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Oracle Spatial and Graph: Technologies 101

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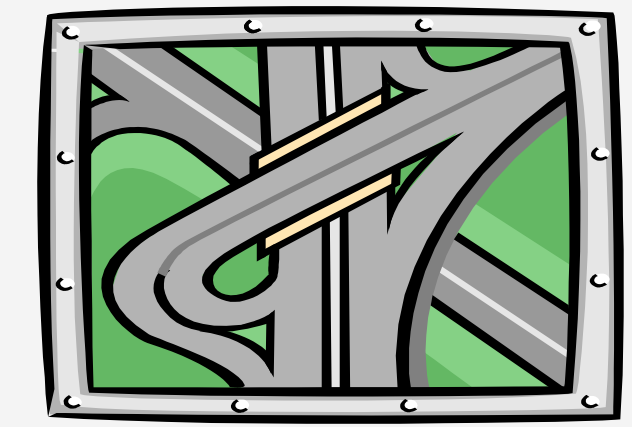
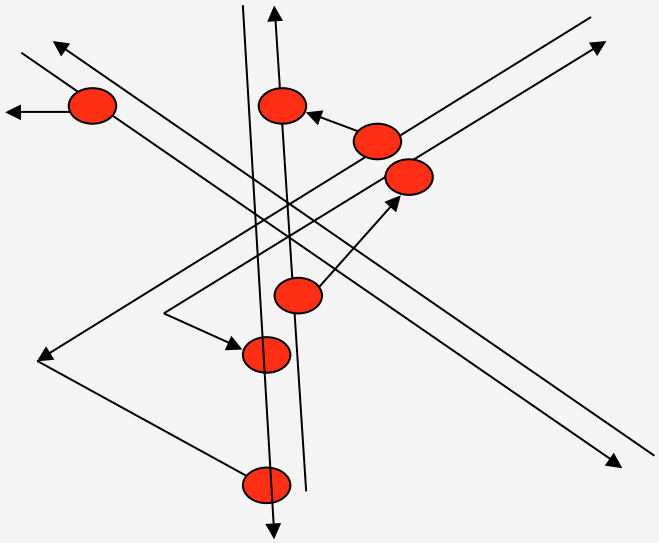
Product Management,
Oracle Server Technologies





Program Agenda

- Introducing Oracle Spatial and Graph
- Advanced Features
- New Features

The following is intended to outline our general product direction. It is intended for information purposes only, and may not be incorporated into any contract.

It is not a commitment to deliver any material, code, or functionality, and should not be relied upon in making purchasing decisions. The development, release, and timing of any features or functionality described for Oracle's products remains at the sole discretion of Oracle.

Why rename this Oracle Database option

- From “Oracle Spatial” to “Oracle Spatial and Graph”

- Addresses increasing market demand for graph database capabilities
  - Social Network Graph database popularity
  - Competes with DB2 NoSQL Graph, Virtuoso, AllegroGraph, BigData, OWLIM

- Highlights existing graph capabilities in Oracle Spatial
  - Network Data Model graph structure with in memory graph analytics
  - W3C RDF graph triple store

Our Strategy

- Products
  - Oracle Spatial and Graph option, Oracle Database 11g Locator
  - Oracle Fusion Middleware MapViewer
- Partnerships With Leading Spatial Vendors
  - Software vendors
  - Integrators
  - Data suppliers
- Commitment To Standards
  - Open Geospatial Consortium, SQL, ISO TC-211, TC-204
- Part of Oracle applications, tools, engineered systems
  - Exadata, Exalogic, Exalytics
  - Oracle Business Intelligence Enterprise Edition, CRM, Primavera, Utilities, and more

ORACLE DATABASE

ORACLE FUSION MIDDLEWARE

ORACLE PARTNERNETWORK

OGC Principal Member

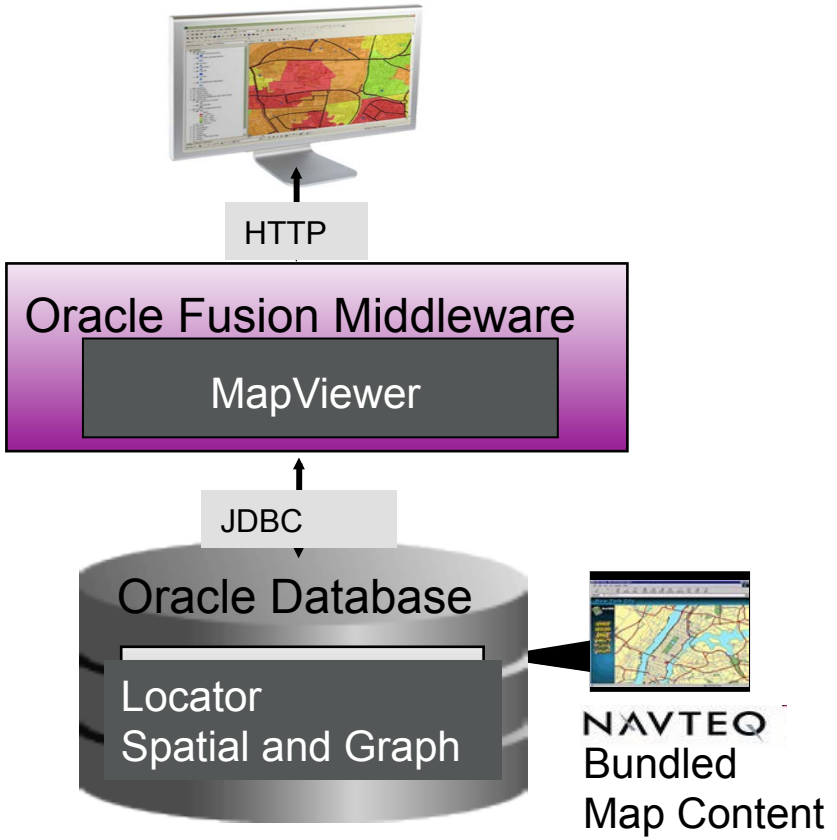
ISO

ORACLE FUSION APPLICATIONS

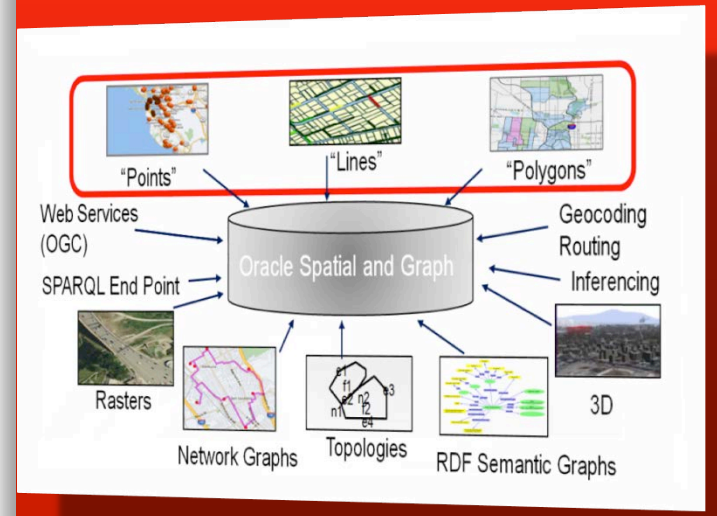
Oracle's Spatial Stack

Key Technologies

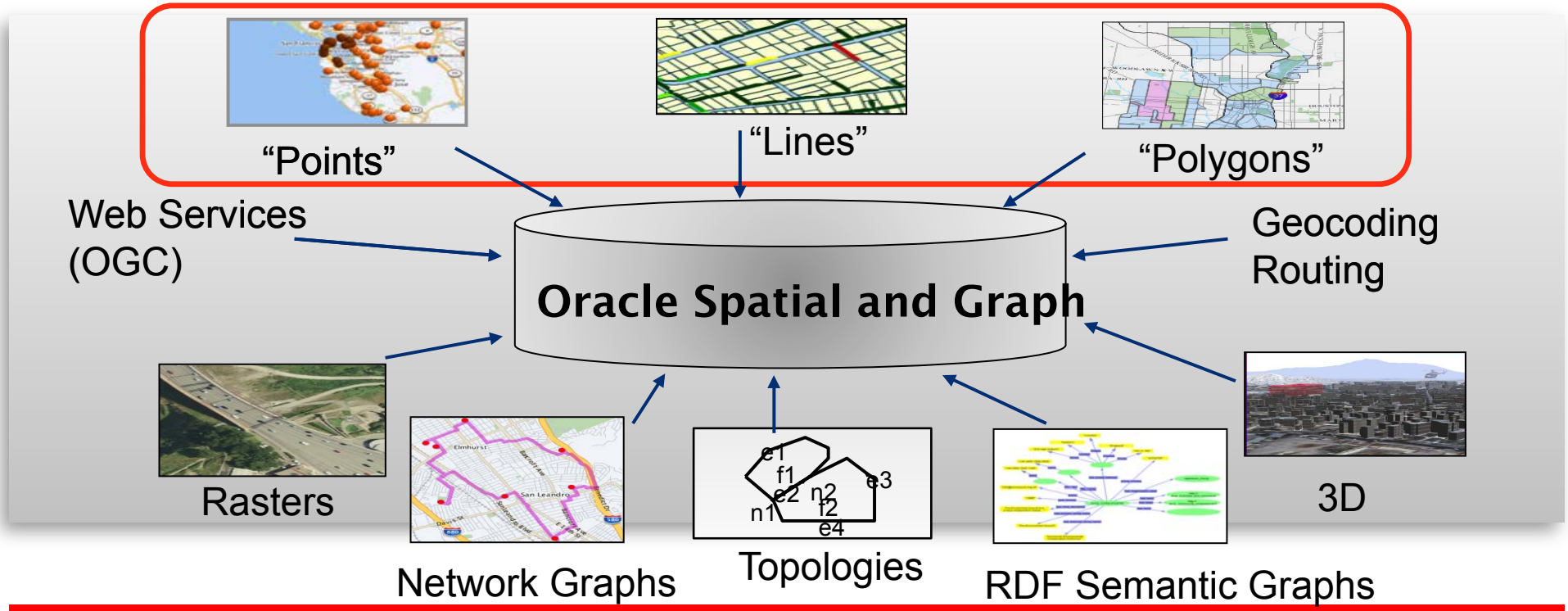
- Oracle Locator
- Oracle Spatial and Graph
- MapViewer
- Bundled Map Content



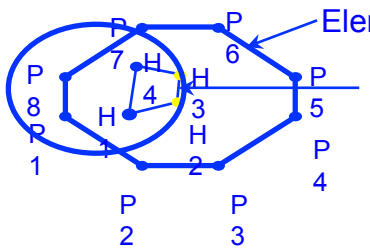
Overview: Spatial Database



Oracle Spatial and Graph option



Oracle Spatial Database Services



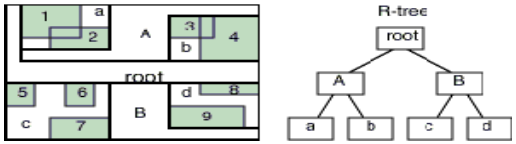
Geometry Data Type

Abstract Data Type

ROADS

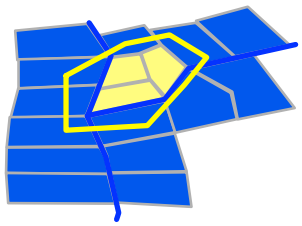
RNAME	ID	TYPE	LANES	GEOMETRY
M40	140	HWY	6	
M25	141	HWY	4	

X	Y
x1	y1
x2	y2
x3	y3
x4	y4
x5	y5



Indexing

Rtree



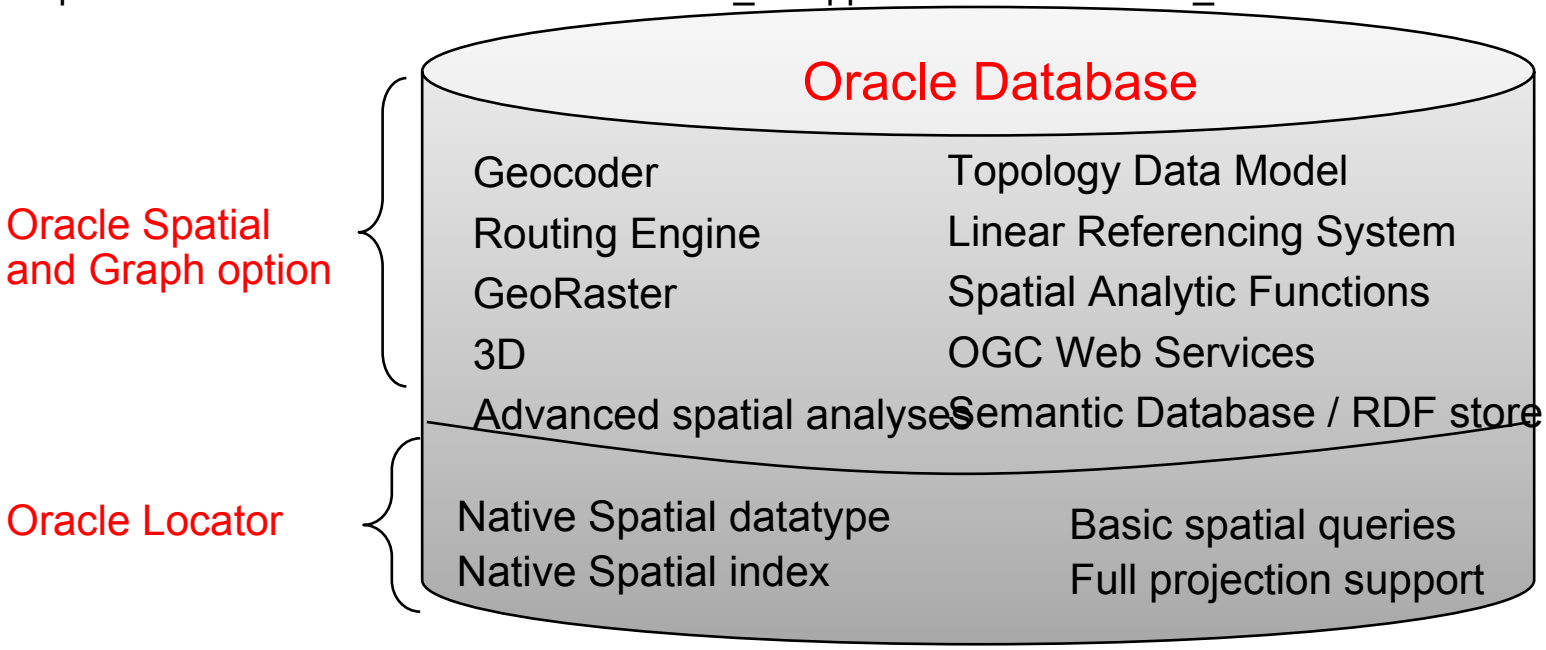
Query/Analysis

Select, join, buffer, within distance, nearest neighbor, intersection, union, convex hull, centroid, ...

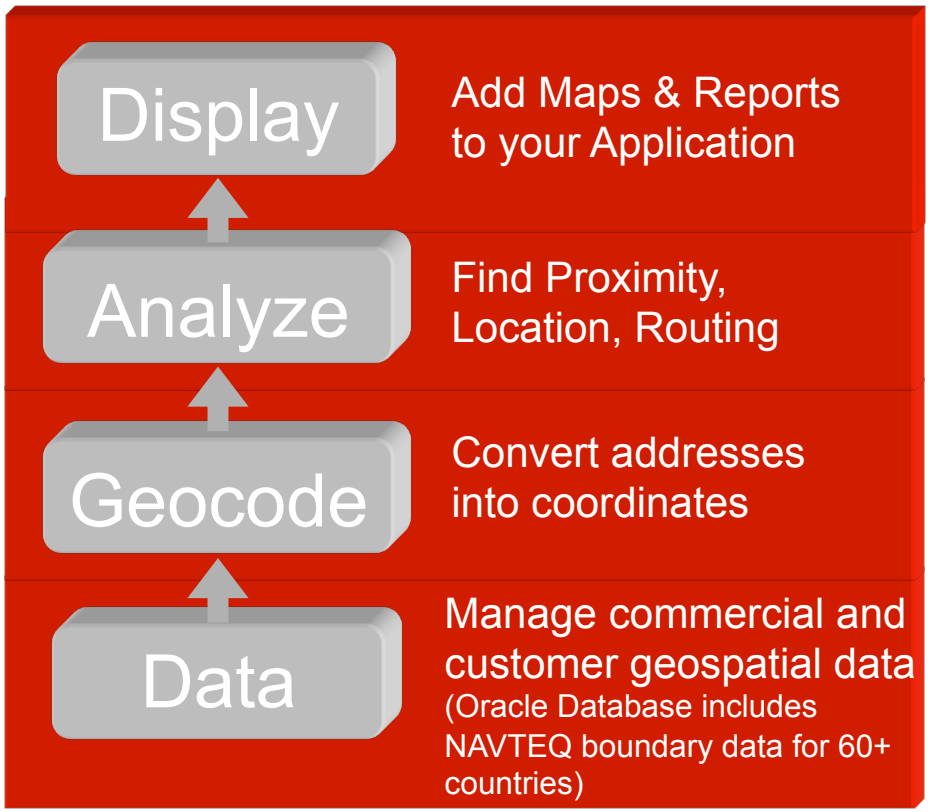
Access: SQL

Packaging: Oracle Spatial and Graph Option vs. Locator

Detailed feature listing in Oracle Spatial and Graph documentation at:
http://download.oracle.com/docs/cd/B28359_01/appdev.111/b28400/sdo_locator.htm#i632018



How Spatial Enhances Application Workflow



Data

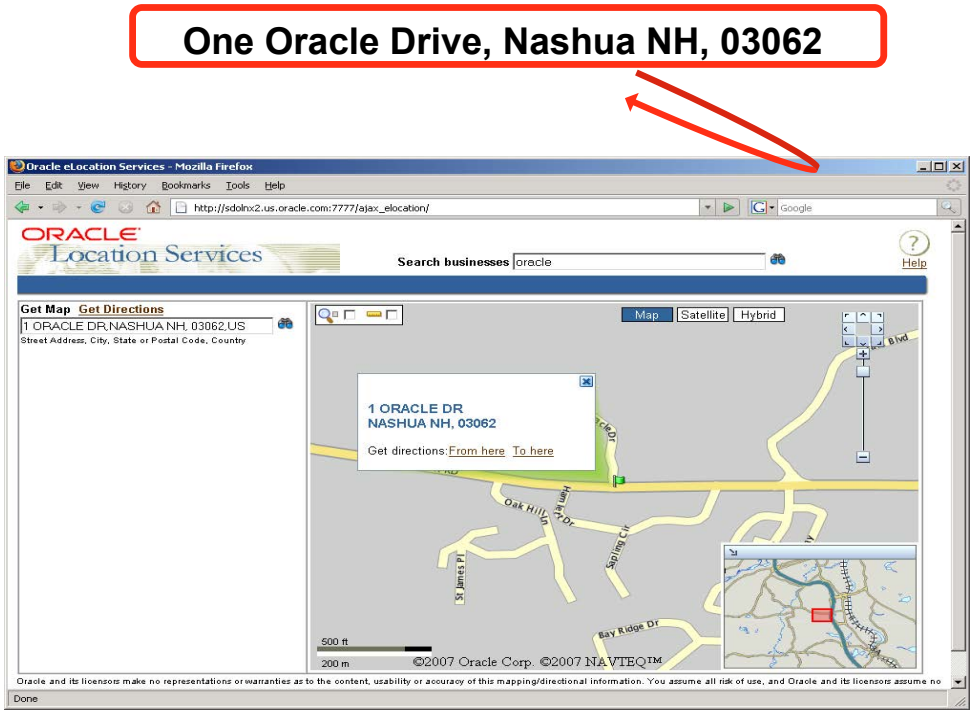
- **Oracle Bundled Map Content**
  - Major roads, admin (city county, state, country boundaries) for whole world from Navteq

- **3rd Party Specialized Map Data**
  - Navteq/Nokia
  - TomTom
  - DigitalGlobe
  - Intermap

3rd Party Mapping Services
- Google Maps
- Microsoft Bing
- Nokia

Geocode:

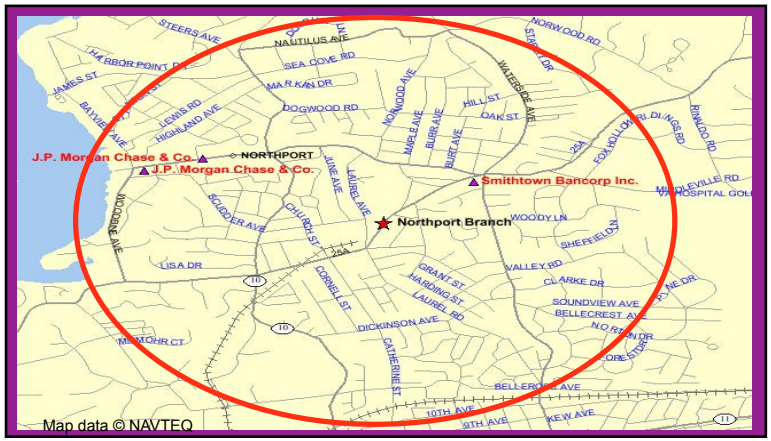
- Generates latitude/longitude (points) from address
- International addressing standardization
- Formatted and unformatted addresses
- Tolerance parameters support fuzzy matching
- 100% Java, open and scalable
- Record-level and batch processes
- Data provided by leading data vendors



Analyze: Geospatial Data

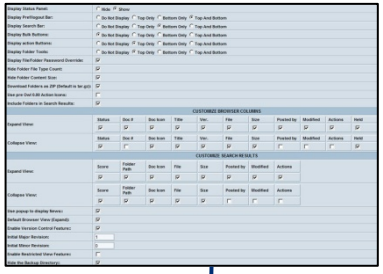
Find all competitors within 2 miles of Northport Branch

```
SELECT c.holding_company, c.location
  FROM competitor c,
       bank b
 WHERE b.site_id = 1604
   AND SDO_WITHIN_DISTANCE(c.location,
                           b.location,
       'distance=2 unit=mile') = 'TRUE'
```

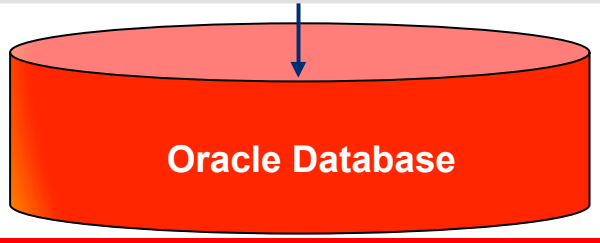


Native Spatial Analyses

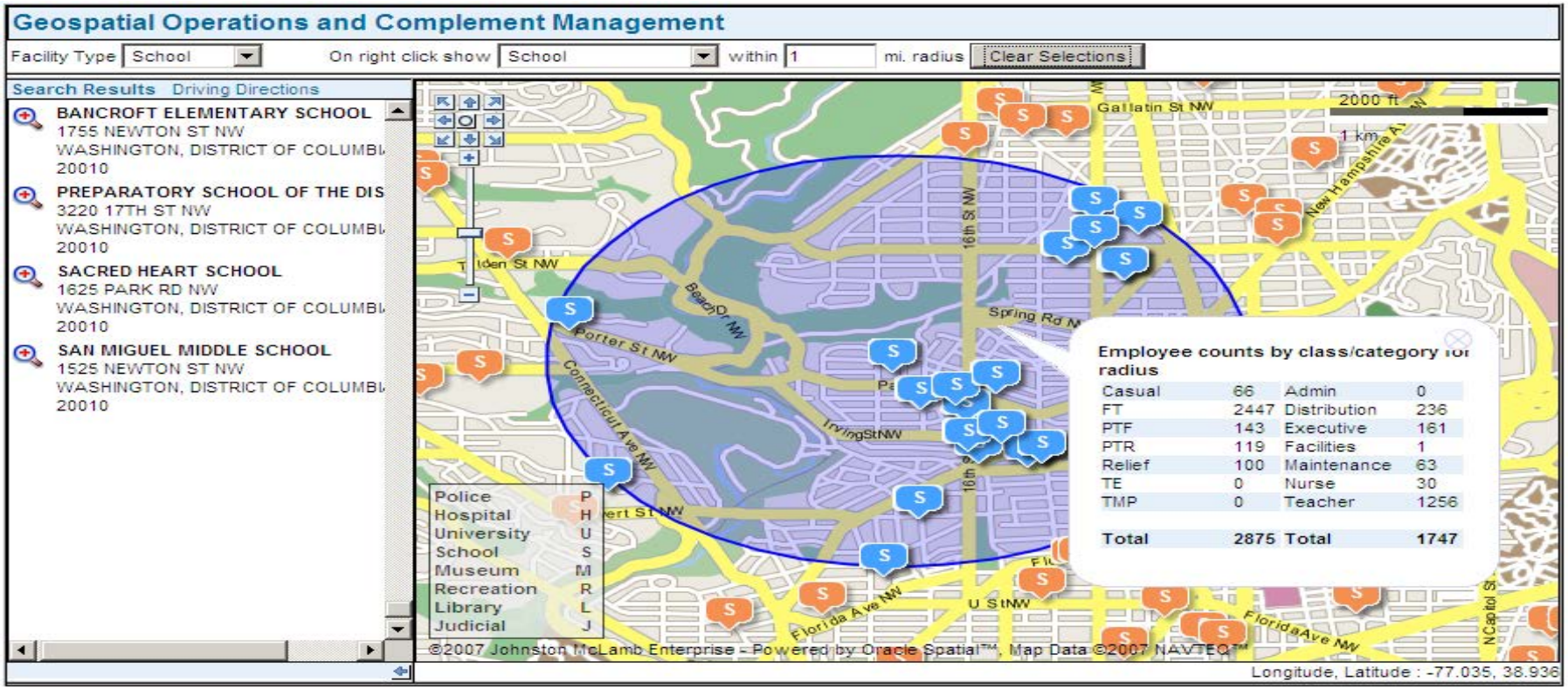
Acquiring rights-of-way for a proposed road widening project



```
SELECT a.owner_name, a.acquisition_status
FROM properties a, projects b
WHERE sdo_within_distance (a.property_geom, b.project_geom,
        'distance = .1 unit = mile') = 'TRUE' and b.project_id=189498;
```

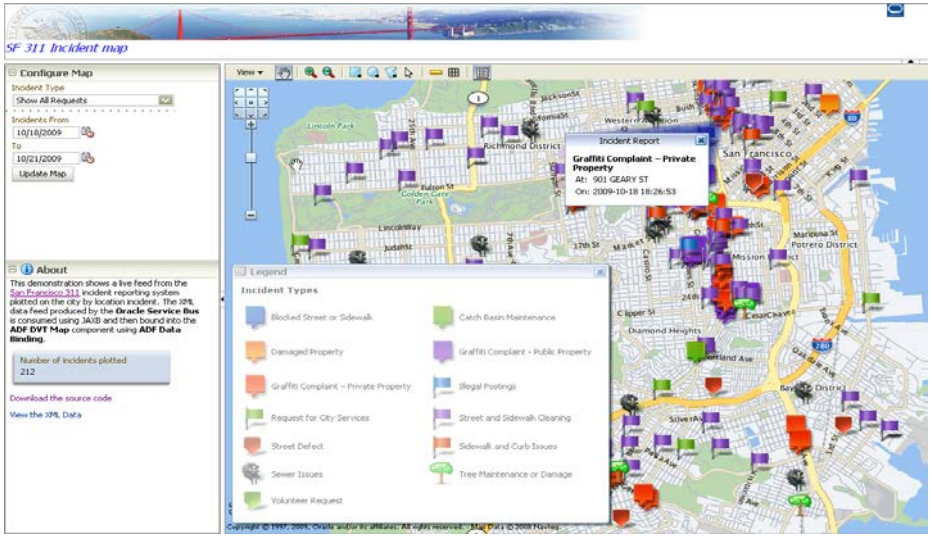


Display: Generate Powerful Maps



Oracle Fusion Middleware MapViewer

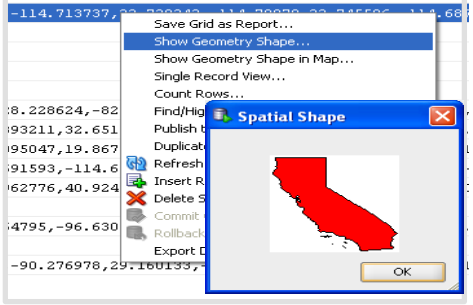
- A J2EE component (.ear) for developing web mapping applications.
- Renders data from Oracle Spatial and Graph (also WMS, WFS, .shp).
- Background maps can be from 3rd party providers
- Provides JavaScript, Java, and XML APIs for web mapping apps



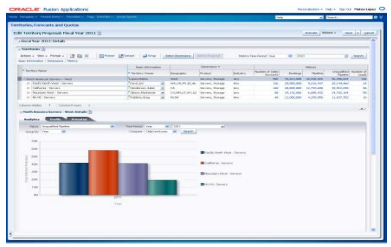
Map Enabling Oracle Apps and Tools

Oracle BI 11g Mobile

Oracle SQL Developer



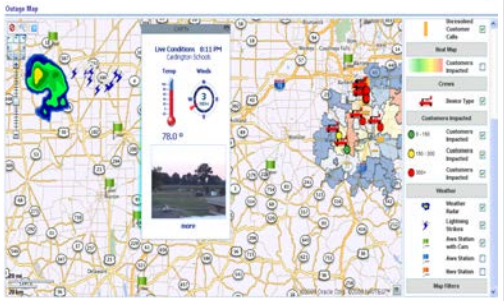
Oracle Fusion CRM Sales



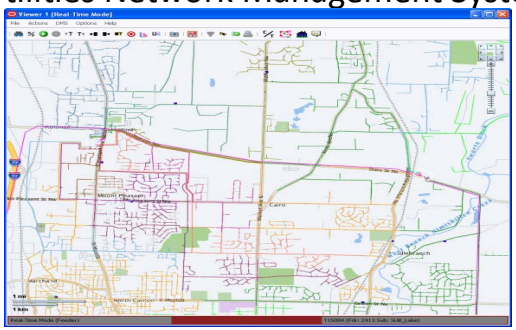
OBIEE 11g

Phase Forward

Utilities Outage Analytics



Utilities Network Management System



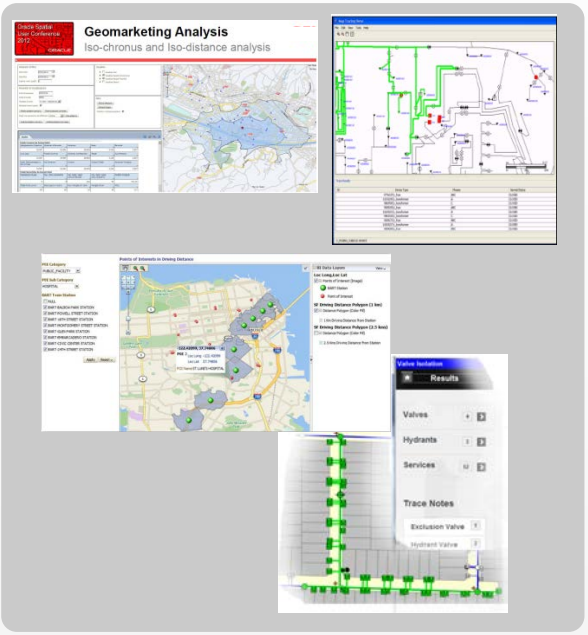
Advanced Spatial Features

- Network Data Model, Routing Engine
- Georaster
- 3D Data Management
  - Point Cloud
  - 3D Vector Model
  - TINs/DEMs
- Vector Performance Acceleration

Network Data Model Graph

Use Cases

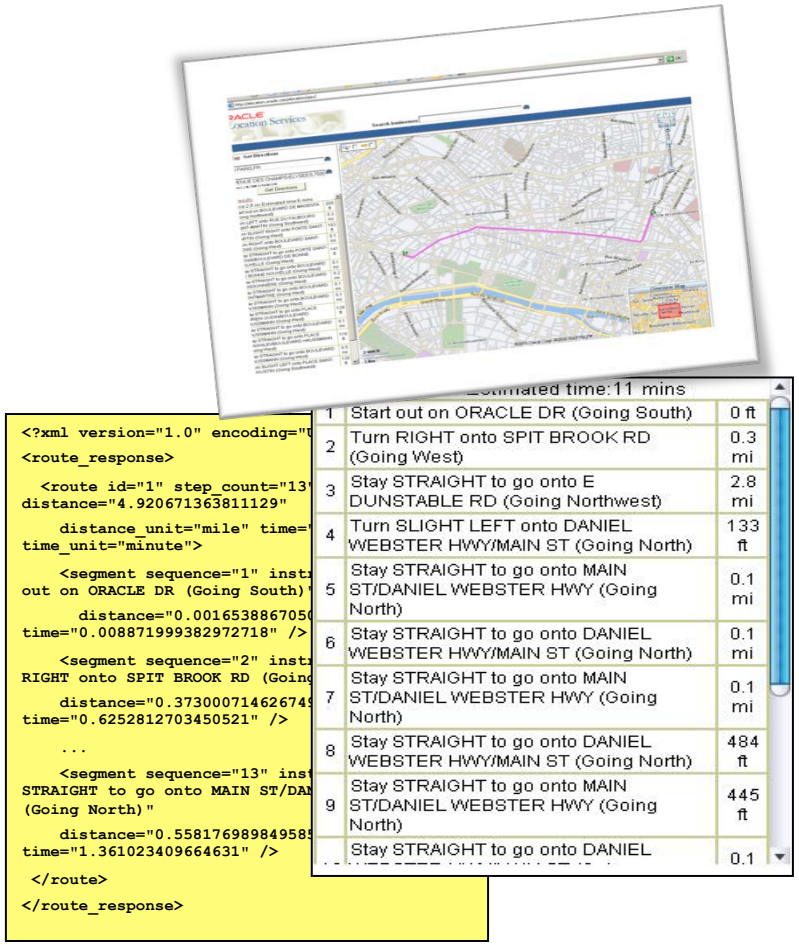
Oracle Spatial and Graph



- Road and Multimodal Networks
- Drive Time Polygon Analysis
- Trade Area Management
- Service Delivery Optimization
- Water, Gas, Electric Utility, Network Applications

Routing Engine

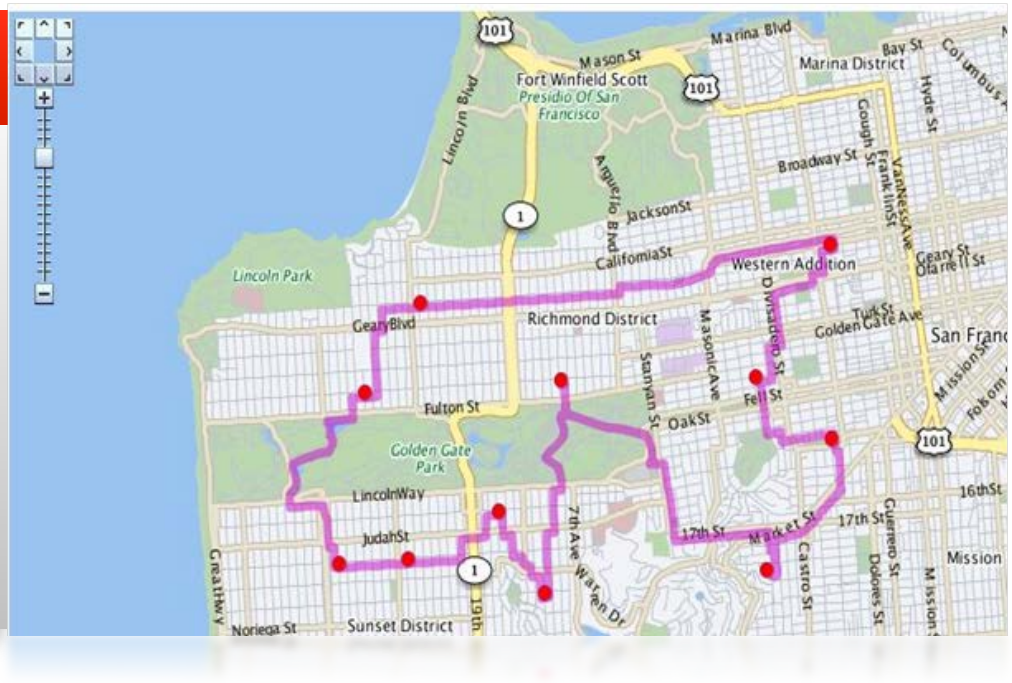
- Web service
- XML requests and responses
- Returns driving directions
- Also route and maneuver geometries
- Choose fastest / shortest routes
- Choose vehicle type
- Choose language for directions


<?xml version="1.0" encoding="U
<route_response>
<route id="1" step_count="13"
distance="4.920671363811129"
distance_unit="mile" time="
time_unit="minute">
<segment sequence="1" instr
out on ORACLE DR (Going South)"
distance="0.0016538867050
time="0.008871999382972718" />
<segment sequence="2" instr
RIGHT onto SPIT BROOK RD (Going
distance="0.373000714626749
time="0.6252812703450521" />
...
<segment sequence="13" inst
STRAIGHT to go onto MAIN ST/DAN
(Going North)"
distance="0.558176989849585
time="1.361023409664631" />
</route>
</route_response>
Estimated time:11 mins
1 Start out on ORACLE DR (Going South) 0 ft
2 Turn RIGHT onto SPIT BROOK RD (Going West) 0.3 mi
3 Stay STRAIGHT to go onto E DUNSTABLE RD (Going Northwest) 2.8 mi
4 Turn SLIGHT LEFT onto DANIEL WEBSTER HWY/MAIN ST (Going North) 133 ft
5 Stay STRAIGHT to go onto MAIN ST/DANIEL WEBSTER HWY (Going North) 0.1 mi
6 Stay STRAIGHT to go onto DANIEL WEBSTER HWY/MAIN ST (Going North) 0.1 mi
7 Stay STRAIGHT to go onto MAIN ST/DANIEL WEBSTER HWY (Going North) 0.1 mi
8 Stay STRAIGHT to go onto DANIEL WEBSTER HWY/MAIN ST (Going North) 484 ft
9 Stay STRAIGHT to go onto MAIN ST/DANIEL WEBSTER HWY (Going North) 445 ft
Stay STRAIGHT to go onto DANIEL 0.1

Oracle Spatial and Graph - Routing Engine

Enhancements

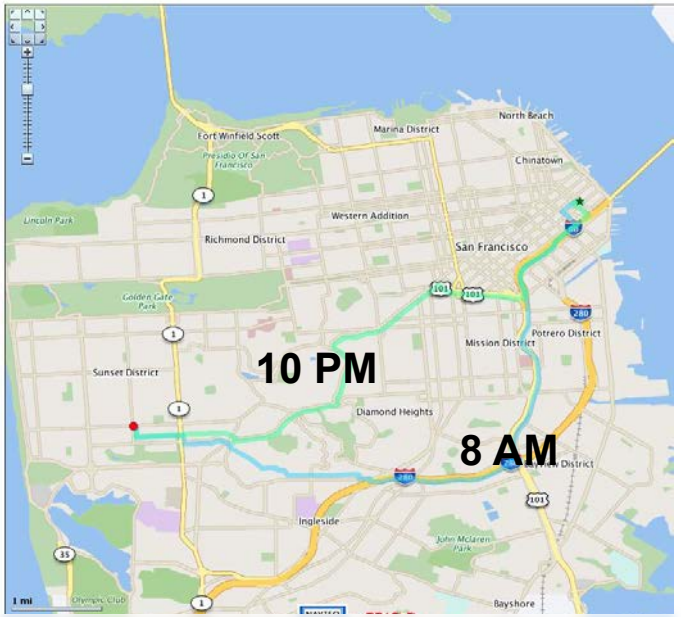
- Traveling Salesman Analysis (TSP)
  - Optimal multiple-stop route
  - Open or closed path



Oracle Spatial and Graph - Network Data Model Best Route Using Traffic Pattern Information

Temporal Modeling/Analysis

- Traffic Patterns
  - Record historical travel patterns for different classes of roads
  - Data collected based on time of day and day of the week
- NDM can use traffic patterns to compute shortest paths
  - Find shorted path from point A to B with start time of 8 AM
  - Find shortest path from point A to B and reach destination at 5.30PM
- Support NAVTEQ Traffic Patterns format out of the box



Oracle Spatial and Graph - Network Data Model Routes with Preferences (walk/car/bus/subway)

Multi-Modal Routing

- Each mode (car, bus, rail, bike, etc) modeled as a separate network
- Single logical network represents all modes of transportation
- Transition nodes where networks meet
- NDM APIs can specify the modes to consider
- Out of the box support for transit data published by transit authorities
  - GTFS (General Transit Feed Spec) supported

Analysis Result:
From: 575456205
To: 575481535

Drive/Walk to
'CONNECTICUT AV and WYOMING AV'
(31 meters).

[1]
Board Route 227 (Inbound)
At 'CONNECTICUT AV and WYOMING AV'
Dep. Time : 10:10:42

Get down at 'NW CONNECTICUT AV and NW 20TH ST';

[2]
Transfer to Route 86
Board Route 86 (Outbound)
At 'NW CONNECTICUT AV and NW 20TH ST'
Dep. Time : 10:21:00

Get down at 'NW H ST and NW JACKSON PL';

[3]
Transfer to Route 75
Board Route 75 (Inbound)
At 'NW H ST and NW JACKSON PL'
Dep. Time : 10:32:42

Get down at 'SE INDEPENDENCE AV and SE 1ST ST';

[4]
Transfer to Route 131
Board Route 131 (Outbound)
At 'E CAPITOL ST and SE 1ST ST'
Dep. Time : 11:01:06

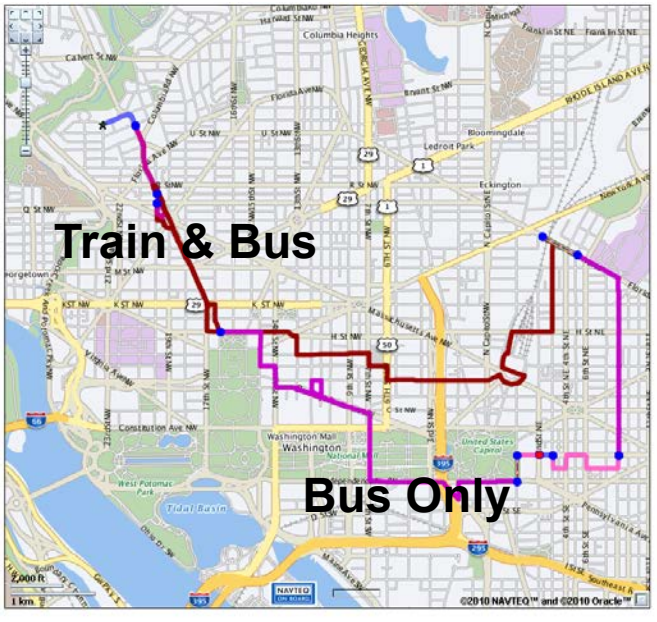
Get down at 'E CAPITOL ST and SE 3RD ST'
At 11:02:00

Drive/Walk from
'E CAPITOL ST and SE 3RD ST'
(0 meters) to destination.

Trip Travel Time: 51 minutes.

Number of Bus Routes=4
Number of Train Routes=0

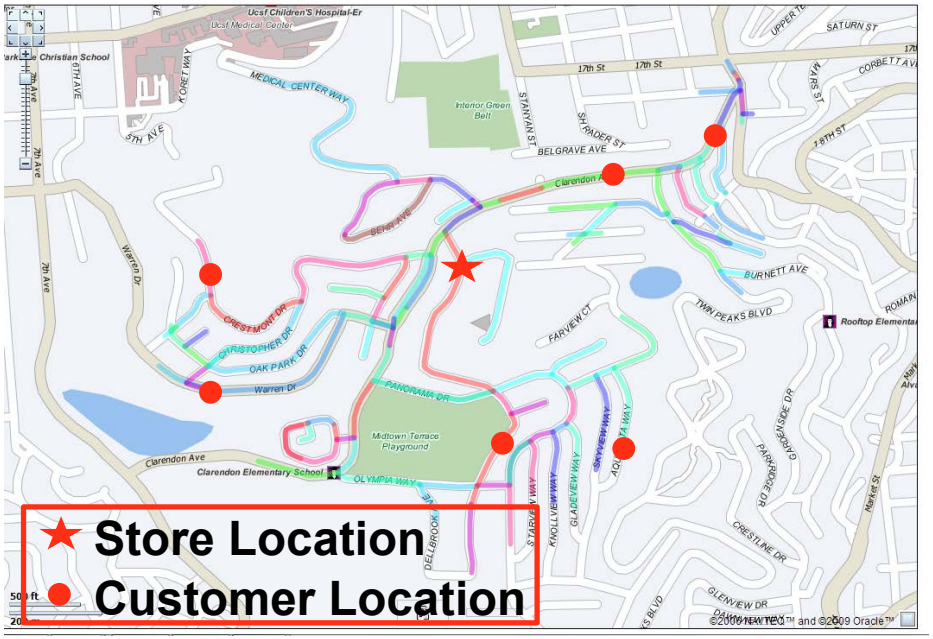
Time to analyze the network: 0.914s.



Large Scale Drive Time/Distance Analysis

For millions of customers, find closest store within a specified drive time

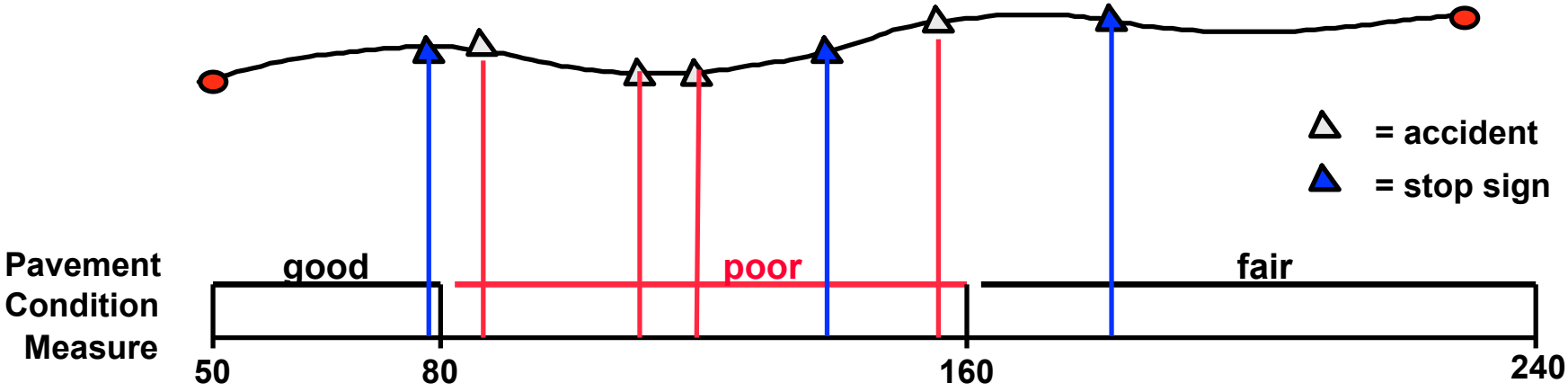
- Same underlying data for geocoder and road network
- Customers geocode as link id and percentage (instead of longitude/latitude)
- 5 mile Network Buffer generates all possible paths
- Each persisted path includes:
  - Covered link IDs, nodes ID, and associated costs
- Single database query to find closest store and drive time/distance for each customer (join on link_id)



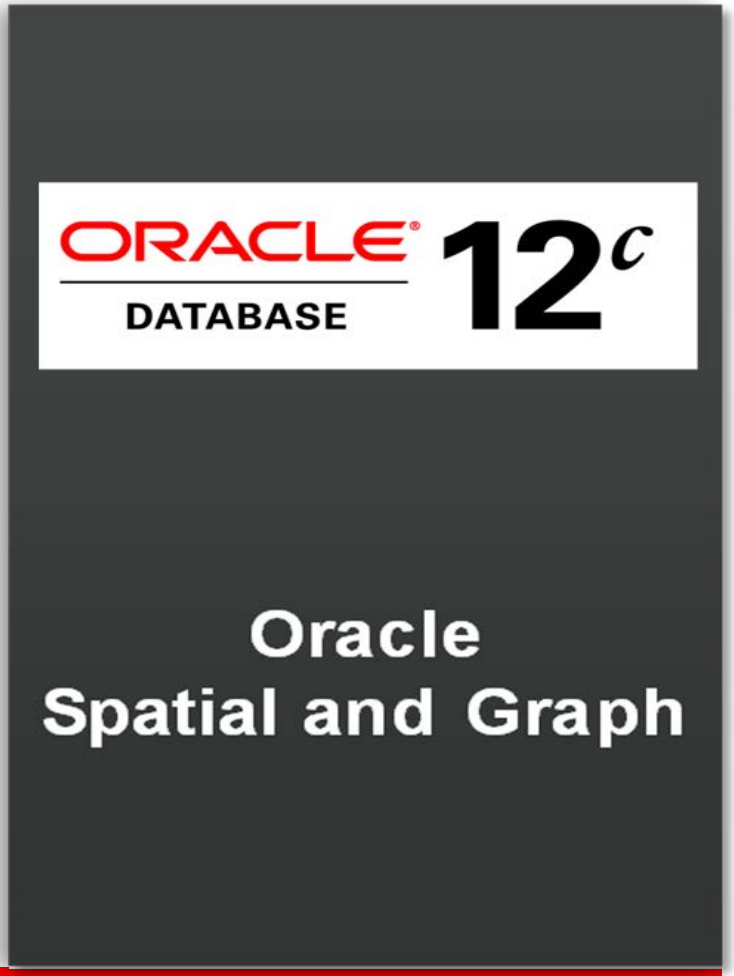
Dynamic Segmentation
Linear Referencing

Associating “Events” with Features

- Point Event: Accidents, Stop Signs, Equipments, …
- Linear Event: Pavement Conditions, Traffic Load, …

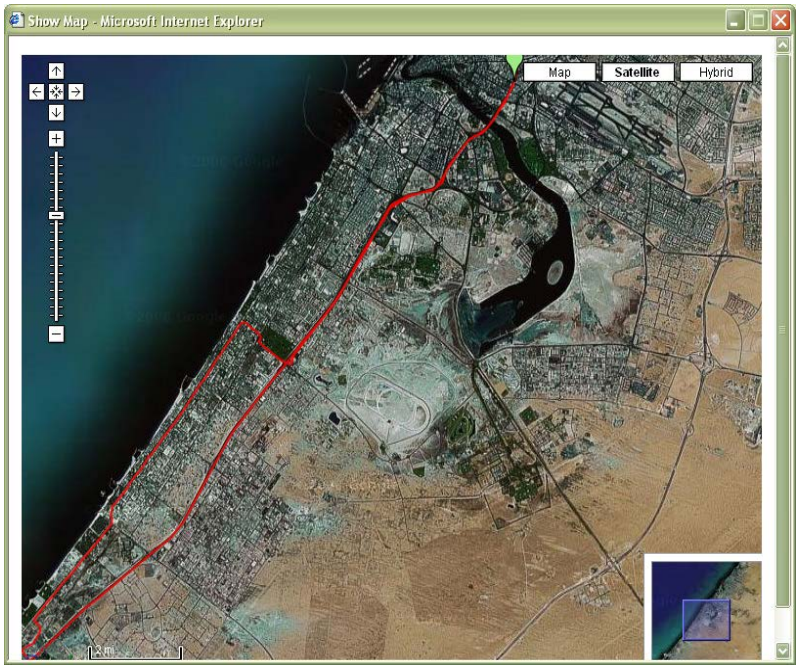


GeoRaster

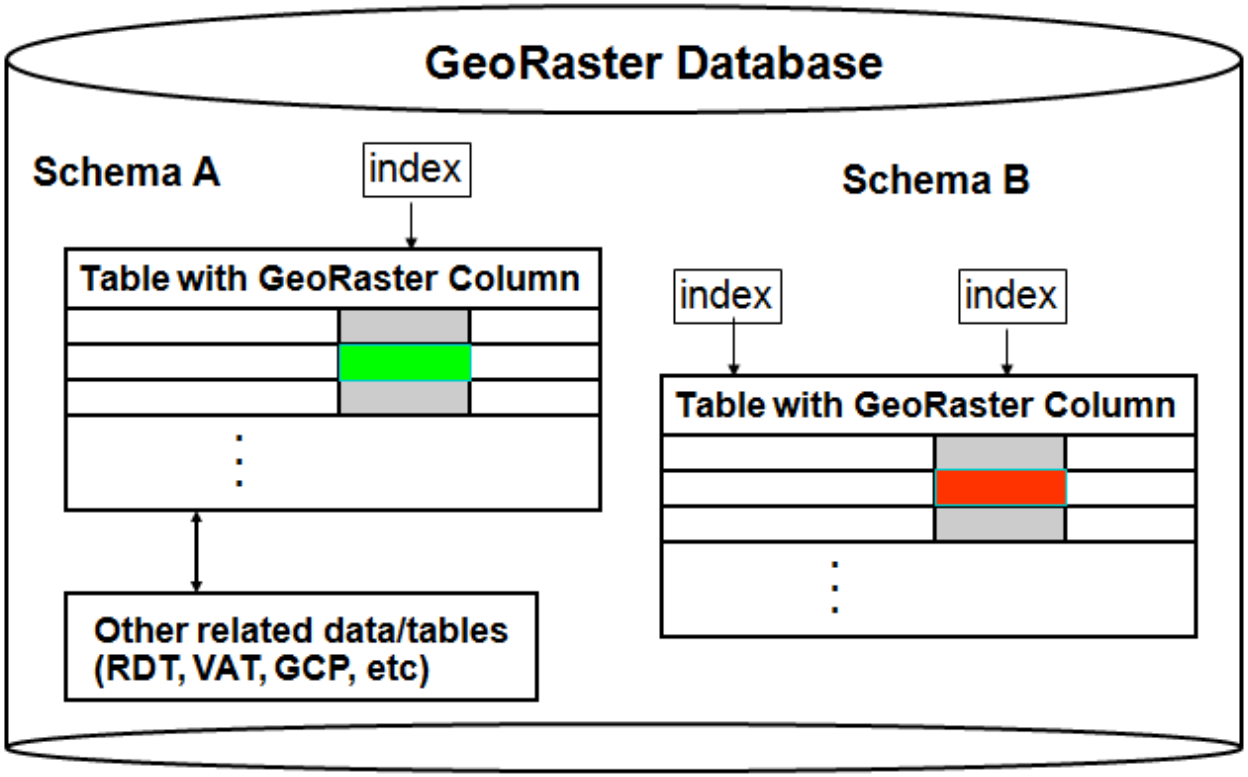


GeoRaster

- A Native Raster Data Type
  - Satellite images, remote sensing data
  - Multi-band, multi-layer
  - An XML schema to store Metadata
    - Data source, layer information
  - Multi-spectral, Hyperspectral
  - High Performance
- Functionality
  - storage and indexing of raster data
    - No size limit for each raster object
  - Generate resolution pyramid
  - query and analysis
  - delivering to external consumers



GeoRaster Databases

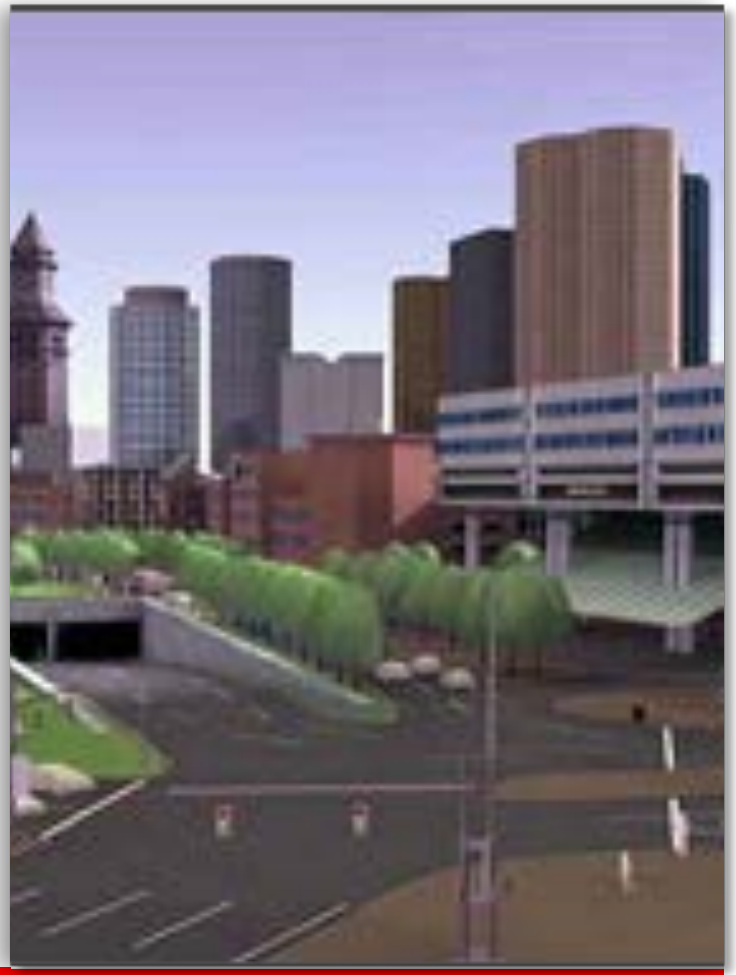


GeoRaster 12c New Features

- In-Database Raster Algebra and Analytics
- In-Database Image Processing and Virtual Mosaic
- GeoRaster Core Enhancements
- Other New Server-Side Subprograms
- New and Enhanced Client-Side Tools and Java API
- Parallel GeoRaster and Performance Improvement

3D Data:

- Point Clouds
- 3D solid models
- TINs



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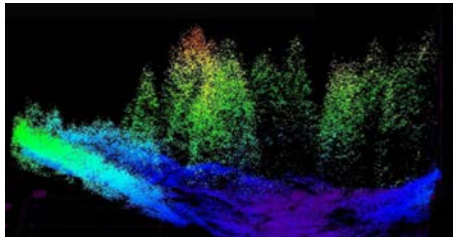
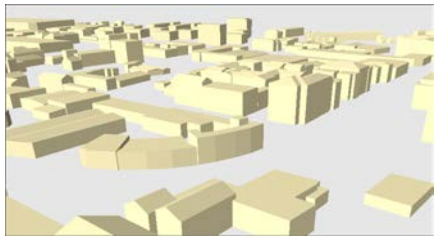
Oracle Spatial and 3D

Point Clouds



3D Models



Triangular Irregular Networks

Import and Export

KML

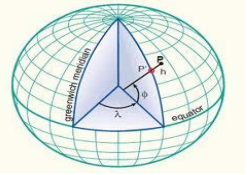
FEATURE MANIPULATION ENGINE

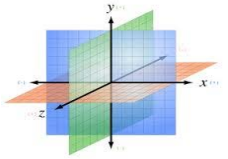
libLAS

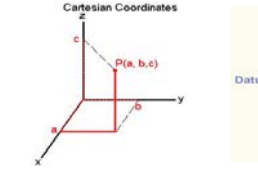
COLLADA

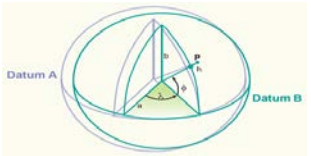
CityGML

3D Coordinate Systems

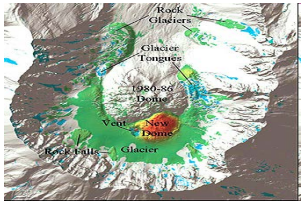




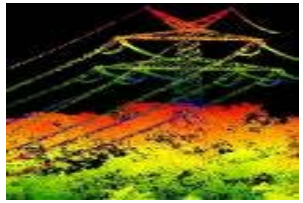




3D Queries



Volumetric Analysis

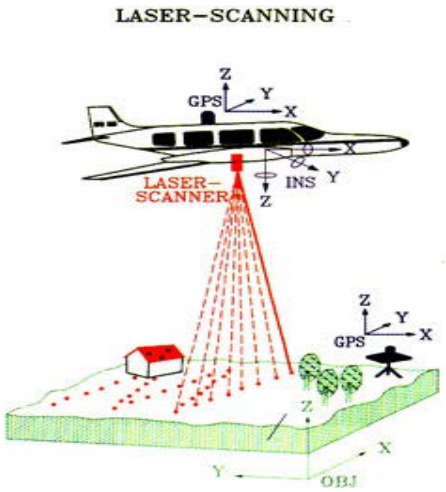


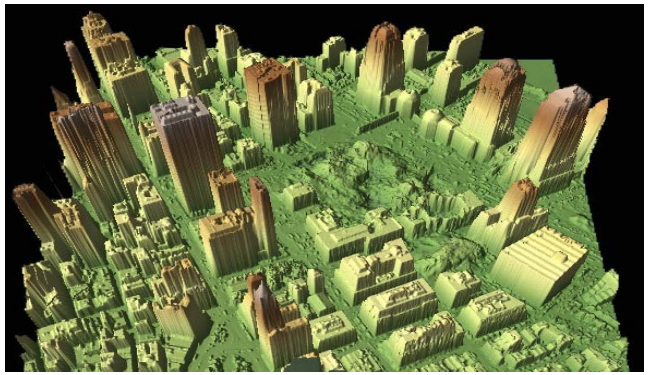
Visibility queries

Spatial and attribute queries

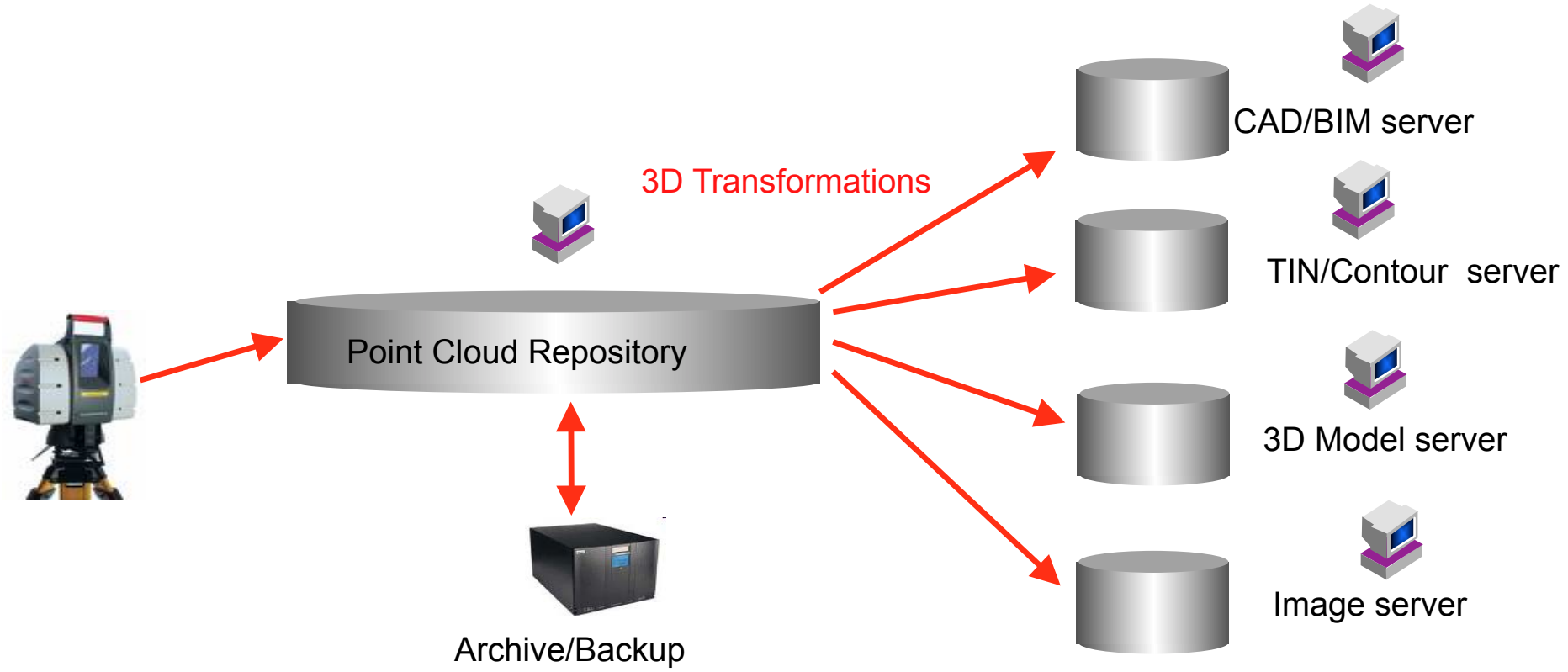
Point Clouds: LIDAR

- Large volumes of point data acquired by sensors
  - LIDAR (*Light Detection and Ranging*)
  - Seismic sensors
- Millions of points used to model a scene
- New data type introduced to efficiently manage this type of point data
- TIN to create triangulation of such points





Creating Value From Raw LiDAR Points



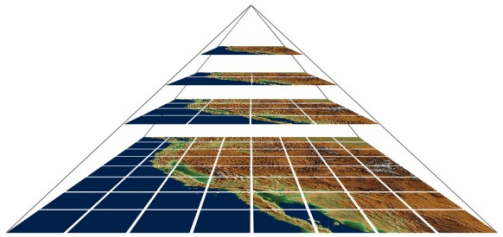
Point Clouds: Features

- Native Point Cloud Data Type: SDO_PC
- API: Clip_PC
- Point Cloud to TIN Function
- Directly Supported By:
  - libLAS* / libPC / PDAL / Safe / Bentley

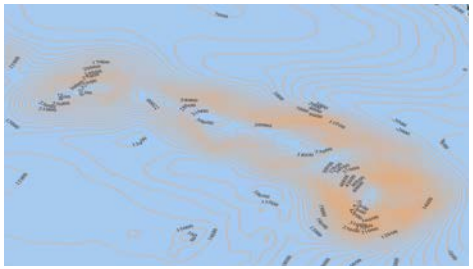
- 12.1
  - Point Cloud Pyramiding
  - Point Cloud to Contour Function

Point Cloud Enhancements

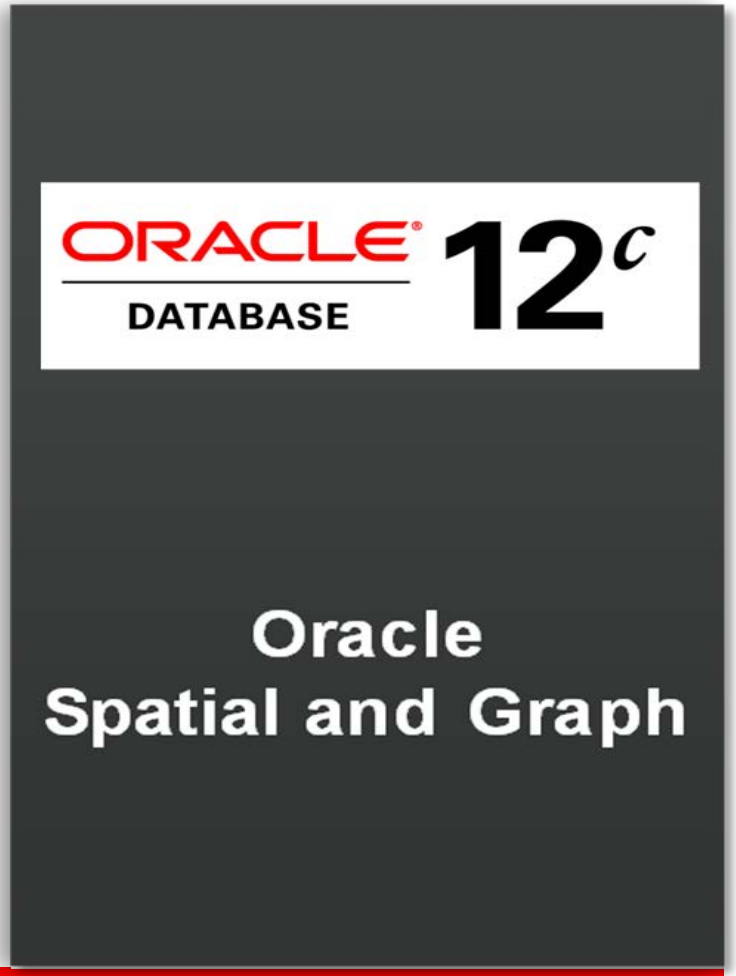
- **Pyramiding support for PC and TIN data**
  - Generate pyramids for existing point clouds
  - Points can be repeated in pyramid levels or mutually exclu
  - Useful for visualization applications



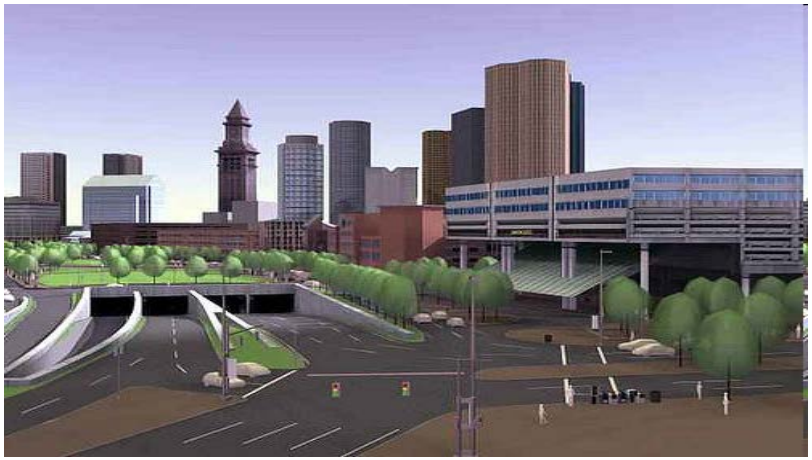
- **Contour generation from PC data**
  - Generate linear geometries that connect points with equal elevation values
  - A polygon can be used to limit contour generation to region
  - Contour generation process is grid-based in x and y
  - Krigging performed to assign heights to grids with no point data

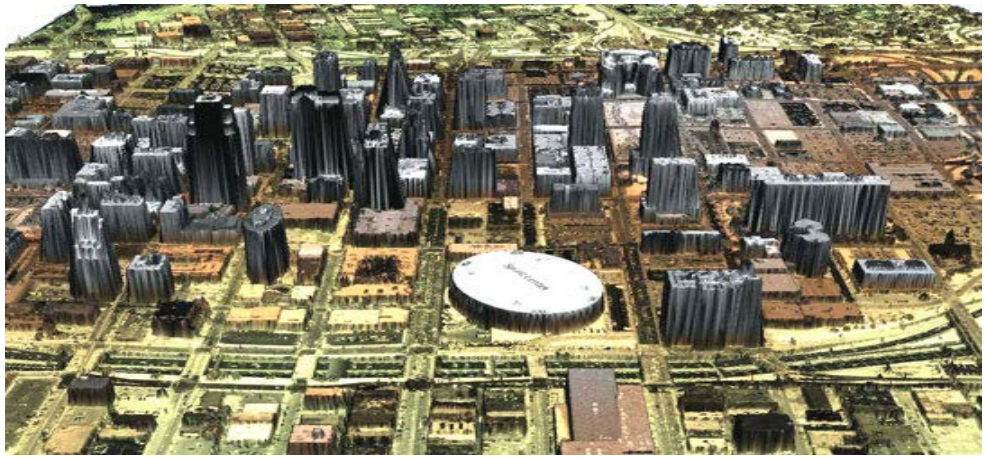


3D Vector Types

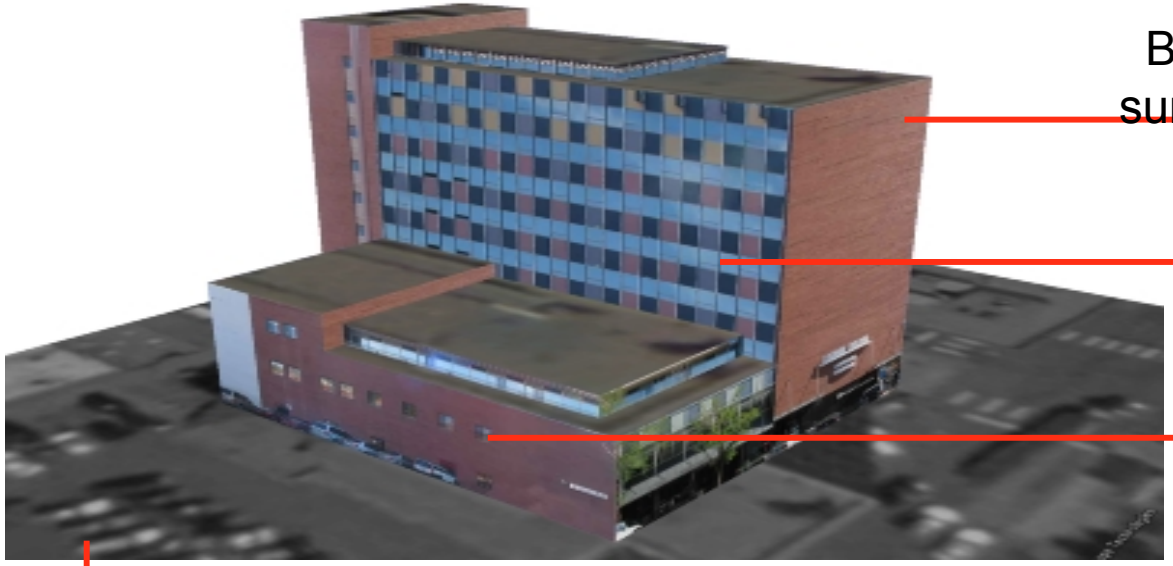


3D City Models (CityGML)





SDO_GEOMETRY for 3D Vector Data



Building surface (3D surface type)

Texture stored as image (GIF)

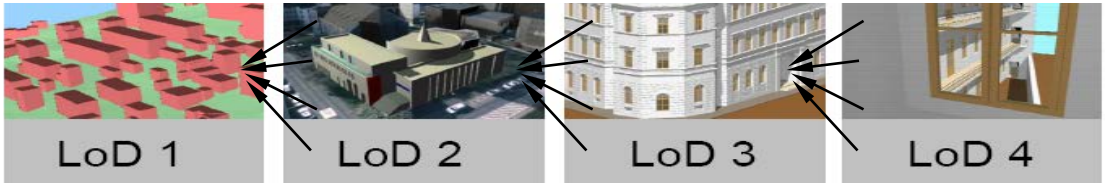
Windows stored as 3D polygons

Ortho photo

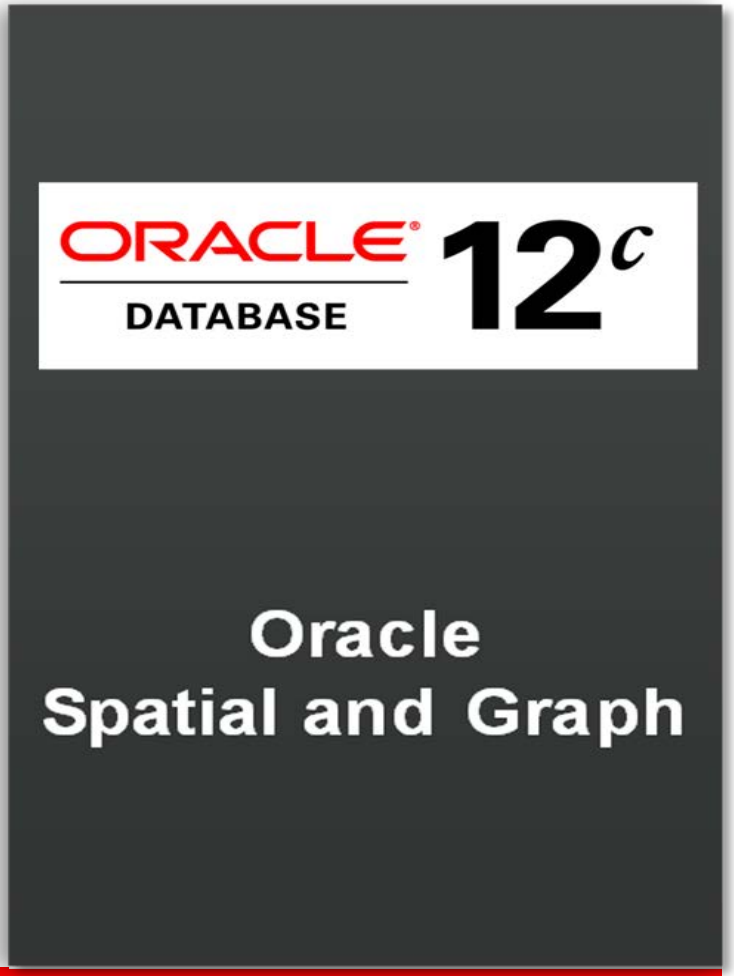
Sample Theme: Generalization

```
create table TEXTURES (
  id      number,
  texture blob,
  CONSTRAINT textures_pk PRIMARY KEY(id));

create table buildings_zoom4 (
  id             number,
  geom           sdo_geometry,
  texture_id     number,
  texture_coords sdo_ordinate_array,
  gen_id         number,
  CONSTRAINT buildings4_pk PRIMARY KEY(id),
  CONSTRAINT buildings4_FK FOREIGN KEY(texture_id) REFERENCES TEXTURES(id)
    deferrable initially deferred,
  CONSTRAINT buildings4_GEN_FK FOREIGN KEY(gen_id) REFERENCES buildings_ZOOM3(id)
    deferrable initially deferred);
```

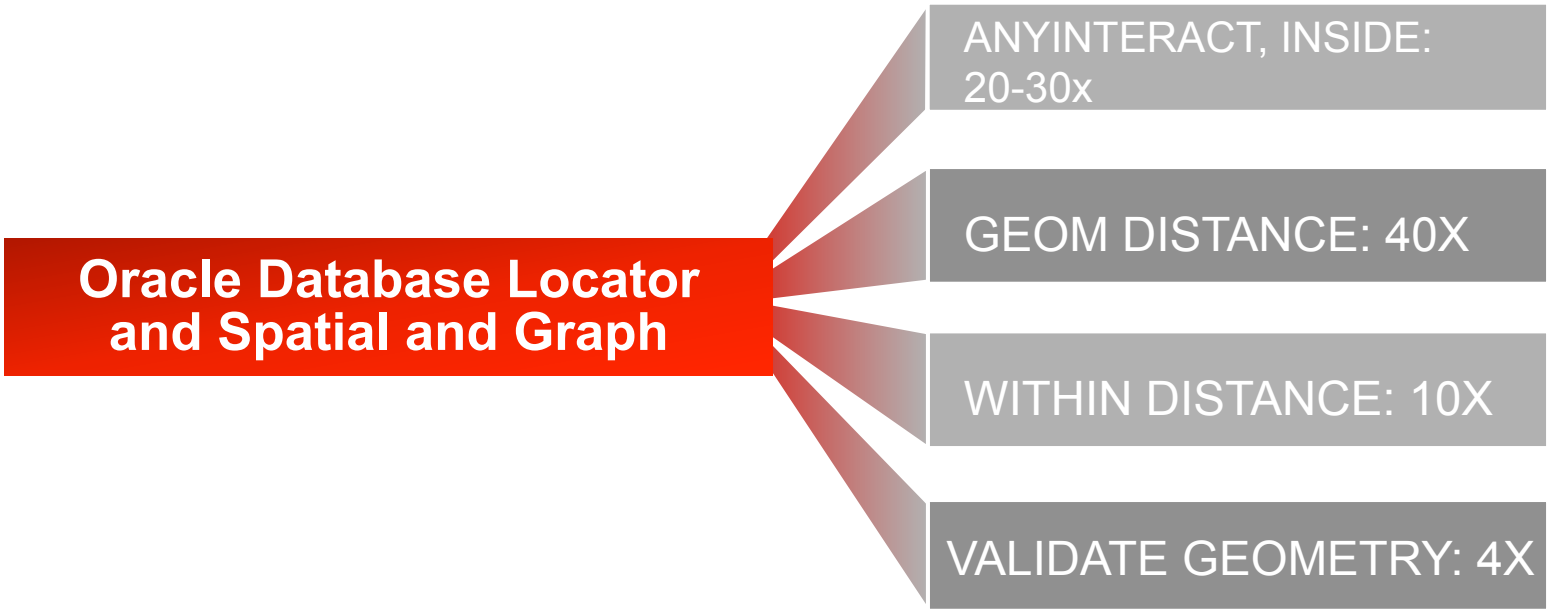


Vector Performance Acceleration



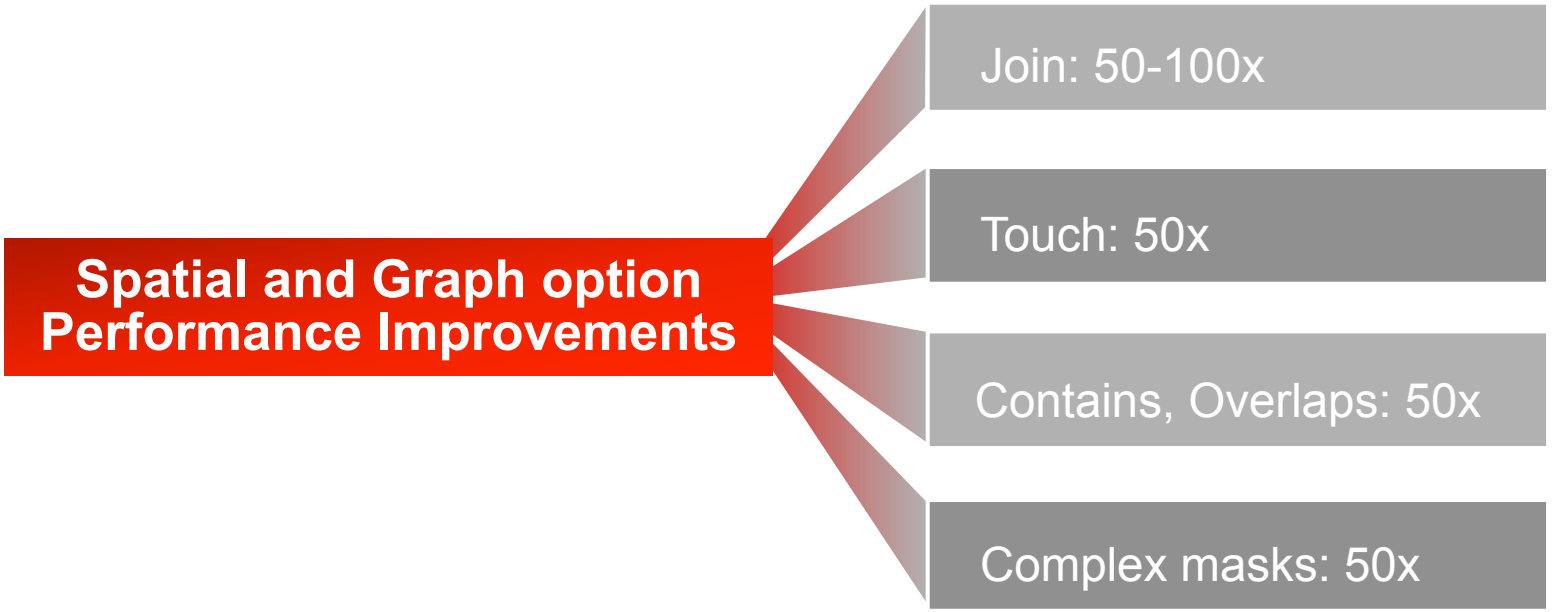
Dramatically Improved performance

Core Spatial Functions and Operations



Vector Performance Acceleration

"Turbo-charged" spatial functions and operators



Benefits on Oracle Exadata Database Machine

Extreme Performance for Spatial Workloads

- Oracle ‘s spatial datatype exploits Exadata’s processing power, bandwidth, and parallelism
  - Breaks new boundaries for ingesting spatial data
  - Data warehouse performance increases of up to 100x faster
  - Box and distance queries up to 25x faster
  - Spatial query analysis up to 100x faster
  - Extreme compression for point data sets with EHCC
  - Successful customer deployments in government (eg environmental analysis/sensor data feeds), national cadasters, oil and gas, more

ORACLE

Summary

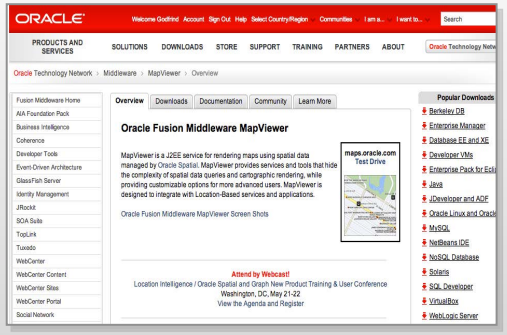
- Consolidated data management for ALL geospatial data types
- Support multiple vendor tools/apps
- Deploy a single IT architecture support all geospatial data types and workflows
- Leverage Oracle scalability, security, and reliability
- Aligned with leading geospatial standards
- Reduce cost & risk, increase productivity & ROI

Resources

- **Oracle Technology Network**

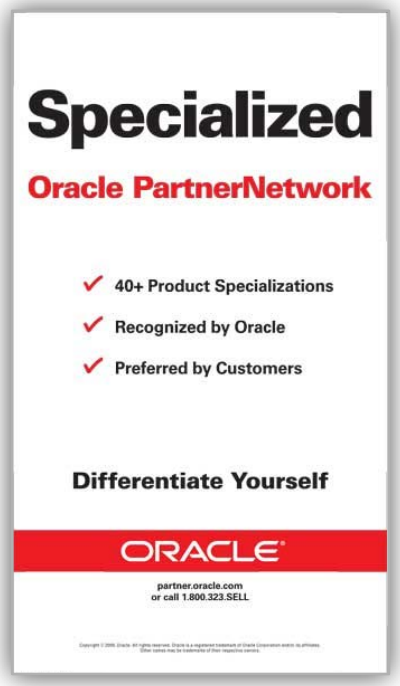
  Get software downloads, sample code, tech info, updates, documentation, partner resources

  - **Oracle Spatial and Graph**
    www.oracle.com/technetwork/database-options/spatialandgraph/overview/spatialfeatures-1902020.html
  - **Oracle Fusion Middleware MapViewer**
    www.oracle.com/technetwork/middleware/mapviewer/



Communities & Certification

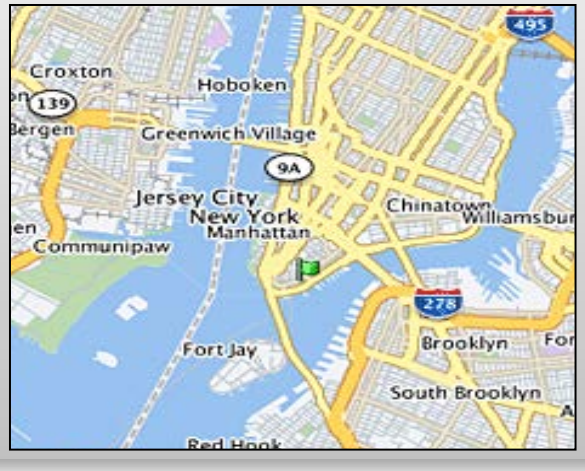
- **Communities:** Stay connected and exchange knowledge with the community of users and experts
  - User Groups Worldwide
    - North American IOUG S&G SIG: http://www.ioug.org/p/cm/ld/fid=148&gid=439
  - Technology blogs, social networking groups
  - **OTN Spatial or MapViewer > Community Tab**
- **Partner Specialization & Individual Certification for Spatial**
  - Credentials for individuals & official partner specialization program through Oracle PartnerNetwork
  - Exam information, training, business/competency requirements for partners, webcast
  - www.oracle.com/technetwork/database-options/spatialandgraph/learnmore/spatial-partners-423197.html
  - Speak with an specialization committee member at the Oracle table today



MapViewer in Action

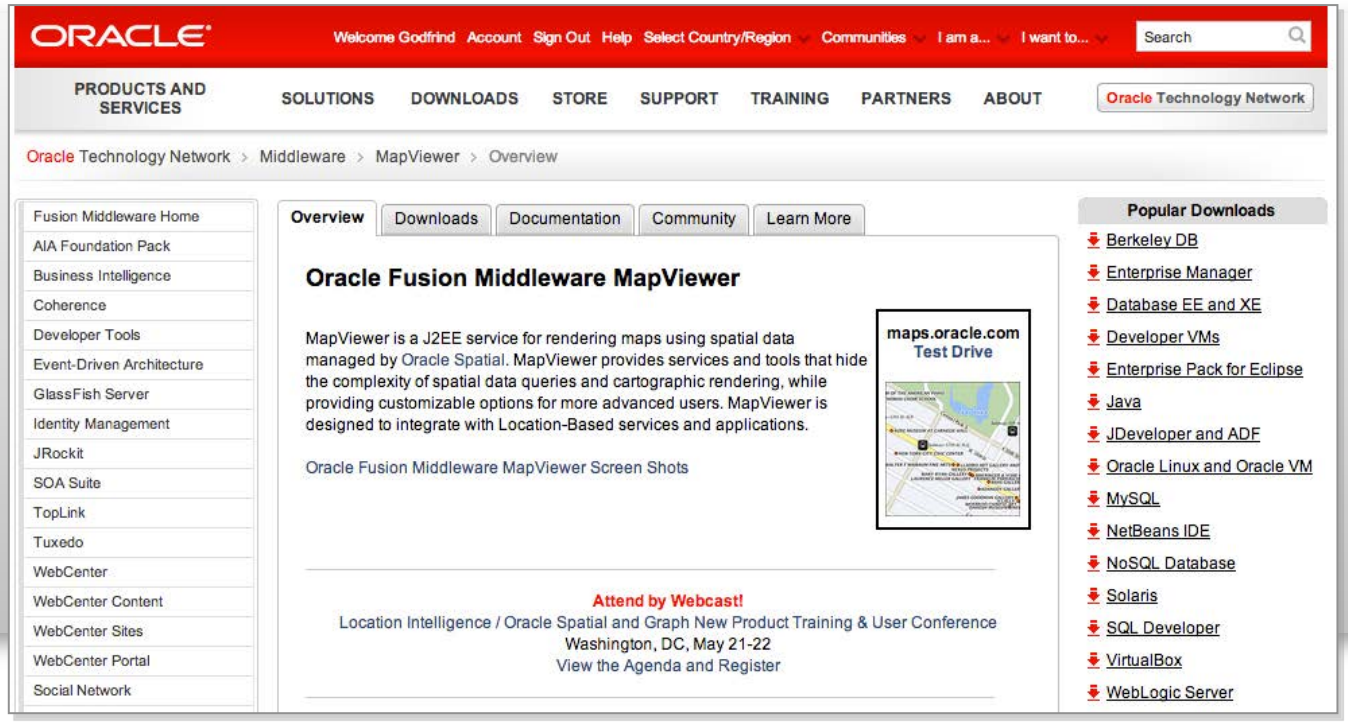
Oracle eLocation Services

http://maps.oracle.com



More Information …

http://www.oracle.com/technetwork/middleware/mapviewer



Q & A