Oracle Spatial 10g: Platform for Enterprise Geospatial Solutions
Xavier Lopez - Oracle USA, Inc.

GS31-2 See how Oracle10g database technology allows users and application developers to seamlessly integrate their Autodesk CAD, GIS, and LBS technology with broader enterprise applications. Learn about the benefits that accrue by expanding the use of mapping data across the enterprise. Doing this brings a high level of scalability, performance, security, and reliability to mapping and CAD data repositories. See how this server-centric approach to delivering high-end applications facilitates timely and cost-effective development, resulting in lower management and training costs, reduced IT churn, and robust solutions. This presentation will highlight how users can leverage Autodesk Map and MapGuide with Oracle Spatial.

About the Speaker:
Xavier is director of Oracle's Spatial and Location Technologies group. He leads Oracle's efforts to incorporate spatial technologies across Oracle's database, application server, and eBusiness applications. He has fourteen years of experience in the area of GIS and spatial databases. He holds advanced engineering and planning degrees from University of Maine, MIT, and the University of California, Davis. He is a recipient of Fulbright, Ford, and UC Berkeley Postdoctoral Fellowships investigating GIS technologies. Xavier has been active in numerous academic and government research initiatives on geographic information, including a number of U.S. National Academies of Science Mapping and Earth Science studies. He is the author of a book on government spatial information policy and has authored over 50 scientific and industry publications in areas related to spatial information technology.

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Oracle’s Spatial Technologies
Technical Overview of Oracle 10g

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Oracle Spatial History


Use of Spatial Data becoming mission critical

<table>
<thead>
<tr>
<th>Local Government</th>
<th>Over 100 major metro areas</th>
</tr>
</thead>
<tbody>
<tr>
<td>National Agricultural Systems</td>
<td>Ireland, Poland, Netherlands, Italy…</td>
</tr>
<tr>
<td>Mapping Agencies and Cadastres</td>
<td>USGS, Ordnance Survey, NGA, Census Bureau, Swedish National Land Survey, Australia, Navtech, TeleAtlas, Ireland, Denmark, Netherlands, N. Ireland</td>
</tr>
<tr>
<td>Emergency Response</td>
<td>FEMA, State EMAs, UK National Flood Protection System</td>
</tr>
<tr>
<td>Transportation Infrastructure And Asset Maintenance</td>
<td>Over 20 US State DoTs, Alberta Transportation 10 International Airports, CSX, Austria Rail, Denmark Rail, Dutch Rail, German Rail, UK Rail</td>
</tr>
<tr>
<td>Telecommunication Services</td>
<td>AT&amp;T, Verizon, Nextel, Sprint, 3 (Hutchinson), Over 20 national telcos</td>
</tr>
<tr>
<td>Police</td>
<td>New York City, LA, Edmonton, Amsterdam, London…</td>
</tr>
</tbody>
</table>
Characteristics Today

- 1000’s of users
- 10’s Terrabytes
- 24x7 systems
- Global distribution of servers
- Decision making based on all available data
- Isolated systems serving specific communities
- Growing use of near real-time data and sensor input

Challenge of Integrating GIS & Design Data within the Enterprise

Specialty GIS/Map servers

- Data isolation
- High systems admin and management costs
- Scalability problems
- High training costs
- Complex support problems

Spatial data tightly coupled to specific application

Information not aligned with Business Processes

Enterprise GIS Architectures

Spatially Enabled Database (Tightly Integrated)

- Geometry fully integrated within the database and native DBMS type
- Geometry data accessible by all applications
- Access based on open standards
- Oracle’s solution supported by all GIS vendors
Why Use a Spatial Database?

- Better data management and more control
- Easier integration with core business data
- Scales from department to enterprise; from Internet to wireless portals and web services
- Open programming standards, Java, SQL, XML, .NET and emerging interoperability standards
- Internet enabled architecture for Web delivery
- 3rd party support for mainstream tools and apps

Enterprise GIS & DBMS: Complementary Roles

Technology
- Design Tools
- GIS Tools
- Spatial DBMS

Task
- Data load
- Editing/ transformation
- Visualization
- Mapping
- Analysis
- Storage & Admin
- Indexing
- Security
- User Mgmt
- Query
- Versioning
- Scalability

GeoSpatial Web Services Architecture

Core SOA Infrastructure
- ORACLE
- ORACLE

SOA-enabled Applications
- Autodesk Tools & Applications

Business Logic
- Industry Models
- Visualization
- Interactive Editing
- Industry Knowledge
- Business Intelligence

Business Logic
- Autodesk Tools & Applications
- Web Portals
- Asset Mgmt
- Web Mapping
- Business Intel
Oracle 10g Spatial Database

Oracle 10g Core Spatial Capabilities

Spatial Data Types
- All Spatial Data Stored in the Database

Spatial Indexing
- Fast Access to Spatial Data

Spatial Access Through SQL

```sql
SELECT a.building_id
FROM facility a, facility b
WHERE sdo_within_distance(a.geom, b.geom, 'distance = 10 unit = mile') = 'TRUE';
```

ALL your Spatial Data in Open DBMS

- Locations (points)
- Networks (Connectivity)
- Parcels (polygons)
- Imagery (Raster)
- Structured Networks/Boundaries (persistent topology)
- Addresses (geocoded points)
Spatial Data Types

- Points
- Line Strings
- Polygons
- Polygons with holes
- Circles
- Arcs, arc strings
- Rectangles
- Compound elements

Spatial Data in Oracle Tables

<table>
<thead>
<tr>
<th>ROAD_ID</th>
<th>NAME</th>
<th>SURFACE</th>
<th>LANCES</th>
<th>LOCATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Homestead</td>
<td>Asphalt</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Bellomy</td>
<td>Asphalt</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Santa Clara</td>
<td>Asphalt</td>
<td>2</td>
<td></td>
</tr>
</tbody>
</table>

Data type: SDO_GEOMETRY

How Spatial IsStored
Spatial Operators

Full range of spatial operators
- Covers
- Covered By
- EqualOverlap
- Boundary
- Distance Operators
  - Within Distance
  - Nearest Neighbor
- Topological Operators
  - InsideContains
  - Touch
  - Disjoint

Spatial Query Via SQL

Find all building within 500 meters of building 902

```
SQL> SELECT a.building_id
2>   FROM base_buildings a,
3>        base_buildings b
4>  WHERE b.building_id = 902
5>    AND MDSYS.SDO_WITHIN_DISTANCE(
6>         a.Location, b.Location,
7>         'distance=500' = 'TRUE';
```

Oracle10g Spatial Spatial Functions
Spatial Functions

Over 330 Spatial Functions
- Union, Difference, Intersect, etc.
- Spatial Aggregates
- Buffer
- Point as bearing
- GML
- Geometry Validations
- Length
- Area
- Distance
- Etc...

Oracle\textsuperscript{10g} Advanced Spatial Features

Coordinate Systems
- Geodetic Support
- Ellipsoidal Computations
- Support for poles & 180 meridian
- Very accurate distance & area calculations (Std unit support)
- Transformations

Linear Referencing
- All Geometry Types
- Geodetic Coordinates
- 3D support for projected coordinates
- Dynamic Segmentation

Support for key database features
- Real Application Clusters
- Table/Index Partitioning
- Advanced Replication
- Workspace Management
- Parallel Indexing & Query
- Function Based Indexes
- Embedded Data Type
- Etc...

Oracle\textsuperscript{10g} Spatial
Major New Features
GeoRaster Data Support

Some of the types of data supported by GeoRaster, classified by Data source:

- Satellite imagery
- Airborne photographs
- Thematic grid maps
- Digital terrain/elevation models
- Lattice GIS data
- Scanned maps and graphs
- Raster data associated with geology, geophysics, and geochemistry
- Medical images
- Others

GeoRaster

Features/Functionality:

- Store, index, and retrieve raster data
- Store, maintain, and retrieve GeoRaster metadata
- Analysis functionality:
  - Generates pyramids
  - Copy
  - Change format: Interleaving, blocking
  - Subset: Crop, cut, clip by band or layer
  - Scaling: Enlarge or reduce
  - Generates the spatial extent of an image
  - Tile adjacent images to build a mosaic of the data
  - Georectified/Georeferenced images supported
  - Image Compression

Geocoder

- Geocoding Engine within the Oracle database
- Generates latitude/longitude (points) from address
- Supports international addressing standardization
- Formatted and unformatted addresses
- Tolerance parameters support fuzzy matching
- Transaction and batch capabilities
- Data dictionary completely extensible
- Base dictionary data available from Navteq & TeleAtlas
Topological Model

Persistent topology maintained within the database
Feature layers derived from topology

Feature Storage
- Based on topological elements (or primitives)
  - Nodes
  - Edges
  - Faces
- Topological element stored once in the database

Network Data Model

Data Model
- Store network (graph) structure in the database
- Maintains connectivity of the network
- Attributes at link and node level

Routing Engine
- Street navigation for single or multiple destinations
- Provide network analysis functionality in the database

Supports Network solutions (Tracing & Routing)
- Transportation and Transit Solutions
- Field Service, Logistics
- Location based Services and Telematics

Bio-Info Pathways (Life Sciences)
- Biological Pathways
- Protein-Protein Interaction

Spatial Analytic Functions

Discovery based on Spatial Patterns
- Explicitly materialize spatial relationships
- Location prospecting
- Cluster analysis
- Neighborhood-based estimation
Oracle Spatial Technology
Case Examples

Oracle10g Value Proposition
Secure Enterprise and Web Services Platform

- Single source of truth
- Strong Security
- Real-time information updates
- Interoperable data and location aware processes
- Integrated spatial information from multiple sources
- Enhanced Business Intelligence
- Creation of Spatially Enabled, Real Time Enterprise

Critical Enterprise GIS Features

- Integrated Data Management
- Seamless Datasets
- Supports Complex Workflows
- Easy to Manage & Program
- Fast - No Middleware
- Supports Terabytes of Data
- Supports 1000s of Users
- Easy to Program
- Transactions-based
- Multi-platform Support

- Open/Standards-based
- Reliable
- Scalability
- Distributed/Replication
- Partitioning
- Parallelism
- Bulk Load Utilities
- Version Management
- History Management
- Leverages Hardware
Advantages of a Spatial Database

- Same access methods (SQL)
  - Select, insert, update, delete
- Same RDBMS features available to GIS
  - Replication, security, parallel, high availability...
- Same utilities
  - Load, import, export, backup
- SAME DATABASE
  - for spatial and non-spatial data

Business Benefits

Low Cost of Ownership
- Applications are deployed corporate-wide, spatial data stored centrally, lowering ownership costs.

Low Risk
- Spatial is integrated into DBMS. Result: scalable, secure, and high-performance apps.
- Developers deploy on any server platform: Unix, Linux, Windows NT, Windows 2000,

High Value
- Users can access the application at virtually no additional costs to the organization.
- Users access mission critical information 24 hours a day, 365 days a year.

Support for Spatial Standards

- OGC: Simple Features, GML, OpenLS
- SQL92, SQLMM
- ISO211
- W3C: (HTTP, HTML, SVG)
To find out more...
http://otn.oracle.com/products/spatial

Examples, white papers, downloads, discussion forum, sample data...

Questions & Answers
otn.oracle.com/products/spatial