WEBGIS FOR URBAN INFORMATION MANAGEMENT -

HAMBURG’S APPROACH FOR INTEGRATING WEBGIS IN E-GOVERNMENT INFRASTRUCTURES

Extended Abstract for the GeoViz Workshop, March 3-5, 2009 | Hamburg, Germany

Presented By: Sascha Tegtmeyer
State Enterprise Geoinformation and Surveying of the Free and Hanseatic City of Hamburg

Introduction
The Free and Hanseatic City of Hamburg is Germany’s second largest city and one of 16 federal states with a population of 1.7 million people. The Hamburg metropolitan area is a dynamic and prospering urban centre which includes Hamburg and 14 other rural districts with a span of nearly 20,000 square kilometres with more than 4 million inhabitants.

In this context the public administration faces several fields of work which are related to spatial information. Some of the main tasks to deal with are urban development, climate-protecting measures and social area development.

The public administration uses geovisualization to explore these spatial information. In times of progressing e-government infrastructures web based geographic information systems (WebGIS) take a growing role in decision support systems. In this context the State Enterprise Geoinformation and Surveying (LGV) of the Free and Hanseatic City of Hamburg develops solutions to meet the demands of a sustainable use of spatial data in the public and the private sector.

These WebGIS build the user interface for dynamic visualizations of geoinformation in different levels of detail and dimensions. They connect people with geodata and resources and are fitted to the requirements of customers from the economy, the general public and the public administration itself.

The development of WebGIS requires the installation of an underlying spatial data and spatial service infrastructure for Hamburg and the metropolitan area described in the first part of this paper. Constitutive on this infrastructure the focus will point on three WebGIS examples and the geovisualizational aspects to deal with in the e-government infrastructure of Hamburg and the metropolitan area.

Requirements
Without an underlying e-government infrastructure no geodata could be published over the world wide web. The technical progress and needs through the development of Spatial Data Infrastructures (SDI) on international, national and regional levels enhanced the development of standards and software for the distribution of geoinformation over the web. The following figure 1 illustrates the different levels of SDI, in which Hamburg as city and federal state is involved in.
Beneath international SDI initiatives like the Infrastructure for Spatial Information in Europe (INSPIRE) or national initiatives like the spatial data infrastructure germany (GDI-DE) Hamburg works directly on SDIs on the regional level like the spatial data infrastructure of the metropolitan region Hamburg (GDI-MRH) and the spatial data infrastructure Hamburg (GDI-HH). Through cross border projects like the GDI-MRH there is an intensive exchange with Hamburgs neighbouring federal states for bringing their SDIs together.

For such infrastructure you need a computer network (the internet), server (hardware) and software for delivering and visualization of geoinformation. These software is divided in services for sharing and visualization of geoinformation and graphical user interfaces to access and interact with these information.

The geoinformation services are standardised by the Open Geospatial Consortium (OGC) and the International Organization for Standardization (ISO). The services used for the realisation of the following WebGIS solutions are the Web Map Service (WMS) for showing geo-registered maps as raster format images and the Web Feature Service (WFS) for retrieving geographic features.

Todays graphical user interfaces for retrieving geoinformation are internet browser based programmes, the so called WebGIS, which communicate over standardised interfaces with geoinformation services. Through this interactive geovisualization WebGIS takes its course under different topics throughout the internet.

The following three example WebGIS solutions for the digital city Hamburg are based on miscellaneous software components for the services and the user interface. Here should only be mentioned the use of the open-source software Mapbender for the Solar Potential Atlas and the Portal of the Spatial Data Infrastructure of the Metropolitan Area of Hamburg. The WebGIS for the Hamburg Transport Association was realized by implementation and adaption of the OpenLayers javascript libraries.

**WebGIS in Hamburg – a practical view**

Static maps have a limited informational capability. Geographic Information Systems in the internet and geovisualization allow the user to explore interactive maps with lots of different types of up-to-date data. You can zoom in or out and change the data combination of the map.

Today’s WebGIS vary between pure information platforms to the point of interactive generic portals with the ability to capture and analyze spatial data. The LGV uses according to the requirements of public tasks several types of WebGIS with a different range of functions. The development of these WebGIS is attended by a wide range of challenges that vary from e-government infrastructure guidelines to security concerns and intuitive user interfaces in service oriented architectures.

The following examples offer only a choice of representative WebGIS solutions for the public scope of duties in hamburg and the surrounding area mentioned in the introduction.
Solar Potential Atlas

In some cases the chain of causality of human influence on the climate is direct and unambiguous. Therefore these days climate protection is an issue on all governmental levels. The city of Hamburg and with it the State Ministry of Urban Development and Environment Hamburg contributes to this with a variety of projects. One of these projects is to find areas for an efficient photovoltaic use.

First of all roofs of public schools will be analyzed regarding their suitability. The LGV developed a browser based geographic information system in the intranet of the City of Hamburg to visualize this process. This WebGIS called Solar Potential Atlas helps to identify and administer roof surfaces of public school buildings for a potential photovoltaic use. Therefore the public school surfaces, the roof surfaces and the solar potential surfaces are displayed on top of hamburgs basic data. Figure 2 shows the start screen of the Solar Potential Atlas.

The whole visualization of geodata in the WebGIS is based on the Open Geospatial Consortiums standard Web Map Service. The searching of streets and house numbers is realised upon the standard Web Feature Service Gazetteer. With this architecture it is possible to deliver the visualization of identified roof surfaces in every workstation browser and in other standard based WebGIS or GIS in the city administration.

By clicking on the solar potential surfaces you get additional information like schoolnames, school adresses, number of floors in the building and if the school is designated to a historic monument. A solar potential analysis is made by the LGV, if the experts of the State Ministry of Urban Development and Environment Hamburg identify a school roof as a potential solar surface. The analysis consists of videos and 3D-PDF-Exposés which are linked in the Solar Potential Atlas after the creation.

The following figure 3 presents a school with an solar potential roof surface as a layer over an aerial image. As well you can see the information window and beneath it a screenshot from the related 3D-PDF-Exposés.
The Solar Potential Atlas is the combination of data-generation and visualization of spatial related public geoinformation in a WebGIS solution based on standard web services. So the LGV provides the public administration with an instrument to support the management of building measures in the climate protection context in Hamburg in an efficient way.

Portal of the spatial data infrastructure of the metropolitan area of Hamburg

Spatial information does not end at state borders. Therefore neighbouring states are co-operating with Hamburg in establishing and running a WebGIS to offer spatial data and services to the public and the private sector for the metropolitan area of Hamburg¹.

The Portal of the Spatial Data Infrastructure of the Metropolitan Area of Hamburg should realize the uniform access to basic and specific spatial data over federal state borders for the three states Hamburg, Schleswig-Holstein and Lower Saxony. The work on this WebGIS differs in a technical and a content regarding part.

The technical part of the realisation includes the definition of standards for web services and the definition of functionalities of the WebGIS. The implementation of functionalities and the administration of the WebGIS is made by the LGV. The technical working group in this SDI project has written a system of rules for all participants who want to take a part with their spatial data. See the start screen of the portal with uniform basic maps served from three different federal states below in figure 4.

¹ Web Address: http://www.geoportal.metropolregion.hamburg.de/
The content regarding part includes the definition of themes and on the semantic and visual harmonisation of spatial data from different federal states. It is additionally required to define uniform styles and legends for the specific data types: e.g. the color and the attributes of nature protection areas shown in figure 5. Therefore working groups with members from three different federal states on different administrative levels discuss and develop styling rules in an time-consuming process for the different themes visualized in the portal.

Figure 4: Start screen of the portal

Figure 5: Nature protection areas over federal state borders
To visualize one theme from three different state server as one is it necessary to cascade the web map services. The LGV administers not only the WebGIS, it also merges a multiplicity of WMS from the three states to build uniform datasets for the user.

Alongside the visualization there is the informational part. To show all information of the different WMS in a uniform way it is necessary to transport the WMS GetFeatureInfo-Request through the cascade. This is often a difficult concern because of the heterogeneous GetFeatureInfo-Result formats of the different WMS software. LGV realised it by using XSLT, which is a language for transforming XML documents into other XML documents. Incoming GetFeatureInfo results in XML from different WMS are parsed through a specific XSLT document and transformed into a standard GML and HTML result.

The Portal of the Spatial Data Infrastructure of the Metropolitan Area of Hamburg shows how a uniform visualization over state and administration border could be realized in a SDI. It also shows that this process is accompanied by a lot of organisational and communicational work.

**WebGIS for the Hamburg Transport Association**

A network of rapid transit and regional rail lines, all leading into the city centre, forms the core of local public transport in the Hamburg area. The Hamburg Transport Association (HVV) manages the entire service offer on behalf of three federal states, seven counties and 35 public transport operating companies. That includes all services by bus, harbour/river ferry and rapid transit (U-, S-, A-Bahn) or regional rail (R-Bahn). The aim of this project was to build a homogenous map for the whole HVV area shown in the overview in figure 6 with an interactive WebGIS interface to get service information about the stations and lines linked with a personal timetable.

![Figure 6: The HVV area](image_url)

This is not a project motivated by a SDI-initiative but an application for a customer. The homogenous map for the HVV area was created by the cartographers of the LGV. Therefore map data from the two other federal states (Schleswig-Holstein and Lower Saxony) were bought to build up one map out of one hand matched to the requirements of the HVV. The HVV area is not full congruent to hamburgs metropolitan region but it covers a big part of it with approximately 3.3 million residents. The HVV WebGIS contains additionally to this basic data the routed bus lines, ferry lines and stops as extra overlays.

The focus at this project lies not on semantic and geometric harmonisation like in SDI initiatives. The focus 2 Web Address: http://www.hvv.de/
lies on the development of an intuitive WebGIS user interface with a high-performance data supply. All developments and geodata come out of one hand.

So far you can enter an address or the name of a stop or station to get your personal timetable on the HVV website. After getting your personal timetable you are able to view the chosen start or destination in a map of the surrounding area.

This map is static and heterogeneous in its presentation and its level of detail. The new WebGIS will be integrated in the HVV website with the possibility to choose your destination first from the map before you get to your timetable.

The HVV WebGIS offers the following new possibilities:

- homogenous map presentation of the whole HVV area in eight different zoom levels made available through a high-performance TileCache³ server
- interactive WebGIS with an intuitive user interface, for example zoom per mousewheel and GetFeatureInfo-Requests without activation over a toolbar
- integrated non-standard gazetteer-service based on the technique used in the personal timetable
- bus lines, ferry lines and stops are available via WMS, their status could be set to hide or show by setting them active or inactive with a map options tool
- GetFeatureInfo request of stop informations by clicking the stops in the map, the information are delivered through a popup window shown in figure 7 which contains the following information:
  - name of the stop
  - operating line numbers
  - a link to retrieve the personal timetable with this stop as start or destination
  - a link to retrieve the line and route timetable
- simple update of lines and stops by a vector based database administration

³ Web Address: http://tilecache.org/

Figure 7: Information popup window with stop characteristics
The combination of TileCache and WMS-techniques guarantees a stable and high-performance geovisualization of the HVV area in the web. The LGV cartographers had made the maps for the different zoom levels by thinking in an object based model of the world.

The WMS Tiling Client Recommendation\(^4\) was the result of a set of discussions at the FOSS4G conference in 2006. The recommendation describes a way to constrain WMS requests to a predefined grid, so that clients can request data that has been pre-rendered or rendered on the fly and then cached.

The vector based WMS layers were visualized with rules for the different types of lines and stops in the several zoom levels over Styled Layer Descriptor (SLD). Every zoom level has slightly other SLD rules to adjust the visualizion of the lines and stops at the current zoom level.

The rapid transit and regional rail stops are inserted in the basic raster map. There is an extra vector layer with transparent symbols over the basic raster map to retrieve the information for these stops.

Developing such a WebGIS shows the challenges of interactive map visualizations. Map data adjusted to predefined zoom levels with the ability to retrieve up-to-date information is here realised with standardised webs services and an intuitive WebGIS user interface.

**Conclusion**

The previous examples of WebGIS developed for Hamburg and the surrounding area showed the practical challenges of geovisualization in todays WebGIS solutions. The display of distributed data over standardised web services like the Portal of the spatial data infrastructure of the metropolitan area of Hamburg require time-consuming communications and work on different organisational levels. But with an installed infrastructure you are able to easily build up different application specific WebGIS. Even the connection of a two-dimensional presentation of schools in the Solar Potential Atlas with the advanced call of three-dimensional information show the ability of geovisualization in practical WebGIS application.

Spatial decision support systems like the WebGIS for the Hamburg Transport Association shows the geovisualizational difficulties to deal with for highly frequented WebGIS solutions. Caching mechanism in combination with standardised web services had to be adjusted for every zoom level to get an user-friendly interface.

The Free and Hanseatic city of Hamburg with the State Enterprise Geoinformation and Surveying is on its way to produce overvalues with the visualization of spatial information in public and private WebGIS solutions. The ongoing delopment of spatial data infrastructure and the progress in web service techniques build the fundament for the development of WebGIS solutions with more functions to edit and analyze spatial data in e-government infrastructures.

\(^4\) WebAdress: http://wiki.osgeo.org/wiki/WMS_Tiling_Client_Recommendation