Preparing for the Oracle Spatial Essentials Exam Session Overview

OVERVIEW

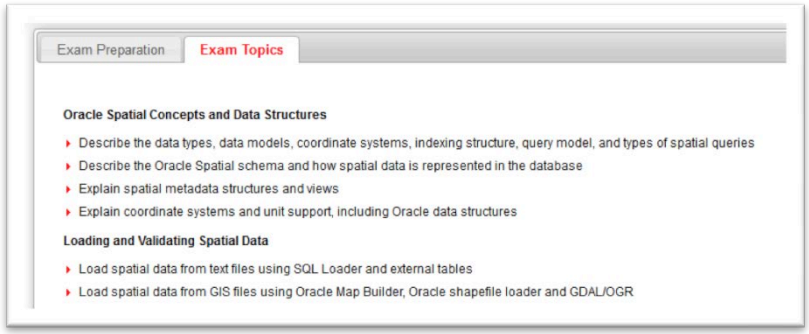
- The Oracle "Spatial Essentials Certification" measures skills in a number of technical areas
- Organizations interested in obtaining Oracle PartnerNetwork "Oracle Spatial 11g Specialized" status must have at least one individual who holds this certification

CHALLENGES / OPPORTUNITIES

- The exam covers a wide range of topics—many of which users might not have had experience with
- Preparation can appear difficult

SOLUTIONS

- Learn about how the exam is structured and what types of questions are included
- Review the topics included and the general level of detail covered for each
- See demonstrations and use cases on the specialized concepts and topics on the exam
- Learn about classroom courses and online resources



Excerpt of topic list from Oracle University site

RESULTS

- Gain a compact, comprehensive overview of all key Oracle Spatial technical capabilities, even if you don't plan to register for the exam
- Learn how to prepare for the certification exam efficiently and effectively
- Prepare yourself to pass the exam and become a recognized expert in Oracle Spatial implementations

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Oracle Spatial Summit

ORACLE

May 21, 2014
Walter E. Washington Convention Center
Washington, DC USA

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Preparing for the Oracle Spatial Essentials Exam:

Topic Review and Strategies

Overview

Certification vs Specialization

- Individual Certification

"The Oracle Spatial 11g Certified Implementation Specialist certification is designed ***for individuals who possess a strong technical background and exposure to Oracle Spatial 11g implementation****. This certification exam covers topics such as: Oracle Spatial Concepts and Data Structures; Loading and Validating Spatial Data; Indexing Spatial Data; Performing Spatial Queries; Performing Spatial Processing; Oracle Fusion Middleware MapViewer; Geocoding, Routing, Spatial Analysis and Mining; Web Services; Advanced Indexing (Partitioning, Parallelism, Function-Based Indexes); Using Linear Referencing and Network and Topology Models; GeoRaster; Managing 3D and Lidar Data; Performance and Tuning / Exadata; and Workspace Manager. This certification differentiates candidates in the marketplace by providing a competitive edge through proven expertise. Up-to-date training and field experience are recommended.*

This certification is available to all candidates but is geared toward members of the Oracle PartnerNetwork. OPN members earning this certification will be recognized as OPN Certified Specialists. This certification qualifies as competency criteria for the Oracle Spatial 11g Specialization."

Overview

Certification vs Specialization

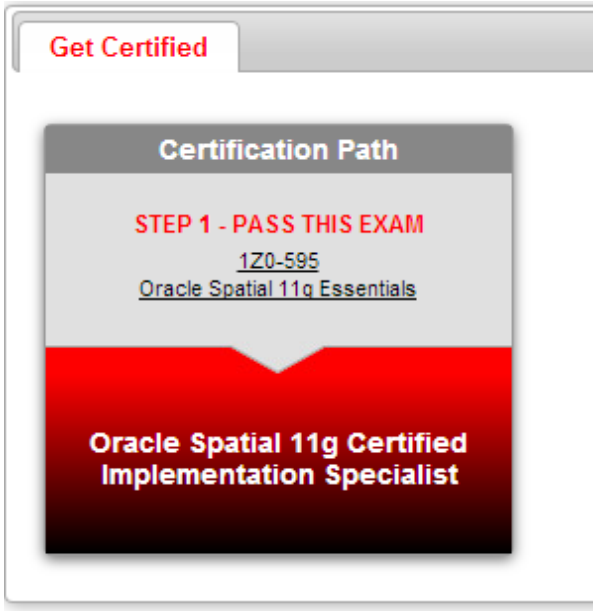
- Company Specialization

"The Oracle Spatial 11g Specialization ***recognizes partner organizations that are proficient in selling, implementing and/or developing Oracle Spatial 11g solutions****. Topics covered in this Specialization include: Oracle Spatial Concepts and Data Structures; Loading and Validating Spatial Data; Indexing Spatial Data; Performing Spatial Queries; Performing Spatial Processing; Oracle Fusion Middleware MapViewer; Geocoding, Routing, Spatial Analysis and Mining; Web Services; Advanced Indexing (Partitioning, Parallelism, Function-Based Indexes); Using Linear Referencing and Network and Topology Models; GeoRaster; Managing 3D and Lidar Data; Performance and Tuning / Exadata; and Workspace Manager."*

Overview

How to Get Certified

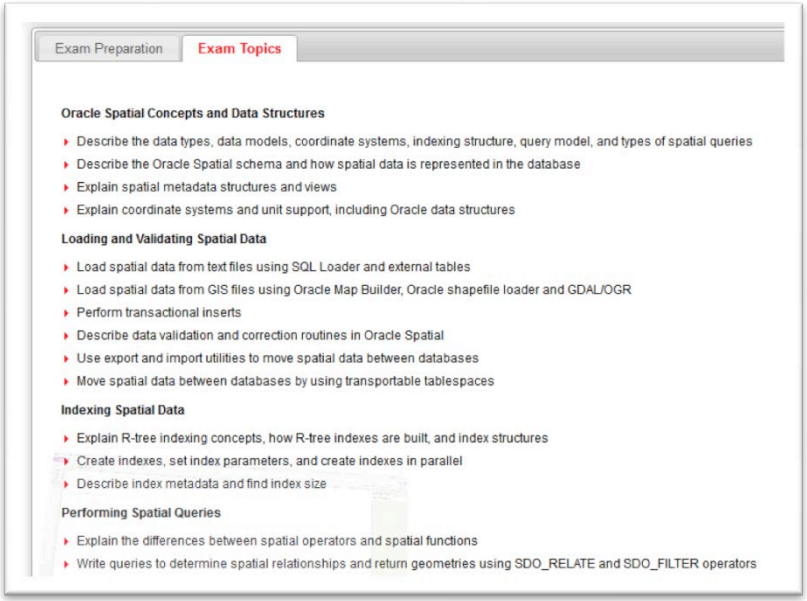
- 2-Step Certification Process
  - Preparation
    - Oracle Spatial: Essentials
    - Oracle Spatial: Advanced
    - Experience
  - Exam
    - Oracle Spatial 11g Essentials 1Z0-595



Overview

Where To Begin with Certification?

- There are a number of challenges when preparing for the exam:
  - The exam covers dozens of topics
  - Many of those topics aren't encountered frequently by spatial users
  - Varying levels of detail are covered for each topic



Excerpt of topic list from Oracle University site

Overview

Included in this Presentation

- Overview of exam topics
- For each topic:
  - Subtopics covered
  - Examples of the type of knowledge to be tested, to include:
    - Demonstrations
    - Sample questions
- Strategies for preparing and taking the exam

Section 1:

Exam Topics

Overview

Exam Topics

1. Oracle Spatial Concepts and Data Structures
2. Loading and Validating Spatial Data
3. Indexing Spatial Data
4. Performing Spatial Queries
5. Performing Spatial Processing
6. Oracle Fusion Middleware MapViewer
7. Geocoding, Routing, Spatial Analysis and Mining

Overview

Exam Topics (continued)

8. Web Services
9. Advanced Indexing
10. Using Linear Referencing / Network & Topology Models
11. GeoRaster
12. Managing 3D and Lidar Data
13. Performance and Tuning / Exadata
14. Workspace Manager

Spatial Concepts & Data Structures

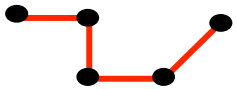
Topic 1

- What you need to know:
  - Describe the data types, data models, coordinate systems, indexing structure, query model, and types of spatial queries
  - Describe the Oracle Spatial schema and how spatial data is represented in the database
  - Explain spatial metadata structures and views
  - Explain coordinate systems and unit support, including Oracle data structures

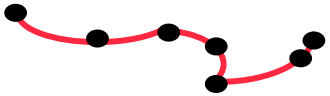
Geometric Primitive Types

Point

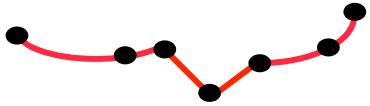
Line string



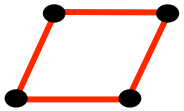
Arc line string



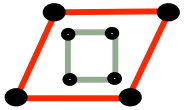
Compound line string



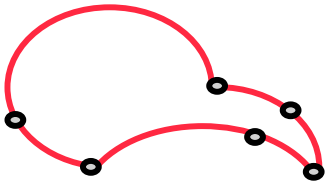
Polygon



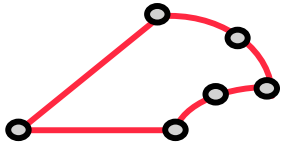
Polygon with one or more holes



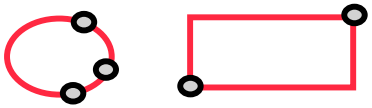
Arc polygon



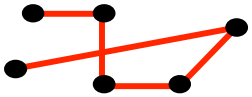
Compound polygon



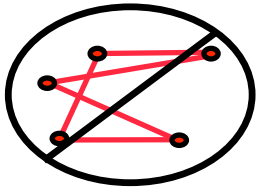
Optimized polygons



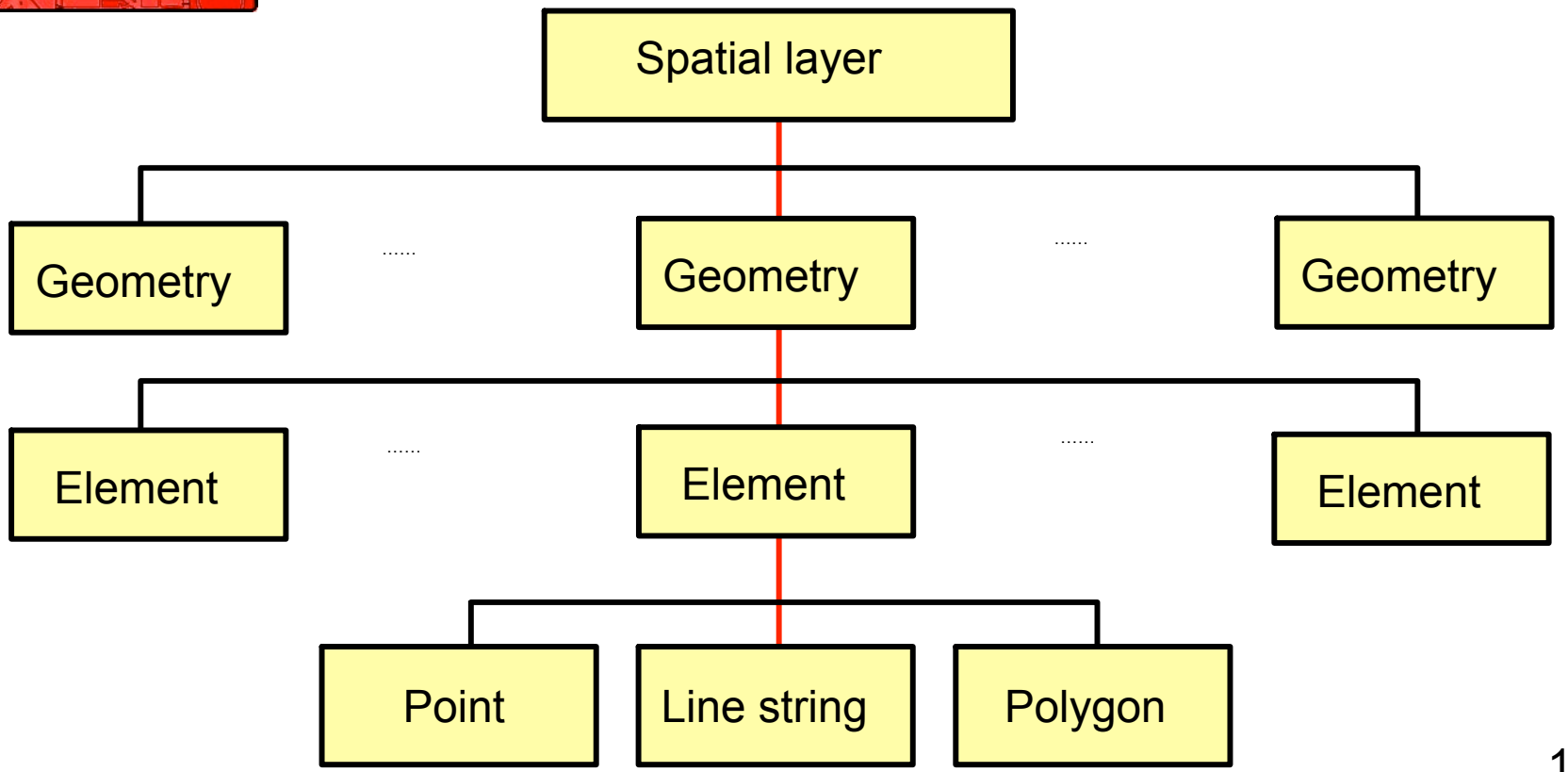
Self-crossing line strings valid



Self-crossing polygons not valid



Spatial Data Model

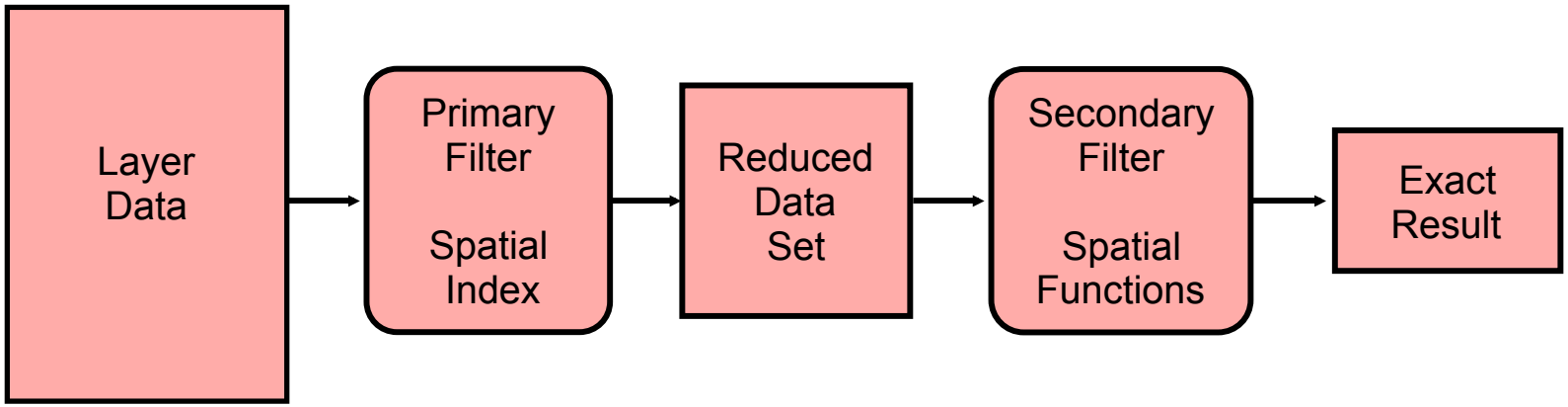


Spatial Metadata & Coordinate Systems

- The spatial routines require you to populate a view that contains metadata about the SDO_GEOMETRY columns.
- For every SDO_GEOMETRY column, insert a row in the USER_SDO_GEOM_METADATA view.
- A coordinate system (CS) is a means of assigning coordinates to a location.
  - It establishes relationships between sets of coordinates.
- All spatial data has an associated coordinate system.

Spatial Query Model

Anatomy of a spatial query



Loading and Validating Spatial Data

Topic 2

- What you need to know:
  - Load spatial data from text files using SQL Loader and external tables
  - Load spatial data from GIS files using Oracle Map Builder, Oracle shapefile loader and GDAL/OGR
  - Perform transactional inserts
  - Describe data validation and correction routines in Oracle Spatial
  - Use export and import utilities to move spatial data between databases
  - Move spatial data between databases by using transportable tablespaces

SQL*Loader sample

```
LOAD DATA
 CONTINUEIF NEXT(1:1) = '#'
 INTO TABLE us_counties
 FIELDS TERMINATED BY ';' (
  county,
  state,
  poppsqmi,
  geom COLUMN OBJECT (
    sdo_gtype     INTEGER EXTERNAL,
    sdo_srid      CONSTANT 8307,
    sdo_elem_info VARRAY TERMINATED BY '/' (e FLOAT EXTERNAL),
    sdo_ordinates VARRAY TERMINATED BY '/' (o FLOAT EXTERNAL) )
 )
```

```
 Autauga;Alabama;57.428300000;
#2003;1;1003;1/
#-86.916969000;32.664028000;-86.816589000;32.659988000;-86.713409000;....;
#-87.765160000;31.297176000;-86.916969000;32.664028000/
 Baldwin;Alabama;61.569000000;
#2003;1;1003;1;/
#-87.765160000;31.297176000;-87.760429000;31.297289000;-87.759232000;..../
```

Using GDAL

- To setup
  - Add **<…>\gdal<xxxx>\bin** to your path
  - Set **GDAL_DATA** to **<…>\gdal<xxxx>\data** (optional)
- Main commands for vector data
  - ogrinfo = get information about a file (or spatial table)
  - ogr2ogr = copy from one format to another (import/export)
- Documentation
  - http://www.gdal.org/ogr/
  - http://www.gdal.org/ogr/ogr_formats.html
  - http://www.gdal.org/ogr/drv_oci.html

Using GDAL

```
ogr2ogr -f OCI OCI:scott/tiger@orcl112 world_countries.shp
-lco DIM=2 -lco SRID=8307 -lco GEOMETRY_NAME=geometry -lco INDEX=NO
```

`-f OCI`	Use Oracle as output
`OCI:scott/tiger@orcl112`	Database connection
`world_countries.shp`	Input shape file
`-lco DIM=2`	Dimension (2D)
`-lco SRID=8307`	SRID
`-lco GEOMETRY_NAME=geometry`	Name of geometry column
`-lco INDEX=NO`	Do not create a spatial index

Validating Geometries

- Oracle Spatial validation routines ensure that spatial data in Oracle Spatial is valid.
  - SDO_GEOM.VALIDATE_GEOMETRY_WITH_CONTEXT
    - Determines whether a single geometry is valid
  - SDO_GEOM.VALIDATE_LAYER_WITH_CONTEXT
    - Determines whether all geometries in a layer are valid
- If data is invalid, both routines return why and where the geometry is invalid.

Indexing Spatial Data

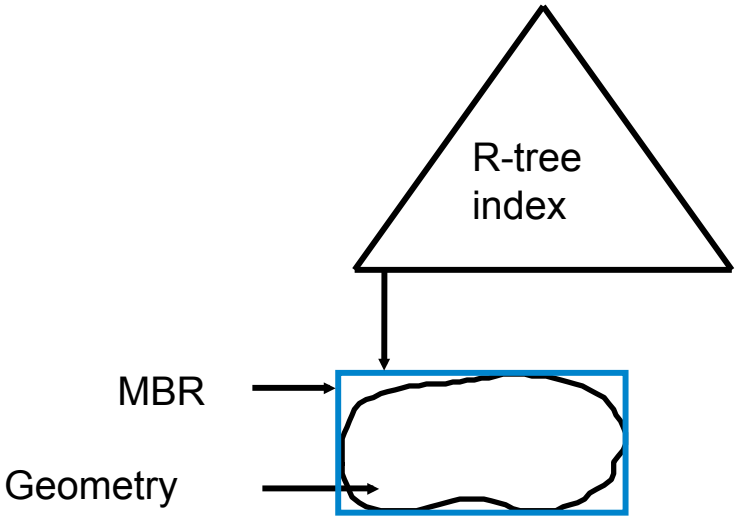
Topic 3

- What you need to know:
  - Explain R-tree indexing concepts, how R-tree indexes are built, and index structures
  - Create indexes, set index parameters, and create indexes in parallel
  - Describe index metadata and find index size

R-tree Indexing

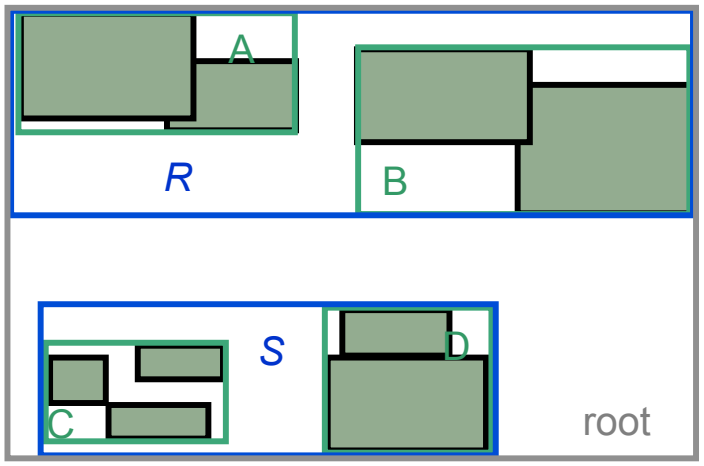
- R-tree indexing is used to index spatial data.
  - Requires almost no configuration
  - Indexes two or three dimensions
- Primary filter (index only query) can operate on two or three dimensions
- Secondary filters are two dimensional or three dimensional
- Each index entry approximates geometry using Minimum Bounding Rectangle (MBR) for 2-D and Minimum Bounding Volume (MBV) for 3-D.
- MBRs and MBVs are indexed internally using a tree structure.

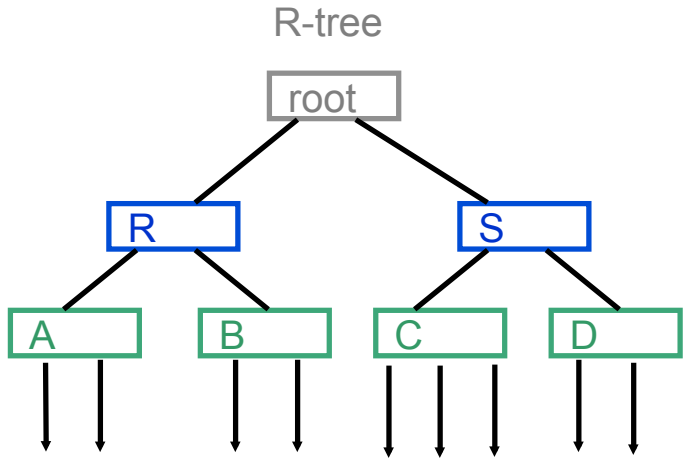
R-tree Indexing Concept



Leaf nodes of R-tree store
<MBR, geometry pointer>

Building the R-Tree



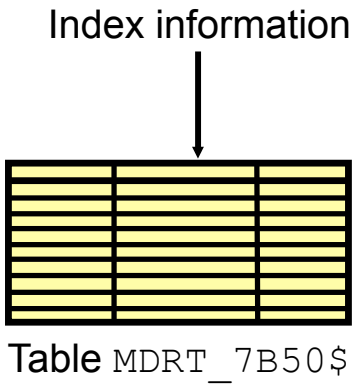


MBRs, pointers to geometries

– Fanout is the number of branches that comes out of each node.
– Oracle Spatial R-tree has the same fanout for all nodes.

A Look at R-tree Index Structures

```
CREATE INDEX us_states_sx
   ON us_states (geom)
 INDEXTYPE IS mdsys.spatial_index;
```



- Index tables are “opaque” structures
- Do not change them in any way

CREATE INDEX

```
CREATE INDEX <index-name>
  ON <table-name> (<column-name>)
  INDEXTYPE IS MDSYS.SPATIAL_INDEX
  [PARAMETERS (
   '<parameter> = <value> … <parameter> = <value>') ]
  [PARALLEL [<parallel_degree>]];
```

- Parameters
  - LAYER_GTYPE
  - PARALLEL
  - SDO_INDX_DIMS
  - SDO_RTR_PCTFREE
  - …

Parallel Index Creation

- PARALLEL [<parallel_degree>]
  - This parameter breaks the work of index creation into smaller pieces that can be performed in parallel.
  - <parallel_degree> is an optional parameter that specifies the degree of parallelism.
  - If the degree of parallelism is not specified, Oracle chooses a default based on the number of CPUs.

```
CREATE INDEX us_counties_sx
   ON us_counties(geom)
    INDEXTYPE IS MDSYS.SPATIAL_INDEX
    PARALLEL 4;
```

Spatial Index Dictionary Views

- USER_SDO_INDEX_INFO
  - Summary information
- USER_SDO_INDEX_METADATA
  - Detailed information
- Also “ALL” variants

USER_SDO_INDEX_INFO

```
INDEX_NAME              VARCHAR2(32)
TABLE_NAME              VARCHAR2(32)
COLUMN_NAME             VARCHAR2(2048)
SDO_INDEX_TYPE          VARCHAR2(32)
SDO_INDEX_TABLE         VARCHAR2(32)
```

- Useful to relate a spatial index to its physical MDRT table
- Allows you to find out the size of the index

USER_SDO_INDEX_METADATA

SDO_INDEX_OWNER	VARCHAR2(32)
SDO_INDEX_TYPE	VARCHAR2(32)
SDO_INDEX_NAME	VARCHAR2(32)
SDO_INDEX_TABLE	VARCHAR2(32)
SDO_INDEX_PRIMARY	NUMBER
SDO_INDEX_PARTITION	VARCHAR2(32)
SDO_PARTITIONED	VARCHAR2(32)
SDO_TSNAME	VARCHAR2(32)
SDO_COLUMN_NAME	VARCHAR2(2048)
SDO_INDEX_DIMS	NUMBER
SDO_RTREE_HEIGHT	NUMBER
SDO_RTREE_NUMNODES	NUMBER
SDO_RTREE_DIMENSIONALITY	NUMBER
SDO_RTREE_FANOUT	NUMBER
SDO_RTREE_ROOT	VARCHAR2(32)
SDO_RTREE_SEQ_NAME	VARCHAR2(32)
SDO_RTREE_PCTFREE	NUMBER
SDO_INDEX_STATUS	VARCHAR2(32)
SDO_LAYER_GTYPE	VARCHAR2(32)

SDO_LEVEL	NUMBER
SDO_NUMTILES	NUMBER
SDO_MAXLEVEL	NUMBER
SDO_COMMIT_INTERVAL	NUMBER
SDO_FIXED_META	RAW(255)
SDO_TABLESPACE	VARCHAR2(32)
SDO_INITIAL_EXTENT	VARCHAR2(32)
SDO_NEXT_EXTENT	VARCHAR2(32)
SDO_PCTINCREASE	NUMBER
SDO_MIN_EXTENTS	NUMBER
SDO_MAX_EXTENTS	NUMBER
SDO_RTREE_QUALITY	VARCHAR2(32)
SDO_INDEX_VERSION	NUMBER
SDO_INDEX_GEODETIC	VARCHAR2(8)
SDO_NL_INDEX_TABLE	VARCHAR2(32)
SDO_DML_BATCH_SIZE	NUMBER
SDO_RTREE_ENT_XPND	NUMBER
SDO_ROOT_MBR	SDO_GEOMETRY

Find Index Size

```
select i.table_name, i.index_name, si.column_name,
       si.sdo_index_table, s.bytes
from   user_indexes i,
       user_sdo_index_info si,
       user_segments s
where  i.index_type = 'DOMAIN'
and    i.ityp_name = 'SPATIAL_INDEX'
and    i.index_name = si.index_name
and    s.segment_name = si.sdo_index_table
order by i.table_name, i.index_name;
```

```
TABLE_NAME       INDEX_NAME           COLUMN_N SDO_INDEX_TA      BYTES
---------------- -------------------- -------- ------------ ----------
US_CITIES        US_CITIES_SX         LOCATION MDRT_1ABA5$       65536
US_COUNTIES      US_COUNTIES_SX       GEOM     MDRT_1ABAE$      327680
US_INTERSTATES   US_INTERSTATES_SX    GEOM     MDRT_1ABC1$       65536
US_PARKS         US_PARKS_SX          GEOM     MDRT_1ABCA$      655360
US_RIVERS        US_RIVERS_SX         GEOM     MDRT_1ABD4$       65536
US_STATES        US_STATES_SX         GEOM     MDRT_1ABB8$       65536
WORLD_CONTINENTS WORLD_CONTINENTS_SX  GEOM     MDRT_1ABDD$       65536
WORLD_COUNTRIES  WORLD_COUNTRIES_SX   GEOM     MDRT_1ABE6$       65536
```

Demo

Performing Spatial Queries

Topic 4

- What you need to know:
  - Explain the differences between spatial operators and spatial functions
  - Write queries to determine spatial relationships and return geometries using SDO_RELATE and SDO_FILTER operators
  - Write queries returning results within a specific distance and nearest neighbors
  - Write queries finding correlations between two spatial layers
  - Write queries combining spatial and non-spatial criteria

Spatial Operators vs. Functions

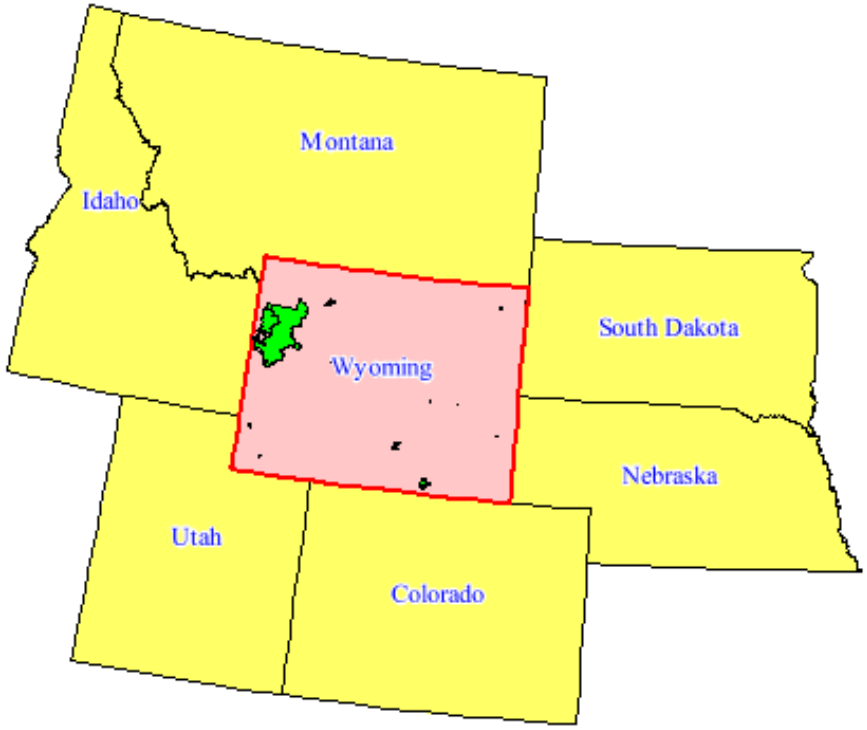
- **Spatial operators:**
  - Require a spatial index on the first geometry specified in the operator
  - Take advantage of spatial indexes
  - Appear only in the WHERE clause
  - Implicitly transform the coordinate system of the window, if required

- **Spatial functions:**
  - Do not take advantage of spatial indexes !
  - Can be used on small tables that are not spatially indexed
  - Can be used in the SELECT list and the WHERE clause
  - Both geometries must exist in the same coordinate system.

SDO_RELATE example

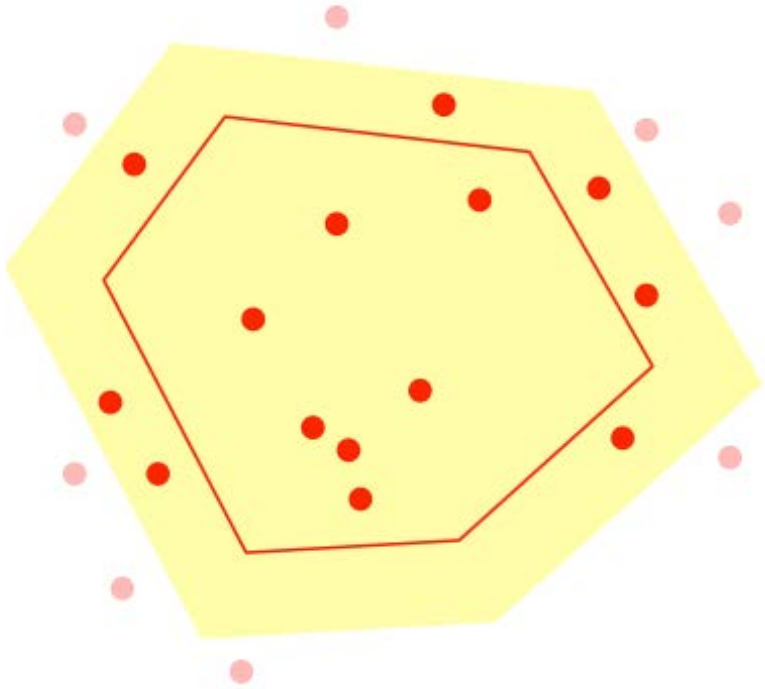
Which parks fully inside the state of Wyoming ?

```
SELECT p.id, p.name
  FROM us_parks p, us_states s
 WHERE s.state = 'Wyoming'
   AND SDO_INSIDE (
         p.geom, s.geom
       ) = 'TRUE';
```



SDO_WITHIN_DISTANCE example

How many customers are within 10 km of a sales region ?



```
SELECT count(*)
  FROM sales_regions r, customers c
 WHERE r.region_id = 'R1'
   AND sdo_within_distance (
         c.location, r.geom,
         'distance=10 unit=km')
       = 'TRUE';
```

```
SELECT count(*)
  FROM sales_regions r, customers c
 WHERE r.region_id = 'R1'
   AND sdo_within_distance (
         c.location, r.geom,
         'distance=10 unit=km')
       = 'TRUE'
   AND SDO_GEOM.SDO_DISTANCE (
         c.location, r.geom, 0.5) > 0;
```

SDO_JOIN example

Which cities are within 10 miles of an interstate ?

```
SELECT c.city, i.interstate
  FROM us_cities c,
       us_interstates i,
       TABLE(SDO_JOIN(
             'US_CITIES', 'LOCATION',
             'US_INTERSTATES', 'GEOM',
             'DISTANCE=10 UNIT=MILE')) j
WHERE j.rowid1 = c.rowid
  AND j.rowid2 = i.rowid
ORDER BY c.city;
```

Performing Spatial Processing

Topic 5

- What you need to know:
  - Perform area, length, and distance calculations using spatial functions
  - Create buffers, combine geometries, and derive geometries
  - Use spatial aggregate functions
  - Describe the functions for arc densification/coordinate transformation
  - Use spatial utility functions
  - Describe the functions for conversion from/to OGC formats
  - Generate GML documents from spatial objects
  - Modify geometries using PL/SQL
  - Use the Java API to work with geometries

The SDO_AREA Function

- <geometry>
  - SDO_GEOMETRY that defines a polygon
    - Can be a variable or table column
- <tolerance>
  - Number used as the tolerance
- <unit>
  - A quoted string with the units for the result
- Returned value
  - A number that is the area of the input polygon

```
area := SDO_GEOM.SDO_AREA
  (<geometry>, <tolerance> [, <unit>])
```

The SDO_LENGTH Function

- <geometry>: SDO_GEOMETRY that defines a polygon or line
  - Can be a variable or table column
- <tolerance>: Number used as the tolerance
- <unit>: Quoted string with the units for the result
- <returned_value>: Numeric length

```
length := SDO_GEOM.SDO_LENGTH
 ( <geometry>, <tolerance> [, <unit>])
```

The SDO_DISTANCE Function

- <geometry-1> <geometry-2>: SDO_GEOMETRY objects
  - Can be variables or table columns
- <tolerance>: Numeric tolerance for the function
- <unit>: Quoted string with the units for the result
- <returned_value>: A number (the minimum distance between the geometries)

```
distance := SDO_GEOM.SDO_DISTANCE
    ( <geometry-1>, <geometry-2>,
      <tolerance> [, <unit>])
```

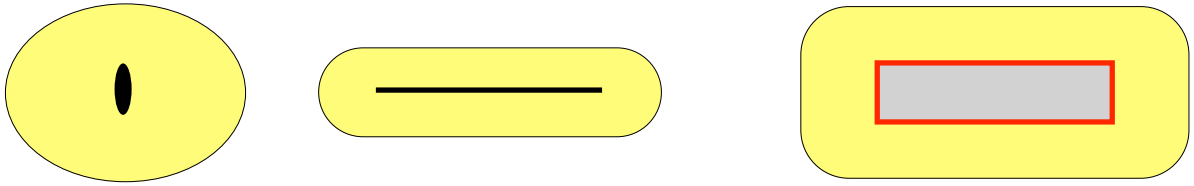
SDO_BUFFER Function

SDO_GEOM.SDO_BUFFER

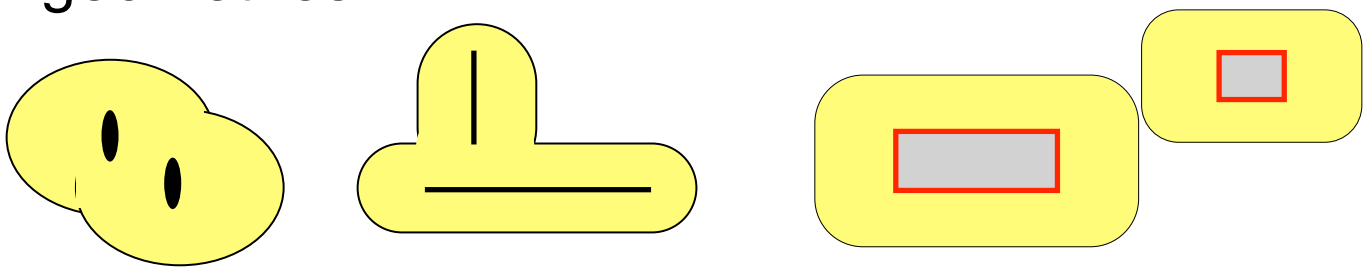
- Generates a buffer polygon around a geometry
- Takes an SDO_GEOMETRY object as input
  - Any kind (point, line, polygon, compound)
  - Can buffer geodetic geometries
- Returns an SDO_GEOMETRY object containing the buffer (polygon)

Buffer Examples

- Simple geometries



- Collection geometries



The SDO_BUFFER Function

DEMO

- <geometry>:SDO_GEOMETRY object to buffer
  - Can be a variable or table column
- <distance>: The buffer distance
- <tolerance>: A number used as the tolerance

```
SDO_GEOMETRY := SDO_GEOM.SDO_BUFFER
   ( <geometry>, <distance>,
     <tolerance> [, '<params>'])
```

```
SELECT SDO_GEOM.SDO_BUFFER(location, 100, .
05, 'unit=km') FROM cities
```

Geometric Intersection

- SDO_GEOM.SDO_UNION
- SDO_GEOM.SDO_INTERSECTION
- SDO_GEOM.SDO_DIFFERENCE
- SDO_GEOM.SDO_XOR

SDO_AGGR_UNION Example

- UNION all the county boundaries for the states of New York and New Jersey, and generate a geometry for each state:

```
SELECT sdo_aggr_union(sdoaggrtype(geom, 0.5)),
       state
FROM us_counties
WHERE state_abrv in ('NY', 'NJ')
GROUP by state;
```

- Note: SDO_AGGR_SET_UNION

Coordinate Transformation Functions

- SDO_CS.TRANSFORM: Transforms a geometry from one coordinate system to another
- SDO_CS.TRANSFORM_LAYER: Transforms a layer from one coordinate system to another

The SDO_CS.TRANSFORM Function

- <geom>
  - Geometry of type SDO_GEOMETRY
  - Can be a variable or a table column
- <to_srid>
  - Spatial reference system ID to transform to
- Return value
  - Geometry of type SDO_GEOMETRY

```
SDO_GEOMETRY := SDO_CS.TRANSFORM (<geom>, <to_srid>)
```

SDO_CS.TRANSFORM: Example

DEMO

- Single geometry transformed, for example, Hillsborough County in New Hampshire:

```
SELECT sdo_cs.transform (geom, 82151)
FROM us_counties_p
WHERE county = 'Hillsborough'
  AND state = 'New Hampshire';
```

- Note: All transformations require valid SDO_SRID field set in source geometry.
- Note: 82151 = “New Hampshire 2800 (1983, meters)” - State Plane CS 1983

Package SDO_UTIL

- simplify()
- circle_polygon()
- ellipse_polygon()
- polygonToLine()
- remove_duplicate_vertices
- append()
- concat_lines
- reverseLinestring()
- getNumElem
- getNumVertices
- convert_unit
- point_at_bearing
- AffineTransforms

OGC Methods

- GET_WKT
  - Returns Well Known Text format of SDO_GEOMETRY
- GET_WKB
  - Returns Well Known Binary format of SDO_GEOMETRY
- Extract Geometries to WKT

```
SELECT c.geom.get_wkt()
FROM us_counties c
WHERE county = 'Denver';
```

```
POLYGON (
  (-105.052597 39.791199, -105.064606 39.789928, ...
   ... -105.024757 39.790947,-105.052597 39.791199),
  (-104.933578 39.698139, -104.936104 39.698299, ...
   ...  -104.9338 39.696701, -104.933578 39.698139))
```

Exporting Geometries to GML

```
SELECT sdo_util.to_gmlgeometry(location)
FROM us_cities
WHERE state_abrv = 'CO';
```

```
<gml:Point srsName="SDO:8307"
  xmlns:gml="http://www.opengis.net/gml">
  <gml:coordinates decimal="." cs="," ts=" ">
    -104.872655,39.768035
  </gml:coordinates>
</gml:Point>
```

Oracle Fusion Middleware MapViewer

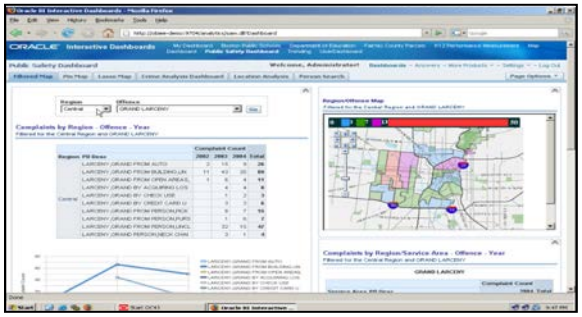
Topic 6

- What you need to know:
  - Explain the use of Oracle Fusion Middleware MapViewer
  - Describe the architecture of MapViewer
  - Install, configure, and administer MapViewer using OC4J and WebLogic Server
  - Define maps using styles, themes, and maps
  - Define and manage tile caches
  - Build applications using the Oracle Maps tutorial
  - Integrate external data
  - Define and access OGC Web Mapping Service and Web Feature Services

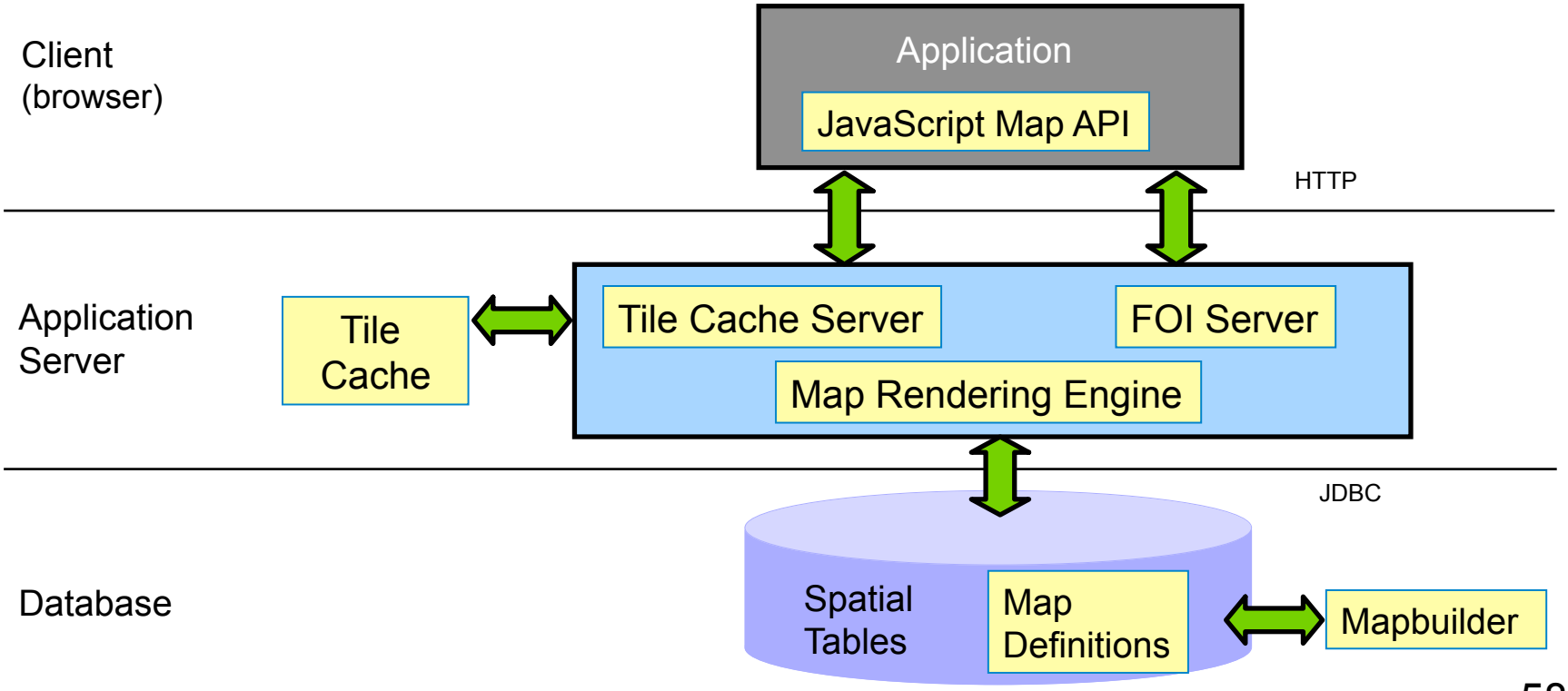
***Resource:** MapViewer Primer

Oracle Application Server MapViewer

- A standard feature of all versions of Fusion Middleware
  - Oracle Application Server
  - Weblogic Server
- XML, Java and JSP APIs
- Map definition tool
- Map definitions and symbology stored in the database
- Thematic mapping
- Produces PNG, GIF, JPEG, SVG
- AJAX API for rich user interfaces
- High performance map cache
- Integration with Business Intelligence tools

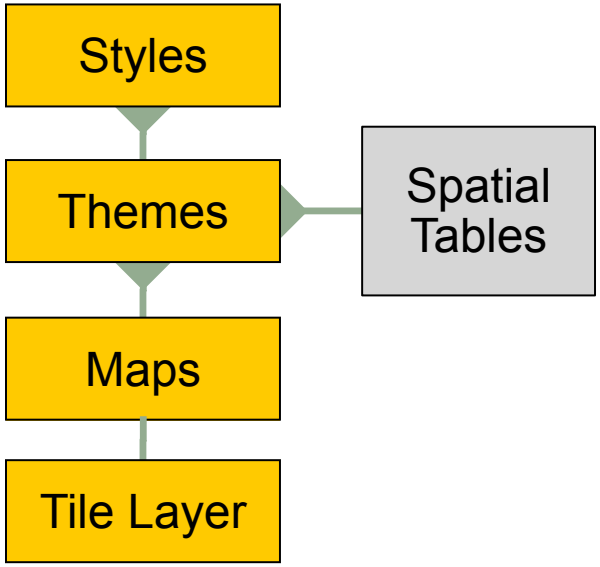


MapViewer "AJAX" Architecture: *Oracle Maps*



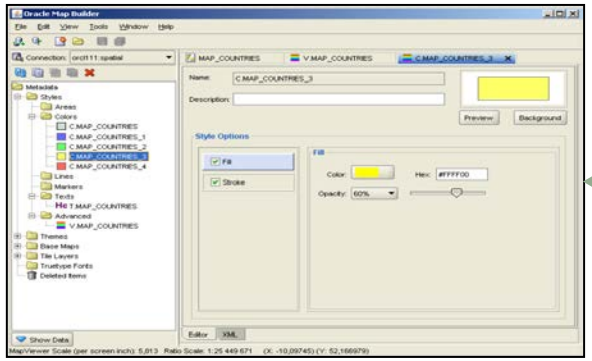
Map Definitions

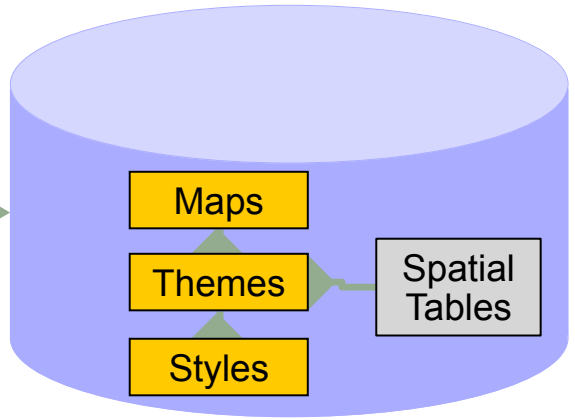
- **Style**: defines how shapes should be rendered
  - Areas: color, transparency, boundary thickness and color, …
  - Lines: color, thickness, center lines, wing lines, hash marks, …
  - Points: symbols, graphics, …
  - Texts: font, styling, color, size, halo, …
- **Theme**: associates a spatial table and a style
  - Graphic style and text style (for labels)
- **Map**: groups a number of themes
  - Visibility of themes based on scale
- **Map Cache**: makes a base map available to web applications



Updating Map Definitions

- Definitions are stored in the database
  - USER_SDO_STYLES
  - USER_SDO_THEMES
  - USER_SDO_MAPS
  - USER_SDO_CACHED_MAPS
- Updated using MapBuilder





USER_SDO_STYLES

- Style information stored in the database
  - Text, colors, line styles, area and fill information, markers
  - Advanced styles for thematic mapping based on a column value
- Includes XML definition of each style
- Can add styles easily using Mapbuilder

```
SQL> describe user_sdo_styles
Name                      Type
------------------------  ------------------
NAME                      VARCHAR2(32)
TYPE                      VARCHAR2(32)
DESCRIPTION               VARCHAR2(4000)
DEFINITION                CLOB
IMAGE                     BLOB
GEOMETRY                  MDSYS.SDO_GEOMETRY
```

USER_SDO_THEMES

- Stores user-defined themes
- User specifies:
  - Theme name and description
  - Table name
  - Geometry column name
  - Styling rules in XML based on values in USER_SDO_STYLES

```
SQL> describe user_sdo_themes
 Name                 Type
 -------------------- ---------------
 NAME                 VARCHAR2(32)
 DESCRIPTION          VARCHAR2(4000)
 BASE_TABLE           VARCHAR2(32)
 GEOMETRY_COLUMN      VARCHAR2(2048)
 STYLING_RULES        CLOB
```

What Are Themes?

- A theme applies one or more styles to a geometry column
  - Feature drawing information (color, fill, marker, and so on)
  - Text and label font, color, size
- Thematic mapping is supported by associating an advanced style to a theme.
- Themes can be based on any kind of spatial data:
  - Vector (SDO_GEOMETRY)
  - Raster (SDO_GEORASTER)
  - Network, topology ,…
  - WMS or WFS servers
- Possible to preview the results …

USER_SDO_MAPS

- A map is a collection of themes
- User specifies a map name and (optionally) a description
- User specifies an XML definition:
  - Theme names to display
  - Zoom scale information to specify when themes display

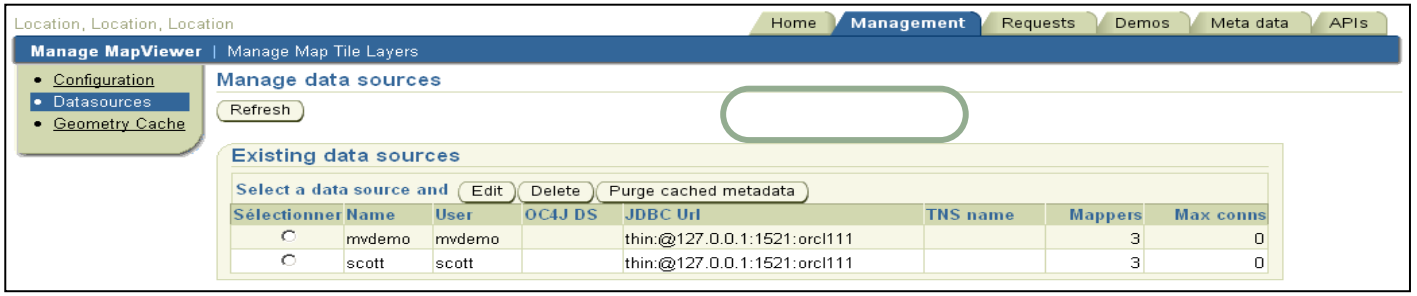
```
SQL> describe user_sdo_maps
 Name                 Type
 -------------------- --------------------
 NAME                 VARCHAR2(32)
 DESCRIPTION          VARCHAR2(4000)
 DEFINITION           CLOB
```

What Are Maps?

- A map groups one or more themes
- Can specify “min scale” and/or “max scale” values to control the visibility of each theme depending on map scale.
- Can also control label visibility
- Use ratio-scales (not “mapviewer native”)
- Can control the order in which themes are rendered
- A theme can be used in many different maps

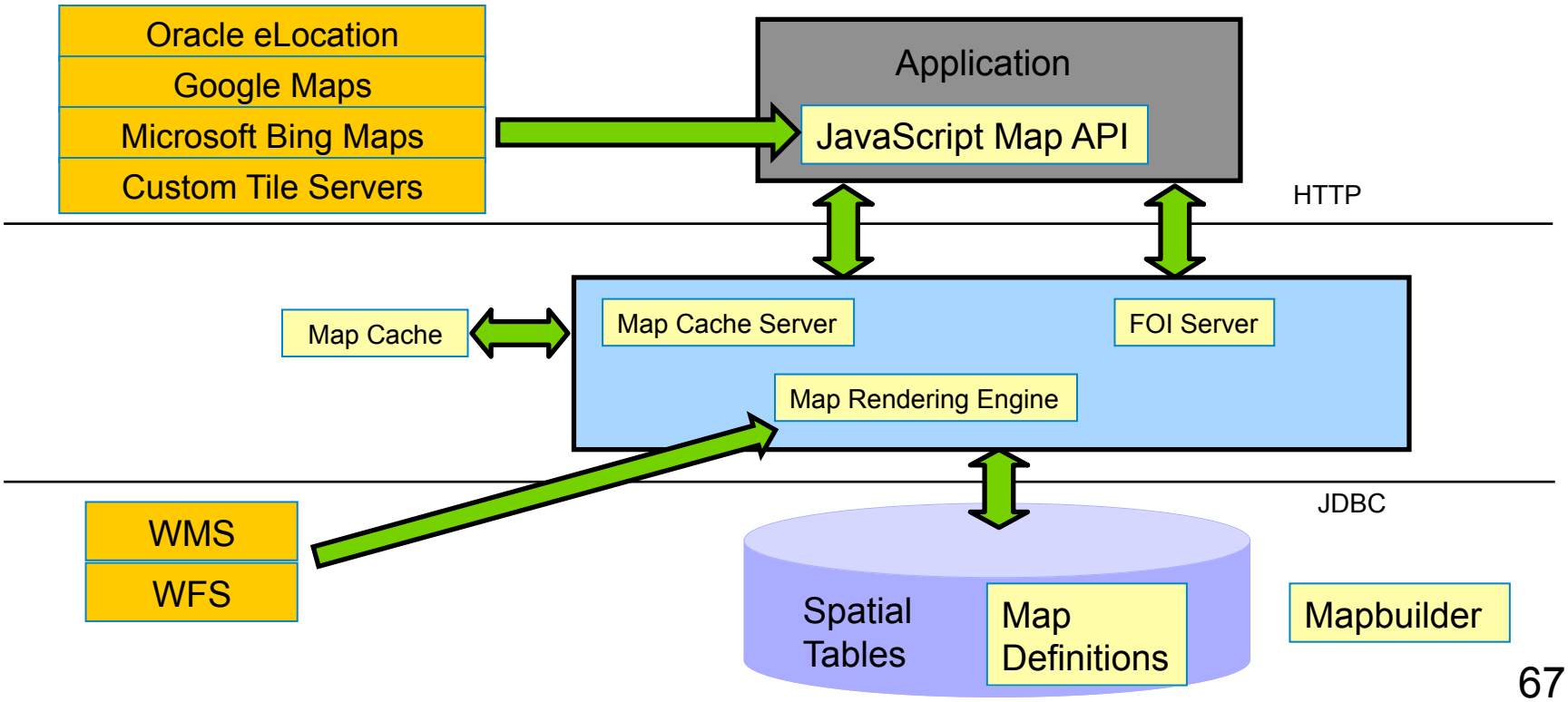
Updating Definitions

- Changes are only applied to the database tables
  - USER_SDO_STYLES, _THEMES and _MAPS
- Existing applications will not see the changes
  - Definitions are cached in memory
  - Clear the cache:



- Map Tile Caches are also invalid now!
  - Rebuild the cache!

Integrating External Data Sources



Integrating External Data Sources

- **From the browser**
  - Use an eLocation background (« Oracle Maps »)
    - Only for Oracle tools and applications!
  - Use a Google Maps or Microsoft Bing Maps background
  - Access any other tile server
    - Custom map tile layer
- **From the server**
  - Use WMS or WFS servers
  - Data will be cached in the map cache

Using an Elocation Background

- Saves you all the effort of buying, loading and maintaining your own spatial data for the base maps.
- Also saves you the effort of designing a base map from scratch.
- Free for use by applications that use Oracle.
- Check out terms and conditions on http://elocation.oracle.com/elocation/legal.html

```
mapview.addMapTileLayer(new MVMapTileLayer("elocation_mercator.world_map",    "http://
elocation.oracle.com/mapviewer/mcserver") );
```

Using a Google or Bing Maps Background

- Saves you all the effort of buying, loading and maintaining your own spatial data for the base maps.
- Also saves you the effort of designing a base map from scratch.
- Google or Bing APIs automatically loaded
- Free for private use, not for commercial use!
  - Check out access restrictions

```
var basemap = new MVBingTileLayer({key:<your_bing_maps_key> ) ;
    mapview.addMapTileLayer(basemap);
```

WMS Themes

Define a WMS Theme - Step 2 of 3 - WMS Basic Parameters

WMS Theme Basic Info

Get Map URL: http://localhost:7001/mapviewer/wms?

Layers: RKS,US_INTERSTATES,US_COUNTIES,US_CITIES Layers

SRS: EPSG:8307

Choose layers

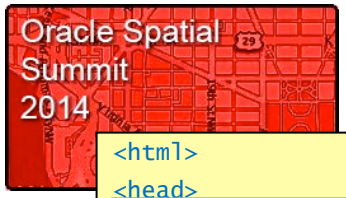
Choose coordinate system

< Back Next > Finish Cancel

Select Layers

Available Fields	Selected Fields
US_CITIES	WORLD_COUNTRIES
US_COUNTIES	US_STATES
US_INTERSTATES	US_PARKS

Help Ok Cancel



Oracle Maps: the Javascript API

```
<html>
<head>
<script language="Javascript" src="/mapviewer/fsmc/jslib/oraclemaps.js"></script>
<script language=JavaScript>
  var baseURL  = "http://"+document.location.host+"/mapviewer";
  function display_map() {
    var mapview = new MVMapView (document.getElementById(« MAP_DIV"), baseURL);
    mapview. addMapTileLayer(new MVMapTileLayer ("mvdemo.demo_map"));
    mapview.setCenter(-122.45, 37.75);
    mapview.setZoomLevel(5);
    mapview.addNavigationPanel("east");

    var foiLayer = new MVThemeBasedFOI ('customers', 'mvdemo.customers') ;
    mapview.addThemeBasedFOI (foiLayer);

    mapview.display();
  }
</script>
</head>
<body onload=display_map() >

  <div id="MAP_DIV" style="left:10; top:60;width: 600px; height: 500px"></div>
</body>
</html>
```

Load the Oracle Maps client library

Initialize and configure the map

Add a dynamic theme

Launch the map

Automatically produce the map when the HTML page is loaded

Geocoding, Routing, Spatial Analysis and Mining

Topic 7

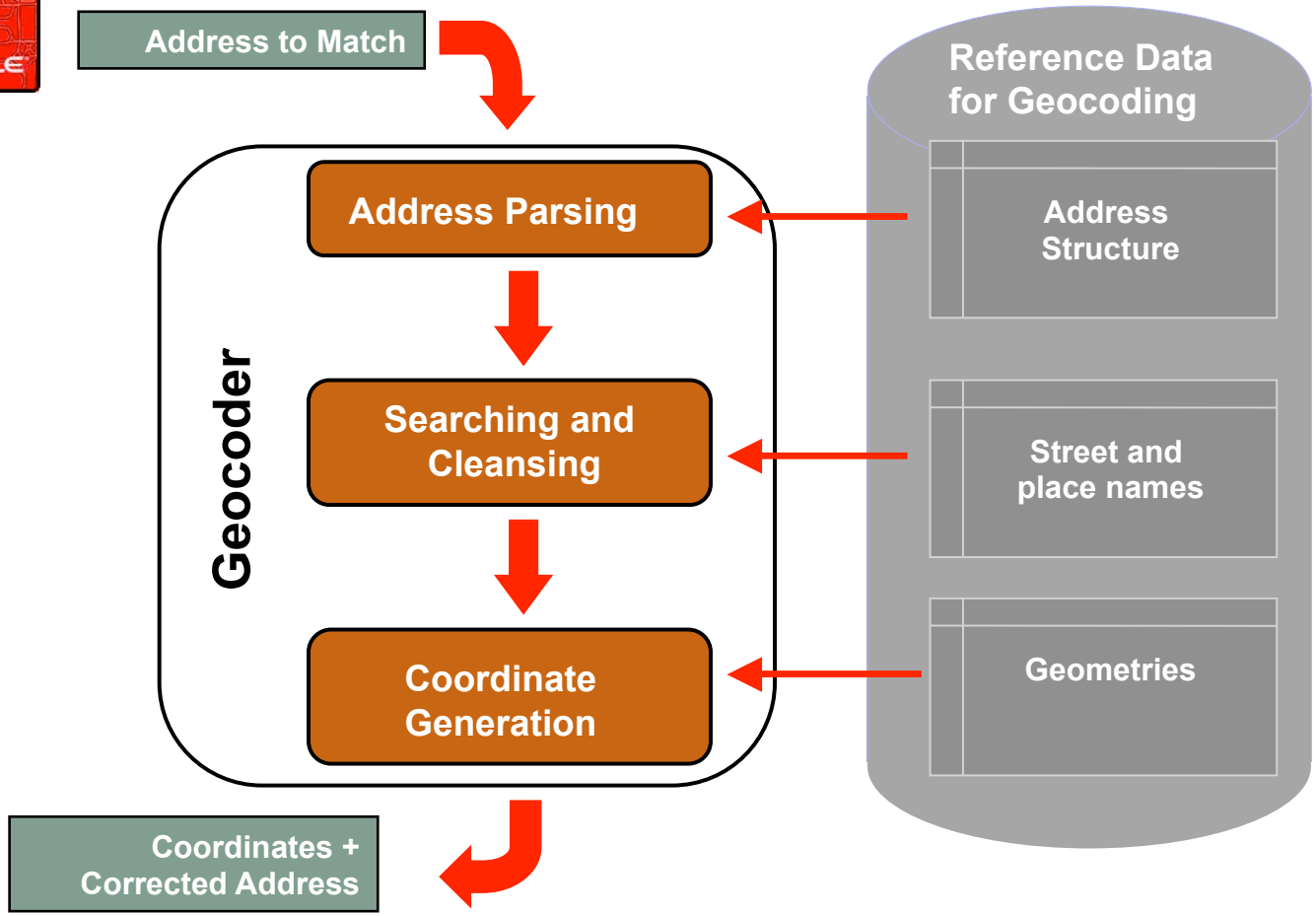
- What you need to know:
  - Describe geocoding concepts, process, and functionality provided in Oracle Spatial
  - Describe the geocoding data model
  - Describe geocoding functions and structure of address results
  - Explain point addressing, structured address geocoding, and reverse geocoding
  - Install, configure, and use geocoding services with the XML API
  - Describe where to obtain data to use with the geocoding and routing engines (…)

Geocoding, Routing, Spatial Analysis and Mining

Topic 7

- What you need to know (continued):
  - Describe the capabilities and architecture of the routing engine
  - Describe the routing engine tables
  - Install and configure the routing engine
  - Formulate XML route requests and describe the structure of route responses
  - Explain the concept of network partitioning
  - Partition the network used by the routing engine
  - Describe the uses and capabilities of the spatial analysis and mining functions

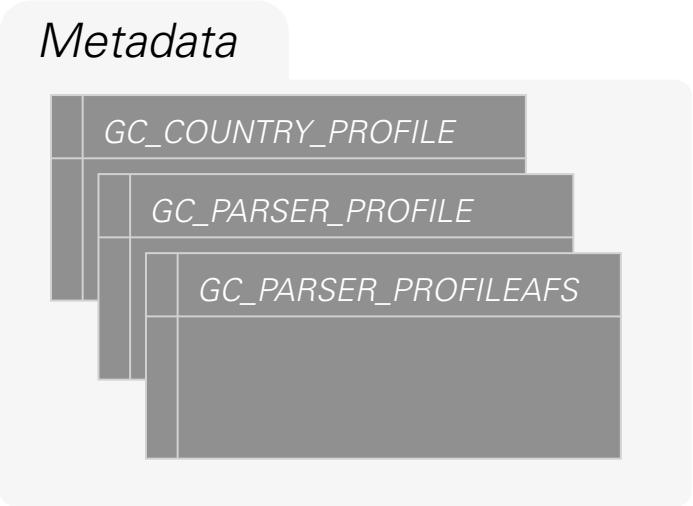
The Geocoding Process



Geocoding Tables

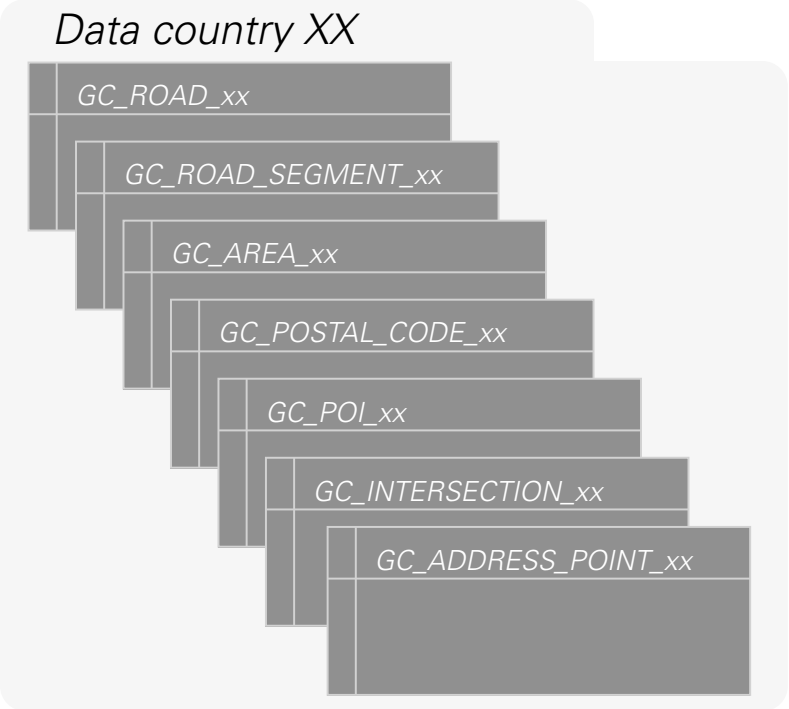
Metadata tables

- Describe the organization of the geocoding data
- Define address structure and parsing rules



Data tables

- Can have multiple sets of data
- One per country, or multiple countries per set
- Typically one set per country, with a country suffix



PL/SQL API Example

```
SELECT SDO_GCDR.GEOCODE('SCOTT',
  SDO_KEYWORDARRAY('Clay Street', 'San Francisco, CA'),
  'US', 'DEFAULT') GEO_ADDR
FROM DUAL;
```

```
SDO_GEO_ADDR(0, SDO_KEYWORDARRAY(), NULL, 'CLAY ST', NULL,
NULL, 'SAN FRANCISCO', 'SAN FRANCISCO', 'CA', 'US',
'94108', NULL,'94108', NULL, '998', 'CLAY', 'ST', 'F', 'F',
NULL, NULL, 'L', 0, 198728956, '????#ENUT?B281CP?', 1,
'DEFAULT', -122.40953, 37.79388, '???14101010??004?')
```

MATCHCODE 1 = exact match with provided input

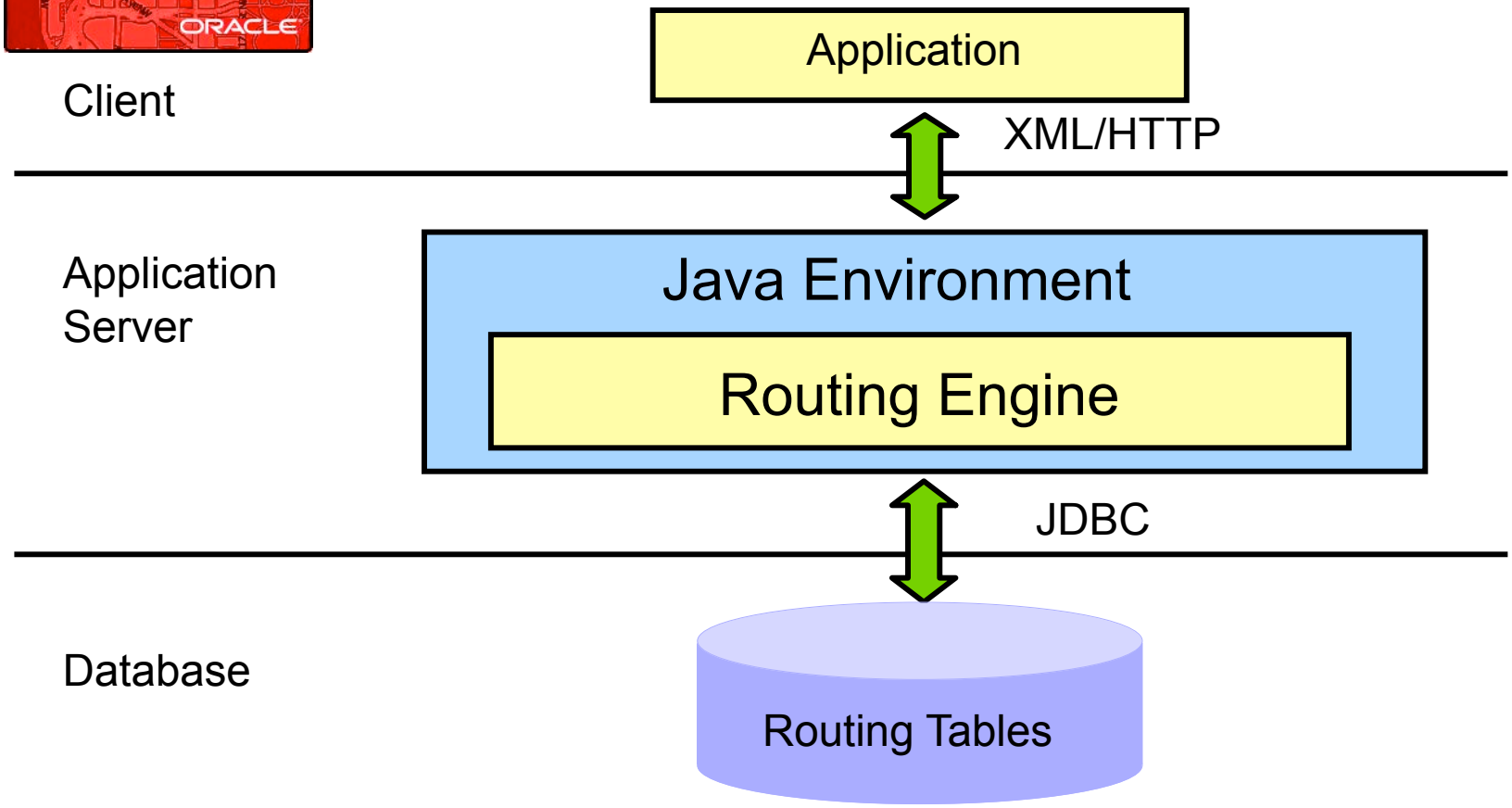
Deploy & use Geocoding web service

- Deploy **GEOCODER.EAR** in your application server
  - File is in **$ORACLE_HOME/md/jlib**
  - The initial startup fails because the default configuration has no database connction
  - Geocoder demonstration
- Update geocoder configuration
  - Using geocoder console: **http://<server>/geocoder/admin.jsp**
  - Or manually update file **$WEB-INF/config/geocodercfg.xml**
  - Set proper database connection to database user that owns the geocoding tables
  - Restart the geocoder application

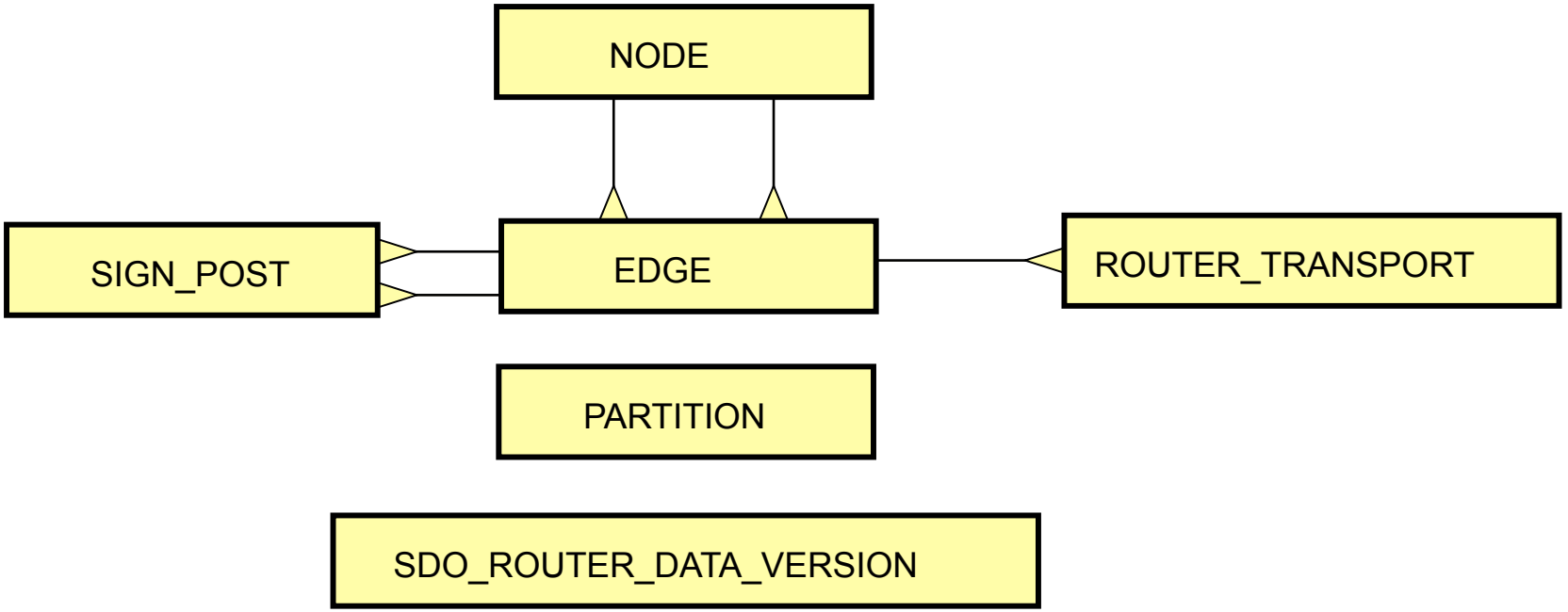
Routing

- Architecture
- Routing tables
- Installation and configuration
- Partitioning the network
- How to formulate route requests
- Structure of the route responses

Routing Web Service Architecture



Routing tables



A route request

Demo

An XML request for a single route includes:

- A numeric route ID
- One start and one end location
- Optionally, one or more attributes:
  - Route preference: fastest or shortest
  - Road preference: highway or local
  - Vehicle type and parameters (Oracle Database 11g Release 2)
  - Whether to return the geometry of the route
  - Time and distance units
  - Language for driving directions
  - And more …

Spatial Analysis and Mining

Correlate data based on location (spatial correlation).

Neighborhood analysis

to determine specific information about an area of interest

Proportion of theme layer geometries overlapping geometry of interest is applied to aggregate analysis

Spatial binning

to classify data based on location

Spatial clustering

to determine patterns based on location

Co-location analysis

to determine how the location of one thing correlates to the location of something else

All functions are in the SDO_SAM package.

Spatial Analysis and Mining

- Find how large a population lives in a radius of 3 miles around a point

```
SELECT sdo_sam.aggregates_for_geometry(
  'US_COUNTIES', 'GEOM','sum', 'totpop',
  SDO_GEOMETRY(2001, 8307,
    SDO_POINT_TYPE(-73.943849, 40.6698,NULL),NULL,NULL),
   'distance=3 unit=mile')
FROM DUAL;
```

```
724464.319
```

Spatial Analysis and Mining

- The area covers counties in NY

COUNTY	ST	TOTPOP	% AREA COVERED
Queens	NY	1951598	00.5437756
Kings	NY	2300664	31.0430579
New York	NY	1487536	00.0188785

Web Services

Topic 8

- What you need to know:
  - Describe the four major Open Geospatial Consortium standards for spatial web services and the services they enable
  - Describe the architecture, configuration steps, and example queries for Web Mapping Service for Oracle Database
  - Describe the architecture, configuration steps, and example queries for Oracle Database for Web Feature Service
  - Use WMS/WFS themes in MapViewer applications (…)

Web Services

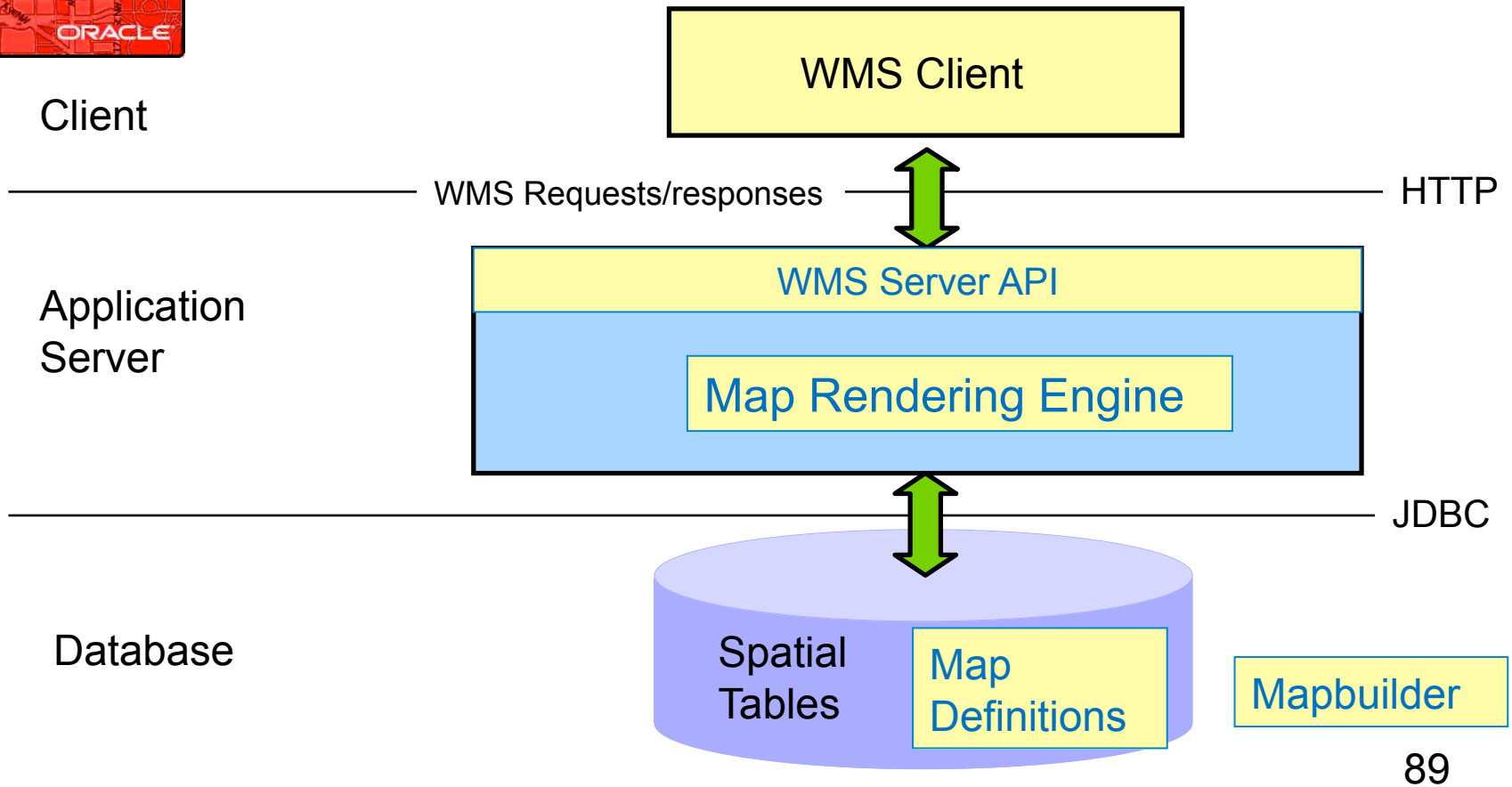
Topic 8

- What you need to know (continued):
  - Describe the architecture, configuration steps, and example queries for Oracle Database for Open Location Services
  - Describe the architecture, configuration steps, and example queries for Oracle Database for Catalog Service
  - Explain the Oracle licensing requirements

Open Geospatial Consortium Standards

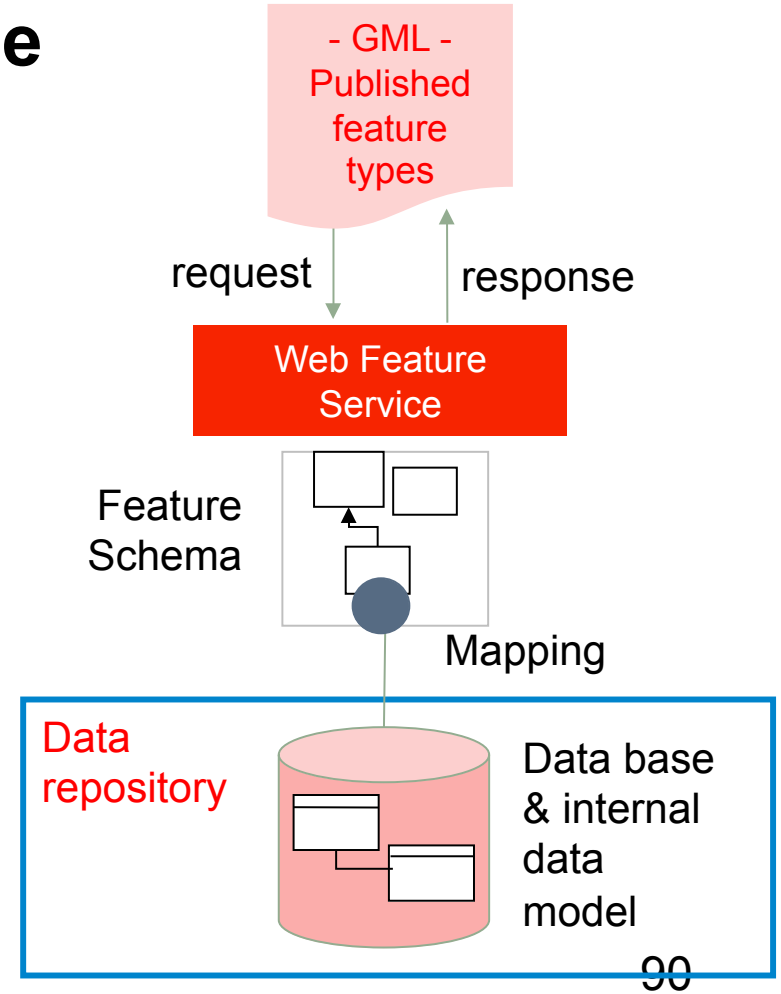
- **Web Map Service (WMS)**
  - Request/Provide **maps**
  - Request/Provide information about content of a map
- **Web Feature Service (WFS)**
  - Request/Provide **data**
  - Access/search/update/delete geo-spatial feature instances
  - Based on spatial/non-spatial search criteria
  - Using a standard interface over the web
- **Catalog Service for Web (CSW)**
  - Defines a common interface that enables diverse but conformant applications to perform discovery, browse and query operations against catalog servers.
- **Location Services (OpenLS)**
  - Geocoding Service
  - Routing Service
  - Mapping Service
  - Directory Service

MapViewer WMS



Web Feature Service

- OGC standard (and ISO 19142)
  - current version 1.1
- A WFS is a Web interface that allows one to publish and deploy geographic feature data locally or across the Internet.
- Two types of services:
  - "standard" WFS
  - "transactional" WFS (WFS-T)
- WFS-T operations include the ability to insert, delete, update, get and query features on spatial and non-spatial constraints



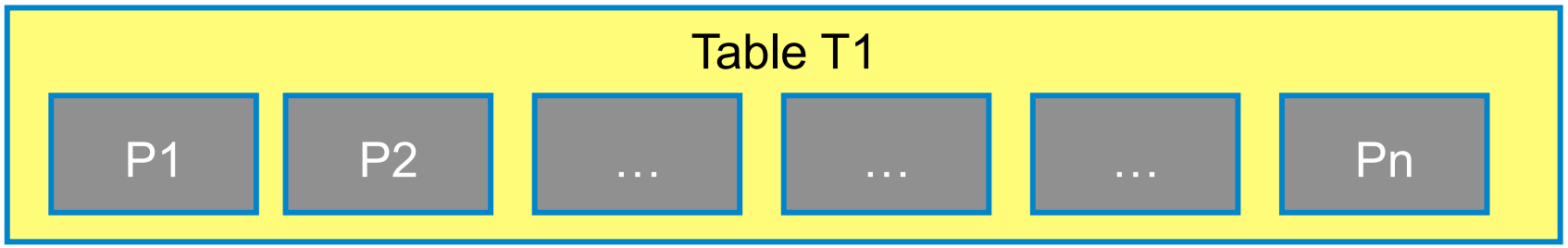
Advanced Indexing

Topic 9

- What you need to know:
  - Explain the concept of table and index partitioning
  - Describe the benefits of partitioning for spatial tables
  - Partition a spatial index using range partitioning
  - Partition spatial data based on location
  - Explain why spatial queries achieve performance benefits from partitioned indexes
  - Create indexes in parallel
  - Explain where parallel query is supported
  - Describe and create a spatial function-based index

Partitioning

- Table partitioning is a key feature of the Oracle database.
  - An option of the Enterprise Edition database
- One table decomposes to multiple “physical tables”, called partitions
- The decomposition is based on the value of a partitioning key (single or multiple columns)
- Indexes can also be partitioned
- Partitions (table or index) can be mapped to different tablespaces
- Transparent to applications



Benefits of Partitioning

- Maintenance:
  - Partition-level index rebuilds
  - Partition-level table and index archives
  - Partition-level table and index **exchanges**, splits, merges
- Performance:
  - Reduce response times for long-running queries: local index scan
  - Single queries that search multiple index partitions can be parallelized

Creating a Partitioned Table

- A table is partitioned at creation time
- Can add/remove/split/merge partitions later.

```
CREATE TABLE yellow_pages_part (
  id       NUMBER, name     VARCHAR2(50),
  category NUMBER, location SDO_GEOMETRY
)
PARTITION BY RANGE (category)(
  PARTITION p1 VALUES LESS THAN (2),
  PARTITION p2 VALUES LESS THAN (3),
  PARTITION p3 VALUES LESS THAN (4),
  PARTITION p4 VALUES LESS THAN (5),
  PARTITION p5 VALUES LESS THAN (6),
  PARTITION p6 VALUES LESS THAN (MAXVALUE)
);
```

Create a Partitioned Spatial Index

- Use the LOCAL keyword

```
CREATE INDEX yp_part_sidx ON yellow_pages_part (location)
  INDEXTYPE IS MDSYS.SPATIAL_INDEX
LOCAL;
```

- Can specify partition-specific parameters

```
CREATE INDEX yp_part_sidx ON yellow_pages_part (location)
  INDEXTYPE IS MDSYS.SPATIAL_INDEX
LOCAL (
  PARTITION p1 PARAMETERS ('TABLESPACE=TBS_1'),
  …
  PARTITION p6 PARAMETERS ('TABLESPACE=TBS_6')
);
```

Partitioned Index Tip

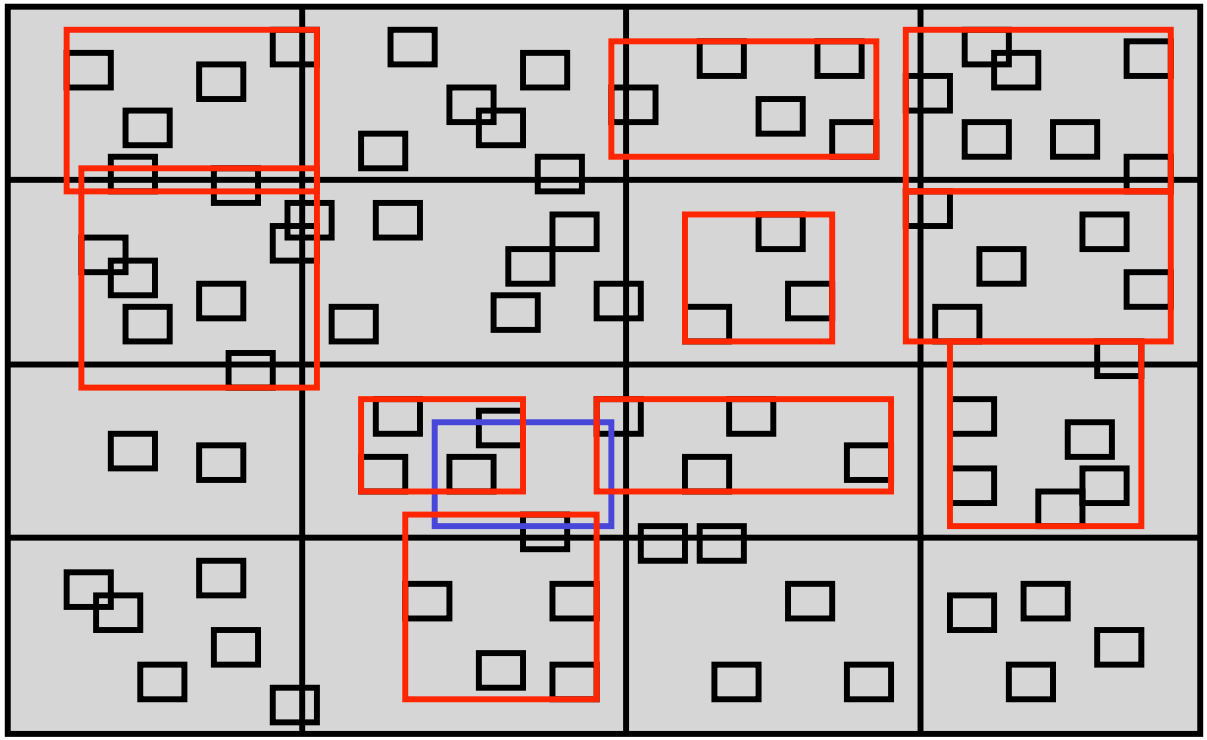
- Create the index without actually building it

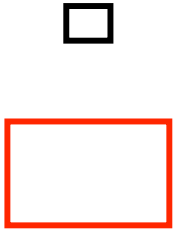
```
CREATE INDEX yp_part_sidx ON yellow_pages_part (location)
  INDEXTYPE IS MDSYS.SPATIAL_INDEX
LOCAL (
  PARTITION p1 PARAMETERS ('TABLESPACE=TBS_1'),
  …
  PARTITION p6 PARAMETERS ('TABLESPACE=TBS_6')
)
UNUSABLE ;
```

- Build individual index partitions

```
ALTER INDEX yp_part_sidx REBUILD PARTITION p1;
…
ALTER INDEX yp_part_sidx REBUILD PARTITION p6;
```

Spatially Partitioned Table and Index





spatial data

query window MBR

Spatial Partition Pruning

- Used with these Spatial operators
  - SDO_WITHIN_DISTANCE
  - SDO_FILTER
  - SDO_RELATE
- Completely transparent and automatic
- Requires no partition key in the WHERE clause
  - Including a spatial partition key may be incorrect
- Occurs at run time

Parallel Spatial Index Creation

Four partitions, local indexes with parallel degree = 4

CREATE INDEX
....
PARALLEL 4;

Index Partition 1 → R-tree Index 1

Index Partition 2 → R-tree Index 2

Index Partition 3 → R-tree Index 3

Index Partition 4 → R-tree Index 4

Function-Based Indexes

- Build an index on the results of a function.
  - If a search by last name was often done in uppercase index can be built using UPPER(LAST_NAME)
- Build a *spatial* index on the result of a function that returns a geometry:
  - Offers a powerful mechanism to enable Oracle Spatial functionality without an SDO_GEOMETRY column in the table.

Function-Based Indexes: Example

- This is a table that does not contain any geometry column
- Only two columns that contain the coordinates of the cities:

```
CREATE TABLE us_cities_xy (
   city          varchar2(20),
   state_abrv    char(2),
   pop90         number,
   rank90        number,
   longitude     number,
   latitude      number
);
```

Function-Based Indexes: Example

- The following function transforms the longitude and latitude columns into a geometry object:

```
CREATE OR REPLACE FUNCTION get_point (
  longitude  NUMBER,
  latitude   NUMBER )
RETURN sdo_geometry DETERMINISTIC IS
BEGIN
  RETURN sdo_geometry (2001,8307,
           sdo_point_type (longitude, latitude, NULL),
           NULL, NULL );
END;
/
```

Function-Based Indexes: Example

- Setup spatial metadata:

```
INSERT INTO user_sdo_geom_metadata values (
  'US_CITIES_XY',
  'SCOTT.GET_POINT(LONGITUDE,LATITUDE)',
  sdo_dim_array(
    sdo_dim_element('LONG', -180, 180, 0.5),
    sdo_dim_element('LAT', -90, 90, 0.5)),
  8307);
```

- You MUST specify explicitly the name of the owner of the function!

Function-Based Indexes: Example

- Create the spatial index on the function

```
CREATE INDEX us_cities_xy_sx ON
 us_cities_xy( get_point(longitude,latitude) )
 INDEXTYPE IS mdsys.spatial_index;
```

Using Linear Referencing and Network and Topology Models

Topic 10

- What you need to know:
  - Explain linear referencing concepts, use cases, and data structures
  - Convert geometries to LRS structures and use the main dynamic segmentation, point, and validation functions
  - Describe network modeling concepts, use cases, and data structures
  - Define, load, and manage networks in the Oracle Spatial network data model using the PL/SQL API
  - Explain the concept of load-on-demand and network partitioning (…)

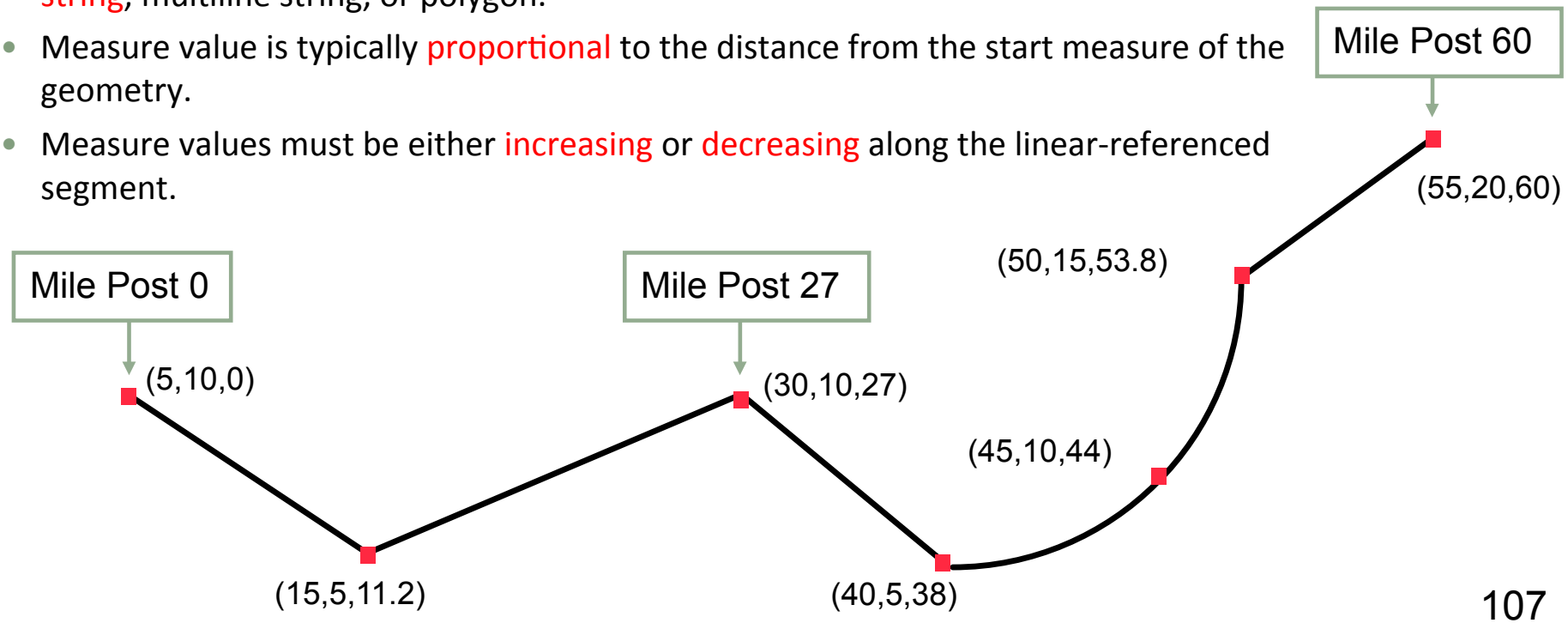
Using Linear Referencing and Network and Topology Models

Topic 10

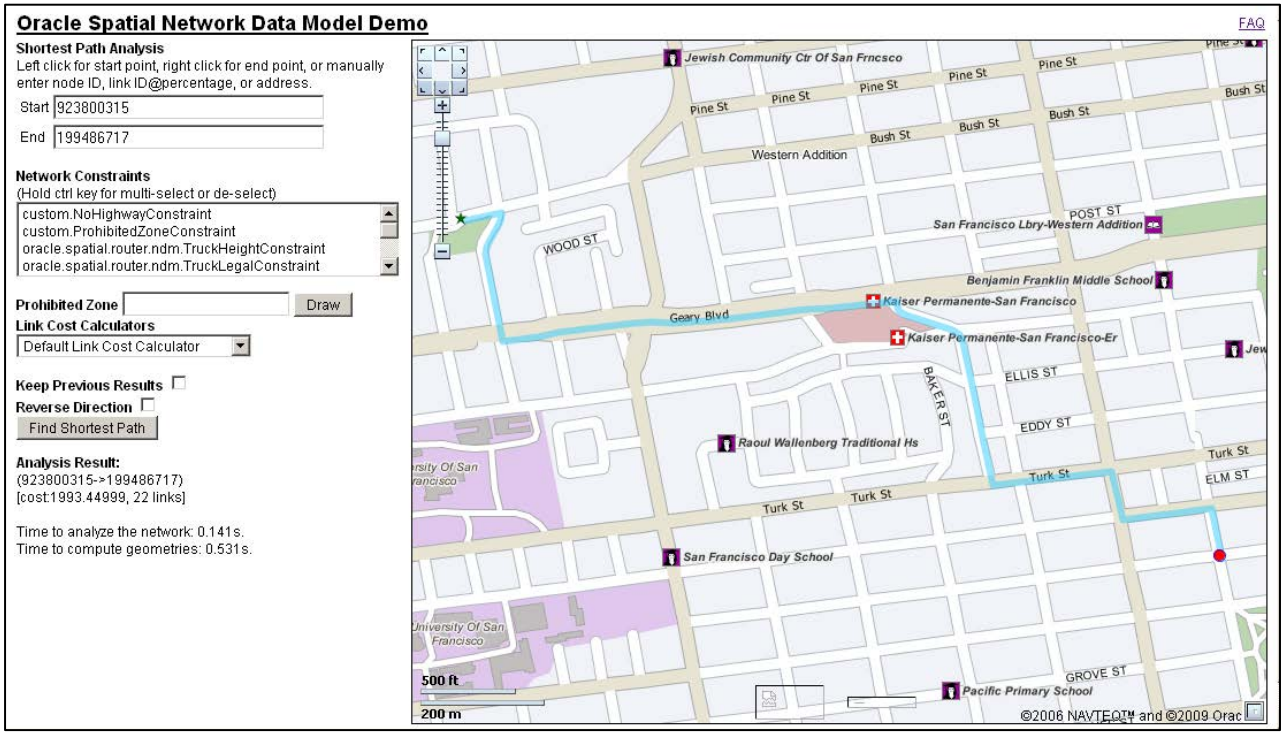
- What you need to know (continued):
  - Describe network analysis functions available with the load-on-demand Java API for analysis
  - Use the network tutorial to build an application using network analysis
  - Describe topology data model concepts, advantages, use cases, and storage model
  - Define and load topologies, define features, and perform topology queries and editing using the PL/SQL and Java APIs

What Is LRS?

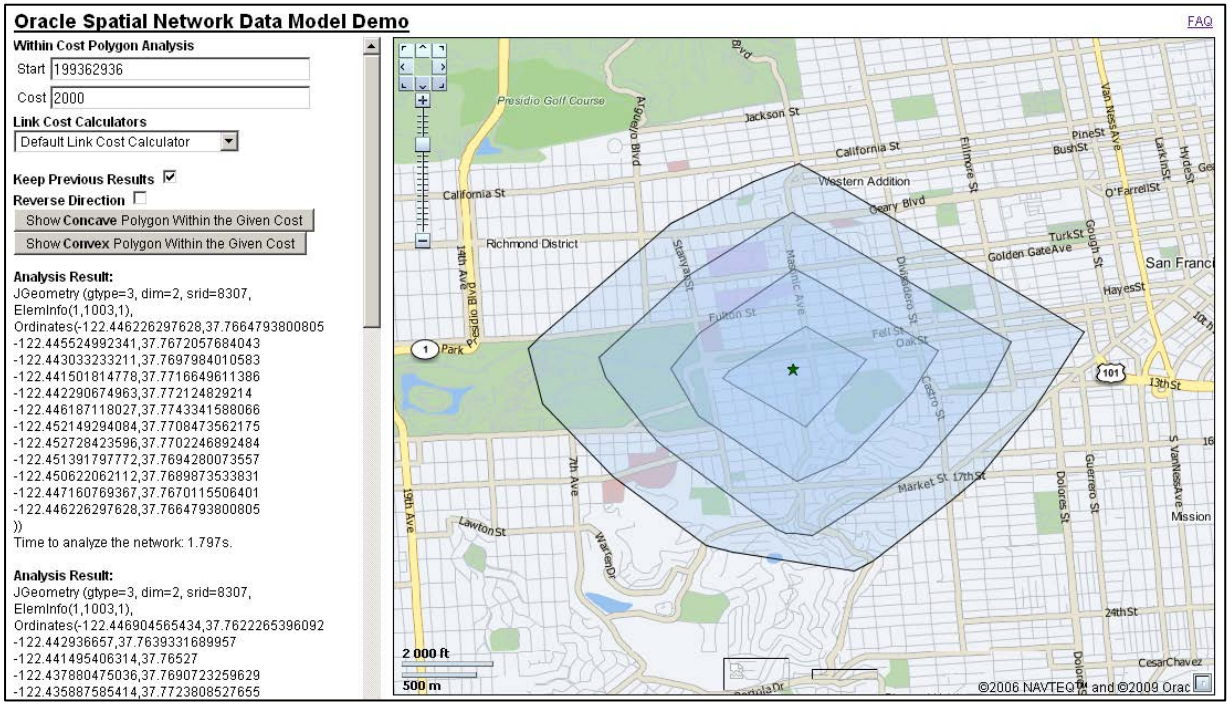
- LRS is a mechanism to associate a measure value with a 2-D or 3-D point along a line string, multiline string, or polygon.
- Measure value is typically proportional to the distance from the start measure of the geometry.
- Measure values must be either increasing or decreasing along the linear-referenced segment.



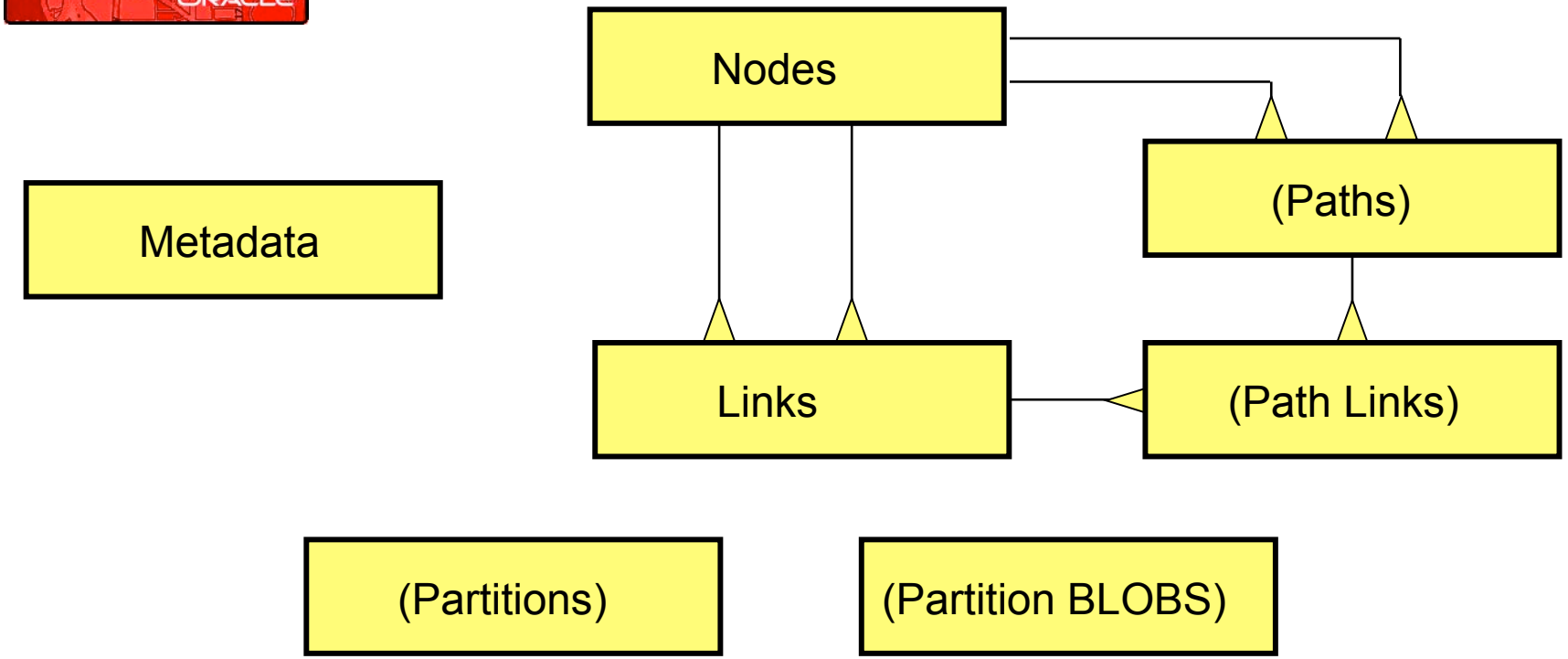
Network Data Model



Network Data Model Isochrones



Network Data Structures



Network Partitioning

Problem

- Network analysis uses a memory-resident copy of the network.
- Large networks (>1000000 nodes) hard to use
  - Memory limitation of the Java runtime
  - Long initialization times

Solution

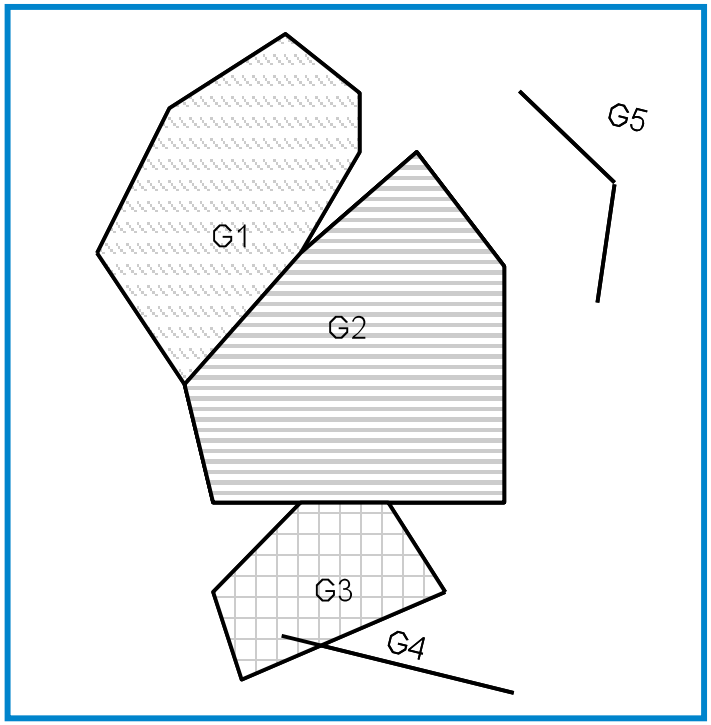
- Divide the network into subsections called “partitions”
- Load partitions as needed
- Limit the number of partitions in memory

Fundamental Analysis Functions

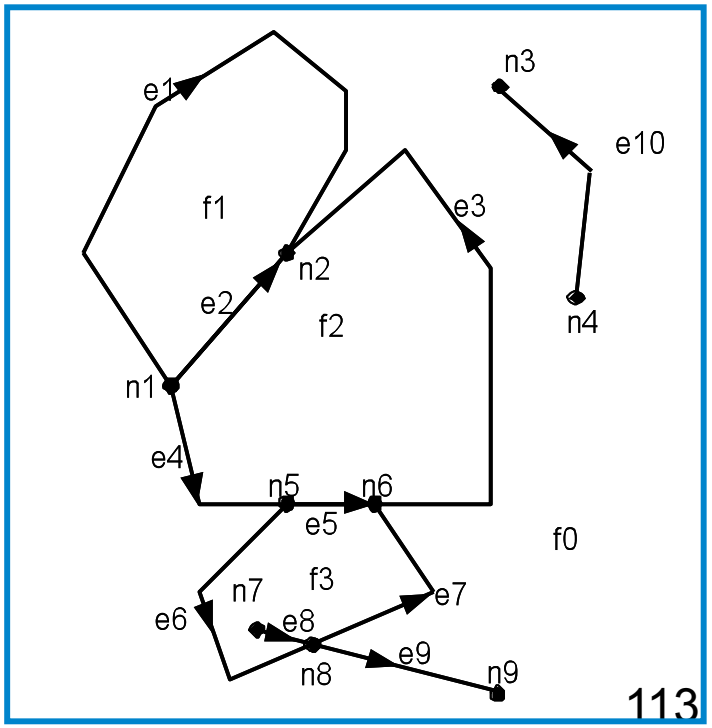
- shortestPathDijkstra() and shortestPathAStar()
  - Find the shortest path between two nodes
- nearestNeighbors() and nearestReachingNeighbors()
  - Find the N nearest nodes from a node
- withinCost() and withinReachingCost()
  - Find all nodes within a chosen distance (=cost) from a node

Geometry vs. Topology

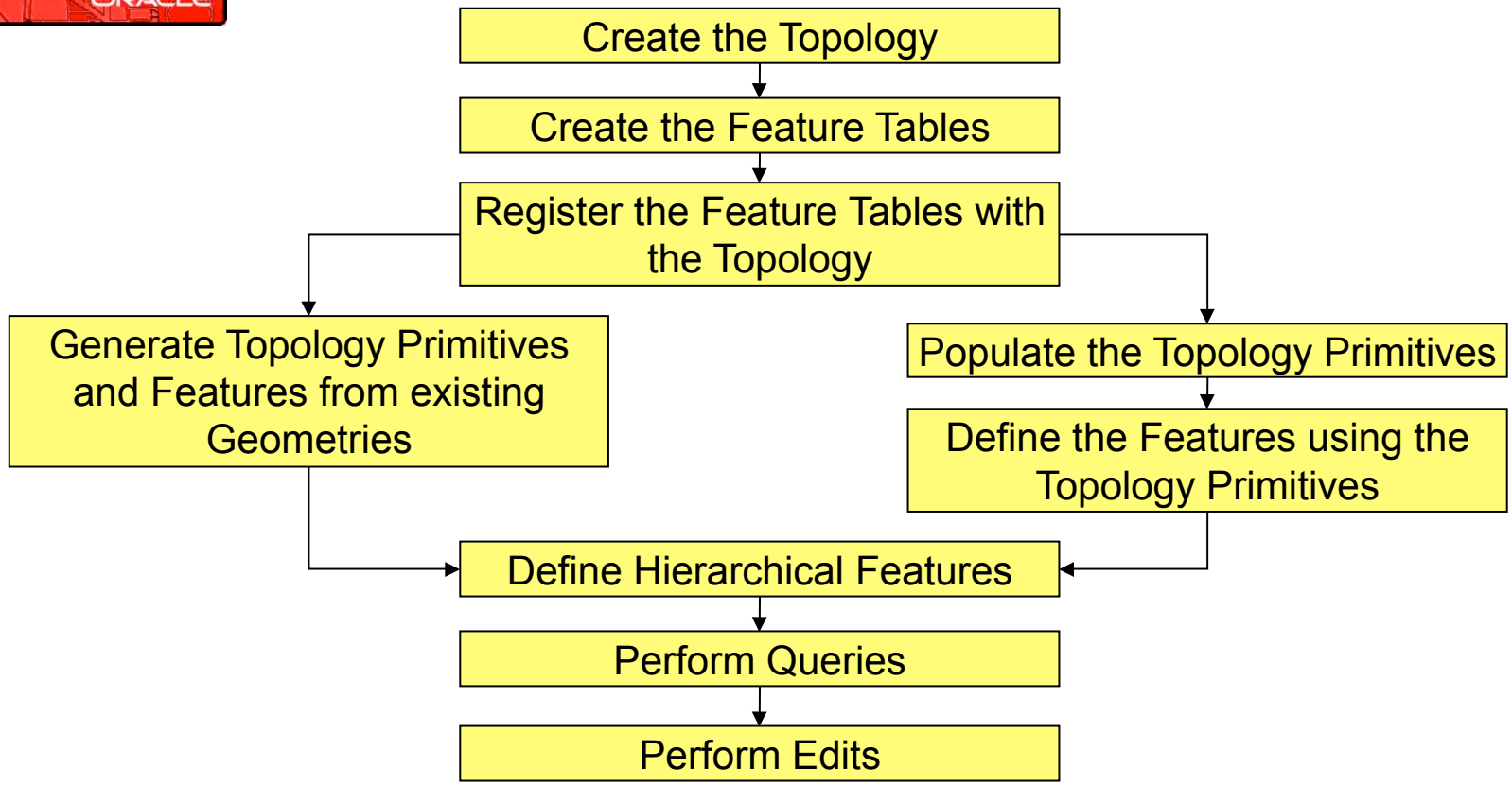
Geometry Storage



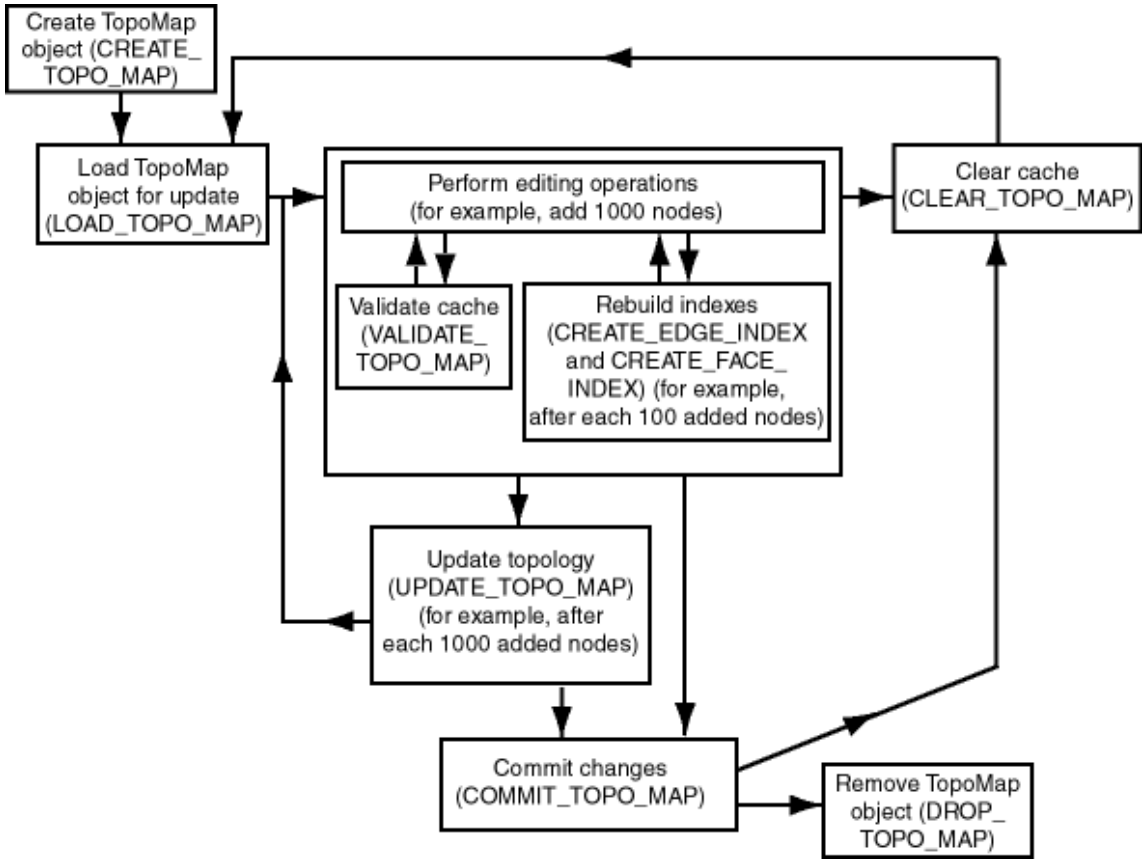
Topology Storage



Creating and Populating Topologies



Editing Topologies



GeoRaster

Topic 11

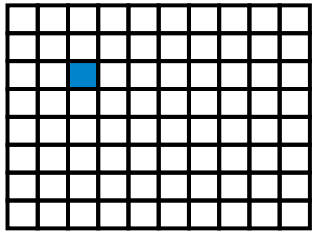
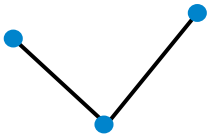
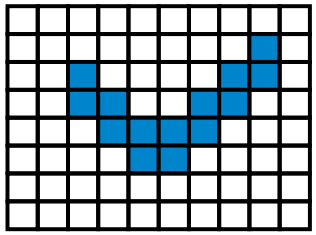
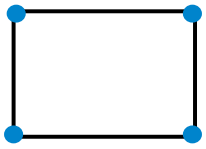
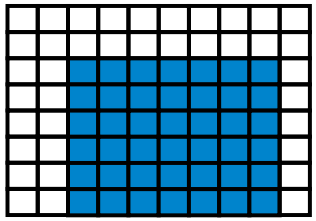
- What you need to know:
  - Describe raster data concepts
  - Describe the Oracle Spatial GeoRaster storage model
  - Explain the compression techniques available/benefits
  - Load, export, use, and manage rasters in Oracle Spatial GeoRaster
  - Use the open source GDAL/OGR library and tools to load and export rasters between other data formats and GeoRaster
  - View/manage raster data by using the features of the GeoRaster viewing tool (…)

GeoRaster

Topic 11

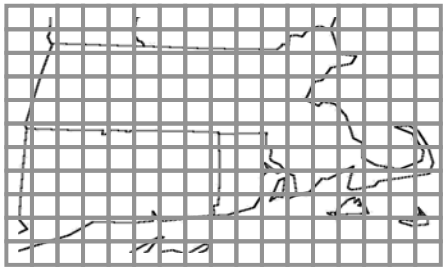
- What you need to know (continued):
  - Describe the GeoRaster functions for managing and manipulating rasters, and the Java API features and functions
  - Describe available 3rd party and open source GeoRaster processing and analysis tools available
  - Use MapViewer to display rasters and overlay them with vectors

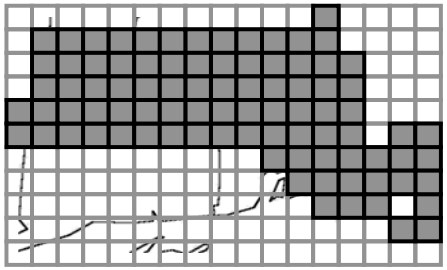
Raster/Vector Data Differences

Vector Data	Vector Coordinates	Raster Data
	-74.1651749, 41.339141	
	-74.1651749, 41.339141, -73.4284481, 40.678193, -72.9792214, 41.686228	
	-74.1651749, 41.339141, -74.1651749, 39.559004, -72.9792214, 39.559004, -72. 9792214, 41.339141	

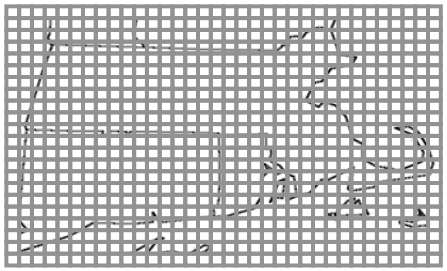
Raster Data and Cell Size

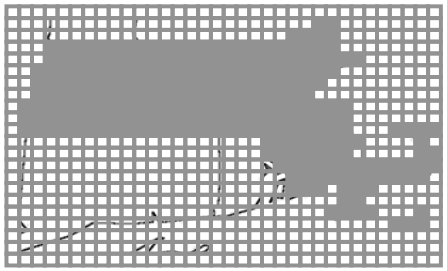
Coarser resolution





Finer resolution

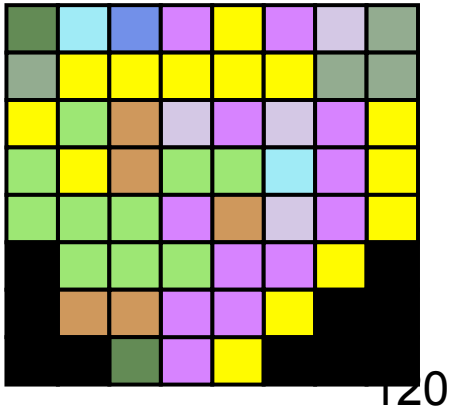




What is a Raster ?

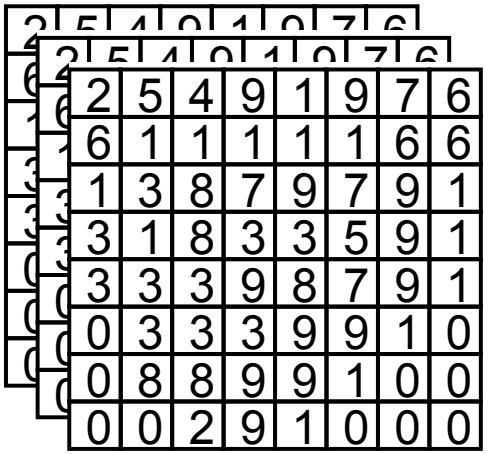
- Two dimensional array of regularly spaced elements (*pixels* or *cells*)
  - Orthophotos
  - Remote Sensing
  - Gridded data (raster GIS)
- Image data is collected by a variety of technologies
  - Satellite remote sensing
  - Airborne photogrammetry
  - Sonar
- Digital images can be composed of one or more bands
  - Bands often represent an interval of wavelengths along the electromagnetic spectrum
  - Band data can be simultaneously recorded

2	5	4	9	1	9	7	6
6	1	1	1	1	1	6	6
1	3	8	7	9	7	9	1
3	1	8	3	3	5	9	1
3	3	3	9	8	7	9	1
0	3	3	3	9	9	1	0
0	8	8	9	9	1	0	0
0	0	2	9	1	0	0	0



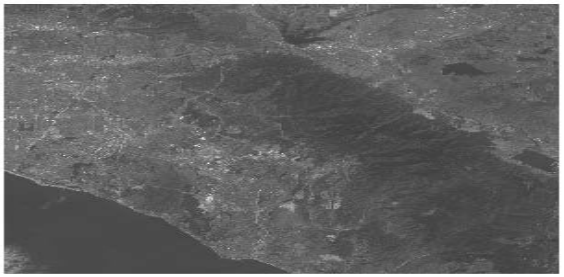
Cells and Bands

- Cell data is the value associated with the cells/pixels
  - Each cell has a value in a raster
  - Each value is associated with a cell/pixel
  - In an RGB image, each cell has 3 values: one each to represent the intensity of red, green, and blue
- In GeoRaster, all cells associated with a 2-D set of rows and columns in a plane is a band
  - An RGB image will have 3 bands
  - A multispectral image with 4 channels will have 4 bands in GeoRaster
  - Grid data with 4 bands will have 4 bands in GeoRaster

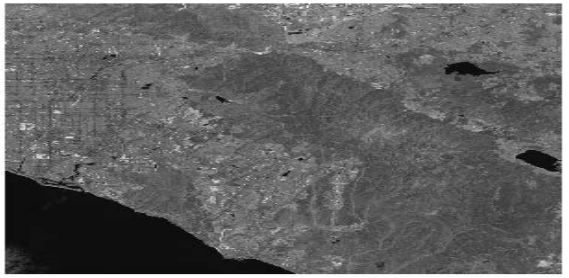


Multi band Images

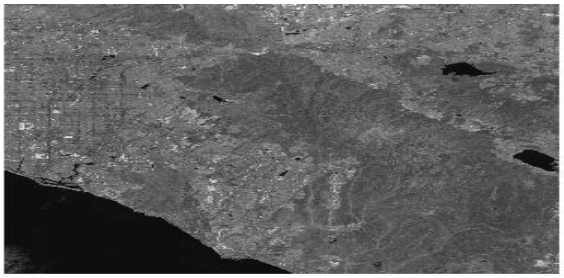
Some bands accentuate different features



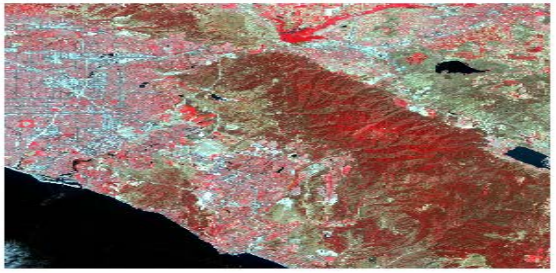
TM Band 2



TM Band 3



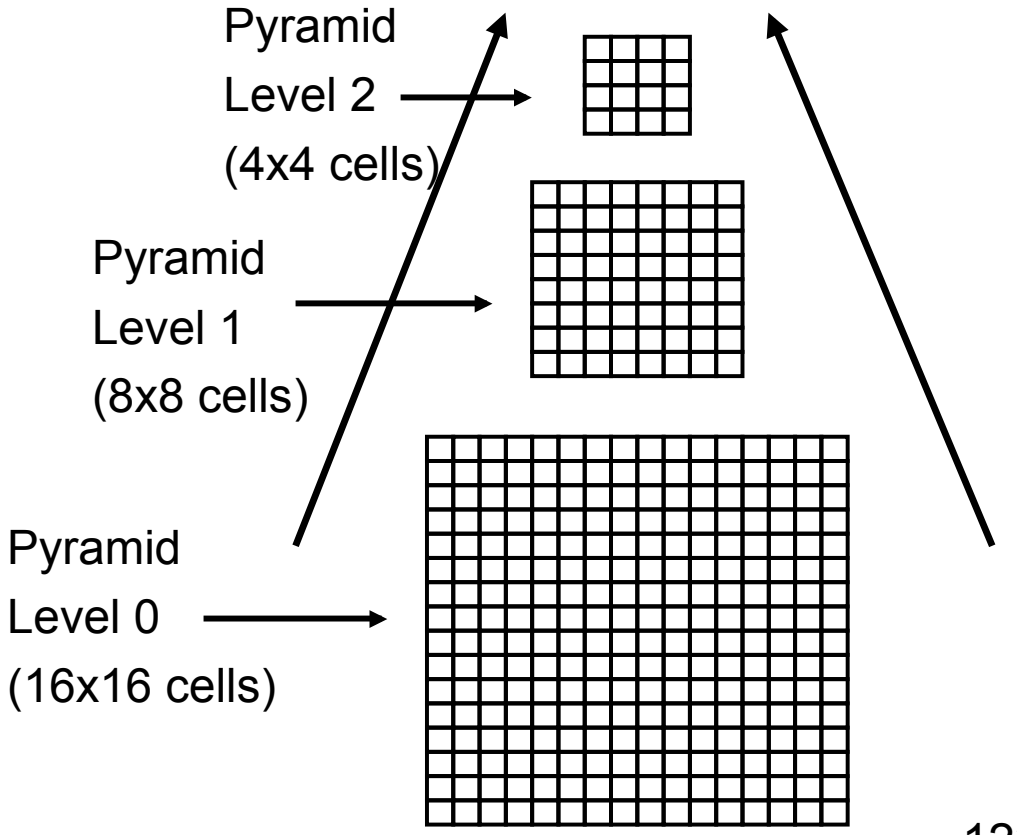
TM Band 4



TM Band 432

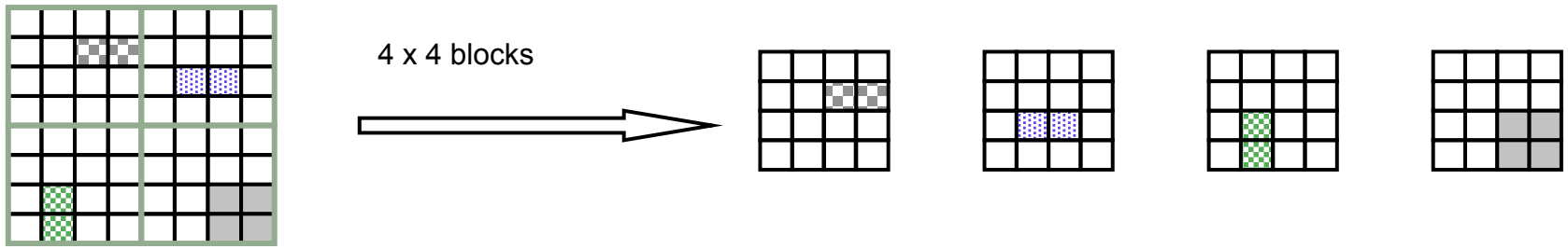
Resolution Pyramid

Typically increases storage cost by 33% to 40%



Blocking

- A GeoRaster image can be composed of an extremely large number of cells
- It is more efficient in terms of storage and retrieval to break large images into smaller blocks
- In GeoRaster, users/applications can determine how data is blocked
  - Specify rows, columns, and optionally bands



Compression

JPEG Compression

- Lossy compression
- For rasters with cellDepth=8BIT_U and no more than 4 bands per block
- JPEG-B or JPEG-F mode
- Control the compression level using the quality parameter
  - 0 (max compression) to 100 (no compression)

DEFLATE Compression

- Lossless compression
- Uses the ZLIB format

JPEG2000 and MrSid Compression

- Via a plugin from LizardTech
- Also loader for JP2/SID files

You can also use securefiles (blob) compression. This is part of the Advanced Compression option.

The Impact of Compression

- Consider one TIFF file of 53 MB (uncompressed)
- When compressed as JPEG-F it is reduced to 4.4 MB
- This a compression ratio of 1:12
- Add 50% to accommodate the pyramid (approx 2.1 MB)
- Total storage will be approx 6.5 MB
- This is now a compression ratio of 1:8

Using GDAL

- To setup
  - Add **<…>\gdal<xxxx>\bin** to your path
  - Set **GDAL_DATA** to **<…>\gdal<xxxx>\data** (optional)
- Main commands for raster data
  - gdalinfo = get information about a file (or spatial table)
  - gdal_translate = copy from one format to another (import/export)
- Documentation
  - http://www.gdal.org/
  - http://www.gdal.org/formats_list.html
  - http://www.gdal.org/frmt_georaster.html

GDAL supported Formats

```
D:\> gdalinfo --formats
```

```
AAIGrid (rw): Arc/Info ASCII Grid
AIG (ro): Arc/Info Binary Grid
...
EIR (ro): Erdas Imagine Raw
ELAS (rw+): ELAS
ERS (rw+): ERMapper .ers Labelled
ESAT (ro): Envisat Image Format
...
GTiff (rw+): GeoTIFF
GXF (ro): GeoSoft Grid Exchange Format
...
GeoRaster (rw+): Oracle Spatial GeoRaster
...
HFA (rw+): Erdas Imagine Images (.img)
...
JPEG (rw): JPEG JFIF
...
VRT (rw+): Virtual Raster
XPM (rw): X11 PixMap Format
```

- See complete list here: http://www.gdal.org/formats_list.html
- Some formats are “built-in”, some use plugins
- Find details about one format:

```
D:\> gdalinfo --format georaster
```

- Useful to find out the syntax of parameters specific to this format

Oracle Georaster plugin is installed

Main GDAL Utilities

- gdal_translate
  - Main tool to convert a raster from one format to another (like TIFF to JPEG)
  - **Will be used to load rasters into Oracle as well as to export from Oracle**
  - Can be used to change the structure of a raster from BSQ to BIP (so that the JAI classes can read it)
  - Can also be used to extract the georeferencing information from a GeoTIFF raster into a TFW file
  - Many other conversions are possible, such a breaking a very large file into a set of smaller files or fusing many into a single large raster (mosaicing)

Other GDAL Utilities

- gdalinfo
  - Prints out information about a raster
  - Useful to find out any georeferencing and projection information as well as the structure of a raster
- gdaladdo
  - Adds overviews to a raster, i.e. generate a resolution pyramid
- gdalwarp
  - Reprojects a raster to a different coordinate system

Many more available. See: http://www.gdal.org/gdal_utilities.html

Supported formats: see: http://www.gdal.org/formats_list.html

Oracle Georaster: see: http://www.gdal.org/frmt_georaster.html

Importing a raster from a file

```
gdal_translate -of georaster sf1.tif
  georaster:scott/tiger@orcl111,us_rasters,georaster
  -co blockxsize=512 -co blockysize=512 -co blockbsize=3
  -co interleave=bip -co srid=26943
  -co "insert=values (1, 'sf1.tif', 'Aerial photo San Francisco 1',
      sdo_geor.init('us_rasters_rdt_01', 1),null,null)"
```

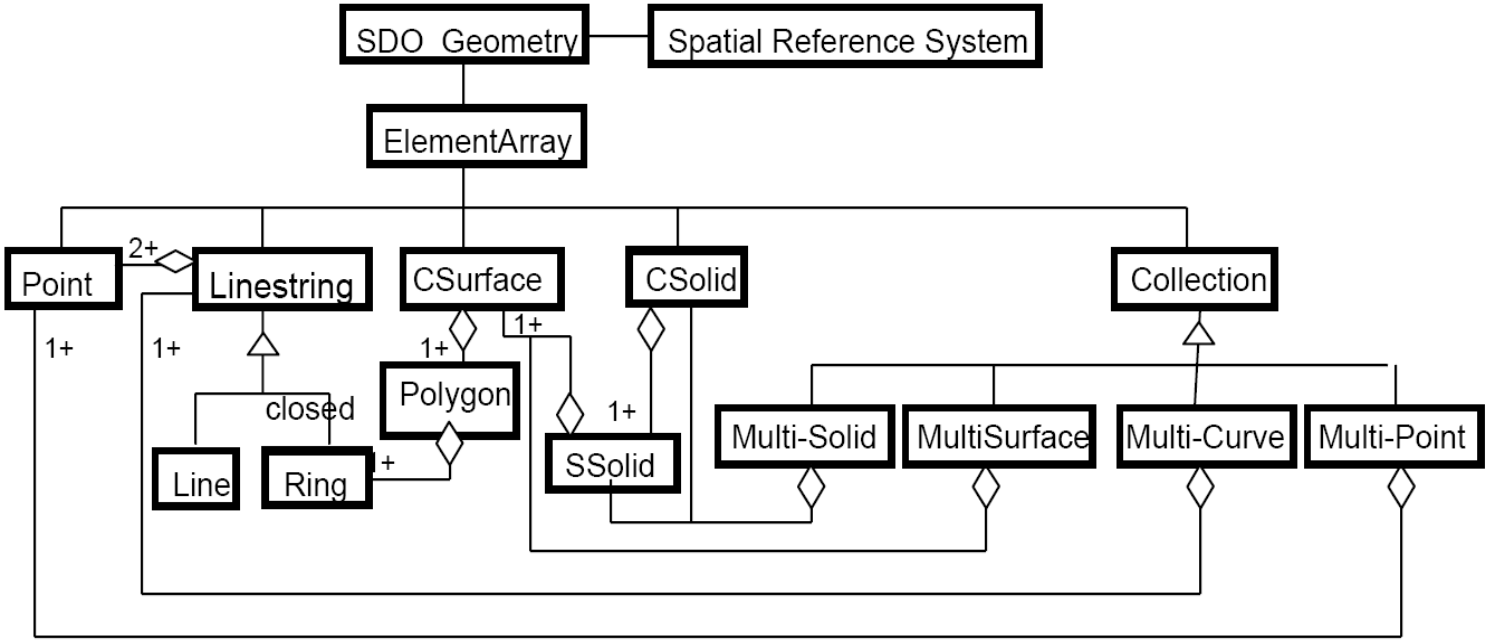
-of georaster	Use Oracle Georaster as output
sf1.tif	Name of input TIFF file
georaster:scott/tiger@orcl112	Database connection
us_rasters,georaster	Destination table and column
-co blocksize	Block size in x, y and b (band)
-co SRID=26943	Coordinate system of the raster
-co interleave	Interleaving (default is band sequential)
-co insert	The VALUES of an insert statement to insert a row in the raster table

Managing 3D and Lidar Data

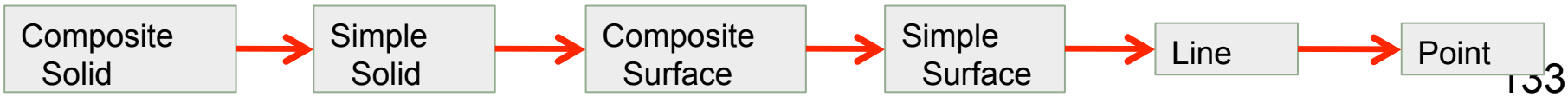
Topic 12

- What you need to know:
  - Describe 3D data concepts, objects/ models supported, coordinate systems, and data structures for modeling surfaces/solids
  - Explain 3D operations available and how to transform 2D to 3D
  - Convert data into CityGML and KML for publishing/viewing, load CityGMLdata, and query 3D data using SQL
  - Describe point clouds and their storage model
  - Load point clouds and describe point cloud processing functions
  - Describe triangulated irregular network concepts, storage model, and available functions for data management/ extraction/conversion

Spatial 3D Data Model



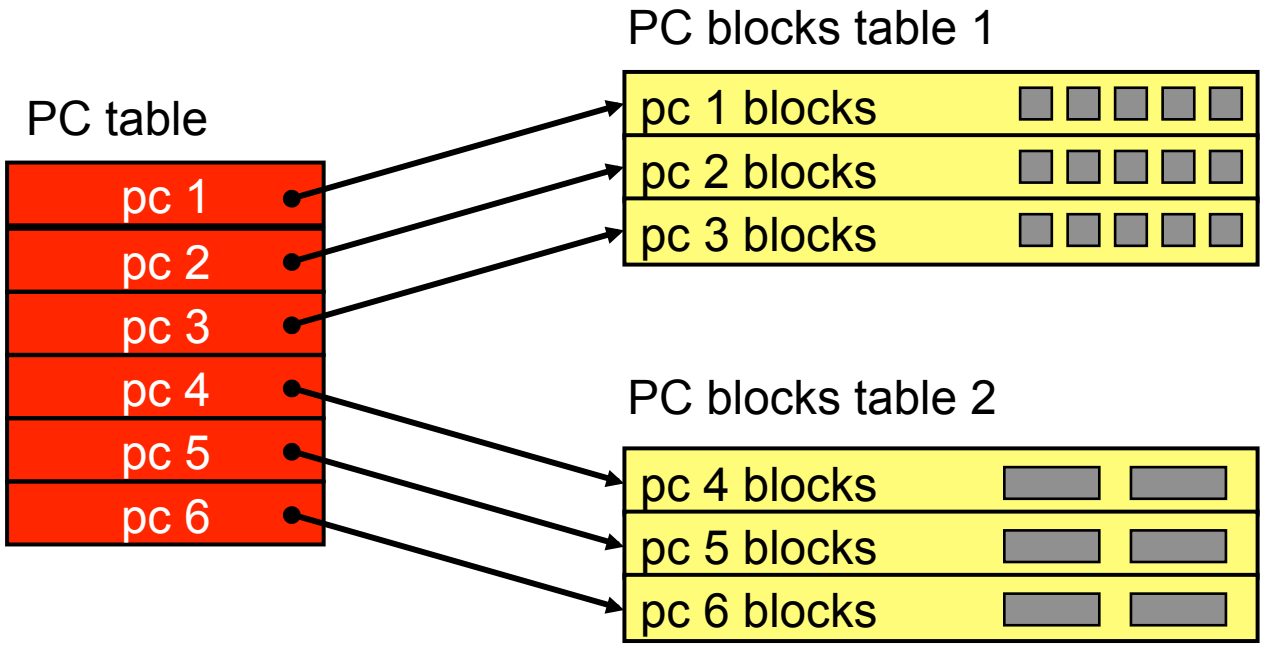
Hierarchical Decomposition



Operations on 3D Data

- Spatial indexing in 3D
  - 3D Rtrees
- Spatial queries
  - SDO_FILTER
  - SDO_ANYINTERACT
  - SDO_WITHIN_DISTANCE
  - SDO_NN
- Measurements
  - Distance
  - Length
  - Area
  - Volume
- Generate 3D shapes
  - Convert 2D polygons to 3D solids (by extrusion)
- Publish
  - Extract 3D objects to KML and GML
- Load
  - Load 3D objects from GML
- Process
  - Extract components of a 3D geometry.
  - Solids, composite surfaces in each solid, simple surfaces, etc
- Validate
  - Verify the validity of a 3D object

Point Clouds Storage Model



Loading a TIN

- Generate the TIN from the point table

```
DECLARE
  TIN SDO_TIN;
BEGIN
  SELECT TIN INTO TIN
  FROM TINS WHERE ID = 1;
  SDO_TIN_PKG.CREATE_TIN (TIN, 'INPUT_POINTS');
END;
/
```

- Structure of the input table

```
RID             VARCHAR2(40)
VAL_D1          NUMBER
VAL_D2          NUMBER
…
VAL_Dn          NUMBER
```

Unique point identifier

Point coordinates

Performance and Tuning / Exadata

Topic 13

- What you need to know:
  - Describe key tips on spatial indexing
  - Optimize your spatial queries
  - Explain best practices of the usage of spatial operators
  - Explain best practices of the usage of spatial functions
  - Describe how to best define your spatial data model
  - Describe best practices for spatial metadata, tolerance and coordinate systems usage
  - Explain best practices for spatial data loading and validation (…)

Performance and Tuning / Exadata

Topic 13

- What you need to know (continued):
  - Describe key spatial application considerations
  - Explain how to optimize Spatial on Exadata
  - Explain how Oracle Spatial is architected to exploit the processing power, bandwidth and parallelism of Exadata
  - Explain how Oracle Spatial on Exadata can ingest massive amounts of data from sensors, weather data, satellites and other streams

Spatial Index Creation Options WORK_TABLESPACE

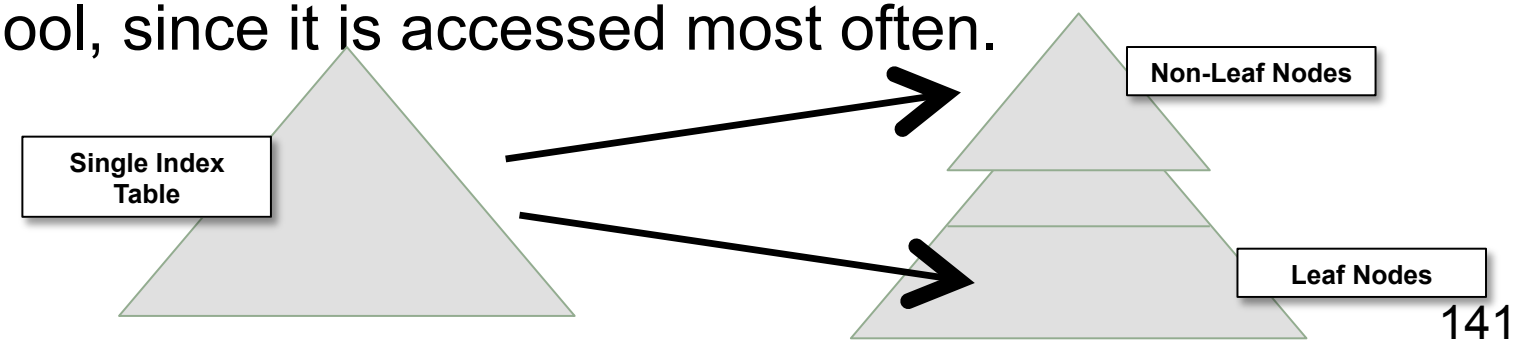
- During spatial index creation, the process creates intermediate tables that get dropped when the index is complete.
- The intermediate tables can take up to **2 times** the size of the final index. If WORK_TABLESPACE is not specified, the intermediate tables are created in the **same tablespace** as the final index, causing fragmentation, and possible performance degradation.
- You can use SDO_TUNE.ESTIMATE_RTREE_INDEX_SIZE, and multiply the result by 2 to provide guidance on sizing the work tablespace. The work tablespace can be re-used to create other spatial indexes.

Spatial Index Creation Options LAYER_GTYPE

- This parameter is needed especially when working with point-only layers. If a point-only layer stores its points in the SDO_ORDINATE_ARRAY, you can still specify **LAYER_GTYPE=POINT** on spatial index creation.
- This can help query performance when performing spatial analysis.

Spatial Index Creation Options SDO_NON_LEAF_TBL

- This parameter is useful for very large spatial indexes
- Splits the index in two tables instead of one.
- The smaller spatial index table is the **non-leaf table**, which is traversed most often during spatial analysis.
- It can be beneficial to pin the non-leaf table into the buffer pool, since it is accessed most often.



Spatial Index Creation Parameters SDO_NON_LEAF_TBL

- Create the index, specifying a “non-leaf” table

```
CREATE INDEX geod_counties_sidx ON geod_counties(geom)
INDEXTYPE IS MDSYS.SPATIAL_INDEX
PARAMETERS ('sdo_non_leaf_tbl=TRUE');
```

- Find the name of the “non-leaf” table

```
SELECT sdo_nl_index_table
FROM user_sdo_index_metadata
WHERE sdo_index_name='GEOD_COUNTIES_SIDX‘;
```

```
MDNT_A930$
```

- “Pin” it in memory

```
ALTER TABLE MDNT_A930$ STORAGE(BUFFER_POOL KEEP)
```

Workspace Manager

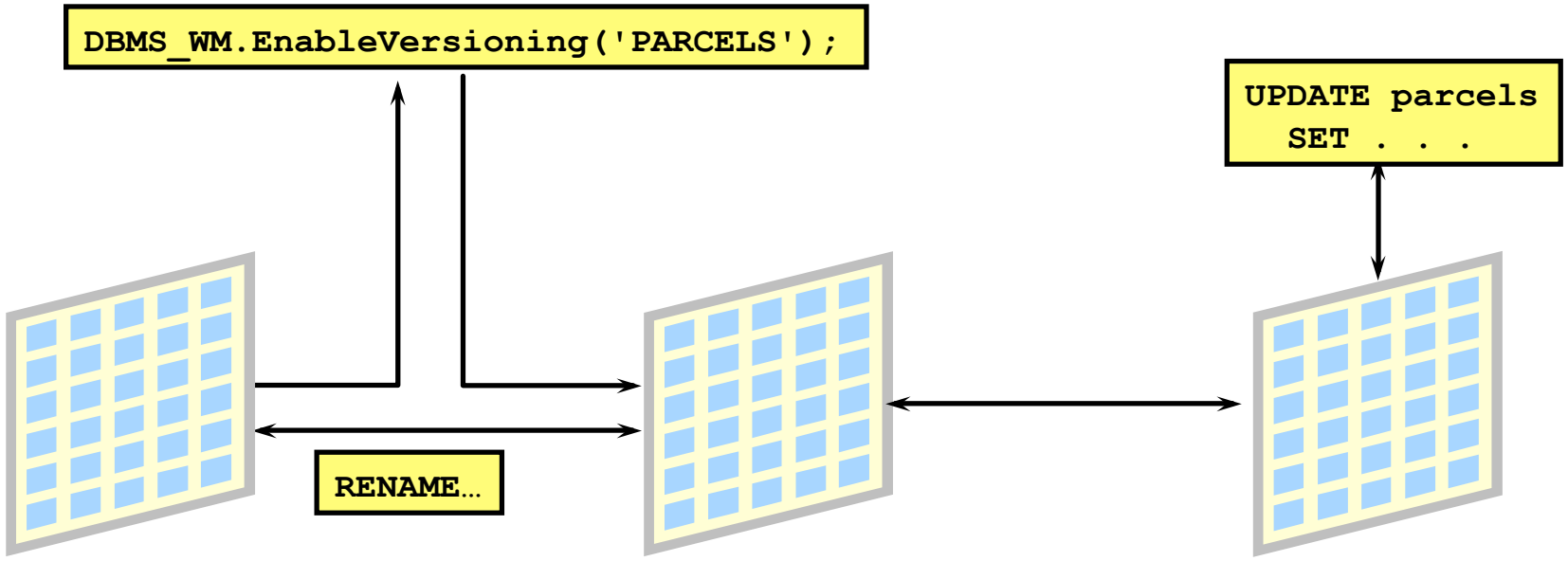
Topic 14

- What you need to know:
  - Explain Workspace Manager concepts, features, and architecture
  - Describe the concepts of versioning on a table and create, merge, refresh tables
  - Describe the concepts of administering privileges and locking, and detecting and resolving conflicts
  - Describe some 3rd party GIS tools that use Workspace Manager

Workspace Manager

- Enables Web and application-based collaboration on database-backed projects
- Provides shareable workspaces within the database to version data
- Example application: managing parcels in a housing development project

Multi-Version a Table



Section 2:

Test Preparation Strategies

Exam Structure

Preparation Strategies

- Exam duration: 120 minutes
- Number of questions: 76
- Question Structure: Multiple Choice
- Multiple Choice: 1-N Answers (Given # Correct)
- Passing score: 62%

Exam Structure

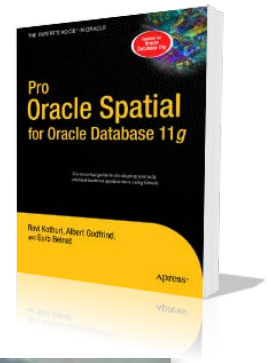
Example Question

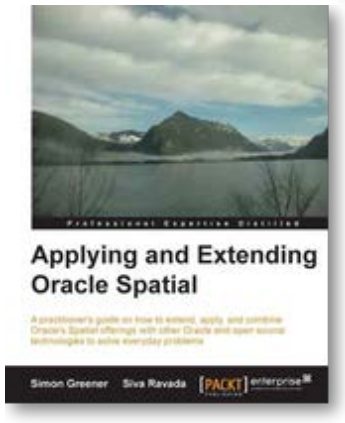
- For a spatial table, what two things are stored in USER_SDO_GEOM_METADATA?
  - A. The name of the table's spatial index
  - B. The table's name
  - C. WKTEXT of the spatial extent of data stored in the table
  - D. Spatial geometry data
  - E. The table's Spatial Reference ID (SRID)

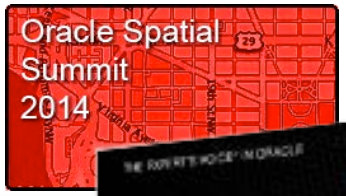
Approaching the Exam

Preparation Strategies

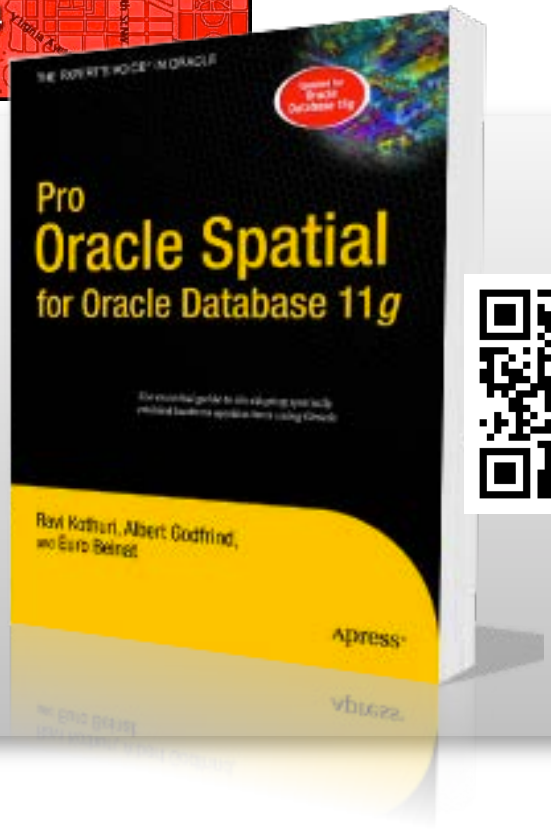
- Read the Book
  - Work through Examples
- Read the Docs
  - 11.2 Documentation
  - Complex Queries in Appendix

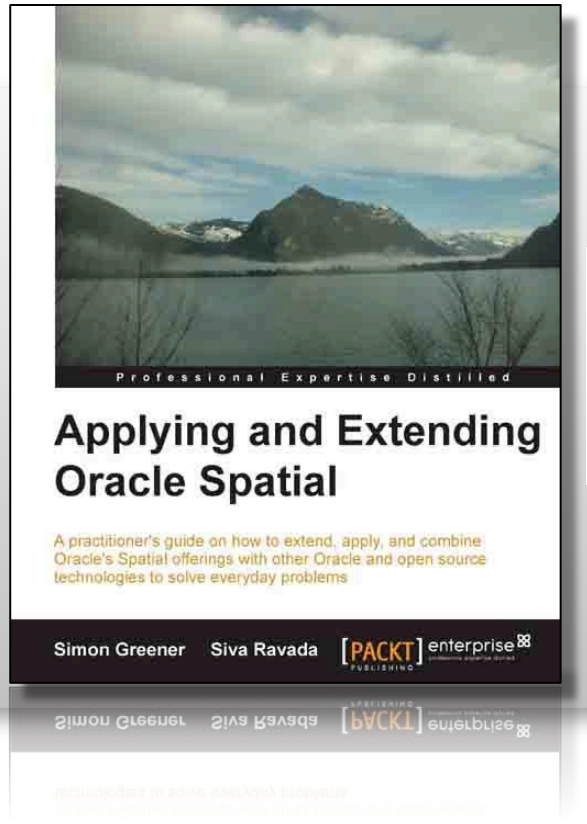






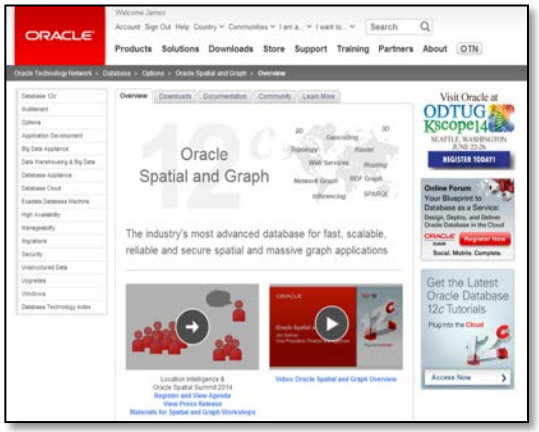
More Resources

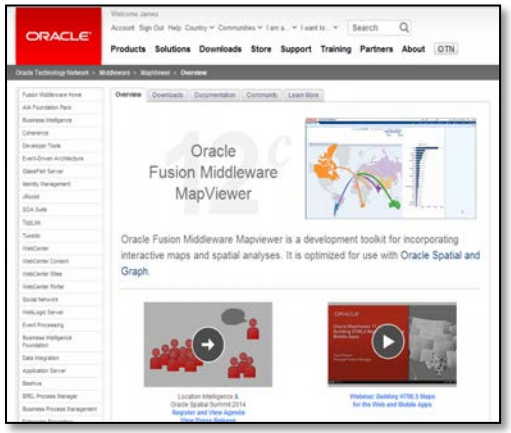




Resources

Oracle Technology Network

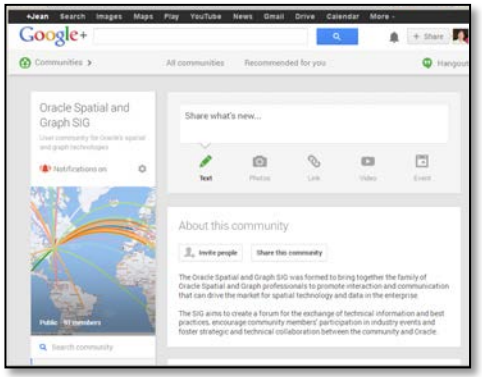




- www.oracle.com/technetwork/database/options/spatialandgraph
- www.oracle.com/technetwork/middleware/mapviewer
- blogs.oracle.com ➔ oraclespatial ➔ oracle_maps_blog

Oracle Spatial & Graph Special Interest Group

Connect and exchange knowledge with the community of Spatial & Graph users



- **Talk with the Board this week**
  - Wednesday lunch – SIG Board presentation (150AB)
  - Stop by the SIG User Group roundtable at Meet the Experts, 4:30pm Wednesday in150AB
  - Visit Oracle's exhibitor table at breaks & sign up
- **Join us**
  - Online communities: LinkedIn , Google+ , IOUG SIG (free membership)
  - Visit OTN Spatial Community page www.oracle.com/technetwork/database/options/spatialandgraph/community (or search online for "Oracle Spatial and Graph Community")
  - Email oraclespatialsig@gmail.com

Spatial Certification & Partner Specialization

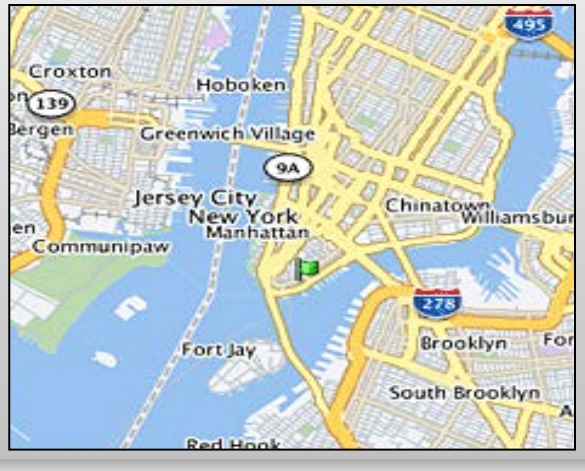
Get valuable credentials – differentiate your skills

- **Learn more at the Summit**
  - Wed, Track C 3:30 – Exam preparation session
  - Talk to us at Oracle's exhibitor table & "Meet the Experts" Certification table (Wed 4:30-5:00)
- **Take the next steps**
  - Schedule an exam, access topic lists / online training, learn about Partner Specialization requirements www.oracle.com/technetwork/database/options/spatialandgraph/learnmore/spatial-specialization-1835642.html
  - Online training materials for Certified Implementation Specialist exam https://competencycenter.oracle.com/opncc/full_glp.cc?group_id=22003

MapViewer in Action

Oracle eLocation Services

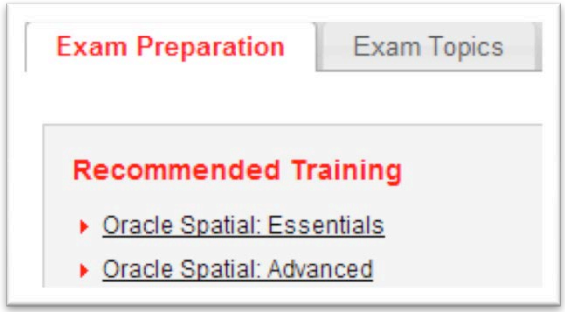
http://maps.oracle.com/elocation



Courses and Other Resources

Preparation Strategies

- Oracle courses
  - Oracle Spatial: Essentials
  - Oracle Spatial: Advanced
- Online resources
  - Spatial Forum
  - Spatial SIG Site
- Talk to us during the “meet the experts” session up next



Exam prep info on Oracle University site

Q&A