“IT Infrastructure for BIM and GIS – 3D Data, Semantics, and Workflows”

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Major challenges of infrastructure projects

IT perspective

• Creating a Single-Source-of-Truth for BIM and GIS
  – Managing all kinds of spatial and non-spatial data
  – Providing metadata for search

• Integrating spatial data into business processes
  – Supporting entire asset management lifecycle
  – Automated workflows between servers, rather than spatial data in silos

• Interoperability on data-, process- and application-level
  – Making use of valuable geospatial data wherever needed
  – Delivering consistent information across domains (semantic interoperability)
Managing data in BIM projects

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, especially when used in the cloud
  – Consistent platform for administration
  – Comprehensive security mechanisms
Data integration requires spatially-enabled database
Ideally supporting semantic integration through RDF

Oracle Spatial and Graph

- "Points"
- "Lines"
- "Polygons"
- Web Services (OGC)
- SPARQL End Point
- Rasters
- Network Graphs
- Topologies
- RDF Semantic Graphs
- Geocoding, Routing
- Inferencing
- 3D
Case Study: ÖBB-Infrastruktur AG, R&D
Implemented by IQsoft, Austria

- Optimized railway planning, construction and maintenance
- Integrated LiDAR, raster and vector data management
- Storing and processing >8 billion points of objects along railway tracks
- Enables LiDAR data to be viewed with existing infrastructure vector data
- Comprehensive metadata management through CSW standard
- Data delivery through OGC WebServices

“[This technology...] is indispensable to process geospatial data with high efficiency at low cost”

Dr. Michaela Haberler-Weber
ÖBB-Infrastruktur AG, R&D
Spatial Data Types are not enough
Using the data requires object model

• Modeling required for any kind of analysis beyond visualization
  – Associating objects with geometry, topology, semantics, appearance, ...

• CityGML is established standard for urban infrastructure
  – Information model to represent relevant 3D urban objects
  – Defining classes and relations for these objects
  – XML-based format to exchange and store data (GML3-based application schema)
  – Standardized by OGC, currently in version 2.0.0
  – Can be used to derive logical data model in databases
3DCityDB implements CityGML
Open source data model - www.3dcitydb.org

• Semantically rich, hierarchically structured model
• Five different Levels of Detail (LODs), including textures and facades
• Representation of generic and prototypical 3D objects
• Free, also recursive aggregation of geo objects
• Complex digital terrain models (DTMs)
• Management of large aerial photographs using SDO_GEORASTER objects
• Version and history management
• Matching/merging of building features
• Works with Oracle Spatial and Graph 10gR2, 11g and 12c
Case study: City of Berlin – 3D City Model
Implemented by TU Berlin

- 3D vector and raster data in 3DCityDB
- Data model based on CityGML
- 560000 buildings, reconstructed from 2D cadastre and LiDAR data
- Textures extracted from oblique aerial photography

Images courtesy of: TU Berlin, Institute for Geodesy and Geoinformation
Integrating spatial data into business processes

Typical issues today

• GIS systems disconnected from business 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: Service-oriented Architectures
With spatial data seamlessly integrated

• Implementing automated workflows across systems
  – Including the GIS System(s)
  – Loose coupling allowing simple transition to cloud computing

• Making use of standard IT development paradigm
  – Structured SOA approach, resulting in reduced cost through reuse
  – Using graphical design tools for rapid application development

• Operational benefits
  – Integrated administration and Business Activity Monitoring
  – Comprehensive security mechanisms
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
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
  – Integrating maps into business applications

• Demand to integrate maps and data from cloud-based services
  – Making use of available datasources

• Identical terms in different systems don’t necessarily mean the same thing
  – Leading to incorrect or inconsistent results
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, KML (or GeoJSON as OGC candidate standard)
  – Supporting semantic queries using GeoSPARQL

• Using OGC Webservices standards
  – WMS to provide maps, WMTS to provide map tiles (both available through MapViewer)
  – WFS and WFS-T to retrieve or manipulate data (available as part of Spatial and Graph license)
Open and Interoperable spatial database
Open Source Tools integrated with Oracle Spatial and Graph
Case Study: Crossrail, UK
Spatial Data Warehouse, Bentley and Esri clients

• Large Engineering & Construction project in UK
• 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

Image courtesy of: Crossrail, UK
Semantic technologies

Using linked data concepts to associate data with meaning

• Automated integration of data from different sources
  – Creating a semantic layer across silo’d systems
  – Using well-defined vocabularies and ontologies
  – Based on W3C standards including the Resource Description Framework (RDF), the Web Ontology Language (OWL), SPARQL, RDB2RDF, ...
  – Allowing consistent query, reporting and analysis

• Enabling inferencing to gain new knowledge
  – Derive new information or verify consistency

• Functionality in Oracle database since Oracle 10gR2
  – Triple store, inferencing engine, SPARQL/GeoSPARQL support, RDB2RDF support, ...
Summary

IT Infrastructure for BIM and GIS

• Create a Single-Source-of-Truth for BIM and GIS
  – Vector data in 2D and 3D, raster imagery, point cloud data
  – Including metadata catalog for search

• Integrate spatial data into business processes
  – Supporting entire asset management lifecycle
  – Automated workflows across systems (eg. work orders, invoices, ...)

• Ensure interoperability on data-, process- and application-level
  – Technical interoperability to supply more than one solution with geospatial data
  – Semantic interoperability by using a common Vocabulary/Ontology
More resources

• Further information on oracle.com
  – www.oracle.com/goto/spatial

• Blogs
  – https://blogs.oracle.com/oraclespatial

• Developer forums on OTN
  – https://community.oracle.com/community/database/oracle-database-options/spatial

• LinkedIn community
  – „Oracle Spatial and Graph“ group

• Google+ community
  – „Oracle Spatial and Graph SIG“