Oracle Spatial and Graph
Agenda

- Introducing Oracle Spatial and Graph
- Goals for Spatial Features in 12c
- New Spatial and NDM Graph Features in 12c
- Goals for RDF Graph Features in 12c
- New RDF Graph Features in 12c
- Unique advantages using Exadata
Oracle Spatial and Graph option

- "Points"
- "Lines"
- "Polygons"

Web Services (OGC)
SPARQL End Point
Rasters
Network Graphs
Topologies
RDF Semantic Graphs

Geocoding
Routing
Inferencing

Oracle Spatial and Graph
Oracle’s Spatial Technologies

- **Oracle Locator**: Feature of Oracle Database XE, SE, EE
- **Oracle Spatial**: Priced option to Oracle Database EE
- **MapViewer**: Java application and map rendering feature of Oracle Fusion Middleware
- **Workspace Manager**: Long transactions feature of Oracle Database SE, EE
- **Bundled Map Content**: Major roads, administrative boundaries (city, county, state, country) - worldwide coverage from Navteq
INTRODUCING

Oracle Spatial and Graph
Why rename this Oracle Database option
From “Oracle Spatial” to “Oracle Spatial and Graph”

• Highlights existing graph capabilities in Oracle Spatial
  – W3C RDF graph since Oracle 10gR2
  – Network Data Model graph since Oracle 10gR1

• Addresses increasing market demand for graph database capabilities
  – Social Network Graph database popularity
  – Multimodal and integrated transportation, utility and communications networks
Spatial Features
Our Spatial Technology Strategy

• Location-Enable the Oracle Stack
  – Oracle Spatial and Graph, Oracle Database 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, Fusion, e-Business, CRM, Primavera, Utilities, Retail and more
Most Widely Deployed Spatial Database

• Utilities

• 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, VIAG, Vodaphone, Wind

• Transportation Management
  – German Rail, Austrian Rail, California, Iowa, Florida, Maine, Maryland, Minnesota, New York, Oklahoma, Pennsylvania, Alabama, Alberta, London Rail, Netherlands Transport, Australia,

• Local Authorities
  – Berlin, Dutch Police, New York City, Chicago, Los Angeles, San Jose, San Mateo, Washington DC, Cleveland, Detroit, Phoenix, Winnipeg, Vancouver, Edmonton, Stockholm…

• National Mapping, Cadasters & Hydrographic Agencies
  – Ordnance Survey (UK, IR, NI), US Census, NIMA, USGS, US Army, Denmark, Sweden, The Netherlands, Poland, Australia, Singapore Land Authority
Location-Enabled Business Applications

Geocoding
Spatial searches
Routing
Mapping
Specialist Geospatial Applications

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

- Fusion Middleware MapViewer
- ADF GeoMAP Component

Spatial and Graph
- Network Data Model Graph
- GeoRaster
- Topology Data Model
- Linear Referencing
- 3D

- Fusion Middleware MapViewer
- Spatial APIs
- Toplink
- Partner tools
Goals for Spatial Features
Big Data Requirements

- Device-generated data
- Documents
- Location data
- Audio, Video, Image
- Social Network and Interaction Models
Advances with Oracle Database 12c
New Spatial Features

Dramatic Performance

Simplified Application Development
Core Spatial Functions and Operations

Performance

Oracle Database Locator

- ANYINTERACT, INSIDE: 20-30x
- GEOM DISTANCE: 40x
- WITHIN DISTANCE: 10x
- VALIDATE GEOMETRY: 4x
Vector Performance Acceleration

“Turbo-charger” feature for spatial functions and operators

Spatial and Graph option
Performance Improvements

- Join: 50-100x
- Touch: 50x
- Contains, Overlaps: 50x
- Complex masks: 50x
Vector Performance Acceleration

“Turbo-charger” feature for spatial functions and operations

Spatial Performance Improvements

- GEOM.relate: 5-10x
- DML single insert: 3x
- Coordinate System Transformations: 40-50%
- General DML operations: 30-50%
Improved performance
Core Spatial Functions and Operations

SPATIAL INDEX STATISTICS
- New Algorithms to Collect Spatial Index Statistics
- Optimized Execution Plans

20-90\% REDUCTION IN REDO LOGS
- Improved DML Performance
- Less Storage Required
Vector Performance Acceleration
Oracle Spatial and Graph “Turbo-charger” feature

OPTIMIZED METADATA QUERIES

- Kernel level caching
- Performance gains for DMLs and Spatial function calls
- Optimization especially noticeable in workflows with many fast running queries
Parallel Raster Operations

- MANY RASTER FUNCTIONS CAN PARALLELIZE
- SERIAL OPERATIONS PERFORM UP TO 3X FASTER
- SCALES TO OVER 100X FASTER ON HIGHLY PARALLEL SYSTEMS
US Army Corps of Engineers is making extensive use of the Point Cloud data type in Oracle Database Spatial and Graph option to store, retrieve, subset and analyze LiDAR data used to model 3D landscapes to support in-theatre, mission-critical DoD operations. ... [W]e are storing more than 150Tb of data including 100Tb of point cloud data (with more on the way). A single instance currently stores more than 1 Trillion points,” said Michael Smith, US Army Corp, Remote Sensing Center.

The enhancements to Oracle Spatial and Graph in Oracle Database 12c have dramatically increased scalability for multisession point cloud creation and provide a considerable savings of storage space.

Michael Smith
US Army Corp, Remote Sensing Center
Advances with Oracle Database 12c
Spatial Features

Dramatic Performance

Simplified Application Development
Virtual Mosaic and Image Processing

In Database Processing

- Virtual Mosaic of collections of any georeferenced GeoRaster objects
- Advanced spatial queries and on-the-fly transformation and mosaics
- Raster Algebra operations to create new map products
- Image Processing: Masking, stretching, segmentation, rectification

Mosaic of Landsat Images
Parametric curve support

**NURBS**  
Non-Uniform B Splines

- Used for highway and rail design, and surface models
- Mathematically precise representation of freeform surfaces and curves
Enhanced 3D and Point Cloud Support

- Simplified Java API for 2D and 3D in memory functions
- Pyramiding support for PC and TIN data
- Contour generation from PC data
- 3D Geodetic Support
Oracle Spatial and Graph

Open Geospatial Consortium Web Feature Server 1.1

Web-based console

• Menu driven GUI simplifies registration of spatial layers
• Includes tutorial on how to configure and use WFS
• Provide sample request and response pages for WFS queries
• Can also be used as a client to other WFS servers
Summary of New Spatial Features

- Vector Performance Acceleration
- Parallel GeoRaster and Enhanced Raster Operations
- Parametric Curve Data Type
- Extended 3D and Point Cloud data type functionality
- Web Feature Server Console
Oracle Spatial and Graph

Graph Features

• Network Data Model graph

• W3C RDF Semantic graph
Network Data Model graph

Use Cases

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

- A storage model to represent graphs and networks
- Graph tables consist of links and nodes
- Explicitly stores and maintains connectivity of the network graph
- Attributes at link and node level
- Logical or spatial graphs
- Can logically partition the network graph

- Java API to perform Analysis in memory
- Loads and retains only the partitions needed
- Dynamic costs with real time input
- Shortest path, within cost, nearest neighbors
- Traveling salesman, spanning tree, ...
- Multiple Cost Support in Path/Subpath Analysis
RDF Semantic Graph

Use Cases

Linked Data & Public Clouds
- Unified content metadata model for public clouds
- Validate consistency

Text Mining & Entity Analytics
- Find related content & relations by navigating connected entities

Social Media Analysis
- Analyze content using integrated metadata
  - Blogs, wikis, video
  - Calendars, IM, voice
What is RDF?
Resource Description Framework

- Basic structure is a “triple”
- RDF can be serialized into XML
- Schemas need not be specified in advance
- RDF data is fully expressible as RDBMS data

And
- RDBMS data is also expressible as RDF

Tony
:has_Best_Friend
:Jack

subject
decredate
object

:Tony
Oracle Spatial and Graph
RDF Semantic Graph

The Only RDF Database with:

- Graph assisted SQL querying
- Fine-grain Label-based Security
- Support for both SPARQL and patented SQL access
- Works with OBIEE, Oracle BPM, Oracle Advanced Analytics
- Full spatial analysis of all 2D, 3D and raster data

Conceptually, Semantic applications look at things as being represented as graphs, rather than tables.

In Oracle Database, we use Triples and Key relationships to represent nodes and links in the Graph.

Wells Fargo
Is owned by
Norwest
Now known as
Wachovia

First Union
Now known as
CIT Group

First Nat Bank
of Philadelphia
Now known as
CIT Group
Oracle Spatial and Graph
RDF Semantic Graph

Mature, complete RDF Database

• Supports all relevant W3C standards
• Supports Latest SPARQL Query Language, Tools and Web Services
• View relational data as RDF triples
• Scales with hardware – petabytes of triples
• 60% data compression reduces storage and enhances performance

Fundamental Concepts and “building blocks”

Querying is based on graphs

LoanProducts

Prime_M
Sub-prime_M
AutoLoan
MortgageLoan
SecuredLoan

Wells Fargo
Norwest

Is owned by
Now known as
Wachovia

Lending Institution
is name of
Wells Fargo
JPMC
BofA

Lender and Lending Institution are same

2/26 A
Advances with Oracle Database 12c

Graph Features

Dramatic Performance

Simplified Application Development
Real World Feature Modeling in NDM Graph

Feature Representation

Network Representation
Temporal Modeling/Analysis

- Traffic Patterns
  - Record historical travel
  - Based on time of day and day of the week
- NDM can use traffic patterns to compute shortest paths
- Support NAVTEQ Traffic Patterns format out of the box
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
- Out of the box support for transit data published by transit authorities
Network Data Model Graph
Large Scale Drive Time/Distance Analysis

Big Data Analysis

• Millions of customers, find closest store within a specified drive time
• Single database query to find closest store and drive time/distance for each customer
• Customers geocode as based on graph segment
• Network Buffer generates all possible paths
New functions in Oracle Database 12c
RDF Semantic Graph

• RDF views on relational tables
  – RDF views can be created on a set of relational tables and/or views
  – SPARQL queries access data from both a relational and RDF store
  – Allows filtering of data in a relational store based upon graph analysis
  – Support RDF view creation using
    • Direct Mapping: simple and straightforward to use
    • R2RML Mapping: customizations allowed
RDF Graph results with Oracle Business Intelligence

SPARQL Gateway
Performance and In-Database Analysis

RDF Semantic Graph

- **Reasoning**: Faster, more efficient, and secure reasoning engine
- **SPARQL 1.1**: Richer query language with improved path analysis. Less application code.
- **GeoSPARQL**: Query language for spatial “linked data.” Less application code.
- **Named Graphs**: Standard Mechanism to distinguish graphs models in large graphs.
Summary of New Graph Features

- Network Data Model graph
  - Real World Feature Modeling
  - Multimodal Routing, Temporal Modeling and Analysis
  - Large Scale Drive Time/Distance Analysis

- RDF Semantic Graph
  - RDF views on relational tables
  - SPARQL 1.1, GeoSPARQL, SPARQL Gateway
  - Enhanced Reasoning and Security
  - Named Graphs
Oracle Exadata

Spatial and Graph Resides in Oracle Database Kernel

- Code resides in Database Address Space
- Spatial Index operations performed in Database SGA
- Spatial operators are parallel enabled by default and execute in Database Address Space for maximum scalability
- Spatial and Graph analysis and data models seamlessly exploit Database security, compression, partitioning services
Oracle Exadata
Faster Index and Query Operations

• Spatial operations are performed in Database System Global Area memory
• Spatial data warehouse performance increases of up to 100x faster
• Spatial Box and Distance queries up to 25x faster
Oracle Exadata
Extreme Compression for Point, Line and Polygon Data Sets

• Point, Line and Polygon geometries can all benefit from EHCC

• Lines and Polygons, they must be stored inline (less than 4K in size).

• Options include:
  – COMPRESS FOR QUERY LOW
  – COMPRESS FOR QUERY HIGH
  – COMPRESS FOR ARCHIVE LOW
  – COMPRESS FOR ARCHIVE HIGH
Oracle Exadata
Extreme Scalability for Millions of Spatial Objects

- Millions of spatial objects evaluated in minutes
  - Point in polygon analysis
  - Polygon to polygon analysis
  - Deviation from route
  - Distance covered
- Millions of Spatial objects ingested in minutes
  - Weather readings
  - Traffic readings
  - Sensor readings
Oracle Exadata
High Performance RDF Graph Workloads

- RDF Semantic Graph is designed for the Exadata architecture
- 3x faster inferencing and querying
- Parallel load, inference and query
- Inferencing accelerated with Hybrid Columnar Compression
- Queries faster with OLTP index compression on B-tree indexes
Oracle Exadata Summary

- Only Oracle Spatial and Graph is designed for the Exadata architecture
- Breaks new boundaries for ingesting spatial data
- Data warehouse spatial query performance up to 100x faster
- Spatial box and distance queries up to 25x faster
- Accelerated parallel, compressed RDF Graph workloads
Oracle Spatial and Graph

Proven, industry-leading technology

Dramatically improved performance

Simpler, more scalable applications

Engineered for Exadata