

# Maps and Spatial Databases: How to use them

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## **Siva Ravada**

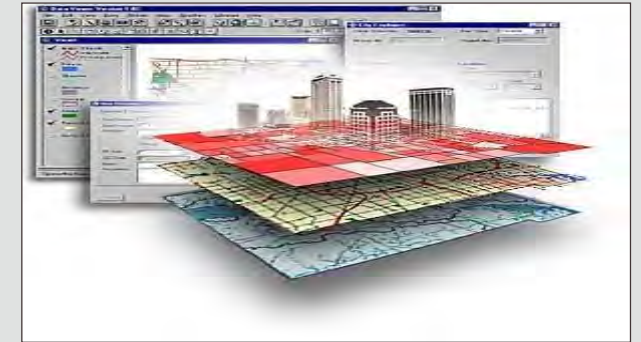
Senior Director of Development  
Oracle Spatial and Graph

## **David Lapp**

Senior Product Manager  
Oracle Spatial and Graph



# Oracle Spatial Platform



Ubiquitous Spatial services in IT infrastructure

Simplify application development

Integrate operational systems

Allow Spatially-enabled solutions to focus on business context,  
not infrastructure services

Database and Application Server manage deployment infrastructure

- Security
- Scalability
- Standards Compliance
- Load Balancing
- Failover
- HW/SW Dependencies

Support multiple application models with standard APIs

- Java
- GML
- Python, Node.js
- .Net
- Web Services/SOA

# Oracle's Spatial Strategy

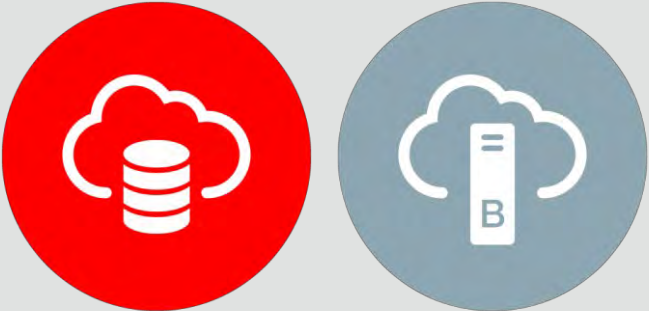
Enable Spatial use cases on every Oracle platform

## Oracle Database Spatial and Graph



**Database 19c:**  
Polyglot (Multi-model)  
Data Store

## Spatial and Graph in Cloud Offerings



**Oracle Big Data Cloud Service**  
**Oracle Database Cloud Service**

- Enterprise Edition High Performance
- Enterprise Edition Extreme Performance
- All Autonomous DB offerings

## Oracle Big Data Spatial and Graph

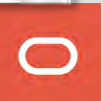
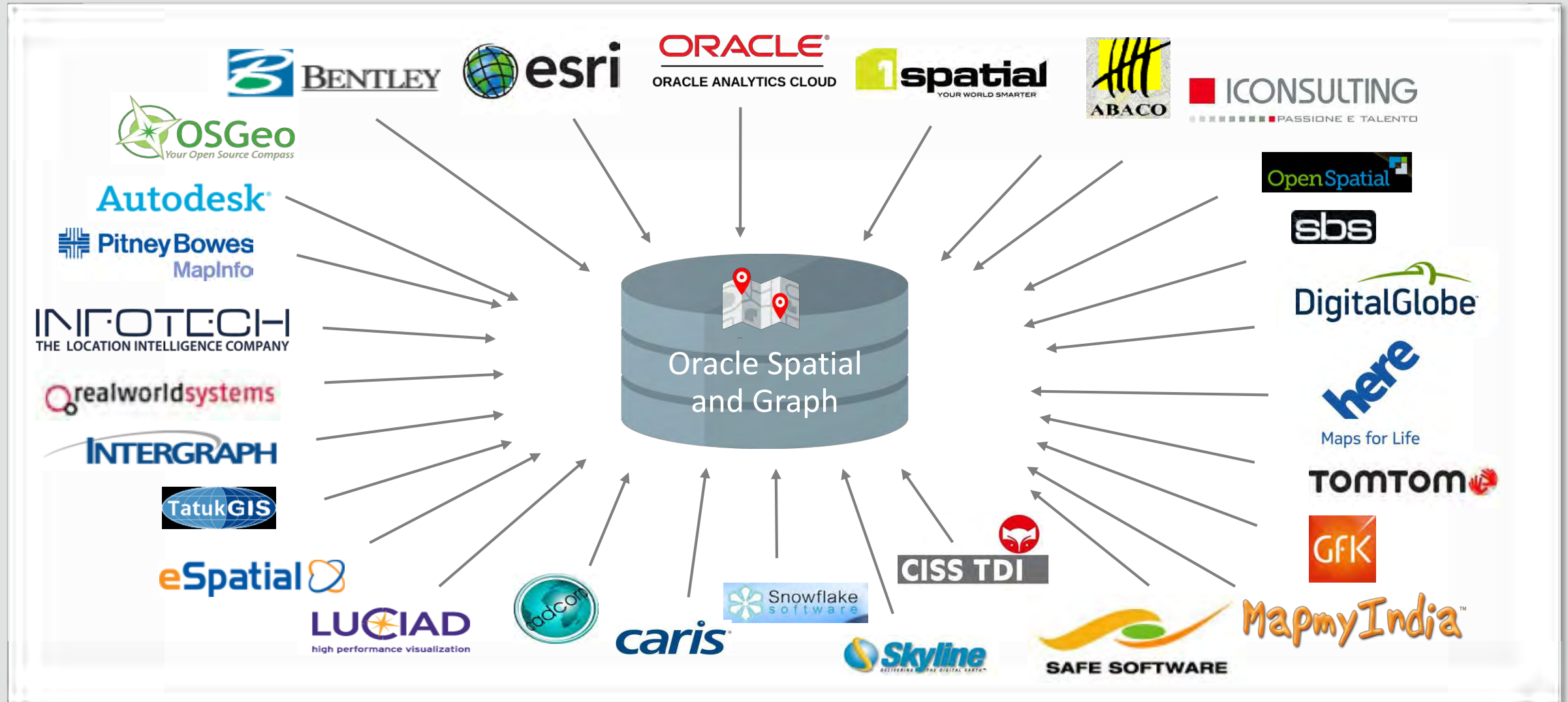


**Big Data:**  
Single Model Data Store



# Open and Interoperable

19<sup>c</sup> ORACLE<sup>®</sup>  
Database





# Location-Enabled Business Applications

Geocoding  
Spatial searches  
Routing  
Mapping

The collage consists of five screenshots from the Oracle Data Visualization Desktop interface:

- Top Left:** A world map titled "Country, Sales, Profit Ratio". The map uses color coding to represent sales and profit ratios across different countries. A legend on the right shows scales for Sales (194K to 1.6M), # of Orders (103 to 1.1K), and Profit Ratio (0.07 to 0.29).
- Top Right:** A screenshot titled "Geospatial Operations and Complement Management". It shows a list of search results for schools in Washington, D.C., such as "ST PETER'S INTERPARISH SCHOOL" and "PEABODY ELEMENTARY SCHOOL". A map overlay shows these locations with red 'S' markers. A pop-up window for "EMERSON PREPARATORY SCHOOL" displays employee counts by class/category: Casual (2), Admin (0), FT (40), Distribution (58), PT Flexible (3), Executive (2), PT Regular (0), Facilities (0), Relief (26), Maintenance (1), Temp Emerg (0), Nurse (0), and Teacher (12). Total counts are 71 and 73.
- Bottom Left:** A screenshot titled "US Cities Map View Selector" showing a map of the United States with various cities marked by colored circles of different sizes, representing data points for different cities.
- Bottom Middle:** A screenshot showing a detailed map of San Diego with a heatmap overlay. A sidebar on the left contains a pie chart and other data visualizations.
- Bottom Right:** A screenshot titled "Sales Analysis - Project" showing a world map with blue circular markers of varying sizes and colors (yellow, green, blue) representing data points across different regions.

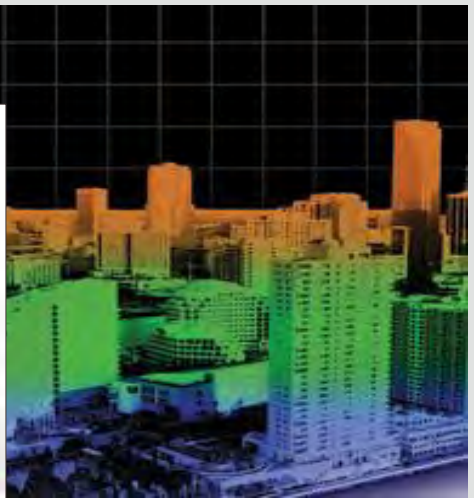
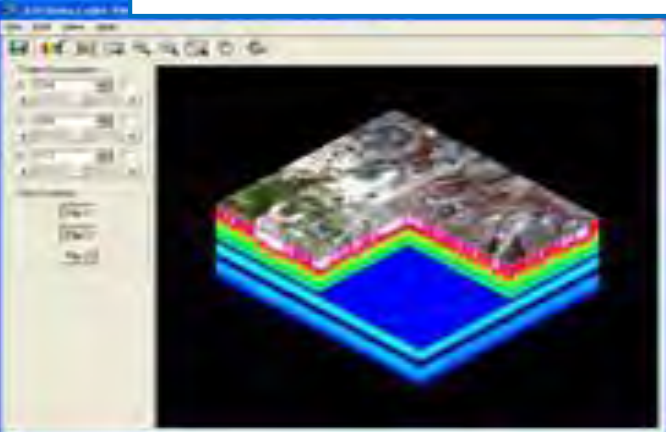




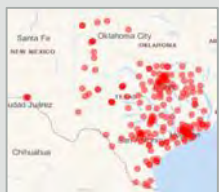
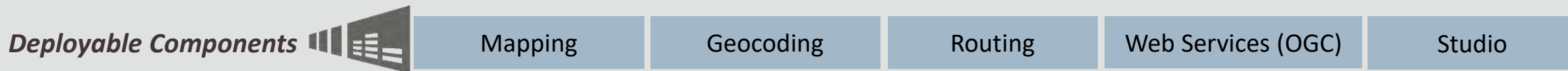
# Specialist Geospatial Applications



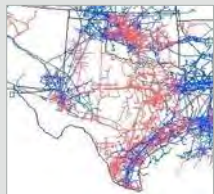
Geometry  
Topology  
GeoRaster  
Networks  
LRS  
Geodetic  
Long Transactions  
3D (Point clouds, LIDAR)



# Oracle Database - Spatial and Graph



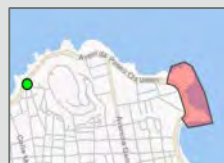
Points



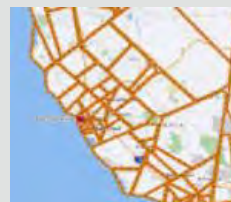
Lines



Polygons



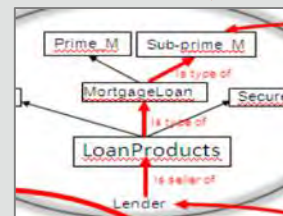
Location Tracking (Geofencing)



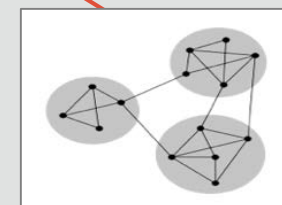
Networks



3D / LiDAR



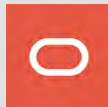
RDF Graphs



Property Graphs



Topologies





# Oracle Spatial and Graph

## Native Geospatial Data Types



```
SELECT a.customer_name, a.phone_number
FROM policy_holders a
WHERE sdo_within_distance( a.geom, hurricane_path_geom,
    'distance = 10 unit = mile') = 'TRUE';
```



# Spatial data type

```
SQL> desc countries
Name          Null? Type
-----
ID            NUMBER
ISO_A3       VARCHAR2(3)
NAME         VARCHAR2(26)
GEOMETRY     MDSYS.SDO_GEOMETRY
SQL>
```

```
SQL> SELECT geometry
2 FROM countries
3* WHERE name='Aruba';

GEOMETRY
-----
-----SDO_GEOMETRY(2003, 8307, NULL,
SDO_ELEM_INFO_ARRAY(1, 1003, 1),
SDO_ORDINATE_ARRAY(-69.8760919,
12.42720123, -69.879425,
12.45340118, -69.9150301,
12.49686106, -69.9238926,
12.51903025, -69.935649, 12.5316393,
-69.9961879, 12.57737295, ...
```



# Spatial query

```
SQL> SELECT a.name  
2 FROM sales_regions a, countries b  
3 WHERE sdo_inside(a.geometry, b.geometry) = 'TRUE'  
4* and b.name=' Belize' ;
```

NAME

-----

El Cayo  
Punta  
Gorda  
Bel mopan  
Orange  
....



# Spatial query

```
SQL> SELECT name
  2   FROM countries
  3   WHERE sdo_contains(
  4           geometry,
  5           SDO_GEOMETRY(2001, 8307,
  6                       SDO_POINT_TYPE(-99.3, 23.1, NULL), NULL, NULL))
  7           = 'TRUE' ;
```

NAME

-----

Mexico





# GeoJSON support

```
select json_value('{ "type": "Point",  
  "coordinates": [125.6, 10.1] }', '$'  
  returning sdo_geometry) from dual
```



- Extend JSON support in the database with Spatial operations
  - JSON\_VALUE() to support GeoJSON and SDO\_GEOMETRY
- SDO\_GEOMETRY constructors extended to take JSON as input
- Support spatial index and spatial queries on JSON documents

# Oracle Spatial and Graph

## 20 Spatial Operators

- 20.1 SDO\_ANYINTERACT
- 20.2 SDO\_CONTAINS
- 20.3 SDO\_COVEREDBY
- 20.4 SDO\_COVERS
- 20.5 SDO\_EQUAL
- 20.6 SDO\_FILTER
- 20.7 SDO\_INSIDE
- 20.8 SDO\_JOIN
- 20.9 SDO\_NN
- 20.10 SDO\_NN\_DISTANCE
- 20.11 SDO\_ON
- 20.12 SDO\_OVERLAPBDYDISJOINT
- 20.13 SDO\_OVERLAPBDYINTERSECT
- 20.14 SDO\_OVERLAPS
- 20.15 SDO\_POINTINPOLYGON
- 20.16 SDO\_RELATE
- 20.17 SDO\_TOUCH
- 20.18 SDO\_WITHIN\_DISTANCE

## 21 Spatial Aggregate Functions

- 21.1 SDO\_AGGR\_CENTROID
- 21.2 SDO\_AGGR\_CONCAT\_LINES
- 21.3 SDO\_AGGR\_CONCAVEHULL
- 21.4 SDO\_AGGR\_CONVEXHULL
- 21.5 SDO\_AGGR\_LRS\_CONCAT
- 21.6 SDO\_AGGR\_MBR
- 21.7 SDO\_AGGR\_SET\_UNION
- 21.8 SDO\_AGGR\_UNION

## 26 SDO\_GEOM Package (Geometry)

- 26.1 SDO\_GEOM.RELATE
- 26.2 SDO\_GEOM.SDO\_ALPHA\_SHAPE
- 26.3 SDO\_GEOM.SDO\_ARC\_DENSIFY
- 26.4 SDO\_GEOM.SDO\_AREA
- 26.5 SDO\_GEOM.SDO\_BUFFER
- 26.6 SDO\_GEOM.SDO\_CENTROID
- 26.7 SDO\_GEOM.SDO\_CLOSEST\_POINTS
- 26.8 SDO\_GEOM.SDO\_CONCAVEHULL
- 26.9 SDO\_GEOM.SDO\_CONCAVEHULL\_BOUNDARY
- 26.10 SDO\_GEOM.SDO\_CONVEXHULL
- 26.11 SDO\_GEOM.SDO\_DIAMETER
- 26.12 SDO\_GEOM.SDO\_DIAMETER\_LINE
- 26.13 SDO\_GEOM.SDO\_DIFFERENCE
- 26.14 SDO\_GEOM.SDO\_DISTANCE
- 26.15 SDO\_GEOM.SDO\_INTERSECTION
- 26.16 SDO\_GEOM.SDO\_LENGTH
- 26.17 SDO\_GEOM.SDO\_MAX\_MBR\_ORDINATE
- 26.18 SDO\_GEOM.SDO\_MAXDISTANCE
- 26.19 SDO\_GEOM.SDO\_MAXDISTANCE\_LINE
- 26.20 SDO\_GEOM.SDO\_MBC
- 26.21 SDO\_GEOM.SDO\_MBC\_CENTER
- 26.22 SDO\_GEOM.SDO\_MBC\_RADIUS
- 26.23 SDO\_GEOM.SDO\_MBR
- 26.24 SDO\_GEOM.SDO\_MIN\_MBR\_ORDINATE
- 26.25 SDO\_GEOM.SDO\_POINTONSURFACE
- 26.26 SDO\_GEOM.SDO\_SELF\_UNION
- 26.27 SDO\_GEOM.SDO\_TRIANGULATE
- 26.28 SDO\_GEOM.SDO\_UNION
- 26.29 SDO\_GEOM.SDO\_VOLUME

## 30 SDO\_PC\_PKG Package (Point Clouds)

- 30.1 SDO\_PC\_PKG.CLIP\_PC
- 30.2 SDO\_PC\_PKG.CLIP\_PC\_FLAT
- 30.3 SDO\_PC\_PKG.CREATE\_CONTOUR\_GEOMETRIES
- 30.4 SDO\_PC\_PKG.CREATE\_PC
- 30.5 SDO\_PC\_PKG.DROP\_DEPENDENCIES
- 30.6 SDO\_PC\_PKG.GET\_PT\_IDS
- 30.7 SDO\_PC\_PKG.HAS\_PYRAMID
- 30.8 SDO\_PC\_PKG.PC\_TO\_POINTS
- 30.9 SDO\_PC\_PKG.PC2DEM
- 30.10 SDO\_PC\_PKG.PRESERVES\_LEVEL1
- 30.11 SDO\_PC\_PKG.SDO\_PC\_NN
- 30.12 SDO\_PC\_PKG.SDO\_PC\_NN\_FOR\_EACH

## 31 SDO\_SAM Package (Spatial Analysis and Mining)

- 31.1 SDO\_SAM.AGGREGATES\_FOR\_GEOMETRY
- 31.2 SDO\_SAM.AGGREGATES\_FOR\_LAYER
- 31.3 SDO\_SAM.BIN\_GEOMETRY
- 31.4 SDO\_SAM.BIN\_LAYER
- 31.5 SDO\_SAM.COLOCATED\_REFERENCE\_FEATURES
- 31.6 SDO\_SAM.SIMPLIFY\_GEOMETRY
- 31.7 SDO\_SAM.SIMPLIFY\_LAYER
- 31.8 SDO\_SAM.SPATIAL\_CLUSTERS
- 31.9 SDO\_SAM.TILED\_AGGREGATES
- 31.10 SDO\_SAM.TILED\_BINS

## 27 SDO\_LRS Package (Linear Referencing System)

- 27.1 SDO\_LRS.CLIP\_GEOM\_SEGMENT
- 27.2 SDO\_LRS.CONCATENATE\_GEOM\_SEGMENTS
- 27.3 SDO\_LRS.CONNECTED\_GEOM\_SEGMENTS
- 27.4 SDO\_LRS.CONVERT\_TO\_LRS\_DIM\_ARRAY
- 27.5 SDO\_LRS.CONVERT\_TO\_LRS\_GEOM
- 27.6 SDO\_LRS.CONVERT\_TO\_LRS\_LAYER
- 27.7 SDO\_LRS.CONVERT\_TO\_STD\_DIM\_ARRAY
- 27.8 SDO\_LRS.CONVERT\_TO\_STD\_GEOM
- 27.9 SDO\_LRS.CONVERT\_TO\_STD\_LAYER
- 27.10 SDO\_LRS.DEFINE\_GEOM\_SEGMENT
- 27.11 SDO\_LRS.DYNAMIC\_SEGMENT
- 27.12 SDO\_LRS.FIND\_LRS\_DIM\_POS
- 27.13 SDO\_LRS.FIND\_MEASURE
- 27.14 SDO\_LRS.FIND\_OFFSET
- 27.15 SDO\_LRS.GEOM\_SEGMENT\_END\_MEASURE
- 27.16 SDO\_LRS.GEOM\_SEGMENT\_END\_PT
- 27.17 SDO\_LRS.GEOM\_SEGMENT\_LENGTH
- 27.18 SDO\_LRS.GEOM\_SEGMENT\_START\_MEASURE
- 27.19 SDO\_LRS.GEOM\_SEGMENT\_START\_PT
- 27.20 SDO\_LRS.GET\_MEASURE
- 27.21 SDO\_LRS.GET\_NEXT\_SHAPE\_PT
- 27.22 SDO\_LRS.GET\_NEXT\_SHAPE\_PT\_MEASURE
- 27.23 SDO\_LRS.GET\_PREV\_SHAPE\_PT
- 27.24 SDO\_LRS.GET\_PREV\_SHAPE\_PT\_MEASURE

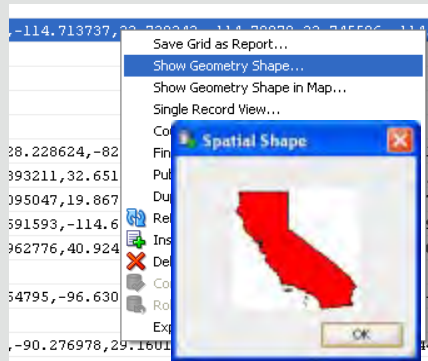
- 100's of spatial operators and functions
- From basic to advanced
- From general purpose to specialized



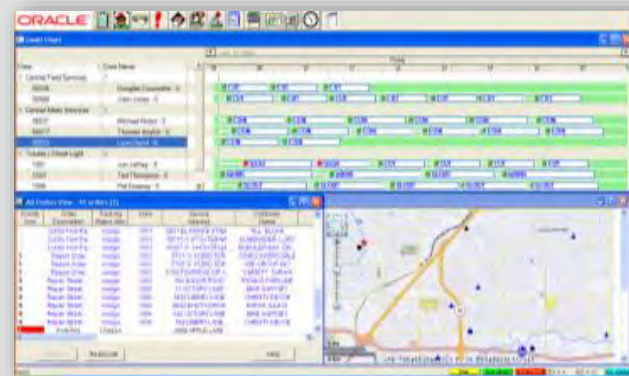
# Spatial Analysis and Maps in Oracle Applications, Tools & BI

OAC and OBIEE

Development Tools (SQL Developer, APEX)



Applications



Mobile Apps





# A Web Mapping Application

## Oracle Database

Basic capabilities for spatial data management

## Oracle Spatial and Graph

Priced option for Geocoding, Routing, High-Performance Query and Analytics, and more  
Includes RDF Graph capabilities (triple store, SPARQL queries, inferencing and ontology support, ...)

## Mapping Technology

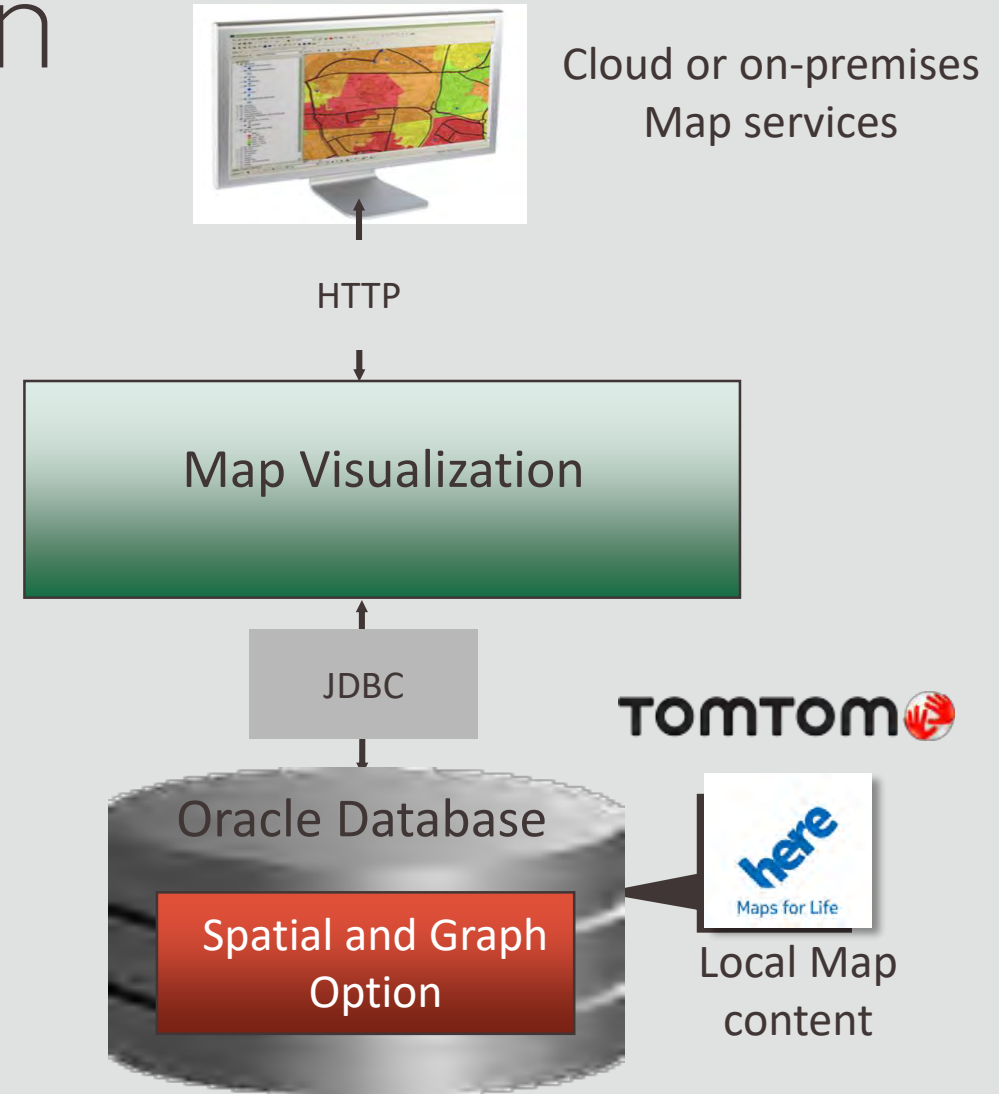
Java-based map rendering engine built on HTML5  
Can consume cloud-based or local mapping services

## Built on open standards

OGC, ISO 191xx, ...

## Partnerships

Partner ecosystem includes data providers, SIs, ISVs



# Oracle Map Visualization

HTML5-based mash-up component

Deployed in WebLogic Application Server

Enabling developers to incorporate interactive maps and spatial analysis into business apps

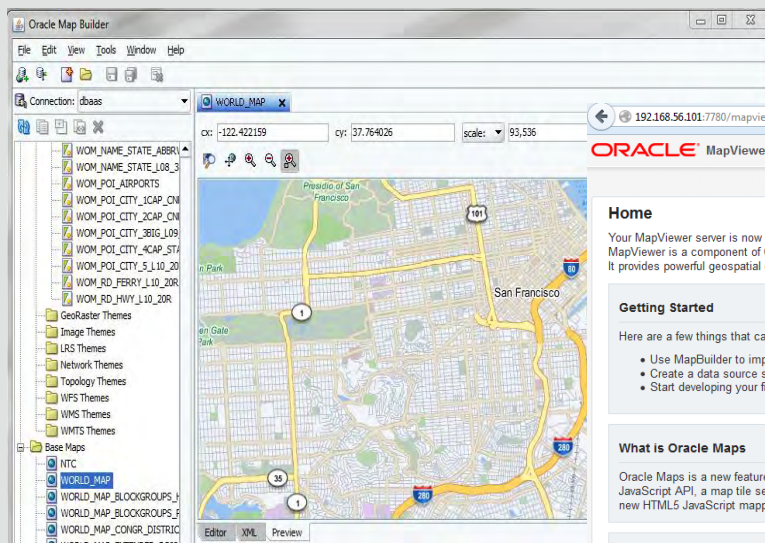
Integrating data from Oracle Spatial and Graph or other sources (WMS, WFS, GeoRSS, WMTS), and background maps from data providers or services

JavaScript, Java, and XML APIs for web mapping apps



# Spatial Visualization

## Map authoring tool



## Web based admin

A screenshot of the Oracle MapViewer Administration Console. The page has a navigation bar with tabs for 'Home', 'Admin', 'Metadata', 'Configuration', 'About', and 'Logout'. The 'Home' page contains the following sections:

- Home**: Your MapViewer server is now running and you can start viewing your Oracle Spatial managed data. MapViewer is a component of Oracle's Fusion Middleware. It provides powerful geospatial data visualization services.
- Getting Started**: Here are a few things that can get you started.
  - Use MapBuilder to import some spatial data into an Oracle database that you have access to.
  - Create a data source so that MapViewer can connect to the database. Please log into the Admin page to do so.
  - Start developing your first MapViewer applications.
- What is Oracle Maps**: Oracle Maps is a new feature of MapViewer. It consists of a free scrolling AJAX-based web mapping interface, a flexible and open JavaScript API, a map tile server and a Feature of Interest (FOI) server. Starting with MapViewer version 11.1.1.7 we also added a new HTML5 JavaScript mapping API.
- Demos and tutorials**: Please note that all demos and tutorials previously bundled with MapViewer have been removed from the product itself. They will be available for download from the OTN MapViewer page.

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## HTML5 mapping API

A screenshot of the Oracle MapViewer HTML5 Mapping Demo for Storm Data Analysis. The interface includes a control panel on the left and a map of the United States on the right. The control panel has the following sections:

- Background map:** Oracle
- Storm damage by state**: Type (Wind, Tornado, Hail) and Thematic options (Auto clustering, Show as heatmap).
- Storm locations**: Wind (checked), Tornado, Hail.

The map shows various states with colored circles representing storm damage. Values for some states are: MT (43), SD (6), WI (97), MI (87), IN (47), IA (119), MO (60), AL (17), MS (51), TN (89), and SC (30).

A screenshot of a dashboard for sales and profit analysis. At the top, there are three data points: Total Sales (\$1,668,041.14), Total Profit (\$191,689.14), and Total Orders (25,406.00). Below these is a map of the United States with colored circles representing data points. To the left of the map are dropdown menus for 'State or Province', 'Region', 'Product Category', 'Customer Segment', and 'Ship Mode'. At the bottom, there are two charts: a horizontal bar chart showing 'Profit' by product category and a donut chart showing 'Shipping Cost' distribution (11.82%, 23.20%, 65.02%).





# Georaster

A data type to store raster data

Aerial photographs, remote sensing, raster maps, grids, ...

Multi-band, multi-layer

An XML schema to store Metadata

Data source, layer information, ...

Geo Referencing information

Relates image pixels to a longitude/latitude on Earth's surface

Features

Storage and indexing of raster data

Generate resolution pyramid, blocking, mosaicking, compression, clipping

Raster algebra



# Precision Farming Example

Goal: Build Predictive Analytical Model to increase the crop yield

Minimize water resources

Minimize fertilizer

Minimize the human capital cost

Use all available sensor based data sources

Satellite imagery, ground based sensors, etc.

GeoRaster provides all the storage models and analytics required for building such an application

# Spatial Networks

## Network Data Model

A data model to store network (graph) structures in the database

Explicitly stores and maintains connectivity of the network

Attributes at link and node level

## Network Analysis

Tracing and routing

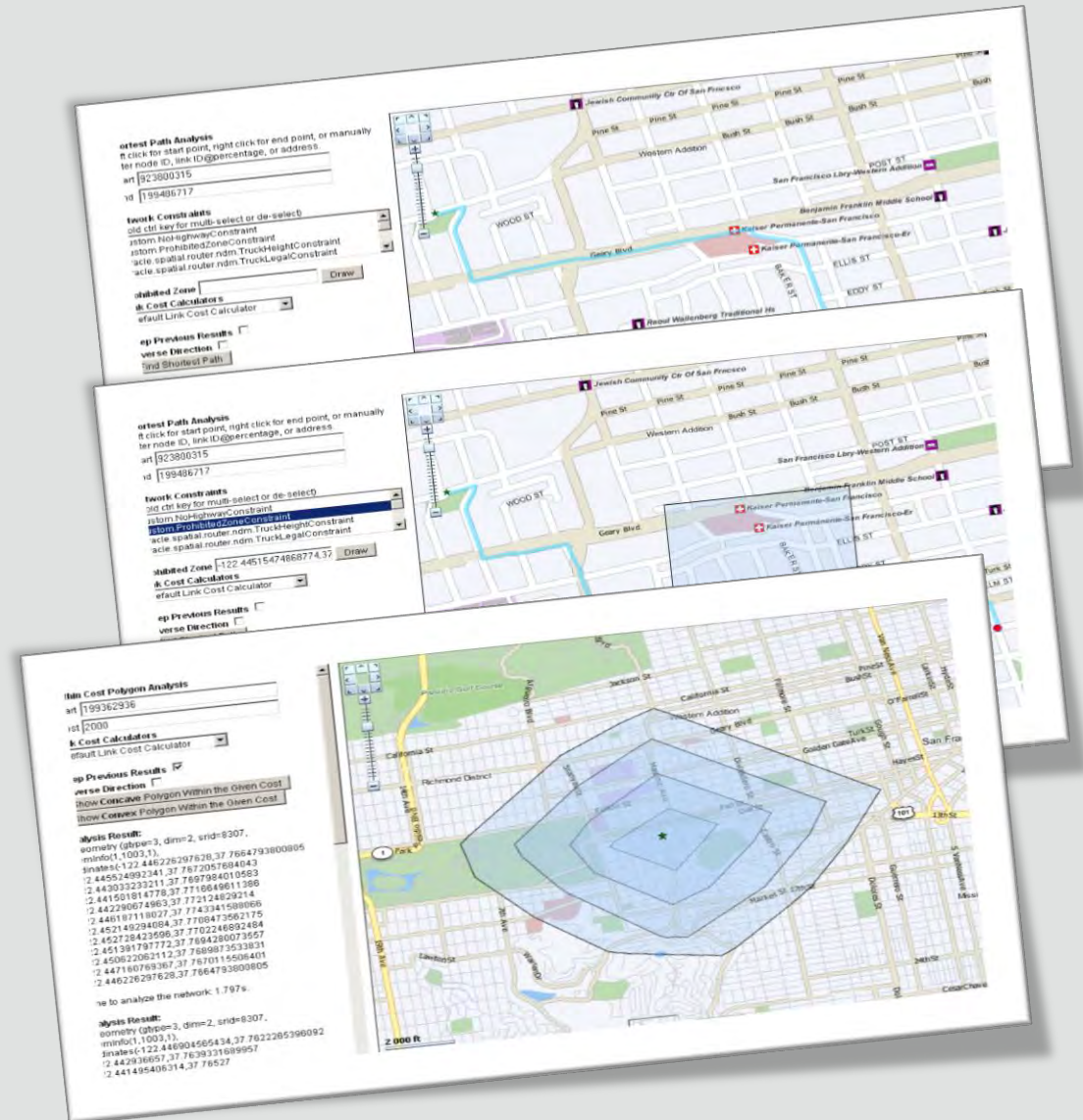
Network-based searches

User-defined constraints

## Supports very large networks

Network partitioning

Hierarchical networks





# Routing

Web service

XML requests and responses

Returns driving directions

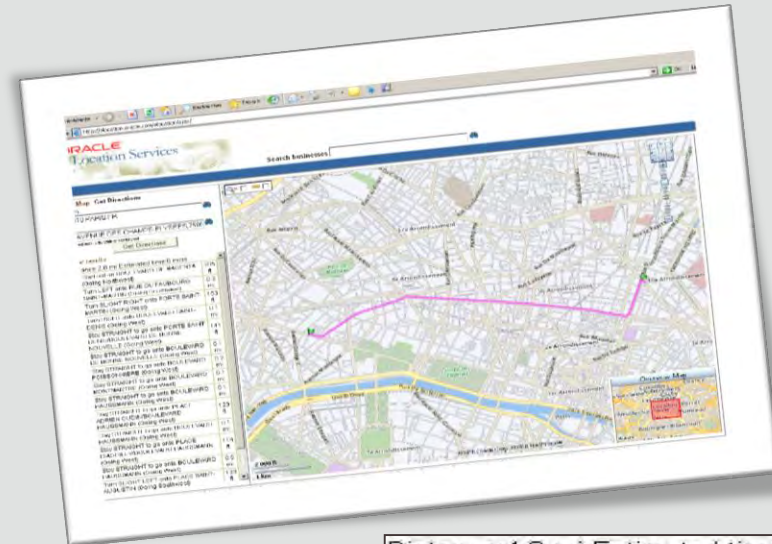
Also route and maneuver geometries

Choose fastest / shortest routes

Open or closed routes

Choose vehicle type

Choose language for directions



```
<?xml version="1.0" encoding="UTF-8" ?>
<route_response>
  <route id="1" step_count="13"
distance="4.920671363811129"
  distance_unit="mile" time="11.884716"
time_unit="minute">
  <segment sequence="1" instruction="Start out on ORACLE DR (Going South)"
distance="0.0016538867050869695"
time="0.008871999382972718" />
  <segment sequence="2" instruction="Turn RIGHT onto SPIT BROOK RD (Going West)"
distance="0.3730007146267496"
time="0.6252812703450521" />
  ...
  <segment sequence="13" instruction="Stay STRAIGHT to go onto MAIN ST/DANIEL WEBSTER HWY (Going North)"
distance="0.5581769898495857"
time="1.361023409664631" />
</route>
</route_response>
```

Distance: 4.9 mi 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
10	Stay STRAIGHT to go onto DANIEL WEBSTER HWY/MAIN ST (Going North)	0.1 mi



# Geocoder

Generates latitude/longitude (points) from address

International addressing

Formatted and unformatted addresses

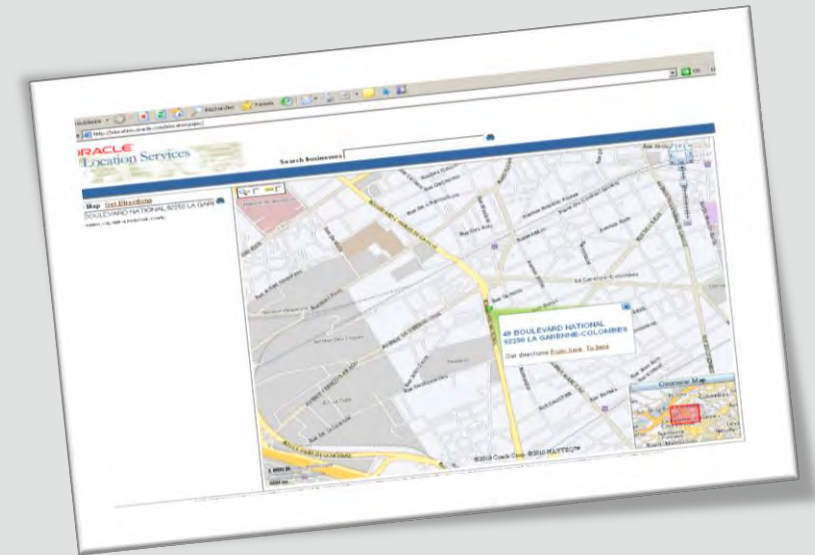
Tolerance parameters for fuzzy matching

Address correction

PL/SQL and XML (web service) API

Record-level and batch processes

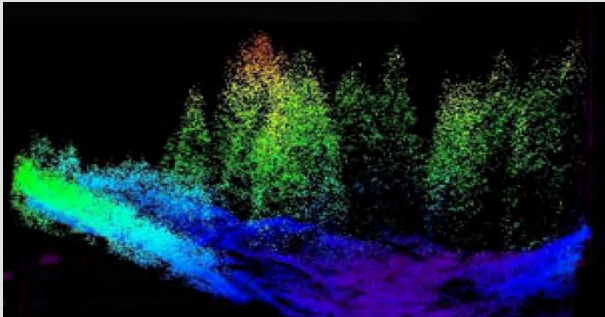
Data providers: Here (Navteq), Tom Tom ...



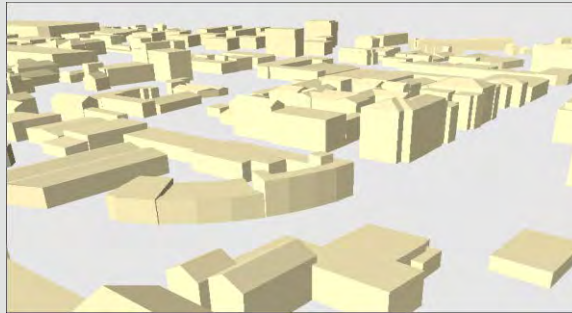


# Oracle Spatial and 3D

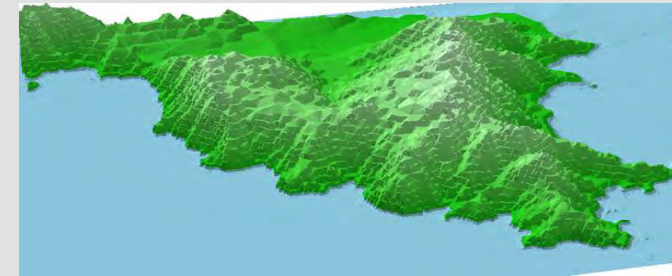
Point Clouds



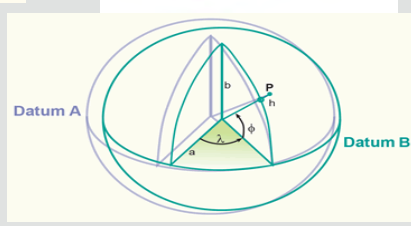
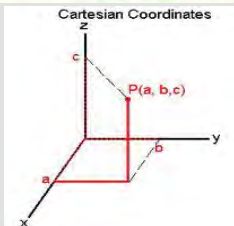
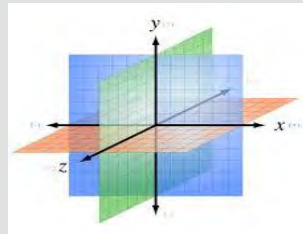
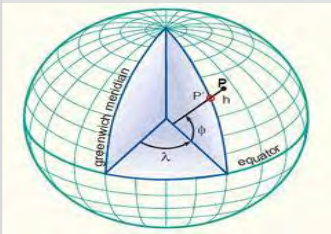
Solids



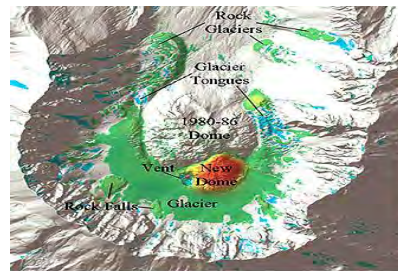
Triangular Irregular Networks



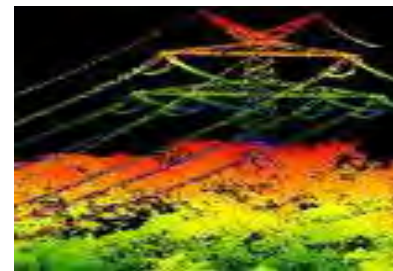
3D Coordinate Systems



3D Queries



Volumetric Analysis



Visibility queries



Spatial and attribute queries



# City Modeling

Many business cases have become economically viable

Cost of 3D data collection has gone down significantly

Leading to large scale projects, sometimes country-wide initiatives

Eg. in Poland, the Netherlands (3D Pilot NL, AHN-2), Germany (AdV), UK, Ireland, ...

Using LiDAR or Photogrammetry for data acquisition

In Europe partly driven by EU mandates (eg. noise emission)

Requiring 3D data for simulation

Lots of use cases

City and urban planning, citizen participation, city marketing, ...

Users in Local Government, Telco, Utilities, Public Transport, Public Safety, ...

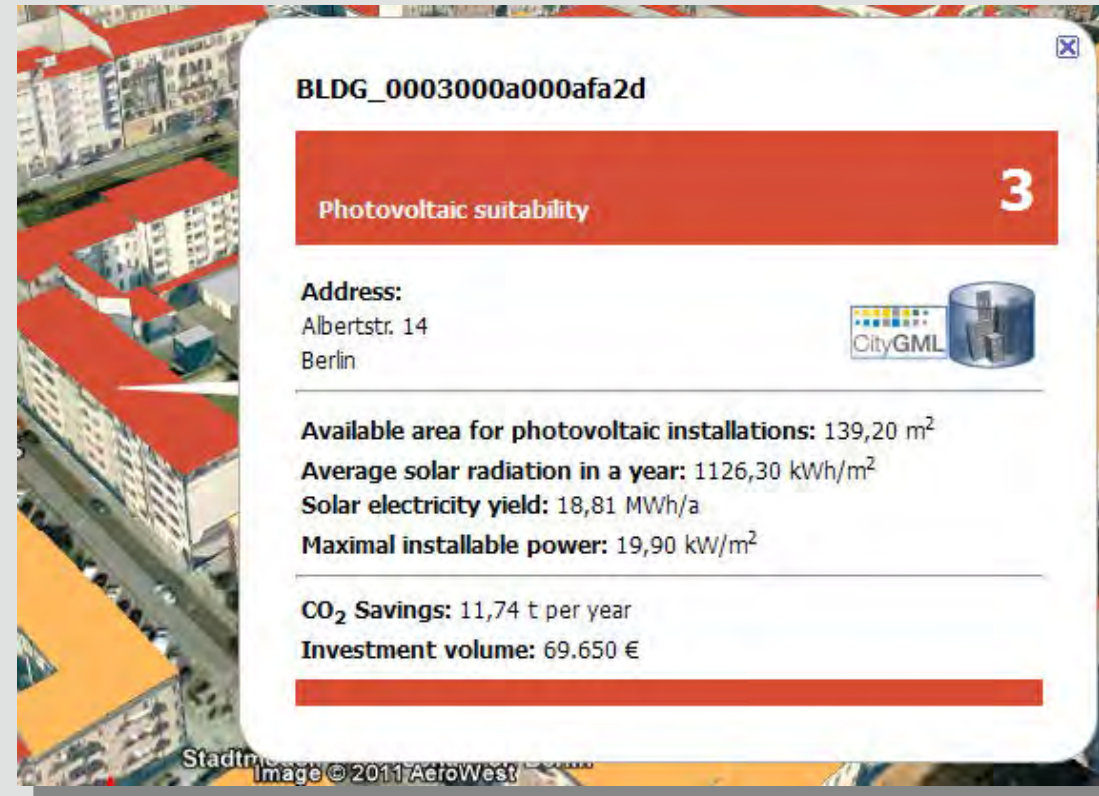
# City of Berlin – 3D City Model

Implemented on Oracle with 3DCityDB

550000 buildings,  
reconstructed  
from 2D cadastre  
and LIDAR data

Textures extracted  
from oblique aerial  
photography

Oracle Spatial  
Excellence Award



Images courtesy of: TU Berlin, Institute for Geodesy and Geoinformation



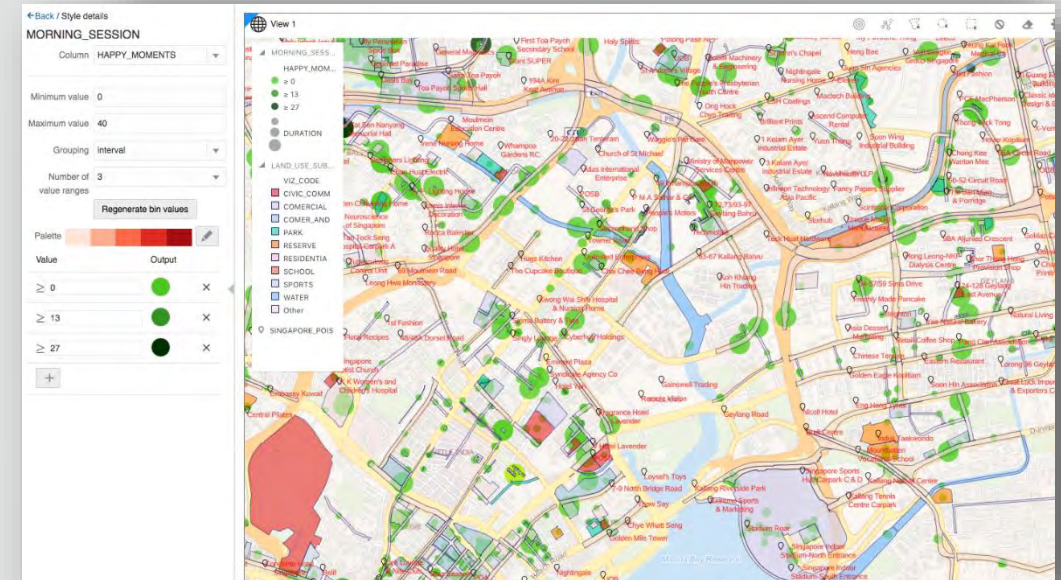
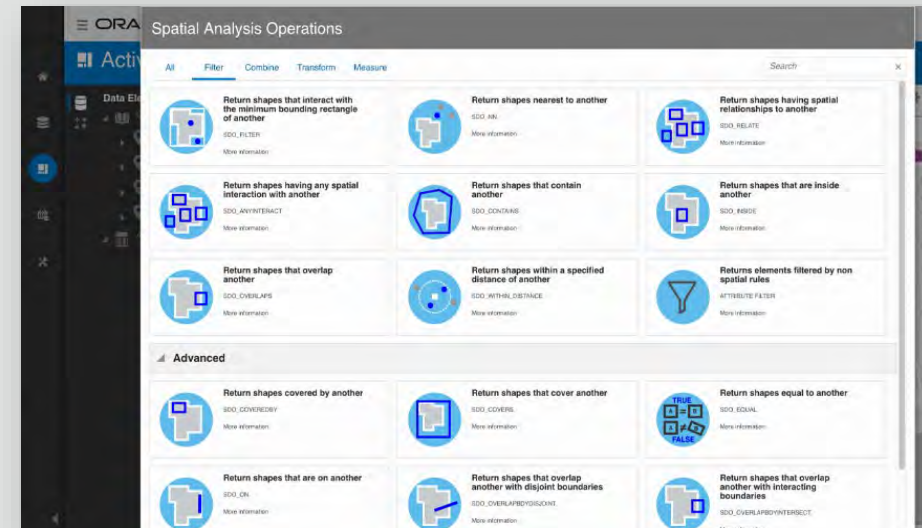
# Spatial Studio

Self Service Spatial Analytics tool

Maps: Fast and Easy

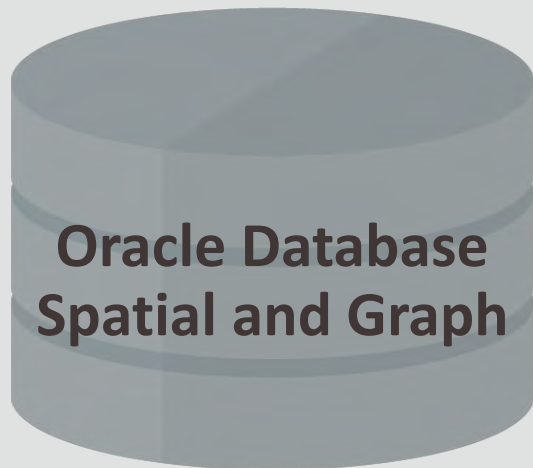
No code environment for developing spatial analytics applications

Supports DB Cloud offerings and on-premises DBs



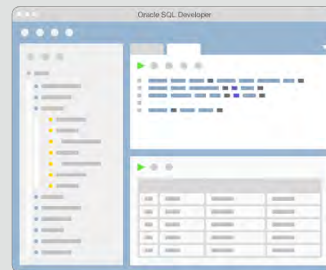


# Spatial Studio



Spatial data management,  
analysis, and processing

Traditional access



SQL, PLSQL, Java coding  
Some technical expertise

Spatial Studio



Self-service  
Drag and drop

# Spatial Studio Features

## Data

- Access content from Oracle db
- Load Shapefiles, Spreadsheets, GeoJSON
- Geocode addresses
- Create longitude/latitude index
- Export as CSV, GeoJSON
- Pre-cache vector tiles

## Developer

- Access analysis SQL
- Integrate published Project
- Access datasets and analyses via REST

## Projects

- Combine datasets
- Create and configure visualizations
- Perform Spatial analysis operations
- Save and share results

## Administration

- Console UI
- Configure proxy
- Configure geocoding service endpoint
- View system status and logs
- Deeper admin outside UI i.e. WLS Console

All Filter Combine Transform Measure

Search  X



**Return shapes that interact with the minimum bounding rectangle of another**

SDO\_FILTER  
[More information](#)



**Return shapes nearest to another**

SDO\_NN  
[More information](#)



**Return shapes having spatial relationships to another**

SDO\_RELATE  
[More information](#)



**Return shapes having any spatial interaction with another**

SDO\_ANYINTERACT  
[More information](#)



**Return shapes that contain another**

SDO\_CONTAINS  
[More information](#)



**Return shapes that are inside another**

SDO\_INSIDE  
[More information](#)



**Return shapes that overlap another**

SDO\_OVERLAPS  
[More information](#)



**Return shapes within a specified distance of another**

SDO\_WITHIN\_DISTANCE  
[More information](#)



**Returns elements filtered by non spatial rules**

ATTRIBUTE FILTER  
[More information](#)

## Advanced



**Return shapes covered by another**

SDO\_COVEREDBY  
[More information](#)



**Return shapes that cover another**

SDO\_COVERS  
[More information](#)



**Return shapes equal to another**

SDO\_EQUAL  
[More information](#)



**Return shapes that are on another**

SDO\_ON  
[More information](#)



**Return shapes that overlap another with disjoint boundaries**

SDO\_OVERLAPBYDISJOINT  
[More information](#)



**Return shapes that overlap another with interacting boundaries**

SDO\_OVERLAPBYINTERSECT  
[More information](#)



## Performance

---

Oracle Database provides unparalleled performance for Spatial Applications

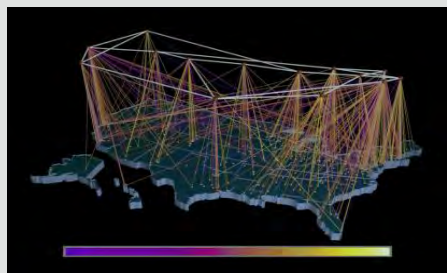


# The Need for Performance

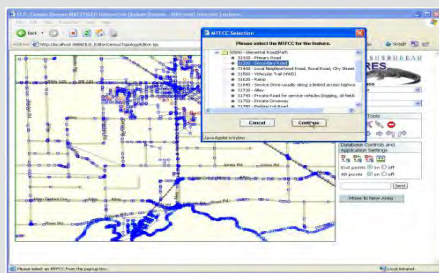
Manage huge volumes of machine generated data

Apply database benefits to fundamental data management challenges

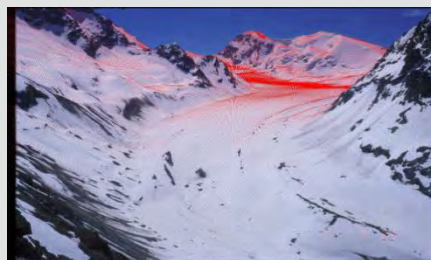
No scalability boundaries



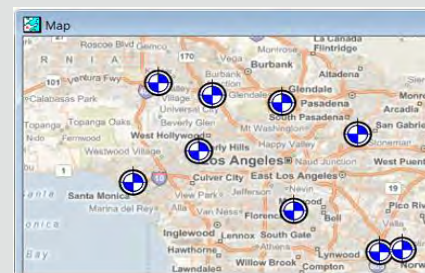
Massive  
Networks



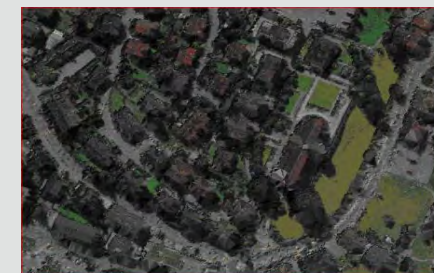
National  
Topology Sets



TB to PB Raster  
Image Sets



Unified Geocoding,  
Routing, Mapping



Massive Point  
Clouds

Enable Integrated Operational Systems



# Extreme Scalability

Process Millions of Spatial Objects

Spatial operations performed in parallel against partitioned and non-partitioned data sets

Can fully utilize multi-core Exadata platform

Millions of spatial objects evaluated in minutes

- Point in polygon analysis

- Polygon to polygon analysis

- Deviations from route

- Distance covered



# Extreme Scalability

## Massive Loading of Spatial Data

Millions of Spatial objects ingested in minutes

- Weather readings

- Traffic readings

- Sensor readings

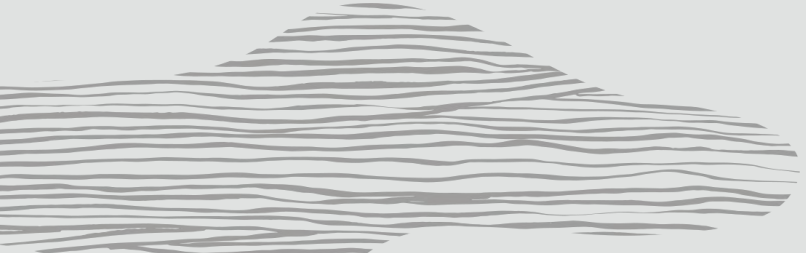
Loading of base data in parallel streams

- Base maps

- Satellite and aerial imagery

- Point clouds

## Ease of use



Provides industry standard APIs,  
including SQL, Java, REST, and many  
more

# Standard APIs

SQL and PL/SQL APIs for database developers

Integrated with cx\_Oracle driver for Python

REST enabled via ORDS

Integrated with Oracle Node driver for Node.js developers



# Java API

Java API for developing client side spatial applications

Useful for disconnected cases

Supports common spatial operations

anyinteract, inside, buffer, distance, etc.

Supports conversions from well known formats

GeoJSON, WKT, WKB

Client side R-tree index

# Web Services

OGC is the standards body that defines several standards for publishing Spatial data on the web

WFS: Web Feature Service for vector data

WMS: Web Mapping Service for maps

WCS: Web coverage Service for raster data

WMTS: Web Map tile service for map tiles

CSW: Web Catalogue service for metadata

Oracle supports all of these services as deployable components

# Oracle Locator

Support for all 2D geometry types

Points, lines, polygons

All Spatial Searches for 2D data

Spatial processing: measurements, buffer, centroid, overlays, affine transforms, .....

Spatial aggregates

Utility, tuning and validation functions

Full Coordinate Systems support

**Included in Oracle Database – All Editions**

# Oracle Spatial

Includes all Locator features +

Spatial Vector Accelerator

3D objects (points, lines, faces, solids)

3D types (point clouds, TINs)

Generic curves (NURBS)

Linear Referencing

Raster storage and processing

Geocoding and Routing

OGC Web Services (WFS, CSW)

Network tracing and searching

Persistent Topology

Map Visualization

Spatial Studio

**A cost option of Oracle Database Enterprise Edition**

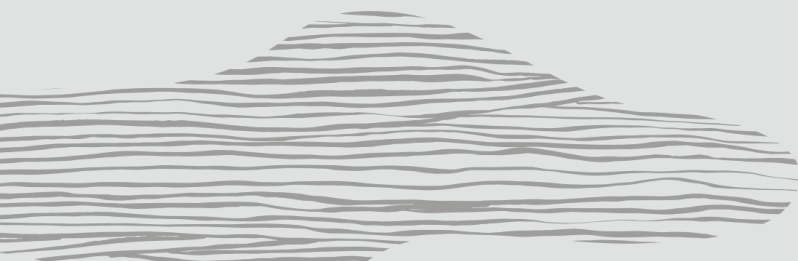
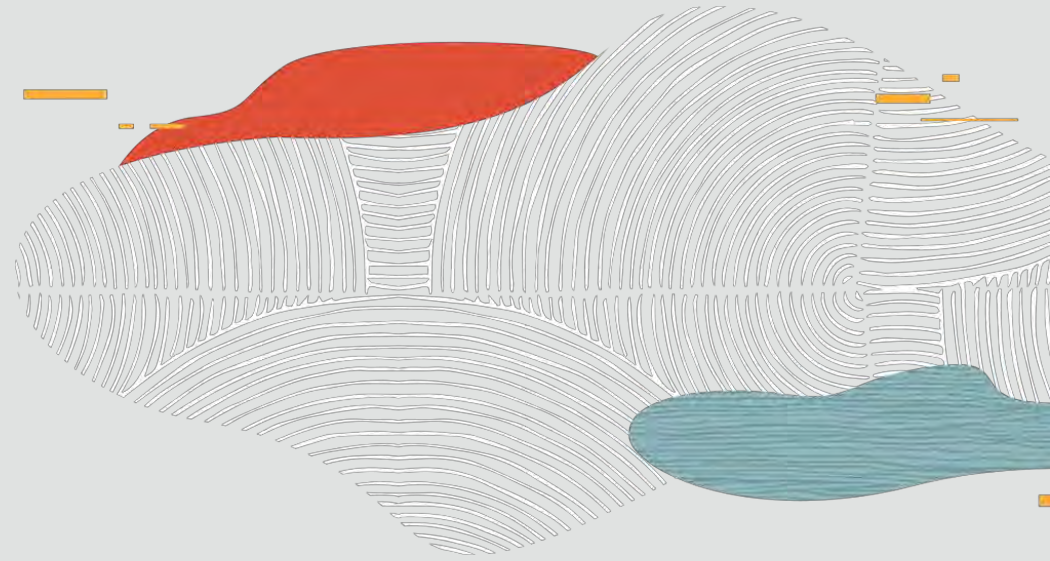




## Spatial on Big Data Platforms

---

Spatial support on Hadoop, Spark, and  
Big Data Cloud Service



# Location Infused Technology

Java, Databases, Applications, Cloud



Article Talk

## Spatial database

From Wikipedia, the free encyclopedia



The Source for Java Technology Collaboration

Home Projects Forums People Java User Groups JCP

**Get Involved**

- ▶ About Java.net
- ▶ Adopt a JSR
- ▶ Create a Project
- ▶ Link an Offsite Project

**Get Informed**

- ▶ Articles
- ▶ Blogs
- ▶ Events
- ▶ Java Magazine
- ▶ Oracle University

### Java and GIS, Part 1: Intro to GIS



#### Oracle Utilities Mobile Workforce Management

Maximize Workflow Efficiencies and Operational Performance

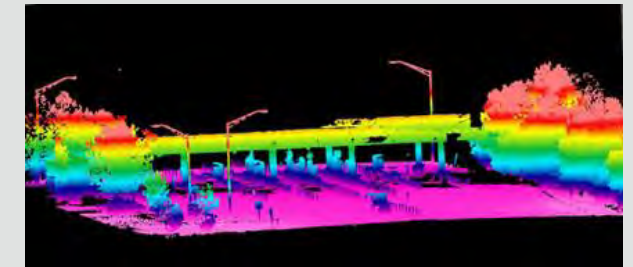
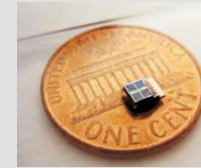
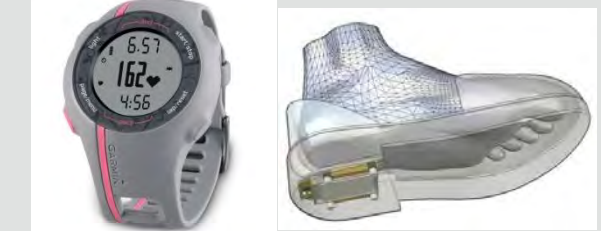
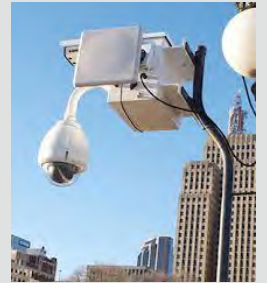
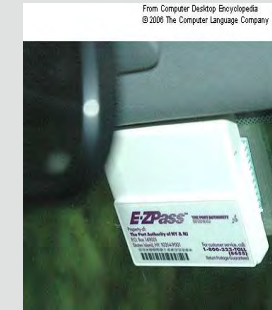
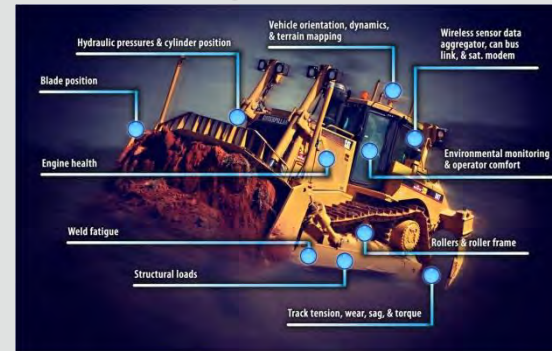
Oracle Utilities Mobile Workforce Management provides a real-time, end-to-end enterprise solution, enabling utilities to achieve maximum visibility, control, and performance of field resources.

[Data Sheet \(PDF\)](#)

### SensorCloud® Live-Connect

Live Streaming Data, Remotely Configure Networks, Change Node/Network Settings, Update Firmware...

Worldwide realtime access and bi-directional communication with your wireless sensor network



# Spatial Big Data Challenges

Geo-tagging in the context of partial or indirect reference

Minimize the time it takes to make the data available for analysis

Discover Spatial and Temporal correlations between different data points

Data loading time should be minimal to make the data available for use

Load the data for immediate use, but create spatial indexes over time

Predictive Analytics for various applications



# Use cases

Prepare address and coordinate data for spatial analysis and mapping

*Geocode customer and competitor address lists*

Visualize data on interactive maps along with other contextual layers

*Navigate interactive map with customers, competitors, suppliers, sales regions...*

Associate data through spatial relationships

*Determine the competitors located within a proposed new sales region*

Enrich data with spatial attributes and metrics for downstream analytics

*Enrich customers with their associated sales region and distance from supplier*

Integrate spatial content and analysis results via REST

*Access customers with enrichments as GeoJSON and integrate using an open source mapping library*

# GeoSpatial Big Data Sources

## Traditional Data sources

- Raster (satellite imagery, elevation models, images)

- Vector (road networks, admin boundaries)

## Machine generated

- Internet of things

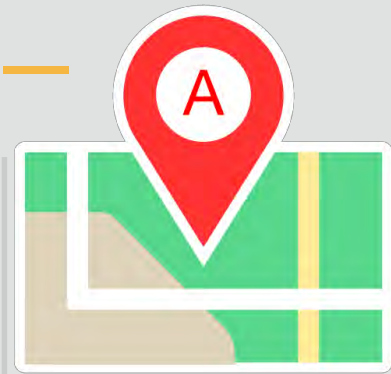
- Social media

- Sensors

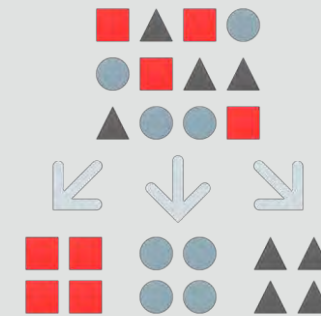
- In vehicle navigation systems (trajectories, traffic information)

- Mobile phones

## What problems can Big Data Spatial analysis address?



Preparation, validation and cleansing of Spatial and Raster data



Data Harmonization using any location attribute (address, postal code, lat/long, placename, etc).

Categorization and filtering based on location and proximity



Visualizing and displaying results on a map



Spatial querying and analysis of Hadoop data with SQL



# Data Harmonization: Linking information by location

Are these data points related?

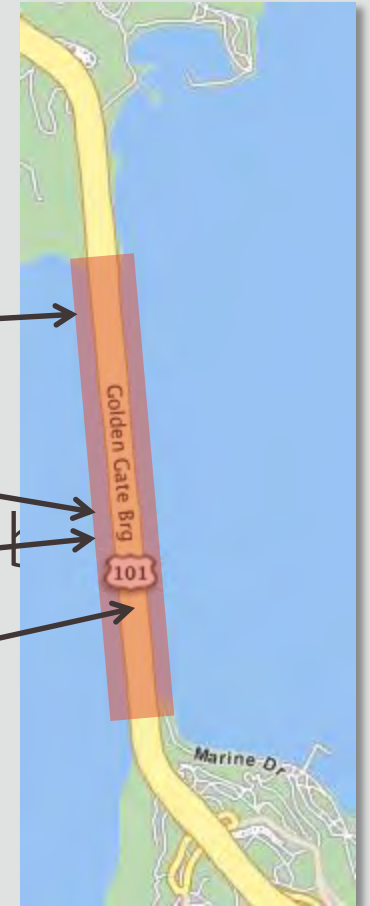
**Tweet:** sailing by #goldengate

**Instagram** image subtitle: 골든게이트 교\*

**Text message:** Driving on 101 North , just reached border of Marin County and San Francisco County

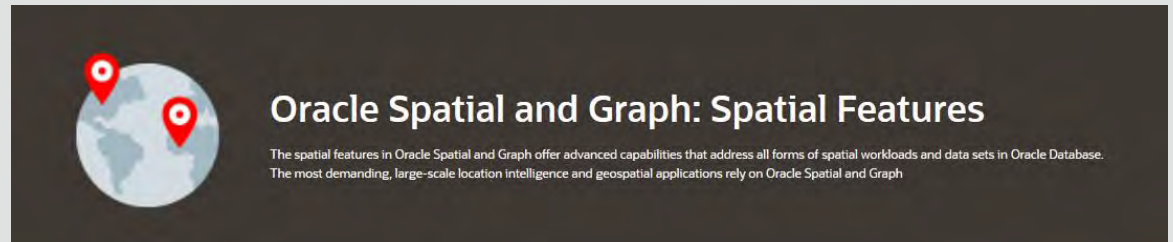
**GPS Sensor:** N 37°49'11" W 122°28'44"

Now find all data points around Golden Gate Bridge ...



\* Golden Gate Bridge (in Korean)

# Resources



Oracle Spatial and Graph [www.oracle.com/database/technologies/spatialandgraph.html](http://www.oracle.com/database/technologies/spatialandgraph.html)  
Software downloads, white papers, case study presentations...

MapView [www.oracle.com/technetwork/middleware/mapviewer](http://www.oracle.com/technetwork/middleware/mapviewer)  
Primers, Quickstart kit, software downloads

Blogs: <https://blogs.oracle.com/oraclespatial>

AskTom webcast series <https://asktom.oracle.com/pls/apex/asktom.search?office=3084>

Developer forums on OTN <https://community.oracle.com/community/database/oracle-database-options/spatial>

Communities: LinkedIn & worldwide user groups [tinyurl.com/oraclespatialcommunity](http://tinyurl.com/oraclespatialcommunity)

 @SpatialHannes



# Resources



Oracle Big Data Spatial and Graph

[www.oracle.com/technetwork/database/database-technologies/bigdata-spatialandgraph](http://www.oracle.com/technetwork/database/database-technologies/bigdata-spatialandgraph)

White papers, software downloads, documentation and videos

Oracle Big Data Lite Virtual Machine - a free sandbox to get started:

[www.oracle.com/technetwork/database/bigdata-appliance/oracle-bigdatalite-2104726.html](http://www.oracle.com/technetwork/database/bigdata-appliance/oracle-bigdatalite-2104726.html)

Hands On Lab for Big Data Spatial: [tinyurl.com/BDSG-HOL](http://tinyurl.com/BDSG-HOL)

Blog – examples, tips & tricks: [blogs.oracle.com/bigdataspatialgraph](http://blogs.oracle.com/bigdataspatialgraph)

 @OracleBigData, @SpatialHannes



# Resources

[www.oracle.com/database/technologies/spatial-studio.html](http://www.oracle.com/database/technologies/spatial-studio.html)

The screenshot shows the Oracle Spatial Studio website. At the top, there is a navigation bar with "Database / Oracle Spatial Studio". Below this is a hero section with a map icon and the text "Spatial Analytics and Maps. Fast and Easy." followed by a description: "Oracle Spatial Studio is a self-service web application that makes it easy for users to create interactive maps and perform spatial analysis on their business data." Two buttons are present: "Get Started with Oracle Spatial Studio" and "Download Oracle Spatial Studio".

The "What's New" section features three items:

- Demo: Oracle Spatial Studio (11:00) - A video thumbnail showing the application interface.
- FAQ: Oracle Spatial Studio - A tablet displaying a list of frequently asked questions.
- Presentation: Oracle Spatial and Graph in Oracle Database 19c (PDF) - A tablet displaying a presentation slide.

The "Documentation" section lists:

- Oracle Spatial Studio Guide
- Oracle Spatial Studio FAQ
- Oracle Spatial and Graph Developer's Guide
- Oracle Database 19c
- Oracle Database Products

The "Related Resources" section lists:

- Oracle Autonomous Database
- Oracle Database 19c
- Oracle Database Cloud Service
- Oracle Database Express Edition
- Oracle Fusion Middleware

The footer contains the text "Follow Oracle Spatial Studio" and social media icons for Forum, Facebook, LinkedIn, Blog, and Twitter. A red circle icon is located in the bottom right corner of the page.

Get started

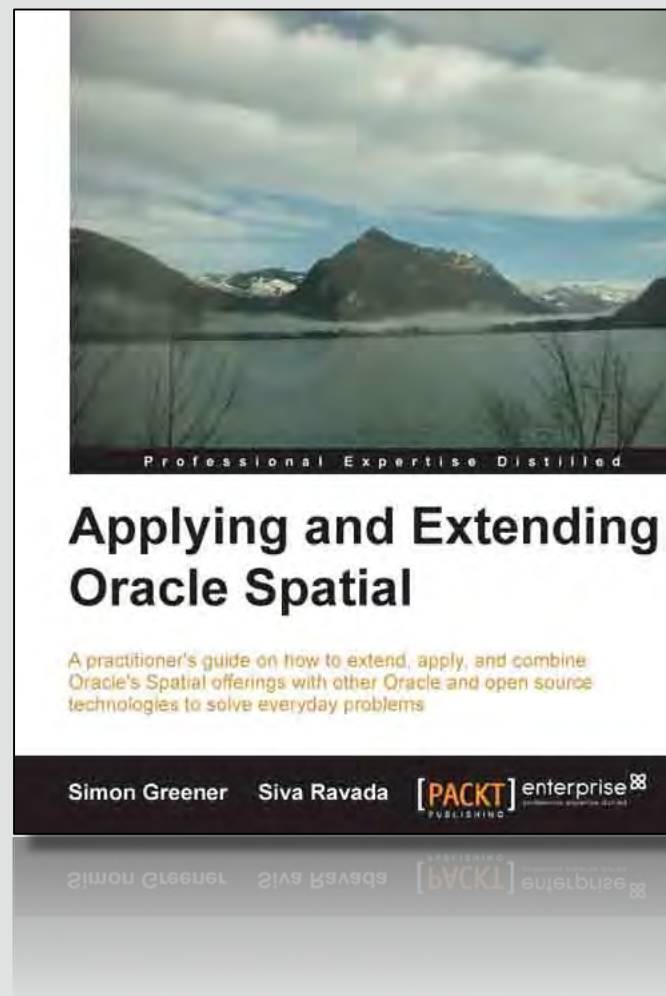
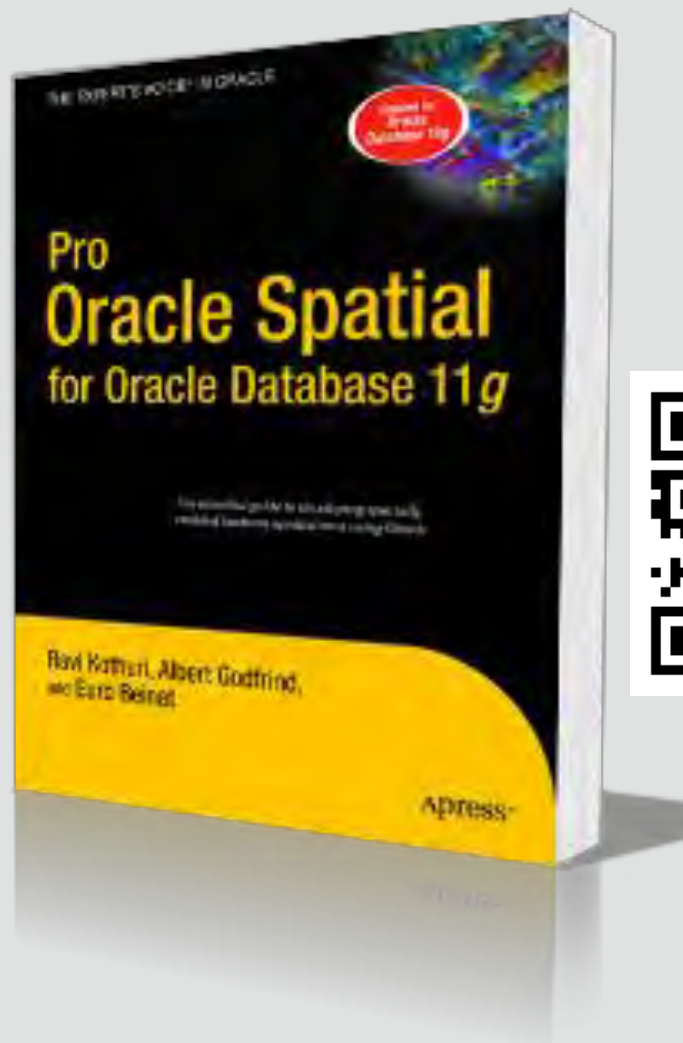
Download

Doc

FAQ

Forum, Blog...

# Resources

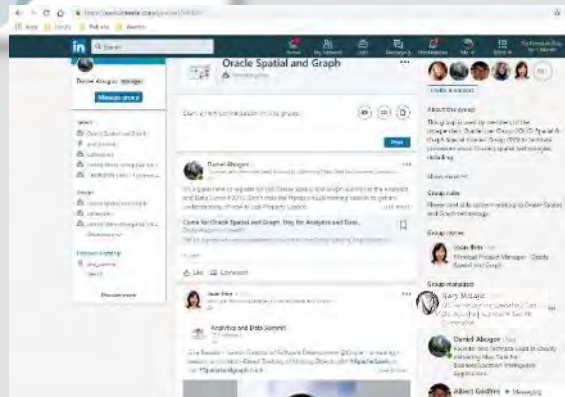


# The Spatial & Graph SIG User Community

*Now part of BIWA User Group*

We are a vibrant community of customers and partners that connects and exchanges knowledge online, and at conferences and events.

Meet us at OpenWorld! Monday-Wednesday  
**Moscone West, Level 3, User Group area**  
at the *BIWA/Analytics Community* table



Join us online

[tinyurl.com/oraclespatialcommunity](https://tinyurl.com/oraclespatialcommunity)



[LinkedIn](#)



[@oraspatialsig](#)



[oraclespatialsig@gmail.com](mailto:oraclespatialsig@gmail.com)





SAVE THE DATE

# ANALYTICS AND DATA SUMMIT 2020

All Analytics. All Data.  
No Nonsense.

February 25-27, 2020

Call for Speakers Now Open!

SIGN UP FOR OUR NEWSLETTER

Formerly the BIWA Summit with the Spatial and Graph Summit.

@AnalyticAndData



[analyticsanddatasummit.org](https://analyticsanddatasummit.org)

Seeking customer use cases and technology sessions  
Dedicated Spatial & Graph track with 20+ sessions



# Q&A