CityGML

Open Standard for the Modelling and Exchange of Virtual 3D City and Landscape Models

The City Geography Markup Language (CityGML) is a new and innovative concept for the modelling and exchange of 3D city and landscape models that is quickly being adopted on an international level.

A driving factor is CityGML's ability to contain complex and georeferenced 3D vector data along with the semantics associated with the data. In contrast to other 3D vector formats, CityGML is based on a rich, general purpose information model in addition to geometry and graphics content. For specific domain areas, CityGML also provides an extension mechanism to enrich the data with identifiable features under preservation of semantic interoperability.

Targeted application areas explicitly include urban and landscape planning; architectural design; tourist and leisure activities; 3D cadastres; environmental simulations; mobile telecommunications; disaster management; homeland security; vehicle and pedestrian navigation; training simulators; and mobile robotics.

Motivation

More and more applications need comprehensive information about the shape and the meaning of urban and landscape structures. Whereas in the past city models often have been built as purely graphical 3D models, new applications have information needs beyond visual characteristics. Besides geometry, semantics and topology of the 3D objects have to be taken into account in order to enable for thematic queries, analysis tasks, automatic integration, validity checking, or spatial data mining. Therefore, a more general modeling approach had to be taken.

CityGML is a common information model for the representation of 3D urban objects. It defines the classes and relations for the most relevant topographic objects in cities and regional models with respect to their geometrical, topological, semantical, and appearance properties. Included are generalization hierarchies between thematic classes, aggregations, relations between objects, and spatial properties. These thematic information go beyond graphic exchange formats and allow to employ virtual 3D city models for sophisticated analysis tasks in different application domains like simulations, urban data mining, facility management, and thematic inquiries.

CityGML is implemented as an XML application schema for the Geography Markup Language 3 (GML3).

GML3 is the extensible international standard for spatial data exchange issued by the Open Geospatial Consortium (OGC) and the ISO TC211. CityGML is heading to become an open standard within the OGC itself (as an approved GML3 application schema), enabling easy and free access to all the international community.

Features of CityGML

- Geospatial information model for urban landscapes based on the ISO 191xx family
- GML3 representation of 3D Geometries, based on the ISO 19107 model
- Texture and material representation of object surfaces
- Taxonomies and aggregations
  - Digital Terrain Models as a combinaton of (including nested) triangulated irregular networks (TINs), regular rasters, break and skeleton lines, mass points
  - Sites (currently buildings; bridges and tunnels tbd. in the future)
  - Vegetation (areas, volumes, and solitary objects with vegetation classification)
  - Water bodies (volumes, surfaces)
  - Transportation facilities (both graph structures and 3D surface data)
  - City furniture
  - Generic City objects and attributes
  - User definable (recursive) grouping

- Multiscale model with 5 well-defined consecutive Levels of Detail (LOD):
  - LOD 0 – Regional, landscape
  - LOD 1 – City, region
  - LOD 2 – City districts, projects
  - LOD 3 – Architectural models (outside), landmarks
  - LOD 4 – Architectural models (interior)
- Multiple representations in different LODs simultaneously; generalization relations
- Optional topological connections between feature (sub)geometries
- Application Domain Extensions (ADE): Specific “hooks” in the CityGML schema allow to define application specific extensions, for example for noise pollution simulation, or to augment CityGML by properties of the new National Building Information Model Standard (NBIMS) in the US.

OGC Web Services and CityGML

Since CityGML is based on GML3 it perfectly combines with the full range of other OGC standards. The Web Feature Service (WFS), the Catalog Service (CS-W), the Web Coordinate Transformation Service (WCTS), and the Web Processing Service (WPS) are especially relevant to access, process, and identify CityGML resources.

For 3D visualization, CityGML should be considered a base format from which 3D graphic formats can be easily derived. The rich semantic information of CityGML objects also help in automatic cartographic generalization and symbolization. Corresponding OGC portrayaling services are the Web 3D Service (W3DS) and the Web Terrain Service (WTS).

CityGML Development

CityGML has been developed since 2002 by the members of the Special Interest Group 3D (SIG 3D) of the initiative Geodata Infrastructure North-Rhine Westphalia (GDI NRW) in Germany. The SIG 3D is an open group with members from more than 70 companies, municipalities, and research institutions working on the development and commercial exploitation of interoperable 3D models and geovisualization.

Since 2004 CityGML is discussed on an international level both within the European Spatial Data Research organization (EuroSDR) and in the 3D Information Modelling Working Group of the OGC.

Web Resources

- CityGML Homepage: http://www.citygml.org (includes test datasets and software tools)
- Open Geospatial Consortium (OGC): http://www.opengeospatial.org
- OGC 3DIM Working Group: http://www.opengeospatial.org/projects/groups/3dimwg
- SIG 3D - NRW Homepage (*in German only*): http://www.ikg.uni-bonn.de/sig3d

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