ARRAY]
) RETURN VARCHAR2;
```

### Description

Checks if an LRS point is valid.

### Parameters

#### point

Point to be checked for validity.

#### dim\_array

Dimensional information array corresponding to *point*, usually selected from one of the xxx\_SDO\_GEOM\_METADATA views (described in [Geometry Metadata Views](#) (page 2-47)).

### Usage Notes

This function returns TRUE if *point* is valid and FALSE if *point* is not valid.

This function checks if *point* is a point with measure information, and it checks for the geometry type and number of dimensions for the point geometry.

All LRS point data must be stored in the SDO\_ELEM\_INFO\_ARRAY and SDO\_ORDINATE\_ARRAY, and cannot be stored in the SDO\_POINT field in the SDO\_GEOMETRY definition of the point.

The *\_3D* format of this function (SDO\_LRS.VALID\_LRS\_PT\_3D) is available. For information about *\_3D* formats of LRS functions, see [3D Formats of LRS Functions](#) (page 7-7).

### Examples

The following example checks if point (9,3,NULL) is a valid LRS point. (This example uses the definitions from the example in [Example of LRS Functions](#) (page 7-15).)

```
SELECT  SDO_LRS.VALID_LRS_PT(
        SDO_GEOMETRY(3301, NULL, NULL,
        SDO_ELEM_INFO_ARRAY(1, 1, 1),
```

```

        SDO_ORDINATE_ARRAY(9, 3, NULL)),
    m.diminfo)
FROM lrs_routes a, user_sdo_geom_metadata m
WHERE m.table_name = 'LRS_ROUTES' AND m.column_name = 'ROUTE_GEOMETRY'
AND a.route_id = 1;

SDO_LRS.VALID_LRS_PT(SDO_GEOMETRY(3301,NULL,NULL,SDO_ELEM_INFO_ARRAY(1,1,1),SDO_
-----
TRUE

```

## 24.46 SDO\_LRS.VALID\_MEASURE

### Format

```

SDO_LRS.VALID_MEASURE(
    geom_segment IN SDO_GEOMETRY,
    measure      IN NUMBER
) RETURN VARCHAR2;

```

or

```

SDO_LRS.VALID_MEASURE(
    geom_segment IN SDO_GEOMETRY,
    dim_array    IN SDO_DIM_ARRAY,
    measure      IN NUMBER
) RETURN VARCHAR2;

```

### Description

Checks if a measure falls within the measure range of a geometric segment.

### Parameters

#### **geom\_segment**

Geometric segment to be checked to see if measure falls within its measure range.

#### **dim\_array**

Dimensional information array corresponding to `geom_segment`, usually selected from one of the `xxx_SDO_GEOM_METADATA` views (described in [Geometry Metadata Views](#) (page 2-47)).

#### **measure**

Measure value to be checked to see if it falls within the measure range of `geom_segment`.

### Usage Notes

This function returns TRUE if measure falls within the measure range of `geom_segment` and FALSE if measure does not fall within the measure range of `geom_segment`.

An exception is raised if `geom_segment` has an invalid geometry type or dimensionality.

The `_3D` format of this function (`SDO_LRS.VALID_MEASURE_3D`) is available. For information about `_3D` formats of LRS functions, see [3D Formats of LRS Functions](#) (page 7-7).

### Examples

The following example checks if 50 is a valid measure on the Route 1 segment. The function returns FALSE because the measure range for that segment is 0 to 27. For example, if the route is 27 miles long with mile markers at 1-mile intervals, there is no 50-mile marker because the last marker is the 27-mile marker. (This example uses the definitions from the example in [Example of LRS Functions](#) (page 7-15).)

```
SELECT SDO_LRS.VALID_MEASURE(route_geometry, 50)
FROM lrs_routes WHERE route_id = 1;
```

```
SDO_LRS.VALID_MEASURE(ROUTE_GEOMETRY,50)
```

```
-----
FALSE
```

## 24.47 SDO\_LRS.VALIDATE\_LRS\_GEOMETRY

### Format

```
SDO_LRS.VALIDATE_LRS_GEOMETRY(
    geom_segment IN SDO_GEOMETRY
    [, dim_array IN SDO_DIM_ARRAY]
) RETURN VARCHAR2;
```

### Description

Checks if an LRS geometry is valid.

### Parameters

#### **geom\_segment**

Geometric segment to be checked.

#### **dim\_array**

Dimensional information array corresponding to `geom_segment`, usually selected from one of the `xxx_SDO_GEOM_METADATA` views (described in [Geometry Metadata Views](#) (page 2-47)).

### Usage Notes

This function returns TRUE if `geom_segment` is valid and one of the following errors if `geom_segment` is not valid:

- ORA-13331 (invalid LRS segment)
- ORA-13335 (measure information not defined)

The `_3D` format of this function (`SDO_LRS.VALIDATE_LRS_GEOMETRY_3D`) is available. For information about `_3D` formats of LRS functions, see [3D Formats of LRS Functions](#) (page 7-7).

### Examples

The following example checks if the Route 1 segment is a valid LRS geometry. (This example uses the definitions from the example in [Example of LRS Functions](#) (page 7-15).)



```
SELECT SDO_LRS.VALIDATE_LRS_GEOMETRY(a.route_geometry, m.diminfo)
       FROM lrs_routes a, user_sdo_geom_metadata m
       WHERE m.table_name = 'LRS_ROUTES' AND m.column_name = 'ROUTE_GEOMETRY'
       AND a.route_id = 1;
```

```
SDO_LRS.VALIDATE_LRS_GEOMETRY(A.ROUTE_GEOMETRY,M.DIMINFO)
```

---

```
TRUE
```



## SDO\_MIGRATE Package (Upgrading)

The [SDO\\_MIGRATE.TO\\_CURRENT](#) (page 25-1) subprogram described in this chapter has both procedure and function interfaces. As a procedure, it lets you upgrade spatial geometry tables from previous releases of Spatial and Graph; and as a function, it lets you upgrade a single SDO\_GEOMETRY object.

This subprogram has very limited uses, as explained in the Usage Notes for its documentation.

### 25.1 SDO\_MIGRATE.TO\_CURRENT

#### Format (Any Object-Relational Model Implementation to Current)

```
SDO_MIGRATE.TO_CURRENT(
    tabname          IN VARCHAR2
    [, column_name   IN VARCHAR2]);
```

or

```
SDO_MIGRATE.TO_CURRENT(
    tabname          IN VARCHAR2,
    column_name      IN VARCHAR2
    [, commit_int    IN NUMBER]);
```

#### Format (Single Object-Relational Model Geometry to Current)

```
SDO_MIGRATE.TO_CURRENT(
    geom IN SDO_GEOMETRY,
    dim  IN SDO_DIM_ARRAY

) RETURN SDO_GEOMETRY;
```

#### Format (Any Relational Model Implementation to Current)

```
SDO_MIGRATE.TO_CURRENT(
    layer          IN VARCHAR2,
    newtabname     IN VARCHAR2,
    gidcolumn      IN VARCHAR2,
    geocolname     IN VARCHAR2,
    layer_gtype    IN VARCHAR2,
    updateflag     IN VARCHAR2);
```

#### Description

Upgrades data from the obsolete Spatial relational model (release 8.1.5 or earlier) to the current release, or upgrades one or more object-relational model (release 8.1.6 or later) geometries that need to be upgraded (as explained in the Usage Notes). As a procedure, TO\_CURRENT upgrades an entire layer (all geometries in a column); as a

function, TO\_CURRENT upgrades a single geometry object, which must be of type SDO\_GEOMETRY.

For upgrading a layer, the procedure format depends on whether you are upgrading from the Spatial relational model (release 8.1.5 or earlier) or object-relational model (release 8.1.6 or later). See the Usage Notes for the model that applies to you.

---

**Note:**

This procedure applies to two-dimensional geometries only. It is not supported for three-dimensional geometries.

---

**Parameters****tablename**

Table with geometry objects.

**column\_name**

Column in `tablename` that contains geometry objects. If `column_name` is not specified or is specified as null, the column containing geometry objects is upgraded.

**commit\_int**

Number of geometries to upgrade before Spatial and Graph performs an internal commit operation. If `commit_int` is not specified, no internal commit operations are performed during the upgrade.

If you specify a `commit_int` value, you can use a smaller rollback segment than would otherwise be needed.

**geom**

Single geometry object to be upgraded to the current release.

**dim**

Dimensional information array for the geometry object to be upgraded. The SDO\_DIM\_ARRAY type is explained in [DIMINFO](#) (page 2-48).

**layer**

Name of the layer to be upgraded.

**newtablename**

Name of the new table to which you are upgrading the data.

**gidcolumn**

Name of the column in which to store the GID from the old table.

**geocolname**

Name of the column in the new table where the geometry objects will be inserted.

**layer\_gtype**

One of the following values: POINT or NOTPOINT (default).

If the layer you are upgrading is composed solely of point data, set this parameter to POINT for optimal performance; otherwise, set this parameter to NOTPOINT. If you set the value to POINT and the layer contains any nonpoint geometries, the upgrade might produce invalid data.

**updateflag**

One of the following values: UPDATE or INSERT (default).

If you are upgrading the layer into an existing populated attribute table, set this parameter to UPDATE; otherwise, set this parameter to INSERT.

**Usage Notes for Object-Relational Model Layer and Single Geometry Upgrade**

This subprogram is not needed for normal upgrades of Oracle Spatial and Graph. It is sometimes needed if spatial data is loaded using a third-party loader and if the resulting geometries have the wrong orientation or invalid ETYPE or GTYPE values. For information about using this subprogram as part of the recommended procedure for loading and validating spatial data, see [Recommendations for Loading and Validating Spatial Data](#) (page 4-4).

This subprogram upgrades the specified geometry or all geometry objects in the specified layer so that their SDO\_GTYPE and SDO\_ETYPE values are in the format of the current release:

- SDO\_GTYPE values of 4 digits are created, using the format (*DLTT*) shown in [SDO\\_GTYPE](#) (page 2-5).
- SDO\_ETYPE values are as discussed in [SDO\\_ELEM\\_INFO](#) (page 2-8).

Geometries are ordered so that exterior rings are followed by their interior rings, and coordinates are saved in the correct rotation (counterclockwise for exterior rings, and clockwise for interior rings).

**Usage Notes for Relational Model Upgrade**

If you are you upgrading from the Spatial relational model (release 8.1.5 or earlier), consider the following when using this procedure:

- The new table must be created before you call this procedure.
- If the data to be upgraded is geodetic, the tolerance value (SDO\_TOLERANCE column value in the <layername>\_SDODIM table or view) must be expressed in decimal degrees (for example, 0.00000005).
- The procedure converts geometries from the relational model to the object-relational model.
- A commit operation is performed by this procedure.
- If any of the upgrade steps fails, nothing is upgraded for the layer.
- *layer* is the underlying layer name, without the \_SDOGEOM suffix.
- The old SDO\_GID is stored in *gidcolumn*.
- SDO\_GTYPE values of 4 digits are created, using the format (*DLTT*) shown in [SDO\\_GTYPE](#) (page 2-5).
- SDO\_ETYPE values are created, using the values discussed in [SDO\\_ELEM\\_INFO](#) (page 2-8).
- The procedure orders geometries so that exterior rings are followed by their interior rings, and it saves coordinates in the correct rotation (counterclockwise for exterior rings, and clockwise for interior rings).

**Examples**

The following example changes the definitions of geometry objects in the ROADS table from the format of a release later than 8.1.5 to the format of the current release.

```
EXECUTE SDO_MIGRATE.TO_CURRENT('ROADS');
```

---

## SDO\_OLS Package (OpenLS)

The MDSYS.SDO\_OLS package contains subprograms for Spatial and Graph OpenLS support.

To use the subprograms in this chapter, you must understand the conceptual and usage information about OpenLS in [OpenLS Support](#) (page 14-1).

[Table 26-1](#) (page 26-1) lists the OpenLS subprograms.

**Table 26-1 Subprograms for OpenLS Support**

Subprogram	Description
<a href="#">SDO_OLS.MakeOpenLSClobRequest</a> (page 26-1)	Submits an OpenLS request using a CLOB object, and returns the result as a CLOB object.
<a href="#">SDO_OLS.MakeOpenLSRequest</a> (page 26-2)	Submits an OpenLS request using an XMLType object, and returns the result as an XMLType object.

The rest of this chapter provides reference information on the subprograms, listed in alphabetical order.

### 26.1 SDO\_OLS.MakeOpenLSClobRequest

#### Format

```
SDO_OLS.MakeOpenLSClobRequest(  
    request IN CLOB  
) RETURN CLOB;
```

#### Description

Submits an OpenLS request using a CLOB object, and returns the result as a CLOB object.

#### Parameters

##### request

OpenLS request in the form of a CLOB object.

#### Usage Notes

To specify the input request as an XMLType object to return an XMLType object, use the [SDO\\_OLS.MakeOpenLSRequest](#) (page 26-2) function.

For information about OpenLS support, see [OpenLS Support](#) (page 14-1).

## Examples

The following example requests the nearest business, in a specified category (that is, with specified SIC\_code value), to a specified location (longitude: -122.4083257, latitude: 37.788208).

```
DECLARE
    request CLOB;
    result CLOB;
BEGIN
    request := TO_CLOB(
        '<?xml version="1.0" encoding="UTF-8"?>
        <XLS xmlns="http://www.opengis.net/xls" xmlns:gml="http://www.opengis.net/gml"
          xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" version="1.1">
          <RequestHeader clientName="someName" clientPassword="password"/>
          <Request requestID="123" maximumResponses="100" version="1.1"
            methodName="DirectoryRequest">
            <DirectoryRequest>
            <POILocation>
            <Nearest nearestCriterion="Proximity">
            <Position>
            <gml:Point xmlns:gml="http://www.opengis.net/gml">
            <gml:pos dimension="2" srsName="4326">-122.4083257 37.788208</gml:pos>
            </gml:Point>
            </Position>
            </Nearest>
            </POILocation>
            <POIProperties>
            <POIProperty name="SIC_code" value="1234567890"/>
            </POIProperties>
            </DirectoryRequest>
          </Request>
        </XLS>');

    result := SDO_OLS.makeOpenLSClobRequest(request);

END;
/
```

## 26.2 SDO\_OLS.MakeOpenLSRequest

### Format

```
SDO_OLS.MakeOpenLSRequest(
    request IN XMLTYPE
) RETURN XMLTYPE;
```

### Description

Submits an OpenLS request using an XMLType object, and returns the result as an XMLType object.

### Parameters

#### request

OpenLS request in the form of an XMLType object.



## Usage Notes

To specify the input request as a CLOB and to return a CLOB, use the [SDO\\_OLS.MakeOpenLSClobRequest](#) (page 26-1) function.

For information about OpenLS support, see [OpenLS Support](#) (page 14-1).

## Examples

The following example requests the nearest business, in a specified category (that is, with specified SIC\_code value), to a specified location (longitude: -122.4083257, latitude: 37.788208).

```
SELECT SDO_OLS.makeOpenLSRequest(XMLTYPE(
'<?xml version="1.0" encoding="UTF-8"?>
<XLS xmlns="http://www.opengis.net/xls" xmlns:gml="http://www.opengis.net/gml"
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" version="1.1">
  <RequestHeader clientName="someName" clientPassword="password"/>
  <Request requestID="123" maximumResponses="100" version="1.1"
    methodName="DirectoryRequest">
    <DirectoryRequest>
      <POILocation>
        <Nearest nearestCriterion="Proximity">
          <Position>
            <gml:Point xmlns:gml="http://www.opengis.net/gml">
              <gml:pos dimension="2" srsName="4326">-122.4083257 37.788208</gml:pos>
            </gml:Point>
          </Position>
        </Nearest>
      </POILocation>
      <POIProperties>
        <POIProperty name="SIC_code" value="1234567890"/>
      </POIProperties>
    </DirectoryRequest>
  </Request>
</XLS>')) "OpenLS Response" FROM DUAL;
```



## SDO\_PC\_PKG Package (Point Clouds)

This chapter contains descriptions of the point cloud subprograms shown in [Table 27-1](#) (page 27-1).

**Table 27-1 Point Cloud Subprograms**

Subprogram	Description
<a href="#">SDO_PC_PKG.CLIP_PC</a> (page 27-1)	Performs a clip operation on a point cloud.
<a href="#">SDO_PC_PKG.CLIP_PC_FLAT</a> (page 27-3)	Performs a clip operation on a flat-format point cloud, in which the point cloud data is stored in a flat table.
<a href="#">SDO_PC_PKG.CREATE_CONTOUR_GEOMETRIES</a> (page 27-6)	Generates contour lines for a point cloud.
<a href="#">SDO_PC_PKG.CREATE_PC</a> (page 27-7)	Creates a point cloud using the points specified in the <code>inptable</code> parameter.
<a href="#">SDO_PC_PKG.DROP_DEPENDENCIES</a> (page 27-9)	Drops the dependencies between a point cloud block table and a specified base table and column.
<a href="#">SDO_PC_PKG.INIT</a> (page 27-10)	Initializes a point cloud.
<a href="#">SDO_PC_PKG.TO_GEOMETRY</a> (page 27-13)	Returns a geometry object representing all or part of a point cloud.

To use the subprograms in this package, you must understand the main concepts related to three-dimensional geometries, including the use of point clouds to model solids. [Three-Dimensional Spatial Objects](#) (page 1-16) describes support for three-dimensional geometries, [Modeling Solids](#) (page 1-20) describes the use of point clouds to model solids, and [Point Cloud-Related Object Types](#) (page 2-19) describes data types related to point clouds.

### 27.1 SDO\_PC\_PKG.CLIP\_PC

#### Format

```
SDO_PC_PKG.CLIP_PC(
    inp           IN SDO_PC,
    ind_dim_qry   IN SDO_GEOMETRY,
    other_dim_qry IN SDO_MBR,
    qry_min_res   IN NUMBER,
    qry_max_res   IN NUMBER,
    blkno         IN NUMBER DEFAULT NULL,
```

```
include_custom_dims IN NUMBER DEFAULT 0  
) RETURN SDO_PC_BLK_TYPE;
```

### Description

Performs a clip operation on a point cloud.

### Parameters

#### **inp**

Point cloud on which to perform the clip operation.

#### **ind\_dimqry**

For querying the indexed dimensions of the point cloud: window from which to select objects to be returned; typically a polygon for two-dimensional geometries or a frustum for three-dimensional geometries.

#### **other\_dimqry**

For querying the nonindexed dimensions of the point cloud: window from which to select objects to be returned; typically a polygon for two-dimensional geometries or a frustum for three-dimensional geometries. The nonindexed dimensions are those that are included in the total dimensionality but are not indexed. For an explanation of index dimensionality and total dimensionality, see the explanation of the `pc_tot_dimensions` parameter of the [SDO\\_PC\\_PKG.INIT](#) (page 27-10) function.

The `SDO_MBR` type is defined as (`LOWER_LEFT` `SDO_VPOINT_TYPE`, `UPPER_RIGHT` `SDO_VPOINT_TYPE`) and `SDO_V_POINT_TYPE` is defined as `VARRAY(64) OF NUMBER`.

#### **qry\_min\_res**

Minimum resolution value. Objects in `qry` with resolutions equal to or greater than `qry_min_res` and less than or equal to `qry_max_res` are returned by the clip operation.

#### **qry\_max\_res**

Maximum resolution value. Objects in `qry` with resolutions equal to or greater than `qry_min_res` and less than or equal to `qry_max_res` are returned by the clip operation.

#### **blkid**

Block ID number of the block to which to restrict the objects returned by the clip operation. If this parameter is null, all objects that satisfy the other parameters are returned.

#### **include\_custom\_dims**

Numeric value 0 or 1, which determines whether the point cloud blocks returned by the function contain only the regular (type `NUMBER`) dimensions, as included in the `PC_TOT_DIMENSIONS` count of `SDO_PC`. If only these regular dimensions should be returned, then `include_custom_dims=0` (the default). The stored point cloud blocks in the block table still contain any additional custom dimensions, but this individual `CLIP_PC` query then does not return them.

`include_custom_dims=1` includes both regular and custom dimensions.

See the Usage Notes for more information about custom dimensions.

## Usage Notes

This function returns points from a point cloud that are within a specified query window and that satisfy any other requirements specified by the parameters. A common use of this function is to perform queries on point clouds. You can maximize the performance of a point cloud query by minimizing the number of objects that the function needs to consider for the operation.

The SDO\_PC and SDO\_PC\_BLK\_TYPE data types are described in [Point Cloud-Related Object Types](#) (page 2-19).

This function supports the storage and querying of custom dimensions. Custom dimensions can be of type NUMBER or other types, and they are not included in the PC\_TOT\_DIMENSIONS count of SDO\_PC. If `include_custom_dims=1`, the custom dimensions can be part of a query result, but they cannot be part of the query restriction, either in the `ind_dimqry` or `other_dimqry` parameters, because custom dimensions might not be of numeric type (and thus cannot be represented in the numeric interface of `ind_dimqry` or `other_dimqry`).

Custom dimensions cannot be created using the [SDO\\_PC\\_PKG.CREATE\\_PC](#) (page 27-7) procedure.

Contrast this function with [SDO\\_PC\\_PKG.CLIP\\_PC\\_FLAT](#) (page 27-3), which takes as input point cloud data stored in a flat table (as opposed to an SDO\_PC object).

[Modeling Solids](#) (page 1-20) describes how to use point clouds to model solids.

## Examples

The following example performs a clip operation on a point cloud. It is taken from the `$ORACLE_HOME/md/demo/PointCloud/examples/plsql/pc.sql` example program, which is available if you installed the files from the Oracle Database Examples media (see *Oracle Database Examples Installation Guide*).

```

. . .
declare
  inp sdo_pc;
begin
  select pc INTO inp  from base where rownum=1;
  insert into restst
    select * from
      table(sdo_pc_pkg.clip_pc
        (
          inp, -- Input point cloud object
          sdo_geometry(2003, 8307, null,
            sdo_elem_info_array(1, 1003, 3),
            sdo_ordinate_array(-175.86157, -14.60521, 0,0)), -- Query
          null, null, null));
end;
/
. . .

```

## 27.2 SDO\_PC\_PKG.CLIP\_PC\_FLAT

### Format

```

SDO_PC_PKG.CLIP_PC_FLAT(
  geometry          IN SDO_GEOMETRY,
  table_name        IN VARCHAR2,
  tolerance          IN NUMBER,

```

```
other_dim_qry IN SDO_MBR,  
mask          IN VARCHAR2 DEFAULT NULL  
) RETURN REF CURSOR;
```

## Description

Performs a clip operation on a flat-format point cloud, in which the point cloud data is stored in a flat table.

## Parameters

### geometry

Two-dimensional geometry to serve as the clip window. For example:

```
geometry =>  
  SDO_GEOMETRY(  
    2003,  
    NULL,  
    NULL,  
    SDO_ELEM_INFO_ARRAY(1, 1003, 3),  
    SDO_ORDINATE_ARRAY(  
      0.75, 0.75,  
      1.25, 1.25))
```

### table\_name

Name of the table or view containing the point cloud data. The first two columns in the table or view must be named X and Y and be of type Oracle NUMBER. Optionally, following X and Y, the table or view can contain a Z column of type NUMBER, and additional nonspatial point cloud attributes. The additional nonspatial point cloud attributes can be any data type, but must be type Oracle NUMBER if they will participate as constraints in the `other_dim_qry` parameter.

### tolerance

Tolerance value for objects in the point cloud (see [Tolerance](#) (page 1-6) for information about spatial tolerance). If this parameter is null, the default value is 0.00000000000005

### other\_dim\_qry

Minimum bounding rectangle (MBR) to provide a user defined query ranges for any Oracle NUMBER type columns (not including the X and Y columns).

The SDO\_MBR type is defined as (LOWER\_LEFT SDO\_VPOINT\_TYPE, UPPER\_RIGHT SDO\_VPOINT\_TYPE) and SDO\_V\_POINT\_TYPE is defined as VARRAY(64) OF NUMBER.

Specify NULL in the SDO\_V\_POINT\_TYPE array for Oracle NUMBER type columns that are not constrained by a query range.

### mask

The topological relationship of interest, as applicable to points interacting with polygons. Valid values are 'mask=<value>' where <value> is one or more of the mask values valid for the [SDO\\_RELATE](#) (page 18-30) operator (TOUCH, OVERLAPBDYDISJOINT, OVERLAPBDYINTERSECT, EQUAL, INSIDE, COVEREDBY, CONTAINS, COVERS, ANYINTERACT, ON), or FILTER, which performs an approximate check. FILTER will return all the candidates that intersect the polygon, and possibly a few more. Multiple masks are combined with the logical Boolean operator OR (for example, 'mask=inside+touch'); however, FILTER cannot be combined with any other mask.

If this parameter is null or contains an empty string, mask=ANYINTERACT is assumed.

### Usage Notes

This function works with flat-format point clouds, in contrast to [SDO\\_PC\\_PKG.CLIP\\_PC](#) (page 27-1), which works with input point cloud data stored in an SDO\_PC object. The flat format has been added to point cloud support to offer an alternative to SDO\_PC, depending on hardware environment and usage patterns. One advantage of the flat format is its dynamic nature, since updates to the point data do not require reblocking.

In environments other than Exadata, it is highly recommended that you create a compound B-tree index on the X, Y columns. In the compound B-tree index, also include any other Oracle NUMBER columns that will be constrained with user-defined query ranges described for the other\_dim\_qry parameter. Any point cloud data update will result in an automatic update of that B-tree index.

Contrast this function with [SDO\\_PC\\_PKG.CLIP\\_PC](#) (page 27-1), which takes as input point cloud data stored in an SDO\_PC object.

[Modeling Solids](#) (page 1-20) describes how to use point clouds to model solids. It includes some discussion of the SDO\_PC and flat table approaches for storing point cloud data.

### Examples

The following example creates a view named INPTAB2 from the first three columns of a table named INPPTAB. It then performs a clip operation on the point cloud data.

```
CREATE VIEW inptab2 AS (select x x, y y, z z from inptab);
```

```
DECLARE
  my_cursor sys_refcursor;
  TYPE rec IS RECORD(x NUMBER, y NUMBER, z number);
  TYPE lst IS TABLE OF rec;
  result_list lst;
BEGIN
  my_cursor :=
    SDO_PC_PKG.CLIP_PC_FLAT(
      geometry =>
        MDSYS.SDO_GEOMETRY(
          2003,
          NULL,
          NULL,
          MDSYS.SDO_ELEM_INFO_ARRAY(1, 1003, 3),
          MDSYS.SDO_ORDINATE_ARRAY(
            0.75, 0.75,
            1.25, 1.25)),
      table_name => 'INPTAB2',
      tolerance => 0.05,
      other_dim_qry => null,
      mask => null);

  FETCH my_cursor BULK COLLECT INTO result_list;
  FOR I in 1 .. result_list.COUNT LOOP
    dbms_output.put_line(
      '(' || result_list(i).x || ', ' ||
        result_list(i).y || ', ' ||
        result_list(i).z || ')');
  END LOOP;
```

```
        CLOSE my_cursor;  
    END;  
    /
```

## 27.3 SDO\_PC\_PKG.CREATE\_CONTOUR\_GEOMETRIES

### Format

```
SDO_PC_PKG.CREATE_CONTOUR_GEOMETRIES(  
    pc                IN SDO_PC,  
    sampling_resolution IN NUMBER,  
    elevations        IN SDO_ORDINATE_ARRAY,  
    region            IN SDO_GEOMETRY  
    ) RETURN SDO_GEOMETRY_ARRAY;
```

### Description

Generates contour lines for a point cloud.

### Parameters

#### **pc**

Point cloud for which to generate contour lines.

#### **sampling\_resolution**

A numeric value that determines the grid cell height and width in the coordinate reference system of the point cloud. The process of the contour generation is grid-based. The points within a grid cell get averaged. This means:

- Two slightly different point clouds may result in the same contours, as long as the grid cells yield the same averages.
- The number of vertices and smoothness of the contour lines is a direct function of the resolution.

#### **elevations**

An array of elevations for which contours should be generated.

#### **region**

A window (within the extent of the point cloud) further restricting the region within which the contour lines should be generated.

### Usage Notes

This function returns an array of SDO\_GEOMETRY contours. The sequence of contours within the array is the same as the sequence in the `elevations` input parameter. Each contour is a multiline string.

Contours enclosing higher elevations are oriented counterclockwise (like outer rings). Contours enclosing lower elevations are oriented clockwise (like inner rings).

[Modeling Solids](#) (page 1-20) describes how to use point clouds to model solids.

### Examples

The following example creates contour lines from a point cloud.



```

SELECT sdo_pc_pkg.create_contour_geometries(
  (SELECT pc FROM pcs WHERE pc_id = 1),
  sampling_resolution => 50,
  elevations => sdo_ordinate_array(100, 101),
  region => mdsys.sdo_geometry(2003, null, null, mdsys.sdo_elem_info_array(1, 1003,
3), mdsys.sdo_ordinate_array(-1000, 0, 999, 100)))
FROM DUAL;

```

```
SDO_PC_PKG.CREATE_CONTOUR_GEOMETRIES((SELECTPCFROMPCSWHEREPC_ID=1),SAMPLING_RESO
```

```

-----
SDO_GEOMETRY_ARRAY(SDO_GEOMETRY(2002, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 2, 1, 5
, 2, 1), SDO_ORDINATE_ARRAY(-75.5, 24.5, -25.5, 74.5, 25.5, 74.5, 74.5, 25.5, 75
.5, 24.5)), SDO_GEOMETRY(2002, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 2, 1, 7, 2, 1)
, SDO_ORDINATE_ARRAY(-76.5, 24.5, -75.5, 25.5, -26.5, 74.5, 26.5, 74.5, 74.5, 26
.5, 76.5, 24.5)))

```

1 row selected.

## 27.4 SDO\_PC\_PKG.CREATE\_PC

### Format

```

SDO_PC_PKG.CREATE_PC(
  inp          IN SDO_PC,
  inptable     IN VARCHAR2,
  clstPcdataTbl IN VARCHAR2 DEFAULT NULL);

```

### Description

Creates a point cloud using the points specified in the `inptable` parameter.

### Parameters

#### **inp**

SDO\_PC object to be used. This object must have been created by the [SDO\\_PC\\_PKG.INIT](#) (page 27-10) function.

#### **inptable**

Name of the table or view containing the input point cloud data. This table or view should have the following columns:

- RID (VARCHAR2(24)): Unique ID for each point
- VAL\_D1 (NUMBER): Ordinate in dimension 1
- VAL\_D2 (NUMBER): Ordinate in dimension 2
- ...
- VAL\_Dn (NUMBER): Ordinate in dimension *n*, where *n* is the highest-numbered dimension. *n* should match the `pc_tot_dimensions` parameter value in the call to the [SDO\\_PC\\_PKG.INIT](#) (page 27-10) function when the point cloud was initialized.

#### **clstPcdataTbl**

Name of the table for storing the resulting point data. If you do not specify a value, this table is not created. For more information about the table, see the Usage Notes.

## Usage Notes

The first few dimensions of the point cloud are indexed and can later be searched using the [SDO\\_PC\\_PKG.CLIP\\_PC](#) (page 27-1) function. The exact number of dimensions to index is determined by the dimensionality of the point cloud extent in the initialized point cloud object, specifically: `inp.pc_extent.sdo_gtype/1000`

If you specify a view name in the `inptable` parameter, the query `SELECT ROWID FROM <view-name>` must not return any errors.

If you specify a table name in the `clstPcdataTbl` parameter, the table must exist and have the following columns:

- PTN\_ID (NUMBER)
- POINT\_ID (NUMBER)
- RID (VARCHAR2(24)): Unique ID for each point
- VAL\_D1 (NUMBER): Ordinate in dimension 1
- VAL\_D2 (NUMBER): Ordinate in dimension 2
- ...
- VAL\_Dn (NUMBER): Ordinate in dimension *n*, where *n* is the highest-numbered dimension. *n* should match the `pc_tot_dimensions` parameter value in the call to the [SDO\\_PC\\_PKG.INIT](#) (page 27-10) function when the point cloud was initialized.

If a value is specified for the `clstPcdataTbl` parameter, this function populates the table by assigning appropriate values for PTN\_ID and POINT\_ID and by copying the values from the `inptable` table or view for other attributes. This table can be created as an index organized table. It can be used in applications for searching using SQL queries on dimensions other than those reflected in the index dimensionality. (For an explanation of index dimensionality and total dimensionality, see the explanation of the `pc_tot_dimensions` parameter of the [SDO\\_PC\\_PKG.INIT](#) (page 27-10) function.)

The SDO\_PC and SDO\_PC\_BLK\_TYPE data types are described in [Point Cloud-Related Object Types](#) (page 2-19).

[Modeling Solids](#) (page 1-20) describes how to use point clouds to model solids.

## Examples

The following example creates a point cloud. It is taken from the `$ORACLE_HOME/md/demo/PointCloud/examples/plsql/pc.sql` example program, which is available if you installed the files from the Oracle Database Examples media (see *Oracle Database Examples Installation Guide*).

```
. . .
-- Create the blocks for the point cloud.
sdo_pc_pkg.create_pc(
  pc,          -- Initialized PointCloud object
  'INPTAB',    -- Name of input table to ingest into the pointcloud
  'RES'        -- Name of output table that stores the points (with ptn_id,pt_id)
);
. . .
```

## 27.5 SDO\_PC\_PKG.DROP\_DEPENDENCIES

### Format

```
SDO_PC_PKG.DROP_DEPENDENCIES(
    basetable IN VARCHAR2,
    col       IN VARCHAR2);
```

### Description

Drops the dependencies between a point cloud block table and a specified base table and column.

### Parameters

#### **basetable**

Name of a base table that was specified (in the `basetable` parameter of the [SDO\\_PC\\_PKG.INIT](#) (page 27-10) function) when the point cloud was initialized.

#### **col**

Name of a column in base table that was specified in the `basecol` parameter of the [SDO\\_PC\\_PKG.INIT](#) (page 27-10) function.

### Usage Notes

This procedure truncates the point cloud block table and removes the association between the block table and the base table and column combination.

After you execute this procedure, you can drop the point cloud block table or associate the table with another base table and column combination. For more information, see the Usage Notes for the [SDO\\_PC\\_PKG.INIT](#) (page 27-10) function.

### Examples

The following example drops the dependencies between a point cloud block table and a base table and column named `BASE` and `PC`, respectively.

```
...
declare
begin
    mdsys.sdo_pc_pkg.drop_dependencies('BASE', 'PC');
end;
/
```

## 27.6 SDO\_PC\_PKG.GET\_PT\_IDS

### Format

```
SDO_PC_PKG.GET_PT_IDS(
    pts          IN BLOB,
    num_pts      IN NUMBER,
    pc_tot_dim   IN NUMBER,
    blk_domain   IN SDO_ORGSCL_TYPE DEFAULT NULL,
    ) RETURN SDO_NUMBER_ARRAY;
```

**Description**

Returns the block ID and point ID values of the points in a block in a point cloud.

**Parameters****pts**

Binary large object (BLOB) containing the point cloud block.

**num\_pts**

Number of points in the point cloud block. For a point cloud block, the number of points is stored in the NUM\_POINTS column of the point cloud block table, which is described in [Table 2-7](#) (page 2-20) in [SDO\\_PC Object Type](#) (page 2-19).

**pc\_tot\_dim**

Number of dimensions for the points in the point cloud block.

**blk\_domain**

(Not currently used.)

**Usage Notes**

This function returns an SDO\_NUMBER\_ARRAY object. The array contains multiple pairs of numbers, with each pair identifying the block ID and point ID of a point. For any specific call to this function, the block ID values associated with all points in the returned array will be the same. The SDO\_NUMBER\_ARRAY type is defined as VARRAY(1048576) OF NUMBER.

[Modeling Solids](#) (page 1-20) describes how to use point clouds to model solids.

**Examples**

The following example returns the block ID and point ID values of points in a point cloud block. It is taken from the \$ORACLE\_HOME/md/demo/PointCloud/examples/plsql/pc.sql example program, which is available if you installed the files from the Oracle Database Examples media (see *Oracle Database Examples Installation Guide*).

```
SELECT SDO_PC_PKG.GET_PT_IDS(
  a.points,    -- LOB containing the points
  a.num_points, -- # of points in the LOB
  3 -- Total dimensionality of the points in the LOB
) FROM restst a WHERE num_points >0;
```

## 27.7 SDO\_PC\_PKG.INIT

**Format**

```
SDO_PC_PKG.INIT(
  basetable      IN VARCHAR2,
  basecol        IN VARCHAR2,
  blktable       IN VARCHAR2,
  ptn_params     IN VARCHAR2,
  pc_extent      IN SDO_GEOMETRY,
  pc_tol         IN NUMBER DEFAULT 0.00000000000005,
  pc_tot_dimensions IN NUMBER DEFAULT 2,
  pc_domain      IN SDO_ORGSCL_TYPE DEFAULT NULL,
  pc_val_attr_tables IN SDO_STRING_ARRAY DEFAULT NULL,
```

```

pc_other_attrs    IN XMLTYPE DEFAULT NULL,
) RETURN SDO_PC;

```

### Description

Initializes a point cloud by creating an SDO\_PC object.

### Parameters

#### **basetable**

Name of the base table containing a column of type SDO\_PC.

#### **basecol**

Name of the column of type SDO\_PC in the base table.

#### **blktable**

Name of the point cloud block table, which is used for storing the blocks of point cloud. This table must exist, and must have been created by a statement in the following form: `CREATE TABLE <table-name> AS select * from mdsys.sdo_pc_blk_table;`

Each point cloud block table can only be associated with only one basetable and basecol combination.

#### **ptn\_params**

Parameters for partitioning the point cloud, specified as a quoted string with keywords delimited by commas. For example:

'blk\_capacity=1000,work\_tablespace=my\_work\_ts'. If this parameter is null, the point cloud is not partitioned. The following keywords are permitted:

- `blk_capacity=n`, where *n* is the maximum number of rows in each partition. The default value is 5000. If specified, must be a number greater than or equal to 50.
- `work_tablespace=x`, where *x* is the name of the tablespace in which to create temporary tables during the partitioning operations.

#### **pc\_extent**

SDO\_GEOMETRY object representing the spatial extent of the point cloud (the minimum bounding object enclosing all objects in the point cloud). This parameter must not be null.

For geodetic data, this geometry must have two dimensions; otherwise, it can have up to four dimensions. The dimensionality of this geometry is used as the minimum value permitted for the `pc_tot_dimensions` parameter, as explained in the description of that parameter.

#### **pc\_tol**

Tolerance value for objects in the point cloud. (For information about spatial tolerance, see Section 1.5.5.) If this parameter is null, the default value is 0.0000000000005.

#### **pc\_tot\_dimensions**

A number specifying the *total dimensionality* of the point cloud object. For each point in the point cloud blocks, `pc_tot_dimensions` ordinates (values) are stored.

The total dimensionality must be greater than or equal to the index dimensionality, which is the number of dimensions in the `pc_extent` geometry. Specifying total dimensionality greater than index dimensionality enables necessary nonspatial attributes to be retrieved in the same fetch operation with spatial data. The maximum total dimensionality value is 8. The default value for this parameter is 2.

**pc\_domain**

(Not currently used.)

**pc\_val\_attr\_tables**

SDO\_STRING\_ARRAY object specifying the names of any value attribute tables for the point cloud. If this parameter is null, the point cloud has no associated value attribute tables. Type SDO\_STRING\_ARRAY is defined as VARRAY(1048576) OF VARCHAR2(32).

**pc\_other\_attrs**

XMLTYPE object specifying any other attributes of the point cloud. If this parameter is null, the point cloud has no other attributes.

This parameter can include metadata on point cloud pyramiding, as explained in the Usage Notes.

**Usage Notes**

After you use this function to initialize an SDO\_PC object, you can create a point cloud by specifying this object as input to the [SDO\\_PC\\_PKG.CREATE\\_PC](#) (page 27-7) procedure.

The SDO\_PC data type is described in [TIN-Related Object Types](#) (page 2-15).

[Modeling Solids](#) (page 1-20) describes how to use point clouds to model solids.

After you use this function, the `blktable` table is kept in synchronization with the base table. For example, if a row is deleted from the basetable, the corresponding blocks of the point cloud object in that row are also deleted from the block table; and if the base table base table is truncated, the block table is truncated also.

The block table can be dropped only after either of the following occurs: the base table is dropped, or the [SDO\\_PC\\_PKG.DROP\\_DEPENDENCIES](#) (page 27-9) procedure is executed.

The `pc_other_attrs` parameter can be used to specify metadata for point cloud pyramiding, for example:

```
xmltype(
  '<opc:sdoPcObjectMetadata
    xmlns:opc="http://xmlns.oracle.com/spatial/vis3d/2011/sdovis3d.xsd"
    xmlns:las="http://liblas.org/schemas/LAS/1.0"
    xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance">
    <opc:sdoPcPyramid preserveLevel1="true"/>
  </opc:sdoPcObjectMetadata>')
```

The XML Schema Definition (XSD) for the `pc_other_attrs` parameter can be viewed by entering the following statements:

```
SET LONG 40000
SELECT xmlschema FROM sdo_xml_schemas WHERE description = 'EPSG sdo3d.xsd';
```

Point cloud pyramiding creates multiple pyramid levels from level 1 (leaves) to level *n* (root). Generally, points already stored at level *i* are not repeated, at any of the more

detailed levels. Any point is physically stored, exactly once. The leaf level 1 can be exempted from this rule by specifying `preserveLevel1="true"` (as in the preceding example), so that applications that are not pyramiding-compliant do not need to adapt. However, this `preserveLevel1="true"` option (of exempting and thus preserving level 1) doubles the space requirement, because each point is then stored twice: once at root level 1, and once in the rest of the pyramid.

### Examples

The following example initializes a point cloud by creating an SDO\_PC object, and it displays the ID of the object. It is taken from the `$ORACLE_HOME/md/demo/PointCloud/examples/plsql/pc.sql` example program, which is available if you installed the files from the Oracle Database Examples media (see *Oracle Database Examples Installation Guide*).

```

. . .
declare
  pc sdo_pc;
begin
  -- Initialize the point cloud object.
  pc := sdo_pc_pkg.init(
    'BASE', -- Table that has the SDO_POINT_CLOUD column defined
    'PC',   -- Column name of the SDO_POINT_CLOUD object
    'BLKTAB', -- Table to store blocks of the point cloud
    'blk_capacity=1000', -- max # of points per block
    mdsys.sdo_geometry(2003, 8307, null,
      mdsys.sdo_elem_info_array(1,1003,3),
      mdsys.sdo_ordinate_array(-180, -90, 180, 90)), -- Extent
    0.5, -- Tolerance for point cloud
    3, -- Total number of dimensions
    null);
. . .

```

## 27.8 SDO\_PC\_PKG.TO\_GEOMETRY

### Format

```

SDO_PC_PKG.TO_GEOMETRY(
  pts          IN BLOB,
  num_pts      IN NUMBER,
  pc_tot_dim   IN NUMBER,
  srid         IN NUMBER DEFAULT NULL,
  blk_domain   IN SDO_ORGSCL_TYPE DEFAULT NULL
) RETURN SDO_GEOMETRY;

```

### Description

Returns a geometry object representing all or part of a point cloud.

### Parameters

**pts**  
BLOB containing the points.

**num\_pts**  
Maximum number of points to be included in the resulting geometry.

**pc\_tot\_dim**

Number of spatial dimensions defined for the data.

**srid**

Spatial reference (coordinate system) ID associated with the data. If this parameter is null, no SRID value is associated with the data.

**blk\_domain**

(Not currently used.)

**Usage Notes**

This function returns a single multipoint SDO\_GEOMETRY object that represents all point geometries in the `pts` parameter. For example, the points could reflect the result of a clip operation or the contents of an entire block.

[Modeling Solids](#) (page 1-20) describes how to use point clouds to model solids.

**Examples**

The following example returns a multipoint collection geometry object representing a point cloud. It is taken from the `$ORACLE_HOME/md/demo/PointCloud/examples/plsql/pc.sql` example program, which is available if you installed the files from the Oracle Database Examples media (see *Oracle Database Examples Installation Guide*).

```
. . .
-- Return points in blk_id of the point cloud as a multipoint collection.
select sdo_pc_pkg.to_geometry(
    a.points,    -- point LOB
    a.num_points, -- # of points in the LOB
    3,          -- total dimensionality
    8307        -- SRID
) from blktab a where blk_id=0;
. . .
```



## SDO\_SAM Package (Spatial Analysis and Mining)

The MDSYS.SDO\_SAM package contains subprograms for spatial analysis and data mining.

To use the subprograms in this chapter, you must understand the conceptual information about spatial analysis and data mining in [Spatial Analysis and Mining](#) (page 8-1).

---

**Note:**

SDO\_SAM subprograms are supported for two-dimensional geometries only. They are not supported for three-dimensional geometries.

---

[Table 28-1](#) (page 28-1) lists the spatial analysis and mining subprograms.

**Table 28-1 Subprograms for Spatial Analysis and Mining**

Function	Description
<a href="#">SDO_SAM.AGGREGATES_FOR_GEOMETRY</a> (page 28-2)	Computes the thematic aggregate for a geometry.
<a href="#">SDO_SAM.AGGREGATES_FOR_LAYER</a> (page 28-4)	Computes thematic aggregates for a layer of geometries.
<a href="#">SDO_SAM.BIN_GEOMETRY</a> (page 28-5)	Computes the most-intersecting tile for a geometry.
<a href="#">SDO_SAM.BIN_LAYER</a> (page 28-6)	Assigns each location (and the corresponding row) in a data mining table to a spatial bin.
<a href="#">SDO_SAM.COLOCATED_REFERENCE_FEATURES</a> (page 28-7)	Performs a partial predicate-based join of tables, and materializes the join results into a table.
<a href="#">SDO_SAM.SIMPLIFY_GEOMETRY</a> (page 28-9)	Simplifies a geometry.
<a href="#">SDO_SAM.SIMPLIFY_LAYER</a> (page 28-10)	Simplifies a geometry layer.
<a href="#">SDO_SAM.SPATIAL_CLUSTERS</a> (page 28-11)	Computes clusters using the existing R-tree index, and returns a set of SDO_REGION objects where the geometry column specifies the boundary of each cluster and the geometry_key value is set to null.

**Table 28-1 (Cont.) Subprograms for Spatial Analysis and Mining**

Function	Description
<a href="#">SDO_SAM.TILED_AGGREGATES</a> (page 28-12)	Tiles aggregates for a domain. For each tile, computes the intersecting geometries from the theme table; the values in the <code>aggr_col_string</code> column are weighted proportionally to the area of the intersection, and aggregated according to <code>aggr_col_string</code> .
<a href="#">SDO_SAM.TILED_BINS</a> (page 28-14)	Tiles a two-dimensional space and returns geometries corresponding to those tiles.

The rest of this chapter provides reference information on the spatial analysis and mining subprograms, listed in alphabetical order.

## 28.1 SDO\_SAM.AGGREGATES\_FOR\_GEOMETRY

### Format

```
SDO_SAM.AGGREGATES_FOR_GEOMETRY(  
    theme_name      IN VARCHAR2,  
    theme_colname   IN VARCHAR2,  
    aggr_type_string IN VARCHAR2,  
    aggr_col_string IN VARCHAR2,  
    geom            IN SDO_GEOMETRY,  
    dst_spec        IN VARCHAR2 DEFAULT NULL  
) RETURN NUMBER;
```

### Description

Computes the thematic aggregate for a geometry.

### Parameters

**theme\_name**

Name of the theme table.

**theme\_colname**

Name of the geometry column in `theme_name`.

**aggr\_type\_string**

Any Oracle SQL aggregate function that accepts one or more numeric values and computes a numeric value, such as `SUM`, `MIN`, `MAX`, or `AVG`.

**aggr\_col\_string**

Name of a column in `theme_name` on which to compute aggregate values, as explained in the Usage Notes. An example might be a `POPULATION` column.

**geom**

Geometry object.

**dst\_spec**

A quoted string specifying either a distance buffer or a number of nearest neighbor geometries to consider. See the Usage Notes for an explanation of the format and meaning.

**Usage Notes**

For a specific geometry, this function identifies the geometries in the `theme_name` table, finds their intersection ratio, multiplies the specified aggregate using this intersection ratio, and aggregates it for the geometry. Specifically, for all rows of the `theme_name` table that intersect with the specified geometry, it returns the value from the following function:

```
aggr_type_string(aggr_col_string * proportional_area_of_intersection(geometry,
theme_name.theme_colname))
```

The `theme_colname` column must have a spatial index defined on it. For best performance, insert simplified geometries into this column.

The `dst_spec` parameter, if specified, is a quoted string that must contain either of the following:

- The `distance` keyword and optionally the `unit` keyword (unit of measurement associated with the distance value), to specify a buffer around the geometry. For example, `'distance=2 unit=km'` specifies a 2-kilometer buffer around the input geometry. If `dst_spec` is not specified, no buffer is used.  
  
If the `unit` keyword is specified, the value must be an `SDO_UNIT` value from the `MDSYS.SDO_DIST_UNITS` table (for example, `'unit=km'`). If the `unit` keyword is not specified, the unit of measurement associated with the geometry is used. See [Unit of Measurement Support](#) (page 2-55) for more information about unit of measurement specification.
- The `sdo_num_res` keyword, to specify the number of nearest-neighbor geometries to consider, without considering proportional coverage. For example, `'sdo_num_res=5'` could be used in a query that asks for the populations of the five cities that are nearest to a specified point.

**Examples**

The following example computes the thematic aggregate for an area with a 3-mile radius around a specified point geometry. In this case, the total population of the area is computed based on the proportion of the circle's area within different counties, assuming uniform distribution of population within the counties.

```
SELECT sdo_sam.aggregates_for_geometry(
  'GEOD_COUNTIES', 'GEOM',
  'sum', 'totpop',
  SDO_GEOMETRY(2001, 8307,
    SDO_POINT_TYPE(-73.943849, 40.6698, NULL),
    NULL, NULL),
  'distance=3 unit=mile')
FROM DUAL a ;
```

## 28.2 SDO\_SAM.AGGREGATES\_FOR\_LAYER

### Format

```
SDO_SAM.AGGREGATES_FOR_LAYER(  
    theme_name      IN VARCHAR2,  
    theme_colname   IN VARCHAR2,  
    aggr_type_string IN VARCHAR2,  
    aggr_col_string IN VARCHAR2,  
    tablename       IN VARCHAR2,  
    colname         IN VARCHAR2,  
    dst_spec        IN VARCHAR2 DEFAULT NULL  
) RETURN SDO_REGAGGRSET;
```

### Description

Computes thematic aggregates for a layer of geometries.

### Parameters

**theme\_name**

Name of the theme table.

**theme\_colname**

Name of the geometry column in theme\_name.

**aggr\_type\_string**

Any Oracle SQL aggregate function that accepts one or more numeric values and computes a numeric value, such as SUM, MIN, MAX, or AVG.

**aggr\_col\_string**

Name of a column in theme\_name on which to compute aggregate values, as explained in the Usage Notes. An example might be a POPULATION column.

**tablename**

Name of the data mining table.

**colname**

Name of the column in tablename that holds the geometries.

**dst\_spec**

A quoted string specifying either a distance buffer or a number of nearest neighbor geometries to consider. See the Usage Notes for the [SDO\\_SAM.AGGREGATES\\_FOR\\_GEOMETRY](#) (page 28-2) function in this chapter for an explanation of the format and meaning.

### Usage Notes

For each geometry in tablename, this function identifies the geometries in the theme\_name table, finds their intersection ratio, multiplies the specified aggregate using this intersection ratio, and aggregates it for each geometry in tablename. Specifically, for all rows of the theme\_name table, it returns the value from the following function:

```
aggr_type_string(aggr_col_string * proportional_area_of_intersection(geometry,  
theme_name.theme_colname))
```

This function returns an object of type SDO\_REGAGGRSET. The SDO\_REGAGGRSET object type is defined as:

TABLE OF SDO\_REGAGGR

The SDO\_REGAGGR object type is defined as:

Name	Null?	Type
REGION_ID		VARCHAR2(24)
GEOMETRY		MDSYS.SDO_GEOMETRY
AGGREGATE_VALUE		NUMBER

The theme\_colname column must have a spatial index defined on it. For best performance, insert simplified geometries into this column.

### Examples

The following example computes the thematic aggregates for all geometries in a table named TEST\_TAB for an area with a 3-mile radius around a specified point geometry. In this case, the total population of each area is computed based on the proportion of the circle's area within different counties, assuming uniform distribution of population within the counties.

```
SELECT a.aggregate_value FROM TABLE(sdo_sam.aggregates_for_layer(
  'GEOD_COUNTIES', 'GEOM', 'SUM', TOTPOP', TEST_TAB', 'GEOM'
  'distance=3 unit=mile')) a;
```

## 28.3 SDO\_SAM.BIN\_GEOMETRY

### Format

```
SDO_SAM.BIN_GEOMETRY(
  geom          IN SDO_GEOMETRY,
  tol           IN SDO_DIM_ARRAY,
  bin_tablename IN VARCHAR2,
  bin_colname   IN VARCHAR2
) RETURN NUMBER;
```

or

```
SDO_SAM.BIN_GEOMETRY(
  geom          IN SDO_GEOMETRY,
  dim           IN SDO_DIM_ARRAY,
  bin_tablename IN VARCHAR2,
  bin_colname   IN VARCHAR2
) RETURN NUMBER;
```

### Description

Computes the most-intersecting tile for a geometry.

### Parameters

#### geom

Geometry for which to compute the bin.

#### tol

Tolerance value (see [Tolerance](#) (page 1-6)).

**dim**

Dimensional array for the table that holds the geometries for the bins.

**bin\_tablename**

Name of the table that holds the geometries for the bins.

**bin\_colname**

Column in `bin_tablename` that holds the geometries for the bins.

**Usage Notes**

This function returns the bin that intersects most with the specified geometry. If multiple bins intersect to the same extent with the specified geometry, the bin with the smallest area is returned.

To perform this operation on all rows in the data mining table, using the specified `bin_tablename`, you can use the [SDO\\_SAM.BIN\\_LAYER](#) (page 28-6) procedure.

**Examples**

The following example computes the bin for a specified geometry.

```
SELECT sdo_sam.bin_geometry(a.geometry, 0.0000005, 'BINTBL', 'GEOMETRY')
FROM poly_4pt a, user_sdo_geom_metadata b
WHERE b.table_name='POLY_4PT' AND a.gid=1;
```

```
SDO_SAM.BIN_GEOMETRY(A.GEOMETRY,0.0000005,'BINTBL','GEOMETRY')
```

-----  
43

1 row selected.

## 28.4 SDO\_SAM.BIN\_LAYER

**Format**

```
SDO_SAM.BIN_LAYER(
    tablename          IN VARCHAR2,
    colname            IN VARCHAR2,
    bin_tablename      IN VARCHAR2,
    bin_colname        IN VARCHAR2,
    bin_id_colname     IN VARCHAR2,
    commit_interval    IN NUMBER DEFAULT 20);
```

**Description**

Assigns each location (and the corresponding row) in a data mining table to a spatial bin.

**Parameters****tablename**

Name of the data mining table.

**colname**

Name of the column in `table_name` that holds the location coordinates.

**bin\_tablename**

Name of the table that contains information (precomputed for the entire two-dimensional space) about the spatial bins.

**bin\_colname**

Column in `bin_tablename` that holds the geometries for the bins.

**bin\_id\_colname**

Name of the column in the data mining table that holds the bin ID value of each geometry added to a bin. (Each affected row in the data mining table is updated with the ID value of the bin geometry in `bin_tablename`.)

**commit\_interval**

Number of bin insert operations to perform before Spatial and Graph performs an internal commit operation. If `commit_interval` is not specified, a commit is performed after every 20 insert operations.

**Usage Notes**

This procedure computes the most-intersecting tile for each geometry in a specified layer using the bins in `bin_tablename`. The bin ID value for each geometry is added in `bin_id_colname`.

Using this procedure achieves the same result as using the [SDO\\_SAM.BIN\\_GEOMETRY](#) (page 28-5) function on each row in the data mining table, using the specified `bin_tablename`.

**Examples**

The following example assigns each GEOMETRY column location and corresponding row in the POLY\_4PT\_TEMP data mining table to a spatial bin, and performs an internal commit operation after each bin table insertion.

```
CALL SDO_SAM.BIN_LAYER('POLY_4PT_TEMP', 'GEOMETRY', 'BINTBL', 'GEOMETRY', 'BIN_ID',
1);
```

## 28.5 SDO\_SAM.COLOCATED\_REFERENCE\_FEATURES

**Format**

```
SDO_SAM.COLOCATED_REFERENCE_FEATURES(
    theme_tablename  IN VARCHAR2,
    theme_colname    IN VARCHAR2,
    theme_predicate   IN VARCHAR2,
    tablename        IN VARCHAR2,
    colname          IN VARCHAR2,
    ref_predicate     IN VARCHAR2,
    dst_spec         IN VARCHAR2,
    result_tablename IN VARCHAR2,
    commit_interval  IN NUMBER DEFAULT 100);
```

**Description**

Performs a partial predicate-based join of tables, and materializes the join results into a table.

**Parameters**

**theme\_tablename**

Name of the table with which to join tablename.

**theme\_colname**

Name of the geometry column in theme\_tablename.

**theme\_predicate**

Qualifying WHERE clause predicate to be applied to theme\_tablename.

**tablename**

Name of the data mining table.

**colname**

Name of the column in tablename that holds the location coordinates.

**ref\_predicate**

Qualifying WHERE clause predicate to be applied to tablename. Must a null or non-null value: if null, no predicate is applied; if non-null, it must be a single table predicate, such as 'country\_code=10'.

**dst\_spec**

A quoted string containing a distance value and optionally a unit value for a buffer around the geometries. See the Usage Notes for an explanation of the format and meaning.

**result\_tablename**

The table in which materialized join results are stored. This table must exist and must have the following definition: (tid NUMBER, rid1 VARCHAR2(24), rid2 VARCHAR2(24))

**commit\_interval**

Number of internal join operations to perform before Spatial and Graph performs an internal commit operation. If commit\_interval is not specified, a commit is performed after every 100 internal join operations.

**Usage Notes**

This procedure materializes each pair of rowids returned from a predicate-based join operation, and stores them in the rid1, rid2 columns of result\_tablename. The tid is a unique generated "interaction" number corresponding to each rid1 value.

The dst\_spec parameter, if specified, is a quoted string containing the distance keyword and optionally the unit keyword (unit of measurement associated with the distance value), to specify a buffer around the geometry. For example, 'distance=2 unit=km' specifies a 2-kilometer buffer around the input geometry. If dst\_spec is not specified, no buffer is used.

If the unit keyword is specified, the value must be an SDO\_UNIT value from the MDSYS.SDO\_DIST\_UNITS table (for example, 'unit=KM'). If the unit keyword is not specified, the unit of measurement associated with the geometry is used. See [Unit of Measurement Support](#) (page 2-55) for more information about unit of measurement specification.

**Examples**

The following example identifies cities with a 1990 population (POP90 column value) greater than 120,000 that are located within 20 kilometers of interstate highways



(GEOM column in the GEOD\_INTERSTATES table). It stores the results in a table named COLOCATION\_TABLE, and performs an internal commit operation after each 20 internal operations.

```
EXECUTE SDO_SAM.COLOCATED_REFERENCE_FEATURES(
  'geod_cities', 'location', 'pop90 > 120000',
  'geod_interstates', 'geom', null,
  'distance=20 unit=km', 'colocation_table', 20);
```

## 28.6 SDO\_SAM.SIMPLIFY\_GEOMETRY

### Format

```
SDO_SAM.SIMPLIFY_GEOMETRY(
  geom                IN SDO_GEOMETRY,
  dim                 IN SDO_DIM_ARRAY,
  pct_area_change_limit IN NUMBER DEFAULT 2
) RETURN SDO_GEOMETRY;
```

or

```
SDO_SAM.SIMPLIFY_GEOMETRY(
  geom                IN SDO_GEOMETRY,
  tol                 IN NUMBER,
  pct_area_change_limit IN NUMBER DEFAULT 2
) RETURN SDO_GEOMETRY;
```

### Description

Simplifies a geometry.

### Parameters

#### geom

Geometry to be simplified.

#### dim

Dimensional array for the geometry to be simplified.

#### tol

Tolerance value (see [Tolerance](#) (page 1-6)).

#### pct\_area\_change\_limit

The percentage of area changed to be used for each simplification iteration, as explained in the Usage Notes.

### Usage Notes

This function reduces the number of vertices in a geometry by internally applying the [SDO\\_UTIL.SIMPLIFY](#) (page 31-49) function (documented in [SDO\\_UTIL Package \(Utility\)](#) (page 31-1)) with an appropriate threshold value.

Reducing the number of vertices may result in a change in the area of the geometry. The `pct_area_change_limit` parameter specifies how much area change can be tolerated while simplifying the geometry. It is usually a number from 1 to 100. The default value is 2; that is, the area of the geometry can either increase or decrease by at most two percent compared to the original geometry as a result of the geometry simplification.

### Examples

The following example simplifies the geometries in the GEOMETRY column of the POLY\_4PT\_TEMP table.

```
SELECT sdo_sam.simplify_geometry(a.geometry, 0.00000005)
FROM poly_4pt_temp a, user_sdo_geom_metadata b
WHERE b.table_name='POLY_4PT_TEMP' ;

SDO_SAM.SIMPLIFY_GEOMETRY(A.GEOMETRY,0.00000005)(ORIG_AREA, CUR_AREA, ORIG_LEN,
-----
SDO_SMPL_GEOMETRY(28108.5905, 28108.5905, 758.440118, 758.440118, SDO_GEOMETRY(2
003, 8307, NULL, SDO_ELEM_INFO_ARRAY(1, 1003, 1), SDO_ORDINATE_ARRAY(-122.4215,
37.7862, -122.422, 37.7869, -122.421, 37.789, -122.42, 37.7866, -122.4215, 37.78
62)))

SDO_SMPL_GEOMETRY(4105.33806, 4105.33806, 394.723053, 394.723053, SDO_GEOMETRY(2
003, 8307, NULL, SDO_ELEM_INFO_ARRAY(1, 1003, 1), SDO_ORDINATE_ARRAY(-122.4019,
37.8052, -122.4027, 37.8055, -122.4031, 37.806, -122.4012, 37.8052, -122.4019, 3
7.8052)))

.
.
.
50 rows selected.
```

## 28.7 SDO\_SAM.SIMPLIFY\_LAYER

### Format

```
SDO_SAM.SIMPLIFY_LAYER(
    theme_tablename      IN VARCHAR2,
    theme_colname         IN VARCHAR2,
    smpl_geom_colname     IN VARCHAR2,
    commit_interval       IN NUMBER DEFAULT 10,
    pct_area_change_limit IN NUMBER DEFAULT 2);
```

### Description

Simplifies a geometry layer.

### Parameters

#### **theme\_tablename**

Name of the table containing the geometry layer to be simplified.

#### **theme\_colname**

Column in theme\_tablename of type SDO\_GEOMETRY containing the geometries to be simplified.

#### **smpl\_geom\_colname**

Column in theme\_tablename of type SDO\_GEOMETRY into which the simplified geometries are to be placed by this procedure.

#### **commit\_interval**

Number of geometries to simplify before Spatial and Graph performs an internal commit operation. If commit\_interval is not specified, a commit is performed after every 10 simplification operations.

**pct\_area\_change\_limit**

The percentage of area changed to be used for each simplification iteration, as explained in the Usage Notes for the [SDO\\_SAM.SIMPLIFY\\_GEOMETRY](#) (page 28-9) function.

**Usage Notes**

This procedure simplifies all geometries in a layer. It is equivalent to calling the [SDO\\_SAM.SIMPLIFY\\_GEOMETRY](#) (page 28-9) function for each geometry in the layer, except that each simplified geometry is put in a separate column in the table instead of being returned to the caller. See also the Usage Notes for the [SDO\\_SAM.SIMPLIFY\\_GEOMETRY](#) (page 28-9) function.

**Examples**

The following example adds a column named SMPL\_GEOM to the POLY\_4PT\_TEMP table, then simplifies all geometries in the GEOMETRY column of the POLY\_4PT\_TEMP table, placing each simplified geometry in the SMPL\_GEOM column in the same row with its associated original geometry.

```
ALTER TABLE poly_4pt_temp ADD (smpl_geom mdsys.sdo_geometry);
```

Table altered.

```
EXECUTE sdo_sam.simplify_layer('POLY_4PT_TEMP', 'GEOMETRY', 'SMPL_GEOM');
```

PL/SQL procedure successfully completed.

## 28.8 SDO\_SAM.SPATIAL\_CLUSTERS

**Format**

```
SDO_SAM.SPATIAL_CLUSTERS(
    tablename      IN VARCHAR2,
    colname        IN VARCHAR2,
    max_clusters   IN NUMBER,
    allow_outliers IN VARCHAR2 DEFAULT 'TRUE',
    tablepartition IN VARCHAR2 DEFAULT NULL
) RETURN SDO_REGIONSET;
```

**Description**

Computes clusters using the existing R-tree index, and returns a set of SDO\_REGION objects where the geometry column specifies the boundary of each cluster and the geometry\_key value is set to null.

**Parameters****tablename**

Name of the data mining table.

**colname**

Name of the column in tablename that holds the location coordinates.

**max\_clusters**

Maximum number of clusters to obtain.

**allow\_outliers**

TRUE (the default) causes outlying values (isolated instances) to be included in the spatial clusters; FALSE causes outlying values not to be included in the spatial clusters. (TRUE accommodates all data and may result in larger clusters; FALSE may exclude some data and may result in smaller clusters.)

**tablepartition**

Name of the partition in tablename.

**Usage Notes**

The clusters are computed using the spatial R-tree index on tablename.

**Examples**

The following example clusters the locations in cities into at most three clusters, and includes outlying values in the clusters.

```
SELECT * FROM
  TABLE(sdo_sam.spatial_clusters('PROJ_CITIES', 'LOCATION', 3, 'TRUE'));
```

## 28.9 SDO\_SAM.TILED\_AGGREGATES

**Format**

```
SDO_SAM.TILED_AGGREGATES(
  theme_name      IN VARCHAR2,
  theme_colname   IN VARCHAR2,
  aggr_type_string IN VARCHAR2,
  aggr_col_string IN VARCHAR2,
  tiling_level    IN NUMBER DEFAULT NULL,
  tiling_domain   IN SDO_DIM_ARRAY DEFAULT NULL,
  zero_agg_tiles  IN NUMBER DEFAULT 0,
  xdivs           IN NUMBER DEFAULT NULL,
  ydivs          IN NUMBER DEFAULT NULL
) RETURN SDO_REGAGGRSET;
```

**Description**

Tiles aggregates for a domain. For each tile, computes the intersecting geometries from the theme table; the values in the aggr\_col\_string column are weighted proportionally to the area of the intersection, and aggregated according to aggr\_col\_string.

**Parameters****theme\_name**

Table containing theme information (for example, demographic information).

**theme\_colname**

Name of the column in the theme\_name table that contains geometry objects.

**aggr\_type\_string**

Any Oracle SQL aggregate function that accepts one or more numeric values and computes a numeric value, such as SUM, MIN, MAX, or AVG.

**aggr\_col\_string**

Name of a column in the `theme_name` table on which to compute aggregate values. An example might be a `POPULATION` column.

**tiling\_level**

Level to be used to create tiles. If you specify this parameter, the extent of each dimension is divided into  $2^{\text{tiling\_level}}$  parts, resulting in at most  $4^{\text{tiling\_level}}$  tiles. (Specify either this parameter or the combination of the `xdivs` and `ydivs` parameters.)

**tiling\_domain**

Domain for the tiling level. The parameter is not required, and if you do not specify it, the extent associated with the `theme_name` table is used.

**zero\_agg\_tiles**

Specify 0 to exclude tiles that have a value of 0 for the computed aggregate, or specify 1 to return all tiles. The default value is 0, which ensures that only tiles with a nonzero aggregate value are returned.

**xdivs**

The number of times that the extent in the first dimension is divided, such that the total number of parts is `xdivs + 1`. For example, if you specify 10 for `xdivs`, the extent of the first dimension is divided into 11 parts.

**ydivs**

The number of times that the extent in the second dimension is divided, such that the total number of parts is `ydivs + 1`. For example, if you specify 10 for `ydivs`, the extent of the second dimension is divided into 11 parts.

**Usage Notes**

This function is similar to [SDO\\_SAM.AGGREGATES\\_FOR\\_LAYER](#) (page 28-4), but the results are dynamically generated using tiling information. Given a `theme_name` table, the tiling domain is determined. Based on the `tiling_level` value or the `xdivs` and `ydivs` values, the necessary tiles are generated. For each tile geometry, thematic aggregates are computed as described in the Usage Notes for [SDO\\_SAM.AGGREGATES\\_FOR\\_LAYER](#) (page 28-4).

You must specify either the `tiling_level` parameter or both the `xdivs` and `ydivs` parameters. If you specify all three of these parameters, the `tiling_level` parameter is ignored and the `xdivs` and `ydivs` parameters are used.

If you specify the `xdivs` and `ydivs` parameters, the total number of grids (tiles) returned is  $(\text{xdivs} + 1) * (\text{ydivs} + 1)$ .

This function returns an object of type `SDO_REGAGGRSET`. The `SDO_REGAGGRSET` object type is defined as:

TABLE OF `SDO_REGAGGR`

The `SDO_REGAGGR` object type is defined as:

Name	Null?	Type
-----	-----	-----
REGION_ID		VARCHAR2(24)
GEOMETRY		MDSYS.SDO_GEOMETRY
AGGREGATE_VALUE		NUMBER

### Examples

The following example computes the sum of the population rows of POLY\_4PT\_TEMP table intersecting with each tile. The extent of the POLY\_4PT\_TEMP table stored in the USER\_SDO\_GEOM\_METADATA view is used as the domain, and a tiling level of 2 is used (that is, the domain is divided into 16 tiles).

```
SELECT a.geometry, a.aggregate_value
  from TABLE(sdo_sam.tiled_aggregates('POLY_4PT_TEMP',
                                         'GEOMETRY', 'SUM', 'POPULATION', 2)) a;

GEOMETRY(SDO_GTYPE, SDO_SRID, SDO_POINT(X, Y, Z), SDO_ELEM_INFO, SDO_ORDINATES)
-----
AGGREGATE_VALUE
-----
SDO_GEOMETRY(2003, 8307, NULL, SDO_ELEM_INFO_ARRAY(1, 1003, 3), SDO_ORDINATE_ARR
AY(-180, -90, -90, -45))
      .007150754

SDO_GEOMETRY(2003, 8307, NULL, SDO_ELEM_INFO_ARRAY(1, 1003, 3), SDO_ORDINATE_ARR
AY(-180, -45, -90, 0))
      .034831005

SDO_GEOMETRY(2003, 8307, NULL, SDO_ELEM_INFO_ARRAY(1, 1003, 3), SDO_ORDINATE_ARR
AY(-180, 0, -90, 45))
      7.73307783

SDO_GEOMETRY(2003, 8307, NULL, SDO_ELEM_INFO_ARRAY(1, 1003, 3), SDO_ORDINATE_ARR
AY(-90, -90, 0, -45))
      .019498368

SDO_GEOMETRY(2003, 8307, NULL, SDO_ELEM_INFO_ARRAY(1, 1003, 3), SDO_ORDINATE_ARR
AY(-90, -45, 0, 0))
      .939061456

SDO_GEOMETRY(2003, 8307, NULL, SDO_ELEM_INFO_ARRAY(1, 1003, 3), SDO_ORDINATE_ARR
AY(-90, 0, 0, 45))
      1.26691592

SDO_GEOMETRY(2003, 8307, NULL, SDO_ELEM_INFO_ARRAY(1, 1003, 3), SDO_ORDINATE_ARR
AY(0, 0, 90, 45))
      40

7 rows selected.
```

## 28.10 SDO\_SAM.TILED\_BINS

### Format

```
SDO_SAM.TILED_BINS(
  l1          IN NUMBER,
  u1          IN NUMBER,
  l2          IN NUMBER,
  u2          IN NUMBER,
  tiling_level IN NUMBER DEFAULT NULL,
  srid        IN NUMBER DEFAULT NULL,
  xdivs       IN NUMBER DEFAULT NULL,
  ydivs       IN NUMBER DEFAULT NULL
) RETURN SDO_REGIONSET;
```

**Description**

Tiles a two-dimensional space and returns geometries corresponding to those tiles.

**Parameters****l1**

Lower bound of the extent in the first dimension.

**u1**

Upper bound of the extent in the first dimension.

**l2**

Lower bound of the extent in the second dimension.

**u2**

Upper bound of the extent in the second dimension.

**tiling\_level**

Level to be used to tile the specified extent. If you specify this parameter, the extent of each dimension is divided into  $2^{\text{tiling\_level}}$  parts, resulting in at most  $4^{\text{tiling\_level}}$  tiles. (Specify either this parameter or the combination of the `xdivs` and `ydivs` parameters.)

**srid**

SRID value to be included for the coordinate system in the returned tile geometries.

**xdivs**

The number of times that the extent in the first dimension is divided, such that the total number of parts is `xdivs + 1`. For example, if you specify 10 for `xdivs`, the extent of the first dimension is divided into 11 parts.

**ydivs**

The number of times that the extent in the second dimension is divided, such that the total number of parts is `ydivs + 1`. For example, if you specify 10 for `ydivs`, the extent of the second dimension is divided into 11 parts.

**Usage Notes**

You must specify either the `tiling_level` parameter or both the `xdivs` and `ydivs` parameters. If you specify all three of these parameters, the `tiling_level` parameter is ignored and the `xdivs` and `ydivs` parameters are used.

If you specify the `xdivs` and `ydivs` parameters, the total number of grids (tiles) returned is  $(\text{xdivs} + 1) * (\text{ydivs} + 1)$ .

This function returns an object of type `SDO_REGIONSET`. The `SDO_REGIONSET` object type is defined as:

TABLE OF `SDO_REGION`

The `SDO_REGION` object type is defined as:

Name	Null?	Type
-----	-----	-----
ID		NUMBER
GEOMETRY		MDSYS.SDO_GEOMETRY

## Examples

The following example tiles the entire Earth's surface at the first tiling level, using the standard longitude and latitude coordinate system (SRID 8307). The resulting SDO\_REGIONSET object contains four SDO\_REGION objects, one for each tile.

```
SELECT * FROM TABLE(sdo_sam.tiled_bins(-180, 180, -90, 90, 1, 8307))
      ORDER BY id;

      ID
-----
GEOMETRY(SDO_GTYPE, SDO_SRID, SDO_POINT(X, Y, Z), SDO_ELEM_INFO, SDO_ORDINATES)
-----
      0
SDO_GEOMETRY(2003, 8307, NULL, SDO_ELEM_INFO_ARRAY(1, 1003, 3), SDO_ORDINATE_ARRAY(-180, -90, 0, 0))

      1
SDO_GEOMETRY(2003, 8307, NULL, SDO_ELEM_INFO_ARRAY(1, 1003, 3), SDO_ORDINATE_ARRAY(-180, 0, 0, 90))

      2
SDO_GEOMETRY(2003, 8307, NULL, SDO_ELEM_INFO_ARRAY(1, 1003, 3), SDO_ORDINATE_ARRAY(0, -90, 180, 0))

      3
SDO_GEOMETRY(2003, 8307, NULL, SDO_ELEM_INFO_ARRAY(1, 1003, 3), SDO_ORDINATE_ARRAY(0, 0, 180, 90))

4 rows selected.
```



## SDO\_TIN\_PKG Package (TINs)

This chapter contains descriptions of the triangulated irregular network (TIN) subprograms shown in [Table 29-1](#) (page 29-1).

**Table 29-1 TIN Subprograms**

Subprogram	Description
<a href="#">SDO_TIN_PKG.CLIP_TIN</a> (page 29-1)	Performs a clip operation on a TIN.
<a href="#">SDO_TIN_PKG.CREATE_TIN</a> (page 29-3)	Creates a TIN using the points specified in the <code>inptable</code> parameter.
<a href="#">SDO_TIN_PKG.DROP_DEPENDENCIES</a> (page 29-4)	Drops the dependencies between a TIN block table and a specified base table and column.
<a href="#">SDO_TIN_PKG.INIT</a> (page 29-5)	Initializes a TIN.
<a href="#">SDO_TIN_PKG.PROJECT_ORDINATES_ONTO_TIN</a> (page 29-8)	Projects two-dimensional points onto a TIN, thereby determining point heights.
<a href="#">SDO_TIN_PKG.TO_DEM</a> (page 29-9)	Creates a DEM (Digital Elevation Model) GeoRaster object from a TIN.
<a href="#">SDO_TIN_PKG.TO_GEOMETRY</a> (page 29-10)	Returns a geometry object representing all or part of a TIN.

To use the subprograms in this package, you must understand the main concepts related to three-dimensional geometries, including the use of triangulated irregular networks (TINs) to model surfaces. [Three-Dimensional Spatial Objects](#) (page 1-16) describes support for three-dimensional geometries, [Modeling Surfaces](#) (page 1-19) describes the use of TINs to model surfaces, and [TIN-Related Object Types](#) (page 2-15) describes data types related to TINs.

### 29.1 SDO\_TIN\_PKG.CLIP\_TIN

#### Format

```
SDO_TIN_PKG.CLIP_TIN(
    inp          IN SDO_TIN,
    qry          IN SDO_GEOMETRY,
    qry_min_res  IN NUMBER,
    qry_max_res  IN NUMBER,
    blkid        IN NUMBER DEFAULT NULL
) RETURN SDO_TIN_BLK_TYPE;
```

**Description**

Performs a clip operation on a TIN.

**Parameters****inp**

TIN on which to perform the clip operation.

**qry**

Window from which to select objects to be returned; typically a polygon for two-dimensional geometries or a frustum for three-dimensional geometries.

**qry\_min\_res**

Minimum resolution value. Objects in `qry` with resolutions equal to or greater than `qry_min_res` and less than or equal to `qry_max_res` are returned by the clip operation.

**qry\_max\_res**

Maximum resolution value. Objects in `qry` with resolutions equal to or greater than `qry_min_res` and less than or equal to `qry_max_res` are returned by the clip operation.

**blkid**

Block ID number of the block to which to restrict the objects returned by the clip operation. If this parameter is null, all objects that satisfy the other parameters are returned.

**Usage Notes**

This function returns triangles from a TIN that are within a specified query window and that satisfy any other requirements specified by the parameters. A common use of this function is to perform queries on TINs. You can maximize the performance of a TIN query by minimizing the number of objects that the function needs to consider for the operation.

The `SDO_TIN` and `SDO_TIN_BLK_TYPE` data types are described in [TIN-Related Object Types](#) (page 2-15).

[Modeling Surfaces](#) (page 1-19) describes how to use TINs to model surfaces.

**Examples**

The following example performs a clip operation on a TIN. It is taken from the `$ORACLE_HOME/md/demo/TIN/examples/plsql/tin.sql` example program, which is available if you installed the files from the Oracle Database Examples media (see *Oracle Database Examples Installation Guide*).

```
...
declare
  inp sdo_tin;
begin
  select tin INTO inp  from base where rownum=1;
  insert into restst
  select * from
    table(sdo_tin_pkg.clip_tin
      (
        inp, -- Input TIN object
```

```

        sdo_geometry(2003, null, null,
            mdsys.sdo_elem_info_array(1, 1003, 3),
            mdsys.sdo_ordinate_array(-74.1, -73.9, 39.99999, 40.00001)), -- Query
        null, null));
end;
. . .

```

## 29.2 SDO\_TIN\_PKG.CREATE\_TIN

### Format

```

SDO_TIN_PKG.CREATE_TIN(
    inp            IN SDO_TIN,
    inptable       IN VARCHAR2,
    clstPcdataTbl  IN VARCHAR2 DEFAULT NULL);

```

### Description

Creates a TIN using the points specified in the `inptable` parameter.

### Parameters

#### **inp**

SDO\_TIN object to be used. This object must have been created by the [SDO\\_TIN\\_PKG.INIT](#) (page 29-5) function

#### **inptable**

Name of the table or view containing the input TIN data. This table or view should have the following columns:

- RID (VARCHAR2(24)): Unique ID for each point
- VAL\_D1 (NUMBER): Ordinate in dimension 1
- VAL\_D2 (NUMBER): Ordinate in dimension 2
- ...
- VAL\_Dn (NUMBER): Ordinate in dimension *n*, where *n* is the highest-numbered dimension. *n* should match the `tin_tot_dimensions` parameter value in the call to the [SDO\\_TIN\\_PKG.INIT](#) (page 29-5) function when the TIN was initialized.

#### **clstPcdataTbl**

Name of the table for storing the resulting point data. If you do not specify a value, this table is not created. For more information about the table, see the Usage Notes.

### Usage Notes

The first few dimensions of the TIN are indexed and can later be searched using the [SDO\\_TIN\\_PKG.CLIP\\_TIN](#) (page 29-1) function. The exact number of dimensions to index is determined by the dimensionality of the TIN extent in the initialized TIN object, specifically: `inp.tin_extent.sdo_gtype/1000`

If you specify a view name in the `inptable` parameter, the query `SELECT ROWID FROM <view-name>` must not return any errors.

If you specify a table name in the `clstPcdataTbl` parameter, the table must exist and have the following columns:

- PTN\_ID (NUMBER)
- POINT\_ID (NUMBER)
- RID (VARCHAR2(24): Unique ID for each point
- VAL\_D1 (NUMBER): Ordinate in dimension 1
- VAL\_D2 (NUMBER): Ordinate in dimension 2
- ...
- VAL\_Dn (NUMBER): Ordinate in dimension *n*, where *n* is the highest-numbered dimension. *n* should match the `tin_tot_dimensions` parameter value in the call to the [SDO\\_TIN\\_PKG.INIT](#) (page 29-5) function when the TIN was initialized.

If a value is specified for the `clstPcdataTbl` parameter, this function populates the table by assigning appropriate values for PTN\_ID and POINT\_ID and by copying the values from the `inptable` table or view for other attributes. This table can be created as an index organized table. It can be used in applications for searching using SQL queries on dimensions other than those reflected in the index dimensionality. (For an explanation of index dimensionality and total dimensionality, see the explanation of the `tin_tot_dimensions` parameter of the [SDO\\_TIN\\_PKG.INIT](#) (page 29-5) function.)

The SDO\_TIN data type is described in [TIN-Related Object Types](#) (page 2-15).

[Modeling Surfaces](#) (page 1-19) describes how to use TINs to model surfaces.

### Examples

The following example creates a TIN. It is taken from the `$ORACLE_HOME/md/demo/TIN/examples/plsql/tin.sql` example program, which is available if you installed the files from the Oracle Database Examples media (see *Oracle Database Examples Installation Guide*).

```
. . .
-- Create the blocks for the TIN.
sdo_tin_pkg.create_tin(
    tin,          -- Initialized TIN object
    'INPTAB',    -- Name of input table to ingest into the pointcloud
    'RES'        -- Name of output table that stores the points (with ptn_id,pt_id)
);
/
. . .
```

## 29.3 SDO\_TIN\_PKG.DROP\_DEPENDENCIES

### Format

```
SDO_TIN_PKG.DROP_DEPENDENCIES(
    basetable IN VARCHAR2,
    col       IN VARCHAR2);
```

**Description**

Drops the dependencies between a TIN block table and a specified base table and column.

**Parameters****basetable**

Name of a base table that was specified (in the `basetable` parameter of the [SDO\\_TIN\\_PKG.INIT](#) (page 29-5) function) when the TIN was initialized.

**col**

Name of a column in base table that was specified in the `basecol` parameter of the [SDO\\_TIN\\_PKG.INIT](#) (page 29-5) function.

**Usage Notes**

This procedure truncates the TIN block table and removes the association between the block table and the base table and column combination.

After you execute this procedure, you can drop the TIN block table or associate the table with another base table and column combination. For more information, see the Usage Notes for the [SDO\\_TIN\\_PKG.INIT](#) (page 29-5) function.

**Examples**

The following example drops the dependencies between a TIN block table and a base table and column named BASE and TIN, respectively.

```

. . .
declare
begin
    mdsys.sdo_tin_pkg.drop_dependencies('BASE', 'TIN');
end;
/

```

## 29.4 SDO\_TIN\_PKG.INIT

**Format**

```

SDO_TIN_PKG.INIT(
    basetable          IN VARCHAR2,
    basecol            IN VARCHAR2,
    blktable           IN VARCHAR2,
    ptn_params          IN VARCHAR2,
    tin_extent          IN SDO_GEOMETRY,
    tin_tol             IN NUMBER DEFAULT 0.0000000000000005,
    tin_tot_dimensions IN NUMBER DEFAULT 2,
    tin_domain          IN SDO_ORGSLC_TYPE DEFAULT NULL,
    tin_break_lines     IN SDO_GEOMETRY DEFAULT NULL,
    tin_stop_lines      IN SDO_GEOMETRY DEFAULT NULL,
    tin_void_rgns       IN SDO_GEOMETRY DEFAULT NULL,
    tin_val_attr_tables IN SDO_STRING_ARRAY DEFAULT NULL,
    tin_other_attrs     IN XMLTYPE DEFAULT NULL,
) RETURN SDO_TIN;

```

**Description**

Initializes a TIN by creating an SDO\_TIN object.

**Parameters****basetable**

Name of the base table containing a column of type SDO\_TIN.

**basecol**

Name of the column of type SDO\_TIN in the base table.

**blktable**

Name of the TIN block table, which is used for storing the blocks of the TIN. This table must exist, and must have been created by a statement in the following form:

```
CREATE TABLE <table-name> AS select * from  
mdsys.sdo_tin_blk_table;
```

Each TIN block table can only be associated with only one basetable and basecol combination.

**ptn\_params**

Parameters for partitioning the TIN, specified as a quoted string with keywords delimited by commas. For example:

'blk\_capacity=1000,work\_tablespace=my\_work\_ts'. If this parameter is null, the TIN is not partitioned. The following keywords are permitted:

- `blk_capacity=n`, where *n* is the maximum number of rows in each partition. The default value is 5000. If specified, must be a number greater than or equal to 50.
- `work_tablespace=x`, where *x* is the name of the tablespace in which to create temporary tables during the partitioning operations.

**tin\_extent**

SDO\_GEOMETRY object representing the spatial extent of the TIN (the minimum bounding object enclosing all objects in the TIN. This parameter must not be null.

For geodetic data, this geometry must have two dimensions; otherwise, it can have up to four dimensions. The dimensionality of this geometry is used as the minimum value permitted for the `tin_tot_dimensions` parameter, as explained in the description of that parameter.

**tin\_tol**

Tolerance value for objects in the TIN. (For information about spatial tolerance, see Section 1.5.5.) If this parameter is null, the default value is 0.00000000000005.

**tin\_tot\_dimensions**

A number specifying the *total dimensionality* of the TIN object. For each point in the TIN blocks, `tin_tot_dimensions` ordinates (values) are stored.

The total dimensionality must be greater than or equal to the index dimensionality, which is the number of dimensions in the `tin_extent` geometry. Specifying total dimensionality greater than index dimensionality enables necessary nonspatial attributes to be retrieved in the same fetch operation with spatial data. The maximum total dimensionality value is 8. The default value for this parameter is 2.

**tin\_domain**  
(Not currently used.)

**tin\_break\_lines**  
(Not currently used.)

**tin\_stop\_lines**  
(Not currently used.)

**tin\_void\_rgns**  
(Not currently used.)

**tin\_val\_attr\_tables**  
SDO\_STRING\_ARRAY object specifying the names of any value attribute tables for the TIN. If this parameter is null, the TIN has no associated value attribute tables. Type SDO\_STRING\_ARRAY is defined as VARRAY(1048576) OF VARCHAR2(32).

**tin\_other\_attrs**  
XMLTYPE object specifying any other attributes of the TIN. If this parameter is null, the TIN has no other attributes.

This parameter can include metadata on TIN pyramiding, as explained in the Usage Notes.

### Usage Notes

After you use this function to initialize an SDO\_TIN object, you can create a TIN by specifying this object as input to the [SDO\\_TIN\\_PKG.CREATE\\_TIN](#) (page 29-3) procedure.

The SDO\_TIN data type is described in [TIN-Related Object Types](#) (page 2-15).

[Modeling Surfaces](#) (page 1-19) describes how to use TINs to model surfaces.

The `tin_other_attrs` parameter can be used to specify metadata for TIN pyramiding, for example:

```
xmltype(
  '<opc:sdoTinObjectMetadata
    xmlns:opc="http://xmlns.oracle.com/spatial/vis3d/2011/sdovis3d.xsd"
    xmlns:las="http://liblas.org/schemas/LAS/1.0"
    xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance">
    <opc:sdoTinPyramid/>
  </opc:sdoTinObjectMetadata>')
```

TIN pyramiding creates multiple pyramid levels from level 1 (most detailed) to level *n* (least detailed). In contrast to point cloud pyramiding (described in the Usage Notes for [SDO\\_PC\\_PKG.INIT](#) (page 27-10)), there is no option relating to preserving level 1 with TIN pyramiding. A TIN with pyramiding will require more storage space than one without pyramiding, because level 1 is basically equal to the TIN without pyramiding, and all other levels require additional space.

### Examples

The following example initializes a TIN by creating an SDO\_TIN object. It is taken from the `$ORACLE_HOME/md/demo/TIN/examples/plsql/tin.sql` example program, which is available if you installed the files from the Oracle Database Examples media (see *Oracle Database Examples Installation Guide*).

```
declare
  tin sdo_tin;
begin
  -- Initialize the TIN object.
  tin := sdo_tin_pkg.init(
    'BASE', -- Table that has the SDO_TIN column defined
    'TIN',  -- Column name of the SDO_TIN object
    'BLKTAB', -- Table to store blocks of the TIN
    'blk_capacity=1000', -- max # of points per block
    mdsys.sdo_geometry(2003, null, null,
      mdsys.sdo_elem_info_array(1,1003,3),
      mdsys.sdo_ordinate_array(-180, -90, 180, 90)), -- Extent
    0.00000000005, -- Tolerance for TIN
    3, -- Total number of dimensions
    null);
  . . .
```

## 29.5 SDO\_TIN\_PKG.PROJECT\_ORDINATES\_ONTO\_TIN

### Format

```
SDO_TIN_PKG.PROJECT_ORDINATES_ONTO_TIN(
  ordinates2D SDO_ORDINATE_ARRAY,
  tin         SDO_TIN
) RETURN SDO_ORDINATE_ARRAY;
```

### Description

Projects two-dimensional points onto a TIN, thereby determining point heights.

### Parameters

#### **ordinates2D**

SDO\_ORDINATE\_ARRAY object with the two-dimensional points to be projected. These cannot be oriented points (which are described in [Oriented Point](#) (page 2-28)).

#### **tin**

SDO\_TIN object onto which to project the points.

### Usage Notes

This function can be thought of as performing height interpolation for the specified two-dimensional input points.

The SDO\_TIN data type is described in [TIN-Related Object Types](#) (page 2-15).

[Modeling Surfaces](#) (page 1-19) describes how to use TINs to model surfaces.

### Examples

The following example projects two-dimensional points (2.3, 3.4), (4.5, 5.6), (6.7, 7.8) onto a TIN, yielding three-dimensional points (2.3, 3.4, 5.7), (4.5, 5.6, 10.1), (6.7, 7.8, 14.5). In this example, the TIN shape is an inclined surface with  $z_i = x_i + y_i$ .

```
SELECT
  sdo_tin_pkg.project_ordinates_onto_tin(
    ordinates2d => sdo_ordinate_array(
      2.3,  3.4,
      4.5,  5.6,
```



```

        6.7, 7.8),
tin => (select tin from tins where tin_id = 1))
FROM DUAL;

SDO_TIN_PKG.PROJECT_ORDINATES_ONTO_TIN(ORDINATES2D=>SDO_ORDINATE_ARRAY(2.3,3.4,4
-----
SDO_ORDINATE_ARRAY(2.3, 3.4, 5.7, 4.5, 5.6, 10.1, 6.7, 7.8, 14.5))

1 row selected.

```

## 29.6 SDO\_TIN\_PKG.TO\_DEM

### Format

```

SDO_TIN_PKG.TO_DEM(
    tin                IN SDO_TIN,
    dem                IN OUT SDO_GEOASTER,
    blocksize          IN NUMBER,
    crs_units_per_pixel IN NUMBER);

```

### Description

Creates a DEM (Digital Elevation Model) GeoRaster object from a TIN.

### Parameters

#### tin

TIN object. (The SDO\_TIN data type is described in [TIN-Related Object Types](#) (page 2-15).)

#### dem

DEM GeoRaster object. (The SDO\_GEOASTER data type is described in *Oracle Spatial and Graph GeoRaster Developer's Guide*.)

#### blocksize

Pixel block size for the DEM.

#### crs\_units\_per\_pixel

TIN and DEM coordinate reference system (SRID) units for each pixel. For example, if the SRID unit of measure is decimal degree and if each pixel represents 1/100 of a degree, the `crs_units_per_pixel` value is 0.01.

### Usage Notes

This procedure modifies the specified GeoRaster object (`dem` parameter) based on information in the input TIN.

The TIN and the DEM must have the same coordinate reference system (SRID).

For the `dem` parameter, the input SDO\_GEOASTER object can be obtained by inserting a GeoRaster object into a table and returning the GeoRaster object into a variable; for example:

```

INSERT INTO raster_table VALUES (1, sdo_geor.init('raster_data_table'))
RETURNING raster_image INTO geor;

```

To determine the horizontal extent in pixels of the DEM, divide the horizontal extent in SRID units by the `crs_units_per_pixel` parameter value. For example, assume the following:

- The TIN and DEM SRID is 4326.
- The SRID unit is decimal degrees.
- The input TIN has a horizontal extent of 7 decimal degrees.
- The `crs_units_per_pixel` value is 0.01.

In this example, the DEM horizontal extent is 700 pixels ( $7/.01 = 700$ ).

The SDO\_TIN data type is described in [TIN-Related Object Types](#) (page 2-15).

[Modeling Surfaces](#) (page 1-19) describes how to use TINs to model surfaces.

### Examples

The following example creates a DEM from a TIN. It is taken from the `$ORACLE_HOME/md/demo/TIN/examples/plsql/tin.sql` example program, which is available if you installed the files from the Oracle Database Examples media (see *Oracle Database Examples Installation Guide*).

```
create table raster_table (id number, raster_image sdo_georaster);

create table raster_data_table of sdo_raster
  (primary key (rasterId, pyramidLevel, bandBlockNumber, rowBlockNumber,
columnBlockNumber))
  lob(rasterblock) store as (nocache nologging);

DECLARE
  inp sdo_tin;
  geor sdo_georaster;
BEGIN
  select tin INTO inp from tins_hawaii_4326 where rownum=1;
  insert into raster_table values (1, sdo_geor.init('raster_data_table')) returning
raster_image into geor;
  sdo_tin_pkg.to_dem(
    tin          => inp,
    dem          => geor,
    blocksize    => 128,
    crs_units_per_pixel => 0.01);
  update raster_table set raster_image = geor where id = 1;
END;
/
```

## 29.7 SDO\_TIN\_PKG.TO\_GEOMETRY

### Format

```
SDO_TIN_PKG.TO_GEOMETRY(
  pts          IN BLOB,
  trs          IN BLOB,
  num_pts      IN NUMBER,
  num_trs      IN NUMBER,
  tin_ind_dim  IN NUMBER,
  tin_tot_dim  IN NUMBER,
  srid         IN NUMBER DEFAULT NULL,
  blk_domain   IN SDO_ORGSCL_TYPE DEFAULT NULL,
```

```

    get_ids      IN NUMBER DEFAULT NULL
  ) RETURN SDO_GEOMETRY;

```

### Description

Returns a geometry object representing all or part of a TIN.

### Parameters

#### **pts**

BLOB containing points.

#### **trs**

BLOB containing triangles.

#### **num\_pts**

Maximum number of points to be included in the resulting geometry.

#### **num\_trs**

Maximum number of triangles to be included in the resulting geometry.

#### **tin\_ind\_dim**

Number of spatial dimensions that are indexed.

#### **tin\_tot\_dim**

Number of spatial dimensions defined for the data.

#### **srid**

Spatial reference (coordinate system) ID associated with the data. If this parameter is null, no SRID value is associated with the data.

#### **blk\_domain**

(Not currently used.)

#### **get\_ids**

Null or 0 (the default) does not include the block ID and point ID for each point in the returned geometry; 1 includes the block ID and point ID for each point in the returned geometry. If `get_ids` is 1, each point in the returned geometry has its spatial dimensions and two additional dimensions. For example: (x, y, z, blk\_id, pt\_id).

### Usage Notes

This function returns a single collection SDO\_GEOMETRY object that represents all point geometries in the `pts` parameter and all triangle geometries in the `trs` parameter. For example, the points and triangles could reflect the result of a clip operation or the contents of an entire block.

[Modeling Surfaces](#) (page 1-19) describes how to use TINs to model surfaces.

### Examples

The following example returns a multipoint collection geometry object representing a TIN. It is taken from the `$ORACLE_HOME/md/demo/TIN/examples/plsql/tin.sql` example program, which is available if you installed the files from the Oracle Database Examples media (see *Oracle Database Examples Installation Guide*).

```
. . .
-- Return points in blk_id of the TIN as a multipoint collection.
select sdo_tin_pkg.to_geometry(
    a.points,    -- point LOB
    a.triangles, -- point LOB
    a.num_points, -- # of points in the LOB
    a.num_triangles, -- # of points in the LOB
    2, -- index dimensionality (gtype dim in extent in INIT)
    3, -- total dimensionality
    null -- SRID
) from blktab a where blk_id=0;
. . .
```

---

## SDO\_TUNE Package (Tuning)

---

This chapter contains descriptions of the tuning subprograms shown in [Table 30-1](#) (page 30-1).

**Table 30-1** *Tuning Subprograms*

Subprogram	Description
<a href="#">SDO_TUNE.AVERAGE_MBR</a> (page 30-1)	Calculates the average minimum bounding rectangle for geometries in a layer.
<a href="#">SDO_TUNE.ESTIMATE_RTREE_INDEX_SIZE</a> (page 30-2)	Estimates the maximum number of megabytes needed for an R-tree spatial index table.
<a href="#">SDO_TUNE.EXTENT_OF</a> (page 30-4)	Returns the minimum bounding rectangle of the data in a layer.
<a href="#">SDO_TUNE.MIX_INFO</a> (page 30-5)	Calculates geometry type information for a spatial layer, such as the percentage of each geometry type.

### 30.1 SDO\_TUNE.AVERAGE\_MBR

#### Format

```
SDO_TUNE.AVERAGE_MBR(  
    table_name IN VARCHAR2,  
    column_name IN VARCHAR2,  
    width      OUT NUMBER,  
    height     OUT NUMBER);
```

#### Description

Calculates the average minimum bounding rectangle (MBR) for geometries in a layer.

#### Parameters

**table\_name**

Spatial geometry table.

**column\_name**

Geometry column for which the average minimum bounding rectangle is to be computed.

**width**

Width of the average minimum bounding rectangle.

**height**

Height of the average minimum bounding rectangle.

**Usage Notes**

This procedure computes and stores the width and height of the average minimum bounding rectangle for all geometries in a spatial geometry table. It calculates the average MBR by keeping track of the maximum and minimum X and Y values for all geometries in a spatial geometry table.

**Examples**

The following example calculates the minimum bounding rectangle for the SHAPE column of the COLA\_MARKETS table.

```
DECLARE
  table_name  VARCHAR2(32) := 'COLA_MARKETS';
  column_name VARCHAR2(32) := 'SHAPE';
  width       NUMBER;
  height      NUMBER;
BEGIN
  SDO_TUNE.AVERAGE_MBR(
    table_name,
    column_name,
    width,
    height);
  DBMS_OUTPUT.PUT_LINE('Width = ' || width);
  DBMS_OUTPUT.PUT_LINE('Height = ' || height);
END;
/
Width = 3.5
Height = 4.5
```

**Related Topics**

[SDO\\_AGGR\\_MBR](#) (page 19-6) spatial aggregate function (in [Spatial Aggregate Functions](#) (page 19-1))

## 30.2 SDO\_TUNE.ESTIMATE\_RTREE\_INDEX\_SIZE

**Format**

```
SDO_TUNE.ESTIMATE_RTREE_INDEX_SIZE(
  schemaname IN VARCHAR2,
  tablename  IN VARCHAR2,
  colname    IN VARCHAR2,
  partname   IN VARCHAR2 DEFAULT NULL
) RETURN NUMBER;
```

or

```
SDO_TUNE.ESTIMATE_RTREE_INDEX_SIZE(
  number_of_geoms IN INTEGER,
  db_block_size   IN INTEGER,
  sdo_rtr_pctfree IN INTEGER DEFAULT 10,
  num_dimensions  IN INTEGER DEFAULT 2,
  is_geodetic     IN INTEGER
  DEFAULT 0
) RETURN NUMBER;
```

**Description**

Estimates the maximum number of megabytes needed for an R-tree spatial index table.

**Parameters****schemaname**

Schema that owns the spatial geometry table.

**tabname**

Spatial geometry table name.

**colname**

Geometry column name.

**partname**

Name of a partition containing geometries from `colname`. If you specify this parameter, the value returned by the function is the estimated size for an R-tree index table on geometries in that partition. If you do not specify this parameter, the value is the estimated size for an R-tree index table on all geometries in `colname`.

**number\_of\_geoms**

Approximate number of geometries in the spatial geometry table.

**db\_block\_size**

Database block size (in bytes).

**sdo\_rtr\_pctfree**

Minimum percentage of slots in each index tree node to be left empty when the index is created. Slots that are left empty can be filled later when new data is inserted into the table. The value can range from 0 to 50. The default value (10) is best for most applications; however, a value of 0 is recommended if no updates will be performed to the geometry column.

**num\_dimensions**

Number of dimensions to be indexed. The default value is 2. If you plan to specify the `sdo_indx_dims` parameter in the [CREATE INDEX](#) (page 17-7) statement, the `num_dimensions` value should match the `sdo_indx_dims` value.

**is\_geodetic**

A value indicating whether or not the spatial index will be a geodetic index: 1 for a geodetic index, or 0 (the default) for a non-geodetic index.

**Usage Notes**

The function returns the estimated maximum number of megabytes needed for the spatial index table (described in [Spatial Index Table Definition](#) (page 2-54)) for an R-tree spatial index to be created. The value returned is the maximum number of megabytes needed after index creation. During index creation, approximately three times this value of megabytes will be needed in the tablespace, to ensure that there is enough space for temporary tables while the index is being created.

This function has two formats:

- Use the format with character string parameters (`schemaname`, `tabname`, `colname`, and optionally `partname`) in most cases when the spatial geometry

table already exists, you do not plan to add substantially more geometries to it before creating the index, and you plan to use the default R-tree indexing parameters.

- Use the format with integer parameters (`number_of_geoms`, `db_block_size`, `sdo_rtr_pctfree`, `num_dimensions`, `is_geodetic`) in any of the following cases: the spatial geometry table does not exist; the spatial geometry table exists but you plan to add substantially more geometries to it before creating the index; or the `num_dimensions` value is not 2 for non-geodetic data or 3 for geodetic data, and a nondefault value will be specified using the `sdo_indx_dims` parameter in the [CREATE INDEX](#) (page 17-7) statement.

### Examples

The following example estimates the maximum number of megabytes needed for a spatial index table for an index given the following information: `number_of_geoms` = 1000000 (one million), `db_block_size` = 2048, `sdo_rtr_pctfree` = 10, `num_dimensions` = 2, `is_geodetic` = 0.

```
SELECT SDO_TUNE.ESTIMATE_RTREE_INDEX_SIZE(1000000, 2048, 10, 2, 0) FROM DUAL;
```

```
SDO_TUNE.ESTIMATE_RTREE_INDEX_SIZE(1000000,2048,10,2,0)
-----
82
```

The following example estimates the maximum number of megabytes needed for a spatial index table for an index on the SHAPE column in the COLA\_MARKETS table in the SCOTT schema. The estimate is based on the geometries that are currently in the table.

```
SELECT SDO_TUNE.ESTIMATE_RTREE_INDEX_SIZE('SCOTT', 'COLA_MARKETS', 'SHAPE') FROM
DUAL;
```

```
SDO_TUNE.ESTIMATE_RTREE_INDEX_SIZE('SCOTT','COLA_MARKETS','SHAPE')
-----
1
```

## 30.3 SDO\_TUNE.EXTENT\_OF

### Format

```
SDO_TUNE.EXTENT_OF(
    table_name IN VARCHAR2,
    column_name IN VARCHAR2,
    use_index   VARCHAR2 default 'TRUE'
) RETURN SDO_GEOMETRY;
```

### Description

Returns the minimum bounding rectangle (MBR) of all geometries in a layer.

### Parameters

#### **table\_name**

Spatial geometry table, or a view based on a spatial geometry table.



**column\_name**

Geometry column for which the minimum bounding rectangle is to be returned.

**use\_index**

The string TRUE (the default) causes the spatial index (if one exists) on the table to be used in the computations. The string FALSE causes any spatial index to be ignored. (See the Usage Notes for more information about this parameter.)

**Usage Notes**

The [SDO\\_AGGR\\_MBR](#) (page 19-6) function, documented in [Spatial Aggregate Functions](#) (page 19-1), also returns the MBR of geometries. The SDO\_TUNE.EXTENT\_OF function has better performance than the [SDO\\_AGGR\\_MBR](#) (page 19-6) function if a spatial index is defined on the geometry column; however, the SDO\_TUNE.EXTENT\_OF function is limited to two-dimensional geometries, whereas the [SDO\\_AGGR\\_MBR](#) (page 19-6) function is not. In addition, the SDO\_TUNE.EXTENT\_OF function computes the extent for all geometries in a table; by contrast, the [SDO\\_AGGR\\_MBR](#) (page 19-6) function can operate on subsets of rows.

If a spatial index is used, this function may return an approximate MBR that encloses the largest extent of data stored in the index, even if data was subsequently deleted.

The default value of TRUE for use\_index is best in most cases, but in some cases you may want to specify FALSE. A spatial index can sometimes have the extent as larger than the actual data extent because DML operations might delete data around the edges, resulting in a smaller actual extent, although such deletions do not reduce the index extent. In such cases, if you want the actual data extent, specify use\_index=> 'FALSE'. Note, however, that specifying FALSE will have a significant negative impact on the performance of the function because it will require a full table scan.

**Examples**

The following example calculates the minimum bounding rectangle for the objects in the SHAPE column of the COLA\_MARKETS table.

```
SELECT SDO_TUNE.EXTENT_OF('COLA_MARKETS', 'SHAPE')
FROM DUAL;

SDO_TUNE.EXTENT_OF('COLA_MARKETS', 'SHAPE')(SDO_GTYPE, SDO_SRID, SDO_POINT(X, Y,
-----
SDO_GEOMETRY(2003, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 1003, 3),
SDO_ORDINATE_ARRAY(1, 1, 10, 11))
```

**Related Topics**

[SDO\\_AGGR\\_MBR](#) (page 19-6) aggregate function (in [Spatial Aggregate Functions](#) (page 19-1))

[SDO\\_TUNE.AVERAGE\\_MBR](#) (page 30-1) procedure

## 30.4 SDO\_TUNE.MIX\_INFO

**Format**

```
SDO_TUNE.MIX_INFO(
    table_name    IN VARCHAR2,
```

```
column_name    IN VARCHAR2
[, total_geom  OUT INTEGER,
point_geom     OUT INTEGER,
curve_geom     OUT INTEGER,
poly_geom      OUT INTEGER,
complex_geom   OUT INTEGER] );
```

### Description

Calculates geometry type information for a spatial layer, such as the percentage of each geometry type.

### Parameters

**table\_name**

Spatial geometry table.

**column\_name**

Geometry object column for which the geometry type information is to be calculated.

**total\_geom**

Total number of geometry objects.

**point\_geom**

Number of point geometry objects.

**curve\_geom**

Number of curve string geometry objects.

**poly\_geom**

Number of polygon geometry objects.

**complex\_geom**

Number of complex geometry objects.

### Usage Notes

This procedure calculates geometry type information for the table. It calculates the total number of geometries, as well as the number of point, curve string, polygon, and complex geometries.

### Examples

The following example displays information about the mix of geometry objects in the SHAPE column of the COLA\_MARKETS table.

```
CALL SDO_TUNE.MIX_INFO('COLA_MARKETS', 'SHAPE');
Total number of geometries: 4
Point geometries:          0 (0%)
Curvestring geometries:  0 (0%)
Polygon geometries:        4 (100%)
Complex geometries:        0 (0%)
```

## SDO\_UTIL Package (Utility)

This chapter contains descriptions of the spatial utility subprograms shown in [Table 31-1](#) (page 31-1).

**Table 31-1 Spatial Utility Subprograms**

Subprogram	Description
<a href="#">SDO_UTIL.AFFINETRANSFORMS</a> (page 31-3)	Returns a geometry that reflects an affine transformation of the input geometry.
<a href="#">SDO_UTIL.APPEND</a> (page 31-8)	Appends one geometry to another geometry to create a new geometry.
<a href="#">SDO_UTIL.BEARING_TILT_FOR_POINTS</a> (page 31-9)	Computes the bearing and tilt from a start point to an end point.
<a href="#">SDO_UTIL.CIRCLE_POLYGON</a> (page 31-11)	Returns the polygon geometry that approximates and is covered by a specified circle.
<a href="#">SDO_UTIL.CONCAT_LINES</a> (page 31-14)	Concatenates two line or multiline two-dimensional geometries to create a new geometry.
<a href="#">SDO_UTIL.CONVERT_UNIT</a> (page 31-15)	Converts values from one angle, area, or distance unit of measure to another.
<a href="#">SDO_UTIL.CONVERT3007TO3008</a> (page 31-16)	Converts an input three-dimensional multisurface geometry (SDO_GTYPE 3007) to a simple solid geometry (SDO_GTYPE 3008).
<a href="#">SDO_UTIL.ELLIPSE_POLYGON</a> (page 31-17)	Returns the polygon geometry that approximates and is covered by a specified ellipse.
<a href="#">SDO_UTIL.EXTRACT</a> (page 31-19)	Returns the two-dimensional geometry that represents a specified element (and optionally a ring) of the input two-dimensional geometry.
<a href="#">SDO_UTIL.EXTRACT_ALL</a> (page 31-21)	Returns all elements and subelements of the input two-dimensional geometry, as an array of one or more geometries.
<a href="#">SDO_UTIL.EXTRACT3D</a> (page 31-24)	Returns the three-dimensional geometry that represents a specified subset of the input three-dimensional geometry.
<a href="#">SDO_UTIL.EXTRUDE</a> (page 31-26)	Returns the three-dimensional extrusion solid geometry from an input two-dimensional polygon geometry.
<a href="#">SDO_UTIL.FROM_GML311GEOMETRY</a> (page 31-28)	Converts a geography markup language (GML 3.1.1) fragment to a Spatial and Graph geometry object.

**Table 31-1 (Cont.) Spatial Utility Subprograms**

Subprogram	Description
<a href="#">SDO_UTIL.FROM_GMLGEOMETRY</a> (page 31-30)	Converts a geography markup language (GML 2.0) fragment to a Spatial and Graph geometry object.
<a href="#">SDO_UTIL.FROM_WKBGEOMETRY</a> (page 31-33)	Converts a geometry in the well-known binary (WKB) format to a Spatial and Graph geometry object.
<a href="#">SDO_UTIL.FROM_WKTGEOMETRY</a> (page 31-34)	Converts a geometry in the well-known text (WKT) format to a Spatial and Graph geometry object.
<a href="#">SDO_UTIL.GET_2D_FOOTPRINT</a> (page 31-35)	Returns a two-dimensional geometry that reflects the footprint of the input three-dimensional geometry.
<a href="#">SDO_UTIL.GETNUMELEM</a> (page 31-36)	Returns the number of elements in the input geometry.
<a href="#">SDO_UTIL.GETNUMVERTICES</a> (page 31-37)	Returns the number of vertices in the input geometry.
<a href="#">SDO_UTIL.GETNURBSAPPROX</a> (page 31-38)	Returns a line string geometry that is an approximation of the input NURBS curve geometry.
<a href="#">SDO_UTIL.GETVERTICES</a> (page 31-40)	Returns the coordinates of the vertices of the input geometry.
<a href="#">SDO_UTIL.INITIALIZE_INDEXES_FOR_TTS</a> (page 31-42)	Initializes all spatial indexes in a tablespace that was transported to another database.
<a href="#">SDO_UTIL.POINT_AT_BEARING</a> (page 31-44)	Returns a point geometry that is at the specified distance and bearing from the start point.
<a href="#">SDO_UTIL.POLYGONTOLINE</a> (page 31-45)	Converts all polygon-type elements in a geometry to line-type elements, and sets the SDO_GTYPE value accordingly.
<a href="#">SDO_UTIL.RECTIFY_GEOMETRY</a> (page 31-46)	Fixes certain problems with the input geometry, and returns a valid geometry.
<a href="#">SDO_UTIL.REMOVE_DUPLICATE_VERTICES</a> (page 31-47)	Removes duplicate (redundant) vertices from a geometry.
<a href="#">SDO_UTIL.REVERSE_LINESTRING</a> (page 31-48)	Returns a line string geometry with the vertices of the input geometry in reverse order.
<a href="#">SDO_UTIL.SIMPLIFY</a> (page 31-49)	Simplifies the input geometry, based on a threshold value, using the Douglas-Peucker algorithm.
<a href="#">SDO_UTIL.SIMPLIFYVW</a> (page 31-52)	Simplifies the input geometry, based on a threshold value, using the Visvalingham-Whyatt algorithm.
<a href="#">SDO_UTIL.THEME3D_GET_BLOCK_TABLE</a> (page 31-53)	Simplifies the input geometry, based on a threshold value, using the Visvalingham-Whyatt algorithm.
<a href="#">SDO_UTIL.THEME3D_HAS_LOD</a> (page 31-54)	Simplifies the input geometry, based on a threshold value, using the Visvalingham-Whyatt algorithm.
<a href="#">SDO_UTIL.THEME3D_HAS_TEXTURE</a> (page 31-56)	Simplifies the input geometry, based on a threshold value, using the Visvalingham-Whyatt algorithm.

**Table 31-1 (Cont.) Spatial Utility Subprograms**

Subprogram	Description
<a href="#">SDO_UTIL.TO_GML311GEOMETRY</a> (page 31-57)	Converts a Spatial and Graph geometry object to a geography markup language (GML 3.1.1) fragment based on the geometry types defined in the Open GIS <code>geometry.xsd</code> schema document.
<a href="#">SDO_UTIL.TO_GMLGEOMETRY</a> (page 31-61)	Converts a Spatial and Graph geometry object to a geography markup language (GML 2.0) fragment based on the geometry types defined in the Open GIS <code>geometry.xsd</code> schema document.
<a href="#">SDO_UTIL.TO_WKBGEOMETRY</a> (page 31-68)	Converts a Spatial and Graph geometry object to the well-known binary (WKB) format.
<a href="#">SDO_UTIL.TO_WKTGEOMETRY</a> (page 31-69)	Converts a Spatial and Graph geometry object to the well-known text (WKT) format.
<a href="#">SDO_UTIL.VALIDATE_3DTHEME</a> (page 31-71)	Validates a 3D theme.
<a href="#">SDO_UTIL.VALIDATE_SCENE</a> (page 31-72)	Validates a 3D scene.
<a href="#">SDO_UTIL.VALIDATE_VIEWFRAME</a> (page 31-73)	Validates a 3D viewframe.
<a href="#">SDO_UTIL.VALIDATE_WKBGEOMETRY</a> (page 31-74)	Validates the input geometry, which is in the standard well-known binary (WKB) format; returns the string <code>TRUE</code> if the geometry is valid or <code>FALSE</code> if the geometry is not valid.
<a href="#">SDO_UTIL.VALIDATE_WKTGEOMETRY</a> (page 31-76)	Validates the input geometry, which is of type <code>CLOB</code> or <code>VARCHAR2</code> and in the standard well-known text (WKT) format; returns the string <code>TRUE</code> if the geometry is valid or <code>FALSE</code> if the geometry is not valid.

## 31.1 SDO\_UTIL.AFFINETRANSFORMS

### Format

```

SDO_UTIL.AFFINETRANSFORMS(
    geometry      IN SDO_GEOMETRY,
    translation   IN VARCHAR2 DEFAULT 'FALSE',
    tx            IN NUMBER DEFAULT 0.0,
    ty            IN NUMBER DEFAULT 0.0,
    tz            IN NUMBER DEFAULT 0.0,
    scaling       IN VARCHAR2 DEFAULT 'FALSE',
    pscl          IN SDO_GEOMETRY DEFAULT NULL,
    sx            IN NUMBER DEFAULT 0.0,
    sy            IN NUMBER DEFAULT 0.0,
    sz            IN NUMBER DEFAULT 0.0,
    rotation      IN VARCHAR2 DEFAULT 'FALSE',
    pl            IN SDO_GEOMETRY DEFAULT NULL,
    line1         IN SDO_GEOMETRY DEFAULT NULL,
    angle         IN NUMBER DEFAULT 0.0,
    dir           IN NUMBER DEFAULT -1,

```

```
shearing      IN VARCHAR2 DEFAULT 'FALSE',
shxy          IN NUMBER DEFAULT 0.0,
shyx          IN NUMBER DEFAULT 0.0,
shxz          IN NUMBER DEFAULT 0.0,
shzx          IN NUMBER DEFAULT 0.0,
shyz          IN NUMBER DEFAULT 0.0,
shzy          IN NUMBER DEFAULT 0.0,
reflection    IN VARCHAR2 DEFAULT 'FALSE',
pref          IN SDO_GEOMETRY DEFAULT NULL,
lineR         IN SDO_GEOMETRY DEFAULT NULL,
dirR          IN NUMBER DEFAULT -1,
planeR        IN VARCHAR2 DEFAULT 'FALSE',
n             IN SDO_NUMBER_ARRAY DEFAULT NULL,
bigD          IN SDO_NUMBER_ARRAY DEFAULT NULL,
) RETURN SDO_GEOMETRY;
```

### Description

Returns a geometry that reflects an affine transformation of the input geometry.

### Parameters

#### **geometry**

Input geometry on which to perform the affine transformation.

#### **translation**

A string value of TRUE causes translation to be performed; a string value of FALSE (the default) causes translation not to be performed. If this parameter is TRUE, translation is performed about the point at (tx,ty) or (tx,ty,tz).

#### **tx**

X-axis value for translation. The default value is 0.0.

#### **ty**

Y-axis value for translation. The default value is 0.0.

#### **tz**

Z-axis value for translation. The default value is 0.0.

#### **scaling**

A string value of TRUE causes scaling to be performed; a string value of FALSE (the default) causes scaling not to be performed.

#### **psc1**

Point on the input geometry about which to perform the scaling. If `scaling` is TRUE, this geometry should be either a zero point (point geometry with 0,0 or 0,0,0 ordinates for scaling about the origin) or a nonzero point (point geometry with ordinates for scaling about a point other than the origin). If `scaling` is FALSE, `psc1` can be a null value.

#### **sx**

X-axis value for scaling (about either the point specified in the `psc1` parameter or the origin). The default value is 0.0.

#### **sy**

Y-axis value for scaling (about either the point specified in the `psc1` parameter or the origin). The default value is 0.0.

**sz**

Z-axis value for scaling (about either the point specified in the `p1` parameter or the origin). The default value is 0.0.

**rotation**

A string value of `TRUE` causes rotation to be performed; a string value of `FALSE` (the default) causes rotation not to be performed.

For two-dimensional geometries, rotation uses the `p1` and `angle` values. For three-dimensional geometries, rotation uses either the `angle` and `dir` values or the `line1` and `angle` values.

**p1**

Point for two-dimensional geometry rotation about a specified point.

**line1**

Line for rotation about a specified axis.

**angle**

Angle rotation parameter (in radians) for rotation about a specified axis or about the X, Y, or Z axis. The default value is 0.0.

**dir**

Rotation parameter for x(0), y(1), or z(2)-axis roll. If the `rotation` parameter value is `TRUE` but the `dir` parameter is not used, use a value of -1 (the default)

**shearing**

A string value of `TRUE` causes shearing to be performed; a string value of `FALSE` (the default) causes shearing not to be performed.

For two-dimensional geometries, shearing uses the `shxy` and `shyx` parameter values. For three-dimensional geometries, shearing uses the `shxy`, `shyx`, `shxz`, `shzx`, `shyz`, and `shzy` parameter values.

**shxy**

Value for shearing due to X along the Y direction. The default value is 0.0.

**shyx**

Value for shearing due to Y along the X direction. The default value is 0.0.

**shxz**

Value for shearing due to X along the Z direction (three-dimensional geometries only). The default value is 0.0.

**shzx**

Value for shearing due to Z along the X direction (three-dimensional geometries only).

**shyz**

Value for shearing due to Y along the Z direction (three-dimensional geometries only).

**shzy**

Value for shearing due to Z along the Y direction (three-dimensional geometries only).

**reflection**

A string value of TRUE causes reflection to be performed; a string value of FALSE (the default) causes reflection not to be performed.

For two-dimensional geometries, reflection uses the `lineR` value for reflection about an axis and the `pref` value for the centroid for self-reflection. For three-dimensional geometries, reflection uses the `lineR` value for reflection about an axis; the `dirR` value for reflection about the yz, xz, and xy planes; the `planeR`, `n`, and `bigD` values for reflection about a specified plane; and the `pref` value for the centroid for self-reflection.

**pref**

Point through which to perform reflection.

**lineR**

Line along which to perform reflection.

**dirR**

Number indicating the plane about (through) which to perform reflection: 0 for the yz plane, 1 for the xz plane, or 2 for the xy plane. If the `reflection` parameter value is TRUE but the `dirR` parameter is not used, use a value of -1 (the default).

**planeR**

A string value of TRUE causes reflection about an arbitrary plane to be performed; a string value of FALSE (the default) causes reflection about an arbitrary plane not to be performed.

**n**

Normal vector of the plane.

**bigD**

Delta value for the plane equation in three-dimensional geometries.

For three-dimensional geometries, `bigD` = delta and `n` = (A,B,C) where `n` is the normal of the plane in three-dimensional space. Thus, the plane equation is:

$$Ax+By+Cz+bigD = 3DDotProd(n,anypointonplane)+bigD = 0$$

**Usage Notes**

The order of affine transforms matter because these are matrix and vector multiplications.

You should validate the resulting geometry using the [SDO\\_GEOM.VALIDATE\\_GEOMETRY\\_WITH\\_CONTEXT](#) (page 23-52) function.

**Examples**

The following example performs an affine transformation on a two-dimensional geometry.

```
-- Polygon reflection in 2D about a specified line segment
SELECT SDO_UTIL.AFFINETRANSFORMS(
  geometry =>   sdo_geometry (2003,8307,null,sdo_elem_info_array (1,1003,1),
                                sdo_ordinate_array (0,2,2,0,5,3,3,5,0,2)),
  translation => 'FALSE',
  tx => 0.0,
  ty => 0.0,
  tz => 0.0,
```



```

scaling => 'FALSE',
pscl => NULL,
sx => 0.0,
sy => 0.0,
sz => 0.0,
rotation => 'TRUE',
p1 => sdo_geometry (2001,8307,sdo_point_type(0,2,null),null,null),
line1 => NULL,
angle => -2.35253274913915,
dir => -1,
shearing => 'FALSE',
shxy => 0.0,
shyx => 0.0,
shxz => 0.0,
shzx => 0.0,
shyz => 0.0,
shzy => 0.0,
reflection => 'FALSE',
pref => NULL,
lineR => NULL,
dirR => 0,
planeR => 'FALSE',
n => NULL,
bigD => NULL
) FROM DUAL;

SDO_UTIL.AFFINETRANSFORMS(GEOMETRY=>SDO_GEOMETRY(2003,8307,NULL,SDO_ELEM_INFO_AR
-----
SDO_GEOMETRY(2003, 8307, NULL, SDO_ELEM_INFO_ARRAY(1, 1003, 1), SDO_ORDINATE_ARR
AY(0, 2, -2.8284082, 1.98964306, -2.8128727, -2.2529692, .015535417, -2.2426122,
0, 2))

```

The following is a simplified version of the preceding example, using the default values for most parameters.

```

-- Simpler form, using most default values
SELECT SDO_UTIL.AFFINETRANSFORMS(
  geometry => sdo_geometry (2003,8307,null,sdo_elem_info_array (1,1003,1),
                                sdo_ordinate_array (0,2,2,0,5,3,3,5,0,2)),
  rotation => 'TRUE',
  p1 => sdo_geometry (2001,8307,sdo_point_type(0,2,null),null,null),
  angle => -2.35253274913915
) FROM DUAL;

SDO_UTIL.AFFINETRANSFORMS(GEOMETRY=>SDO_GEOMETRY(2003,8307,NULL,SDO_ELEM_INFO_AR
-----
SDO_GEOMETRY(2003, 8307, NULL, SDO_ELEM_INFO_ARRAY(1, 1003, 1), SDO_ORDINATE_ARR
AY(0, 2, -2.8284082, 1.98964306, -2.8128727, -2.2529692, .015535417, -2.2426122,
0, 2))

```

The following example performs an affine transformation on a three-dimensional geometry.

```

-- Polygon reflection in 3D about a specified plane (z=1 plane in this example)
SELECT SDO_UTIL.AFFINETRANSFORMS(
  geometry => MDSYS.SDO_GEOMETRY(3003, 0, NULL,
    MDSYS.SDO_ELEM_INFO_ARRAY(1,1003,1),
    MDSYS.SDO_ORDINATE_ARRAY(
      1.5,0,0,
      2.5,1,0,
      1.5,2,0,

```

```
        0.5,2,0,
        0.5,0,0,
        1.5,0,0)),
translation => 'FALSE',
tx => 0.0,
ty => 0.0,
tz => 0.0,
scaling => 'FALSE',
pscl => NULL,
sx => 0.0,
sy => 0.0,
sz => 0.0,
rotation => 'FALSE',
pl => NULL,
line1 => NULL,
angle => 0.0,
dir => 0,
shearing => 'FALSE',
shxy => 0.0,
shyx => 0.0,
shxz => 0.0,
shzx => 0.0,
shyz => 0.0,
shzy => 0.0,
reflection => 'TRUE',
pref => NULL,
lineR => NULL,
dirR => -1,
planeR => 'TRUE',
n => SDO_NUMBER_ARRAY(0.0, 0.0, 1.0),
bigD => SDO_NUMBER_ARRAY(-1.0)
) FROM DUAL;

SDO_UTIL.AFFINETRANSFORMS(GEOMETRY=>MDSYS.SDO_GEOMETRY(3003,0,NULL,MDSYS.SDO_ELE
-----
SDO_GEOMETRY(3003, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 1003, 1), SDO_ORDINATE_ARR
AY(1.5, 0, 2, 2.5, 1, 2, 1.5, 2, 2, .5, 2, 2, .5, 0, 2, 1.5, 0, 2))
```

### Related Topics

- [SDO\\_UTIL.CONVERT\\_UNIT](#) (page 31-15)
- [SDO\\_UTIL.POINT\\_AT\\_BEARING](#) (page 31-44)

## 31.2 SDO\_UTIL.APPEND

### Format

```
SDO_UTIL.APPEND(
    geometry1 IN SDO_GEOMETRY,
    geometry2 IN SDO_GEOMETRY
) RETURN SDO_GEOMETRY;
```

### Description

Appends one geometry to another geometry to create a new geometry.

### Parameters

**geometry1**

Geometry object to which geometry2 is to be appended.

**geometry2**

Geometry object to append to geometry1.

**Usage Notes**

This function should be used only on geometries that do not have any spatial interaction (that is, on disjoint objects). If the input geometries are not disjoint, the resulting geometry might be invalid.

This function does not perform a union operation or any other computational geometry operation. To perform a union operation, use the [SDO\\_GEOM.SDO\\_UNION](#) (page 23-44) function, which is described in [SDO\\_GEOM Package \(Geometry\)](#) (page 23-1). The APPEND function executes faster than the [SDO\\_GEOM.SDO\\_UNION](#) (page 23-44) function.

The geometry type (SDO\_GTYPE value) of the resulting geometry reflects the types of the input geometries and the append operation. For example, if the input geometries are two-dimensional polygons (SDO\_GTYPE = 2003), the resulting geometry is a two-dimensional multipolygon (SDO\_GTYPE = 2007).

An exception is raised if geometry1 and geometry2 are based on different coordinate systems.

**Examples**

The following example appends the cola\_a and cola\_c geometries. (The example uses the definitions and data from [Simple Example: Inserting, Indexing, and Querying Spatial Data](#) (page 2-1).)

```
SELECT SDO_UTIL.APPEND(c_a.shape, c_c.shape)
   FROM cola_markets c_a, cola_markets c_c
   WHERE c_a.name = 'cola_a' AND c_c.name = 'cola_c';

SDO_UTIL.APPEND(C_A.SHAPE,C_C.SHAPE)(SDO_GTYPE, SDO_SRID, SDO_POINT(X, Y, Z), SD
-----
SDO_GEOMETRY(2007, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 1003, 3, 5, 1003, 1), SDO_
ORDINATE_ARRAY(1, 1, 5, 7, 3, 3, 6, 3, 6, 5, 4, 5, 3, 3))
```

**Related Topics**

- [SDO\\_GEOM.SDO\\_UNION](#) (page 23-44) (in [SDO\\_GEOM Package \(Geometry\)](#) (page 23-1))

## 31.3 SDO\_UTIL.BEARING\_TILT\_FOR\_POINTS

**Format**

```
SDO_UTIL.BEARING_TILT_FOR_POINTS(
    start_point IN SDO_GEOMETRY,
    end_point   IN SDO_GEOMETRY,
    tol         IN NUMBER,
    bearing     OUT NUMBER,
    tilt        OUT NUMBER
) RETURN SDO_GEOMETRY;
```

**Description**

Computes the bearing and tilt from a start point to an end point.

**Parameters****start\_point**

Starting point geometry object from which to compute the bearing and tilt. The point geometry must be based on a geodetic coordinate system.

**end\_point**

Ending point geometry object to use in computing the bearing and tilt. The point geometry must be based on the same geodetic coordinate system as `start_point`.

**tol**

Tolerance value (see [Tolerance](#) (page 1-6)).

**bearing**

Number of radians, measured clockwise from North.

**tilt**

Number of radians, measured from the normal.

**Usage Notes**

The input point geometries must be based on the same geodetic coordinate system. If they are based on a non-geodetic coordinate system, the output bearing is a null value.

The tilt is computed as the arctangent of the difference between the height values divided by the distance between the points (with height excluded from the distance calculation). That is: `tilt = atan(height_difference/distance)`

To convert radians to decimal degrees or decimal degrees to radians, you can use the [SDO\\_UTIL.CONVERT\\_UNIT](#) (page 31-15) function. To return a point geometry that is at a specified distance and bearing from a start point, you can use the [SDO\\_UTIL.POINT\\_AT\\_BEARING](#) (page 31-44) function.

**Examples**

The following example computes the bearing and tilt for two longitude/latitude points, where the elevation of the start point is 0 (zero) and the elevation of the end point is 5000 meters. This example displays the bearing and tilt values in radians.

```
DECLARE
  bearing NUMBER;
  tilt    NUMBER;
BEGIN
  SDO_UTIL.BEARING_TILT_FOR_POINTS(
    SDO_GEOMETRY(2001, 8307,
      SDO_POINT_TYPE(-71.5, 43, 0), NULL, NULL), -- start_point
    SDO_GEOMETRY(2001, 8307,
      SDO_POINT_TYPE(-71, 43.5, 5000), NULL, NULL), -- end_point
    0.05, --tolerance
    bearing,
    tilt);
  DBMS_OUTPUT.PUT_LINE('Bearing = ' || bearing);
  DBMS_OUTPUT.PUT_LINE('Tilt = ' || tilt);
END;
/
```

```
Bearing = .628239101930666
Tilt = .0725397288678286910476298724869396973718
```

The following example is the same as the preceding one, except that it displays the bearing and tilt in decimal degrees instead of radians.

```
DECLARE
  bearing NUMBER;
  tilt     NUMBER;
BEGIN
  SDO_UTIL.BEARING_TILT_FOR_POINTS(
    SDO_GEOMETRY(2001, 8307,
      SDO_POINT_TYPE(-71.5, 43, 0), NULL, NULL), -- start_point
    SDO_GEOMETRY(2001, 8307,
      SDO_POINT_TYPE(-71, 43.5, 5000), NULL, NULL), -- end_point
    0.05, --tolerance
    bearing,
    tilt);
  DBMS_OUTPUT.PUT_LINE('Bearing in degrees = '
    || bearing * 180 / 3.1415926535897932384626433832795);
  DBMS_OUTPUT.PUT_LINE('Tilt in degrees = '
    || tilt * 180 / 3.1415926535897932384626433832795);
END;
/
Bearing in degrees = 35.99544906571628894295547577999851892359
Tilt in degrees = 4.15622031114988533540349823511872120415
```

### Related Topics

- [SDO\\_UTIL.CONVERT\\_UNIT](#) (page 31-15)
- [SDO\\_UTIL.POINT\\_AT\\_BEARING](#) (page 31-44)

## 31.4 SDO\_UTIL.CIRCLE\_POLYGON

### Format

```
SDO_UTIL.CIRCLE_POLYGON(
  point          IN SDO_GEOMETRY,
  radius         IN NUMBER,
  arc_tolerance  IN NUMBER,
  start_azimuth  IN NUMBER DEFAULT NULL,
  end_azimuth    IN NUMBER DEFAULT NULL,
  orientation    IN NUMBER DEFAULT NULL,
  arc            IN NUMBER DEFAULT NULL
) RETURN SDO_GEOMETRY;
```

or

```
SDO_UTIL.CIRCLE_POLYGON(
  center_longitude IN NUMBER,
  center_latitude  IN NUMBER,
  radius           IN NUMBER,
  arc_tolerance    IN NUMBER
) RETURN SDO_GEOMETRY;
```

or

```
SDO_UTIL.CIRCLE_POLYGON(
  center_longitude IN NUMBER,
```

```
center_latitude IN NUMBER,  
radius         IN NUMBER,  
start_azimuth  IN NUMBER,  
end_azimuth    IN NUMBER,  
arc_tolerance  IN NUMBER  
) RETURN SDO_GEOMETRY;
```

### Description

Creates polygon or polyline approximations of circles and arcs in geodetic coordinate systems.

- The first format allows full control of the output.
- The second format returns the polygon geometry that approximates and is covered by a specified circle.
- The third format returns a line geometry that approximates the boundary of the circle from the start to the end azimuth (an arc).

### Parameters

#### **point**

The center of the circle. Must be a point geometry in a geodetic coordinate system. The returned geometry will be in the same coordinate system.

#### **center\_longitude**

Center longitude (in degrees) of the circle to be used to create the returned geometry.

#### **center\_latitude**

Center latitude (in degrees) of the circle to be used to create the returned geometry.

#### **radius**

Length (in meters) of the radius of the circle to be used to create the returned geometry.

#### **arc\_tolerance**

A numeric value to be used to construct the polygon geometry. The `arc_tolerance` parameter value has the same meaning and usage guidelines as the `arc_tolerance` keyword value in the `params` parameter string for the [SDO\\_GEOM.SDO\\_ARC\\_DENSIFY](#) (page 23-7) function. The unit of measurement associated with the geometry is associated with the `arc_tolerance` parameter value. (For more information, see the Usage Notes for the [SDO\\_GEOM.SDO\\_ARC\\_DENSIFY](#) (page 23-7) function in [SDO\\_GEOM Package \(Geometry\)](#) (page 23-1).)

#### **start\_azimuth**

Start angle (in degrees) of the arc, measured counterclockwise from due south.

If `start_azimuth` and `end_azimuth` are null, the behavior is comparable to the second format, which returns the polygon geometry that approximates and is covered by a specified circle.

#### **end\_azimuth**

End angle (in degrees) of the arc, measured counterclockwise from due south. If orientation is not explicitly specified, then the arc will be the counterclockwise section of the circle from `start_azimuth` if `end_azimuth` is greater than

start\_azimuth, and the arc will be the clockwise section if end\_azimuth is less than start\_azimuth.

If start\_azimuth and end\_azimuth are null, the behavior is comparable to the second format, which returns the polygon geometry that approximates and is covered by a specified circle.

### orientation

Controls which portion of the circle from start\_azimuth to end\_azimuth is used. This controls the shape of the returned output, not the orientation of the output: a returned polygon is always oriented counterclockwise, and a returned arc is always from start\_azimuth to end\_azimuth. The value can be one of the following:

- 0 or null (default): Automatic (see the end\_azimuth parameter description).
- 1 or +1: Arc is drawn counterclockwise from start\_azimuth to end\_azimuth.
- -1: Arc is drawn clockwise from start\_azimuth to end\_azimuth.

### arc

If set to 1, the result will be a line; if 0 or null (the default), the result is a polygon. If start\_azimuth and end\_azimuth specify a subset of the circle with a polygon result, the returned polygon will include the center of the circle (that is, will be a sector of the circle).

## Usage Notes

The first format of this function is useful for creating a circle-like polygon around a specified center point when a true circle cannot be used (a circle is not valid for geodetic data with Oracle Spatial and Graph). The returned geometry has an SDO\_SRID value of 8307 (for Longitude / Latitude (WGS 84)).

The second and third formats of this function are useful for creating a polyline approximation to a circular arc or a polygon that represents a sector of the circle.

If the start and end azimuth values are specified, they must not be equal to each other, and must cover no more than a 360 degree rotation. Angles must be in the range -720 to +720.

Circles will always be created with at least four distinct vertices (a square).

## Examples

The following example returns a circle-like polygon around a point near the center of Concord, Massachusetts. A radius value of 100 meters and an arc\_tolerance value of 5 meters are used in computing the polygon vertices.

```
SELECT SDO_UTIL.CIRCLE_POLYGON(-71.34937, 42.46101, 100, 5)
FROM DUAL;
```

```
SDO_UTIL.CIRCLE_POLYGON(-71.34937,42.46101,100,5)(SDO_GTYPE, SDO_SRID, SDO_POINT
-----
SDO_GEOMETRY(2003, 8307, NULL, SDO_ELEM_INFO_ARRAY(1, 1003, 1), SDO_ORDINATE_ARR
AY(-71.34937, 42.4601107, -71.348653, 42.4602824, -71.348211, 42.4607321, -71.34
8211, 42.4612879, -71.348653, 42.4617376, -71.34937, 42.4619093, -71.350087, 42.
4617376, -71.350529, 42.4612879, -71.350529, 42.4607321, -71.350087, 42.4602824,
-71.34937, 42.4601107))
```

**Related Topics**

- [SDO\\_UTIL.ELLIPSE\\_POLYGON](#) (page 31-17)

## 31.5 SDO\_UTIL.CONCAT\_LINES

**Format**

```
SDO_UTIL.CONCAT_LINES(  
    geometry1 IN SDO_GEOMETRY,  
    geometry2 IN SDO_GEOMETRY  
) RETURN SDO_GEOMETRY;
```

**Description**

Concatenates two line or multiline two-dimensional geometries to create a new geometry.

**Parameters****geometry1**

First geometry object for the concatenation operation.

**geometry2**

Second geometry object for the concatenation operation.

**Usage Notes**

Each input geometry must be a two-dimensional line or multiline geometry (that is, the SDO\_GTYPE value must be 2002 or 2006). This function is not supported for LRS geometries. To concatenate LRS geometric segments, use the [SDO\\_LRS.CONCATENATE\\_GEOM\\_SEGMENTS](#) (page 24-6) function (described in [SDO\\_LRS Package \(Linear Referencing System\)](#) (page 24-1)).

The input geometries must be line strings whose vertices are connected by straight line segments. Circular arcs and compound line strings are not supported.

If an input geometry is a multiline geometry, the elements of the geometry must be disjoint. If they are not disjoint, this function may return incorrect results.

The topological relationship between geometry1 and geometry2 must be DISJOINT or TOUCH; and if the relationship is TOUCH, the geometries must intersect only at two end points.

You can use the [SDO\\_AGGR\\_CONCAT\\_LINES](#) (page 19-3) spatial aggregate function (described in [Spatial Aggregate Functions](#) (page 19-1)) to concatenate multiple two-dimensional line or multiline geometries.

An exception is raised if geometry1 and geometry2 are based on different coordinate systems.

**Examples**

The following example concatenates two simple line string geometries.

```
-- Concatenate two touching lines: one from (1,1) to (5,1) and the  
-- other from (5,1) to (8,1).  
SELECT SDO_UTIL.CONCAT_LINES(  
    SDO_GEOMETRY(2002, NULL, NULL, SDO_ELEM_INFO_ARRAY(1,2,1),
```



```

        SDO_ORDINATE_ARRAY(1,1, 5,1)),
        SDO_GEOMETRY(2002, NULL, NULL, SDO_ELEM_INFO_ARRAY(1,2,1),
        SDO_ORDINATE_ARRAY(5,1, 8,1))
    ) FROM DUAL;

SDO_UTIL.CONCAT_LINES(SDO_GEOMETRY(2002,NULL,NULL,SDO_ELEM_INFO_ARRAY(1,2,1),SDO
-----
SDO_GEOMETRY(2002, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 2, 1), SDO_ORDINATE_ARRAY(
1, 1, 5, 1, 8, 1))

```

### Related Topics

- [SDO\\_AGGR\\_CONCAT\\_LINES](#) (page 19-3) (in [Spatial Aggregate Functions](#) (page 19-1))
- [SDO\\_LRS.CONCATENATE\\_GEOM\\_SEGMENTS](#) (page 24-6) (in [SDO\\_LRS Package \(Linear Referencing System\)](#) (page 24-1))

## 31.6 SDO\_UTIL.CONVERT\_UNIT

### Format

```

SDO_UTIL.CONVERT_UNIT(
    ivalue      IN NUMBER,
    in_unit     IN VARCHAR2,
    out_unit    IN VARCHAR2
) RETURN NUMBER;

```

### Description

Converts values from one angle, area, or distance unit of measure to another.

### Parameters

#### value

Number of units to be converted. For example, to convert 10 decimal degrees to radians, specify 10.

#### in\_unit

The unit of measure from which to convert the input value. Must be a value from the SDO\_UNIT column of the MDSYS.SDO\_ANGLE\_UNITS table (described in [MDSYS.SDO\\_ANGLE\\_UNITS View](#) (page 6-52)), the MDSYS.SDO\_AREA\_UNITS table (described in [Unit of Measurement Support](#) (page 2-55)), or the MDSYS.SDO\_DIST\_UNITS table (described in [Unit of Measurement Support](#) (page 2-55)). For example, to convert decimal degrees to radians, specify Degree.

#### out\_unit

The unit of measure into which to convert the input value. Must be a value from the SDO\_UNIT column of the same table used for in\_unit. For example, to convert decimal degrees to radians, specify Radian.

### Usage Notes

The value returned by this function might not be correct at an extremely high degree of precision because of the way internal mathematical operations are performed, especially if they involve small numbers or irrational numbers (such as *pi*). For

example, converting 1 decimal degree into decimal minutes results in the value 60.0000017.

### Examples

The following example converts 1 radian into decimal degrees.

```
SQL> SELECT SDO_UTIL.CONVERT_UNIT(1, 'Radian', 'Degree') FROM DUAL;

SDO_UTIL.CONVERT_UNIT(1,'RADIANT','DEGREE')
-----
57.2957796
```

### Related Topics

None.

## 31.7 SDO\_UTIL.CONVERT3007TO3008

### Format

```
SDO_UTIL.CONVERT3007TO3008(  
    geometry IN SDO_GEOMETRY  
    ) RETURN SDO_GEOMETRY;
```

### Description

Converts an input three-dimensional multisurface geometry (SDO\_GTYPE 3007) to a simple solid geometry (SDO\_GTYPE 3008).

### Parameters

#### geometry

Geometry object with SDO\_GTYPE 3007 (multisurface). The surfaces are simple polygons without interiors.

### Usage Notes

For information about SDO\_GEOMETRY attributes for 3D geometries, see [Three-Dimensional Spatial Objects](#) (page 1-16).

This function does not check the validity of the returned simple solid geometry. To check the validity of a geometry object, use the [SDO\\_GEOM.VALIDATE\\_GEOMETRY\\_WITH\\_CONTEXT](#) (page 23-52) function.

### Examples

The following example converts an input three-dimensional multisurface geometry (SDO\_GTYPE 3007) to a simple solid geometry (SDO\_GTYPE 3008). It assumes that a table named GEOMS3D exists with at least a numeric ID column and a column named GEOM of type SDO\_GEOMETRY containing three-dimensional multisurface geometries.

```
SELECT sdo_util.convert3007to3008(g.geom) FROM geoms3d g WHERE g.id=1;
```

## 31.8 SDO\_UTIL.DROP\_WORK\_TABLES

### Format

```
SDO_UTIL.DROP_WORK_TABLES(
    oidstr IN VARCHAR2);
```

### Description

Drops any transient ("scratch") tables and views in the current schema that were created during the creation of a point cloud or TIN.

### Parameters

#### oidstr

Object ID string representing a hexadecimal number. Use the string given in the error message that indicated that scratch tables need to be dropped.

### Usage Notes

If scratch tables still exist from a previous [SDO\\_PC\\_PKG.CREATE\\_PC](#) (page 27-7) or [SDO\\_TIN\\_PKG.CREATE\\_TIN](#) (page 29-3) operation when you try to create a point cloud or TIN, an error message is displayed indicating that you must first drop the scratch tables. Use the SDO\_UTIL.DROP\_WORK\_TABLES procedure to drop these scratch tables.

This procedure drops all tables and views that match 'M%\_<oidstr>\$\$% '.

### Examples

The following example drops the scratch tables from a previous [SDO\\_PC\\_PKG.CREATE\\_PC](#) (page 27-7) or [SDO\\_TIN\\_PKG.CREATE\\_TIN](#) (page 29-3) operation, using an OID string specified in a previous error message.

```
EXECUTE SDO_UTIL.DROP_WORK_TABLES('A1B2C3');
```

### Related Topics

- [SDO\\_PC\\_PKG.CREATE\\_PC](#) (page 27-7)
- [SDO\\_TIN\\_PKG.CREATE\\_TIN](#) (page 29-3)

## 31.9 SDO\_UTIL.ELLIPSE\_POLYGON

### Format

```
SDO_UTIL.ELLIPSE_POLYGON(
    center_longitude IN NUMBER,
    center_latitude  IN NUMBER,
    semi_major_axis  IN NUMBER,
    semi_minor_axis  IN NUMBER,
    azimuth          IN NUMBER,
    arc_tolerance     IN NUMBER
) RETURN SDO_GEOMETRY;
```

**Description**

Returns the polygon geometry that approximates and is covered by a specified ellipse.

**Parameters****center\_longitude**

Center longitude (in degrees) of the ellipse to be used to create the returned geometry.

**center\_latitude**

Center latitude (in degrees) of the ellipse to be used to create the returned geometry.

**semi\_major\_axis**

Length (in meters) of the semi-major axis of the ellipse to be used to create the returned geometry.

**semi\_minor\_axis**

Length (in meters) of the semi-minor axis of the ellipse to be used to create the returned geometry.

**azimuth**

Number of degrees of the azimuth (clockwise rotation of the major axis from north) of the ellipse to be used to create the returned geometry. Must be from 0 to 180. The returned geometry is rotated by the specified number of degrees.

**arc\_tolerance**

A numeric value to be used to construct the polygon geometry. The `arc_tolerance` parameter value has the same meaning and usage guidelines as the `arc_tolerance` keyword value in the `params` parameter string for the [SDO\\_GEOM.SDO\\_ARC\\_DENSIFY](#) (page 23-7) function. The unit of measurement associated with the geometry is associated with the `arc_tolerance` parameter value. (For more information, see the Usage Notes for the [SDO\\_GEOM.SDO\\_ARC\\_DENSIFY](#) (page 23-7) function in [SDO\\_GEOM Package \(Geometry\)](#) (page 23-1).)

**Usage Notes**

This function is useful for creating an ellipse-like polygon around a specified center point when a true ellipse cannot be used (an ellipse is not valid for geodetic data with Oracle Spatial and Graph). The returned geometry has an `SDO_SRID` value of 8307 (for Longitude / Latitude (WGS 84)).

**Examples**

The following example returns an ellipse-like polygon, oriented east-west (`azimuth = 90`), around a point near the center of Concord, Massachusetts. An `arc_tolerance` value of 5 meters is used in computing the polygon vertices.

```
SELECT SDO_UTIL.ELLIPSE_POLYGON(-71.34937, 42.46101, 100, 50, 90, 5)
FROM DUAL;

SDO_UTIL.ELLIPSE_POLYGON(-71.34937,42.46101,100,50,90,5)(SDO_GTYPE, SDO_SRID, SD
-----
SDO_GEOMETRY(2003, 8307, NULL, SDO_ELEM_INFO_ARRAY(1, 1003, 1), SDO_ORDINATE_ARR
AY(-71.350589, 42.46101, -71.350168, 42.4606701, -71.349708, 42.460578, -71.3493
7, 42.4605603, -71.349032, 42.460578, -71.348572, 42.4606701, -71.348151, 42.461
```

```
01, -71.348572, 42.4613499, -71.349032, 42.461442, -71.34937, 42.4614597, -71.34
9708, 42.461442, -71.350168, 42.4613499, -71.350589, 42.46101))
```

### Related Topics

- [SDO\\_UTIL.CIRCLE\\_POLYGON](#) (page 31-11)

## 31.10 SDO\_UTIL.EXTRACT

### Format

```
SDO_UTIL.EXTRACT(
    geometry IN SDO_GEOMETRY,
    element  IN NUMBER,
    ring     IN NUMBER DEFAULT 0
) RETURN SDO_GEOMETRY;
```

### Description

Returns the two-dimensional geometry that represents a specified element (and optionally a ring) of the input two-dimensional geometry.

### Parameters

#### geometry

Geometry from which to extract the geometry to be returned. Must be a two-dimensional geometry.

#### element

Number of the element in the geometry: 1 for the first element, 2 for the second element, and so on. Geometries with SDO\_GTYPE values (explained in [SDO\\_GTYPE](#) (page 2-5)) ending in 1, 2, or 3 have one element; geometries with SDO\_GTYPE values ending in 4, 5, 6, or 7 can have more than one element. For example, a multipolygon with an SDO\_GTYPE of 2007 might contain three elements (polygons).

#### ring

Number of the subelement (ring) within element: 1 for the first subelement, 2 for the second subelement, and so on. This parameter is valid only for specifying a subelement of a polygon with one or more holes or of a point cluster:

- For a polygon with holes, its first subelement is its exterior ring, its second subelement is its first interior ring, its third subelement is its second interior ring, and so on. For example, in the polygon with a hole shown in [Figure 2-4](#) (page 2-23) in [Polygon with a Hole](#) (page 2-23), the exterior ring is subelement 1 and the interior ring (the hole) is subelement 2.
- For a point cluster, its first subelement is the first point in the point cluster, its second subelement is the second point in the point cluster, and so on.

The default is 0, which causes the entire element to be extracted.

### Usage Notes

This function applies to two-dimensional geometries only. For three-dimensional geometries, use the [SDO\\_UTIL.EXTRACT3D](#) (page 31-24) function.

This function is useful for extracting a specific element or subelement from a complex geometry. For example, if you have identified a geometry as invalid by using the [SDO\\_GEOM.VALIDATE\\_GEOMETRY\\_WITH\\_CONTEXT](#) (page 23-52) function or the [SDO\\_GEOM.VALIDATE\\_LAYER\\_WITH\\_CONTEXT](#) (page 23-56) procedure (both of which are documented in [SDO\\_GEOM Package \(Geometry\)](#) (page 23-1)), you can use the EXTRACT function to extract the invalid geometry in order to examine it.

For a polygon with one or more holes, the returned geometry representing an extracted interior ring is reoriented so that its vertices are presented in counterclockwise order (as opposed to the clockwise order within an interior ring).

If `geometry` is null or has an SDO\_GTYPE value ending in 0, this function returns a null geometry.

`geometry` cannot contain a type 0 (zero) element. Type 0 elements are described in [Type 0 \(Zero\) Element](#) (page 2-31).

This function is not intended for use with geometries that have any null ordinate values. Any null ordinate values in the returned geometry are replaced by 0 (zero).

An exception is raised if `element` or `ring` is an invalid number for `geometry`.

### Examples

The following example extracts the first (and only) element in the `cola_c` geometry. (The example uses the definitions and data from [Simple Example: Inserting Indexing and Querying Spatial Data](#) (page 2-1).)

```
SELECT c.name, SDO_UTIL.EXTRACT(c.shape, 1)
  FROM cola_markets c WHERE c.name = 'cola_c';

NAME
-----
SDO_UTIL.EXTRACT(C.SHAPE,1)(SDO_GTYPE, SDO_SRID, SDO_POINT(X, Y, Z), SDO_ELEM_IN
-----
cola_c
SDO_GEOMETRY(2003, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 1003, 1), SDO_ORDINATE_ARR
AY(3, 3, 6, 3, 6, 5, 4, 5, 3, 3))
```

The following example inserts a polygon with a hole (using the same INSERT statement as in [Example 2-7](#) (page 2-24) in [Polygon with a Hole](#) (page 2-23)), and extracts the geometry representing the hole (the second subelement). Notice that in the geometry returned by the EXTRACT function, the vertices are in counterclockwise order, as opposed to the clockwise order in the hole (second subelement) in the input geometry.

```
-- Insert polygon with hole.
INSERT INTO cola_markets VALUES(
  10,
  'polygon_with_hole',
  SDO_GEOMETRY(
    2003, -- two-dimensional polygon
    NULL,
    NULL,
    SDO_ELEM_INFO_ARRAY(1,1003,1, 19,2003,1), -- polygon with hole
    SDO_ORDINATE_ARRAY(2,4, 4,3, 10,3, 13,5, 13,9, 11,13, 5,13, 2,11, 2,4,
      7,5, 7,10, 10,10, 10,5, 7,5)
  )
);

1 row created.
```

```
-- Extract the hole geometry (second subelement).
SELECT SDO_UTIL.EXTRACT(c.shape, 1, 2)
       FROM cola_markets c WHERE c.name = 'polygon_with_hole';

SDO_UTIL.EXTRACT(C.SHAPE,1,2)(SDO_GTYPE, SDO_SRID, SDO_POINT(X, Y, Z), SDO_ELEM_
-----
SDO_GEOMETRY(2003, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 1003, 1), SDO_ORDINATE_ARR
AY(7, 5, 10, 5, 10, 10, 7, 10, 7, 5))
```

### Related Topics

- [SDO\\_UTIL.EXTRACT3D](#) (page 31-24)
- [SDO\\_UTIL.GETVERTICES](#) (page 31-40)
- [SDO\\_GEOM.VALIDATE\\_GEOMETRY\\_WITH\\_CONTEXT](#) (page 23-52)
- [SDO\\_GEOM.VALIDATE\\_LAYER\\_WITH\\_CONTEXT](#) (page 23-56)

## 31.11 SDO\_UTIL.EXTRACT\_ALL

### Format

```
SDO_UTIL.EXTRACT_ALL(
    geometry IN SDO_GEOMETRY,
    flatten  IN NUMBER DEFAULT 1
) RETURN SDO_GEOMETRY_ARRAY;
```

### Description

Returns all elements and subelements of the input two-dimensional geometry, as an array of one or more geometries. Returns an object of type SDO\_GEOMETRY\_ARRAY, which is defined as VARRAY OF SDO\_GEOMETRY.

### Parameters

#### geometry

Geometry from which to extract all elements and subelements. Must be a two-dimensional geometry.

#### flatten

A flag indicating whether to "flatten" rings into individual geometries for geometries that contain an exterior ring and one or more interior rings:

- 0 (zero) returns one geometry for each element, but does not flatten rings into individual geometries. (A geometry will still be returned for each element of the input geometry.)
- 1 (the default) or any other nonzero value flattens rings into individual geometries.

For example, if a polygon contains an outer ring and an inner ring, a value of 0 returns a single geometry containing both rings, and a value of 1 returns two geometries, each containing a ring as a geometry.

This parameter is ignored for geometries that do not contain an exterior ring and one or more interior rings.

## Usage Notes

This function applies to two-dimensional geometries only. For three-dimensional geometries, use the [SDO\\_UTIL.EXTRACT3D](#) (page 31-24) function.

This function enables you to extract all elements and subelements from a geometry, regardless of how many elements and subelements the geometry has. Geometries with SDO\_GTYPE values (explained in [SDO\\_GTYPE](#) (page 2-5)) ending in 1, 2, or 3 have one element; geometries with SDO\_GTYPE values ending in 4, 5, 6, or 7 can have more than one element. For example, a multipolygon with an SDO\_GTYPE of 2007 might contain three elements (polygons). To extract individual elements, use the [SDO\\_UTIL.EXTRACT](#) (page 31-19) function instead.

For a polygon with one or more holes, with the default value for the `flatten` parameter, the returned geometry representing an extracted interior ring is reoriented so that its vertices are presented in counterclockwise order (as opposed to the clockwise order within an interior ring). However, if the `flatten` parameter value is 0, no reorientation is performed.

If `geometry` is null or has an SDO\_GTYPE value ending in 0, this function returns a null geometry.

`geometry` cannot contain a type 0 (zero) element. Type 0 elements are described in [Type 0 \(Zero\) Element](#) (page 2-31).

This function is not intended for use with geometries that have any null ordinate values. Any null ordinate values in the returned geometry are replaced by 0 (zero).

## Examples

The following example extracts all elements from the `cola_b` geometry. (The example uses the definitions and data from [Simple Example: Inserting\\_ Indexing\\_ and Querying Spatial Data](#) (page 2-1).)

```
SELECT * FROM TABLE(
  SELECT SDO_UTIL.EXTRACT_ALL(c.shape)
    FROM cola_markets c WHERE c.name = 'cola_b');
```

```
SDO_GTYPE    SDO_SRID
-----
```

```
SDO_POINT(X, Y, Z)
-----
```

```
SDO_ELEM_INFO
-----
```

```
SDO_ORDINATES
-----
```

```
2003
```

```
SDO_ELEM_INFO_ARRAY(1, 1003, 1)
```

```
SDO_ORDINATE_ARRAY(5, 1, 8, 1, 8, 6, 5, 7, 5, 1)
```

The following example inserts a polygon with a hole (using the same INSERT statement as in [Example 2-7](#) (page 2-24) in [Polygon with a Hole](#) (page 2-23)), and extracts all elements and subelements from the `polygon_with_hole` geometry. Notice that because the `flatten` parameter is not specified, in the second geometry returned by the `EXTRACT_ALL` function the vertices are in counterclockwise order, as opposed to the clockwise order in the hole (second subelement) in the input geometry.

```
-- Insert polygon with hole.
INSERT INTO cola_markets VALUES(
  10,
```



```

        'polygon_with_hole',
        SDO_GEOMETRY(
            2003, -- two-dimensional polygon
            NULL,
            NULL,
            SDO_ELEM_INFO_ARRAY(1,1003,1, 19,2003,1), -- polygon with hole
            SDO_ORDINATE_ARRAY(2,4, 4,3, 10,3, 13,5, 13,9, 11,13, 5,13, 2,11, 2,4,
                               7,5, 7,10, 10,10, 10,5, 7,5)
        )
    );

1 row created.

-- Extract all, with default for flatten.
SELECT * FROM TABLE(
    SELECT SDO_UTIL.EXTRACT_ALL(c.shape)
    FROM cola_markets c WHERE c.name = 'polygon_with_hole');

SDO_GTYPE    SDO_SRID
-----
SDO_POINT(X, Y, Z)
-----
SDO_ELEM_INFO
-----
SDO_ORDINATES
-----
2003

SDO_ELEM_INFO_ARRAY(1, 1003, 1)
SDO_ORDINATE_ARRAY(2, 4, 4, 3, 10, 3, 13, 5, 13, 9, 11, 13, 5, 13, 2, 11, 2, 4)

SDO_GTYPE    SDO_SRID
-----
SDO_POINT(X, Y, Z)
-----
SDO_ELEM_INFO
-----
SDO_ORDINATES
-----
2003

SDO_ELEM_INFO_ARRAY(1, 1003, 1)
SDO_ORDINATE_ARRAY(7, 5, 10, 5, 10, 10, 7, 10, 7, 5)

```

The following example extracts all elements and subelements from the `polygon_with_hole` geometry (inserted in the preceding example), and it specifies the `flatten` parameter value as 0 (zero). This causes the returned array to contain a single geometry that is the same as the input geometry; thus, in the geometry returned by the `EXTRACT_ALL` function, the vertices are in same clockwise order in the hole (second subelement) as in the input geometry.

```

-- Extract all, with flatten = 0.
SELECT * FROM TABLE(
    SELECT SDO_UTIL.EXTRACT_ALL(c.shape, 0)
    FROM cola_markets c WHERE c.name = 'polygon_with_hole');

SDO_GTYPE    SDO_SRID
-----
SDO_POINT(X, Y, Z)
-----

```

```
SDO_ELEM_INFO
-----
SDO_ORDINATES
-----
2003

SDO_ELEM_INFO_ARRAY(1, 1003, 1, 19, 2003, 1)
SDO_ORDINATE_ARRAY(2, 4, 4, 3, 10, 3, 13, 5, 13, 9, 11, 13, 5, 13, 2, 11, 2, 4,
7, 5, 7, 10, 10, 10, 10, 5, 7, 5)

SDO_GTYPE    SDO_SRID
-----
SDO_POINT(X, Y, Z)
-----
SDO_ELEM_INFO
-----
SDO_ORDINATES
-----
```

### Related Topics

- [SDO\\_UTIL.EXTRACT](#) (page 31-19)

## 31.12 SDO\_UTIL.EXTRACT3D

### Format

```
SDO_UTIL.EXTRACT3D(
    geometry IN SDO_GEOMETRY,
    label     IN VARCHAR2
) RETURN SDO_GEOMETRY;
```

### Description

Returns the three-dimensional geometry that represents a specified subset of the input three-dimensional geometry.

### Parameters

#### **geometry**

Geometry from which to extract the geometry to be returned. Must be a three-dimensional geometry

#### **label**

A comma-delimited string of numbers that identify the subset geometry to be returned. Each number identifies the relative position of a geometry item within the input geometry. The items and their positions within the `label` string are:

- `pointID`: Point number
- `edgeID`: Edge number
- `ringID`: Ring number
- `polygonID`: Polygon number
- `csurfID`: Composite surface number

- `solidID`: Solid number
- `multiID`: Multisolid number

A value of 0 (zero) means that the item does not apply, and you can omit trailing items that do not apply. For example, '0,2,1,4,1' means that point number does not apply, and it specifies the second edge of the first ring of the fourth polygon of the first composite surface.

### Usage Notes

This function applies to three-dimensional geometries only. For two-dimensional geometries, use the [SDO\\_UTIL.EXTRACT](#) (page 31-19) function.

This function uses the `getElementByLabel` method of the `oracle.spatial.geometry.ElementExtractor` Java class, which is described in *Oracle Spatial and Graph Java API Reference*.

### Examples

The following example extracts, from a specified three-dimensional geometry, the subset geometry consisting of the following: edge 2 of ring 1 of polygon 4 of composite surface 1 of the input geometry.

```
SELECT SDO_UTIL.EXTRACT3D(
  SDO_GEOMETRY (3008,NULL,NULL ,
    SDO_ELEM_INFO_ARRAY(
      1,1007,1,
      1,1006,6,
      1,1003,1,
      16,1003,1,
      31,1003,1,
      46,1003,1,
      61,1003,1,
      76,1003,1),
    SDO_ORDINATE_ARRAY(
      1.0,0.0,-1.0,
      1.0,1.0,-1.0,
      1.0,1.0,1.0,
      1.0,0.0,1.0,
      1.0,0.0,-1.0,
      1.0,0.0,1.0,
      0.0,0.0,1.0,
      0.0,0.0,-1.0,
      1.0,0.0,-1.0,
      1.0,0.0,1.0,
      0.0,1.0,1.0,
      0.0,1.0,-1.0,
      0.0,0.0,-1.0,
      0.0,0.0,1.0,
      0.0,1.0,1.0,
      1.0,1.0,-1.0,
      0.0,1.0,-1.0,
      0.0,1.0,1.0,
      1.0,1.0,1.0,
      1.0,1.0,-1.0,
      1.0,1.0,1.0,
      0.0,1.0,1.0,
      0.0,0.0,1.0,
      1.0,0.0,1.0,
      1.0,1.0,1.0,
```

```
        1.0,1.0,-1.0,
        1.0,0.0,-1.0,
        0.0,0.0,-1.0,
        0.0,1.0,-1.0,
        1.0,1.0,-1.0
      )
    ),
    '0,2,1,4,1')
FROM DUAL;

SDO_UTIL.EXTRACT3D(SDO_GEOMETRY(3008,NULL,NULL,SDO_ELEM_INFO_ARRAY(1,1007,1,1,10
-----
SDO_GEOMETRY(3002, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 2, 1), SDO_ORDINATE_ARRAY(
0, 1, -1, 0, 1, 1))
```

### Related Topics

- [SDO\\_UTIL.EXTRACT](#) (page 31-19)

## 31.13 SDO\_UTIL.EXTRUDE

### Format

```
SDO_UTIL.EXTRUDE(
  geometry   IN SDO_GEOMETRY,
  grdheight  IN SDO_NUMBER_ARRAY,
  height     IN SDO_NUMBER_ARRAY,
  tol        IN NUMBER,
  optional3dSrid IN NUMBER DEFAULT NULL
) RETURN SDO_GEOMETRY;
```

### Description

Returns the three-dimensional extrusion solid geometry from an input two-dimensional polygon or multipolygon geometry.

### Parameters

#### **geometry**

Two-dimensional polygon geometry from which to return the extrusion geometry. This geometry forms the "base" of the returned geometry.

#### **grdheight**

Ground heights as a set of Z (height) values at the base of the solid. The numbers in this array should be the Z (height) values at the base of each vertex in the input geometry.

#### **height**

Height values for the extrusion geometry. The numbers in this array should be the Z (height) values at the "top" of each corresponding point in the `grdheight` array. For example, if the ground height at the base of the first vertex is 0 and the height at that vertex is 10, the solid at that point along the base extends 10 units high.

#### **tol**

Tolerance value (see [Tolerance](#) (page 1-6)).

**optional3dSrid**

Three-dimensional coordinate system (SRID) to be assigned to the returned geometry. If you do not specify this parameter, Spatial and Graph automatically assigns a three-dimensional SRID value based on the SRID value of the input geometry.

**Usage Notes**

The input geometry must be a two-dimensional polygon or multipolygon geometry.

If the input geometry is a polygon with multiple inner rings, this function internally combines these inner rings to make them one inner ring, producing a new geometry that approximately represents the original appearance; the function then performs the extrusion process on this new geometry, and returns the result.

**Examples**

The following example returns the three-dimensional solid geometry representing an extrusion from a two-dimensional polygon geometry.

```
SELECT SDO_UTIL.EXTRUDE(
  SDO_GEOMETRY(
    2003,
    null,
    null,
    SDO_ELEM_INFO_ARRAY(1,1003,1),
    SDO_ORDINATE_ARRAY(5, 1,8,1,8,6,5,7,5,1)),
  SDO_NUMBER_ARRAY(0,0,0,0,0),
  SDO_NUMBER_ARRAY(5,10,10,5,5),
  0.005) from dual;

SDO_UTIL.EXTRUDE(SDO_GEOMETRY(2003,NULL,NULL,SDO_ELEM_INFO_ARRAY(1,1003,1),SDO_O
-----
SDO_GEOMETRY(3008, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 1007, 1, 1, 1006, 6, 1, 10
03, 1, 16, 1003, 1, 31, 1003, 1, 46, 1003, 1, 61, 1003, 1, 76, 1003, 1), SDO_ORD
INATE_ARRAY(5, 1, 0, 5, 7, 0, 8, 6, 0, 8, 1, 0, 5, 1, 0, 5, 1, 5, 8, 1, 10, 8, 6
, 10, 5, 7, 5, 5, 1, 5, 5, 1, 0, 8, 1, 0, 8, 1, 10, 5, 1, 5, 5, 1, 0, 8, 1, 0, 8
, 6, 0, 8, 6, 10, 8, 1, 10, 8, 1, 0, 8, 6, 0, 5, 7, 0, 5, 7, 5, 8, 6, 10, 8, 6,
0, 5, 7, 0, 5, 1, 0, 5, 1, 5, 5, 7, 5, 5, 7, 0))
```

The following example returns the three-dimensional composite solid geometry representing an extrusion from a two-dimensional polygon geometry with inner rings.

```
SELECT SDO_UTIL.EXTRUDE(
  SDO_GEOMETRY(
    2003,
    null,
    null,
    SDO_ELEM_INFO_ARRAY(1, 1003, 1, 11, 2003, 1,
      21, 2003, 1, 31, 2003, 1, 41, 2003, 1),
    SDO_ORDINATE_ARRAY(0,0, 8,0, 8,8, 0,8, 0,0,
      1,3, 1,4, 2,4, 2,3, 1,3, 1,1, 1,2, 2,2, 2,1, 1,1,
      1,6, 1,7, 2,7, 2,6, 1,6, 3,2, 3,4, 4,4, 4,2, 3,2)),
    SDO_NUMBER_ARRAY(-1.0),
    SDO_NUMBER_ARRAY(1.0),
    0.0001) from dual;

SDO_UTIL.EXTRUDE(SDO_GEOMETRY(2003,NULL,NULL,SDO_ELEM_INFO_ARRAY(1,1003,1,11,200
-----
SDO_GEOMETRY(3008, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 1008, 4, 1, 1007, 1, 1, 10
06, 16, 1, 1003, 1, 46, 1003, 1, 91, 1003, 1, 106, 1003, 1, 121, 1003, 1, 136, 1
```

```
003, 1, 151, 1003, 1, 166, 1003, 1, 181, 1003, 1, 196, 1003, 1, 211, 1003, 1, 22
6, 1003, 1, 241, 1003, 1, 256, 1003, 1, 271, 1003, 1, 286, 1003, 1, 301, 1007, 1
, 301, 1006, 10, 301, 1003, 1, 328, 1003, 1, 355, 1003, 1, 370, 1003, 1, 385, 10
03, 1, 400, 1003, 1, 415, 1003, 1, 430, 1003, 1, 445, 1003, 1, 460, 1003, 1, 475
, 1007, 1, 475, 1006, 6, 475, 1003, 1, 490, 1003, 1, 505, 1003, 1, 520, 1003, 1,
535, 1003, 1, 550, 1003, 1, 565, 1007, 1, 565, 1006, 10, 565, 1003, 1, 592, 100
3, 1, 619, 1003, 1, 634, 1003, 1, 649, 1003, 1, 664, 1003, 1, 679, 1003, 1, 694,
1003, 1, 709, 1003, 1, 724, 1003, 1), SDO_ORDINATE_ARRAY(4, 0, -1, 4, 2, -1, 4,
4, -1, 3, 4, -1, 2, 4, -1, 2, 7, -1, 1, 7, -1, 1, 6, -1, 1, 4, -1, 1, 3, -1, 0,
3, -1, 0, 8, -1, 8, 8, -1, 8, 0, -1, 4, 0, -1, 4, 0, 1, 8, 0, 1, 8, 8, 1, 0, 8,
1, 0, 3, 1, 1, 3, 1, 1, 4, 1, 1, 6, 1, 1, 7, 1, 2, 7, 1, 2, 4, 1, 3, 4, 1, 4,
1, 4, 2, 1, 4, 0, 1, 4, 0, -1, 8, 0, -1, 8, 0, 1, 4, 0, 1, 4, 0, -1, 8, 0, -1,
8, 8, -1, 8, 8, 1, 8, 0, 1, 8, 0, -1, 8, 8, -1, 0, 8, -1, 0, 8, 1, 8, 8, 1, 8,
8, -1, 0, 8, -1, 0, 3, -1, 0, 3, 1, 0, 8, 1, 0, 8, -1, 0, 3, -1, 1, 3, -1, 1, 3,
1, 0, 3, 1, 0, 3, -1, 1, 3, -1, 1, 4, -1, 1, 4, 1, 1, 3, 1, 1, 3, -1, 1, 4, -1,
1, 6, -1, 1, 6, 1, 1, 4, 1, 1, 4, -1, 1, 6, -1, 1, 7, -1, 1, 7, 1, 1, 6, 1, 1,
6, -1, 1, 7, -1, 2, 7, -1, 2, 7, 1, 1, 7, 1, 1, 7, -1, 2, 7, -1, 2, 4, -1, 2, 4,
1, 2, 7, 1, 2, 7, -1, 2, 4, -1, 3, 4, -1, 3, 4, 1, 2, 4, 1, 2, 4, -1, 3, 4, -1,
4, 4, -1, 4, 4, 1, 3, 4, 1, 3, 4, -1, 4, 4, -1, 4, 2, -1, 4, 2, 1, 4, 4, 1, 4,
4, -1, 4, 2, -1, 4, 0, -1, 4, 0, 1, 4, 2, 1, 4, 2, -1, 0, 3, -1, 1, 3, -1, 1, 1,
-1, 2, 1, -1, 3, 2, -1, 4, 2, -1, 4, 0, -1, 0, 0, -1, 0, 3, -1, 0, 3, 1, 0, 0,
1, 4, 0, 1, 4, 2, 1, 3, 2, 1, 2, 1, 1, 1, 1, 1, 3, 1, 0, 3, 1, 0, 3, -1, 0, 0,
-1, 0, 0, 1, 0, 3, 1, 0, 3, -1, 0, 0, -1, 4, 0, -1, 4, 0, 1, 0, 0, 1, 0, 0, -1
, 4, 0, -1, 4, 2, -1, 4, 2, 1, 4, 0, 1, 4, 0, -1, 4, 2, -1, 3, 2, -1, 3, 2, 1, 4
, 2, 1, 4, 2, -1, 3, 2, -1, 2, 1, -1, 2, 1, 1, 3, 2, 1, 3, 2, -1, 2, 1, -1, 1, 1
, -1, 1, 1, 1, 2, 1, 1, 2, 1, -1, 1, 1, -1, 1, 3, -1, 1, 3, 1, 1, 1, 1, 1, 1, -1
, 1, 3, -1, 0, 3, -1, 0, 3, 1, 1, 3, 1, 1, 3, -1, 1, 6, -1, 2, 6, -1, 2, 4, -1,
1, 4, -1, 1, 6, -1, 1, 6, 1, 1, 4, 1, 2, 4, 1, 2, 6, 1, 1, 6, 1, 1, 6, -1, 1, 4,
-1, 1, 4, 1, 1, 6, 1, 1, 6, -1, 1, 4, -1, 2, 4, -1, 2, 4, 1, 1, 4, 1, 1, 4, -1,
2, 4, -1, 2, 6, -1, 2, 6, 1, 2, 4, 1, 2, 4, -1, 2, 6, -1, 1, 6, -1, 1, 6, 1, 2,
6, 1, 2, 6, -1, 1, 3, -1, 2, 3, -1, 2, 4, -1, 3, 4, -1, 3, 2, -1, 2, 1, -1, 2,
2, -1, 1, 2, -1, 1, 3, -1, 1, 3, 1, 1, 2, 1, 2, 1, 1, 3, 2, 1, 3, 4, 1,
2, 4, 1, 2, 3, 1, 1, 3, 1, 1, 3, -1, 1, 2, -1, 1, 2, 1, 1, 3, 1, 1, 3, -1, 1, 2
, -1, 2, 2, -1, 2, 2, 1, 1, 2, 1, 1, 2, -1, 2, 2, -1, 2, 1, -1, 2, 1, 1, 2, 2, 1
, 2, 2, -1, 2, 1, -1, 3, 2, -1, 3, 2, 1, 2, 1, 1, 2, 1, -1, 3, 2, -1, 3, 4, -1,
3, 4, 1, 3, 2, 1, 3, 2, -1, 3, 4, -1, 2, 4, -1, 2, 4, 1, 3, 4, 1, 3, 4, -1, 2, 4
, -1, 2, 3, -1, 2, 3, 1, 2, 4, 1, 2, 4, -1, 2, 3, -1, 1, 3, -1, 1, 3, 1, 2, 3, 1
, 2, 3, -1))
```

### Related Topics

None.

## 31.14 SDO\_UTIL.FROM\_GML311GEOMETRY

### Format

```
SDO_UTIL.FROM_GML311GEOMETRY(
    geometry      IN CLOB,
    srsNamespace  IN VARCHAR2 DEFAULT NULL
) RETURN SDO_GEOMETRY;
```

or

```
SDO_UTIL.FROM_GML311GEOMETRY(
    geometry      IN CLOB,
    srsNamespace  IN VARCHAR2,
    coordOrder    IN NUMBER
) RETURN SDO_GEOMETRY;
```

or

```
SDO_UTIL.FROM_GML311GEOMETRY(  
    geometry IN VARCHAR2,  
    srsNamespace IN VARCHAR2 DEFAULT NULL  
) RETURN SDO_GEOMETRY;
```

or

```
SDO_UTIL.FROM_GML311GEOMETRY(  
    geometry IN VARCHAR2,  
    coordOrder IN NUMBER DEFAULT NULL  
) RETURN SDO_GEOMETRY;
```

or

```
SDO_UTIL.FROM_GML311GEOMETRY(  
    geometry IN VARCHAR2,  
    srsNamespace IN VARCHAR2,  
    coordOrder IN NUMBER  
) RETURN SDO_GEOMETRY;
```

### Description

Converts a geography markup language (GML 3.1.1) fragment to a Spatial and Graph geometry object.

### Parameters

#### **geometry**

Geometry in GML version 3.1.1 format to be converted to SDO\_GEOMETRY format.

#### **srsNamespace**

(Reserved for Oracle use.)

#### **coordOrder**

If the data in GML format is in latitude/longitude format instead of the longitude/latitude format used by Oracle Spatial, specify 1 for this parameter. Otherwise, do not specify this parameter. (See the Usage Notes for more information.)

### Usage Notes

The input geometry must be a valid GML fragment describing a GML version 3.1.1 geometry type defined in the Open GIS Implementation Specification.

Some EPSG geodetic coordinate systems have the axis order reversed in their definition. For such SRIDs, the data in the GML format might come in as latitude/longitude instead of longitude/latitude. If such GML is to be converted to the SDO\_GEOMETRY type, the coordOrder parameter should be specified as 1 so that the latitude/longitude values are converted to longitude/latitude, because longitude/latitude is the order used in the SDO\_GEOMETRY type.

### Examples

The following example shows conversion to and from GML version 3.1.1 format. (The example uses the definitions and data from [Simple Example: Inserting\\_ Indexing\\_ and Querying Spatial Data](#) (page 2-1), specifically the cola\_b geometry from the COLA\_MARKETS table.)

```
DECLARE
    gmlgeom CLOB;
    geom_result SDO_GEOMETRY;
    geom SDO_GEOMETRY;
BEGIN
    SELECT c.shape INTO geom FROM cola_markets c WHERE c.name = 'cola_b';

    -- To GML 3.1.1 geometry
    gmlgeom := SDO_UTIL.TO_GML311GEOMETRY(geom);
    DBMS_OUTPUT.PUT_LINE('To GML 3.1.1 geometry result = ' || TO_CHAR(gmlgeom));

    -- From GML 3.1.3 geometry
    geom_result := SDO_UTIL.FROM_GML311GEOMETRY(gmlgeom);

END;
/
To GML 3.1.1 geometry result = <gml:Polygon srsName="SDO:"
xmlns:gml="http://www.opengis.net/gml"><gml:exterior><gml:LinearRing><gml:posList
srsDimension="2">5.0 1.0 8.0 1.0 8.0 6.0 5.0 7.0 5.0 1.0
</gml:posList></gml:LinearRing></gml:exterior></gml:Polygon>

PL/SQL procedure successfully completed.
```

### Related Topics

- [SDO\\_UTIL.FROM\\_GMLGEOMETRY](#) (page 31-30)
- [SDO\\_UTIL.TO\\_GML311GEOMETRY](#) (page 31-57)
- [SDO\\_UTIL.TO\\_GMLGEOMETRY](#) (page 31-61)

## 31.15 SDO\_UTIL.FROM\_GMLGEOMETRY

### Format

```
SDO_UTIL.FROM_GMLGEOMETRY(
    geometry      IN CLOB,
    srsNamespace IN VARCHAR2 DEFAULT NULL
) RETURN SDO_GEOMETRY;
```

or

```
SDO_UTIL.FROM_GMLGEOMETRY(
    geometry      IN VARCHAR2,
    srsNamespace IN VARCHAR2 DEFAULT NULL
) RETURN SDO_GEOMETRY;
```

### Description

Converts a geography markup language (GML 2.0) fragment to a Spatial and Graph geometry object.

### Parameters

#### **geometry**

Geometry in GML version 2.0 format to be converted to SDO\_GEOMETRY format.



**srsNamespace**  
(Reserved for Oracle use.)

### Usage Notes

The input geometry must be a valid GML fragment describing a GML version 2.0 geometry type defined in the Open GIS Implementation Specification.

### Examples

The following example shows conversion to and from GML version 2.0 format. (The example uses the definitions and data from [Simple Example: Inserting\\_ Indexing\\_ and Querying Spatial Data](#) (page 2-1), specifically the cola\_b geometry from the COLA\_MARKETS table.)

```
DECLARE
  gmlgeom CLOB;
  geom_result SDO_GEOMETRY;
  geom SDO_GEOMETRY;
BEGIN
  SELECT c.shape INTO geom FROM cola_markets c WHERE c.name = 'cola_b';

  -- To GML geometry
  gmlgeom := SDO_UTIL.TO_GMLGEOMETRY(geom);
  DBMS_OUTPUT.PUT_LINE('To GML geometry result = ' || TO_CHAR(gmlgeom));

  -- From GML geometry
  geom_result := SDO_UTIL.FROM_GMLGEOMETRY(gmlgeom);

END;
/
To GML geometry result = <gml:Polygon srsName="SDO:"
xmlns:gml="http://www.opengis.net/gml"><gml:outerBoundaryIs><gml:LinearRing><gml
:coordinates decimal="." cs="," ts=" ">5.0,1.0 8.0,1.0 8.0,6.0 5.0,7.0 5.0,1.0
</gml:coordinates></gml:LinearRing></gml:outerBoundaryIs></gml:Polygon>
```

PL/SQL procedure successfully completed.

### Related Topics

- [SDO\\_UTIL.FROM\\_GML311GEOMETRY](#) (page 31-28)
- [SDO\\_UTIL.TO\\_GML311GEOMETRY](#) (page 31-57)
- [SDO\\_UTIL.TO\\_GMLGEOMETRY](#) (page 31-61)

## 31.16 SDO\_UTIL.FROM\_KMLGEOMETRY

### Format

```
SDO_UTIL.FROM_KMLGEOMETRY(
  geometry IN CLOB
) RETURN SDO_GEOMETRY;
```

or

```
SDO_UTIL.FROM_KMLGEOMETRY(
  geometry IN VARCHAR2
) RETURN SDO_GEOMETRY;
```

**Description**

Converts a KML (Keyhole Markup Language) document to a Spatial and Graph geometry object.

**Parameters****geometry**

Geometry in KML format of type CLOB or VARCHAR2 to be converted to SDO\_GEOMETRY format.

**Usage Notes**

The input geometry must be a valid document conforming to the KML 2.1 specification.

This function does not process the whole KML document; it only processes the KML geometry tags.

**Examples**

The following example shows conversion to and from KML format. (The example uses the definitions and data from [Simple Example: Inserting\\_ Indexing\\_ and Querying Spatial Data](#) (page 2-1), specifically the cola\_c geometry from the COLA\_MARKETS table.)

```
-- Convert cola_c geometry to a KML document; convert that result to
-- a spatial geometry.
DECLARE
    kmlgeom CLOB;
    val_result VARCHAR2(5);
    geom_result SDO_GEOMETRY;
    geom SDO_GEOMETRY;
BEGIN
    SELECT c.shape INTO geom FROM cola_markets c WHERE c.name = 'cola_c';

    -- To KML geometry
    kmlgeom := SDO_UTIL.TO_KMLGEOMETRY(geom);
    DBMS_OUTPUT.PUT_LINE('To KML geometry result = ' || TO_CHAR(kmlgeom));

    -- From KML geometry
    geom_result := SDO_UTIL.FROM_KMLGEOMETRY(kmlgeom);
    -- Validate the returned geometry
    val_result := SDO_GEOM.VALIDATE_GEOMETRY_WITH_CONTEXT(geom_result, 0.005);
    DBMS_OUTPUT.PUT_LINE('Validation result = ' || val_result);

END;
/
To KML geometry result =
<Polygon><extrude>0</extrude><tessellate>0</tessellate><altitudeMode>relativeToG
round</altitudeMode><outerBoundaryIs><LinearRing><coordinates>3.0,3.0 6.0,3.0
6.0,5.0 4.0,5.0 3.0,3.0 </coordinates></LinearRing></outerBoundaryIs></Polygon>
Validation result = TRUE
```

**Related Topics**

- [SDO\\_UTIL.TO\\_KMLGEOMETRY](#) (page 31-66)

## 31.17 SDO\_UTIL.FROM\_WKBGEOMETRY

### Format

```
SDO_UTIL.FROM_WKBGEOMETRY(  
    geometry IN BLOB  
    ) RETURN SDO_GEOMETRY;
```

### Description

Converts a geometry in the well-known binary (WKB) format to a Spatial and Graph geometry object.

### Parameters

#### **geometry**

Geometry in WKB format to be converted to SDO\_GEOMETRY format.

### Usage Notes

The input geometry must be in the well-known binary (WKB) format, as defined by the Open Geospatial Consortium and the International Organization for Standardization (ISO).

This function is patterned after the SQL Multimedia recommendations in *ISO 13249-3, Information technology - Database languages - SQL Multimedia and Application Packages - Part 3: Spatial*.

To convert an SDO\_GEOMETRY object to WKB format, use the [SDO\\_UTIL.TO\\_WKBGEOMETRY](#) (page 31-68) function.

### Examples

The following example shows conversion to and from WKB and WKT format, and validation of WKB and WKT geometries. (The example uses the definitions and data from [Simple Example: Inserting, Indexing, and Querying Spatial Data](#) (page 2-1), specifically the cola\_b geometry from the COLA\_MARKETS table.)

```
DECLARE  
    wkbgeom BLOB;  
    wktgeom CLOB;  
    val_result VARCHAR2(5);  
    geom_result SDO_GEOMETRY;  
    geom SDO_GEOMETRY;  
BEGIN  
    SELECT c.shape INTO geom FROM cola_markets c WHERE c.name = 'cola_b';  
  
    -- To WBT/WKT geometry  
    wkbgeom := SDO_UTIL.TO_WKBGEOMETRY(geom);  
    wktgeom := SDO_UTIL.TO_WKTGEOMETRY(geom);  
    DBMS_OUTPUT.PUT_LINE('To WKT geometry result = ' || TO_CHAR(wktgeom));  
  
    -- From WBT/WKT geometry  
    geom_result := SDO_UTIL.FROM_WKBGEOMETRY(wkbgeom);  
    geom_result := SDO_UTIL.FROM_WKTGEOMETRY(wktgeom);  
  
    -- Validate WBT/WKT geometry  
    val_result := SDO_UTIL.VALIDATE_WKBGEOMETRY(wkbgeom);
```

```
DBMS_OUTPUT.PUT_LINE('WKB validation result = ' || val_result);
val_result := SDO_UTIL.VALIDATE_WKTGEOMETRY(wktgeom);
DBMS_OUTPUT.PUT_LINE('WKT validation result = ' || val_result);

END;

To WKT geometry result = POLYGON ((5.0 1.0, 8.0 1.0, 8.0 6.0, 5.0 7.0, 5.0 1.0))
WKB validation result = TRUE
WKT validation result = TRUE
```

### Related Topics

- [SDO\\_UTIL.FROM\\_WKTGEOMETRY](#) (page 31-34)
- [SDO\\_UTIL.TO\\_WKBGEOMETRY](#) (page 31-68)
- [SDO\\_UTIL.TO\\_WKTGEOMETRY](#) (page 31-69)
- [SDO\\_UTIL.VALIDATE\\_WKBGEOMETRY](#) (page 31-74)
- [SDO\\_UTIL.VALIDATE\\_WKTGEOMETRY](#) (page 31-76)

## 31.18 SDO\_UTIL.FROM\_WKTGEOMETRY

### Format

```
SDO_UTIL.FROM_WKTGEOMETRY(
    geometry IN CLOB
) RETURN SDO_GEOMETRY;
```

or

```
SDO_UTIL.FROM_WKTGEOMETRY(
    geometry IN VARCHAR2
) RETURN SDO_GEOMETRY;
```

### Description

Converts a geometry in the well-known text (WKT) format to a Spatial and Graph geometry object.

### Parameters

#### **geometry**

Geometry in WKT format to be converted to SDO\_GEOMETRY format.

### Usage Notes

The input geometry must be in the well-known text (WKT) format, as defined by the Open Geospatial Consortium and the International Organization for Standardization (ISO).

This function is patterned after the SQL Multimedia recommendations in *ISO 13249-3, Information technology - Database languages - SQL Multimedia and Application Packages - Part 3: Spatial*.

To convert an SDO\_GEOMETRY object to a CLOB in WKT format, use the [SDO\\_UTIL.TO\\_WKTGEOMETRY](#) (page 31-69) function. (You can use the SQL function TO\_CHAR to convert the resulting CLOB to VARCHAR2 type.)

## Examples

The following example shows conversion to and from WKB and WKT format, and validation of WKB and WKT geometries. (The example uses the definitions and data from [Simple Example: Inserting, Indexing, and Querying Spatial Data](#) (page 2-1), specifically the cola\_b geometry from the COLA\_MARKETS table.)

```
DECLARE
    wkbgeom BLOB;
    wktgeom CLOB;
    val_result VARCHAR2(5);
    geom_result SDO_GEOMETRY;
    geom SDO_GEOMETRY;
BEGIN
    SELECT c.shape INTO geom FROM cola_markets c WHERE c.name = 'cola_b';

    -- To WBT/WKT geometry
    wkbgeom := SDO_UTIL.TO_WKBGEOMETRY(geom);
    wktgeom := SDO_UTIL.TO_WKTGEOMETRY(geom);
    DBMS_OUTPUT.PUT_LINE('To WKT geometry result = ' || TO_CHAR(wktgeom));

    -- From WBT/WKT geometry
    geom_result := SDO_UTIL.FROM_WKBGEOMETRY(wkbgeom);
    geom_result := SDO_UTIL.FROM_WKTGEOMETRY(wktgeom);

    -- Validate WBT/WKT geometry
    val_result := SDO_UTIL.VALIDATE_WKBGEOMETRY(wkbgeom);
    DBMS_OUTPUT.PUT_LINE('WKB validation result = ' || val_result);
    val_result := SDO_UTIL.VALIDATE_WKTGEOMETRY(wktgeom);
    DBMS_OUTPUT.PUT_LINE('WKT validation result = ' || val_result);

END;/

To WKT geometry result = POLYGON ((5.0 1.0, 8.0 1.0, 8.0 6.0, 5.0 7.0, 5.0 1.0))
WKB validation result = TRUE
WKT validation result = TRUE
```

## Related Topics

- [SDO\\_UTIL.FROM\\_WKBGEOMETRY](#) (page 31-33)
- [SDO\\_UTIL.TO\\_WKBGEOMETRY](#) (page 31-68)
- [SDO\\_UTIL.TO\\_WKTGEOMETRY](#) (page 31-69)
- [SDO\\_UTIL.VALIDATE\\_WKBGEOMETRY](#) (page 31-74)
- [SDO\\_UTIL.VALIDATE\\_WKTGEOMETRY](#) (page 31-76)

## 31.19 SDO\_UTIL.GET\_2D\_FOOTPRINT

### Format

```
SDO_UTIL.GET_2D_FOOTPRINT(
    geometry IN SDO_GEOMETRY,
    tolerance IN NUMBER DEFAULT 0.0000005
) RETURN SDO_GEOMETRY;
```

**Description**

Returns a two-dimensional geometry that reflects the footprint of the input three-dimensional geometry.

**Parameters****geometry**

Three-dimensional geometry object.

**tolerance**

Tolerance value (see [Tolerance](#) (page 1-6)).

**Usage Notes**

You can use this function to return the 2D (on an x-y plane) footprint of 3D geometries such as buildings.

**Examples**

The following example returns the 2D footprint of a 3D geometry. It assumes that a table named FTPTS exists with at least a numeric ID column and a column named GEOMETRY of type SDO\_GEOMETRY containing three-dimensional geometries.

```
SELECT sdo_util.get_2d_footprint(geometry, 0.05) FROM ftpts WHERE id =1;
```

## 31.20 SDO\_UTIL.GETNUMELEM

**Format**

```
SDO_UTIL.GETNUMELEM(  
    geometry IN SDO_GEOMETRY  
) RETURN NUMBER;
```

**Description**

Returns the number of elements in the input geometry.

**Parameters****geometry**

Geometry for which to return the number of elements.

**Usage Notes**

None.

**Examples**

The following example returns the number of elements for each geometry in the SHAPE column of the COLA\_MARKETS table. (The example uses the definitions and data from [Simple Example: Inserting\\_ Indexing\\_ and Querying Spatial Data](#) (page 2-1).)

```
SELECT c.name, SDO_UTIL.GETNUMELEM(c.shape)  
FROM cola_markets c;
```

NAME	SDO_UTIL.GETNUMELEM(C.SHAPE)
cola_a	1
cola_b	1
cola_c	1
cola_d	1

### Related Topics

- [SDO\\_UTIL.GETNUMVERTICES](#) (page 31-37)

## 31.21 SDO\_UTIL.GETNUMVERTICES

### Format

```
SDO_UTIL.GETNUMVERTICES(
    geometry IN SDO_GEOMETRY
) RETURN NUMBER;
```

### Description

Returns the number of vertices in the input geometry.

### Parameters

#### geometry

Geometry for which to return the number of vertices.

### Usage Notes

None.

### Examples

The following example returns the number of vertices for each geometry in the SHAPE column of the COLA\_MARKETS table. (The example uses the definitions and data from [Simple Example: Inserting, Indexing, and Querying Spatial Data](#) (page 2-1).)

```
SELECT c.name, SDO_UTIL.GETNUMVERTICES(c.shape)
FROM cola_markets c;
```

NAME	SDO_UTIL.GETNUMVERTICES(C.SHAPE)
cola_a	2
cola_b	5
cola_c	5
cola_d	3

### Related Topics

- [SDO\\_UTIL.GETVERTICES](#) (page 31-40)
- [SDO\\_UTIL.GETNUMELEM](#) (page 31-36)

## 31.22 SDO\_UTIL.GETNURBSAPPROX

### Format

```
SDO_UTIL.GETNURBSAPPROX(  
    geometry IN SDO_GEOMETRY,  
    tolerance IN NUMBER  
) RETURN SDO_GEOMETRY;
```

### Description

Returns a line string geometry that is an approximation of the input NURBS curve geometry.

### Parameters

#### **geometry**

NURBS curve geometry object.

#### **tolerance**

Tolerance value (see [Tolerance](#) (page 1-6)). As long as the tolerance value is valid, it does not affect the operation and output of the function, as explained in the Usage Notes.

### Usage Notes

This function is useful for returning a polyline approximation of the input geometry for further processing by subprograms that cannot directly process NURBS curve geometries. The function is called internally by several Oracle Spatial and Graph functions, and it can also be called directly by users.

The input geometry must be a NURBS curve in projected (not geodetic) coordinate system.

If the input geometry does not contain at least one NURBS curve element, the function returns the input geometry.

A tolerance value is required as input because of Oracle Spatial and Graph's internal usage of the function. However, for direct calls to the function by users, the specified tolerance value does not affect the returned polyline, which can have up to approximately 200 points.

The end points of the returned line string geometry are the first and last control points, because a NURBS curve is clamped at its end points.

For information about support for NURBS (non-uniform rational B-spline) geometries, see [NURBS Curve Support in Oracle Spatial and Graph](#) (page 1-27).

### Examples

The following example creates a spatial table and inserts a NURBS curve geometry, then uses the SDO\_UTIL.GETNURBSAPPROX function (with a tolerance value of 0.05) to return a line string geometry that is an approximation of the NURBS curve geometry.

```
-- Create Table  
create table test (gid INTEGER,  
    geom mdsys.sdo_geometry);
```



```
-- Insert metadata
Insert into user_sdo_geom_metadata VALUES('TEST', 'GEOM',
      sdo_dim_array( sdo_dim_element('X', -10, 10, 0.05),
                    sdo_dim_element('Y', -10, 10, 0.05)),
      NULL);

-- Two-dimensional NURBS curve with degree 3, 7 control points, and 11 knots
insert into test values(1, SDO_GEOMETRY(2002, NULL, NULL,
      SDO_ELEM_INFO_ARRAY(1, 2, 3),
      SDO_ORDINATE_ARRAY(3, 7, 0, 0, 1, -0.5, 1, 1, 0.2, 2,
                        1, 0.5, 3.5, 1, 0.8, 2, 1, 0.9, 1,
                        1, 0.3, 0, 1, 11, 0, 0, 0, 0, 0.25,
                        0.5, 0.75, 1.0, 1.0, 1.0, 1.0)));

-- sdo_util.getNurbsApprox gives an approximate polyline for the NURBS curve.
Select gid, sdo_util.getNurbsApprox(a.geom, 0.05) from test a where gid = 1;
```

GID

```
-----
SDO_UTIL.GETNURBSAPPROX(A.GEOM,0.05)(SDO_GTYPE, SDO_SRID, SDO_POINT(X, Y, Z), SD
```

1

```
SDO_GEOMETRY(2002, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 2, 1), SDO_ORDINATE_ARRAY(
0, 0, -.02912839, .059699523, -.05624374, .118211319, -.08139356, .175559751, -.
10462535, .231769184, -.12598662, .286863981, -.14552488, .340868505, -.16328764
, .39380712, -.17932241, .445704191, -.1936767, .496584079, -.20639802, .5464711
5, -.21753387, .595389767, -.22713177, .643364292, -.23523922, .690419091, -.241
90374, .736578527, -.24717284, .781866962, -.25109401, .826308762, -.25371477, .
869928288, -.25508264, .912749906, -.25524512, .954797979, -.25424971, .99609687
, -.25214393, 1.03667094, -.24897529, 1.07654456, -.24479129, 1.11574209, -.2396
3945, 1.15428789, -.23356727, 1.19220633, -.22662227, 1.22952177, -.21885194, 1.
26625857, -.21030381, 1.3024411, -.20102538, 1.33809372, -.19106416, 1.37324079,
-.18046765, 1.40790668, -.16928338, 1.44211576, -.15755884, 1.47589238, -.14534
154, 1.50926091, -.132679, 1.54224571, -.11961872, 1.57487115, -.10620822, 1.607
16159, -.092495, 1.63914139, -.07852657, 1.67083492, -.06435044, 1.70226654, -.0
5001412, 1.73346062, -.03556511, 1.76444151, -.02105094, 1.79523359, -.0065191,
1.82586121, .007982896, 1.85634874, .022407535, 1.88672054, .036707311, 1.917000
98, .050834714, 1.94721442, .064742236, 1.97738522, .078382506, 2.00753762, .091
725045, 2.03768051, .104772175, 2.06779294, .117529987, 2.09785056, .130004572,
2.12782899, .14220202, 2.15770388, .154128423, 2.18745085, .165789872, 2.2170455
6, .177192457, 2.24646363, .188342269, 2.27568069, .1992454, 2.3046724, .2099079
4, 2.33341438, .22033598, 2.36188226, .23053561, 2.3900517, .240512923, 2.417898
31, .250274008, 2.44539774, .259824957, 2.47252563, .269171861, 2.49925761, .278
32081, 2.52556931, .287277896, 2.55143638, .296049209, 2.57683445, .30464084, 2.
60173916, .31305888, 2.62612614, .321309421, 2.64997102, .329398552, 2.67324946,
.337332365, 2.69593707, .345116951, 2.71800951, .352758401, 2.7394424, .3602628
05, 2.76021137, .367636255, 2.78029208, .374884841, 2.79966015, .382014654, 2.81
829122, .389031786, 2.83616093, .395942326, 2.85324491, .402752367, 2.8695188, .
409467999, 2.88495824, .416095312, 2.89953885, .422640398, 2.91323629, .42910934
8, 2.92602618, .435508253, 2.93788416, .441843203, 2.94878587, .448120289, 2.958
70695, .454345602, 2.96762302, .460525234, 2.97550973, .466665275, 2.98234271, .
472771816, 2.98809761, .478850948, 2.99275004, .484908761, 2.99627566, .49095134
8, 2.9986501, .496984798, 2.999849, .50301505, 2.999849, .509044541, 2.9986501,
.515072205, 2.99627566, .521096823, 2.99275004, .527117177, 2.98809761, .5331320
5, 2.98234271, .539140223, 2.97550973, .545140477, 2.96762302, .551131595, 2.958
70695, .557112359, 2.94878587, .56308155, 2.93788416, .56903795, 2.92602618, .57
4980341, 2.91323629, .580907505, 2.89953885, .586818223, 2.88495824, .592711277,
2.8695188, .59858545, 2.85324491, .604439523, 2.83616093, .610272278, 2.8182912
2, .616082496, 2.79966015, .621868959, 2.78029208, .62763045, 2.76021137, .63336
575, 2.7394424, .639073641, 2.71800951, .644752905, 2.69593707, .650402323, 2.67
```

```
324946, .656020678, 2.64997102, .661606751, 2.62612614, .667159324, 2.60173916,
.672677178, 2.57683445, .678159097, 2.55143638, .683603861, 2.52556931, .6890102
52, 2.49925761, .694377052, 2.47252563, .699703043, 2.44539774, .704987007, 2.41
789831, .710227725, 2.3900517, .71542398, 2.36188226, .720574553, 2.33341438, .7
25678226, 2.3046724, .730733781, 2.27568069, .735739999, 2.24646363, .740695663,
2.21704556, .745599554, 2.18745085, .750450454, 2.15770388, .755247146, 2.12782
899, .75998841, 2.09785056, .764673028, 2.06779294, .769299783, 2.03768051, .773
867456, 2.00753762, .778372773, 1.97738522, .782794569, 1.94721442, .787102465,
1.91700098, .791266007, 1.88672054, .795254739, 1.85634874, .799038208, 1.825861
21, .802585958, 1.79523359, .805867536, 1.76444151, .808852487, 1.73346062, .811
510356, 1.70226654, .813810689, 1.67083492, .815723031, 1.63914139, .817216927,
1.60716159, .818261924, 1.57487115, .818827566, 1.54224571, .8188834, 1.50926091
, .818398969, 1.47589238, .817343821, 1.44211576, .8156875, 1.40790668, .8133995
52, 1.37324079, .810449523, 1.33809372, .806806957, 1.3024411, .802441401, 1.266
25857, .797322399, 1.22952177, .791419497, 1.19220633, .784702242, 1.15428789, .
777140177, 1.11574209, .768702849, 1.07654456, .759359802, 1.03667094, .74908058
4, .99609687, .737834738, .954797979, .725591811, .912749906, .712321348, .86992
8288, .697992894, .826308762, .682575995, .781866962, .666040196, .736578527, .6
48355043, .690419091, .629490081, .643364292, .609414855, .595389767, .588098912
, .54647115, .565511797, .496584079, .541623054, .445704191, .51640223, .3938071
2, .48981887, .340868505, .46184252, .286863981, .432442724, .231769184, .401589
029, .175559751, .36925098, .118211319, .335398121, .059699523, .3, 0))
```

1 row selected.

## 31.23 SDO\_UTIL.GETVERTICES

### Format

```
SDO_UTIL.GETVERTICES(
    geometry IN SDO_GEOMETRY
) RETURN VERTEX_SET_TYPE;
```

### Description

Returns the coordinates of the vertices of the input geometry.

### Parameters

#### geometry

Geometry for which to return the coordinates of the vertices.

### Usage Notes

This function returns an object of MDSYS.VERTEX\_SET\_TYPE, which consists of a table of objects of MDSYS.VERTEX\_TYPE. Oracle Spatial and Graph defines the type VERTEX\_SET\_TYPE as:

```
CREATE TYPE vertex_set_type as TABLE OF vertex_type;
```

Oracle Spatial and Graph defines the object type VERTEX\_TYPE as:

```
CREATE TYPE vertex_type AS OBJECT
(
    x    NUMBER,
    y    NUMBER,
    z    NUMBER,
    w    NUMBER,
    v5   NUMBER,
    v6   NUMBER,
```

```

v7  NUMBER,
v8  NUMBER,
v9  NUMBER,
v10 NUMBER,
v11 NUMBER,
id  NUMBER);

```

**Note:**

The VERTEX\_SET\_TYPE and VERTEX\_TYPE types are intended for use by Oracle only. Do not use these types in column definitions or functions that you create.

This function can be useful in finding a vertex that is causing a geometry to be invalid. For example, if you have identified a geometry as invalid by using the [SDO\\_GEOM.VALIDATE\\_GEOMETRY\\_WITH\\_CONTEXT](#) (page 23-52) function or the [SDO\\_GEOM.VALIDATE\\_LAYER\\_WITH\\_CONTEXT](#) (page 23-56) procedure (both of which are documented in [SDO\\_GEOM Package \(Geometry\)](#) (page 23-1)), you can use the GETVERTICES function to view the vertices in tabular format.

**Examples**

The following example returns the X and Y coordinates and ID values of the vertices of the geometries in the SHAPE column of the COLA\_MARKETS table. (The example uses the definitions and data from [Simple Example: Inserting, Indexing, and Querying Spatial Data](#) (page 2-1).)

```

SELECT c.mkt_id, c.name, t.X, t.Y, t.id
FROM cola_markets c,
     TABLE(SDO_UTIL.GETVERTICES(c.shape)) t
ORDER BY c.mkt_id, t.id;

```

MKT_ID	NAME	X	Y	ID
1	cola_a	1	1	1
1	cola_a	5	7	2
2	cola_b	5	1	1
2	cola_b	8	1	2
2	cola_b	8	6	3
2	cola_b	5	7	4
2	cola_b	5	1	5
3	cola_c	3	3	1
3	cola_c	6	3	2
3	cola_c	6	5	3
3	cola_c	4	5	4
3	cola_c	3	3	5
4	cola_d	8	7	1
4	cola_d	10	9	2
4	cola_d	8	11	3

15 rows selected.

**Related Topics**

- [SDO\\_UTIL.EXTRACT](#) (page 31-19)
- [SDO\\_GEOM.VALIDATE\\_GEOMETRY\\_WITH\\_CONTEXT](#) (page 23-52)

- [SDO\\_GEOM.VALIDATE\\_LAYER\\_WITH\\_CONTEXT](#) (page 23-56)
- [SDO\\_UTIL.GETNUMVERTICES](#) (page 31-37)

## 31.24 SDO\_UTIL.INITIALIZE\_INDEXES\_FOR\_TTS

### Format

```
SDO_UTIL.INITIALIZE_INDEXES_FOR_TTS;
```

### Description

Initializes all spatial indexes in a tablespace that was transported to another database.

### Parameters

None.

### Usage Notes

This procedure is part of the support for using the Oracle transportable tablespace feature with tablespaces that contain any spatial indexes. Use this procedure only either (A) the import operation of pre-Release 11.2 dump files is completed, or (B) after the import operation from different endian platform in Release 11.2 or later is completed. Each user that has a spatial index in the tablespace must call the procedure.

For pre-Release 11.2 dump files, after calling the SDO\_UTIL.INITIALIZE\_INDEXES\_FOR\_TTS procedure, you must execute a statement in the following format for each index that is in the imported transportable tablespace:

```
ALTER INDEX spatial-index-from-imported-tts PARAMETERS ('CLEAR_TTS=TRUE');
```

For detailed information about transportable tablespaces and transporting tablespaces to other databases, see *Oracle Database Administrator's Guide*.

### Examples

The following example for an import of pre-Release 11.2 dump files initializes all spatial indexes in a tablespace that was transported to another database. It also includes the required ALTER INDEX statement for two hypothetical spatial indexes.

```
CALL SDO_UTIL.INITIALIZE_INDEXES_FOR_TTS;
ALTER INDEX xyz1_spatial_idx PARAMETERS ('CLEAR_TTS=TRUE');
ALTER INDEX xyz2_spatial_idx PARAMETERS ('CLEAR_TTS=TRUE');
```

In the following example, the owner of the spatial index must call the SDO\_UTIL.INITIALIZE\_INDEXES\_FOR\_TTS procedure only if the SELECT statement returns the string Y, to reflect the fact that the spatial indexes are imported from different endian platforms in Release 11.2.

```
SELECT DECODE(BITAND(sdo_index_version, 1024), 1024, 'Y', 'N') ENDIAN_FLAG
FROM user_sdo_index_metadata
WHERE sdo_index_name = :index_name;
-- If the result is 'Y', perform the next statement.
CALL SDO_UTIL.INITIALIZE_INDEXES_FOR_TTS;
-- No ALTER INDEX statements are needed.
```

In this example, if you call the SDO\_UTIL.INITIALIZE\_INDEXES\_FOR\_TTS procedure when the SELECT statement returns the string N, the procedure does nothing because there is no need to perform endian conversion.

### Related Topics

None.

## 31.25 SDO\_UTIL.INTERIOR\_POINT

### Format

```
SDO_UTIL.INTERIOR_POINT(
    geom IN SDO_GEOMETRY,
    tol  IN NUMBER  DEFAULT 0.00000000005
) RETURN SDO_GEOMETRY;
```

### Description

Returns a point that is guaranteed to be an interior point (not on the boundary or edge) on the surface of a polygon geometry object.

### Parameters

#### geom

Polygon geometry object. The SDO\_GTYPE value of the geometry must be 2003 or 2007. (SDO\_GTYPE values are explained in [SDO\\_GTYPE](#) (page 2-5).)

#### tol

Tolerance value (see [Tolerance](#) (page 1-6)).

### Usage Notes

This function returns a point geometry object representing a point that is guaranteed to be an interior point on the surface, but not on the boundary or edge, of *geom*. The returned point can be any interior point on the surface; however, if you call the function multiple times with the same *geom* and *tol* parameter values, the returned point will be the same.

The relationship between the returned point and the original geometry is INSIDE, which you can check using the [SDO\\_RELATE](#) (page 18-30) operator with 'mask=inside'.

In most cases this function is more useful than the [SDO\\_GEOM.SDO\\_POINTONSURFACE](#) (page 23-41) function, which returns a point that is not guaranteed to be an interior point.

### Examples

The following example returns a geometry object that is an interior point on the surface of *cola\_a*. (The example uses the definitions and data from [Simple Example: Inserting, Indexing, and Querying Spatial Data](#) (page 2-1).)

```
-- Return an interior point on the surface of a geometry.
SELECT SDO_UTIL.INTERIOR_POINT(c.shape, 0.005)
FROM cola_markets c
WHERE c.name = 'cola_a';
```

```
SDO_UTIL.INTERIOR_POINT(C.SHAPE,0.005)(SDO_GTYPE, SDO_SRID, SDO_POINT(X, Y, Z),  
-----  
SDO_GEOMETRY(2001, NULL, SDO_POINT_TYPE(2.75, 2.875, NULL), NULL, NULL)
```

### Related Topics

None.

## 31.26 SDO\_UTIL.POINT\_AT\_BEARING

### Format

```
SDO_UTIL.POINT_AT_BEARING(  
    start_point IN SDO_GEOMETRY,  
    bearing      IN NUMBER,  
    distance     IN NUMBER  
) RETURN SDO_GEOMETRY;
```

### Description

Returns a point geometry that is at the specified distance and bearing from the start point.

### Parameters

#### start\_point

Point geometry object from which to compute the distance at the specified bearing, to locate the desired point. The point geometry must be based on a geodetic coordinate system.

#### bearing

Number of radians, measured clockwise from North. Must be in the range of either  $-pi$  to  $pi$  or 0 to  $2*pi$ . (Either convention on ranges will work).

#### distance

Number of meters from `start_point` and along the initial bearing direction to the computed destination point. Must be less than one-half the circumference of the Earth.

### Usage Notes

The input point geometry must be based on a geodetic coordinate system. If it is based on a non-geodetic coordinate system, this function returns a null value.

To convert decimal degrees to radians or nonmetric distances to meters, you can use the [SDO\\_UTIL.CONVERT\\_UNIT](#) (page 31-15) function. To compute the bearing and tilt from a start point to an end point, you can use the [SDO\\_UTIL.BEARING\\_TILT\\_FOR\\_POINTS](#) (page 31-9) procedure.

### Examples

The following example returns the point 100 kilometers at a bearing of 1 radian from the point with the longitude and latitude coordinates (-72, 43).

```
SELECT SDO_UTIL.POINT_AT_BEARING(  
    SDO_GEOMETRY(2001, 8307,  
    SDO_POINT_TYPE(-72, 43, NULL), NULL, NULL),
```

```

1, -- 1 radian (57.296 degrees clockwise from North)
100000 -- 100 kilometers
) FROM DUAL;

SDO_UTIL.POINT_AT_BEARING(SDO_GEOMETRY(2001,8307,SDO_POINT_TYPE(-72,43,NULL),NUL
-----
SDO_GEOMETRY(2001, 8307, NULL, SDO_ELEM_INFO_ARRAY(1, 1, 1), SDO_ORDINATE_ARRAY(
-70.957053, 43.4811935))

```

### Related Topics

- [SDO\\_UTIL.BEARING\\_TILT\\_FOR\\_POINTS](#) (page 31-9)
- [SDO\\_UTIL.CONVERT\\_UNIT](#) (page 31-15)

## 31.27 SDO\_UTIL.POLYGONTOLINE

### Format

```

SDO_UTIL.POLYGONTOLINE(
    geometry IN SDO_GEOMETRY
) RETURN SDO_GEOMETRY;

```

### Description

Converts all polygon-type elements in a geometry to line-type elements, and sets the SDO\_GTYPE value accordingly.

### Parameters

#### geometry

Geometry to convert.

### Usage Notes

The order of the vertices of each resulting line-type element is the same as in the associated polygon-type element, and the start and end points of each line-type segment are the same point.

If the input geometry is a line, it is returned.

### Examples

The following example converts the input polygon geometry, which is the same geometry as cola\_b (see [Simple Example: Inserting, Indexing, and Querying Spatial Data](#) (page 2-1)), to a line string geometry. In the returned geometry, the SDO\_GTYPE value (2002) indicates a two-dimensional LINE geometry, and the SDO\_ETYPE value (2) and SDO\_INTERPRETATION value (1) in the SDO\_ELEM\_INFO array indicate a line string whose vertices are connected by straight line segments.

```

SELECT SDO_UTIL.POLYGONTOLINE(
    SDO_GEOMETRY(
        2003, -- two-dimensional polygon
        NULL,
        NULL,
        SDO_ELEM_INFO_ARRAY(1,1003,1), -- one polygon (exterior polygon ring)
        SDO_ORDINATE_ARRAY(5,1, 8,1, 8,6, 5,7, 5,1)
    )
)

```

```
) FROM DUAL;

SDO_UTIL.POLYGONTOLINE(SDO_GEOMETRY(2003,--TWO-DIMENSIONALPOLYGONNULL,NULL,SDO_E
-----
SDO_GEOMETRY(2002, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 2, 1), SDO_ORDINATE_ARRAY(
5, 1, 8, 1, 8, 6, 5, 7, 5, 1))
```

### Related Topics

None.

## 31.28 SDO\_UTIL.RECTIFY\_GEOMETRY

### Format

```
SDO_UTIL.RECTIFY_GEOMETRY(
    geometry IN SDO_GEOMETRY,
    tolerance IN NUMBER
) RETURN SDO_GEOMETRY;
```

### Description

Fixes certain problems with the input geometry, and returns a valid geometry.

### Parameters

#### **geometry**

Geometry to be checked for problems that can be fixed.

#### **tolerance**

Tolerance value (see [Tolerance](#) (page 1-6)).

### Usage Notes

This function checks for the following problems that can make a geometry invalid, and fixes the problems in the returned geometry:

- Duplicate vertices
- Polygon boundary intersecting itself
- Incorrect orientation of exterior or interior rings (or both) of a polygon

If the input geometry has any other problem that makes it invalid, the function raises an exception.

If the input geometry is valid, the function returns a geometry that is identical to the input geometry.

For information about using this function as part of the recommended procedure for loading and validating spatial data, see [Recommendations for Loading and Validating Spatial Data](#) (page 4-4).

This function is used internally by the [SDO\\_UTIL.SIMPLIFY](#) (page 31-49) function as part of the geometry simplification process.

This function internally calls the [SDO\\_GEOM.SDO\\_SELF\\_UNION](#) (page 23-42) function if necessary.



## Examples

The following example checks the cola\_b geometry to see if it has problems that can be fixed. (In this case, the geometry is valid, so the input geometry is returned. The example uses the definitions and data from [Simple Example: Inserting\\_ Indexing\\_ and Querying Spatial Data](#) (page 2-1).)

```
SELECT SDO_UTIL.RECTIFY_GEOMETRY(shape, 0.005)
       FROM COLA_MARKETS c WHERE c.name = 'cola_b';

SDO_UTIL.RECTIFY_GEOMETRY(SHAPE,0.005)(SDO_GTYPE, SDO_SRID, SDO_POINT(X, Y, Z),
-----
SDO_GEOMETRY(2003, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 1003, 1), SDO_ORDINATE_ARR
AY(5, 1, 8, 1, 8, 6, 5, 7, 5, 1))
```

## Related Topics

[SDO\\_UTIL.RECTIFY\\_GEOMETRY](#) (page 31-46)

[SDO\\_GEOM.SDO\\_SELF\\_UNION](#) (page 23-42)

# 31.29 SDO\_UTIL.REMOVE\_DUPLICATE\_VERTICES

## Format

```
SDO_UTIL.REMOVE_DUPLICATE_VERTICES(
    geometry IN SDO_GEOMETRY,
    tolerance IN NUMBER
) RETURN SDO_GEOMETRY;
```

## Description

Removes duplicate (redundant) vertices from a geometry.

## Parameters

### geometry

Geometry from which to remove duplicate vertices.

### tolerance

Tolerance value (see [Tolerance](#) (page 1-6)).

## Usage Notes

When two consecutive vertices in a geometry are the same or within the tolerance value associated with the geometry, Spatial and Graph considers the geometry to be invalid. The Spatial and Graph geometry validation functions return the error ORA-13356 in these cases. You can use the REMOVE\_DUPLICATE\_VERTICES function to change such invalid geometries into valid geometries.

This function also closes polygons so that the first vertex of the ring is the same as the last vertex of the ring.

This function is not supported for any point geometries (including oriented points).

If the input geometry does not contain any duplicate vertices, it is returned.

### Examples

The following example removes a duplicate vertex from the input geometry, which is the same geometry as cola\_b (see [Figure 2-1](#) (page 2-2) and [Example 2-1](#) (page 2-2) in [Simple Example: Inserting, Indexing, and Querying Spatial Data](#) (page 2-1)) except that it has been deliberately made invalid by adding a third vertex that is the same point as the second vertex (8,1).

```
SELECT SDO_UTIL.REMOVE_DUPLICATE_VERTICES(
  SDO_GEOMETRY(
    2003, -- two-dimensional polygon
    NULL,
    NULL,
    SDO_ELEM_INFO_ARRAY(1,1003,1), -- one polygon (exterior polygon ring)
    SDO_ORDINATE_ARRAY(5,1, 8,1, 8,1, 8,6, 5,7, 5,1) -- 2nd and 3rd points
                                              -- are duplicates.
  ),
  0.005 -- tolerance value
) FROM DUAL;

SDO_UTIL.REMOVE_DUPLICATE_VERTICES(SDO_GEOMETRY(2003,--TWO-DIMENSIONALPOLYGONNULL
-----
SDO_GEOMETRY(2003, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 1003, 1), SDO_ORDINATE_ARR
AY(5, 1, 8, 1, 8, 6, 5, 7, 5, 1))
```

### Related Topics

None.

## 31.30 SDO\_UTIL.REVERSE\_LINESTRING

### Format

```
SDO_UTIL.REVERSE_LINESTRING(
  geometry IN SDO_GEOMETRY
) RETURN SDO_GEOMETRY;
```

### Description

Returns a line string geometry with the vertices of the input geometry in reverse order.

### Parameters

#### geometry

Line string geometry whose vertices are to be reversed in the output geometry. The SDO\_GTYPE value of the input geometry must be 2002. ([SDO\\_GTYPE](#) (page 2-5) explains SDO\_GTYPE values.)

### Usage Notes

Because the SDO\_GTYPE value of the input geometry must be 2002, this function cannot be used to reverse LRS geometries. To reverse an LRS geometry, use the [SDO\\_LRS.REVERSE\\_GEOMETRY](#) (page 24-53) function, which is described in [SDO\\_LRS Package \(Linear Referencing System\)](#) (page 24-1).

## Examples

The following example returns a line string geometry that reverses the vertices of the input geometry.

```
SELECT SDO_UTIL.REVERSE_LINESTRING(
  SDO_GEOMETRY(2002, 8307, NULL, SDO_ELEM_INFO_ARRAY(1,2,1),
    SDO_ORDINATE_ARRAY(-72,43, -71.5,43.5, -71,42, -70,40))
) FROM DUAL;

SDO_UTIL.REVERSE_LINESTRING(SDO_GEOMETRY(2002,8307,NULL,SDO_ELEM_INFO_ARRAY(1,2,
-----
SDO_GEOMETRY(2002, 8307, NULL, SDO_ELEM_INFO_ARRAY(1, 2, 1), SDO_ORDINATE_ARRAY(
-70, 40, -71, 42, -71.5, 43.5, -72, 43))
```

## Related Topics

- [SDO\\_LRS.REVERSE\\_GEOMETRY](#) (page 24-53) (in [SDO\\_LRS Package \(Linear Referencing System\)](#) (page 24-1))

# 31.31 SDO\_UTIL.SIMPLIFY

## Format

```
SDO_UTIL.SIMPLIFY(
  geometry      IN SDO_GEOMETRY,
  threshold     IN NUMBER
  tolerance     IN NUMBER DEFAULT 0.0000005,
  remove_loops  IN NUMBER DEFAULT 0
) RETURN SDO_GEOMETRY;
```

## Description

Simplifies the input geometry, based on a threshold value, using the Douglas-Peucker algorithm.

## Parameters

### geometry

Geometry to be simplified.

### threshold

Threshold value to be used for the geometry simplification. Should be a positive number. (Zero causes the input geometry to be returned.) If the input geometry is geodetic, the value is the number of meters; if the input geometry is non-geodetic, the value is the number of units associated with the data.

As the threshold value is decreased, the returned geometry is likely to be closer to the input geometry; as the threshold value is increased, fewer points are likely to be in the returned geometry. See the Usage Notes for more information.

### tolerance

Tolerance value (see [Tolerance](#) (page 1-6)). Must not be greater than threshold; and for better performance, should not be the same as threshold. If you do not specify a value, the default value is 0.0000005.

**remove\_loops**

For some line geometries, when the line is simplified, it might end up with self-crossing loops in the middle. While this is a valid geometry (for lines), in some cases it is not desirable to have these loops in the result of the simplify operation. A value of 0 (the default) does not remove such loops; a value of 1 (or any other nonzero positive number) removes any such loops and always returns simple line segments.

**Usage Notes**

This function also converts arcs to line stings, eliminates duplicate vertices, and corrects many overlapping edge polygon problems. The reason this function sometimes fixes problems is that it internally calls the [SDO\\_UTIL.RECTIFY\\_GEOMETRY](#) (page 31-46) function at the end of the simplification process to ensure that a valid geometry is returned.

This function is useful when you want a geometry with less fine resolution than the original geometry. For example, if the display resolution cannot show the hundreds or thousands of turns in the course of a river or in a political boundary, better performance might result if the geometry were simplified to show only the major turns.

If you use this function with geometries that have more than two dimensions, only the first two dimensions are used in processing the query, and only the first two dimensions in the returned geometry are to be considered valid and meaningful.

This function uses the Douglas-Peucker algorithm, which is explained in several cartography textbooks and reference documents. (In some explanations, the term *tolerance* is used instead of *threshold*; however, this is different from the Oracle Spatial and Graph meaning of tolerance.)

Compare this function with [SDO\\_UTIL.SIMPLIFYVW](#) (page 31-52), which uses the Visvalingham-Whyatt algorithm.

The returned geometry can be a polygon, line, or point, depending on the geometry definition and the threshold value. The following considerations apply:

- A polygon can simplify to a line or a point and a line can simplify to a point, if the threshold value associated with the geometry is sufficiently large. For example, a thin rectangle will simplify to a line if the distance between the two parallel long sides is less than the threshold value, and a line will simplify to a point if the distance between the start and end points is less than the threshold value.
- In a polygon with a hole, if the exterior ring or the interior ring (the hole) simplifies to a line or a point, the interior ring disappears from (is not included in) the resulting geometry.
- Topological characteristics of the input geometry might not be maintained after simplification. For a collection geometry, the number of elements might increase, to prevent overlapping of individual elements. In all cases, this function will not return an invalid geometry.

This function is not supported for Linear referencing system (LRS) geometries (which are described in [Linear Referencing System](#) (page 7-1)).

**Examples**

The following example simplifies a line string geometry that reflects the vertices of the road shown in [Figure 7-20](#) (page 7-16) in [Example of LRS Functions](#) (page 7-15), although the geometry in this example is not an LRS geometry. With the threshold

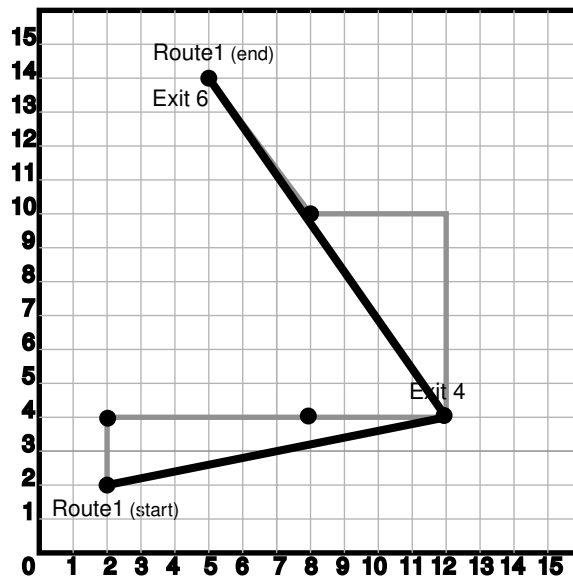
value as 6, the resulting line string has only three points: the start and end points, and (12, 4,12).

```
SELECT SDO_UTIL.SIMPLIFY(
  SDO_GEOMETRY(
    2002, -- line string, 2 dimensions (X,Y)
    NULL,
    NULL,
    SDO_ELEM_INFO_ARRAY(1,2,1), -- one line string, straight segments
    SDO_ORDINATE_ARRAY(
      2,2, -- Starting point
      2,4,
      8,4,
      12,4,
      12,10,
      8,10,
      5,14) -- Ending point
    ),
    6, -- threshold value for geometry simplification
    0.5 -- tolerance
  ) FROM DUAL;
```

```
SDO_UTIL.SIMPLIFY(SDO_GEOMETRY(2002,--LINESTRING,2DIMENSIONS(X,Y)NULL,NULL,SDO_E
-----
SDO_GEOMETRY(2002, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 2, 1), SDO_ORDINATE_ARRAY(
2, 2, 12, 4, 5, 14))
```

Figure 31-1 (page 31-51) shows the result of this example. In Figure 31-1 (page 31-51), the thick solid black line is the resulting geometry, and the thin solid light line between the start and end points is the input geometry.

**Figure 31-1 Simplification of a Geometry**



#### Related Topics

[SDO\\_UTIL.SIMPLIFYVW](#) (page 31-52)

[SDO\\_UTIL.RECTIFY\\_GEOMETRY](#) (page 31-46)

## 31.32 SDO\_UTIL.SIMPLIFYVW

### Format

```
SDO_UTIL.SIMPLIFYVW(  
    geometry          IN SDO_GEOMETRY,  
    vertex_threshold  IN NUMBER,  
    tolerance         IN NUMBER DEFAULT 0.0000005,  
    remove_loops      IN NUMBER DEFAULT 0  
    ) RETURN SDO_GEOMETRY;
```

### Description

Simplifies the input geometry, based on a threshold value, using the Visvalingham-Whyatt algorithm.

### Parameters

#### **geometry**

Geometry to be simplified.

#### **vertex\_threshold**

Threshold value to be used for the geometry simplification, expressed as a percentage value between 0 and 100. As the value is decreased, the returned geometry is likely to be closer to the input geometry; as the value is increased, fewer points are likely to be in the returned geometry.

You may want to experiment with different values to get the desired level of simplification.

#### **tolerance**

Tolerance value (see [Tolerance](#) (page 1-6)). If you do not specify a value, the default value is 0.0000005.

#### **remove\_loops**

For some line geometries, when the line is simplified, it might end up with self-crossing loops in the middle. While this is a valid geometry (for lines), in some cases it is not desirable to have these loops in the result of the simplify operation. A value of 0 (the default) does not remove such loops; a value of 1 (or any other nonzero positive number) removes any such loops and always returns simple line segments.

### Usage Notes

See the Usage Notes for the [SDO\\_UTIL.SIMPLIFY](#) (page 31-49) function, which also simplifies an input geometry but uses a different algorithm (Douglas-Peucker).

### Examples

The following example simplifies the same line string geometry used in the example for [SDO\\_UTIL.SIMPLIFY](#) (page 31-49).

```
SELECT SDO_UTIL.SIMPLIFYVW(  
    SDO_GEOMETRY(  
        2002, -- line string, 2 dimensions (X,Y)  
        NULL,  
        NULL,
```

```

SDO_ELEM_INFO_ARRAY(1,2,1), -- one line string, straight segments
SDO_ORDINATE_ARRAY(
  2,2,  -- Starting point
  2,4,
  8,4,
  12,4,
  12,10,
  8,10,
  5,14) -- Ending point
),
80, -- threshold "percentage" value for geometry simplification
0.5 -- tolerance
) FROM DUAL;

SDO_UTIL.SIMPLIFYVW(SDO_GEOMETRY(2002,--LINESTRING,2DIMENSIONS(X,Y)NULL,NULL,SDO
-----
SDO_GEOMETRY(2002, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 2, 1), SDO_ORDINATE_ARRAY(
2, 2, 12, 4, 5, 14))

```

Note that the resulting geometry in this case, using 80 as the `vertex_threshold` value, has the same points as the example for [SDO\\_UTIL.SIMPLIFY](#) (page 31-49), but without any measure dimension information (that is, the vertices are 2,2, 12,4, and 5,14). A significantly lower `vertex_threshold` value would probably result in a geometry with more vertices.

### Related Topics

[SDO\\_UTIL.SIMPLIFY](#) (page 31-49)

[SDO\\_UTIL.RECTIFY\\_GEOMETRY](#) (page 31-46)

## 31.33 SDO\_UTIL.THEME3D\_GET\_BLOCK\_TABLE

### Format

```

SDO_UTIL.THEME3D_GET_BLOCK_TABLE(
  theme_name IN VARCHAR2
) RETURN NUMBER;

```

### Description

Returns the block table (if any) for a 3D theme (DEM, PC, and TIN themes).

### Parameters

#### theme\_name

Name of the 3D theme. Must be a value from the `USER_SDO_3DTHEMES` or `ALL_SDO_3DTHEMES` view (described in [xxx\\_SDO\\_3DTHEMES Views](#) (page 2-49)).

### Usage Notes

This function returns the name of the block table for the theme, if the theme has an associated block table. If there is no associated block table, the function returns a null value.

## Examples

This example does the following for each theme in the USER\_SDO\_3DTHEMES table: checks if it has multiple LODs and has texture, and returns the block table name. (It assumes that the themes were previously inserted into the USER\_SDO\_3DTHEMES table.)

```
SELECT
    name,
    sdo_util.theme3d_has_lod(name) "Has LOD",
    sdo_util.theme3d_has_texture(name) "Has Texture",
    sdo_util.theme3d_get_block_table(name) "Block Table"
FROM user_sdo_3dthemes
ORDER BY name;
```

NAME	Has LOD	Has Texture	Block Table
DEM Hawaii Theme 4326	1	0	DEM_BLOCKS_HAWAII_4326
DEM Hawaii Theme w/ Map Tiles	1	1	DEM_BLOCKS_HAWAII_4326
DEM Splitted Theme	1	0	DEM_SPLITTED_HAWAII_4326
Geom Theme	0	0	
GeomForDEM Theme	0	0	
GeomForTIN Theme	0	0	
PC Category Theme	1	0	PC_BLOCKS_CATEGORY
PC Hawaii Theme 4326	1	0	PC_BLOCKS_HAWAII_4326
PC Intensity Theme	1	0	PC_BLOCKS_INTENSITY
PC LAS File Theme	1	0	PC_BLOCKS_LAS
PC RGB Theme	1	0	PC_BLOCKS_RGB
PC Split Theme	1	0	PC_SPLIT_BLOCKS_4326
PC Subset Hawaii Theme	1	0	PC_SUBSET_BLOCKS_4326
PC Theme	0	0	PC_BLOCKS_NULL_CRS
TIN Hawaii Theme 4326	1	0	TIN_BLOCKS_HAWAII_4326
TIN Hawaii Theme w/ Map Tiles	1	1	TIN_BLOCKS_HAWAII_4326
TIN Split Theme	1	0	TIN_SPLIT_BLOCKS_4326
TIN Subset Hawaii Theme	1	0	TIN_SUBSET_BLOCKS_4326

18 rows selected.

## Related Topics

- [SDO\\_UTIL.THEME3D\\_HAS\\_LOD](#) (page 31-54)
- [SDO\\_UTIL.THEME3D\\_HAS\\_TEXTURE](#) (page 31-56)

## 31.34 SDO\_UTIL.THEME3D\_HAS\_LOD

### Format

```
SDO_UTIL.THEME3D_HAS_LOD(
    theme_name IN VARCHAR2
) RETURN NUMBER;
```

### Description

Checks if a 3D theme has multiple levels of detail (LODs) (for DEM, PC, and TIN themes with pyramiding), or if a theme is involved in a chain of themes at multiple LODs (for SDO\_GEOMETRY themes).

### Parameters



**theme\_name**

Name of the 3D theme. Must be a value from the USER\_SDO\_3DTHEMES or ALL\_SDO\_3DTHEMES view (described in [xxx\\_SDO\\_3DTHEMES Views](#) (page 2-49)).

**Usage Notes**

This function returns 0 (zero) if the theme does not have multiple LODs or link to a theme with multiple LODs; otherwise, it returns 1.

**Examples**

This example does the following for each theme in the USER\_SDO\_3DTHEMES table: checks if it has multiple LODs and has texture, and returns the block table name. (It assumes that the themes were previously inserted into the USER\_SDO\_3DTHEMES table.)

```
SELECT
  name,
  sdo_util.theme3d_has_lod(name) "Has LOD",
  sdo_util.theme3d_has_texture(name) "Has Texture",
  sdo_util.theme3d_get_block_table(name) "Block Table"
FROM user_sdo_3dthemes
ORDER BY name;
```

NAME	Has LOD	Has Texture	Block Table
DEM Hawaii Theme 4326	1	0	DEM_BLOCKS_HAWAII_4326
DEM Hawaii Theme w/ Map Tiles	1	1	DEM_BLOCKS_HAWAII_4326
DEM Splitted Theme	1	0	DEM_SPLITTED_HAWAII_4326
Geom Theme	0	0	
GeomForDEM Theme	0	0	
GeomForTIN Theme	0	0	
PC Category Theme	1	0	PC_BLOCKS_CATEGORY
PC Hawaii Theme 4326	1	0	PC_BLOCKS_HAWAII_4326
PC Intensity Theme	1	0	PC_BLOCKS_INTENSITY
PC LAS File Theme	1	0	PC_BLOCKS_LAS
PC RGB Theme	1	0	PC_BLOCKS_RGB
PC Split Theme	1	0	PC_SPLIT_BLOCKS_4326
PC Subset Hawaii Theme	1	0	PC_SUBSET_BLOCKS_4326
PC Theme	0	0	PC_BLOCKS_NULL_CRS
TIN Hawaii Theme 4326	1	0	TIN_BLOCKS_HAWAII_4326
TIN Hawaii Theme w/ Map Tiles	1	1	TIN_BLOCKS_HAWAII_4326
TIN Split Theme	1	0	TIN_SPLIT_BLOCKS_4326
TIN Subset Hawaii Theme	1	0	TIN_SUBSET_BLOCKS_4326

18 rows selected.

**Related Topics**

- [SDO\\_UTIL.THEME3D\\_GET\\_BLOCK\\_TABLE](#) (page 31-53)
- [SDO\\_UTIL.THEME3D\\_HAS\\_TEXTURE](#) (page 31-56)

## 31.35 SDO\_UTIL.THEME3D\_HAS\_TEXTURE

### Format

```
SDO_UTIL.THEME3D_HAS_TEXTURE(  
    theme_name IN VARCHAR2  
) RETURN NUMBER;
```

### Description

Checks if a 3D theme has textures (for DEM, TIN, map tile server, and SDO\_GEOMETRY themes).

### Parameters

**theme\_name**

Name of the 3D theme. Must be a value from the USER\_SDO\_3DTHEMES or ALL\_SDO\_3DTHEMES view (described in [xxx\\_SDO\\_3DTHEMES Views](#) (page 2-49)).

### Usage Notes

This function returns 0 (zero) if the theme does not have textures; otherwise, it returns 1.

### Examples

This example does the following for each theme in the USER\_SDO\_3DTHEMES table: checks if it has multiple LODs and has texture, and returns the block table name. (It assumes that the themes were previously inserted into the USER\_SDO\_3DTHEMES table.)

```
SELECT  
    name,  
    sdo_util.theme3d_has_lod(name) "Has LOD",  
    sdo_util.theme3d_has_texture(name) "Has Texture",  
    sdo_util.theme3d_get_block_table(name) "Block Table"  
FROM user_sdo_3dthemes  
ORDER BY name;
```

NAME	Has LOD	Has Texture	Block Table
DEM Hawaii Theme 4326	1	0	DEM_BLOCKS_HAWAII_4326
DEM Hawaii Theme w/ Map Tiles	1	1	DEM_BLOCKS_HAWAII_4326
DEM Splitted Theme	1	0	DEM_SPLITTED_HAWAII_4326
Geom Theme	0	0	
GeomForDEM Theme	0	0	
GeomForTIN Theme	0	0	
PC Category Theme	1	0	PC_BLOCKS_CATEGORY
PC Hawaii Theme 4326	1	0	PC_BLOCKS_HAWAII_4326
PC Intensity Theme	1	0	PC_BLOCKS_INTENSITY
PC LAS File Theme	1	0	PC_BLOCKS_LAS
PC RGB Theme	1	0	PC_BLOCKS_RGB
PC Split Theme	1	0	PC_SPLIT_BLOCKS_4326
PC Subset Hawaii Theme	1	0	PC_SUBSET_BLOCKS_4326
PC Theme	0	0	PC_BLOCKS_NULL_CRS
TIN Hawaii Theme 4326	1	0	TIN_BLOCKS_HAWAII_4326
TIN Hawaii Theme w/ Map Tiles	1	1	TIN_BLOCKS_HAWAII_4326

TIN Split Theme	1	0 TIN_SPLIT_BLOCKS_4326
TIN Subset Hawaii Theme	1	0 TIN_SUBSET_BLOCKS_4326

18 rows selected.

### Related Topics

- [SDO\\_UTIL.THEME3D\\_GET\\_BLOCK\\_TABLE](#) (page 31-53)
- [SDO\\_UTIL.THEME3D\\_HAS\\_LOD](#) (page 31-54)

## 31.36 SDO\_UTIL.TO\_GML311GEOMETRY

### Format

```
SDO_UTIL.TO_GML311GEOMETRY(
    geometry IN SDO_GEOMETRY
) RETURN CLOB;
```

### Description

Converts a Spatial and Graph geometry object to a geography markup language (GML version 3.1.1) fragment based on the geometry types defined in the Open GIS `geometry.xsd` schema document.

### Parameters

#### **geometry**

Geometry for which to return the GML version 3.1.1 fragment.

### Usage Notes

This function does not convert circles, geometries containing any circular arcs, LRS geometries, or geometries with an SDO\_ETYPE value of 0 (type 0 elements); it returns an empty CLOB in these cases.

This function converts the input geometry to a GML version 3.1.1 fragment based on some GML geometry types defined in the Open GIS Implementation Specification.

Polygons must be defined using the conventions for Oracle9i and later releases of Spatial and Graph. That is, the outer boundary is stored first (with ETYPE=1003) followed by zero or more inner boundary elements (ETYPE=2003). For a polygon with holes, the outer boundary must be stored first in the SDO\_ORDINATES definition, followed by coordinates of the inner boundaries.

LRS geometries must be converted to standard geometries (using the [SDO\\_LRS.CONVERT\\_TO\\_STD\\_GEOM](#) (page 24-16) or [SDO\\_LRS.CONVERT\\_TO\\_STD\\_LAYER](#) (page 24-17) function) before being passed to the TO\_GMLGEOMETRY function. (See the Examples section for an example that uses CONVERT\_TO\_STD\_GEOM with the TO\_GMLGEOMETRY function.)

Any circular arcs or circles must be densified (using the [SDO\\_GEOM.SDO\\_ARC\\_DENSIFY](#) (page 23-7) function) or represented as polygons (using the [SDO\\_GEOM.SDO\\_BUFFER](#) (page 23-11) function) before being passed to the TO\_GMLGEOMETRY function. (See the Examples section for an example that uses SDO\_ARC\_DENSIFY with the TO\_GMLGEOMETRY function.)

Label points are discarded. That is, if a geometry has a value for the SDO\_POINT field and values in SDO\_ELEM\_INFO and SDO\_ORDINATES, the SDO\_POINT is not output in the GML fragment.

The SDO\_SRID value is output in the form `srsName="SDO:<srid>"`. For example, `"SDO:8307"` indicates SDO\_SRID 8307, and `"SDO:"` indicates a null SDO\_SRID value. No checks are made for the validity or consistency of the SDO\_SRID value. For example, the value is not checked to see if it exists in the MDSYS.CS\_SRS table or if it conflicts with the SRID value for the layer in the USER\_SDO\_GEOM\_METADATA view.

Coordinates are always output using the `<coordinates>` tag and `decimal='.',` `cs=' , '` (that is, with the comma as the coordinate separator), and `ts=' '` (that is, with a space as the tuple separator), even if the NLS\_NUMERIC\_CHARACTERS setting has `' , '` (comma) as the decimal character.

The GML output is not formatted; there are no line breaks or indentation of tags. To see the contents of the returned CLOB in SQL\*Plus, use the TO\_CHAR() function or set the SQL\*Plus parameter LONG to a suitable value (for example, SET LONG 40000). To get formatted GML output or to use the return value of TO\_GMLGEOMETRY in SQLX or Oracle XML DB functions such as XMLELEMENT, use the XMLTYPE(clobval CLOB) constructor.

### Examples

The following example returns the GML version 3.1.1 fragment for the cola\_b geometry in the COLA\_MARKETS table. (The example uses the definitions and data from [Simple Example: Inserting, Indexing, and Querying Spatial Data](#) (page 2-1).)

```
-- Convert cola_b geometry to GML 3.1.1 fragment.
SELECT TO_CHAR(SDO_UTIL.TO_GML311GEOMETRY(shape)) AS Gml311Geometry
  FROM COLA_MARKETS c WHERE c.name = 'cola_b';

GML311GEOMETRY
-----
<gml:Polygon srsName="SDO:" xmlns:gml="http://www.opengis.net/gml"><gml:exterior
><gml:LinearRing><gml:posList srsDimension="2">5.0 1.0 8.0 1.0 8.0 6.0 5.0 7.0 5
.0 1.0 </gml:posList></gml:LinearRing></gml:exterior></gml:Polygon>
```

The following example returns the GML version 3.1.1 fragment for the arc densification of the cola\_d geometry in the COLA\_MARKETS table. (The example uses the definitions and data from [Simple Example: Inserting, Indexing, and Querying Spatial Data](#) (page 2-1).)

```
SET LONG 40000
SELECT XMLTYPE(SDO_UTIL.TO_GML311GEOMETRY(
  SDO_GEOM.SDO_ARC_DENSIFY(c.shape, m.diminfo, 'arc_tolerance=0.05')))
  AS Gml311Geometry FROM cola_markets c, user_sdo_geom_metadata m
  WHERE m.table_name = 'COLA_MARKETS' AND m.column_name = 'SHAPE'
  AND c.name = 'cola_d';

GML311GEOMETRY
-----
<gml:Polygon srsName="SDO:" xmlns:gml="http://www.opengis.net/gml">
  <gml:exterior>
    <gml:LinearRing>
      <gml:posList srsDimension="2">8.0 7.0 8.76536686473018 7.15224093497743 9.
4142135623731 7.58578643762691 9.84775906502257 8.23463313526982 10.0 9.0 9.8477
5906502257 9.76536686473018 9.4142135623731 10.4142135623731 8.76536686473018 10
.8477590650226 8.0 11.0 7.23463313526982 10.8477590650226 6.58578643762691 10.41
```

```

42135623731 6.15224093497743 9.76536686473018 6.0 9.0 6.15224093497743 8.2346331
3526982 6.58578643762691 7.5857864376269 7.23463313526982 7.15224093497743 8.0 7
.0 </gml:posList>
    </gml:LinearRing>
  </gml:exterior>
</gml:Polygon>

```

The following example converts an LRS geometry to a standard geometry and returns the GML version 3.1.1 fragment for the geometry. (The example uses the definitions and data from [Example of LRS Functions](#) (page 7-15).)

```

SET LONG 40000
-- Convert LRS geometry to standard geometry before using TO_GML311GEOMETRY.
SELECT XMLTYPE(SDO_UTIL.TO_GML311GEOMETRY(
  SDO_LRS.CONVERT_TO_STD_GEOM(route_geometry)))
  AS Gml311Geometry FROM lrs_routes a WHERE a.route_id = 1;

GML311GEOMETRY
-----
<gml:Curve srsName="SDO:" xmlns:gml="http://www.opengis.net/gml">
  <gml:segments>
    <gml:LineStringSegment>
      <gml:posList srsDimension="2">2.0 2.0 2.0 4.0 8.0 4.0 12.0 4.0 12.0 10.0 8
.0 10.0 5.0 14.0 </gml:posList>
    </gml:LineStringSegment>
  </gml:segments>
</gml:Curve>

```

The following examples return GML version 3.1.1 fragments for a variety of geometry types.

```

-- Point geometry with coordinates in SDO_ORDINATES. Note the
--   coordinates in the GML are (10.0 10.0) and the values in the
--   SDO_POINT field are discarded.
SELECT TO_CHAR(
  SDO_UTIL.TO_GML311GEOMETRY(sdo_geometry(2001, 8307,
    sdo_point_type(-80, 70, null),
    sdo_elem_info_array(1,1,1), sdo_ordinate_array(10, 10)))
)
  AS Gml311Geometry FROM DUAL;

GML311GEOMETRY
-----
<gml:Point srsName="SDO:8307" xmlns:gml="http://www.opengis.net/gml"><gml:posList
srsDimension="2">10.0 10.0 </gml:posList></gml:Point>

-- Multipolygon
SET LONG 40000
SELECT SDO_UTIL.TO_GML311GEOMETRY(
  sdo_geometry(2007, 8307, null,
    sdo_elem_info_array(1,1003,1, 13,1003,1, 23,1003,3),
    sdo_ordinate_array(10.10,10.20, 20.50,20.10, 30.30,30.30, 40.10,40.10,
      30.50, 30.20, 10.10, 10.20,
      5,5, 5,6, 6,6, 6,5, 5,5, 7,7, 8,8 ))
)
  AS Gml311Geometry FROM DUAL;

GML311GEOMETRY
-----
<gml:MultiSurface srsName="SDO:8307" xmlns:gml="http://www.opengis.net/gml"><gml

```

```
:surfaceMember><gml:Polygon><gml:exterior><gml:LinearRing><gml:posList srsDimension="2">10.1 10.2 20.5 20.1 30.3 30.3 40.1 40.1 30.5 30.2 10.1 10.2 </gml:posList></gml:LinearRing></gml:exterior></gml:Polygon></gml:surfaceMember><gml:surfaceMember><gml:Polygon><gml:exterior><gml:LinearRing><gml:posList srsDimension="2">5.0 5.0 5.0 6.0 6.0 6.0 6.0 5.0 5.0 5.0 </gml:posList></gml:LinearRing></gml:exterior></gml:Polygon></gml:surfaceMember><gml:surfaceMember><gml:Polygon><gml:exterior><gml:LinearRing><gml:posList srsDimension="2">7.0 7.0 8.0 7.0 8.0 8.0 7.0 8.0 7.0 7.0 </gml:posList></gml:LinearRing></gml:exterior></gml:Polygon></gml:surfaceMember></gml:MultiSurface>
```

```
SET LONG 80
```

```
-- Rectangle (geodetic)
```

```
SELECT TO_CHAR(
```

```
    SDO_UTIL.TO_GML311GEOMETRY(sdo_geometry(2003, 8307, null,
        sdo_elem_info_array(1,1003,3),
        sdo_ordinate_array(10.10,10.10, 20.10,20.10 )))
```

```
)
```

```
AS Gml311Geometry FROM DUAL;
```

```
GML311GEOMETRY
```

```
-----
<gml:Polygon srsName="SDO:8307" xmlns:gml="http://www.opengis.net/gml"><gml:exterior><gml:LinearRing><gml:posList srsDimension="2">10.1 10.1 20.1 10.1 20.1 20.1 10.1 20.1 10.1 10.1 </gml:posList></gml:LinearRing></gml:exterior></gml:Polygon>
```

```
-- Polygon with holes
```

```
SELECT TO_CHAR(
```

```
    SDO_UTIL.TO_GML311GEOMETRY(sdo_geometry(2003, 262152, null,
        sdo_elem_info_array(1,1003,3, 5, 2003, 1, 13, 2003, 1),
        sdo_ordinate_array(10.10,10.20, 40.50, 41.10, 30.30, 30.30, 30.30,
            40.10, 40.10, 40.10, 30.30, 30.30, 5, 5, 5, 6, 6, 6, 6, 5, 5, 5 )))
```

```
)
```

```
AS Gml311Geometry FROM DUAL;
```

```
GML311GEOMETRY
```

```
-----
<gml:Polygon srsName="SDO:262152" xmlns:gml="http://www.opengis.net/gml"><gml:exterior><gml:LinearRing><gml:posList srsDimension="2">10.1 10.2 40.5 10.2 40.5 41.1 10.1 41.1 10.1 10.2 </gml:posList></gml:LinearRing></gml:exterior><gml:interior><gml:LinearRing><gml:posList srsDimension="2">30.3 30.3 30.3 40.1 40.1 40.1 30.3 30.3 </gml:posList></gml:LinearRing></gml:interior><gml:interior><gml:LinearRing><gml:posList srsDimension="2">5.0 5.0 5.0 6.0 6.0 6.0 6.0 5.0 5.0 5.0 </gml:posList></gml:LinearRing></gml:interior></gml:Polygon>
```

```
-- Creating an XMLTYPE from the GML fragment. Also useful for "pretty
```

```
-- printing" the GML output.
```

```
SET LONG 40000
```

```
SELECT XMLTYPE(
```

```
    SDO_UTIL.TO_GML311GEOMETRY(sdo_geometry(2003, 262152, null,
        sdo_elem_info_array(1,1003,1, 11, 2003, 1, 21, 2003, 1),
        sdo_ordinate_array(10.10,10.20, 40.50,10.2, 40.5,41.10, 10.1,41.1,
            10.10, 10.20, 30.30,30.30, 30.30, 40.10, 40.10, 40.10, 30.30,
            30.30, 30.30, 5, 5, 5, 6, 6, 6, 6, 5, 5, 5 )))
```

```
)
```

```
AS Gml311Geometry FROM DUAL;
```

```
GML311GEOMETRY
```

```
-----
<gml:Polygon srsName="SDO:262152" xmlns:gml="http://www.opengis.net/gml">
```

```

    <gml:exterior>
      <gml:LinearRing>
        <gml:posList srsDimension="2">10.1 10.2 40.5 10.2 40.5 41.1 10.1 41.1 10.1
10.2 </gml:posList>
      </gml:LinearRing>
    </gml:exterior>
    <gml:interior>
      <gml:LinearRing>
        <gml:posList srsDimension="2">30.3 30.3 30.3 40.1 40.1 40.1 40.1 30.3 30.3
30.3 </gml:posList>

```

GML311GEOMETRY

```

    </gml:LinearRing>
  </gml:interior>
  <gml:interior>
    <gml:LinearRing>
      <gml:posList srsDimension="2">5.0 5.0 5.0 6.0 6.0 6.0 6.0 5.0 5.0 5.0 </gm
l:posList>
    </gml:LinearRing>
  </gml:interior>
</gml:Polygon>

```

### Related Topics

[SDO\\_UTIL.TO\\_GMLGEOMETRY](#) (page 31-61)

## 31.37 SDO\_UTIL.TO\_GMLGEOMETRY

### Format

```

SDO_UTIL.TO_GMLGEOMETRY(
  geometry IN SDO_GEOMETRY
) RETURN CLOB;

```

or

```

SDO_UTIL.TO_GML311GEOMETRY(
  geometry IN SDO_GEOMETRY,
  coordOrder IN NUMBER
) RETURN CLOB;

```

### Description

Converts a Spatial and Graph geometry object to a geography markup language (GML 2.0) fragment based on the geometry types defined in the Open GIS `geometry.xsd` schema document.

### Parameters

#### **geometry**

Geometry for which to return the GML fragment.

#### **coordOrder**

(Reserved for Oracle use.)

## Usage Notes

This function does not convert circles, geometries containing any circular arcs, LRS geometries, or geometries with an SDO\_ETYPE value of 0 (type 0 elements); it returns an empty CLOB in these cases.

This function converts the input geometry to a GML fragment based on some GML geometry types defined in the Open GIS Implementation Specification.

Polygons must be defined using the conventions for Oracle9i and later releases of Spatial and Graph. That is, the outer boundary is stored first (with ETYPE=1003) followed by zero or more inner boundary elements (ETYPE=2003). For a polygon with holes, the outer boundary must be stored first in the SDO\_ORDINATES definition, followed by coordinates of the inner boundaries.

LRS geometries must be converted to standard geometries (using the [SDO\\_LRS.CONVERT\\_TO\\_STD\\_GEOM](#) (page 24-16) or [SDO\\_LRS.CONVERT\\_TO\\_STD\\_LAYER](#) (page 24-17) function) before being passed to the TO\_GMLGEOMETRY function. (See the Examples section for an example that uses CONVERT\_TO\_STD\_GEOM with the TO\_GMLGEOMETRY function.)

Any circular arcs or circles must be densified (using the [SDO\\_GEOM.SDO\\_ARC\\_DENSIFY](#) (page 23-7) function) or represented as polygons (using the [SDO\\_GEOM.SDO\\_BUFFER](#) (page 23-11) function) before being passed to the TO\_GMLGEOMETRY function. (See the Examples section for an example that uses SDO\_ARC\_DENSIFY with the TO\_GMLGEOMETRY function.)

Label points are discarded. That is, if a geometry has a value for the SDO\_POINT field and values in SDO\_ELEM\_INFO and SDO\_ORDINATES, the SDO\_POINT is not output in the GML fragment.

The SDO\_SRID value is output in the form `srsName="SDO:<srid>"`. For example, `"SDO:8307"` indicates SDO\_SRID 8307, and `"SDO:"` indicates a null SDO\_SRID value. No checks are made for the validity or consistency of the SDO\_SRID value. For example, the value is not checked to see if it exists in the MDSYS.CS\_SRS table or if it conflicts with the SRID value for the layer in the USER\_SDO\_GEOM\_METADATA view.

Coordinates are always output using the `<coordinates>` tag and `decimal='.'`, `cs=' , '` (that is, with the comma as the coordinate separator), and `ts=' '` (that is, with a space as the tuple separator), even if the NLS\_NUMERIC\_CHARACTERS setting has `' , '` (comma) as the decimal character.

The GML output is not formatted; there are no line breaks or indentation of tags. To see the contents of the returned CLOB in SQL\*Plus, use the TO\_CHAR() function or set the SQL\*Plus parameter LONG to a suitable value (for example, `SET LONG 40000`). To get formatted GML output or to use the return value of TO\_GMLGEOMETRY in SQLX or Oracle XML DB functions such as XMLELEMENT, use the XMLTYPE(clobval CLOB) constructor.

## Examples

The following example returns the GML fragment for the cola\_b geometry in the COLA\_MARKETS table. (The example uses the definitions and data from [Simple Example: Inserting, Indexing, and Querying Spatial Data](#) (page 2-1).)

```
-- Convert cola_b geometry to GML fragment.
SELECT TO_CHAR(SDO_UTIL.TO_GMLGEOMETRY(shape)) AS GmlGeometry
  FROM COLA_MARKETS c WHERE c.name = 'cola_b';

GMLGEOMETRY
```



```
-----
<gml:Polygon srsName="SDO:" xmlns:gml="http://www.opengis.net/gml"><gml:outerBoundaryIs><gml:LinearRing><gml:coordinates decimal="." cs="," ts=" ">5,1 8,1 8,6 5,7 5,1 </gml:coordinates></gml:LinearRing></gml:outerBoundaryIs></gml:Polygon>
```

The following example returns the GML fragment for the arc densification of the cola\_d geometry in the COLA\_MARKETS table. (The example uses the definitions and data from [Simple Example: Inserting\\_ Indexing\\_ and Querying Spatial Data](#) (page 2-1).)

```
SET LONG 40000
SELECT XMLTYPE(SDO_UTIL.TO_GMLGEOMETRY(
  SDO_GEOM.SDO_ARC_DENSIFY(c.shape, m.diminfo, 'arc_tolerance=0.05'))
  AS GmlGeometry FROM cola_markets c, user_sdo_geom_metadata m
  WHERE m.table_name = 'COLA_MARKETS' AND m.column_name = 'SHAPE'
  AND c.name = 'cola_d';
```

GMLGEOMETRY

```
-----
<gml:Polygon srsName="SDO:" xmlns:gml="http://www.opengis.net/gml"><gml:outerBoundaryIs><gml:LinearRing><gml:coordinates decimal="." cs="," ts=" ">8,7 8.7653668 6473018,7.15224093497743 9.4142135623731,7.58578643762691 9.84775906502257,8.234 63313526982 10,9 9.84775906502257,9.76536686473018 9.4142135623731,10.4142135623 731 8.76536686473018,10.8477590650226 8,11 7.23463313526982,10.8477590650226 6.5 8578643762691,10.4142135623731 6.15224093497743,9.76536686473018 6,9 6.152240934 97743,8.23463313526982 6.58578643762691,7.5857864376269 7.23463313526982,7.15224 093497743 8,7 </gml:coordinates></gml:LinearRing></gml:outerBoundaryIs></gml:Polygon>
```

The following example converts an LRS geometry to a standard geometry and returns the GML fragment for the geometry. (The example uses the definitions and data from [Example of LRS Functions](#) (page 7-15).)

```
SET LONG 40000
-- Convert LRS geometry to standard geometry before using TO_GMLGEOMETRY.
SELECT XMLTYPE(SDO_UTIL.TO_GMLGEOMETRY(
  SDO_LRS.CONVERT_TO_STD_GEOM(route_geometry)))
  AS GmlGeometry FROM lrs_routes a WHERE a.route_id = 1;
```

GMLGEOMETRY

```
-----
<gml:LineString srsName="SDO:" xmlns:gml="http://www.opengis.net/gml">
  <gml:coordinates decimal="." cs="," ts=" ">2,2 2,4 8,4 12,4 12,10 8,10 5,14 </
gml:coordinates>
</gml:LineString>
```

The following examples return GML fragments for a variety of geometry types.

```
-- Point geometry with coordinates in SDO_ORDINATES. Note the
-- coordinates in the GML are (10,10) and the values in the
-- SDO_POINT field are discarded.
SELECT TO_CHAR(
  SDO_UTIL.TO_GMLGEOMETRY(sdo_geometry(2001, 8307,
    sdo_point_type(-80, 70, null),
    sdo_elem_info_array(1,1,1), sdo_ordinate_array(10, 10)))
)
AS GmlGeometry FROM DUAL;
```

GMLGEOMETRY

```
-----
<gml:Point srsName="SDO:8307" xmlns:gml="http://www.opengis.net/gml"><gml:coordi
```

```
nates decimal="." cs="," ts=" ">10,10 </gml:coordinates></gml:Point>
```

```
-- Multipolygon
SET LONG 40000
SELECT SDO_UTIL.TO_GMLGEOMETRY(
  sdo_geometry(2007, 8307, null,
    sdo_elem_info_array(1,1003,1, 13,1003,1, 23,1003,3),
    sdo_ordinate_array(10.10,10.20, 20.50,20.10, 30.30,30.30, 40.10,40.10,
      30.50, 30.20, 10.10, 10.20,
      5,5, 5,6, 6,6, 6,5, 5,5, 7,7, 8,8 ))
)
AS GmlGeometry FROM DUAL;
```

```
GMLGEOMETRY
```

```
-----
<gml:MultiPolygon srsName="SDO:8307" xmlns:gml="http://www.opengis.net/gml"><gml:
:polygonMember><gml:Polygon><gml:outerBoundaryIs><gml:LinearRing><gml:coordinate
s decimal="." cs="," ts=" ">10.1,10.2 20.5,20.1 30.3,30.3 40.1,40.1 30.5,30.2 10
.1,10.2 </gml:coordinates></gml:LinearRing></gml:outerBoundaryIs></gml:Polygon><
/gml:polygonMember><gml:polygonMember><gml:Polygon><gml:outerBoundaryIs><gml:Lin
earRing><gml:coordinates decimal="." cs="," ts=" ">5.0,5.0 5.0,6.0 6.0,6.0 6.0,5
.0 5.0,5.0 </gml:coordinates></gml:LinearRing></gml:outerBoundaryIs></gml:Polygo
n></gml:polygonMember><gml:polygonMember><gml:Polygon><gml:outerBoundaryIs><gml:
LinearRing><gml:coordinates decimal="." cs="," ts=" ">7.0,7.0 8.0,7.0 8.0,8.0 7.
0,8.0 7.0,7.0 </gml:coordinates></gml:LinearRing></gml:outerBoundaryIs></gml:Pol
ygon></gml:polygonMember></gml:MultiPolygon>
```

```
SQL> SET LONG 80
```

```
-- Rectangle (geodetic)
SELECT TO_CHAR(
  SDO_UTIL.TO_GMLGEOMETRY(sdo_geometry(2003, 8307, null,
    sdo_elem_info_array(1,1003,3),
    sdo_ordinate_array(10.10,10.10, 20.10,20.10 )))
)
AS GmlGeometry FROM DUAL;
```

```
GMLGEOMETRY
```

```
-----
<gml:Box srsName="SDO:8307" xmlns:gml="http://www.opengis.net/gml"><gml:coordina
tes decimal="." cs="," ts=" ">10.1,10.1 20.1,20.1 </gml:coordinates></gml:Box>
```

```
-- Polygon with holes
SELECT TO_CHAR(
  SDO_UTIL.TO_GMLGEOMETRY(sdo_geometry(2003, 262152, null,
    sdo_elem_info_array(1,1003,3, 5, 2003, 1, 13, 2003, 1),
    sdo_ordinate_array(10.10,10.20, 40.50, 41.10, 30.30, 30.30, 30.30,
      40.10, 40.10, 40.10, 30.30, 30.30, 5, 5, 5, 6, 6, 6, 6, 5, 5, 5 )))
)
AS GmlGeometry FROM DUAL;
```

```
GMLGEOMETRY
```

```
-----
<gml:Polygon srsName="SDO:262152" xmlns:gml="http://www.opengis.net/gml"><gml:ou
terBoundaryIs><gml:LinearRing><gml:coordinates decimal="." cs="," ts=" ">10.1,10
.2, 40.5,10.2, 40.5,41.1, 10.1,41.1, 10.1,10.2 </gml:coordinates></gml:LinearRin
g></gml:outerBoundaryIs><gml:innerBoundaryIs><gml:LinearRing><gml:coordinates de
cimal="." cs="," ts=" ">30.3,30.3 30.3,40.1 40.1,40.1 30.3,30.3 </gml:coordinate
s></gml:LinearRing></gml:innerBoundaryIs><gml:innerBoundaryIs><gml:LinearRing><g
```

```
ml:coordinates decimal="." cs="," ts=" ">5,5 5,6 6,6 6,5 5,5 </gml:coordinates><
/gml:LinearRing></gml:innerBoundaryIs></gml:Polygon>
```

```
-- Creating an XMLTYPE from the GML fragment. Also useful for "pretty
-- printing" the GML output.
```

```
SET LONG 40000
```

```
SELECT XMLTYPE(
```

```
    SDO_UTIL.TO_GMLGEOMETRY(sdo_geometry(2003, 262152, null,
        sdo_elem_info_array(1,1003,1, 11, 2003, 1, 21, 2003, 1),
        sdo_ordinate_array(10.10,10.20, 40.50,10.2, 40.5,41.10, 10.1,41.1,
            10.10, 10.20, 30.30,30.30, 30.30, 40.10, 40.10, 40.10, 30.30,
            30.30, 30.30, 5, 5, 5, 6, 6, 6, 5, 5, 5 )))
)
```

```
AS GmlGeometry FROM DUAL;
```

```
GMLGEOMETRY
```

```
-----
<gml:Polygon srsName="SDO:262152" xmlns:gml="http://www.opengis.net/gml"><gml:ou
terBoundaryIs><gml:LinearRing><gml:coordinates decimal="." cs="," ts=" ">10.1,10
.2 40.5,10.2 40.5,41.1 10.1,41.1 10.1,10.2 </gml:coordinates></gml:LinearRing></
gml:outerBoundaryIs><gml:innerBoundaryIs><gml:LinearRing><gml:coordinates decima
l="." cs="," ts=" ">30.3,30.3 30.3,40.1 40.1,40.1 40.1,30.3 30.3,30.3 </gml:coor
dinates></gml:LinearRing></gml:innerBoundaryIs><gml:innerBoundaryIs><gml:LinearR
ing><gml:coordinates decimal="." cs="," ts=" ">5,5 5,6 6,6 6,5 5,5 </gml:coordin
ates></gml:LinearRing></gml:innerBoundaryIs></gml:Polygon>
```

The following example uses the TO\_GMLGEOMETRY function with the Oracle XML DB XMLTYPE data type and the XMLELEMENT and XMLFOREST functions.

```
SELECT xmlelement("State", xmlattributes(
    'http://www.opengis.net/gml' as "xmlns:gml"),
    xmlforest(state as "Name", totpop as "Population",
    xmltype(sdo_util.to_gmlgeometry(geom)) as "gml:geometryProperty"))
AS theXMLElements FROM states WHERE state_abrv in ('DE', 'UT');
```

```
THEXMLEMENTS
```

```
-----
<State xmlns:gml="http://www.opengis.net/gml">
  <Name>Delaware</Name>
  <Population>666168</Population>
  <gml:geometryProperty>
    <gml:Polygon srsName="SDO:" xmlns:gml="http://www.opengis.net/gml">
      <gml:outerBoundaryIs>
        <gml:LinearRing>
          <gml:coordinates decimal="." cs="," ts=" ">-75.788704,39.721699 -75.78
8704,39.6479 -75.767014,39.377106 -75.76033,39.296497 -75.756294,39.24585 -75.74
8016,39.143196 -75.722961,38.829895 -75.707695,38.635166 -75.701912,38.560619 -7
5.693871,38.460011 -75.500336,38.454002 -75.341614,38.451855 -75.049339,38.45165
3 -75.053841,38.538429 -75.06015,38.605465 -75.063263,38.611275 -75.065308,38.62
949 -75.065887,38.660919 -75.078697,38.732403 -75.082527,38.772045 -75.091667,38
.801208 -75.094185,38.803699 -75.097572,38.802986 -75.094116,38.793579 -75.09926
6,38.78756 -75.123619,38.781784 -75.137962,38.782703 -75.18692,38.803772 -75.215
019,38.831547 -75.23735,38.849014 -75.260498,38.875 -75.305908,38.914673 -75.316
399,38.930309 -75.317284,38.93676 -75.312851,38.945576 -75.312859,38.945618 -75.
31205,38.967804 -75.31778,38.986012 -75.341431,39.021233 -75.369606,39.041359 -7
5.389229,39.051422 -75.40181,39.06702 -75.401306,39.097713 -75.411369,39.148029
-75.407845,39.175201 -75.396271,39.187778 -75.39225,39.203377 -75.40181,39.23104
9 -75.402817,39.253189 -75.409355,39.264759 -75.434006,39.290424 -75.439041,39.3
13065 -75.453125,39.317093 -75.457657,39.326653 -75.469231,39.330677 -75.486336,
39.341743 -75.494888,39.354324 -75.504448,39.357346 -75.51284,39.366291 -75.5129
```

```

24,39.366482 -75.523773,39.392052 -75.538651,39.415707 -75.56749,39.436436 -75.5
9137,39.463696 -75.592941,39.471806 -75.590019,39.488026 -75.587311,39.496136 -7
5.5774,39.508076 -75.554192,39.506947 -75.528442,39.498005 -75.530373,39.510303
-75.527145,39.531326 -75.52803,39.535168 -75.53437,39.540592 -75.519386,39.55528
6 -75.512291,39.567505 -75.515587,39.580639 -75.528046,39.584 -75.538269,39.5935
67 -75.554016,39.601727 -75.560143,39.622578 -75.556602,39.6348 -75.549599,39.63
7699 -75.542397,39.645901 -75.535507,39.647099 -75.514999,39.668499 -75.507523,3
9.69685 -75.496597,39.701302 -75.488914,39.714722 -75.477997,39.714901 -75.47550
2,39.733501 -75.467972,39.746975 -75.463707,39.761101 -75.448494,39.773857 -75.4
38301,39.783298 -75.405701,39.796101 -75.415405,39.801678 -75.454102,39.820202 -
75.499199,39.833199 -75.539703,39.8381 -75.5802,39.838417 -75.594017,39.837345 -
75.596107,39.837044 -75.639488,39.82893 -75.680145,39.813839 -75.71096,39.796352
-75.739716,39.772881 -75.760689,39.74712 -75.774101,39.721699 -75.788704,39.721
699 </gml:coordinates>
    </gml:LinearRing>
  </gml:outerBoundaryIs>
</gml:Polygon>
</gml:geometryProperty>
</State>

<State xmlns:gml="http://www.opengis.net/gml">
  <Name>Utah</Name>
  <Population>1722850</Population>
  <gml:geometryProperty>
    <gml:Polygon srsName="SDO:" xmlns:gml="http://www.opengis.net/gml">
      <gml:outerBoundaryIs>
        <gml:LinearRing>
          <gml:coordinates decimal="." cs="," ts=" ">-114.040871,41.993805 -114.
038803,41.884899 -114.041306,41 -114.04586,40.116997 -114.046295,39.906101 -114.
046898,39.542801 -114.049026,38.67741 -114.049339,38.572968 -114.049095,38.14864
-114.0476,37.80946 -114.05098,37.746284 -114.051666,37.604805 -114.052025,37.10
3989 -114.049797,37.000423 -113.484375,37 -112.898598,37.000401 -112.539604,37.0
00683 -112,37.000977 -111.412048,37.001514 -111.133018,37.00079 -110.75,37.00320
1 -110.5,37.004265 -110.469505,36.998001 -110,36.997967 -109.044571,36.999088 -1
09.045143,37.375 -109.042824,37.484692 -109.040848,37.881176 -109.041405,38.1530
27 -109.041107,38.1647 -109.059402,38.275501 -109.059296,38.5 -109.058868,38.719
906 -109.051765,39 -109.050095,39.366699 -109.050697,39.4977 -109.050499,39.6605
-109.050156,40.222694 -109.047577,40.653641 -109.0494,41.000702 -109.2313,41.00
2102 -109.534233,40.998184 -110,40.997398 -110.047768,40.997696 -110.5,40.994801
-111.045982,40.998013 -111.045815,41.251774 -111.045097,41.579899 -111.045944,4
2.001633 -111.506493,41.999588 -112.108742,41.997677 -112.16317,41.996784 -112.1
72562,41.996643 -112.192184,42.001244 -113,41.998314 -113.875,41.988091 -114.040
871,41.993805 </gml:coordinates>
        </gml:LinearRing>
      </gml:outerBoundaryIs>
    </gml:Polygon>
  </gml:geometryProperty>
</State>

```

## Related Topics

[SDO\\_UTIL.TO\\_GML311GEOMETRY](#) (page 31-57)

# 31.38 SDO\_UTIL.TO\_KMLGEOMETRY

## Format

```

SDO_UTIL.TO_KMLGEOMETRY(
  geometry IN SDO_GEOMETRY
) RETURN CLOB;

```

## Description

Converts a Spatial and Graph geometry object to a KML (Keyhole Markup Language) document.

## Parameters

### geometry

Geometry for which to return the KML document.

## Usage Notes

This function does not convert circles, geometries containing any circular arcs, LRS geometries, or geometries with an SDO\_ETYPE value of 0 (type 0 elements); it returns an empty CLOB in these cases.

Polygons must be defined using the conventions for Oracle9i and later releases of Spatial and Graph. That is, the outer boundary is stored first (with ETYPE=1003) followed by zero or more inner boundary elements (ETYPE=2003). For a polygon with holes, the outer boundary must be stored first in the SDO\_ORDINATES definition, followed by coordinates of the inner boundaries.

LRS geometries must be converted to standard geometries (using the [SDO\\_LRS.CONVERT\\_TO\\_STD\\_GEOM](#) (page 24-16) or [SDO\\_LRS.CONVERT\\_TO\\_STD\\_LAYER](#) (page 24-17) function) before being passed to the TO\_KMLGEOMETRY function.

Any circular arcs or circles must be densified (using the [SDO\\_GEOM.SDO\\_ARC\\_DENSIFY](#) (page 23-7) function) or represented as polygons (using the [SDO\\_GEOM.SDO\\_BUFFER](#) (page 23-11) function) before being passed to the TO\_KMLGEOMETRY function.

Label points are discarded. That is, if a geometry has a value for the SDO\_POINT field and values in SDO\_ELEM\_INFO and SDO\_ORDINATES, the SDO\_POINT is not output in the KML document.

Solid geometries are converted to KML MultiGeometry objects, because KML 2.1 does not support solids. If you then use the [SDO\\_UTIL.FROM\\_KMLGEOMETRY](#) (page 31-31) function on the MultiGeometry, the result is not an Oracle Spatial and Graph solid geometry (that is, its SDO\_GTYPE value does not reflect a geometry type of SOLID or MULTISOLID).

The KML output is not formatted; there are no line breaks or indentation of tags. To see the contents of the returned CLOB in SQL\*Plus, use the TO\_CHAR() function or set the SQL\*Plus parameter LONG to a suitable value (for example, SET LONG 2000). To get formatted GML output or to use the return value of TO\_KMLGEOMETRY in SQLX or Oracle XML DB functions such as XMLELEMENT, use the XMLTYPE(clobval CLOB) constructor.

## Examples

The following example shows conversion to and from KML format. (The example uses the definitions and data from [Simple Example: Inserting, Indexing, and Querying Spatial Data](#) (page 2-1), specifically the cola\_c geometry from the COLA\_MARKETS table.)

```
-- Convert cola_c geometry to a KML document; convert that result to
-- a spatial geometry.
set long 2000;
```

```
DECLARE
    kmlgeom CLOB;
    val_result VARCHAR2(5);
    geom_result SDO_GEOMETRY;
    geom SDO_GEOMETRY;
BEGIN
    SELECT c.shape INTO geom FROM cola_markets c WHERE c.name = 'cola_c';

    -- To KML geometry
    kmlgeom := SDO_UTIL.TO_KMLGEOMETRY(geom);
    DBMS_OUTPUT.PUT_LINE('To KML geometry result = ' || TO_CHAR(kmlgeom));

    -- From KML geometry
    geom_result := SDO_UTIL.FROM_KMLGEOMETRY(kmlgeom);
    -- Validate the returned geometry.
    val_result := SDO_GEOM.VALIDATE_GEOMETRY_WITH_CONTEXT(geom_result, 0.005);
    DBMS_OUTPUT.PUT_LINE('Validation result = ' || val_result);

END;
/
To KML geometry result =
<Polygon><extrude>0</extrude><tessellate>0</tessellate><altitudeMode>relativeToG
round</altitudeMode><outerBoundaryIs><LinearRing><coordinates>3.0,3.0 6.0,3.0
6.0,5.0 4.0,5.0 3.0,3.0 </coordinates></LinearRing></outerBoundaryIs></Polygon>
Validation result = TRUE
```

### Related Topics

- [SDO\\_UTIL.FROM\\_KMLGEOMETRY](#) (page 31-31)

## 31.39 SDO\_UTIL.TO\_WKBGEOMETRY

### Format

```
SDO_UTIL.TO_WKBGEOMETRY(
    geometry IN SDO_GEOMETRY
) RETURN BLOB;
```

### Description

Converts a Spatial and Graph geometry object to the well-known binary (WKB) format.

### Parameters

#### **geometry**

SDO\_GEOMETRY object to be converted to WKB format.

### Usage Notes

The input geometry is converted to the well-known binary (WKB) format, as defined by the Open Geospatial Consortium and the International Organization for Standardization (ISO).

This function is patterned after the SQL Multimedia recommendations in *ISO 13249-3, Information technology - Database languages - SQL Multimedia and Application Packages - Part 3: Spatial*.

To convert a geometry in WKB format to an SDO\_GEOMETRY object, use the [SDO\\_UTIL.FROM\\_WKBGEOMETRY](#) (page 31-33) function.

### Examples

The following example shows conversion to and from WKB and WKT format, and validation of WKB and WKT geometries. (The example uses the definitions and data from [Simple Example: Inserting, Indexing, and Querying Spatial Data](#) (page 2-1), specifically the cola\_b geometry from the COLA\_MARKETS table.)

```
DECLARE
  wkbgeom BLOB;
  wktgeom CLOB;
  val_result VARCHAR2(5);
  geom_result SDO_GEOMETRY;
  geom SDO_GEOMETRY;
BEGIN
  SELECT c.shape INTO geom FROM cola_markets c WHERE c.name = 'cola_b';

  -- To WBT/WKT geometry
  wkbgeom := SDO_UTIL.TO_WKBGEOMETRY(geom);
  wktgeom := SDO_UTIL.TO_WKTGEOMETRY(geom);
  DBMS_OUTPUT.PUT_LINE('To WKT geometry result = ' || TO_CHAR(wktgeom));

  -- From WBT/WKT geometry
  geom_result := SDO_UTIL.FROM_WKBGEOMETRY(wkbgeom);
  geom_result := SDO_UTIL.FROM_WKTGEOMETRY(wktgeom);

  -- Validate WBT/WKT geometry
  val_result := SDO_UTIL.VALIDATE_WKBGEOMETRY(wkbgeom);
  DBMS_OUTPUT.PUT_LINE('WKB validation result = ' || val_result);
  val_result := SDO_UTIL.VALIDATE_WKTGEOMETRY(wktgeom);
  DBMS_OUTPUT.PUT_LINE('WKT validation result = ' || val_result);

END;/

To WKT geometry result = POLYGON ((5.0 1.0, 8.0 1.0, 8.0 6.0, 5.0 7.0, 5.0 1.0))
WKB validation result = TRUE
WKT validation result = TRUE
```

### Related Topics

- [SDO\\_UTIL.FROM\\_WKBGEOMETRY](#) (page 31-33)
- [SDO\\_UTIL.FROM\\_WKTGEOMETRY](#) (page 31-34)
- [SDO\\_UTIL.TO\\_WKTGEOMETRY](#) (page 31-69)
- [SDO\\_UTIL.VALIDATE\\_WKBGEOMETRY](#) (page 31-74)
- [SDO\\_UTIL.VALIDATE\\_WKTGEOMETRY](#) (page 31-76)

## 31.40 SDO\_UTIL.TO\_WKTGEOMETRY

### Format

```
SDO_UTIL.TO_WKTGEOMETRY(
  geometry IN SDO_GEOMETRY
) RETURN CLOB;
```

## Description

Converts a Spatial and Graph geometry object to the well-known text (WKT) format.

## Parameters

### **geometry**

SDO\_GEOMETRY object to be converted to WKT format.

## Usage Notes

The input geometry is converted to the well-known text (WKT) format, as defined by the Open Geospatial Consortium and the International Organization for Standardization (ISO).

This function is patterned after the SQL Multimedia recommendations in *ISO 13249-3, Information technology - Database languages - SQL Multimedia and Application Packages - Part 3: Spatial*.

To convert a geometry in WKT format to an SDO\_GEOMETRY object, use the [SDO\\_UTIL.FROM\\_WKTGEOMETRY](#) (page 31-34) function.

## Examples

The following example shows conversion to and from WKB and WKT format, and validation of WKB and WKT geometries. (The example uses the definitions and data from [Simple Example: Inserting, Indexing, and Querying Spatial Data](#) (page 2-1), specifically the cola\_b geometry from the COLA\_MARKETS table.)

```
DECLARE
    wkbgeom BLOB;
    wktgeom CLOB;
    val_result VARCHAR2(5);
    geom_result SDO_GEOMETRY;
    geom SDO_GEOMETRY;
BEGIN
    SELECT c.shape INTO geom FROM cola_markets c WHERE c.name = 'cola_b';

    -- To WBT/WKT geometry
    wkbgeom := SDO_UTIL.TO_WKBGEOMETRY(geom);
    wktgeom := SDO_UTIL.TO_WKTGEOMETRY(geom);
    DBMS_OUTPUT.PUT_LINE('To WKT geometry result = ' || TO_CHAR(wktgeom));

    -- From WBT/WKT geometry
    geom_result := SDO_UTIL.FROM_WKBGEOMETRY(wkbgeom);
    geom_result := SDO_UTIL.FROM_WKTGEOMETRY(wktgeom);

    -- Validate WBT/WKT geometry
    val_result := SDO_UTIL.VALIDATE_WKBGEOMETRY(wkbgeom);
    DBMS_OUTPUT.PUT_LINE('WKB validation result = ' || val_result);
    val_result := SDO_UTIL.VALIDATE_WKTGEOMETRY(wktgeom);
    DBMS_OUTPUT.PUT_LINE('WKT validation result = ' || val_result);

END;

To WKT geometry result = POLYGON ((5.0 1.0, 8.0 1.0, 8.0 6.0, 5.0 7.0, 5.0 1.0))
WKB validation result = TRUE
WKT validation result = TRUE
```



**Related Topics**

- [SDO\\_UTIL.FROM\\_WKBGEOMETRY](#) (page 31-33)
- [SDO\\_UTIL.FROM\\_WKTGEOMETRY](#) (page 31-34)
- [SDO\\_UTIL.TO\\_WKBGEOMETRY](#) (page 31-68)
- [SDO\\_UTIL.VALIDATE\\_WKBGEOMETRY](#) (page 31-74)
- [SDO\\_UTIL.VALIDATE\\_WKTGEOMETRY](#) (page 31-76)

**31.41 SDO\_UTIL.VALIDATE\_3DTHEME****Format**

```
SDO_UTIL.VALIDATE_3DTHEME(
    theme_name IN VARCHAR2
) RETURN VARCHAR2;
```

**Description**

Validates a 3D theme.

**Parameters****theme\_name**

Name of the 3D theme. Must be a value from the USER\_SDO\_3DTHEMES or ALL\_SDO\_3DTHEMES view (described in [xxx\\_SDO\\_3DTHEMES Views](#) (page 2-49)).

**Usage Notes**

This function performs several validity checks appropriate to the type of theme. For each check it returns the string TRUE if there are no issues, or a brief description of the issue.

If the specified theme has not been defined, the output indicates that there is no theme with that name.

**Examples**

The following example validates the themes in the USER\_SDO\_3DTHEMES table. (It assumes that the themes were previously inserted into the USER\_SDO\_3DTHEMES table.)

```
SELECT
    name || ' : ' ||
    sdo_util.validate_3dtheme(name) "Theme validity"
FROM user_sdo_3dthemes
ORDER BY name;
```

Theme validity

```
-----
Test PC Hawaii Theme 4326: TRUE
Test PC Hawaii Theme 4326 A: No Theme-related Metadata
Test PC Hawaii Theme 4326 A2: XML metadata for "Test PC Hawaii Theme 4326 A2" not
well-formed
Test PC Hawaii Theme 4326 C1: SRID 0 not found
Test PC Hawaii Theme 4326 C2: No VERTICAL SRID 5758 allowed
```

Test PC Hawaii Theme 4326 D: THEME\_COLUMN column and xml metadata do not match, regarding feature table column  
Test PC Hawaii Theme 4326 D2: User "MDMETT"'s table "PCS\_HAWAII\_4326" has no column "PC3", according to USER\_TAB\_COLUMNS  
.

Test PC Hawaii Theme 4326 D3: User "MDMETT" has no table "PCS\_HAWAII\_4326A", according to USER\_TABLES.  
Test PC Hawaii Theme 4326 D4: THEME\_TYPE column and xml metadata do not match, regarding geometric feature type  
Test PC Hawaii Theme 4326 D5: User "MDMETT"'s table "PCS\_HAWAII\_4326" has a column "PC" of type "SDO\_PC", not "SDO\_PC3", according to USER\_TAB\_COLUMNS.

Test PC Hawaii Theme 4326 E: Elevation not strictly monotonously rising from position 1 to 2 (value 123.2 >= 123.1)  
Test PC Hawaii Theme 4326 E2: No elevation @color specified at position 2  
Test PC Hawaii Theme 4326 E3: No @elevation specified at position 2  
Test PC Hawaii Theme 4326 E4: Elevation @color at position 2 does not have hex format RRGGBB  
Test PC Hawaii Theme 4326 E5: Elevation @color at position 2 does not have hex format RRGGBB (character 6)

15 rows selected.

### Related Topics

- [SDO\\_UTIL.THEME3D\\_GET\\_BLOCK\\_TABLE](#) (page 31-53)
- [SDO\\_UTIL.THEME3D\\_HAS\\_LOD](#) (page 31-54)
- [SDO\\_UTIL.THEME3D\\_HAS\\_TEXTURE](#) (page 31-56)
- [SDO\\_UTIL.VALIDATE\\_SCENE](#) (page 31-72)
- [SDO\\_UTIL.VALIDATE\\_VIEWFRAME](#) (page 31-73)

## 31.42 SDO\_UTIL.VALIDATE\_SCENE

### Format

```
SDO_UTIL.VALIDATE_SCENE(  
    scene_name  IN VARCHAR2  
) RETURN VARCHAR2;
```

### Description

Validates a 3D scene.

### Parameters

#### scene\_name

Name of the 3D scene. Must be a value from the USER\_SDO\_SCENES or ALL\_SDO\_SCENES view (described in [xxx\\_SDO\\_SCENES Views](#) (page 2-50)).

### Usage Notes

This function performs several validity checks. For each check it returns the string TRUE if there are no issues, or a brief description of the issue.

If the specified scene has not been defined, the output indicates that there is no scene with that name.

### Examples

The following example validates the scenes in the USER\_SDO\_SCENES table. (It assumes that the scenes were previously inserted into the USER\_SDO\_SCENES table.)

```
SELECT
  name || ' : ' ||
  sdo_util.validate_scene(name) "Scene validity"
FROM user_sdo_scenes
ORDER BY name;
```

Scene validity

```
-----
Test PC Hawaii Scene 4326: TRUE
Test PC Hawaii Scene 4326 A: No Scene-related Metadata
Test PC Hawaii Scene 4326 A2: XML metadata for "Test PC Hawaii Scene 4326 A2" not
well-formed
Test PC Hawaii Scene 4326 B: Referenced theme "Test PC Hawaii Theme 4326 A": No
Theme-related Metadata
Test PC Hawaii Scene 4326 C1: SRID 0 not found
Test PC Hawaii Scene 4326 C2: No VERTICAL SRID 5758 allowed
```

6 rows selected.

### Related Topics

- [SDO\\_UTIL.VALIDATE\\_3DTHEME](#) (page 31-71)
- [SDO\\_UTIL.VALIDATE\\_VIEWFRAME](#) (page 31-73)

## 31.43 SDO\_UTIL.VALIDATE\_VIEWFRAME

### Format

```
SDO_UTIL.VALIDATE_VIEWFRAME(
  viewframe_name IN VARCHAR2
) RETURN VARCHAR2;
```

### Description

Validates a 3D viewframe.

### Parameters

#### viewframe\_name

Name of the 3D theme. Must be a value from the USER\_SDO\_VIEWFRAMES or ALL\_SDO\_VIEWFRAMES view (described in [xxx\\_SDO\\_VIEWFRAMES Views](#) (page 2-50)).

### Usage Notes

This function performs several validity checks. For each check it returns the string TRUE if there are no issues, or a brief description of the issue.

If the specified viewframe has not been defined, the output indicates that there is no viewframe with that name.

### Examples

The following example validates the themes in the USER\_SDO\_3DTHEMES table. (It assumes that the themes were previously inserted into the USER\_SDO\_3DTHEMES table.)

```
SELECT
    name || ' : ' ||
    sdo_util.validate_viewframe(name) "Viewframe validity"
FROM user_sdo_viewframes
ORDER BY name;
```

Viewframe validity  
-----

Test PC Hawaii Viewpoint 4326: TRUE  
Test PC Hawaii Viewpoint 4326 A: No Viewframe-related Metadata  
Test PC Hawaii Viewpoint 4326 A2: XML metadata for "Test PC Hawaii Viewpoint 4326 A2" not well-formed  
Test PC Hawaii Viewpoint 4326 B1: Referenced scene "Made up": No scene with name "Made up"  
Test PC Hawaii Viewpoint 4326 B2: Referenced scene "Test PC Hawaii Scene 4326 B": Referenced theme "Test PC Hawaii Theme 4326 A": No Theme-related Metadata  
  
Test PC Hawaii Viewpoint 4326 B3: SCENE\_NAME column and xml metadata do not match, regarding scene name  
Test PC Hawaii Viewpoint 4326 C1: SRID 0 not found  
Test PC Hawaii Viewpoint 4326 C2: No VERTICAL SRID 5758 allowed

8 rows selected.

### Related Topics

- [SDO\\_UTIL.VALIDATE\\_3DTHEME](#) (page 31-71)
- [SDO\\_UTIL.VALIDATE\\_SCENE](#) (page 31-72)

## 31.44 SDO\_UTIL.VALIDATE\_WKBGEOMETRY

### Format

```
SDO_UTIL.VALIDATE_WKBGEOMETRY(  
    geometry IN BLOB  
) RETURN VARCHAR2;
```

### Description

Validates the input geometry, which is in the standard well-known binary (WKB) format; returns the string TRUE if the geometry is valid or FALSE if the geometry is not valid.

## Parameters

### geometry

Geometry in WKB format to be checked for validity.

## Usage Notes

To be valid, the input geometry must be in the well-known binary (WKB) format, as defined by the Open Geospatial Consortium and the International Organization for Standardization (ISO).

This function is patterned after the SQL Multimedia recommendations in *ISO 13249-3, Information technology - Database languages - SQL Multimedia and Application Packages - Part 3: Spatial*.

To validate a geometry in the well-known text (WKT) format, use the [SDO\\_UTIL.VALIDATE\\_WKTGEOMETRY](#) (page 31-76) function.

## Examples

The following example shows conversion to and from WKB and WKT format, and validation of WKB and WKT geometries. (The example uses the definitions and data from [Simple Example: Inserting, Indexing, and Querying Spatial Data](#) (page 2-1), specifically the `cola_b` geometry from the `COLA_MARKETS` table.)

```
DECLARE
  wkbgeom BLOB;
  wktgeom CLOB;
  val_result VARCHAR2(5);
  geom_result SDO_GEOMETRY;
  geom SDO_GEOMETRY;
BEGIN
  SELECT c.shape INTO geom FROM cola_markets c WHERE c.name = 'cola_b';

  -- To WBT/WKT geometry
  wkbgeom := SDO_UTIL.TO_WKBGEOMETRY(geom);
  wktgeom := SDO_UTIL.TO_WKTGEOMETRY(geom);
  DBMS_OUTPUT.PUT_LINE('To WKT geometry result = ' || TO_CHAR(wktgeom));

  -- From WBT/WKT geometry
  geom_result := SDO_UTIL.FROM_WKBGEOMETRY(wkbgeom);
  geom_result := SDO_UTIL.FROM_WKTGEOMETRY(wktgeom);

  -- Validate WBT/WKT geometry
  val_result := SDO_UTIL.VALIDATE_WKBGEOMETRY(wkbgeom);
  DBMS_OUTPUT.PUT_LINE('WKB validation result = ' || val_result);
  val_result := SDO_UTIL.VALIDATE_WKTGEOMETRY(wktgeom);
  DBMS_OUTPUT.PUT_LINE('WKT validation result = ' || val_result);

END;

To WKT geometry result = POLYGON ((5.0 1.0, 8.0 1.0, 8.0 6.0, 5.0 7.0, 5.0 1.0))
WKB validation result = TRUE
WKT validation result = TRUE
```

## Related Topics

- [SDO\\_UTIL.FROM\\_WKBGEOMETRY](#) (page 31-33)
- [SDO\\_UTIL.FROM\\_WKTGEOMETRY](#) (page 31-34)

- [SDO\\_UTIL.TO\\_WKBGEOMETRY](#) (page 31-68)
- [SDO\\_UTIL.TO\\_WKTGEOMETRY](#) (page 31-69)
- [SDO\\_UTIL.VALIDATE\\_WKTGEOMETRY](#) (page 31-76)

## 31.45 SDO\_UTIL.VALIDATE\_WKTGEOMETRY

### Format

```
SDO_UTIL.VALIDATE_WKTGEOMETRY(  
    geometry IN CLOB  
    ) RETURN VARCHAR2;
```

or

```
SDO_UTIL.VALIDATE_WKTGEOMETRY(  
    geometry IN VARCHAR2  
    ) RETURN VARCHAR2;
```

### Description

Validates the input geometry, which is of type CLOB or VARCHAR2 and in the standard well-known text (WKT) format; returns the string TRUE if the geometry is valid or FALSE if the geometry is not valid.

### Parameters

#### **geometry**

Geometry in WKT format to be checked for validity.

### Usage Notes

To be valid, the input geometry must be in the well-known text (WKT) format, as defined by the Open Geospatial Consortium and the International Organization for Standardization (ISO).

This function is patterned after the SQL Multimedia recommendations in *ISO 13249-3, Information technology - Database languages - SQL Multimedia and Application Packages - Part 3: Spatial*.

To validate a geometry in the well-known binary (WKB) format, use the [SDO\\_UTIL.VALIDATE\\_WKBGEOMETRY](#) (page 31-74) function.

### Examples

The following example shows conversion to and from WKB and WKT format, and validation of WKB and WKT geometries. (The example uses the definitions and data from [Simple Example: Inserting, Indexing, and Querying Spatial Data](#) (page 2-1), specifically the `cola_b` geometry from the `COLA_MARKETS` table.)

```
DECLARE  
    wkbgeom BLOB;  
    wktgeom CLOB;  
    val_result VARCHAR2(5);  
    geom_result SDO_GEOMETRY;  
    geom SDO_GEOMETRY;  
BEGIN  
    SELECT c.shape INTO geom FROM cola_markets c WHERE c.name = 'cola_b';
```

```
-- To WBT/WKT geometry
wkbgeom := SDO_UTIL.TO_WKBGEOMETRY(geom);
wktgeom := SDO_UTIL.TO_WKTGEOMETRY(geom);
DBMS_OUTPUT.PUT_LINE('To WKT geometry result = ' || TO_CHAR(wktgeom));

-- From WBT/WKT geometry
geom_result := SDO_UTIL.FROM_WKBGEOMETRY(wkbgeom);
geom_result := SDO_UTIL.FROM_WKTGEOMETRY(wktgeom);

-- Validate WBT/WKT geometry
val_result := SDO_UTIL.VALIDATE_WKBGEOMETRY(wkbgeom);
DBMS_OUTPUT.PUT_LINE('WKB validation result = ' || val_result);
val_result := SDO_UTIL.VALIDATE_WKTGEOMETRY(wktgeom);
DBMS_OUTPUT.PUT_LINE('WKT validation result = ' || val_result);

END;/

To WKT geometry result = POLYGON ((5.0 1.0, 8.0 1.0, 8.0 6.0, 5.0 7.0, 5.0 1.0))
WKB validation result = TRUE
WKT validation result = TRUE
```

### Related Topics

- [SDO\\_UTIL.FROM\\_WKBGEOMETRY](#) (page 31-33)
- [SDO\\_UTIL.FROM\\_WKTGEOMETRY](#) (page 31-34)
- [SDO\\_UTIL.TO\\_WKBGEOMETRY](#) (page 31-68)
- [SDO\\_UTIL.TO\\_WKTGEOMETRY](#) (page 31-69)
- [SDO\\_UTIL.VALIDATE\\_WKBGEOMETRY](#) (page 31-74)





---

## SDO\_WFS\_LOCK Package (WFS)

The MDSYS.SDO\_WFS\_LOCK package contains subprograms for WFS support for registering and unregistering feature tables. Registering a feature table enables the table for WFS transaction locking; unregistering a feature table disables the table for WFS transaction locking.

To use the subprograms in this chapter, you must understand the conceptual and usage information about Web Feature Services (WFS) in [Web Feature Service \(WFS\) Support](#) (page 15-1).

[Table 32-1](#) (page 32-1) lists the WFS support subprograms.

**Table 32-1 Subprograms for WFS Support**

Subprogram	Description
<a href="#">SDO_WFS_LOCK.RegisterFeatureTable</a> (page 32-2)	Registers a feature table; that is, enables the feature table for WFS transaction locking.
<a href="#">SDO_WFS_LOCK.UnRegisterFeatureTable</a> (page 32-3)	Unregisters a feature table; that is, disables the feature table for WFS transaction locking.

The rest of this chapter provides reference information on the subprograms, listed in alphabetical order.

### 32.1 SDO\_WFS\_LOCK.EnableDBTxns

#### Format

```
SDO_WFS_LOCK.EnableDBTxns();
```

#### Description

Enables database transactions on WFS tables.

#### Parameters

None.

#### Usage Notes

This procedure overrides, through the end of the session, the WFS-T standard restriction against database transactions on WFS tables, so that any transaction with the current session ID can perform update and delete operations on WFS tables. Oracle Database triggers still check the WFS locks before the current transaction is allowed to modify a row; and so if a WFS transaction has a lock on a row, the triggers will not

allow the operation to be performed. However, if there is no WFS lock on the current row, the triggers will allow the current transaction to modify the row.

You must call this procedure to perform certain operations when using Oracle Workspace Manager to version-enable a WFS table, as explained in [Using WFS with Oracle Workspace Manager](#) (page 15-24). However, you can also use this procedure even if you do not use Workspace Manager with WFS tables.

For information about support for Web Feature Services, see [Web Feature Service \(WFS\) Support](#) (page 15-1).

### Examples

The following example enables database transactions on WFS tables for the remainder of the current session.

```
BEGIN
    SDO_WFS_LOCK.enableDBTxns;
END;
/
```

## 32.2 SDO\_WFS\_LOCK.RegisterFeatureTable

### Format

```
SDO_WFS_LOCK.RegisterFeatureTable(
    username IN VARCHAR2,
    tablename IN VARCHAR2);
```

### Description

Registers a feature table; that is, enables the feature table for WFS transaction locking.

### Parameters

#### username

Name of the database user that owns the feature table to be registered.

#### tablename

Name of the feature table to be registered.

### Usage Notes

This procedure ensures that the necessary constraints for implementing WFS transaction semantics are associated with the feature table.

For information about support for Web Feature Services, see [Web Feature Service \(WFS\) Support](#) (page 15-1).

To unregister a table that has not been version-enabled, use the [SDO\\_WFS\\_LOCK.UnRegisterFeatureTable](#) (page 32-3) procedure.

### Examples

The following example registers the feature table named COLA\_MARKETS\_CS, which is owned by user WFS\_REL\_USER.

```
BEGIN
    SDO_WFS_LOCK.registerFeatureTable('wfs_rel_user', 'cola_markets_cs');
```

```
END;  
/
```

## 32.3 SDO\_WFS\_LOCK.UnRegisterFeatureTable

### Format

```
SDO_WFS_LOCK.UnRegisterFeatureTable(  
    username IN VARCHAR2,  
    tablename IN VARCHAR2);
```

### Description

Unregisters a feature table; that is, disables the feature table for WFS transaction locking.

### Parameters

#### username

Name of the database user that owns the feature table to be unregistered.

#### tablename

Name of the feature table to be unregistered.

### Usage Notes

This procedure disables, for the feature table, the constraints for implementing WFS transaction semantics.

The feature table must have been previously registered in a call to the [SDO\\_WFS\\_LOCK.RegisterFeatureTable](#) (page 32-2) procedure.

For information about support for Web Feature Services, see [Web Feature Service \(WFS\) Support](#) (page 15-1).

### Examples

The following example unregisters the feature table named COLA\_MARKETS\_CS, which is owned by user WFS\_REL\_USER.

```
BEGIN  
    SDO_WFS_LOCK.unRegisterFeatureTable('wfs_rel_user', 'cola_markets_cs');  
END;  
/
```



## SDO\_WFS\_PROCESS Package (WFS Processing)

The MDSYS.SDO\_WFS\_PROCESS package contains subprograms for various processing operations related to support for Web Feature Services.

To use the subprograms in this chapter, you must understand the conceptual and usage information about Web Feature Services in [Web Feature Service \(WFS\) Support](#) (page 15-1).

[Table 33-1](#) (page 33-1) lists the WFS processing subprograms.

**Table 33-1 Subprograms for WFS Processing Operations**

Subprogram	Description
<a href="#">SDO_WFS_PROCESS.DropFeatureType</a> (page 33-2)	Deletes a specified feature type.
<a href="#">SDO_WFS_PROCESS.DropFeatureTypes</a> (page 33-3)	Deletes all feature types in a specified namespace.
<a href="#">SDO_WFS_PROCESS.GenCollectionProcs</a> (page 33-3)	Generates helper procedures for relational feature types that have collection-based columns (for example, VARRAYs or nested tables).
<a href="#">SDO_WFS_PROCESS.GetFeatureTypeId</a> (page 33-4)	Gets the feature type ID of a specified feature type.
<a href="#">SDO_WFS_PROCESS.GrantFeatureTypeToUser</a> (page 33-4)	Grants access to a feature type to a database user.
<a href="#">SDO_WFS_PROCESS.GrantMDAccessToUser</a> (page 33-5)	Grants access to WFS metadata tables to a database user.
<a href="#">SDO_WFS_PROCESS.InsertCapabilitiesInfo</a> (page 33-6)	Inserts the capabilities template information.
<a href="#">SDO_WFS_PROCESS.InsertFtDataUpdated</a> (page 33-6)	Inserts a notification that the data for one or more feature instances was updated in the database.
<a href="#">SDO_WFS_PROCESS.InsertFtMDUpdated</a> (page 33-7)	Inserts a notification that the metadata for a feature type was updated in the database.
<a href="#">SDO_WFS_PROCESS.PopulateFeatureTypeXMLInfo</a> (page 33-8)	Populates metadata for relational feature types that have XMLType columns.
<a href="#">SDO_WFS_PROCESS.PublishFeatureType</a> (page 33-9)	Publishes a feature type; that is, registers metadata related to the feature type.

**Table 33-1 (Cont.) Subprograms for WFS Processing Operations**

Subprogram	Description
<a href="#">SDO_WFS_PROCESS.RegisterMTableView</a> (page 33-14)	Enables the publishing of content from a multitable view as a feature instance.
<a href="#">SDO_WFS_PROCESS.RevokeFeatureTypeFromUser</a> (page 33-16)	Revokes access to a feature type from a database user.
<a href="#">SDO_WFS_PROCESS.RevokeMDAccessFromUser</a> (page 33-17)	Revokes access to WFS metadata tables from a database user.
<a href="#">SDO_WFS_PROCESS.UnRegisterMTableView</a> (page 33-17)	Disables the publishing of content from a multitable view as a feature instance.

The rest of this chapter provides reference information on the subprograms, listed in alphabetical order.

## 33.1 SDO\_WFS\_PROCESS.DropFeatureType

### Format

```
SDO_WFS_PROCESS.DropFeatureType(  
    ftnsUrl IN VARCHAR2,  
    ftName  IN VARCHAR2);
```

### Description

Deletes a specified feature type.

### Parameters

#### ftnsUrl

Uniform resource locator (URL) of the namespace for the feature type.

#### ftName

Name of the feature type.

### Usage Notes

If you want to drop a feature type whose content comes from a multitable view, you must call the [SDO\\_WFS\\_PROCESS.UnRegisterMTableView](#) (page 33-17) procedure before you call the SDO\_WFS\_PROCESS.DropFeatureType procedure.

If you want to drop all feature types in the namespace, you can use the [SDO\\_WFS\\_PROCESS.DropFeatureTypes](#) (page 33-3) procedure.

For information about support for Web Feature Services, see [Web Feature Service \(WFS\) Support](#) (page 15-1).

### Examples

The following example deletes the feature type named COLA in a specified namespace.

```
BEGIN  
    SDO_WFS_PROCESS.dropFeatureType('http://www.example.com/myns', 'COLA');
```

```
END;
/
```

## 33.2 SDO\_WFS\_PROCESS.DropFeatureTypes

### Format

```
SDO_WFS_PROCESS.DropFeatureTypes(
    ftnsUrl IN VARCHAR2);
```

### Description

Deletes all feature types in a specified namespace.

### Parameters

#### ftnsUrl

Uniform resource locator (URL) of the namespace.

### Usage Notes

To drop a single feature type in a namespace, use the [SDO\\_WFS\\_PROCESS.DropFeatureType](#) (page 33-2) procedure.

For information about support for Web Feature Services, see [Web Feature Service \(WFS\) Support](#) (page 15-1).

### Examples

The following example deletes all feature types in a specified namespace.

```
BEGIN
    SDO_WFS_PROCESS.dropFeatureTypes('http://www.example.com/myns');
END;
/
```

## 33.3 SDO\_WFS\_PROCESS.GenCollectionProcs

### Format

```
SDO_WFS_PROCESS.GenCollectionProcs();
```

### Description

Generates helper procedures for relational feature types that have collection-based columns (for example, VARRAYs or nested tables).

### Parameters

None.

### Usage Notes

Use this procedure if any feature tables have features that are defined in collection-based columns (for example, VARRAYs or nested tables).

For information about support for Web Feature Services, see [Web Feature Service \(WFS\) Support](#) (page 15-1).

### Examples

The following example generates helper procedures for relational feature types that have collection-based columns.

```
BEGIN
  SDO_WFS_PROCESS.GenCollectionProcs;
END;
/
```

## 33.4 SDO\_WFS\_PROCESS.GetFeatureTypeId

### Format

```
SDO_WFS_PROCESS.GetFeatureTypeId(
  ftnsUrl IN VARCHAR2,
  ftName  IN VARCHAR2) RETURN NUMBER;
```

### Description

Gets the feature type ID of a specified feature type.

### Parameters

#### ftnsUrl

Uniform resource locator (URL) of the namespace for the feature type.

#### ftName

Name of the feature type.

### Usage Notes

For information about support for Web Feature Services, see [Web Feature Service \(WFS\) Support](#) (page 15-1).

### Examples

The following example gets the feature type ID of a feature type named COLA.

```
DECLARE
  ftid number;
BEGIN
  ftId := SDO_WFS_PROCESS.GetFeatureTypeId('http://www.example.com/myns', 'COLA');
END;
/
```

## 33.5 SDO\_WFS\_PROCESS.GrantFeatureTypeToUser

### Format

```
SDO_WFS_PROCESS.GrantFeatureTypeToUser(
  ftnsUrl IN VARCHAR2,
  ftName  IN VARCHAR2,
  userName IN VARCHAR2);
```



**Description**

Grants access to a feature type to a database user.

**Parameters****ftnsUrl**

Uniform resource locator (URL) of the namespace for the feature type.

**ftName**

Name of the feature type.

**userName**

Name of the database user.

**Usage Notes**

To revoke access to a feature type from a database user, use the [SDO\\_WFS\\_PROCESS.RevokeFeatureTypeFromUser](#) (page 33-16) procedure.

For information about support for Web Feature Services, see [Web Feature Service \(WFS\) Support](#) (page 15-1).

**Examples**

The following example grants access to the COLA feature type to user SMITH.

```
BEGIN
  SDO_WFS_PROCESS.GrantFeatureTypeToUser('http://www.example.com/myns', 'COLA',
    'SMITH');
END;
/
```

## 33.6 SDO\_WFS\_PROCESS.GrantMDAccessToUser

**Format**

```
SDO_WFS_PROCESS.GrantMDAccessToUser(
  userName IN VARCHAR2);
```

**Description**

Grants access to Web Feature Service metadata tables to a database user.

**Parameters****userName**

Name of the database user.

**Usage Notes**

To call this procedure, you should be connected to the database as a user with the DBA role.

To revoke access to Web Feature Service metadata tables from a database user, use the [SDO\\_WFS\\_PROCESS.RevokeMDAccessFromUser](#) (page 33-17) procedure.

For information about support for Web Feature Services, see [Web Feature Service \(WFS\) Support](#) (page 15-1).

### Examples

The following example grants access to Web Feature Service metadata tables to the database user named WFS\_REL\_USER.

```
BEGIN
  SDO_WFS_PROCESS.GrantMDAccessToUser('WFS_REL_USER');
END;
/
```

## 33.7 SDO\_WFS\_PROCESS.InsertCapabilitiesInfo

### Format

```
SDO_WFS_PROCESS.InsertCapabilitiesInfo(
  capabilitiesInfo IN XMLTYPE);
```

### Description

Inserts the capabilities template information.

### Parameters

#### capabilitiesInfo

XML document for the capabilities template, which is used at runtime to generate capabilities documents.

### Usage Notes

At runtime, the capabilities document is dynamically generated by binding feature type information from the WFS metadata with the capabilities template. For information about capabilities documents, see [Capabilities Documents](#) (page 15-3).

For information about support for Web Feature Services, see [Web Feature Service \(WFS\) Support](#) (page 15-1).

### Examples

The following example inserts the capabilities template information.

```
BEGIN
  SDO_WFS_PROCESS.insertCapabilitiesInfo(
    xmltype(bfilename('WFSUSERDIR', 'capabilitiesTemplate.xml'),
      nls_charset_id('AL32UTF8')));
END
/
```

## 33.8 SDO\_WFS\_PROCESS.InsertFtDataUpdated

### Format

```
SDO_WFS_PROCESS.InsertFtDataUpdated(
  ns          IN VARCHAR2,
  name        IN VARCHAR2,
```

```
updatedRowList IN ROWPOINTERLIST,
updateTs      IN TIMESTAMP);
```

### Description

Inserts a notification that the data for one or more feature instances was updated in the database.

### Parameters

#### ns

Namespace of the feature type.

#### name

Name of the feature type.

#### updatedRowList

Rowids of feature instances that have been updated.

#### updateTS

Date and time when the data was updated.

### Usage Notes

This procedure is used for WFS cache data synchronization.

For information about support for Web Feature Services, see [Web Feature Service \(WFS\) Support](#) (page 15-1).

### Examples

The following example inserts a notification that the data for the feature instances associated with specific rowids in the COLA\_MARKETS\_CS table was updated in the database.

```
. . .
begin
updatedRowIdList:= . . . -- list of rowIds of the
--           WFS_REL_USER.COLA_MARKETS_CS table
--           that have been updated.
. . .
SDO_WFS_PROCESS.InsertFtDataUpdated(
    'http://www.example.com/myns', 'COLA', updatedRowIdList, sysdate);
. . .
end;
/
```

## 33.9 SDO\_WFS\_PROCESS.InsertFtMDUpdated

### Format

```
SDO_WFS_PROCESS.InsertFtMDUpdated(
    ns      IN VARCHAR2,
    name    IN VARCHAR2,
    updateTs IN TIMESTAMP);
```

**Description**

Inserts a notification that the metadata for a feature type was updated in the database.

**Parameters****ns**

Namespace of the feature type.

**name**

Name of the feature type.

**updateTS**

Date and time when the metadata was updated.

**Usage Notes**

This procedure is used for WFS cache metadata synchronization.

For information about support for Web Feature Services, see [Web Feature Service \(WFS\) Support](#) (page 15-1).

**Examples**

The following example inserts a notification that the metadata for the COLA feature type was updated in the database.

```
begin
SDO_WFS_PROCESS.InsertFtMDUpdated(
    'http://www.example.com/myns', 'COLA', sysdate);
end;
/
```

## 33.10 SDO\_WFS\_PROCESS.PopulateFeatureTypeXMLInfo

**Format**

```
SDO_WFS_PROCESS.PopulateFeatureTypeXMLInfo(
    xmlColTypeXsd IN XMLTYPE,
    fTypeId        IN NUMBER,
    columnName     IN VARCHAR2,
    objPathInfo    IN MDSYS.STRINGLIST);
```

**Description**

Populates metadata for a relational feature type that has an XMLType column.

**Parameters****xmlColTypeXsd**

Schema definition of the relational feature type that has an XMLType column.

**fTypeId**

ID of the relational feature type that has an XMLType column.

**columnName**

Name of the XMLType column in the feature table

**objPathInfo**

Path information. The MDSYS.STRINGLIST type is defined as  
 VARRAY(1000000) OF VARCHAR2(4000).

**Usage Notes**

For information about support for Web Feature Services, see [Web Feature Service \(WFS\) Support](#) (page 15-1).

**Examples**

The following example populates the metadata for the relational feature type described by the XML schema definition in `ROADS.xsd` and stored in an XMLType column named `DATA COL`

```
BEGIN
  SDO_WFS_PROCESS.populateFeatureTypeXMLInfo(
    xmltype(bfilename('WFSUSERDIR', 'ROADS.xsd'), nls_charset_id('AL32UTF8')),
    1,
    'DATA COL',
    mdsys.StringList('METADATA'));
END;
/
```

## 33.11 SDO\_WFS\_PROCESS.PublishFeatureType

**Format**

```
SDO_WFS_PROCESS.PublishFeatureType(
  dataSrc          IN VARCHAR2,
  ftNsUrl          IN VARCHAR2,
  ftName           IN VARCHAR2,
  ftNsAlias        IN VARCHAR2,
  featureDesc      IN XMLTYPE,
  schemaLocation   IN VARCHAR2,
  pkeyCol          IN VARCHAR2,
  columnInfo       IN MDSYS.STRINGLIST,
  pSpatialCol      IN VARCHAR2,
  featureMemberNs  IN VARCHAR2,
  featureMemberName IN VARCHAR2,
  srsNs            IN VARCHAR2,
  srsNsAlias       IN VARCHAR2,
  mandatoryColumnInfo IN MDSYS.STRINGLIST);
```

or

```
SDO_WFS_PROCESS.PublishFeatureType(
  dataSrc          IN VARCHAR2,
  ftNsUrl          IN VARCHAR2,
  ftName           IN VARCHAR2,
  ftNsAlias        IN VARCHAR2,
  featureDesc      IN XMLTYPE,
  schemaLocation   IN VARCHAR2,
  pkeyCol          IN VARCHAR2,
  columnInfo       IN MDSYS.STRINGLIST,
  pSpatialCol      IN VARCHAR2,
  featureMemberNs  IN VARCHAR2,
  featureMemberName IN VARCHAR2,
  srsNs            IN VARCHAR2,
```

```
srsNsAlias          IN VARCHAR2,  
viewTableName       IN VARCHAR2,  
viewTablepkeyCol    IN VARCHAR2,  
mandatoryColumnInfo IN MDSYS.STRINGLIST);
```

or

```
SDO_WFS_PROCESS.PublishFeatureType(  
  dataSrc          IN VARCHAR2,  
  ftNsUrl          IN VARCHAR2,  
  ftName           IN VARCHAR2,  
  ftNsAlias        IN VARCHAR2,  
  featureDesc      IN XMLTYPE,  
  schemaLocation   IN VARCHAR2,  
  pkeyCol          IN VARCHAR2,  
  columnInfo       IN MDSYS.STRINGLIST,  
  pSpatialCol      IN VARCHAR2,  
  featureMemberNs  IN VARCHAR2,  
  featureMemberName IN VARCHAR2,  
  srsNs            IN VARCHAR2,  
  srsNsAlias       IN VARCHAR2,  
  featureCollectionNs IN VARCHAR2,  
  featureCollectionName IN VARCHAR2,  
  isGML3           IN VARCHAR2,  
  formattedKeyCols IN MDSYS.STRINGLIST,  
  viewTableName    IN VARCHAR2,  
  viewTablepkeyCol IN VARCHAR2,  
  viewTableFmtKeyCols IN VARCHAR2,  
  mandatoryColumnInfo IN MDSYS.STRINGLIST);
```

## Description

Publishes a feature type; that is, registers metadata related to the feature type.

## Parameters

### dataSrc

Name of the feature table or view containing the spatial features. It must be in the format *schema-name.table-name* or *schema-name.view-name*; that is, the name of the database user that owns the table must be included.

### ftNsUrl

Uniform resource locator (URL) of the namespace for the feature type.

### ftName

Name of the feature type.

### ftNsAlias

Alias of the namespace for the feature type.

### featureDesc

Feature type description to be reported in the capabilities document, as a document of type XMLTYPE.

### schemaLocation

String to be used to populate the `xsi:schemaLocation` attribute in the feature type XSD. If this parameter is null, a string is automatically generated.

**pkeyCol**

Primary key column in the feature table or view identified in `dataSrc`. If a feature type table or view has a multicolumn primary key, use a semicolon to separate the columns in the primary key. For example: `'COL1;COL2'`

**columnInfo**

Type string associated with each spatial column (SDO\_GEOMETRY type) in the feature table identified in `dataSrc`, as an object of type `MDSYS.STRINGLIST` (for example, for WFS 1.1.0, `MDSYS.STRINGLIST('PolygonPropertyType','PointPropertyType')`).

See the Usage Notes for information about any spatial columns specified in the `columnInfo` parameter.

**pSpatialCol**

Spatial column of type SDO\_GEOMETRY in the feature table.

**featureMemberNs**

Namespace of the feature member element that will contain feature instances in a feature collection. If this parameter is null, the default is: `http://www.opengis.net/gml`

**featureMemberName**

Name of the feature member element that will contain feature instances in a feature collection. If this parameter is null, the default is `featureMember`.

**srsNs**

User-defined namespace of the spatial reference system (coordinate system) associated with the spatial data for the feature type. This namespace (if specified) is also used to generate the `srsName` attribute in the `<boundedBy>` element of the FeatureCollection result generated for the GetFeature request.

**srsNsAlias**

Namespace alias of the namespace of the spatial reference system (coordinate system) associated with the spatial data for the feature type.

**featureCollectionNs**

Namespace of the WFS feature collection within which this feature type instances can occur.

**featureCollectionName**

Name of the WFS feature collection within which this feature type instances can occur.

**isGML3**

A string value: Y means that the geometries inside instances of this feature type are GML 3.1.1 compliant; N means that the geometries inside instances of this feature type are GML 2.1.2 compliant.

**formattedKeyCols**

String formatted representation of the content of the primary key column or (for a multicolumn primary key) columns. For example, if `ROAD_ID` is the primary key column of type `NUMBER`, specify `MDSYS.STRINGLIST('to_char(ROAD_ID)')`. To specify multiple strings in the `MDSYS.STRINGLIST` type constructor, separate each with a comma. The list of string formatted primary key columns should be

specified in the same order as the primary key columns specified in the `pkeyCol` parameter.

**viewTableName**

Name of the underlying table if the feature type will be defined on a view based on a single underlying table. The published feature type will be based on the view, specified in the `dataSrc` parameter (*user-name.view-name*). Do not enter a value for the `viewTableName` parameter if the feature type is based on a table or on a multitable view.

**viewTablepkeyCol**

Primary key column of the table specified in the `viewTableName` parameter, if the feature type will be defined on a view based on a single underlying table.

**viewTableFmtKeyCols**

If the feature type is based on a view defined on a single table, and if the view has one or more formatted primary key columns, this parameter represents a list of string formatted primary key columns in the underlying table that correspond to the string formatted primary key columns in the view (specified by `formattedkeyCols` parameter). For example, if `ROAD_ID` is the primary key column of type `NUMBER`, specify `MDSYS.STRINGLIST('to_char(ROAD_ID)')`. To specify multiple strings in the `MDSYS.STRINGLIST` type constructor, separate each with a comma.

If feature type is not based on a single table view, or if the feature type is based on a single table view but the feature type does not have formatted primary key columns, this parameter should be null.

**mandatoryColumnInfo**

List of columns that must be returned in the `GetFeature` request, irrespective of the columns requested. (The requested columns will be returned in all cases.) If this parameter is omitted, all columns are mandatory (that is, all columns will be returned). However, if this parameter is specified as `NULL`, no columns are mandatory (that is, only the requested columns will be returned). To specify column names, use the `MDSYS.STRINGLIST` type constructor as in the following example: `MDSYS.STRINGLIST('COL1', 'COL2', 'COL5')`

**Usage Notes**

In the `columnInfo` parameter, each column of type `SDO_GEOMETRY` in the feature type instances table must have the correct associated string value specified in the `columnInfo` parameter, with the string values in the same order as the order of the spatial columns in the table definition.

For WFS 1.0.*n*, for example, if the single `SDO_GEOMETRY` column named `SHAPE` in the feature type instances table contains polygon geometries, the `columnInfo` value must be `SHAPE_GEOMETRYTYPE>PolygonMemberType`. [Table 33-2](#) (page 33-12) lists the geometry types and their required associated `columnInfo` parameter values for WFS version 1.0.*n*. (Replace *<column-name>* with the name of the column.)

**Table 33-2    Geometry Types and columnInfo Parameter Values (WFS 1.0.n)**

Geometry Type	columnInfo Parameter Value
Polygon or Surface	<i>&lt;column-name&gt;</i> _GEOMETRYTYPE>PolygonMemberType
Multipolygon or Multisurface	<i>&lt;column-name&gt;</i> _GEOMETRYTYPE>MultiPolygonMemberType



**Table 33-2 (Cont.) Geometry Types and columnInfo Parameter Values (WFS 1.0.n)**

Geometry Type	columnInfo Parameter Value
Point	<column-name>_GEOMETRYTYPE>PointMemberType
Multipoint	<column-name>_GEOMETRYTYPE>MultiPointMemberType
Line or Curve	<column-name>_GEOMETRYTYPE>CurveMemberType
Multiline or multicurve	<column-name>_GEOMETRYTYPE>MultiCurveMemberType
Solid	<column-name>_GEOMETRYTYPE>SolidMemberType
Multisolid	<column-name>_GEOMETRYTYPE>MultiSolidMemberType
Collection	<column-name>_GEOMETRYTYPE>GeometryMemberType

For WFS 1.1.*n*, for example, if the single SDO\_GEOMETRY column in the feature type instances table contains polygon geometries, the columnInfo value must be PolygonPropertyType. [Table 33-3](#) (page 33-13) lists the geometry types and their required associated columnInfo parameter values for WFS version 1.1.*n*.

**Table 33-3 Geometry Types and columnInfo Parameter Values (WFS 1.1.n)**

Geometry Type	columnInfo Parameter Value
Polygon or Surface	PolygonPropertyType
Multipolygon or Multisurface	MultiPolygonPropertyType
Point	PointPropertyType
Multipoint	MultiPointPropertyType
Line or Curve	CurvePropertyType
Multiline or multicurve	MultiCurvePropertyType
Solid	SolidPropertyType
Multisolid	MultiSolidPropertyType
Collection	GeometryPropertyType

For information about support for Web Feature Services, see [Web Feature Service \(WFS\) Support](#) (page 15-1).

### Examples

The following example registers metadata for a feature type named COLA with the polygon geometries stored in the column named SHAPE. (It assumes the use of WFS 1.1.*n*.)

```
DECLARE
columnInfo MDSYS.StringList := MDSYS.StringList('PolygonPropertyType');
```

```
BEGIN
SDO_WFS_PROCESS.publishFeatureType(
  'WFS_USER.COLA_MARKETS_VIEW',
  'http://www.example.com/myns',
  'COLA',
  'myns',
  xmltype(bfilename('WFSUSERDIR', 'featuredesct.xml'), nls_charset_id('AL32UTF8')),
  null, 'MKT_ID', columnInfo, 'SHAPE', null, null, null, null);
END;
/
```

## 33.12 SDO\_WFS\_PROCESS.RegisterMTableView

### Format

```
SDO_WFS_PROCESS.RegisterMTableView(
  ftNsUrl           IN VARCHAR2,
  ftName            IN VARCHAR2,
  viewTableList     IN MDSYS.STRINGLIST,
  viewTablePkeyColList IN MDSYS.STRINGLIST,
  tablePkeyColList  IN MDSYS.STRINGLIST);
```

or

```
SDO_WFS_PROCESS.RegisterMTableView(
  ftNsUrl           IN VARCHAR2,
  ftName            IN VARCHAR2,
  viewTableList     IN MDSYS.STRINGLIST,
  viewTablePkeyColList IN MDSYS.STRINGLIST,
  formattedViewTableColList IN MDSYS.STRINGLISTLIST,
  tablePkeyColList  IN MDSYS.STRINGLIST);
```

### Description

Enables the publishing of content from a multitable view as a feature instance.

### Parameters

#### ftNsUrl

Uniform resource locator (URL) of the namespace for the feature type.

#### ftName

Name of the feature type.

#### viewTableList

List of tables in the view. To specify table names, use the MDSYS.STRINGLIST type constructor as in the following example: MDSYS.STRINGLIST('MYUSER.ROADS', 'MYUSER.ROADS\_DESC')

#### viewTablePkeyColList

List of view columns that correspond to the primary key columns in the tables in the view, in the order that corresponds to the order of the tables in viewTableList. To specify column names, use the MDSYS.STRINGLIST type constructor as in the following example: MDSYS.STRINGLIST('ROAD\_ID', 'ROAD\_ID'), where both the ROADS and ROAD\_DESC table have ROAD\_ID as primary key.

If the view has columns that correspond to table columns in a multicolumn primary key, use a semicolon to separate the columns in the primary key. For example:

```
'COL1;COL2'
```

#### **formattedViewTableColList**

A list of string formatted table primary key columns that correspond to the string formatted primary key columns in the view, in the order that corresponds to the order of the tables in `viewTableList`. To specify column names, use the `MDSYS.STRINGLISTLIST` type constructor as in the following example:

```
MDSYS.STRINGLISTLIST(MDSYS.STRINGLIST('to_char(ROAD_ID)'),  
MDSYS.STRINGLIST('to_char(ROAD_ID)'))
```

The list of string formatted primary key columns for each table should be specified in the same order as the primary key columns for each table specified in `tablePkeyColList` parameter.

#### **tablePkeyColList**

List of the primary key columns in the tables, in the order that corresponds to the order of the tables in `viewTableList`. For each table the primary key columns should be specified in the order that correspond to the key columns in the view as specified in `viewTablePkeyColList` parameter. To specify column names, use the `MDSYS.STRINGLIST` type constructor as in the following example:

```
MDSYS.STRINGLIST('ROAD_ID', 'ROAD_ID')
```

If a table has a multicolumn primary key, use a semicolon to separate the columns in the primary key. For example: `'COL1;COL2'`

### **Usage Notes**

If you need to publish content from a multitable view as a feature instance, you must call this procedure after calling the [SDO\\_WFS\\_PROCESS.PublishFeatureType](#) (page 33-9) procedure.

To disable the publishing of content from a multitable view as a feature instance, use the [SDO\\_WFS\\_PROCESS.UnRegisterMTableView](#) (page 33-17) procedure.

For information about support for Web Feature Services, see [Web Feature Service \(WFS\) Support](#) (page 15-1).

### **Examples**

The following example creates two feature tables, creates a view based on these tables, publishes a feature type, and registers the multitable view to enable the publishing of content from the view.

```
CREATE TABLE cola_markets_cs (  
  mkt_id NUMBER PRIMARY KEY,  
  name VARCHAR2(32),  
  shape MDSYS.SDO_GEOMETRY);  
  
CREATE TABLE cola_markets_cs_details (  
  mkt_id NUMBER PRIMARY KEY,  
  description VARCHAR2(400));  
  
create view cola_markets_view as select t1.mkt_id, t1.name, t1.shape,  
  t2.description from  
  cola_markets_cs t1, cola_markets_cs_details t2  
  where t1.mkt_id = t2.mkt_id;  
  
DECLARE
```

```
cm MDSYS.StringList := MDSYS.StringList('PolygonMemberType');
BEGIN
SDO_WFS_PROCESS.publishFeatureType(
  'WFS_USER.COLA_MARKETS_VIEW',
  'http://www.example.com/myns',
  'COLA',
  'myns',
  xmltype(bfilename('WFSUSERDIR', 'featuredesct.xml'), nls_charset_id('AL32UTF8')),
  null, 'MKT_ID', cm, 'SHAPE', null, null, null, null);
END;
/

BEGIN
SDO_WFS_PROCESS.registerMTableView('http://www.example.com/myns',
  'COLA', mdsys.StringList('WFS_USER.COLA_MARKETS_CS',
  'WFS_USER.COLA_MARKETS_CS_DETAILS'),
  mdsys.StringList('MKT_ID', 'MKT_ID'), -- view keys per table
  mdsys.StringList('MKT_ID', 'MKT_ID'));-- corresponding table keys
END;
/
```

## 33.13 SDO\_WFS\_PROCESS.RevokeFeatureTypeFromUser

### Format

```
SDO_WFS_PROCESS.RevokeFeatureTypeFromUser(
  ftnsUrl  IN VARCHAR2,
  ftName   IN VARCHAR2,
  userName IN VARCHAR2);
```

### Description

Revokes access to a feature type from a database user.

### Parameters

#### ftnsUrl

Uniform resource locator (URL) of the namespace for the feature type.

#### ftName

Name of the feature type.

#### userName

Name of the database user.

### Usage Notes

To grant access to a feature type to a database user, use the [SDO\\_WFS\\_PROCESS.GrantFeatureTypeToUser](#) (page 33-4) procedure.

For information about support for Web Feature Services, see [Web Feature Service \(WFS\) Support](#) (page 15-1).

### Examples

The following example revokes access to the COLA feature type from user SMITH.

```
BEGIN
  SDO_WFS_PROCESS.RevokeFeatureTypeFromUser('http://www.example.com/myns', 'COLA',
```

```

        'SMITH' );
END;
/

```

## 33.14 SDO\_WFS\_PROCESS.RevokeMDAccessFromUser

### Format

```

SDO_WFS_PROCESS.RevokeMDAccessFromUser(
    userName IN VARCHAR2);

```

### Description

Revokes access to Web Feature Service metadata tables from a database user.

### Parameters

#### userName

Name of the database user.

### Usage Notes

To call this procedure, you should be connected to the database as a user with the DBA role.

To grant access to Web Feature Service metadata tables to a database user, use the [SDO\\_WFS\\_PROCESS.GrantMDAccessToUser](#) (page 33-5) procedure.

For information about support for Web Feature Services, see [Web Feature Service \(WFS\) Support](#) (page 15-1).

### Examples

The following example revokes access to Web Feature Service metadata tables from the database user named WFS\_REL\_USER.

```

BEGIN
    SDO_WFS_PROCESS.RevokeMDAccessToUser('WFS_REL_USER');
END;
/

```

## 33.15 SDO\_WFS\_PROCESS.UnRegisterMTableView

### Format

```

SDO_WFS_PROCESS.UnRegisterMTableView(
    ftNsUrl IN VARCHAR2,
    ftName IN VARCHAR2);

```

### Description

Disables the publishing of content from a multitable view as a feature instance.

### Parameters

#### ftNsUrl

Uniform resource locator (URL) of the namespace for the feature type.

**ftName**

Name of the feature type.

**Usage Notes**

The [SDO\\_WFS\\_PROCESS.RegisterMTableView](#) (page 33-14) procedure must have been called previously to enable the publishing of content from the multitable view as a feature instance.

If you want to drop a feature type whose content comes from a multitable view, you must call this procedure before you call the [SDO\\_WFS\\_PROCESS.DropFeatureType](#) (page 33-2) procedure.

For information about support for Web Feature Services, see [Web Feature Service \(WFS\) Support](#) (page 15-1).

**Examples**

The following example unregisters a multitable view to disable the publishing of content from the view.

```
DECLARE
BEGIN
    SDO_WFS_PROCESS.unRegisterMTableView('http://www.example.com/myns', 'COLA');
END;
/
```

# Part IV

---

## Supplementary Information

This document has the following parts:

- [Conceptual and Usage Information](#) (page 1) provides conceptual and usage information about Oracle Spatial and Graph.
- [Spatial Web Services](#) (page 1) provides conceptual and usage information about Oracle Spatial and Graph web services.
- [Reference Information](#) (page 1) provides reference information about Oracle Spatial and Graph operators, functions, and procedures.
- Part IV provides supplementary information (appendixes and a glossary).

Part IV contains the following:

- [Installation\\_ Migration\\_ Compatibility\\_ and Upgrade](#) (page A-1)
- [Oracle Locator](#) (page B-1)
- [Complex Spatial Queries: Examples](#) (page C-1)
- [Loading ESRI Shapefiles into Spatial and Graph](#) (page D-1)
- [Glossary](#) (page 1)





---

# Installation, Migration, Compatibility, and Upgrade

If you are upgrading to the current Oracle Database release, Oracle Spatial and Graph is automatically upgraded as part of the operation. For information about the upgrade procedure, see *Oracle Database Upgrade Guide*.

If you need to downgrade Spatial and Graph to the previous Oracle Database release, follow the instructions for downgrading a database back to the previous Oracle Database release in *Oracle Database Upgrade Guide*.

If you need to migrate spatial data from one database to another, see [Migrating Spatial Data from One Database to Another](#) (page A-1).

If you use Oracle Spatial and Graph GeoRaster, see [Ensuring That GeoRaster Works Properly After an Installation or Upgrade](#) (page A-1).

If you are using Spatial and Graph Web Feature Service (WFS) or Catalog Services for the Web (CSW) support, and if you have data from a previous release that was indexed using one or more SYS.XMLTABLEINDEX indexes, see [Index Maintenance Before and After an Upgrade \(WFS and CSW\)](#) (page A-2).

If you need to support geometries with more than 1,048,576 ordinates, see [Increasing the Size of Ordinate Arrays to Support Very Large Geometries](#) (page A-3).

## A.1 Migrating Spatial Data from One Database to Another

Migrating spatial data refers to moving or copying Oracle Spatial and Graph geometry objects from one Oracle database to another. (The databases can have the same or different Oracle Database release numbers.)

If you are migrating spatial data using database links, export/import, Oracle Data Pump, or transportable tablespaces, the MDSYS schema must already exist in the destination database.

In limited situations you might also need to use the [SDO\\_MIGRATE.TO\\_CURRENT](#) (page 25-1) subprogram (described in [SDO\\_MIGRATE Package \(Upgrading\)](#) (page 25-1)). See the Usage Notes for that subprogram.

## A.2 Ensuring That GeoRaster Works Properly After an Installation or Upgrade

To use the GeoRaster feature of Oracle Spatial and Graph, you must enable it and ensure that Oracle XML DB Repository is properly installed, as explained in these topics:

- [Enabling GeoRaster](#) (page A-2)
- [Ensuring Oracle XML DB Repository is Installed](#) (page A-2)

## A.2.1 Enabling GeoRaster

By default the GeoRaster feature is disabled after the Oracle Spatial and Graph is initially installed. To enable GeoRaster, follow these steps:

1. Connect to the database as SYS AS SYSDBA.
2. Enter the following statement:

```
EXECUTE MDSYS.enableGeoRaster;
```

After GeoRaster is enabled, if you later upgrade the database, you do *not* need to re-enable GeoRaster.

## A.2.2 Ensuring Oracle XML DB Repository is Installed

For more information, see the installation and upgrade notes near the start of Chapter 1 in *Oracle Spatial and Graph GeoRaster Developer's Guide*.

To use the GeoRaster feature of Oracle Spatial and Graph, Oracle XML DB Repository must be installed properly. (In general, you should ensure that Oracle XML DB Repository is installed before you install Oracle Spatial and Graph.)

If Oracle Spatial and Graph has been installed (such as during an upgrade) but Oracle XML DB Repository is not installed, you need to install the Oracle XML DB Repository and reload related GeoRaster PL/SQL packages. In this case, follow these steps

1. Install Oracle XML DB Repository.  
For information about installing and uninstalling Oracle XML DB Repository, see *Oracle XML DB Developer's Guide*.
2. Go to the `$ORACLE_HOME/md/admin` directory.
3. Connect to the database as SYS AS SYSDBA.
4. Enter the following SQL statements:

```
ALTER SESSION SET CURRENT_SCHEMA=MDSYS;  
@prvtgrs.plb  
@sdogrxml.sql
```

## A.3 Index Maintenance Before and After an Upgrade (WFS and CSW)

Effective with Release 11.2, the SYS.XMLTABLEINDEX index type is deprecated, and therefore the Spatial WFS and CSW `createXMLTableIndex` methods create indexes of type XDB.XMLINDEX instead of type SYS.XMLTABLEINDEX as in previous releases. However, if you have data from a previous release that was indexed using one or more SYS.XMLTABLEINDEX indexes, you must drop the associated indexes before the upgrade and re-create the indexes after the upgrade, as follows:

1. Using Oracle Database Release 11.1, call the `dropXMLTableIndex` method (in `oracle.spatial.csw.CSWAdmin` or `oracle.spatial.wfs.WFSAdmin`, as appropriate depending on the application) to drop associated indexes.
2. Upgrade the database from Release 11.1 to Release 11.2.
3. Using Oracle Database Release 11.2, call the `createXMLTableIndex` (in `oracle.spatial.csw.CSWAdmin` or `oracle.spatial.wfs.WFSAdmin`, as

appropriate depending on the application) to create indexes that were dropped in step 1.

For information about Spatial and Graph Web Feature Service (WFS) support, see [Web Feature Service \(WFS\) Support](#) (page 15-1), and especially the following:

- `createXMLTableIndex` method ([createXMLTableIndex method](#) (page 15-13))
- `dropXMLTableIndex` method ([dropXMLTableIndex method](#) (page 15-13))
- `getIsXMLTableIndexCreated` method ([getIsXMLTableIndexCreated method](#) (page 15-14))
- `genXMLIndex` and `idxPaths` parameters of the `publishFeatureType` method ([publishFeatureType method](#) (page 15-14))
- `setXMLTableIndexInfo` method ([setXMLTableIndexInfo method](#) (page 15-23))

For information about Spatial and Graph Catalog Services for the Web (CSW) support, see [Catalog Services for the Web \(CSW\) Support](#) (page 16-1), and especially the following:

- `createXMLTableIndex` method ([createXMLTableIndex method](#) (page 16-15))
- `dropXMLTableIndex` method ([dropXMLTableIndex method](#) (page 16-16))
- `getIsXMLTableIndexCreated` method ([getIsXMLTableIndexCreated method](#) (page 16-16))
- `genXMLIndex` and `idxPaths` parameters of the `publishRecordType` method ([publishRecordType method](#) (page 16-18))
- `setXMLTableIndexInfo` method ([setXMLTableIndexInfo method](#) (page 16-27))

## A.4 Increasing the Size of Ordinate Arrays to Support Very Large Geometries

If you need to support geometries with more than 1,048,576 ordinates, you must follow the instructions in this section. However, doing so involves significant extra work (running a script, migrating existing spatial data), some database downtime, and some considerations and restrictions. Therefore, you should not perform the actions in this section unless you need to.

To increase the size of ordinate arrays to support geometries with up to 10M ordinates, follow these steps:

1. Ensure that no users are using any spatial tables or Oracle Spatial and Graph or Locator features.
2. Connect to the database as the SYS user with SYSDBA privileges (SYS AS SYSDBA, and enter the SYS account password when prompted).
3. Enter the following statement:
  - Linux: `@$ORACLE_HOME/md/admin/sdoupgeom.sql`
  - Windows: `@%ORACLE_HOME%\md\admin\sdoupgeom.sql`

One of the actions of the `sdoupgeom.sql` script is to automatically migrate all spatial data to accommodate the new `SDO_ORDINATE_ARRAY` definition. This

script may take a long time to complete, and the amount of time will depend on the amount of spatial data that exists in the database.

After you perform these steps, the following considerations and restrictions apply:

- Any existing transportable tablespaces that were created with the old SDO\_ORDINATE\_ARRAY definition will not work.
- If an export file was created using the Original Export utility on a database with the old SDO\_ORDINATE\_ARRAY definition, and if that file needs to be imported into a database that is using the new SDO\_ORDINATE\_ARRAY definition, you must specify the TOID\_NOVALIDATE flag with the Original Import utility, as in the following example:

```
imp scott/<password> file=states.dmp tables=states  
TOID_NOVALIDATE=MDSYS.SDO_GEOMETRY,MDSYS.SDO_ORDINATE_ARRAY,MDSYS.SDO_ELEM_INFO_AR  
RAY
```

- If you plan to use Oracle Data Pump to import data after `sdoupgeom.sql` has been executed on a source database, you must also run `sdoupgeom.sql` on the target (destination) database after the import operation.

---

## Oracle Locator

Oracle Locator (also referred to as Locator) is a feature of Oracle Database Standard Edition. Locator provides core features and services available in Oracle Spatial and Graph. It provides significant capabilities typically required to support Internet and wireless service-based applications and partner-based GIS solutions. Locator is not designed to be a solution for geographic information system (GIS) applications requiring complex spatial data management. If you need capabilities such as linear referencing, advanced spatial functions, or Spatial and Graph web services, use Oracle Spatial and Graph instead of Locator.

Like Spatial and Graph, Locator is not designed to be an end-user application, but is a set of spatial capabilities for application developers.

Locator is available with the Standard Edition One, Standard Edition, and Enterprise Edition of Oracle Database, and with Oracle Database XE (Express Edition). Spatial and Graph is a priced option available only with Oracle Database Enterprise Edition. Spatial and Graph includes all Locator features as well as other features that are not available with Locator.

If you want to ensure that you are using only features available in Locator, see [Installing and Deinstalling Locator or Spatial and Graph Manually](#) (page B-5). For licensing information about Spatial and Graph and Locator, see *Oracle Database Licensing Information*.

The installation of Locator depends on the successful and proper installation of Oracle Multimedia. Oracle Multimedia is installed and configured with Oracle Database, although you can install Oracle Multimedia manually if necessary, as documented in *Oracle Multimedia User's Guide*. During the installation of Oracle Multimedia, Locator is installed.

In general, Locator includes the data types, operators, and indexing capabilities of Oracle Spatial and Graph, along with a limited set of the subprograms (functions and procedures) of Spatial and Graph. The Locator features include the following:

- An object type (SDO\_GEOMETRY) that describes and supports any type of geometry
- A spatial indexing capability that lets you create spatial indexes on geometry data
- Spatial operators (described in [Spatial Operators](#) (page 18-1)) that use the spatial index for performing spatial queries
- Geometry subprograms (SDO\_GEOM package, described in [SDO\\_GEOM Package \(Geometry\)](#) (page 23-1))
- Spatial aggregate functions (described in [Spatial Aggregate Functions](#) (page 19-1))

- Coordinate system support for geometry and layer transformations (SDO\_CS package, described in [SDO\\_CS Package \(Coordinate System Transformation\)](#) (page 20-1))
- Tuning subprograms (SDO\_TUNE package, described in [SDO\\_TUNE Package \(Tuning\)](#) (page 30-1))
- Spatial utility functions (SDO\_UTIL package, described in [SDO\\_UTIL Package \(Utility\)](#) (page 31-1))
- Classes in the `oracle.spatial.geometry` (`sdoapi.jar`) and `oracle.spatial.util` (`sdoutil.jar`) packages of the Spatial and Graph Java API (described in *Oracle Spatial and Graph Java API Reference*)

For information about spatial concepts, the SDO\_GEOMETRY object type, support for SQL Multimedia types annotation text, and indexing and loading of spatial data, see Chapters 1 through 5 in this guide. For reference and usage information about features supported by Locator, see the chapter or section listed in [Table B-1](#) (page B-2).

**Table B-1 Features Included with Locator**

Feature	Described in
Spatial operators, including <a href="#">SDO_JOIN</a> (page 18-12) but <i>not</i> including <a href="#">SDO_POINTINPOLYGON</a> (page 18-28). ( <a href="#">SDO_JOIN</a> (page 18-12) and <a href="#">SDO_POINTINPOLYGON</a> (page 18-28) are technically table functions, but they are documented with the operators.)	<a href="#">Spatial Operators</a> (page 18-1)
SDO_GEOM package subprograms	<a href="#">SDO_GEOM Package (Geometry)</a> (page 23-1)
Spatial aggregate functions	<a href="#">Spatial Aggregate Functions</a> (page 19-1)
Coordinate system transformation subprograms (SDO_CS package)	<a href="#">SDO_CS Package (Coordinate System Transformation)</a> (page 20-1)
Implicit coordinate system transformations for operator calls where a window needs to be converted to the coordinate system of the queried layer	<a href="#">Spatial Operators</a> (page 18-1)
Function-based spatial indexing	<a href="#">SDO_GEOMETRY Objects in Function-Based Indexes</a> (page 9-3)
Table partitioning support for spatial indexes (including splitting, merging, and exchanging partitions and their indexes)	<a href="#">Using Partitioned Spatial Indexes</a> (page 5-3) and <a href="#">Exchanging Partitions Including Indexes</a> (page 5-6)
Geodetic data support	<a href="#">Geodetic Coordinate Support</a> (page 6-2) and <a href="#">Legacy Tables and Views</a> (page 6-47)
SQL statements for creating, altering, and deleting indexes	<a href="#">SQL Statements for Indexing Spatial Data</a> (page 17-1)

**Table B-1 (Cont.) Features Included with Locator**

Feature	Described in
Parallel spatial index builds (PARALLEL keyword with <a href="#">ALTER INDEX REBUILD</a> (page 17-3) and <a href="#">CREATE INDEX</a> (page 17-7) statements) (new with release 9.2)	<a href="#">SQL Statements for Indexing Spatial Data</a> (page 17-1)
SDO_GEOMETRY object type methods	<a href="#">SDO_GEOMETRY Methods</a> (page 2-12)
SQL Multimedia spatial types (ST_xxx types)	<a href="#">SQL Multimedia Type Support</a> (page 3-1)
SQL Multimedia functions (ST_xxx functions) whose Oracle Spatial and Graph counterparts are supported for Locator	<a href="#">ST_xxx Functions and Spatial and Graph Counterparts</a> (page 3-7)
Annotation text	<a href="#">Annotation Text Type and Views</a> (page 3-8)
Package (SDO_MIGRATE) to upgrade data from previous Spatial and Graph releases to the current release	<a href="#">SDO_MIGRATE Package (Upgrading)</a> (page 25-1)
Tuning subprograms (SDO_TUNE package)	<a href="#">SDO_TUNE Package (Tuning)</a> (page 30-1)
Spatial utility functions (SDO_UTIL package)	<a href="#">SDO_UTIL Package (Utility)</a> (page 31-1)
Classes in the oracle.spatial.geometry (sdoapi.jar) and oracle.spatial.util (sdoutil.jar) packages of the Spatial and Graph Java API	<i>Oracle Spatial and Graph Java API Reference</i>
Object replication	<i>Oracle Database Advanced Replication</i>

[Table B-2](#) (page B-3) lists Spatial and Graph features that are *not* supported for Locator, with the chapter in this guide or the separate manual that describes the feature.

**Table B-2 Features Not Included with Locator**

Feature	Described in
Linear referencing system (LRS) support (SDO_LRS package)	<a href="#">Linear Referencing System</a> (page 7-1) (concepts and usage) and <a href="#">SDO_LRS Package (Linear Referencing System)</a> (page 24-1) (reference)
Three-dimensional geometry support: the use of 3D spatial indexing, 3D operators, and subprograms on 3D data is not supported for Locator.	<a href="#">Three-Dimensional Spatial Objects</a> (page 1-16) (3D concepts and usage)
Spatial analysis and mining subprograms (SDO_SAM package)	<a href="#">SDO_SAM Package (Spatial Analysis and Mining)</a> (page 28-1)

---

**Table B-2 (Cont.) Features Not Included with Locator**

Feature	Described in
OpenLS support, including support for geocoding, mapping, business directory (Yellow Pages), and driving directions (routing) services	<a href="#">OpenLS Support</a> (page 14-1) and <a href="#">SDO_OLS Package (OpenLS)</a> (page 26-1). See also: <ul style="list-style-type: none"><li>• <a href="#">Geocoding Address Data</a> (page 11-1) and <a href="#">SDO_GCDR Package (Geocoding)</a> (page 22-1)</li><li>• <a href="#">Business Directory (Yellow Pages) Support</a> (page 12-1)</li><li>• <a href="#">Routing Engine</a> (page 13-1)</li></ul>
Web feature service (WFS) support (SDO_WFS_PROCESS and SDO_WFS_LOCK packages)	<a href="#">Web Feature Service (WFS) Support</a> (page 15-1) (concepts and usage), and <a href="#">SDO_WFS_PROCESS Package (WFS Processing)</a> (page 33-1) and <a href="#">SDO_WFS_LOCK Package (WFS)</a> (page 32-1) (reference)
Catalog services for the Web (CSW) support (SDO_CSW_PROCESS package)	<a href="#">Catalog Services for the Web (CSW) Support</a> (page 16-1) (concepts and usage) and <a href="#">SDO_CSW_PROCESS Package (CSW Processing)</a> (page 21-1) (reference)
Triangulated irregular network (TIN) and point cloud (PC) data types and related subprograms	<a href="#">Three-Dimensional Spatial Objects</a> (page 1-16) (concepts and usage), and <a href="#">SDO_TIN_PKG Package (TINs)</a> (page 29-1) (SDO_TIN_PKG reference) and <a href="#">SDO_PC_PKG Package (Point Clouds)</a> (page 27-1) (SDO_PC_PKG reference)
<a href="#">SDO_POINTINPOLYGON</a> (page 18-28) (technically a table function but documented with the operators)	<a href="#">Spatial Operators</a> (page 18-1)
GeoRaster support	<i>Oracle Spatial and Graph GeoRaster Developer's Guide</i>
Topology data model	<i>Oracle Spatial and Graph Topology Data Model and Network Data Model Graph Developer's Guide</i>
Network data model	<i>Oracle Spatial and Graph Topology Data Model and Network Data Model Graph Developer's Guide</i>
Classes in packages <i>other than</i> the <code>oracle.spatial.geometry</code> ( <code>sdoapi.jar</code> ) and <code>oracle.spatial.util</code> ( <code>sdoutil.jar</code> ) packages of the Spatial and Graph Java API	<i>Oracle Spatial and Graph Java API Reference</i>

Although Locator is available on both the Standard and Enterprise Editions of Oracle Database, some Locator features require database features that are not available or are limited on the Standard Edition. Some of those Locator features and their availability are listed in [Table B-3](#) (page B-5).



**Table B-3 Feature Availability with Standard or Enterprise Edition**

Feature	Standard/Enterprise Edition Availability
Parallel spatial index builds	Supported with Enterprise Edition only.
Multimaster replication of SDO_GEOMETRY objects	Supported with Enterprise Edition only. (Single master/materialized view replication for SDO_GEOMETRY objects is supported with both Standard Edition and Enterprise Edition. See <i>Oracle Database Advanced Replication</i> for more information.)
Partitioned spatial indexes	Requires the Partitioning Option with Enterprise Edition. Not supported with Standard Edition.

## B.1 Installing and Deinstalling Locator or Spatial and Graph Manually

To install Spatial and Graph or to use any features that are specific to Spatial and Graph but not Locator, you must meet the licensing requirements for Spatial and Graph. For licensing information about Spatial and Graph and Locator, see *Oracle Database Licensing Information*.

---

### Note:

If you install and configure Oracle Multimedia with Oracle Database, then Oracle Locator is also installed.

---

Scripts are available to perform certain installation and deinstallation operations relating to Locator and Spatial and Graph:

- `mddins.sql` manually deinstalls Spatial and Graph and leaves only Locator, thus "installing" only Locator. This ensures that you can use only features available in Locator and no features that are available only with Spatial and Graph.
- `mdinst.sql` manually installs Spatial and Graph, so that you are able to use all features available with Spatial and Graph and Locator.

If you want to ensure that you are using only Locator features, but Spatial and Graph is already installed, run the `mddins.sql` script, as follows:

1. Ensure that Oracle Multimedia is installed.
2. Connect to the database as the SYS user with SYSDBA privileges (SYS AS SYSDBA, and enter the SYS account password when prompted).
3. Start SQL\*Plus, and enter the following statement:
  - Linux: `@$ORACLE_HOME/md/admin/mddins.sql`
  - Windows: `@%ORACLE_HOME%\md\admin\mddins.sql`

If you need to be able to use Spatial and Graph, you can run the `mdinst.sql` script, as follows:

1. Connect to the database as the SYS user with SYSDBA privileges (SYS AS SYSDBA, and enter the SYS account password when prompted).

2. Start SQL\*Plus, and enter the following statement:

- Linux: @\$ORACLE\_HOME/md/admin/mdinst.sql
- Windows: @%ORACLE\_HOME%\md\admin\mdinst.sql

## Complex Spatial Queries: Examples

This appendix provides examples, with explanations, of queries that are more complex than the examples in the reference chapters in [Reference Information](#) (page 1). This appendix focuses on operators that are frequently used in Spatial and Graph applications, such as [SDO\\_WITHIN\\_DISTANCE](#) (page 18-36) and [SDO\\_NN](#) (page 18-17).

This appendix is based on input from Oracle personnel who provide support and training to Spatial and Graph users. The Oracle Spatial and Graph training course covers many of these examples, and provides additional examples and explanations.

Before you use any of the examples in this appendix, be sure you understand the usage and reference information for the relevant operator or function in [Conceptual and Usage Information](#) (page 1) and [Reference Information](#) (page 1).

This appendix contains the following major sections:

- [Tables Used in the Examples](#) (page C-1)
- [SDO\\_WITHIN\\_DISTANCE Examples](#) (page C-1)
- [SDO\\_NN Examples](#) (page C-3)

### C.1 Tables Used in the Examples

The examples in this appendix refer to tables named GEOD\_CITIES, GEOD\_COUNTIES, and GEOD\_INTERSTATES, which are defined as follows:

```
CREATE TABLE GEOD_CITIES(
  LOCATION      SDO_GEOMETRY,
  CITY          VARCHAR2(42),
  STATE_ABRV    VARCHAR2(2),
  POP90         NUMBER,
  RANK90        NUMBER);

CREATE TABLE GEOD_COUNTIES(
  COUNTY_NAME   VARCHAR2(40),
  STATE_ABRV    VARCHAR2(2),
  GEOM          SDO_GEOMETRY);

CREATE TABLE GEOD_INTERSTATES(
  HIGHWAY       VARCHAR2(35),
  GEOM          SDO_GEOMETRY);
```

### C.2 SDO\_WITHIN\_DISTANCE Examples

The [SDO\\_WITHIN\\_DISTANCE](#) (page 18-36) operator identifies the set of spatial objects that are within some specified distance of a given object. You can indicate that the distance is approximate or exact. If you specify `querytype=FILTER`, the distance

is approximate because only a primary filter operation is performed; otherwise, the distance is exact because both primary and secondary filtering operations are performed.

**Example C-1 Finding All Cities Within a Distance of a Highway**

[Example C-1](#) (page C-2) finds all cities within 15 miles of the interstate highway I170.

```
SELECT /*+ ORDERED */ c.city
FROM geod_interstates i, geod_cities c
WHERE i.highway = 'I170'
      AND sdo_within_distance (
          c.location, i.geom,
          'distance=15 unit=mile') = 'TRUE';
```

[Example C-1](#) (page C-2) finds all cities within 15 miles ('distance=15 unit=mile') of the specified highway (i.highway = 'I170'), and by default the result is exact (because the querytype parameter was not used to limit the query to a primary filter operation). In the WHERE clause of this example:

- i.highway refers to the HIGHWAY column of the INTERSTATES table, and I170 is a value from the HIGHWAY column.
- c.location specifies the search column (geometry1). This is the LOCATION column of the GEOD\_CITIES table.
- i.geom specifies the query window (aGeom). This is the spatial geometry in the GEOM column of the GEOD\_INTERSTATES table, in the row whose HIGHWAY column contains the value I170.

**Example C-2 Finding All Highways Within a Distance of a City**

[Example C-2](#) (page C-2) finds all interstate highways within 15 miles of the city of Tampa.

```
SELECT /*+ ORDERED */ i.highway
FROM geod_cities c, geod_interstates i
WHERE c.city = 'Tampa'
      AND sdo_within_distance (
          i.geom, c.location,
          'distance=15 unit=mile') = 'TRUE';
```

[Example C-2](#) (page C-2) finds all highways within 15 miles ('distance=15 unit=mile') of the specified city (c.city = 'Tampa'), and by default the result is exact (because the querytype parameter was not used to limit the query to a primary filter operation). In the WHERE clause of this example:

- c.city refers to the CITY column of the GEOD\_CITIES table, and Tampa is a value from the CITY column.
- i.geom specifies the search column (geometry1). This is the GEOM column of the GEOD\_INTERSTATES table.
- c.location specifies the query window (aGeom). This is the spatial geometry in the LOCATION column of the GEOD\_CITIES table, in the row whose CITY column contains the value Tampa.

## C.3 SDO\_NN Examples

The [SDO\\_NN](#) (page 18-17) operator determines the nearest neighbor geometries to a geometry. No assumptions should be made about the order of the returned results, unless you specify the [SDO\\_NN\\_DISTANCE](#) (page 18-21) ancillary operator in the ORDER BY clause to have the results returned in distance order. If you specify no optional parameters, one nearest neighbor geometry is returned.

If you specify the optional `sdo_num_res` keyword, you can request how many nearest neighbors you want, but no other conditions in the WHERE clause are evaluated. For example, assume that you want the five closest banks from an intersection, but only where the bank name is CHASE. If the five closest banks are not named CHASE, [SDO\\_NN](#) (page 18-17) with `sdo_num_res=5` will return no rows because the `sdo_num_res` keyword only takes proximity into account, and not any other conditions in the WHERE clause.

If you specify the optional `sdo_batch_size` keyword, any `sdo_num_res` specification is ignored, and [SDO\\_NN](#) (page 18-17) keeps returning neighbor geometries in distance order to the WHERE clause. If the WHERE clause specifies `bank_name = 'CHASE' AND rownum < 6`, you can return the five closest banks with `bank_name = 'CHASE'`.

[SDO\\_NN\\_DISTANCE](#) (page 18-21) is an ancillary operator to the [SDO\\_NN](#) operator. It returns the distance of an object returned by the [SDO\\_NN](#) (page 18-17) operator and is valid only within a call to the [SDO\\_NN](#) (page 18-17) operator.

See also [Example 5-1](#) (page 5-5) in [Using Partitioned Spatial Indexes](#) (page 5-3).

### **Example C-3 Finding the Cities Nearest to a Highway**

[Example C-3](#) (page C-3) finds the five cities nearest to the interstate highway I170 and the distance in miles from the highway for each city, ordered by distance in miles.

```
SELECT /*+ ORDERED */
      c.city,
      sdo_nn_distance (1) distance_in_miles
FROM   geod_interstates i,
      geod_cities c
WHERE  i.highway = 'I170'
      AND sdo_nn(c.location, i.geom,
                'sdo_num_res=5 unit=mile', 1) = 'TRUE'
ORDER BY distance_in_miles;
```

In [Example C-3](#) (page C-3), because the `/*+ ORDERED*/` optimizer hint is used, it is important to have an index on the `GEOD_INTERSTATES.HIGHWAY` column. In this example, the hint forces the query to locate highway I170 before it tries to find nearest neighbor geometries. In the WHERE clause of this example:

- `i.highway` refers to the `HIGHWAY` column of the `GEOD_INTERSTATES` table, and `I170` is a value from the `HIGHWAY` column.
- `c.location` specifies the search column (`geometry1`). This is the `LOCATION` column of the `GEOD_CITIES` table.
- `i.geom` specifies the query window (`geometry2`). This is the spatial geometry in the `GEOM` column of the `GEOD_INTERSTATES` table, in the row whose `HIGHWAY` column contains the value `I170`.
- `sdo_num_res=5` specifies how many nearest neighbor geometries to find.

- `unit=mile` specifies the unit of measurement to associate with distances returned by the [SDO\\_NN\\_DISTANCE](#) (page 18-21) ancillary operator.
- `1` (in `sdo_nn_distance (1)` and `'sdo_num_res=5 unit=mile', 1`) is the number parameter value that associates the call to [SDO\\_NN](#) (page 18-17) with the call to [SDO\\_NN\\_DISTANCE](#) (page 18-21).

In [Example C-3](#) (page C-3), `ORDER BY distance_in_miles` orders the results from the `WHERE` clause by distance in miles.

The statement in [Example C-3](#) (page C-3) produces the following output (slightly reformatted for readability):

CITY	DISTANCE_IN_MILES
St Louis	5.36297295
Springfield	78.7997464
Peoria	141.478022
Evansville	158.22422
Springfield	188.508631

#### **Example C-4 Finding the Cities Above a Specified Population Nearest to a Highway**

[Example C-4](#) (page C-4) extends [Example C-3](#) (page C-3) by limiting the results to cities with a 1990 population over a certain number. It finds the five cities nearest to the interstate highway I170 that have a population greater than 300,000, the 1990 population for each city, and the distance in miles from the highway for each city, ordered by distance in miles.

```
SELECT /*+ ORDERED NO_INDEX(c pop90_idx) */
       c.city, pop90,
       sdo_nn_distance (1) distance_in_miles
FROM   geod_interstates i,
       geod_cities c
WHERE  i.highway = 'I170'
       AND sdo_nn(c.location, i.geom,
                  'sdo_batch_size=10 unit=mile', 1) = 'TRUE'
       AND c.pop90 > 300000
       AND rownum < 6
ORDER BY distance_in_miles;
```

In [Example C-4](#) (page C-4), because the `ORDERED` optimizer hint is used, it is important to have an index on the `GEOD_INTERSTATES.HIGHWAY` column. In this example, the hint forces the query to locate highway I170 before it tries to find nearest neighbor geometries.

To ensure correct results, disable all nonspatial indexes on columns that come from the same table as the `SDO_NN` search column (`geometry1`). In this example, the `NO_INDEX(c pop90_idx)` optimizer hint disables the nonspatial index on the `POP90` column.

In the `WHERE` clause of this example:

- `sdo_batch_size=10` causes geometries to be returned continually (in distance order, in batches of 10 geometries), to be checked to see if they satisfy the other conditions in the `WHERE` clause.
- `c.pop90 > 300000` restricts the results to rows where the `POP90` column value is greater than 300,000.
- `rownum < 6` limits the number of results returned to five.

In [Example C-4](#) (page C-4), `ORDER BY distance_in_miles` orders the results from the `WHERE` clause by distance in miles.

The statement in [Example C-4](#) (page C-4) produces the following output (slightly reformatted for readability):

CITY	POP90	DISTANCE_IN_MILES
-----	-----	-----
St Louis	396685	5.36297295
Kansas City	435146	227.404883
Indianapolis	741952	234.708666
Memphis	610337	244.202072
Chicago	2783726	253.547961





# Loading ESRI Shapefiles into Spatial and Graph

The Java shapefile converter transforms an ESRI shapefile into an Oracle Database table for use with Oracle Spatial and Graph and Locator. The shapefile converter uses the Oracle Spatial and Graph Java-based shapefile `AdapterShapefileJGeom` and `SampleShapefileToJGeomFeature` classes to load a shapefile directly into a database table, with the Oracle-equivalent `.dbf` data types for the attribute columns and the `SDO_GEOMETRY` data type for the geometry column.

To load a shapefile into the database, use the converter as described in this appendix. (You can also use the `Adapter` class to create your own applications and interfaces that transform shapefiles to `SDO_GEOMETRY` or `JGeometry` data types; however, doing this is beyond the scope of this manual. For information about shapefile-related classes, see *Oracle Spatial and Graph Java API Reference*).

To use the shapefile converter, you must have the following:

- The following Oracle utilities and JDBC libraries: `ojdbc14.jar` or `ojdbc5.jar`, `sdoutl.jar`, and `sdoapi.jar`
- One or more ESRI shapefiles (`.shp`, `.shx`, and `.dbf` files) to be converted

## D.1 Usage of the Shapefile Converter

The following is the syntax for the shapefile converter. (Enter the command all on a single line.)

```
> java -cp [ORACLE_HOME]/jdbc/lib/ojdbc5.jar:[ORACLE_HOME]/md/jlib/sdoutl.jar:
[ORACLE_HOME]/md/jlib/sdoapi.jar oracle.spatial.util.SampleShapefileToJGeomFeature -
h db_host -p db_port -s db_sid|-sn db_service_name -u db_username -d db_password -t
db_table -f shapefile_name [-r srid] [-i table_id_column_name][-n start_id] [-g
db_geometry_column] [-x max_x,min_x] [-y max_y,min_y] [-o tolerance] [-k
keyword_table] [-a append][-c commit_int] [-v println_int]
```

### Parameters

- h: Host machine with an existing Oracle database
- p: Port on the host machine (for example, 1521)
- s: SID (database name) on the host machine
- sn: Service name on the host machine (do not specify -s when using -sn)
- u: Database user
- d: Password for the database user
- t: Table name for the converted shapefile
- f: File name of an input shapefile (with or without extension)

- r: Valid Oracle SRID for coordinate system; use 0 if unknown
- i: Column name for unique numeric ID, if required
- n: Start ID for column specified in -i parameter
- g: Preferred SDO\_GEOMETRY column name
- x: Bounds for the X dimension; use -180,180 if unknown
- y: Bounds for the Y dimension; use -90,90 if unknown
- o: Load tolerance fields (x and y) in metadata; if not specified, tolerance fields are 0.05
- k: Table name that contains Oracle reserved word(s) in a column named KEYWORD
- a: Append shapefile data to an existing table
- c: Commit interval; by default, commits occur every 1000 conversions and at the end
- v: Println interval; by default, a display every 10 conversions

## D.2 Examples of the Shapefile Converter

The following examples show the use of the shapefile converter to transform a file named `shapes.shp` to a table named `shapes` containing an `SDO_GEOMETRY` column named `geom`. The SRID for the Longitude/Latitude (WGS 84) coordinate system is used (8307).

### Linux Example

```
> setenv classpath $ORACLE_HOME/jdbc/lib/ojdbc5.jar:$ORACLE_HOME/md/jlib/sdoutl.jar:
$ORACLE_HOME/md/jlib/sdoapi.jar
> java -cp $classpath oracle.spatial.util.SampleShapefileToJGeomFeature -h gis01 -p
1521 -s orcl -u scott -d <password-for-scott> -t shapes -f shapes.shp -r 8307 -g geom
```

### Windows Example

```
> java -classpath %ORACLE_HOME%\jdbc\lib\ojdbc5.jar;%ORACLE_HOME%\md\jlib\sdoutl.jar;
%ORACLE_HOME%\md\jlib\sdoapi.jar oracle.spatial.util.SampleShapefileToJGeomFeature -
h gis01 -p 1521 -s orcl -u scott -d <password-for-scott> -t shapes -f shapes.shp -r
8307 -g geom
```

---

# Routing Engine Administration

---

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**Note:**

This appendix is for advanced users who need to administer the routing engine. It is not intended for most routing users.

It assumes that you are familiar with the concepts and techniques described in [Routing Engine](#) (page 13-1).

---

The Oracle Spatial and Graph routing engine uses subprograms to handle the administration of the routing data. There are subprograms to partition the road data, to build a Network Data Model (NDM) network using the road data, to generate user data for trucking and turn restrictions, and to dump and validate the routing engine data and user data.

This section includes the following topics:

- [Logging Administration Operations](#) (page E-1)
- [Network Data Model \(NDM\) Network Administration](#) (page E-2)
- [Routing Engine Data](#) (page E-4)
- [User Data](#) (page E-13)
- [Other Functions and Procedures](#) (page E-21)

## E.1 Logging Administration Operations

The routing engine logs all of its administration functions to either a specified log file or to a default log file. All administrative logs are written to the directory described by the Oracle directory object SDO\_ROUTER\_LOG\_DIR.

The SDO\_ROUTER\_LOG\_DIR directory must exist; and both the MDSYS and routing engine schema must have the privileges to read and write to this directory from both PL/SQL and Java.

The following are related to logging administration operations:

- [CREATE\\_SDO\\_ROUTER\\_LOG\\_DIR Procedure](#) (page E-1)
- [VALIDATE\\_SDO\\_ROUTER\\_LOG\\_DIR Procedure](#) (page E-2)

### E.1.1 CREATE\_SDO\_ROUTER\_LOG\_DIR Procedure

Syntax:

```
SDO_ROUTER_PARTITION.CREATE_SDO_ROUTER_LOG_DIR(  
  ROUTER_SCHEMA IN VARCHAR2,  
  NEW_DIR_PATH  IN VARCHAR2 DEFAULT NULL);
```

The `CREATE_SDO_ROUTER_LOG_DIR` procedure must be run from an account that has the Oracle privileges to create directory objects and grant privileges to other database users. Because this procedure grants privileges to the routing engine and MDSYS schemas, it cannot be run from either of these schemas.

The `ROUTER_SCHEMA` parameter must be specified and must be a valid schema containing the routing engine data.

The `NEW_DIR_PATH` parameter is an optional parameter. If the directory path is not specified, a valid `SDO_ROUTER_LOG_DIR` Oracle directory must already exist in the database. If it does not, an exception is raised. If the directory path is specified, a new `SDO_ROUTER_LOG_DIR` Oracle directory is created. If `SDO_ROUTER_LOG_DIR` had already been defined, the new definition replaces the old definition.

After the directory is created, read/write access is granted to the routing engine and MDSYS schemas from both PL/SQL and Java.

In previous versions of the routing engine, users ran the individual steps to create the directory and grant the privileges. This is no longer advised. Use of the `CREATE_SDO_ROUTER_LOG_DIR` procedure is now the recommended way to manage the Oracle directory needed by the routing engine.

## E.1.2 VALIDATE\_SDO\_ROUTER\_LOG\_DIR Procedure

Syntax:

```
SDO_ROUTER_PARTITION.VALIDATE_SDO_ROUTER_LOG_DIR(  
  LOG_FILE_NAME IN VARCHAR2 := 'sdo_router_partition.log');
```

The `VALIDATE_SDO_ROUTER_LOG_DIR` procedure should be run from both the routing engine and MDSYS schema.

The `LOG_FILE_NAME` parameter is the name of the log file to open and attempt to write to. You can specify a name or use the default log file, `sdo_router_partition.log`.

If the log file does not exist, it is created and opened in the `SDO_ROUTER_LOG_DIR` directory. If the log file does exist, it is reopened. The validation procedure attempts to write to the log file from both PL/SQL and Java, and then closes the log file.

If the directory does not exist or if PL/SQL and/or Java fail to write to the log file, an exception is thrown.

## E.2 Network Data Model (NDM) Network Administration

The Oracle Routing Engine requires an Oracle Spatial and Graph network data model (NDM) network, built on the routing engine data, to process route requests and to generate responses.

The following are related to NDM network administration operations:

- [CREATE\\_ROUTER\\_NETWORK Procedure](#) (page E-3)
- [DELETE\\_ROUTER\\_NETWORK Procedure](#) (page E-3)

[Network Creation Example](#) (page E-3) describes the steps for creating a sample NDM network for routing engine use.

## E.2.1 CREATE\_ROUTER\_NETWORK Procedure

Syntax:

```
SDO_ROUTER_PARTITION.CREATE_ROUTER_NETWORK(
  LOG_FILE_NAME IN VARCHAR2 := 'sdo_router_partition.log',
  NETWORK_NAME IN VARCHAR2 := 'ROUTER_NETWORK');
```

The CREATE\_ROUTER\_NETWORK procedure must be run from a routing engine schema that contains routing engine Oracle Data Format (ODF) data.

The LOG\_FILE\_NAME parameter is the name of the log file written during network creation. This log file is created in the SDO\_ROUTER\_LOG\_DIR directory. You can choose to log network creation in its own log file or write to the default partitioning log file, sdo\_router\_partition.log.

The NETWORK\_NAME parameter names the network being created. The name of the network is at the discretion of the user. Oracle recommends including the country code and data version in the name for clarity. For example, for North American data released in the first quarter of 2012 a suitable network name would be ROUTER\_NA\_Q112.

Creating a network using a name of an already existing network simply replaces the old network with the new network. This is not recommended. The old network should be deleted first (using the [DELETE\\_ROUTER\\_NETWORK Procedure](#) (page E-3)), then the new network created.

## E.2.2 DELETE\_ROUTER\_NETWORK Procedure

Syntax:

```
SDO_ROUTER_PARTITION.DELTE_ROUTER_NETWORK(
  LOG_FILE_NAME      IN VARCHAR2 := 'sdo_router_partition.log',
  NETWORK_NAME       IN VARCHAR2 := 'ROUTER_NETWORK',
  LOG_DELETE         IN BOOLEAN DEFAULT TRUE);
```

The DELETE\_ROUTER\_NETWORK procedure must be run from a routing engine schema, and a network matching the network name parameter must exist within the schema.

The LOG\_FILE\_NAME parameter is the name of the log file written during network deletion. This log file is created in the SDO\_ROUTER\_LOG\_DIR directory. You can choose to log network deletion in its own log file or write to the default partitioning log file, sdo\_router\_partition.log.

The NETWORK\_NAME parameter is name of the network being deleted. If a network of this name does not exist, an exception is thrown and an error message is written to the log file.

The LOG\_DELETE parameter controls whether the delete operation is logged to the log file. This parameter is used primarily for debugging.

## E.2.3 Network Creation Example

This section describes the steps for creating a sample NDM network for routing engine use.

1. Validate the routing engine log directory in the routing engine schema. SDO\_ROUTER\_LOG\_DIR must exist and have the correct privileges. Log in to the routing engine schema and execute the following statement:

```
EXECUTE SDO_ROUTER_PARTITION.VALIDATE_ROUTER_LOG_DIR(
    'validate_log.log');
```

When validation completes successfully, the `validate_log.log` file should contain the following messages:

```
[INFO] PLSQL logging OK (ROUTER_SCHEMA)
[INFO] Java logging OK (ROUTER_SCHEMA)
[INFO] PLSQL logging OK (MDSYS)
[INFO] Java logging OK (MDSYS)
```

2. Validate the routing engine log directory in the MDSYS schema. SDO\_ROUTER\_LOG\_DIR must exist and have the correct privileges. Log in to the MDSYS schema and execute the same statement as is step 1.
3. In the routing engine schema, use the following query to find the name of any existing networks:

```
SELECT SUBSTR(view_name, 0, LENGTH(view_name)-7) Network_Name
FROM user_views
WHERE view_name LIKE '%PLOB$';
```

If no results are returned, go to step 5. If a result similar to the following is returned, go to the next step to delete the network before creating a new network.

```
NETWORK_NAME
-----
<any-network-name>
```

4. Use the DELETE\_NETWORK procedure to delete an existing network. For example, if the existing network is named ROUTER\_NA\_Q112:

```
EXECUTE SDO_ROUTER_PARTITION.DELETE_ROUTER_NETWORK(
    'delete_net.log', 'ROUTER_NA_Q112');
```

When deletion completes successfully, the `delete_net.log` file should contain the following message:

```
INFO: deleting the Routeserver network: ROUTER_NA_Q112
```

5. Use the CREATE\_ROUTER\_NETWORK procedure to build a new network. For example:

```
EXECUTE SDO_ROUTER_PARTITION.CREATE_ROUTER_NETWORK(
    'create_net.log', 'ROUTER_NA_112');
```

When the create operation completes successfully, the `create_net.log` file should contain the following messages:

```
INFO: creating the Routeserver network: ROUTER_NA_Q112
INFO: rebuild edge table statistics
      creating views
      generating metadata
```

## E.3 Routing Engine Data

The routing engine uses routing engine data and user data. The routing engine data is stored in the EDGE, NODE, SIGN\_POST, and PARTITION tables.

The routing engine data models a road network as a directed graph of nodes and edges. Partitioning breaks this road network into  $2^N$  subgraphs (local partitions) and one highway partition. The nodes of the road network are partitioned topologically, so each local partition contains the same number of nodes. Each node in the network is in one and only one partition. An edge can be entirely within a partition, an internal edge, or a bridge two partitions (that is, a boundary edge). The partitions are stored in the database as BLOBs, so they can easily be read into and removed from a cache. This allows the routing engine to operate without needing the entire road network to be in memory.

Partitions 1 through N, local partitions, are all roughly the same size. Local partitions are read into the cache as needed when computing a route. These partitions remain in the cache until the cache is full, at which point the least used partitions are swapped out to make room for the partitions needed to compute the current route.

Partition 0 (zero), the highway partition, differs from local partitions in two respects:

- It is not a topological partition of the road network. Instead, it is a subgraph of the road network containing only highway information. Because of this, the highway partition is much larger than a local partition.
- It is read into the cache at routing engine start up and remains resident.

The road network is partitioned in three phases. The first phase partitions the data, computing the number of partitions needed and which partitions contain which nodes and edges. The second phase converts these partitions into BLOBs and writes them to the database. The final phase rebuilds the routing engine network, partitions any user data, and writes the user data BLOBs to the database.

Routing engine data is versioned. During the third phase of partitioning the routing engine version is written to the SDO\_ROUTER\_DATA\_VERSION table and becomes the data version for this data set. If the data set is exported for use in another routing engine schema, this new routing engine's version must be compatible with the data version of the data set.

Routing engine data is provided by data vendors in the Oracle Data Format (ODF) and is already partitioned. Generally, there is no need for a customer to repartition the data. However, there may be cases, such as when performance testing different partition sizes or merging data sets, where you may want to repartition the routing engine data.

---

**Note:**

Repartitioning routing engine data can be a very time and resource intensive operation. Depending on the hardware being used, repartitioning a large data set, such as North America or the European Union, can easily run for a day or more.

---

This section includes the following topics:

- [PARTITION\\_ROUTER Procedure](#) (page E-6)
- [CLEANUP\\_ROUTER Procedure](#) (page E-7)
- [DUMP\\_PARTITIONS Procedure](#) (page E-7)
- [VALIDATE\\_PARTITIONS Procedure](#) (page E-7)

- [GET\\_VERSION Procedure](#) (page E-8)
- [Routing Engine Data Examples](#) (page E-8)

### E.3.1 PARTITION\_ROUTER Procedure

Syntax:

```
SDO_ROUTER_PARTITION.PARTITION_ROUTER(  
    LOG_FILE_NAME IN VARCHAR2 := 'sdo_router_partition.log',  
    MAX_V_NO      IN NUMBER DEFAULT 10000,  
    DRIVING_SIDE  IN VARCHAR2 := 'R',  
    NETWORK_NAME  IN VARCHAR  := 'ROUTER_NETWORK',  
    MAX_MEMORY    IN NUMBER := 1.75,  
    CLEANUP       IN BOOLEAN DEFAULT TRUE,  
    USE_SECUREFILES      IN BOOLEAN DEFAULT TRUE,  
    GENERATE_11G_RESTRICTIONS IN BOOLEAN DEFAULT TRUE);
```

The PARTITION\_ROUTER procedure must be run from a routing engine schema that contains routing engine Oracle Data Format data. This procedure partitions the road network and creates the PARTITION table containing the routing engine data in BLOB format.

The LOG\_FILE\_NAME parameter specifies the name of the log file written during routing engine partitioning. This log file is created in the SDO\_ROUTER\_LOG\_DIR directory. Users can choose a log file name or use the default partitioning log file sdo\_router\_partition.log.

The MAX\_V\_NO parameter specifies the maximum number of nodes allowed in a partition. There must be at least (MAX\_V\_NO+1) nodes in the NODE table.

The DRIVING\_SIDE parameter is a legacy parameter. Its only use was to generate Release 11g turn restrictions. Valid values are R (right side) and L (left side). The NETWORK\_NAME parameter specifies the name of the routing engine network that is created during partitioning.

The MAX\_MEMORY parameter specifies the maximum Java heap size, in gigabytes, available to the partitioning process. The default value of 1.75G is enough for most data sets. This parameter only needs to be adjusted when partitioning data sets that are much smaller or much larger than normal.

The CLEANUP parameter is used for debugging. By default, all of the intermediate tables created during the partitioning of the routing engine data are cleaned up. If there is problem while partitioning, leaving these tables in place (specifying CLEANUP=>FALSE) can provide substantial debugging information.

The USE\_SECUREFILES parameter lets you create the routing engine's BLOBs in either BASICFILE or SECUREFILE format. Oracle recommends using the SECUREFILE format.

The GENERATE\_11G\_RESTRICTIONS parameter controls the generation of Release 11g turn restriction data. In Oracle Database Release 11g, basic turn restrictions were implemented and stored in the PARTITION table. In Oracle Database Release 12c, turn restrictions are expanded and are stored in a user data table, ROUTER\_TURN\_RESTRICTION\_DATA. To allow data providers to ship data partitioned under Release 12c to users still using a Release 11g Route Server, both types of turn restrictions are generated by default. When repartitioning data under Oracle Release 12c, for a Release 12c Route Server, you may set this parameter to FALSE.



### E.3.2 CLEANUP\_ROUTER Procedure

Syntax:

```
SDO_ROUTER_PARTITION.CLEANUP_ROUTER(
    ALL_TABLES IN BOOLEAN DEFAULT TRUE);
```

The CLEANUP\_ROUTER procedure resets the routing engine's state, ensuring that all the tables and indexes are in good order and all intermediate tables are deleted. This is useful if partitioning fails or if partitioning completed successfully with the CLEANUP flag set to FALSE.

The ALL\_TABLES parameter controls what is reset. When set to FALSE, the routing engine is reset to a stable state but leaves the intermediate tables for debugging. This can be useful if partitioning failed. When set to TRUE, the routing engine is reset to a stable state and all intermediate tables used in partitioning are deleted. This can be useful when cleaning up after a successful [PARTITION\\_ROUTER Procedure](#) (page E-6) that was run with the CLEANUP parameter set to FALSE.

### E.3.3 DUMP\_PARTITIONS Procedure

Syntax:

```
DUMP_PARTITIONS(
    LOG_FILE_NAME IN VARCHAR2 := 'sdo_router_partition.log',
    START_PID     IN NUMBER DEFAULT 0,
    END_PID       IN NUMBER DEFAULT -1,
    VERBOSE       IN BOOLEAN DEFAULT FALSE);
```

The DUMP\_PARTITIONS procedure dumps the contents of routing engine data partition BLOBs. This procedure unpacks a BLOB, formats the data, and writes it to a log file. A single running of this procedure can dump a single partition or a contiguous range of partitions. This range is defined from START\_PID to END\_PID, inclusive. The default is to dump all partitions. A non-contiguous range of partitions cannot be dumped in a single call.

The LOG\_FILE\_NAME parameter is the name of the log file written when dumping routing engine partitions. This log file is created in the SDO\_ROUTER\_LOG\_DIR directory. You can choose a log file name or write to the default partitioning log file `sdo_router_partition.log`.

The START\_PID parameter is the ID of the first partition to dump. The default START\_PID is 0. The START\_PID must be less than or equal to END\_PID.

The END\_PID parameter is the ID of the last partition to dump. The default END\_PID is -1, which is converted to the highest partition ID in the data set. If the start and end PID values are equal, a single partition is dumped. If END\_PID is less than START\_PID, an error message is written to the log.

The VERBOSE parameter controls what data is dumped. The default value of FALSE dumps a summary of the partition information, including, the number of node and edges and the size of the BLOB. If this parameter is TRUE, in addition to the summary, all the information describing all the nodes and edges in the partition is dumped.

### E.3.4 VALIDATE\_PARTITIONS Procedure

Syntax:

```
VALIDATE_PARTITIONS(  
    LOG_FILE_NAME IN VARCHAR2 := 'sdo_router_partition.log',  
    START_PID      IN NUMBER DEFAULT 0,  
    END_PID        IN NUMBER DEFAULT -1,  
    VERBOSE        IN BOOLEAN DEFAULT FALSE);
```

The `VALIDATE_PARTITIONS` procedure validates the contents of routing engine data partition BLOBs. Validating all the partitions in a large dataset can take some time to run, but it is the fastest way to read every byte in every partition to ensure that the partitions are ready to be used for routing. Validation only needs to be run if you suspect that there may be a problem with the partitions. If validation is run, Oracle recommends running the initial validation on all partitions with the `VERBOSE` flag set to `FALSE`. If a problem is found, then rerun the validation on the problem partitions with `VERBOSE` set to `true`.

The `LOG_FILE_NAME` parameter is the name of the log file written while validating the routing engine data partitions. This log file is created in the `SDO_ROUTER_LOG_DIR` directory. You can choose a log file name or write to the default partitioning log file `sdo_router_partition.log`.

The `START_PID` parameter is the ID of the first partition to validate. The default `START_PID` is 0. The `START_PID` must be less than or equal to `END_PID`.

The `END_PID` parameter is the ID of the last partition to validate. The default `END_PID` is -1, which is converted to the highest partition ID in the data set. If the start and end PID values are equal, a single partition is validated. If `END_PID` is less than `START_PID`, an error message is written to the log.

The `VERBOSE` parameter controls the level of detail of the validation messages. The default value of `FALSE` simply logs whether a partition passed or failed validation. If this parameter is `TRUE`, the validation of each element in the BLOB is logged.

### E.3.5 GET\_VERSION Procedure

Syntax:

```
GET_VERSION(  
    LOG_FILE_NAME IN VARCHAR2 := 'sdo_router_partition.log');
```

The `GET_VERSION` procedure queries the `SDO_ROUTER_DATA_VERSION` table to get the routing engine data version and writes the result to the log file. (An alternative, you can use SQL to query the `SDO_ROUTER_DATA_VERSION` table.)

The `LOG_FILE_NAME` parameter is the name of the log file where the routing engine data version is written. This log file is created in the `SDO_ROUTER_LOG_DIR` directory. You can choose a log file name or write to the default partitioning log file `sdo_router_partition.log`.

### E.3.6 Routing Engine Data Examples

This section contains examples of the following:

- [Partitioning a Small Data Set](#) (page E-9)
- [Partitioning a Full Data Set](#) (page E-9)
- [Dumping the Contents of a Partition](#) (page E-10)
- [Validating the Contents of a Partition](#) (page E-12)

- [Querying the Routing Engine Data Version](#) (page E-13)

### E.3.6.1 Partitioning a Small Data Set

[Example E-1](#) (page E-9) shows partitioning of a small data set. The data set in this example is the road network data for a radius of 100 miles around the center of San Francisco. This data set contains about 520,000 nodes and 1,200,00 edges. To partition the routing engine data, execute the statement from within the routing engine schema.

#### **Example E-1 Partitioning a Small Data Set**

```
EXECUTE SDO_ROUTER_PARTITION.PARTITION_ROUTER(
    'sdo_router_partition.log', 1000, 'R',
    'ROUTER_SF_NET', .75, FALSE, FALSE, FALSE);

***** Beginning SDO Router partitioning
** Schema: ROUTER_SF_SCHEMA
** Logfile location:/scratch/logs/sdo_router_partition.log
** Nodes per partition: 1000
** Driving side: R
** Router network name: ROUTER_SF_NET
** Max JVM Memory Size: .75GB (805306368 bytes)
** Cleanup temporary files: FALSE
** BLOBs stored in BASICFILE format
** Generating 11g turn restrictions: FALSE
[This header is followed by extensive logging of the partitioning process.]
```

This example produces 1025 partitions, 1 highway partition, and 1024 local partitions. There are, on average, 516 nodes per partition. The driving side is set but is not used because Release 11g turn restrictions were not requested. The Java maximum heap size was set to three quarters of a gigabyte, more than enough to partition such a small data set. The partition BLOBs were written in Basicfile format, and when the partitioning completed the intermediate tables were not cleaned up.

To clean up the intermediate tables left behind by partitioning, enter the following:

```
EXECUTE SDO_ROUTER_PARTITION.CLEANUP_ROUTER()
```

### E.3.6.2 Partitioning a Full Data Set

[Example E-2](#) (page E-9) shows partitioning of a full data set. The data set for this example is the entire North American road network. This data set contains about 30 million nodes and 74 million edges. To partition the routing engine data, execute the statement from within the routing engine schema.

#### **Example E-2 Partitioning a Full Data Set**

```
EXECUTE SDO_ROUTER_PARTITION.PARTITION_ROUTER(
    'sdo_router_partition.log', 32000, 'R', 'ROUTER_NA_NET');

***** Beginning SDO Router partitioning
** Schema: ROUTER_NA_SCHEMA
** Logfile location:/scratch/logs/sdo_router_partition.log
** Nodes per partition: 32000
** Driving side: R
** Router network name: ROUTER_NA_NET
** Max JVM Memory Size: 1.75GB (1879048192 bytes)
** Cleanup temporary files: TRUE
** BLOBs stored in SECUREFILE format
** Generating 11g turn restrictions: TRUE
[This header is followed by extensive logging of the partitioning process.]
```

```
++ Partitioning a data set of this size is time and resource intensive ++
```

This example produces 1025 partitions, 1 highway partition, and 1024 local partitions. There are, on average, 29443 nodes per partition. The driving side is set to 'Right Side' and is used to generate the requested Oracle 11g turn restrictions. The default Java heap size of 1.75 gigabytes is used. All routing engine data and user data BLOBs are stored in SECUREFILE format, and all intermediate tables are cleaned up after the successful partitioning.

### E.3.6.3 Dumping the Contents of a Partition

[Example E-3](#) (page E-10) shows a dump of partitions 0 through 3 with the default VERBOSE value (FALSE) from the San Francisco data set. Note the BLOB size difference between the highway and local partitions. Also note that the highway partition is completely self-contained so there are no outbound edges. Local partitions have outgoing edges that connect them to other local partitions.

#### **Example E-3    Dumping the Contents of a Partition (VERBOSE = FALSE)**

```
EXEC SDO_ROUTER_PARTITION.DUMP_PARTITIONS(
    'dump_part0-3.log', 0, 3);

***** Beginning partition dump
** Logfile location: /scratch/logs/dump_part0-3.log
** Routeserver data version: 12.1.0.2.1
** Start partition id: 0
** End partition id: 3
** Verbose mode: FALSE
[INFO] Starting dump of partition 0
    Number of Nodes: 19392
    Number of Nonboundary Edges: 22706
    Number of Outgoing Boundary Edges: 0
    Number of Incoming Boundary Edges: 0
    Stored Partition ID: 0
    Blob Length: 1748332

[INFO] Starting dump of partition 1
    Number of Nodes: 516
    Number of Nonboundary Edges: 1190
    Number of Outgoing Boundary Edges: 49
    Number of Incoming Boundary Edges: 49
    Stored Partition ID: 1
    Blob Length: 81372

[INFO] Starting dump of partition 2
    Number of Nodes: 516
    Number of Nonboundary Edges: 1099
    Number of Outgoing Boundary Edges: 68
    Number of Incoming Boundary Edges: 68
    Stored Partition ID: 2
    Blob Length: 78388
[INFO] Starting dump of partition 3
    Number of Nodes: 516
    Number of Nonboundary Edges: 1101
    Number of Outgoing Boundary Edges: 60
    Number of Incoming Boundary Edges: 60
    Stored Partition ID: 3
    Blob Length: 77756
```

**Example E-4 Dumping the Contents of a Partition (VERBOSE = TRUE)**

[Example E-4](#) (page E-11) shows a dump of partition 8 with VERBOSE set to TRUE from the San Francisco data set. Note that the outbound edges log the partition ID where they terminate, and the inbound edges log the partition ID where they originate.

```
EXEC SDO_ROUTER_PARTITION.DUMP_PARTITIONS(
  'dump_part8.log', 8, 8, TRUE);

***** Beginning partition dump
** Logfile location:/scratch/logs/dump_part8.log
** Routeserver data version: 12.1.0.2.1
** Start partition id: 8
** End partition id: 8
** Verbose mode: TRUE
[INFO] Starting dump of partition 8
  Number of Nodes: 517
  Number of Non-boundary Edges: 1145
  Number of Outgoing Boundary Edges: 37
  Number of Incoming Boundary Edges: 37
  Stored Partition ID: 8
  Blob Length: 77957

Node information for partition 8:
  Node ID/X/Y/Highway: 84096388/-120.50809/37.98399/false
  In Edges(3): -120862233, -120862227, 120862232
  Out Edges(3): -120862232, 120862227, 120862233
  *****

  Node ID/X/Y/Highway: 84098023/-120.4882/37.99961/true
  In Edges(3): -127829801, -120428259, 776737023
  Out Edges(3): -776737023, 120428259, 127829801
  *****

*** Node information for the other 515 nodes...

Non-boundary Edge information for partition 8:
Internal Edges(1145):
  Edge ID/Start Node ID/End Node ID: 910681077/942981443/206194644
  Length/Speed Limit/Function Class: 130.3/5/5
  *****

  Edge ID/Start Node ID/End Node ID: -105461005/206194651/206194644
  Length/Speed Limit/Function Class: 229.93/11/5
  *****

*** Edge information for the other 1143 internal edges...

Outbound Boundary Edges(37):
  Edge ID/Start Node ID/End Node ID: -724019630/253265936/810705655
  End Node Partition ID/Length: 7/511.07
  Speed Limit/Function Class: 26/2
  *****

  Edge ID/Start Node ID/End Node ID: -105462459/252152310/206193109
  End Node Partition ID/Length: 7/814.68
  Speed Limit/Function Class: 11/5
  *****

*** Edge information for the other 35 outbound boundary edges...

Inbound Boundary Edges(37):
  Edge ID/Start Node ID/End Node ID: 724019630/810705655/253265936
  Start Node Partition ID/Length: 7/511.07
  Speed Limit/Function Class: 26/2
  *****
```

```
Edge ID/Start Node ID/End Node ID: 105462459/206193109/252152310
Start Node Partition ID/Length: 7/814.68
Speed Limit/Function Class: 11/5
*****
*** Edge information for the other 35 inbound boundary edges...
```

### E.3.6.4 Validating the Contents of a Partition

[Example E-5](#) (page E-12) shows validation of the contents of all the partitions in the data set with the default VERBOSE value (FALSE).

#### **Example E-5 Validating the Contents of Partitions (VERBOSE = FALSE)**

```
EXEC SDO_ROUTER_PARTITION.VALIDATE_PARTITIONS(
    'validate_all_partitions.log');

***** Beginning partition validation
** Logfile location: /scratch/logs/validate_all_partitions.log
** Routerserver data version: 12.1.0.2.1
** Start partition id: 0
** End partition id: 1024
** Verbose mode: FALSE
[INFO] Starting validation of partition 0
[INFO] Starting validation of partition 1
[INFO] Starting validation of partition 2
...
[INFO] Starting validation of partition 1022
[INFO] Starting validation of partition 1023
[INFO] Starting validation of partition 1024
[INFO] Partition validation complete
```

#### **Example E-6 Validating the Contents of Partitions (VERBOSE = TRUE)**

[Example E-6](#) (page E-12) shows validation of the contents of partitions 7 and 8 with VERBOSE set to TRUE.

```
EXEC SDO_ROUTER_PARTITION.VALIDATE_PARTITIONS(
    'validate_part7-8.log', 7, 8, TRUE);

***** Beginning partition validation
** Logfile location: /scratch/logs/validate_part7-8.log
** Routerserver data version: 12.1.0.2.1
** Start partition id: 7
** End partition id: 8
** Verbose mode: TRUE
[INFO] Starting validation of partition 7
    Header node count: OK
    Header edge count: OK
    BLOB partition id: OK
    BLOB length: OK
    BLOB node count: OK
    BLOB information for 516 nodes: OK
    BLOB information for 1154 internal edges: OK
    BLOB information for 66 outbound boundary edges: OK
    BLOB information for 65 inbound boundary edges: OK

[INFO] Starting validation of partition 8
    Header node count: OK
    Header edge count: OK
    BLOB partition id: OK
    BLOB length: OK
    BLOB node count: OK
```

```
BLOB information for 517 nodes: OK
BLOB information for 1145 internal edges: OK
BLOB information for 37 outbound boundary edges: OK
BLOB information for 37 inbound boundary edges: OK
```

```
[INFO] Partition validation complete
```

### E.3.6.5 Querying the Routing Engine Data Version

[Example E-7](#) (page E-13) queries the routing engine data version number, writing the result to a log file.

```
SELECT * FROM sdo_router_data_version;
```

#### **Example E-7 Querying the Routing Data Version**

```
EXEC SDO_ROUTER_PARTITION.GET_VERSION('version.log');
```

```
INFO: Routeserver data version: 12.1.0.2.1
```

Alternatively, you could use the following SQL query to get the routing engine data version:

## E.4 User Data

User data models restrictions on the road network. Currently, there are two kinds of user data in the routing engine: restricted driving maneuvers (turn restrictions) and trucking user data.

User data is versioned. When user data is partitioned, the routing engine data version from the SDO\_ROUTER\_DATA\_VERSION table is stored in the user data BLOBs. When user data is brought into the cache, the version stored in the user data partition must be compatible with the version in the SDO\_ROUTER\_DATA\_VERSION table.

Partitioning user data is generally a very fast operation. It can be done as part of the partitioning the routing engine data or, if the routing engine data is already partitioned, as a standalone operation. In both cases the user data partitioning uses the partitioned routing engine data as a guide, substantially speeding up the partitioning operation.

The number of user data partitions is equal to or less than the number of routing engine data partitions. If there is no user data associated with a routing engine data partition, then no user data partition is produced. User data local partitions move into and out of the cache with their associated routing engine data partition. The user data highway partition is loaded at routing engine startup and remains resident in the cache.

In Release 12c the restricted driving maneuver user data is part of the routing engine ODF data shipped by data vendors. Trucking user data is not shipped with the routing engine ODF data and must be purchased separately. When a Release 12c or later routing engine starts, it detects and uses any available user data. All versions of the routing engine before Release 12c do not detect the user data and will only use routing engine data to compute the routes.

This section includes the following topics:

- [Restricted Driving Maneuvers User Data](#) (page E-14)
- [CREATE\\_TURN\\_RESTRICTION\\_DATA Procedure](#) (page E-14)
- [DUMP\\_TURN\\_RESTRICTION\\_DATA Procedure](#) (page E-15)

- [CREATE\\_TRUCKING\\_DATA Procedure](#) (page E-15)
- [DUMP\\_TRUCKING\\_DATA Procedure](#) (page E-16)
- [User Data Examples](#) (page E-16)

### E.4.1 Restricted Driving Maneuvers User Data

A restricted driving maneuver can be as simple as not allowing movement from one edge to another, such as a simple turn restriction that does not allow a left turn. Or it might be a highly complex maneuver involving many edges, such as a no U-turn restriction on a road divided with a median where there is a start edge, an edge over the median, and the edge on the road going the other direction.

The routing engine uses three tables for restricted driving maneuvers. The first two tables, `ROUTER_NAV_STRAND` and `ROUTER_CONDITION` contain the raw data to build the restricted maneuvers user data.

The final table, `ROUTER_TURN_RESTRICTION_DATA`, contains the partitioned restricted maneuver user data stored in BLOB format. Partitioning the restricted maneuver data allows it to move in and out of the cache with the routing engine data of the same partition.

In Release 12c the restricted driving maneuver user data is part of the ODF data shipped by the data vendors. When a Release 12c routing engine starts, it detects and uses the turn restriction user data. If a Release 11g routing engine starts, it will not detect the user data and will only use routing engine data to compute the routes.

Because the restricted driving maneuver user data is part of the ODF data set, it is already partitioned. Generally, there is no reason to repartition this user data. However, if the routing engine data is repartitioned, the user data will also be repartitioned. It is also possible to repartition the turn restriction user data without having to repartition the routing engine data by re-creating the restricted driving maneuver user data.

### E.4.2 CREATE\_TURN\_RESTRICTION\_DATA Procedure

Syntax:

```
SDO_ROUTER_PARTITION.CREATE_TURN_RESTRICTION_DATA(  
    LOG_FILE_NAME IN VARCHAR2 := 'sdo_router_partition.log',  
    CLEANUP        IN BOOLEAN DEFAULT TRUE);
```

The `CREATE_TURN_RESTRICTION_DATA` procedure must be run from a routing engine schema that contains the restricted driving maneuver raw data tables `ROUTER_NAV_STRAND` and `ROUTER_CONDITION`. This procedure partitions the restricted driving maneuver data and creates the `ROUTER_TURN_RESTRICTION_DATA` table containing the turn restriction user data in BLOB format. Turn restriction user data creation requires access to the data version so the `SDO_ROUTER_DATA_VERSION` table must exist in the routing engine schema.

The `LOG_FILE_NAME` parameter is the name of the log file written during turn restriction generation. This log file is created in the `SDO_ROUTER_LOG_DIR` directory. You can choose a log file name or use the default partitioning log file `sdo_router_partition.log`.

The `CLEANUP` parameter is used for debugging. By default, all of the intermediate tables created during turn restriction generation are cleaned up. If there is problem



with turn restriction generation, leaving these tables in place can provide substantial debugging information.

### E.4.3 DUMP\_TURN\_RESTRICTION\_DATA Procedure

Syntax:

```
SDO_ROUTER_PARTITION.DUMP_TURN_RESTRICTION_DATA(
    LOG_FILE_NAME IN VARCHAR2 := 'sdo_router_partition.log',
    START_PID     IN NUMBER DEFAULT 0,
    END_PID       IN NUMBER DEFAULT -1,
    DUMP_SOFT_RESTRICTIONS IN BOOLEAN DEFAULT FALSE);
```

The DUMP\_TURN\_RESTRICTION\_DATA procedure dumps the contents of the turn restriction user data partition BLOBs. This procedure unpacks a BLOB, formats the data, and writes it to a log file. A single call to this procedure can dump a single partition or a contiguous range of partitions. This range is defined from START\_PID to END\_PID, inclusive. The default is to dump all partitions. A non-contiguous range of partitions cannot be dumped in a single call.

The LOG\_FILE\_NAME parameter specifies the name of the log file written when dumping turn restriction user data partitions. This log file is created in the SDO\_ROUTER\_LOG\_DIR directory. You can choose a log file name or write to the default partitioning log file `sdo_router_partition.log`.

The START\_PID parameter is the ID of the first partition to dump. The default START\_PID is 0. The START\_PID must be less than or equal to END\_PID.

The END\_PID parameter is the ID of the last partition to dump. The default END\_PID is -1, which is converted to the highest partition ID in the data set. If the start and end PID values are equal, a single partition is dumped. If END\_PID is less than START\_PID, an error message is written to the log.

The DUMP\_SOFT\_RESTRICTIONS parameter controls how the turn restriction data is dumped. In turn restrictions that have more than two edges, a soft restriction is a series of edges that partially describe the turn restriction. This is a debugging parameter and should generally be left set to its default value, FALSE.

### E.4.4 CREATE\_TRUCKING\_DATA Procedure

Syntax:

```
SDO_ROUTER_PARTITION.CREATE_TRUCKING_DATA(
    LOG_FILE_NAME IN VARCHAR2 := ' sdo_router_partition.log',
    CLEANUP       IN BOOLEAN DEFAULT TRUE);
```

The CREATE\_TRUCKING\_DATA procedure must be run from a routing engine schema that contains the raw trucking data table ROUTER\_TRANSPORT. This procedure partitions the trucking data and creates the ROUTER\_TRUCKING\_DATA table containing the trucking user data in BLOB format. Trucking user data creation requires access to the data version, so the SDO\_ROUTER\_DATA\_VERSION table must exist in the routing engine schema.

The LOG\_FILE\_NAME parameter is the name of the log file written during trucking restriction generation. This log file is created in the SDO\_ROUTER\_LOG\_DIR directory. You can choose a log file name or use the default partitioning log file `sdo_router_partition.log`.

The CLEANUP parameter is used for debugging. By default, all of the intermediate tables created during trucking restriction generation are cleaned up. If there is

problem with trucking restriction generation, leaving these tables in place can provide substantial debugging information.

### E.4.5 DUMP\_TRUCKING\_DATA Procedure

Syntax:

```
SDO_ROUTER_PARTITION.DUMP_TRUCKING_DATA(  
    LOG_FILE_NAME    IN VARCHAR2 := ' sdo_router_partition.log',  
    START_PID        IN NUMBER DEFAULT 0,  
    END_PID          IN NUMBER DEFAULT -1,  
    SKIP_UNSUPPORTED IN BOOLEAN DEFAULT TRUE);
```

The DUMP\_TRUCKING\_DATA procedure dumps the contents of the trucking restriction user data partition BLOBs. This procedure unpacks a BLOB, formats the data, and writes it to a log file. A single call to this procedure can dump a single partition or a contiguous range of partitions. This range is defined from START\_PID to END\_PID, inclusive. The default is to dump all partitions. A non-contiguous range of partitions cannot be dumped in a single call.

The LOG\_FILE\_NAME parameter specifies the name of the log file written when dumping trucking restriction user data partitions. This log file is created in the SDO\_ROUTER\_LOG\_DIR directory. You can choose a log file name or write to the default partitioning log file `sdo_router_partition.log`.

The START\_PID parameter is the ID of the first partition to dump. The default START\_PID is 0. The START\_PID must be less than or equal to END\_PID.

The END\_PID parameter is the ID of the last partition to dump. The default END\_PID is -1, which is converted to the highest partition ID in the data set. If the start and end PID values are equal, a single partition is dumped. If END\_PID is less than START\_PID, an error message is written to the log.

The SKIP\_UNSUPPORTED parameter controls how the trucking restriction data is dumped. The user data contains a number of restrictions included for future work but not currently supported. Setting SKIP\_UNSUPPORTED to TRUE (the default) only dumps currently supported trucking restrictions. Setting SKIP\_UNSUPPORTED to FALSE causes all trucking restrictions to be dumped.

### E.4.6 User Data Examples

This section presents examples of operations involving user data. The data set in these examples is the road network data for a radius of 100 miles around the center of San Francisco. This data set contains about 520,000 nodes and 1,200,00 edges, including 82,000 edges with truck restrictions and 30,000 edges with restricted driving maneuvers.

This section contains examples of the following:

- [Rebuilding the Turn Restriction User Data](#) (page E-17)
- [Dumping All Hard Turn Restriction User Data BLOBs](#) (page E-17)
- [Rebuilding the Trucking User Data](#) (page E-19)
- [Dumping the Trucking User Data Restrictions](#) (page E-19)

### E.4.6.1 Rebuilding the Turn Restriction User Data

[Example E-8](#) (page E-17) rebuilds the turn restriction user data. Because cleanup is set to FALSE, the intermediate tables used to rebuild the turn restriction user data will not be deleted. (To delete these tables execute the [SDO\\_ROUTER\\_PARTITION.CLEANUP\\_ROUTER Procedure](#) (page E-7).)

#### **Example E-8 Rebuilding the Turn Restriction User Data**

```
EXEC SDO_ROUTER_PARTITION.CREATE_TURN_RESTRICTION_DATA(
    'rebuild_turn_restriction_data.log', FALSE);

***** Begin generation of turn restriction user data
** Logfile location: /scratch/logs/rebuild_turn_restriction_data.log
[INFO] Generating turn restriction user data for 995 partitions, data version
(12.1.0.1.2)

[INFO] SQL String: CREATE TABLE new_turn_restriction_data(partition_id NUMBER,
num_edges NUMBER, turn_restriction_data BLOB) LOB(turn_restriction_data) STORE AS
(STORAGE (INITIAL 512K NEXT 128K MAXEXTENTS UNLIMITED) CHUNK 32768 NOCACHE NOLOGGING)
[INFO] ---- Writing 573 edges for partition 0
[INFO] ---- Writing 16 edges for partition 1
[INFO] ---- Writing 10 edges for partition 2

*** Note that partition 3 contains no turn restriction user data

[INFO] ---- Writing 8 edges for partition 4
[INFO] ---- Writing 23 edges for partition 5
[INFO] ---- Writing 39 edges for partition 6
*** Many more Writing partition messages
[INFO] ---- Writing 4 edges for partition 1023
[INFO] ---- Writing 11 edges for partition 1024

INFO: creating the final turn restriction user data table
INFO: create index rtrud_p_idx on router_turn_restriction_data table
***** Completed generation of turn restriction user data
```

### E.4.6.2 Dumping All Hard Turn Restriction User Data BLOBs

[Example E-9](#) (page E-17) dumps all of the hard turn restriction user data BLOBs. (Dumping soft restrictions produces much larger dump files and is only useful when debugging problems in the turn restrictions constraints.)

#### **Example E-9 Dumping All Hard Turn Restriction User Data BLOBs**

```
EXEC SDO_ROUTER_PARTITION.DUMP_TURN_RESTRICTION_DATA(
    'dump_all_turn_restrictions.log');

***** Beginning turn restriction dump
** Logfile location: /scratch/logs/dump_all_turn_restrictions.log
** Routeserver data version: 12.1.0.1.2 (A)
** Start partition id: 0
** End partition id: 1024
** Dumping soft restrictions: FALSE

Starting turn restriction dump for partition 0, blob length 19956 bytes
Data version: 12.1.0.1.2
Partition 0 has 573 edges with turn restrictions (B)
edge id -937799058 has 1 turn restrictions
Restriction Type/Attributes: Hard/None
AppliesTo(959): Trucks, Through Traffic, Taxies, Motorcycles,
```

```

Emergency Vehicles, Delivery Vehicles, Carpools,
Buses, Automobiles
Subpath(1): 24501308
*****
edge id -936524317 has 2 turn restrictions          (C)
  Restriction Type/Attributes: Hard/None
  AppliesTo(943): Trucks, Through Traffic, Taxies, Motorcycles,
                  Delivery Vehicles, Carpools, Buses, Automobiles
  Subpath(1): -724922777
  -----
  Restriction Type/Attributes: Hard/None
  AppliesTo(959): Trucks, Through Traffic, Taxies, Motorcycles,
                  Emergency Vehicles, Delivery Vehicles, Carpools,
                  Buses, Automobiles
  Subpath(1): 936524317
  *****
edge id -932185370 has 2 turn restrictions
  Restriction Type/Attributes: Hard/None
  AppliesTo(1023): All Vehicles
  Subpath(1): 836074944
  -----
  Restriction Type/Attributes: Hard/None
  AppliesTo(1023): All Vehicles
  Subpath(1): -24638792
  *****
edge id 834380593 has 1 turn restrictions          (D)
  Restriction Type/Attributes: Hard/None
  AppliesTo(943): Trucks, Through Traffic, Taxies, Motorcycles,
                  Delivery Vehicles, Carpools, Buses, Automobiles
  Subpath(4): 112065672, -112065610, -112008660, -834380591
  *****

*** Dump of the remaining restrictions in Partition 0
Starting turn restriction dump for partition 1, blob length 520 bytes
Partition 1 has 16 edges with turn restrictions      (E)
edge id -806530190 has 1 turn restrictions
  Restriction Type/Attributes: Hard/None
  AppliesTo(703): Trucks, Taxies, Motorcycles, Emergency Vehicles,
                  Delivery Vehicles, Carpools, Buses, Automobiles
  Subpath(1): 120865027
  *****

*** Dump of the remaining restrictions in Partition 1 through 1024

```

In [Example E-9](#) (page E-17):

- **(A):** The standard user dump header contains the location of the log file and the parameters used in the dump. It also contains the routing engine data version as queried from the SDO\_ROUTER\_DATA\_VERSION table. This data version must match the data version stored in the header of the partition 0 BLOB.
- **(B):** In the BLOB header section for the partition 0 BLOB, all turn restriction user data BLOB headers contain the partition ID, length of the BLOB in bytes, and number of edges with turn restrictions on them. The BLOB header for partition 0 also contains the user data version. This version must match the data version found in the SDO\_ROUTER\_DATA\_VERSION table.
- **(C):** In the dump of the turn restrictions for edge -936524317., this edge has two simple turn restrictions associated with it. Both restrictions are simple turn restrictions that do not allow movement from the single edge in the subpath to edge -936524317. Also note the difference in the vehicles to which the restrictions

apply: the first restriction does not apply to emergency vehicles, but the second restriction does apply to emergency vehicles.

- **(D):** Edge 834380593 has only one turn restriction, but the restriction being described is much more complicated than a simple turn. If the subpath immediately previous to edge 834380593 matches the subpath that starts at edge -834380591 and goes through edges -112008660, -112065610, 112065672 in precisely that order, then the maneuver is not allowed. If the subpath to the current edge is missing one of the listed subpath edges or if the edges in the subpath are in a different order, then the maneuver is allowed.
- **(E):** In the BLOB header for local partitions, all turn restriction user data BLOB headers contain the partition ID, length of the BLOB in bytes, and number of edges with turn restrictions on them.

### E.4.6.3 Rebuilding the Trucking User Data

[Example E-10](#) (page E-19) rebuilds the trucking user data. Since cleanup is using the default value of TRUE the intermediate tables used to rebuild the turn restriction user data are deleted when the build completes.

#### **Example E-10 Rebuilding the Trucking User Data**

```
EXEC SDO_ROUTER_PARTITION.CREATE_TRUCKING_DATA(
    'rebuild_trucking_data.log');
***** Begin generation of trucking user data
** Logfile location:/scratch/logs/rebuild_trucking_data.log
[INFO] Generating trucking user data for 974 partitions,
data version (12.1.0.1.2) (A)

[INFO] SQL String: CREATE TABLE new_trucking_data
(partition_id NUMBER, num_edges NUMBER, trucking_data BLOB) LOB(trucking_data) STORE
AS (STORAGE (INITIAL 512K NEXT 128K MAXEXTENTS UNLIMITED) CHUNK 32768 NOCACHE
NOLOGGING)

INFO: creating the final trucking user data table
INFO: create index rtud_p_idx on router_trucking_data table
***** Completed generation of trucking user data
```

In [Example E-10](#) (page E-19):

- **(A):** Note that there are only 974 partitions of trucking user data compared to the 1023 local partitions (see the output in [Example E-9](#) (page E-17)) of routing engine data. If a partition is missing in the user data output, this means there is no trucking data for the associated routing engine data partition.

### E.4.6.4 Dumping the Trucking User Data Restrictions

[Example E-11](#) (page E-20) dumps the trucking user data restrictions. This example dumps the supported restrictions for partitions 0 through 25. In the dump, Main Type is type of restriction, Subtype is the reason for the restriction, and Value is the means to measure the restriction. For example, a height restriction is a Main Type, the Subtype can be a thing like Bridge or Tunnel or can be Unknown, and Value can be a measure (always metric) like meters for height and width or metric tons for weight. Value can also be 0 for some restrictions (for example legal restrictions) that cannot be physically measured.

**Example E-11 Dumping the Trucking User Data Restrictions**

```

EXEC SDO_ROUTER_PARTITION.DUMP_TRUCKING_DATA(
    'dump_trucking_data0-25.log', 0, 25);

***** Beginning trucking data dump
** Logfile location: /scratch/logs/dump_trucking_data0-25.log
** Routeserver data version: 12.1.0.1.2                (A)
** Start partition id: 0
** End partition id: 25

Starting truck data dump for partition 0, blob length 1019048 bytes
Data version: 12.1.0.1.2
Partition 0 has 21808 edges with truck data              (B)
  edge id -939054768 has 4 truck restrictions
    Main Type(10): Physical Height Restriction
    Sub-type(99): Unknown
    Value: 4.65
*****
  edge id -854677940 has 3 truck restrictions
    Main Type(10): Physical Height Restriction
    Sub-type(1): Bridge
    Value: 4.67
*****
  edge id -929320205 has 4 truck restrictions              (C)
    Main Type(10): Physical Height Restriction
    Sub-type(2): Tunnel
    Value: 4.27
  -----
    Main Type(20): Physical Weight Restriction
    Sub-type(99): Unknown
    Value: 4.08
*****

*** The rest of the trucking data for edges in partition 0

Starting truck data dump for partition 2, blob length 296 bytes
                                                                    (D)

Starting truck data dump for partition 3, blob length 3272 bytes
Partition 3 has 91 edges with truck data
  edge id -811551125 has 1 truck restrictions
    Main Type(50): Legal Restriction
    Sub-type(22): All trailers forbidden
    Value: 0.0
*****
  edge id 105439903 has 1 truck restrictions
    Main Type(20): Physical Weight Restriction
    Sub-type(99): Unknown
    Value: 9.07
*****
  edge id -105491810 has 1 truck restrictions              (E)
    Main Type(50): Legal Restriction
    Sub-type(21): All trucks forbidden
    Value: 0.0
*****
  edge id -105449802 has 1 truck restrictions
    Main Type(50): Legal Restriction
    Sub-type(26): All trucks forbidden except deliveries and residents
    Value: 0.0
*****

```

\*\*\* The rest of the trucking data for edges in partitions 3 through 25

In [Example E-11](#) (page E-20):

- **(A):** The standard user dump header contains the location of the log file and the parameters used in the dump. It also contains the routing engine data version as queried from the SDO\_ROUTER\_DATA\_VERSION table. This data version must match the data version stored in the header of the partition 0 BLOB.
- **(B):** In the BLOB header section for the partition 0 BLOB, all turn restriction user data BLOB headers contain the partition ID, length of the BLOB in bytes, and number of edges with turn restrictions on them. The BLOB header for partition 0 also contains the user data version. This version must match the data version found in the SDO\_ROUTER\_DATA\_VERSION table.

Edge -939054768 is listed as having 4 truck restrictions, but only one is listed. The other three restrictions are there, but are currently unsupported in the routing engine. To see these restrictions, set the SKIP\_UNSUPPORTED to FALSE when requesting the dump.

For edge -929320205 the Height restriction is because of a Bridge. Edge -939054768 also has a Height restriction, but there is no Subtype specified to explain why.

- **(C):** This is an example of an edge that has multiple restrictions on it, in this case both a height and weight restriction expressed in meters and metric tons.
- **(D):** Two things to note here: (1) partition 1 is missing, which means there is no trucking user data for partition 1; and (2) a partition header was printed for partition 2 but there is no data dumped, which means that there are trucking restrictions for partition 2 but the routing engine currently supports none of them.
- **(E):** This is an example of two kinds of legal restrictions that can be modeled. (1) Edge -105491810 is an example of an exclusive legal restriction. There is a legal restriction on the edge that forbids all trucks. (2) Edge -105449802 is an example of an inclusive legal restriction. There is a legal restriction that excludes trucks on the edge but also lists an exception for delivery and resident trucks.

## E.5 Other Functions and Procedures

The following functions and procedures are for internal use by the routing engine during the partitioning process. You should not call them directly unless instructed to by Oracle Support.

- **GET\_PID:** Used to get partition ids during partitioning.
- **MIN\_EIGENVECTOR:** Eigenvector used during partitioning.
- **GATHER\_TABLE\_STATS:** Deprecated. Used to rebuild table and index statistics.
- **All ELOCATION\_\*:** Wrappers for Java code used in partitioning.
- **BUILD\_TURN\_RESTRICTIONS** Deprecated. Used to build Release 11g turn restrictions.
- **GET\_EDGE\_INFO:** Collects edge information for building driving directions for a route.
- **GET\_GEOMETRY\_INFO:** Builds the line string geometry for a route.





---

# Glossary

## area

An extent or region of dimensional space.

## attribute

Descriptive information characterizing a geographical feature such as a point, line, or area.

## attribute data

Nondimensional data that provides additional descriptive information about multidimensional data, for example, a class or feature such as a bridge or a road.

## batch geocoding

An operation that simultaneously geocodes many records from one table. *See also* [geocoding](#).

## boundary

1. The lower or upper extent of the range of a dimension, expressed by a numeric value.
2. The line representing the outline of a polygon.

## Cartesian coordinate system

A coordinate system in which the location of a point in  $n$ -dimensional space is defined by distances from the point to the reference plane. Distances are measured parallel to the planes intersecting a given reference plane. *See also* [coordinate system](#).

## colocation

The presence of two or more spatial objects at the same location or at significantly close distances from each other.

## contain

A geometric relationship where one object encompasses another and the inner object does not touch any boundaries of the outer. The outer object *contains* the inner object. *See also* [inside](#).

## convex hull

A simple convex polygon that completely encloses the associated geometry object.

## coordinate

A set of values uniquely defining a point in an  $n$ -dimensional coordinate system.

## coordinate reference system

Synonymous with [coordinate system](#) in Oracle Spatial and Graph documentation. The term *coordinate reference system* is used extensively by the European Petroleum Survey Group (EPSG).

## coordinate system

A reference system for the unique definition for the location of a point in  $n$ -dimensional space. Also called a spatial reference system. *See also* [Cartesian coordinate system](#), [geodetic coordinates](#), [projected coordinates](#), and [local coordinates](#).

## cover

A geometric relationship in which one object encompasses another and the inner object touches the boundary of the outer object in one or more places.

## data dictionary

A repository of information about data. A data dictionary stores relational information on all objects in a database.

## datum transformation

*See* [transformation](#).

## dimensional data

Data that has one or more dimensional components and is described by multiple values.

## direction

The direction of an LRS geometric segment is indicated from the start point of the geometric segment to the end point. Measures of points on a geometric segment always increase along the direction of the geometric segment.

## disjoint

A geometric relationship where two objects do not interact in any way. Two *disjoint* objects do not share any element or piece of their geometry.

## element

A basic building block (point, line string, or polygon) of a geometry.

## equal

A geometric relationship in which two objects are considered to represent the same geometric figure. The two objects must be composed of the same number of points; however, the ordering of the points defining geometries of the two objects may differ (clockwise or counterclockwise).

## extent

A rectangle bounding a map, the size of which is determined by the minimum and maximum map coordinates.

## feature

An object with a distinct set of characteristics in a spatial database.

## geocoding

The process of converting tables of address data into standardized address, location, and possibly other data. *See also* [batch geocoding](#).

## geodetic coordinates

Angular coordinates (longitude and latitude) closely related to spherical polar coordinates and defined relative to a particular Earth geodetic datum. Also referred to as geographic coordinates.

## geodetic datum

A means of representing the figure of the Earth, usually as an oblate ellipsoid of revolution, that approximates the surface of the Earth locally or globally, and is the reference for the system of geodetic coordinates.

## geographic coordinates

*See* [geodetic coordinates](#).

## geographic information system (GIS)

A computerized database management system used for the capture, conversion, storage, retrieval, analysis, and display of spatial data.

## geographically referenced data

See [spatiotemporal data](#).

## geometric segment (LRS segment)

An LRS element that contains start and end measures for its start and end points, and that can contain measures for other points on the segment.

## geometry

The geometric representation of the shape of a spatial feature in some coordinate space. A geometry is an ordered sequence of vertices that are connected by straight line segments or circular arcs.

## georeferenced data

See [spatiotemporal data](#).

## GIS

See [geographic information system \(GIS\)](#).

## grid

A data structure composed of points located at the nodes of an imaginary grid. The spacing of the nodes is constant in both the horizontal and vertical directions.

## hole

A subelement of a polygon that negates a section of its interior. For example, consider a polygon representing a map of buildable land with an inner polygon (a hole) representing where a lake is located.

## homogeneous

Spatial data of one feature type such as points, lines, or regions.

## hyperspatial data

In mathematics, any space having more than the three standard X, Y, and Z dimensions. Sometimes referred to as multidimensional data.

## index

A database object that is used for fast and efficient access to stored information.

## inside

A geometric relationship where one object is surrounded by a larger object and the inner object does not touch the boundary of the outer. The smaller object is *inside* the larger. See also [contain](#).

## key

A field in a database used to obtain access to stored information.

## latitude

North/south position of a point on the Earth defined as the angle between the normal to the Earth's surface at that point and the plane of the equator.

## layer

A collection of geometries having the same attribute set and stored in a geometry column.

## line

A geometric object represented by a series of points, or inferred as existing between two coordinate points.

## line string

One or more pairs of points that define a line segment. *See also* [multiline string](#).

## linear feature

Any spatial object that can be treated as a logical set of linear segments.

## local coordinates

Cartesian coordinates in a non-Earth (non-georeferenced) coordinate system.

## longitude

East/west position of a point on the Earth defined as the angle between the plane of a reference meridian and the plane of a meridian passing through an arbitrary point.

## LRS point

A point with linear measure information along a geometric segment. *See also* [geometric segment \(LRS segment\)](#).

## measure

The linear distance (in the LRS measure dimension) to a point measured from the start point (for increasing values) or end point (for decreasing values) of the geometric segment.

## measure range

The measure values at the start and end of a geometric segment.

## minimum bounding rectangle (MBR)

A single rectangle that minimally encloses a geometry or a collection of geometries.

## multidimensional data

See [hyperspatial data](#).

## multiline string

A geometry object made up of nonconnected line string elements (for example, a street with a gap caused by a city park, such as Sixth Avenue in New York City with Central Park as the gap). See also [line string](#).

## multipolygon

A polygon collection geometry in which rings must be grouped by polygon, and the first ring of each polygon must be the exterior ring.

## neighborhood influence

See [spatial correlation](#).

## offset

The perpendicular distance between a point along a geometric segment and the geometric segment. Offsets are positive if the points are on the left side along the segment direction and are negative if they are on the right side. Points are on a geometric segment if their offsets to the segment are zero.

## oriented point

A special type of point geometry that includes coordinates representing the locations of the point and a virtual end point, to indicate an orientation vector that can be used for rotating a symbol at the point or extending a label from the point

## polygon

A class of spatial objects having a nonzero area and perimeter, and representing a closed boundary region of uniform characteristics.

## primary filter

The operation that permits fast selection of candidate records to pass along to the secondary filter. The primary filter compares geometry approximations to reduce computation complexity and is considered a lower-cost filter. Because the primary filter compares geometric approximations, it returns a superset of the exact result set. See also [secondary filter](#) and [two-tier query model](#).

## projected coordinates

Planar Cartesian coordinates that result from performing a mathematical mapping from a point on the Earth's surface to a plane. There are many such mathematical mappings, each used for a particular purpose.

## projection

The point on the LRS geometric segment with the minimum distance to the specified point.

## proximity

A measure of distance between objects.

## query

A set of conditions or questions that form the basis for the retrieval of information from a database.

## query window

Area within which the retrieval of spatial information and related attributes is performed.

## RDBMS

See [Relational Database Management System \(RDBMS\)](#).

## recursion

A process, function, or routine that executes continuously until a specified condition is met.

## region

An extent or area of multidimensional space.

## Relational Database Management System (RDBMS)

A computer program designed to store and retrieve shared data. In a relational system, data is stored in tables consisting of one or more rows, each containing the same set of columns. Oracle Database is an object-relational database management system. Other types of database systems are called hierarchical or network database systems.

## resolution

The number of subdivision levels of data.

## scale

The ratio of the distance on a map, photograph, or image to the corresponding image on the ground, all expressed in the same units.

## secondary filter

The operation that applies exact computations to geometries that result from the primary filter. The secondary filter yields an accurate answer to a spatial query. The secondary filter operation is computationally expensive, but it is only applied to the primary filter results, not the entire data set. *See also* [primary filter](#) and [two-tier query model](#).

## shape points

Points that are specified when an LRS segment is constructed, and that are assigned measure information.

## sort

The operation of arranging a set of items according to a key that determines the sequence and precedence of items.

## spatial

A generic term used to reference the mathematical concept of  $n$ -dimensional data.

## spatial binning

The process of discretizing the location values into a small number of groups associated with geographical areas. Also referred to as *spatial discretization*.

## spatial correlation

The phenomenon of the location of a specific object in an area affecting some nonspatial attribute of the object. Also referred to as *neighborhood influence*.

## spatial data

Data that is referenced by its location in  $n$ -dimensional space. The position of spatial data is described by multiple values. *See also* [hyperspatial data](#).

## spatial data model

A model of how objects are located on a spatial context.

## spatial data structures

A class of data structures designed to store spatial information and facilitate its manipulation.



## spatial database

A database containing information indexed by location.

## spatial discretization

See [spatial binning](#).

## spatial join

A query in which each of the geometries in one layer is compared with each of the geometries in the other layer. Comparable to a spatial cross product.

## spatial query

A query that includes criteria for which selected features must meet location conditions.

## spatial reference system

See [coordinate system](#).

## spatiotemporal data

Data that contains time or location (or both) components as one of its dimensions, also referred to as geographically referenced data or georeferenced data.

## SQL\*Loader

A utility to load formatted data into spatial tables.

## tolerance

The distance that two points can be apart and still be considered the same (for example, to accommodate rounding errors). The tolerance value must be a positive number greater than zero. The significance of the value depends on whether or not the spatial data is associated with a geodetic coordinate system.

## touch

A geometric relationship where two objects share a common point on their boundaries, but their interiors do not intersect.

## transformation

The conversion of coordinates from one coordinate system to another coordinate system. If the coordinate system is georeferenced, transformation can involve datum transformation: the conversion of geodetic coordinates from one geodetic datum to another geodetic datum, usually involving changes in the shape, orientation, and center position of the reference ellipsoid.

## two-tier query model

The query model used by Spatial and Graph to resolve spatial queries and spatial joins. Two distinct filtering operations (primary and secondary) are performed to resolve queries. The output of both operations yields the exact result set. *See also* [primary filter](#) *and* [secondary filter](#).

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