

# Geospatial Technology Innovations and Convergence

## Processing Big and Fast Data: Best with a Multi-Model Database

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August, 2015

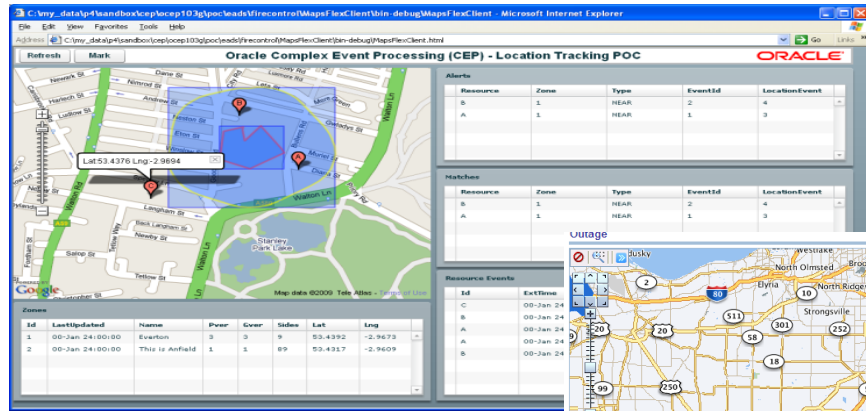
# Data Volume & Variety Explosion Continues -Terabytes, Petabytes, Exabytes, Zettabytes



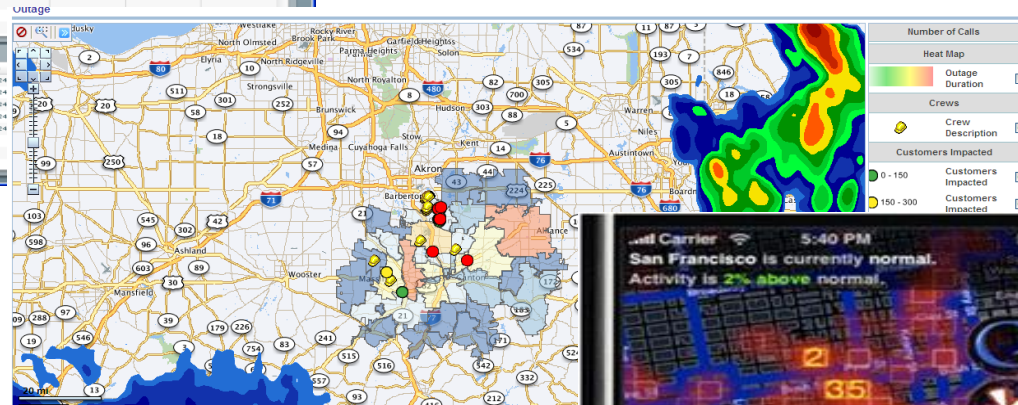
- Sensors, RFID, LIDAR, Raster, 3D, Terrain and City Models, SDIs
- New data products for consumers, mobility, defense, intelligence, land and water mgmt, transportation, environment, agriculture, and constituent services
- Terrain Models and 3D for planning, maintenance, emergency response, tourism
- Tagged Data , Semantics , Ontologies -- Location is a Powerful Organizing Principle
- Integrate Social Media (Video, Audio, Text, Wikis, Facebook, Imagery) with Spatial, Graph Databases
- Wearable Technologies

# Data Velocity: Spatially-aware Real-Time Streams / Events / Sensors / “Internet of Things”

Track / Monitor Moving Objects – Cars, UAVs



Real-Time Business Intelligence



Real-Time Pattern Detection

– Ultra-high throughput (1 million/sec++) and microsecond latency

– Filtering, correlation, and aggregation across event sources

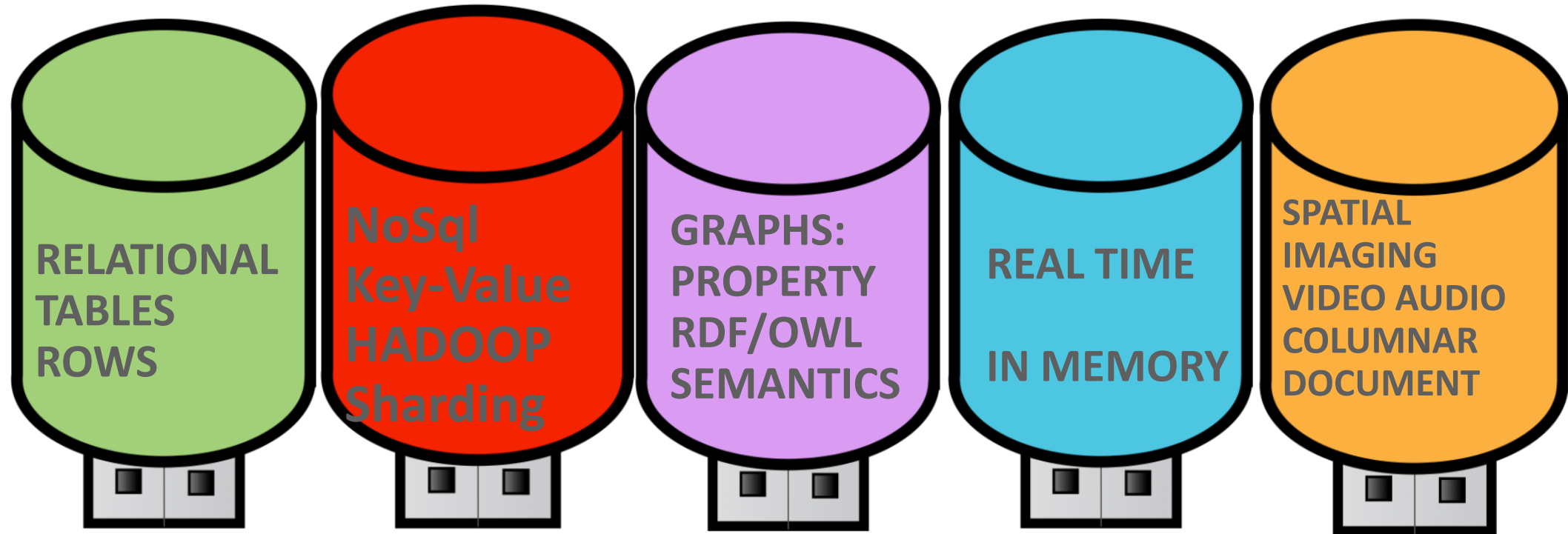
– Detect patterns in the flow of events and message payloads, CEP

– Business Intelligence in Real Time

– Self-Driving Cars

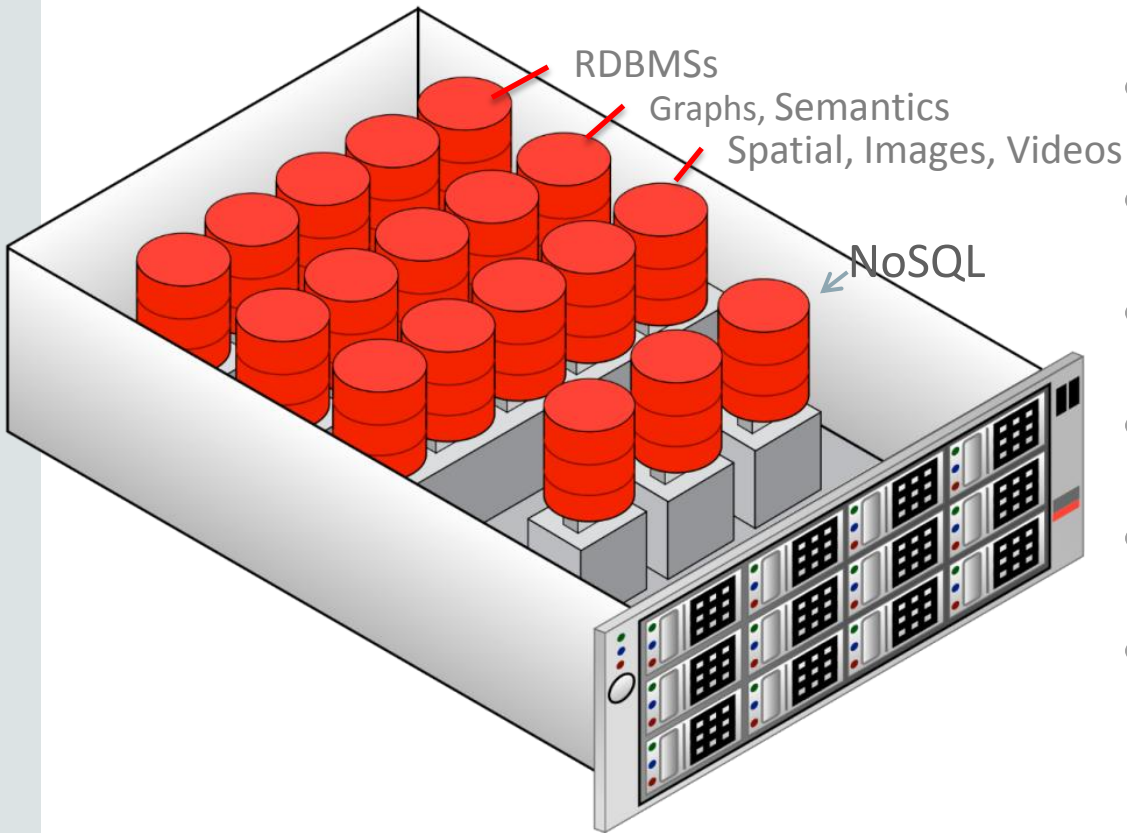
# SEVERAL POPULAR DATA MODELS – EXAMPLES

But Unique separate persistent stores results in:  
MANY databases to secure & manage



# MULTI-MODEL (POLY-MODEL) Database is Needed (Oracle has this Today)

## Many Different Data Models Supported in **ONE SHARED STORE**



- Database Server can host multiple models
- Unified Security Approach
- Highly Available
- Disaster Tolerant
- Shares Main Memory; more efficient
- Shares Disks, Flash Storage: more efficient
- Managed as a single entity: more efficient

# Oracle Multi-Model Platform and Cloud Data Platforms

One Shared Multi-Model Store or Multiple Independent Stores: *Your Choice*

Support any data type, any scale, on-premises or in the Cloud

In-Memory / Flash Based / Disk Based – Scale to Many Petabytes



## Relational Store

- Relational
- Spatial
- Graph – RDF and Property
- Document
- Real-time Analytics



## NoSQL Store

- Key-value
- Graph – RDF
- Graph - Property
- Document



## Big Data Store HADOOP, Spark

- Logs
- Streaming
- Archive
- Spatial
- Graph – RDF and Property
- Web Analytics

## Data Integration

Change Capture and Apply, ETL, and Federated SQL

# Innovation in Convergence – Mfg Platform From Many Custom to One Standardized

- HENRY FORD: 100 YEARS AGO
- Industrialized the Manufacturing Process
- Popularized the use of
  - Assembly Line in Manufacturing
- ***ONE Automated Machine Driven Platform***
  - for the entire car assembly process
  - **Used STANDARD, INTERCHANGEABLE, SHARABLE parts**
  - Lowered the priced of a car by factor of 10, in 3 years.
- His success led to widespread adoption

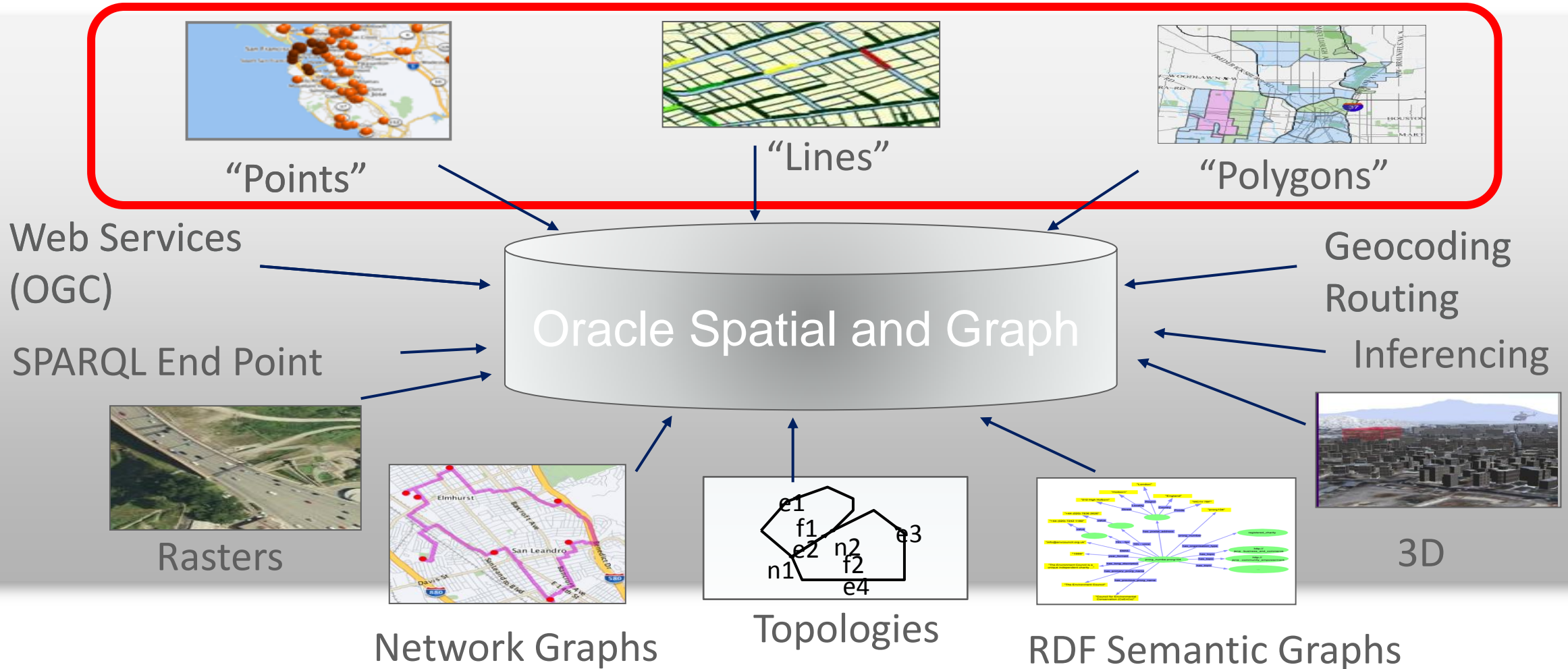
**Don't find fault,  
find a remedy.**



Henry Ford

# Oracle Spatial and Graph

Tens of Thousands of Installations





# Oracle Spatial and Graph: **Parallel Spatial Store!**

Parallel Query And Spatial Operators

Customer Performance Results – Linear Scaling!

- On Exadata Half RAC:
  - 34.75 hours serially vs. 44.1 minutes in parallel
  - 48 database cores - **47x faster**
- On Exadata Full Rack
  - 128 database cores – about **125x faster**
  - About 16.6 minutes in parallel

# Buzzwords For Apps & Workflows using *Graph Technology*: What terms to look for:

- Semantic Web
- W3C RDF/OWL/SPARQL
- Graph Data Management
- Social Network Analysis (SNA)
- Knowledge Discovery
- Knowledge Mining
- Big Data
- Property Graphs
- Taxonomy/Terminology Mgmt
- Faceted Search
- Inferencing / Reasoning
- Sentiment Analysis
- Text Mining
- NoSQL Database

# Convergence: Geospatial: one Multi-Model Store

## External Data Sources

- Transactional & Operational Systems
- Contents Repository
- Databases
- Web resources
- Blogs, Mails, news
- Satellite Imagery, UAVs



### Real-time Data Streams

### Search, Presentation, Report, Visualization, Query

Text Files \* Binary Images \* XML \* HTML \* PDF \* Excel \* Map Files \* Shape Files \* User Sessions

Tables Relationships Charts Timelines Geospatial

### Multi-Model Data Management Infrastructure

**Secured**

GeoSpatial

Historical Records

POIs

Demographics

Customer Data

Call Records

Documents

### Automatic Responses and Publishing

SMS Console Alerts

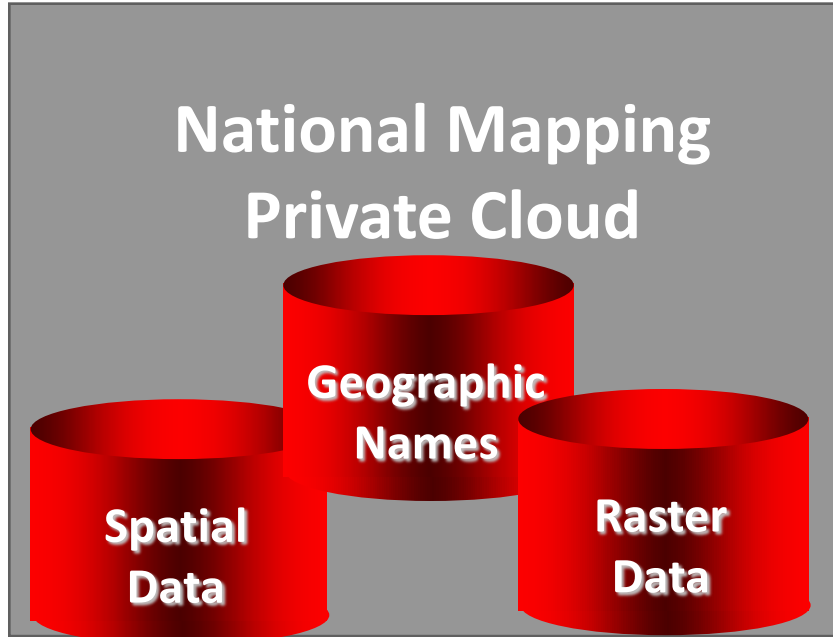
EV Grid Management

Workflow Initiation

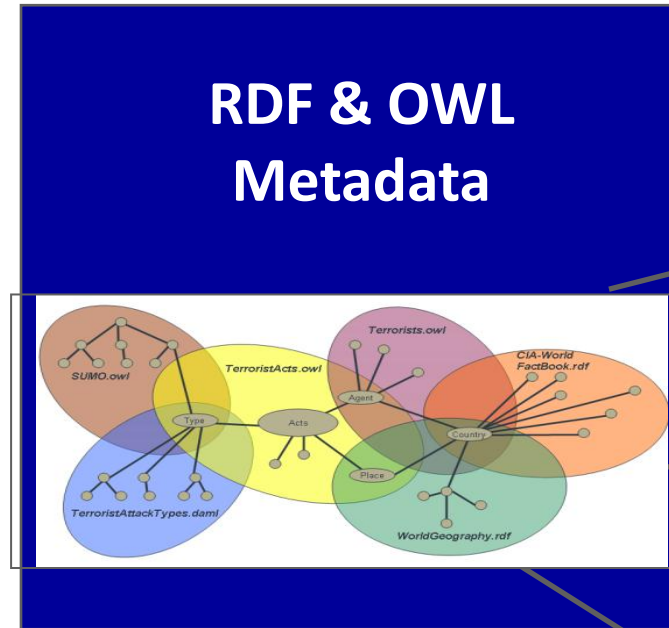
Real-time Dashboards

# Geospatial Data Repurposing: Ontology-driven Enable Shared, Actionable Knowledge

## Application Ontologies



- Simple Features
- GeoRaster
- Topology
- Networks
- Gazetteers



- Data Integration
- National Map schemas
- Geographic names
- Temporal
- Naïve Geography
- ...



Environmental Monitoring



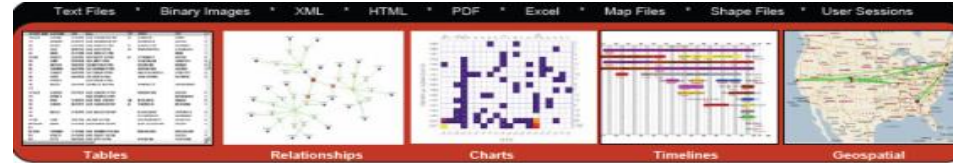
Famine Relief



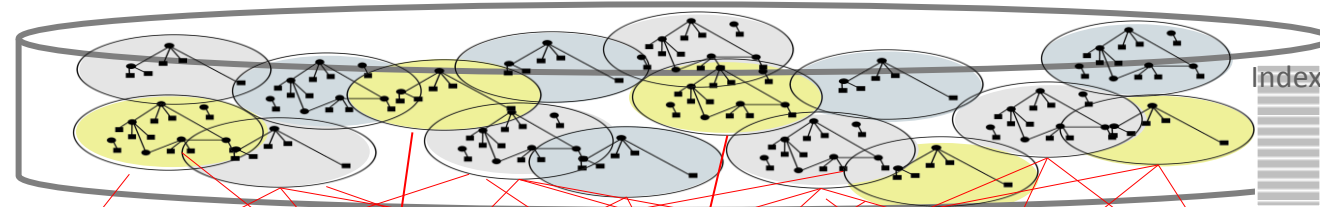
Disaster Response

# Convergence Requires Access to Different Data model Stores Either Write Custom Software or use Semantics

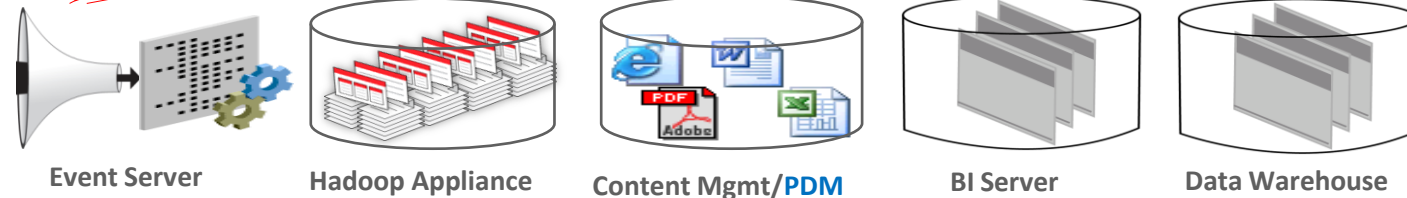
Access & Presentation Layer



Semantic Graph model



Data Servers



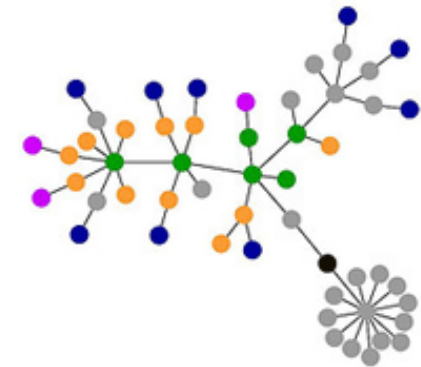
Data Sources / Types



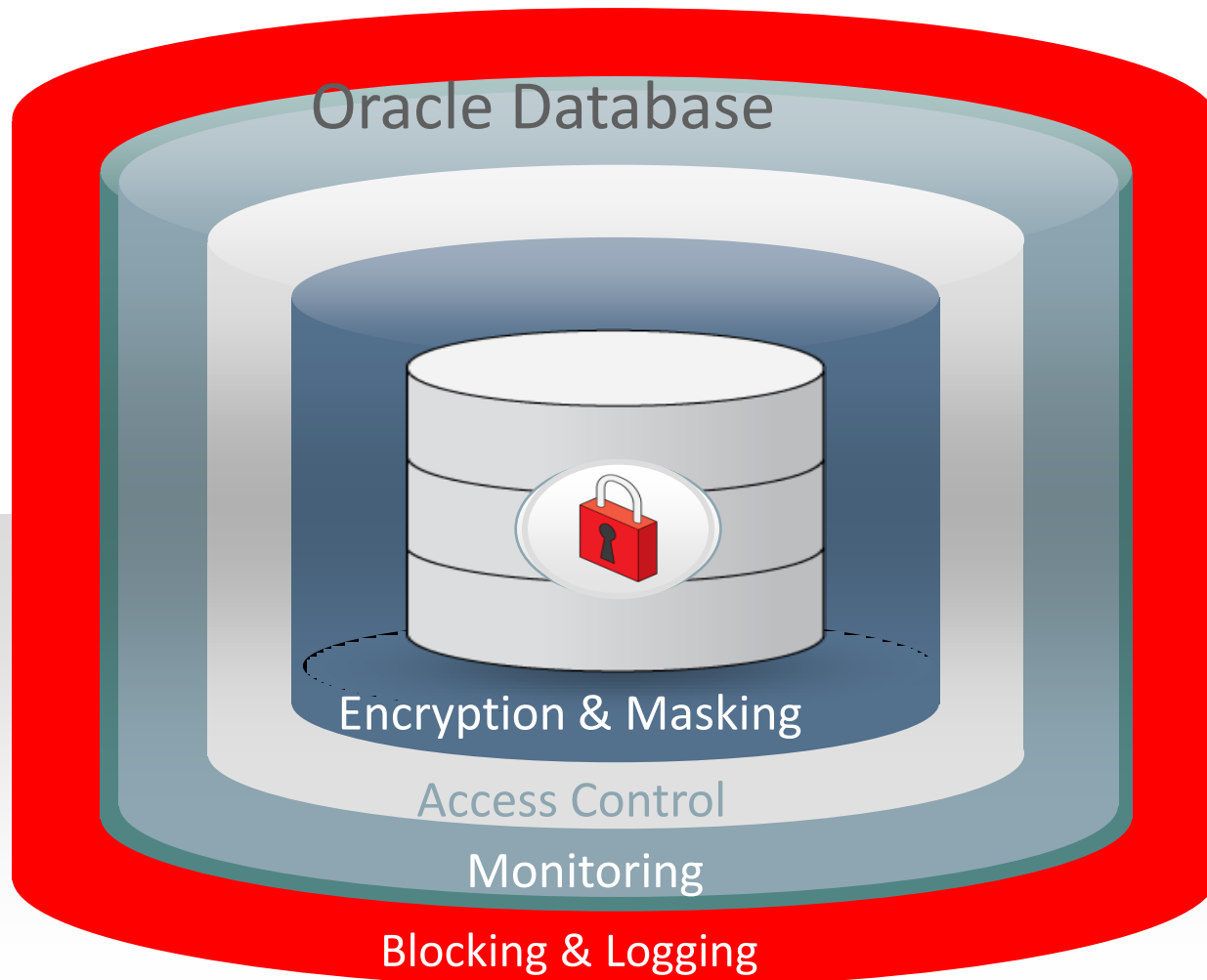
# Oracle: Linked Open Data support: on-premise or in the Cloud

## Included in Oracle Database-as-a-Service Cloud Offering

- Highly scalable, secure triple store based on **RDF**
  - **1 TRILLION TRIPLE BENCHMARK**, leading Triple Store: [W3.org](http://W3.org)
  - 1.13 million triples per second query performance
- **SPARQL and SPARQL** in SQL support
  - Apache Jena and OpenRDF Sesame pre-integrated
  - SPARQL endpoint enhanced with query control
  - **GeoSPARQL** support (classes, properties, datatypes, query functions)
- Forward-chaining based inferencing engine in the database
  - Various native rulebases (**RDFS, OWL2 RL, SKOS, ...**), integration with OWL2 reasoners (TrOWL, Pellet)
- RDB to RDF mapping on relational data aligned with RDB2RDF standard



# Convergence: **CYBERSECURITY** is Major Challenge Requires Information Security and Privacy



## Monitoring

- Configuration Management
- Audit Vault
- Total Recall

## Access Control

- Database Vault
- Label Security

## Encryption & Masking

- Advanced Security
- Secure Backup
- Data Masking

# United Nation Analysis – September 2013

## Initiative on Global GeoSpatial Information Management

### Future Trends

- Technology Trends in Data Creation, Maintenance, and Management
- Reliance on '*big data*' technologies
- The *right* information at the *right time*
- **Machine-processable descriptions of data.**
- **Semantic technologies will play an important role**
- Skills and Training: train the individuals is at least five years



## Requirement for enhanced Data Management Systems



# You Enhance Innovation & Convergence By Using **STANDARDS**

- **ISO**
  - TC 211; TC 204
- **Open Geospatial Consortium**
  - Simple Features; GML; Web Services
- **De-facto Standards**
  - SHP, MGE, DXF, KML
- **Professional Standards**
  - ISPRS, FIG, WMO
- **Java, .NET, Flash**
- **W3C: RDF, OWL, SPARQL, GeoSPARQL**
- **TAGGED METADATA – agree on tags**

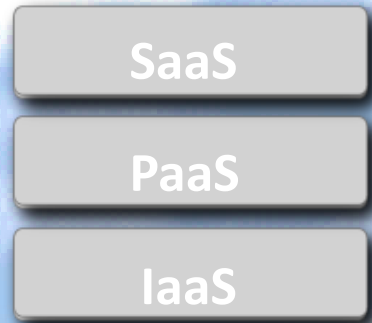


SQL3/MM Spatial

# Public Clouds, Private Clouds: Convergence Platforms

- Used by multiple tenants on a shared basis
- Hosted and managed by cloud service provider

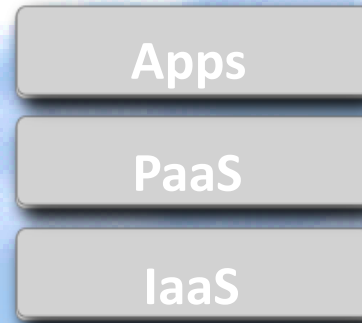
## Public Clouds



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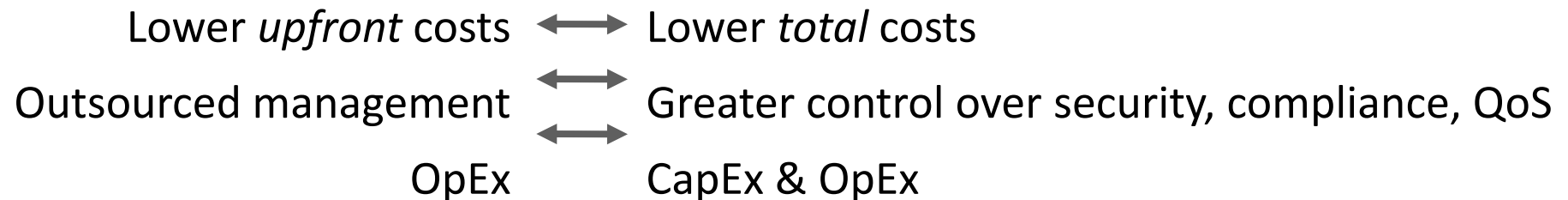
## Private Cloud



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- Exclusively used by a single organization
- Controlled and managed by in-house IT

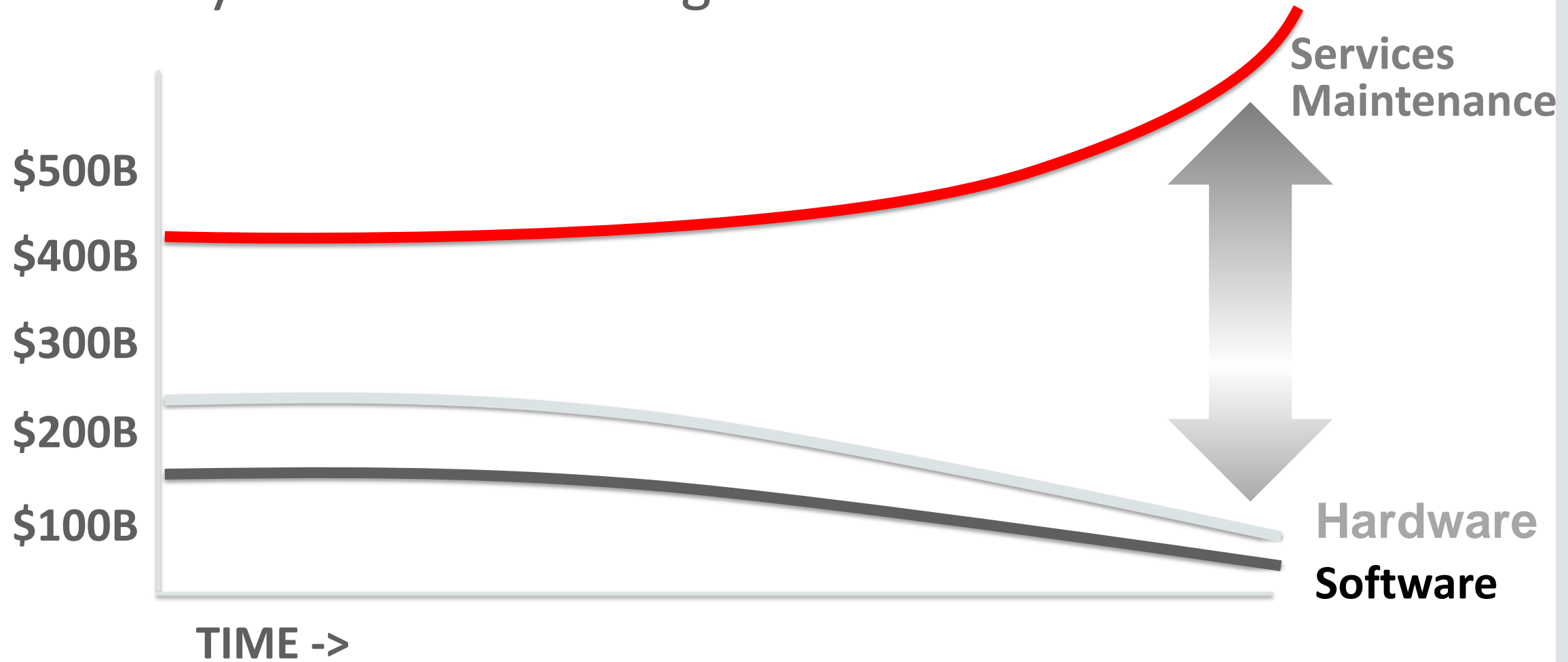
## Trade-offs



Oracle Technology Supplies both Public and Private clouds

Oracle Cloud Data Centers in Germany: Frankfurt and Munich

# Today: More HW/SW Efficiencies: But **Labor Costs Growing** Innovative Systems for Convergence Needed



# Do Not Build Your Convergent Solutions From Scratch

UN-GGIM: “train the individuals is at least five years”



**Time to Build**  
**Optimizations**  
**Maintenance**

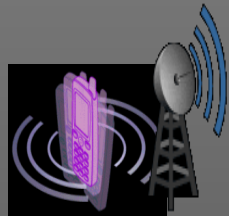
**Long Term Cost of Ownership rises with custom construction**

# Convergence & Innovation: Big and Fast Data Best Success Requires MULTI-MODEL DATABASE PLATFORM

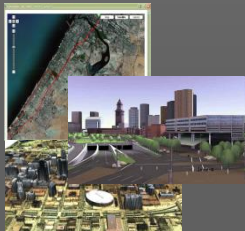
## Big & Fast Data



Volunteered  
Geographic  
Information



Sensors  
Streaming Data



Geo-  
referenced  
Video,  
3D, LiDAR

## Simplified Spatial IT



Support for  
Open Standards



Spatial Database,  
Application Server, BI,  
tools



Support by  
Leading Partner  
solutions



Spatially-enabled  
Engineered  
Systems



## Deep Analytics



Real-time Spatial  
Event Processing

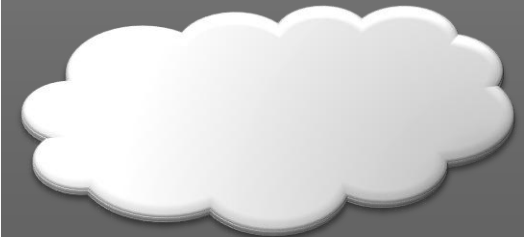


Dense Visualization



Spatial Analysis  
Graphs

## On Premise, On Cloud, Shared Services



Shared GeoSpatial Services  
Location Aware Everything

## Fully Parallel and Secure