Challenges of Information Society for Map Generalization

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Abstract

The advances in communication technologies – the Internet and mobile networks – have transformed the information infrastructure more than any previous networks. The increased speed of connectivity and information transmission, as well as the increased facility of movement, have changed our notions of time, and of distances as well. An interesting question is now how this development will reflect to the use of spatial information and furthermore, what will be the challenges for map generalization? The paper discusses briefly the requirements of the map in the changing world, where *ex tempore* lifestyle is more and more present. Finally, a case study implementation on real-time generalization will be presented and demonstrated by examples. In the prototype implementation *Open GIS* specifications and XML-based tools has been applied.

1. Introduction

While approaching the new millenium the advances in communication technologies – the Internet and mobile networks – have transformed the information infrastructure more than any previous networks. One of the central themes for changes in social communication, brought about by the Internet and mobility is placeless accessibility: any-where/any-time.

The Web platform has been widely recognized by the GIS community as an important new media for the delivery of geographic information. According to Calvert et al. (1997), the impact the new Internet technologies have on traditional surveying and mapping industry could be compared to that of the Global Position System (GPS) technology, satellite imagery and the GIS itself. Never before has such a diverse set of geoprocessing software been connected to the same network, as is the case in the current global World Wide Web environment. The expansion of the Internet provides data suppliers with completely new means for disseminating geospatial information in a visual and interactive manner to the general public.

Besides the Internet environment, a new area of map products has been opened up by mobile technology, combined with GPS receivers. A portable phone offers a possibility to spontaneous forms of real-time interaction with no temporal or spatial limitations. The idea of constant accessibility holds an irresistible fascination for the modern individual – the possibility of receiving attention regardless of time and space. With mobile connections, proximity is electronic and therefore ubiquitous (Kopomaa, 2001). With the convergence of mobile telecommunication and Internet technologies, it will also become possible to send live video images. Furthermore, with location services, the mobile phone may be used as a navigation device in the near future. We are on the brink of a mobile information and interaction society and our interest is now on how these changes will reflect to the role of map and spatial information.

2. The New Roles of a Map

Maps are very efficient tools for transferring geospatial data and they may provide insights and overviews that cannot be obtained with other means of communication. Kraak and Brown (2001) list up the advantages of the Internet as a medium under two main headings: accessibility and actuality. Advantages with Web maps are the possibilities to easily look up places on a map, to pan and to zoom, to select map layers to be displayed, to make use of hyperlink functionality and integrated multimedia components (like sound, pictures and video or animations). According to Kraak and Brown (2001) Web maps satisfy such functions as:

- web maps as the searching mechanisms, further information is reached by using a map as a clickable interface
- web maps as preview of the geospatial data to be downloaded

The current *ex tempore* life style sets demand for accessibility to information in any-where/any-time. Easily accessible and up-to-date spatial information is urgently needed, not only for amusement but also, for instance, rescue workers in cause of natural disasters. It is also expected that the users will become more critical in the respect of the information provided being up-to-date and complete. The use of mobile phones as a navigation device put pressure in developing effective WAP[1]-maps.

With the convergence of mobile telecommunication and Internet technologies it will be possible to supply the users with really up-to-date geographic information any-where/any-time. However, the problem is still in transmitting this information in a flexible way and there is an ever growing need for functional real-time methods, also for generalization of spatial information.

3. The Characteristics of Mobile Maps

Mobile devices have small displays, limited processing power and internal memory and therefore application servers have to be able to adapt presentations to these characteristics (Bjørke, 2000). Since the displays of the devices are very small, the content of the maps and their design must be

[1] The WAP is a specification for a set of communication protocols that standardises the way in which wireless devices, such as cellular telephones and radio, can be used for Internet access, including e-mail (Whatis.com, 2000).

very simple and it is possible to show only the most essential information (Kraak and Brown, 2001). At the moment, several limitations are also set by the monochrome and rather low-resolution displays.

Among design principles applied to WAP/mobile maps could be:
- show relative importance of the map objects, i.e. visual hierarchy of map content
- relative locations between objects important
- objects can be used to access the second level of information content
- maps do not usually have any specific scale since they can be zoomed in and out
- high degree of generalization

4. Prototype Development for Real-Time Generalization

As discussed above the instant nature of the on-line information services necessitates a real-time transfer of data. Consequently, the main motivations for real-time generalization lies in the possibilities to transmit always up-to-date information to the user in any-where/any-time and also, in need to generalize this up-to-date information in arbitrary scales according to the varying user requirements.

The current map data delivery on the Internet is usually based on raster images. The spatial resolution of the image is decided on the server side, and a proper visualization of the map data is achieved only in that predefined resolution. Some map services provide maps in different scales, but the scale levels are often based on pre-created raster datasets. If the various scales are produced from a live database, then all the scale levels have to be stored and maintained in the database level beforehand. However, the approach does not allow an arbitrary display scale to be used. A service might support a continuous scale variation, but achieved simply by zooming the original map image without appropriate changes in the displayed map contents or generalization level of the map objects and symbols. When using the real-time generalization approach the generalized datasets are not stored in the database but rather computed during the data request in real time. The use of individual *ad hoc* scales with appropriate contents and generalization levels opens up more flexible use scenarios for geospatial databases.

A working prototype system has been developed at the Finnish Geodetic Institute (FGI) for testing the above-mentioned techniques (Lehto and Kilpeläinen, 2000). The prototype is based on a three-tier processing model. The first level consists of a Smallworld GIS database server. The middle tier has been developed in-house as a Java Servlet-based Web server extension. Communication between the Smallworld GIS and the middle tier is based on the CORBA technology and on an OGC Simple Features (SF) specification-compliant access interface provided by Smallworld. This is going to be replaced by the SIAS server of Smallworld. A client application on the third level has been built using a free map-visualization Java library, called OpenMap (BBN Technologies, 2000). OGC's GML being used as data encoding language. Another client application tested is the SVG Viewer browser plugin from Adobe (Adobe, 2000).

Major part of the Java development of the prototype done at the FGI is related to the communication between the middle tier and the Smallworld Simple Features CORBA server and to the construction of the XML[2] (eXtensible Markup Language) source tree from the received data.

[2] XML is a subset od SGML (Standard Generalised Markup Language), the international standard of defining descriptions of the structure and content of different types of electronic documents.

The source tree is constructed according to a proprietary data model, designed to facilitate easy XSLT[3] transformations to the known destination data models.

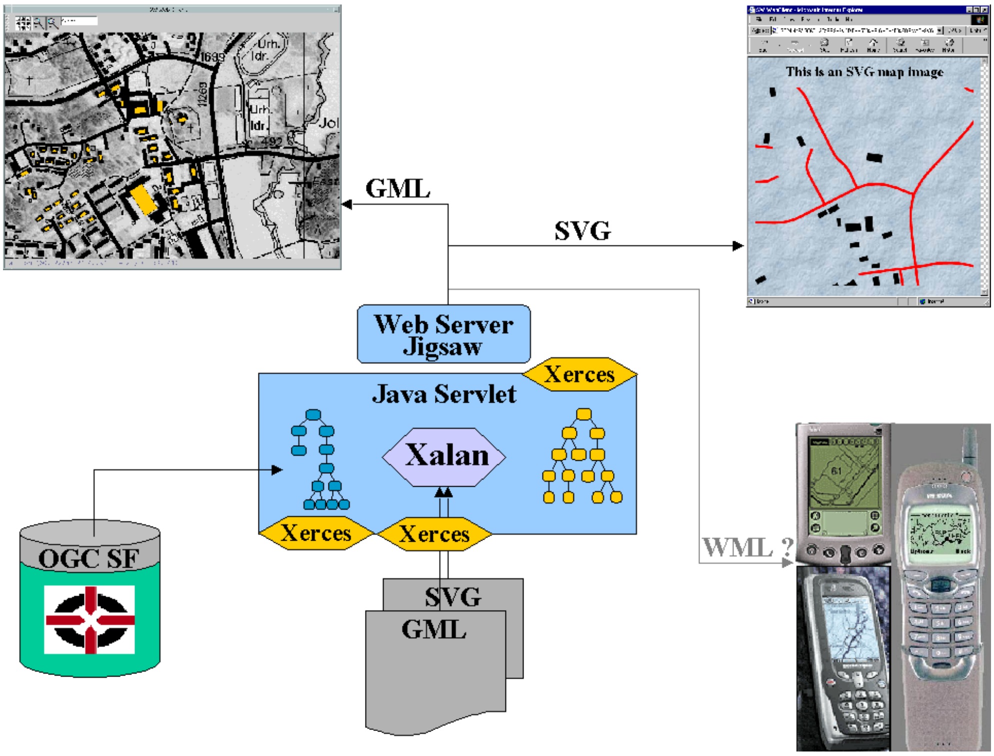


Figure 1. Real-time generalization of XML-based GI

Figure 1 shows:

- XML encoding of GI, OGC's GML, W3C's SVG
- Extensible Stylesheet Language Transformations (XSLT) (by Xalan-XSLT processor)
- XSLTs defined from an application-specific vocabulary to
    - GML, visualized in Open Map-based client
    - SVG, visualized in IE with Adobe SVGViewer plugin
- Real-time generalization carried out during the XSLT transformation

5. Examples on Real-Time Generalization

The main interest in the XSLT-related research carried out at the Finnish Geodetic Institute (FGI) lays in the XSLT process as a means to generalize XML-encoded spatial data in real-time The generalisation operators being developed in XSLT include selection, simplification and aggregation. Individual spatial objects can be selected or rejected for inclusion in the result dataset based on their feature type (like being a building), property value (like having a certain classification code), geometric property (like having an area over a given threshold value) or context in a spatial

[3] XSLT (Extensible Stylesheet Language Transformations) is primarily designed for transforming XML documents for presentation purposes. In the graphics domain XSLT could be used, for instance, to transform a dataset from an application-specific data structure to the new Web vector graphics standard SVG (Scalable Vector Graphics).

hierarchy (like an individual building belonging to a farm). The extension mechanism available in the XSLT processing enables arbitrary, application-specific functions to be introduced into the transformation process. The example functions developed at the FGI include building simplification and aggregation operators.

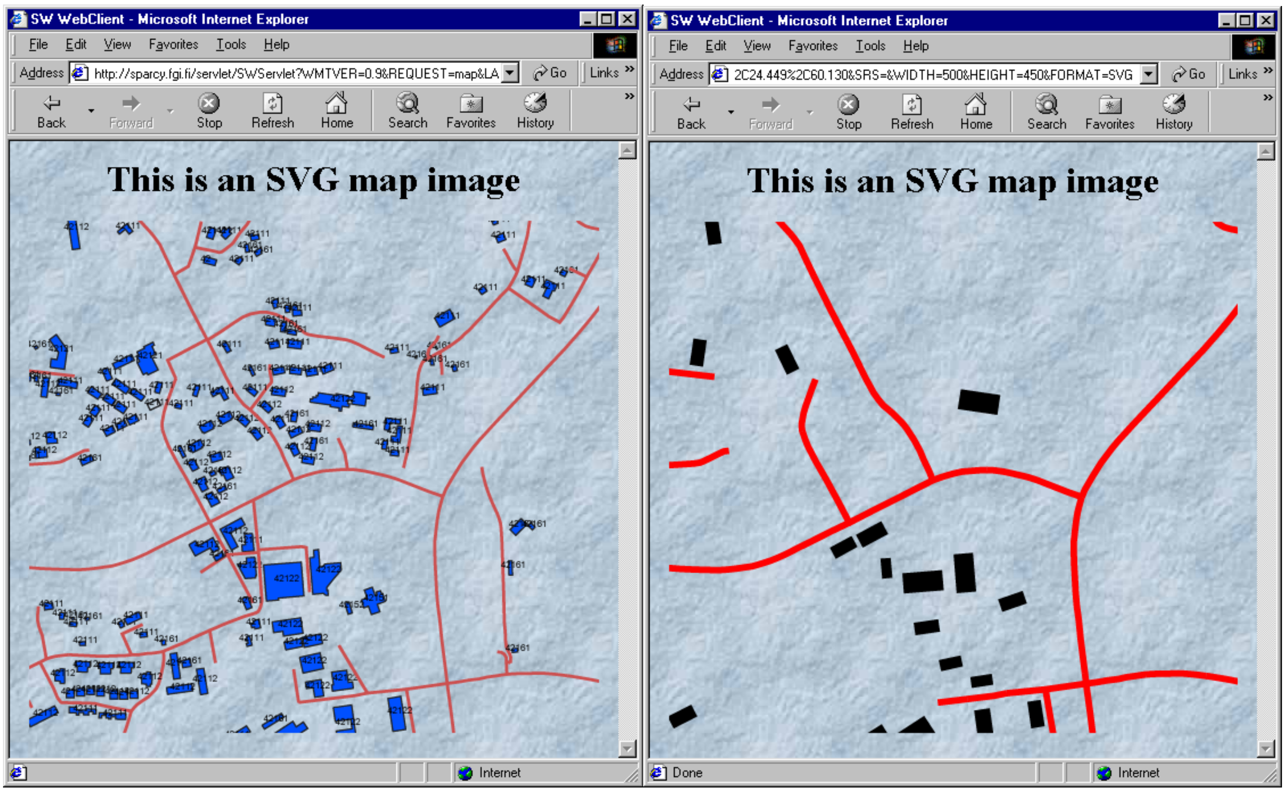
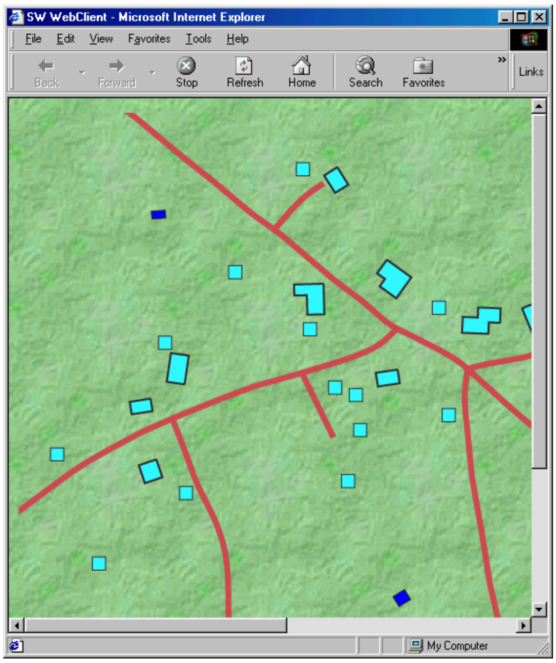
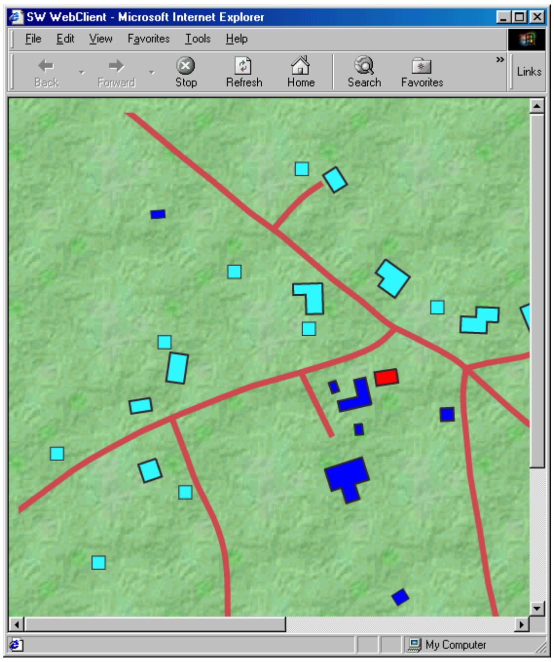


Figure 2. Two SVG displays of the same dataset, transformed by different XSLT processes. Two generalization methods are used in the process: selection and simplification.

In Figure 3 a spatial dataset displayed by Adobe's SVG viewer plugin in Internet Explorer is shown. Displays demonstrate the local interaction capabilities available when datasets are downloaded in vector form. The figure shows a farm represented by individual buildings with out-buildings shown as symbols in Figure 3A. With mouse over the outbuilding are shown with their real geometry in Figure 3B. With mouse click the farm is displayed as one aggregated unit (Figure 3C).

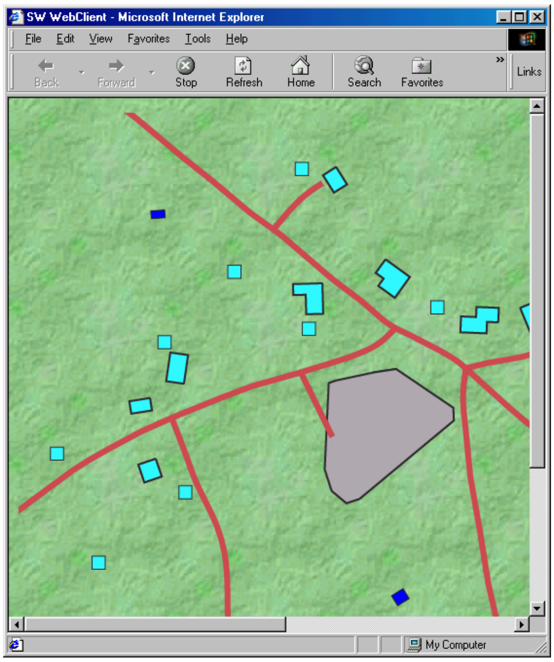


A



B

Figure3. A farm as individual buildings with out-buildings shown as symbols (A). With mouse over the outbuilding are shown with their real geometry (B). With mouse click the farm is displayed as one aggregated unit (C).



C

6. Conclusions

With the convergence of mobile telecommunication and Internet technologies it will be possible to supply the users with up-to-date spatial data in any-where/any-time. At the same time there is a growing need for methods on real-time generalization. As the XML-based data processing becomes widely adopted in the Web, solutions for spatial data transmission using this new technology are needed. Varying needs of the users of GI resources on the Web, and the diverse set of client devices, like mobile phones, they are using, call for mechanisms for generalizing geodatasets in real-time. The XSLT specification is a promising solution to this need. Most simple generalization operations, like filtering out the unneeded parts of the dataset and selecting from among alternative geometries, are readily available. More sophisticated generalization tools can be added via the XSLT extension mechanism. Typical examples include coordinate manipulations, like line smoothing. The generalized datasets are written out as XML data and can thus be easily visualized in various XML-conscious client applications.

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