OSGeo Journal

The Journal of the Open Source Geospatial Foundation Volume 3 / December 2007

Proceedings of FOSS4G 2007

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Interoperability for 3D Geodata

Experiences with CityGML and OGC Web Services

Hans Plum and Dr. Markus Lupp

Summary

Storage, processing and visualization of 3D geodata are an important subject in the GIS world even before the leading search engine introduced its globe viewer. Usage of standards of the Open Geospatial Consortium (OGC) open up new possibilities for combination and usage of 3D geodata. First practical experiences show promising results.

Introduction

Processing and visualization of 3D geodata became a common subject during the last years. Some indicators for this are the number of offered software solutions but also the amount of interest for the development of CityGML. CityGML is a GML-based exchange format for three dimensional digital city models, that is already implemented in a number of software products. With the definition of CityGML and application of OGC Web Services for access to and visualization of 3D geodata the areas of 3D geodata processing and Spatial Data Infrastructures (SDI) are converging.

This article is discussing solutions that were realized using technology from the deegree project. The mentioned projects are: “Storage and administration of 3D city models for the cities of Bonn, Berlin and Hamburg”, “Visualization of digital terrain models for the Federal Agency for Cartography and Geodesy of Germany”, “Realization of a transactional CityGML WFS for the Open Geospatial Consortium” are outlined.

OGC-Standards with relevance for 3D

A number of discussion papers and specifications of the OGC are of importance for 3D geodata handling. In particular these are CityGML as data model and exchange format, Web Feature Service and Web Coverage Service for data access and Web Terrain Service and Web 3D Service respectively for visualization purposes.

City Geography Markup Language (CityGML)

CityGML defines a semantic object model for 3D objects in urban areas. It is a GML application schema that is it model objects of an application domain using constructs of the Geography Markup Language. In this aspect CityGML is a semantic model as well as an exchange format.

CityGML is so far mainly developed by a working group of the SDI initiative of Northrhine-Westfalia, although members from all over Germany are part of this group. In version 0.3 CityGML was introduced into the OGC and published as a discussion paper (1). CityGML 1.0 will in short time become an official OGC Best Practice paper.

Web Feature Service

A Web Feature Service (WFS, (2) allows to query geodata modeled in GML. Filter Encoding (3), an SQL-like language encoded in XML is used to query a WFS. A WFS that allows not only to read, but also write access (create, update and delete) is called a transactional WFS (WFS-T).

WFS is an official OGC-standard in the current version 1.1.0. A WFS implementing this 1.1.0 specification has to support GML 3.1.1 – the same version that is the base for CityGML. It is therefore possible to use a WFS as a data access layer to CityGML.

Web Coverage Service

A Web Coverage Service (WCS, (4) allows to access all kinds of data that is modeled "field-based", e.g. Raster- or TIN-based. Examples of such data are those created by remote sensing or digital terrain models. In the context of 3D SDI a WCS can be used to access terrain models. WCS is an official OGC standard with the current version 1.1.0.

Web Terrain Service

A Web Terrain Service (WTS), still in OGC discussion paper status, generates Views of 3D scenes. In contrast to a WMS that creates 2D visualizations, an image depicting 3D data is generated.

Unfortunately, the development of the WTS specification advances rather slow. The current draft version bears the name "Web Perspective View Service" (WPVS) to express that the service is able to depict 3D objects besides "Terrain".

Figure 1 shows the result of a GetView-request. A digital terrain model is depicted that is textured with aerial photographs. On top of the terrain a number of buildings are displayed (one of them transparently).

WPVS creates presentations of 3D objects. The most important operation of this service is GetView which returns static pictures of 3D landscapes. The GetView operation can be seen as an extension to the GetMap operation of WMS. In comparison to GetMap, GetView defines additional parameters allowing to specify a 3D scene. Among these parameters are a rotation angle and the azimuth of the depicted scene. As the result of a GetView operation is a (static) image; it is not possible to navigate directly through the scene. A WPVS client is therefore in comparison with real 3D viewers not very interactive, but can be implemented as a web application using DHTML without the need for browser plugins. Another advantage is that such a simple and web-based 3D client can easily be integrated with other web-client software, like e.g. WMS-based portals.

The challenge when creating a WPVS client is to hide the complexity of a GetView request behind an easy to use graphical user interface, that allows navigation in 3D space.

Use cases

To support the projects mentioned in the introduction, the following use cases have to be supported.

Storage of digital city models

Digital city models are often created using CAD systems and stored in CAD file formats. This results in a number of disadvantages. It is not possible to easily select parts of the city model or to organize updates. Because of this reason, organizations who own such city models need homogeneous data that best is stored in a database.

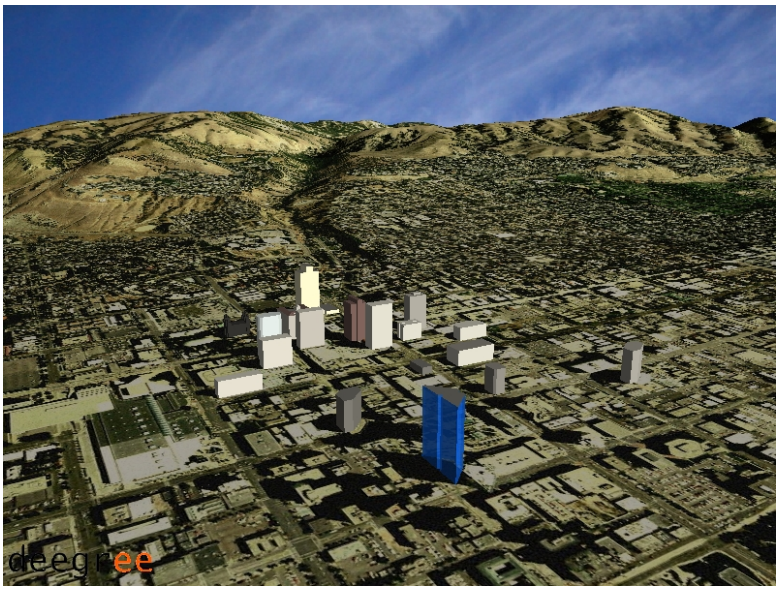

Figure 1: Visualization of terrain and buildings using deegree WTS/WPVS

To support this use case it is necessary to store CityGML in a – most likely relational – database. For access to this database a WFS is the obvious choice, CityGML can then directly be inserted and pulled out of the database.

To control the access to the WFS it is necessary to use an access control mechanism. In the mentioned projects components of deegree iGeoSecurity are used for this.

Web Visualization

The advantage of 3D geodata is mostly to be found in its possibilities on visualization. Application areas are support of urban planning processes and navigation. In the context of planning processes, 3D geovisualizations allow to display the consequences of planned projects before they are realized.

Tourist information systems can also benefit from 3D visualization. Recognition of landmarks or navigation can be enhanced. Great potential also lies in the coupling of classical 2D maps with 3D scene visualizations.

For marketing purposes of the data itself, terrain and city models are displayed on the Internet. The potential of the data is shown in this way.

Architecture of a 3D SDI

In the following, the architecture of 3D SDIs realized by deegree will be described (c.f. figure 2).

The building information models will be kept in a spatial enabled database, e.g. PostGIS or Oracle Spatial. A transactional WFS (WFS-T) supports the access for reading and writing of the city models. In order to control the information flow, especially transactions against the WFS, a owsProxy is used to protect the building information against unauthorized access. The editing component – mostly a CAD system – accesses the data via owsProxy and WFS.

Digital elevation data can also be saved in a geodatabase. Especially for TINs or points. Alternatively, raster data can be saved in the filesystem. In order to support a fast access method the mechanisms described above have to be used. Accessing digital terrain data in raster format are provided by a WCS. Getting the according terrain model while rendering a city model is easily done through the Web Coverage Service.

On the right hand side of figure 2 the visualization process is shown. deegree-WPVS accesses the data out of the geodatabase. Furthermore, it is possible to integrate external WFS- or WCS-services. Textures like ortho imagery or maps for navigation are also needed. Via a WMS these kind of data can be integrated. A web-based WPVS-Client provides a graphical user interface that can be used in web browsers.

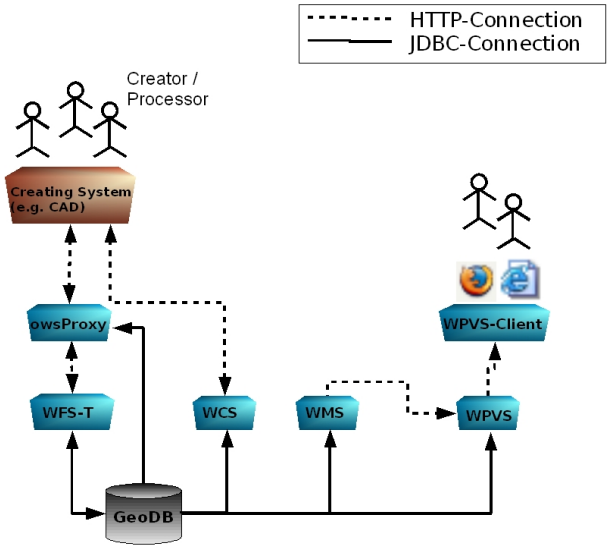

Figure 2: Architecture of a 3D SDI

Conclusion

The development of CityGML defines an important step towards 3D SDIs. The experiences using deegree components for development of such systems that were made in a number of projects are promising. They show that it is already possible to create 3D SDIs using Open Source software.

The mentioned components are available via www.deegree.org. At the time of writing the RC1 for WPVS (including a client), WFS and WCS are available as easily installable WAR archives.

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Acknowledgements
Various reviewers & the GRASS News Project

The *OSGeo Journal* is a publication of the *OSGeo Foundation*. The base of this journal, the LaTeX 2_ε style source has been kindly provided by the GRASS and R News editorial board.

Journal online: http://www.osgeo.org/journal
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ISSN 1994-1897