



Figure 2: Architecture of the shell model.

for geodata infrastructures of North Rhine-Westphalia (GID NRW), bring up the conversion, management and visualization of the data for discussion in order to support the application of these systems. The CityServer3D technology represents one of these systems and extends these concepts. Besides a geodata server for three-dimensional city models, it also makes mechanisms available, which do not only support management and visualization, but also provide a simple integration of analysis and dynamic data. This, in particular, permits the development of systems extending the possibilities from mere (simple) visualizations and a static data management to systems with various application possibilities.

Technology

Besides the GeoBase21 database, the technology of the CityServer3D consists of a server component and clients which fulfill different tasks. Apart from the geometry, the

database also stores the thematic and spatial classification of the data sets. Further attribute data sets can be held. Besides objects on the earth's surface, the digital elevation model can be stored in different levels of detail and queried, whereas it is managed in different common models, so that both an optimized GRID and TINs (optionally with breaklines) can be stored. Thematic and spatial attributes of the objects are assigned to presentations which contain optional symbol presentations or the color representation of the objects and object groups.

A central role within the CityServer3D plays the server component, serving to make the data stored in the data base accessible over different interfaces. The architecture permits the query of not only the data stored in its own database but also additional data sources. These can be other data bases or files loaded using import components. In order to realize this, the CityServer3D uses a meta-model. The data transferred

into this model can be processed in various ways within the server's functional unit and, afterwards, be transmitted over different interfaces and 2D and/or 3D formats to clients or other servers. In this way, the interoperability of the server is ensured. Since the server has components for authentications and recordings of transactions, it can be used as a fundamental technology for eCommerce.

The server component consists of different modules. The interaction of the different modules is steered via the control unit. It enables the processes to be defined, so that, for example, a web mapping service (WMS) based on orthophotos can be realized fast and simple. This mechanism can be generally used and also serves for the integration of more complex modules. In this way, objects from data sources also can be dynamically manipulated depending on the actual situation.

The WebViewer of the CityServer3D forms the interface between the user and the database. The WebViewer is based on standard technologies of the World Wide Web and can be called using any Java-capable Browser.

With the help of the 2D-component of the WebViewer, the user can define a polygon to select the area of interest on the map. By a mouse-click, the user gets a three-dimensional visualization of the selected area in the WebViewer which uses Java3D technology. In a virtual universe, the user can freely navigate through the areas and objects. One can for example, select buildings to get further information. The user interface is configured by XML files and is available in several languages (like English and German).

For the management of the data base as well as for importing and exporting the geodata, a special client is provided for content administration. This tool uses the visualization and navigation functionalities of the WebViewer as well as special data filters for data administration.

The main functionality of the AdministrationTool, however, consists in the import and export of

geodata of different formats. In order to support different formats, the AdministrationTool contains components which make a conversion of external data into the internal format possible. Since these converters are tied up as independent libraries up to the server (an extension for upcoming geodata standards and formats), the adaptation effort is minimized. Presently, an exchange of SVG, SHP, VRML, raster-based, AutoCAD and GML3 files is realized. For the import, the AdministrationTool offers the possibility of accomplishing global manipulations of the geodata. The necessity for such a feature shows up already with the import of VRML-files due to different coordinate systems. The definition of an offset for the point of origin of the visualized scene graph is also possible.

Application

The CityServer3D serves as an enabling technology for several application areas like tourism, traffic, risk management or site planning and marketing. The WebViewer of CityServer offers the provider to serve the user with models from a site. These can be actual situations as well as differing planning phases and possibilities. The user is able to navigate inside the models using a free navigation or by flying or walking in the model.

In analogy to the WebViewer used for stationary systems, the MobileViewer serves as an interface between the database and the user of a mobile device, expanding the CityServer3D with location-based service (LBS) functionality. The Java-based MobileViewer enables the user to navigate inside lower-detailed three-dimensional dynamic maps as highly-detailed 3D-building models on newer mobile devices supporting 3D-rendering.

Thus, different fields of application can profit from CityServer3D: As a dynamic tourist-guide, MobileViewer presents, for example, a visitor of a town the shortest way from his position to the nearest restaurant by providing a 3D-map with his destination position highlighted. Special objects with a high grade of

interest, like historical buildings, are presented in a highly-detailed way, allowing the user to promenade virtually through the building. As different representations of the same object can be offered, the historical development of a building and its surroundings can be watched right on the spot and be compared with the actual, real view.

The MobileViewer also serves as a supporting tool in site planning and marketing. Construction managers can examine various designs of a building in the planning-phase while actually being at the construction-site and base their decisions on the virtual model and the vicinity in the real world. While the building is still in construction, the CityServer3D can provide potential investors and the public three-dimensional models of that building, allowing them to navigate through and examine it on their mobile devices.

Cooperations

The Graphic Information Systems department of the Fraunhofer Institute for Computer Graphics Research IGD is involved in different committees and cooperations with the aim to define standards for 3D GIS and to set up prototype solutions for actual and future market requirements.

The technology is also introduced to other committees, for example the SIG3D of the GDI North Rhine-Westphalia. The CityGML profile of GML3.1, developed within the SIG3D, is integrated as an export and import module into the CityServer3D and, thereby, represents one of the driving forces for standard developments in the 3D GIS area. The GDI North Rhine-Westphalia is an initiative of the state of North Rhine-Westphalia which aims at supporting and activating the geodata market as well as improving the use of and a simplified access to geoinformation.

The Open GeoSpatial Consortium (OGC) represents one of the most important international consortiums with regard to the formulation of standards within geoinformatics. The Fraunhofer society plays a part in the consortium as a technical

member, which opens up the possibility to participate in the preparation of future standards and guidelines. Apart from the development of the GML3 profile, the department also supports the development of a Web3DService (W3DS) which shall be presented to OGC.

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