

# GEOSPATIAL INFO-MOBILITY SERVICES – A CHALLENGE FOR NATIONAL MAPPING AGENCIES<sup>1</sup>

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### ABSTRACT:

The aim of this paper is to describe the background and the objectives of an European Commission funded project GiMoDig (Geospatial info-mobility service by real-time data-integration and generalisation), which was recently started. The background of the project lies in the goal to improve the accessibility of the national primary topographic databases, especially for mobile users. A prototype system providing geo-spatial service will be implemented and used as a test-bed in the frame of the project. The common access interface is based on the emerging standards like XML and Open GIS Consortium's specifications. Besides methods for transferring vector-formatted data based on standards like GML and SVG, the work comprises several important issues like 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 EUREF co-ordinate system, a study on small-display cartography and identification of the most important use cases for topographic data in mobile environment.

## 1. INTRODUCTION

### 1.1 Background

Geospatial information is vital for many mobile applications, like personal navigation, tracking of vehicles, shipment, and search of services of varying nature. Although many different spatial datasets might be used in services involving a mobile user, the national topographic map plays a key role in applications requiring detailed geospatial information with an extensive coverage. In Europe the National Mapping Agencies (NMAs) are responsible for maintaining the primary topographic databases, covering the whole country. Several smaller scale map products are derived from these databases by applying cartographic generalisation, e.g. (Jakobsson and Salo-Merta, 2001; Just, 2001; Illert, 2001; Kilpeläinen, 1997). Therefore efficient methods

for generalisation are essential for versatile production of highly varying set of map products from geo-databases, and for presenting results obtained in geospatial applications on a mobile platform.

### 1.2 Need to harmonise spatial data

National primary geo-databases are designed mainly national tasks in mind, without considering international co-operation and demands set by the mobile use scenarios. The semantic content of these databases varies from country to country. To create maps covering several countries, harmonisation of these datasets is often carried out as a separate, time consuming conversion task. For a mobile user, real-time harmonisation of geospatial data to a known semantic frame is indispensable, because up-to-date geospatial data is needed especially in an unknown, foreign environment. For the traditional map production

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data integration can also be seen as a possibility to update generalised spatial data (Illert, 2001). Harmonising national primary databases lays foundation to the possibility to integrate cross-border data – a necessity for a mobile user.

### 1.3 Need for common access

A few European NMAs currently provide an open access to the primary topographic geo-database to their citizens. The existing NMA services are based on individual technical architectures – a fact effectively precluding international cross-border map services, needed in activities like environmental monitoring, from being introduced. Pre-prepared raster map series also constitute a serious restrictive factor in the new demand-driven approach to spatial data provision in which the end user or a value-added service provider is seen as the primary actor defining the map extent, contents, style and layout.

### 1.4 Need for real-time generalisation

In each European country only the primary database is usually updated continuously by the local NMA. The need to provide a mobile end-user with up-to-date information, often in a drastically generalised form due to display constraints of the device used, necessitates efficient generalisation methods to be developed. The generalisation methods related to the production of *ad hoc*, personalised maps in a real-time environment have not yet been extensively investigated (Reichenbacher, 2001; Kraak and Brown, 2001).

However, the future user of geospatial data services will expect means for defining, by himself, the contents, coverage, scale, and visual appearance of the product when data are accessed via a network by a mobile device. It can also be assumed that network-based approaches for organising the maintenance and distribution of data will be further developed and also become everyday practice in different areas of life. These trends necessitate the development of more advanced methods for generalisation of geodata, such as real-time generalisation (Lehto and Kilpeläinen, 2000; 2001; van Oosterom and Schenkelaars, 1995; Jones et al., 2000). When using real-time generalisation, the datasets are not stored in the database but rather computed during the data request – response dialogue.

### 1.5 Need for common coordinate system

Modern, satellite based positioning systems like Global Positioning Systems (GPS) make use of the internationally defined geodetic reference frame WGS'84. As a consequence, many European countries have started to modernise their geodetic coordinate systems to be based on EUREF that can be called as the European implementation of WGS'84. However, most of the national primary geo-databases are still maintained in national geodetic co-ordinate systems and nationally

defined map projections. To be used in positioning and navigation applications for a mobile user, it is important to transform the data of national primary spatial databases to a common EUREF-based coordinate system in real time.

### 1.6 Need for small display cartography

Currently, a few examples exist of operative services providing map information to a mobile terminal. The solutions available today in Europe are mostly based on the Wireless Application Protocol (WAP)-technology. In these services map data is transmitted to the terminal as Wireless Bitmap (WBMP)-encoded one-bit raster images. The low resolution of the terminal display naturally sets serious restrictions for the visualisation of map data. Although the display technology can be expected to improve rapidly, intensive research on real-time generalisation and small-display cartography is clearly needed.

### 1.7 Need for vector-data

There are lots of applications, currently available on the Web, that make use of raster-based delivery of spatial data. The approach has several serious limitations. The integration of map datasets coming from different sources becomes practically impossible. The provision of highly customised screen maps is difficult, because map layout and content are usually fixed in the initial configuration of the service. The zooming of the map on the terminal can be accomplished by retrieving a more detailed raster map on each zoom level from the server. Vector-based map information, once downloaded to the mobile terminal, could be locally zoomed without any loss in the graphical quality. The display style of the map could be locally modified according to personal preferences of the user, and additional information could be easily requested from another service and displayed, overlaid on top of the previously downloaded vector map. The use of vector-formatted spatial information on the Web, specifically by applying Extensible Markup Language (XML)-based encodings, is currently under intensive research and development.

## 2. THE SCOPE OF GIMODIG

### 2.1 Project resources

The paper introduces an European Commission-funded project, GiMoDig, Geospatial info-mobility service by real-time data-integration and generalisation, (GiMoDig, 2002). This development and research project is a part of the European Union's Information Society Technologies (IST) – 5<sup>th</sup> framework programme, the theme "Ubiquitous and intelligent info-mobility and geo-information systems". The Finnish Geodetic Institute acts as the co-ordinator for the project and the other partners are: the University of Hanover (Institute of Cartography and

Geoinformatics); Federal Agency for Cartography and Geodesy (Germany); National Survey and Cadastre of Denmark; National Land Survey of Sweden, and National Land Survey of Finland. The project started in November 2001 and its duration is 3 years.

## 2.2 Main goals

The purpose of the GiMoDig project is to develop methods for delivering geospatial data to a mobile user by means of real-time data-integration and generalisation. The project aims to a seamless data service infrastructure providing access, through a common interface, to topographic geo-databases maintained by the National Mapping Agencies in various countries. A special emphasis will be put on providing appropriately generalised map data to the user depending on a mobile terminal with limited display capabilities.

## 2.3 Sub-objectives

Sub-objectives of the project are listed as follows:

- Development of methods and usage practices for generalising the graphic representation of geospatial data in real-time, to be suited for display of the data in varying scales on small, mobile devices with different display resolutions.
- Investigating the problems between national primary geospatial databases, often mutually heterogeneous in thematic definitions, and developing means for real-time harmonisation of data.
- Analysis of mobile use cases to adapt real-time generalisation and harmonisation of geospatial data to the requirements of a user in varying usage situations.
- Development of methods for real-time transformation of spatial data from different national geo-databases to a common, EUREF-based co-ordinate system.
- Investigating and developing methods for transferring vector-formatted spatial data to a mobile user using emerging standards, like Geography Markup Language (GML) (GML, 2002) and Scalable Vector Graphics (SVG) (World Wide Web Consortium, 2002) and testing the applicability of the standards for Web-based spatial services in a international pilot project involving national primary geodata sets.
- Development and implementation of a prototype system that can be used as a test-bed for the developed methods.

## 2.4 Scientific goals

The scientific aims of the project lay on the development of methods for real-time generalisation of spatial data – a field of science so far not extensively researched, but becoming increasingly critical in the modern networked society where up-to-date databases are to be directly accessed by consumers using a widely varying set of terminal devices. The spatial datasets in the GiMoDig project will be served in an XML-based vector format to facilitate flexible data integration and processing by and also support the traditional Web browsing. The pilot will enable a seamless access to the NMAs' data resources from a set of different mobile devices, and from a traditional PC as well. Real-time generalisation of the map data will be performed either on the data providers' server, on a middleware service platform or on the client device. In the GiMoDig system architecture spatial data is maintained in the NMA's server and provided to the network through a standardised access interface. Various value-added services can then be built as layered middleware solutions. The communication between actors in various levels of the system hierarchy are to be based on the emerging spatial Web-standards, especially those developed by the Open GIS Consortium (OGC), (OGC, 2002). The encoding of spatial data being transferred across the network from database level to the middle-layer service providers is going to be based on the XML-technology. Therefore, a specific goal in the research on generalisation is to employ XML-based computing technologies in the process.

## 3. SYSTEM ARCHITECTURE

In Figure 1 a schematic model of the GiMoDig system architecture for the aimed testbed prototype service is shown. The design architecture should facilitate the system to serve a wide array of mobile end user devices with varying characteristics.

The main points to be taken into consideration in system development are:

- the need to integrate spatial data from heterogeneous sources into one seamless service
- the need to perform real-time generalisation of data
- the wide variation in display characteristics of the end-user devices on which the final data visualisation will be carried out
- the aim to satisfy the highly individual needs of a mobile user by providing ad hoc, personalised maps

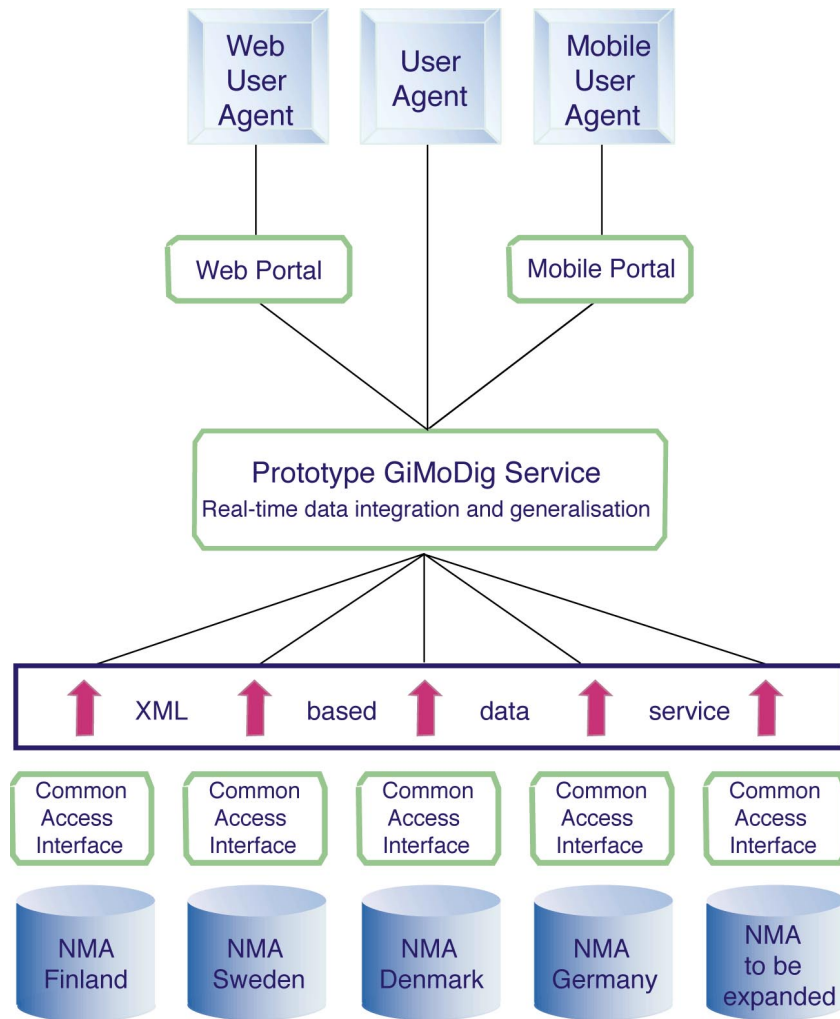


Figure 1. The system architecture of the GiMoDig test bed.

The system should be scalable to support a potentially extensive user community, given the importance of the spatial datasets involved. The architecture should be modular enough to facilitate a reasonable amount of the harmonising work to be done locally by each NMA participating in the project. The system architecture should also support internationally developed interface standards to achieve a maximum possible benefit on the global mobile geospatial applications market place.

#### 4. DISCUSSION AND CONCLUSIONS

GiMoDig is a research and development project with the goal to improve accessibility to and interoperability between national topographic databases. On European level there are other projects, like the already completed “European Territorial Management Information Infrastructure”-project (ETeMII, 2002) and the just recently initiated “Infrastructure for Spatial Information in Europe”-project (INSPIRE, 2002) having a parallel goal but with a broader and more policy oriented approach.

On national and regional level many mapping organisations have already taken steps towards for establishing web-based access to their databases, e.g. the Ordnance Survey’s MasterMap (OS MasterMap, 2002) and Spatial Data Infrastructure North Rhine Westphalia (GDI NRW, 2002). The NMAs in the GiMoDig Consortium have also initiated similar projects. One of the motivations for these projects is the NMAs’ need to deliver the most updated data to their customers. A clear tendency is that these services are built on standard technology, especially using XML and GML.

The main practical goal of the GiMoDig project is to design and implement a prototype of a cross-border spatial data service providing access through a common interface, conformant with international spatial Web standards, into the primary national topographic databases. The provision of a standards-compliant service will promote creation of third-party, value-added mobile information services needed in the position-dependent applications, like traffic guidance, rescue operation management and personal navigation. The GiMoDig project thus aims at facilitating efficient use of the

extensive amount of resources invested in the creation of nation-wide topographic databases, and at the same time advances the exploitation of the multimedia-capabilities available in the technically advanced telecommunication networks in Europe.

Besides the practical goals, the research in real-time generalisation is seen as important. Real-time generalisation of geospatial data seems to be especially critical in mobile applications needing timely and focused information, customised according to the user preferences and actual location.

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### References:

- ETeMII, 2002. European Territorial Management Information Infrastructure, <http://www.ec-gis.org/etemii> (accessed March 22, 2002).
- GiMoDig, 2002. Geospatial info-mobility service by real-time data-integration and generalisation, <http://gimodig.fgi.fi/> (accessed March 22, 2002).
- GDI NRW, 2002. Spatial Data Infrastructure North Rhine Westphalia GDI NRW, [http://gdi-nrw.uni-muenster.de/index\\_e.html](http://gdi-nrw.uni-muenster.de/index_e.html) (accessed March 22, 2002).
- GML, 2002. Geography Markup Language (GML) 2.0 OpenGIS® Implementation Specification, 20 February 2001, <http://www.opengis.net/gml/01-029/GML2.html> (accessed March 22, 2002).
- Illert, A., 2001. Multi-Scale GIS: From Generalisation to Data Integration. In: *Proceedings of 20<sup>th</sup> International Cartographic Conference*, August 6–10, 2001, Beijing, China, Vol. 3, pp. 1690-1699.
- Jakobsson, A. and L. Salo-Merta, 2001. Definition of a Basic Topographic framework for National GI Policy – One Database for All Basic Topographic Data. In: *Proceedings of 20<sup>th</sup> International Cartographic Conference*, August 6–10, 2001, Beijing, China, Vol. 4, pp. 2197-2205.
- Jones, C. B., A. I. Abdelmoty, M. E. Lonergan, P. van der Poorten, and S. Zhou, 2000. Multi-Scale Spatial Database Design for Online Generalisation. In: *Proceedings of the 9<sup>th</sup> Spatial Data Handling Symposium*, Beijing, pp. 7b.34-7b.44.
- Just, L., 2001. Designing new maps adapted to user needs. In: *Proceedings of 20<sup>th</sup> International Cartographic Conference*, August 6–10, 2001, Beijing, China, Vol. 2, pp. 1056-1062.
- Kilpeläinen, T., (currently L. T. Sarjakoski), 1997. Multiple Representation and Generalization of Geo-Databases for Topographic Maps. *Publications of the Finnish Geodetic Institute*, No. 124, Doctoral dissertation, Kirkkonummi, 229 p.
- Kraak, M-J. and A. Brown, 2001. *Web Cartography, developments and prospects*. Taylor & Francis Inc, London, 209 p.
- Lehto, L., and T. Kilpeläinen, 2000. Real-Time Generalization of Geodata in the Web. In: *International Archives of Photogrammetry and Remote Sensing*, Vol. XXXIII, Part B4, Amsterdam, pp. 559-566.
- Lehto, L. and T. Kilpeläinen, 2001. Generalizing XML-encoded Spatial Data on the Web. In: *Proceedings of 20<sup>th</sup> International Cartographic Conference*, August 6–10, 2001, Beijing, China, Vol. 4, pp. 2390–2396.
- OGC, 2002. OpenGIS® Implementation Specifications, <http://www.opengis.org/techno/implementation.htm> (accessed March 13, 2002).
- OS MasterMap, 2002. [http://www.ordsvy.gov.uk/os\\_mastermap/](http://www.ordsvy.gov.uk/os_mastermap/) (accessed March 22, 2002).
- Reichenbacher, T., 2001. The world in your pocket – towards a mobile cartography. In: *Proceedings of 20<sup>th</sup> International Cartographic Conference*, August 6–10, 2001, Beijing, China, Vol. 4, pp. 2514-2521.
- van Oosterom, P., and V. Schenkelaars, 1995. The Development of an Interactive Multi-Scale GIS. In: *International Journal of Geographical Information Systems*, Vol. 9, No. 5, pp. 489-507.
- World Wide Web Consortium, 2002. Scalable Vector Graphics (SVG), <http://www.w3.org/Graphics/SVG/> (accessed March 8, 2002).