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Contents

Send Us Your Comments	xvii
Preface.....	xix
Audience	xx
Documentation Accessibility	xx
Organization.....	xxi
Technologies Released Separately.....	xxiii
Related Documentation	xxiii
Conventions.....	xxiv
New and Changed Features.....	xxv
Validation with Context.....	xxv
Utility Functions	xxv
Partitioned Spatial Indexes: Splitting and Merging Supported.....	xxvi
Exchanging Partitions Including Indexes	xxvi
Parallel Index Creation and Rebuilding.....	xxvi
Deferred Modifications to an Index.....	xxvi
SDO_CS.VIEWPORT_TRANSFORM to_surname Parameter Not Supported.....	xxvi

Part I Conceptual and Usage Information

1 Spatial Concepts

1.1	What Is Oracle Spatial?	1-1
1.2	Object-Relational Model	1-1
1.3	Introduction to Spatial Data.....	1-2
1.4	Geometry Types.....	1-3
1.5	Data Model	1-4
1.5.1	Element	1-5
1.5.2	Geometry	1-5
1.5.3	Layer.....	1-5
1.5.4	Coordinate System	1-6
1.5.5	Tolerance.....	1-7
1.5.5.1	In the Geometry Metadata for a Layer.....	1-7
1.5.5.2	As an Input Parameter	1-9
1.6	Query Model	1-9
1.7	Indexing of Spatial Data	1-11
1.7.1	R-tree Indexing	1-12
1.7.1.1	R-tree Quality.....	1-13
1.7.2	Quadtree Indexing	1-14
1.7.2.1	Tessellation of a Layer During Indexing	1-15
1.7.2.2	Fixed Indexing.....	1-16
1.8	Spatial Relations and Filtering.....	1-20
1.9	Spatial Aggregate Functions	1-23
1.9.1	SDOAGGRTYPE Object Type	1-24
1.10	Geocoding.....	1-25
1.11	Performance and Tuning Information.....	1-25
1.12	Spatial Release (Version) Number	1-26
1.13	Spatial Application Hardware Requirement Considerations.....	1-26
1.14	Spatial Error Messages.....	1-26
1.15	Spatial Examples.....	1-27

2 Spatial Data Types and Metadata

2.1	Simple Example: Inserting, Indexing, and Querying Spatial Data	2-1
2.2	SDO_GEOMETRY Object Type.....	2-6
2.2.1	SDO_GTYPE.....	2-7
2.2.2	SDO_SRID	2-8

2.2.3	SDO_POINT.....	2-9
2.2.4	SDO_ELEM_INFO	2-9
2.2.5	SDO_ORDINATES.....	2-14
2.2.6	Usage Considerations.....	2-14
2.3	Geometry Examples.....	2-14
2.3.1	Rectangle	2-15
2.3.2	Polygon with a Hole	2-16
2.3.3	Compound Line String.....	2-18
2.3.4	Compound Polygon.....	2-20
2.3.5	Point	2-22
2.3.6	Type 0 (Zero) Element	2-24
2.4	Geometry Metadata Structure	2-26
2.4.1	TABLE_NAME.....	2-27
2.4.2	COLUMN_NAME	2-28
2.4.3	DIMINFO	2-28
2.4.4	SRID	2-29
2.5	Spatial Index-Related Structures.....	2-29
2.5.1	Spatial Index Views	2-29
2.5.1.1	xxx_SDO_INDEX_INFO Views	2-29
2.5.1.2	xxx_SDO_INDEX_METADATA Views	2-30
2.5.2	Spatial Index Table Definition.....	2-33
2.5.3	R-Tree Index Sequence Object.....	2-34
2.6	Unit of Measurement Support.....	2-34

3 Loading Spatial Data

3.1	Bulk Loading	3-1
3.1.1	Bulk Loading SDO_GEOMETRY Objects.....	3-1
3.1.2	Bulk Loading Point-Only Data in SDO_GEOMETRY Objects	3-3
3.2	Transactional Insert Operations Using SQL.....	3-4

4 Indexing and Querying Spatial Data

4.1	Creating a Spatial Index	4-1
4.1.1	Creating R-Tree Indexes.....	4-1
4.1.2	Determining Index Creation Behavior (Quadtree Indexes).....	4-3
4.1.3	Spatial Indexing with Fixed-Size Tiles (Quadtree Indexes).....	4-3

4.1.4	Indexing Geodetic Data.....	4-7
4.1.5	Constraining Data to a Geometry Type	4-7
4.1.6	Creating a Cross-Schema Index	4-8
4.1.7	Using Partitioned Spatial Indexes.....	4-8
4.1.8	Exchanging Partitions Including Indexes	4-10
4.2	Querying Spatial Data.....	4-11
4.2.1	Spatial Query	4-12
4.2.1.1	Primary Filter Operator	4-13
4.2.1.2	Primary and Secondary Filter Operator	4-15
4.2.1.3	Within-Distance Operator.....	4-16
4.2.1.4	Nearest Neighbor Operator.....	4-17
4.2.1.5	Spatial Functions	4-18
4.2.2	Spatial Join.....	4-18
4.2.3	Cross-Schema Operator Invocation.....	4-19

5 Coordinate Systems (Spatial Reference Systems)

5.1	Terms and Concepts.....	5-1
5.1.1	Coordinate System (Spatial Reference System)	5-1
5.1.2	Cartesian Coordinates	5-1
5.1.3	Geodetic Coordinates (Geographic Coordinates).....	5-2
5.1.4	Projected Coordinates.....	5-2
5.1.5	Local Coordinates.....	5-2
5.1.6	Geodetic Datum.....	5-2
5.1.7	Authalic Sphere	5-2
5.1.8	Transformation	5-2
5.2	Geodetic Coordinate Support	5-3
5.2.1	Geodesy and Two-Dimensional Geometry	5-3
5.2.2	Choosing a Geodetic or Projected Coordinate System	5-3
5.2.3	Other Considerations and Requirements with Geodetic Data.....	5-4
5.3	Local Coordinate Support	5-5
5.4	Coordinate Systems Data Structures	5-6
5.4.1	MDSYS.CS_SRS Table.....	5-7
5.4.1.1	Well-Known Text (WKTEXT).....	5-8
5.4.2	MDSYS.SDO_ANGLE_UNITS Table	5-10
5.4.3	MDSYS.SDO_DIST_UNITS Table.....	5-11

5.4.4	MDSYS.SDO_DATUMS Table	5-11
5.4.5	MDSYS.SDO_ELLIPSOIDS Table	5-14
5.4.6	MDSYS.SDO_PROJECTIONS Table.....	5-15
5.5	Creating a User-Defined Coordinate System.....	5-16
5.6	Coordinate System Transformation Functions	5-19
5.7	Notes and Restrictions with Coordinate Systems Support	5-19
5.7.1	Different Coordinate Systems for Geometries with Operators and Functions... ..	5-19
5.7.2	Functions Not Supported with Geodetic Data	5-19
5.7.3	Functions Supported by Approximations with Geodetic Data.....	5-20
5.8	Example of Coordinate System Transformation	5-20

6 Linear Referencing System

6.1	Terms and Concepts	6-1
6.1.1	Geometric Segments (LRS Segments)	6-2
6.1.2	Shape Points.....	6-2
6.1.3	Direction of a Geometric Segment.....	6-3
6.1.4	Measure (Linear Measure)	6-3
6.1.5	Offset.....	6-3
6.1.6	Measure Populating.....	6-4
6.1.7	Measure Range of a Geometric Segment.....	6-6
6.1.8	Projection.....	6-6
6.1.9	LRS Point	6-6
6.1.10	Linear Features	6-6
6.2	LRS Data Model.....	6-7
6.3	Indexing of LRS Data.....	6-8
6.4	3D Formats of LRS Functions	6-9
6.5	LRS Operations.....	6-10
6.5.1	Defining a Geometric Segment	6-10
6.5.2	Redefining a Geometric Segment	6-11
6.5.3	Clipping a Geometric Segment	6-12
6.5.4	Splitting a Geometric Segment.....	6-13
6.5.5	Concatenating Geometric Segments.....	6-13
6.5.6	Scaling a Geometric Segment	6-15
6.5.7	Offsetting a Geometric Segment	6-16
6.5.8	Locating a Point on a Geometric Segment.....	6-17

6.5.9	Projecting a Point onto a Geometric Segment.....	6-18
6.5.10	Converting LRS Geometries	6-19
6.6	Example of LRS Functions	6-20

7 Extending Spatial Indexing Capabilities

7.1	SDO_GEOMETRY Objects in User-Defined Type Definitions.....	7-1
7.2	SDO_GEOMETRY Objects in Function-Based Indexes	7-3
7.2.1	Example: Function with Standard Types.....	7-4
7.2.2	Example: Function with User-Defined Object Type	7-6

Part II Reference Information

8 SQL Statements for Indexing Spatial Data

ALTER INDEX.....	8-2
ALTER INDEX REBUILD.....	8-7
ALTER INDEX RENAME TO.....	8-11
CREATE INDEX.....	8-12
DROP INDEX.....	8-19

9 SDO_GEOMETRY Object Type Methods

GET_DIMS.....	9-2
GET_GTYPE.....	9-3
GET_LRS_DIM.....	9-4

10 Spatial Operators

SDO_FILTER.....	10-2
SDO_NN.....	10-6
SDO_NN_DISTANCE.....	10-11
SDO_RELATE.....	10-13
SDO_WITHIN_DISTANCE.....	10-18

11 Geometry Functions

SDO_GEOM.RELATE.....	11-4
SDO_GEOM.SDO_ARC_DENSIFY	11-7
SDO_GEOM.SDO_AREA	11-10
SDO_GEOM.SDO_BUFFER.....	11-12
SDO_GEOM.SDO_CENTROID	11-16
SDO_GEOM.SDO_CONVEXHULL	11-18
SDO_GEOM.SDO_DIFFERENCE.....	11-20
SDO_GEOM.SDO_DISTANCE.....	11-23
SDO_GEOM.SDO_INTERSECTION.....	11-25
SDO_GEOM.SDO_LENGTH.....	11-28
SDO_GEOM.SDO_MAX_MBR_ORDINATE.....	11-30
SDO_GEOM.SDO_MBR.....	11-32
SDO_GEOM.SDO_MIN_MBR_ORDINATE.....	11-34
SDO_GEOM.SDO_POINTONSURFACE.....	11-36
SDO_GEOM.SDO_UNION.....	11-38
SDO_GEOM.SDO_XOR	11-41
SDO_GEOM.VALIDATE_GEOMETRY.....	11-44
SDO_GEOM.VALIDATE_GEOMETRY_WITH_CONTEXT	11-46
SDO_GEOM.VALIDATE_LAYER.....	11-49
SDO_GEOM.VALIDATE_LAYER_WITH_CONTEXT	11-52
SDO_GEOM.WITHIN_DISTANCE.....	11-55

12 Spatial Aggregate Functions

SDO_AGGR_CENTROID	12-2
SDO_AGGR_CONVEXHULL.....	12-4
SDO_AGGR_LRS_CONCAT.....	12-5
SDO_AGGR_MBR.....	12-7
SDO_AGGR_UNION	12-8

13 Coordinate System Transformation Functions

SDO_CS.TRANSFORM	13-2
SDO_CS.TRANSFORM_LAYER.....	13-5
SDO_CS.VIEWPORT_TRANSFORM.....	13-7

14 Linear Referencing Functions

SDO_LRS.CLIP_GEOM_SEGMENT	14-5
SDO_LRS.CONCATENATE_GEOM_SEGMENTS.....	14-7
SDO_LRS.CONNECTED_GEOM_SEGMENTS	14-10
SDO_LRS.CONVERT_TO_LRS_DIM_ARRAY	14-12
SDO_LRS.CONVERT_TO_LRS_GEOM.....	14-15
SDO_LRS.CONVERT_TO_LRS_LAYER.....	14-18
SDO_LRS.CONVERT_TO_STD_DIM_ARRAY	14-21
SDO_LRS.CONVERT_TO_STD_GEOM	14-23
SDO_LRS.CONVERT_TO_STD_LAYER	14-25
SDO_LRS.DEFINE_GEOM_SEGMENT.....	14-27
SDO_LRS.DYNAMIC_SEGMENT.....	14-30
SDO_LRS.FIND_LRS_DIM_POS	14-32
SDO_LRS.FIND_MEASURE.....	14-33
SDO_LRS.GEOM_SEGMENT_END_MEASURE.....	14-35
SDO_LRS.GEOM_SEGMENT_END_PT.....	14-37
SDO_LRS.GEOM_SEGMENT_LENGTH	14-39
SDO_LRS.GEOM_SEGMENT_START_MEASURE.....	14-41
SDO_LRS.GEOM_SEGMENT_START_PT.....	14-43
SDO_LRS.GET_MEASURE.....	14-45
SDO_LRS.IS_GEOM_SEGMENT_DEFINED	14-47
SDO_LRS.IS_MEASURE_DECREASING.....	14-49
SDO_LRS.IS_MEASURE_INCREASING.....	14-51
SDO_LRS.LOCATE_PT	14-53
SDO_LRS.MEASURE_RANGE.....	14-56
SDO_LRS.MEASURE_TO_PERCENTAGE.....	14-58

SDO_LRS.OFFSET_GEOM_SEGMENT.....	14-60
SDO_LRS.PERCENTAGE_TO_MEASURE.....	14-64
SDO_LRS.PROJECT_PT	14-66
SDO_LRS.REDEFINE_GEOM_SEGMENT	14-68
SDO_LRS.RESET_MEASURE.....	14-71
SDO_LRS.REVERSE_GEOMETRY	14-73
SDO_LRS.REVERSE_MEASURE.....	14-75
SDO_LRS.SCALE_GEOM_SEGMENT	14-77
SDO_LRS.SET_PT_MEASURE.....	14-80
SDO_LRS.SPLIT_GEOM_SEGMENT.....	14-83
SDO_LRS.TRANSLATE_MEASURE.....	14-86
SDO_LRS.VALID_GEOM_SEGMENT	14-88
SDO_LRS.VALID_LRS_PT	14-90
SDO_LRS.VALID_MEASURE.....	14-92
SDO_LRS.VALIDATE_LRS_GEOMETRY.....	14-94

15 Migration Procedures

SDO_MIGRATE.FROM_815_TO_81X.....	15-2
SDO_MIGRATE.OGIS_METADATA_FROM.....	15-4
SDO_MIGRATE.OGIS_METADATA_TO.....	15-5
SDO_MIGRATE.TO_734	15-6
SDO_MIGRATE.TO_81X	15-8
SDO_MIGRATE.TO_CURRENT.....	15-11

16 Tuning Functions and Procedures

SDO_TUNE.ANALYZE_RTREE.....	16-3
SDO_TUNE.AVERAGE_MBR.....	16-5
SDO_TUNE.ESTIMATE_INDEX_PERFORMANCE.....	16-7
SDO_TUNE.ESTIMATE_TILING_LEVEL	16-10
SDO_TUNE.ESTIMATE_TILING_TIME	16-12
SDO_TUNE.ESTIMATE_TOTAL_NUMTILES	16-14

SDO_TUNE.EXTENT_OF	16-17
SDO_TUNE.HISTOGRAM_ANALYSIS	16-19
SDO_TUNE.MIX_INFO.....	16-21
SDO_TUNE.QUALITY_DEGRADATION	16-23
SDO_TUNE.RTREE_QUALITY	16-25

17 Utility Functions

SDO_UTIL.EXTRACT.....	17-2
SDO_UTIL.GETVERTICES	17-5

A Installation, Compatibility, and Migration

A.1	Introduction.....	A-1
A.2	Installation of Spatial	A-2
A.3	Upgrading from Spatial Release 8.1.5, 8.1.6, or 8.1.7.....	A-3
A.4	Upgrading from Spatial Release 9.0.1.....	A-3
A.5	Upgrading LRS Data.....	A-4

B Hybrid Indexing

B.1	Creating a Hybrid Index.....	B-4
B.2	Tuning Considerations with Hybrid Indexes.....	B-5

C Locator

Glossary

Index

List of Examples

2-1	Simple Example: Inserting, Indexing, and Querying Spatial Data	2-3
2-2	SQL Statement to Insert a Rectangle.....	2-15
2-3	SQL Statement to Insert a Polygon with a Hole	2-17
2-4	SQL Statement to Insert a Compound Line String.....	2-20
2-5	SQL Statement to Insert a Compound Polygon.....	2-22
2-6	SQL Statement to Insert a Point-Only Geometry.....	2-23
2-7	Query for Point-Only Geometry Based on a Coordinate Value	2-24
2-8	SQL Statement to Insert a Geometry with a Type 0 Element	2-26
3-1	Control File for Bulk Load of Cola Market Geometries.....	3-1
3-2	Control File for Bulk Load of Polygons	3-3
3-3	Control File for a Bulk Load of Point-Only Data.....	3-4
3-4	Procedure to Perform Transactional Insert Operation	3-5
3-5	PL/SQL Block Invoking Procedure to Insert a Geometry	3-5
4-1	Creating a Fixed Index.....	4-6
4-2	Primary Filter with a Temporary Query Window	4-14
4-3	Primary Filter with a Transient Instance of the Query Window.....	4-14
4-4	Primary Filter with a Stored Query Window.....	4-14
4-5	Secondary Filter Using a Temporary Query Window.....	4-15
4-6	Secondary Filter Using a Stored Query Window	4-16
5-1	Creating a User-Defined Projected Coordinate System.....	5-18
5-2	Creating a User-Defined Geodetic Coordinate System	5-18
5-3	Simplified Example of Coordinate System Transformation	5-21
5-4	Output of SELECT Statements in Coordinate System Transformation Example.....	5-25
6-1	Including LRS Measure Dimension in Spatial Metadata	6-7
6-2	Simplified Example: Highway	6-22
6-3	Simplified Example: Output of SELECT Statements	6-26
B-1	Creating a Hybrid Index	B-5

List of Figures

1-1	Geometric Types.....	1-4
1-2	Query Model.....	1-10
1-3	MBR Enclosing a Geometry.....	1-12
1-4	R-tree Hierarchical Index on MBRs.....	1-13
1-5	Quadtree Decomposition and Morton Codes.....	1-16
1-6	Fixed-Size Tiling with Many Small Tiles.....	1-17
1-7	Fixed-Size Tiling with Fewer Large Tiles.....	1-18
1-8	Tessellated Geometry.....	1-19
1-9	The 9-Intersection Model.....	1-21
1-10	Topological Relationships.....	1-22
1-11	Distance Buffers for Points, Lines, and Polygons.....	1-22
1-12	Tolerance in an Aggregate Union Operation.....	1-24
2-1	Areas of Interest for Simple Example.....	2-2
2-2	Rectangle.....	2-15
2-3	Polygon with a Hole.....	2-16
2-4	Compound Line String.....	2-19
2-5	Compound Polygon.....	2-21
2-6	Point-Only Geometry.....	2-23
2-7	Geometry with Type 0 (Zero) Element.....	2-25
4-1	Sample Domain.....	4-4
4-2	Fixed-Size Tiling at Level 1.....	4-5
4-3	Fixed-Size Tiling at Level 2.....	4-5
4-4	Tessellated Layer with Multiple Objects.....	4-12
4-5	Tessellated Layer with a Query Window.....	4-13
6-1	Geometric Segment.....	6-2
6-2	Describing a Point Along a Segment with a Measure and an Offset.....	6-4
6-3	Measures, Distances, and Their Mapping Relationship.....	6-5
6-4	Measure Populating of a Geometric Segment.....	6-5
6-5	Measure Populating With Disproportional Assigned Measures.....	6-6
6-6	Linear Feature, Geometric Segments, and LRS Points.....	6-7
6-7	Creating a Geometric Segment.....	6-8
6-8	Defining a Geometric Segment.....	6-11
6-9	Redefining a Geometric Segment.....	6-12
6-10	Clipping, Splitting, and Concatenating Geometric Segments.....	6-12
6-11	Measure Assignment in Geometric Segment Operations.....	6-14
6-12	Segment Direction with Concatenation.....	6-15
6-13	Scaling a Geometric Segment.....	6-16
6-14	Offsetting a Geometric Segment.....	6-17
6-15	Locating a Point Along a Segment with a Measure and an Offset.....	6-17
6-16	Ambiguity in Location Referencing with Offsets.....	6-18

6-17	Multiple Projection Points.....	6-19
6-18	Conversion from Standard to LRS Line String	6-20
6-19	Simplified LRS Example: Highway	6-21
11-1	Arc Tolerance	11-8
11-2	SDO_GEOM.SDO_DIFFERENCE.....	11-21
11-3	SDO_GEOM.SDO_INTERSECTION.....	11-26
11-4	SDO_GEOM.SDO_UNION.....	11-39
11-5	SDO_GEOM.SDO_XOR	11-42
14-1	Translating a Geometric Segment.....	14-87
B-1	Variable-Sized Tile Spatial Indexing	B-2
B-2	Decomposition of the Geometry	B-3

List of Tables

1-1	Choosing R-tree or Quadtree Indexing	1-11
1-2	SDOINDEX Table Using Fixed-Size Tiles.....	1-19
2-1	Valid SDO_GTYPE Values	2-7
2-2	Values and Semantics in SDO_ELEM_INFO	2-12
2-3	Columns in the xxx_SDO_INDEX_INFO Views	2-30
2-4	Columns in the xxx_SDO_INDEX_METADATA Views.....	2-31
2-5	Columns in an R-tree Spatial Index Data Table	2-33
2-6	Columns in a Quadtree Spatial Index Data Table	2-34
2-7	Columns in the SDO_DIST_UNITS Table	2-35
2-8	Columns in the SDO_AREA_UNITS Table	2-35
5-1	MDSYS.CS_SRS Table.....	5-7
5-2	MDSYS.SDO_ANGLE_UNITS Table.....	5-11
5-3	MDSYS.SDO_DIST_UNITS Table.....	5-11
5-4	MDSYS.SDO_DATUMS Table.....	5-12
5-5	MDSYS.SDO_ELLIPSOIDS Table	5-14
5-6	MDSYS.SDO_PROJECTIONS Table	5-15
6-1	Highway Features and LRS Counterparts.....	6-21
8-1	Spatial Index Creation and Usage Statements	8-1
8-2	SDO_LEVEL and SDO_NUMTILES Combinations	8-16
9-1	SDO_GEOMETRY Type Methods	9-1
10-1	Spatial Usage Operators	10-1
10-2	Keywords for SDO_NN Parameter	10-6
11-1	Geometry Functions	11-1
12-1	Spatial Aggregate Functions	12-1
13-1	Functions and Procedures for Coordinate Systems	13-1
13-2	Table to Hold Transformed Layer.....	13-6
14-1	Functions for Creating and Editing Geometric Segments.....	14-1
14-2	Functions for Querying Geometric Segments	14-2
14-3	Functions for Converting Geometric Segments.....	14-3
14-4	Functions to Use Instead of SCALE_GEOM_SEGMENT.....	14-78
15-1	Migration Procedures	15-1
16-1	Tuning Functions and Procedures	16-1
17-1	Utility Functions and Procedures.....	17-1
B-1	Section of the SDOINDEX Table	B-4
C-1	Spatial Features Supported for Locator.....	C-2
C-2	Spatial Features Not Supported for Locator	C-3
C-3	Feature Availability with Standard and Enterprise Editions.....	C-4

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Preface

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

Oracle Spatial requires Oracle9i Enterprise Edition and is a priced option. 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 Oracle9i Standard and Enterprise Editions. It offers a subset of Oracle Spatial capabilities (see [Appendix C](#) for a list of Locator features) typically required to support Internet and wireless service applications and partner-based GIS solutions.

Oracle9i and Oracle9i Enterprise Edition 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 Oracle9i table partitioning, you must have the Enterprise Edition and the Partitioning Option.

For information about the differences between Oracle9i Standard Edition and Oracle9i Enterprise Edition and the features and options that are available to you, see *Oracle9i Database New Features*.

Note: The relational geometry model of Oracle Spatial is no longer supported, effective with this release. Only the object-relational model is supported.

This preface contains these topics:

- [Audience](#)

- [Documentation Accessibility](#)
- [Organization](#)
- [Technologies Released Separately](#)
- [Related Documentation](#)
- [Conventions](#)

Audience

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

Documentation Accessibility

Our goal is to make Oracle products, services, and supporting documentation accessible, with good usability, to the disabled community. To that end, our documentation includes features that make information available to users of assistive technology. This documentation is available in HTML format, and contains markup to facilitate access by the disabled community. Standards will continue to evolve over time, and Oracle Corporation is actively engaged with other market-leading technology vendors to address technical obstacles so that our documentation can be accessible to all of our customers. For additional information, visit the Oracle Accessibility Program Web site at

<http://www.oracle.com/accessibility>

Accessibility of Code Examples in Documentation

JAWS, a Windows screen reader, may not always correctly read the code examples in this document. The conventions for writing code require that closing braces should appear on an otherwise empty line; however, JAWS may not always read a line of text that consists solely of a bracket or brace.

Accessibility of Links to External Web Sites in Documentation

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Organization

This guide has two main parts (conceptual and usage information, and reference information) and several appendixes with supplementary information. The first part is organized for efficient learning about Oracle Spatial; 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).

This guide has the following elements.

Part I, "Conceptual and Usage Information"

Contains chapters with conceptual and usage information.

Chapter 1, "Spatial Concepts"

Introduces spatial data concepts.

Chapter 2, "Spatial Data Types and Metadata"

Explains the object-relational schema.

Chapter 3, "Loading Spatial Data"

Explains how to load spatial data.

Chapter 4, "Indexing and Querying Spatial Data"

Explains how to index and query spatial data.

Chapter 5, "Coordinate Systems (Spatial Reference Systems)"

Provides conceptual and usage information about coordinate system (spatial reference system) support.

Chapter 6, "Linear Referencing System"

Provides conceptual and usage information about the Oracle Spatial linear referencing system (LRS).

Chapter 7, "Extending Spatial Indexing Capabilities"

Explains how to extend the capabilities of Oracle Spatial indexing.

Part II, "Reference Information"

Contains chapters with reference information.

Chapter 8, "SQL Statements for Indexing Spatial Data"

Provides the syntax and semantics for SQL indexing statements.

Chapter 9, "SDO_GEOMETRY Object Type Methods"

Provides the syntax and semantics for methods used with the spatial object data type.

Chapter 10, "Spatial Operators"

Provides the syntax and semantics for operators used with the spatial object data type.

Chapter 11, "Geometry Functions"

Provides the syntax and semantics for the geometric functions and procedures.

Chapter 12, "Spatial Aggregate Functions"

Provides the syntax and semantics for the spatial aggregate functions.

Chapter 13, "Coordinate System Transformation Functions"

Provides the syntax and semantics for the coordinate system transformation functions.

Chapter 14, "Linear Referencing Functions"

Provides the syntax and semantics for the linear referencing (LRS) functions.

Chapter 15, "Migration Procedures"

Provides the syntax and semantics for the migration functions.

Chapter 16, "Tuning Functions and Procedures"

Provides the syntax and semantics for the tuning functions and procedures.

Chapter 17, "Utility Functions"

Provides the syntax and semantics for the utility functions and procedures.

Other: Supplementary Information

Contains appendixes with supplementary Information, and a glossary.

Appendix A, "Installation, Compatibility, and Migration"

Describes installation, compatibility, and migration issues.

Appendix B, "Hybrid Indexing"

Describes hybrid indexing.

Appendix C, "Locator"

Describes Oracle Locator.

Glossary

Defines important terms.

Technologies Released Separately

Technologies of interest to spatial application developers, but not officially part of Oracle Spatial, are sometimes made available through the Oracle Technology Network (OTN). To access the OTN, go to

<http://otn.oracle.com>

Related Documentation

For more information, see the following documents:

- *Oracle9i Database New Features*
- *Oracle9i Database Administrator's Guide*
- *Oracle9i Application Developer's Guide - Fundamentals*
- *Oracle9i Application Developer's Guide - Workspace Manager*
- *Oracle9i Database Error Messages* - Spatial messages are in the range of 13000 to 13499.
- *Oracle9i Database Concepts*
- *Oracle9i Database Performance Guide and Reference*
- *Oracle9i Database Utilities*

In North America, printed documentation is available for sale in the Oracle Store at

<http://oraclestore.oracle.com/>

Customers in Europe, the Middle East, and Africa (EMEA) can purchase documentation from

<http://www.oraclebookshop.com/>

Other customers can contact their Oracle representative to purchase printed documentation.

To download free release notes, installation documentation, white papers, or other collateral, go to the Oracle Technology Network (OTN). You must register online before using OTN; registration is free and can be done at

<http://otn.oracle.com/admin/account/membership.html>

If you already have a username and password for OTN, then you can go directly to the documentation section of the OTN Web site at

<http://otn.oracle.com/docs/index.htm>

To access the database documentation search engine directly, go to

<http://tahiti.oracle.com>

Conventions

In examples, an implied carriage return occurs at the end of each line, unless otherwise noted. You must press the Return key at the end of a line of input.

The following conventions are used in this guide:

Convention	Meaning
.	Vertical ellipsis points in an example mean that information not directly related to the example has been omitted.
...	Horizontal ellipsis points in statements or commands mean that parts of the statement or command not directly related to the example have been omitted
boldface text	Boldface text indicates a term defined in the text, the glossary, or in both locations.
< >	Angle brackets enclose user-supplied names.
[]	Brackets enclose optional clauses from which you can choose one or none.
%	The percent sign represents the system prompt on a UNIX system.

New and Changed Features

This section describes new and changed Oracle Spatial features for Release 9.2.

Validation with Context

You can now validate a geometry or a layer and obtain additional information about the context (the coordinate, edge, or ring) that causes any geometry to be invalid.

- The new [SDO_GEOM.VALIDATE_GEOMETRY_WITH_CONTEXT](#) function performs the same checks as the [SDO_GEOM.VALIDATE_GEOMETRY](#) function, but also includes context information if the geometry is not valid.
- The new [SDO_GEOM.VALIDATE_LAYER_WITH_CONTEXT](#) procedure performs the same checks as the [SDO_GEOM.VALIDATE_LAYER](#) procedure, but also includes context information about any invalid geometries.

Both of these new interfaces are documented in [Chapter 11](#).

Note that [SDO_GEOM.VALIDATE_GEOMETRY](#) function and [SDO_GEOM.VALIDATE_LAYER](#) procedure are deprecated and will not be supported in future release of Spatial. You are encouraged to switch to the new interfaces.

Utility Functions

A new Spatial utility package (SDO_UTIL) is provided, with the following functions.

- The [SDO_UTIL.EXTRACT](#) function returns the geometry that represents a specified element (and optionally a ring) of the input geometry

- The `SDO_UTIL.GETVERTICES` function returns the coordinates of the vertices of the input geometry.

The utility functions are documented in [Chapter 17](#).

Partitioned Spatial Indexes: Splitting and Merging Supported

`ALTER TABLE` partitioning statements for splitting and merging partitions, which were not supported in the previous release, are now supported. For information about using partitioned Spatial indexes, see [Section 4.1.7](#).

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, as explained in [Section 4.1.8](#). In the previous release of Spatial, this operation caused an error to be generated.

Parallel Index Creation and Rebuilding

Spatial indexes can now be created and rebuilt using parallel execution. The { `NOPARALLEL` | `PARALLEL` [integer] } option is supported for the `CREATE INDEX` and `ALTER INDEX REBUILD` statements, which are documented in [Chapter 8](#).

Deferred Modifications to an Index

Modifications to a spatial index can be deferred until after spatial table insert, update, and delete operations are finished, and then the index can be synchronized with the table. See the description of the `index_status` keyword for the `ALTER INDEX` statement in [Chapter 8](#).

SDO_CS.VIEWPORT_TRANSFORM to_sname Parameter Not Supported

The `SDO_CS.VIEWPORT_TRANSFORM` function format with the `to_sname` parameter, which was supported in the previous release, is no longer supported. You must use the format with the `to_srid` parameter.

Part I

Conceptual and Usage Information

This document has two main parts:

- Part I provides conceptual and usage information about Oracle Spatial.
- Part II provides reference information about Oracle Spatial methods, operators, functions, and procedures.

Appendixes with supplementary information follow Part II.

Part I is organized for efficient learning about Oracle Spatial. 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:

- [Chapter 1, "Spatial Concepts"](#)
- [Chapter 2, "Spatial Data Types and Metadata"](#)
- [Chapter 3, "Loading Spatial Data"](#)
- [Chapter 4, "Indexing and Querying Spatial Data"](#)
- [Chapter 5, "Coordinate Systems \(Spatial Reference Systems\)"](#)
- [Chapter 6, "Linear Referencing System"](#)
- [Chapter 7, "Extending Spatial Indexing Capabilities"](#)

Spatial Concepts

Oracle Spatial is an integrated set of functions and procedures that enables spatial data to be stored, accessed, and analyzed quickly and efficiently in an Oracle9i 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.

1.1 What Is Oracle Spatial?

Oracle Spatial, often referred to as Spatial, provides a SQL schema and functions that facilitate the storage, retrieval, update, and query of collections of spatial features in an Oracle9i database. Spatial consists of the following components:

- A schema (MDSYS) that prescribes the storage, syntax, and semantics of supported geometric data types
- A spatial indexing mechanism
- A set of operators and functions for performing area-of-interest queries, spatial join queries, and other spatial analysis operations
- Administrative utilities

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**.

1.2 Object-Relational Model

Spatial supports the **object-relational** model for representing geometries. The object-relational model uses a table with a single column of MDSYS.SDO_GEOMETRY and a single row per geometry instance. The object-relational model

corresponds to a "SQL with Geometry Types" implementation of spatial feature tables in the OpenGIS ODBC/SQL specification for geospatial features.

Note: The relational geometry model of Oracle Spatial is no longer supported, effective with this release. Only the object-relational model is supported.

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 Oracle9i database server
- Geometries modeled in a single row and single column
- Optimal performance

1.3 Introduction to Spatial Data

Oracle Spatial is designed to make spatial data management easier and more natural to users of location-enabled applications and Geographic Information System (GIS) applications. Once this data is stored in an Oracle database, it can be easily manipulated, retrieved, and related to all the 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 (latitude and longitude, or height and depth) 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 that can be stored using Spatial other than GIS data 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 only in the relative sizes of the data, not the data's complexity. The systems might all actually 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 are off by a few tenths of an inch, the engine will not run. A printed circuit board is likely to have many thousands of objects etched on its surface that are no bigger than the smallest detail 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 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

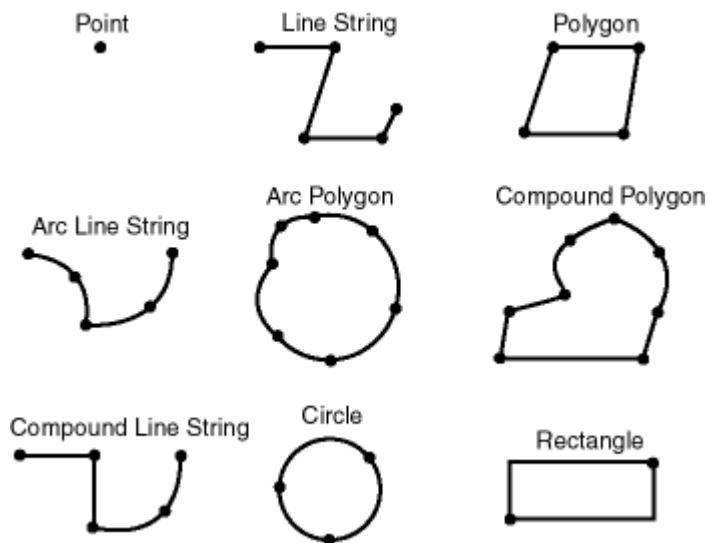
Two-dimensional points are elements composed of two ordinates, X and Y, often corresponding to longitude and latitude. **Line strings** are composed of one or more

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.

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.

Figure 1-1 illustrates the geometric types.

Figure 1-1 Geometric Types



Spatial 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. However, spatial functions (except for LRS functions and MBR-related functions) can work with only the first two dimensions, and all spatial operators except [SDO_FILTER](#) are disabled if the spatial index has been created on more than two dimensions.

1.5 Data Model

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

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.

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 the interior ring of a polygon with holes are considered as two distinct elements that together make up a complex polygon.

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). Each layer's geometries and associated spatial index 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 automatically return results in another specified unit (such as miles). (For more information about unit of measurement support, see [Section 2.6](#).)

Before Oracle Spatial release 8.1.6, geometries (objects of type SDO_GEOMETRY) were stored as strings of coordinates without reference to any specific coordinate system. Spatial functions and operators always assumed a coordinate system that had the properties of an orthogonal Cartesian system, and sometimes did not provide correct results if Earth-based geometries were stored in latitude and longitude coordinates. With release 8.1.6, Spatial provided support for many different coordinate systems, and for converting data freely between different coordinate systems.

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 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, including geodetic, projected, and local coordinates and coordinate system transformation, see [Chapter 5](#).

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 non-negative 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 [Section 1.5.4](#).)

- 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.
- 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 105 feet), and a tolerance value of 2 indicates a tolerance of two miles.

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

A tolerance value is specified in two cases:

- In the geometry metadata definition for a layer (see [Section 1.5.5.1](#))
- As an optional input parameter to certain functions (see [Section 1.5.5.2](#))

1.5.5.1 In the Geometry Metadata for a Layer

The dimensional information for a layer includes a tolerance value. Specifically, the DIMINFO column (described in [Section 2.4.3](#)) of the xxx_SDO_GEOM_METADATA views includes an SDO_TOLERANCE value.

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 [Section 2.1](#), the actual distance between geometries *cola_b* and *cola_d* is 0.846049894. If a query uses the [SDO_GEOM.SDO_DISTANCE](#) 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 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.

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 the 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 [Section 2.1](#)), the appropriate value is 0.5. However, if geometries are defined using numbers up to 4 decimal positions (for example, 31.2587), such as with longitude and latitude values, the appropriate value is 0.00005.

Note: This guideline, however, 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 As an Input Parameter

Many Spatial functions accept an optional *tolerance* parameter, which (if specified) overrides the default tolerance value for the layer (explained in [Section 1.5.5.1](#)). If the distance between two points is less than or equal to the tolerance value, Spatial 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.

1.6 Query Model

Spatial 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.

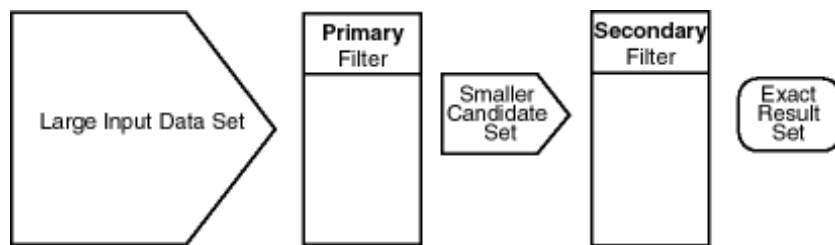
- The **primary filter** permits fast selection of candidate records to pass along to the secondary filter. The primary filter compares geometry approximations to reduce computation complexity and is considered a lower-cost filter. Because

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](#) illustrates the relationship between the primary and secondary filters.

Figure 1-2 Query Model



As shown in [Figure 1-2](#), 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 uses a spatial index to implement the primary filter. Spatial 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 [Section 4.2](#).

1.7 Indexing of Spatial Data

The introduction of spatial indexing capabilities into the Oracle database engine is a key feature of the Spatial product. A spatial index, like any other index, provides a mechanism to limit searches, but in this case 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)

A spatial index is considered a logical index. The entries in the spatial index are dependent on the location of the geometries in a coordinate space, but the index values are in a different domain. Index entries may be ordered using a linearly ordered domain, and the coordinates for a geometry may be pairs of integer, floating-point, or double-precision numbers.

Oracle Spatial lets you use R-tree indexing (the default) or quadtree indexing, or both. Each index type is appropriate in different situations. You can maintain both an R-tree and quadtree index on the same geometry column, by using the *add_index* parameter with the [ALTER INDEX](#) statement (described in [Chapter 8](#)), and you can choose which index to use for a query by specifying the *idxtab1* and/or *idxtab2* parameters with certain Spatial operators, such as [SDO_RELATE](#), described in [Chapter 10](#).

In choosing whether to use an R-tree or quadtree index for a spatial application, consider the items in [Table 1-1](#).

Table 1-1 *Choosing R-tree or Quadtree Indexing*

R-tree Indexing	Quadtree Indexing
The approximation of geometries cannot be fine-tuned. (Spatial uses the minimum bounding rectangles, as described in Section 1.7.1 .)	The approximation of geometries can be fine-tuned by setting the tiling level and number of tiles.
Index creation and tuning are easier.	Tuning is more complex, and setting the appropriate tuning parameter values can affect performance significantly.
Less storage is required.	More storage is required.
If your application workload includes nearest-neighbor queries (SDO_NN operator), R-tree indexes are faster.	If your application workload includes nearest-neighbor queries (SDO_NN operator), quadtree indexes are slower.

Table 1–1 Choosing R-tree or Quadtree Indexing (Cont.)

R-tree Indexing	Quadtree Indexing
If there is heavy update activity to the spatial column, an R-tree index may not be a good choice.	Heavy update activity does not affect the performance of a quadtree index.
You can index up to four dimensions.	You can index only two dimensions.
An R-tree index is recommended for indexing geodetic data if <code>SDO_WITHIN_DISTANCE</code> queries will be used on it.	
An R-tree index is required for a whole-earth index.	

Testing of R-tree and quadtree indexes with many workloads and operators is ongoing, and results and recommendations will be documented as they become available. However, before choosing an index type for an application, you should understand the concepts and options associated with both R-tree indexing (described in [Section 1.7.1](#)) and quadtree indexing (described in [Section 1.7.2](#)).

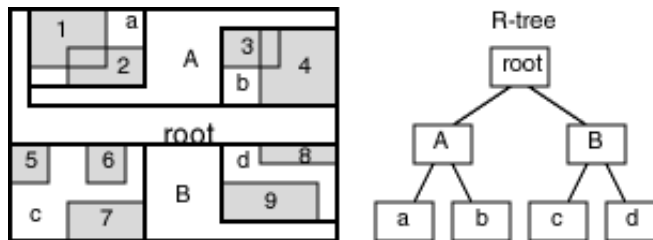
1.7.1 R-tree Indexing

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](#).

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](#).

Figure 1–4 R-tree Hierarchical Index on MBRs



In [Figure 1-4](#):

- 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 [Section 2.5](#)). The R-tree index also maintains a sequence number generator (`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.

1.7.1.1 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.

Spatial provides several functions and procedures related to the quality of an R-tree index:

- [SDO_TUNE.ANALYZE_RTREE](#) provides advice about whether or not an index needs to be rebuilt. It computes the current index quality score and compares it to the quality score when the index was created or most recently rebuilt, and it displays a recommendation.
- [SDO_TUNE.RTREE_QUALITY](#) returns the current index quality score.
- [SDO_TUNE.QUALITY_DEGRADATION](#) returns the current index quality degradation.

These functions and procedures are described in [Chapter 16](#).

To rebuild an R-tree index, use the [ALTER INDEX REBUILD](#) statement, which is described in [Chapter 8](#).

1.7.2 Quadtree Indexing

In the linear quadtree indexing scheme, the coordinate space (for the layer where all geometric objects are located) is subjected to a process called **tessellation**, which defines exclusive and exhaustive cover tiles for every stored geometry. Tessellation is done by decomposing the coordinate space in a regular hierarchical manner. The range of coordinates, the coordinate space, is viewed as a rectangle. At the first level of decomposition, the rectangle is divided into halves along each coordinate dimension generating four tiles. Each tile that interacts with the geometry being tessellated is further decomposed into four tiles. This process continues until some termination criteria, such as size of the tiles or the maximum number of tiles to cover the geometry, is met.

Spatial can use either fixed-size or variable-sized tiles to cover a geometry:

- Fixed-size tiles are controlled by tile resolution. If the resolution is the sole controlling factor, then tessellation terminates when the coordinate space has been decomposed a specific number of times. Therefore, each tile is of a fixed size and shape.
- Variable-sized tiling is controlled by the value supplied for the maximum number of tiles. If the number of tiles per geometry, n , is the sole controlling factor, the tessellation terminates when n tiles have been used to cover the given geometry.

Fixed-size tile resolution and the number of variable-sized tiles used to cover a geometry are user-selectable parameters called `SDO_LEVEL` and `SDO_NUMTILES`, respectively. Smaller fixed-size tiles or more variable-sized tiles provides better geometry approximations. The smaller the number of tiles, or the larger the tiles, the coarser are the approximations.

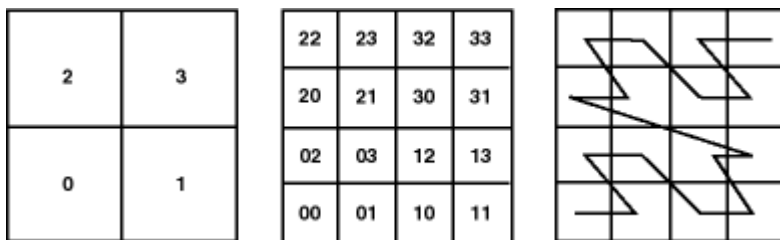
Spatial supports two quadtree indexing types, reflecting two valid combinations of `SDO_LEVEL` and `SDO_NUMTILES` values:

- **Fixed indexing:** a non-null and non-zero `SDO_LEVEL` value and a null or zero (0) `SDO_NUMTILES` value, resulting in fixed-sized tiles. Fixed indexing is described in [Section 1.7.2.2](#).
- **Hybrid indexing:** non-null and non-zero values for `SDO_LEVEL` and `SDO_NUMTILES`, resulting in two sets of tiles per geometry. One set contains fixed-size tiles and the other set contains variable-sized tiles. Hybrid indexing is *not recommended* for most spatial applications, and is described in [Appendix B](#).

1.7.2.1 Tessellation of a Layer During Indexing

The process of determining which tiles cover a given geometry is called **tessellation**. The tessellation process is a quadtree decomposition, where the two-dimensional coordinate space is broken down into four covering tiles of equal size. Successive tessellations divide those tiles that interact with the geometry down into smaller tiles, and this process continues until the desired level or number of tiles has been achieved. The results of the tessellation process on a geometry are stored in a table, referred to as the `SDOINDEX` table.

The tiles at a particular level can be linearly sorted by systematically visiting tiles in an order determined by a space-filling curve as shown in [Figure 1-5](#). The tiles can also be assigned unique numeric identifiers, known as Morton codes or z-values. The terms tile and tile code will be used interchangeably in this and other sections related to spatial indexing.

Figure 1–5 Quadtree Decomposition and Morton Codes

1.7.2.2 Fixed Indexing

Fixed spatial indexing uses tiles of equal size to cover a geometry. Because all the tiles are the same size, they all have codes of the same length, and the standard SQL equality operator (=) can be used to compare tiles during a join operation. This results in excellent performance characteristics.

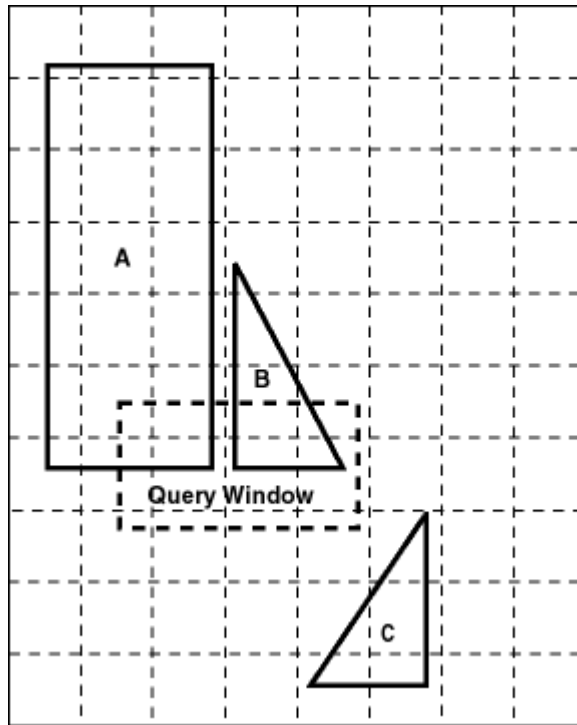
Two geometries are likely to interact, and hence pass the primary filter stage, if they share one or more tiles. The SQL statement for the primary filter stage is:

```
SELECT DISTINCT <select_list for geometry identifiers>
  FROM table1_sdoindex A, table2_sdoindex B
  WHERE A.sdo_code = B.sdo_code
```

The effectiveness and efficiency of this indexing method depends on the tiling level and the variation in size of the geometries in the layer. If you select a small fixed-size tile to cover small geometries and then try to use the same size tile to cover a very large geometry, a large number of tiles would be required. However, if the chosen tile size is large, so that fewer tiles are generated in the case of a large geometry, then the index selectivity suffers because the large tiles do not approximate the small geometries very well. [Figure 1–6](#) and [Figure 1–7](#) illustrate the relationships between tile size, selectivity, and the number of cover tiles.

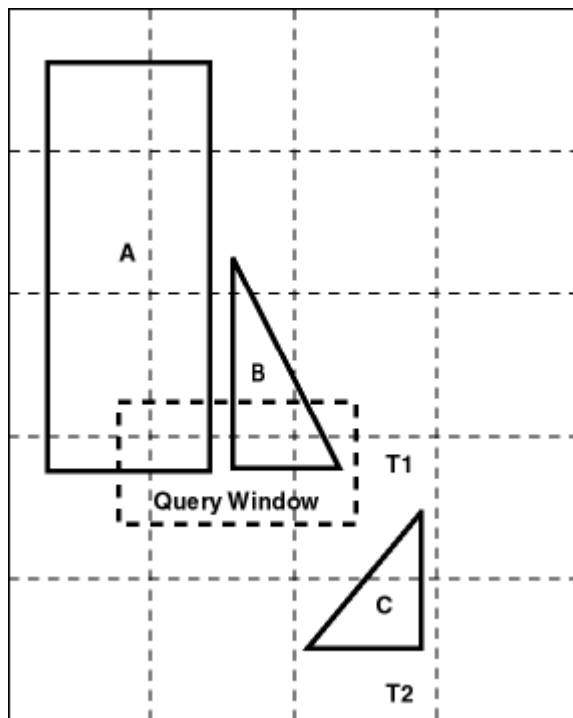
With a small fixed-size tile as shown in [Figure 1–6](#), selectivity is good, but a large number of tiles is needed to cover large geometries. A window query would easily identify geometries A and B, but would reject C.

Figure 1-6 Fixed-Size Tiling with Many Small Tiles



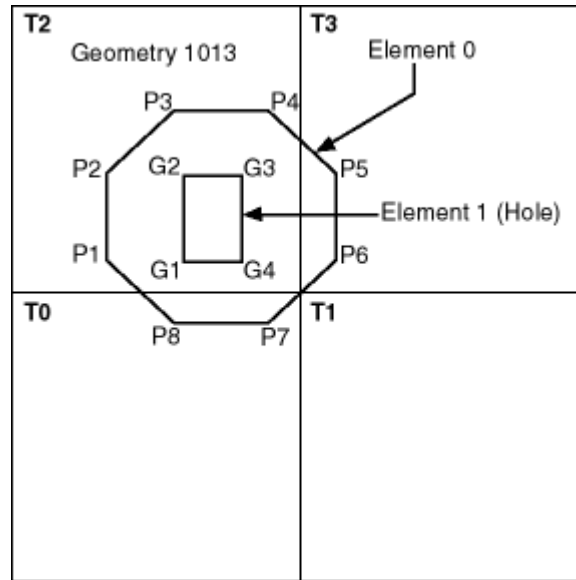
With a large fixed-size tile as shown in [Figure 1-7](#), fewer tiles are needed to cover the geometries, but the selectivity is not as good. The same window query as in [Figure 1-6](#) would probably pick up all three geometries. Any object that shares tile T1 or T2 would identify object C as a candidate, even though the objects may be far apart, such as objects B and C are in [Figure 1-7](#).

Figure 1–7 Fixed-Size Tiling with Fewer Large Tiles



You can use the [SDO_TUNE.ESTIMATE_TILING_LEVEL](#) function or the tiling wizard of the Spatial Index Advisor tool in Oracle Enterprise Manager to help determine an appropriate tiling level for your data set.

[Figure 1–8](#) illustrates geometry 1013 tessellated to three fixed-sized tiles at level 1. The codes for these cover tiles are then stored in an SDOINDEX table.

Figure 1-8 Tessellated Geometry

Only three of the four tiles generated by the first tessellation interact with the geometry. Only those tiles that interact with the geometry are stored in the SDOINDEX table, as shown in [Table 1-2](#). In this example, three fixed-size tiles are used. The table structure is shown for illustrative purposes only, because you should not directly access the index tables.

Table 1-2 SDOINDEX Table Using Fixed-Size Tiles

SDO_GID <number>	SDO_CODE <raw>
1013	T0
1013	T2
1013	T3

All elements in a geometry are tessellated. In a multielement geometry such as 1013, Element 1 is already covered by tile T2 from the tessellation of Element 0. If, however, the specified tiling resolution was such that tile T2 was further subdivided

and one of these smaller tiles was completely contained in Element 1, then that tile would be excluded because it would not interact with the geometry.

1.8 Spatial Relations and Filtering

Spatial uses secondary filters to determine the spatial relationship between entities in the database. The spatial relation is based on geometry locations. The most common spatial relations 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 relations, Spatial has several secondary filter methods:

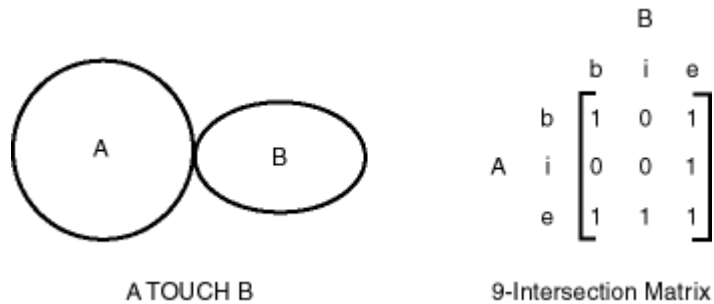
- The [SDO_RELATE](#) operator evaluates topological criteria.
- The [SDO_WITHIN_DISTANCE](#) operator determines if two spatial objects are within a specified distance of each other.
- The [SDO_NN](#) operator identifies the nearest neighbors for a spatial object.

The syntax of these operators is given in [Chapter 10](#).

The [SDO_RELATE](#) operator implements a 9-intersection model for categorizing binary topological relations 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 consists of its end points. 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.

Given that an object A has 3 components (a boundary A_b , an interior A_i , and an exterior A_e), any pair of objects has 9 possible interactions between their components. Pairs of components have an empty (0) or a non-empty (1) set intersection. The set of interactions between 2 geometries is represented by a 9-intersection matrix that specifies which pairs of components intersect and which do not. [Figure 1-9](#) shows the 9-intersection matrix for 2 polygons that are adjacent to one another. This matrix yields the following bit mask, generated in row-major form: “101001111”.

Figure 1–9 The 9-Intersection Model

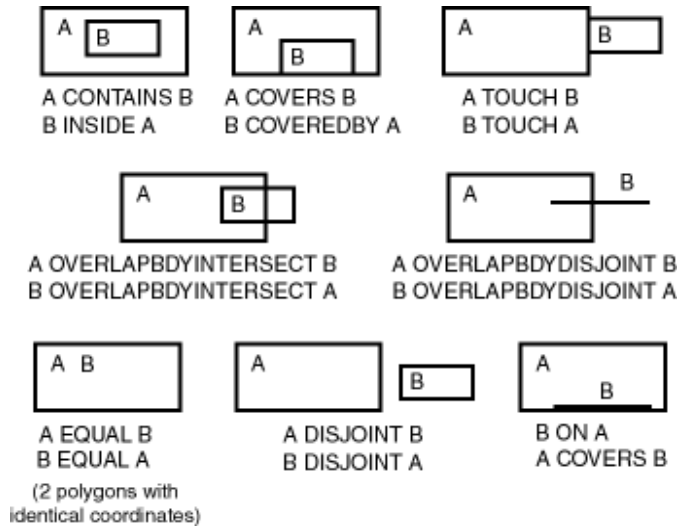


Some of the topological relationships identified in the seminal work by Professor Max Egenhofer (University of Maine, Orono) and colleagues have names associated with them. Spatial uses the following names:

- 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 interior of one object is completely contained in the interior of the other object and their boundaries 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 (and the second object covers the first object). This relationship occurs, for example, when a line is on the boundary of a polygon.
- ANYINTERACT -- The objects are non-disjoint.

Figure 1–10 illustrates these topological relationships.

Figure 1–10 Topological Relationships



The `SDO_WITHIN_DISTANCE` 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 1–11 shows the distance buffers for a point, a line, and a polygon.

Figure 1–11 Distance Buffers for Points, Lines, and Polygons



In the geometries shown in Figure 1–11:

- 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` 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 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;
```

Oracle 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 the geometries in a table (using the definitions and data from [Section 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(MDSYS.SDOAGGRTYPE(c.shape, 0.005))
       FROM cola_markets c WHERE c.name < 'cola_d';
```

All geometries used with spatial aggregate functions must be defined using 4-digit `SDO_GTYPE` values (that is, must be in the format used by Oracle Spatial release 8.1.6 or higher). For information about `SDO_GTYPE` values, see [Section 2.2.1](#).

For reference information about the spatial aggregate functions and examples of their use, see [Chapter 12](#).

1.9.1 SDOAGGRTYPE Object Type

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

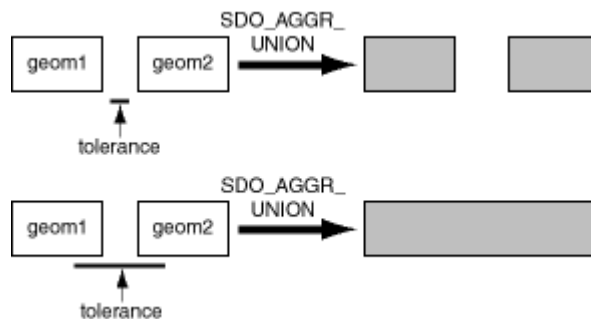
```
CREATE TYPE sdoaggrtype AS OBJECT (
  geometry MDSYS.SDO_GEOMETRY,
  tolerance NUMBER);
```

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` 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 [Section 1.5.5](#); for information about the `xxx_SDO_GEOM_METADATA` views, see [Section 2.4](#).

The *tolerance* value in the `SDOAGGRTYPE` definition can affect the result of a spatial aggregate function. [Figure 1-12](#) shows a spatial aggregate union (`SDO_AGGR_UNION`) operation of two geometries using two different tolerance values: one smaller and one larger than the distance between the geometries.

Figure 1-12 Tolerance in an Aggregate Union Operation



In the first aggregate union operation in [Figure 1-12](#), 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.

1.10 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 is 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 result of the geocoding operation is *-71.34937, 42.46101*.

Given a geocoded address, you can then perform proximity or location queries using a spatial engine, such as Oracle Spatial, or demographic analysis using tools and data from Oracle's business partners. In addition, geocoded data can be used 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.

Oracle Spatial is integrated with all major geocoding service providers. The usual and recommended approach for application developers is to use the API for the geocoding provider to obtain a geocoded result (longitude/latitude coordinate pair) for an address, and then use these coordinates to construct an MDSYS.SDO_GEOMETRY object for input to a spatial operator, function, or procedure.

1.11 Performance and Tuning Information

Many factors can affect the performance of Oracle Spatial applications, such as the indexing method (R-tree or quadtree), the SOD_LEVEL value for a quadtree index, and 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, [Section 1.7](#) includes performance-related items among the considerations for choosing an R-tree or quadtree index.

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 users. To find that information on the OTN, go to

<http://otn.oracle.com>

Search for *Spatial*, and then search for white papers relevant to performance and tuning.

1.12 Spatial Release (Version) Number

To check which release of Spatial you are running, use the `SDO_VERSION` function. For example:

```
SELECT SDO_VERSION FROM DUAL;
```

```
SDO_VERSION
```

```
-----  
9.0.1
```

The `SDO_VERSION` function replaces the `SDO_ADMIN.SDO_VERSION` function, which was available with the deprecated relational model of Oracle Spatial.

1.13 Spatial Application Hardware Requirement Considerations

This section discusses some general guidelines that affect the amount of disk storage space and CPU power needed for spatial applications. They are not, however, intended to replace any other guidelines you use for general application sizing, but to supplement them.

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*.

1.14 Spatial Error Messages

Spatial error message numbers are in the range of 13000 to 13499. The messages are documented in *Oracle9i Database Error Messages*.

1.15 Spatial Examples

Oracle Spatial provides examples that you can use to reinforce your learning and to create models for coding certain operations. Several examples are provided in the following directory:

`$ORACLE_HOME/md/demos/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, as well as several functions and procedures:

- Inserting, indexing, and querying spatial data ([Section 2.1](#))
- Coordinate systems (spatial reference systems) ([Section 5.8](#))
- Linear referencing system (LRS) ([Section 6.6](#))

Spatial Data Types and Metadata

The object-relational implementation of Oracle Spatial consists 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:

- [Section 2.1, "Simple Example: Inserting, Indexing, and Querying Spatial Data"](#)
- [Section 2.2, "SDO_GEOMETRY Object Type"](#)
- [Section 2.3, "Geometry Examples"](#)
- [Section 2.4, "Geometry Metadata Structure"](#)
- [Section 2.5, "Spatial Index-Related Structures"](#)
- [Section 2.6, "Unit of Measurement Support"](#)

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

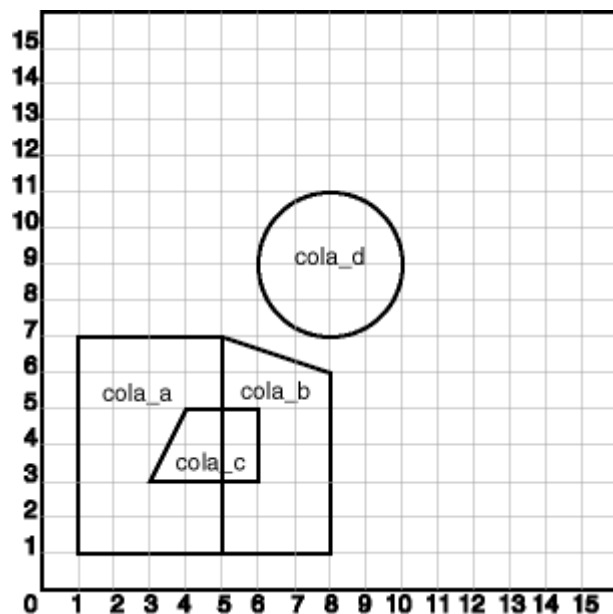
This section presents a simple example of creating a spatial table, inserting data, creating the spatial index, and performing spatial queries. It refers to concepts that were explained in [Chapter 1](#) and that will be explained in other sections of this chapter.

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 shows the areas of interest for four colas.

Figure 2-1 Areas of Interest for Simple Example



Example 2-1 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 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
-- Section 2.4.1 and Section 2.4.2.)

CREATE TABLE cola_markets (
    mkt_id NUMBER PRIMARY KEY,
    name VARCHAR2(32),
    shape MDSYS.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',
    MDSYS.SDO_GEOMETRY(
        2003, -- 2-dimensional polygon
        NULL,
        NULL,
        MDSYS.SDO_ELEM_INFO_ARRAY(1,1003,3), -- one rectangle (1003 = exterior)
        MDSYS.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',
    MDSYS.SDO_GEOMETRY(
```

```

        2003, -- 2-dimensional polygon
        NULL,
        NULL,
        MDSYS.SDO_ELEM_INFO_ARRAY(1,1003,1), -- one polygon (exterior polygon ring)
        MDSYS.SDO_ORDINATE_ARRAY(5,1, 8,1, 8,6, 5,7, 5,1)
    )
);

```

```

INSERT INTO cola_markets VALUES(
    3,
    'cola_c',
    MDSYS.SDO_GEOMETRY(
        2003, -- 2-dimensional polygon
        NULL,
        NULL,
        MDSYS.SDO_ELEM_INFO_ARRAY(1,1003,1), -- one polygon (exterior polygon ring)
        MDSYS.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',
    MDSYS.SDO_GEOMETRY(
        2003, -- 2-dimensional polygon
        NULL,
        NULL,
        MDSYS.SDO_ELEM_INFO_ARRAY(1,1003,4), -- one circle
        MDSYS.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
VALUES (

```

```
'cola_markets',
'shape',
MDSYS.SDO_DIM_ARRAY( -- 20X20 grid
  MDSYS.SDO_DIM_ELEMENT('X', 0, 20, 0.005),
  MDSYS.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 created an R-tree index.
-- Following line was for an earlier quadtree index:
--   PARAMETERS('SDO_LEVEL = 8');

-----
-- 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));
EXECUTE SDO_GEOM.VALIDATE_LAYER_WITH_CONTEXT('COLA_MARKETS', 'SHAPE',
      'VAL_RESULTS', 2);
SELECT * from val_results;
```

2.2 SDO_GEOMETRY Object Type

In the Spatial object-relational model, 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 geometry tables.

Oracle Spatial 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 MDSYS.SDO_ELEM_INFO_ARRAY,
  SDO_ORDINATES MDSYS.SDO_ORDINATE_ARRAY);
```

Oracle Spatial 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;
```

The sections that follow describe the semantics of each `SDO_GEOMETRY` attribute, and then describe some usage considerations ([Section 2.2.6](#)).

The `SDO_GEOMETRY` object type has methods that provide convenient access to some of the attributes. These methods are described in [Chapter 9](#).

2.2.1 SDO_GTYPE

SDO_GTYPE 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 default of the last dimension as the measure for an LRS geometry, specify 0. For information about the linear referencing system (LRS), see [Chapter 6](#).
- *tt* identifies the geometry type (00 through 07, with 08 through 99 reserved for future use).

[Table 2-1](#) 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
<i>d</i> 00	UNKNOWN_GEOMETRY	Spatial ignores this geometry.
<i>d</i> 01	POINT	Geometry contains one point.
<i>d</i> 02	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.)
<i>d</i> 03	POLYGON	Geometry contains one polygon with or without holes. ¹
<i>d</i> 04	COLLECTION	Geometry is a heterogeneous collection of elements. ² COLLECTION is a superset that includes all other types.
<i>d</i> 05	MULTIPOINT	Geometry has one or more points. (MULTIPOINT is a superset of POINT.)
<i>d</i> 06	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.)

Table 2–1 Valid SDO_GTYPE Values

Value	Geometry Type	Description
<i>d</i> 07	MULTIPOLYGON	Geometry can have multiple, disjoint polygons (more than one exterior boundary). (MULTIPOLYGON is a superset of POLYGON.)

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

² Polygons in the collection can be disjoint.

The *d* in the Value column of [Table 2–1](#) is the number of dimensions: 2, 3, or 4. For example, an SDO_GTYPE value of 2003 indicates a two-dimensional polygon.

Note: The pre-release 8.1.6 format of a 1-digit SDO_GTYPE value is still supported. If a 1-digit value is used, however, Oracle Spatial determines the number of dimensions from the DIMINFO column of the metadata views described in [Section 2.4](#).

Also, if 1-digit SDO_GTYPE values are converted to 4-digit values, any SDO_ETYPE values that end in 3 or 5 in the SDO_ELEM_INFO array (described in [Section 2.2.4](#)) must also be converted.

The number of dimensions reflects the number of ordinates used to represent each vertex (for example, X,Y for two-dimensional objects). Points and lines are considered two-dimensional objects. (However, see [Section 6.2](#) for dimension information about LRS points.)

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 *d*l*tt* components of the SDO_GTYPE for a geometry object: [GET_DIMS](#), [GET_LRS_DIM](#), and [GET_GTYPE](#). These methods are described in [Chapter 9](#).

2.2.2 SDO_SRID

SDO_SRID 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 MDSYS.CS_SRS table (described in [Section 5.4.1](#)), and this

value must be inserted into the SRID column of the USER_SDO_GEOM_METADATA view (described in [Section 2.4](#)).

All geometries in a geometry column must have the same SDO_SRID value.

For information about coordinate systems, see [Chapter 5](#).

2.2.3 SDO_POINT

SDO_POINT 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 [Section 2.2](#).) If the SDO_ELEM_INFO and SDO_ORDINATES arrays are both null, and the SDO_POINT attribute is non-null, then the X and Y values are considered to be the coordinates for a point geometry. Otherwise, the SDO_POINT attribute is ignored by Spatial. 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.

[Section 2.3.5](#) 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. For information about LRS, see [Chapter 6](#).

2.2.4 SDO_ELEM_INFO

SDO_ELEM_INFO 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 [Section 2.2.5](#)).

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 [Figure 2-3](#) later in this chapter).

- SDO_ETYPE - Indicates the type of the element. Valid values are shown in [Table 2-2](#).

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 migrate the table or layer to the current format using the [SDO_MIGRATE.TO_CURRENT](#) procedure, described in [Chapter 15](#).

You cannot mix 1-digit and 4-digit SDO_ETYPE values in a single geometry. If you use 4-digit SDO_ETYPE values, you must use 4-digit SDO_GTYPE values.

SDO_ETYPE values 4, 1005, and 2005 considered *compound elements*. They contain at least one header triplet with a series of triplet values that belong to the compound element. For SDO_ETYPE values 1005 and 2005, 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)

Note: The use of 5 as an SDO_ETYPE value for polygon ring elements in a single geometry is discouraged. You should specify 5 only if you do not know if the compound polygon is exterior or interior, and you should then migrate the table or layer to the current format using the [SDO_MIGRATE.TO_CURRENT](#) procedure, described in [Chapter 15](#).

You cannot mix 1-digit and 4-digit SDO_ETYPE values in a single geometry. If you use 4-digit SDO_ETYPE values, you must use 4-digit SDO_GTYPE values.

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](#).

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 and 5), 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 `OCIColSize` 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](#).

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. For more information, see Section 2.3.6 .
1	1	Point type.
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 arc's start point, any point on the arc, and the arc's end point. 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.
1003 or 2003	1	Simple polygon whose vertices are connected by straight line segments. Note that you must specify a point for each vertex, and the last point specified must be identical to the first (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	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. Each circular arc is described using three coordinates: the arc's start point, any point on the arc, and the arc's end point. 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, and point 3 is not repeated.

Table 2–2 Values and Semantics in SDO_ELEM_INFO (Cont.)

SDO_ETYPE	SDO_INTERPRETATION	Meaning
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.</p> <p>Using this type (that is, defining a rectangle using only two points) is not supported for geodetic data; it is supported only for data associated with a Cartesian coordinate system. With geodetic data, define a rectangle using 5 points (with point 5 the same as point 1) and an SDO_INTERPRETATION value of 1. (You can also use the SDO_CS.VIEWPORT_TRANSFORM function to convert optimized rectangles to valid geodetic rectangles for use with the SDO_FILTER operator.)</p>
1003 or 2003	4	Circle type. Described by three 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, n, in the Interpretation column specifies the number of contiguous subelements that make up the line string.</p> <p>The next n 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 Section 2.3.3 and Figure 2–4 for an example of a geometry using this type.</p>
1005 or 2005	$n > 1$	<p>Compound polygon with some vertices connected by straight line segments and some by circular arcs. The value, n, in the Interpretation column specifies the number of contiguous subelements that make up the polygon.</p> <p>The next n 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 the same.</p> <p>See Section 2.3.4 and Figure 2–5 for an example of a geometry using this type.</p>

2.2.5 SDO_ORDINATES

SDO_ORDINATES 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 3-dimensional, then they are stored as {X1, Y1, Z1, X2, Y2, Z2, X3, Y3, Z3, X4, Y4, Z4, X1, Y1, Z1}. Spatial index creation, operators, and functions ignore the Z values because this release of the product supports only two-dimensional spatial objects. The number of dimensions associated with each point is stored as metadata in the xxx_SDO_GEOM_METADATA views, described in [Section 2.4](#).

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 previously. 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 [Table 2-1](#); however, Spatial does not check or enforce all geometry consistency constraints. Spatial 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 [Section 2.2.4](#)).

The [SDO_GEOM.VALIDATE_GEOMETRY](#) function can be used to evaluate the consistency of a single geometry object or all the instances of SDO_GEOMETRY in a specified feature table.

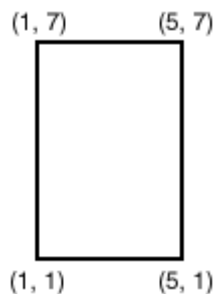
2.3 Geometry Examples

This section contains examples of several geometry types.

2.3.1 Rectangle

Figure 2-2 illustrates the rectangle that represents *cola_a* in the example in Section 2.1.

Figure 2-2 Rectangle



In the SDO_GEOMETRY definition of the geometry illustrated in Figure 2-2:

- 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 2-2 shows a SQL statement that inserts the geometry illustrated in Figure 2-2 into the database.

Example 2-2 SQL Statement to Insert a Rectangle

```
INSERT INTO cola_markets VALUES(  
  1,  
  'cola_a',  
  MDSYS.SDO_GEOMETRY(  
    2003, -- 2-dimensional polygon  
    NULL,
```

```

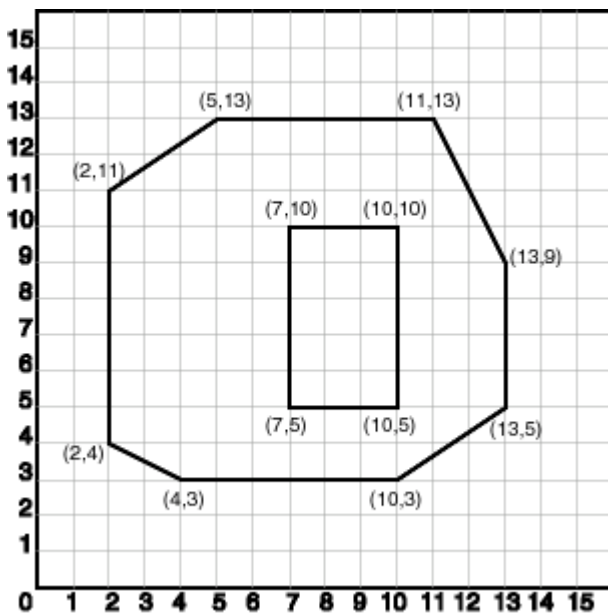
NULL,
MDSYS.SDO_ELEM_INFO_ARRAY(1,1003,3), -- one rectangle (1003 = exterior)
MDSYS.SDO_ORDINATE_ARRAY(1,1, 5,7) -- only 2 points needed to
-- define rectangle (lower left and upper right) with
-- Cartesian-coordinate data
)
);

```

2.3.2 Polygon with a Hole

Figure 2-3 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 2-3 Polygon with a Hole



In the SDO_GEOMETRY definition of the geometry illustrated in Figure 2-3:

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

Example 2-3 SQL Statement to Insert a Polygon with a Hole

```
INSERT INTO cola_markets VALUES(
  10,
  'polygon_with_hole',
  MDSYS.SDO_GEOMETRY(
    2003, -- 2-dimensional polygon
    NULL,
    NULL,
    MDSYS.SDO_ELEM_INFO_ARRAY(1,1003,1, 19,2003,1), -- polygon with hole
    MDSYS.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

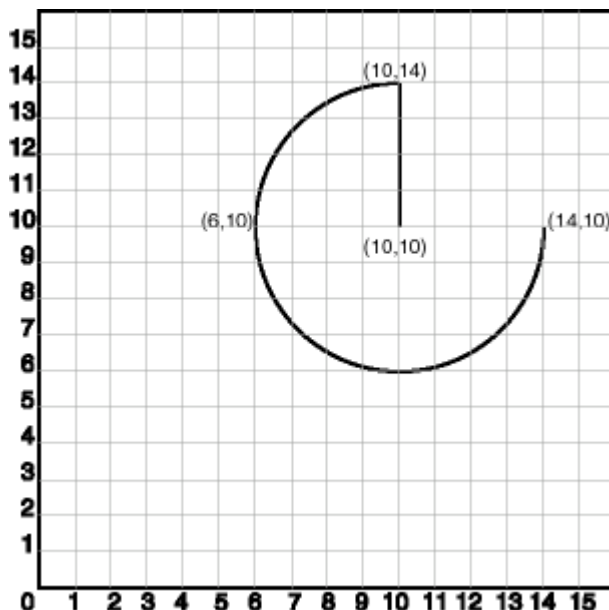
The elements in SDO_ELEM_INFO and SDO_ORDINATES must be in one of the following orders (depending on whether you specify Polygon A or Polygon B first):

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

2.3.3 Compound Line String

[Figure 2-4](#) 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), (10,6), and (14,10) describe the circular arc.

Figure 2-4 Compound Line String



In the SDO_GEOMETRY definition of the geometry illustrated in [Figure 2-4](#):

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

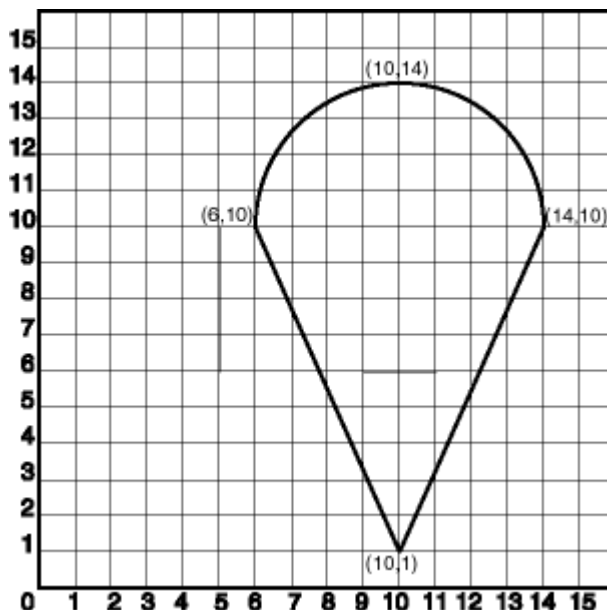
Example 2-4 SQL Statement to Insert a Compound Line String

```
INSERT INTO cola_markets VALUES(  
    11,  
    'compound_line_string',  
    MDSYS.SDO_GEOMETRY(  
        2002,  
        NULL,  
        NULL,  
        MDSYS.SDO_ELEM_INFO_ARRAY(1,4,2, 1,2,1, 3,2,2), -- compound line string  
        MDSYS.SDO_ORDINATE_ARRAY(10,10, 10,14, 6,10, 14,10)  
    )  
);
```

2.3.4 Compound Polygon

[Figure 2-5](#) 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 2-5 Compound Polygon



In the SDO_GEOMETRY definition of the geometry illustrated in [Figure 2-5](#):

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

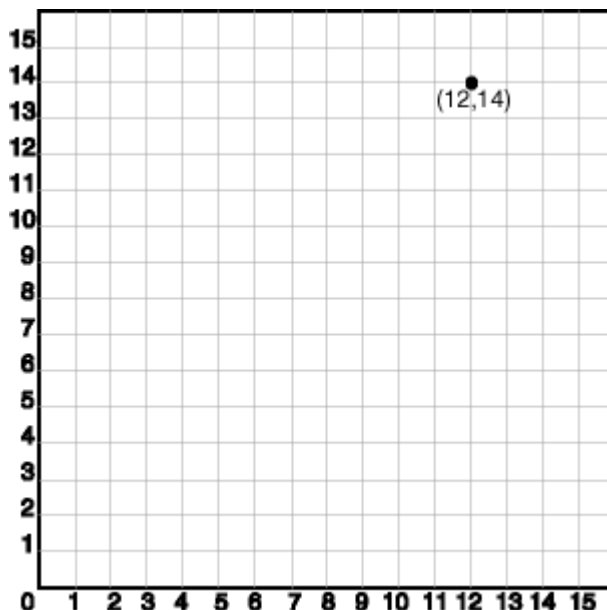
Example 2-5 SQL Statement to Insert a Compound Polygon

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

2.3.5 Point

[Figure 2-6](#) illustrates a point-only geometry at coordinates (12,14).

Figure 2–6 Point-Only Geometry



In the SDO_GEOMETRY definition of the geometry illustrated in [Figure 2–6](#):

- SDO_GTYPE = 2001. The 2 indicates two-dimensional, and the 1 indicates a single point.
- SDO_SRID = NULL.
- SDO_POINT = MDSYS.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 [Section 2.2.3](#).

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

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

Example 2–6 SQL Statement to Insert a Point-Only Geometry

```
INSERT INTO cola_markets VALUES(
```

```

90,
'point_only',
MDSYS.SDO_GEOMETRY(
  2001,
  NULL,
  MDSYS.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 2-7](#) 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 2-6](#).

Example 2-7 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
-----
SHAPE(SDO_GTYPE, SDO_SRID, SDO_POINT(X, Y, Z), SDO_ELEM_INFO, SDO_ORDINATES)
-----
          90 point_only
SDO_GEOMETRY(2001, NULL, SDO_POINT_TYPE(12, 14, NULL), NULL, NULL)

```

2.3.6 Type 0 (Zero) Element

Type 0 (zero) elements are used to model geometry types that are not supported by Oracle Spatial, such as curves and splines. A type 0 element has an SDO_ETYPE value of 0. (See [Section 2.2.4](#) for information about the SDO_ETYPE.) Type 0 elements are not indexed by Oracle Spatial, 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
- An SDO_INTERPRETATION value that is valid for the SDO_ETYPE value (see [Table 2-2](#))

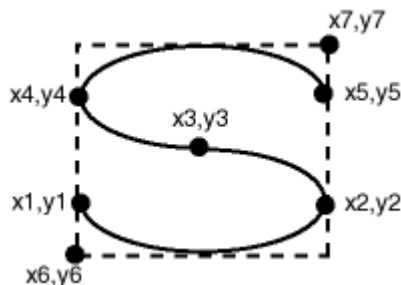
(The SDO_INTERPRETATION value for the type 0 element can be any numeric value, and applications are responsible for determining the validity and significance of the value.)

The nonzero element is indexed by Spatial, and 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 2-7 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 2-7 Geometry with Type 0 (Zero) Element



In the example shown in Figure 2-7:

- 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 2-8 shows a SQL statement that inserts the geometry with a type 0 element (similar to the geometry illustrated in [Figure 2-7](#)) 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 2-8 SQL Statement to Insert a Geometry with a Type 0 Element

```
INSERT INTO cola_markets VALUES(
  13,
  'type_zero_element_geom',
  MDSYS.SDO_GEOMETRY(
    2003, -- 2-dimensional polygon
    NULL,
    NULL,
    MDSYS.SDO_ELEM_INFO_ARRAY(1,0,57, 11,1003,3), -- 1st is type 0 element
    MDSYS.SDO_ORDINATE_ARRAY(6,6, 12,6, 9,8, 6,10, 12,10, 6,4, 12,12)
  )
);
```

2.4 Geometry Metadata Structure

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 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 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.

- `DBA_SDO_GEOM_METADATA` contains metadata information for all spatial tables on which the user has `SELECT` permission if the user has the DBA role.

Spatial 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 ensures that the other two views (`ALL_SDO_GEOM_METADATA` and `DBA_SDO_GEOM_METADATA`) are also updated to reflect the rows that you insert into `USER_SDO_GEOM_METADATA`.

Note: These views were new for release 8.1.6. If you are migrating from an earlier release of Spatial, see [Appendix A](#) and the information about the [SDO_MIGRATE.TO_CURRENT](#) procedure in [Chapter 15](#).

Each metadata view has the following definition:

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

In addition, the `ALL_SDO_GEOM_METADATA` and `DBA_SDO_GEOM_METADATA` views have an `OWNER` column identifying the schema that owns the table specified in `TABLE_NAME`.

2.4.1 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.

2.4.2 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).

2.4.3 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 [Section 1.5.5](#), especially [Section 1.5.5.1](#).

Spatial 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.

[Example 2–1](#) in [Section 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.

2.4.4 SRID

The SRID column should contain either of the following: the SRID value for the coordinate system (see [Chapter 5](#)) for all geometries in the column, or NULL if no specific coordinate system should be associated with the geometries.

2.5 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 [Section 1.7](#). The spatial index data and metadata are stored in tables that are created and maintained by the Spatial 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.

2.5.1 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, DBA, or ALL. These views are read-only to users; they are created and maintained by the Spatial indexing routines.

2.5.1.1 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.

- `DBA_SDO_INDEX_INFO` contains index information for all spatial tables on which the user has `SELECT` permission if the user has the `DBA` role.

The `USER_SDO_INDEX_INFO`, `ALL_SDO_INDEX_INFO`, and `DBA_SDO_INDEX_INFO` views contain the same columns, as shown [Table 2-3](#), 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 2-3 Columns in the xxx_SDO_INDEX_INFO Views

Column Name	Data Type	Purpose
<code>SDO_INDEX_OWNER</code>	<code>VARCHAR2</code>	Owner of the index (<code>ALL_SDO_INDEX_INFO</code> and <code>DBA_SDO_INDEX_VIEWS</code> only).
<code>INDEX_NAME</code>	<code>VARCHAR2</code>	Name of the index.
<code>TABLE_NAME</code>	<code>VARCHAR2</code>	Name of the table containing the column on which this index is built.
<code>COLUMN_NAME</code>	<code>VARCHAR2</code>	Name of the column on which this index is built.
<code>SDO_INDEX_TYPE</code>	<code>VARCHAR2</code>	Contains <code>QTREE</code> (for a quadtree index) or <code>RTREE</code> (for an R-tree index).
<code>SDO_INDEX_TABLE</code>	<code>VARCHAR2</code>	Name of the spatial index table (described in Section 2.5.2).
<code>SDO_INDEX_STATUS</code>	<code>VARCHAR2</code>	Contains <code>DEFERRED</code> if the index status has been set to deferred (using the <code>index_status</code> keyword with the <code>ALTER INDEX</code> statement) and <code>VALID</code> if the index status is not deferred.

2.5.1.2 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. (`USER_SDO_INDEX_METADATA` is the same as `SDO_INDEX_METADATA`, which was the only metadata view for Oracle Spatial release 8.1.5.)
- `ALL_SDO_INDEX_METADATA` contains index information for all spatial tables on which the user has `SELECT` permission.
- `DBA_SDO_INDEX_METADATA` contains index information for all spatial tables on which the user has `SELECT` permission if the user has the `DBA` role.

Note: These views were new for release 8.1.6. If you are migrating from an earlier release of Spatial, see [Appendix A](#).

The USER_SDO_INDEX_METADATA, ALL_SDO_INDEX_METADATA, and DBA_SDO_INDEX_METADATA views contain the same columns, as shown [Table 2-4](#). (The columns are listed in their order in the view definition.)

Table 2-4 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 QTREE (for a quadtree index) or RTREE (for an R-tree index).
SDO_INDEX_NAME	VARCHAR2	Name of the index.
SDO_INDEX_TABLE	VARCHAR2	Name of the spatial index table (described in Section 2.5.2).
SDO_INDEX_PRIMARY	NUMBER	Indicates if this is a primary or secondary index. 1 = primary, 2 = secondary.
SDO_INDEX_PARTITION	VARCHAR2	For a partitioned index, name of the index partition.
SDO_PARTITIONED	NUMBER	Contains 0 if the index is not partitioned or 1 if the index is partitioned.
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_INDEX_DIMS	NUMBER	Number of dimensions of the geometry objects in the column on which this index is built.
SDO_RTREE_HEIGHT	NUMBER	Height of the R-tree for an R-tree index.
SDO_RTREE_NUM_NODES	NUMBER	Number of nodes in the R-tree for an R-tree index.
SDO_RTREE_DIMENSIONALITY	NUMBER	Number of dimensions indexed for an R-tree index.
SDO_RTREE_FANOUT	NUMBER	Maximum number of children in each R-tree node for an R-tree index.

Table 2-4 Columns in the xxx_SDO_INDEX_METADATA Views (Cont.)

Column Name	Data Type	Purpose
SDO_RTREE_ROOT	VARCHAR2	Rowid corresponding to the root node of the R-tree in the index table for an R-tree index.
SDO_RTREE_SEQ_NAME	VARCHAR2	Sequence name associated with the R-tree for an R-tree index.
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_LAYER_GTYPE	VARCHAR2	Contains DEFAULT if the layer can contain both point and polygon data, or a value from the Geometry Type column of Table 2-1 in Section 2.2.1 .
SDO_LEVEL	NUMBER	The fixed tiling level at which to tile all objects in the geometry column for a quadtree index.
SDO_NUMTILES	NUMBER	Suggested number of tiles per object that should be used to approximate the shape for a quadtree index.
SDO_MAXLEVEL	NUMBER	Maximum level for any tile for any object for a quadtree index. It will always be greater than the SDO_LEVEL value.
SDO_COMMIT_INTERVAL	NUMBER	Number of geometries (rows) to process, during index creation, before committing the insertion of spatial index entries into the SDOINDEX table.
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 SQL CREATE TABLE statement.
SDO_NEXT_EXTENT	VARCHAR2	Same as in SQL CREATE TABLE statement.
SDO_PCTINCREASE	NUMBER	Same as in SQL CREATE TABLE statement.
SDO_MIN_EXTENTS	NUMBER	Same as in SQL CREATE TABLE statement.
SDO_MAX_EXTENTS	NUMBER	Same as in SQL CREATE TABLE statement.

Table 2–4 Columns in the xxx_SDO_INDEX_METADATA Views (Cont.)

Column Name	Data Type	Purpose
SDO_RTREE_QUALITY	NUMBER	Quality score for an R-tree index. Do not attempt to interpret this value directly; instead, use the SDO_TUNE.ANALYZE_RTREE procedure and the SDO_TUNE.QUALITY_DEGRADATION function, which are described in Chapter 16 .
SDO_INDEX_VERSION	NUMBER	Internal version number of the index.
SDO_INDEX_GEODETTIC	VARCHAR2	Contains TRUE if the index is geodetic (see Section 4.1.4) and FALSE if the index is not geodetic.
SDO_INDEX_STATUS	VARCHAR2	Contains DEFERRED if the index status has been set to deferred (using the <i>index_status</i> keyword with the ALTER INDEX statement) and VALID if the index status is not deferred.

2.5.2 Spatial Index Table Definition

The information in each quadtree spatial index table (each SDO_INDEX_TABLE entry as described in [Table 2–4](#) in [Section 2.5.1](#)) depends on whether the index is an R-tree index or a quadtree index.

For an R-tree index, the spatial index table contains the columns shown in [Table 2–5](#).

Table 2–5 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 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 <i><child_mbr, child_rowid></i> pairs (maximum of fanout value, or number of children in each R-tree node, such pairs), where <i>child_rowid</i> is the rowid of a child node, or the rowid of a data item from the base table.

For a quadtree index, the spatial index table contains the columns shown in [Table 2–6](#).

Table 2–6 Columns in a Quadtree Spatial Index Data Table

Column Name	Data Type	Purpose
SDO_CODE	RAW	Index entry for the object in the row identified by SDO_ROWID.
SDO_ROWID	ROWID	Rowid of a row in a feature table containing the indexed object.
SDO_STATUS	VARCHAR2	Contains <i>I</i> if the tile is inside the geometry, or contains <i>B</i> if the tile is on the boundary of the geometry.
SDO_GROUPCODE	RAW	Index entry at level SDO_LEVEL (hybrid indexes only).

For a quadtree index, the SDO_CODE, SDO_ROWID, and SDO_STATUS columns are always present. The SDO_GROUPCODE column is present only when the selected index type is HYBRID.

2.5.3 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 [Table 2–4](#) in [Section 2.5.1](#)). 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\$ associated with the index table MDRT_5C01\$).

2.6 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 [Chapter 5](#).

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 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 SDO_UNIT value from the MDSYS.SDO_DIST_UNITS or MDSYS.SDO_AREA_UNITS table. For example, 'unit=KM' in the following example (using data and definitions from [Example 5-3](#) in [Section 5.8](#)) 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 uses the information in the MDSYS.SDO_DIST_UNITS and MDSYS.SDO_AREA_UNITS tables to determine which unit names are valid and what ratios to use in comparing or converting between different units.

The MDSYS.SDO_DIST_UNITS table contains the columns shown in [Table 2-7](#).

Table 2-7 Columns in the SDO_DIST_UNITS Table

Column Name	Data Type	Purpose
SDO_UNIT	VARCHAR2	Unit string to be specified with the <i>unit</i> parameter. Examples: <i>M, KM, CM, MM, MILE, NAUT_MILE, FOOT, INCH</i>
UNIT_NAME	VARCHAR2	Descriptive name of the unit. Examples: <i>Meter, Kilometer, Centimeter, Millimeter, Mile, Nautical Mile, Foot, Inch</i>
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.

The MDSYS.SDO_AREA_UNITS table contains the columns shown in [Table 2-8](#).

Table 2-8 Columns in the SDO_AREA_UNITS Table

Column Name	Data Type	Purpose
SDO_UNIT	VARCHAR2	Unit string to be specified with the <i>unit</i> parameter. Examples: <i>SQ_M, SQ_KM, SQ_CM, SQ_MM, SQ_MILE, SQ_FOOT, SQ_INCH</i>

Table 2–8 Columns in the SDO_AREA_UNITS Table (Cont.)

Column Name	Data Type	Purpose
UNIT_NAME	VARCHAR2	Descriptive name of the unit. Examples: <i>Square Meter, Square Kilometer, Square Centimeter, Square Millimeter, Square Mile, Square Foot, Square Inch</i>
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.

For a complete list of supported unit strings, unit names, and conversion factors, view the contents of the MDSYS.SDO_DIST_UNITS and MDSYS.SDO_AREA_UNITS tables. For example:

```
SELECT * from MDSYS.SDO_DIST_UNITS;  
SELECT * from MDSYS.SDO_AREA_UNITS;
```

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 [Chapter 4](#).

The process of loading data can be classified into two categories:

- Bulk loading of data
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
This process is used to insert relatively small amounts of data into the database using the INSERT statement in SQL.

3.1 Bulk Loading

Bulk loading can import large amounts of ASCII data into an Oracle database. Bulk loading is accomplished with the SQL*Loader utility. (For information about SQL*Loader, see *Oracle9i Database Utilities*.)

3.1.1 Bulk Loading SDO_GEOMETRY Objects

[Example 3-1](#) 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](#) in [Section 2.1](#).

Example 3-1 Control File for 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 3-1](#):

- 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 3-2](#) assumes that a table named `POLY_4PT` was created as follows:

```

CREATE TABLE POLY_4PT (GID          VARCHAR2(32),
                       GEOMETRY     MDSYS.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 3–2](#) shows the control file for loading the data.

Example 3–2 Control File for Bulk Load of Polygons

```
LOAD DATA
  INFILE *
  TRUNCATE
  CONTINUEIF NEXT(1:1) = '#'
  INTO TABLE POLY_4PT
  FIELDS TERMINATED BY '|'
  TRAILING NULLCOLS (
    GID INTEGER EXTERNAL,
    GEOM 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|/
```

3.1.2 Bulk Loading Point-Only Data in SDO_GEOMETRY Objects

[Example 3–3](#) shows a control file for loading a table with point data.

Example 3–3 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|
  200
  1| -122.4215| 37.7862|
  2|
  200
  1| -122.4019| 37.8052|
  3|
  200
  1| -122.426| 37.803|
  4|
  200
  1| -122.4171| 37.8034|
  5|
  200
  1| -122.416151| 37.8027228|

```

3.2 Transactional Insert Operations Using SQL

Oracle Spatial uses standard Oracle9i tables that can be accessed or loaded with standard SQL syntax. This section contains examples of transactional inserts into columns of type SDO_GEOMETRY. Note that 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 3-4](#) creates a procedure to perform the insert operation.

Example 3-4 Procedure to Perform Transactional Insert Operation

```
CREATE OR REPLACE PROCEDURE
    INSERT_GEOM(GEOM MDSYS.SDO_GEOMETRY)
IS
BEGIN
    INSERT INTO TEST_1 VALUES (GEOM);
    COMMIT;
END;
/
```

Using the procedure created in [Example 3-4](#), you can insert data by using a PL/SQL block, such as the one in [Example 3-5](#), which loads a geometry into the variable named *geom* and then invokes the `INSERT_GEOM` procedure to insert that geometry.

Example 3-5 PL/SQL Block Invoking Procedure to Insert a Geometry

```
DECLARE
geom mdsys.sdo_geometry :=
    mdsys.sdo_geometry (2003, null, null,
        mdsys.sdo_elem_info_array (1,1003,3),
        mdsys.sdo_ordinate_array (-109,37,-102,40));
BEGIN
    INSERT_GEOM(geom);
    COMMIT;
END;
/
```

For additional examples with various geometry types, see the following:

- Rectangle: [Example 2-2](#) in [Section 2.3.1](#)
- Polygon with a hole: [Example 2-3](#) in [Section 2.3.2](#)
- Compound polygon: [Example 2-5](#) in [Section 2.3.4](#)
- Point: [Example 2-6](#) and [Example 2-7](#) in [Section 2.3.5](#)

- Type 0 (zero) element: [Example 2–8 in Section 2.3.6](#)

Indexing and Querying Spatial Data

After you have loaded spatial data (discussed in [Chapter 3](#)), 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
- Query spatial data efficiently, based on an understanding of the Oracle Spatial query model and primary and secondary filtering

4.1 Creating a Spatial Index

Once data has been loaded into the spatial tables through either bulk or transactional loading, a spatial index must be created on the tables for efficient access to the data. Each spatial index can be an R-tree index or a quadtree index. To decide which type of index to use for a spatial application, you must understand the concepts and guidelines discussed in [Section 1.7](#).

If the index creation does not complete for any reason, the index is invalid and must be deleted with the [DROP INDEX](#) <index_name> [FORCE] statement.

4.1.1 Creating R-Tree Indexes

If you create a spatial index without specifying any quadtree-specific parameters, an R-tree index is created. For example, the following statement creates a spatial R-tree index named *territory_idx* using default values for parameters that apply to R-tree indexes:

```
CREATE INDEX territory_idx ON territories (territory_geom)
  INDEXTYPE IS MDSYS.SPATIAL_INDEX;
```

For detailed information about options when creating a spatial index, see the documentation for the [CREATE INDEX](#) statement in [Chapter 8](#).

R-tree indexes can be built on two, three, or four dimensions of data. The default number of dimensions for an R-tree index 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. However, if a spatial index has been built on more than two dimensions of a layer, the only spatial operator that can be used against that layer is [SDO_FILTER](#) (the primary filter or index-only query), which considers all dimensions. The [SDO_RELATE](#), [SDO_NN](#), and [SDO_WITHIN_DISTANCE](#) operators are disabled if the index has been built on more than two dimensions.

If the rollback segment is not large enough, an attempt to create an R-tree index will fail. The rollback segment should be $100*n$ 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 an R-tree 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 that are available to the schema that owns the table with the geometries. 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. For information about performing these operations on a rollback segment, see the *Oracle9i Database Administrator's Guide*.

The system 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 an R-tree 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;
```

The tablespace specified with the `tablespace` keyword in the [CREATE INDEX](#) 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.

- The R-tree index data table requires approximately $70*n$ bytes (where n is the number of rows in the table)

- The transient tables require up to approximately $200*n$ bytes (where n is the number of rows in the table); however, this space is freed up after the R-tree index is created.

For large databases (over 1 million rows), a temporary tablespace may be needed to perform internal sorting operations. The recommended size for this temporary tablespace is $100*n$ bytes, where n is the number of rows in the table.

4.1.2 Determining Index Creation Behavior (Quadtree Indexes)

With a quadtree index, the tessellation algorithm used by the [CREATE INDEX](#) statement and by index maintenance routines on insert or update operations is determined by the `SDO_LEVEL` and `SDO_NUMTILES` values, which are supplied in the `PARAMETERS` clause of the [CREATE INDEX](#) statement. They are interpreted as follows:

<code>SDO_LEVEL</code>	<code>SDO_NUMTILES</code>	Action
Not specified or 0	Not specified or 0	R-tree index.
≥ 1	Not specified or 0	Fixed indexing (indexing with fixed-size tiles).
≥ 1	≥ 1	Hybrid indexing with fixed-size and variable-sized tiles. The <code>SDO_LEVEL</code> column defines the fixed tile size. The <code>SDO_NUMTILES</code> column defines the number of variable tiles to generate per geometry.
Not specified or 0	≥ 1	Not supported (error).

An explicit commit operation is executed after the tessellation of all the geometries in a geometry column.

By default, spatial index creation requires a sizable amount of rollback space. To reduce the amount of rollback space required, you can supply the `SDO_COMMIT_INTERVAL` parameter in the [CREATE INDEX](#) statement. This will perform a database commit after every n geometries are indexed, where n is a user-defined value.

4.1.3 Spatial Indexing with Fixed-Size Tiles (Quadtree Indexes)

If you choose quadtree indexing for a spatial index, you should use fixed indexing for most applications, except for the rare circumstances where hybrid indexing should be considered. (See [Appendix B](#) for information about hybrid indexing.)

However, you should also consider using R-tree indexing before deciding on hybrid indexing.)

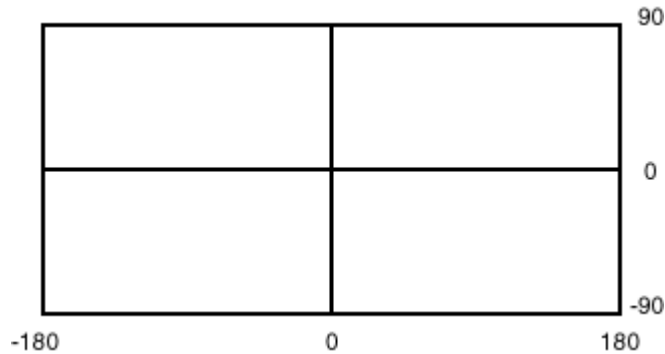
The fixed-size tile algorithm is expressed as a level referring to the number of tessellations performed. To use fixed-size tile indexing, omit the `SDO_NUMTILES` parameter and set the `SDO_LEVEL` value to the desired tiling level. The relationship between the tiling level and the resulting size of the tiles depends on the domain of the layer.

The domain used for indexing is defined by the upper and lower boundaries of each dimension stored in the `DIMINFO` column of the `USER_SDO_GEOM_METADATA` view, which contains an entry for the table and geometry column to spatially index. A typical domain could be -180 to 180 degrees for longitude, and -90 to 90 degrees for latitude, as represented in [Figure 4-1](#). (The transference of the domain onto a sphere or other projection is left up to an application, unless a coordinate system is specified, as explained in [Chapter 5](#).)

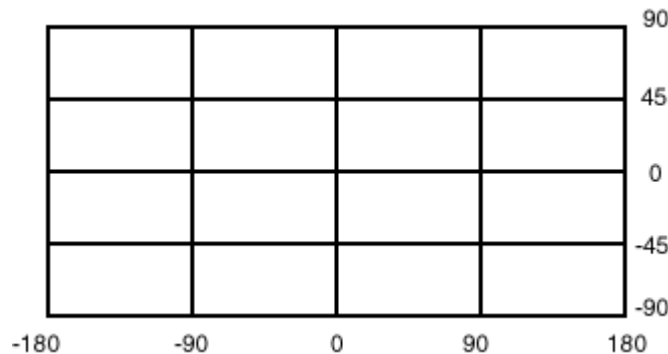
Figure 4-1 Sample Domain



If the `SDO_LEVEL` column is set to 1, then the tiles created by the indexing mechanism are the same size as tiles at the first level of tessellation. Each tile would be 180 degrees by 90 degrees as shown in [Figure 4-2](#).

Figure 4–2 Fixed-Size Tiling at Level 1

The formula for the number of fixed-size tiles in a domain is 4^n where n is the number of tessellations, stored in the SDO_LEVEL column. In reality, tiles are only generated where geometries exist, and not for the whole domain. [Figure 4–3](#) shows fixed-size tiling at level 2. In this figure, each tile is 90 degrees by 45 degrees.

Figure 4–3 Fixed-Size Tiling at Level 2

The size of a tile can be determined by applying the following formula to each dimension:

$$\text{length} = (\text{upper_bound} - \text{lower_bound}) / 2^{\text{sdo_level}}$$

The length refers to the length of the tile along the specified dimension. Applying this formula to the tiling shown in [Figure 4–3](#) yields the following sizes:

```
length for dimension X = (180 - (-180) ) / 2^2
                       = (360) / 4
                       = 90
length for dimension Y = (90 - (-90) ) / 2^2
                       = (180) / 4
                       = 45
```

At level 2, the tiles are 90 degrees by 45 degrees in size. As the number of levels increases, the tiles become smaller and smaller. Smaller tiles provide a more precise fit of the tiles over the geometry being indexed. However, because the number of tiles generated is unbounded, you must take into account the performance implications of using higher levels.

Note: The Spatial Index Advisor component of Oracle Enterprise Manager can be used to determine an appropriate level for indexing with fixed-size tiles. The [SDO_TUNE.ESTIMATE_TILING_LEVEL](#) function, described in [Chapter 16](#), can also be used for this purpose; however, this function performs less analysis than the Spatial Index Advisor.

Besides the performance aspects related to selecting a fixed-size tile, tessellating the geometry into fixed-size tiles might have benefits related to the type of data being stored, such as using tiles sized to represent 1-acre farm plots, city blocks, or individual pixels on a display. Data modeling, an important part of any database design, is essential in a spatial database where the data often represents actual physical locations.

In [Example 4-1](#), assume that data has been loaded into a table called `ROADS`, and the `USER_SDO_GEOM_METADATA` view has an entry for `ROADS.SHAPE`. You can use the following SQL statement to create a fixed index named `ROADS_FIXED`.

Example 4-1 Creating a Fixed Index

```
CREATE INDEX ROADS_FIXED ON ROADS(SHAPE) INDEXTYPE IS MDSYS.SPATIAL_INDEX
  PARAMETERS('SDO_LEVEL=8');
```

The `SDO_LEVEL` value is used while tessellating objects. Increasing the level results in smaller tiles and better geometry approximations.

4.1.4 Indexing Geodetic Data

To take full advantage of Spatial features, you must index geodetic data using a geodetic R-tree index. *Geodetic data* consists of geometries that have geodetic SDO_SRID values, reflecting the fact that they are based on a geodetic coordinate system (such as using longitude and latitude) as opposed to a flat or projected plane coordinate system. (Chapter 5 explains coordinate systems and related concepts.) A *geodetic index* is one that provides the full range of Spatial features with geodetic data. Thus, it is highly recommended that you use a geodetic index with geodetic data.

Only R-tree indexes can be geodetic indexes. Quadtree indexes cannot be geodetic indexes. If you create an R-tree or quadtree index and specify `'geodetic=false'` in the [CREATE INDEX](#) statement, the index is non-geodetic. The following notes and restrictions apply to non-geodetic indexes:

- If you create a non-geodetic index on geodetic data, you cannot use the *unit* parameter with the [SDO_WITHIN_DISTANCE](#) operator or the [SDO_NN_DISTANCE](#) ancillary operator with the [SDO_NN](#) operator.
- If you create a non-geodetic index on projected data that has a projected SDO_SRID value, you can use the full range of Spatial features.
- If you create a non-geodetic index on projected data that has a null SDO_SRID value, you cannot use the *unit* parameter with the [SDO_WITHIN_DISTANCE](#) operator or the [SDO_NN_DISTANCE](#) ancillary operator with the [SDO_NN](#) operator.

For additional information, see the Usage Notes about the *geodetic* parameter for the [CREATE INDEX](#) statement in [Chapter 8](#).

4.1.5 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](#) or [ALTER INDEX REBUILD](#) statement, and specify a value from the Geometry Type column of [Table 2-1](#) in [Section 2.2.1](#). 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 [Table 2-1](#) 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.

4.1.6 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. User B must perform the following steps:

1. Connect as user A (or have user A connect) and execute the following statement:

```
GRANT select on T1 to B;
```

1. Connect as user B and execute a statement such as the following:

```
GRANT create table to A;
CREATE INDEX t1_spatial_idx on A.T1(geometry)
    INDEXTYPE IS mdsys.spatial_index;
```

4.1.7 Using Partitioned Spatial Indexes

You can create a partitioned spatial index on a partitioned table. This section describes usage considerations specific to Oracle Spatial. For a detailed explanation of partitioned tables and partitioned indexes, see the *Oracle9i Database Administrator's 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.

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. Hash and composite partitioning are not currently supported for partitioned spatial indexes.

To create a partitioned spatial index, you must specify the LOCAL keyword. For example:

```
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.
- Any Oracle Spatial parameters (relating to R-tree or quadtree indexing) should be the same for each partition.

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>')]
    )]
```

For example, if the COUNTIES table has two partitions, P1 and P2, you can create a quadtree index as follows:

```
CREATE INDEX counties_idx ON counties(geometry)
  INDEXTYPE IS MDSYS.SPATIAL_INDEX
  PARAMETERS ('sdo_level=6 tablespace=def_tbs')
LOCAL
  (PARTITION ip1 PARAMETERS ('sdo_level=6 tablespace=local_tbs1'),
   PARTITION ip2 PARAMETERS ('sdo_level=6 tablespace=local_tbs2'),
   PARTITION ip3);
```

In the preceding example:

- IP1 is the index partition that corresponds to partition P1 of the COUNTIES table, and IP2 is the index partition that corresponds to partition P2.
- The tablespace parameters are specified for each of the local index partitions as LOCAL_TBS1 and LOCAL_TBS2, respectively.
- If you omit the PARTITION ip2 PARAMETERS . . . clause (as is done for partition IP3), the default parameters specified before LOCAL are used. Specifically, the DEF_TBS tablespace is used for storing the index partition (which will have the same name as the second partition of the COUNTIES table, that is, P2).

Queries can operate on partitioned tables to perform the query on only one partition. For example:

```
SELECT * FROM counties PARTITION(p1)
  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](#) (nearest neighbor). With [SDO_NN](#), the requested number of geometries is returned for each partition that is affected by the query. For example, if you request the 5 closest restaurants to a point and the spatial index has 4 partitions, [SDO_NN](#) 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. See the description of the [SDO_NN](#) in [Chapter 10](#) for more information.

4.1.8 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 the *Oracle9i SQL 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 be of compatible types. Specifically:

- Both indexes must be either R-tree indexes with the same dimensionality (*sdo_indx_dims* value) or quadtree indexes with the same SDO_LEVEL and SDO_NUMTILES values.
- Both indexes must be either geodetic or non-geodetic. (Geodetic and non-geodetic indexes are explained in [Section 4.1.4](#).)
- Neither index can have a status of deferred updates. (Deferred update status is set by specifying 'index_status=deferred' with the ALTER INDEX statement, as described in [Chapter 8](#).)

If the indexes not compatible, 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.

4.2 Querying Spatial Data

This section describes how the structures of a Spatial layer are used to resolve spatial queries and spatial joins.

Spatial uses a two-tier query model with primary and secondary filter operations to resolve spatial queries and spatial joins, as explained in [Section 1.6](#). The term

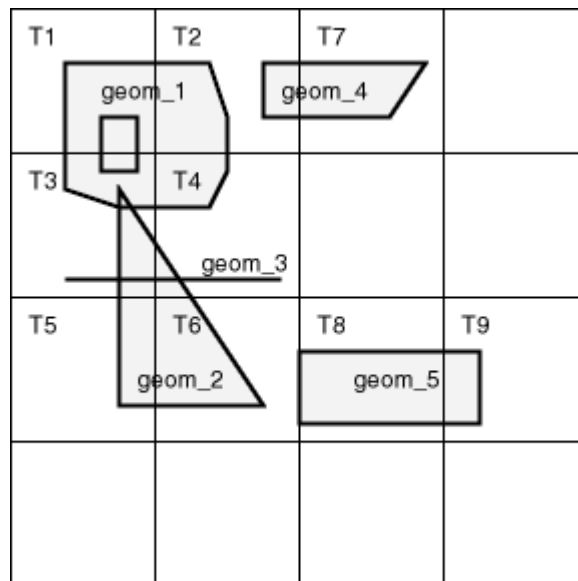
two-tier is used to indicate that two distinct operations are performed in order to resolve queries. If both operations are performed, the exact result set is returned.

4.2.1 Spatial Query

An important concept in the spatial data model is that each geometry is represented by a set of exclusive and exhaustive tiles. This means that no tiles overlap each other (**exclusive**), and the tiles fully cover the object (**exhaustive**).

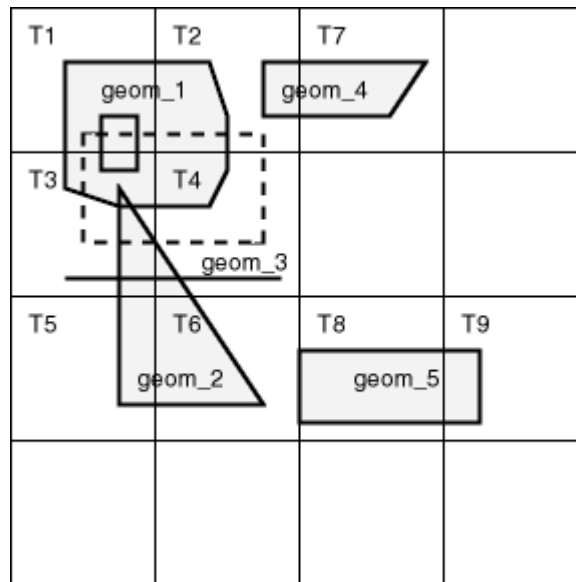
Consider the following layer containing several objects in [Figure 4-4](#). Each object is labeled with its geometry name (geom_1 for the polygon with a hole, geom_2 for the triangular polygon, geom_3 for the line, and geom_4 and geom_5 for other polygons). The relevant tiles are labeled with T_n (T1, T2, and so on)

Figure 4-4 Tessellated Layer with Multiple Objects



A typical spatial query is to request all objects that lie within a defined fence or window. A **query window** is shown in [Figure 4-5](#) by the dotted-line box. A dynamic query window refers to a fence that is not defined in the database, but that must be defined before it is used.

Figure 4–5 Tessellated Layer with a Query Window



4.2.1.1 Primary Filter Operator

The **SDO_FILTER** operator implements the primary filter portion of the two-step process involved in the product's query processing model. The primary filter uses the index data only to determine a set of candidate object pairs that may interact. The syntax is as follows:

```
SDO_FILTER(geometry1 MDSYS.SDO_GEOMETRY, geometry2 MDSYS.SDO_GEOMETRY,
           params VARCHAR2)
```

Where:

- *geometry1* is a column of type MDSYS.SDO_GEOMETRY in a table. *geometry1* must be spatially indexed.
- *geometry2* is an object of type MDSYS.SDO_GEOMETRY. *geometry2* may or may not come from a table. If it comes from a table, it may or may not be spatially indexed.
- *params* is a quoted string of keyword value pairs that determine the behavior of the operator. See the **SDO_FILTER** operator in [Chapter 10](#) for a list of parameters.

The following examples perform a primary filter operation only. They will return all the geometries shown in [Figure 4-5](#) that have an index tile in common with one of the index tiles that approximates the query window: tiles T1, T2, T3, and T4. The result of the following examples are geometries with IDs 1013, 1243, 12, and 501.

[Example 4-2](#) 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 4-2 Primary Filter with a Temporary Query Window

```
SELECT A.Feature_ID FROM TARGET A
WHERE sdo_filter(A.shape, mdsys.sdo_geometry(2003,NULL,NULL,
                                             mdsys.sdo_elem_info_array(1,1003,3),
                                             mdsys.sdo_ordinate_array(x1,y1, x2,y2)),
               'querytype=window') = 'TRUE';
```

Note that $(x1,y1)$ and $(x2,y2)$ are the lower-left and upper-right corners of the query window.

In [Example 4-3](#), a transient instance of type SDO_GEOMETRY was constructed for the query window instead of specifying the window parameters in the query itself.

Example 4-3 Primary Filter with a Transient Instance of the Query Window

```
SELECT A.Feature_ID FROM TARGET A
WHERE sdo_filter(A.shape, :theWindow, 'querytype=window') = 'TRUE';
```

[Example 4-4](#) assumes the query window was inserted into a table called WINDOWS, with an ID of WINS_1.

Example 4-4 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, 'querytype=window') = 'TRUE';
```

If the B.SHAPE column is not spatially indexed, the [SDO_FILTER](#) operator indexes the query window in memory and performance is very good.

If the B.SHAPE column is spatially indexed with the same SDO_LEVEL value as the A.SHAPE column, the [SDO_FILTER](#) operator reuses the existing index, and performance is very good or better.

If the B.SHAPE column is spatially indexed with a different SDO_LEVEL value than the A.SHAPE column, the [SDO_FILTER](#) operator reindexes B.SHAPE in the same

way as if there were no index on the column originally, and then performance is very good.

4.2.1.2 Primary and Secondary Filter Operator

The `SDO_RELATE` operator performs both the primary and secondary filter stages when processing a query. 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_RELATE(geometry1 MDSYS.SDO_GEOMETRY,
            geometry2 MDSYS.SDO_GEOMETRY,
            params    VARCHAR2)
```

Where:

- *geometry1* is a column of type `MDSYS.SDO_GEOMETRY` in a table. *geometry1* must be spatially indexed.
- *geometry2* is an object of type `MDSYS.SDO_GEOMETRY`. *geometry2* may or may not come from a table. If it comes from a table, it may or may not be spatially indexed.
- *params* is a quoted string of keyword value pairs that determine the behavior of the operator. See the `SDO_NN` operator in [Chapter 10](#) for a list of parameters.

The following examples perform both primary and secondary filter operations. They return all the geometries in [Figure 4-5](#) that lie within or overlap the query window. The result of these examples is objects 1243 and 1013.

[Example 4-5](#) 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 4-5 Secondary Filter Using a Temporary Query Window

```
SELECT A.Feature_ID FROM TARGET A
       WHERE sdo_relate(A.shape, mdsys.sdo_geometry(2003,NULL,NULL,
                                                    mdsys.sdo_elem_info_array(1,1003,3),
                                                    mdsys.sdo_ordinate_array(x1,y1, x2,y2)),
                        'mask=anyinteract querytype=window') = 'TRUE';
```

Note that $(x1,y1)$ and $(x2,y2)$ are the lower-left and upper-right corners of the query window.

[Example 4-6](#) assumes the query window was inserted into a table called `WINDOWS`, with an ID of `WINS_1`.

Example 4–6 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 querytype=window') = 'TRUE';
```

If the B.SHAPE column is not spatially indexed, the [SDO_NN](#) operator indexes the query window in memory and performance is very good.

If the B.SHAPE column is spatially indexed with the same SDO_LEVEL value as the A.SHAPE column, the [SDO_NN](#) operator reuses the existing index, and performance is very good or better.

If the B.SHAPE column is spatially indexed with a different SDO_LEVEL value than the A.SHAPE column, the [SDO_FILTER](#) operator reindexes B.SHAPE in the same way as if there were no index on the column originally, and then performance is very good.

4.2.1.3 Within-Distance Operator

The [SDO_WITHIN_DISTANCE](#) operator 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 MDSYS.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 MDSYS.SDO_GEOMETRY,
                    aGeom       MDSYS.SDO_GEOMETRY,
                    params      VARCHAR2);
```

Where:

- *geometry1* is a column of type MDSYS.SDO_GEOMETRY in a table. *geometry1* must be spatially indexed.
- *aGeom* is an instance of type MDSYS.SDO_GEOMETRY.
- *params* is a quoted string of keyword value pairs that determines the behavior of the operator. See the [SDO_WITHIN_DISTANCE](#) operator in [Chapter 10](#) 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. The distance units are those specified in the UNIT field of the well-known text (WKTEXT) associated with the coordinate system. (The WKTEXT is explained in [Section 5.4.1.1](#).) 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` 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` 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 the geometries of a layer. This method does not use the `SDO_WITHIN_DISTANCE` 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 a.gif, b.gid FROM parks A cosine_bufs B
WHERE SDO_Relate(A.shape, B.shape, 'mask=ANYINTERACT querytype=JOIN') = 'TRUE';
```

4.2.1.4 Nearest Neighbor Operator

The `SDO_NN` operator 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 MDSYS.SDO_GEOMETRY,
        geometry2 MDSYS.SDO_GEOMETRY,
        param VARCHAR2
        [, number NUMBER]);
```

Where:

- *geometry1* is a column of type MDSYS.SDO_GEOMETRY in a table. *geometry1* must be spatially indexed.
- *geometry2* is an instance of type MDSYS.SDO_GEOMETRY.
- *param* is a quoted string of a keyword value pair that determines how many nearest neighbor geometries are returned by the operator. See the [SDO_NN](#) operator in [Chapter 10](#) for information about this parameter.
- *number* is the same number used in the call to [SDO_NN_DISTANCE](#). Use this only if the [SDO_NN_DISTANCE](#) ancillary operator is included in the call to [SDO_NN](#). See the [SDO_NN](#) operator in [Chapter 10](#) 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](#) operator in [Chapter 10](#).)

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

4.2.1.5 Spatial Functions

Spatial 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.

4.2.2 Spatial Join

A **spatial join** is the same as a regular join except that the predicate involves a spatial operator. In Spatial, a spatial join takes place when you compare all the geometries of one layer to all the geometries of another layer. This is unlike a query window that only compares a single geometry to all geometries of a layer.

In a spatial join, all tables must have the same type of spatial index (that is, R-tree or quadtree) defined on the geometry column; and if they have quadtree indexes, the SDO_LEVEL value must be the same for all the indexes.

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 MDSYS.SDO_GEOMETRY)
HIGHWAYS( GID VARCHAR2(32), SHAPE MDSYS.SDO_GEOMETRY)
```

The primary filter would identify pairs of *GID* values from the PARKS and HIGHWAYS tables that interact in their index entries. The query that performs the primary filter join is:

```
SELECT A.GID, B.GID
       FROM PARKS A, HIGHWAYS B
       WHERE sdo_filter(A.shape, B.shape, 'querytype=join') = 'TRUE';
```

The original question, asking about highways that cross national parks, requires the secondary filter operator to find the exact relationship between highways and parks.

The query that performs this join using both primary and secondary filters is:

```
SELECT A.GID, B.GID
       FROM parks A, highways B
       WHERE sdo_relate(A.shape, B.shape,
                        'mask=ANYINTERACT querytype=join');
```

4.2.3 Cross-Schema Operator Invocation

You can invoke spatial operators on an indexed table that is not in your schema. Assume that user A has a spatial table T1 (with index table IDX_TAB1) with a spatial index defined, that user B has a spatial table T2 (with index table IDX_TAB2) with a spatial index defined, and that user C wants to invoke operators on tables in one or both of the other schemas.

If user C wants to invoke an operator only on T1, user C must perform the following steps:

1. Connect as user A and execute the following statements:

```
GRANT select on T1 to C;
GRANT select on idx_tab1 to C;
```

2. Connect as user C and execute a statement such as the following:

```
SELECT a.gid
       FROM T1 a
       WHERE sdo_filter(a.geometry, :theGeometry, 'querytype=WINDOW') = 'TRUE';
```

If user C wants to invoke an operator on both T1 and T2, user C must perform the following steps:

1. Connect as user A and execute the following statements:

```
GRANT select on T1 to C;  
GRANT select on idx_tab1 to C;
```

2. Connect as user B and execute the following statements:

```
GRANT select on T2 to C;  
GRANT select on idx_tab2 to C;
```

3. Connect as user C and execute a statement such as the following:

```
SELECT a.gid  
FROM T1 a, T2 b  
WHERE b.gid = 5 AND  
      sdo_filter(a.geometry, b.geometry, 'querytype=WINDOW') = 'TRUE';
```

Coordinate Systems (Spatial Reference Systems)

This chapter describes in greater detail the Oracle Spatial coordinate system support, which was introduced in [Section 1.5.4](#). You can store and manipulate SDO_GEOMETRY objects in a variety of coordinate systems.

For reference information about coordinate system transformation functions and procedures, see [Chapter 13](#).

5.1 Terms and Concepts

This section explains important terms and concepts related to coordinate system support in Oracle Spatial.

5.1.1 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.

5.1.2 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.

5.1.3 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 [Section 5.1.6](#)). For more information about geodetic coordinate system support, see [Section 5.2](#).

5.1.4 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.

5.1.5 Local Coordinates

Local coordinates are Cartesian coordinates in a non-Earth (non-georeferenced) coordinate system. [Section 5.3](#) describes local coordinate system support in Spatial.

5.1.6 Geodetic Datum

A **geodetic datum** is 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.

5.1.7 Authalic Sphere

An **authalic sphere** is a sphere that has the same surface area as a particular oblate ellipsoid of revolution representing the figure of the Earth.

5.1.8 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.

5.2 Geodetic Coordinate Support

With Oracle9i, Spatial provides a rational and complete treatment of geodetic coordinates. Before Oracle 9i, 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.

With the current release, ellipsoidal surface computations consider the curvatures of arcs in the specified geodetic coordinate system and return correct, accurate results. In other words, with the current release, Spatial queries return the right answers all the time.

5.2.1 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.

With Oracle9i, Spatial 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.

5.2.2 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, and take longer to complete. In general, a Spatial operation using geodetic coordinates will take two to three times longer than the same operation using Cartesian coordinates.

5.2.3 Other Considerations and Requirements with Geodetic Data

The following geometries are not permitted if a geodetic coordinate system is used:

- Circles
- Circular arcs
- Optimized rectangles (rectangles defined specifying only two points)

However, you can use the [SDO_CS.VIEWPORT_TRANSFORM](#) function to convert optimized longitude/latitude rectangles to valid geodetic polygons for use with the [SDO_FILTER](#) operator.

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](#) function (documented in [Chapter 11](#)) 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 one-half the surface of the Earth.
- No line element can have a length longer than 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 an element representing all the ocean surface of the Earth; however, you can create multiple elements, each representing part of the overall ocean surface.

To take full advantage of Spatial features, you must index geodetic data layers using a geodetic R-tree index. (You can create a non-geodetic R-tree or quadtree index on geodetic data by specifying `'geodetic=FALSE'` in the PARAMETERS clause of the [CREATE INDEX](#) statement; however, this is not recommended. See the Usage Notes for the [CREATE INDEX](#) statement in [Chapter 8](#) for more information.) In addition, for Spatial release 9.0.1 and higher you must delete ([DROP INDEX](#)) and re-create all spatial indexes on geodetic data from a release before 9.0.1.

Tolerance is specified as meters for geodetic layers. Note that if you use tolerance values typical for non-geodetic data, these values are interpreted as meters for geodetic data. For example, if you specify a tolerance value of 0.005 for geodetic data, this is interpreted as precise to 5 millimeters. 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 [Section 1.5.5](#).)

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 5-3](#) in [Section 5.8](#)) specifies these extents (with a 10-meter tolerance value in each dimension) for a geodetic data layer:

```
INSERT INTO USER_SDO_GEOM_METADATA
VALUES (
  'cola_markets_cs',
  'shape',
  MDSYS.SDO_DIM_ARRAY(
    MDSYS.SDO_DIM_ELEMENT('Longitude', -180, 180, 10), -- 10 meters tolerance
    MDSYS.SDO_DIM_ELEMENT('Latitude', -90, 90, 10) -- 10 meters tolerance
  ),
  8307 -- SRID for 'Longitude / Latitude (WGS 84)' coordinate system
);
```

See [Section 5.7](#) for additional notes and restrictions relating to geodetic data.

5.3 Local Coordinate Support

With Oracle9i, Spatial 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 in the MDSYS.CS_SRS table (described in [Section 5.4.1](#)). 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 can use these local coordinate systems only to convert coordinates in a local coordinate system from one unit of measurement to another (for example, inches to millimeters) by transforming a geometry or a layer of geometries.

5.4 Coordinate Systems Data Structures

The coordinate systems functions and procedures use information provided in the following tables supplied with Oracle Spatial:

- MDSYS.CS_SRS (see [Section 5.4.1](#)) defines 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 OpenGIS Consortium (<http://www.opengis.org>).
- MDSYS.SDO_ANGLE_UNITS (see [Section 5.4.2](#)) defines the valid angle units. The angle unit is part of the well-known text description.
- MDSYS.SDO_DIST_UNITS (see [Section 5.4.3](#)) defines the valid distance units. The distance unit is included in the well-known text description.
- MDSYS.SDO_DATUMS (see [Section 5.4.4](#)) defines the valid datums. The datum is part of the well-known text description.
- MDSYS.SDO_ELLIPSOIDS (see [Section 5.4.5](#)) defines the valid ellipsoids. The ellipsoid is part of the well-known text description.
- MDSYS.SDO_PROJECTIONS (see [Section 5.4.6](#)) defines the valid map projections. The map projection is part of the well-known text description.

Note: You should not modify or delete any Oracle-supplied information in any of the tables that are used for coordinate system support.

You should not add any information to the MDSYS.CS_SRS table unless you are creating a user-defined coordinate system. (Do not add information to the MDSYS.SDO_DATUMS, MDSYS.SDO_ELLIPSOIDS, or MDSYS.PROJECTIONS tables.) [Section 5.5](#) describes how to create a user-defined coordinate system.

5.4.1 MDSYS.CS_SRS Table

The MDSYS.CS_SRS reference table contains over 900 rows, one for each valid coordinate system.

Note: You should probably not modify, delete, or add any information in the MDSYS.CS_SRS table. If you plan to add any user-defined coordinate systems, be sure to use SRID values of 1000000 (1 million) or higher, and follow the guidelines in [Section 5.5](#).

The MDSYS.CS_SRS table contains the columns shown in [Table 5-1](#).

Table 5-1 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 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.

Table 5–1 MDSYS.CS_SRS Table (Cont.)

Column Name	Data Type	Description
WKTEXT	VARCHAR2(2046)	The well-known text (WKT) description of the SRS, as defined by the OpenGIS Consortium. For more information, see Section 5.4.1.1 .
CS_BOUNDS	MDSYS.SDO_GEOMETRY	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.

5.4.1.1 Well-Known Text (WKTEXT)

The WKTEXT column of the MDSYS.CS_SRS table contains the well-known text (WKT) description of the SRS, as defined by the OpenGIS Consortium.

The following is the WKT EBNF syntax. All user-defined coordinate systems must strictly comply with this 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 ]

```

The prime meridian (PRIMEM) must be 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 semimajor 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 supports all the 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]]
```

Local coordinate systems are described in [Section 5.3](#).

5.4.2 MDSYS.SDO_ANGLE_UNITS Table

The MDSYS.SDO_ANGLE_UNITS reference table contains one row for each valid UNIT specification in the well-known text (WKT) description in the coordinate system definition. The WKT is described in [Section 5.4.1.1](#).

The MDSYS.SDO_ANGLE_UNITS table contains the columns shown in [Table 5-2](#).

Table 5–2 MDSYS.SDO_ANGLE_UNITS Table

Column Name	Data Type	Description
SDO_UNIT	VARCHAR2(32)	(Reserved for future use by Oracle Spatial.)
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: <i>Decimal Degree, Radian, Decimal Second, Decimal Minute, Gon, Grad</i>
CONVERSION_FACTOR	NUMBER	The ratio of the specified unit to one <i>Radian</i> . For example, the ratio of <i>Decimal Degree</i> to <i>Radian</i> is 0.017453293.

5.4.3 MDSYS.SDO_DIST_UNITS Table

The MDSYS.SDO_DIST_UNITS reference table 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 [Section 5.4.1.1](#).

The MDSYS.SDO_DIST_UNITS table contains the columns shown in [Table 5–3](#).

Table 5–3 MDSYS.SDO_DIST_UNITS Table

Column Name	Data Type	Purpose
SDO_UNIT	VARCHAR2	Unit string identifier. Examples: <i>M, KM, CM, MM, MILE, NAUT_MILE, FOOT, INCH</i> . Do not use this in the WKT definition; instead, use a value from UNIT_NAME.
UNIT_NAME	VARCHAR2	Descriptive name of the unit, to be used in the WKT specification. Examples: <i>Meter, Kilometer, Centimeter, Millimeter, Mile, Nautical Mile, Foot, Inch</i>
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.

5.4.4 MDSYS.SDO_DATUMS Table

The MDSYS.SDO_DATUMS reference table contains one row for each valid DATUM specification in the well-known text (WKT) description in the coordinate system definition. The WKT is described in [Section 5.4.1.1](#).

The MDSYS.SDO_DATUMS table contains the columns shown in [Table 5–4](#).

Table 5–4 MDSYS.SDO_DATUMS Table

Column Name	Data Type	Description
NAME	VARCHAR2(64)	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: <i>Adindan</i> , <i>Afgooye</i> , <i>Ain el Abd 1970</i> , <i>Anna 1 Astro 1965</i> , <i>Arc 1950</i> , <i>Arc 1960</i> , <i>Ascension Island 1958</i> .
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: $1.0 + (\text{SCALE_ADJUST} * 10^{-6})$

The following are the names (in tabular format) of the supported datums:

Adindan	Afgooye	Ain el Abd 1970
Anna 1 Astro 1965	Arc 1950	Arc 1960
Ascension Island 1958	Astro B4 Sorol Atoll	Astro Beacon E
Astro DOS 71/4	Astronomic Station 1952	Australian Geodetic 1966
Australian Geodetic 1984	Belgium Hayford	Bellevue (IGN)
Bermuda 1957	Bogota Observatory	CH 1903 (Switzerland)
Campo Inchauspe	Canton Astro 1966	Cape
Cape Canaveral	Carthage	Chatham 1971

Chua Astro	Corrego Alegre	DHDN (Potsdam/Rauenberg)
DOS 1968	Djakarta (Batavia)	Easter Island 1967
European 1950	European 1979	European 1987
GRS 67	GRS 80	GUX 1 Astro
Gandajika Base	Geodetic Datum 1949	Guam 1963
Hito XVIII 1963	Hjorsey 1955	Hong Kong 1963
Hu-Tzu-Shan	ISTS 073 Astro 1969	Indian (Bangladesh, etc.)
Indian (Thailand/Vietnam)	Ireland 1965	Johnston Island 1961
Kandawala	Kerguelen Island	Kertau 1948
L.C. 5 Astro	Liberia 1964	Lisboa (DLx)
Luzon (Mindanao Island)	Luzon (Philippines)	Mahe 1971
Marco Astro	Massawa	Melrica 1973 (D73)
Merchich	Midway Astro 1961	Minna
NAD 27 (Alaska)	NAD 27 (Bahamas)	NAD 27 (Canada)
NAD 27 (Canal Zone)	NAD 27 (Caribbean)	NAD 27 (Central America)
NAD 27 (Continental US)	NAD 27 (Cuba)	NAD 27 (Greenland)
NAD 27 (Mexico)	NAD 27 (Michigan)	NAD 27 (San Salvador)
NAD 83	NTF (Greenwich meridian)	NTF (Paris meridian)
NWGL 10	Nahrwan (Masirah Island)	Nahrwan (Saudi Arabia)
Nahrwan (Un. Arab Emirates)	Naparima, BWI	Netherlands Bessel
Observatorio 1966	Old Egyptian	Old Hawaiian
Oman	Ordinance Survey Great Brit	Pico de las Nieves
Pitcairn Astro 1967	Provisional South American	Puerto Rico
Pulkovo 1942	Qatar National	Qornoq

RT 90 (Sweden)	Reunion	Rome 1940
Santo (DOS)	Sao Braz	Sapper Hill 1943
Schwarzeck	South American 1969	South Asia
Southeast Base	Southwest Base	Timbalai 1948
Tokyo	Tristan Astro 1968	Viti Levu 1916
WGS 60	WGS 66	WGS 72
WGS 84	Wake-Eniwetok 1960	Yacare
Zanderij		

5.4.5 MDSYS.SDO_ELLIPSOIDS Table

The MDSYS.SDO_ELLIPSOIDS reference table contains one row for each valid SPHEROID specification in the well-known text (WKT) description in the coordinate system definition. The WKT is described in [Section 5.4.1.1](#).

The MDSYS.SDO_ELLIPSOIDS table contains the columns shown in [Table 5–5](#).

Table 5–5 MDSYS.SDO_ELLIPSOIDS Table

Column Name	Data Type	Description
NAME	VARCHAR2(64)	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: <i>Clarke 1866</i> , <i>WGS 72</i> , <i>Australian</i> , <i>Krassovsky</i> , <i>International 1924</i> .
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 = semi-major axis and b = semi-minor axis.

The following are the names (in tabular format) of the supported ellipsoids:

Airy 1930	Airy 1930(Ireland 1965)	Australian
Bessel 1841	Bessel 1841 (NGO 1948)	Bessel 1841 (Schwarzeck)
Clarke 1858	Clarke 1866	Clarke 1866 (Michigan)
Clarke 1880	Clarke 1880 (Arc 1950)	Clarke 1880 (IGN)

Clarke 1880 (Jamaica)	Clarke 1880 (Merchich)	Clarke 1880 (Palestine)
Everest	Everest (Kalianpur)	Everest (Kertau)
Everest (Timbalai)	Fischer 1960 (Mercury)	Fischer 1960 (South Asia)
Fischer 1968	GRS 67	GRS 80
Hayford	Helmert 1906	Hough
IAG 75	Indonesian	International 1924
Krassovsky	MERIT 83	NWL 10D
NWL 9D	New International 1967	OSU86F
OSU91A	Plessis 1817	South American 1969
Sphere (6370997m)	Struve 1860	WGS 60
WGS 66	WGS 72	WGS 84
Walbeck	War Office	

5.4.6 MDSYS.SDO_PROJECTIONS Table

The MDSYS.SDO_PROJECTIONS reference table contains one row for each valid PROJECTION specification in the well-known text (WKT) description in the coordinate system definition. The WKT is described in [Section 5.4.1.1](#).

The MDSYS.SDO_PROJECTIONS table contains the column shown in [Table 5–6](#).

Table 5–6 MDSYS.SDO_PROJECTIONS Table

Column Name	Data Type	Description
NAME	VARCHAR2(64)	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: <i>Geographic (Lat/Long)</i> , <i>Universal Transverse Mercator</i> , <i>State Plane Coordinates</i> , <i>Albers Conical Equal Area</i> .

The following are the names (in tabular format) of the supported projections:

Alaska Conformal	Albers Conical Equal Area
Azimuthal Equidistant	Bonne
Cassini	Cylindrical Equal Area

Eckert IV	Eckert VI
Equidistant Conic	Equiarectangular
Gall	General Vertical Near-Side Perspective
Geographic (Lat/Long)	Gnomonic
Hammer	Hotine Oblique Mercator
Interrupted Goode Homolosine	Interrupted Mollweide
Lambert Azimuthal Equal Area	Lambert Conformal Conic
Lambert Conformal Conic (Belgium 1972)	Mercator
Miller Cylindrical	Mollweide
New Zealand Map Grid	Oblated Equal Area
Orthographic	Polar Stereographic
Polyconic	Robinson
Sinusoidal	Space Oblique Mercator
State Plane Coordinates	Stereographic
Swiss Oblique Mercator	Transverse Mercator
Transverse Mercator Danish System 34 Jylland-Fyn	Transverse Mercator Danish System 45 Bornholm
Transverse Mercator Finnish KKJ	Transverse Mercator Sjaelland
Universal Transverse Mercator	Van der Grinten
Wagner IV	Wagner VII

5.5 Creating a User-Defined Coordinate System

To create a user-defined coordinate system, add a row to the MDSYS.CS_SRS table. See [Section 5.4.1](#) for information about this table, including the requirements for values in each column.

To specify the WKTEXT column in the MDSYS.CS_SRS table, follow the syntax specified in [Section 5.4.1.1](#). See also the examples in that section.

When you specify the WKTEXT column entry, use valid values from several Spatial reference tables:

- `MDSYS.SDO_ANGLE_UNITS` (see [Section 5.4.2](#)) in a UNIT specification for angle units
- `MDSYS.SDO_DIST_UNITS` (see [Section 5.4.3](#)) in a UNIT specification for distance units
- `MDSYS.SDO_DATUMS` (see [Section 5.4.4](#)) in the DATUM specification, or a user-defined datum not in `MDSYS.SDO_DATUMS`

If you supply a user-defined datum, the datum name must be different from any datum name in the `MDSYS.SDO_DATUMS` table, and the WKT must specify at least the datum name and the spheroid (or ellipsoid) information listed in [Section 5.4.1.1](#). If the shift, rotation, and scale parameters are all zero, you can omit them; however, if any of these parameter values are nonzero, you must specify them all.

- `MDSYS.SDO_ELLIPSOIDS` (see [Section 5.4.5](#)) in the SPHEROID specification
If you supply a user-defined ellipsoid, the ellipsoid name must be different from any ellipsoid name in the `MDSYS.SDO_ELLIPSOIDS` table. You must also specify the semi-major axis and inverse flattening for a user-defined ellipsoid.
- `MDSYS.SDO_PROJECTIONS` (see [Section 5.4.6](#)) in the PROJECTION specification

The name in each PARAMETER specification must be one of the following, depending on the projection that you use:

- *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 meters)
- *False_Northing* (in meters)
- *Perspective_Point_Height* (in meters)
- *Landsat_Number* (must be 1, 2, 3, 4, or 5)
- *Path_Number*
- *Scale_Factor*

Some of these parameters are appropriate for several projections. They are not all appropriate for every projection.

Example 5-1 creates a user-defined projected coordinate system. The first four columns are not the WKT information, but specify other fields in the MSDYD.CS_SRS table. The WKT information starts with PROJCS. This example is similar to an existing coordinate system, but has a different name, SRID, and central meridian.

Example 5-1 Creating a User-Defined Projected Coordinate System

```
INSERT INTO mdsys.cs_srs VALUES ('UTM Zone 44.5, Northern Hemisphere (WGS 84)',
1082378, 1082378, 'Oracle',
'PROJCS["UTM Zone 44.5, Northern Hemisphere (WGS 84)",
GEOGCS [ "WGS 84",
DATUM [ "WGS 84 ",
SPHEROID [ "WGS 84", 6378137.000000, 298.257224]],
PRIMEM [ "Greenwich", 0.000000 ],
UNIT ["Decimal Degree", 0.01745329251994330]],
PROJECTION ["Transverse Mercator"],
PARAMETER ["Scale_Factor", 0.999600],
PARAMETER ["Central_Meridian", 84.000000],
PARAMETER ["False_Easting", 500000.000000],
UNIT ["Meter", 1.000000000000]]',NULL);
```

Example 5-2 creates a user-defined geodetic coordinate system. The first four columns are not the WKT information, but specify other fields in the MSDYD.CS_SRS table. The WKT information starts with GEOGCS. This example includes an ellipsoid (SPHEROID) definition in which the semi-major axis and inverse flattening parameters are slightly changed from the WGS 84 coordinate system, as well as a different datum definition. Because the *shift_x* and *shift_y* parameter values are specified, all the shift, rotation, and scaling values must be specified. There is no projection information included for a geodetic coordinate system.

Example 5-2 Creating a User-Defined Geodetic Coordinate System

```
INSERT INTO mdsys.cs_srs VALUES
( 'Longitude / Latitude (WGS 90)', 1008307, 1008307, 'Oracle',
'GEOGCS [ "Longitude / Latitude (WGS 90)",
DATUM [ "WGS 90",
SPHEROID [ "WGS 90", 6378137.032499, 298.257236], 100, 100, 0, 0, 0, 0, 0 ],
PRIMEM [ "Greenwich", 0.000000 ],
UNIT ["Decimal Degree", 0.01745329251994330]]',NULL);
```


5.6 Coordinate System Transformation Functions

The current release of Oracle Spatial includes the following functions and procedures for data transformation using coordinate systems:

- [SDO_CS.TRANSFORM](#) function: Transforms a geometry representation using a coordinate system (specified by SRID or name).
- [SDO_CS.TRANSFORM_LAYER](#) procedure: Transforms an entire layer of geometries (that is, all geometries in a specified column in a table).
- [SDO_CS.VIEWPORT_TRANSFORM](#) function: Transforms an optimized rectangle into a valid geodetic polygon for use with Spatial operators and functions.

Reference information about these functions and procedures is in [Chapter 13](#).

Support for additional functions and procedures is planned for future releases of Oracle Spatial.

5.7 Notes and Restrictions with Coordinate Systems Support

The following notes and restrictions apply to coordinate systems support in the current release of Spatial.

If you have geodetic data, see also [Section 5.2](#) for considerations, guidelines, and additional restrictions.

5.7.1 Different Coordinate Systems for Geometries with Operators and Functions

For Spatial operators (described in [Chapter 10](#)) 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; it does not affect any stored query-window geometry.

For SDO_GEOM package geometry functions (described in [Chapter 11](#)) that take two geometries as input parameters, both geometries must be based on the same coordinate system.

5.7.2 Functions Not Supported with Geodetic Data

In the current release, the following functions are not supported with geodetic data:

- [SDO_AGGR_MBR](#)
- [SDO_GEOM.SDO_MBR](#)
- [SDO_GEOM.SDO_MAX_MBR_ORDINATE](#)
- [SDO_GEOM.SDO_MIN_MBR_ORDINATE](#)
- All 3D formats of LRS functions (explained in [Section 6.4](#))

5.7.3 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](#)
- [SDO_GEOM.SDO_CENTROID](#)
- [SDO_GEOM.SDO_CONVEXHULL](#)

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](#), generated arcs are approximated by line segments before the back-transform.

5.8 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 [Chapter 13](#).

[Example 5–3](#) uses mostly the same geometry data (cola markets) as in [Section 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 5–3](#) uses the geometries illustrated in [Figure 2–1](#) in [Section 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 5-3](#) 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)

[Example 5-4](#) includes the output of the SELECT statements in [Example 5-3](#).

Example 5-3 Simplified Example of Coordinate System Transformation

```
-- 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, etc.

CREATE TABLE cola_markets_cs (
    mkt_id NUMBER PRIMARY KEY,
    name VARCHAR2(32),
    shape MDSYS.SDO_GEOMETRY);

-- Note re. areas of interest: cola_a (rectangle) and
-- cola_b (4-sided polygon) are side by side (share 1 border).
-- cola_c is a small 4-sided polygon that overlaps parts of
-- cola_a and cola_b. A rough sketch:
--
--      +-----+
--      |   a   | b   \
--      |   +-----+
--      |  /_c_  |
--      |         |
--      +-----+-----+
--
-- 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',
  MDSYS.SDO_GEOMETRY(
    2003, -- 2-dimensional polygon
    8307, -- SRID for 'Longitude / Latitude (WGS 84)' coordinate system
    NULL,
    MDSYS.SDO_ELEM_INFO_ARRAY(1,1003,1), -- polygon
    MDSYS.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',
  MDSYS.SDO_GEOMETRY(
    2003, -- 2-dimensional polygon
    8307,
    NULL,
    MDSYS.SDO_ELEM_INFO_ARRAY(1,1003,1), -- one polygon (exterior polygon ring)
    MDSYS.SDO_ORDINATE_ARRAY(5,1, 8,1, 8,6, 5,7, 5,1)
  )
);

INSERT INTO cola_markets_cs VALUES(
  3,
  'cola_c',
  MDSYS.SDO_GEOMETRY(
    2003, -- 2-dimensional polygon
    8307,
    NULL,
    MDSYS.SDO_ELEM_INFO_ARRAY(1,1003,1), --one polygon (exterior polygon ring)
    MDSYS.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',
MDSYS.SDO_GEOMETRY(
  2003, -- 2-dimensional polygon
  8307, -- SRID for 'Longitude / Latitude (WGS 84)' coordinate system
  NULL,
  MDSYS.SDO_ELEM_INFO_ARRAY(1,1003,1), -- polygon
  MDSYS.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 (i.e., table-column combination; here: cola_markets_cs and shape).

INSERT INTO USER_SDO_GEOM_METADATA
VALUES (
  'cola_markets_cs',
  'shape',
  MDSYS.SDO_DIM_ARRAY(
    MDSYS.SDO_DIM_ELEMENT('Longitude', -180, 180, 10), -- 10 meters tolerance
    MDSYS.SDO_DIM_ELEMENT('Latitude', -90, 90, 10) -- 10 meters tolerance
  ),
  8307 -- SRID for 'Longitude / Latitude (WGS 84)' coordinate system
);

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

-- Must be R-tree; quadtree not supported for geodetic data.
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, m.diminfo, 8199)
  FROM cola_markets_cs c, user_sdo_geom_metadata m
  WHERE m.table_name = 'COLA_MARKETS_CS' AND m.column_name = 'SHAPE'
  AND c.name = 'cola_c';

-- Same as preceding, but using to_sname parameter.
SELECT c.name, SDO_CS.TRANSFORM(c.shape, m.diminfo, 'Longitude / Latitude (Arc
1950)')
  FROM cola_markets_cs c, user_sdo_geom_metadata m
  WHERE m.table_name = 'COLA_MARKETS_CS' AND m.column_name = 'SHAPE'
  AND 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.
EXECUTE 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;

-- Viewport_Transform
SELECT c.name FROM cola_markets_cs c WHERE
  SDO_FILTER(c.shape, SDO_CS.VIEWPORT_TRANSFORM(
    MDSYS.SDO_GEOMETRY(
      2003,
      0, -- SRID = 0 (special case)
      NULL,
      MDSYS.SDO_ELEM_INFO_ARRAY(1,1003,3),
      MDSYS.SDO_ORDINATE_ARRAY(-180,-90,180,90)),
    8307), 'querytype=window') = 'TRUE';

```

Example 5-4 shows the output of the SELECT statements in [Example 5-3](#). 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 5-4 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, m.diminfo, 8199)
      2   FROM cola_markets_cs c, user_sdo_geom_metadata m
      3   WHERE m.table_name = 'COLA_MARKETS_CS' AND m.column_name = 'SHAPE'
      4   AND c.name = 'cola_c';

NAME
-----
SDO_CS.TRANSFORM(C.SHAPE,M.DIMINFO,8199)(SDO_GTYPE, SDO_SRID, SDO_POINT(X, Y, Z)
-----
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_srsname parameter.
SQL> SELECT c.name, SDO_CS.TRANSFORM(c.shape, m.diminfo, 'Longitude / Latitude
(Arc 1950)')
      2   FROM cola_markets_cs c, user_sdo_geom_metadata m
      3   WHERE m.table_name = 'COLA_MARKETS_CS' AND m.column_name = 'SHAPE'
      4   AND c.name = 'cola_c';

NAME
-----
SDO_CS.TRANSFORM(C.SHAPE,M.DIMINFO,'LONGITUDE/LATITUDE(ARC1950)')(SDO_GTYPE, 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> EXECUTE SDO_CS.TRANSFORM_LAYER('COLA_MARKETS_CS', 'SHAPE', 'COLA_MARKETS_CS_
8199', 8199);

PL/SQL procedure successfully completed.

```

Example of Coordinate System Transformation

```
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_ARR
AY(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_ARR
AY(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)
-----
AAABZzAABAAAa6AAA
SDO_GEOMETRY(2003, 8199, NULL, SDO_ELEM_INFO_ARRAY(1, 1003, 1), SDO_ORDINATE_ARR
AY(1.00078604, 1.00274579, 5.00069354, 1.00274488, 5.0006986, 7.00323528, 1.0007
9179, 7.00324162, 1.00078604, 1.00274579))

AAABZzAABAAAa6AAB
```



```
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)  
-----
```

```
AAABZzAABAAA0a6AAC
```

```
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))
```

```
AAABZzAABAAA0a6AAD
```

```
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, 10.00
```

```
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		MDSYS.SDO_GEOMETRY

```
SQL>
```

```
SQL> -- Viewport_Transform
```

```
SQL> SELECT c.name FROM cola_markets_cs c WHERE  
2 SDO_FILTER(c.shape, SDO_CS.VIEWPORT_TRANSFORM(  
3 MDSYS.SDO_GEOMETRY(  
4 2003,  
5 0, -- SRID = 0 (special case)  
6 NULL,  
7 MDSYS.SDO_ELEM_INFO_ARRAY(1,1003,3),  
8 MDSYS.SDO_ORDINATE_ARRAY(-180,-90,180,90)),  
9 8307), 'querytype=window') = 'TRUE';
```

NAME

cola_a

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 *latitude/longitude* 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 provides server-side LRS capabilities at the cartographic level. The linear measure information is directly integrated into the Oracle Spatial geometry structure. The Oracle Spatial LRS API provides support for dynamic segmentation, and it serves as a groundwork for third-party or middle-tier application development virtually for any linear referencing methods and models in any coordinate systems.

For an example of LRS, see [Section 6.6](#). 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, see [Chapter 14](#).

If you have LRS data from a previous release of Spatial, see [Section A.5](#) for information about migrating LRS data.

6.1 Terms and Concepts

This section explains important terms and concepts related to linear referencing support in Oracle Spatial.

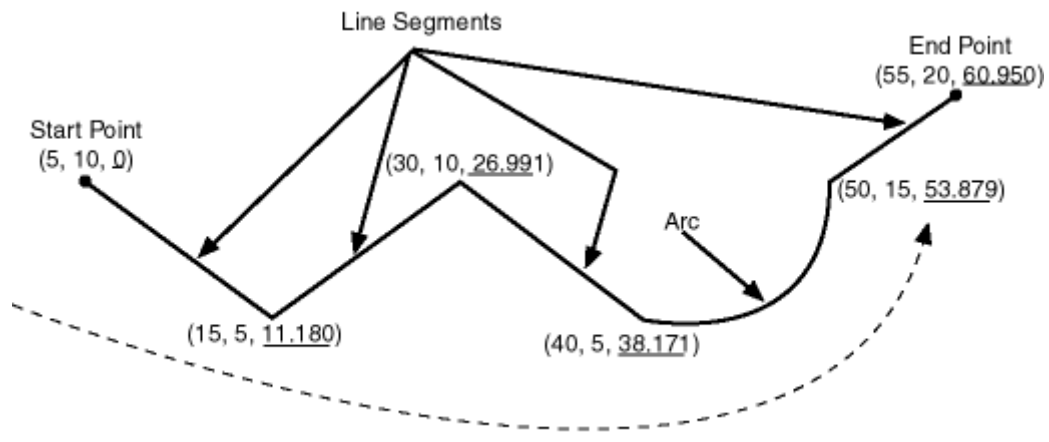
6.1.1 Geometric Segments (LRS Segments)

Geometric segments are basic LRS elements in Oracle Spatial. A geometric segment can be any of the following:

- Line string: an ordered, non-branching, and continuous geometry (for example, a simple road)
- Multiline string: non-connected 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 6-1](#) 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 6-1](#)).

Figure 6-1 Geometric Segment



6.1.2 Shape Points

Shape points are points that are specified when an LRS segment is constructed, and that are assigned measure information. In Oracle Spatial, 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](#) procedure.

6.1.3 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.

6.1.4 Measure (Linear Measure)

The **measure** of a point along a geometric segment is the linear distance (in the measure dimension) 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 their 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 LRS refers to as measure, offset has a different meaning in Oracle Spatial from measure, as explained in [Section 6.1.5](#).

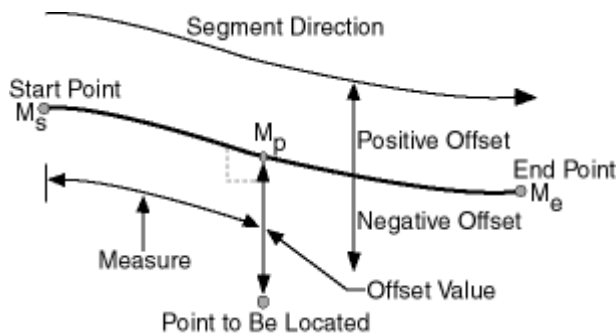
6.1.5 Offset

The **offset** of a point along a geometric segment is the perpendicular distance between the point and the geometric segment. Offsets are positive if 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 6-2 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 6-2 Describing a Point Along a Segment with a Measure and an Offset



6.1.6 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). 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 6-3 and the example in Figure 6-4.

Figure 6–3 Measures, Distances, and Their Mapping Relationship

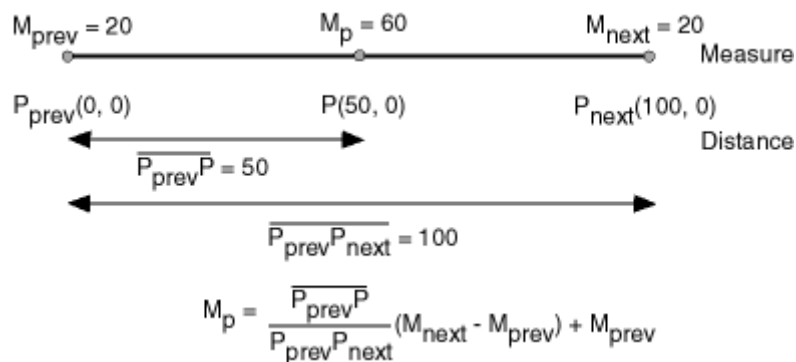
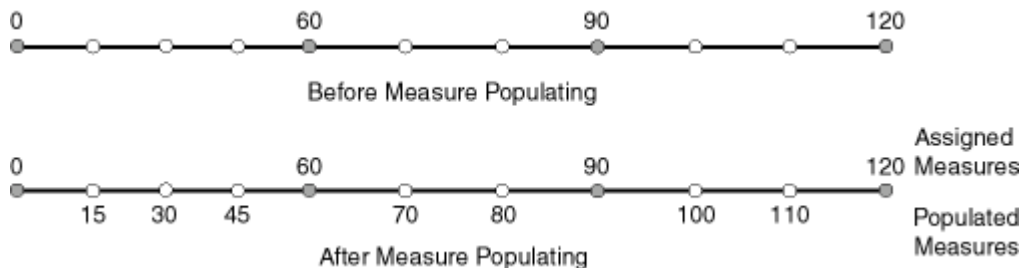
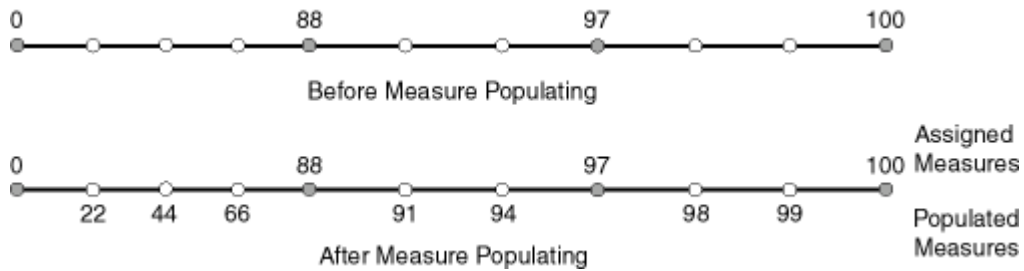


Figure 6–4 Measure Populating of a Geometric Segment



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 6–5 shows the measure population that results when assigned measure values are not proportional and reflect widely varying gaps.

Figure 6–5 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.

6.1.7 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.

6.1.8 Projection

The **projection** of a point along a geometric segment is the point on the geometric segment with the minimum distance to the point. The measure information of the resulting point is also returned in the point geometry.

6.1.9 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.

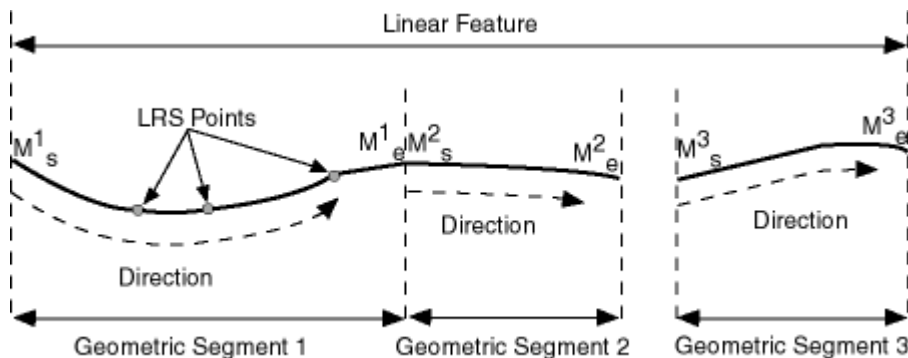
All LRS point data must be stored in the SDO_ELEM_INFO_ARRAY and SDO_ORDINATE_ARRAY, and cannot be stored in the SDO_POINT field in the SDO_GEOMETRY definition of the point.

6.1.10 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 6-6](#).

Figure 6-6 Linear Feature, Geometric Segments, and LRS Points



6.2 LRS Data Model

The Oracle Spatial LRS data model incorporates measure information into its geometry representation at the point level. The measure information is directly integrated into the Oracle Spatial model. To accomplish this, an additional *measure* dimension must be added to the Oracle Spatial metadata.

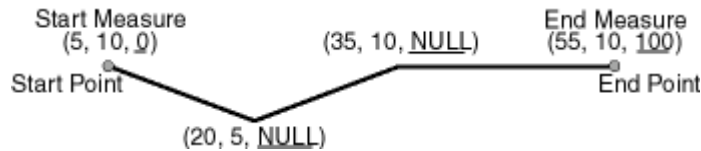
Oracle Spatial LRS support affects the Spatial metadata and data (the geometries). [Example 6-1](#) shows how a measure dimension can be added to two-dimensional geometries in the Spatial metadata. The measure dimension must be the last element of the SDO_DIM_ARRAY in a spatial object definition (shown in bold in [Example 6-1](#)).

Example 6-1 Including LRS Measure Dimension in Spatial Metadata

```
INSERT INTO user_sdo_geom_metadata VALUES(
  'LRS_ROUTES',
  'GEOMETRY',
  MDSYS.SDO_DIM_ARRAY (
    MDSYS.SDO_DIM_ELEMENT('X', 0, 100, 0.005),
    MDSYS.SDO_DIM_ELEMENT('Y', 0, 100, 0.005),
    MDSYS.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 6-7](#).

Figure 6-7 *Creating a Geometric Segment*



In [Figure 6-7](#), the geometric segment has the following definition (with measure values underlined):

```
SDO_GEOMETRY(3302, NULL, NULL,
  MDSYS.SDO_ELEM_INFO_ARRAY(1,2,1),
  MDSYS.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 LRS API works with geometries in formats of Oracle Spatial before release 8.1.6, but the resulting geometries will be converted to the Oracle Spatial release 8.1.6 or higher format, specifically with 4-digit SDO_GTYPE and SDO_ETYPE values. For example, in Oracle Spatial release 8.1.6 and higher, the geometry type (SDO_GTYPE) of a spatial object includes the number of dimensions of the object as the first digit of the SDO_GTYPE value. Thus, the SDO_GTYPE value of a point is 1 in the pre-release 8.1.6 format but 2001 in the release 8.1.6 format (the number of dimensions of the point is 2). However, an LRS point (which includes measure information) has three dimensions, and thus the SDO_GTYPE of any point geometry used with an LRS function must be 3301.

6.3 Indexing of LRS Data

If LRS data is indexed using a spatial quadtree index, only the first two dimensions are indexed; the measure dimension and its values are not indexed.

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 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, the only Spatial operator that can be used on the indexed geometries is **SDO_FILTER**; the other operators described in [Chapter 10](#) 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** statement and its parameters and keywords is in [Chapter 8](#).

6.4 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 [Chapter 14](#).

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 geodetic data.

6.5 LRS Operations

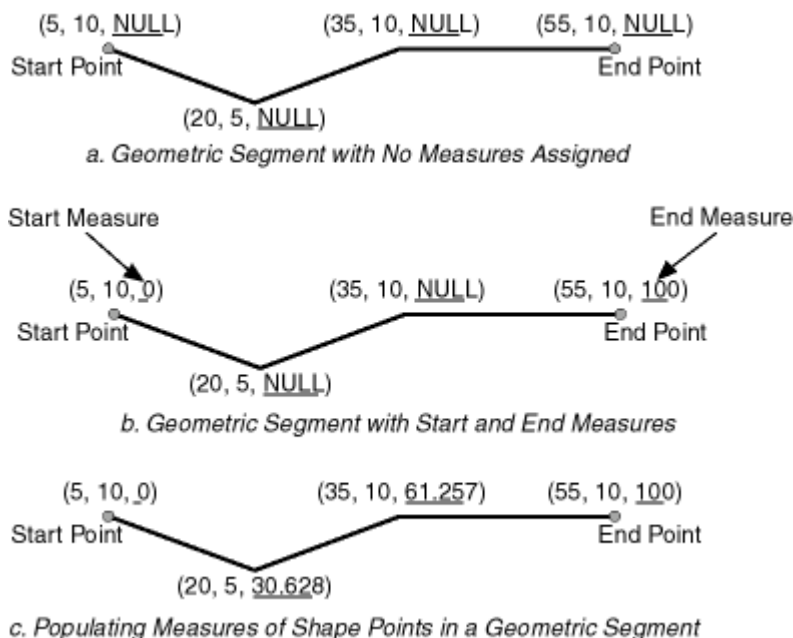
This section describes several linear referencing operations supported by the Oracle Spatial LRS API.

6.5.1 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/or 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 6–8](#) shows different ways of defining a geometric segment.

Figure 6–8 Defining a Geometric Segment

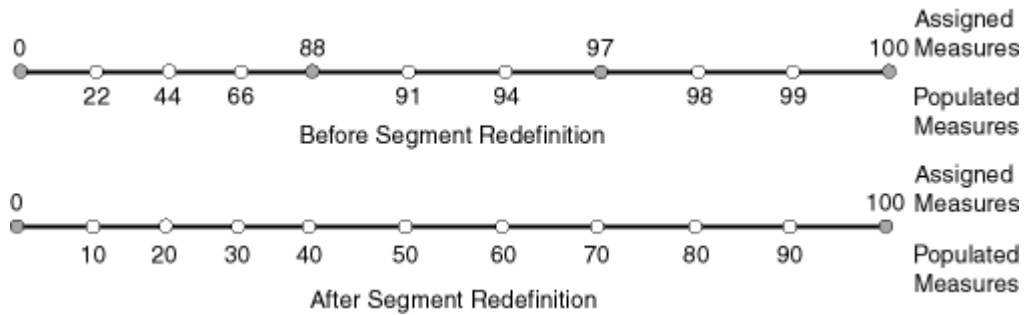
An LRS segment must be defined (or must already exist) before any LRS operations can proceed. That is, the start, end, and any other assigned measures must be present to derive the location from a specified measure. The measure information of intermediate shape points will automatically be populated if they are not assigned.

6.5.2 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 6–9 shows the redefinition of a segment where the existing (before) assigned measure values are not proportional and reflect widely varying gaps.

Figure 6–9 Redefining a Geometric Segment

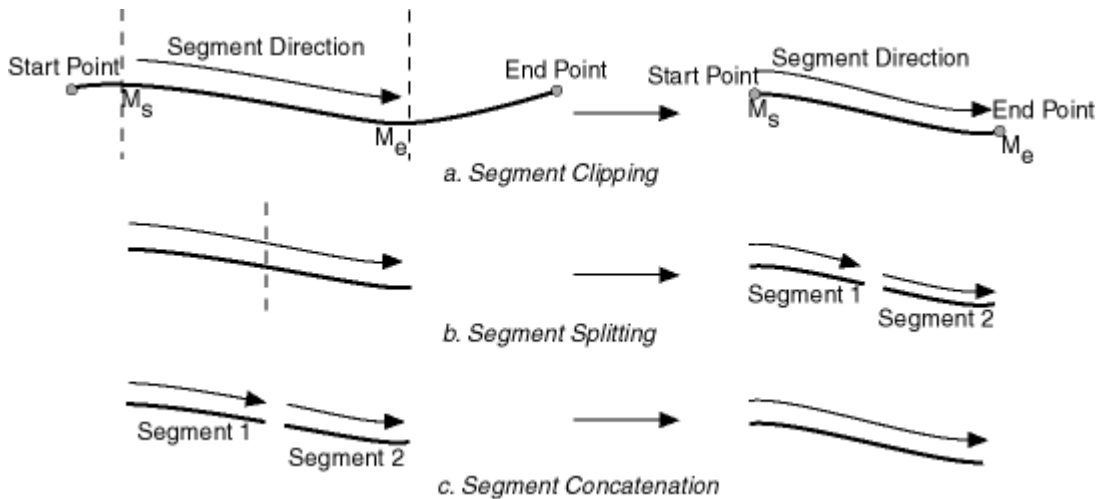


After the segment redefinition in [Figure 6–9](#), the populated measures reflect proportional distances along the segment.

6.5.3 Clipping a Geometric Segment

You can clip a geometric segment to create a new geometric segment out of an existing geometric segment ([Figure 6–10](#), part a).

Figure 6–10 Clipping, Splitting, and Concatenating Geometric Segments



6.5.4 Splitting a Geometric Segment

You can create two new geometric segments by splitting a geometric segment (Figure 6–10, part b).

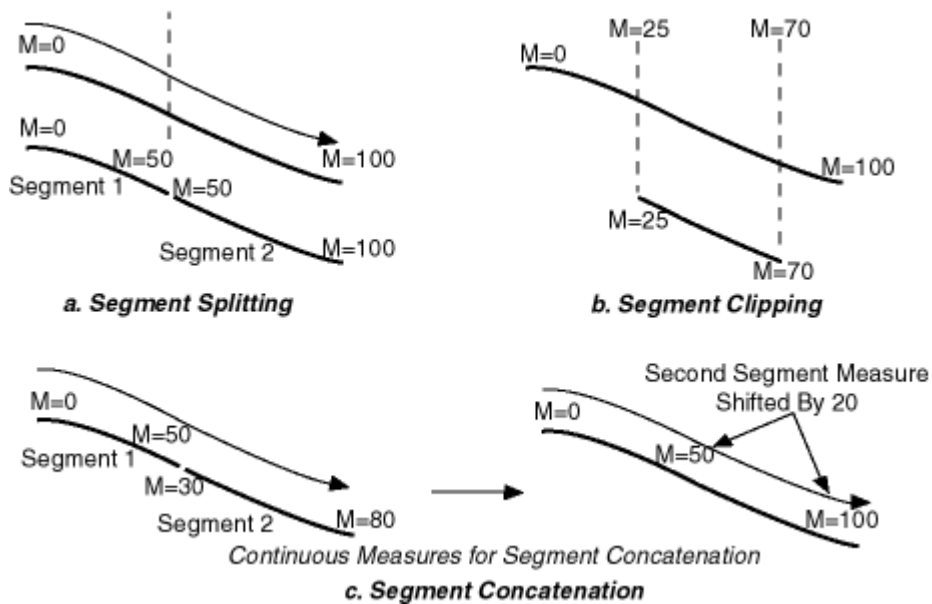
Note: In Figure 6–10 and several that follow, small gaps between segments are used in illustrations of segment splitting and concatenation. Each gap simply reinforces the fact that two different segments are involved. However, the two segments (such as segment 1 and segment 2 in Figure 6–10, parts b and c) are actually connected. The tolerance (see Section 1.5.5) is considered in determining whether or not segments are connected.

6.5.5 Concatenating Geometric Segments

You can create a new geometric segment by concatenating two geometric segments (Figure 6–10, part c). Note that the geometric segments do not need to be spatially connected, although they are connected in the illustration in Figure 6–10, part c. 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.

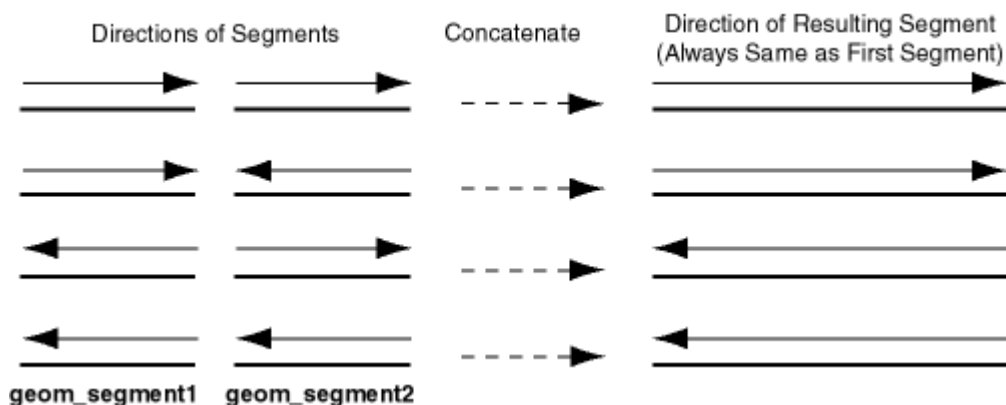
Measure assignments for the clipping, splitting, and concatenating operations in Figure 6–10 are shown in Figure 6–11. Measure information and segment direction are preserved in a consistent manner. The assignment is done automatically when the operations have completed.

Figure 6–11 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](#) function), as shown in [Figure 6–12](#).

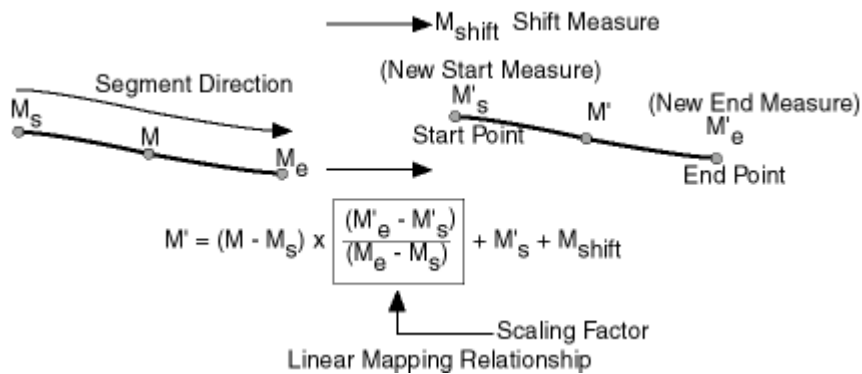
Figure 6–12 Segment Direction with Concatenation



In addition to explicitly concatenating two connected segments using the [SDO_LRS.CONCATENATE_GEOM_SEGMENTS](#) 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](#) spatial aggregate function. (See the description and example of the [SDO_AGGR_LRS_CONCAT](#) spatial aggregate function in [Chapter 12](#).)

6.5.6 Scaling a Geometric Segment

You can create a new geometric segment by performing a linear scaling operation on a geometric segment. [Figure 6–13](#) shows the mapping relationship for geometric segment scaling.

Figure 6–13 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:

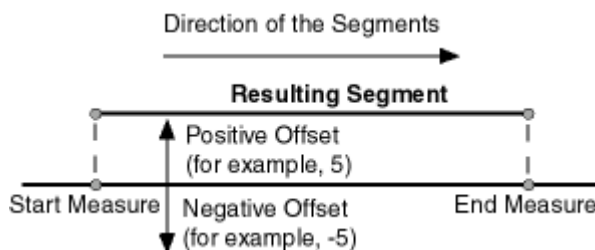
- Translating (shifting) measure information. (For example, add the same value to M_s and M_e to get M'_s and M'_e .)
- Reversing measure information. (Let $M'_s = M_e$, $M'_e = M_s$, and $M_{\text{shift}} = 0$.)
- Performing simple scaling of measure information. (Let $M_{\text{shift}} = 0$.)

For examples of these operations, see usage notes and examples for the [SDO_LRS.SCALE_GEOM_SEGMENT](#) function in [Chapter 14](#).

6.5.7 Offsetting a Geometric Segment

You can create a new geometric segment by performing an offsetting operation on a geometric segment. [Figure 6–14](#) shows the mapping relationship for geometric segment offsetting.

Figure 6–14 Offsetting a Geometric Segment



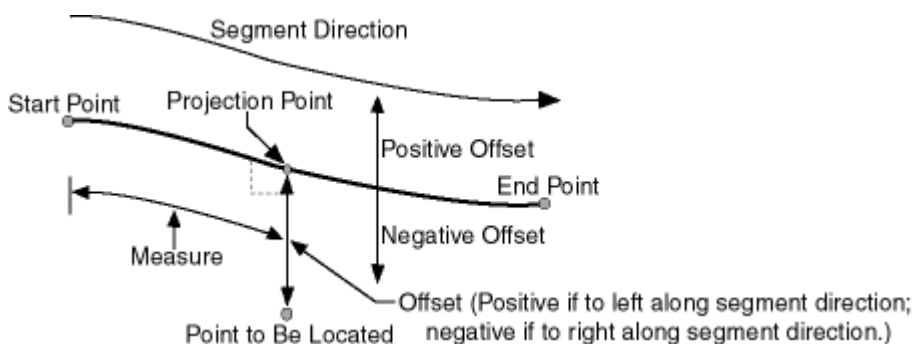
In the offsetting operation shown in [Figure 6–14](#), the resulting geometric segment is offset by 5 units from the specified start and end measures of the original segment.

For more information, see usage notes and examples for the [SDO_LRS.OFFSET_GEOM_SEGMENT](#) function in [Chapter 14](#).

6.5.8 Locating a Point on a Geometric Segment

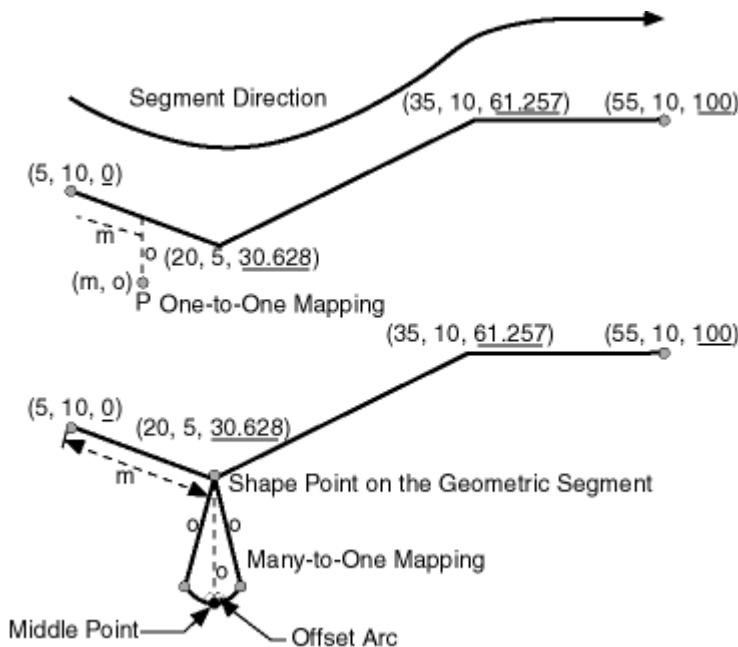
You can find the position of a point described by a measure and an offset on a geometric segment (see [Figure 6–15](#)).

Figure 6–15 Locating a Point Along a Segment with a Measure and an Offset



There is always a unique a 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 6–16](#)).

Figure 6–16 Ambiguity in Location Referencing with Offsets



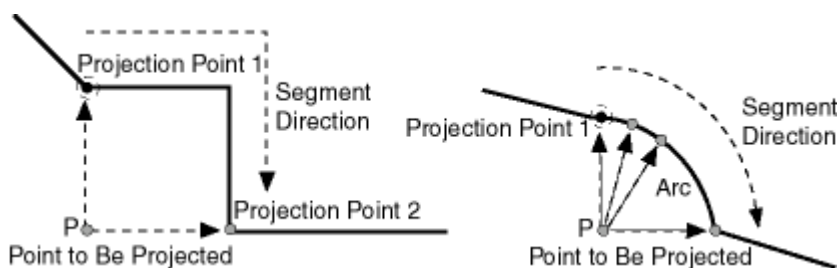
As shown in [Figure 6–16](#), an offset arc of a shape point on a geometric segment is an arc on which all points have the same minimum distance to the shape point. As a result, all points on the offset arc are represented by the same (measure, offset) pair. To resolve this one-to-many mapping problem, the middle point on the offset arc is returned.

6.5.9 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 6–15](#). 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 6–16](#)). If there are multiple projection points for a point, the first one from the start point is returned (projection pt 1 in both illustrations in [Figure 6–17](#)).

Figure 6–17 Multiple Projection Points



6.5.10 Converting LRS Geometries

You can convert geometries from standard line string format to Linear Referencing System format, and vice versa. 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.

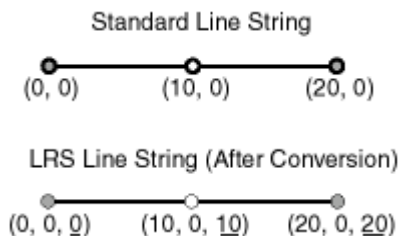
- Dimensional information (DIMINFO)

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 6–18 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](#) function). The measure dimension values are underlined in Figure 6–18.

Figure 6–18 Conversion from Standard to LRS Line String



For conversions of point geometries, the SDO_POINT attribute (described in [Section 2.2.3](#)) 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 [Section 2.2.4](#) and [Section 2.2.5](#)) 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 [Section 2.2.4](#) and [Section 2.2.5](#)) 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.

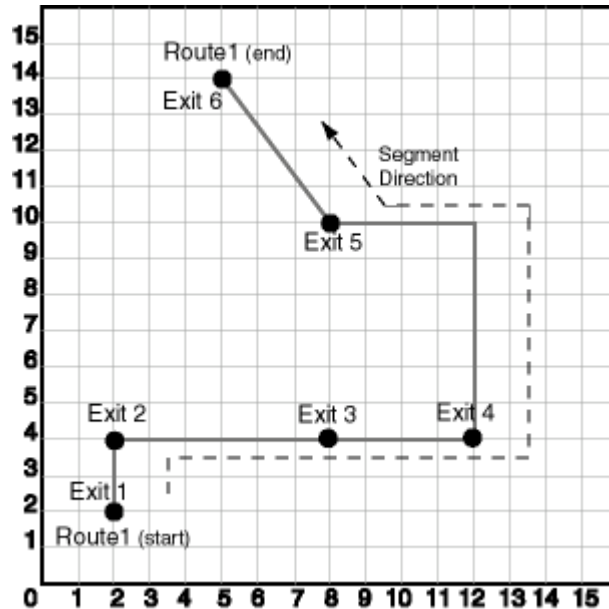
The conversion functions are listed in [Table 14–3](#) in [Chapter 14](#). See also the reference information in [Chapter 14](#) about each conversion function.

6.6 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 [Chapter 14](#).

This example uses the road that is illustrated in [Figure 6–19](#).

Figure 6–19 Simplified LRS Example: Highway



In Figure 6–19, 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 6–1 lists an actual highway-related feature and the LRS feature that corresponds to it or that can be used to represent it.

Table 6–1 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	SDO_LRS.LOCATE_PT function
Construction zone (portion of a road)	SDO_LRS.CLIP_GEOM_SEGMENT function

Table 6–1 Highway Features and LRS Counterparts (Cont.)

Highway Feature	LRS Feature
Road extension (adding at the beginning or end) or combination (designating or renaming two roads that meet as one road)	SDO_LRS.CONCATENATE_GEOM_SEGMENTS function
Road reconstruction or splitting (resulting in two named roads from one named road)	SDO_LRS.SPLIT_GEOM_SEGMENT function
Finding the closest point on the road to a point off the road (such as a building)	SDO_LRS.PROJECT_PT function
Guard rail or fence alongside a road.	SDO_LRS.OFFSET_GEOM_SEGMENT function

Example 6–2 does the following:

- Creates a table to hold the segment
- Inserts the definition of the highway 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 6–3 includes the output of the SELECT statements in [Example 6–2](#).

Example 6–2 Simplified Example: Highway

```
-- Create a table for routes (highways).
CREATE TABLE lrs_routes (
  route_id NUMBER PRIMARY KEY,
  route_name VARCHAR2(32),
  route_geometry MDSYS.SDO_GEOMETRY);

-- Populate table with just one route for this example.
INSERT INTO lrs_routes VALUES(
  1,
  'Route1',
  MDSYS.SDO_GEOMETRY(
    3302, -- line string, 3 dimensions: X,Y,M
    NULL,
    NULL,
    MDSYS.SDO_ELEM_INFO_ARRAY(1,2,1), -- one line string, straight segments
    MDSYS.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
VALUES (
    'lrs_routes',
    'route_geometry',
    MDSYS.SDO_DIM_ARRAY( -- 20X20 grid
        MDSYS.SDO_DIM_ELEMENT('X', 0, 20, 0.005),
        MDSYS.SDO_DIM_ELEMENT('Y', 0, 20, 0.005),
        MDSYS.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 MDSYS.SDO_GEOMETRY;
line_string MDSYS.SDO_GEOMETRY;
dim_array MDSYS.SDO_DIM_ARRAY;
result_geom_1 MDSYS.SDO_GEOMETRY;
result_geom_2 MDSYS.SDO_GEOMETRY;
result_geom_3 MDSYS.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're 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;

-- Shift by 5 (for example, 5-mile segment added before original start)
SELECT SDO_LRS.SCALE_GEOM_SEGMENT(a.route_geometry, m.dinfo, 0, 27, 5)
      FROM lrs_routes a, user_sdo_geom_metadata m
      WHERE m.table_name = 'LRS_ROUTES' AND a.route_id = 1;

-- "Convert" mile measures to kilometers (27 * 1.609 = 43.443)
SELECT SDO_LRS.SCALE_GEOM_SEGMENT(route_geometry, 0, 43.443, 0)
      FROM lrs_routes WHERE route_id = 1;

-- Clip a piece of Route1.
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,
  MDSYS.SDO_GEOMETRY(3301, NULL, NULL,
    MDSYS.SDO_ELEM_INFO_ARRAY(1, 1, 1),
    MDSYS.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,
    MDSYS.SDO_GEOMETRY(3301, NULL, NULL,
      MDSYS.SDO_ELEM_INFO_ARRAY(1, 1, 1),
      MDSYS.SDO_ORDINATE_ARRAY(9, 3, NULL)) ),
  m.diminfo )
  FROM lrs_routes a, user_sdo_geom_metadata m
  WHERE m.table_name = 'LRS_ROUTES' AND a.route_id = 1;

-- Is point (9,3,NULL) a valid LRS point? (Should return TRUE.)
SELECT SDO_LRS.VALID_LRS_PT(
  MDSYS.SDO_GEOMETRY(3301, NULL, NULL,
    MDSYS.SDO_ELEM_INFO_ARRAY(1, 1, 1),
    MDSYS.SDO_ORDINATE_ARRAY(9, 3, NULL)),
  m.diminfo)
  FROM lrs_routes a, user_sdo_geom_metadata m
  WHERE m.table_name = 'LRS_ROUTES' AND a.route_id = 1;

-- Locate the point on Route1 at measure 9, offset 0.
SELECT SDO_LRS.LOCATE_PT(route_geometry, 9, 0)
  FROM lrs_routes WHERE route_id = 1;

```

Example 6-3 shows the output of the SELECT statements in **Example 6-2**.

Example 6-3 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 Route1
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_ORDIN
-----
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>

```

```

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>

```

```

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>

```

```

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>
```

```
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>
```

```
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>
```

```
SQL> -- What is the start measure of Route1?
```

```
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>
```

```
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>
```

```
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>
```

```
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>
```

```
SQL> -- Shift by 5 (for example, 5-mile segment added before original start)
```

```
SQL> SELECT SDO_LRS.SCALE_GEOM_SEGMENT(a.route_geometry, m.diminfo, 0, 27, 5)
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.SCALE_GEOM_SEGMENT(A.ROUTE_GEOMETRY,M.DIMINFO,0,27,5)(SDO_GTYPE, SDO_SRI
-----
SDO_GEOMETRY(3302, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 2, 1), SDO_ORDINATE_ARRAY(
2, 2, 5, 2, 4, 7, 8, 4, 13, 12, 4, 17, 12, 10, 23, 8, 10, 27, 5, 14, 32))
```

```
SQL>
```

```
SQL> -- "Convert" mile measures to kilometers (27 * 1.609 = 43.443)
```

```
SQL> SELECT SDO_LRS.SCALE_GEOM_SEGMENT(route_geometry, 0, 43.443, 0)
2 FROM lrs_routes WHERE route_id = 1;
```

```
SDO_LRS.SCALE_GEOM_SEGMENT(ROUTE_GEOMETRY,0,43.443,0)(SDO_GTYPE, SDO_SRID, SDO_P
-----
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>
```

```
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>

SQL> -- Point (9,3,NULL) is off the road; should return (9,4,9).

```
SQL> SELECT SDO_LRS.PROJECT_PT(route_geometry,
2 MDSYS.SDO_GEOMETRY(3301, NULL, NULL,
3 MDSYS.SDO_ELEM_INFO_ARRAY(1, 1, 1),
4 MDSYS.SDO_ORDINATE_ARRAY(9, 3, NULL)) )
5 FROM lrs_routes WHERE route_id = 1;
```

```
SDO_LRS.PROJECT_PT(ROUTE_GEOMETRY,MDSYS.SDO_GEOMETRY(3301,NULL,NULL,MDSYS.SDO_EL
```

```
-----
SDO_GEOMETRY(3301, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 1, 1), SDO_ORDINATE_ARRAY(
9, 4, 9))
```

SQL>

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 MDSYS.SDO_GEOMETRY(3301, NULL, NULL,
4 MDSYS.SDO_ELEM_INFO_ARRAY(1, 1, 1),
5 MDSYS.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,MDSYS.SDO_GEOM
```

9

SQL>

SQL> -- Is point (9,3,NULL) a valid LRS point? (Should return TRUE.)

```
SQL> SELECT SDO_LRS.VALID_LRS_PT(
2 MDSYS.SDO_GEOMETRY(3301, NULL, NULL,
3 MDSYS.SDO_ELEM_INFO_ARRAY(1, 1, 1),
4 MDSYS.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(MDSYS.SDO_GEOMETRY(3301,NULL,NULL,MDSYS.SDO_ELEM_INFO_ARRAY
```

TRUE

SQL>

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))

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
- Create an use a function-based index where the function returns an `SDO_GEOMETRY` object

The techniques in this chapter are intended for experienced and knowledgeable application developers. You should be familiar with the Spatial 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 functional indexing.

7.1 `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 wanted to follow the cola markets scenario in the simplified example in [Section 2.1](#), but wanted 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 MDSYS.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 [Section 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',
  MDSYS.SDO_GEOMETRY(
    2003, -- 2-dimensional polygon
    NULL,
    NULL,
    MDSYS.SDO_ELEM_INFO_ARRAY(1,1003,3), -- one rectangle (1003 = exterior)
    MDSYS.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 [Section 2.4.2](#)) in the metadata view.

```
INSERT INTO USER_SDO_GEOM_METADATA
  VALUES (
    'cola_markets_2',
    'market.shape',
    MDSYS.SDO_DIM_ARRAY( -- 20X20 grid
```

```

MDSYS.SDO_DIM_ELEMENT('X', 0, 20, 0.005),
MDSYS.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,
MDSYS.SDO_GEOMETRY(2003, NULL, NULL,
MDSYS.SDO_ELEM_INFO_ARRAY(1,1003,3),
MDSYS.SDO_ORDINATE_ARRAY(4,6, 8,8)),
'mask=anyinteract querytype=window' = 'TRUE');

```

7.2 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:

- *Oracle9i Application Developer's Guide - Fundamentals*

- *Oracle9i Database Administrator's Guide*

See especially the information in those documents about requirements and restrictions related to function-based indexes. For example, you must grant Spatial application users the QUERY REWRITE privilege, and you must have the initialization parameters COMPATIBLE set to 8.1.0.0.0 or higher, QUERY_REWRITE_ENABLED=TRUE, and QUERY_REWRITE_INTEGRITY=TRUSTED.

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.

7.2.1 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 wanted 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 MDSYS.SDO_GEOMETRY deterministic is
begin
    return mdsys.sdo_geometry(2001, 8307,
                              mdsys.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
(longitude number, latitude 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(LONGITUDE,LATITUDE) as the COLUMN_NAME (explained in [Section 2.4.2](#)) in the metadata view.

```

-- Set up the metadata entry for this table.
-- note that 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(longitude,latitude)',
    mdsys.sdo_dim_array(
        mdsys.sdo_dim_element('Longitude', -180, 180, 0.005),
        mdsys.sdo_dim_element('Latitude', -90, 90, 0.005)), 8307);

```

Create the spatial index, specifying the function name with parameters. For example, creating an R-tree index:

```

create index LONG_LAT_TABLE_IDX on
    LONG_LAT_TABLE(get_long_lat_pt(longitude,latitude))
indextype is mdsys.spatial_index;

```

Perform queries on the data. In the following example, the two queries accomplish the same thing; however, the first query does not use a user-defined function (instead using a constructor to specify the point), whereas the second query uses the function to specify the point.

```
-- First query: call sdo_filter with an SDO_GEOMETRY constructor
select name from LONG_LAT_TABLE a
  where sdo_filter(get_long_lat_pt(a.longitude,a.latitude),
    mdsys.sdo_geometry(2001, 8307,
      mdsys.sdo_point_type(10,10,NULL), NULL, NULL),
    'querytype=WINDOW')='TRUE';

-- Second query: call sdo_filter with the function that returns an sdo_geometry
select name from LONG_LAT_TABLE a
  where sdo_filter(get_long_lat_pt(a.longitude,a.latitude),
    get_long_lat_pt(10,10),
    'querytype=WINDOW')='TRUE';
```

7.2.2 Example: Function with 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 wanted 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 MDSYS.SDO_GEOMETRY DETERMINISTIC)
/

create or replace type body long_lat as
  member function GetGeometry(self in long_lat)
  return MDSYS.SDO_GEOMETRY is
  begin
    return mdsys.sdo_geometry(2001, 8307,
      mdsys.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 [Section 2.4.2](#)) in the metadata view.

```
insert into user_sdo_geom_metadata values('test_long_lat',
    'scott.long_lat.GetGeometry(location)',
    mdsys.sdo_dim_array(
        mdsys.sdo_dim_element('Longitude', -180, 180, 0.005),
        mdsys.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 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(),
        MDSYS.SDO_GEOMETRY(2001, 8307,
            MDSYS.SDO_POINT_TYPE(10,10,NULL), NULL, NULL),
        'querytype=window') = 'TRUE';
```


Part II

Reference Information

This document has two main parts:

- Part I provides conceptual and usage information about Oracle Spatial.
- Part II provides reference information about Oracle Spatial methods, operators, functions, and procedures.

Appendixes with supplementary information follow Part II.

Part II contains the following chapters with reference information:

- [Chapter 8, "SQL Statements for Indexing Spatial Data"](#)
- [Chapter 9, "SDO_GEOMETRY Object Type Methods"](#)
- [Chapter 10, "Spatial Operators"](#)
- [Chapter 11, "Geometry Functions"](#)
- [Chapter 12, "Spatial Aggregate Functions"](#)
- [Chapter 13, "Coordinate System Transformation Functions"](#)
- [Chapter 14, "Linear Referencing Functions"](#)
- [Chapter 15, "Migration Procedures"](#)
- [Chapter 16, "Tuning Functions and Procedures"](#)
- [Chapter 17, "Utility Functions"](#)

To understand the examples in the reference chapters, you must understand the conceptual and data type information in [Chapter 2, "Spatial Data Types and Metadata"](#), especially [Section 2.2, "SDO_GEOMETRY Object Type"](#).

SQL Statements for Indexing Spatial Data

This chapter describes the statements used when working with the spatial object data type. The statements are listed in [Table 8–1](#).

Table 8–1 Spatial Index Creation and Usage Statements

Statement	Description
ALTER INDEX	Alters a spatial index on a column of type MDSYS.SDO_GEOMETRY.
ALTER INDEX REBUILD	Rebuilds a spatial index on a column of type MDSYS.SDO_GEOMETRY.
ALTER INDEX RENAME TO	Changes the name of a spatial index on a column of type MDSYS.SDO_GEOMETRY.
CREATE INDEX	Creates a spatial index on a column of type MDSYS.SDO_GEOMETRY.
DROP INDEX	Deletes a spatial index on a column of type MDSYS.SDO_GEOMETRY.

This chapter focuses on using these SQL statements with spatial indexes. For complete reference information about any statement, see the *Oracle9i SQL Reference*.

ALTER INDEX

Purpose

Alters specific parameters for a spatial index or rebuilds a spatial index.

Syntax

```
ALTER INDEX [schema.]index PARAMETERS ('index_params [physical_storage_params]');
```

Keywords and Parameters

Value	Description
<i>INDEX_PARAMS</i>	Allows you to change the characteristics of the spatial index, and the type (fixed or hybrid) of a quadtree index. Some keywords apply only to R-tree or to quadtree indexes.
add_index	Specifies the name of the new index table to add. Data type is VARCHAR2.
delete_index	Specifies the name of the index table to delete. You can only delete index tables that were created with the ALTER INDEX add_index statement. The primary index table cannot be deleted with this parameter. To delete the primary index table, use the DROP INDEX statement. Data type is VARCHAR2.
index_status	Specifies that index modifications are to be deferred ('index_status=deferred') or that deferred index modifications are to be synchronized with the data in the spatial table ('index_status=synchronize'). See the Usage Notes for further details. Data type is VARCHAR2.
sdo_commit_interval	Quadtree indexes only: Specifies the number of underlying table rows that are processed between commit intervals for the index data. The default behavior commits the index data only after all rows in the underlying table have been processed. See the Usage Notes for the CREATE INDEX statement for further details. Data type is NUMBER.

Value	Description
sdo_indx_dims	R-tree indexes only: Specifies the number of dimensions to be indexed. For example, a value of 2 causes the first two dimensions to be indexed. Must be less than or equal to the number of actual dimensions (number of SDO_DIM_ELEMENT instances in the dimensional array that describes the geometry objects in the column). Note that if the value is 3 or higher, the only Spatial operator that can be used on the indexed geometries is SDO_FILTER ; the other operators described in Chapter 10 cannot be used. Data type is NUMBER. Default = 2.
sdo_level	Quadtree indexes only: Specifies the desired fixed-size tiling level. Data type is NUMBER.
sdo_numtiles	Quadtree indexes only: Specifies the number of variable-sized tiles to be used in tessellating an object. Data type is NUMBER.
sdo_rtr_pctfree	R-tree indexes only: 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.
<i>PHYSICAL_STORAGE_PARAMS</i>	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.

Value	Description
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.
btree_initial	Is the same as INITIAL in the STORAGE clause of a CREATE INDEX statement in the case of a standard B-tree index. (Quadtree indexes only.)
btree_next	Is the same as NEXT in the STORAGE clause of a CREATE INDEX statement in the case of a standard B-tree index. (Quadtree indexes only.)
btree_pctincrease	Is the same as PCTINCREASE in the STORAGE clause of a CREATE INDEX statement in the case of a standard B-tree index. (Quadtree indexes only.)

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

This statement is used to change the parameters of an existing index. This is the only way you can add or build multiple indexes on the same column.

The *index_status* keyword lets you defer modifications to the spatial index when geometries are inserted, updated, or deleted in a spatial table. Deferring the index modifications allows the geometry insert, update, and delete operations to be completed sooner, and it can reduce concurrency issues with R-tree indexes if multiple sessions are inserting rows into the spatial table. While index modifications are being deferred, spatial functions and procedures will work correctly with the current table data; however, spatial operator-based queries might perform more slowly, will not include the results of new insert operations, and might not include the results of new update operations. Therefore, you are advised not to use spatial operators while index modifications are being deferred.

For partitioned indexes, the index status can only be changed for a single partition at a time. That is, you cannot set all index partitions to deferred status with a single ALTER INDEX statement.

If you set the index status to *deferred*, you must later set the status to *synchronize* to make the index reflect the data in the table and to set the index to a valid state.

See the Usage Notes for the [CREATE INDEX](#) statement for usage information about many of the other available parameters.

Examples

The following example adds a new index table named FIXED_INDEX\$ to the index named QTREE.

```
ALTER INDEX qtree PARAMETERS ('add_index=fixed_index$
                             sdo_level=8
                             initial=100M
                             next=1M
                             pctincrease=0
                             btree_initial=5M
                             btree_next=1M
                             btree_pctincrease=0');
```

The following example modifies the tablespace and the SDO_LEVEL value for partition IP2 of the spatial index named BGI.

```
ALTER INDEX bgi MODIFY PARTITION ip2
    PARAMETERS ('tablespace=TBS_3 sdo_level=4');
```

The following example defers index modifications and later (after the updates to the spatial table) synchronizes the index to reflect the table.

```
ALTER INDEX xyz_idx PARAMETERS ('index_status=deferred');
.
. <Insert rows in spatial table.>
.
ALTER INDEX xyz_idx PARAMETERS ('index_status=synchronize');
```

The following example defers index modifications for an index partition and later (after the updates to the spatial table) synchronizes the index partition to reflect the table.

```
ALTER INDEX part_sidx MODIFY PARTITION p3
    PARAMETERS ('index_status=deferred');
.
. <Insert rows in spatial table.>
.
ALTER INDEX part_sidx MODIFY PARTITION p3
    PARAMETERS ('index_status=synchronize');
```

Related Topics

- [ALTER INDEX REBUILD](#)
- [ALTER INDEX RENAME TO](#)
- [CREATE INDEX](#)
- [ALTER TABLE \(clauses for partition maintenance\) in the *Oracle9i SQL Reference*](#)

ALTER INDEX REBUILD

Syntax

```
ALTER INDEX [schema.]index REBUILD
  [PARAMETERS ('rebuild_params [physical_storage_params]' ) ]
  [{ NOPARALLEL | PARALLEL [ integer ] }];

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
<i>REBUILD_PARAMS</i>	Specifies in a command string the index parameters to use in rebuilding the spatial index. Some keywords apply only to R-tree or to quadtree indexes.
layer_gtype	Checks to ensure that all geometries are of a specified geometry type. The value must be from the Geometry Type column of Table 2-1 in Section 2.2.1 (except that UNKNOWN_GEOMETRY is not allowed). In addition, specifying POINT allows for optimized processing of point data. Data type is VARCHAR2.
rebuild_index	Specifies the name of the spatial index table to be rebuilt. Data type is VARCHAR2.
sdo_commit_interval	Quadtree indexes only: Specifies the number of underlying table rows that are processed between commit intervals for the index data. The default behavior commits the index data only after all rows in the underlying table have been processed. See the Usage Notes for further details. Data type is NUMBER.

Value	Description
sdo_indx_dims	R-tree indexes only: Specifies the number of dimensions to be indexed. For example, a value of 2 causes the first two dimensions to be indexed. Must be less than or equal to the number of actual dimensions (number of SDO_DIM_ELEMENT instances in the dimensional array that describes the geometry objects in the column). Note that if the value is 3 or higher, the only Spatial operator that can be used on the indexed geometries is <i>SDO_FILTER</i> ; the other operators described in Chapter 10 cannot be used. Data type is NUMBER. Default = 2.
sdo_level	Quadtree indexes only: Specifies the desired fixed-size tiling level. Data type is NUMBER.
sdo_numtiles	Quadtree indexes only: Specifies the number of variable-sized tiles to be used in tessellating an object. Data type is NUMBER.
sdo_rtr_pctfree	R-tree indexes only: 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.
<i>PHYSICAL_STORAGE_PARAMS</i>	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.
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.

Value	Description
btree_initial	Is the same as INITIAL in the STORAGE clause of a CREATE INDEX statement in the case of a standard B-tree index. (Quadtree indexes only.)
btree_next	Is the same as NEXT in the STORAGE clause of a CREATE INDEX statement in the case of a standard B-tree index. (Quadtree indexes only.)
btree_pctincrease	Is the same as PCTINCREASE in the STORAGE clause of a CREATE INDEX statement in the case of a standard B-tree index. (Quadtree indexes only.)
{ <i>NOPARALLEL</i> <i>PARALLEL</i> [<i>integer</i>] }	Controls whether the rebuilding of the index is performed using serial execution (NOPARALLEL) or parallel (PARALLEL) execution. For parallel execution you can specify an integer value of degree of parallelism. See the Usage Notes for the CREATE INDEX 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 server 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. The default, or normal, operation is that all rows in the underlying table are processed before the insertion of index data is committed. This requires adequate rollback segment space.

You may choose to commit index data after every *n* rows of the underlying table have been processed. This is done by specifying SDO_COMMIT_INTERVAL = *n*. The potential complication is that, if there is an error during index rebuild and if periodic commit operations have taken place, then the spatial index will be in an inconsistent state. The only recovery option is to use [DROP INDEX](#) (possibly with the FORCE option) and [CREATE INDEX](#) statements after ensuring that the various tablespaces are the required size and any other error conditions have been removed.

This statement does not use any previous parameters from the index creation. All parameters should be specified for the index you want to rebuild.

For more information about using the *layer_gtype* keyword to constrain data in a layer to a geometry type, see [Section 4.1.5](#).

With a partitioned spatial index, you must use a separate ALTER INDEX REBUILD statement for each partition to be rebuilt.

See also the Usage Notes for the [CREATE INDEX](#) statement for usage information about many of the available parameters and about the use of the PARALLEL keyword.

Examples

The following example rebuilds OLDINDEX with an SDO_LEVEL value of 12.

```
ALTER INDEX oldindex REBUILD PARAMETERS('sdo_level=12');
```

The following example uses the [ALTER INDEX](#) statement to add a new index table named USBG_IDX_QTREE to the index named USBG_IDX, and later it uses the ALTER INDEX REBUILD statement to rebuild the index table using a different sdo_level value and specifying parallel execution. This approach lets you add a small index table, and later rebuild it in parallel execution mode with the desired parameter values (necessary because you cannot specify parallel execution for ALTER INDEX).

```
ALTER INDEX usbg_idx PARAMETERS (add_index=usbg_idx_qtree sdo_level=6');
```

```
-- (Add substantial geometry data to the spatial table)
```

```
ALTER INDEX usbg_idx REBUILD  
  PARAMETERS ('rebuild_index=usbg_idx_qtree sdo_level=14') PARALLEL;
```

Related Topics

- [CREATE INDEX](#)
- [DROP INDEX](#)
- ALTER TABLE (clauses for partition maintenance) in the *Oracle9i SQL Reference*

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

Alters the name of a spatial index or a partition of a spatial index.

Keywords and Parameters

Value	Description
new_index_name	Specifies the new name of the index.
new_partition_name	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](#)
- [DROP INDEX](#)

CREATE INDEX

Syntax

```
CREATE INDEX [schema.]<index_name> ON [schema.]<tableName> (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 MDSYS.SDO_GEOMETRY.

Keywords and Parameters

Value	Description
<i>INDEX_PARAMS</i>	Determines the type (R-tree or quadtree; and for quadtree, fixed or hybrid) and the characteristics of the spatial index. Some keywords apply only to R-tree or to quadtree indexes.
geodetic	'geodetic=FALSE' allows a non-geodetic index to be built on geodetic data, but with restrictions. (FALSE is the only acceptable value for this keyword.) See the Usage Notes for more information. Data type is VARCHAR2.
layer_gtype	Checks to ensure that all geometries are of a specified geometry type. The value must be from the Geometry Type column of Table 2-1 in Section 2.2.1 (except that UNKNOWN_GEOMETRY is not allowed). In addition, specifying POINT allows for optimized processing of point data. Data type is VARCHAR2.
sdo_commit_interval	Quadtree indexes only: Specifies the number of underlying table rows that are processed between commit intervals for the index data. The default behavior commits the index data only after all rows in the underlying table have been processed. See the Usage Notes for further details. Data type is NUMBER.

Value	Description
sdo_indx_dims	R-tree indexes only: Specifies the number of dimensions to be indexed. For example, a value of 2 causes the first two dimensions to be indexed. Must be less than or equal to the number of actual dimensions (number of SDO_DIM_ELEMENT instances in the dimensional array that describes the geometry objects in the column). Note that if the value is 3 or higher, the only Spatial operator that can be used on the indexed geometries is SDO_FILTER ; the other operators described in Chapter 10 cannot be used. Data type is NUMBER. Default = 2.
sdo_level	Quadtree indexes only: Specifies the desired fixed-size tiling level. Data type is NUMBER.
sdo_numtiles	Quadtree indexes only: Specifies the number of variable-sized tiles to be used in tessellating an object. Data type is NUMBER.
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. (R-tree indexes only.) The value can range from 0 to 50. Data type is NUMBER. Default = 10.
<i>PHYSICAL_STORAGE_PARAMS</i>	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_params 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.
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.

Value	Description
<code>btree_initial</code>	Is the same as INITIAL in the STORAGE clause of a CREATE INDEX statement in the case of a standard B-tree index. (Quadtree indexes only.)
<code>btree_next</code>	Is the same as NEXT in the STORAGE clause of a CREATE INDEX statement in the case of a standard B-tree index. (Quadtree indexes only.)
<code>btree_pctincrease</code>	Is the same as PCTINCREASE in the STORAGE clause of a CREATE INDEX statement in the case of a standard B-tree index. (Quadtree indexes only.)
<code>{ NOPARALLEL / PARALLEL [integer] }</code>	Controls whether the creation of the index is performed using serial execution (NOPARALLEL) or parallel (PARALLEL) execution. 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 server calculates the optimum degree of parallelism.)

Prerequisites

- All the 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 R-tree and quadtree indexes, see [Section 1.7](#).

By default, an R-tree index is created if the `index_params` string does not contain the `sdo_level` keyword or if the `sdo_level` value is zero (0). If the `index_params` string contains the `sdo_level` keyword with a nonzero value, a quadtree index is created. Some keywords apply only to R-tree or quadtree indexes, as noted in the Keywords and Parameters section.

Before you create an R-tree index, be sure that the rollback segment size and the `SORT_AREA_SIZE` parameter value are adequate, as described in [Section 4.1.1](#).

For a quadtree index, the *index_params* string must contain either *sdo_level* or both *sdo_level* and *sdo_numtiles*, and any values specified for these parameters must be valid.

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 [Section 6.2](#).)

A partitioned spatial index can be created on a partitioned table. See [Section 4.1.7](#) for more information about partitioned spatial indexes, including benefits and restrictions.

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 the *Oracle9i SQL Reference*. In addition, the following notes apply to the use of the **PARALLEL** keyword for creating or rebuilding (using the [ALTER INDEX REBUILD](#) statement) spatial indexes:

- The **PARALLEL** clause is not supported for adding an index table with the [ALTER INDEX](#) statement; however, it is supported for rebuilding such an index table with the [ALTER INDEX REBUILD](#) statement. One useful scenario is to add a small second index table, and later rebuild the index table specifying the desired parameters and using parallel execution. See the parallel execution example for the [ALTER INDEX REBUILD](#) statement.
- The performance cost and benefits from parallel execution for creating or rebuilding an index depend on a system's resources and load. If the system's 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. However, for a

function-based quadtree index on point data, parallel execution does improve index creation performance significantly.

- For a quadtree index on mixed point and nonpoint data, specifying `PARALLEL` can degrade the performance of creating or rebuilding an index

Other options available for regular indexes (such as `ASC` and `DESC`) are not applicable for spatial indexes.

Default values for quadtree indexing:

- `sdo_numtiles` must be supplied with a value greater than or equal to 1 to perform hybrid indexing. If this parameter is not supplied, indexing with fixed-size tiles is performed.
- `sdo_commit_interval` does not allow spatial data to be committed at intervals. Insertion of spatial index data is committed only at the end of the index creation process. That is, it is committed after all rows in the underlying table have been processed.

The `sdo_level` value must be greater than zero.

If an `sdo_numtiles` value is specified, it might be overridden by the indexing algorithm.

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. The default, or normal, operation is that all rows in the underlying table are processed before the insertion of index data is committed. This requires adequate rollback segment space.

You may choose to commit index data after every n rows of the underlying table have been processed. This is done by specifying `SDO_COMMIT_INTERVAL = n`. The potential complication is that, if there is an error during index rebuild and if periodic commit operations have taken place, then the spatial index will be in an inconsistent state. The only recovery option is to use `DROP INDEX` (possibly with the `FORCE` option) and `CREATE INDEX` statements after ensuring that the various tablespaces are the required size and any other error conditions have been removed.

Interpretation of `sdo_level` and `sdo_numtiles` value combinations (quadtree indexing) is shown in [Table 8-2](#).

Table 8-2 SDO_LEVEL and SDO_NUMTILES Combinations

SDO_LEVEL	SDO_NUMTILES	Action
Not specified or 0	Not specified or 0	R-tree index.

Table 8–2 SDO_LEVEL and SDO_NUMTILES Combinations (Cont.)

SDO_LEVEL	SDO_NUMTILES	Action
>= 1	Not specified or 0	Fixed indexing (indexing with fixed-size tiles).
>= 1	>= 1	Hybrid indexing with fixed-size and variable-sized tiles. The SDO_LEVEL column defines the fixed tile size. The SDO_NUMTILES column defines the number of variable tiles to generate for each geometry.
Not specified or 0	>= 1	Not supported (error).

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 [Section 4.1.5](#).

The '*geodetic=FALSE*' parameter allows you to bypass the restriction that a standard quadtree index cannot be used with geodetic data. However, using this parameter is not recommended, because much of the Oracle Spatial geodetic support will be disabled, and some Spatial operations that use the quadtree index with geodetic data will not work correctly or will return less accurate results. This parameter should only be used if you cannot yet reindex the data with an R-tree index and if the results using the non-geodetic quadtree index are acceptable. (For more information about geodetic and non-geodetic indexes, see [Section 4.1.4](#).)

Moreover, if you specify '*geodetic=FALSE*', ensure that the tolerance value stored in the USER_SDO_GEOM_METADATA view is what would be used for Cartesian data. That is, do not use meters for the units of the tolerance value, but instead use the number of decimal places in the data followed by a 5 (for example, 0.00005). This tolerance value will be used for spatial operators. When you use spatial functions that require a tolerance value with this data, use the function format that allows you to specify a tolerance value, and specify the tolerance value in meters.

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 [Section 7.2](#).

To determine if a **CREATE INDEX** statement for a spatial index has failed, check to see if the DOMIDX_OPSTATUS column in the USER_INDEXES view is set to

FAILED. Note that 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](#) 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](#) statement fails for any reason, then the [DROP INDEX](#) statement must be used to clean up the partially built index and associated metadata. If [DROP INDEX](#) does not work, add the FORCE parameter and try again.

Examples

The following example creates a spatial R-tree index named COLA_SPATIAL_IDX. (An R-tree index is created by default if no quadtree-specific parameters are specified.)

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

The following example creates a spatial quadtree index named QTREE.

```
CREATE INDEX qtree ON POLY_4PT(geometry)
  INDEXTYPE IS MDSYS.SPATIAL_INDEX
  PARAMETERS('sdo_level=6
  sdo_commit_interval=500 tablespace=TBS_3 initial=10K
  next=10K pctincrease=10 minextents=10 maxextents=20');
```

The following example creates a spatial quadtree index named BG06075 with two partitions, named IP1 and IP2.

```
CREATE INDEX BGI ON BG06075(geometry)
  INDEXTYPE IS MDSYS.SPATIAL_INDEX
  PARAMETERS ('tablespace=TBS_3 sdo_level=6') LOCAL
  (PARTITION IP1 PARAMETERS ('tablespace=TBS_3 sdo_level=6'),
  PARTITION IP2 PARAMETERS ('tablespace=TBS_2 sdo_level=6'));
```

Related Topics

- [ALTER INDEX](#)
- [DROP INDEX](#)

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](#) indexname FORCE to clean up after a failure in the [CREATE INDEX](#) statement.

Examples

The following example deletes a spatial quadtree 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](#)

SDO_GEOMETRY Object Type Methods

This chapter contains reference and usage information for the SDO_GEOMETRY object type methods.

The SDO_GEOMETRY object type is described in [Section 2.2](#). The type methods are listed in [Table 9-1](#).

Table 9-1 SDO_GEOMETRY Type Methods

Method	Description
GET_DIMS	Returns the number of dimensions of a geometry object.
GET_GTYPE	Returns the geometry type of a geometry object.
GET_LRS_DIM	Returns the measure dimension of an LRS geometry object.

GET_DIMS

Format

GET_DIMS() RETURN NUMBER;

Description

Returns the number of dimensions of a geometry object, as specified in its SDO_GTYPE value.

Parameters

None.

Usage Notes

The SDO_TYPE value is 4 digits in the format *dltt*, as described in [Section 2.2.1](#). This method returns the *d* (dimensionality) value, that is, the number of dimensions.

Examples

The following example returns the number of dimensions of the *cola_d* geometry object. (The example uses the definitions and data from [Section 2.1](#).)

```
SELECT c.mkt_id, c.shape.GET_DIMS()  
FROM cola_markets c WHERE c.name = 'cola_d';
```

```
      MKT_ID C.SHAPE.GET_DIMS()  
-----  
          4                2
```

GET_GTYPE

Format

GET_GTYPE() RETURN NUMBER;

Description

Returns the geometry type of a geometry object, as specified in its SDO_GTYPE value.

Parameters

None.

Usage Notes

The SDO_TYPE value is 4 digits in the format *dltt*, as described in [Section 2.2.1](#). This method returns the *tt* value, that is, the geometry type.

Examples

The following example returns the geometry type of each geometry object in the COLA_MARKETS table. (The example uses the definitions and data from [Section 2.1](#).)

```
SELECT c.mkt_id, c.shape.GET_GTYPE() FROM cola_markets c;
```

MKT_ID	C.SHAPE.GET_GTYPE()
1	3
2	3
3	3
4	3

GET_LRS_DIM

Format

GET_LRS_DIM() RETURN NUMBER;

Description

Returns the measure dimension of an LRS geometry object, as specified in its SDO_GTYPE value.

Parameters

None.

Usage Notes

The SDO_TYPE value is 4 digits in the format *dltt*, as described in [Section 2.2.1](#). This method returns the *l* value.

The *l* value is meaningful only for LRS geometry objects, and must be 0, 3, or 4:

- 0 indicates that the geometry is a pre-release 9.0.1 LRS geometry with measure as the default (last) dimension, or that the geometry is a release 9.0.1 standard geometry.
- 3 indicates that the third dimension contains the measure information.
- 4 indicates that the fourth dimension contains the measure information.

Examples

The following example returns the measure dimension of the Route 1 geometry object. (This example uses the definitions from the example in [Section 6.6](#).)

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

```
ROUTE_ID A.ROUTE_GEOMETRY.GET_LRS_DIM()  
-----  
1                               3
```

10

Spatial Operators

This chapter describes the operators used when working with the spatial object data type. The operators are listed in [Table 10-1](#).

Table 10-1 *Spatial Usage Operators*

Operator	Description
SDO_FILTER	Specifies which geometries may interact with a given geometry.
SDO_NN	Determines the nearest neighbor geometries to a geometry.
SDO_NN_DISTANCE	Returns the distance of an object returned by the SDO_NN operator.
SDO_RELATE	Determines whether or not two geometries interact in a specified way.
SDO_WITHIN_DISTANCE	Determines if two geometries are within a specified distance from one another.

SDO_FILTER

Format

SDO_FILTER(*geometry1*, *geometry2*, *params*);

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](#) operator, can be used to determine with certainty if objects interact spatially.

Keywords and Parameters

Value	Description
<i>geometry1</i>	Specifies a geometry column in a table. The column must be spatially indexed. Data type is MDSYS.SDO_GEOMETRY.
<i>geometry2</i>	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 MDSYS.SDO_GEOMETRY.
PARAMS	Determines the behavior of the operator. Data type is VARCHAR2.
<i>querytype</i>	Specifies valid query types: WINDOW or JOIN. This is a required parameter. WINDOW is recommended in almost all cases. WINDOW implies that a query is performed for every <i>geometry1</i> candidate geometry to be compared with <i>geometry2</i> . WINDOW can be used to compare a single geometry (<i>geometry2</i>) to all the geometries in a column (<i>geometry1</i>). JOIN is rarely used. Use JOIN when you want to compare all the geometries of a column to all the geometries of another column. JOIN implies that <i>geometry2</i> refers to a table column that must have a spatial index built on it. (See the Usage Notes for additional requirements.)
<i>idxtab1</i>	Specifies the name of the index table, if there are multiple spatial indexes, for <i>geometry1</i> .

Value	Description
idxtab2	Specifies the name of the index table, if there are multiple spatial indexes, for <i>geometry2</i> . Valid only if <i>querytype</i> is JOIN.

Returns

The expression `SDO_FILTER(arg1, arg2, arg3) = 'TRUE'` evaluates to TRUE for object pairs that are non-disjoint, and FALSE otherwise.

Usage Notes

SDO_FILTER is the only operator that can be used with data that is indexed using more than two dimensions. The operator considers all dimensions specified in the spatial index.

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_FILTER(arg1, arg2, arg3) = 'TRUE'`.

If *querytype* is WINDOW, *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 the *geometry2* column is spatially indexed with the same SDO_LEVEL value as the *geometry1* column, the operator reuses the existing index, and performance is very good or better.
- If the *geometry2* column is spatially indexed with a different SDO_LEVEL value than the *geometry1* column, the operator reindexes *geometry2* in the same way as if there were no index on the column originally, and then 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 *querytype* is JOIN:

- *geometry2* must be a column in a table.
- For best performance, both *geometry1* and *geometry2* should have the same type of index (R-tree or quadtree); and if the geometries have quadtree indexes, the indexes should have the same *sdo_level* value. If the geometries do not have the

same index type (and for quadtree indexes the same *sdo_level* value), *geometry2* is reindexed to be indexed as *geometry1* (with the considerations listed for *querytype* = WINDOW), and performance is less efficient.

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 [Section 5.7.1](#).

The *layer_gtype* keyword for *PARAMS* has been deprecated, and it is ignored if specified. The operator automatically optimizes its behavior based on the SDO_GTYPE value (explained in [Section 2.2.1](#)) of the geometries, which can be specified using the *layer_gtype* keyword in the parameters for the [CREATE INDEX](#) or [ALTER INDEX REBUILD](#) statement.

Examples

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, 'querytype = WINDOW') = '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, 'querytype=WINDOW') = '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, mdsys.sdo_geometry(2003,NULL,NULL,
                                                mdsys.sdo_elem_info_array(1,1003,3),
                                                mdsys.sdo_ordinate_array(x1,y1,x2,y2)),
 'querytype=WINDOW') = '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 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, 'querytype = WINDOW') = '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 QUERY_POLYS.GEOMETRY column must be spatially indexed.

```
SELECT A.gid
  FROM Polygons A, query_polys B
  WHERE SDO_FILTER(A.Geometry, B.Geometry, 'querytype = JOIN') = 'TRUE';
```

Related Topics

- [SDO_RELATE](#)

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 MDSYS.SDO_GEOMETRY.
geometry2	Specifies either a geometry from a table or a transient instance of a geometry. The nearest neighbor or neighbors to <i>geometry2</i> will be returned from <i>geometry1</i> . (<i>geometry2</i> is specified using a bind variable or SDO_GEOMETRY constructor.) Data type is MDSYS.SDO_GEOMETRY.
param	Determines the behavior of the operator. The available keywords are listed in Table 10-2 . Data type is VARCHAR2.
number	If the SDO_NN_DISTANCE ancillary operator is included in the call to SDO_NN, specifies the same number used in the call to SDO_NN_DISTANCE . Data type is NUMBER.

[Table 10-2](#) lists the keywords for the *param* parameter.

Table 10-2 Keywords for SDO_NN Parameter

Keyword	Description
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. See the Usage Notes for more information. Data type is NUMBER. For example: 'sdo_batch_size=10'

Table 10–2 Keywords for SDO_NN Parameter (Cont.)

Keyword	Description
<code>sdo_num_res</code>	If <code>sdo_batch_size</code> is not specified, specifies the number of results (nearest neighbors) to be returned. If <code>sdo_batch_size</code> is specified, this keyword is ignored; instead, use the <code>ROWNUM</code> pseudocolumn to limit the number of results. See the Usage Notes and Examples for more information. Data type is <code>NUMBER</code> . Default = 1. For example: <code>'sdo_num_res=5'</code>
<code>unit</code>	If the <code>SDO_NN_DISTANCE</code> ancillary operator is included in the call to <code>SDO_NN</code> , specifies the unit of measurement: a quoted string with <code>unit=</code> and an <code>SDO_UNIT</code> value from the <code>MDSYS.SDO_DIST_UNITS</code> table. See Section 2.6 for more information about unit of measurement specification. Data type is <code>NUMBER</code> . Default = unit of measurement associated with the data. For geodetic data, the default is meters. For example: <code>'unit=KM'</code>

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 index has been built on more than two dimensions.

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 operator can be used in two ways:

- If all geometries in the layer are candidates, use the `sdo_num_res` keyword to specify the number of geometries returned.
- 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.

Specify the `sdo_batch_size` keyword if any geometries in the table might be nearer than the geometries specified in the `WHERE` clause. For example, assume that a

RESTAURANTS table contained different types of restaurants, and you wanted to find the two nearest Italian restaurants to your hotel. The query might look like the following:

```
SELECT r.name FROM restaurants r WHERE
  SDO_NN(r.geometry, :my_hotel, 'sdo_batch_size=10') = 'TRUE'
  AND r.cuisine = 'Italian' AND ROWNUM <=2;
```

If the *sdo_batch_size* keyword is not specified in this example, only the two nearest restaurants are returned, regardless of their CUISINE value; and if the CUISINE value of these two rows is not *Italian*, the query may return no rows. The ROWNUM <=2 clause is necessary to limit the number of results returned to no more than 2 where CUISINE is *Italian*.

The *sdo_batch_size* keyword can be used only when SDO_NN will be using an R-tree index to perform the operation. This keyword cannot be used with a quadtree index.

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.

If the *sdo_batch_size* keyword is specified, any *sdo_num_res* value is ignored. Do not specify both keywords.

Specify the *number* parameter only if you are using the [SDO_NN_DISTANCE](#) ancillary operator in the call to SDO_NN. See the information about [SDO_NN_DISTANCE](#).

If this operator is used with geodetic data, the data must be indexed with an R-tree spatial index. If this operator is used with geodetic data and if the R-tree spatial index is created with *geodetic=false* specified, you cannot use the *unit* parameter.

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 [Section 4.1.7](#)), 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 [Section 5.7.1](#).

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(cola_markets cola_spatial_idx) */
       c.mkt_id, c.name, ... FROM cola_markets c, ...;
```

For detailed information about using optimizer hints, see *Oracle9i Database Performance Guide and Reference*.

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 from [Section 2.1](#).)

```
SELECT /*+ INDEX(cola_markets cola_spatial_idx) */
       c.mkt_id, c.name FROM cola_markets c WHERE SDO_NN(c.shape,
       mdsys.sdo_geometry(2001, NULL, mdsys.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 [Section 2.1](#).)

```
SELECT /*+ INDEX(cole_markets cola_spatial_idx) */ c.mkt_id, c.name
FROM cole_markets c
WHERE SDO_NN(c.shape, mdsys.sdo_geometry(2001, NULL,
    mdsys.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
```

Related Topics

- [SDO_NN_DISTANCE](#)

SDO_NN_DISTANCE

Format

SDO_NN_DISTANCE(number);

Description

Returns the distance of an object returned by the [SDO_NN](#) operator. Valid only within a call to the [SDO_NN](#) operator.

Keywords and Parameters

Value	Description
number	Specifies a number that must be the same as the last parameter passed to the SDO_NN operator. Data type is NUMBER.

Returns

This operator returns the distance of an object returned by the [SDO_NN](#) 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](#) 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](#) operator. (For an explanation of how operators can use ancillary data, see the section on ancillary data in the chapter on domain indexes in the *Oracle9i 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](#) 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 from [Section 2.1](#).)

```
SELECT /*+ INDEX(cola_markets cola_spatial_idx) */
       c.mkt_id, c.name, mdsys.SDO_NN_DISTANCE(1) dist
FROM   cola_markets c
WHERE  SDO_NN(c.shape, mdsys.sdo_geometry(2001, NULL,
      mdsys.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 (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.)

Related Topics

- [SDO_NN](#)

SDO_RELATE

Format

```
SDO_RELATE(geometry1, geometry2, params);
```

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 MDSYS.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 MDSYS.SDO_GEOMETRY.
PARAMS	Determines the behavior of the operator. Data type is VARCHAR2.
Keyword	Description
mask	Specifies the topological relation of interest. This is a required parameter. Valid values are one or more of the following in the 9-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'; however, see the Usage Notes for an alternative syntax using UNION ALL that may result in better performance. See Section 1.8 for an explanation of the 9-intersection relationship pattern.

Value	Description
querytype	<p>Valid query types are: WINDOW or JOIN. This is a required parameter if <i>geometry2</i> is from another table, but it is not a required parameter if <i>geometry2</i> is a literal or a host variable.</p> <p>WINDOW is recommended in almost all cases. WINDOW implies that a query is performed for every <i>geometry1</i> candidate geometry to be compared with <i>geometry2</i>. WINDOW can be used to compare a single geometry (<i>geometry2</i>) to all the geometries in a column (<i>geometry1</i>).</p> <p>JOIN is rarely used. Use JOIN when you want to compare all the geometries of a column to all the geometries of another column. JOIN implies that <i>geometry2</i> refers to a table column that must have a spatial index built on it. (See the Usage Notes for additional requirements.)</p>
idxTAB1	Specifies the name of the index table, if there are multiple spatial indexes, for <i>geometry1</i> .
idxTAB2	Specifies the name of the index table, if there are multiple spatial indexes, for <i>geometry2</i> . Only valid for 'querytype = JOIN'.

Returns

The expression `SDO_RELATE(geometry1,geometry2, 'mask = <some_mask_val> querytype = <some_querytype>') = '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 index has been built on more than two dimensions.

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> querytype = <some_querytype>') = 'TRUE'`.

If *querytype* is WINDOW, *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 the *geometry2* column is spatially indexed with the same SDO_LEVEL value as the *geometry1* column, the operator reuses the existing index, and performance is very good or better.

- If the *geometry2* column is spatially indexed with a different SDO_LEVEL value than the *geometry1* column, the operator reindexes *geometry2* in the same way as if there were no index on the column originally, and then 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 *querytype* is JOIN:

- *geometry2* must be a column in a table.
- For best performance, both *geometry1* and *geometry2* should have the same type of index (R-tree or quadtree); and if the geometries have quadtree indexes, the indexes should have the same *sdo_level* value. If the geometries do not have the same index type (and for quadtree indexes the same *sdo_level* value), *geometry2* is reindexed to be indexed as *geometry1* (with the considerations listed for *querytype* = WINDOW), and performance is less efficient.

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 [Section 5.7.1](#).

The *layer_gtype* keyword for *PARAMS* has been deprecated, and it is ignored if specified. The operator automatically optimizes its behavior based on the SDO_GTYPE value (explained in [Section 2.2.1](#)) of the geometries, which can be specified using the *layer_gtype* keyword in the parameters for the [CREATE INDEX](#) or [ALTER INDEX REBUILD](#) statement.

Unlike with the [SDO_GEOM.RELATE](#) 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.

Although multiple masks can be combined using the logical Boolean operator OR, for example, 'mask=inside+coveredby', 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 can apply under certain conditions when masks are specified singly rather than grouped within the same SDO_RELATE operator call. For example, 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=inside+coveredby querytype=WINDOW') = 'TRUE';
```

may result in better performance if it is expressed thus, 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=inside querytype=WINDOW') = '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 querytype=WINDOW') = 'TRUE';
```

Examples

The following examples are similar to those for the [SDO_FILTER](#) operator; however, they identify a specific type of interaction (using the *mask* parameter), and they determine with certainty (not mere likelihood) if the spatial interaction occurs.

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 querytype=WINDOW') = '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 querytype=WINDOW')
= '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, mdsys.sdo_geometry(2003,NULL,NULL,
        mdsys.sdo_elem_info_array(1,1003,3),
        mdsys.sdo_ordinate_array(x1,y1,x2,y2)),
        'mask=ANYINTERACT querytype=WINDOW') = '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, 'querytype = WINDOW') = 'TRUE';
```

The following example selects the GID values from the POLYGONS table where a GEOMETRY column object has any spatial interaction with any GEOMETRY column object in the QUERY_POLYS table. In this example, the QUERY_POLYS.GEOMETRY column must be spatially indexed.

```
SELECT A.gid
FROM Polygons A, query_polys B
WHERE SDO_RELATE(A.Geometry, B.Geometry,
        'mask=ANYINTERACT querytype=JOIN') = 'TRUE';
```

Related Topics

- [SDO_FILTER](#)
- [SDO_WITHIN_DISTANCE](#)
- [SDO_GEOM.RELATE](#) function

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 (<i>aGeom</i>). The column must be spatially indexed. Data type is MDSYS.SDO_GEOMETRY.
aGeom	Specifies the object to be checked for distance against the geometry objects in <i>geometry1</i> . 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 MDSYS.SDO_GEOMETRY.
PARAMS	Determines the behavior of the operator. 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 parameter. Data type is NUMBER.
idxTAB1	Specifies the name of the index table if there are multiple spatial index tables for <i>geometry1</i> .
querytype	Set 'querytype=FILTER' to perform only a primary filter operation. If <i>querytype</i> is not specified, both primary and secondary filter operations are performed (default). Data type is VARCHAR2.

Value	Description
unit	Specifies the unit of measurement: a quoted string with <i>unit=</i> and an SDO_UNIT value from the MDSYS.SDO_DIST_UNITS table (for example, 'unit=KM'). See Section 2.6 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

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.

If this operator is used with geodetic data, the data must be indexed with an R-tree spatial index. If this operator is used with geodetic data and if the R-tree spatial index is created with *'geodetic=false'* specified, you cannot use the *unit* parameter.

The operator is disabled if the table does not have a spatial index or if the index has been built on more than two dimensions.

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 geometry column must have a spatial index built on it. If the data is geodetic, the spatial index must be an R-tree index.

The *layer_gtype* keyword for *PARAMS* has been deprecated, and it is ignored if specified. The operator automatically optimizes its behavior based on the SDO_GTYPE value (explained in [Section 2.2.1](#)) of the geometries, which can be specified using the *layer_gtype* keyword in the parameters for the [CREATE INDEX](#) or [ALTER INDEX REBUILD](#) statement.

SDO_WITHIN_DISTANCE is not supported for spatial joins. See [Section 4.2.1.3](#) for a discussion on how to perform a spatial join within-distance operation.

Examples

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, mdsys.sdo_geometry(2003,NULL,NULL,
                                                       mdsys.sdo_elem_info_array(1,1003,3),
                                                       mdsys.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';
```

Related Topics

- [SDO_FILTER](#)
- [SDO_RELATE](#)

Geometry Functions

This chapter contains descriptions of the geometry functions, which can be grouped into the following categories:

- Relationship (True/False) between two objects: RELATE, WITHIN_DISTANCE
- Validation: VALIDATE_GEOMETRY, VALIDATE_LAYER
- Single-object operations: SDO_ARC_DENSIFY, SDO_AREA, SDO_BUFFER, SDO_CENTROID, SDO_CONVEXHULL, SDO_LENGTH, SDO_MBR, SDO_POINTONSURFACE
- Two-object operations: SDO_DISTANCE, SDO_DIFFERENCE, SDO_INTERSECTION, SDO_UNION, SDO_XOR

The geometry functions are listed [Table 11-1](#), and some usage information follows the table.

Table 11-1 *Geometry Functions*

Function	Description
SDO_GEOM.RELATE	Determines how two objects interact.
SDO_GEOM.SDO_ARC_DENSIFY	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.
SDO_GEOM.SDO_AREA	Computes the area of a two-dimensional polygon.
SDO_GEOM.SDO_BUFFER	Generates a buffer polygon around a geometry.
SDO_GEOM.SDO_CENTROID	Returns the centroid of a polygon.

Table 11–1 Geometry Functions (Cont.)

Function	Description
SDO_GEOM.SDO_CONVEXHULL	Returns a polygon-type object that represents the convex hull of a geometry object.
SDO_GEOM.SDO_DIFFERENCE	Returns a geometry object that is the topological difference (MINUS operation) of two geometry objects.
SDO_GEOM.SDO_DISTANCE	Computes the distance between two geometry objects.
SDO_GEOM.SDO_INTERSECTION	Returns a geometry object that is the topological intersection (AND operation) of two geometry objects.
SDO_GEOM.SDO_LENGTH	Computes the length or perimeter of a geometry.
SDO_GEOM.SDO_MAX_MBR_ORDINATE	Returns the maximum value for the specified ordinate (dimension) of the minimum bounding rectangle of a geometry object.
SDO_GEOM.SDO_MBR	Returns the minimum bounding rectangle of a geometry.
SDO_GEOM.SDO_MIN_MBR_ORDINATE	Returns the minimum value for the specified ordinate (dimension) of the minimum bounding rectangle of a geometry object.
SDO_GEOM.SDO_POINTONSURFACE	Returns a point that is guaranteed to be on the surface of a polygon.
SDO_GEOM.SDO_UNION	Returns a geometry object that is the topological union (OR operation) of two geometry objects.
SDO_GEOM.SDO_XOR	Returns a geometry object that is the topological symmetric difference (XOR operation) of two geometry objects.
SDO_GEOM.VALIDATE_GEOMETRY	Determines if a geometry is valid.
SDO_GEOM.VALIDATE_LAYER	Determines if all the geometries stored in a column are valid.
SDO_GEOM.WITHIN_DISTANCE	Determines if two geometries are within a specified distance from one another.

Note: The SDO_POLY_xxx functions were deprecated at release 8.1.6 and have been removed from this guide. You should use instead the corresponding generic (not restricted to polygons) SDO_xxx functions: [SDO_GEOM.SDO_DIFFERENCE](#), [SDO_GEOM.SDO_INTERSECTION](#), [SDO_GEOM.SDO_UNION](#), and [SDO_GEOM.SDO_XOR](#).

The following usage information applies to the geometry functions. (See also the Usage Notes under the reference information for each function.)

- 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](#)) 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.RELATE

Format

```
SDO_GEOM.RELATE(  
    geom1 IN MDSYS.SDO_GEOMETRY,  
    dim1  IN MDSYS.SDO_DIM_ARRAY,  
    mask  IN VARCHAR2,  
    geom2 IN MDSYS.SDO_GEOMETRY,  
    dim2  IN MDSYS.SDO_DIM_ARRAY  
    ) RETURN VARCHAR2;
```

or

```
SDO_GEOM.RELATE(  
    geom1 IN MDSYS.SDO_GEOMETRY,  
    mask  IN VARCHAR2,  
    geom2 IN MDSYS.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 (see [Section 2.4](#)).

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 (see [Section 2.4](#)).

tol

Tolerance value (see [Section 1.5.5](#)).

Usage Notes

The MDSYS.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 name of the relationship if it is true for the pair of geometries. If all the 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' or 'FALSE' depending on the outcome of the test.

If the function format with *tol* is used, all geometry objects must be defined using 4-digit SDO_GTYPE values (explained in [Section 2.2.1](#)).

An exception is raised if *geom1* and *geom2* are based on different coordinate systems.

Examples

The following example checks if there is any spatial interaction between geometry objects *cola_b* and *cola_d*. (The example uses the definitions and data from [Section 2.1](#).)

```
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';

SDO_GEOM.RELATE(C_B.SHAPE,'ANYINTERACT',C_D.SHAPE,0.005)
-----
FALSE
```

Related Topics

None.

SDO_GEOM.SDO_ARC_DENSIFY

Format

```
SDO_GEOM.SDO_ARC_DENSIFY(  
    geom    IN MDSYS.SDO_GEOMETRY,  
    dim     IN MDSYS.SDO_DIM_ARRAY  
    params  IN VARCHAR2  
    ) RETURN MDSYS.SDO_GEOMETRY;
```

or

```
SDO_GEOM.SDO_ARC_DENSIFY(  
    geom    IN MDSYS.SDO_GEOMETRY,  
    tol     IN NUMBER  
    params  IN VARCHAR2  
    ) RETURN MDSYS.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 (see [Section 2.4](#)).

tol

Tolerance value (see [Section 1.5.5](#)).

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

This function is especially useful when operations involve geodetic coordinate systems. Geodetic coordinate system support is provided only for geometries that consist of points or geodesics (lines on the sphere). If you have geometries containing circles or circular arcs, you can transform them to a projected coordinate system, use this function to densify them into regular polygons, and perform Spatial operations on the resulting geometries. You can then transform the geometries to any projected or geodetic coordinate system.

The *params* parameter is a quoted string that must contain the *arc_tolerance* keyword and that may contain 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 11-1](#) shows a line whose length is the *arc_tolerance* value for the arc between points A and B.

Figure 11-1 Arc Tolerance



The *arc_tolerance* keyword value must be greater than or equal to the tolerance value associated with the geometry. 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 [Section 2.6](#) for more information about unit of measurement specification.

If the function format with *tol* is used, all geometry objects must be defined using 4-digit SDO_GTYPE values (explained in [Section 2.2.1](#)).

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 [Section 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

- [Section 5.2.3, "Other Considerations and Requirements with Geodetic Data"](#)

SDO_GEOM.SDO_AREA

Format

```
SDO_GEOM.SDO_AREA(  
    geom IN MDSYS.SDO_GEOMETRY,  
    dim  IN MDSYS.SDO_DIM_ARRAY  
    [, unit IN VARCHAR2]  
    ) RETURN NUMBER;
```

or

```
SDO_GEOM.SDO_AREA(  
    geom IN MDSYS.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 (see [Section 2.4](#)).

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 [Section 2.6](#) 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 [Section 1.5.5](#)).

Usage Notes

This function works with any polygon, including polygons with holes.

Lines that close to form a ring have no area.

If the function format with *tol* is used, all geometry objects must be defined using 4-digit SDO_GTYPE values (explained in [Section 2.2.1](#)).

Examples

The following example returns the areas of geometry objects stored in the COLA_MARKETS table. The first statement returns the areas all objects; the second returns just the area of *cola_a*. (The example uses the definitions and data from [Section 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.

SDO_GEOM.SDO_BUFFER

Format

```
SDO_GEOM.SDO_BUFFER(  
    geom    IN MDSYS.SDO_GEOMETRY,  
    dim     IN MDSYS.SDO_DIM_ARRAY,  
    dist    IN NUMBER  
    [, params IN VARCHAR2]  
    ) RETURN MDSYS.SDO_GEOMETRY;
```

or

```
SDO_GEOM.SDO_BUFFER(  
    geom    IN MDSYS.SDO_GEOMETRY,  
    dist    IN NUMBER,  
    tol     IN NUMBER  
    [, params IN VARCHAR2]  
    ) RETURN MDSYS.SDO_GEOMETRY;
```

Description

Generates a buffer polygon around 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 (see [Section 2.4](#)).

dist

Distance value. Must be greater than the tolerance value, as specified in the dimensional array (*dim* parameter) or in the *tol* parameter.

tol

Tolerance value (see [Section 1.5.5](#)).

params

A quoted string with 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 [Section 2.6](#) 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](#) 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, 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

This function returns a geometry object representing the buffer polygon.

This function creates a rounded buffer around a point, line, or 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 1–11](#) for an illustration.

If the function format with *tol* is used, all geometry objects must be defined using 4-digit SDO_GTYPE values (explained in [Section 2.2.1](#)).

With geodetic data, this function is supported by approximations, as explained in [Section 5.7.3](#).

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 [Section 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 [Section 5.8](#).

```

-- 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_TUNE.EXTENT_OF](#)
- [SDO_GEOM.SDO_UNION](#)
- [SDO_GEOM.SDO_INTERSECTION](#)
- [SDO_GEOM.SDO_UNION](#)

- [SDO_GEOM.SDO_XOR](#)

SDO_GEOM.SDO_CENTROID

Format

```
SDO_GEOM.SDO_CENTROID(  
    geom1 IN MDSYS.SDO_GEOMETRY,  
    dim1  IN MDSYS.SDO_DIM_ARRAY  
    ) RETURN MDSYS.SDO_GEOMETRY;
```

or

```
SDO_GEOM.SDO_CENTROID(  
    geom1 IN MDSYS.SDO_GEOMETRY,  
    tol   IN NUMBER  
    ) RETURN MDSYS.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 (see [Section 2.4](#)).

tol

Tolerance value (see [Section 1.5.5](#)).

Usage Notes

The function returns a null value if *geom* is not a polygon, multipolygon, point, or point cluster.

If *geom1* is a point, the function returns the point (the input geometry).

If the function format with *tol* is used, all geometry objects must be defined using 4-digit SDO_GTYPE values (explained in [Section 2.2.1](#)).

With geodetic data, this function is supported by approximations, as explained in [Section 5.7.3](#).

Examples

The following example returns a geometry object that is the centroid of *cola_c*. (The example uses the definitions and data from [Section 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.

SDO_GEOM.SDO_CONVEXHULL

Format

```
SDO_GEOM.SDO_CONVEXHULL(  
    geom1 IN MDSYS.SDO_GEOMETRY,  
    dim1  IN MDSYS.SDO_DIM_ARRAY  
    ) RETURN MDSYS.SDO_GEOMETRY;
```

or

```
SDO_GEOM.SDO_CONVEXHULL(  
    geom1 IN MDSYS.SDO_GEOMETRY,  
    tol   IN NUMBER  
    ) RETURN MDSYS.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 *geom*, usually selected from one of the xxx_SDO_GEOM_METADATA views (see [Section 2.4](#)).

tol

Tolerance value (see [Section 1.5.5](#)).

Usage Notes

The **convex hull** is a simple convex polygon that completely encloses the geometry object. Spatial 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 the original (input) geometry if *geom* is of point type, has fewer than three points or vertices, or consists of multiple points all in a straight line.

If the function format with *tol* is used, all geometry objects must be defined using 4-digit SDO_GTYPE values (explained in [Section 2.2.1](#)).

With geodetic data, this function is supported by approximations, as explained in [Section 5.7.3](#).

Examples

The following example returns a geometry object that is the convex hull of *cola_c*. (The example uses the definitions and data from [Section 2.1](#). This specific example, however, does not produce useful output -- the returned polygon is identical to 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

None.

SDO_GEOM.SDO_DIFFERENCE

Format

```
SDO_GEOM.SDO_DIFFERENCE(  
    geom1 IN MDSYS.SDO_GEOMETRY,  
    dim1  IN MDSYS.SDO_DIM_ARRAY,  
    geom2 IN MDSYS.SDO_GEOMETRY,  
    dim2  IN MDSYS.SDO_DIM_ARRAY  
    ) RETURN MDSYS.SDO_GEOMETRY;
```

or

```
SDO_GEOM.SDO_DIFFERENCE(  
    geom1 IN MDSYS.SDO_GEOMETRY,  
    geom2 IN MDSYS.SDO_GEOMETRY,  
    tol   IN NUMBER  
    ) RETURN MDSYS.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 (see [Section 2.4](#)).

geom2

Geometry object.

dim2

Dimensional information array corresponding to *geom2*, usually selected from one of the xxx_SDO_GEOM_METADATA views (see [Section 2.4](#)).

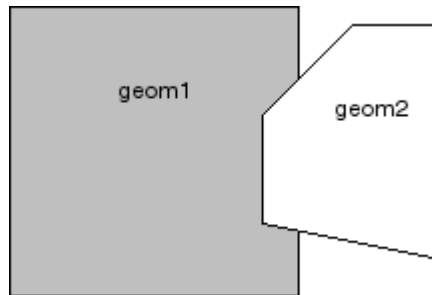
tol

Tolerance value (see [Section 1.5.5](#)).

Usage Notes

In [Figure 11-2](#), the shaded area represents the polygon returned when SDO_DIFFERENCE is used with a square (*geom1*) and another polygon (*geom2*).

Figure 11-2 SDO_GEOM.SDO_DIFFERENCE



If the function format with *tol* is used, all geometry objects must be defined using 4-digit SDO_GTYPE values (explained in [Section 2.2.1](#)).

An exception is raised if *geom1* and *geom2* are based on different coordinate systems.

You should use this function instead of the deprecated function SDO_GEOM.SDO_POLY_DIFFERENCE.

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 [Section 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](#)
- [SDO_GEOM.SDO_UNION](#)
- [SDO_GEOM.SDO_XOR](#)

SDO_GEOM.SDO_DISTANCE

Format

```
SDO_GEOM.SDO_DISTANCE(  
    geom1 IN MDSYS.SDO_GEOMETRY,  
    dim1  IN MDSYS.SDO_DIM_ARRAY,  
    geom2 IN MDSYS.SDO_GEOMETRY,  
    dim2  IN MDSYS.SDO_DIM_ARRAY  
    [, unit IN VARCHAR2]  
    ) RETURN NUMBER;
```

or

```
SDO_GEOM.SDO_DISTANCE(  
    geom1 IN MDSYS.SDO_GEOMETRY,  
    geom2 IN MDSYS.SDO_GEOMETRY,  
    tol   IN NUMBER  
    [, unit IN VARCHAR2]  
    ) RETURN NUMBER;
```

Description

Computes the distance between two geometry objects. The distance between two geometry objects 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 (see [Section 2.4](#)).

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 (see [Section 2.4](#)).

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 [Section 2.6](#) 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 [Section 1.5.5](#)).

Usage Notes

If the function format with *tol* is used, all geometry objects must be defined using 4-digit SDO_GTYPE values (explained in [Section 2.2.1](#)).

An exception is raised if *geom1* and *geom2* are based on different coordinate systems.

Examples

The following example returns the shortest distance between *cola_b* and *cola_d*. (The example uses the definitions and data from [Section 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.WITHIN_DISTANCE](#)

SDO_GEOM.SDO_INTERSECTION

Format

```
SDO_GEOM.SDO_INTERSECTION(  
    geom1 IN MDSYS.SDO_GEOMETRY,  
    dim1  IN MDSYS.SDO_DIM_ARRAY,  
    geom2 IN MDSYS.SDO_GEOMETRY,  
    dim2  IN MDSYS.SDO_DIM_ARRAY  
    ) RETURN MDSYS.SDO_GEOMETRY;
```

or

```
SDO_GEOM.SDO_INTERSECTION(  
    geom1 IN MDSYS.SDO_GEOMETRY,  
    geom2 IN MDSYS.SDO_GEOMETRY,  
    tol   IN NUMBER  
    ) RETURN MDSYS.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 (see [Section 2.4](#)).

geom2

Geometry object.

dim2

Dimensional information array corresponding to *geom2*, usually selected from one of the xxx_SDO_GEOM_METADATA views (see [Section 2.4](#)).

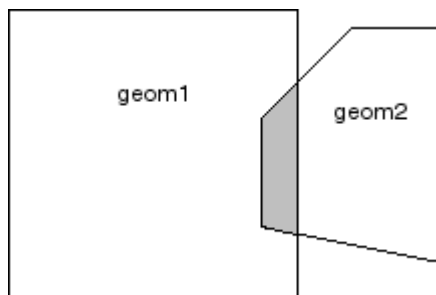
tol

Tolerance value (see [Section 1.5.5](#)).

Usage Notes

In [Figure 11-3](#), the shaded area represents the polygon returned when SDO_INTERSECTION is used with a square (*geom1*) and another polygon (*geom2*).

Figure 11-3 SDO_GEOM.SDO_INTERSECTION



If the function format with *tol* is used, all geometry objects must be defined using 4-digit SDO_GTYPE values (explained in [Section 2.2.1](#)).

An exception is raised if *geom1* and *geom2* are based on different coordinate systems.

You should use this function instead of the deprecated function SDO_GEOM.SDO_POLY_INTERSECTION.

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 [Section 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](#)
- [SDO_GEOM.SDO_UNION](#)
- [SDO_GEOM.SDO_XOR](#)

SDO_GEOM.SDO_LENGTH

Format

```
SDO_GEOM.SDO_LENGTH(  
    geom IN MDSYS.SDO_GEOMETRY,  
    dim  IN MDSYS.SDO_DIM_ARRAY  
    [, unit IN VARCHAR2]  
    ) RETURN NUMBER;
```

or

```
SDO_GEOM.SDO_LENGTH(  
    geom IN MDSYS.SDO_GEOMETRY,  
    tol  IN NUMBER  
    [, unit IN VARCHAR2]  
    ) 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 (see [Section 2.4](#)).

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 [Section 2.6](#) 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.

tol

Tolerance value (see [Section 1.5.5](#)).

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 the perimeters.

If the function format with *tol* is used, all geometry objects must be defined using 4-digit SDO_GTYPE values (explained in [Section 2.2.1](#)).

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 [Section 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.

SDO_GEOM.SDO_MAX_MBR_ORDINATE

Format

```
SDO_GEOM.SDO_MAX_MBR_ORDINATE(  
    geom          IN MDSYS.SDO_GEOMETRY,  
    ordinate_pos  IN NUMBER  
    ) RETURN NUMBER;
```

or

```
SDO_GEOM.SDO_MAX_MBR_ORDINATE(  
    geom          IN MDSYS.SDO_GEOMETRY,  
    dim           IN MDSYS.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 (see [Section 2.4](#)).

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

This function is not supported with geodetic data.

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 [Section 2.1](#). The minimum bounding rectangle of *cola_d* is returned in the example for the [SDO_GEOM.SDO_MBR](#) 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](#)
- [SDO_GEOM.SDO_MIN_MBR_ORDINATE](#)

SDO_GEOM.SDO_MBR

Format

```
SDO_GEOM.SDO_MBR(  
    geom IN MDSYS.SDO_GEOMETRY  
    [, dim IN MDSYS.SDO_DIM_ARRAY]  
    ) RETURN MDSYS.SDO_GEOMETRY;
```

Description

Returns the minimum bounding rectangle of a geometry object, that is, a single rectangle that minimally encloses the geometry.

Parameters

geom

Geometry object.

dim

Dimensional information array corresponding to *geom*, usually selected from one of the xxx_SDO_GEOM_METADATA views (see [Section 2.4](#)).

Usage Notes

This function is not supported with geodetic data.

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 [Section 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_ARRAY(6, 7, 10, 11))

Related Topics

- [SDO_GEOM.SDO_MAX_MBR_ORDINATE](#)
- [SDO_GEOM.SDO_MIN_MBR_ORDINATE](#)

SDO_GEOM.SDO_MIN_MBR_ORDINATE

Format

```
SDO_GEOM.SDO_MIN_MBR_ORDINATE(  
    geom          IN MDSYS.SDO_GEOMETRY,  
    ordinate_pos  IN NUMBER  
    ) RETURN NUMBER;
```

or

```
SDO_GEOM.SDO_MIN_MBR_ORDINATE(  
    geom          IN MDSYS.SDO_GEOMETRY,  
    dim           IN MDSYS.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 (see [Section 2.4](#)).

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

This function is not supported with geodetic data.

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 [Section 2.1](#). The minimum bounding rectangle of *cola_d* is returned in the example for the [SDO_GEOM.SDO_MBR](#) 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](#)
- [SDO_GEOM.SDO_MBR](#)

SDO_GEOM.SDO_POINTONSURFACE

Format

```
SDO_GEOM.SDO_POINTONSURFACE(  
    geom1 IN MDSYS.SDO_GEOMETRY,  
    dim1  IN MDSYS.SDO_DIM_ARRAY  
    ) RETURN MDSYS.SDO_GEOMETRY;
```

or

```
SDO_GEOM.SDO_POINTONSURFACE(  
    geom1 IN MDSYS.SDO_GEOMETRY,  
    tol   IN NUMBER  
    ) RETURN MDSYS.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 *geom*, usually selected from one of the xxx_SDO_GEOM_METADATA views (see [Section 2.4](#)).

tol

Tolerance value (see [Section 1.5.5](#)).

Usage Notes

This function returns a point geometry object representing a point that is guaranteed to be on the surface 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.

If the function format with *tol* is used, all geometry objects must be defined using 4-digit SDO_GTYPE values (explained in [Section 2.2.1](#)).

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 [Section 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.

SDO_GEOM.SDO_UNION

Format

```
SDO_GEOM.SDO_UNION(  
    geom1 IN MDSYS.SDO_GEOMETRY,  
    dim1  IN MDSYS.SDO_DIM_ARRAY,  
    geom2 IN MDSYS.SDO_GEOMETRY,  
    dim2  IN MDSYS.SDO_DIM_ARRAY  
    ) RETURN MDSYS.SDO_GEOMETRY;
```

or

```
SDO_GEOM.SDO_UNION(  
    geom1 IN MDSYS.SDO_GEOMETRY,  
    geom2 IN MDSYS.SDO_GEOMETRY,  
    tol   IN NUMBER  
    ) RETURN MDSYS.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 (see [Section 2.4](#)).

geom2

Geometry object.

dim2

Dimensional information array corresponding to *geom2*, usually selected from one of the xxx_SDO_GEOM_METADATA views (see [Section 2.4](#)).

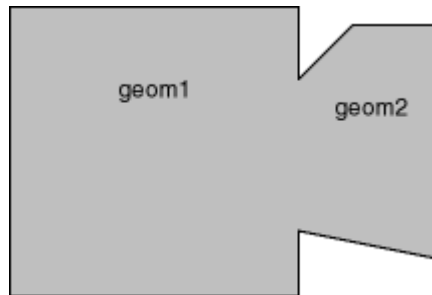
tol

Tolerance value (see [Section 1.5.5](#)).

Usage Notes

In [Figure 11-4](#), the shaded area represents the polygon returned when SDO_UNION is used with a square (*geom1*) and another polygon (*geom2*).

Figure 11-4 SDO_GEOM.SDO_UNION



If the function format with *tol* is used, all geometry objects must be defined using 4-digit SDO_GTYPE values (explained in [Section 2.2.1](#)).

An exception is raised if *geom1* and *geom2* are based on different coordinate systems.

You should use this function instead of the deprecated function SDO_GEOM.SDO_POLY_UNION.

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 [Section 2.1](#).)

```
-- Return the topological intersection 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](#)
- [SDO_GEOM.SDO_INTERSECTION](#)
- [SDO_GEOM.SDO_XOR](#)

SDO_GEOM.SDO_XOR

Format

```
SDO_GEOM.SDO_XOR(  
    geom1 IN MDSYS.SDO_XOR,  
    dim1  IN MDSYS.SDO_DIM_ARRAY,  
    geom2 IN MDSYS.SDO_GEOMETRY,  
    dim2  IN MDSYS.SDO_DIM_ARRAY  
    ) RETURN MDSYS.SDO_GEOMETRY;
```

or

```
SDO_GEOM.SDO_XOR(  
    geom1 IN MDSYS.SDO_GEOMETRY,  
    geom2 IN MDSYS.SDO_GEOMETRY,  
    tol   IN NUMBER  
    ) RETURN MDSYS.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 (see [Section 2.4](#)).

geom2

Geometry object.

dim2

Dimensional information array corresponding to *geom2*, usually selected from one of the xxx_SDO_GEOM_METADATA views (see [Section 2.4](#)).

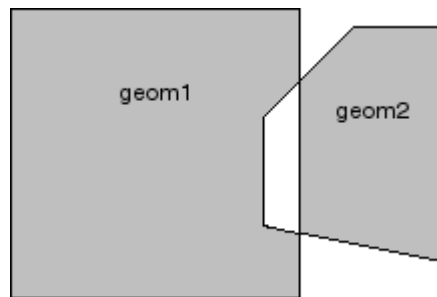
tol

Tolerance value (see [Section 1.5.5](#)).

Usage Notes

In [Figure 11-5](#), the shaded area represents the polygon returned when SDO_XOR is used with a square (*geom1*) and another polygon (*geom2*).

Figure 11-5 SDO_GEOM.SDO_XOR



If the function format with *tol* is used, all geometry objects must be defined using 4-digit SDO_GTYPE values (explained in [Section 2.2.1](#)).

An exception is raised if *geom1* and *geom2* are based on different coordinate systems.

You should use this function instead of the deprecated function SDO_GEOM.SDO_POLY_XOR.

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 [Section 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 in 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](#)
- [SDO_GEOM.SDO_INTERSECTION](#)
- [SDO_GEOM.SDO_UNION](#)

SDO_GEOM.VALIDATE_GEOMETRY

Format

```
SDO_GEOM.VALIDATE_GEOMETRY(  
    theGeometry IN MDSYS.SDO_GEOMETRY,  
    theDimInfo  IN MDSYS.SDO_DIM_ARRAY  
    ) RETURN VARCHAR2;
```

or

```
SDO_GEOM.VALIDATE_GEOMETRY(  
    theGeometry IN MDSYS.SDO_GEOMETRY,  
    tolerance   IN NUMBER  
    ) RETURN VARCHAR2;
```

Description

Performs a consistency check for valid geometry types. 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 *geom*, usually selected from one of the xxx_SDO_GEOM_METADATA views (see [Section 2.4](#)).

tolerance

Tolerance value (see [Section 1.5.5](#)).

Usage Notes

The VALIDATE_GEOMETRY function is deprecated and will not be supported in future releases of Oracle Spatial. You should use instead the [SDO_GEOM.VALIDATE_GEOMETRY_WITH_CONTEXT](#) function.

This function performs the same checks as the [SDO_GEOM.VALIDATE_GEOMETRY_WITH_CONTEXT](#) function; however, if the geometry is not valid, it does not return information about the context.

If the geometry is not valid, this function returns one of the following:

- An Oracle error message number based on the specific reason the geometry is invalid
- FALSE if the geometry fails for some other reason

If the function format with *tolerance* is used, the following guidelines apply:

- All geometry objects must be defined using 4-digit SDO_GTYPE values (explained in [Section 2.2.1](#)).
- 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*.

You can use this function in a PL/SQL procedure as an alternative to using the [SDO_GEOM.VALIDATE_LAYER](#) procedure. See the Usage Notes for [SDO_GEOM.VALIDATE_LAYER](#) for more information.

Examples

The following example validates the geometry of *cola_c*. (The example uses the definitions and data from [Section 2.1](#).)

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

```
NAME
-----
SDO_GEOM.VALIDATE_GEOMETRY(C.SHAPE,0.005)
-----
cola_c
TRUE
```

Related Topics

- [SDO_GEOM.VALIDATE_GEOMETRY_WITH_CONTEXT](#)
- [SDO_GEOM.VALIDATE_LAYER](#)

SDO_GEOM.VALIDATE_GEOMETRY_WITH_CONTEXT

Format

```
SDO_GEOM.VALIDATE_GEOMETRY_WITH_CONTEXT(  
    theGeometry IN MDSYS.SDO_GEOMETRY,  
    theDimInfo  IN MDSYS.SDO_DIM_ARRAY  
    ) RETURN VARCHAR2;
```

or

```
SDO_GEOM.VALIDATE_GEOMETRY_WITH_CONTEXT(  
    theGeometry IN MDSYS.SDO_GEOMETRY,  
    tolerance   IN NUMBER  
    ) 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 *geom*, usually selected from one of the xxx_SDO_GEOM_METADATA views (see [Section 2.4](#)).

tolerance

Tolerance value (see [Section 1.5.5](#)).

Usage Notes

If the geometry is valid, this function returns TRUE.

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)

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.)
- An interior polygon ring touches the exterior polygon ring at no more than one point.
- If two or more interior polygon rings are in an exterior polygon ring, the interior polygon rings touch at no more than one point.
- Line strings have at least two points.
- 1-digit and 4-digit SDO_ETYPE 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 [Chapter 6](#)) have three or four dimensions and a valid measure dimension position (3 or 4, depending on the number of dimensions).

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, the following guidelines apply:

- All geometry objects must be defined using 4-digit SDO_GTYPE values (explained in [Section 2.2.1](#)).
- 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*.

You can use this function in a PL/SQL procedure as an alternative to using the [SDO_GEOM.VALIDATE_LAYER_WITH_CONTEXT](#) procedure. See the Usage Notes for [SDO_GEOM.VALIDATE_LAYER_WITH_CONTEXT](#) for more information.

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>]
```

Related Topics

- [SDO_GEOM.VALIDATE_LAYER_WITH_CONTEXT](#)

SDO_GEOM.VALIDATE_LAYER

Format

```
SDO_GEOM.VALIDATE_LAYER(  
    geom_table      IN VARCHAR2,  
    geom_column     IN VARCHAR2,  
    pkey_column     IN VARCHAR2,  
    result_table    IN VARCHAR2  
    [, commit_interval IN NUMBER]);
```

Description

Examines a geometry column to determine if the stored geometries follow the defined rules for geometry objects.

Parameters

geom_table

Geometry table.

geom_column

Geometry object column to be examined.

pkey_column

The primary key column. This must be a single numeric (NUMBER data type) column.

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 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. If the primary key is indexed, you can look at the last PKEY_COLUMN value to see approximately how much of the validation is completed.

Usage Notes

The VALIDATE_LAYER procedure is deprecated and will not be supported in future releases of Oracle Spatial. You should use instead the [SDO_GEOM.VALIDATE_LAYER_WITH_CONTEXT](#) procedure.

This procedure loads the result table with validation results. (VALIDATE_LAYER is a procedure, not a function.)

An empty result table (*result_table* parameter) must be created before calling this procedure. The format of the result table is: (pkey_column NUMBER, result VARCHAR2(10)). If *result_table* is not empty, you should truncate the table before calling the procedure; otherwise, the procedure appends rows to the existing data in the table.

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 PKEY_COLUMN column contains the primary key value of the row containing the invalid geometry, and the RESULT column contains an Oracle error message number. You can then look up this error message to determine the cause of the failure.

This procedure performs the following checks on each geometry in the layer (*geom_column*):

- All the type consistency and geometry consistency checks that are performed by the [SDO_GEOM.VALIDATE_GEOMETRY](#) function (see Usage Notes for that function).
- If 4-digit SDO_GTYPE values are used, the geometry's SDO_GTYPE specifies the same dimensionality as specified in the applicable DIMINFO column value (from the USER_SDO_GEOM_METADATA view).
- 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).

As an alternative to using the VALIDATE_LAYER procedure, you can use a PL/SQL procedure that calls the [SDO_GEOM.VALIDATE_GEOMETRY](#) function for each input row and inserts rows in a result table for errors. With this approach, you have more options in defining the result table; for example, the key field can be anything that you choose.

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. (The example uses the definitions and data from [Section 2.1](#).) In this case, a row with a RESULT value of DONE is written to the result table, because all the geometries are valid.

```
-- Is a layer valid? (First, create the result table.)
CREATE TABLE val_results (mkt_id number, result varchar2(10));
EXECUTE SDO_GEOM.VALIDATE_LAYER('COLA_MARKETS','SHAPE','MKT_ID','VAL_RESULTS');
```

PL/SQL procedure successfully completed.

```
SELECT * from val_results;
```

```
      MKT_ID RESULT
-----
          1  DONE
```

Related Topics

- [SDO_GEOM.VALIDATE_LAYER_WITH_CONTEXT](#)
- [SDO_GEOM.VALIDATE_GEOMETRY](#)

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]);
```

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

Geometry table.

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 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.

Usage Notes

This procedure loads the result table with validation results. (`VALIDATE_LAYER_WITH_CONTEXT` is a procedure, not a function.)

An empty result table (*result_table* parameter) must 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, you should truncate the table before calling the procedure; otherwise, the procedure appends rows to the existing data in the table.

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 the type consistency and geometry consistency checks that are performed by the [SDO_GEOM.VALIDATE_GEOMETRY_WITH_CONTEXT](#) function (see the Usage Notes for that function).
- If 4-digit SDO_GTYPE values are used, the geometry's SDO_GTYPE specifies the same dimensionality as specified in the applicable DIMINFO column value (from the USER_SDO_GEOM_METADATA view).
- 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).

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.)
EXECUTE SDO_GEOM.VALIDATE_LAYER_WITH_CONTEXT('COLA_MARKETS', 'SHAPE', 'VAL_
RESULTS');
```

PL/SQL procedure successfully 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](#)

SDO_GEOM.WITHIN_DISTANCE

Format

```
SDO_GEOM.WITHIN_DISTANCE(  
    geom1 IN MDSYS.SDO_GEOMETRY,  
    dim1  IN MDSYS.SDO_DIM_ARRAY,  
    dist  IN NUMBER,  
    geom2 IN MDSYS.SDO_GEOMETRY,  
    dim2  IN MDSYS.SDO_DIM_ARRAY  
    ) RETURN VARCHAR2;
```

or

```
SDO_GEOM.WITHIN_DISTANCE(  
    geom1 IN MDSYS.SDO_GEOMETRY,  
    dist  IN NUMBER,  
    geom2 IN MDSYS.SDO_GEOMETRY,  
    tol   IN NUMBER  
    ) 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 (see [Section 2.4](#)).

dist

Distance value.

geom2

Geometry object.

dim2

Dimensional information array corresponding to *geom2*, usually selected from one of the xxx_SDO_GEOM_METADATA views (see [Section 2.4](#)).

tol

Tolerance value (see [Section 1.5.5](#)).

Usage Notes

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.

If the function format with *tol* is used, all geometry objects must be defined using 4-digit SDO_GTYPE values (explained in [Section 2.2.1](#)).

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 [Section 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](#)

Spatial Aggregate Functions

This chapter contains reference and usage information for the spatial aggregate functions, which are listed in [Table 12-1](#).

Table 12-1 *Spatial Aggregate Functions*

Method	Description
SDO_AGGR_CENTROID	Returns a geometry object that is the centroid ("center of gravity") of the specified geometry objects.
SDO_AGGR_CONVEXHULL	Returns a geometry object that is the convex hull of the specified geometry objects.
SDO_AGGR_LRS_CONCAT	Returns an LRS geometry object that concatenates specified LRS geometry objects.
SDO_AGGR_MBR	Returns the minimum bounding rectangle of the specified geometry objects
SDO_AGGR_UNION	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 [Section 1.9](#).

Most of these aggregate functions accept a parameter of type `MDSYS.SDOAGGRTYPE`, which is described in [Section 1.9.1](#).

SDO_AGGR_CENTROID

Format

```
SDO_AGGR_CENTROID(  
    AggregateGeometry MDSYS.SDOAGGRTYPE  
    ) RETURN MDSYS.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 MDSYS.SDOAGGRTYPE (see [Section 1.9.1](#)) 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](#) function in [Chapter 12](#).

Examples

The following example returns the centroid of the geometry objects in the COLA_MARKETS table. (The example uses the definitions and data from [Section 2.1](#).)

```
SELECT SDO_AGGR_CENTROID(MDSYS.SDOAGGRTYPE(shape, 0.005))  
       FROM cola_markets;
```

```
SDO_AGGR_CENTROID(MDSYS.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)
```

SDO_AGGR_CONVEXHULL

Format

```
SDO_AGGR_CONVEXHULL(  
    AggregateGeometry MDSYS.SDOAGGRTYPE  
    ) RETURN MDSYS.SDO_GEOMETRY;
```

Description

Returns a geometry object that is the convex hull of the specified geometry objects.

Parameters

AggregateGeometry

An object of type MDSYS.SDOAGGRTYPE (see [Section 1.9.1](#)) that specifies the geometry column and dimensional array.

Usage Notes

See also the information about the [SDO_GEOM.SDO_CONVEXHULL](#) in [Chapter 12](#).

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 [Section 2.1](#).)

```
SELECT SDO_AGGR_CONVEXHULL(MDSYS.SDOAGGRTYPE(shape, 0.005))  
    FROM cola_markets;
```

```
SDO_AGGR_CONVEXHULL(MDSYS.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))
```

SDO_AGGR_LRS_CONCAT

Format

```
SDO_AGGR_LRS_CONCAT(  
    AggregateGeometry MDSYS.SDOAGGRTYPE  
    ) RETURN MDSYS.SDO_GEOMETRY;
```

Description

Returns an LRS geometry that concatenates specified LRS geometries.

Parameters

AggregateGeometry

An object of type MDSYS.SDOAGGRTYPE (see [Section 1.9.1](#)) 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 [Section 6.4](#).)

For information about the Spatial linear referencing system, see [Chapter 6](#).

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 [Section 6.6](#).)

```
-- Add a segment with route_id less than 1 (here, zero).
INSERT INTO lrs_routes VALUES(
  0,
  'Route0',
  MDSYS.SDO_GEOMETRY(
    3302, -- line string, 3 dimensions (X,Y,M), 3rd is linear referencing
    dimension
    NULL,
    NULL,
    MDSYS.SDO_ELEM_INFO_ARRAY(1,2,1), -- one line string, straight segments
    MDSYS.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(MDSYS.SDOAGGRTYPE(route_geometry, 0.005))
FROM lrs_routes;
```

```
SDO_AGGR_LRS_CONCAT(MDSYS.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(MDSYS.SDOAGGRTYPE(route_geometry, 0.005))
FROM (
      SELECT /*+ NO_MERGE */ route_geometry
      FROM lrs_routes
      ORDER BY route_id);
```

```
SDO_AGGR_LRS_CONCAT(MDSYS.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))
```

SDO_AGGR_MBR

Format

```
SDO_AGGR_MBR(  
    geom MDSYS.SDO_GEOMETRY  
    ) RETURN MDSYS.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

Use this function instead of the deprecated [SDO_TUNE.EXTENT_OF](#) function to return the MBR of geometries. The [SDO_TUNE.EXTENT_OF](#) function is limited to two-dimensional geometries, whereas this function is not.

This function is not supported with geodetic data.

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 [Section 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))
```

SDO_AGGR_UNION

Format

```
SDO_AGGR_UNION(  
    AggregateGeometry MDSYS.SDOAGGRTYPE  
    ) RETURN MDSYS.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 MDSYS.SDOAGGRTYPE (see [Section 1.9.1](#)) that specifies the geometry column and dimensional array.

Usage Notes

See also the information about the [SDO_GEOM.SDO_UNION](#) function in [Chapter 12](#).

Examples

The following example returns the union of the first three geometry objects in the COLA_MARKETS table (that is, all except *cola_d*). (The example uses the definitions and data from [Section 2.1](#).)

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

Coordinate System Transformation Functions

The MDSYS.SDO_CS package contains functions and procedures 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 functions and procedures in this chapter, you must understand the conceptual information about coordinate systems in [Section 1.5.4](#) and [Chapter 5](#).

[Table 13-1](#) lists the coordinate systems functions and procedures.

Table 13-1 *Functions and Procedures for Coordinate Systems*

Function	Description
SDO_CS.TRANSFORM	Transforms a geometry representation using a coordinate system (specified by SRID or name).
SDO_CS.TRANSFORM_LAYER	Transforms an entire layer of geometries (that is, all geometries in a specified column in a table).
SDO_CS.VIEWPORT_TRANSFORM	Transforms an optimized rectangle into a valid polygon for use with Spatial operators and functions.

The rest of this chapter provides reference information on the functions and procedures, listed in alphabetical order.

SDO_CS.TRANSFORM

Format

```
SDO_CS.TRANSFORM(  
    geom IN MDSYS.SDO_GEOMETRY,  
    to_srid IN NUMBER  
    ) RETURN MDSYS.SDO_GEOMETRY;
```

or

```
SDO_CS.TRANSFORM(  
    geom IN MDSYS.SDO_GEOMETRY,  
    dim IN MDSYS.SDO_DIM_ARRAY,  
    to_srid IN NUMBER  
    ) RETURN MDSYS.SDO_GEOMETRY;
```

or

```
SDO_CS.TRANSFORM(  
    geom IN MDSYS.SDO_GEOMETRY,  
    to_sname IN VARCHAR2  
    ) RETURN MDSYS.SDO_GEOMETRY;
```

or

```
SDO_CS.TRANSFORM(  
    geom IN MDSYS.SDO_GEOMETRY,  
    dim IN MDSYS.SDO_DIM_ARRAY,  
    to_sname IN VARCHAR2  
    ) RETURN MDSYS.SDO_GEOMETRY;
```

Description

Transforms a geometry representation using a coordinate system (specified by SRID or name).

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 MDSYS.CS_SRS table (described in [Section 5.4.1](#)).

dim

Dimensional information array corresponding to *geom*, usually selected from one of the xxx_SDO_GEOM_METADATA views.

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 MDSYS.CS_SRS table (described in [Section 5.4.1](#)).

to_sname

The name of the coordinate system to be used for the transformation. It must be a value (specified exactly) in the CS_NAME column of the MDSYS.CS_SRS table (described in [Section 5.4.1](#)).

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 *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 MDSYS.CS_SRS table (described in [Section 5.4.1](#)).

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 [Section 5.8](#).)

```
-- Return the transformation of cola_c using to_srid 8199
-- ('Longitude / Latitude (Arc 1950)')
SELECT c.name, SDO_CS.TRANSFORM(c.shape, m.diminfo, 8199)
      FROM cola_markets_cs c, user_sdo_geom_metadata m
      WHERE m.table_name = 'COLA_MARKETS_CS' AND m.column_name = 'SHAPE'
      AND c.name = 'cola_c';
```

NAME

```

SDO_CS.TRANSFORM(C.SHAPE,M.DIMINFO,8199)(SDO_GTYPE, SDO_SRID, SDO_POINT(X, Y, Z)
-----
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, m.diminfo,
        'Longitude / Latitude (Arc 1950)')
FROM cola_markets_cs c, user_sdo_geom_metadata m
WHERE m.table_name = 'COLA_MARKETS_CS' AND m.column_name = 'SHAPE'
AND c.name = 'cola_c';

```

NAME

```

-----
SDO_CS.TRANSFORM(C.SHAPE,M.DIMINFO,'LONGITUDE/LATITUDE(ARC1950)')(SDO_GTYPE, 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))

```

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);
```

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 MDSYS.CS_SRS table (described in [Section 5.4.1](#)).

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 13–2](#).

Table 13–2 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 the <i>Oracle9i SQL Reference</i> .
GEOMETRY	MDSYS.SDO_GEOMETRY	Geometry object with coordinate values in the specified (<i>to_srid</i> 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 [Section 5.8](#).)

```
-- Transform the entire SHAPE layer and put results in the table
-- named cola_markets_cs_8199, which the procedure will create.
EXECUTE SDO_CS.TRANSFORM_LAYER('COLA_MARKETS_CS', 'SHAPE', 'COLA_MARKETS_CS_8199', 8199);
```

[Example 5–4](#) in [Section 5.8](#) includes a display of the geometry object coordinates in both tables (COLA_MARKETS_CS and COLA_MARKETS_CS_8199).

SDO_CS.VIEWPORT_TRANSFORM

Format

```
SDO_CS.VIEWPORT_TRANSFORM(  
    geom      IN MDSYS.SDO_GEOMETRY,  
    to_srid   IN NUMBER  
    ) RETURN MDSYS.SDO_GEOMETRY;
```

Description

Transforms an optimized rectangle into a valid polygon for use with Spatial operators and functions.

Parameters

geom

Geometry whose representation is to be transformed from an optimized rectangle to a valid polygon. The input geometry must have an SRID value of 0 (zero), as explained in the Usage Notes.

to_srid

The SRID of the coordinate system to be used for the transformation (that is, the SRID to be used in the returned geometry). *to_srid* must be either a value in the SRID column of the MDSYS.CS_SRS table (described in [Section 5.4.1](#)) or NULL.

Usage Notes

The geometry passed in must be an optimized rectangle.

If *to_srid* is a geodetic SRID, a geometry (not an optimized rectangle) is returned that conforms to the Oracle Spatial requirements for a geodetic geometry (for example, each polygon element's area must be less than one-half the surface area of the Earth).

If *to_srid* is not a geodetic SRID, an optimized rectangle is returned in which the SRID is set to *to_srid*

Visualizer applications that work on geodetic data usually treat the longitude and latitude space as a regular Cartesian coordinate system. Fetching the data corresponding to a viewport is usually done with the help of an [SDO_FILTER](#) or

[SDO_GEOM.RELATE](#) operation where the viewport (with an optimized rectangle representation) is sent as the window query. With the current restriction of not allowing this optimized rectangle type in geodetic space, this type of viewport queries cannot be sent to the database.

The `VIEWPORT_TRANSFORM` function provides a workaround. The viewport rectangles should be constructed with the `SRID` value as 0 and input to the function to generate a corresponding valid geodetic polygon. This geodetic polygon can then be used in the [SDO_FILTER](#) or [SDO_GEOM.RELATE](#) call as the window object.

Note that an `SRID` value of 0 should only be specified when calling the `VIEWPORT_TRANSFORM` function. It is not valid in any other context in Spatial.

This function should be used only when the display space is equirectangular (a rectangle), and the data displayed is geodetic.

Note: The function format with the `to_sname` parameter, which was supported in the previous release, is no longer supported. You must use the format with the `to_srid` parameter.

Examples

The following example specifies the viewport as the whole Earth represented by an optimized rectangle. It returns the names of all four cola markets. (This example uses the definitions from the example in [Section 5.8](#).)

```
SELECT c.name FROM cola_markets_cs c WHERE
  SDO_FILTER(c.shape, SDO_CS.VIEWPORT_TRANSFORM(
    MDSYS.SDO_GEOMETRY(
      2003,
      0, -- SRID = 0 (special case)
      NULL,
      MDSYS.SDO_ELEM_INFO_ARRAY(1,1003,3),
      MDSYS.SDO_ORDINATE_ARRAY(-180,-90,180,90)),
    8307), 'querytype=window') = 'TRUE';
```

NAME

cola_a
cola_c
cola_b
cola_d

If the optimizer does not generate an optimal plan and performance is not as you expect, you can try the following alternative version of the query.

```
SELECT c.name FROM cola_markets_cs c,  
       (SELECT  
         SDO_CS.VIEWPORT_TRANSFORM(  
           MDSYS.SDO_GEOMETRY(2003, 0, NULL,  
             MDSYS.SDO_ELEM_INFO_ARRAY(1,1003,3),  
             MDSYS.SDO_ORDINATE_ARRAY(-180,-90,180,90)), 8307)  
         window_geom FROM DUAL)  
WHERE SDO_FILTER(c.shape, window_geom, 'querytype=window') = 'TRUE';
```

NAME

```
-----  
cola_a  
cola_c  
cola_b  
cola_d
```

Linear Referencing Functions

The MDSYS.SDO_LRS package contains functions that create, modify, query, and convert linear referencing elements. These functions do not change the state of the database.

Note: Most Oracle LRS interfaces are functions. Any that are procedures, such as `DEFINE_GEOM_SEGMENT`, are identified as such. (Functions return a value; procedures do not return a value.)

The word *functions* is often used to refer to LRS interfaces (both functions and procedures) collectively.

To use the functions in this chapter, you must understand the linear referencing system (LRS) concepts and techniques described in [Chapter 6](#).

[Table 14–1](#) lists functions related to creating and editing geometric segments.

Table 14–1 Functions for Creating and Editing Geometric Segments

Function	Description
SDO_LRS.DEFINE_GEOM_SEGMENT (procedure)	Defines a geometric segment.
SDO_LRS.REDEFINE_GEOM_SEGMENT (procedure)	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.
SDO_LRS.CLIP_GEOM_SEGMENT	Clips a geometric segment (synonym of SDO_LRS.DYNAMIC_SEGMENT).
SDO_LRS.DYNAMIC_SEGMENT	Clips a geometric segment (synonym of SDO_LRS.CLIP_GEOM_SEGMENT).

Table 14–1 Functions for Creating and Editing Geometric Segments (Cont.)

Function	Description
SDO_LRS.CONCATENATE_GEOM_SEGMENTS	Concatenates two geometric segments into one segment.
SDO_LRS.OFFSET_GEOM_SEGMENT	Returns the geometric segment at a specified offset from a geometric segment.
SDO_LRS.SCALE_GEOM_SEGMENT	Scales a geometric segment.
SDO_LRS.SPLIT_GEOM_SEGMENT (procedure)	Splits a geometric segment into two segments.
SDO_LRS.REVERSE_MEASURE	Returns a new geometric segment by reversing the original geometric segment.
SDO_LRS.TRANSLATE_MEASURE	Returns a new geometric segment by translating the original geometric segment (that is, shifting the start and end measures by a specified value).
SDO_LRS.REVERSE_GEOMETRY	Returns a new geometric segment by reversing the measure values and the direction of the original geometric segment.

Table 14–2 lists functions related to querying geometric segments.

Table 14–2 Functions for Querying Geometric Segments

Function	Description
SDO_LRS.VALID_GEOM_SEGMENT	Checks if a geometric segment is valid.
SDO_LRS.VALID_LRS_PT	Checks if an LRS point is valid.
SDO_LRS.VALID_MEASURE	Checks if a measure falls within the measure range of a geometric segment.
SDO_LRS.CONNECTED_GEOM_SEGMENTS	Checks if two geometric segments are connected.
SDO_LRS.GEOM_SEGMENT_LENGTH	Returns the length of a geometric segment.
SDO_LRS.GEOM_SEGMENT_START_PT	Returns the start point of a geometric segment.
SDO_LRS.GEOM_SEGMENT_END_PT	Returns the end point of a geometric segment.
SDO_LRS.GEOM_SEGMENT_START_MEASURE	Returns the start measure of a geometric segment.

Table 14–2 Functions for Querying Geometric Segments (Cont.)

Function	Description
SDO_LRS.GEOM_SEGMENT_END_MEASURE	Returns the end measure of a geometric segment.
SDO_LRS.GET_MEASURE	Returns the measure of an LRS point.
SDO_LRS.MEASURE_RANGE	Returns the measure range of a geometric segment, that is, the difference between the start measure and end measure.
SDO_LRS.MEASURE_TO_PERCENTAGE	Returns the percentage (0 to 100) that a specified measure is of the measure range of a geometric segment.
SDO_LRS.PERCENTAGE_TO_MEASURE	Returns the measure value of a specified percentage (0 to 100) of the measure range of a geometric segment.
SDO_LRS.LOCATE_PT	Finds the location of a point described by a measure and an offset on a geometric segment.
SDO_LRS.PROJECT_PT	Returns the projection point of a point on a geometric segment.
SDO_LRS.FIND_LRS_DIM_POS	Returns the position of the measure dimension within the SDO_DIM_ARRAY structure for a specified SDO_GEOMETRY column.
SDO_LRS.FIND_MEASURE	Returns the measure of the closest point on a segment to a specified projection point.

Table 14–3 lists functions related to converting geometric segments.

Table 14–3 Functions for Converting Geometric Segments

Function	Description
SDO_LRS.CONVERT_TO_LRS_DIM_ARRAY	Converts a standard dimensional array to a Linear Referencing System dimensional array by creating a measure dimension.
SDO_LRS.CONVERT_TO_LRS_GEOM	Converts a standard SDO_GEOMETRY line string to a Linear Referencing System geometric segment by adding measure information.

Table 14–3 Functions for Converting Geometric Segments (Cont.)

Function	Description
SDO_LRS.CONVERT_TO_LRS_LAYER	Converts all geometry objects in a column of type SDO_GEOMETRY from standard line string geometries without measure information to Linear Referencing System geometric segments with measure information, and updates the metadata.
SDO_LRS.CONVERT_TO_STD_DIM_ARRAY	Converts a Linear Referencing System dimensional array to a standard dimensional array by removing the measure dimension.
SDO_LRS.CONVERT_TO_STD_GEOM	Converts a Linear Referencing System geometric segment to a standard SDO_GEOMETRY line string by removing measure information.
SDO_LRS.CONVERT_TO_STD_LAYER	Converts all geometry objects in a column of type SDO_GEOMETRY from Linear Referencing System geometric segments with measure information to standard line string geometries without measure information, and updates the metadata.

For more information about conversion functions, see [Section 6.5.10](#).

The rest of this chapter provides reference information on the functions, listed in alphabetical order.

SDO_LRS.CLIP_GEOM_SEGMENT

Format

```
SDO_LRS.CLIP_GEOM_SEGMENT(  
    geom_segment IN MDSYS.SDO_GEOMETRY,  
    start_measure IN NUMBER,  
    end_measure  IN NUMBER  
    ) RETURN MDSYS.SDO_GEOMETRY;
```

or

```
SDO_LRS.CLIP_GEOM_SEGMENT(  
    geom_segment IN MDSYS.SDO_GEOMETRY,  
    dim_array    IN MDSYS.SDO_DIM_ARRAY,  
    start_measure IN NUMBER,  
    end_measure  IN NUMBER  
    ) RETURN MDSYS.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](#) 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.

start_measure

Start measure of the geometric segment.

end_measure

End measure of the geometric segment.

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 [Section 6.4](#).

For more information about clipping geometric segments, see [Section 6.5.3](#).

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 [Section 6.6](#).)

```
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))
```

SDO_LRS.CONCATENATE_GEOM_SEGMENTS

Format

```
SDO_LRS.CONCATENATE_GEOM_SEGMENTS(  
    geom_segment_1 IN MDSYS.SDO_GEOMETRY,  
    geom_segment_2 IN MDSYS.SDO_GEOMETRY,  
    tolerance      IN NUMBER  
    ) RETURN MDSYS.SDO_GEOMETRY;
```

or

```
SDO_LRS.CONCATENATE_GEOM_SEGMENTS(  
    geom_segment_1 IN MDSYS.SDO_GEOMETRY,  
    dim_array_1    IN MDSYS.SDO_DIM_ARRAY,  
    geom_segment_2 IN MDSYS.SDO_GEOMETRY,  
    dim_array_2    IN MDSYS.SDO_DIM_ARRAY  
    ) RETURN MDSYS.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.

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.

tolerance

Tolerance value (see [Section 1.5.5](#)).

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 *_3D* format of this function (SDO_LRS.CONCATENATE_GEOM_SEGMENTS_3D) is available. For information about *_3D* formats of LRS functions, see [Section 6.4](#).

For more information about concatenating geometric segments, see [Section 6.5.5](#)

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 [Section 6.6](#). The definitions of *result_geom_1*, *result_geom_2*, and *result_geom_3* are displayed in [Example 6-3](#).)

```
DECLARE
geom_segment MDSYS.SDO_GEOMETRY;
line_string MDSYS.SDO_GEOMETRY;
dim_array MDSYS.SDO_DIM_ARRAY;
result_geom_1 MDSYS.SDO_GEOMETRY;
result_geom_2 MDSYS.SDO_GEOMETRY;
result_geom_3 MDSYS.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;
/
```

SDO_LRS.CONNECTED_GEOM_SEGMENTS

Format

```
SDO_LRS.CONNECTED_GEOM_SEGMENTS(  
    geom_segment_1 IN MDSYS.SDO_GEOMETRY,  
    geom_segment_2 IN MDSYS.SDO_GEOMETRY,  
    tolerance      IN NUMBER  
    ) RETURN VARCHAR2;
```

or

```
SDO_LRS.CONNECTED_GEOM_SEGMENTS(  
    geom_segment_1 IN MDSYS.SDO_GEOMETRY,  
    dim_array_1   IN MDSYS.SDO_DIM_ARRAY,  
    geom_segment_2 IN MDSYS.SDO_GEOMETRY,  
    dim_array_2   IN MDSYS.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.

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.

tolerance

Tolerance value (see [Section 1.5.5](#)).

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 [Section 6.4](#).

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
```

SDO_LRS.CONVERT_TO_LRS_DIM_ARRAY

Format

```
SDO_LRS.CONVERT_TO_LRS_DIM_ARRAY(  
    dim_array      IN MDSYS.SDO_DIM_ARRAY  
    [, lower_bound IN NUMBER,  
    upper_bound   IN NUMBER,  
    tolerance     IN NUMBER]  
    ) RETURN MDSYS.SDO_DIM_ARRAY;
```

or

```
SDO_LRS.CONVERT_TO_LRS_DIM_ARRAY(  
    dim_array      IN MDSYS.SDO_DIM_ARRAY,  
    dim_name       IN VARCHAR2  
    [, lower_bound IN NUMBER,  
    upper_bound   IN NUMBER,  
    tolerance     IN NUMBER]  
    ) RETURN MDSYS.SDO_DIM_ARRAY;
```

or

```
SDO_LRS.CONVERT_TO_LRS_DIM_ARRAY(  
    dim_array      IN MDSYS.SDO_DIM_ARRAY,  
    dim_name       IN VARCHAR2,  
    dim_pos        IN INTEGER  
    [, lower_bound IN NUMBER,  
    upper_bound   IN NUMBER,  
    tolerance     IN NUMBER]  
    ) RETURN MDSYS.SDO_DIM_ARRAY;
```


Description

Converts a standard dimensional array to a Linear Referencing System 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.

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 [Section 1.5.5](#)).

Usage Notes

This function converts a standard dimensional array to a Linear Referencing System 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 diminfo (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 if 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 [Section 6.4](#).

For more information about conversion functions, see [Section 6.5.10](#).

Examples

The following example converts the dimensional array for the LRS_ROUTES table to Linear Referencing System format. (This example uses the definitions from the example in [Section 6.6](#).)

```
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))
```

SDO_LRS.CONVERT_TO_LRS_GEOM

Format

```
SDO_LRS.CONVERT_TO_LRS_GEOM(  
    standard_geom IN MDSYS.SDO_GEOMETRY  
    [, start_measure IN NUMBER,  
    end_measure IN NUMBER]  
    ) RETURN MDSYS.SDO_GEOMETRY;
```

or

```
SDO_LRS.CONVERT_TO_LRS_GEOM(  
    standard_geom IN MDSYS.SDO_GEOMETRY,  
    dim_array IN MDSYS.SDO_DIM_ARRAY  
    [, start_measure IN NUMBER,  
    end_measure IN NUMBER]  
    ) RETURN MDSYS.SDO_GEOMETRY;
```

or

```
SDO_LRS.CONVERT_TO_LRS_GEOM(  
    standard_geom IN MDSYS.SDO_GEOMETRY,  
    m_pos IN INTEGER  
    [, start_measure IN NUMBER,  
    end_measure IN NUMBER]  
    ) RETURN MDSYS.SDO_GEOMETRY;
```

Description

Converts a standard SDO_GEOMETRY line string to a Linear Referencing System 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.

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 miles and the unit of measure is miles).

Usage Notes

This function returns a Linear Referencing System 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 [Section 6.4](#).

For more information about conversion functions, see [Section 6.5.10](#).

Examples

The following example converts the geometric segment representing Route 1 to Linear Referencing System format. (This example uses the definitions from the example in [Section 6.6](#).)

```
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_GEOG(A.ROUTE_GEOMETRY,M.DIMINFO)(SDO_GTYPE, SDO_SRID, SDO
-----
SDO_GEOMETRY(3002, 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))
```

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 Linear Referencing System 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 [Section 1.5.5](#)).

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](#) and [CREATE INDEX](#) statements in [Chapter 8](#).

The `_3D` format of this function (`SDO_LRS.CONVERT_TO_LRS_LAYER_3D`) is available. For information about `_3D` formats of LRS functions, see [Section 6.4](#).

For more information about conversion functions, see [Section 6.5.10](#).

Examples

The following example converts the geometric segments in the `ROUTE_GEOMETRY` column of the `LRS_ROUTES` table to Linear Referencing System format. (This example uses the definitions from the example in [Section 6.6](#).) 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))
```

SDO_LRS.CONVERT_TO_STD_DIM_ARRAY

Format

```
SDO_LRS.CONVERT_TO_STD_DIM_ARRAY(  
    dim_array IN MDSYS.SDO_DIM_ARRAY  
    [, m_pos   IN INTEGER]  
    ) RETURN MDSYS.SDO_DIM_ARRAY;
```

Description

Converts a Linear Referencing System 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.

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 a Linear Referencing System 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 *diminfo*.

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 [Section 6.4](#).

For more information about conversion functions, see [Section 6.5.10](#).

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 [Section 6.6](#).)

```
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, .00
5))
```

SDO_LRS.CONVERT_TO_STD_GEOM

Format

```
SDO_LRS.CONVERT_TO_STD_GEOM(  
    lrs_geom IN MDSYS.SDO_GEOMETRY  
    [, dim_array IN MDSYS.SDO_DIM_ARRAY]  
    ) RETURN MDSYS.SDO_GEOMETRY;
```

Description

Converts a Linear Referencing System geometric segment to a standard SDO_GEOMETRY line string by removing measure information.

Parameters

lrs_geom

Linear Referencing System 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.

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 [Section 6.4](#).

For more information about conversion functions, see [Section 6.5.10](#).

Examples

The following example converts the geometric segment representing Route 1 to standard format. (This example uses the definitions from the example in [Section 6.6](#).)

```
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))
```

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 Linear Referencing System 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.

An exception is raised if the conversion failed.

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](#) and [CREATE INDEX](#) statements in [Chapter 8](#).

The *_3D* format of this function (SDO_LRS.CONVERT_TO_STD_LAYER_3D) is available. For information about *_3D* formats of LRS functions, see [Section 6.4](#).

For more information about conversion functions, see [Section 6.5.10](#).

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 [Section 6.6](#).) 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))
```

SDO_LRS.DEFINE_GEOM_SEGMENT

Format

```
SDO_LRS.DEFINE_GEOM_SEGMENT(  
    geom_segment IN OUT MDSYS.SDO_GEOMETRY  
    [, start_measure IN NUMBER,  
    end_measure IN NUMBER]);
```

or

```
SDO_LRS.DEFINE_GEOM_SEGMENT(  
    geom_segment IN OUT MDSYS.SDO_GEOMETRY,  
    dim_array IN MDSYS.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. (This is a procedure, not a function.)

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.

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 [Section 6.4](#).

For more information about defining a geometric segment, see [Section 6.5.1](#)

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 [Section 6.6](#). The definitions of *result_geom_1*, *result_geom_2*, and *result_geom_3* are displayed in [Example 6-3](#).)

```
DECLARE
geom_segment MDSYS.SDO_GEOMETRY;
line_string MDSYS.SDO_GEOMETRY;
dim_array MDSYS.SDO_DIM_ARRAY;
result_geom_1 MDSYS.SDO_GEOMETRY;
result_geom_2 MDSYS.SDO_GEOMETRY;
result_geom_3 MDSYS.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;
/
```

SDO_LRS.DYNAMIC_SEGMENT

Format

```
SDO_LRS.DYNAMIC_SEGMENT(  
    geom_segment IN MDSYS.SDO_GEOMETRY,  
    start_measure IN NUMBER,  
    end_measure  IN NUMBER  
    ) RETURN MDSYS.SDO_GEOMETRY;
```

or

```
SDO_LRS.DYNAMIC_SEGMENT(  
    geom_segment IN MDSYS.SDO_GEOMETRY,  
    dim_array    IN MDSYS.SDO_DIM_ARRAY,  
    start_measure IN NUMBER,  
    end_measure  IN NUMBER  
    ) RETURN MDSYS.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](#) 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.

start_measure

Start measure of the geometric segment.

end_measure

End measure of the geometric segment.

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 [Section 6.5.3](#)

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 [Section 6.6](#).)

```
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))
```

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 [Section 6.6](#).)

```
SELECT SDO_LRS.FIND_LRS_DIM_POS('LRS_ROUTES', 'ROUTE_GEOMETRY') FROM DUAL;
```

```
SDO_LRS.FIND_LRS_DIM_POS('LRS_ROUTES', 'ROUTE_GEOMETRY')
```

```
-----
```

3

SDO_LRS.FIND_MEASURE

Format

```
SDO_LRS.FIND_MEASURE(  
    geom_segment IN MDSYS.SDO_GEOMETRY,  
    point        IN MDSYS.SDO_GEOMETRY  
    ) RETURN NUMBER;
```

or

```
SDO_LRS.FIND_MEASURE(  
    geom_segment IN MDSYS.SDO_GEOMETRY,  
    dim_array    IN MDSYS.SDO_DIM_ARRAY,  
    point        IN MDSYS.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.

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_1* or *geom_segment_2* 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 [Section 6.4](#).

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 [Section 6.6](#).)

```
-- 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,
    MDSYS.SDO_GEOMETRY(3001, NULL, NULL,
        MDSYS.SDO_ELEM_INFO_ARRAY(1, 1, 1),
        MDSYS.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,MDSYS.SDO_GEOMETRY(3001,NULL,NUL
-----
```

SDO_LRS.GEOM_SEGMENT_END_MEASURE

Format

```
SDO_LRS.GEOM_SEGMENT_END_MEASURE(  
    geom_segment IN MDSYS.SDO_GEOMETRY  
    [, dim_array  IN MDSYS.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.

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 [Section 6.4](#).

Examples

The following example returns the end measure of the geometric segment representing Route 1. (This example uses the definitions from the example in [Section 6.6](#).)

```
SELECT SDO_LRS.GEOM_SEGMENT_END_MEASURE(route_geometry)  
FROM lrs_routes WHERE route_id = 1;
```

SDO_LRS.GEOM_SEGMENT_END_MEASURE(ROUTE_GEOMETRY)

27

SDO_LRS.GEOM_SEGMENT_END_PT

Format

```
SDO_LRS.GEOM_SEGMENT_END_PT(
    geom_segment IN MDSYS.SDO_GEOMETRY
    [, dim_array  IN MDSYS.SDO_DIM_ARRAY]
) RETURN MDSYS.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.

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 [Section 6.4](#).

Examples

The following example returns the end point of the geometric segment representing Route 1. (This example uses the definitions from the example in [Section 6.6](#).)

```
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))
```

SDO_LRS.GEOM_SEGMENT_LENGTH

Format

```
SDO_LRS.GEOM_SEGMENT_LENGTH(  
    geom_segment IN MDSYS.SDO_GEOMETRY  
    [, dim_array  IN MDSYS.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.

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](#) operation from the result of an [SDO_LRS.GEOM_SEGMENT_END_MEASURE](#) 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 [Section 6.4](#).

Examples

The following example returns the length of the geometric segment representing Route 1. (This example uses the definitions from the example in [Section 6.6](#).)

```
SELECT SDO_LRS.GEOM_SEGMENT_LENGTH(route_geometry)
       FROM lrs_routes WHERE route_id = 1;
```

```
SDO_LRS.GEOM_SEGMENT_LENGTH(ROUTE_GEOMETRY)
```

27

SDO_LRS.GEOM_SEGMENT_START_MEASURE

Format

```
SDO_LRS.GEOM_SEGMENT_START_MEASURE(  
    geom_segment IN MDSYS.SDO_GEOMETRY  
    [, dim_array  IN MDSYS.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.

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 [Section 6.4](#).

Examples

The following example returns the start measure of the geometric segment representing Route 1. (This example uses the definitions from the example in [Section 6.6](#).)

```
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

SDO_LRS.GEOM_SEGMENT_START_PT

Format

```
SDO_LRS.GEOM_SEGMENT_START_PT(  
    geom_segment IN MDSYS.SDO_GEOMETRY  
    [, dim_array  IN MDSYS.SDO_DIM_ARRAY]  
    ) RETURN MDSYS.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.

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 [Section 6.4](#).

Examples

The following example returns the start point of the geometric segment representing Route 1. (This example uses the definitions from the example in [Section 6.6](#).)

```
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))
```


SDO_LRS.GET_MEASURE

Format

```
SDO_LRS.GET_MEASURE(  
    point          IN MDSYS.SDO_GEOMETRY  
    [, dim_array  IN MDSYS.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.

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](#), 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](#).

The *_3D* format of this function (SDO_LRS.GET_MEASURE_3D) is available. For information about *_3D* formats of LRS functions, see [Section 6.4](#).

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.

```
SQL> SELECT SDO_LRS.GET_MEASURE(  
  SDO_LRS.PROJECT_PT(a.route_geometry, m.diminfo,  
    MDSYS.SDO_GEOMETRY(3001, NULL, NULL,  
      MDSYS.SDO_ELEM_INFO_ARRAY(1, 1, 1),  
      MDSYS.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,MDSYS.SDO_GEOM  
-----
```

SDO_LRS.IS_GEOM_SEGMENT_DEFINED

Format

```
SDO_LRS.IS_GEOM_SEGMENT_DEFINED(  
    geom_segment IN MDSYS.SDO_GEOMETRY  
    [, dim_array  IN MDSYS.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.

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 [Section 6.4](#).

See also the [SDO_LRS.VALID_GEOM_SEGMENT](#) function.

Examples

The following example checks if the geometric segment representing Route 1 is defined. (This example uses the definitions from the example in [Section 6.6](#).)

```
SELECT SDO_LRS.IS_GEOM_SEGMENT_DEFINED(route_geometry)
```

SDO_LRS.IS_GEOM_SEGMENT_DEFINED

```
FROM lrs_routes WHERE route_id = 1;  
  
SDO_LRS.IS_GEOM_SEGMENT_DEFINED(ROUTE_GEOMETRY)  
-----  
TRUE
```

SDO_LRS.IS_MEASURE_DECREASING

Format

```
SDO_LRS.IS_MEASURE_DECREASING(  
    geom_segment IN MDSYS.SDO_GEOMETRY  
    [, dim_array  IN MDSYS.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.

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 [Section 6.4](#).

See also the [SDO_LRS.IS_MEASURE_INCREASING](#) 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 [Section 6.6](#).)

SDO_LRS.IS_MEASURE_DECREASING

```
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
```

SDO_LRS.IS_MEASURE_INCREASING

Format

```
SDO_LRS.IS_MEASURE_INCREASING(  
    geom_segment IN MDSYS.SDO_GEOMETRY  
    [, dim_array  IN MDSYS.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.

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 [Section 6.4](#).

See also the [SDO_LRS.IS_MEASURE_DECREASING](#) 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 [Section 6.6](#).)

SDO_LRS.IS_MEASURE_INCREASING

```
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
```


SDO_LRS.LOCATE_PT

Format

```
SDO_LRS.LOCATE_PT(  
    geom_segment IN MDSYS.SDO_GEOMETRY,  
    measure      IN NUMBER  
    [, offset    IN NUMBER  
    ) RETURN MDSYS.SDO_GEOMETRY;
```

or

```
SDO_LRS.LOCATE_PT(  
    geom_segment IN MDSYS.SDO_GEOMETRY,  
    dim_array    IN MDSYS.SDO_DIM_ARRAY,  
    measure      IN NUMBER  
    [, offset    IN NUMBER]  
    ) RETURN MDSYS.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.

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 [Section 6.4](#).

For more information about locating a point on a geometric segment, see [Section 6.5.8](#).

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 [Section 6.6](#).)

```
-- Create a table for accidents
CREATE TABLE accidents (
  accident_id NUMBER PRIMARY KEY,
  route_id NUMBER,
  accident_geometry MDSYS.SDO_GEOMETRY);

-- Insert an accident record.
DECLARE
geom_segment MDSYS.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))
```

SDO_LRS.MEASURE_RANGE

Format

```
SDO_LRS.MEASURE_RANGE(  
    geom_segment IN MDSYS.SDO_GEOMETRY  
    [, dim_array  IN MDSYS.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.

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 [Section 6.4](#).

Examples

The following example returns the measure range of the geometric segment representing Route 1. (This example uses the definitions from the example in [Section 6.6](#).)

```
SELECT SDO_LRS.MEASURE_RANGE(route_geometry)  
    FROM lrs_routes WHERE route_id = 1;  
  
SDO_LRS.MEASURE_RANGE(ROUTE_GEOMETRY)
```

SDO_LRS.MEASURE_TO_PERCENTAGE

Format

```
SDO_LRS.MEASURE_TO_PERCENTAGE(  
    geom_segment IN MDSYS.SDO_GEOMETRY,  
    measure      IN NUMBER  
    ) RETURN NUMBER;
```

or

```
SDO_LRS.MEASURE_TO_PERCENTAGE(  
    geom_segment IN MDSYS.SDO_GEOMETRY,  
    dim_array    IN MDSYS.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.

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](#) 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 geometric segment representing Route 1. (This example uses the definitions from the example in [Section 6.6](#).) 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
```

SDO_LRS.OFFSET_GEOM_SEGMENT

Format

```
SDO_LRS.OFFSET_GEOM_SEGMENT(  
    geom_segment IN MDSYS.SDO_GEOMETRY,  
    start_measure IN NUMBER,  
    end_measure  IN NUMBER,  
    offset       IN NUMBER  
    [, tolerance IN NUMBER]  
    ) RETURN MDSYS.SDO_GEOMETRY;
```

or

```
SDO_LRS.OFFSET_GEOM_SEGMENT(  
    geom_segment IN MDSYS.SDO_GEOMETRY,  
    start_measure IN NUMBER,  
    end_measure  IN NUMBER,  
    offset       IN NUMBER,  
    tolerance    IN NUMBER  
    [, unit      IN VARCHAR2]  
    ) RETURN MDSYS.SDO_GEOMETRY;
```

or

```
SDO_LRS.OFFSET_GEOM_SEGMENT(  
    geom_segment IN MDSYS.SDO_GEOMETRY,  
    dim_array    IN MDSYS.SDO_DIM_ARRAY,  
    start_measure IN NUMBER,  
    end_measure  IN NUMBER,  
    offset       IN NUMBER  
    [, unit      IN VARCHAR2]
```



```
) RETURN MDSYS.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.

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 [Section 1.5.5](#)).

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 [Section 2.6](#) 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](#) function in [Chapter 11](#) 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. (This example uses the definitions from the example in [Section 6.6](#).)

```
-- 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_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.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_SR
-----
SDO_GEOMETRY(3302, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 2, 1), SDO_ORDINATE_ARRAY(
5, 6, 5, 10, 6, 10))
```

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.

SDO_LRS.PERCENTAGE_TO_MEASURE

Format

```
SDO_LRS.PERCENTAGE_TO_MEASURE(  
    geom_segment IN MDSYS.SDO_GEOMETRY,  
    percentage    IN NUMBER  
    ) RETURN NUMBER;
```

or

```
SDO_LRS.PERCENTAGE_TO_MEASURE(  
    geom_segment IN MDSYS.SDO_GEOMETRY,  
    dim_array    IN MDSYS.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.

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 this 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](#) 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 geometric segment representing Route 1. (This example uses the definitions from the example in [Section 6.6](#).) The measure range of this segment is 27, and 50 percent of 17 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
```

SDO_LRS.PROJECT_PT

Format

```
SDO_LRS.PROJECT_PT(  
    geom_segment IN MDSYS.SDO_GEOMETRY,  
    point        IN MDSYS.SDO_GEOMETRY  
    ) RETURN MDSYS.SDO_GEOMETRY;
```

or

```
SDO_LRS.PROJECT_PT(  
    geom_segment IN MDSYS.SDO_GEOMETRY,  
    dim_array    IN MDSYS.SDO_DIM_ARRAY,  
    point        IN MDSYS.SDO_GEOMETRY  
    [, point_dim_array IN MDSYS.SDO_GEOMETRY]  
    ) RETURN MDSYS.SDO_GEOMETRY;
```

Description

Returns the projection point of a point on a 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.

point

Point to be projected.

point_dim_array

Dimensional information array corresponding to *point*, usually selected from one of the xxx_SDO_GEOM_METADATA views.

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.

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 [Section 6.4](#).

For more information about projecting a point onto a geometric segment, see [Section 6.5.9](#).

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 [Section 6.6](#).)

```
-- Point 9,3,NULL is off the road; should return 9,4,9
SELECT  SDO_LRS.PROJECT_PT(route_geometry,
      MDSYS.SDO_GEOMETRY(3301, NULL, NULL,
        MDSYS.SDO_ELEM_INFO_ARRAY(1, 1, 1),
        MDSYS.SDO_ORDINATE_ARRAY(9, 3, NULL)) )
FROM lrs_routes WHERE route_id = 1;
```

```
SDO_LRS.PROJECT_PT(ROUTE_GEOMETRY,MDSYS.SDO_GEOMETRY(3301,NULL,NULL,MDSYS.SDO_EL
-----
SDO_GEOMETRY(3301, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 1, 1), SDO_ORDINATE_ARRAY(
9, 4, 9))
```

SDO_LRS.REDEFINE_GEOM_SEGMENT

Format

```
SDO_LRS.REDEFINE_GEOM_SEGMENT(  
    geom_segment IN OUT MDSYS.SDO_GEOMETRY  
    [, start_measure IN NUMBER,  
    end_measure IN NUMBER]);
```

or

```
SDO_LRS.REDEFINE_GEOM_SEGMENT(  
    geom_segment IN OUT MDSYS.SDO_GEOMETRY,  
    dim_array IN MDSYS.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.

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 [Section 6.4](#).

For more information about redefining a geometric segment, see [Section 6.5.2](#).

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 [Section 6.6](#).)

```
-- 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 geom segment to "convert" miles to kilometers.
DECLARE
geom_segment MDSYS.SDO_GEOMETRY;
dim_array MDSYS.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))
```

SDO_LRS.RESET_MEASURE

Format

```
SDO_LRS.RESET_MEASURE(
    geom_segment IN OUT MDSYS.SDO_GEOMETRY
    [, dim_array IN MDSYS.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.

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 [Section 6.6](#).)

```
-- 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 geom segment measures.
```

```
DECLARE
geom_segment MDSYS.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))
```

SDO_LRS.REVERSE_GEOMETRY

Format

```
SDO_LRS.REVERSE_GEOMETRY(  
    geom          IN MDSYS.SDO_GEOMETRY  
    [, dim_array  IN MDSYS.SDO_DIM_ARRAY]  
    ) RETURN MDSYS.SDO_GEOMETRY;
```

Description

Returns a new geometric segment by reversing the measure values and 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.

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.
- Reverses the direction of *geom_segment*

Compare this function with [SDO_LRS.REVERSE_MEASURE](#), which reverses only the measure values (not the direction) of a geometric segment.

An exception is raised if *geom_segment* 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 [Section 6.4](#).

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 [Section 6.6](#).)

```
-- 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).

SDO_LRS.REVERSE_MEASURE

Format

```
SDO_LRS.REVERSE_MEASURE(  
    geom_segment IN MDSYS.SDO_GEOMETRY  
    [, dim_array  IN MDSYS.SDO_DIM_ARRAY]  
    ) RETURN MDSYS.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.

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](#), 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 [Section 6.4](#).

Note: The behavior of the SDO_LRS.REVERSE_MEASURE function changed between Release 8.1.7 and the current release. 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 the current release, you must use the [SDO_LRS.REVERSE_GEOMETRY](#) 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 [Section 6.6](#).)

```
-- 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_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).

SDO_LRS.SCALE_GEOM_SEGMENT

Format

```
SDO_LRS.SCALE_GEOM_SEGMENT(  
    geom_segment IN MDSYS.SDO_GEOMETRY,  
    start_measure IN NUMBER,  
    end_measure  IN NUMBER,  
    shift_measure IN NUMBER  
) RETURN MDSYS.SDO_GEOMETRY;
```

or

```
SDO_LRS.SCALE_GEOM_SEGMENT(  
    geom_segment IN MDSYS.SDO_GEOMETRY,  
    dim_array    IN MDSYS.SDO_DIM_ARRAY,  
    start_measure IN NUMBER,  
    end_measure  IN NUMBER,  
    shift_measure IN NUMBER  
) RETURN MDSYS.SDO_GEOMETRY;
```

Description

Returns the geometry object resulting from the scaling of a geometric segment.

Parameters

geom_segment

Geometric segment to be scaled.

dim_array

Dimensional information array corresponding to *geom_segment*, usually selected from one of the xxx_SDO_GEOM_METADATA views.

start_measure

Start measure of the scaled geometric segment.

end_measure

End measure of the scaled geometric segment.

shift_measure

Shift measure of the scaled geometric segment.

Usage Notes

This function performs a general scaling operation to the geometric segment. The new start and end measures are assigned, and all measures are populated by a linear mapping between old and new start and end measures. The shift measure is applied to the segment after scaling.

Note: This general-purpose function has been deprecated and will not be supported in a future release of Spatial. You should instead use other functions for specific purposes, as described in [Table 14-4](#).

[Table 14-4](#) lists some common tasks and the suggested functions to use instead of `SCALE_GEOM_SEGMENT`.

Table 14-4 Functions to Use Instead of `SCALE_GEOM_SEGMENT`

Task	Suggested Function
Shift all measures by a specified amount (for example, to accommodate new construction at the start of a road that causes the original start point to be <i>n</i> measure units beyond the new start point).	SDO_LRS.TRANSLATE_MEASURE
Reverse the direction of a segment (for example, to allow one road segment to be concatenated with another coming from the opposite direction, because both segments to be concatenated must have the same direction).	SDO_LRS.REVERSE_GEOMETRY
Scale the measure information without performing a shift (for example, to change the measures from miles to kilometers).	SDO_LRS.REDEFINE_GEOM_SEGMENT

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.

For more information about scaling a geometric segment, see [Section 6.5.6](#).

Examples

The following examples illustrate some `SCALE_GEOM_ELEMENT` uses. (These examples use the definitions from the example in [Section 6.6](#).)

```
-- Shift by 5 (for example, 5-mile segment added before original start)
SELECT SDO_LRS.SCALE_GEOM_SEGMENT(a.route_geometry, m.diminfo, 0, 27, 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.SCALE_GEOM_SEGMENT(A.ROUTE_GEOMETRY,M.DIMINFO,0,27,5)(SDO_GTYPE, SDO_SRI
-----
SDO_GEOMETRY(3002, NULL, NULL, SDO_ELEM_INFO_ARRAY(1, 2, 1), SDO_ORDINATE_ARRAY(
2, 2, 5, 2, 4, 7, 8, 4, 13, 12, 4, 17, 12, 10, 23, 8, 10, 27, 5, 14, 32))
```

```
-- "Convert" mile measures to kilometers (27 * 1.609 = 43.443)
SELECT SDO_LRS.SCALE_GEOM_SEGMENT(route_geometry, 0, 43.443, 0)
      FROM lrs_routes WHERE route_id = 1;
```

```
SDO_LRS.SCALE_GEOM_SEGMENT(ROUTE_GEOMETRY,0,43.443,0)(SDO_GTYPE, SDO_SRID, SDO_P
-----
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))
```

SDO_LRS.SET_PT_MEASURE

Format

```
SDO_LRS.SET_PT_MEASURE(  
    geom_segment IN OUT MDSYS.SDO_GEOMETRY,  
    point        IN MDSYS.SDO_GEOMETRY,  
    measure      IN NUMBER) RETURN VARCHAR2;
```

or

```
SDO_LRS.SET_PT_MEASURE(  
    geom_segment IN OUT MDSYS.SDO_GEOMETRY,  
    dim_array    IN MDSYS.SDO_DIM_ARRAY,  
    point        IN MDSYS.SDO_GEOMETRY,  
    pt_dim_array IN MDSYS.SDO_DIM_ARRAY,  
    measure      IN NUMBER) RETURN VARCHAR2;
```

or

```
SDO_LRS.SET_PT_MEASURE(  
    point    IN OUT MDSYS.SDO_GEOMETRY,  
    measure  IN NUMBER) RETURN VARCHAR2;
```

or

```
SDO_LRS.SET_PT_MEASURE(  
    point    IN OUT MDSYS.SDO_GEOMETRY,  
    dim_array IN MDSYS.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.

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.

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 [Section 6.4](#).

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 [Section 6.6](#).)

```
-- Set the measure value of point 8,10 to 20 (originally 22).
```

```
DECLARE
geom_segment MDSYS.SDO_GEOMETRY;
dim_array MDSYS.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,
MDSYS.SDO_GEOMETRY(3301, NULL, NULL,
MDSYS.SDO_ELEM_INFO_ARRAY(1, 1, 1),
MDSYS.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.
```

SDO_LRS.SPLIT_GEOM_SEGMENT

Format

```
SDO_LRS.SPLIT_GEOM_SEGMENT(  
    geom_segment IN MDSYS.SDO_GEOMETRY,  
    split_measure IN NUMBER,  
    segment_1    OUT MDSYS.SDO_GEOMETRY,  
    segment_2    OUT MDSYS.SDO_GEOMETRY);
```

or

```
SDO_LRS.SPLIT_GEOM_SEGMENT(  
    geom_segment IN MDSYS.SDO_GEOMETRY,  
    dim_array    IN MDSYS.SDO_DIM_ARRAY,  
    split_measure IN NUMBER,  
    segment_1    OUT MDSYS.SDO_GEOMETRY,  
    segment_2    OUT MDSYS.SDO_GEOMETRY);
```

Description

Splits a geometric segment into two geometric segments. (This is a procedure, not a function.)

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.

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 [Section 6.4](#).

For more information about splitting a geometric segment, see [Section 6.5.4](#).

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 [Section 6.6](#). The definitions of *result_geom_1*, *result_geom_2*, and *result_geom_3* are displayed in [Example 6-3](#).)

```
DECLARE
geom_segment MDSYS.SDO_GEOMETRY;
line_string MDSYS.SDO_GEOMETRY;
dim_array MDSYS.SDO_DIM_ARRAY;
result_geom_1 MDSYS.SDO_GEOMETRY;
result_geom_2 MDSYS.SDO_GEOMETRY;
result_geom_3 MDSYS.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;
/
```

SDO_LRS.TRANSLATE_MEASURE

Format

```
SDO_LRS.TRANSLATE_MEASURE(  
    geom_segment IN MDSYS.SDO_GEOMETRY,  
    translate_m   IN NUMBER  
    ) RETURN MDSYS.SDO_GEOMETRY;
```

or

```
SDO_LRS.TRANSLATE_MEASURE(  
    geom_segment IN MDSYS.SDO_GEOMETRY,  
    dim_array    IN MDSYS.SDO_DIM_ARRAY,  
    translate_m   IN NUMBER  
    ) RETURN MDSYS.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.

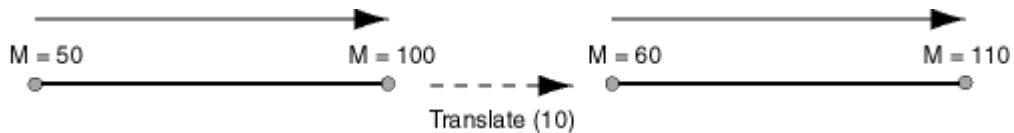
translate_m

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 [Figure 14-1](#).

Figure 14-1 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 [Section 6.4](#).

Examples

The following example translates (shifts) by 10 the geometric segment representing Route 1. (This example uses the definitions from the example in [Section 6.6](#).)

```
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(3002, 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))
```

SDO_LRS.VALID_GEOM_SEGMENT

Format

```
SDO_LRS.VALID_GEOM_SEGMENT(  
    geom_segment IN MDSYS.SDO_GEOMETRY  
    [, dim_array  IN MDSYS.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.

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 metadata.

This function only checks for geometry type and number of dimensions of the geometric segment. To further validate measure information, use the IS_GEOM_SEGMENT_DEFINED function.

The *_3D* format of this function (SDO_LRS.VALID_GEOM_SEGMENT_3D) is available. For information about *_3D* formats of LRS functions, see [Section 6.4](#).

Examples

The following example checks if the geometric segment representing Route 1 is valid. (This example uses the definitions from the example in [Section 6.6](#).)

```
SELECT SDO_LRS.VALID_GEOM_SEGMENT(route_geometry)
       FROM lrs_routes WHERE route_id = 1;
```

```
SDO_LRS.VALID_GEOM_SEGMENT(ROUTE_GEOMETRY)
```

```
-----  
TRUE
```

SDO_LRS.VALID_LRS_PT

Format

```
SDO_LRS.VALID_LRS_PT(  
    point          IN MDSYS.SDO_GEOMETRY  
    [, dim_array  IN MDSYS.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.

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 [Section 6.4](#).

Examples

The following example checks if point (9,3,NULL) is a valid LRS point. (This example uses the definitions from the example in [Section 6.6](#).)

```
SELECT SDO_LRS.VALID_LRS_PT(  
    (9,3,NULL),  
    MDSYS.SDO_DIM_ARRAY(  
        MDSYS.SDO_DIM_ELEMENT('LINESTRING', 0, 1, 0, 0, 0),  
        MDSYS.SDO_DIM_ELEMENT('LINESTRING', 0, 1, 0, 0, 0),  
        MDSYS.SDO_DIM_ELEMENT('LINESTRING', 0, 1, 0, 0, 0)    )
```

```
MDSYS.SDO_GEOMETRY(3001, NULL, NULL,  
  MDSYS.SDO_ELEM_INFO_ARRAY(1, 1, 1),  
  MDSYS.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(MDSYS.SDO_GEOMETRY(3001, NULL, NULL, MDSYS.SDO_ELEM_INFO_ARRAY
```

```
-----  
TRUE
```

SDO_LRS.VALID_MEASURE

Format

```
SDO_LRS.VALID_MEASURE(  
    geom_segment IN MDSYS.SDO_GEOMETRY,  
    measure      IN NUMBER  
    ) RETURN VARCHAR2;
```

or

```
SDO_LRS.VALID_MEASURE(  
    geom_segment IN MDSYS.SDO_GEOMETRY,  
    dim_array    IN MDSYS.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 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.

measure

Geometric segment to be checked to see if *geom_segment* falls within its measure range.

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 [Section 6.4](#).

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 and there is a mile marker at one-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 [Section 6.6](#).)

```
SELECT SDO_LRS.VALID_MEASURE(route_geometry, 50)
       FROM lrs_routes WHERE route_id = 1;
```

```
SDO_LRS.VALID_MEASURE(ROUTE_GEOMETRY,50)
```

```
-----  
FALSE
```

SDO_LRS.VALIDATE_LRS_GEOMETRY

Format

```
SDO_LRS.VALIDATE_LRS_GEOMETRY(  
    geom_segment IN MDSYS.SDO_GEOMETRY  
    [, dim_array  IN MDSYS.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.

Usage Notes

This function returns TRUE if *geom_segment* is valid and one of the following error codes if *geom_segment* is not valid:

- 13331 (invalid LRS geometry type)
- 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 [Section 6.4](#).

Examples

The following example checks if the Route 1 segment is a valid LRS geometry. (This example uses the definitions from the example in [Section 6.6](#).)

```
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
```

Migration Procedures

The procedures described in this chapter let you upgrade geometry tables from previous releases of Spatial Cartridge or Spatial Data Option.

This chapter contains descriptions of the migration procedures shown in [Table 15-1](#).

Table 15-1 Migration Procedures

Procedure	Description
SDO_MIGRATE.FROM_815_TO_81X	Migrates data from Spatial release 8.1.5 to the current release.
SDO_MIGRATE.OGIS_METADATA_FROM	Generates a temporary table used when migrating OGIS (OpenGIS) metadata tables.
SDO_MIGRATE.OGIS_METADATA_TO	Reads a temporary table used when migrating OGIS metadata tables.
SDO_MIGRATE.TO_734	Migrates data from a previous release of Spatial Data Option to release 7.3.4.
SDO_MIGRATE.TO_81X	Migrates tables from Spatial Data Option release 7.3.4 or Spatial Cartridge release 8.0.4 to Oracle Spatial.
SDO_MIGRATE.TO_CURRENT	Migrates data from a previous Spatial release to the current release.

SDO_MIGRATE.FROM_815_TO_81X

Format

```
SDO_MIGRATE.FROM_815_TO_81X(  
    tabname      IN VARCHAR2  
    [, commit_int IN NUMBER]);
```

Description

Migrates data from Spatial release 8.1.5 to the current release.

Note: You should use the [SDO_MIGRATE.TO_CURRENT](#) procedure instead of this procedure.

Parameters

tabname

Table with geometry objects.

commit_int

Number of geometries to migrate before Spatial performs an internal commit operation. If *commit_int* is not specified, no internal commit operations are performed during the migration.

If you specify a *commit_int* value, you can use a smaller rollback segment than would otherwise be needed.

Usage Notes

See [Section A.3](#) for important information about migrating from Spatial release 8.1.5.

All geometry objects in *tabname* will be migrated 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 (*d00n*) shown in [Table 2-1](#) in [Section 2.2.1](#).
- SDO_ETYPE values are as discussed in [Section 2.2.4](#).

The procedure also orders geometries so that exterior rings are followed by their interior rings, and saves them 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 release 8.1.5 format to the format of the current release.

```
SQL> execute sdo_migrate.from_815_to_81x('ROADS');
```

SDO_MIGRATE.OGIS_METADATA_FROM

Format

SDO_MIGRATE.OGIS_METADATA_FROM

Description

Called at the source database when migrating from one 8.1.5 database to another 8.1.5 database. The procedure migrates OGIS (OpenGIS) metadata entries from schemas owned by MDSYS.

Parameters

None.

Usage Notes

Consider the following when using this procedure:

- The tables involved are strictly maintained by the user, and not by Spatial. Details are available in the `sdocat.sql` file and the OpenGIS specification.
- Call this procedure once before migrating the data, and it will generate a temporary table called `SDO_GC_MIG`. Export the temporary table to the new database and call [SDO_MIGRATE.OGIS_METADATA_TO](#) to restore the data.

SDO_MIGRATE.OGIS_METADATA_TO

Format

SDO_MIGRATE.OGIS_METADATA_TO

Description

Used at the destination database when migrating from one 8.1.5 database to another 8.1.5 database. The procedure migrates OGIS (OpenGIS) metadata entries from schemas owned by MDSYS.

Parameters

None.

Usage Notes

Consider the following when using this procedure:

- The tables involved are strictly maintained by the user, and not by Spatial. Details are available in the `sdocat.sql` file and the OpenGIS specification.
- Call this procedure once after migrating the data. See [SDO_MIGRATE.OGIS_METADATA_FROM](#).

SDO_MIGRATE.TO_734

Format

```
SDO_MIGRATE.TO_734(  
    sn      IN VARCHAR2,  
    layer   IN VARCHAR2,  
    tess_type IN VARCHAR2,  
    param   IN INTEGER);
```

Description

Migrates data from a previous release of Spatial Data Option to release 7.3.4.

Parameters

sn

Schema name of the owner of *layer*.

layer

Name of the layer to be migrated.

tess_type

Type of tessellation (indexing) to be used: FIXED or VARIABLE.

param

Parameter whose significance depends on *tess_type*:

- If *tess_type* is FIXED, *param* is the SDO_LEVEL value.
- If *tess_type* is VARIABLE, *param* is the SDO_NUMTILES value.

Usage Notes

None.

Examples

For fixed-size tessellation:

```
SQL> execute sdo_migrate.to_734('HERMAN', 'ROADS', 'FIXED', 10);
```

For variable-sized tessellation:

```
SQL> execute sdo_migrate_to_734('HERMAN', 'ROADS', 'VARIABLE',4);
```

SDO_MIGRATE.TO_81X

Format

```
SDO_MIGRATE.TO_81X(  
    layer      IN VARCHAR2,  
    newtabname IN VARCHAR2,  
    gidcolumn  IN VARCHAR2,  
    geocolname IN VARCHAR2,  
    layer_gtype IN VARCHAR2,  
    updateflag IN VARCHAR2);
```

Description

Migrates data from a previous release of Spatial Cartridge or Spatial Data Option to the current release of Oracle Spatial.

Note: You should use the [SDO_MIGRATE.TO_CURRENT](#) procedure instead of this procedure.

Parameters

layer

Name of the layer to be migrated.

newtabname

Name of the new table to which you are migrating 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 migrating 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 migration might produce invalid data.

updateflag

One of the following values: UPDATE or INSERT (default).

If you are migrating the layer into an existing populated attribute table, set this parameter to UPDATE; otherwise, set this parameter to INSERT.

Usage Notes

Consider the following when using this procedure:

- The new table must be created before calling this procedure.
- 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 migration steps fails, nothing is migrated 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 (*d00n*) shown in [Table 2-1](#) in [Section 2.2.1](#).
- SDO_ETYPE values are created, using the values discussed in [Section 2.2.4](#).
- The procedure orders geometries so that exterior rings are followed by their interior rings, and saves them in the correct rotation (counter clockwise for exterior rings, and clockwise for interior rings).

Examples

Insert point-only data into new rows:

```
execute sdo_migrate.to_81x('raptor', 'raptor', 'sdo_gid', 'feature', 'point');
```

Insert nonpoint data into new rows:

```
execute sdo_migrate.to_81x('BTU', 'BTU', 'sdo_gid', 'feature');
```

Update point-only data in existing rows:

```
execute sdo_migrate.to_81x('raptor', 'raptor', 'sdo_gid', 'feature',  
    'point', 'update');
```

Update nonpoint data in existing rows:

```
execute sdo_migrate.to_81x('BTU', 'BTU', 'sdo_gid', 'feature',  
    'notpoint', 'update');
```

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 (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

Migrates data from a previous Spatial release to the current release. The format depends on whether you are migrating from the Spatial relational model (release 8.1.5 or lower) or object-relational model (release 8.1.6 or higher). See the Usage Notes for the model that applies to you.

You are encouraged to use this procedure instead of the [SDO_MIGRATE.FROM_815_TO_81X](#) or [SDO_MIGRATE.TO_81X](#) procedure.

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 migrated.

commit_int

Number of geometries to migrate before Spatial performs an internal commit operation. If *commit_int* is not specified, no internal commit operations are performed during the migration.

If you specify a *commit_int* value, you can use a smaller rollback segment than would otherwise be needed.

layer

Name of the layer to be migrated.

newtablename

Name of the new table to which you are migrating 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 migrating 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 migration might produce invalid data.

updateflag

One of the following values: UPDATE or INSERT (default).

If you are migrating 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 Migration

See [Section A.3](#) for important information about upgrading from Spatial release 8.1.5.

All geometry objects in *tablename* will be migrated 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 (*d00n*) shown in [Table 2-1](#) in [Section 2.2.1](#).
- SDO_ETYPE values are as discussed in [Section 2.2.4](#).

The procedure also orders geometries so that exterior rings are followed by their interior rings, and saves them in the correct rotation (counter clockwise for exterior rings, and clockwise for interior rings).

Usage Notes for Relational Model Migration

Consider the following when using this procedure:

- The new table must be created before calling this procedure.
- 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 migration steps fails, nothing is migrated 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 (*d00n*) shown in [Table 2-1](#) in [Section 2.2.1](#).
- SDO_ETYPE values are created, using the values discussed in [Section 2.2.4](#).
- The procedure orders geometries so that exterior rings are followed by their interior rings, and saves them in the correct rotation (counter clockwise for exterior rings, and clockwise for interior rings).

Examples

The following example changes the definitions of geometry objects in the ROADS table from the release 8.1.5 or higher format to the format of the current release.

```
SQL> execute sdo_migrate.to_current('ROADS');
```

Tuning Functions and Procedures

This chapter contains descriptions of the tuning functions and procedures shown in [Table 16-1](#).

Table 16-1 *Tuning Functions and Procedures*

Function/Procedure	Description
SDO_TUNE.ANALYZE_RTREE	Analyzes an R-tree index; generates statistics about the index use, and recommends a rebuild of the index if a rebuild would improve query performance significantly.
SDO_TUNE.AVERAGE_MBR	Calculates the average minimum bounding rectangle for geometries in a layer.
SDO_TUNE.ESTIMATE_INDEX_PERFORMANCE	Estimates the spatial index selectivity.
SDO_TUNE.ESTIMATE_TILING_LEVEL	Determines an appropriate tiling level for creating fixed-size index tiles.
SDO_TUNE.ESTIMATE_TILING_TIME	Estimates the tiling time for a layer, in seconds.
SDO_TUNE.ESTIMATE_TOTAL_NUMTILES	Estimates the total number of spatial tiles for a layer.
SDO_TUNE.EXTENT_OF	Determines the minimum bounding rectangle of the data in a layer.
SDO_TUNE.HISTOGRAM_ANALYSIS	Calculates statistical histograms for a spatial layer.
SDO_TUNE.MIX_INFO	Calculates geometry type information for a spatial layer, such as the percentage of each geometry type.

Table 16–1 Tuning Functions and Procedures

Function/Procedure	Description
SDO_TUNE.QUALITY_DEGRADATION	Returns the quality degradation for an R-tree index or the average quality degradation for all index tables for an R-tree index.
SDO_TUNE.RTREE_QUALITY	Returns the quality score for an R-tree index or the average quality score for all index tables for an R-tree index.

SDO_TUNE.ANALYZE_RTREE

Format

```
SDO_TUNE.ANALYZE_RTREE(  
    schemaname IN VARCHAR2,  
    indexname   IN VARCHAR2);
```

Description

Analyzes an R-tree index; generates statistics about the index, and recommends a rebuild of the index if a rebuild would improve query performance significantly.

Parameters

schemaname

Name of the schema that contains the index specified in *indexname*.

indexname

Name of the Spatial R-tree index to be analyzed.

Usage Notes

The procedure computes an index quality score and compares it to the quality score when the index was created or most recently rebuilt (stored as `SDO_RTREE_QUALITY` in the `xxx_INDEX_METADATA` views, described in [Section 2.5.1](#)). If the comparison of the index quality scores shows that quality has degraded by 50% or more, the procedure recommends that the index be rebuilt.

For R-tree indexes with secondary indexes (created using the [ALTER INDEX](#) statement with the *add_index* keyword), the statistics for each index table are printed.

This procedure should be used only in a PL/SQL procedure or from the SQL*Plus command line; it should not be used in an OCI program or with any other programming interface.

Because this procedure only prints the output to standard output, the [SDO_TUNE_RTREE_QUALITY](#) and [SDO_TUNE_QUALITY_DEGRADATION](#) functions are also provided, to return the quality score and quality degradation, respectively, for an R-tree index.

For more information about R-tree quality and its effect on query performance, see [Section 1.7.1.1](#).

Examples

The following example analyzes the quality of the COLA_SPATIAL_IDX index.

```
EXECUTE SDO_TUNE.ANALYZE_RTREE('SCOTT', 'COLA_SPATIAL_IDX');
```

The display to standard output might be as follows:

```
--- Quality Statistics for Index table: MDRT_11A5$ ---  
Current Perf. Index : 1.000000  
Previous Perf. Index: 1.000000  
Index Quality: Good, No Rebuild Necessary
```

Related Topics

[SDO_TUNE.QUALITY_DEGRADATION](#)

[SDO_TUNE.RTREE_QUALITY](#)

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 a geometry object column.

Parameters

table_name

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 geometry table. It calculates the average MBR by keeping track of the maximum and minimum X and Y values for all geometries in a geometry table.

AVERAGE_MBR is a procedure, not a function. (Procedures do not return values.)

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_TUNE.EXTENT_OF](#)

SDO_TUNE.ESTIMATE_INDEX_PERFORMANCE

Format

```
SDO_TUNE.ESTIMATE_INDEX_PERFORMANCE(  
    table_name    IN VARCHAR2,  
    column_name   IN VARCHAR2,  
    sample_ratio  IN INTEGER,  
    tiling_level  IN INTEGER,  
    num_tiles     IN INTEGER,  
    window_obj    IN MDSYS.SDO_GEOMETRY,  
    tiling_time   OUT NUMBER,  
    filter_time   OUT NUMBER,  
    query_time    OUT NUMBER  
) RETURN NUMBER;
```

Description

Estimates the spatial index performance such as query selectivity and window query time for a column of type SDO_GEOMETRY.

Parameters

table_name

Geometry table.

column_name

Geometry column for which the tiling time is to be estimated.

sample_ratio

Approximate ratio between the geometries in the original layer and those in the sample layer (to be generated in order to perform the estimate). The default is 20: that is, the sample layer will contain approximately 1/20 (5 percent) of the geometries in the original layer. The larger the *sample_ratio* value, the faster the function will run, but the less accurate will be the result (the estimate).

Note that Spatial obtains the sample by using the `SAMPLE(sample_percent)` feature internally. For a description of this feature, see the *sample_clause* description in the `SELECT` statement section of the *Oracle9i SQL Reference*.

tiling_level

Spatial index level at which the layer is to be tessellated.

num_tiles

Number of tiles for variable or hybrid tessellation. Should be 0 for fixed tessellation. The default is 0.

window_obj

Window geometry object.

tiling_time

Estimated tiling time in seconds.

filter_time

Estimated spatial index filter time in seconds.

query_time

Estimated window query time in seconds.

Usage Notes

The function returns a number between 0.0 and 1.0 representing estimated spatial index selectivity. The larger the number, the better the selectivity.

The *sample_ratio* parameter lets you control the trade-off between speed and accuracy. Note that *sample_ratio* is not exact, but reflects an average. For example, a *sample_ratio* value of 20 sometimes causes fewer than 5 percent of geometry objects to be sampled and sometimes more than 5 percent, but over time an average of 5 percent will be sampled.

A return value of 0.0 indicates an error.

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';
  sample_ratio INTEGER := 15;
```

```
tiling_level INTEGER := 4;
num_tiles INTEGER := 10;
window_obj MDSYS.SDO_GEOMETRY :=
MDSYS.SDO_GEOMETRY(
  2003, -- 2-dimensional polygon
  NULL,
  NULL,
  MDSYS.SDO_ELEM_INFO_ARRAY(1,1003,1), -- one polygon
  MDSYS.SDO_ORDINATE_ARRAY(3,3, 6,3, 6,5, 4,5, 3,3)
);
tiling_time NUMBER;
filter_time NUMBER;
query_time NUMBER;
ret_number NUMBER;
BEGIN
ret_number := SDO_TUNE.ESTIMATE_INDEX_PERFORMANCE(
  table_name,
  column_name,
  sample_ratio,
  tiling_level,
  num_tiles,
  window_obj,
  tiling_time,
  filter_time,
  query_time
);
END;
/
```

SDO_TUNE.ESTIMATE_TILING_LEVEL

Format

```
SDO_TUNE.ESTIMATE_TILING_LEVEL(  
    table_name      IN VARCHAR2,  
    column_name     IN VARCHAR2,  
    num_tiles       IN INTEGER  
    [, type_of_estimate IN VARCHAR2]  
    ) RETURN INTEGER;
```

Description

Estimates the appropriate SDO_LEVEL value to use when indexing with hybrid or fixed-size tiles.

Parameters

table_name

Geometry table.

column_name

Geometry column for which the tiling level is to be estimated.

num_tiles

Maximum number of tiles that can be used to index the rectangle defined by *type_of_estimate*.

type_of_estimate

Keyword to specify the type of estimate:

- LAYER_EXTENT -- Uses the rectangle defined by your coordinate system.
- ALL_GID_EXTENT -- Uses the minimum bounding rectangle that encompasses all the geometric objects in the column. This estimate is recommended for most applications.
- AVG_GID_EXTENT (default) -- Uses a rectangle representing the average size of the individual geometric objects within the column. This option is the default

and performs the most analysis of the three types, but it takes the longest time to complete.

Usage Notes

The function returns an integer representing the level to use when creating a spatial index for the specified layer. The function returns NULL if the data is inconsistent.

If *type_of_estimate* is ALL_GID_EXTENT, a *maxtiles* value of 10000 is recommended for most applications.

Examples

The following example estimates the appropriate SDO_LEVEL value to use with the SHAPE column of the COLA_MARKETS table.

```
SELECT SDO_TUNE.ESTIMATE_TILING_LEVEL('COLA_MARKETS', 'SHAPE',  
                                     10000, 'ALL_GID_EXTENT')  
FROM DUAL;
```

```
SDO_TUNE.ESTIMATE_TILING_LEVEL('COLA_MARKETS', 'SHAPE', 10000, 'ALL_GID_EXTENT')
```

7

Related Topics

- [SDO_TUNE.EXTENT_OF](#)

SDO_TUNE.ESTIMATE_TILING_TIME

Format

```
SDO_TUNE.ESTIMATE_TILING_TIME(  
    table_name    IN VARCHAR2,  
    column_name   IN VARCHAR2,  
    sample_ratio  IN INTEGER,  
    tiling_level  IN INTEGER,  
    num_tiles     IN INTEGER  
    ) RETURN NUMBER;
```

Description

Returns the estimated time (in seconds) to tessellate a column of type SDO_GEOMETRY.

Parameters

table_name

Geometry table.

column_name

Geometry column for which the tiling time is to be estimated.

sample_ratio

Approximate ratio between the geometries in the original layer and those in the sample layer (to be generated to perform the estimate). The default is 20: that is, the sample layer will contain approximately 1/20 (5 percent) of the geometries in the original layer. As you increase the *sample_ratio* value, the execution time for the function decreases, but the accuracy of the result (the estimate) decreases also.

Note that Spatial obtains the sample by using the SAMPLE(sample_percent) feature internally. For a description of this feature, see the *sample_clause* description in the SELECT statement section of the *Oracle9i SQL Reference*.

tiling_level

Spatial index level at which the layer is to be tessellated.

num_tiles

Number of tiles for variable or hybrid tessellation. Should be 0 for fixed tessellation. The default is 0.

Usage Notes

A return value of 0 indicates an error.

The tiling time estimate is based on the tiling time of a small sample geometry table that is automatically generated from the original table column. (This generated table is deleted before the function completes.)

The *sample_ratio* parameter lets you control the trade-off between speed and accuracy. Note that *sample_ratio* is not exact, but reflects an average. For example, a *sample_ratio* value of 20 sometimes causes fewer than 5 percent of geometry objects to be sampled and sometimes more than 5 percent, but over time an average of 5 percent will be sampled.

The CREATE TABLE privilege is required for using this function.

Examples

The following example estimates the tiling time to tessellate the REGIONS column of the XYZ_MARKETS table.

```

DECLARE
  table_name  VARCHAR2(32) := 'XYZ_MARKETS';
  column_name VARCHAR2(32) := 'REGIONS';
  sample_ratio INTEGER := 15;
  tiling_level INTEGER := 6;
  num_tiles   INTEGER := 10;
  ret_number  NUMBER;
BEGIN
ret_number := SDO_TUNE.ESTIMATE_TILING_TIME(
  table_name,
  column_name,
  sample_ratio,
  tiling_level,
  num_tiles
);
END;
/

```

SDO_TUNE.ESTIMATE_TOTAL_NUMTILES

Format

```
SDO_TUNE.ESTIMATE_TOTAL_NUMTILES(  
    table_name    IN VARCHAR2,  
    column_name   IN VARCHAR2,  
    sample_ratio  IN INTEGER,  
    tiling_level  IN INTEGER,  
    num_tiles     IN INTEGER,  
    num_targetiles OUT INTEGER  
) RETURN INTEGER;
```

Description

Estimates the total number of spatial tiles for a layer.

Parameters

table_name

Geometry table.

column_name

Geometry column for which the total number of spatial tiles is to be estimated.

sample_ratio

Approximate ratio between the geometries in the original layer and those in the sample layer (to be generated to perform the estimate). The default is 20: that is, the sample layer will contain approximately 1/20 (5 percent) of the geometries in the original layer. The larger the *sample_ratio* value, the faster the function will run, but the less accurate will be the result (the estimate).

Note that Spatial obtains the sample by using the SAMPLE(sample_percent) feature internally. For a description of this feature, see the *sample_clause* description in the SELECT statement section of the *Oracle9i SQL Reference*.

tiling_level

Spatial index level at which the layer is to be tessellated.

num_tiles

Number of tiles for variable or hybrid tessellation. Should be 0 for fixed tessellation. The default is 0.

num_largetiles

Output parameter to contain the number of spatial tiles that are of the same size as group tiles for hybrid indexing. (For fixed indexing, *num_largetiles* will be the same as the returned value: the total number of spatial tiles.)

Usage Notes

The estimate is based on the total number of tiles for a small sample layer that is automatically generated from the original layer. (This generated table is deleted before the function completes.)

The *sample_ratio* parameter lets you control the trade-off between speed and accuracy. Note that *sample_ratio* is not exact, but reflects an average. For example, a *sample_ratio* value of 20 sometimes causes fewer than 5 percent of geometry objects to be sampled and sometimes more than 5 percent, but over time an average of 5 percent will be sampled.

The CREATE TABLE privilege is required for using this function.

Examples

The following example estimates the total number of spatial tiles required to index the REGIONS column of the XYZ_MARKETS table.

```
DECLARE
  table_name VARCHAR2(32) := 'XYZ_MARKETS';
  column_name VARCHAR2(32) := 'REGIONS';
  sample_ratio INTEGER := 15;
  tiling_level INTEGER := 4;
  num_tiles INTEGER := 10;
  num_largetiles INTEGER;
  ret_integer INTEGER;
BEGIN
ret_integer := SDO_TUNE.ESTIMATE_TOTAL_NUMTILES(
  table_name,
  column_name,
  sample_ratio,
  tiling_level,
  num_tiles,
  num_largetiles
);
```

```
END;  
/
```

SDO_TUNE.EXTENT_OF

Format

```
SDO_TUNE.EXTENT_OF(  
    table_name IN VARCHAR2,  
    column_name IN VARCHAR2  
) RETURN MDSYS.SDO_GEOMETRY;
```

Description

Returns the minimum bounding rectangle of all geometries in a column of type SDO_GEOMETRY.

Parameters

table_name
Geometry table.

column_name
Geometry column for which the minimum bounding rectangle is to be returned.

Usage Notes

The function returns NULL if the data is inconsistent.

Note: This function is deprecated, and will not be supported in future versions of Spatial. You are instead encouraged to use the [SDO_AGGR_MBR](#) function, documented in [Chapter 12](#), to return the MBR of geometries. The SDO_TUNE.EXTENT_OF function is limited to two-dimensional geometries, whereas the [SDO_AGGR_MBR](#) function is not.

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](#) (in Chapter 12)

[SDO_TUNE.ESTIMATE_TILING_LEVEL](#)

[SDO_TUNE.AVERAGE_MBR](#) procedure

SDO_TUNE.HISTOGRAM_ANALYSIS

Format

```
SDO_TUNE.HISTOGRAM_ANALYSIS(  
    table_name      IN VARCHAR2,  
    column_name     IN VARCHAR2,  
    result_table    IN VARCHAR2,  
    type_of_histogram IN VARCHAR2,  
    max_value       IN NUMBER,  
    intervals       IN INTEGER);
```

Description

Generates statistical histograms based on columns of type SDO_GEOMETRY.

Parameters

table_name

Geometry table.

column_name

Geometry object column for which the histogram is to be computed.

result_table

Result table to hold the histogram.

type_of_histogram

Keyword to specify the type of histogram:

- **TILES_VS_LEVEL** (default) -- Provides the number of tiles at different spatial index levels. (Available only with hybrid indexes.) This histogram is the default, and is used to evaluate the spatial index that is already built on the geometry column.
- **GEOMS_VS_TILES** -- Provides the number of geometries in different number-of-tiles ranges. This histogram is used to evaluate the spatial index that is already built on the geometry column.

- **GEOMS_VS_AREA** -- Provides the number of geometries in different size ranges. The shape of this histogram could be helpful in choosing a proper index type and index level
- **GEOMS_VS_VERTICES** -- Provides a histogram of the geometry count against the number of vertices. This histogram could help determine if spatial index selectivity is important for the layer. Because the number of vertices determines the performance of the secondary filter, selectivity of the primary filter could be crucial for layers that contain many complicated geometries.

max_value

The upper limit of the histogram. That is, the histogram runs in range (0, *max_value*).

intervals

Number of intervals between 0 and *max_value*.

Usage Notes

The procedure populates the result table with statistical histograms for a geometry table. (HISTOGRAM_ANALYSIS is a procedure, not a function. Procedures do not return values.)

Before calling this procedure, create the result table (*result_table* parameter) with VALUE and COUNT columns. For example:

```
CREATE TABLE histogram (value NUMBER, count NUMBER);
```

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

Provides information about each geometry type stored in a column of type SDO_GEOMETRY.

Parameters

table_name

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.

```
EXECUTE 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_TUNE.QUALITY_DEGRADATION

Format

```
SDO_TUNE.QUALITY_DEGRADATION(  
    schemaname IN VARCHAR2,  
    indexname   IN VARCHAR2  
    [, indextable IN VARCHAR2]  
    ) RETURN NUMBER;
```

Description

Returns the quality degradation for an R-tree index or the average quality degradation for all index tables for an R-tree index.

Parameters

schemaname

Name of the schema that contains the index specified in *indexname*.

indexname

Name of the Spatial R-tree index.

indextable

Name of the index table associated with the index specified in *indexname*. (This parameter is appropriate only if multiple index tables have been created using the [ALTER INDEX](#) statement with the *add_index* keyword.)

Usage Notes

The **quality degradation** is a number indicating approximately how much longer it will take to execute the I/O operations of the index portion of any given query with the current index (or index table), compared to executing the I/O operations of the index portion of the same query when the index was created or most recently rebuilt. For example, if the I/O operations of the index portion of a typical query will probably take twice as much time as when the index was created or rebuilt, the quality degradation is 2. The exact degradation in overall query time is impossible to predict; however, a substantial quality degradation (2 or 3 or higher) will

probably affect query performance significantly for large databases, such as those with millions of rows.

If *indextable* is not specified, the function returns the average quality degradation for all index tables associated with *indexname* if multiple index tables have been created for the R-tree index. If multiple index tables have not been created (that is, if only one index table exists for the index), the quality degradation for the index is returned.

Index names and index table names are available through the `xxx_SDO_INDEX_INFO` and `xxx_SDO_INDEX_METADATA` views, which are described in [Section 2.5.1](#).

For more information about R-tree quality and its effect on query performance, see [Section 1.7.1.1](#).

Examples

The following example returns the quality degradation for the `COLA_SPATIAL_IDX` index. In this example, the quality has not degraded at all, and therefore the degradation is 1; that is, the I/O operations of the index portion of queries will typically take the same time using the current index as using the original or previous index.

```
SELECT SDO_TUNE.QUALITY_DEGRADATION('SCOTT', 'COLA_SPATIAL_IDX') FROM DUAL;

SDO_TUNE.QUALITY_DEGRADATION('SCOTT', 'COLA_SPATIAL_IDX')
-----
1
```

Related Topics

[SDO_TUNE.ANALYZE_RTREE](#)

[SDO_TUNE.RTREE_QUALITY](#)

SDO_TUNE.RTREE_QUALITY

Format

```
SDO_TUNE.RTREE_QUALITY(  
    schemaname IN VARCHAR2,  
    indexname   IN VARCHAR2  
    [, indextable IN VARCHAR2]  
    ) RETURN NUMBER;
```

Description

Returns the quality score for an R-tree index table or the average quality score for all index tables for an R-tree index.

Parameters

schemaname

Name of the schema that contains the index specified in *indexname*.

indexname

Name of the Spatial R-tree index.

indextable

Name of the index table associated with the index specified in *indexname*. (This parameter is appropriate only if multiple index tables have been created using the [ALTER INDEX](#) statement with the *add_index* keyword.)

Usage Notes

If *indextable* is not specified, the function returns the average quality score for all index tables associated with *indexname* if multiple index tables have been created for the R-tree index. If multiple index tables have not been created (that is, if only one index table exists for the index), the quality score for the index is returned.

Index names and index table names are available through the `xxx_SDO_INDEX_INFO` and `xxx_SDO_INDEX_METADATA` views, which are described in [Section 2.5.1](#).

This function can be useful in determining the quality of an R-tree and whether or not an R-tree index should be rebuilt in order to improve query performance. You can compare the index quality score returned by the function to the quality score at the time the index was created or most recently rebuilt (stored as SDO_RTREE_QUALITY in the xxx_INDEX_METADATA views, described in [Section 2.5.1](#)).

For more information about R-tree quality and its effect on query performance, see [Section 1.7.1.1](#).

Examples

The following example returns the current quality score for the COLA_SPATIAL_IDX index.

```
SELECT SDO_TUNE.RTREE_QUALITY('SCOTT', 'COLA_SPATIAL_IDX') FROM DUAL;  
  
SDO_TUNE.RTREE_QUALITY('SCOTT', 'COLA_SPATIAL_IDX')  
-----  
1
```

Related Topics

[SDO_TUNE.ANALYZE_RTREE](#)

[SDO_TUNE.QUALITY_DEGRADATION](#)

Utility Functions

This chapter contains descriptions of the utility functions and procedures shown in [Table 17-1](#).

Table 17-1 *Utility Functions and Procedures*

Function/Procedure	Description
SDO_UTIL.EXTRACT	Returns the geometry that represents a specified element (and optionally a ring) of the input geometry.
SDO_UTIL.GETVERTICES	Returns the coordinates of the vertices of the input geometry.

SDO_UTIL.EXTRACT

Format

```
SDO_UTIL.EXTRACT(  
    geometry IN MDSYS.SDO_GEOMETRY,  
    element  IN NUMBER  
    [, ring   IN NUMBER]  
    ) RETURN MDSYS.SDO_GEOMETRY;
```

Description

Returns the geometry that represents a specified element (and optionally a ring) of the input geometry.

Parameters

geometry

Geometry from which to extract the geometry to be returned.

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 [Section 2.2.1](#)) ending in 1, 2, or 3 have one element; geometries with SDO_TYPE 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 2-3](#) in [Section 2.3.2](#), 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 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](#) function or the [SDO_GEOM.VALIDATE_LAYER_WITH_CONTEXT](#) procedure (both of which are documented in [Chapter 11](#)), you can use 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 [Section 2.3.6](#).

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 [Section 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 2–3 in Section 2.3.2](#)), 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',
  MDSYS.SDO_GEOMETRY(
    2003, -- 2-dimensional polygon
    NULL,
    NULL,
    MDSYS.SDO_ELEM_INFO_ARRAY(1,1003,1), -- polygon with hole
    MDSYS.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.GETVERTICES](#)

[SDO_GEOM.VALIDATE_GEOMETRY_WITH_CONTEXT](#)

[SDO_GEOM.VALIDATE_LAYER_WITH_CONTEXT](#)

SDO_UTIL.GETVERTICES

Format

```
SDO_UTIL.GETVERTICES(  
    geometry IN MDSYS.SDO_GEOMETRY  
    ) RETURN MDSYS.VERTEX_SET_TYPE;
```

Description

Returns a table containing 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 VERTEX_TYPE. Oracle Spatial defines the type VERTEX_SET_TYPE as:

```
CREATE TYPE vertex_set_type as TABLE OF vertex_type;
```

Oracle Spatial defines the object type VERTEX_TYPE as:

```
CREATE TYPE vertex_type AS OBJECT  
    (x NUMBER,  
    y NUMBER,  
    z NUMBER,  
    w NUMBER);
```

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](#) function or the [SDO_GEOM.VALIDATE_LAYER_WITH_CONTEXT](#) procedure (both of which are documented in [Chapter 11](#)), you can use the GETVERTICES function to view the vertices in tabular format.

Examples

The following example returns the X and Y coordinates of the vertices of the geometries in the SHAPE column of the COLA_MARKETS table. (The example uses the definitions and data from [Section 2.1](#).)

```
SELECT c.name, t.X, t.Y
   FROM cola_markets c,
   TABLE(SDO_UTIL.GETVERTICES(c.shape)) t;
```

NAME	X	Y
cola_a	1	1
cola_a	5	7
cola_b	5	1
cola_b	8	1
cola_b	8	6
cola_b	5	7
cola_b	5	1
cola_c	3	3
cola_c	6	3
cola_c	6	5
cola_c	4	5
cola_c	3	3
cola_d	8	7
cola_d	10	9
cola_d	8	11

15 rows selected.

Related Topics

[SDO_UTIL.EXTRACT](#)

[SDO_GEOM.VALIDATE_GEOMETRY_WITH_CONTEXT](#)

[SDO_GEOM.VALIDATE_LAYER_WITH_CONTEXT](#)

Installation, Compatibility, and Migration

This appendix provides information concerning installation, compatibility, and migration between various Oracle Spatial product releases.

You must upgrade both the database server and Spatial at the same time if you wish to use older spatial applications with an Oracle9*i* release of Spatial. Spatial must always be synchronized with the Oracle9*i* database server on upgrade or downgrade. In both cases, Spatial must be reinstalled.

A.1 Introduction

Many of the Spatial release 9*i* features depend on new features in release 9*i* of the database server. Therefore, there are compatibility and migration issues that need to be addressed in this release of Spatial. This appendix outlines the database and application compatibility issues.

An upgrade or downgrade of the database server version requires a corresponding upgrade or downgrade of Spatial. If an Oracle8*i* (8.1.5, 8.1.6, or 8.1.7) database server is upgraded to an Oracle9*i* database server, Spatial must also be upgraded. Similarly, if an Oracle9*i* database server is downgraded, Spatial must be downgraded too. Lastly, if an Oracle9*i* database server is running in Oracle8*i* compatibility mode, features that are new for Spatial in release 9.0.1 (Oracle9*i*) will not work.

In summary:

- The Spatial release and the Oracle database server release must match.
- Upgrade and downgrade scripts must be run when upgrading or downgrading between Oracle8*i* and Oracle9*i*.

A.2 Installation of Spatial

This section applies to new users of Oracle Spatial. If you are upgrading from a previous release of Spatial, see [Section A.3, "Upgrading from Spatial Release 8.1.5, 8.1.6, or 8.1.7"](#) or [Section A.4, "Upgrading from Spatial Release 9.0.1"](#).

When you install Oracle release 9.2.0, the option to install Spatial is preselected by default. If you accept this default, you do not need to perform the installation steps described in this section, because the MDSYS user is already created and locked automatically.

If you create an Oracle database using the Database Configuration Assistant (DBCA), Spatial is installed by default and you do not need to perform the installation steps described in this section.

If you did not select the option to install Spatial at installation time and you want to install Spatial later, follow these steps.

Note: Installation of Spatial for release 9.2.0 requires that the COMPATIBLE init.ora parameter is set to 9.0.0.0.0 or higher. This is required for the creation and definition of Spatial index types and operators. Thus, if the database was created with a compatibility parameter value of 8.n.n.n.n, the DBA must shut down the database and restart with COMPATIBLE=9.0.n.n.n.

1. Connect to the database instance specifying AS SYSDBA.
2. Create the MDSYS user with a command in the following format:
3. Grant the required privileges to the MDSYS user by running the following procedure:

```
SQL> CREATE USER MDSYS IDENTIFIED BY <password>;
```

```
SQL> @ORACLE_HOME/md/admin/mdprivs.sql
```

4. Connect as MDSYS.
5. Install Spatial by running the following procedure:

```
SQL> @ORACLE_HOME/md/admin/catmd.sql
```

After you install Spatial, it is strongly recommended that you lock the MDSYS user. The MDSYS user is created with administrator privileges; therefore, it is important

to protect this account from unauthorized use. To lock the MDSYS user, connect as SYS and enter the following command:

```
SQL> ALTER USER MDSYS ACCOUNT LOCK;
```

A.3 Upgrading from Spatial Release 8.1.5, 8.1.6, or 8.1.7

If you are upgrading from Spatial release 8.1.5, 8.1.6, or 8.1.7 to Spatial 9i release 2 (9.2.0), and if you have not chosen the automatic upgrade option, perform the following steps to upgrade to Spatial release 9.2.0.

Note: The following steps are not necessary if you chose the Oracle Installer option for an automatic upgrade.

If you have linear referencing system (LRS) data, you must perform the steps in [Section A.5](#) regardless of whether or not you chose an automatic upgrade.

1. Make sure that the Oracle RDBMS is upgraded to release 9.2.0.
2. Connect to the database instance specifying AS SYSDBA.
3. Grant the required privileges to the MDSYS user by running the following procedure:

```
SQL> @$ORACLE_HOME/md/admin/mdprivs.sql
```

4. Connect as MDSYS.
5. Perform the migration by running the following procedure:

```
SQL> @$ORACLE_HOME/md/admin/c81Xu9X.sql
```

A.4 Upgrading from Spatial Release 9.0.1

If you are upgrading from Spatial 9i release 1 (9.0.1) to Spatial 9i release 2 (9.2.0), and if you have not chosen the automatic upgrade option, perform the following steps to upgrade to Spatial release 9.2.0.

Note: The following steps are not necessary if you chose the Oracle Installer option for an automatic upgrade.

If you have linear referencing system (LRS) data in release 8.1.7 or lower format (that is, if the LRS data was not already converted to release 9.0.1 format), you must perform the steps in [Section A.5](#) regardless of whether or not you chose an automatic upgrade.

1. Make sure that the Oracle RDBMS is upgraded to release 9.2.0.
2. Connect to the database instance specifying AS SYSDBA.
3. Grant the required privileges to the MDSYS user by running the following procedure:

```
SQL> @$ORACLE_HOME/md/admin/mdprivs.sql
```

4. Connect as MDSYS.
5. Perform the migration by running the following procedure:

```
SQL> @$ORACLE_HOME/md/admin/c901u920.sql
```

A.5 Upgrading LRS Data

If you have linear referencing data (that is, geometries with measure information) in release 8.1.5, 8.1.6, or 8.1.7 format, you must upgrade that data to the format for Spatial releases 9.0.1 and 9.2.0, as follows:

1. Drop any spatial indexes on the table with the linear referencing data.
2. Find out which dimension of the object has the linear referencing information.

This could be the third or the fourth dimension, depending on the dimensionality of the data. For example, if the data has three dimensions (such as X, Y, and height), the LRS geometry object is 4D, and the LRS dimension in this case is usually 4.
3. Make sure that the data is in the format for release 8.1.6 or higher (that is, it has 4-digit SDO_GTYPE values).
4. Update the LRS geometry objects by setting the LRS dimension in the SDO_GTYPE field, as in the following examples.

Example 1: The LRS dimension is 3 for the geometries in the GEOMETRY column of table LRS_DATA. Update the SDO_GTYPE as follows:

```
UPDATE LRS_DATA a SET a.geometry.sdo_gtype = a.geometry.sdo_gtype + 300;
```

Example 2: The LRS dimension is 4 for the geometries in the GEOMETRY column of table LRS_DATA. Update the SDO_GTYPE as follows:

```
UPDATE LRS_DATA a SET a.geometry.sdo_gtype = a.geometry.sdo_gtype + 400;
```

Hybrid Indexing

Quadtree hybrid indexing uses a combination of fixed-size and variable-sized tiles for spatially indexing a layer. Variable-sized tile spatial indexing uses tiles of different sizes to approximate a geometry. For each geometry, you will have a set of fixed-size tiles that fully cover the geometry, and also a set of variable-sized tiles that fully cover the geometry.

For most applications, you should not use hybrid indexes, but should instead use quadtree fixed indexes or R-tree indexes. The rare circumstances where hybrid indexes should be considered are as follows:

- When joins are required between layers whose optimal fixed index level (SDO_LEVEL) values are significantly different (4 levels or more), it may be possible to get better performance by bringing the layer with a higher optimal SDO_LEVEL down to the lower SDO_LEVEL and adding the SDO_NUMTILES parameter to ensure adequate tiling of the layer.

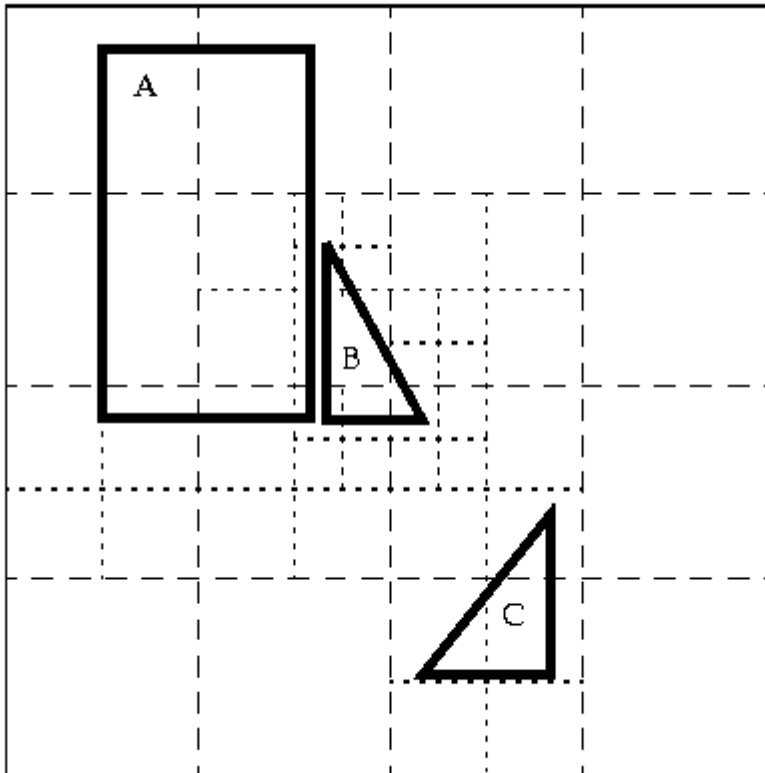
The best starting value for SDO_NUMTILES in the new hybrid layer can be calculated by getting a count of the rows in the spatial index table and dividing this number by the number of rows with geometries in the layer, then rounding up. A spatial join ('QUERYTYPE=JOIN') is not a common requirement for applications, and it is comparable to a spatial cross product where each of the geometries in one layer will be compared with each of the geometries in the other layer.

- When both of the following are true for a single layer, hybrid indexing may be preferable: (1) the layer has a mixture of many geometries covering a very small area and many polygons covering a very large area; and (2) the optimal fixed tiling level for the very small geometries will result in an extremely large number of tiles to be generated for the very large geometries, causing the spatial index to grow to an unreasonable size.

If both of these conditions are true, it may be better to use the `SDO_NUMTILES` parameter to get coverage for the smaller geometries, while keeping the fixed tile size relatively large for the large geometries by using a smaller `SDO_LEVEL` value.

In [Figure B-1](#), the variable-sized cover tiles closely approximate each geometry. This results in good selectivity. The number of variable tiles needed to cover a geometry is controlled using the `SDO_NUMTILES` parameter.

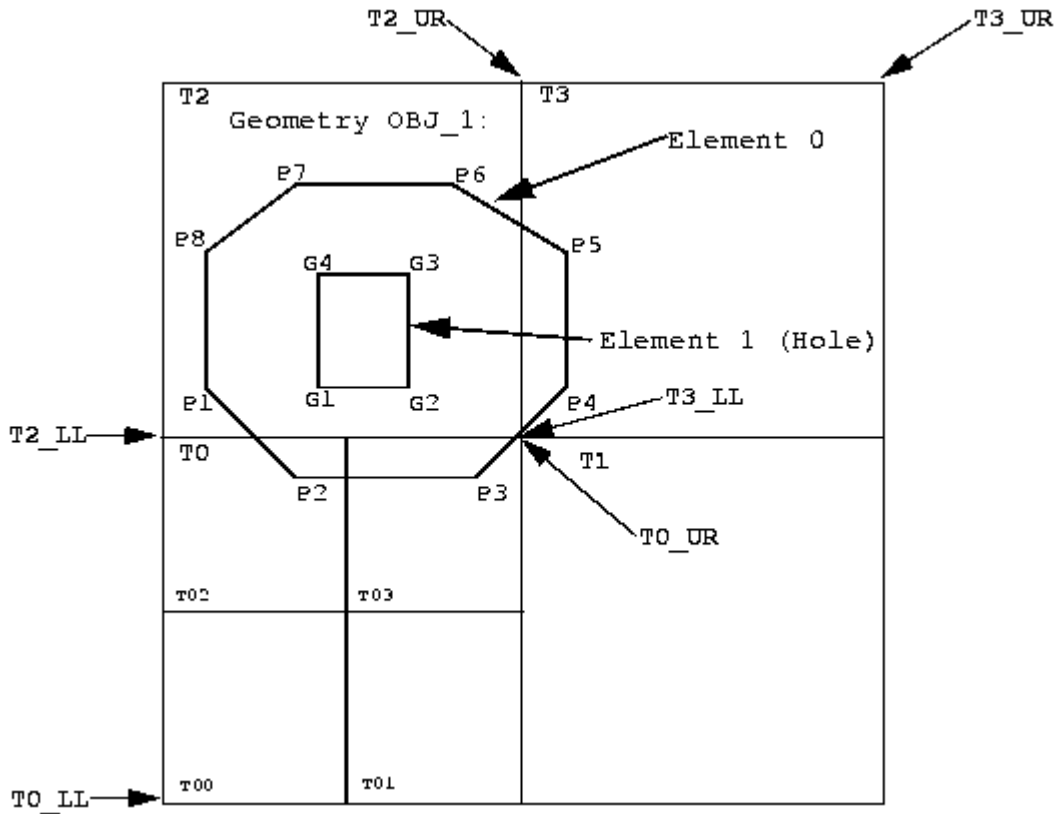
Figure B-1 Variable-Sized Tile Spatial Indexing



A variable tile is subdivided if it interacts with the geometry, and subdivision will not result in tiles that are smaller than a predetermined size. This size, or tiling resolution, is determined by a default `SDO_MAXLEVEL` value.

Figure B-2 illustrates how geometry OBJ_1 is approximated with hybrid indexing (SDO_LEVEL = 1 and SDO_NUMTILES = 4). These are not recommended values for SDO_LEVEL and SDO_NUMTILES; they were chosen to simplify this example. The cover tiles are stored in the SDOINDEX table as shown in Table B-1.

Figure B-2 Decomposition of the Geometry



In Figure B-2, note that for simplicity the tiles have been numbered, and *LL* and *UR* indicate *lower left* and *upper right*, respectively. For example, T2_LL indicates the lower left corner of tile T2. (This designation scheme does not reflect the actual format use in Spatial.)

In [Figure B-2](#), note which fixed-size tiles are associated with geometry OBJ_1. Only three (T0, T2, T3) of the four large tiles (T0, T1, T2, T3) generated by the tessellation actually interact with the geometry. Only those three are stored in the SDOINDEX table. In examining which variable-sized tiles are used, tile T0 shows a further tessellation to four smaller tiles, two of which (T02, T03) are used to cover a portion of the geometry. The variable-sized tiles are stored in the SDO_CODE column in the Spatial index table. The fixed-size tiles are stored in the SDO_GROUPCODE column. The spatial index structure is discussed in [Section 2.5](#).

[Table B-1](#) shows the tiles from [Figure B-2](#) that are stored in the SDOINDEX table.

Table B-1 Section of the SDOINDEX Table

SDO_ROWID <RAW>	SDO_CODE <RAW>	SDO_MAXCODE <RAW>	SDO_GROUPCODE <RAW>	SDO_META <RAW>
GID_OBJ_1	T02	<binary data>	T0	<binary data>
GID_OBJ_1	T03	<binary data>	T0	<binary data>
GID_OBJ_1	T2	<binary data>	T2	<binary data>
GID_OBJ_1	T3	<binary data>	T3	<binary data>

As with the fixed-size tile model, all elements in a geometry are tessellated in one step. In a multielement geometry like OBJ_1, Element 1 (the hole shown in [Figure B-2](#)) is covered by a redundant tile (T2) from the tessellation of Element 0, but this tile is stored only once.

The SDO_TUNE package has some functions that help determine appropriate SDO_LEVEL and SDO_NUMTILES values.

B.1 Creating a Hybrid Index

This section describes hybrid indexing, which uses both fixed-size and variable-sized tiles as a spatial indexing mechanism. For each geometry, you will have a set of fixed-size tiles that fully covers the geometry, and a set of variable-sized tiles that fully covers the geometry. The terms hybrid indexing, hybrid tiling, and hybrid tessellation are used interchangeably in this section.

To use hybrid tiling, the SDO_LEVEL and SDO_NUMTILES keywords in the PARAMETERS clause must contain valid values. Both SDO_LEVEL and SDO_NUMTILES must be greater than 1.

The `SDO_NUMTILES` value determines the number of variable tiles that will be used to fully cover a geometry being indexed. Typically this value is small. For points, `SDO_NUMTILES` is always one. For other element types, you might set `SDO_NUMTILES` to a value around 8. The larger the `SDO_NUMTILES` value, the better the tiles will approximate the geometry being covered. A larger `SDO_NUMTILES` value improves the selectivity of the primary filter, but it also increases the number of index entries per geometry (see [Section 4.2.1.1](#) and [Section 4.2.1.2](#) for a discussion of primary and secondary filters). The `SDO_NUMTILES` value should be larger for long, linear spatial entities, such as major highways or rivers, than for area-related spatial entities such as county or state boundaries.

The `SDO_LEVEL` value determines the size of the fixed tiles used to fully cover the geometry being indexed. Setting the proper `SDO_LEVEL` value may appear more like art than science. Performing some simple data analysis and testing puts the process back in the realm of science. One approach would be to use the [SDO_TUNE.ESTIMATE_TILING_LEVEL](#) function to determine an appropriate starting `SDO_LEVEL` value, and then compare the performance with slightly higher or lower values.

In [Example B-1](#), assume that data has been loaded into a table called `ROADS`, and the `USER_SDO_GEOM_METADATA` view has an entry for `ROADS.SHAPE`. (Assume also that no spatial index has already been created on the `ROADS.SHAPE` column.) You can use the following SQL statement to create a hybrid index named `ROADS_HYBRID`.

Example B-1 Creating a Hybrid Index

```
CREATE INDEX ROADS_HYBRID ON ROADS(SHAPE)
  INDEXTYPE IS MDSYS.SPATIAL_INDEX PARAMETERS('SDO_LEVEL=6 SDO_NUMTILES=12');
```

B.2 Tuning Considerations with Hybrid Indexes

Hybrid indexing allows indexes to be built using the tiling mechanism by specifying the `SDO_LEVEL`. Additionally, hybrid indexing introduces the ability to specify the minimum number of tiles to be created for each geometry during the indexing process by specifying the indexing parameter `SDO_NUMTILES`.

If the number of tiles created for a geometry using the `SDO_LEVEL` value is less than the value specified by the `SDO_NUMTILES` value, then the indexing process continues by creating more tiles for the geometry until the `SDO_NUMTILES` value has been reached. The ability to specify the minimum number of tiles for each geometry is important for a number of reasons:

- It ensures that all geometries will have at least as many index entries as the value of SDO_NUMTILES, regardless of the tiling level.
- It can reduce (as compared to fixed indexing) the space required for index data to get full indexing coverage of all geometries.
- Special performance enhancing algorithms have been coded within Spatial to make use of hybrid indexes.

If hybrid indexing is used and if the layer being indexed is point-only data, the SDO_NUMTILES value should be set to 1.

Oracle9i Locator (also referred to as Locator) is a feature of Oracle *interMedia*, which is available on the Oracle Standard Edition. Locator provides core features and services available in Oracle Spatial. 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 GIS applications requiring complex spatial data management. If you need capabilities such as linear referencing, spatial functions, or coordinate system transformations, use Oracle Spatial instead of Locator.

Like Spatial, Locator is not designed to be an end-user application, but is a set of spatial capabilities for application developers.

Locator is available with both Oracle9i Standard Edition and Oracle9i Enterprise Edition. Spatial is a priced option available only with Oracle9i Enterprise Edition. Spatial includes all Locator features as well as other features that are not available with Locator.

Locator has been enhanced for Oracle9i. In general, it includes the data types, operators, and indexing capabilities of Oracle Spatial, along with a limited set of the functions and procedures of Spatial. 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 R-tree or quadtree-based spatial indexes on geometry data
- Spatial operators that use the spatial index for performing spatial queries: [SDO_FILTER](#), [SDO_NN](#), [SDO_NN](#), [SDO_NN_DISTANCE](#), and [SDO_WITHIN_DISTANCE](#)

Note: For Oracle8i, LOCATOR_WITHIN_DISTANCE was the only Locator operator supported. For Oracle9i, LOCATOR_WITHIN_DISTANCE and SDO_WITHIN_DISTANCE are synonyms (same signatures and behavior), and both are supported.

- Some geometry functions and the SDO_AGGR_MBR spatial aggregate function
- Ability to work with third-party geocoding tools
- Integration with Oracle9iAS Wireless Edition

For information about spatial concepts, the SDO_GEOMETRY object type, and indexing and loading spatial data, see Chapters 1 through 4 in this guide. For reference and usage information about features supported by Locator, see the chapter or section listed in [Table C-1](#).

Table C-1 Spatial Features Supported for Locator

Spatial Feature	Described in
Ability to integrate with third-party geocoders	Section 1.10
Function-based spatial indexing	Section 7.2
Table partitioning support for spatial indexes (including splitting, merging, and exchanging partitions and their indexes)	Section 4.1.7 and Section 4.1.8
Geodetic data support	Section 5.2 and Section 5.4
SQL statements for creating, altering, and deleting indexes (except deferred updates to spatial indexes, as noted in Table C-2)	Chapter 8
Parallel spatial index builds (PARALLEL keyword with ALTER INDEX REBUILD and CREATE INDEX statements) (new with Release 9.2)	Chapter 8
SDO_GEOMETRY object type methods	Chapter 9
Spatial operators	Chapter 10
Implicit coordinate system transformations for operator calls where a window needs to be converted to the coordinate system of the queried layer	Chapter 10

Table C-1 Spatial Features Supported for Locator (Cont.)

Spatial Feature	Described in
The following SDO_GEOM package functions and procedures: SDO_GEOM.SDO_DISTANCE SDO_GEOM.VALIDATE_GEOMETRY_WITH_CONTEXT SDO_GEOM.VALIDATE_LAYER_WITH_CONTEXT SDO_GEOM.VALIDATE_GEOMETRY (deprecated) SDO_GEOM.VALIDATE_LAYER (deprecated)	Chapter 11
SDO_AGGR_MBR spatial aggregate function (new to Locator with Release 9.2)	Chapter 12
Function (SDO_CS.VIEWPORT_TRANSFORM) to transform a viewport MBR to work with geodetic coordinate systems, thus allowing client tools to select geodetic data for viewing	Chapter 13
Package (SDO_MIGRATE) to migrate data from release 8.1.5 object-relational format to the release 8.1.6 object-relational format (data using the release 8.1.6 format requires no further migration)	Chapter 15
Object replication	<i>Oracle9i Replication</i>
Graphical tool for tuning spatial quadtree indexes (Spatial Index Advisor integrated application in Oracle Enterprise Manager)	Online help for Oracle Enterprise Manager

[Table C-2](#) lists Spatial features that are *not* supported for Locator, with the chapter or section in this guide that describes the feature.

Table C-2 Spatial Features Not Supported for Locator

Spatial Feature	Described in
Deferred updates to spatial indexes (' index_status=deferred ' with the ALTER INDEX statement)	Chapter 8
SDO_GEOM package functions and procedures, except for those listed in Table C-1	Chapter 11
Spatial aggregate functions, except for any listed in Table C-1	Chapter 12
Linear Referencing System (LRS) support	Chapter 6 (concepts and usage) and Chapter 14 (reference)

Table C-2 Spatial Features Not Supported for Locator (Cont.)

Spatial Feature	Described in
Coordinate system support for explicit geometry and layer transformations (SDO_CS.TRANSFORM function and SDO_CS.TRANSFORM_LAYER procedure)	Chapter 13
Tuning functions and procedures (SDO_TUNE package)	Chapter 16
Spatial utility functions (SDO_UTIL package)	Chapter 17

Locator is available on both Oracle9i Standard Edition and Oracle9i Enterprise Edition. Some capabilities requires server features that are not available or are limited on Oracle9i Standard Edition. Some of those features and their availability are listed in [Table C-3](#).

Table C-3 Feature Availability with Standard and Enterprise Editions

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>Oracle9i Replication</i> for more information.)
Partitioned spatial indexes	Requires the Partitioning Option with Enterprise Edition. Not supported with Standard Edition.

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.

authalic sphere

A sphere that has the same surface area as a particular oblate ellipsoid of revolution representing the figure of the Earth.

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](#).

contain

To describe 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 system

A reference system for the unique definition for the location of a point in n -dimensional space. Also called a *spatial reference system*.

cover

To describe 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 the objects in a database.

datum transformation

See [transformation](#).

decompose

To separate or resolve into constituent parts or elements, or into simpler compounds.

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.

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 the two objects' geometries 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.

geodetic coordinates

Angular coordinates (longitude and latitude), closely related to spherical polar coordinates, and are 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](#).

geographical 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](#).

geometry

The geometric representation of the shape of a spatial feature in some coordinate space.

georeferenced data

See [spatiotemporal data](#).

GIS

See [geographical 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 polygon can include subelements that negate sections 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, also referred to as multidimensional data.

index

Identifier that is not part of a database and used to access stored information.

inside

To describe 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.

keyword

Synonym for reserved word.

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.

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.

measure

The linear distance (in the LRS measure dimension) measured from the start point of the geometric segment.

measure range

The measure values at the start and end measures of a geometric segment.

multidimensional data

See [hyperspatial data](#).

offset

The perpendicular distance between a point along a geometric segment and the geometric segment. Offsets are positive if 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.

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 inter-object distance.

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. Oracle9i 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 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 database

A database containing information indexed by location.

spatial data model

A model of how objects are located on a spatial context.

Spatial data dictionary

An extension of the Oracle9i data dictionary. It keeps track of the number of partitions created in a spatial table. The Spatial data dictionary is owned by user MDSYS. The data dictionary is used only by the deprecated partitioned point routines.

spatial data structures

A class of data structures designed to store spatial information and facilitate its manipulation.

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 and/or location 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.

tessellation

The process of covering a geometry with rectangular tiles without gaps or overlaps.

tiling

See [tessellation](#).

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 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](#).

Index

Symbols

`_3D`
formats of LRS functions, 6-9

Numerics

0
SRID value used with `SDO_CS.VIEWPORT_TRANSFORM` function, 13-8
type 0 (zero) element, 2-24

9i
migrating to Oracle9i, 15-11

A

aggregate functions
description, 1-23
reference information, 12-1
`SDO_AGGR_CENTROID`, 12-2
`SDO_AGGR_CONVEXHULL`, 12-4
`SDO_AGGR_LRS_CONCAT`, 12-5
`SDO_AGGR_MBR`, 12-7
`SDO_AGGR_UNION`, 12-8
`SDOAGGRTYPE` object type, 1-24

`ALL_SDO_GEOM_METADATA` view, 2-26

`ALL_SDO_INDEX_INFO` view, 2-29

`ALL_SDO_INDEX_METADATA` view, 2-30

`ALTER INDEX` statement, 8-2
REBUILD clause, 8-7
RENAME TO clause, 8-11

`ANALYZE_RTREE` procedure, 16-3

angle units, 5-10

ANYINTERACT mask relationship, 11-5

application size (hardware) requirements, 1-26

arc
densifying, 11-7
not supported with geodetic data, 5-4

area, 11-10

authalic sphere, 5-2

average minimum bounding rectangle, 16-5

AVERAGE_MBR procedure, 16-5

B

bounding rectangle
minimum, 16-17

buffer area, 11-12

bulk loading of spatial data, 3-1

C

C language
examples (using OCI), 1-27

Cartesian coordinates, 1-6, 5-1

center of gravity (centroid), 11-16

centroid
`SDO_AGGR_CENTROID` aggregate function, 12-2
`SDO_CENTROID` function, 11-16

circle
not supported with geodetic data, 5-4
type, 2-13

`CLIP_GEOM_SEGMENT` function, 14-5

clipping a geometric segment, 6-12

column name
restrictions on spatial column names, 2-28

`COLUMN_NAME` (in `USER_SDO_GEOM_`

- METADATA), 2-28
- compatibility, A-1
- compound element, 2-10
- compound line string, 2-13, 2-18
- compound polygon, 2-13
- CONCATENATE_GEOM_SEGMENTS
 - function, 14-7
- concatenating geometric segments, 6-13
 - aggregate concatenation, 6-15, 12-5
- CONNECTED_GEOM_SEGMENTS
 - function, 14-10
- consistency
 - checking for valid geometry types, 11-44, 11-46
- constraining data to a geometry type, 4-7
- CONTAINS mask relationship, 11-5
- CONVERSION_FACTOR column
 - in SDO_ANGLE_UNITS table, 5-11
 - in SDO_AREA_UNITS table, 2-36
 - in SDO_DIST_UNITS table, 2-35
- CONVERSION_FACTOR column in SDO_DIST_UNITS table, 5-11
- CONVERT_TO_LRS_DIM_ARRAY function, 14-12
- CONVERT_TO_LRS_GEOM function, 14-15
- CONVERT_TO_LRS_LAYER function, 14-18
- CONVERT_TO_STD_DIM_ARRAY
 - function, 14-21
- CONVERT_TO_STD_GEOM function, 14-23
- CONVERT_TO_STD_LAYER function, 14-25
- converting
 - geometric segments
 - functions for, 14-3
 - overview, 6-19
- convex hull
 - SDO_AGGR_CONVEXHULL aggregate
 - function, 12-4
 - SDO_CONVEXHULL function, 11-18
- coordinate systems
 - conceptual and usage information, 5-1
 - example, 5-20
 - function reference information, 13-1
 - local, 5-5
 - user-defined, 5-16
- coordinates
 - Cartesian, 1-6, 5-1
 - geodetic, 1-6, 5-2, 5-3

- geographic, 1-6, 5-2
- local, 1-7, 5-2
- projected, 1-6, 5-2
- COVEREDBY mask relationship, 11-5
- COVERS mask relationship, 11-5
- CPU requirements for spatial applications, 1-26
- CREATE INDEX statement, 8-12
- creating
 - geometric segments
 - functions for, 14-1
- cross-schema index creation, 4-8
- CS_SRS table, 5-7
- current release
 - migrating to, 15-11

D

- data model, 1-4
 - LRS, 6-7
- data types
 - spatial, 2-1
- datum
 - geodetic, 1-6, 5-2
 - MDSYS.SDO_DATUMS table, 5-11
 - transformation, 5-2
- DBA_SDO_GEOM_METADATA view, 2-27
- DBA_SDO_INDEX_INFO view, 2-30
- DBA_SDO_INDEX_METADATA view, 2-30
- deferred index updates, 8-2
- DEFINE_GEOM_SEGMENT function, 14-27
- defining a geometric segment, 6-10
- densification of arcs, 11-7
- difference, 11-20
- dimension (in SDO_GTYPE), 2-7, 2-8
 - GET_DIMS method, 9-2
 - GET_LRS_DIM method, 9-4
- DIMINFO (in USER_SDO_GEOM_METADATA), 2-28
- direction of geometric segment, 6-3
 - concatenation result, 6-14
- DISJOINT mask relationship, 11-5
- disk storage requirements for spatial applications, 1-26
- distance
 - SDO_NN_DISTANCE ancillary operator, 10-11

WITHIN_DISTANCE function, 11-55
distance units, 5-11
DROP INDEX statement, 8-19
dynamic query window, 4-12
DYNAMIC_SEGMENT function, 14-30

E

editing
 geometric segments
 functions for, 14-1
ELEM_INFO (SDO_ELEM_INFO), 2-9
element, 1-5
 extracting from a geometry, 17-2
ellipsoids, 5-14
embedded SDO_GEOMETRY object in user-defined
 type, 7-1
EQUAL mask relationship, 11-5
error messages
 Spatial, 1-26
ESTIMATE_INDEX_PERFORMANCE
 function, 16-7
ESTIMATE_TILING_LEVEL function, 16-10
ESTIMATE_TILING_TIME function, 16-12
ESTIMATE_TOTAL_NUMTILES function, 16-14
ETYPE (SDO_ETYPE), 2-10
examples
 C, 1-27
 coordinate systems, 5-20
 creating, indexing, and querying spatial
 data, 2-1
 directory for Spatial examples, 1-27
 Linear Referencing System (LRS), 6-20
 OCI (Oracle Call Interface), 1-27
 PL/SQL, 1-27
 SQL, 1-27
exchanging partitions including indexes, 4-10
EXTENT_OF function, 16-17
exterior polygon rings, 2-7, 2-10, 2-16, 2-18
EXTRACT function, 17-2

F

features
 linear, 6-6

FIND_LRS_DIM_POS function, 14-32
FIND_MEASURE function, 14-33
fixed indexing, 1-16
fixed-size tiles, 4-3
FROM_815_TO_81x procedure, 15-2
function-based index
 with SDO_GEOMETRY objects, 7-3
function-based indexes
 privilege and session requirements, 7-4
functions and procedures
 aggregate (spatial), 12-1
 ANALYZE_RTREE, 16-3
 AVERAGE_MBR, 16-5
 CLIP_GEOM_SEGMENT, 14-5
 CONCATENATE_GEOM_SEGMENTS, 14-7
 CONNECTED_GEOM_SEGMENTS, 14-10
 CONVERT_TO_LRS_DIM_ARRAY, 14-12
 CONVERT_TO_LRS_GEOM, 14-15
 CONVERT_TO_LRS_LAYER, 14-18
 CONVERT_TO_STD_DIM_ARRAY, 14-21
 CONVERT_TO_STD_GEOM, 14-23
 CONVERT_TO_STD_LAYER, 14-25
 coordinate system transformation, 13-1
 DEFINE_GEOM_SEGMENT, 14-27
 DYNAMIC_SEGMENT, 14-30
 ESTIMATE_INDEX_PERFORMANCE, 16-7
 ESTIMATE_TILING_LEVEL, 16-10
 ESTIMATE_TILING_TIME, 16-12
 ESTIMATE_TOTAL_NUMTILES, 16-14
 EXTENT_OF, 16-17
 EXTRACT, 17-2
 FIND_LRS_DIM_POS, 14-32
 FIND_MEASURE, 14-33
 FROM_815_TO_81x, 15-2
 GEOM_SEGMENT_END_MEASURE, 14-45
 GEOM_SEGMENT_END_PT, 14-37
 GEOM_SEGMENT_LENGTH, 14-39
 GEOM_SEGMENT_START_MEASURE, 14-41
 GEOM_SEGMENT_START_PT, 14-43
 geometry, 11-1
 GET_MEASURE, 14-45
 GETVERTICES, 17-5
 HISTOGRAM_ANALYSIS, 16-19
 IS_GEOM_SEGMENT_DEFINED, 14-47
 IS_MEASURE DECREASING, 14-49

- IS_MEASURE_INCREASING, 14-51
- linear referencing (LRS), 14-1
- LOCATE_PT, 14-53
- MEASURE_RANGE, 14-56
- MEASURE_TO_PERCENTAGE, 14-58
- migration, 15-1
- MIX_INFO, 16-21
- not supported with geodetic data, 5-19
- OFFSET_GEOM_SEGMENT, 14-60
- OGIS_METADATA_FROM, 15-4
- OGIS_METADATA_TO, 15-5
- PERCENTAGE_TO_MEASURE, 14-64
- PROJECT_PT, 14-66
- QUALITY_DEGRADATION, 16-23
- REDEFINE_GEOM_SEGMENT, 14-68
- RELATE, 11-4
- RESET_MEASURE, 14-71
- REVERSE_GEOMETRY, 14-73
- REVERSE_MEASURE, 14-75
- RTREE_QUALITY, 16-25
- SCALE_GEOM_SEGMENT, 14-77
- SDO_AGGR_CENTROID, 12-2
- SDO_AGGR_CONVEXHULL, 12-4
- SDO_ARC_DENSIFY, 11-7
- SDO_AREA, 11-10
- SDO_BUFFER, 11-12
- SDO_CENTROID, 11-16
- SDO_CONVEXHULL, 11-18
- SDO_DIFFERENCE, 11-20
- SDO_DISTANCE, 11-23
- SDO_INTERSECTION, 11-25
- SDO_LENGTH, 11-28
- SDO_MAX_MBR_ORDINATE, 11-30
- SDO_MBR, 11-32
- SDO_MIN_MBR_ORDINATE, 11-34
- SDO_POINTONSURFACE, 11-36
- SDO_UNION, 11-38
- SDO_XOR, 11-41
- SET_PT_MEASURE, 14-80
- spatial aggregate, 12-1
- SPLIT_GEOM_SEGMENT, 14-83
- supported by approximations with geodetic data, 5-20
- TO_734, 15-6
- TO_81x, 15-8

- TO_CURRENT, 15-11
- TRANSFORM, 13-2
- TRANSFORM_LAYER, 13-5
- TRANSLATE_MEASURE, 14-86
- tuning, 16-1
- utility, 17-1
- VALID_GEOM_SEGMENT, 14-88
- VALID_LRS_POINT, 14-90
- VALID_MEASURE, 14-92
- VALIDATE_GEOMETRY, 11-44
- VALIDATE_GEOMETRY_WITH_CONTEXT, 11-46
- VALIDATE_LAYER, 11-49
- VALIDATE_LAYER_WITH_CONTEXT, 11-52
- VALIDATE_LRS_GEOMETRY, 14-94
- VIEWPORT_TRANSFORM function, 13-7
- WITHIN_DISTANCE, 11-55

G

- geocoding, 1-25
- geodetic coordinates, 1-6, 5-2
 - arcs and circles not supported, 5-4
 - functions not supported, 5-19
 - functions supported by approximations, 5-20
 - support for, 5-3
- geodetic datum, 1-6, 5-2
- geodetic index, 4-7
- geographic coordinates, 1-6, 5-2
- GEOM_SEGMENT_END_MEASURE
 - function, 14-45
- GEOM_SEGMENT_END_PT function, 14-37
- GEOM_SEGMENT_LENGTH function, 14-39
- GEOM_SEGMENT_START_MEASURE
 - function, 14-41
- GEOM_SEGMENT_START_PT function, 14-43
- geometric segment
 - clipping, 6-12
 - concatenating, 6-13
 - aggregate, 6-15, 12-5
 - converting (functions for), 14-3
 - converting (overview), 6-19
 - creating (functions for), 14-1
 - defining, 6-10
 - definition of, 6-2

- direction, 6-3
- direction with concatenation, 6-14
- editing (functions for), 14-1
- locating point on, 6-17
- offsetting, 6-16
- projecting point onto, 6-18
- querying (functions for), 14-2
- redefining, 6-11
- scaling, 6-15
- splitting, 6-13
- geometry functions
 - reference information, 11-1
- geometry type
 - constraining data to, 4-7
 - GET_DIMS method, 9-3
 - SDO_GTYPE, 2-7
- geometry types, 1-3
- GET_DIMS method, 9-2
- GET_GTYPE method, 9-3
- GET_LRS_DIM method, 9-4
- GET_MEASURE function, 14-45
- GETVERTICES function, 17-5
- GTYPE (SDO_GTYPE), 2-7
 - constraining data to a geometry type, 4-7

H

- hardware requirements for spatial
 - applications, 1-26
- HISTOGRAM_ANALYSIS procedure, 16-19
- hybrid indexing, B-1

I

- index
 - creation, 4-1
 - cross-schema, 4-8
 - parallel execution, 8-14
 - deferred updating, 8-2
 - description of Spatial indexing, 1-11
 - geodetic and non-geodetic, 4-7
 - hybrid, B-1
 - partitioned, 4-8
 - exchanging partitions including indexes, 4-10

- performance, 16-7
- quadtree, 1-14
- rebuilding
 - parallel execution, 8-9
- R-tree, 1-12
- R-tree (requirements before creating), 4-2
- synchronizing deferred updates, 8-2
- index-organized table
 - cannot create spatial index on, 8-15
- inserting spatial data
 - PL/SQL, 3-4
- INSIDE mask relationship, 11-5
- installation, A-1
- installation procedure for Spatial, A-2
- INTEPRETATION (SDO_INTERPRETATION), 2-11
- interaction
 - ANYINTERACT, 11-5
- interior polygon rings, 2-7, 2-10, 2-16, 2-18
- interMedia* Locator
 - See* Locator
- intersection, 11-25
- inverse flattening, 5-14
- IS_GEOM_SEGMENT_DEFINED function, 14-47
- IS_MEASURE DECREASING function, 14-49
- IS_MEASURE INCREASING function, 14-51

L

- layer, 1-5
 - transforming, 13-5
 - validating, 11-49
 - validating with context, 11-52
- layer_gtype
 - constraining data to a geometry type, 4-7
- length
 - SDO_LENGTH function, 11-28
- line
 - data, 1-5
 - length, 11-28
- line string
 - compound, 2-13, 2-18
 - self-crossing, 1-4
- linear features, 6-6
- linear measure, 6-3

- Linear Referencing System (LRS)
 - 3D formats of functions, 6-9
 - conceptual and usage information, 6-1
 - data model, 6-7
 - example, 6-20
 - function reference information, 14-1
 - GET_LRS_DIM method, 9-4
 - limiting indexing to X and Y dimensions, 6-8
 - LRS point, 6-6
 - segments, 6-2
 - upgrading data to current release, A-4
- loading spatial data, 3-1
- local coordinate systems, 5-5
- local coordinates, 1-7, 5-2
- LOCAL partitioning
 - spatial index, 4-8
- LOCATE_PT function, 14-53
- Locator, C-1
- LRS
 - See* Linear Referencing System (LRS)
- LRS point, 6-6
- measure range, 6-6
- MEASURE_RANGE function, 14-56
- MEASURE_TO_PERCENTAGE function, 14-58
- messages
 - Spatial error messages, 1-26
- migration
 - instructions and issues, A-1
 - OGIS, 15-4, 15-5
 - procedures, 15-1
 - to current Spatial release, 15-11
 - to release 7.3.4, 15-6
 - See also* upgrading
- minimum bounding rectangle
 - AVERAGE_MBR procedure, 16-5
 - EXTENT_OF function, 16-17
 - SDO_AGGR_MBR aggregate function, 12-7
 - SDO_MAX_MBR_ORDINATE function, 11-30
 - SDO_MBR function, 11-32
 - SDO_MIN_MBR_ORDINATE function, 11-34
- MIX_INFO procedure, 16-21
- multipolygon, 2-18

M

- map projections, 5-15
- MBR
 - SDO_AGGR_MBR aggregate function, 12-7
 - SDO_MAX_MBR_ORDINATE function, 11-30
 - SDO_MBR function, 11-32
 - SDO_MIN_MBR_ORDINATE function, 11-34
- MDSYS schema, 1-1
- MDSYS user
 - created during default installation, A-2
 - protecting against unauthorized use, A-2
- MDSYS.CS_SRS table, 5-7
- MDSYS.SDO_ANGLE_UNITS table, 5-10
- MDSYS.SDO_CS package, 13-1
- MDSYS.SDO_DATUMS table, 5-11
- MDSYS.SDO_DIST_UNITS table, 5-11
- MDSYS.SDO_ELLIPSOIDS table, 5-14
- MDSYS.SDO_PROJECTIONS table, 5-15
- measure, 6-3
 - populating, 6-4
 - resetting, 14-71
 - reversing, 14-75

N

- nearest neighbor
 - SDO_NN operator, 10-6
- non-geodetic index, 4-7

O

- object types
 - embedding SDO_GEOMETRY objects in, 7-1, 7-6
- object-relational model, 2-1
- OCI (Oracle Call Interface) examples, 1-27
- offset, 6-3
- OFFSET_GEOM_SEGMENT function, 14-60
- offsetting a geometric segment, 6-16
- OGIS_METADATA_FROM procedure, 15-4
- OGIS_METADATA_TO procedure, 15-5
- ON mask relationship, 11-6
- operators
 - cross-schema invocation, 4-19
 - SDO_FILTER, 10-2
 - SDO_NN, 10-6

- SDO_NN_DISTANCE, 10-11
- SDO_RELATE, 10-13
- SDO_WITHIN_DISTANCE, 10-18
- optimized rectangle, 2-13
- Oracle Call Interface (OCI) examples, 1-27
- OVERLAPBDYDISJOINT mask relationship, 11-6
- OVERLAPBDYINTERSECT mask relationship, 11-6

P

- parallel execution for index creation and rebuilding, 8-9, 8-14
- partitioned spatial index, 4-8
 - exchanging partitions, 4-10
- PERCENTAGE_TO_MEASURE function, 14-64
- performance and tuning information, 1-25
- PL/SQL and SQL examples, 1-27
- point
 - data, 1-5
 - illustration and examples of point-only geometry, 2-22
 - locating on geometric segment, 6-17
 - LRS, 6-6
 - on surface of polygon, 11-36
 - shape, 6-2
- polygon
 - area of, 11-10
 - centroid, 11-16
 - compound, 2-13
 - exterior and interior rings, 2-7, 2-10, 2-16, 2-18
 - point on surface, 11-36
 - self-crossing not supported, 1-4
- polygon collection, 2-18
- polygon data, 1-5
- populating
 - measure, 6-4
- primary filter, 1-9, 4-13, 4-15
- primitive types, 1-3
- problems in current release, 5-19
 - geodetic data, 5-4
- procedures
 - See functions and procedures
- PROJECT_PT function, 14-66
- projected coordinates, 1-6, 5-2

- projection, 6-6
 - point onto geometric segment, 6-18
 - PROJECT_PT function, 14-66
- projections, 5-15

Q

- quadtree indexes, 1-14
- quality
 - degradation of R-tree index, 16-23
 - R-tree, 1-13
- QUALITY_DEGRADATION function, 16-23
- query, 4-12
- query model for Spatial, 1-9
- QUERY REWRITE
 - privilege and session requirements, 7-4
- query window, 4-12
- querying geometric segments
 - functions for, 14-2

R

- range
 - measure, 6-6
- rectangle
 - minimum bounding, 16-17
 - type, 2-13
- REDEFINE_GEOM_SEGMENT procedure, 14-68
- redefining a geometric segment, 6-11
- RELATE function, 11-4
- release 9i
 - migrating to Oracle9i, 15-11
- release number (Spatial)
 - retrieving, 1-26
- RESET_MEASURE procedure, 14-71
- restrictions in current release, 5-19
 - geodetic data, 5-4
- REVERSE_GEOMETRY function, 14-73
- REVERSE_MEASURE function, 14-75
- ring
 - exterior and interior polygon, 2-10
 - extracting from a geometry, 17-2
- rollback segment
 - R-tree index creation, 4-2
- R-tree indexes, 1-12

- analyzing quality, 16-3
- before creating, 4-2
- quality degradation, 16-23
- quality score, 16-25
- sequence object, 2-34

R-tree quality, 1-13

RTREE_QUALITY function, 16-25

S

SCALE_GEOM_SEGMENT function, 14-77

scaling a geometric segment, 6-15

schema

- creating index on table in another schema, 4-8
- invoking operators on table in another schema, 4-19

SDO_AGGR_CENTROID aggregate function, 12-2

SDO_AGGR_CONVEXHULL aggregate function, 12-4

SDO_AGGR_LRS_CONCAT aggregate function, 12-5

SDO_AGGR_MBR aggregate function, 12-7

SDO_AGGR_UNION aggregate function, 12-8

SDO_ANGLE_UNITS table, 5-10

SDO_ARC_DENSIFY function, 11-7

SDO_AREA function, 11-10

SDO_AREA_UNITS table, 2-35

SDO_BUFFER function, 11-12

SDO_CENTROID function, 11-16

SDO_CODE, 2-34

SDO_CONVEXHULL function, 11-18

SDO_CS package, 13-1

SDO_DATUMS table, 5-11

SDO_DIFFERENCE function, 11-20

SDO_DIST_UNITS table, 2-35, 5-11

SDO_DISTANCE function, 11-23

SDO_ELEM_INFO, 2-9

SDO_ELEM_INFO_ARRAY type, 2-6

SDO_ELLIPSOIDS table, 5-14

SDO_ETYPE, 2-10

SDO_FILTER operator, 10-2

SDO_GEOMETRY object type, 2-6

- embedding in user-defined type, 7-1, 7-6
- in function-based indexes, 7-3
- methods, 9-1, 12-1

SDO_GROUPCODE, 2-34

SDO_GTYPE, 2-7

- constraining data to a geometry type, 4-7
- GET_DIMS method, 9-2
- GET_GTYPE method, 9-3
- GET_LRS_DIM method, 9-4

SDO_INDEX_TABLE, 2-33

SDO_INDX_DIMS keyword, 6-8

SDO_INTERPRETATION, 2-11

SDO_INTERSECTION function, 11-25

SDO_LENGTH function, 11-28

SDO_LEVEL, 1-15

SDO_MAX_MBR_ORDINATE function, 11-30

SDO_MBR function, 11-32

SDO_MIN_MBR_ORDINATE function, 11-34

SDO_NN operator, 10-6

- optimizer hint, 10-9

SDO_NN_DISTANCE ancillary operator, 10-11

SDO_NUMTILES, 1-15

SDO_ORDINATE_ARRAY type, 2-6

SDO_ORDINATES, 2-14

SDO_POINT, 2-9

SDO_POINT_TYPE object type, 2-6

SDO_POINTONSURFACE function, 11-36

SDO_POLY_xxx functions (deprecated and removed), 11-3

SDO_PROJECTIONS table, 5-15

SDO_RELATE operator, 10-13

SDO_ROWID, 2-34

SDO_RTREE_SEQ_NAME, 2-34

SDO_SRID, 2-8

SDO_STARTING_OFFSET, 2-9

SDO_STATUS, 2-34

SDO_UNION function, 11-38

SDO_UNIT column

- in SDO_AREA_UNITS table, 2-35
- in SDO_DIST_UNITS table, 2-35, 5-11

SDO_VERSION function, 1-26

SDO_WITHIN_DISTANCE operator, 10-18

SDO_XOR function, 11-41

SDOAGGRTYPE object type, 1-24

secondary filter, 1-9, 4-15

segments

- geometric, 6-2

self-crossing line strings and polygons, 1-4

- semi-major axis, 5-14
- sequence object for R-tree index, 2-34
- SET_PT_MEASURE procedure, 14-80
- shape point, 6-2
- simple element, 2-10
- size requirements (hardware) for spatial applications, 1-26
- SORT_AREA_SIZE parameter
 - R-tree index creation, 4-2
- spatial aggregate functions
 - See aggregate functions
- spatial data structures
 - object-relational model, 2-1
- spatial data types, 2-1
- spatial index
 - See index
- Spatial Index Advisor
 - using to determine best tiling level, 4-6
- spatial indexing
 - fixed, 1-16
- spatial join, 4-18
- spatial query, 4-12
- spatial reference systems
 - conceptual and usage information, 5-1
 - example, 5-20
 - function reference information, 13-1
- sphere
 - authalic, 5-2
- spheroids (ellipsoids), 5-14
- SPLIT_GEOM_SEGMENT procedure, 14-83
- splitting a geometric segment, 6-13
- SQL and PL/SQL examples, 1-27
- SQL*Loader, 3-1
- SRID
 - 0 (zero) special case with SDO_CS.VIEWPORT_TRANSFORM function, 13-8
 - in USER_SDO_GEOM_METADATA, 2-29
 - SDO_SRID in SDO_GEOMETRY, 2-8
- synchronizing deferred index updates, 8-2

T

- table name
 - restrictions on spatial table names, 2-27
- TABLE_NAME (in USER_SDO_GEOM_

- METADATA), 2-27
- tessellation, 1-15
- three-dimensional (3D)
 - formats of LRS functions, 6-9
- tile, 1-15, 4-12
- tiling level
 - estimating, 16-10
- TO_734 procedure, 15-6
- TO_81x procedure, 15-8
- TO_CURRENT procedure, 15-11
- tolerance, 1-7
- TOUCH mask relationship, 11-6
- transactional insertion of spatial data, 3-4
- TRANSFORM, 13-2
- TRANSFORM_LAYER, 13-5
 - table for transformed layer, 13-6
- transformation, 5-2
- TRANSLATE_MEASURE procedure, 14-86
- tuning and performance information, 1-25
- tuning functions and procedures, 16-1
- two-tier query, 1-9
- type zero (0) element, 2-24

U

- union, 11-38
- unit of measurement
 - MDSYS tables, 2-34
- UNIT_NAME column
 - in SDO_ANGLE_UNITS table, 5-11
 - in SDO_AREA_UNITS table, 2-36
 - in SDO_DIST_UNITS table, 2-35
- UNIT_NAME column in SDO_DIST_UNITS table, 5-11
- upgrading
 - from Spatial release 8.1.5, 8.1.6, or 8.7.1, A-3
 - from Spatial release 9.0.1, A-3
 - instructions and issues, A-1
 - LRS data, A-4
 - See also migration
- USER_SDO_GEOM_METADATA view, 2-26
- USER_SDO_INDEX_INFO view, 2-29
- USER_SDO_INDEX_METADATA view, 2-30
- user-defined coordinate system, 5-16
- user-defined data types

embedding SDO_GEOMETRY objects in, 7-1,
7-6
utility functions, 17-1

V

VALID_GEOM_SEGMENT function, 14-88
VALID_LRS_POINT function, 14-90
VALID_MEASURE function, 14-92
VALIDATE_GEOMETRY function, 11-44
VALIDATE_GEOMETRY_WITH_CONTEXT
function, 11-46
VALIDATE_LAYER procedure, 11-49
VALIDATE_LAYER_WITH_CONTEXT
procedure, 11-52
VALIDATE_LRS_GEOMETRY function, 14-94
version number (Spatial)
retrieving, 1-26
VERTEX_SET_TYPE data type, 17-5
VERTEX_TYPE object type, 17-5
vertices
returning geometry coordinates as, 17-5
VIEWPORT_TRANSFORM, 13-7

W

well-known text (WKTEXT), 5-8
WITHIN_DISTANCE function, 11-55
WKTEXT column of MDSYS.CS_SRS table, 5-8

X

XOR
SDO_XOR function, 11-41

Z

zero
SRID value used with SDO_CS.VIEWPORT_
TRANSFORM function, 13-8
type 0 element, 2-24