Oracle Spatial and Oracle Locator: A Location Platform for Enterprise IT
Overview

- Platform for Spatial Solutions
- Oracle Spatial & Locator
- Customer Examples
- Oracle Spatial 10g: Advanced Technology Features
- 10g Release 2 Enhancements
Platform for Spatial Solutions
What is spatial data?

- Business data that contains or describes location
  - Street and postal address (customers, stores, factory, etc.)
  - Sales data (sales territory, customer registration, etc.)
  - Assets (cell tower, fire hydrant, electrical transformer, etc.)
  - Geographic features (roads, rivers, parks, etc.)
- Anything connected to a physical location
- Every database in the world contains some form of business data that can be leveraged using spatial technologies
- Location is a “universal key”
Bringing it all together

<table>
<thead>
<tr>
<th>Information Type</th>
<th>Location-enabled Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Address</td>
<td>Map Customers and Business Relationships</td>
</tr>
<tr>
<td>Routes, Utility, infrastructure, etc.</td>
<td>Develop Routes / Trace &amp; Manage Field Assets</td>
</tr>
<tr>
<td>Administrative areas (zip, tax, county, area code, real estate, sales territories etc.)</td>
<td>Summarize, Compare, Drill Down Analytics, Track Assets etc.</td>
</tr>
</tbody>
</table>
Early Spatial Systems: Hybrids

- Attributes in database
- Geometries in database - but in proprietary binary format
- IT can access geometries via proprietary interfaces only
- Poor integration
Key Challenges with Spatial Data

• Little or no information sharing
  - Intra-Organizational
    • Transportation, Public Safety, Health & Human Services, etc.
  - Inter-Organizational
    • Cities, Counties, States, Federal Govt., Utilities, etc.

• Multiple data formats and high administration costs

• Stovepipe systems

• Specialty servers for specialty applications
Open Spatial Databases

- Spatial is native DBMS type
- Attributes and geometries integrated in database
- Supported by all GIS
- Supported by eBusiness applications
- Spatial data queried using SQL, Java
Why add advanced spatial services to Oracle Database?

- Enable Integrated Operational Systems
- Manage huge volumes of machine generated data
- Apply database benefits to fundamental data management challenges; no scalability boundaries
  - Raster Images: Single images < 1 TB; Logical datasets ~ 1 Petabyte
  - Utility and transportation networks: Billions of Nodes/Links; millions of graphs
  - Point Clouds: Terabytes of point data to be indexed and analyzed
  - Topology: data validation for seamless national datasets
  - Geocoding, Routing, Mapping: single dataset for all functions for telco, call center, telematics applications, ITS
- Common user management, administration, security
The Spatial Platform for IT

• Ubiquitous Spatial services in IT infrastructure
  - Dramatically lower costs
  - 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
    • Transactions, Versioning, Security, Backup/Recovery
    • Scalability
    • Standards compliance
    • Load Balancing, Failover
    • Hardware / Software dependencies
  - Support multiple application models with common data model
    • Java, GML, .Net, Web Services
Benefits of Using a Spatial Database

Lower Cost of Ownership
- Store spatial data centrally & eliminate separate file systems – reduce maintenance, hardware support costs
- Reduce training costs

Reduce Risk
- Open – no proprietary data types – supported by every leading GIS vendor
- Scalable: Supports Terabytes of Data & transparent scaling through RAC
- Secure and Reliable

Improve Decision Making and Customer Service
- Access to spatial data by more people /departments/ organizations
- Access to better quality data
- High Performance - no Middleware
- Supports 1000s of Users
- Business applications can take advantage of location analysis

Easy to Program
- SQL and Java, leverage existing DBA and application development skills
Oracle10g Value Proposition

*Integrated and Assured Information Sharing*

- Single source of truth
- Strong Security
- Real-time information updates
- Interoperable data and location-aware processes
- Integrated spatial information from multiple sources
- Enhanced Business and Operational Intelligence
- Creation of a Network Centric, Spatially Enabled, Real Time Enterprise
Spatial Platform for GIS, LBS, Imaging

Technology

- GIS/ Web Mapping Tools
- Remote Sensing/ Photogrammetry Tools

Task

- Data loading
- Editing
- Visualization
- Image processing
- Analysis
- Business Processes
- Storage & Admin
- Indexing
- Security
- User Mgmt
- Query
- Versioning
- Scalability
Oracle’s Approach to Market: Broad Platform for Geospatial Solutions

- **Enterprise Geospatial (Specialized)**
  - Leverage Internet Computing Platform
  - Planning and Land Management
  - Facilities Asset Management
  - Defense & Intelligence Surveillance
  - Energy Exploration

- **LBS & Business Applications (General)**
  - Map-enabled Business Applications
  - Web Mapping, Map Portals
  - CRM (Sales, Marketing, Call Centers)
  - ERP (Supply Chain, Asset Management, Financials)
  - Tracking & Logistics (RFID, Sensor Web)
Specialized Applications

Oracle10g Features
Geometry
Topology
GeoRaster
Networks
LRS
Geodetic
Long Transactions
General Business Applications

Oracle10g Features
Simple Feature Geometries
Spatial Operators
Geocoding
Routing
Web Mapping
Portal/SOA Integration
Combined Specialized & General Applications

- Asset Management
- Environmental Planning
- Business Intel
- Land Management
- Logistics
Enhance Any Business Intelligence Platform

OracleBI Discoverer, Oracle Spatial & MapViewer
Supporting Open Standards

- OGC (Simple Features, GML, OpenLS…)
- ISO TC211 (Spatial Schema, Metadata, Coordinate Systems…)
- W3C Consortium (XML/SVG…)
- Sun (Java)
- ISO/IEC JTC1 SC32 (SQL-1999 – SQL/MM-Spatial)
  - Oracle Locator & Spatial support SQL-MM-style types & operators
- Open Mobile Alliance-Location Working Group (cell phone locations)
Partners Supporting Oracle Spatial/Locator

Autodesk®
INTERGRAPH
PCI Geomatics
Leica Geosystems
Geodon
ESRI
Skyline
MapInfo
GE
Bentley
Navteq
Exor
Ionic Software
Aquis
POWEL
miniMax
SAFE SOFTWARE
ObjectFX
Laser-Scan
Tele Atlas

ORACLE
What the Analysts are Saying about Oracle Spatial...

“In four separate surveys since 1999, IDC has found that Oracle holds about an 80-90% share of the overall geospatial database management market within medium-sized and large organizations.”

IDC, February 2005
A Service-Oriented Architecture Platform for Geospatial Solutions
Importance of Web Services Infrastructure

- By 2008 web services will be a preferred method to publish and query spatial data stores
- Simplifies and expands access to valuable geographic data and location based services
- Open, standard, easy access methods
- Low computation environments
- Consumer-oriented or specialist information
Why build on an SOA Platform?

- Scalability
- Load balancing
- Managing service integration complexity
- Orchestration of services in a workflow
- Security for sensitive information
- Transaction management
- Semantic interoperability
- Monitoring and management of multiple services
Geospatial Web Services Architecture

Core SOA Infrastructure
- Simple Features
- GeoRaster
- Topology
- Networks
- Spatial Data Mining
- Geocoding
- Routing
- Versioning
- DBMS Rules

SOA-enabled Services
- J2EE Container
- SOAP Web services
- Orchestration & Workflow
- Security provisioning
- Policy based resource mgmt
- Workload scaling
- Workload redistribution
- Portal
- Wireless & Sensor

Partner Applications & Services
- Business Logic
- Industry Models
- Visualization
- Interactive Editing
- Industry Specific APIs
- Industry Knowledge
- Packaged Solutions

Oracle Database 10g
Oracle Application Server 10g

Tracking/routing
Map Editing
Web Portals
Asset Maintenance
Web Mapping
Business Intelligence
Securing Spatial Information

User Security

Network Security

Data Security

Access control
Privacy & integrity of data
Comprehensive auditing

Authenticate
Privacy & integrity of communications

Points of Interest
Buildings
Infrastructure

Boundaries

Points of Interest

Network Security

User Security

ORACLE DATABASE 10g
Oracle Spatial & Locator
What is a Spatial Database?

Spatial Analysis

Spatial Data Types
All Location/Spatial Data Stored in the Database

Spatial Indexing
Fast Access to Spatial Data

Spatial Access Through SQL

ORACLE DATABASE 10g
All Spatial Types in Oracle 10g

- Networks (lines)
- Parcels (polygons)
- Locations (points)
- Rasters (imagery, grids)
- Addresses (geocoded points)
- Topological Relations (persistent topology)
### Geospatial Map Data in Oracle Tables

#### Road Data

<table>
<thead>
<tr>
<th>ROAD_ID</th>
<th>NAME</th>
<th>SURFACE</th>
<th>Lanes</th>
<th>LOCATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Pine Cir.</td>
<td>Asphalt</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>2nd St.</td>
<td>Asphalt</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>3rd St.</td>
<td>Asphalt</td>
<td>2</td>
<td></td>
</tr>
</tbody>
</table>

#### Data Types and Models:
- **Vector**: SDO_GEOMETRY, SDO_TOPO_GEOMETRY
- **Raster**: SDO_GEORASTER
Spatial Operators

- Full range of spatial operators
  - Implemented as functional extensions in SQL
  - Topological Operators
    - Inside
    - Touch
    - Covers
    - Equal
  - Distance Operators
    - Within Distance
    - Nearest Neighbor

Inside Contains

Touch Disjoint
Covers Covered By
Equal Overlap Boundary
Spatial Functions

- Return a geometry
  - Union
  - Difference
  - Intersect
  - XOR
  - Buffer
  - CenterPoint
  - ConvexHull

- Return a number
  - Length
  - Area
  - Distance
Oracle: Defining the Spatial DBMS

- SQL Spatial Type
- R-Tree Index
- Spatial Operators
- Spatial Reference System
- Coordinate System Support Based on EPSG Model (New with 10g Release 2)
- Geodetic (lat/long) Support
- Linear Referencing
- Spatial Aggregates
- Long Transactions
- Parallel Index, Query, Load
- Transportable Tablespaces

- GeoRaster Type
- Network Data Model
- Topology Data Model
- Geocoding Engine
- Routing Engine
eLocation Quick Start (New with 10g Release 2)
- Spatial Data Analysis / Mining
- GML 2.0 and 3.0
- SVG Support
- Oriented Point / Text Geometry
Oracle Locator and Spatial: Typical Deployments

**Locator Usage**
- Most location-based business applications
- Simple GIS applications
- Partner-supported GIS

**Spatial Usage**
- Business applications requiring geocoder, routing engine in database
- Complex GIS applications
- Intensive database-driven geoprocessing
- Network modeling
- Raster data management
Oracle Locator & Spatial Features

Locator – bundled in Express, Standard, Standard One, Enterprise Editions
- Support for all geometry types
- 2D, 3D, 4D data
- All Spatial Operators
- Distance and validation functions
- Coordinate Systems support (incl. explicit transformations†)
- Utility & tuning packages†
- Long Transactions
- Parallel spatial query and index builds*
- Table Partitioning*
- Object Replication*
  †New to Locator in 10g Release 2
  * Require EE and/or EE options

Spatial – priced option of Enterprise Edition
- All Locator features
- Spatial Functions
  - area/length calculation
  - buffer, centroid, union, etc
- Linear Referencing Support
- Spatial Aggregates
- GeoRaster Support (10g)
- Topology Data Model (10g)
- Network Data Model (10g)
- Geocoder (10g)
- Spatial Analytical Functions (10g)
- eLocation Quick Start (New with 10g Release 2!)
Workspace Manager

Oracle Database feature that version-enables tables and creates virtual workspaces to manage long transactions with isolation, history and “what if” scenarios:

- Workspace hierarchies any size
- No changes to application SQL
- Continually Refreshed workspaces
- Multi-Parent Workspaces
- Optimistic and pessimistic persistent workspace locks
- Differencing and Conflict detection/resolution
- Partial and Full Merge/Refresh of workspace/table
- Garbage collection operations to optimize version storage
Oracle Database 10g Enhancements for Workspace Manager

- Oracle Spatial topology versioning
- Valid time (Effective Dating)
- Multiparent workspaces
- System parameters to enforce global settings
- Workspace event notification
- More Database feature support:
  - Import / export, SQL*Loader, unique constraints, nested tables, Virtual Private Database, `TIMESTAMP WITH TIME ZONE` type, more DDL on versioned tables
Oracle Application Server MapViewer

- Build / visualize custom maps using XML APIs, Java and JSP tag libraries
- Executes in OC4J
- Supports business geographics and spatial analysis
  - Identify / query complex data
  - Uses Oracle Spatial / Locator
- Designed for integration with Location-based Services, Business Applications, Wireless platforms
- Feature of Oracle Application Server Java, Standard and Enterprise Editions
Customer Examples
British Telecom

- 999 (Trinity) – Emergency response
  - Locate caller, route call to first responders
  - High performance boundary matching
  - 100,000 calls/day

- Network Records, Maintenance, Fault locator
  - Used by 17,000 field engineers for 6.1 M customers visits/year

- Spatial data hub for multiple applications
  - Coverage maps
  - Marketing, product/service bundle campaigns
  - Network planning, maintenance

- Built using Oracle Spatial 10g, Network Data Model, AS 10g MapViewer
Ireland Department of Agriculture
Monitoring Correlation of Land Valuation and Boundaries

- Single, integrated web-enabled information system
- Key Benefits
  - Improved public service
  - Support for accurate and efficient payment administration
  - Remote farm inspection
  - Fast identification of land use inconsistencies
  - Web access to dataset
New York City

- Department of Information Technology & Telecommunications
  - Developed standardized digital basemap for all agencies
    - 6,000 miles of underground pipes
    - 1 million water/sewer connections
    - 32,000 sq. miles of Infrastructure Data
    - 7,500 digital photographs
      - Use ESRI, Bentley, MapInfo, GE Smallworld…..

- The Office of Emergency Management created a public site for emergency preparedness
Integrated NYC Spatial Architecture

GIS Specialist Systems:
- Environmental Management
- Transportation
- Crime Monitoring
- DPW Services
- Health & Social Services
- Education

Core Spatial & Business Data Repository:
- Topographic/Raster
- Cadastre
- Geo-coded Address
- Street Center Lines
- Assets
- Environmental
- Transport
- Health/Social services
- Education
- Crime

Spatially Enabled Business Applications:
- Logistics Management
- Financial Management
- Citizen Portal
- Asset Maintenance
- Criminal Justice
- Health Planning
Business Benefits to NYC

- **Scalability**
  - Platform is enterprise and Internet oriented

- **Multi-User GIS**
  - Requirements were for multi-user update access for many users

- **Interoperability**
  - Corporate enterprise implementation strategy involved multiple mapping and GIS vendors.
  - ESRI, MapInfo, Intergraph and Smallworld software are all used on the Oracle Spatial warehouse

- **Openness**
  - When you need open access to and interoperability with multiple Oracle applications

- **Enable eGovernment**
US Environmental Protection Agency

• EnviroFacts
  - Oracle Spatial manages location data associated with EPA regulated facilities
  - Data collected from federal, state and regional sources
  - Public Internet access to environmental data (Window to My Environment)

  http://www.epa.gov/enviro/wme/

• NEPAssist
  - Web application that facilitates environmental review process
  - Prototype available for New York and New Jersey
Ordnance Survey

• Ordnance Survey is Britain’s National Mapping Agency, and an internationally recognized leader
• Open repository standardized on Oracle Spatial
• Its “Maia” database system stores the digital mapping base of Great Britain
• Foundation for its current and future products in the OS MasterMap line
• Strategic enterprise software within Ordnance Survey
• Around 1 terabyte database, will grow to over 2 terabytes in first year
• Oracle Spatial is key to its profitability
The Most Popular Spatial Database

- **Utilities**

- **National Mapping, Cadasters & Agricultural Agencies**
  - NGA, USGS, US Army, Ordnance Survey (UK, IR, NI), Denmark, Sweden, The Netherlands, Poland, Australia, Greece

- **Transportation Management**
  - Iowa, Florida, Maine, Maryland, Minnesota, Nevada, New York, Oklahoma, Pennsylvania, Tennessee, Utah, Alabama, Alberta, London Rail, Netherlands Transport, Australia, Austrian Rail, German Rail

- **Telco & Wireless LBS**
  - AT&T, Bell South, British Telecom, Cingular, DoCoMo, KDDI, Intrado, JPhone, Nextel, Sprint, T-Mobile, Telkom, Telenor, Telstra, Telus, Telia, Cellcom, Verizon, Vodafone, Wind

- **Local Authorities**
  - New York City, Chicago, Los Angeles, San Jose, San Mateo, Washington DC, Cleveland, Detroit, Phoenix, Winnipeg, Vancouver, Edmonton, Stockholm...
Oracle Spatial 10g: Advanced Technology Features
Overview

- Network Data Model
- Topology Data Model
- GeoRaster
- Geocoder
- Routing Engine
- eLocation Quick Start (New for 10g Release 2!)
- Spatial Analytic Functions
Network Data Model

- **Network Data Model**
  - A data model to store network (graph) structure in the database
  - Explicitly stores and maintains connectivity of the network
  - Attributes at link and node level

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

- **Bio-Info Pathways (Life Sciences)**
  - Hierarchical Networks
  - Scale-free Networks
Topology Data Model

- **Data model to store** persistent topology
  - Easier to check for data consistency in this model
  - Example: when the road moves, the property boundary automatically moves with it
- **Topology Data Model and Schema**
  - Describes how different spatial features are related to each other
  - A land parcel shares the boundary with a road
- **10g continues to support transient topology**
  - Topology computed on demand
  - Customers have choice of 2 topology management capabilities
GeoRaster

GeoRaster
- A new data type to store raster data
  - Satellite images, remote sensing
- An XML schema to store metadata
  - Data source, layer information
- Georeferencing system
  - Relates image pixels to a longitude/latitude on Earth’s surface

Functionality
- Open, general purpose raster data model
- Storage, indexing, query & analysis of raster data
- No size limit for each raster object
- Publish as JPEG, GIF images
- Compression support (New with 10g Release 2)
  - JPEG baseline (lossy)
  - DEFLATE (lossless)
Geocoder

- 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
Routing Engine

- Enables the hosting of XML-based Web services that
  - Given a route request that includes start location and an end location (address information or latitude/longitude), returns route information (which can include directions, driving distances, estimated drive times, and geometry information) between the two locations
  - Given a batch route request consisting of a single start location and multiple end locations, can return information (driving distances and estimated drive times) for each of the start and end location pairs
- Supports international routing
- Integrated with geocoding engine capability
eLocation Quick Start
(New for 10g Release 2)

- Location service Java and XML APIs
- Enables application developers to quickly and easily deploy mapping, geocoding, and routing services right “out of the box” from data stored in Oracle Spatial
- Ships with sample HTML interfaces to jump-start creation of driving directions, mapping, and geocoding applications
- Sample data & data sets in Oracle Spatial 10g format available from leading data providers
  - Visit http://www.oracle.com/technology/products/spatial for more info
- May be used by OracleAS MapViewer, many third party mapping tools, or user-developed applications
Spatial Analytic Functions

• Discovery based on Spatial Patterns
  - Explicitly materialize spatial relationships

• Usage
  - Insurance risk analysis, crime analysis
  - Demographic analysis, customer profiling
  - Epidemiology, facility placement
  - Insurance risk analysis:
    • cluster house-holds based on high risk neighborhoods
  - Identify business prospects across a region:
    • examine the average incomes across different regions of the space
Oracle Application Server 10g MapViewer Enhancements
Oracle Application Server 10g MapViewer Enhancements

- Note: MapViewer is a component of Oracle Application Server

New Features:
- Support for Spatial 10g new features
  - GeoRaster
  - Topology data model
  - Network data model
- Workspace Manager support
- SVG, JPEG, transparent PNG, HTML imagemap support
- Open Geospatial Consortium’s Web Map Service 1.1 interface
- Dynamic coordinate transformations, multiple datasources per map, and temporary styles in a map request
Oracle Locator & Oracle Spatial: 10g Release 2 Enhancements
Oracle Locator: 10g Release 2 Enhancements

- Coordinate system support for European Petroleum Survey Group (EPSG) specification
- Explicit coordinate transformations (new to Locator in 10g Release 2)
- Utility package (new to Locator in 10g Release 2)
- Tuning functions and procedures (new to Locator in 10g Release 2)
Oracle Spatial:
10g Release 2 Enhancements

- Coordinate system support for European Petroleum Survey Group (EPSG) specification
- eLocation Quick Start
- GeoRaster compression
  - JPEG baseline (lossy)
  - DEFLATE (lossless)
- Topology Data Model – feature level spatial transactions
- Network Data Model – PL/SQL interface for creating, editing, analyzing network data
- Routing engine support for Western Europe
- Reverse & batch geocoding
- RDF Data Model
Summary

Oracle Spatial, Locator and MapViewer

- One platform for general and specialized location applications
- Manage ALL your spatial data with scalability, security, performance and reliability
- Leverage industry-standard SOA platform
- Utilize choice of GIS and LBS partner tools

Location-Enable Your Enterprise
To find out more...

http://www.oracle.com/technology/products/spatial/

Examples, white papers, downloads, discussion forum, sample data, customer successes, partner information, more