

Oracle Spatial Technology, Tools and Techniques



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Outline

- Overview of Spatial Data processing
 - Overview of Spatial Database Technology
 - Oracle Spatial Technology
 - Spatial Application Architectures and Tools
 - Demo
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Background

Martin Davis

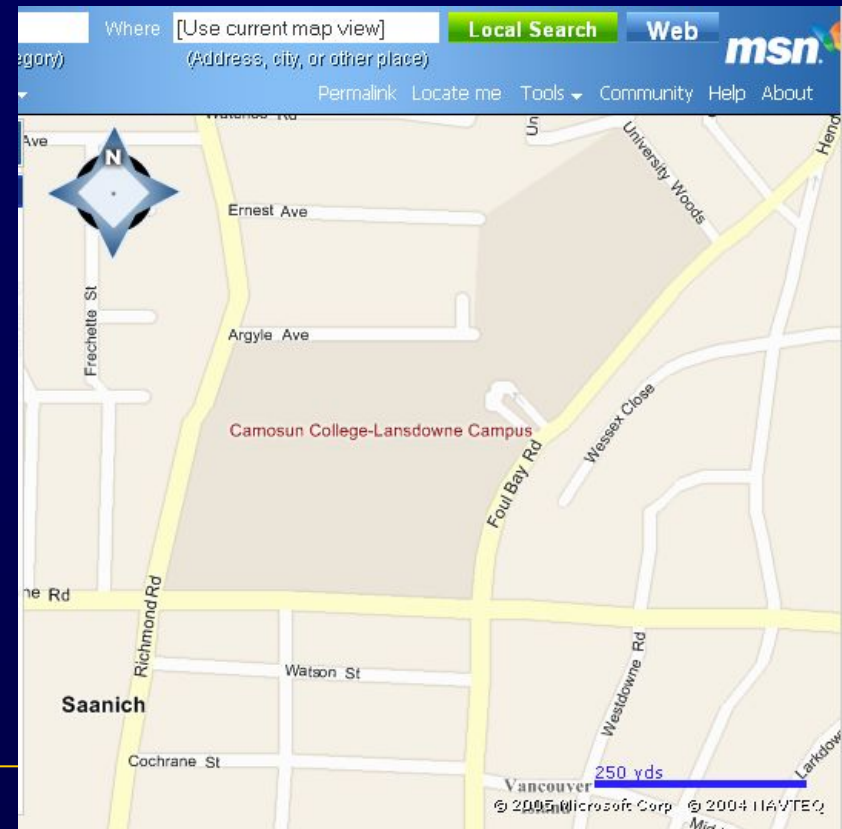
- 10 years of experience in spatial data processing, in government and the private sector
- Spatial Architect for enterprise-level geospatial applications
- Designer & lead developer of the JTS, JUMP and JCS open source geospatial projects

Vivid Solutions, Inc.

- Victoria-based software consulting company
 - In business for 8 years
 - 25 staff – almost all consultants or software developers
 - Mix of government and private sector clients
 - Enterprise Geospatial Applications are a primary business focus
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Spatial Data has gone mainstream!

- Google Map & Earth
- Microsoft Virtual Earth, *etc.*
- Drivers:
 - Cheap cycles & storage
 - Easy access to Data



Spatial Data in the Enterprise

- “80-90% of business databases include location information.”

– *Xavier Lopez, Oracle Corp.*

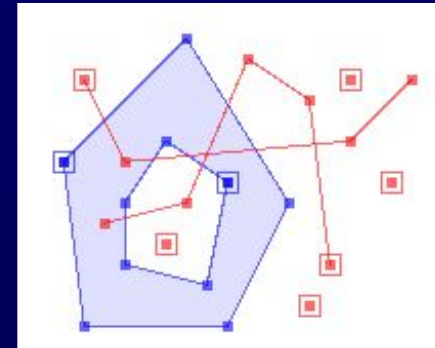
- Oracle holds 80% of the geospatial database management market

– *Oracle Corp.*

What Is Spatial Data?

- **Vector Data**

- Geometry (e.g. *Points/Lines/Polygons*)
- 2 D or 2.5 D (*position + elevation*)
- Spatial + Attributes = **Feature**



- **Raster Data**

- Pixels + attributes
- Georeferenced Imagery



- **Coordinate Systems (Georeferencing)**

- Geographic (lat/long)
- Projected (e.g. UTM, Albers)
- Local (unreferenced)



- Geographic Location is a “*universal key*”

Spatial Standards

- Open Geospatial Consortium (OGC)
 - Simple Features for SQL (SFS)
 - *Point, LineString, Polygon, MultiPoint, MultiLineString, MultiPolygon, GeometryCollection*
 - Web Map Service (WMS)
 - Web Feature Service (WFS)
 - Geography Markup Language (GML)
 - Filter
 - Coordinate Transformation Service (CTS)
 - ISO TC211
 - EPSG (European Petroleum Survey Group)
 - Coordinate Systems
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Evolution of Spatial Data storage technology

- Flat Files
 - Spatial in pure Relational
 - Highly non-standard
 - poor performance
 - Proprietary Spatial Extensions
 - layered on top of (and in!) DBMS
 - uses BLOBS to store data
 - spatial index implemented as SQL tables
 - separate process and API to interact with spatial data (=> more moving parts, non-transactional)
 - no query language
 - limited database tools
 - Object-Relational
 - e.g. Illustra/Informix, PostgreSQL
 - Native indexing
 - New spatial type, functions, SQL extensions
 - Vendor-supported or proprietary
 - Integrated Spatial Database
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Spatial Database Capabilities

- Complex objects representing spatial data types (geometry)
 - Spatial indexing capability
 - usually some variant of an R-Tree
 - Spatial functions
 - spatial predicates (*intersects, overlaps, contains, etc.*)
 - manipulating geometry
 - analytic operations (*intersection, union, buffer, etc.*)
 - metrics (*area, length, distance*)
 - linear referencing, etc.
 - Spatial SQL extensions
 - spatially aware optimizer
 - Ideal: spatial “just another column type”
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Spatial Databases- Advantages

- Single repository for *all* enterprise data
 - Transactional
 - Performance and scalability
 - SQL query language for spatial relationships, analysis
 - Spatial “*just another datatype*” => integration with all DMBS functions:
 - Joins & Views involving spatial data
 - Stored procedures & triggers
 - Replication
 - Backup/Recovery
 - Maintenance, Design Tools
 - Security
 - Support for versioning (long transactions, “what-if” capability)
 - Reduces training for developers and DBAs
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Spatial Databases - Products

Commercial

- Oracle Spatial
- IBM DB2 Extended Edition
- Illustra -> Informix -> IBM

• Open Source

- PostGIS
 - MySQL (limited functionality)
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Oracle Spatial - History

1995 Oracle 7.1.6 - MultiDimension

- Points only

1997 Oracle 7.3.3 - Spatial Data Option

- Points, Lines, Polygons
- Quad-Tree indexing
- Spatial Operators

1999 Oracle 8i - Spatial

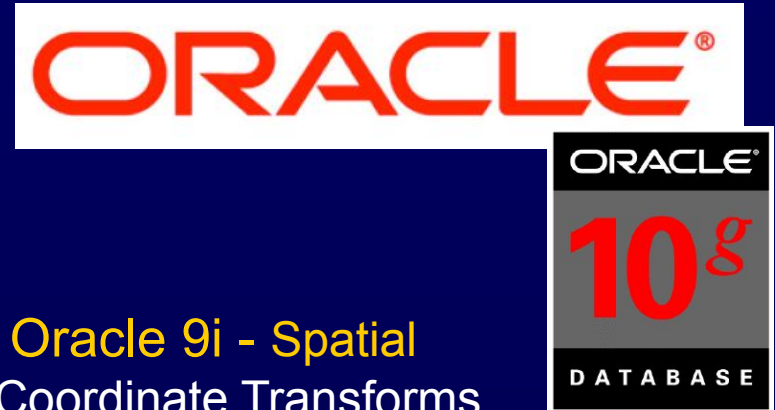
- Object Data type
- Circles, Arcs
- R-Tree Indexing
- Topology/Distance Operators
- Spatial Functions

2002 Oracle 9i - Spatial

- Coordinate Transforms
- Linear Referencing
- Spatial Replication
- Spatial Partitioning

2004 Oracle 10g - Spatial

- Raster Data Management
- Topology & Networking
- Spatial Analysis & Mining



Oracle Spatial - Features

- **Locator** – Bundled with Standard & Enterprise Edition
- **Spatial** - Licensed Option, Enterprise Edition only

Oracle Locator

All Spatial Data Types (SDO_GEOMETRY)

Spatial Indexing (Quadtree, R-tree)

- Function-based spatial indexing

Spatial Operators

- Topological predicates

- Distance

Implicit Coordinate Transformations

Long Transactions (via Workspace Manager)

Table Partitioning

Object Replication

Oracle Label Security

Oracle Spatial

Spatial functions

- **area & length**
- aggregates
- intersection, union, buffer, centroid, etc.

Coordinate Transformations

Linear Referencing

Topology Data Model

Network Data Model

Geocoding

Routing

GeoRaster Data Type

Client-side Java Geometry API

Oracle Spatial – SQL Examples

- Defining a spatial table

```
CREATE TABLE muni_parcel (  
    pid          NUMBER(38),  
    geometry     MDSYS.SDO_GEOMETRY,  
    description  VARCHAR2(30) );
```

- Defining spatial metadata

```
INSERT INTO USER_SDO_GEOM_METADATA (TABLE_NAME, COLUMN_NAME, DIMINFO,  
SRID)  
VALUES ('MUNI_PARCEL', 'GEOMETRY',  
    MDSYS.SDO_DIM_ARRAY  
        (MDSYS.SDO_DIM_ELEMENT('X', 200000.0, 1900000.0, 0.00000005),  
        MDSYS.SDO_DIM_ELEMENT('Y', 300000.0, 1800000.0, 0.00000005)  
    ), 1042102 -- Coordinate system  
);
```

- Creating a spatial index

```
CREATE INDEX muni_parcel_idx ON (geometry)  
    INDEXTYPE IS MDSYS.SPATIAL_INDEX;
```

Oracle Spatial – SQL Examples

- Loading geometry data via SQL

```
INSERT INTO muni_parcel VALUES (  
    999,  
    MDSYS.SDO_GEOMETRY(  
        2003,      -- 2-dimensional polygon  
        1042102,  -- Coordinate system  
        NULL,  
        MDSYS.SDO_ELEM_INFO_ARRAY(1,1003,1),  
        MDSYS.SDO_ORDINATE_ARRAY(  
            1035493.9, 603977.1, 1035533.2, 598412.8, . . .)  
        ), "Test Parcel" );
```

- Simple spatial query

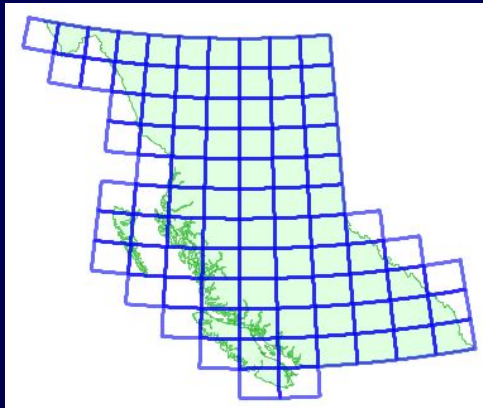
- (return features intersecting a bounding box)

```
SELECT * FROM muni_parcel  
WHERE sdo_relate(GEOMETRY,  
    mdsys.sdo_geometry(2003, 1042102, NULL,  
        mdsys.sdo_elem_info_array(1,1003,3),  
    mdsys.sdo_ordinate_array(1000000, 2000000, 1000000, 2000000)),  
    'mask=anyinteract querytype=window') = 'TRUE'
```

Oracle Spatial – SQL Examples

- Complex analytic query
 - “Find all mapsheets which contain roads”

```
SELECT * FROM bc_grid_250k g
WHERE g.map_tile IN (
  SELECT a.map_tile FROM bc_grid_250k a, bc_basemap_5k b
  WHERE b.fcode = 'DA24900010'
  AND sdo_filter(a.geometry, b.geometry, 'querytype=join') = 'TRUE'
);
```



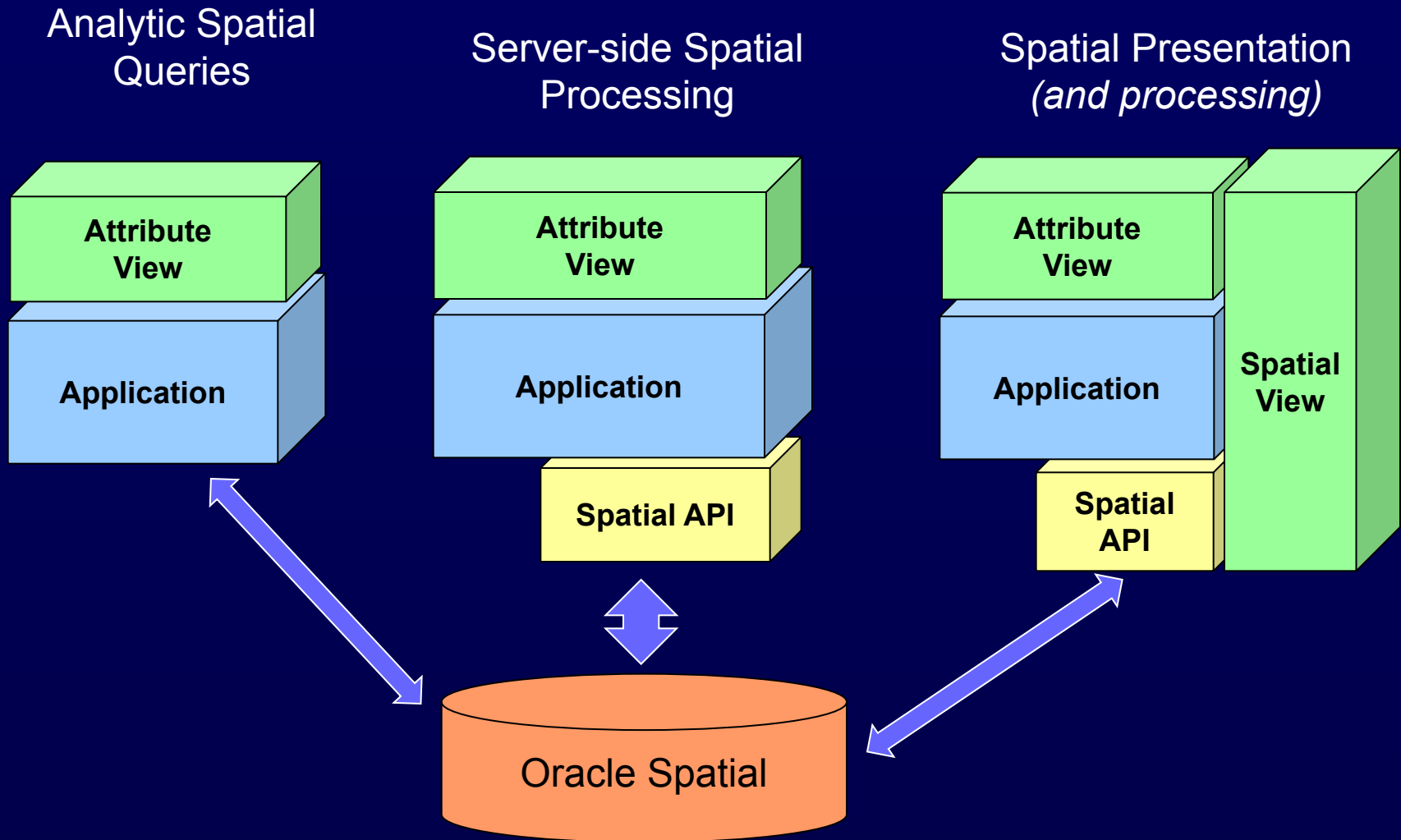
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Spatial Application Architectures



Spatial Tools - Web Presentation

- Commercial

- Oracle MapViewer, ESRI ArcIMS (via SDE), AutoDesk MapGuide, etc.

- Open-Source

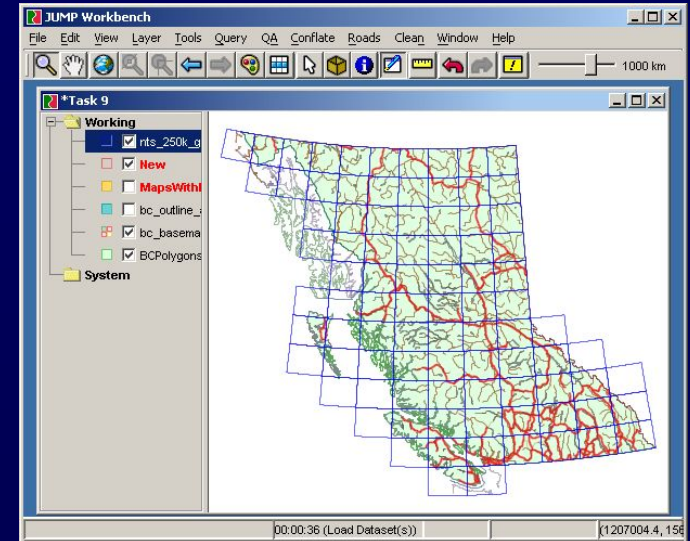
- Minnesota MapServer
- GeoServer

- Also need a Web spatial application framework

- IMF (*BC Gov & Moxie Media*), Chameleon, etc.
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Spatial Tools - Desktop Client

- Commercial
 - ESRI ArcGIS (via ArcSDE)
 - Intergraph GeoMedia
 - Autodesk, Manifold, Smallworld, etc
- Open Source
 - JUMP (*Vivid Solutions*)
 - uDig (*Refractions Research*)
 - Etc.

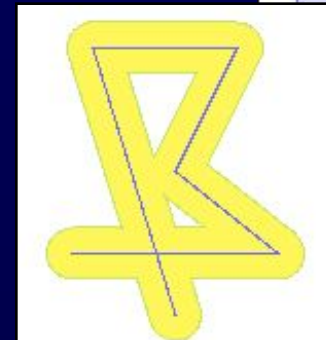
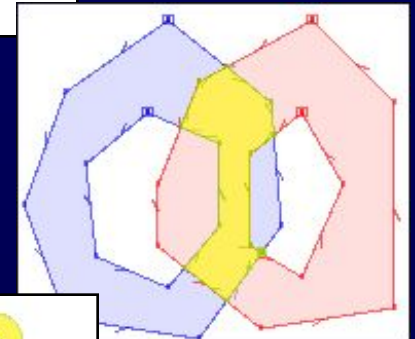
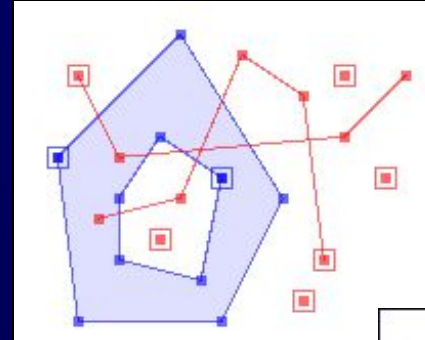


Other Tools

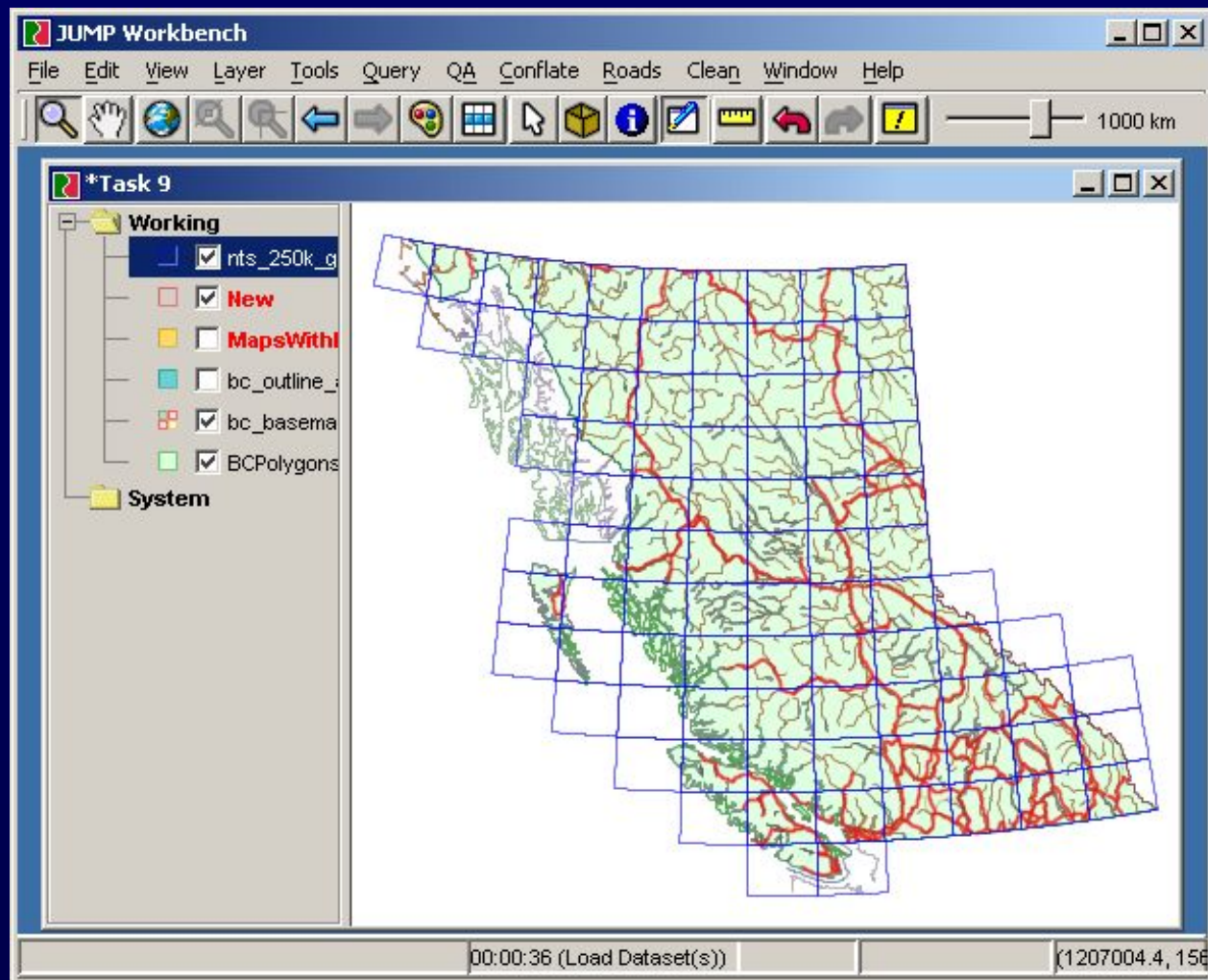
- Standard Oracle development tools
 - ETL (Extract-Transform-Load)
 - FME (*Safe Software*)
 - JUMP
 - GeoTools
 - Spatial APIs
 - Oracle Java API
 - JTS Topology Suite (*Vivid Solutions*)
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JTS Topology Suite Spatial API

- **Geometry model**
 - Points/Lines/Polygons
- **Spatial predicates**
 - Intersects, contains, overlaps, etc.
- **Spatial Metrics**
 - area, length, distance
- **Spatial Analysis functions**
 - Intersection, union, difference, symmetricDifference
 - Buffer
 - centroid, interior point
 - simplification
- **Topology Building**
 - Polygonization, Line Merging
- **Linear Referencing**
- **I/O**
 - Well-Known Text, Well-Known Binary



Demo: Oracle Spatial via JUMP



Conclusion

- Spatial Data has gone mainstream!
 - Spatial databases make it easier to manage spatial data and integrate it with other enterprise applications.
 - “Middleware” is no longer required
 - Oracle Spatial is a mature product which provides a full set of spatial functionality
 - There are many tools for development and visualization for Oracle Spatial
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