A USE CASE BASED MOBILE GI SERVICE WITH EMBEDDED MAP GENERALISATION[1]

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ABSTRACT

This paper describes the application of a mobile service that includes embedded map generalisation capability. This technology has been implemented in a project referred to as GiMoDig (Geospatial info-mobility service by real-time data-integration and generalisation). The project has been initiated, in part, to improve accessibility of the national primary topographic databases, especially for mobile users. A prototype system providing a geospatial service have been implemented, and is based on emerging standards, such as XML and Open GIS Consortium's specifications. The work includes a number of innovative aspects. In particular, the GiMoDig involves development of methods for real-time generalisation and data integration, definition of global schema, thematic harmonisation of geodata, development of methods for data transformation to a common EUREF coordinate system, studies on small-display cartography, and implementation of mobile applications tailored to meet a range of needs for different users. This paper provides examples on the application scenarios implemented in the GiMoDig service and shows how the transmitted maps can be adapted to meet the specific user needs through embedded generalisation.

1. BACKGROUND

The evolving applications of different types of mobile devices present new challenges for mobile services and map application providers. Geospatial information is becoming critical for many mobile applications, such as personal navigation, vehicle and shipment tracking, emergency and search operations and a host of other activities. Among many different spatial datasets that can be used in services involving a mobile user, the national topographic map plays a key role in applications that need detailed geospatial information. On top of these data services, third-party service developers can build various end-user applications. This new user-oriented approach to map service provision is beginning to affect the way in which National Mapping Agencies (NMAs) see their role. The traditional supplier-centric view is gradually being replaced by a more flexible and operational workflow, in which the individual user's needs are given a high priority.

The overall objective of the GiMoDig (Geospatial info-mobility service by real-time data-integration and generalisation) project is to improve the accessibility and interoperability of national topographic databases (GiMoDig, 2004; Sarjakoski et al., 2002). A prototype for a cartographic map service has been built

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which delivers geospatial data to a mobile user in real-time. The data is delivered from the geo-databases in the participating countries' NMAs (Finland, Sweden, Denmark and Germany), where the common interfaces are based on XML-coded (Extensible Mark-up Language) data delivery and OGC's specifications (Open GIS Consortium). The data is harmonised according to the Global Schema, defined during the project, and processed into the common ETRS89 coordinate system in real-time. Finally, a vector-formatted high quality SVG (scalable vector graphics) map is displayed on a users' mobile device. Special emphasis has been placed on proving users, who depend on mobile terminals with limited display capabilities with appropriately generalised map data.

The GiMoDig prototype service provides end user applications implemented as use case based approaches. The paper demonstrates how maps for specific user or application cases can be delivered to mobile devices embedding generalisation into the processing. The challenge for the use case based approach requires definition of the user requirements as well as development of easy-to-use applications. One of the key concerns is to define how best to embed the map generalisation functionalities into the applications. This must be done in such a way that end users get the greatest benefit from it to meet their various needs.

2. TECHNOLOGY USED IN THE PROJECT

The general service architecture and the functionality of the GiMoDig map service have thoroughly been described by Lehto and Sarjakoski (2004a, b). A detailed illustration of the GiMoDig service architecture is shown in Figure 1. In brief, the GiMoDig architecture can be described as follows:

The access interfaces are based on OpenGIS Consortium Specifications, Lehto et al. (2004). These interfaces include the Web Map Service (WMS) and Web Feature Service (WFS) and Open Location Services (OpenLS) by the OGC (2004). Testing the interface specifications has been one of the tasks in the GiMoDig project.

The Value Added Service (VAS) and Generalisation Interfaces deviate considerably from the access interfaces, in part because it was necessary to design them for an expansive array of functionality. The parameters of the VAS interface specify the Client Applications information request in such a way that a use-case dependent map can be derived.

A commonly accepted query interface for a spatial data generalisation service does not yet exist. Therefore we designed in the project an access interface on the Data Processing layer for the purpose. This interface includes a part, which indicates the WFS query providing the source dataset for the generalisation process, and a set of detailed instructions and parameters to guide the generalisation computations. The generalisation query interface also provides facilities to add overlay information (points of interest data (POIs)) on top of the topographic data.

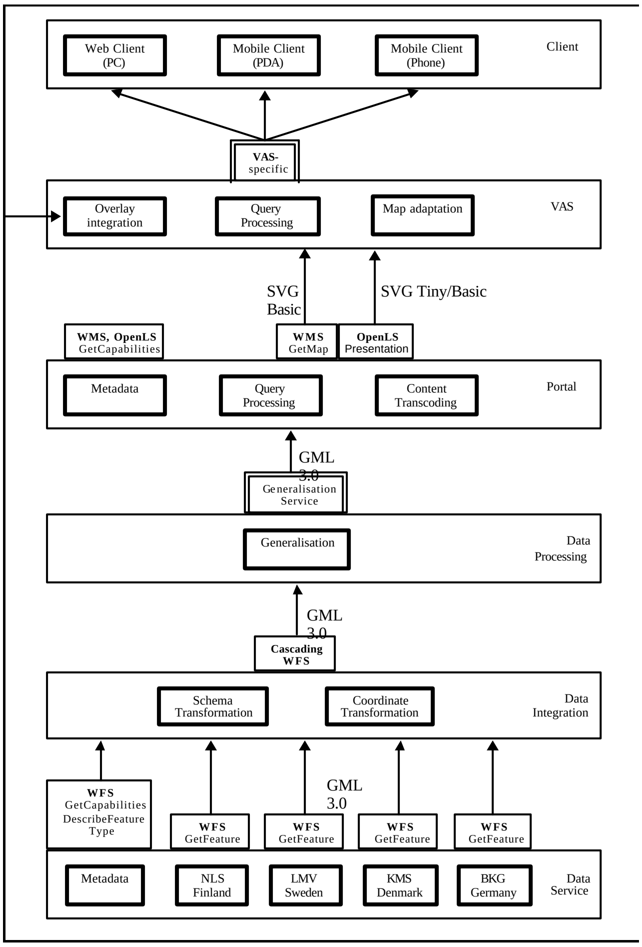

Figure 1. The detailed GiMoDig service architecture (Lehto and Sarjakoski, 2004).

The Data Processing layer forwards the WFS part of the Generalisation query directly to the Data Integration layer. The Integration Service subsequently translates this query to the national data models and coordinate systems as well as sends queries to the relevant national WFS nodes, as determined by the spatial extent of the query window. The transformations from the Global Schema to the national data models are carried out as declarative XSL Transformations. The Data Service Layer contains the national WFS nodes, one in each of the participating countries. These services provide data in the national data models and coordinate systems, encoded in a GML Application Schema.

For implementing the use cases for the end users, the client user interface (UI) and the adaptive maps on a personal digital assistant (PDA) Scalable Vector Graphics (SVG) was used. Our implementation on a PDA, as described by Sarjakoski et al. (2004), were carried out with a Mobile SVG viewer called Embedded Scalable Vector Graphics, eSVG (2004) from Embedding.net.

3. USE CASES FOR MOBILE USERS

There are already a couple of commercial applications for maps on mobile devices, in which the maps are displayed on the screen of a PDA, or a cell phone (Sarjakoski and Nivala, 2004). Most of the applications are for car navigation purposes, but there are also products for off-road navigation for cyclists or walkers

(WebPark (Edwardes et al., 2003); Navman GPS 3300 Terrain 2004; Outdoor Navigator 2004; TomTom CityMaps 2004; Falk City Guide 2004; MapWay 2004).

In the beginning of the GiMoDig project user requirements for potential usage of topographic data for mobile applications were defined (Jakobsson, 2002), since the special aim for the project has been improving the accessibility of national primary topographic databases.

The term use case follows here the terminology used in usability engineering (Kulak, 2002.) In order to evaluate at an early stage of the project the usability of mobile topographic maps, field tests in a national park were arranged with a group of test users (Nivala et al., 2003). The purpose of the evaluation was to identify design principles for maps in small displays, as well as main benefits and obstacles for using topographic maps in mobile devices. One of the key findings was that the main benefit of the mobile map services (besides the location information provided by the GPS module) was the capacity to combine additional information from various databases and present it on top of the topographic map data. From the users' point of view, topographic datasets in different scales are not enough. The users believed that one of the main advantages was also the possibility of zooming between different map scales. The users wanted the step between the scales to be smooth enough so that no one would lose his sense of being in the area, implying that the step should not show the user a totally different-looking view. Visual representation should be consistent between the scales, but users also believed that the step was not needed unless the information content changed. It was also noted, quite naturally, that the small-scale maps were used for planning a route and the larger-scales once for walking along the route. The overview map should contain general information on the terrain, routes and services in the area. With larger-scale maps people were interested in seeing more specific information on nearby areas and also on the available services. The large-scale maps were also expected to provide detailed information on the landmarks in the area.

The test also showed the need to adapt map symbols and other visualizations so that small displays could be effectively used outdoors. The need to adapt the map visualisations has also been discussed by Reichenbacher (2001). It also became apparent that the mobile maps required adaptability to complement specific usage requirements, (Nivala and Sarjakoski, 2003). Based on the defined user requirements and the results from the field-testing, four use cases were identified for implementation during the project: 1) A Hiker in a National Park, 2) An Emergency case, 3) A Cyclist and 4) Expert use. The test area for Use case 1 covers a national park in southern Finland. The Use case 2 test data covers Hanover city, the cycling routes cross the Danish-German boarder area in Use case 3 and finally expert use in Use case 4 will be tested for all our four test areas.

4. EMBEDDED REAL-TIME GENERALISATION

4.1 Personalizing the service

To adapt the mobile maps for different mobile users in different usage situations, the service can be personalised, Figure 2. Based on the results of field testing the implementation includes personalisation of the following characteristics: identity, activity, time, location and device (Sarjakoski et al., 2004). However, the user is not obliged to define the user preferences if she/he so wishes, in which case the application sets the default parameters automatically. The methods of personalizing the service according to the identity of the user include: choice of language and a user's age group. The choice of language reflects the language of the UI. The choice of an age group, reflects the requested map's content and layout of the points of interest

(POI) symbols. We have created a symbol directory for four different age groups (Nivala and Sarjakoski, 2004). Activities here refer to the use cases implemented in the service. The user may select the season or the current time according to which map information she/he is interested in displaying.

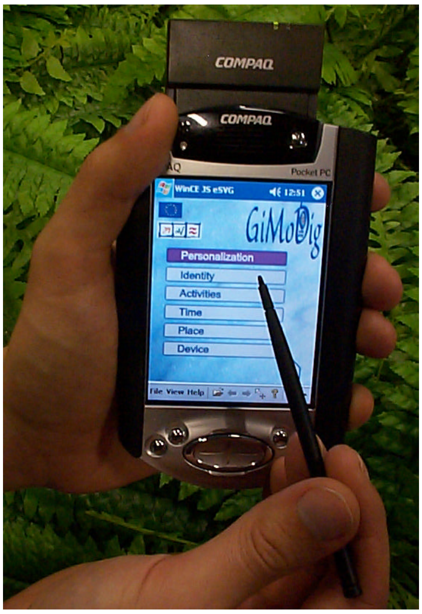

Figure 2. Personalization of the GiMoDig service on a PDA.

4.2 Creating map types

To provide third-party service developers a possibility to create maps that satisfy different users needs, a sophisticated editor has been implemented. This allows the definition of different specifications for a range of map types. As such, map types in different use cases with different levels of details (LoDs) can be specified and automatically entered into the knowledge base of the server. With the aid of the editor the following features of the map types can be controlled:

1) Topographic feature classes to be shown on the map
2) POI data to be shown on the top of the topographic data
3) LoD of the map and generalisation operators to be executed on the topographic features
4) Other visualisation operators to be executed (e.g. symbol placement)
5) Other map layout (e.g. colours, line widths)

Embedded generalisation implies that the generalisation process is done as a part of the whole visualisation process of the map to be delivered to the mobile device and not guided by the end user during the request. The innovative aspect of the map specification editor is that the service can deliver various types of maps which match in real-time with the current context parameters and user preferences.

The real-time generalisation functionality currently implemented into the service includes the following operators:

- Feature selection by object class
- Area selection by min/max value
- Line selection by min/max length
- Contour line selection by interval

- Line simplification by Douglas-Peucker
- Line simplification by Lang
- Line smoothing by Gauss-filtering
- Building outline simplification

In Figure 2 some examples of adaptive mobile maps implemented in the GiMoDig service are shown. The delivered maps have been processed for visualization in real-time. The figure shows how, after personalization, the GiMoDig service can provide adaptive seasonal maps for use cases Hiker in the National Park and Expert use, with embedded generalisation.

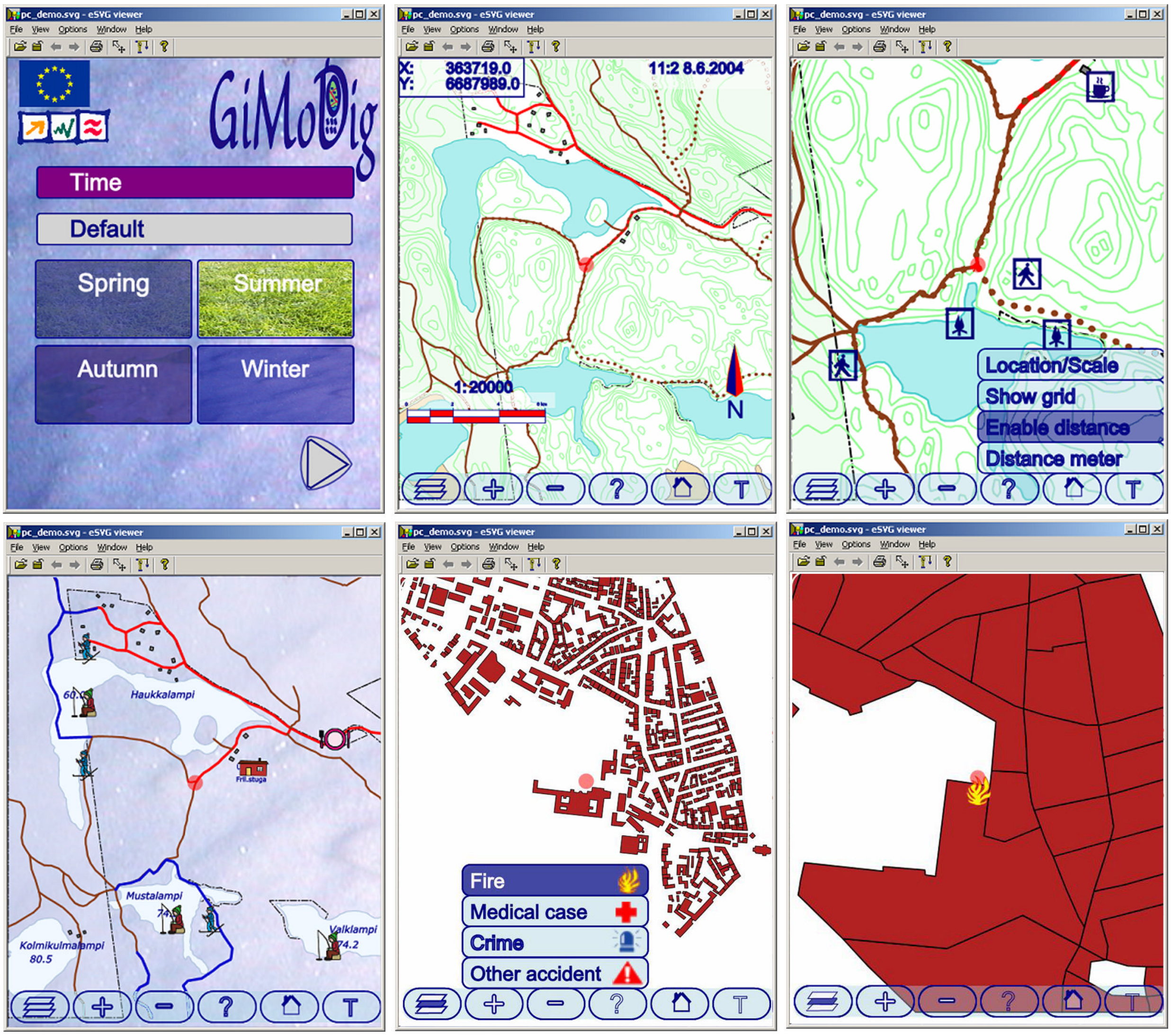

Figure 3. The Figure shows examples of adaptive maps from the GiMoDig service for use cases Hiker in the National Park, Expert use and Emergency: A Fire in Hanover.

In the use case Hiker in the National park, Figure 3, the user is able to get different kinds of maps adapted for the season. The embedded real-time generalisation process includes here a selection of feature types (varying depending on the season), simplification (Douglas-Peucker or Lang), and smoothing by Gauss-filtering. Additionally, symbol placement of POIs is done during the request from the mobile user, (Harrie, 2004). The use case of emergency, shown in Figure 3, is also currently running on the PDA. The use case applies multiple representation techniques as described by Hampe et al., 2003.

5. CONCLUDING REMARKS

The GiMoDig research and development project aims to improve accessibility and interoperability of national topographic databases. Real-time generalisation of geospatial data seems to be especially critical in mobile applications requiring timely and focused information, customised according to context parameters, user preferences and actual location. We have described the architecture of the GiMoDig service developed and shown some examples on the implemented use cases for mobile users in the service, where real-time generalisation is embedded. We also demonstrated how the generalisation functionality is used through the editor to guide the map specifications. This editor could be used as a tool by third-party service developers to add data on top of the national topographic data and tailor the map service for each specific purpose. The development work still continues to the end of the year and still aims to integrate additional generalisation capabilities developed into the service (see also Harrie, 2004; Sester and Hampe, 2004; and Stigmar, 2004). Performance testing is also to be finished during this final stage of the project.

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