virtualcitySYSTEMS

3D Spatial Data Infrastructure

Create - Maintain - Distribute

3D geodata includes innovative geo data products such as 3D building models, digital terrain models and others that are recorded, maintained and operated for an increasing number of cities and countries. In Germany and Europe, the international OGC standard CityGML is used for the description of 3D geodata. The German product standard for 3D building models is based on CityGML and the current proposal for specification of the INSPIRE Annex III "Buildings" theme also references the CityGML schema.

Against this backdrop, virtualcitySYSTEMS has designed a 3D spatial data infrastructure solution (3D-SDI) based on the CityGML-compliant open-source database 3D City Database (3DCityDB) which addresses the management, exchange and web-based publication of geodata. Our geodata infrastructure solution has a modular structure and can be combined and enhanced with existing systems.

Target Group

This document targets anyone who is interested in learning more about the 3D-SDI solutions from virtualcitySYSTEMS GmbH. It introduces the available components and concepts for setting up innovative spatial data infrastructures for three-dimensional geodata. We are happy to advise interested readers in personal discussions.

About virtualcitySYSTEMS

virtualcitySYSTEMS is a systems developer specializing in the development and provision of system solutions for 3D geodata. The company was founded in 2005 and is based in Berlin. Our employees have many years of experience in the development and implementation of system solutions for modeling, managing and visualizing complex three-dimensional information spaces. Our showcase project and the driver of constant innovation is the Berlin 3D City Model that we operate for the Berlin Partner GmbH. This model includes over 560,000 buildings in Level of Detail (LoD) 2, hundreds of LoD3 and LoD4 models as well as street trees and location information. Initiated as part of two EFRE projects, the Berlin 3D city model is, to our knowledge, the first comprehensive city model in CityGML-format worldwide and has been managed and published on the basis of our 3D-SDI solution for over five years.

The Berlin 3D city model can be viewed online at www.businesslocationcenter.de/wirtschaftsatlas.

Further information about CityGML can be found at
www.citygml.org
www.opengeospatial.org/standards/citygml.

3D Spatial Data Infrastructure

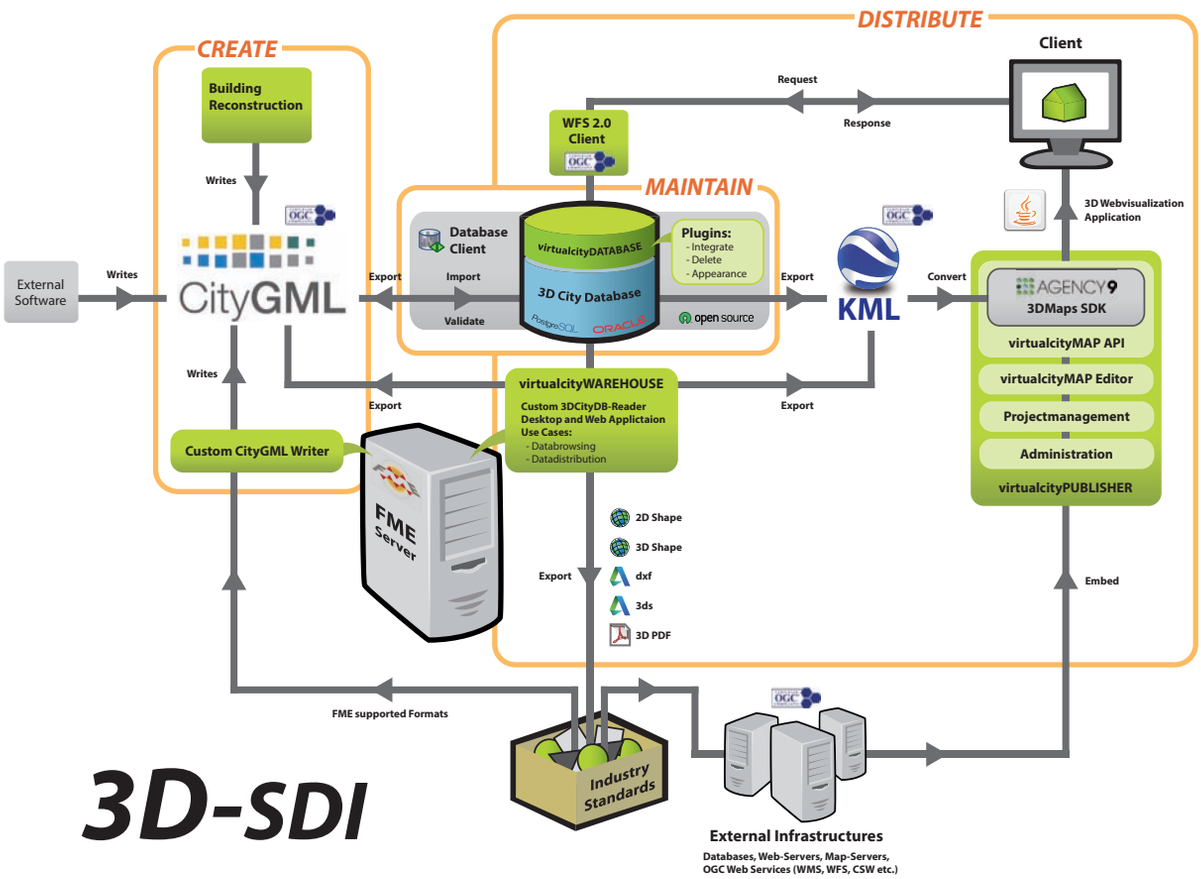
The requirements for a 3D-SDI include not only tools and processes for the initial recording and storage of 3D data but also solutions for an efficient data management and data distribution. Accordingly a state-of-the-art 3D-SDI solution must provide processes and tools for data storage and management, the publication of the 3D data as 3D webmapping applications, and automated data transformation and distribution. The overall goal of a 3D-SDI must be to ease the access to the available 3D data in order to satisfy the needs of heterogeneous user groups.

Naturally, such a solution must fulfill the basic requirements of a SDI, i.e. it should be scalable, robust and reliable and should be based on established technologies wherever possible. This is the basis for the 3D-SDI concept of virtualcitySYSTEMS. It purposely employs established technologies specially optimized for 3D spatial data management and processing. Our 3D-SDI solution comprises the three following core components:

Core components:

- *virtualcityDATABASE for the storage and management of 3D data based on the open-source solution 3DCityDB*
- *virtualcityPUBLISHER as an authoring system for creating 3D webmapping applications based on the virtualcityDATABASE and the Agency9 visualization solution 3DMaps, and*
- *virtualcityWAREHOUSE as data conversion and exchange solution based on the Feature Manipulation Engine (FME) and a 3DCityDB connector developed in-house.*

These modules can be used alone or in combination to handle specific requirements for a 3D-SDI. The following figure illustrates the interaction of the three components.



virtualcityDATABASE

The virtualcityDATABASE (vcDB) is an enhanced version of the open-source 3D City Database (www.3dcitydb.net), that provides a CityGML-compliant database schema for Oracle Spatial and PostgreSQL/PostGIS as well as a Java-based tool for data import and export. The vcDB is based on the database schema and functional scope of the open-source solution, but enhances it with additional functions and modules to optimize the updating and management of 3D data. To do so, it employs an enhancement mechanism provided by the 3D City Database, which ensures the compatibility of both solutions. We also offer our customers comprehensive support, bug fixing and consulting as part of a maintenance contract. Thus users of the vcDB benefit from an open-source database model which can be adapted and enhanced to customer needs as required and at the same time they can use additional functions and modules for data maintenance and management.

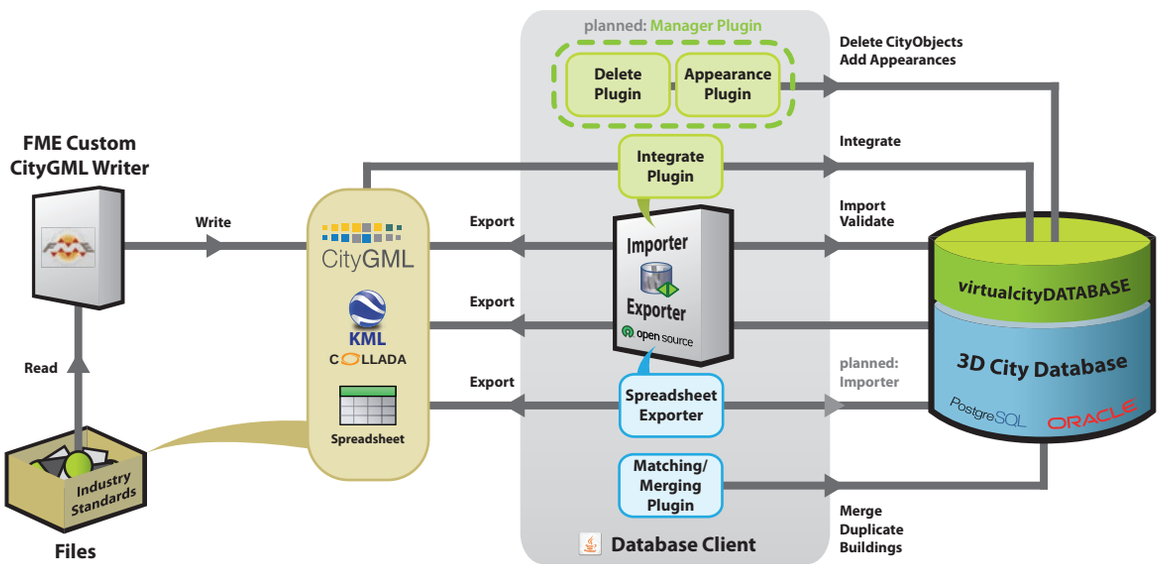
Since the virtualcityDATABASE is based on established database technologies (Oracle, PostgreSQL), it is very powerful and scalable if necessary. Users of the vcDB receive a powerful data storage component that does not only allow the storage of 3D building data but also all other topographic objects of a virtual city model (tree models, bridges, street furniture and other elements). At the same time the open source code basis and the modeling and storage of the 3D data based on the international standard CityGML provides a future proof investment and is system and vendor neutral.

The virtualcityDATABASE is the basis for our publishing solution virtualcityPUBLISHER and our data conversion and exchange solution virtualcityWAREHOUSE. These can naturally also be used with the open-source version of the database. However, we recommend using the virtualcityDATABASE as it has been extensively tested and optimized for interaction with the publishing and data distribution solutions.

virtualcityDATABASE Extensions

Compared to the 3DCityDB, the virtualcityDATABASE contains enhancements that effectively support data management and thereby greatly simplify the updating of 3D city models. In version 1 (as of June 2013), the following enhancements are available:

- *Integrate Plugin - Supports the integration of different LoD levels of a building feature respectively the replacement of existing building geometries and attribute, and thus simplifies continuation workflows*
- *Delete Plugin - Supports the deletion of buildings via delete lists or complex filters*
- *Appearance Plugin - Supports the assignment of simple materials (color values, transparency) to building surfaces based on simple and complex filters*
- *ISO/OGC-compliant WFS 2.0 interface*



virtualcityPUBLISHER

The virtualcityPUBLISHER is a solution for web-based publishing of 3D City Models. The system makes it possible to create large-area 3D webmapping applications on the basis of virtualcityMAP technology and the virtualcityDATABASE. It is an ideal solution for the publication of CityGML-based 3D City Models.

The virtualcityPUBLISHER provides a web-based interface that enables users to select project areas of any size and configure them for web-based 3D visualization. The city model data within the selected region is automatically converted into a data streaming format. In addition to the 3D data generated this way, external WMS services can be integrated into the 3D visualisation as map overlays. After conversion of the city model and terrain data, the map editor in virtualcityPUBLISHER is used to configure the layers and views for display as interactive 3D web map in just a few steps.

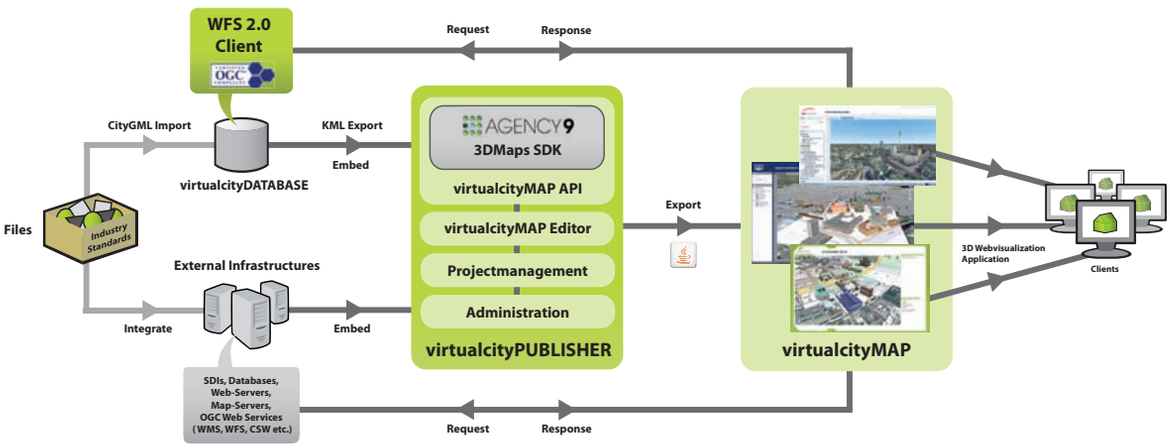
In addition to the automated data conversion processes and the layer editor the solution provides many options to further enhance the 3D web maps. These options include the support for the integration of WMS services as terrain overlay and the support for oblique images as well as Widgets that integrate special functionalities. Such Widgets can be used to integrate WFS layers, activate WMS GetFeatureInfo requests and search functionalities as well as creating a link of the active view, measurements and real-time shadows. Customers that want to combine the virtualcityPUBLISHER with our WAREHOUSE solution can additionally embed an export Widget that will enable users to interactively select and export single objects or an area within the 3D view.

Target Groups

Thanks to its modular structure, use of web standards and support for CityGML, virtualcityPUBLISHER is ideally suited to implementing individual solutions for different user groups. The focus is primarily on 3D geodata providers which want to grant access to their 3D data for different user groups. The integrated job management and database connection make it possible to generate 3D web mapping applications and update them regularly or as needed. Typical usage examples include 3D geodata portals for public presentation and distribution of 3D spatial data.

virtualcityMAP-Technology

The visualization technology integrated into the virtualcityPUBLISHER is the 3DMaps technology of our Swedish partner Agency9. The Java-based rendering engine supports the visualization of very large 3D City Models in a browser. As part of the virtualcityPUBLISHER a JavaScript API for our virtualcityMAP framework can be used to directly interact with the 3D web maps that users have created.



virtualcityWAREHOUSE

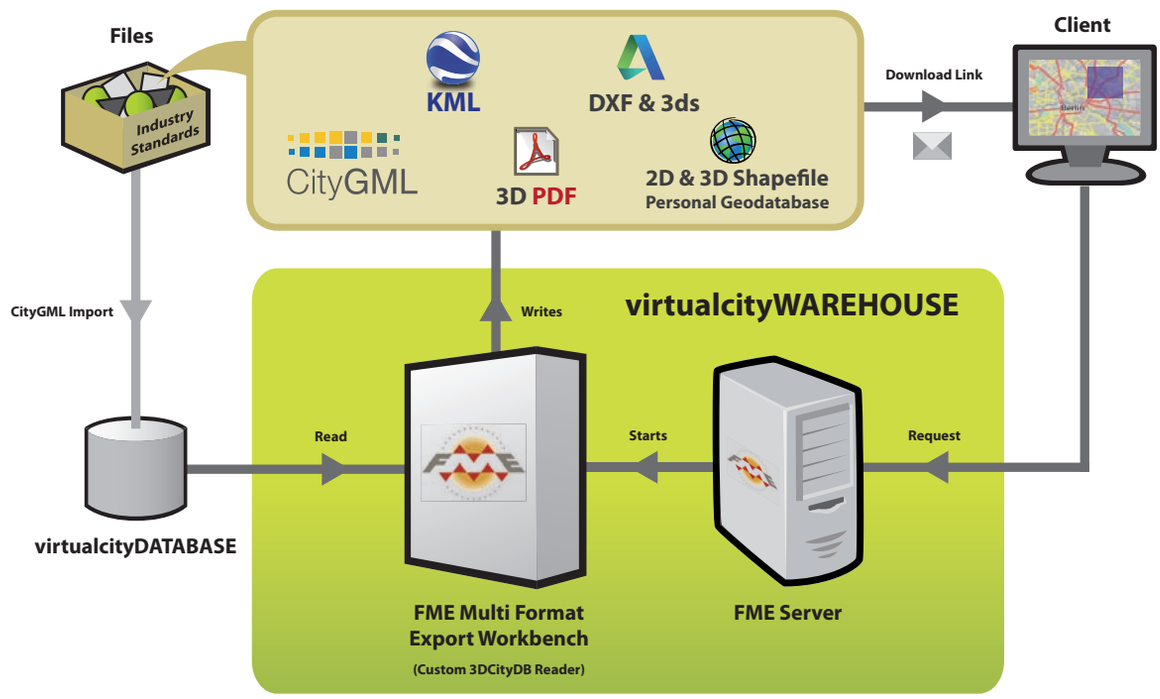
Building on the virtualcityDATABASE and the FME technology from Safe Software, we offer a flexible and scalable data distribution solution. With our virtualcityWAREHOUSE solution, it is possible to extract 3D data from 3DCityDB or virtualcityDATABASE, transform it into various target formats and coordinate systems and ultimately integrate it into different target systems.

The foundation for this solution is our in-house-developed custom 3DCityDB reader for FME with which CityGML data can be loaded directly from a virtualcityDATABASE/3DCityDB and converted into common 3D formats. These transformations can be directly integrated into an existing FME Workbench or FME Server, so users can prepare and export data with just a few clicks. If implemented as a server solution, the data export can be completely automated. A website is provided through which the selection of the region to be exported, the target format and the target coordinate system can be configured in just a few steps and the export process initiated. In combination with an eShop system, a geodata warehouse solution can be implemented.

If an FME Server solution is not available or data formatting is to be conducted by internal staff, data extraction and export to the desired target formats can be done using an FME Desktop version.

Key Features

- *Automatic tiling of large datasets*
- *Selection of six target formats - ESRI Shapefile (PolygonZ), ESRI Multipatch (FGDB), Autodesk DWG and 3DS, CityGML and KML/Collada (support of additional formats is possible)*
- *Support of coordinate transformations*
- *Selection of desired LoD level*
- *Supports textured and untextured data export*
- *Supports the CityGML feature types Building, ReliefFeature and SolitaryVegetationObject (others in planning)*
- *Supports the 3DCityDB/virtualcityDATABASE versions based on Oracle Spatial and PostgreSQL/PostGIS 2.0*



Technical Requirements

The technical requirements listed here are for orientation purposes and make no claim to completeness. The actual requirements can differ in practice from the basic requirements depending on the use, data volume, system infrastructure and performance expectations. We would be happy to put together an individualized requirements profile optimized for the client's particular needs.

virtualcityDATABASE - System Requirements

The virtualcityDATABASE requires Oracle Spatial 10g R2/11g R2 or PostgreSQL with PostGIS enhancement (version 2.0 or higher). The minimum system recommendations for these products can be found in the respective product documentation. To ensure high performance, we recommend using powerful hardware that conforms to the following guidelines.

- *OS: Microsoft Windows Server 2008 R2 / 2012 Standard Edition (x64) or a UNIX/ Linux-based system (e.g., Redhat Enterprise Linux)*
- *CPU: 2x Quad-Core with 2,9 GHz or better (Intel Xeon oder AMD Opteron)*
- *RAM: 32 GB DDR3 (should be extensible)*
- *HDD: Dedicated SAS RAID controller with 512 MB cache / 2x 146 GB SAS (6G), min. 10.000 U/min for system and software installations (RAID 1) / 6x 128 GB SSD as RAID-5 (4+1, 1x Hotspare) memory for database user data (should be extensible)*
- *Software: PostgreSQL 9.2, PostGIS 2.0 or Oracle Spatial 10g R2/11g R2*

virtualcityPUBLISHER - System Requirements

The virtualcityPUBLISHER requires the virtualcityDATABASE or the 3D City Database. Standard internet technologies are also required on both the server and the clients.

virtualcityPUBLISHER Application Server

- *OS: Microsoft Windows Server 2008 R2 / 2012 Standard Edition (x64)*
- *CPU: 1x Quad-Core mit 2,4 GHz or better (Intel oder AMD)*
- *RAM: 8 GB (should be extensible)*
- *HDD: 50 GB for system and software installations / Memory for usage data in accordance with the scope (e.g. quality/resolution of input data, etc.), min. 500 GB (should be extensible) / SAS disks and RAID-5 configuration are recommended (fast data access)*
- *Software: Apache HTTPD Web server; Apache Tomcat 7; Java 7; MySQL 5.5*

Client Requirements

Current Web browser (e.g., IE9, Firefox, Chrome)
Java Runtime Environment 1.6 or current

3DMaps License Server

Use of the 3DMaps technology from Agency9 requires that each client can access a license server. This license server does not require special hardware requirements at the server side, but must be reachable for all accessing clients. If used simultaneously on intranet and/or internet, special firewall/proxy configurations are necessary. We are happy to advise clients on appropriate network planning.

virtualcityWAREHOUSE - System Requirements

The virtualcityWAREHOUSE solution requires at least an available FME Desktop installation. In this basic configuration, data extraction and conversion can be conducted via properly equipped work stations via the FME Workbench program interface.

Optionally, and in combination with the FME Server, Web-based geodata formatting solutions can be implemented which utilise the full range of functions of the FME Server (such as e-mail notifications, download or FTP file upload services) and can be integrated in existing portals.

The recommended system requirements depend on the selected scenario and the FME product being used. Further information is available at the Safe Software website: www.safe.com.

If you have any questions, we would be happy to advise you personally.

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If you have further questions,
We are happy to advise you in a personal conversation.

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