Geospatial Practices in National Development Projects
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How do we fit in?
"While hardcore GIS professionals may start their work in other applications, when they want to solve spatial problems in production and with web- and IoT-scale data, Oracle gives them the platform to do so."

Analysts: Rowan Curran with Holger Kisker, Ph.D. and Emily Miller
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Five major challenges of spatial infrastructure projects

• Integrating spatial data into operational and organizational processes
  – Automated workflows between systems, rather than spatial data in silos

• Interoperability between servers and various clients
  – Supplying more than one solution with geospatial data

• Managing various kinds of geospatial data
  – Vector data in 2D and 3D, raster imagery, point cloud data plus metadata

• Scalability
  – Supporting larger user communities and larger data volumes

• Application-level integration through maps
  – Using Location information and maps in business applications
Program Agenda

1. Process Integration
2. Interoperability
3. Heterogeneous Data
4. Scalability
5. Application Integration
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Integrating spatial data into business processes

Typical issues today

• GIS systems disconnected from operational systems
  – Dedicated, specialized systems
  – High training cost
  – Costly operations and maintenance

• Manual effort in delivering location-related information
  – Labour intensive, time consuming, error prone
  – Not scalable for large infrastructure projects

• Not making use of the full value of geospatial information
Solution approach

With spatial data seamlessly integrated
• Implementing automated workflows across systems
  – Including the GIS System(s)
• Making use of standard IT development paradigm
  – Structured SOA approach, resulting in reduced cost through reuse
  – Using graphical design tools for rapid application development
  – Deployment through Cloud architecture
• Operational benefits
  – Real-time monitoring
  – Integrated administration
  – Comprehensive security mechanisms
BRIEF ORGANIZATIONAL OVERVIEW
Ordnance Survey Ireland is the Irish national mapping agency.
• Established in 1824, OSI is mandated to create & maintain the definitive; authoritative spatial reference platform for the Irish State

BUSINESS CHALLENGES / OPPORTUNITIES
A database platform that can provide scalability, redundancy and performance for the supply of national spatial datasets
• The use of Exadata to allow for the analyses of large data sets.
• The ability to publish our geospatial platform via the semantic web
• Replacement of current human workflows with automated processes for map generation

ORACLE TECHNOLOGIES USED
• Oracle Database 12c Enterprise Edition Exadata
  • Spatial & Graph, Workspace Manager
  • Partitioning, RAC, Tuning Pack, Diagnostics Pack
• Oracle Enterprise Manager
• Oracle Fusion Middleware
  • MapViewer, WebLogic, Bpel

BUSINESS BENEFITS REALIZED BY ORACLE SOLUTION
• The implementation of Oracle engineered systems had a number of key benefits
  • Single source for all spatial data
  • No manual update cycles for silo systems
  • Scalability, Reliability, Performance
• The new features in 12c Spatial and Graph will allow for the automation of products, dramatically reduced the number of man hours required and decreased the time to market.
• Oracle Enterprise Manager reduces the workload for our DBA & Middleware team.
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Interoperability

Typical issues today

• More than one GIS or mapping component in the organization
  – Need to share data online

• Adding more components to the infrastructure
  – Specific tools for various purposes
  – Open source or commercial software

• Need to access location information from business applications
  – Providing valuable data to non-GIS user community

• Demand to integrate maps and data from cloud-based services
  – making use of available datasources
Solution approach: Open standards on all levels

OGC standards for Geospatial data

• Using open standards at database level
  – OGC Simple Features specification, ISO SQL/MM
  – Allowing data access from many tools and components through SQL
  – Conversion to and from GML or KML

• Using OGC Webservices standards
  – WMS to provide maps, WMTS to provide map tiles
  – WFS and WFS-T to retrieve or manipulate data
  – WCS for coverages (data together with their detailed descriptions)
Solution approach: Defacto standards and Cloud Architecture

• Integration of microservices through
  – REST APIs
  – NODE.js engine, relational, NoSQL
  – JSON / GeoJSON data representation
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Managing various kinds of geospatial data

Typical issues today

• Different kinds of data are held in files or speciality data stores
  – Need different skill sets for each specialized system
  – Making integrated analysis difficult

• Support for new datatypes is required
  – LiDAR data collection growing particularly rapidly

• Finding the appropriate dataset is challenging
  – Metadata are either incomplete or not accessible/searchable

• Datasets are semantically inconsistent
  – Identical terms do not necessarily mean the same thing
Solution approach: Data integration
Combining all kinds of geospatial data, metadata and attribute data

• Integrated storage allows joint analysis
  – Without moving potentially large datasets between systems
  – Including metadata for efficient search

• Database offers semantic technologies for further analysis

• Using a single system simplifies application development significantly
  – Same development paradigm and toolset

• Operational benefits
  – Consistent platform for administration
  – Comprehensive security mechanisms
Shared “multi-model” Spatial Database
Location and Graph analysis with Secure, scalable storage for enterprise data

SQL access
Web Services (OGC)
SPARQL End Point
40+ Graph Analysis Functions (PGX)

“Points”
“Lines”
“Polygons”

Oracle Spatial and Graph

Spatial Vector Acceleration
Geocoding
Routing
Inferencing

Property Graphs
Network Graphs
RDF Semantic Graphs
Topologies
Rasters
3D, point clouds (LiDAR)
Case Study: Crossrail, UK

Shared Spatial Data Warehouse, Bentley and Esri clients

• Largest Engineering & Construction project in Europe
• 21 km twin tunnel under City of London, 90 km of new railway line
• Visualization and Analysis, incl. 3D data management
• Oracle Spatial and Graph as “single source of truth”
  – Database for 300+ staff and contractors as well as the public
  – Serving Bentley Map, Geo Web Publisher, ESRI ArcMap
  – 500+ layers of information, 45,000,000+ records
  – integrated security
• Using London Survey Grid for accuracy
Integration through services and microservices
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Scalability

Typical issues today

• Massive increase in spatial data collected
  – Through sensor measurements, sometimes coming in as streams (eg. GPS)
  – Through growing popularity of 3D data

• More demand for highly parallel processing
  – Driven by Big Data scenarios

• Growth of user communities requiring location information
  – Mobile workers
  – Business users
Solution approach: Big Data, Database and Engineered Systems

With spatial data seamlessly integrated

• Use mature database capabilities such as
  – In-database processing (PL/SQL, Java, JSON)
  – Parallelism and Clustering
  – Partitioning
  – Compression

• Use horizontal scalability of Big Data Hadoop or NoSQL where appropriate

• Deploy optimized combinations of hard- and software
  – Using capabilities of Oracle Exadata, Big Data Appliance
  – Move towards dynamic allocation of resources through cloud computing
Case study: AHN2 dataset (Rijkswaterstraat, NL)

- LiDAR data acquisition at 6-10 pts/m² covering all of the Netherlands
- 12TB of data, >60000 LAS files
- Analysis on Exadata X4-2 full rack
  - Direct load of 640bn records in 4h40
  - Requiring 2.25TB storage in database
  - Query on compressed data ("query high" mode) without indexes, using partitioning
  - Typical data extraction queries running sub-second mostly, scaling extremely well
  - Full paper will be published in "Computers & Graphics"
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Application-level integration

Typical issues today

• Mapping systems disconnected from business systems
  – Business users would already benefit from simple maps

• Lack of integrated use of location information in decision-support systems
  – Missing relevant relationships

• Local datasets not necessarily fit for purpose
  – Integration of cloud-based services and microservices may be more adequate
Solution approach: Applications with maps pre-integrated

Considering location information as strategic asset

• Use data models with spatial data explicitly included
  – Not only implicitly as addresses

• Accommodate external systems and 3rd party datasets
  – Street network for Geocoding, Routing, as well as statistical/socio-demographic data
  – Wide range of languages, tools and APIs – SQL, JAVA, Scala, Ruby, Python, REST, etc.
  – Standards-based (HTML5, JSON, OGC Web Services, ...)

• Choose or build applications with maps pre-integrated
  – Common visualization component
  – Cloud-based services pre-integrated
Case study: DPR COSEA

- Consortium building high-speed railway line from Tours to Bordeaux
- Centralized spatial data repository for collaborative construction planning, synchronization and analysis
  - Project Management, Document Management, GIS, Business Intelligence
  - High-availability platform, serving 2500 users
  - Autodesk as GIS client, using LRS
- Primavera P6 for project portfolio management consolidating all project plans
- Partners: IBM, Qualora

Image courtesy of: VINCI, France
Case study: Unicoop Firenze

OVERVIEW
• Incorporates all of Business Intelligence systems and all of departmental systems
• Supports Marketing, Development and Management divisions

CHALLENGES / OPPORTUNITIES
• Need to have a simple to use, standardized, complete and shared solution
• Need to integrate disparate data sets (statistical & internal)
• Need to relate more than 1.2 Million records with lat/long coordinates
• Need to decrease operational time cost

SOLUTIONS
• Oracle Database Enterprise Edition on Exadata ¼ Rack
  • Spatial Option with Network Data Model, Partitioning
• Oracle Fusion Middleware
  • MapViewer, Oracle Business Intelligence Enterprise Ed.

RESULTS
• Consolidation of geo data and network data model
• Standardization of all addresses and coordinates in a consistent format and datum
• The Organization now better understands activities in context of location and directs marketing and assortment policies of the stores
• The Organization now explains the business events dependent on territorial characteristics
• The solution allows to save 35% of operational costs of the people involved
Summary
Commercial-quality Spatial technology for every Platform

Spatial NoSQL, Hadoop, Spark

Spatial Database

Cloud
Commercial-quality Spatial technology for every Platform

Oracle Big Data Spatial and Graph

Oracle Spatial and Graph Database

Oracle Public Cloud
Summary

Benefits of integrated spatial technologies

• Integrated use of geospatial data in the IT infrastructure
  – Adding value by combining all kinds of 2D and 3D data with attributes and metadata

• Reduced operational cost
  – Making use of IT and data management capabilities of database and middleware

• Minimized strategic risk
  – Enabling interoperability through open standards support
  – Using capabilities of a mature technology stack such as scalability, reliability, security

• Reduced development effort
  – Allowing developers to concentrate on business requirements rather than infrastructure
  – Using an integrated, consistent IT architecture with common paradigms, tools and APIs