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## 3D WebClient based on the 3D City Database for CityGML

### Overview

Semantic 3D city models describe the urban topography by decomposing and classifying the occupied physical space according to a semantic data model. The relevant real world entities are represented by objects with thematic and spatial attributes and interrelationships to other objects. Today, more and more cities worldwide are representing their 3D city models according to the CityGML standard issued by the OGC. CityGML allows to further decompose complex objects like buildings into their parts like walls, stairs, etc. and these may again consist of parts like windows or doors. Since CityGML objects can have attributes and relations on all levels of this aggregation hierarchy, the exploration of, querying on and interaction with such a 3D city model must take into account these deeply nested structures. A multi-level System has been developed. The whole system architecture consists of three tiers; information backbone, application level, and end user level.

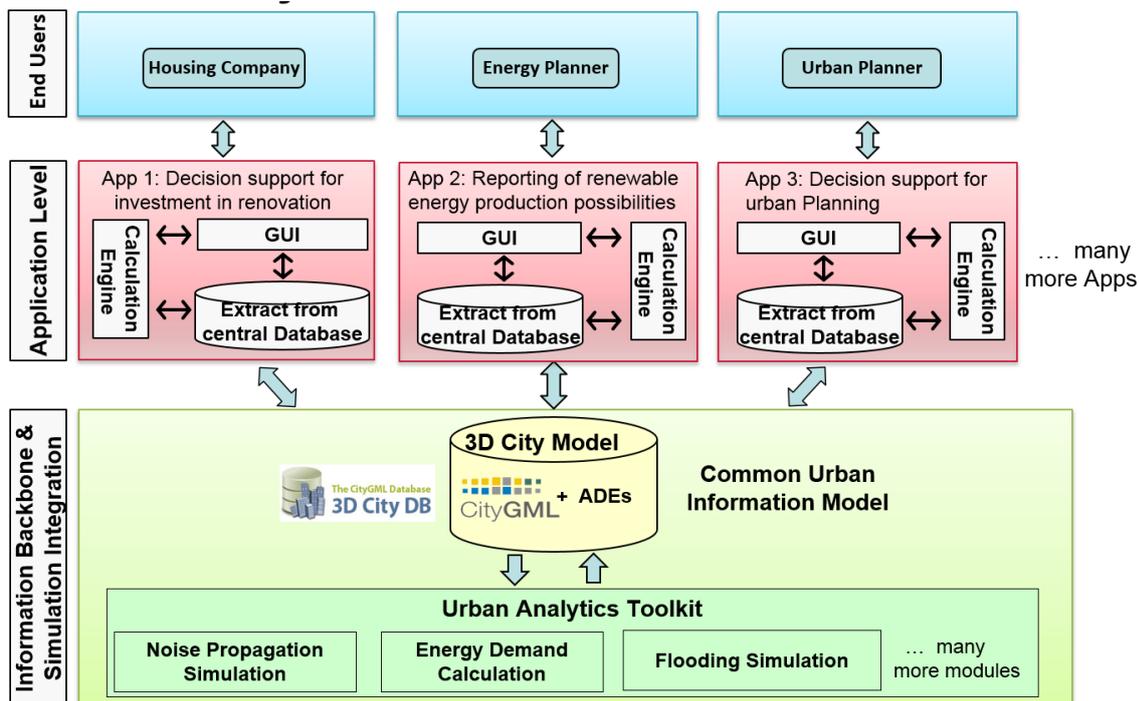


Figure 1: 3-tier system architecture

On the bottom level (information backbone), the semantic 3D city models are stored in an central database, which allows to store, integrate, and manage different contexts of urban information according to the CityGML standard. The urban analytics toolkit, which are being used in many different application fields like urban planning, environmental and training simulations, disaster management, and energy assessment, can be performed at the system level.

Normally, the users (end users level) have very little GIS expertise and have nearly no knowledge of the complex 3D city models. Such users need only intuitive tools that allow access to the semantic 3D city

models, as well as to perform simple simulations and calculations. For this reason, an application level has been introduced, which can be seen as a “bridge” between the end users and the information backbone. This is based on the principle of "app-concept", which is established in recent years in the context of smartphones and tablet PCs. This means that for specific users or user groups, the applications have a very limited range of functions, and are therefore relatively easy to understand and intuitive to use. At the application level, applications for users are created. As data basis, arbitrary subset of the 3D city model including the thematic and spatial information can be extracted from the central database and mapped to simple data structure. Furthermore, a lightweight calculation engine can also be integrated into the application. In combination with a simple and easy user-friendly graphical user interface, the analysis and processing of the semantic 3D city models is possible.

### 3D City Database

The 3D City Database (3DCityDB) is an Open Source geodatabase schema and set of tools for managing and visualization of large 3D city models. Berlin and has been wide employed in various production environments and commercial projects all over Europe for the storage, management, and analysis of 3D city models according to the CityGML standards. It is Open Source software released under the Lesser GNU Public License 3 (LGPL 3) and available to be used with either the commercial Oracle Relational Database Management System (RDBMS) plus Spatial Extension (Oracle Spatial) starting from version 10.2 or the Open Source spatial RDBMS PostGIS version 2.0. The 3D City Database is currently developed in collaboration of the Chair of Geoinformatics, Technische Universität München (TUMGI), virtualcitySYSTEMS GmbH, and M.O.S.S. Computer Grafik Systeme GmbH. The development is continuing the work of the Institute for Geodesy and Geoinformation Science (IGG), TU Berlin, and the Institute for Cartography and Geoinformation (IKG), University of Bonn.

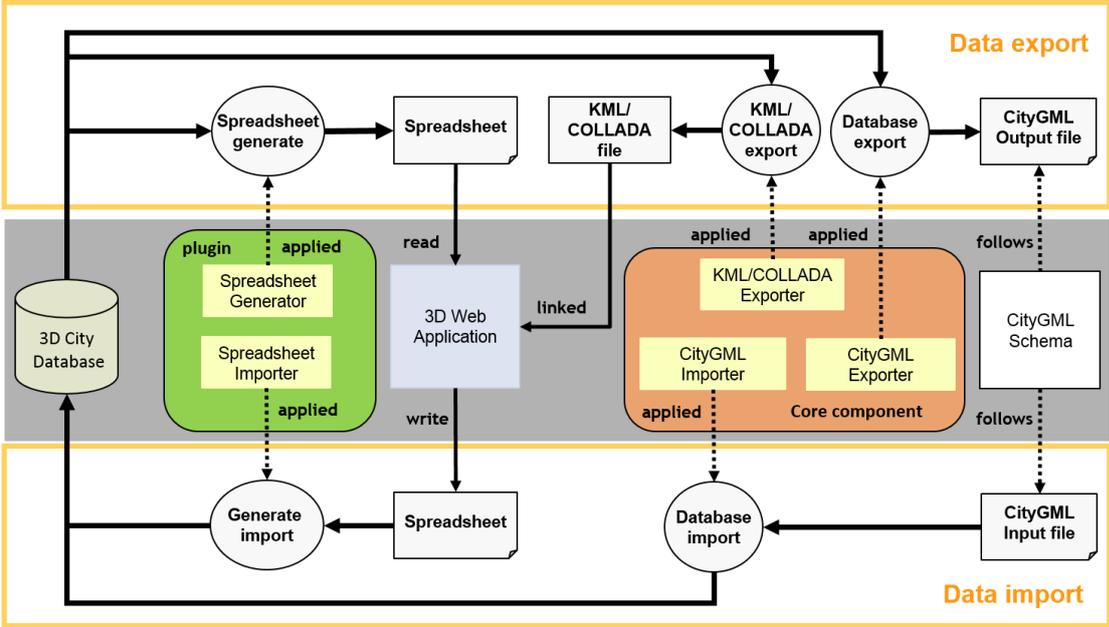


Figure 2: 3D City Database software suite

The 3D City Database consist of comprehensive Documentation and SQL scripts to create database schema and some useful function to manage the city model in database. Separately a Java frontend application named 3DCityDB Importer/Exporter was developed which allow for high-performance importing and exporting CityGML dataset and export the KML/COLLADA visualization model to be

shown and interactively explored in a 3D viewer like Google Earth, Cesium or ESRI ArcGIS. Functionalities in the Importer/Exporter can also be extended in a modular way with installation of plugins that add specific abilities for interacting with the 3D City Database or external data. For instance, by using the Spreadsheet Generator Plugin (SPSHG), it is possible to export arbitrary subsets of the city model data in tabular form with respect to the selected attributes from a 3D City Database (3DCityDB) instance either as a CSV file or directly be uploaded as a Google Spreadsheet Document using the corresponding Google Cloud Service (Google Docs).

### 3D Web Client

A specific 3D web client acting as user interface to the end-user was developed to perform the functions such as energy simulation, interactive 3D visualization, and exploration. The client is web-based and therefore available from any location with Internet access. Users can view the 3D webclient over the internet using a web browser to use directly without having to in-stall any other software locally. It is a JavaScript-based static application and can operate with any webserver like Apache without the need of an application server which reduces the administrative effort. The basic structure of the user interface is created using the ExtJS JavaScript-based web framework. The 3D webclient enables to visualize graphical representation of the 3D building models and perform spatial operations such as geocoding. Furthermore, user can control the dynamic elements of 3D building models using JavaScript commands embedded with the Google Earth Plugin, the Google Maps API and Cesium. Through an interactive 3D visualization a variety of features are available to display information of the target area. For example, panning, zoom, rotation with 3D view are provided by the Google Earth Plugin or Cesium with their tools that provide the basic functions for navigation in the 3D map. In addition, the 3D webclient allows to select one or more objects and display their attribute values in a table. The selected objects can be both highlighted in the 3D view, as also be hidden from the current view.

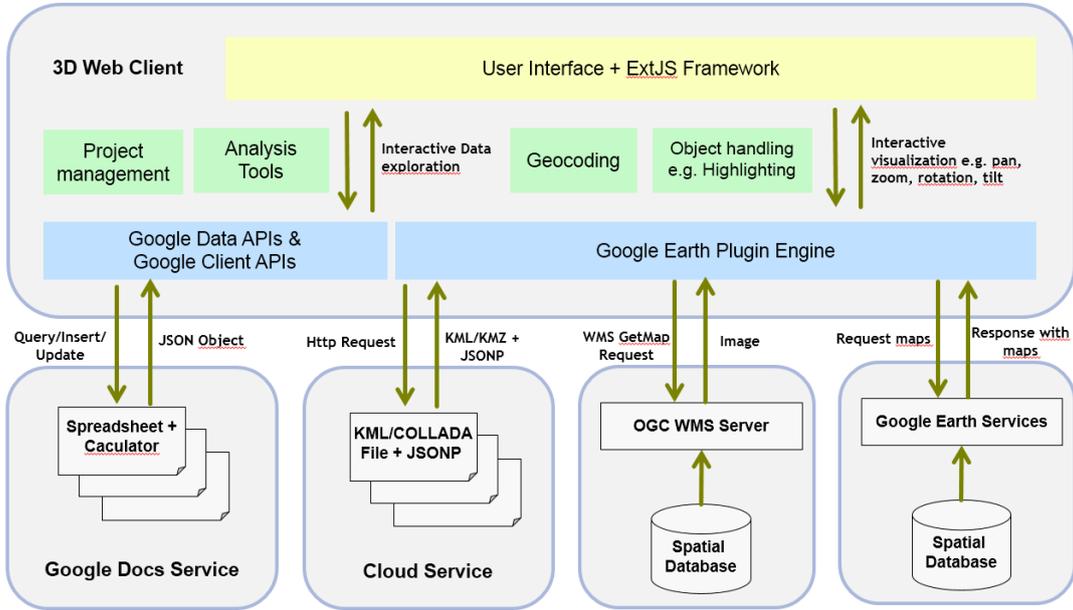


Figure 3: Structure of the 3D WebClient (Google Earth)

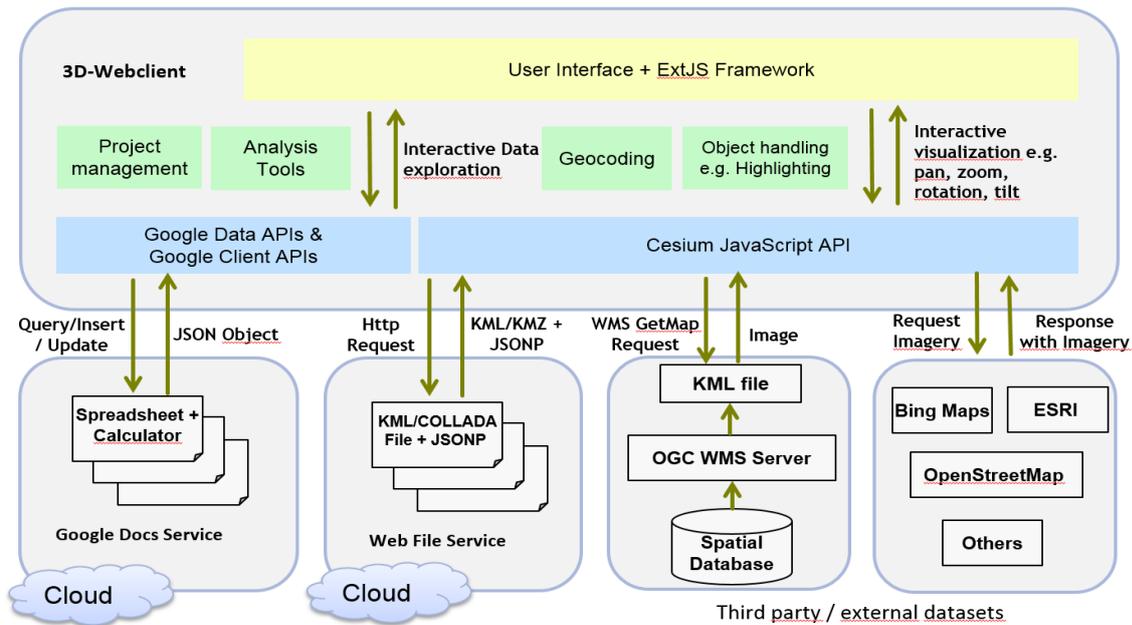


Figure 4: Structure of the 3D WebClient (Cesium)

## Progress

The details of the current development of the 3D City Database can be found at GitHub public repository of 3DCityDB and its homepage. The links are:

[www.3dcitydb.org](http://www.3dcitydb.org)

<https://github.com/3dcitydb>

The 3-tier system architecture and 3D web client are to be introduced in more details in the following full-accepted papers with presentations

[1] <http://www.dgpf.de/neu/Proc2014/proceedings/papers/Beitrag234.pdf>

[2] [http://www.dgpf.de/src/tagung/jt2015/proceedings/papers/34\\_DGPF2015\\_Chaturvedi\\_et\\_al.pdf](http://www.dgpf.de/src/tagung/jt2015/proceedings/papers/34_DGPF2015_Chaturvedi_et_al.pdf)

[2] [http://link.springer.com/chapter/10.1007/978-3-319-12181-9\\_11](http://link.springer.com/chapter/10.1007/978-3-319-12181-9_11)

[3] <http://www.gbv.de/dms/tib-ub-hannover/778774740.pdf>