Proceedings of the 5th WSEAS Int. Conf. on APPLIED INFORMATICS and COMMUNICATIONS, Malta, September 15-17, 2005 (pp276-280)

Internet Geographic Information Systems as a Part of Information Systems – State of Art

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Abstract: - Along with increasing dependency of mankind on information and communication technologies their quality has become an important issue in the branch. People are now interested in the quality of service, data, software, information system, etc. Internet geographic information systems are a quite new kind of information system but their utilization and importance rapidly grows. They are used not only for business and planning purposes but for such a critical application like emergency system too. Article deals with utilization of Internet geographic information systems in a role of regular information system for everyday work. The state of art is described. Some quality issues connected to the topic are mentioned too.

Key-Words: - Internet geographic information systems, Internet GIS, quality, Geoenabled Web

1 Introduction

Internet geographic information systems represent quite new branch of information and communication technologies although history of geographic information systems (GIS) themselves started in 1960s. Internet GIS have risen in the end of the 20th century and they undergo a rapid development. Their development was driven by a wide spreading of Internet and increasing demand for easier access of regular and casual users to geographic information [1].

Today, many various technologies exist which allow remote access of end-users without special education in the field of geoinformation science to geographic information. One can find a lot of various terms which are used while talking about this kind of technology. Some examples are: GIS applications on Internet/intranet [2], GIS on-line, distributed geographic information [3, 4], Web-based GIS [5], Internet GIS, mobile GIS [1, 5] interactive mapping [6, 7], distributed GIService [5], geo-enabled Web [8] GeoWeb, Internet map servers, and many others. These terms are sometimes understood as synonyms but it is not the best way of their understanding. For example, Internet does not provide only WWW service so Internet GIS has a different meaning from Web-based GIS. Mobile GIS is not the same as Internet GIS because mobile devices like PDA, and mobile phones use different protocols and technologies, and so on [5]. In the framework of this paper the term Internet GIS will be used although attention will be paid mostly to the Web-based solutions.

A significance of Internet and mobile GIS solutions continuously grows. It has become normal for many tourists, citizens, businessman to use their services, e.g. searching the shortest/fastest route, realty, sightseeing, camp, hotel, restaurant, and many others [1, 5]. Besides this mostly casual utilization, Internet and mobile GIS solutions have become a common software tool for regular utilization and an inherent part of institutional information systems. They are used by managers, traffic controllers, salesmen, civil servants, and many others. Intelligent transportation systems [9], facility management systems [10], geoenabled portals provided as a part of e-government services [11] can be randomly named as a very few examples.

A part of results of a research dedicated to the utilization of Internet GIS in the Czech public administration are described in the paper. In the next part of the paper there is a problem formulated. Chapter 3 deals with Internet GIS solution. Attention is paid especially to the users of Internet GIS, functional requirements, distributed character of Internet GIS, and standardization. In the Chapter 4 there is given a description of utilization of Internet GIS in a role of an ordinary information system. Conclusions are in the Chapter 5.

2 Problem formulation

As it was stated above, Internet and mobile GIS have become an inherent part of enterprises and governmental information systems so they are used for everyday regular work. It means that all the services provided by these solutions must be of an adequate quality, i.e. they must be of the same quality like services provided by the other information systems. For example, reliability,

security, trustworthy, interoperability, availability, fault tolerance, and adequately fast response are demanded.

There is one significant problem connected to GIS and utilization of spatial data in general. Needed data are usually available from various sources – producers. It means that they are available in different formats, different quality, different scale, and different coordinate systems. But in the end they must be used all together in the framework of one information system, i.e. by means of one software tool. Further, collected data and provided services are usually used by various types of users and for various purposes, e.g. for strategic and tactical planning, operational decisions (executing), and controlling [9, 12]. So there is a set of problems connected to a design of the whole system (including databases, data models, and user's interfaces), pre-processing of data, and their maintenance. The paper deals with state of art in the field of utilization of Internet GIS as a part of a regular information system.

3 Internet Geographic Information Systems

Spatial data are necessary for everyday work and life of many people. They have even become a necessary part of decision support systems. But all these potential users do not have any special education in computer science and GIS. Internet GIS can provide them user-friendly environment, mobile and flexible access and if proper designed powerful functionality [1].

Design of Internet GIS solution should respect target users, functional requirements and assumed utilization of the solution.

3.1 Target User's Groups

Today, several classifications of Internet GIS users exist. These classifications vary from author to author and they are dependent on the purpose of classification too. Anyway, following types of users are usually distinguished [1, 5, 13]:

- *Casual users*, e.g. tourists, residents, businessmen, etc. They use Internet GIS solution irregularly and casually. They are usually not educated in computer science and their skills how to use computer, may be very low. On the other side, only a few functions are interesting for these users. They usually need to select region of interest, select appropriate data layers, view geographic information, change scale, run very simple queries and print outputs or save result maps. It is supposed that they can use various Web browsers, they may not be able to install any software, and their Internet connection can be slow.
- *Regular users*, e.g. civil servants, managers, controllers, regular customers, cooperating partners, etc. Regular, everyday use of Internet GIS is typical of this group of users. Their demands are a little different but they usually need only several functions too. It can be supposed that they access Internet GIS by means of appointed Web browser or other defined client.
- *High-end users*, e.g. data providers, GIS specialists who pre-process data, run analyses and publish results of their work.
- *Mobile users*, i.e. people who use wireless technologies and devices like PDA or mobile phones to connect to a server and access geographic information and/or GIS functionality provided by the server. They can vary from low-end users to high-end users. Utilities management (e.g. water, electrical utilities) can be given as an example of a branch where mobile GIS solutions are very often used.

3.2 Functional requirements

Available data can be used in many ways and in different functions. Functional requirements can be shown on a real example of transportation data. The data can be divided into following types in according to the way of their usage [9]:

- *Planning data*, i.e. data which are used for long-term planning, e.g. estimation of environmental impacts, and planning of infrastructure.
- *Engineering data*, i.e. data which are used for shorter-term planning, e.g. signal timing planning, and freeway management.
- *Operational data*, i.e. real-time data from on-line sensors which are used by traffic operators and other people for operational decisions.

In more general view planning, executing (operating) and controlling phases can be distinguished during each business process. Each of these phases needs different data [12, 14].

3.3 Architecture of Internet GIS

Architecture of Internet GIS is usually based on n-tier client/server architecture. It means that at minimum next parts can be usually recognized [5, 12]:

- *Data* – data management system which is able to store and provide spatial and non-spatial data.

- *Application logic* (business logic) – processing functionality (at least map server and Web server in this case).
- *Presentation layer* – user interface.

Internet GIS are supposed to quickly provide a large amount of data from various sources including terabytes of data from remote sensing. Thanks to an existence of interoperability standards which are accepted by wide community, Internet GIS were found as a suitable domain for application of ideas of parallel and distributed computing [5, 15].

In the framework of Internet GIS the attribute 'distributed' means that there is a distributed platform available for storing, processing and accessing geographic information on the Internet [5].

In according to [5] an Internet GIS solution must meet following characteristics to be qualified as a true distributed system:

- It must be composed of distributed components which work separately and which have different functions.
- The components are distributed. Each component can be installed on different computer but they must cooperate.
- The components are mobile so they can be moved from computer to another one.
- The components are open and interoperable. The components have to follow standards to be able to interoperate with any new component.
- Data are distributed. Data stored anywhere on the Internet can be accessed.
- Data are interchangeable. It means that it is possible to integrate data from various different sources.

An example of simple distributed solution with more map servers and data repositories is shown on Fig. 1 [5].

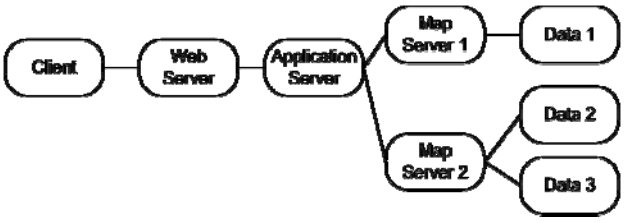

Fig. 1 – Simple distributed Internet GIS – example of an architecture [5]

Web Services technology is used to ensure interoperability of proprietary Internet GIS solutions. But, along with implementing principles of Web services by Internet GIS, a quality of services should be considered too [16].

Distributed architecture of Internet GIS can easily allow utilization of various regional data repositories and warehouses. As it was found warehouses are suitable even for smaller municipalities and they can provide a fuzzy approach in enquiries [17].

3.3 Standardization

There are two significant standardization organizations on the field of Internet GIS. The Open Geospatial Consortium, Inc. (OGC) is the first one. It is a non-profit, international organization. Companies, government agencies and universities are its members. OGC develops OpenGIS® Specifications which "...support interoperable solutions that "geo-enable" the Web, wireless and location-based services, and mainstream IT" [8]. These standards are highly respected by software producers including e.g. ESRI, and Intergraph.

The second important standardization activity is done by the ISO Technical Committee of Geographic Information/Geomatics ISO/TC 211 [5].

4 Internet GIS as an Ordinary Information System

Internet based GIS solutions have become a widely used and inherent part of information systems both in private and public sector. Their expansion is driven by the increasing demand for geographic data and GIS services by the end-users.

One part of the solutions has become a part of e-government services which are oriented at casual users (e.g. residents, tourists) who are searching for some spatial information on the Internet. Smart maps offering intuitive user interface can be the first step like in GeoNet 4D project [18]. Agent technologies have been more and more used for speeding and improving information retrieval. But there are many languages which use specific features. Czech language can be given as an example – it uses many specific features and signs which must be considered [19].

Paper [9] describes utilization of common object request brokerage architecture (CORBA) for development of a framework of intelligent transportation system based on distributed architecture which provides GIS functionality in the Internet environment.

Another functioning framework, INFRAWEBS II, based on semantic Web technology, Web services and multi-agent technologies was designed to provide a

framework for creating, running, and maintaining "dynamic" applications [20].

There are many quality models available which are used for evaluation of the quality of information system. If it is necessary, everyone can create his/her own quality model in according to the needs of the given situation [21]. In according to [22] extended ISO/IEC 9126 quality model can be used for evaluation of the quality of Internet and intranet applications.

As far as Internet GIS use Web server for communication, queuing model theory should be taken into account while evaluating performance of the solution. Web server is modeled as an open queuing network. An upper limit of a performance capability of a server can be clearly found. This limit depends on a size of a published file [23].

Data and information system security belongs to today's essentials because some of the solutions are used to provide access to sensitive data or to provide paid access (e.g. cadastre, real-estates). On the other side, the security measurements can significantly decrease response time of server (by 20 – 70% depending on the used algorithm in the case of UMN MapServer) [24].

5 Conclusion

As far as geographic information are more and more used in everyday life Internet GIS solutions have become a widely spread and used as an ordinary information system. They are used in many ways: as a part of decision support systems by managers on one side, and as a support tool for operational controlling on the other side. They are used as a part of emergency systems too so man is becoming dependent on them. It leads into increasing quality requirements on these solutions.

Although there are many software packages available, thanks to available standards and support of Web services, many of Internet GIS software products are interoperable. At the same time they can be built as a distributed system so it is possible to use data from various sources together, to balance load, and to build reliable solution.

7 Acknowledgements

This paper was created with a kind support of the University of Pardubice, grant projects Nr. FG452012, Nr. FG452015 and FG452008.

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