CityGML-based SDIs
Implementation requirements and examples

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Dr. Lutz Ross | lross@virtualcitysystems.de
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Implementation requirements and examples
What is CityGML?

- **International OGC standard** for semantic 3D city models

- Represents **all relevant topographic object types** of a city (buildings, vegetation, water, terrain, traffic, etc.)

- ISO 19100 compliant, extensible **information model** and GML-based **exchange format**

- CityGML represents the city objects with **3D geometry, 3D topology, semantics** and **appearance**
Rich in semantics compared to pure 3D graphics and 3D map formats

Objects know **WHAT** they are and **WHERE** they are

Hierarchical structure of features and their components

**Required** for sophisticated **queries, simulations** and **analyses**
Five Levels-of-Detail suitable to many different applications fields

Every city object can be represented in each LOD simultaneously

Source: Filip Biljecki, TU Delft
Why CityGML?

Marseille, France

- Terrain Model
- Building
- Land Use
- Vegetation Object
- City Furniture
- Road
- Traffic Area
- Water Body

Geospatial World Forum 2016
CityGML timeline

- **2002**: First CityGML draft by SIG 3D
- **2006**: 0.3.0 (OGC Discussion Paper)
- **2007**: 0.4.0 (OGC Best Practice Paper)
- **2008**: 1.0.0 (OGC Encoding Standard)
- **April 2012**: 2.0.0 (OGC Encoding Standard)
CityGML world map

Based on a survey from 2010
CityGML-based SDIs

Implementation requirements and examples
Implementation requirements

- Robust and scalable data storage
- Update and maintenance workflows
- Easy-to-use publishing/visualization of data
- Integration with OGC web services and existing infrastructure
Implementation requirements

Update/maintain → Store → Distribute

CityGML

OGC Service
"The award winning 3D City Database is a free 3D geo database to store and manage virtual 3D city models on top of a standard spatial relational database. The database model contains semantically rich, hierarchically structured, multi-scale urban objects facilitating complex GIS modeling and analysis tasks, far beyond visualization."

http://www.3dcitydb.org
What is the 3D City Database?

- CityGML data management solution
  - CityGML 2.0 compliant relational schema for 3D city models
  - Realized on top of established spatial database systems (PostgreSQL/PostGIS, Oracle)
  - Oracle Spatial Excellence Award 2012

- Efficient database tools
  - Loading/extracting massive CityGML-based 3D city models
  - Export of KML/COLLADA/gITF visualization models

- Open Source project under LGPL 3.0
CityGML, 3D City Database and tools
OGC Web Feature Service (WFS) interface

- **OGC WFS 2.0** service interface for the 3DCityDB
  - Live queries to the city model using spatial and thematic filters
  - Transactions (insert, update, delete) on the data
  - Open Source (WFS Simple conformance class)

- **Open and standardized**
  - CityGML used as data exchange format
  - Vendor-neutral data workflows and processes
  - WFS abstracts from the data backend

- **Web-based data management** of the 3D city model data
Query your City Model
3D City Database timeline

- Work on CityGML 3.0 started in 2013
- 3D City Database timeline 2005-2017
- CityGML versions: 0.3, 0.4, 1.0, 2.0, 3.0
- Oracle Spatial Award Winner 2012
- Geospatial World Forum 2016
CityGML-based SDIs
Implementation requirements and examples
Senate of Berlin / Berlin Partner

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Main use is for City marketing
Update and maintenance
- on a project base
- Change detection and update every 3-5 years

Storage
- Since 2009 in 3DCityDB

Visualization
- 2009: Autodesk LandXplorer (Desktop) and Google Earth (Web)
- 2011: virtualcityMAP / 3DMaps from Agency9 (Web)
- 2016: virtualcityMAP / CesiumJS

URL: http://www.businesslocationcenter.de/wab/maps/main/
Rotterdam
Rotterdam challenges

- 3D City Model shall become an integrated and reliable base dataset for many different applications
  - Urban planning
  - Collision detection
  - Solar potential
  - Energy planning
  - …

- Approach: Rotterdam 3D working group
  - Ask the users from different departments
  - Create proof-of-concepts
  - Define workflows
  - Integrate with existing systems and workflows
Rotterdam – Underground infrastructure
Singapore
Singapore

- Data creation: Bentley Map

- Data storage: 3DCityDB

- Core requirement: Data update and maintenance is still unsolved
  - Direct connection between Bentley Map and 3DCityDB
  - Check out and feature look mechanism
  - Support of the complete CityGML information model

⇒ In 2D solved but in 3D still a challenge
Further users of the 3D City Database

- In production use in many cities and organizations worldwide
  - Berlin, Hamburg, Munich, Frankfurt, Dresden, Potsdam, Kempten, …
  - Federal Surveying departments in Germany
  - ZSHH in Germany: Nation-wide CityGML model containing buildings in LOD1 and LOD2 (ongoing); Currently more than 50 Mio. buildings in one 3DCityDB instance

- Research & Development
  - TU Delft, TU Munich, TU Berlin, Karlsruhe Institute of Technology, Eifer, EDF, …

- Companies
  - virtualcitySYSTEMS, MOSS, Luciad, …
Interested in 3D SDIs?
Open Source tools to get you started
Streaming of arbitrarily large CityGML-based 3D city models on the web

Open Source JavaScript API on top of Cesium

Allows for adding 3D object layers and for interacting with the content

- Tile-based loading and unloading
- Selection and highlighting of objects
- Hide/show 3D objects
- Cloud-based access to object attributes

SIMPLE: glTF exports from the 3DCityDB can be directly loaded into Cesium
Connecting 3DCityDB ecosystem to Geospatial World Forum 2016

3D City Database

CityGML

CityGML WFS

WFS / WMS / ...

2D/3D geo data

OGC services

query and update 3D city model

integration of 2D/3D geodata

fully automated process chain

3dcitydb-web-map

CESIUM

WebGL

virtualcitySYSTEMS
Find the 3DCityDB and tools on GitHub
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Conclusions

- Reliable solutions for data storage and data distribution are available
  - 3DCityDB
  - 3DCityDB Web Feature Service
  - virtualcityMAP / virtualcityPUBLISHER

- Data creation, maintenance and update is still not fully solved
  - Deleting and replacing features – ok
  - Replacing the complete model – ok
  - Continuous updates through import and export workflows – ok
  - Direct database connection using an editor – not yet implemented
3D SDI as basis for complex Urban Simulation

Wind field and turbulence simulation

Smoke dispersion simulation

Blast simulation

Flooding
virtualcitySYSTEMS

The next generation of 3D city models

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