BULETINUL Universităţii Petrol – Gaze din Ploieşti	Vol. LX No. 1/2008	83 - 88	Seria Tehnică

A Point of View Over the Modern Perspectives of the Geographical Information Systems Development

Sorin Mihai

S.C. PETROMSERVICE S.A., Str. General Constantin Budisteanu, 11 bis, Bucureşti, România
e-mail: sxn.mihai@hotmail.com

Abstract

The geographical information systems are well-known for their deep impact on the present society, put into value through the served applications and the target public. This paper deals with present status of the geographical information systems, by taking also into account the evolution trends in this field. Subjects like dynamic mapping, geo-spatial localization and migration from Desktop applications to mobile solutions are presented. Also, some considerations of the author regarding reconsidering the information about altitude and the integration of vectorial components with the raster type ones in the modern GIS platforms are emphasized.

Key words: *geographical information systems (GIS), mapping servers, tracking services, GIS solutions*.

Introduction

The field of the geographical information systems (*GIS – Geographical Information System*) has an extraordinary dynamic of development, not only in regard of the vertical, evolutionary dimension, but also on the horizontal dimension, by the diversification of the applications and of the target public [1, 3]. From this point of view, in the present work, the author whishes to present a series of own examinations – incorporated in a point of view over the opened perspectives in the field of geographical information systems.

Implications of the Use of Dynamic Mapping Servers

Frequently the GIS applications market provided to the public via the global Internet network is marked by the development of new applications/objectives: tourist guides, traffic support, meteorological forecasts, satellites images' delivery upon order, professional applications (satellite images processing, vectorisations, spectral information extractions, conversions between co-ordinates/projection systems) and so on [1, 3].

The publishing of the geo-spatial information through the global service WWW is materialized in fact in the establishment of ASP (*Application Service Providers*), and their consulting and studying by the clients usually addresses to the use of maps and digital plans located on a dedicated server.

The provision of the geographical information services for the broad public (not only in an amateur regime but also for professionals) is made usually via a client-server type protocol,

according to which the web server receives the information request from the client (browser), to which it returns as a reply a HTML page comprising of the requested map – as suggested in figure 1. The user accessing the cartographic material via the web browser may interactively make wide prospects, zoom in/zoom out, queries, searches, descriptive attributes accessing and so on, similar to an interaction with a desktop GIS (though in a certain degree more limited and slower).

The publishing of GIS projects by Internet is made either by solutions owned by each GIS platforms/applications manufacturers, either by the solutions of independent manufacturers (capable to simultaneous handle more types of GIS sources), all these however subscribing, from a conceptual point of view, to the transfer diagram previously presented.

Among the issues raised by the Web-publishing applications and GIS data, nevertheless, it is noticed the provision of data security (specially in the vectorial domain), respectively the development of a network environment complying to the service's quality standards (obviously, a broadband connection guaranteed by the telecommunication lines supplier, together with an availability coefficient as closer as possible to 100%, solves, in principle, the issue).

On the other side, the acknowledged GIS environments providers offer Web-mapping solutions also for the management of geo-spatial resources. Also, *OpenGIS Corporation* (to which have affiliated almost all the players on the GIS and connected markets) has a series of valuable contributions to the standardization of technologies and data involved in the development of GIS applications via Internet, being mentioned in this respect the *LandXML* standard, as an XML extension recommended for landed applications (cadastre, agriculture, forestry and so on).

It is to be mentioned also the fact that, usually, the GIS systems should access information from multiple sources, stored in different formats – which initially lead to a series of inconveniences in respect of the used technical solutions. However, as an effect of modern requirements concerning the opening, the current trend leads to the availability of an increasing number of GIS data sources for which there will no longer be necessary, in principle, the explicit conversion (importing).

Geo-spatial Tracking Services Supply

Geo-spatial tracking services (*LBS – Location-Based Services*) refer to the services capable to automatically and dynamically supply information about a geographic position. In principle, in this case is returned either the current location of the user, either the position of a tracked objective (person, vehicle, sea/aerial ship, cargo, building, object) relating to the current position of the user.

Geo-spatial tracking services combine the GIS applications with the hardware support provided by the mobile devices (cell phones, PDAs, GPS receivers, notebooks), having therefore profound connections with the telecommunication industry and applied informatics. Consequently, most of the GIS software manufacturers entered also on this (relatively) new market, cooperating with various telecommunication providers for the delivery of the required infrastructure for the geo-spatial tracking services [2, 4].

The field, naturally, behaved in conjunction with the Internet (sometimes being referred at as *Internet Mobile Services/Applications*), the global network ensuring in this case either the communication infrastructure, either the model for the interoperation of the involved devices and applications.

Obviously, the services based on localization are depending on the specialized devices, respectively the telecommunication networks, the technical solutions developing the support not only for dedicated radio transmissions (wireless services), but also for the services provided by Web network, SMS, MMS/EMS services, public voice telecommunication network services

(classic telecommunication) and so on. In essence, the issue can be minimized in principle to a trustful telecommunication system connected to a tracking system (either by mobile GPS receivers, either by cellular connection to the mobile telecommunication network, either by other means), able to provide positional information which an application (software + hardware) is able to represent (on a coherent map of the covered area or by other conventions/means) in order to be read by the human operator.

Modern LBS services find their applicability in professional areas like the fleet management, sales/distribution agents' management (*SFA – Sales Force Automation*) and, in general, the management of any mobile resources [2].

Among applications/geo-spatial tracking services' generic clients can be enumerated the internal and international transporters, mobile operators, intervention teams (from the technical area, police, firemen, ambulance and so on), crisis situations management cells, large companies' sales departments and so on.

Also in the category of the LBS systems can be enclosed the support which a mobile telecommunication operator provides in serious situations for the tracking of disappeared persons, whose cell phone is still operational. Nevertheless, in such a situation the exactness of localization is low (of a size of one GSM/CDMA cell – dozens or even hundreds of meters – as suggested in figure 2).

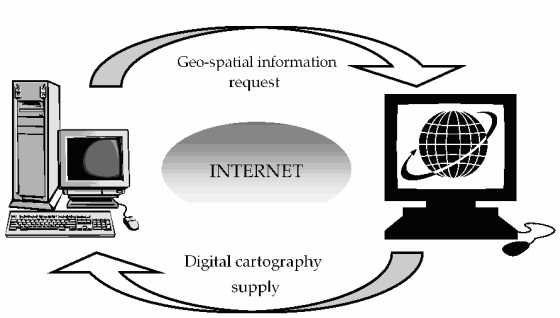

Fig. 1. Client-server type logical architecture.

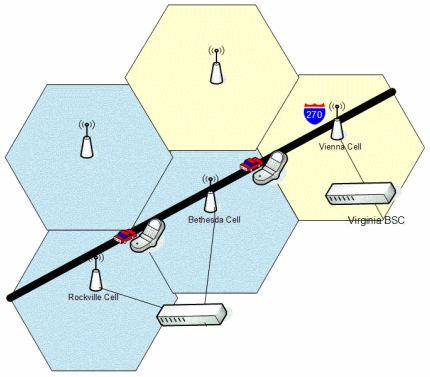

Fig. 2. Cellular network segment architecture.

In respect of the tracking inside/via the mobile telecommunication cellular network (GSM, CDMA) are used as technologies, the identification of the cell where the mobile phone is located in, based on the information type *Cell Broadcasting*, *Cell-ID*, *Cell-ID plus Timing Advance*, *Enhanced Cell-ID* and so on, respectively the estimation of the time difference in which the signal (radio wave) reaches to/from the telephonic terminal (*Time Difference of Arrival – TDOA*, *Enhanced Observed Time Difference – E-OTD* and so on) [4].

The LBS area developed during the last years due to the convergence of five technologies:

- data telecommunication services (GPRS, 3G, UMTS);
- new generation mobile devices (GSM/CDMA phones, PDAs, PDA/phone combos);
- shared documents standards (HTML, DHTML);
- geographical information (GIS sources);
- GPS technology (the localization on terrestrial surface by the correlation of the vectorial positioning information simultaneously read from more specialized satellites).

The *OpenGIS Corporation* (OGC) members have adopted a series of regulations for the operation of the services based on geo-spatial localization. *OpenGIS Location Services* specifications (approved on 20th of January 2004) define a set of inter-operable interfaces-core,

recommended for the implementation of services' applications based on localization [2]. The designation of these interfaces address to the accessing of the services type directory (for instance "*Yellow Pages*"), the routes' establishment, the gateways development for the ascertainment of the locations, geo-encryption (the ascertainment of the geo-spatial positions of some entities based on their descriptive attributed associated to these – specialized GIS function) and reverse geo-encryption (the generation of descriptive information starting from the vectorial information of the geo-spatial entities).

These interfaces permit the telecommunication companies, telematics services suppliers, GIS traditional companies and obviously, LBS companies, to develop and efficiently implement inter-operable applications which can access multiple data and services operating on heterogeneous infrastructure bases.

The companies affiliated to the *OpenLS* implementation specifications are: *Autodesk*, *ESRI*, *Image Matters*, *Intergraph IntelliWhere*, *MapInfo*, *Webraska*. In the same time, these companies have noticed the contribution of other OGC members: *Hutchison 3G*, *IONIC Software SA*, *Navigation Technologies*, *Oracle*, *Sun Microsystems*.

The Evolution from Desktop Solutions to GIS Applications on Bearer

Lately it is noticed the remarkable spreading of pocket devices incorporating GIS facilities:

- digital assistants (PDAs) with mapping applications, very useful on the field;
- mobile phones with GPS functions (and, respectively, localization on monochrome/color displayed maps);
- mobile GPS receivers;
- multi-functional equipments (including mapping applications or GPS localization functions);
- micro/mini-LBS receivers (using real time telecommunication technologies – GSM mobile telecommunication, satellite telecommunication, GPS – for the positioning on site of entities/phenomenon).

GIS solutions usable on mobile devices (PDAs, Pocket PCs, notebooks, WAP phones, GPS receivers, LBS receivers) provide consulting and analyzing functionalities, either based on the stored maps/information, either by dynamically accessing digital mapping servers.

Most of the GIS solutions' manufactures provide also mobile versions which incorporate few essential technologies: online positioning system (GPS), the telecommunication system with the headquarters/dispatcher/server, handheld device and GIS software.

The persons using on the field such assembly beneficiates from GIS facilities, accessing geo-spatial data stored on handheld devices or received from the server, dynamically follow-up/report the position and (eventually) update the GIS database. Beyond the personal type applications, at the professional level can beneficiate from such systems the telecommunications, electricity distribution, oil, gases, governmental institutions or the ones managing natural resources and so on.

A Present Subject: Altitude Consideration

Another major trend is the management of Z co-ordinate (materialized by particular/partial approaches, formats capable to store three-dimensional models of the field (*DTM*), gridding technologies (the ascertainment of the altitudes of an area by the extrapolation of some punctual information) and also by the extrapolation of the classic curve levels.

Presently, this new trend makes that the powerful satellite imagery applications and the photogrammetry ones to include aspects related to altitude.

In the applications/projects where the visual impact is important, it can be resorted to:

- the rendering of the 3D model of the field (wire-frame representation is replaced by a photo-representation, each face of the model being filled with a color/hachure appropriately chosen, where there are calculated/represented including the shadows generated by global/local light sources);
- the draping of some raster texture (bitmap image appropriated from the symbols or graphical point of view) over the three-dimensional model;
- the generation of quasi-realistic 3D animations (by calling to top software + hardware solutions).

Raster-vector Convergence Trends

Following the increase of computing systems' performances (in terms of speed and storage capacity), the present time underlined a new trend, the one of free combination of vectorial graphics with the raster one.

Bitmap images from the scanning of the plans/maps in analogical archive, aero-photograms or even satellite images, intensively participate to the use of GIS applications, not only in the primary stages of constitution of the vectorial graphic fund [5]. It is appreciated that the GIS/CAD applications will be capable to geo-referentiate such images (either by simple algorithms – like Helmert transformations or heckle, either by applying more profound deformations to the images – like rubber-sheeting, projective deformations), opening therefore the possibility of construction of raster-vector hybrid projects, combining the plasticity of the images with the precision of the geometry, as can be noticed in figure 3.

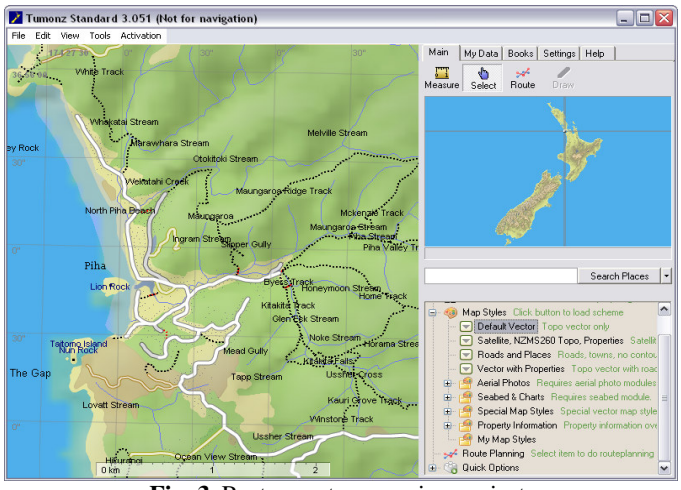

Fig. 3. Raster-vector mapping project.

The advanced software dedicated to photogrammetry (e.g. *ER Mapper – Earth Resource Mapping Inc.*, *ERDAS Image*, *PCI*, *EASI/PACE – PCI Geomatics*, *ENVI – Research System*, *PG-STEAMER*, *EarthWin – Pixoneer Geomatics*, *ImageStation – Intergraph*, *ArcView Image Analysis Extension – ESRI*, *Imaging Software – Meyer Instruments Inc.*, *MicroImages* and so on) is capable to geo-referentiate the raster images (after polynomial transformations of various ranges, by triangulation or even ortho-rectification), being able to use large collections of adjacent images, which is assembling and chromatically balancing, either by subsequently extracting eventual vectorial contours, either by creating the possibility of free superposing of a

vectorial material. Due to the fact that such a collection of raster images can easily exceed, cumulating the sizes of the files, impressive size ranges, (dozens or hundreds of terabytes) the storage beneficiates from advanced compression algorithms (like *ECW*, *MrSID* or *JPEG2000*), which not only that save the space in external memory, but are characterized also by the reasonable compression/decompression times.

Conclusions

The present work presented a point of view of the author over the present status of the geographical information systems, and also of the evolution trends in this field. There were approached issued connected to the dynamic mapping, geo-spatial localization and migration from Desktop applications to mobile solutions. Also, the work presented the two modern evolution trends, respectively the reconsideration of the information about altitude, and also the integration more and more obvious of vectorial components with the raster type ones in the modern GIS platforms.

References

1. Băduț, *M.* – *GIS. Sisteme informatice geografice. Fundamente practice*. Editura Albastră, Cluj-Napoca, 2004.
2. Burrough, P., McDonnell, R. – *Principles of Geographical Information Systems.* Oxford University Press, 1998.
3. Dimitriu, G. – *Sisteme informatice geografice – GIS.* Editura Albastră, Cluj-Napoca, 2001.
4. Hillebrand, F. – *GSM & UMTS: The Creation of Global Mobile Communication.* John Wiley & Sons, 2001.
5. Morain, S., Lopez B. S. – *Raster Imagery in Geographic Information Systems*. On Word Press, 1996.

Un punct de vedere asupra perspectivelor moderne ale dezvoltării sistemelor informatice geografice

Rezumat

Sistemele informatice geografice sunt recunoscute pentru impactul remarcabil pe care îl au supra societății în ansamblul său, atât prin prisma aplicațiilor deservite cât şi prin valoarea publicului-țintă. Acest articol expune o serie de considerații asupra prezentului sistemelor informatice geografice, evidențiind totodată şi trendul evolutiv al acestui domeniu. Sunt prezentate contextual aspecte legate de cartografierea dinamică, localizarea geo-spațială şi migrarea de la aplicațiile Desktop la soluții echivalente mobile. De asemenea, autorul prezintă o serie de considerente proprii asupra unor aspecte problematice referitoare la reconsiderarea altitudinii ca informație sensibilă, respectiv integrarea componentelor vectoriale cu cele de tip raster în cadrul sistemelor informatice geografice moderne.