Oracle Spatial 11g

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New in Oracle Spatial 11g

- 3D Support
- Spatial Web Services
- Network Data Model
- GeoRaster
- Performance Improvements
3D Applications

• Location-based services
  • Augmented reality
• GIS Analytical Modeling
  • Terrain (2.5D) and 3D objects
• City Planning/Administration
• Infrastructure Design
  • Accurate descriptions of objects
3D Mash-ups
GIS Analytical Modeling & Simulation

Flood Plain Analysis

Petroleum Exploration
CAD Infrastructure Design

Infrastructure Supermodel
3D/4D Modeling
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www.pbworld.com
Simulation, Gaming, and VR
Customer Requirements

- Enterprise-class RDBMS to manage ALL geospatial types
  - 2D, 3D, Rasters, Networks, Topology, Attributes
  - Native type support, indexing, and analysis
  - Support for coordinate systems
  - Standards based: SQL, Java, .NET

- Addresses range of 3D application domains
  - GIS, CAD/CAM
  - City Modeling, environmental analysis
  - Building City models (Collada, CityGML)
  - Real Estate, asset management
  - Personal navigation
  - VR, gaming, simulation
  - Geo-engineering (CAD)

- Addresses large volumes of 3D point data
  - Laser scanning (LIDAR, sonar)
  - Surfaces (TINS, DEMS)
Technology Trends in 3D

- Massive new sensor hardware capabilities
  - Automated Data Capture with millions of points
- Increased productivity in 3D data management workflow
  - Automatic and semi-automatic extraction of features from raw data
  - Improve performance and scalability of existing workflows
- Bridging gap between GIS and CAD
- Bring 3D to Mainstream Business Applications
  - Current applications do navigation and visualization with 3D data
  - Mass Market: Consumer-focused systems
  - Benefit from IT scalability, security, and reliability
- Files to Databases
  - Merge Point Cloud content with other geospatial types
  - Integrate attribute data with 3D feature data
  - 3D features have more attributes than 2D data
Spatial DBMS in a Production Workflow

**Data Collection**
- LIDAR Surveys
- Aerial Photos
- Satellite Imagery
- COTS Scenes
- CAD Designs

**Production**
- Model/Scene Generation
- Image Texture Wrapping
- Editing/Updates
- Quality Control
- Spatial Analysis

**Dissemination & Exploitation**
- 3D Mapping
- Fly Through
- 3D analysis
- Predictive Analysis
- Navigation Systems
3D Spatial Systems

- 3D Data acquisition and automated object reconstruction
- Data Model to handle a variety of 3D Objects
  - Landmarks, buildings, bridges, point clouds
- Data quality control
  - Validation rules
- Geo-Referencing
  - Ability to accurately describe the location of 3D objects
- Comprehensive Location based search and Analysis
  - Nearest, Within-Distance
- Handling level of detail for seamless operation
- High Performance dissemination of 3D data
  - Web services, load and publish
- High performance real-time 3D rendering
- Support for 3D standards
Data Acquisition using 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
  - SDO_PointCloud
- TIN to create triangulated surfaces from such point sets
  - SDO_TIN
Challenges: Managing Point Cloud Data

- Robust Data Management Challenges
  - High Density LIDAR: Sub-meter point spacing (billions of points)
  - Combine with multi-spectral gridded data (terabytes of data)
  - Versioning, Archiving (terabytes, petabytes)
  - Back-up/recovery

- Data Transformation
  - LIDAR point filtering, visualization, analysis
  - Generation of Surfaces and 3D vector models
  - Attribute Data Integration

- Spatial 11g Support for Point Clouds
  - Integrate 3D models into business workflows
  - Associate 3D objects/features to attributes
  - Spatial query across point cloud features
  - Managing updates
Data Model to Handle 3D objects

- 3D Types for points/lines/polygons/solids
- Support for multi-points, multi-lines, multi-surfaces, multi-solids
- 3D Coordinate System Support
- Follows GML3.1.1, ISO 19107 Specifications
- No arcs and parametric surfaces supported
**Notation:**
- △ denotes *is-a* relationship
- ◇ denotes *many-to-1* relationship

CSurface is short for *Composite Surface*
CSolid is short for *Composite Solid*
SSolid is short for *Simple Solid*
Geometry types mapped to City Objects

- Composite Solid
  - Solid
    - Surface
    - Surface
    - Polygon
- Solid
- Building
  - House
  - GuestHouse
    - Roof
    - Walls
    - Window
SDO_GEOMETRY for 3D Data

- Ortho photo
- Building surface (3D surface type)
- Texture stored as image (GIF)
- Windows stored as 3D polygons
Data Quality Control

• Requires a robust data model
  • Constructive Solid Geometry in CAD
  • Boundary Representation in GIS
• Validation is an essential and important component of 3-D data modeling
  • Enables subsequent operations on valid data to run correctly and efficiently
• There are different data models and standards
  • GML, CityGML, ISO 19107
• There are different 3D communities
  • CAD/CAM, Gaming, VR, 3D GIS
• There is a need to preserve the validity when data is exchanged across these communities and standards
3D Geo-Referencing

- 3D data comes from multiple sources
  - high resolution imagery from aerial photography and satellites, 3D point clouds from airborne laser range-finding systems, such as LIDAR
- Traditional 3D data does not have geographic context
  - CAD models do not have geographic reference information
  - VRML does not support Geographically referenced data
- Comprehensive Coordinate System support required to bring all the 3D data together
  - Associate a coordinate system with 3D data
    - SDO_GEOMETRY, SDO_POINTCLOUD, SDO_TIN
  - Support multiple reference systems: Geocentric: 3-d cartesian, Geographic-2d and 3d, Compound Coordinate System
  - Support transformations between different coordinate system
  - Compute distances, and other spatial relationships between two objects within the same coordinate system
3D Queries

• 3D visibility queries
  • From which windows in which rooms of buildings do I have visible coverage of a certain place, road, or monument?

• Volumetric Analysis
  • To what floor level have all buildings in a flooded area been affected?

• Spatial and Attribute queries
  • Where is office space in a specific area of the town with more than 100 meters elevation, good visibility of the lake and less than 15min to walk from a public transportation stop?
Location based search and Analysis

• 2D spatial search extended to handle 3D spatial search
  • Extended the indexing from 2D to 3D
  • Index based 3D spatial search is done with 3D R-tree index
    • SDO_FILTER, SDO_ANYINTERACT, SDO_NN, SDO_WITHIN_DISTANCE
  • Distance based operations are extended to work with 3D distances
    • Finding nearest neighbors
    • Finding objects within a distance
  • INSIDE operation is extended for 3D
    • Determine if a ship can dock at a port
Supporting Level Of Detail (LOD)

- 3D Application Data models have discrete levels of detail
  - CityGML has 5 Levels of Detail
- LOD 0 – Regional model
  - 2.5D Digital Terrain Model
  - 11g: GeoRaster/TIN/PointCloud
- LOD 1 – City / Site model
  - block model without roof structures
  - 11g: 3D Polygons/Surfaces
- LOD 2 – City / Site model
  - textured roof structures
  - 11g: 3D Surfaces, GIF images
- LOD 3 – City / Site model
  - detailed architecture model
  - 11g: 3D surfaces, GIF images
- LOD 4 – Interior model
  - architecture models
  - 11g: 3D Lines/Polygons/Solids/Surfaces
High Performance Dissemination of 3D data

Web 3D Services

- Image server (WCS)
- Feature server (WFS)
- 2DMap server (WMS)

Oracle Spatial DB

GeoRaster

2D Data

3D Data: Geometry, PointClouds, TINs

Graphics data: Textures, Colors

• Deliver 3D display elements
  • VRML97; X3D; KML, etc.
• Generate 3D scenes with predefined initial viewpoint
Exporting and Importing of 3D Data

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GML
KML
CityGML
COLLADA

GeoRaster
2D Data

3D Data: Geometry, PointClouds, TINs

Graphics data: Textures, Colors
Creating 3D Data from 2D data

- EXTRUDE: Construct a 3D geometry from 2D geometry
  - Useful for generating city models with building footprints and height values
  - This is also useful in 3D thematic mapping: height of a building can be derived from a thematic attribute
Visualization Support

• DB Schema for visual elements
  • Combine visualization elements from
    • COLLADA (Collaboative Digital Asset Exchange Format)
    • X3D (latest incarnation of VRML)
    • Java3D
  • Easily associate Textures with Buildings
• All the required elements for visualization persistently stored in the database
• Support multiple rendering engines
  • Java 3D, X3D, OpenGL
3D Standards

- Specific **OGC Web Services for 3D visualization**
  - **Web Terrain Service** WTS (now: Web Perspective View Service)
  - **Web 3D Service** W3DS
- GML
- KML
- GeoVRML
- Catalog Services (Web Catalog Service CS-W)
- WFS
- WCS
- X3D
Summary: 3D in Spatial 11g

Types
- SDO_GEOMETRY (3D)
- SDO_TIN
- SDO_POINT_CLOUD

3D COORDINATE SYSTEMS

Building Models,
Surface Modeling
Scene,
Object Modeling

Efficient
Storage
Query
Analysis
Spatial Web Services
Support for OGC Web Services

- Single source of truth
- Strong security
- Centralized maintenance
Spatial 11g Web Services Framework

- **http POST**
  - simple but not secure
- **SOAP/XML**
  - secure

**Services**
- WFS
- WMS
- CS-W
- OpenLS

**OC4J**

**Data**
- 3D Models (Buildings)
- Networks (Highway network)
- Parcels/Roads/POIs (polygons/lines/points)

**Imagery**
- Imagery (Satellite)

**Lidar** (Point Clouds)

**User Management**

**DB Security**

**Persistent topology**
Federated Search with Web Services
Federated Search with Web Services
Federated Search with Web Services

USER

CS-W

WFS

11g Database

WFS

11g Database

WFS

11g Database
Federated Search with Web Services

USER

CS-W

WFS

11g Database

WFS

11g Database

WFS

11g Database
Network Data Model
Two approaches to Network Analysis

- 11g Load-On-Demand Analysis
  - Handle network analysis on very large networks
  - Supports variety of network applications
GeoRaster

• Just Announced: GeoRaster JAVA API (Beta 1)
  • `oracle.spatial.georaster.image`: Provides support for generating Java images from a GeoRaster object and for processing the images
  • `oracle.spatial.georaster.sql`: Provides support for wrapping the GeoRaster PL/SQL API

• Source code provided for four sample applications built with this new Java API

Tools.java  Loader.java  Viewer.java  Exporter.java

www.oracle.com/technology/sample_code/products/spatial/htdocs/georaster.html
Summary

• Support for large seamless 3D scenes: Terabytes of objects
• Provides bridge to fuse 3D, 2D, CAD, raster data
• Fusion of aerial imagery, close-range airborne and ground video/LIDAR with traditional 2D vector models
• Integrated support for Web delivery
• Spatial analysis: conduct traditional GIS queries on 3D scenes
• Transactional Updates
• Enterprise Integration: Integrate 3D models with business information.
• Data security, access control, encryption, authentication
• Open: Support by third party 3D viz and analysis tools
To find out more...

http://otn.oracle.com/products/spatial