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Oracle Spatial Technology: Enabling Location Analysis in Oracle

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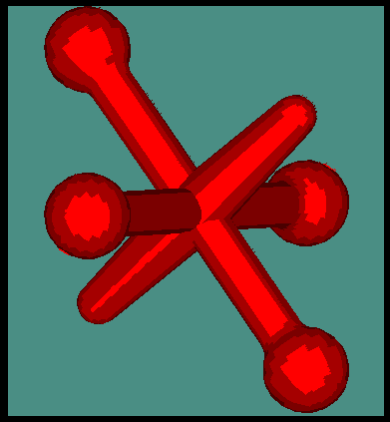
Overview

- Introduction
- Oracle Spatial: An Overview
- New Features in 10*g*
- Oracle Spatial in Action

What is Spatial Data?

GIS (mapping) data

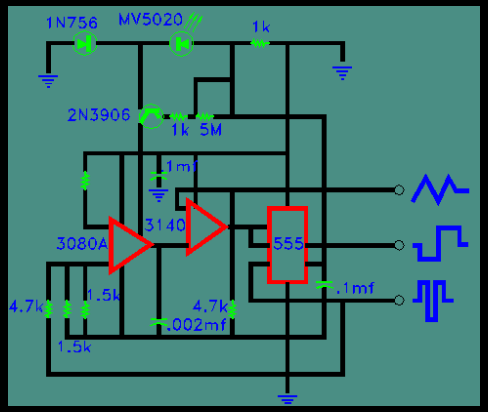
CAD data



Address data

1 WTC, New York: Geocode to obtain Spatial location

Points of Interest



CAM data

In General

85% of Customer Data has a ***Spatial*** *component e.g. zipcode, City, state*

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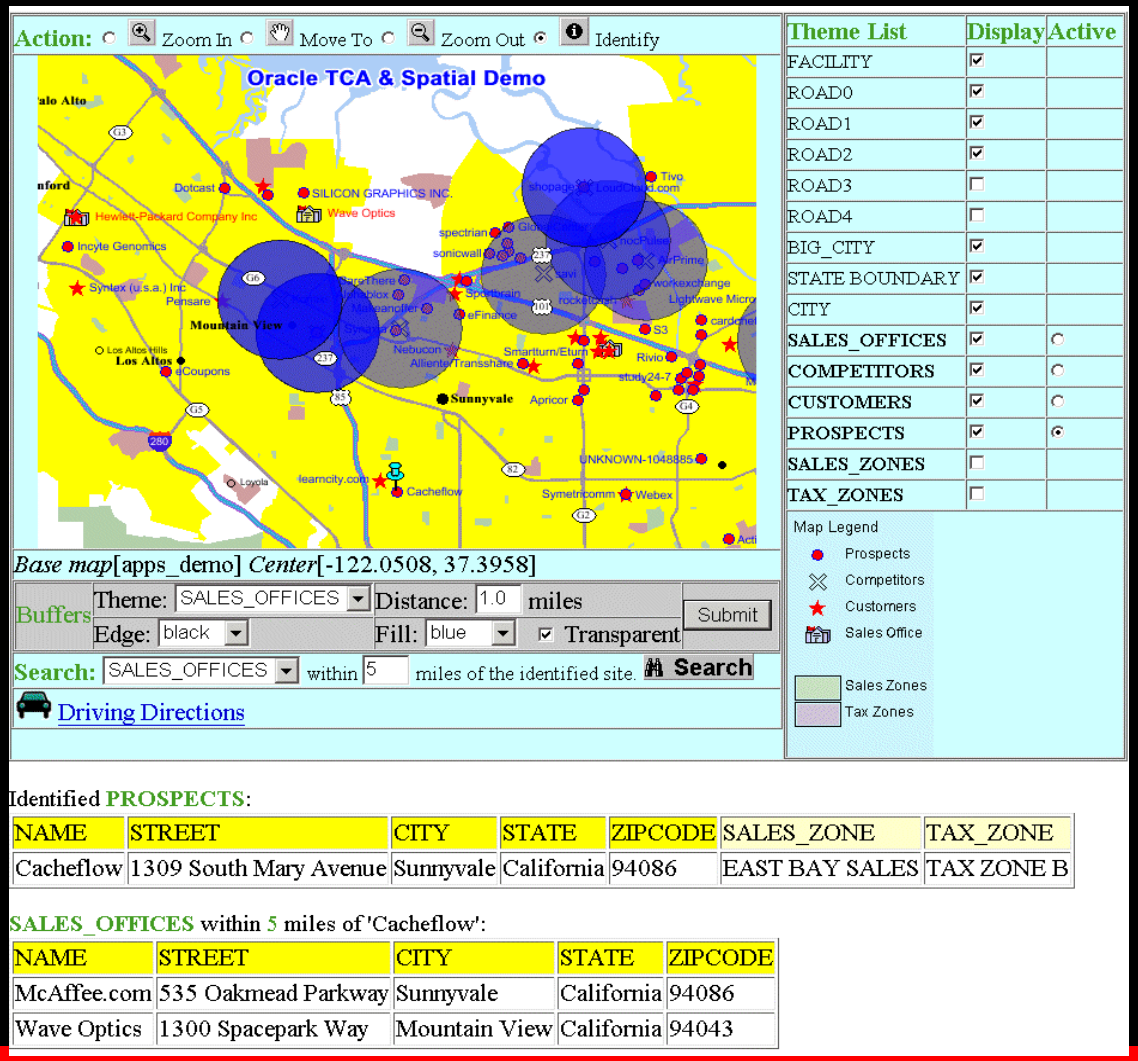
Integrating Spatial & eBusiness



Identified **PROSPECTS**:

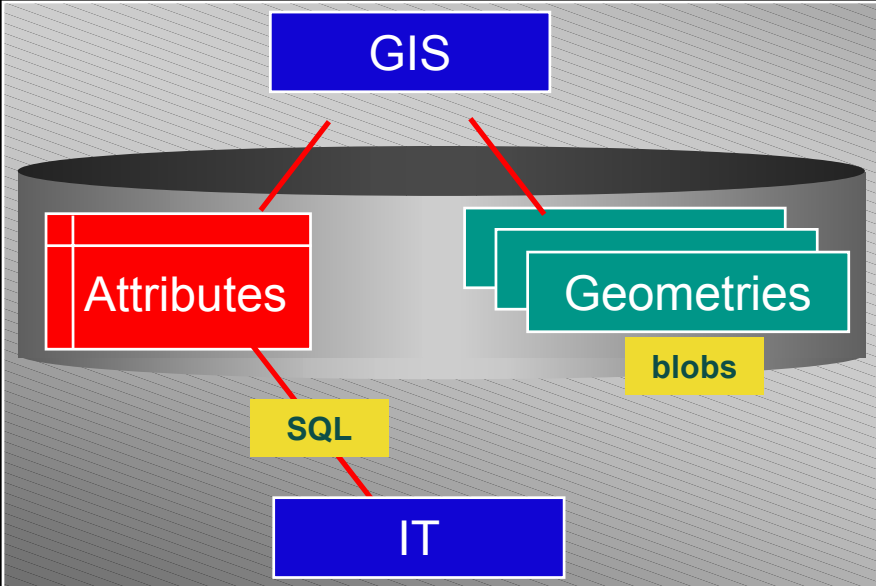
NAME	STREET	CITY	STATE	ZIPCODE	SALES_ZONE	TAX_ZONE
Cacheflow	1309 South Mary Avenue	Sunnyvale	California	94086	EAST BAY SALES	TAX ZONE B

SALES_OFFICES within 5 miles of 'Cacheflow':

NAME	STREET	CITY	STATE	ZIPCODE
McAffee.com	535 Oakmead Parkway	Sunnyvale	California	94086
Wave Optics	1300 Spacepark Way	Mountain View	California	94043

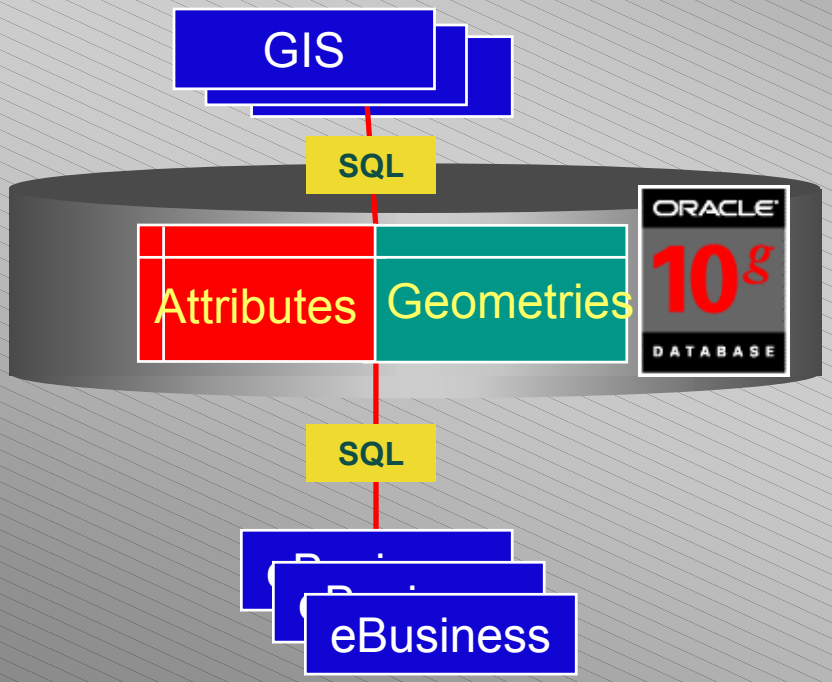
- Location adds significant value providing graphical view of supply chain, assets, customers, suppliers

How to Manage Spatial Data: Early Spatial Systems - Hybrids



- Attributes in database
- Geometries in database - but in proprietary binary format
- IT can access geometries via proprietaty interfaces only
- Poor integration

Open Spatial Databases: Oracle Spatial



- 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

Oracle Stack is Spatially Enabled

3rd party GIS Tools

Mobile & Wireless

Design Tools

JDeveloper Tools

ERP Applications

XML Database

CRM Applications

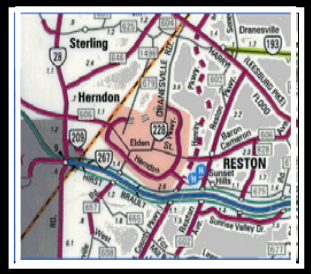
Business Intelligence

A Spatially-enabled Database

Oracle Spatial: Overview

Spatial Data Analysis, Mapviewer

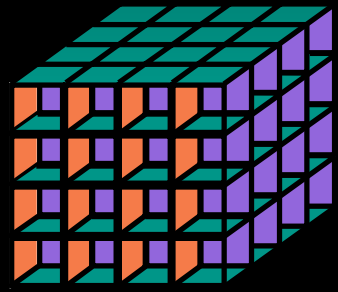
Spatial Data Types



All Spatial Data
Stored in the Database

Oracle10*g* Spatial

Spatial Indexing



Fast Access to
Spatial Data

Spatial Access Through SQL

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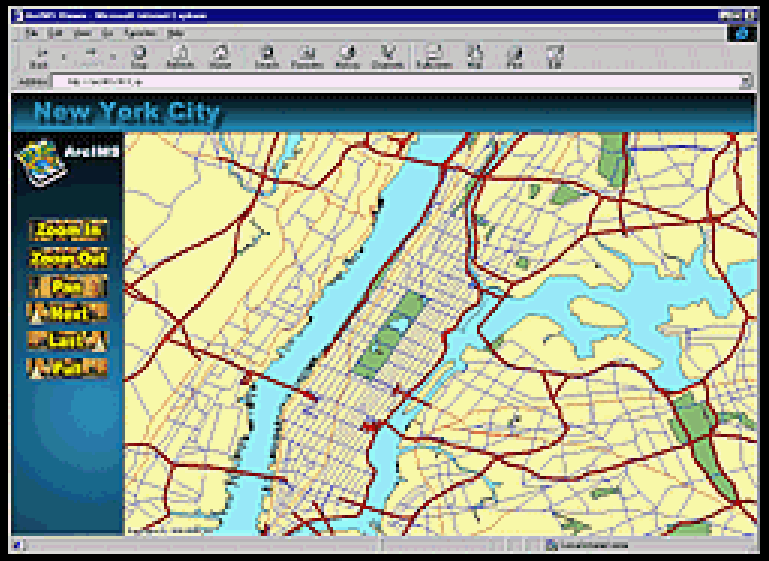
Storing Spatial Data in Oracle



Roads Table

ROAD_ID	NAME	SURFACE	LANES	LOCATION
1	Pine Cir.	Asphalt	4	
2	2nd St.	Asphalt	2	
3	3rd St.	Asphalt	2	

Example

```
SQL> CREATE TABLE roads (
  2      name          VARCHAR2(30),
  3      surface       VARCHAR2(30),
  4      lanes         NUMBER,
  5      location      MDSYS.SDO_GEOMETRY);
```

```
SQL> CREATE TABLE hospitals (
  2      name          VARCHAR2(30),
  3      location      MDSYS.SDO_GEOMETRY);
```

SDO_GEOMETRY Type

SDO_GTYPE	NUMBER
SDO_SRID	NUMBER
SDO_POINT	SDO_POINT_TYPE
SDO_ELEM_INFO	SDO_ELEM_INFO_ARRAY
SDO_ORDINATES	SDO_ORDINATE_ARRAY

- SDO_GTYPE: Type of geometry
  - Point (2001), Line (2002), Polygon (2003), Collection (2004), ...
- SDO_SRID: Coordinate System for Data
  - Geodetic, Projected, or Non-Earth

SDO_GEOMETRY Type

- SDO_POINT of type SDO_POINT_TYPE:
  - Attributes: X, Y, Z: Number
  - Specifies a point geometry
- SDO_ELEM_INFO, SDO_ORDINATES: Varray of Numbers
  - Varray of NUMBERs
  - Specify a ***non-point*** geometry
  - SDO_ORDINATES: stores ordinates
  - SDO_ELEM_INFO: interpret ordinates

Insertion in Spatial Tables

```
SQL> INSERT INTO hospitals  values(
  'St. John Hospital',
  SDO_GEOMETRY(2001, NULL,
     SDO_POINT_TYPE(-78, 37, NULL),
     NULL, NULL));
```

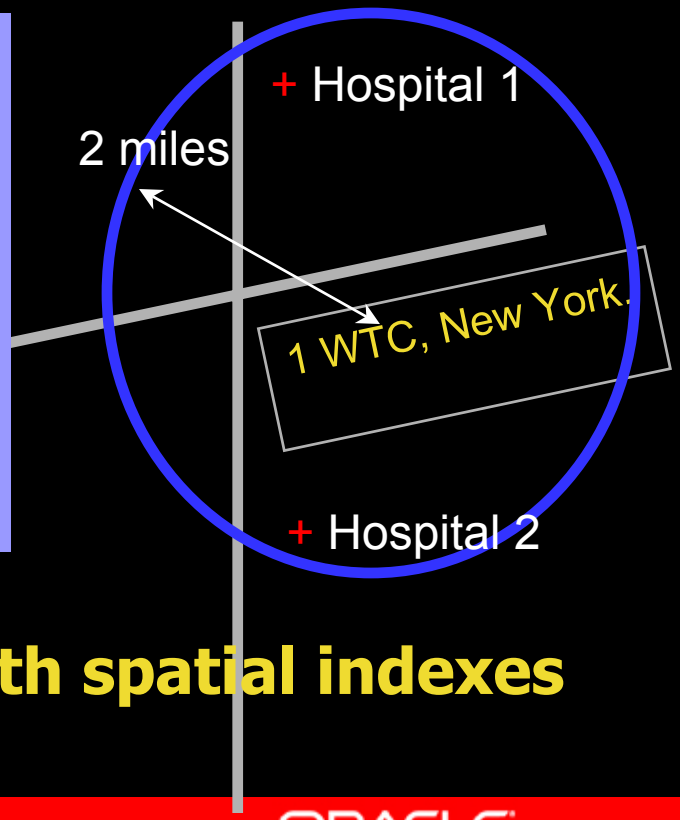
Data type

Geographic coordinates

Queries on Location in 10g

Find hospitals within 2-miles of World Trade Center

```
SQL> SELECT P.Name, P.Address
  2>   FROM Hospitals P,
  3>  Address_Master A
  4>  WHERE
  5>  A.St_Address='1 World Trade Center'
  6>   and A.City = 'New York'
  7>    AND MDSYS.SDO_WITHIN_DISTANCE(
  8>          A.Location, P.Location,
  9>          'distance=2') = 'TRUE';
```



Location queries answered fast with spatial indexes

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Indexes on Spatial Tables

```
SQL> CREATE INDEX hosp_sidx on
     hospitals(location)
     indextype is mdsys.spatial_index;
```

- Spatial index is Oracle's R-tree
- Implemented using Oracle Extensibility
- Parallel Index Creation: Performance
- Partitioned Indexes on Partitioned Tables
  - Manageability, Scalability, Performance
- Supports a variety of spatial queries (*operators*)

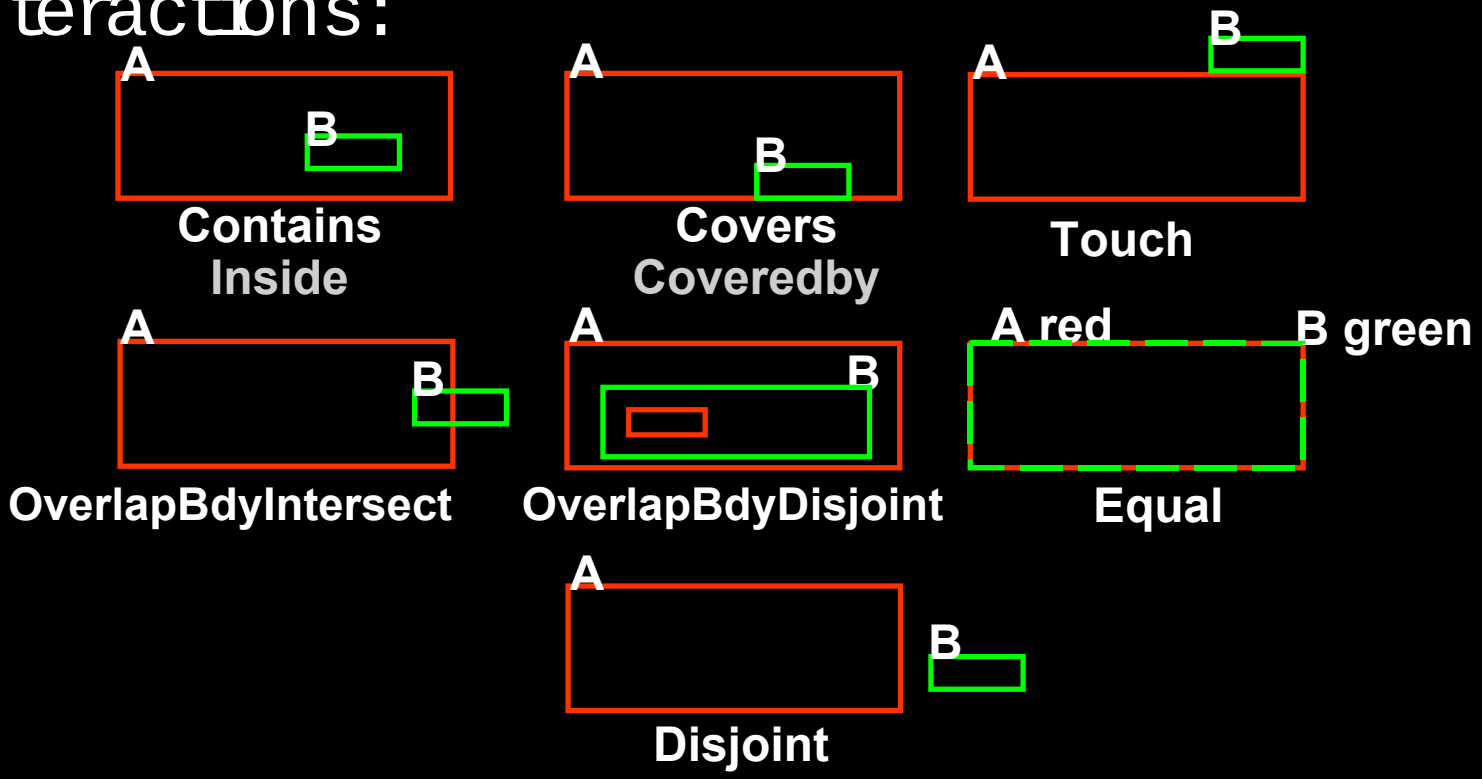
Spatial Query Operators

- SDO_WITHIN_DISTANCE:
- SDO_NN: Nearest neighbor
  - Find nearest hospital to World Trade Center

```
SQL> SELECT P.Name, P.Address
  2>   FROM Hospitals P,
  3>  Address_Master A
  4>  WHERE
  5>  A.St_Address='1 World Trade Center'
  6>   and A.City = 'New York'
  7>    AND MDSYS.SDO_NN(
  8>          A.Location, P.Location)
  9>           = 'TRUE' and rownum<=1;
```

Spatial Query Operators (contd.)

- SDO_RELATE: Find table rows (A) that interact with query geometry (B)
- Interactions:



Spatial Analysis Functions (non-index based)

- Metric Functions
  - AREA, LENGTH, DISTANCE
  - E.g., select sdo_area(geom) from dual;
- Set Functions
  - Union, Intersection, Difference, XOR
- Analysis Functions
  - Buffer, Centroid, Convex Hull
- Aggregate Functions
  - similar to SQL aggregates (sum, avg, etc)
  - aggregate unions, centroid, etc.

Oracle10*g* Location Features

Locator

- Points, lines, polys
- 2D, 3D, 4D data
- Spatial Operators
  - Within-distance
  - Spatial Relations
- Coordinate Systems
- Long Transactions Table Partitioning*
- Object Replication*
- Oracle10*g* Standard & Enterprise

Spatial

- All Locator features
- Linear Referencing
- Spatial Aggregates
- Coordinate Transforms
- `Network Data Model`
- `Topology Data Model`
- `GeoRaster`
- Geocoder
- `Spatial Analytic Functions` Oracle10*g* Enterprise Option Only

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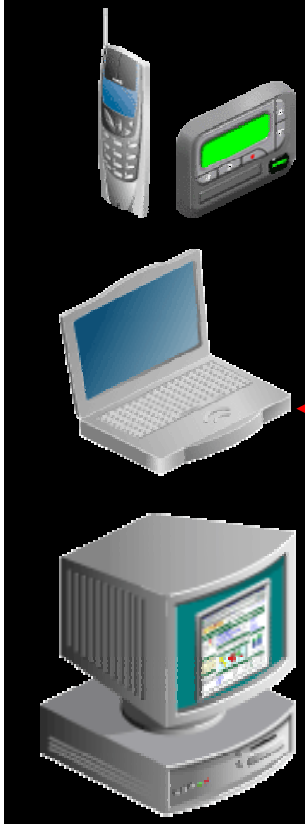
* Available on Enterprise Edition Only

Location-enabling Oracle Stack



Any device

CRM & ERP Applications

TCA schema | Field Service

e-Business Suite

Application Server

Location Base Service Components

9iAS | MapViewer

Data Server

Spatial | Locator

Oracle9i

SOAP
WSDL

Web Services

B2B, B2E, B2C

eLocation

Oracle Location Technology

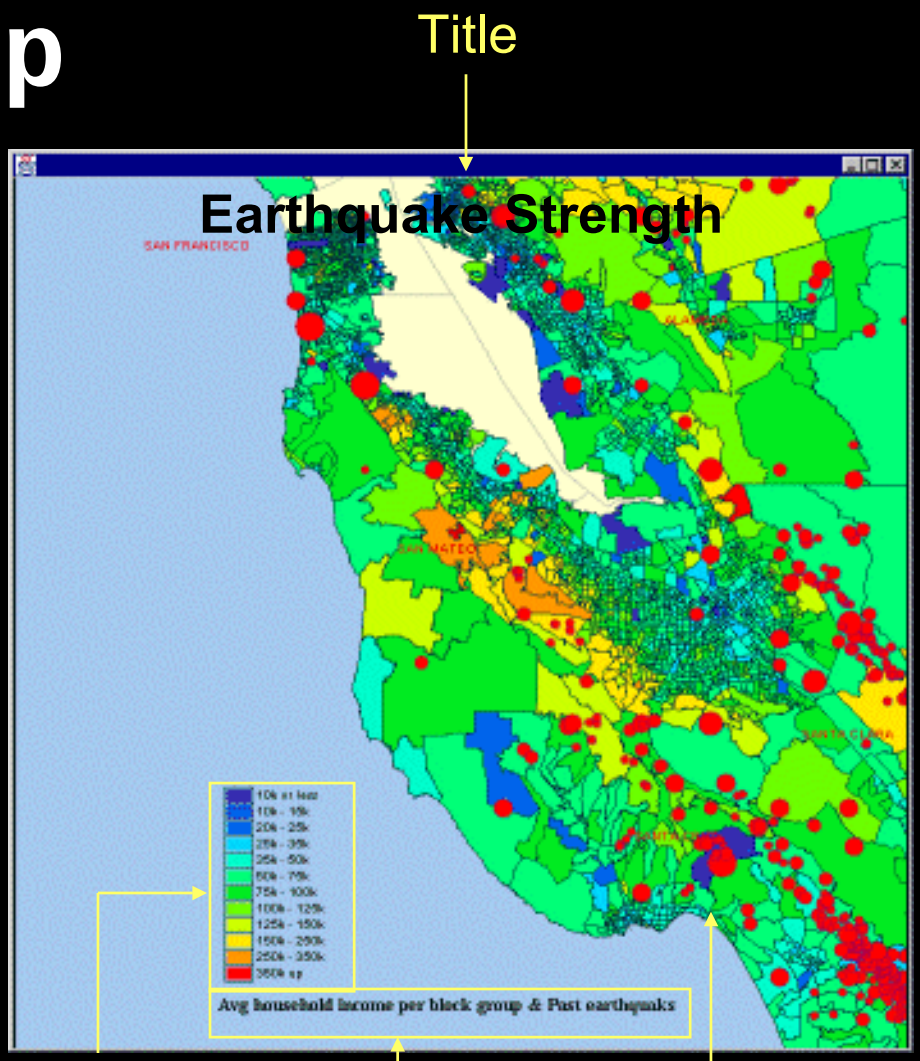
Oracle core technologies

Oracle ApplicationServer 10*g* MapViewer

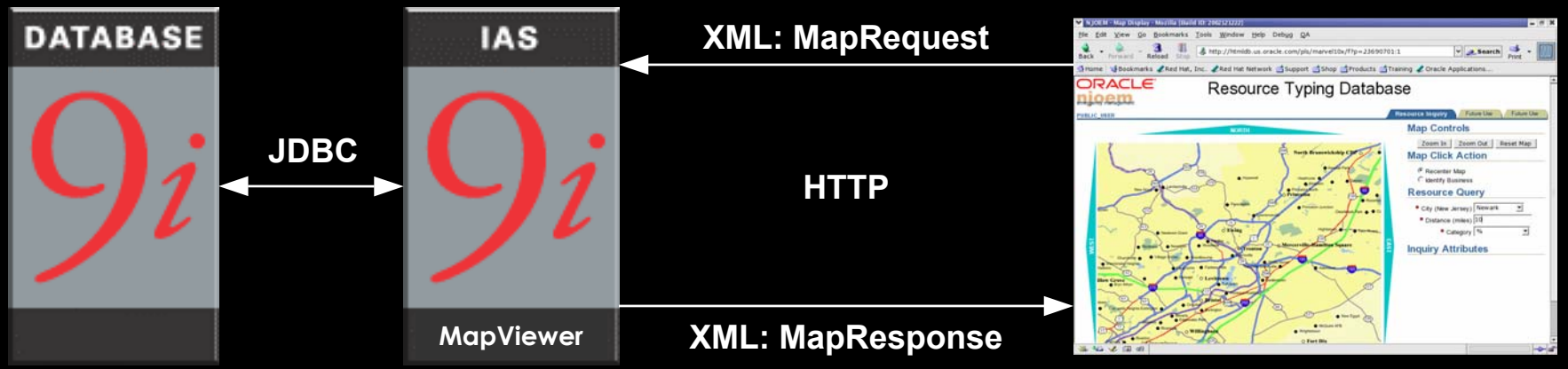
- Standard component of Oracle ApplicationServer 10*g*
- 100% J2EE compliant Mapping engine
- Tightly integrated with Oracle Locator and Oracle Spatial
- Provides an XML API for defining and deploying maps via the web
- Renders data from Oracle8i R3 and beyond

MapViewer: Map

- Renders data stored using Oracle's native spatial data type (SDO_GEOMETRY)
- Maps are defined as a collection of themes
- Maps may contain a title, legend and footnote
- Theme styles can be based on attribute values (thematic maps)
- GIF, BMP and PNG image formats



MapViewer Architecture



New Features in Oracle Spatial 10*g*

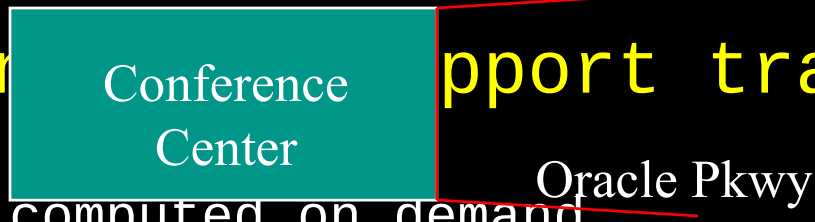
- Network Data Model
- Topology Data Model
- GeoRaster
- Geocoder
- Spatial Analytic Functions

10*g*: 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
- Routing Engine
  - Street navigation for single or multiple destinations
  - Provide network analysis functionality in the database
- Supports network solutions (Tracin
  Routing)
  - Transportation and Transit Solutions
  - Field Service, Logistics
  - Location based Services and Telematic

10*g*: Topology Data Model

- New data model to store ***persistent*** topology
  - Easier to do data consistency checks 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
- 10*g* contin pport transient topology
  - Topology computed on demand



10*g*: GeoRaster

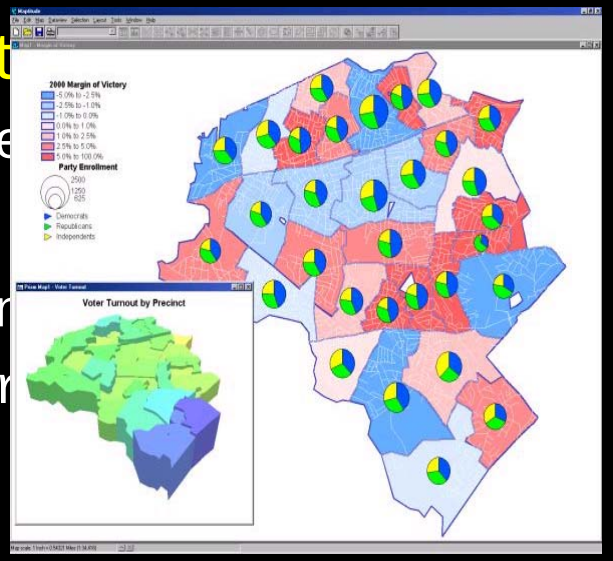
- What is GeoRaster
  - A new data type to store raster dat
    - Satellite images, remote
  - An XML schema to store Metadata
    - Data source, layer information
  - Geo Referencing information
    - How to relate a pixel in the image to a longitude/latitude on Earth's surface
- Functionality
  - Open, general purpose raster data model
  - storage and indexing of raster data
    - No size limit for each raster object
  - querying and analyzing raster data
  - delivering GeoRaster to external consumers
    - Publish as JPEG, GIFF images

10*g* Geocoder

- Generates latitude/longitude (points) from address
- International addressing standardization
- Formatted and unformatted addresses
- Tolerance parameters support fuzzy matching
- Record-level and batch processes
- Data provided by leading data vendors

10*g*: Spatial Analytic Functions

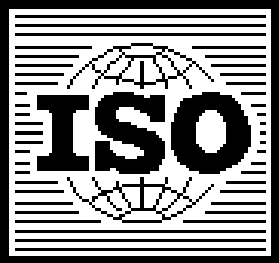
- Discovery based on Spatial Patt
  - Explicitly materialize spatial re
- Usage
  - Insurance risk analysis, crime an
  - Demographic analysis, customer pr
  - Epidemiology, Facility placement
  - Insurance Risk analysis:
    - cluster house-holds based on high risk neighborhoods
  - Identify business prospects across a region:
    - examine the average incomes across different regions of the space



Complying to Open Standards

- OGC (GML,OpenLS
- ISO TC211
- W3C Consortium (XML/Web Services)
- J2EE

SQL/MM



The Dominant Spatial Database

- National Mapping, Cadasters & Hydrographic Agencies
  - NIMA, USGS, US Army, Ordnance Survey (UK, IR, NI), Denmark, Sweden, The Netherlands, Poland, Australia
- Transportation Management
  - California, Iowa, Florida, Maine, Maryland, Minnesota, New York, Oklahoma, Pennsylvania, Alabama, Alberta, London Rail, Netherlands Transport, Australia, Austrian Rail, German Rail
- Telco & Wireless LBS
  - AT&T, Bell South, Cingular, DoCoMo, KDDI, Intrado, JPhone, Nextel, Sprint, T-Mobile, Telkom, Telenor, Telstra, Telus, Telia, Cellcom, Verizon, VIAG, Vodaphone, Wind
- Utilities
  - Omaha Public Power, Reliant, US DoE, Western Power Corp, Severn Trent, Bejing Power, Czech Telem, Copenhagen Energy, Electrable, Gaz de France, Hydro-Quebec, Equitable Resources, Nova Naturgas, Sao Paulo Electric,
- Local Authorities
  - New York City, Chicago, Los Angeles, San Jose, San Mateo, Washington DC, Cleveland, Detroit, Phoenix, Winnipeg, Vancouver, Edmonton, Stockholm…

Oracle Spatial in Action

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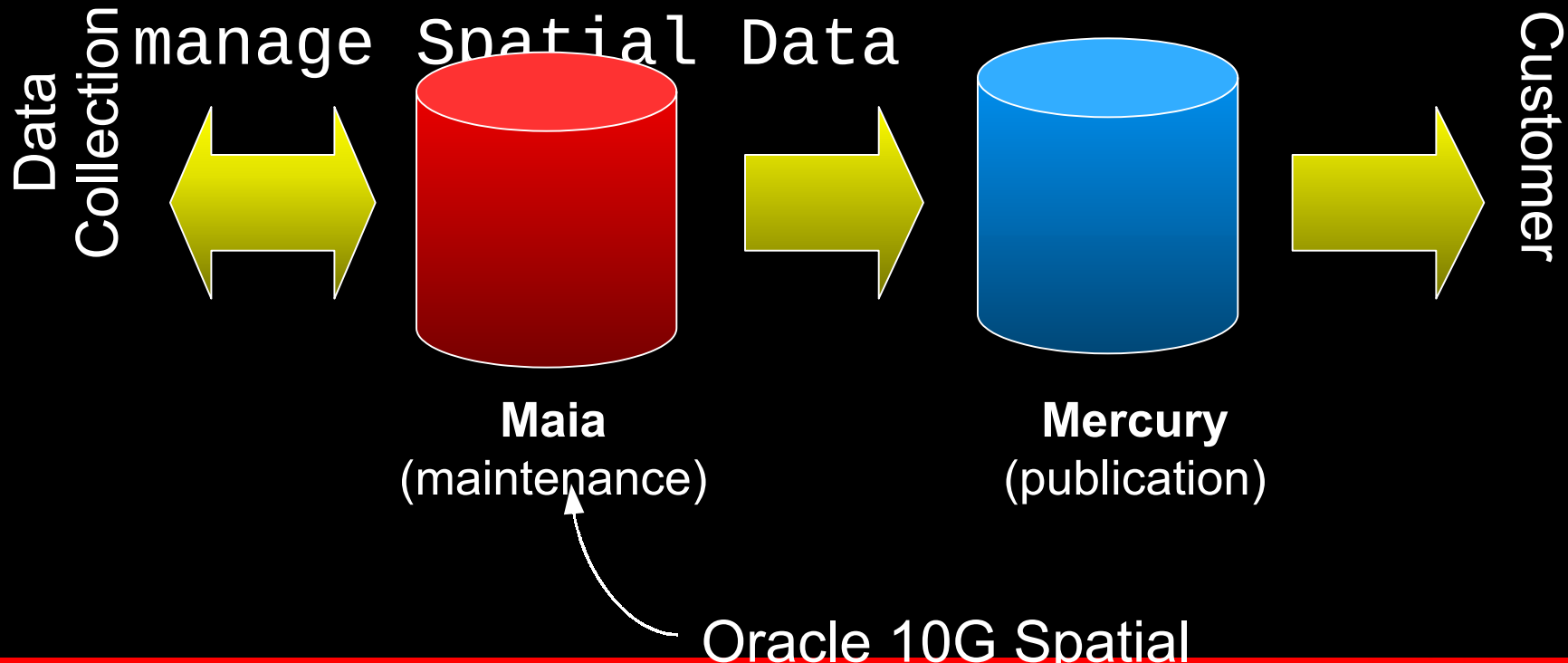
Ordnance Survey, UK

- Captures data: Surveying
- Migrates (partially) from *Complex Systems* to *Oracle* (and Spatial) to manage Spatial Data

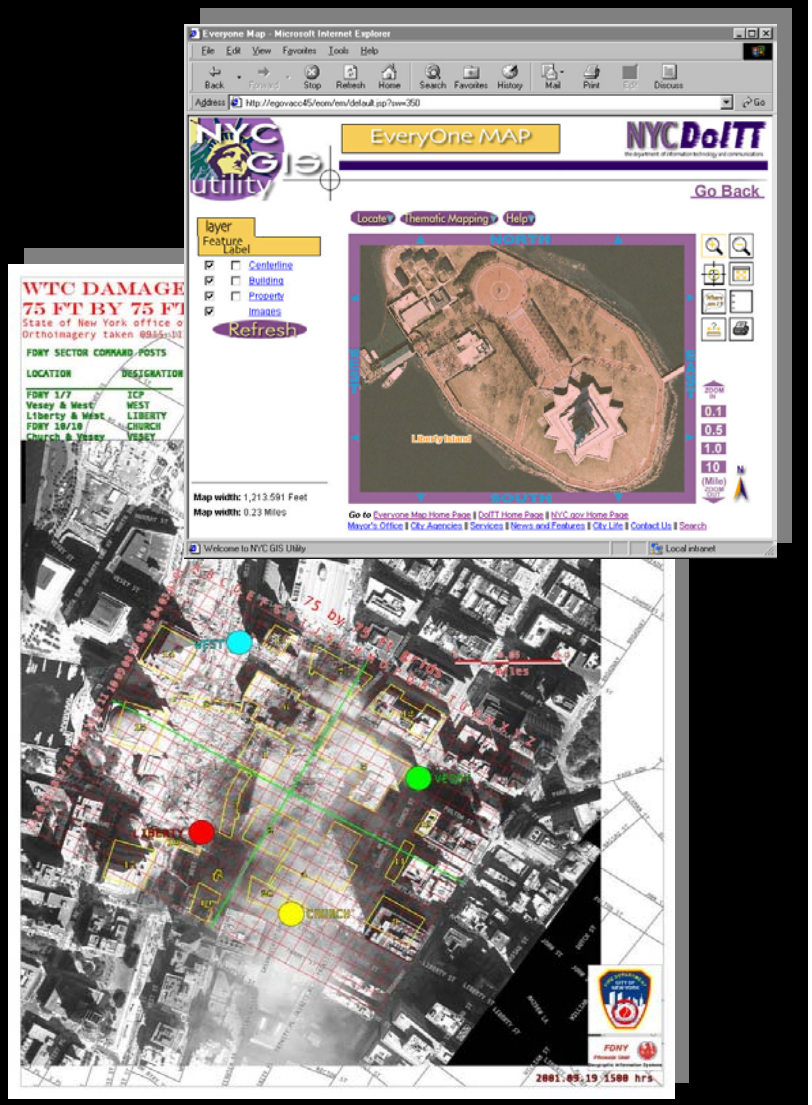


OS Summary

- 450M features, 1TB Data
- Robustness, reliability, scalability, availability
- Expect financial and strategic gains from the move to Commercial Off-The-Shelf software (Oracle and ESRI)

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
- The Office of Emergency Management created a public site for emergency preparedness
  - **Extensively Used To Support**



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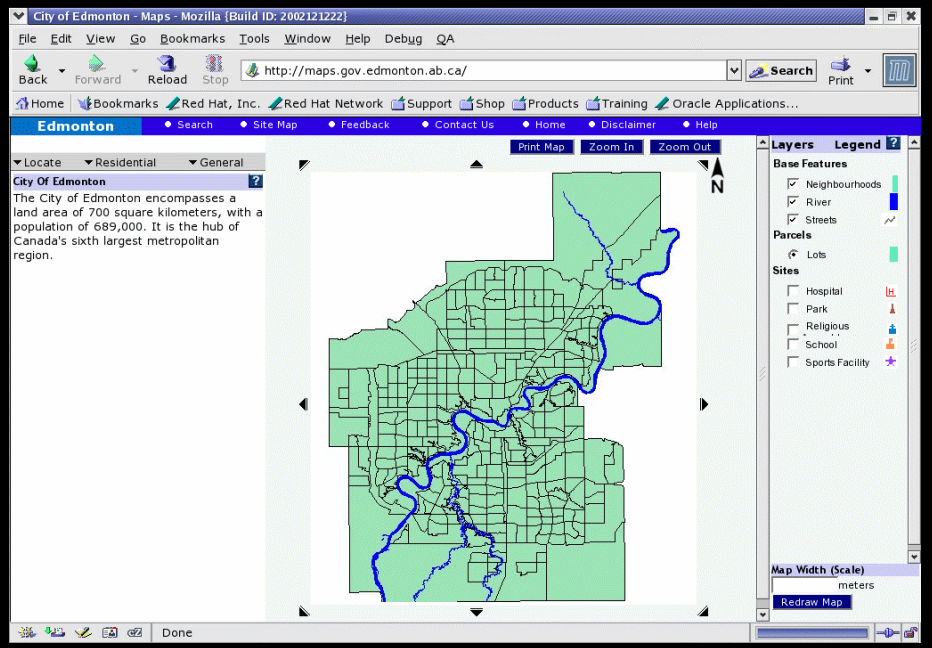
Oracle in Action:

- The consolidated spatial data warehouse was the foundation for NYC's response to the recent tragedies
  - First responder deployment
  - Critical infrastructure management
  - Road closures
  - Evacuation areas
  - Damage assessment
- The Office of Emergency Management created a public site for emergency preparedness
  - Hurricane flood risks and evacuation routes
  - Heat Advisory "cool down locator" (pools, senior centers, community centers)
- Department of Health uses the system to track instances of West Nile Virus

City of Edmonton

- Integrated, central repository for spatial and relational data
  - Replaced 49 disparate land apps &166 databases
  - Citywide sharing of standardized data
- Data feeds: land registry and surveys, utilities and phone co., tax assessments, Dept. of Public Works
- Users: engineers, planners, cartographers, city officials and departments, mortgage lenders, citizens



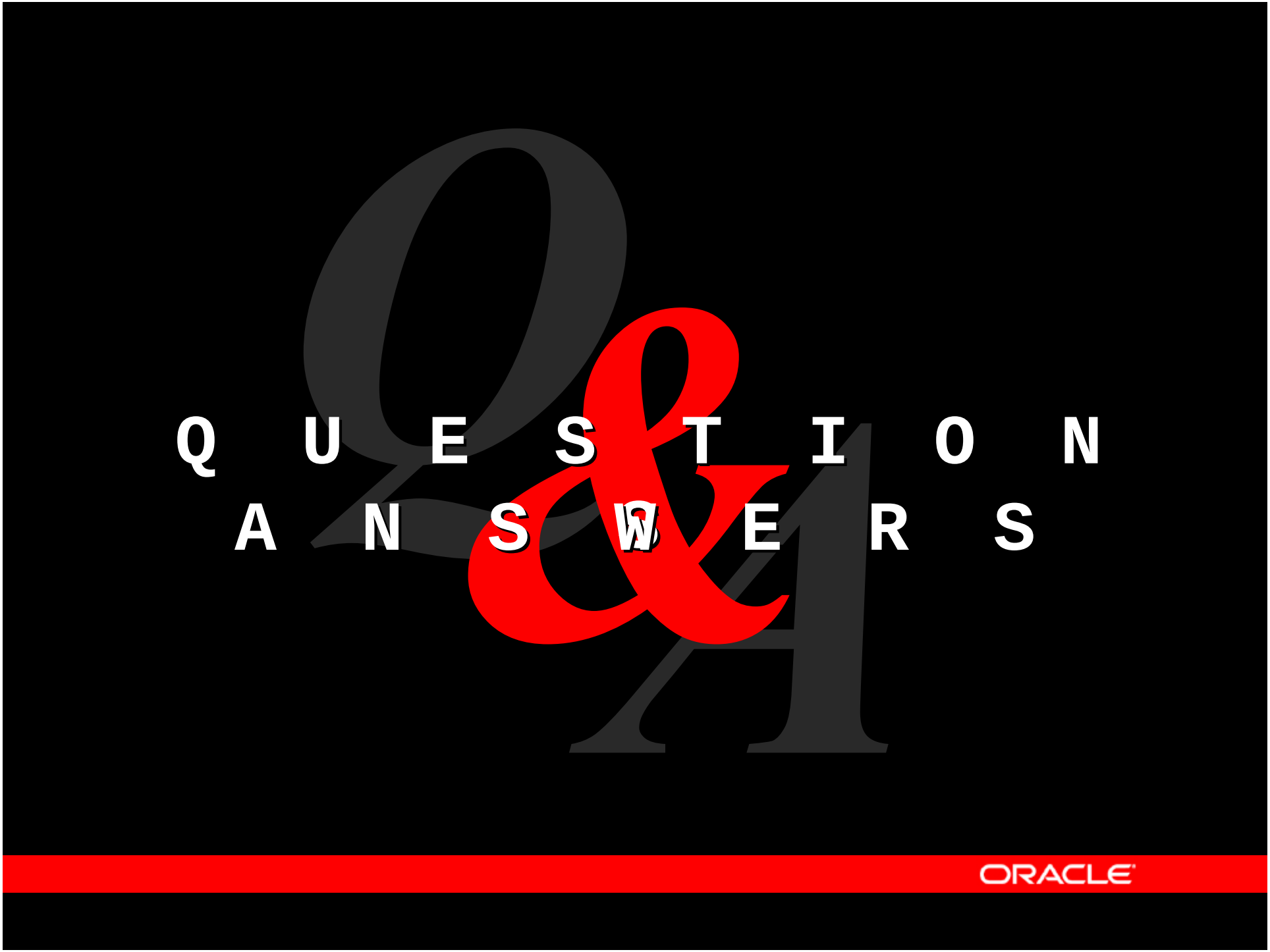
Oracle Spatial Technology: Summary

- An open repository for Geospatial data
- Integrate location & Business data in RDBMS
- Industry standard for Spatial data in RDBMS
- Robustness, reliability, scalability, availability
  - Support Terabytes of Data, 1000s of Users
- Security and Reliability
- Short & Long Transaction Management

What the Analysts are Saying about Oracle Spatial…

"In repeated surveys, IDC has found that Oracle is used in an 80%-90% share of Spatial Information Management oriented database installations."

IDC, December 2002


QUESTION
&
ANSWERS
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