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Public Participation and Urban Planning supported by OGC Web Services

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1 ABSTRACT

In cities of the future the efficient administration and exchange of information will become more and more important. This especially affects the communication between the municipality and the inhabitants of the city. An effective and sustainable urban planning is only possible with the participation of as many persons concerned as possible. For this purpose, effective methods for communicating planning information, as well as corresponding comments and proposals of citizens have to be developed, using the rapidly growing medium Internet.

A basic prerequisite for the effective usage of internet technology in the communal area is the support of standards. Standardized data models and exchange formats have to be established for the communal planning data itself and for the internet based access to the data. This paper deals with spatial planning in the urban area and introduces some relevant standardized internet services (Web Feature Service - WMS, Web Map Service - WFS) and data exchanges formats (CityGML, XPlanGML).

The actual potential to support spatial planning and public participation on the basis of these technologies is demonstrated by two examples. The first example is a WMS-based Internet platform of the city of Hamburg, used for public participation in the approval procedure for urban plans. The urban plans are inserted into the corresponding database via the XPlanGML exchange format. Furthermore, the IfcExplorer software is presented, enabling the common evaluation and visualization of virtual 3D-City Models (CityGML format), Detailed Urban Plans (XPlanGML format), and georeferenced raster images.

The principal capabilities of the Internet and Web Service technology are by far not used to day. Especially by using intelligent combinations of different data sources via standardized exchange formats new communal services can be established in the future.

2 INTRODUCTION

The design of urban land-use plans requires the cooperation of different actors. For the success of planning projects traceability and acceptance are of fundamental importance. Hence it is necessary to inform the stakeholder as far and extensive as possible and to give them an overview about planning and status quo of proceedings. Particularly in urban planning there are often most different competing interests and land-uses. In context of participation processes in urban planning these diverse interests and ideas of land-use must be recognised, analysed and balanced to minimise conflicts and to reduce consequential costs. In general the participation of public authorities, public agencies and general public in preparation of a land-use plan has the following aims:

- to broaden consideration documents (information function);
- to participate general public in planning processes (strengthening democracy);
- to improve influence in planning processes (legal protection);
- to raise the acceptance of planning projects.

The realisation of participation processes is as a general rule costly, longsome and responsible for up to 60% of the total cost of the urban land-use plan procedures. In many places these participation processes are still completely analogously dealt (round tables, written inputs, planning documents sent by post, etc.), because for a long time there was no legal regulation for realisation of e-participation processes in Germany. With the adaptation of EU guidelines from 24.6.2004 in the German federal town planning law (BauGB, §4a, Nr. 4) it is now possible to use e-information technologies for public participation in urban planning.

An important prerequisite for the efficient and cost-effective implementation and operation of e-participation platforms is the usage of standards. This concerns the planning data itself as well as the methods to access these data. Participation platforms normally integrate data produced by different providers, e.g. different communal agencies or private planning companies. Without a standardized format to collect and integrate the data, large effort in data conversion and quality control has to be spent. During a participation process different actors, which normally have different IT-systems, need to access and evaluate the data. Again, without standardized access methods this will be technically difficult and cost intensive. This paper therefore reviews some relevant standards, specified by the international standardization organisation “Open Geospatial Consortium” (OGC), and demonstrates two software applications based on OGC standards.

3 URBAN PLANNING RELATED OGC STANDARDS

3.1 Standardized data models

At the moment, there are two standards for the exchange of geographical information relevant for public participation in urban planning: CityGML and XPlanGML. Both are derived from the XML-based OGC standard GML-3 (OGC 2007A) for the exchange of geographic data.

CityGML (OGC 2008) represents important “objects” of a city like relief, buildings, traffic infrastructure, water bodies, vegetation or city furnitures with their three dimensional geometry, their semantic meaning and their relevant attributes. The attributes cover classification, function and actual usage of an object. Certain classes e.g. buildings have additional attributes like the “year of construction” or the “number of storeys”.

All CityGML classes can occur in 5 different „levels of detail“ (LOD0 – LOD4). Each LOD corresponds to a certain degree of accuracy and complexity in the geometric representation and the semantic structuring. A LOD0 CityGML model only contains a Digital Terrain Model representing the relief. In LOD1, semantic objects like buildings exist, but they have no thematic structuring and are roughly approximated geometrically by an extrusion of the building footprint. In higher levels of detail, the geometric representation is more and more refined, and a thematic structuring of a building is possible. A LOD2 CityGML building allows a classification of the exterior shell into wall surfaces, roof surfaces, ground surfaces and additional building installations. In a LOD3 model, these objects additionally can refer to openings like doors or windows. In the highest level of detail, a CityGML building may also have interior rooms, being composed of interior wall-, floor- and ceiling surfaces.

An important feature of CityGML is an inherent mechanism called Application Domain Extension (ADE) to extend the standard. By defining an ADE the set of attributes and relations of each CityGML class can be extended, and new classes being related to CityGML classes can be specified. This is especially important for defining data exchange formats for special applications, which need application specific objects and attributes. As first example, an ADE supporting noise simulation has been defined (Czerwinski et al. 2007). Actually, extensions of the CityGML standard for modelling subsurface objects, bridges and supply networks are being defined. In a first step the new thematic models will be published as ADE, before they will become part of the standard.

The standard XPlanGML (Benner, Krause 2007) represents the planned use of a city area from a juridical point of view. In contrast to CityGML, the XPlanGML objects have a two dimensional geometrical representation. The standard is based on the regulations of the German urban planning law: Baugesetzbuch (BauGB), Baunutzungsverordnung (BauNVO) and Planzeichenverordnung (PlanzV). The XPlanGML objects and their corresponding attributes represent legal restrictions and regulations in using selected parts of a city for buildings or other purposes. Restrictions may be formulated geometrically (e.g. specification of the area where buildings are allowed or forbidden) and/or attributive (e.g. specification of a maximal height, number of storeys or occupancy index of a building). If a specific regulation cannot be formalized by a set of attributes, an integration into the XPlanGML data model as free text is possible. Optionally, this text can be related to specific parts of the planning area.

3.2 Standards for Internet based services

The two most frequently used services specified by the OGC for internet based access to geographical information are the Web Map Service (WMS) and the Web Feature Service (WFS). Both have a common structure, defining a number of XML-based requests and responses exchanged between client and server, and use the HTTP communication protocol.

A WMS (OGC 2006) produces maps of spatially referenced data dynamically from geographic information. A map is defined to be a portrayal of geographic information as a digital image file suitable for display on a computer screen. WMS–produced maps are generally rendered in a pictorial format such as PNG, GIF or JPEG, or occasionally as vector-based graphical elements in Scalable Vector Graphics (SVG) or Web Computer Graphics Metafile (WebCGM) formats. Thus, normal internet browsers can be used as client software for a WMS.

The WMS standard defines three operations: one returns service-level metadata (**GetCapabilities**); another returns a map with well-defined geographic and dimensional parameters (**GetMap**); and an optional third operation (**GetFeatureInfo**) returns information about particular features shown on the map. The parameters of the GetMap request enable e.g. the specification what information is to be shown on the map, which portion of the earth is to be mapped, the desired reference coordinate system, and the output image width and height.

A WMS delivers access to geographic data by means of a pictorial (map) representation. If the original data are available as features and the client software needs to access these data, e.g. for data-transfer or interpretation purposes, a Web Feature Service (WFS) has to be provided. This is another internet service standardized by OGC (OGC 2005), transferring vector data in GML format like CityGML or XPlanGML. Like the WMS, the WFS standard defines a number of operations in terms of XML-based requests and responses. The **GetCapabilities** requests delivers metadata of the service, in response of a **DescribeFeatureType** request the server provides the corresponding GML-3 application schema, and **GetFeature** requests for GML features. The syntax of the GetFeature request allows a spatial or semantically filtering of features using XPath (W3C 2007) expressions.

4 ONLINE PLATFORM FOR PUBLIC PARTICIPATION IN URBAN PLANNING

Internet supported participation of public authorities, public agencies and general public in preparation of a binding land-use plan saves expenses, raises the transparency and the attraction of the public management. But there is no established „Best Practice solution" for the internet supported delivery of comments in planning process throughout Germany. Therefore, in the Free and Hanseatic City of Hamburg a new web (GIS) application prototype was developed in cooperation with the TuTech Innovation GmbH to support the formal participation processes in urban land-use planning. The online participation platform becomes part of the geodatainfrastructure of the Free and Hanseatic City of Hamburg and hence must consider the corresponding GIS (OpenGIS) standards and services.

The project "Bauleitplanung Online - Pilot" (BOP)" (urban land-use planning online prototype) has the scope to determine a solution to design an Internet based working environment (online-platform) for the formal legal public participation and the participation of public agencies in urban land-use planning. Within the project a prototypical participation internet portal platform was designed and tested on the basis of two real urban land-use planning participation processes. The online participation platform centrally allocated all relevant planning documents online. The comments from public authorities, public agencies and general public to the respective planning processes could be delivered electronically on the participation platform and processed without media conversion. For presentation of spatial data a WMS webgis map client is integrated into the platform.

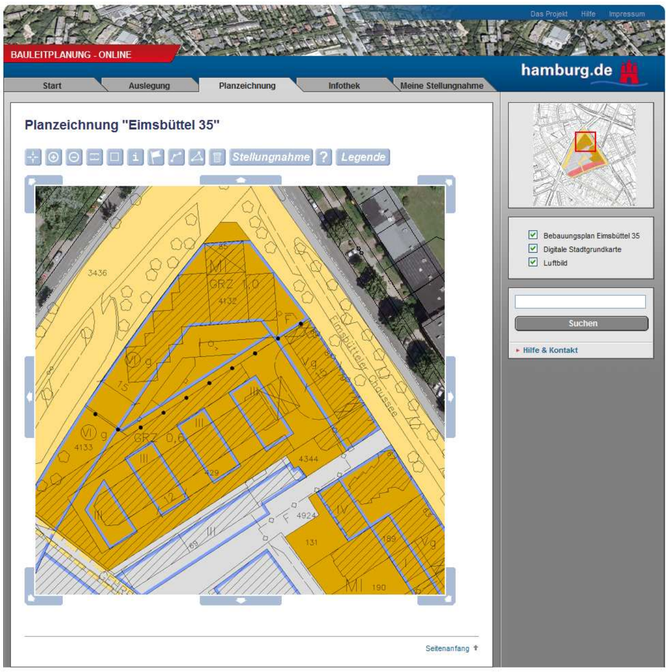

Figure 1a: WMS Map Client

Information	Inhalt
Geschossfläche in qm, als Höchstmaß	17400
Grundflächenzahl	0,4
Gliederung	WA 1
Festsetzung gemäß	1.1.3. Allgemeine Wohngebiete
textliche Festlegung	1. Im allgemeinen Wohngebiet werden Ausnahmen für Gartenbaubetriebe und Tankstellen nach § 4 Absatz 3 der Baunutzungsverordnung in der Fassung vom 23. Januar 1990 (BGBl. I S. 133), zuletzt geändert am 22. April 1993 (BGBl. I S. 466, 479) ausgeschlossen.
textliche Festlegung	2. In den mit WA1 bis WA5 bezeichneten Allgemeinen Wohngebieten sind bei der Berechnung der Geschossfläche die Flächen von Aufenthaltsräumen in Geschossen, die keine Vollgeschosse sind, einschließlich der zu ihnen gehörenden Treppenräume und einschließli
textliche Festlegung	3. In den mit WA1 bis WA5 bezeichneten Allgemeinen Wohngebieten sind Stellplätze nur in Tiefgaragen zulässig. Die Oberkante der Tiefgarage einschließlich ihrer Überdeckung darf nicht über die natürliche Geländeoberfläche herausragen.
textliche Festlegung	4. In den mit WA1 bis WA5 bezeichneten Allgemeinen Wohngebieten darf die festgesetzte GRZ für Tiefgaragen bis zu einem Wert von 0,7 überschritten werden.
textliche Festlegung	15. Auf der mit (B) gekennzeichneten Fläche ist Wohnen nur dann zulässig, wenn zuvor auf der angrenzenden mit (A) gekennzeichneten Fläche ein Lärmschutz errichtet wurde, der mindestens die Höhe der auf der Fläche (B) zu errichtenden Gebäude hat.
textliche Festlegung	16. Durch geeignete Grundrissgestaltung sind die Wohn- und Schlafräume innerhalb der mit (A) und (A1) gekennzeichneten Flächen den lärmabgewandten Gebäudeseiten zuzuordnen. Kinderzimmer sowie Wohn-/Schlafräume in Einzimmerwohnungen sind wie Schlafräu
textliche Festlegung	17. Im Allgemeinen Wohngebiet ist für je 300 m2 der nicht versiegelbaren Grundstücks-fläche mindestens ein Baum zu pflanzen.

Figure 1b: GetFeatureInfo response from a regulation contained within the binding land-use plan

The practical test has confirmed that a visualisation of a binding land-use plan as a WMS achieves an obvious added value, as soon as additional information is questionable like textual regulations contained within the binding land-use plan.

Comments can be handed on textual planning documents as well as on geometric features representing regulations contained within the binding land-use plan. In addition annotations can be marked as a point, line or surface on the map in the webgis client. These annotations together with the corresponding statement are stored in a spatial database with the help of an OGC transactional Web Feature Service (WFS-T). These statements again can be visualized in the map client of the participation platform with help of OGC WMS geoservices and checked upon theirs relevance in external professional GIS systems of public authorities or public agencies.

For the first time the semantic data model XPlanGML (see chapter 3.2) describing the geometrical and logical content of spatial German urban, regional and landscape plans independent from its graphical representation was considered. With introduction of the XPlanGML standard in the Free and Hanseatic City of Hamburg binding land-use plans will be stored on the central geodataserver in a uniform object schema. With the help of a standardized data format for binding land-use plans, in future it will be not anymore necessary to convert and process binding land-use plans, stored in different data formats, for a presentation in a WMS client of a participation platform individually.

5 INTEGRATION OF PLANNING DATA VIA STANDARDIZED INTERFACES AND WEB SERVICES

5.1 The IfcExplorer Software

The IfcExplorer is prototypic software for integration, analysis, three dimensional visualization and conversion of spatially referenced data. Originally designed for exploring the semantic building model IFC (Eastman 1999), the software now supports different GML-based GIS data formats (CityGML with different ADEs, XPlanGML, rudimentary GeoSciML) and DXF. For GML based information, different sources belonging to different GML application schemata can be merged in one internal data model. Actually, CAD data are stored in a separate internal data model. Under certain conditions, a transformation from a CAD data model into the GIS model is possible. By means of a geometrical generalization, IFC models can be mapped on LOD1 CityGML models (Nagel 2007). The transformation of DXF data into CityGML LOD2 *Building*, *WallSurface* and *RoofSurface* objects is possible, provided the DXF file has a specified layer structure.

The IfcExplorer can access file-based information and (for GIS-data) internet based information via Web Feature Services. Furthermore, three dimensional vector data can be overlaid with georeferenced raster information provided by Web Map Services.

The visualization component of the IfcExplorer supports a broad spectrum of possibilities for an interactive exploration of the 3D scene. Viewing position and viewing angle of the scene camera can be chosen arbitrarily. The amount of objects visible in the scene can be selected on the level of classes ("show only buildings", "hide the relief") or on the level of individual objects. In a similar way, the graphical style of visible objects (colour, transparency, texture) may be determined by the object class or the value of a selected object attribute. For configuring these presentation parameters, the 3D scene is supported by a textual representation of a scene tree (figure 2 a), showing the hierarchy of all loaded objects. A single object can be selected in the scene tree, and the attributive information associated with this object is optionally displayed (figure 2b).

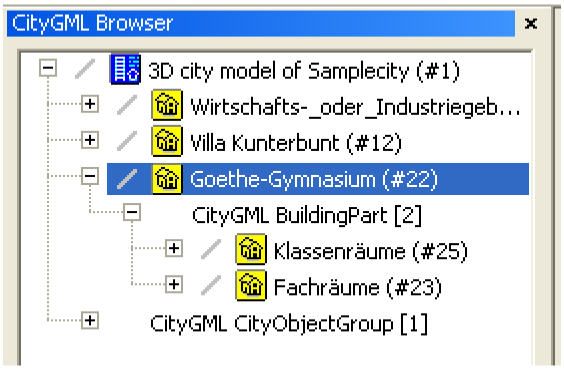

Figure 2a: IfcExplorer scene tree

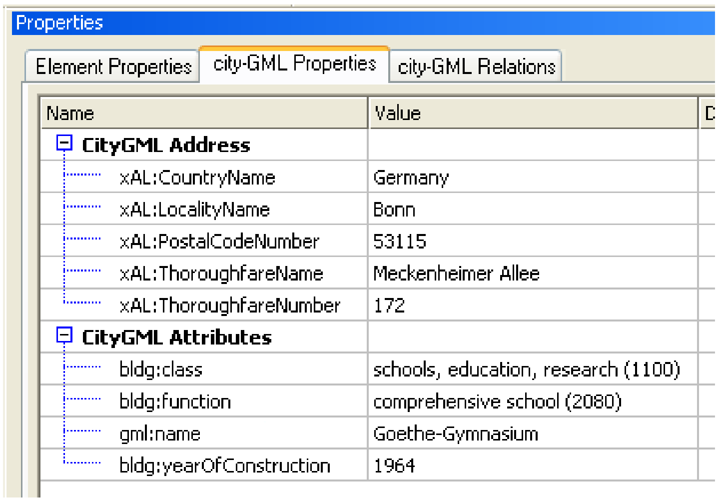

Figure 2b: Attributes of the building "Goethe-Gymnasium"

5.2 Integration of urban planning related data

For testing the integration of urban planning related geographical information with the software tool IfcExplorer, a test scenario has been established. It uses data of a building area in the city of Hamburg where the prototypic public participation procedure "Bauleitplanung Online" (chapter 4) also has been tested. For this area, the following information is available:

- A virtual 3D city model (buildings and relief) as CityGML LOD1 and LOD2 model;
- the draft of new urban plan in XPlanGML vector format and (via WMS) as raster image;
- digital orthophotos (via WMS);
- a digital map (Digitale Stadtgrundkarte) with measure 1:1.000 (via WMS).

With these data, the IfcExplorer software in its actual implementation status is able to support the following functions:

- Intuitive visualization of the actual building development in the planning area;
- Checking the consistency of the virtual 3D city model by overlaying the model objects with digital orthophotos (figure 3a) or a digital map (figure 3b). In both cases, the georeferenced raster images are projected on the CityGML relief.
- Checking the consistency of the actual building development (represented by the CityGML model) with the new urban plan (figure 4).

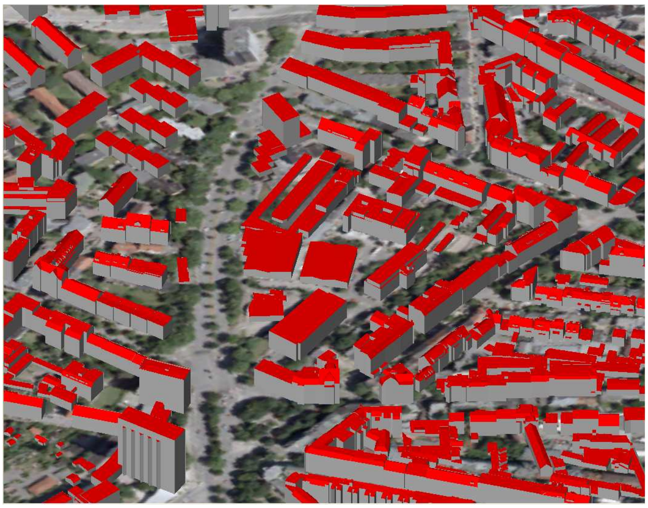

Figure 3a: Overlay of virtual 3D city model with a digital orthophoto

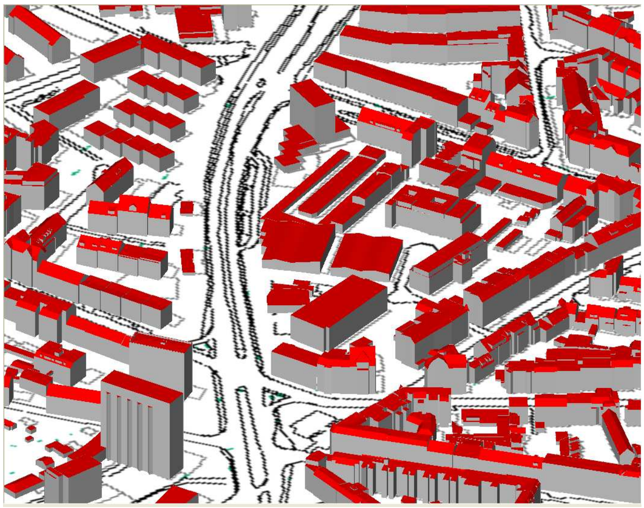

Figure 3b: Overlay of a virtual 3D city model with a digital map.

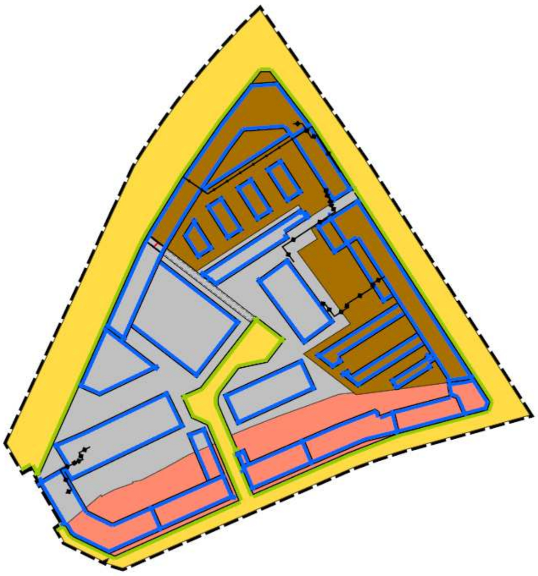

Figure 4a: Urban plan in vector format

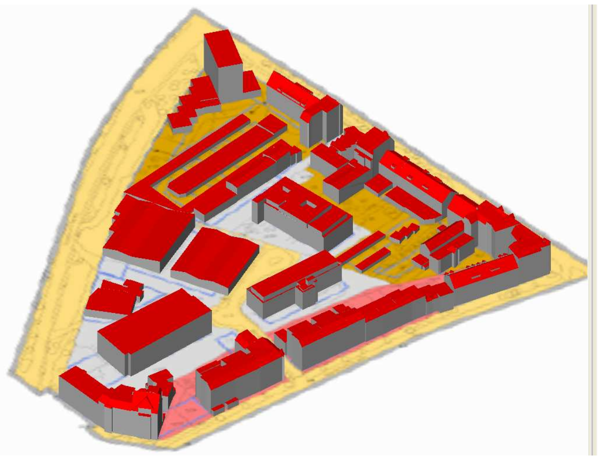

Figure 4b: Overlay of urban plan (raster format) with virtual 3D city model

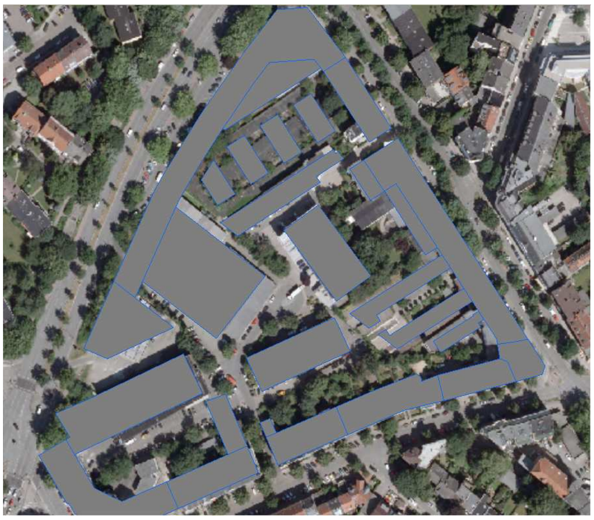

Figure 4c: Overlay of a part of the urban plan (allowed area for

Figure 4d: Overlay of a part of the urban plan (allowed area

buildings) with orthophoto for buildings) orthophoto and 3D city model.

Actually, the IfcExplorer mainly supports the visual exploration and comparison of geodata from different sources by integration into a common spatial reference system and a problem suited three dimensional visualization. The overlay of LOD2 city model with the official map and the orthophoto (figure 3) proves a high quality of the virtual model. The combined visualization of the abstract and complex urban plan (XPlanGML format) and the intuitively understandable virtual 3D city model (figure 4) supports interpretation of the planning situation especially for non-professionals. The overlay obviously shows some inconsistencies between the actual building situation and the planned status, due to the fact that in course of an urban development project some of the buildings will be demolished.

In the next releases of the IfcExplorer software the purely visual examination will be supported by geometric and semantic analyses. The condition that each CityGML building object is located within the "allowed area" for buildings (XPlanGML class *BP_UeberbaubareGrundstuecksflache*) can easily be checked geometrically. Furthermore, the CityGML building model contains attributive information like *storeysAboveGround* (actual number of storeys) which is restricted by selected XPlanGML-attributes (*Zmax* – maximal number of storeys above ground, see figure 5). The standardized CityGML model not yet contains all parameters and attributes relevant for an approval due to German planning and building licensing law. However, a CityGML ADE may be defined for this specific application. Thus, on a long term an automation or at least software-based support of the licensing procedure for buildings seems to be possible

Figure 5: Evaluation of attributes

6 SUMMARY AND OUTLOOK

In the paper two different standardized data formats, relevant for spatial planning in the communal area have been presented, and the two important communication standards WFS und WMS for internet based access to spatially referenced data have been introduced. Both communication methods are successfully used in the online platform BOP for public participation in urban planning, developed and operated by the Free and Hanseatic City of Hamburg.

The user interface of the BOP system, as well as its corresponding functionality in visually exploring, analysing and commenting urban planning documents demonstrate the actual state of the art in e-participation technology. The prototypic software IfcExplorer shows the additional functionality which could be realized with advanced software on the client side. Besides the visual overlay of 2D and 3D information from local files, vector data from WFS Servers and raster data from WMS servers, the IfcExplorer software enables the geometric and semantic analysis of the integrated data. In cities of the future, this opens new possibilities for the provision of communal services in the area of public participation in land-use planning processes or online support in the licensing process of new buildings.

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Internet Resources

XPlanGML: www.xplanung.de

CityGML: www.citygml.org; www.citygmlwiki.org

Open Geospatial Consortium: www.opengeospatial.org