Change of Geographic Information Service Model in Mobile Context

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ABSTRACT A research on that how the topic of mobility, which is completely different but tightly relevant to space, provides new approaches and methods so as to promote the further development of geographic information services, will accumulate basic experience for different types of relative information systems in the wide fields of location based services. This paper analyzes the meaning of mobility and the change for geographic information service model, it describes the differences and correlation between M-GIS and traditional GIS. It sets a technical framework of geographic information services according to mobile context and provides a case study.

KEY WORDS geographic information services; mobile GIS; mobile computing; LBS; mobility; GIS

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Introduction

Great progress of scientific and technological civilization dramatically improves the interactive methods between people and world. At the same time various intelligent mobile terminals spread Internet over anywhere in human’s life. Mobile computing and mobility of computational tools will reform traditional geographic information service model, combine seamlessly people, reality and digital world through networks each other, achieve interoperability without limitation of time and space and renovate ultimately the interactive methods between people and digital world. Now research on geographic information service model in mobile context focuses on more basic technologies than people such as individuation and humanization and thus it can provide an entirely new operable pattern for systems based on spatial information, such as navigation, digital battlefield, field data collection, logistics management, intelligent traffic, modern education, travel, amusement and so on.

1 Meanings of mobility

In physical view mobility can be understood as changes of location in macroscopic or microcosmic world and also can be recorded and surveyed. But in information view mobility has the following meanings.

1.1 Mobility is a basic way of human’s intercommunion

Substance, energy and information are essential elements that compose of human society. Exchange of substance or energy is mobile in physical environment, but exchange of information is intercommunion of human’s wisdom and feeling. Mobility is a main approach that receives and feedbacks information.

1.2 Mobility depending on technological drive

Mobility not only means location change,
which is a necessary but not sufficient factor, for example, operating computer in a running train does not create new technological ideas, but also depends on creative technological drive and speed up continuously technological originality, for instance, boom of cell phone industry is a successful case. Technological drive loop of mobility contains following aspects: embedded technologies lead to wireless communication; wireless communication means mobility; mobility have to be miniaturization and individuation (see Fig. 1).

![Fig. 1 Technological drive loop of mobility](image_url)

### 1.3 Mobility is result from computing revolution

With the idea of computing penetrating in many fields, it not only is becoming a universal way which helps human recognize nature, life, thinking and society, but also will gradually be a brand-new world view. In information era computers which appear and are used widely in various fashions and WWW (world wide web) enables Internet be an information warehouse. For the sake of meeting such social demands that people can browse and obtain information anytime and anywhere, it’s inevitable for computing revolution to reach mobile computing epoch.

“Mobile computing is an umbrella term used to describe technologies that enable people to access network services anywhere, anytime, and anyway. Ubiquitous computing and nomadic computing are synonymous with mobile computing.” (from ACM). Mobile computing is a technology that allows continuous transmission of data via a computer without having to be connected to a fixed physical link and has a number of important properties: communication, mobility and portability. Its researching emphases are, user mobility, terminal mobility and mobile access to resources. For hardware manufacturing there exist more than hundreds of companies including IBM, MicroOptical and Xybernaut etc., which produce products related to mobile computing such as integrated eyeglassesplays, data gloves, lightweight display headset and so on. For application development, many famous universities especially American Massachusetts Institute of Technology, Columbia University, Swiss Federal Institute of Technology and Holland Delft University of Technology are carrying out application development related to mobile computing in the fields of physic and industry. In geographic field, American Iowa State University cooperate with Center for Geographic Information and Analysis (NCGIA) in executing a plan named Batutta which pursues researching a set of mobile system for filed data collection including integration of geographical conditions and GIS in wireless context and use integration of wearable computing, portable computer, PDA and desktop server for NASA and Federal Statistic Institute.

### 1.4 Mobility means change

Comparing traditional GIS, mobility has made following changes (see Fig. 2), which lead to individuation such as various terminals, plenty content, multipurpose networks services and different application and so on. Thus meaning of mobility is as follows (see Fig. 3).

Mobile computing will accelerate computer industry and communication industry united and increases value point in IT field. It is indubitable that mobile computing greatly impact on geographic information service model.

### 2 Change of geographic information service model

Informational service is divided into three types according to its form: 1. voice/graphics/image; 2. characters/number; 3. geographic position. There exist a good number of needs for informational service and SMS is a successful instance in
Fig. 2 Change via mobility

Fig. 3 Meaning of mobility

mobile context.

Geographic information service model is driven by continuous upgrading of technologies and it is transforming from pattern of "people-maps" into pattern of "people-computer-spatial database".

2.1 Change for simple cartographic information communication model

From Fig. 4 changes are clear: cartographer’s reality ($U_1$) approach reality ($U$) increasingly, namely people know world more accurately, high-grade fidelity and profoundly; shareable spatial knowledge between cartographer and user expands gradually, namely technological progress, especially spatial information visualization, facilitates analysis and understanding for spatial knowledge.

2.2 Focus change for geographic information service

It is an ultimate tendency for GIS to provide services and set standardization in academe and industry. Until the last few years, national or local abundant geographic data were created by specialists either with complex and costly survey equipment or by digitizing hardcopy maps originally compiled from surveys and aerial photography. On one hand, these data are ready to be converted to information in a form suitable for various practical applications ranging from urban planning to personal navigation, on other hand, a lots of civil projects have a great and urgent need of high precision geographic data. Geographic information service model is key solution and its focus is shifting from products to services, from collection to integration, from func-

tion to interoperability, from technical skills to human. Software replaces human’s work partly and becomes tools which design and process spatial information, and thus technical threshold descended dramatically, and product precision improved greatly, but lots of data were wasted for lack of high efficient services mechanism. Use of single map is substituted by integrated use that geographic data with characters of different contents, multiple scales and different time can integrate with aerial photos, GPS collection and statistical data, and further support decision making. Operators not only lay emphasis on function, but more concern on satisfaction namely human-computer interaction (HCI).

2.3 Properties of geographic information service

Services possess a good number of properties, they are always available (subject to security and connectivity constrains), they can support lightweight client, they can process multiple clients at the same time, they can scale to support large numbers of requests, by adding additional machines, and they can be maintained centrally in secure facilities by specially trained staff\(^1\). Excluding above properties, geographic information service is sensitive to location, and location is a fundamental way that we understand and manage the world.

3 Geographic information service model in mobile context—mobile GIS

3.1 Mobile GIS

Mobile GIS is a new field derived by technologies and is pivotal point from geographical information system to geographic information services.

In the world a great deal of objects are moving and sensitive to location, for example, delivery vehicles (logistics), trains, buses, taxies, emergency service patrols, weather fronts and wild animals, diseases, and it is significant for knowing when, where, how and how quickly they move and direction and route taken in real time. In another view we are most in need of location information on the move, for instance, knowing location at which casual events happened, finding a suitable alternative route and field data collection.

Mobile GIS demands the ability to capture location information on moving objects and events, and to transmit this, in real time, to recipients who may be moving. M-GIS provides tools (intelligent terminals) and services (wireless communication) to capture, format, extract and transmit location information in the overall development and expansion of what is now termed ‘mobile computing’, providing both services and content\(^2\). M-GIS changes perpetually geographic information service model and is characterized of itinerant, distributed, ubiquitous.

The fundamental algorithms, data structure and spatial operation (spatial intersection, spatial searching etc.) used in delivering services are mostly the same as in traditional geographic information system. The application of core GIS technology is very different though, partly because the data are streaming in from a great number of mobile devices, and partly because the useful applications are very different. Mobile devices operate in a dynamic and ever-changing environment. Therefore, the advanced nature of technology warrants the definition of M-GIS as a separate field.

3.2 Geographic information service design

A famous saying goes like this; “Every disadvantage has its advantage”. The inherent usability constraints for mobile devices, including small screens, limited input possibilities, limited browsers, poor data transfer performance, distracting environment of use etc., are crucial to make mobile strategies clear and concise. On one hand, try to design services that offer a high enough value to the user so as to overcome the usability constraints. On the other hand, try to minimize usability problems within the device constraints. Seen from a HCI perspective, the
success and failure of SMS and WAP respectively, can be explained by looking at the balance between values versus 'basic' usability. Apparently SMS offers people so much value in terms of social interaction and communication that the user is willing to invest time in a poor user interface. At this moment WAP is obviously at the wrong side of the balance: poor value on top of poor usability. These examples illustrate that success in the mobile industry is more a matter of addressing "killer values" than offering "killer applications". Thereby mobility arouses new problems for geographic information service: as far provider, how to offer true value information to user? As far mobile people, what are new needs of service design in mobile context?

As far as mobile people are concerned, research on technological mechanism, which can be adopted according to user's preferences and the capabilities of the terminal, and psychological factor, which have effect on user obtaining geographic information in mobile context, offers usage. Now contents of geographic information service are location and time on the context of use of a single terminal, and not widely supported by operators yet. With the rapid growth of offering services through different channels (web, WAP, phone resident application, PC resident application) and various mobile devices (cell phone, PDA etc.) focus of geographic information service is ecosystem of connected terminals. For example service is SMS for cell phone, but flash or movie clips for PDA. Multi-channel services in the ecosystem should also try to take advantage of the specific context of use of each channel in such a way that the different channels reinforce each other.

As far as service provider is concerned, research on relation between spatial information expression and natural language plays an important role. As yet, the philological models developed in the spatial information field, may be divided into completely different but tightly relevant two kinds; one starts with analyzing spatial conception of natural language, to improve the shortage of the present spatial information conception model, a representative harvest is the research on "spatial relation language"; the other borrows semiotic and philological models to explain and resolve the problems of maps and spatial information. Regard namely, spatial information as a special language form, and make use of the grammar, semantics and pragmatics means to analyze and recognize the inner structure and application of spatial information. In context of geographic information service based on SM (short message), it is a thoughtful issue; how to abstract key words from natural language so as to execute spatial query automatically and express the queried location through organizing words of natural language to user automatically? Nowadays its realization has to depend on normally formed SM input expression and manual achievement of "location-language".

Geographic information service designs match a specific context of use to user goals and generate service ideas which conduct technological framework on the basis of above mentioned principles.

3.3 Technological Framework of geographic information service in mobile context

The framework (see Fig. 5) is an open and integrated architecture. Information technologies are bases of GIS. The integration of spatial information and communication comes into being two new fields, tele-geoprocessing/tele-geomonitoring and location based service (LBS), the
former focuses on updating periodically geographic database by telecommunication so as to support decision making. The latter aims at obtaining location information anytime and anywhere.

4 Applied instances

4.1 Successful instance in industry—ArcPad

ArcPad is an essential part of ArcGIS solution and provide shortcut of having access to central database, mapping, seeking location, receipting and storing data for field users (see Fig. 6).

4.2 A self-developed instance

4.2.1 Framework design

According to following hierarchy (see Fig. 7), and information integration ideas, and on the basis of enterprise database, the COM components based on OpenGIS are designed and implemented, and the application platform is built as well, then a professional system based on application and need of relational field can be developed.

Mobile application is part of whole framework, and is, in essence, a highly optimized toolkit which allows exchanging or synchronizing spatial information with a computing desktop environment, and developed in Embedded C++ and personal Java environment (J2ME). Based on online or offline connected mode, the toolkit transfers spatial database into diverse electronic map and various tables which help people locate or navigate themselves in mobile context.

4.2.2 Application instance

Being guided by the framework, we succeed in achieving following mobile applications (see Fig. 8).

1) Field data collection system based on pattern of “vector + images + GPS”, for instance, PDA and GPS based on field forest data collection system, replace traditional topography and compass respectively, mobile land mark collection system based on maps in PDA, quickly collects feature of land mark.

2) Personal navigation system based on C++ environment and cell phone maps browser based on personal Java environment.

5 Conclusions

Just as Internet changing people’s life, mobility and its derived technologies will inevitably influence whole human life. In mobile context geographic information services greatly reinforce human spatial cognition and its model research must be a focus in future.
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