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Mobile geoinformation services—Concept , Reality &Problems

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Abstract

We are witnessing the exploding development of Mobile Geoinformation Services(MGS) .However, MGS is a complex system engineering involving many different technological fields or disciplines. There are many problems still existing and deserving to be further clarified and studied. Based on the analysis of the derivation of MGS and different related terms, a relatively universal concept of MGS is first defined in this paper. After that, this paper illuminates the present application level in China by summarizing the five modes that exist in all application related to MGS. In addition, five aspects of problems that hinder MGS from developing on a large scale are put forward. Finally the paper concludes that the implementation of MGS can be only performed on a limited basis in current China and there are still many barriers that prevent MGS from reaching its full potentials.

KeyWords：Mobil Information Services，Spatial Information，LBS，GIS, Spatial IT, Mobile Application, GPS, positioning technologies, Mobile communications

1. Introduction

Location is the foundation for human beings to perceive and understand the real world. With the speedy development of socio-economy, the quickening of people's living rhythms, and frequent changing of time and space, people want the location-related information to be available at any moment and any place. The evolvement of modern mobile communications, mobile database, geographic information system (GIS),global positioning system(GPS) and mobile devices etc. makes it possible to turn people's wishes into reality. With the technological possibility, market demand and driven by greed for profit, many research institutes and commercial sectors engage in the related research and development. And the world once saw an explosive development in Mobile Geoinformation Services(MGS). However, 1) Different people use different terms to describe MGS or use the same term for different meanings, take for example, terms like mobile GIS, location-based service, GPS/GIS/GSM integrated system, mobile positioning service and spatial information mobile service etc. All these call for further delimitation. 2) Although rapid technological advances have already contributed to the construction of some applied systems on a preliminary basis in China, to name just a few, GPS based vehicle monitoring systems and phone-based positioning services systems etc, one can by no means always have his own way as promoted and bragged about by some businessmen. It is still necessary to clarify what is reality and what is the future.3) Technology develops in a process, and we have confidence that we can offer 4A service (services to anyone, at anytime, in anyplace and on any device). But we can be sure that under the present circumstances in China, a lot of problems are lying on the way to the industrialization of MGS on a large scare.

For this purpose, the article plans to first specify the concept of MGS scientifically and then make a summary of

the five applied modes in present China, with an introduction and analysis of each mode. Finally, the six aspects of problems that hinder the extensive development of MGS will be raised.

2 Mobile Geoinformation Service

2.1 The Concept

It is a consensus among IT professionals that people should give priority to service rather than software itself, and the former is accomplished through the internet, which has a substantial positive effect on both the academic and the industrial world. As a software system to gather, store, manage, analyze, and display geographical information, GIS aims at providing better service, which is made possible by technology and called on by market.

From the perspective of the market, it is very necessary for men to get geographic location information at any moment or in any place. Almost 80 percent of information is related with geographic location information in resource management, socio-economic activity and daily life. There is evidence suggesting that the drawing of maps often predates the development of a written language in many primitive societies. 'Map' has been and will always be the best "language" for people's communication and a useful tool for person to perceive the world. Location (usually shown on a map) is crucial for us to understand where we are, where we want to get to and how to achieve this in the most efficient way, or to select suitable sites for houses, crops or businesses and to understand the factors that make these flourish in one place, but not in the next. Traditionally we record and present location on static maps – fixed images that show a snapshot at a certain time. However the static geoinformation service, like traditional GIS cannot meet people's needs. Firstly many of the items we want to locate are far from static – they move – and there is significant value in knowing when, how and how quickly they move, and the direction and route taken. Delivery vehicles, emergency service patrols, weather fronts, trains, buses, taxis, wild animals, diseases – they all move, and being able to track them in real time is valuable. Secondly, often it is when we are on the move ourselves that we are most in need of location information. To be warned of traffic accidents and congestion, and be given driving instructions for a suitable alternative route is far more useful if it can be delivered to your car rather than be waiting for you on your computer at the end of your (delayed) journey. For asset service personnel to be guided to a faulty appliance whilst they are in the field is far more useful than having to drop back to the office to pick this information up from a map or computer in headquarters

From the technological perspective, the technologies such as mobile communication, mobile terminal, embedded software development, GIS ,GPS , mobile positioning technology and wireless internet have all undergone great progress (See the following section 3 and 4 for details).It is possible for people to be free from the limitations inherent in the information transmission medium and enjoy the GeoInformation service at all times and places.

What then are Mobile GeoInformation Services (MGS)? MGS is a geospatial service system providing service wherever and whenever is needed. It defines an interactive model between the user and the actual world, which can provide different information service dynamically to cater to individual users at different times, in different places. When the same mobile user is interacting with the model, his view will change along with his type of role and the environment. Generally speaking， MGS is all those combine GIS applications with easy-to-use mobile devices to provide information wherever and whenever is needed, which is putting spatial information into the dashboards of vehicles, and the hands of those in the street or out in the field, it is giving service providers and emergency responders real-time location information that enables them to offer rapid response, targeted, relevant assistance and better services.

As a kind of mobile information service, MGS has the following features : mobility, real-time service,

non-structural data contents and multi-points(Variability of the mobile terminal).

2.2 The related terms

MGS engages multiple fields and there are many different understanding and definitions related to it. The related terms or concepts include: Brad Spencer's Mobile Geographic Information System(M-GIS) , Glenn Letham's Location based service（LBS）; Evangelos Kotsakis' Mobile Cartography（MC）and Tumasch Reichenbacher's Infomobility; as well as Embeded Geographic Information System（EMGIS）,Mobile Positioning Service(MPS), Mobile Location Service(MLS) and GPS/GIS/GSM Integrated Systems(3Gs) etc.

In spite of the differences in the denotations, the above terms share basically the same connotations with MGS. Tab.1 compares the connotations of different terms and concepts, finding as a result that MGS is a relatively intuitionistic term and suggest more layers of meaning literally.

Tab.1 the contrast of different terms and concepts,

connation / terms	mobility	Spatial aspect	service	terminal	Info service	
MGS	√	√	√		√	4
LBS		√	√			2
MGIS	√	√				2
EMGIS		√		√		2
3Gs	√	√		√		3
MPS	√	√	√			3
MLS	√	√	√			3
MC	√	√				2
Infomobility	√				√	2

3 Reality—technology and application

In terms of the technology structure, MGS involves such technological areas as mobile communications, GIS, mobile positioning, mobile terminals, embedded software development, mobile database, and application server architecture. After those years of developing, MGS has achieved considerable advance in all technological fields. But there still exist many restrictive factors (See section 4 for more details). In addition, since different technological fields prefer different technological choices, the biggest problem that the construction of MGS is now faced with is that there exist too many solutions to choose from. With so many complications, 'choice choke' may follow---- no choice before so many choices.

MGS will then be separated into five modes based on the technological features of its application cases in present China: 1) offline applied mode based on CF card +GPS+ PDA; 2) online applied mode based on WAP phone; 3) online applied mode based on SMS and net-based positioning technology; 4) online applied mode based on SMS+GPS; 5) real-time online application based on SHD. The article will then go on to introduce and analyze them one after one.

3.1 offline applied mode based on PDA +GPS+ CF card

In this mode, users can download large amounts of spatial data (for example, a city map data) at a time to PDA (here PDA refers to the mobile device that has operating systems and a considerable processing power, including Pocket、Helded and AtuoPC etc.)

Since PDA is usually equipped with 16M~64M RAM, 206~400MHz and CF card with 32M~128M, the mode can perform such functions as map browse, information query, analysis and navigation. (See Fig 1) It is now mainly used in automatic vehicle location (AVL) systems, mobile city information system and some other professional applications like electric wire checking and forest survey.

The shortcomings of the mode are: 1) When the user moves to another area, the data has to be downloaded again; 2) real time information changes can not be provided instantly (c.f. instant traffic information). The strong point is: the system usually becomes robust and convenient to operate because of infrequent contact with the server.

图 1　offline applied mode based on H/PC+GPS+ CF card

3.2 online applied mode based on WAP phone

This mode functions through establishing a net server that supports the map service function and usually consist of the map database,applied Server,Web server and WAP gateway. Making use of WAP gateway, it can transmit information between the mobile terminal and the server by protocol converting, encoding and decoding, In this way, based on WAP telephone, the mode can display the map and some other textual information with the help of built-in WML parser (c.f.the result of a path searching). To secure location-related information, network-based positioning is necessary to be introduced.

The mode (See Fig. 2) realizes MGS directly on a WAP telephone, obtaining stable and convenient property . But it still has its drawbacks: 1) Presently, the transmission rate of WAP is too slow, only 9.6Kbps. 2) The screen of WAP telephone is too small to ensure easy map viewing. 3) The processing power of WAP telephone is too poor. 4) At present, most of the pictures shown are black and white, negatively influencing the visual impressions.

Fig.2 the online applied mode based on WAP phone

3.3 the mobile telephone online positioning application based on SMS

This mode (See Fig. 3) takes advantage of network-based positioning technology to obtain real-time location information; SMS enables it to realize wireless communications between the mobile users and the server. The users can easily set the interactive functions of spatial information on mobile telephone with the help of STK（SIM card Tool Kit）technology and Java programming.

The mode achieves easy and stable mobile service directly on the mobile phone. However, SMS can only transmit 140 characters at a time, unable to transmit map data. So it can now only appear in textual form to display related information, not visually direct enough. Besides, the positioning precision is also a problem. The mode has already been put to use in Shanxi Province and Beijing in China, but not widely spread.

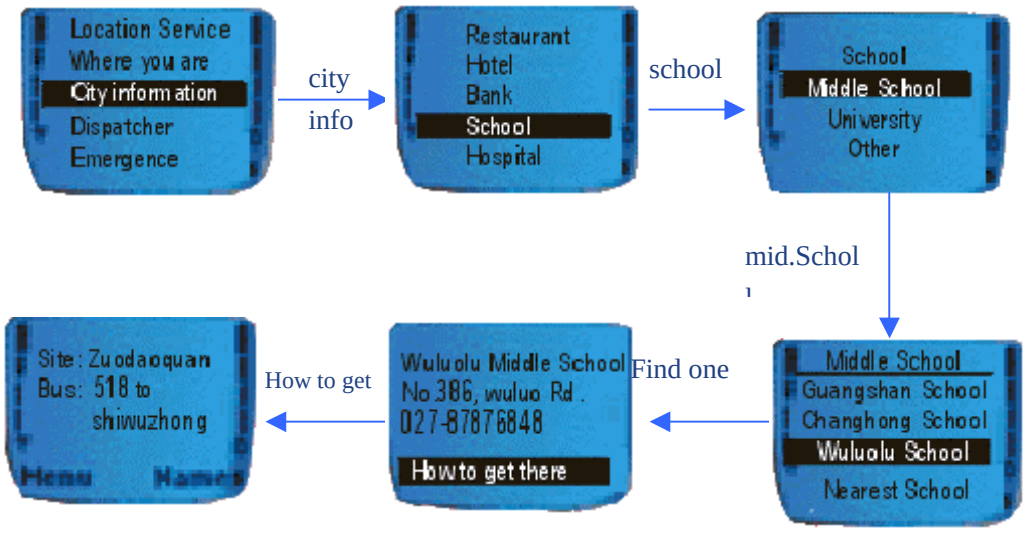

Fig.3 the mobile telephone online positioning application based on SMS

3.4 online applied mode based on SMS+GPS

This mode is the 3Gs integrated system, typically applied in vehicle monitoring systems. The solution can be described as : obtaining vehicle location fix with the GPS receiver; transmitting the location fix to the controlling center and then the control information from the center to the drivers through SMS; With the help of desktop GIS, the location information can be presented vividly before the users and dynamically monitoring function can be fulfilled.

The mode (see Fig.4) has already been put to good use in lines of work like public security, logistics and taxi management. The present drawback of the mode is: since the mobile terminal is a single chip micyoco device which integrates GPS OEM and GSM module, its processing power is too handicapped to handle geospatial data and the mobile users(usually drivers) can only locate themselves not by referring to the maps but by contacting the server ,using a handset for a call or sending short messages.

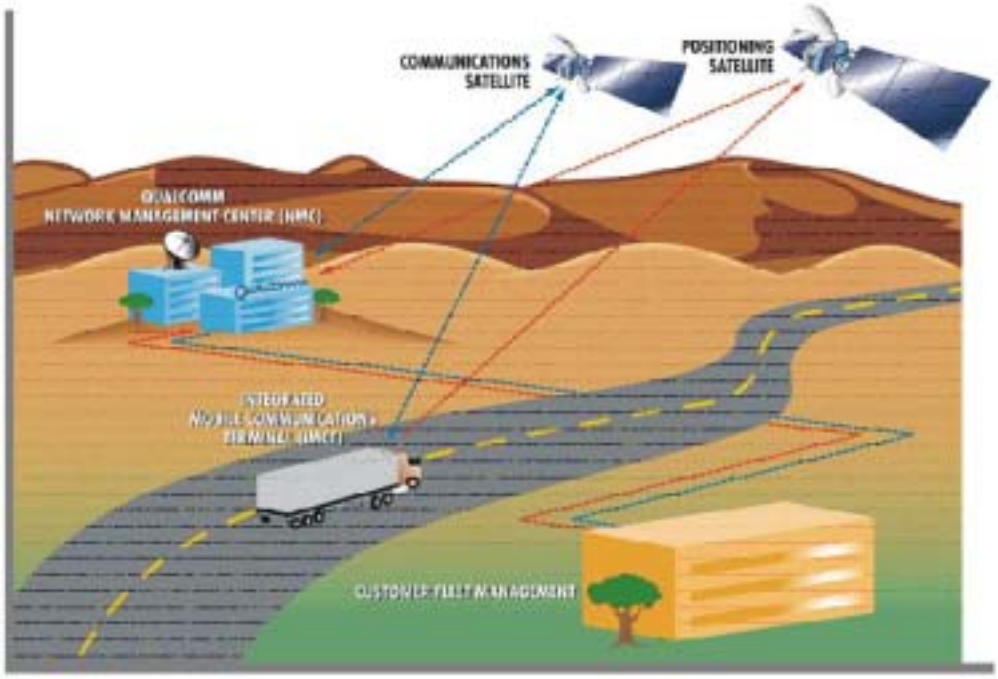

Fig.4 the online applied mode based on SMS+GPS—logistic application

3.5 real-time online application based on SHD+3G

Given the strengths and weaknesses of the above four modes, it is now obvious that 3G is superior to WAP or SMS based on GSM as far as wireless communications is concerned. In terms of positioning technology, GPS enjoys higher precision than the network-based positioning technology ; In terms of spatial information presentation and processing, PDA is better than mobile telephone. Consequently, objectively speaking, mobile GIS requires such a mobile terminal that is an integration of 3G, GPS and PDA with a higher quality-price ratio. People call that Smart Helded Device(SHD), which can present the spatial information to its full potential. Although our society has not seen such a mature product, the widespread use of it will not be very far. With such a mode, people can stay online and come by real-time information brought about by 3G. What's more, people will have at their disposal highly accurate positional information, and they will have easy access to information wherever is needed in various forms: sound, colorful pictures, and the like.

4. Technological problems

It should be realized that establishing a rounded MGS system is a huge systems engineering, which involves lots of newest technologies in fields of wireless interlinkage and spatial IT. These technologies are evolving, and have not yet been fully finalized. There are still many problems that block the MGS from going to the public. They are: 1）the development of the intelligent mobile terminal device. 2) mobile positioning technologies;3) wide band wireless communication technology,4) integration model of spatial IT and telecommunication, and 5)real-time data service and high-speed data capture etc.

4.1 the development of the Smart Handheld device.

Objectively the mobile terminals used in MGS entail all the following five performances / functionalities:1)considerable processing power;2)suitable display size and colors;3)convenient wear-ability;4) integrated with mobile communication;5)integrated with GPS. But most of the current mobile devices still fall short of the above requirements. As shown in Tab.2 one of the advantages of mobile handset is the small size and light weight. However the screen size is too small. It is unsuitable for large amounts of information viewing, e.g. map. A lack of better processing power and low resolution of screen display are the other limitations for the mobile phone. Notebook is a

mini-desktop computer and has strong processing power, but the size is relatively large and the life of battery is relatively short when compared with other mobile devices. From the aspects of size, processing power, speed, function, cost and extensibility, personal digital assistant (PDA), here including palmtop, handheld, AutoPC etc,should be the optimum choice to perform the mobile GIS when compared with the former two. However the common PDA is still not the best choice to realize MGS. You must wear a jacket when using add-ons hardware such as modem, memory card, GPS receiver to extend its functions and this is very inconvenient. Even those that are called Smart Handheld devices(SHD) ,such as PDAphone,SmartPhone,GPSphone etc. meet only two or more of the five requirements.

Tab. 2 the main performances of common mobile devices: PDA,mobile Handset and notebook pc

device / performance		PDA	Mobile Handset	Notebook PC
Processing power	CPU	moderate（400MHz）	weak	strong（1800 MHz）
	memory	ROM 48M		
		RAM 64M	32MB MMC	256M DDR
Display performances	Screen Size & Resolution	240×320	100×80	1024×768
	Color	colorful	usually blank and white	Colorful
wear-ability	Volume	moderate 133×84×16mm	Small 109×46×21mm	large
	Weight	moderate (186g)	light (88 g)	Heavy (1250g)
Wireless commutation		Inconvenient(with add-in modem)	convenient （ with built-in modem）	Inconvenient(with add-in modem)
Positioning		Inconvenient(with add-in GPS)	Low precision(Network-based)	Not available
cost		moderate	low	high

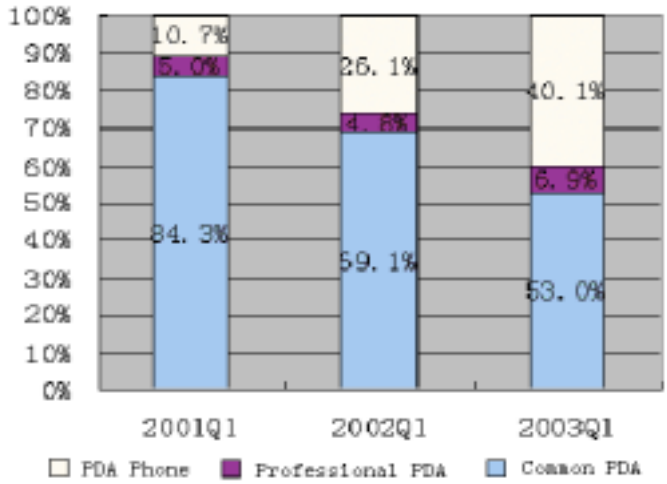

Fig.5 PDA market structure in China from 2001Q to 2003Q

Research has shown that mobile terminal is going towards the integration of PDA , mobile handset and other devices. As shown in Fig.5,from 2001Q1 to 2003Q1,the sales share that PDA phone takes up in the whole PDA market has increased from 10.7% to 40.1% .Estimates are that sales volume will have exceeded 1 million by the end of 2003.Nevertheless, further research is needed to make the mobile terminal meet the requirements necessary in the MGS application

4.2 Mobile Positioning Technologies

Providing real-time position fix is one of the most important technologies in location-based MGS system. Three fundamental solutions can be identified: Handset-based, Network-based and Network-based.(Tab3)

Table3: Positioning Technologies

Technique	**Method and strengths**	**precision**	**coverage**	**Examples**
Handset-based	Location calculated by handset based GPS receiver or packet switching capabilities. Very accurate position fix.	High(5-100m)	limited(open area)	GPS, A-GPS, E-OTD
Network-based	Location calculated based on triangulation of three base stations. Fast and accurate, but increased overheads	Low(50-250m)	large	TOA, TDOA, CGI-TA
Data-based	Location calculated with reference to a single base station. Fast and cheap but reliant on density of base station distribution and provide limited accuracy	Lower(200-300m)	large	Cell-ID, Time Advance, MAHO/NMR.

Due to the low precision of positioning, the Data-based approach is prevented from wide promotion and application, but still can act as an aid positioning technology. GPS, as representative of the handset-based methods, makes use of more than three satellites to capture position fix with high precision and speed. But it does not woke well in places where the satellite signal cannot cover, for example inside buildings. The network-based positioning solution obtains location data with the help of three base stations and the overall precision is not high. All in all, the adoption of any one of the three methods has obvious deficiencies in precision, sensitivity, speed and usability.

To solve these issues ,further research must be done on the combined positioning technologies and differential GPS as well as GPS antenna. China has produced KZ850, the first cellular phone with gpsOne positioning technique, which take advantage of the strong points of both the network based and the GPS methods. Its positioning precision reaches as high as 5~50m and enables the users to know their exact location. In AVL system, the combined positioning technologies of GPS, gyro and cyclometer have been put to preliminary use. It's no double that he combined positioning technologies is the trend of mobile positioning technologies. Besides, the portable GPS antenna very needed for individual consumer and differential GPS shout be adopt in some special application which need the precision of 1m.

4.3 Wide band mobile communication

With the help of mobile communication and wireless net technology, we can break away from the restriction of cable and access Internet freely. Fig6 tells us the distribution of networks supporting newest handsets from Jan. to June in 2003.It implies that most of the handsets support only GSM in China ,GPRS handsets are being popularized and those supporting CDMA are emerging and developing rapidly.Tab.4 lists the transmission speed of 2.5 G mobile communication in China .it tell us the 2.5 G is popularing in the country but the actual speed has a long distance from the the theory one, let alone getting 3 Gmobile services.

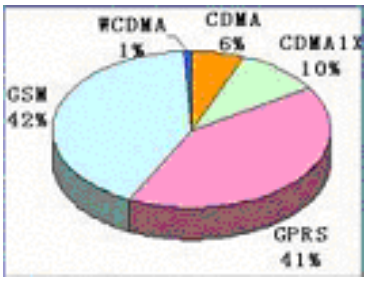

Fig.6 Networks supporting newest handset Jan. to June, 2003 in China

Tab.4 transmission speed of 2.5 G mobile communication in China

	Theory speed (Kbps)	Actual highest speed (Kbps)	Actual Average speed (Kbps)	Coverage	Network operator
CDMA1X	384	153.6	80 or lower	Some cities	China Unicom

GPRS	171.2	53.6	40 or lower	Almost the whole country	China Mobile

4.4 The approaches to realize the server side of a MGS system----How to integrate geospatial aspects and wireless network aspects

There are three approaches available to realize the server side of a MGS system, which are also the methods with which geospatial aspects and wireless network aspects in MGS are integrated together. The first (Fig.7a)sees the development of an internally hosted and managed Geospatial platform behind the wireless operator's firewall which will handle all server-side location operations. The second (Fig.7b)permits the wireless operator to take advantage of externally hosted location solutions via Web-based External Geospatial Service platforms. The last(Fig.7c) is the middleware/geoserver-centric model. Within it, application providers residing outside the operator firewall in the IP domain consume APIs and embed functionality from both the location-enabling middleware and the geoserver in their applications. Developed applications are then published back to the carrier for deployment and advertisement in the mainstream. The process works the same way for enterprise and/or government applications.

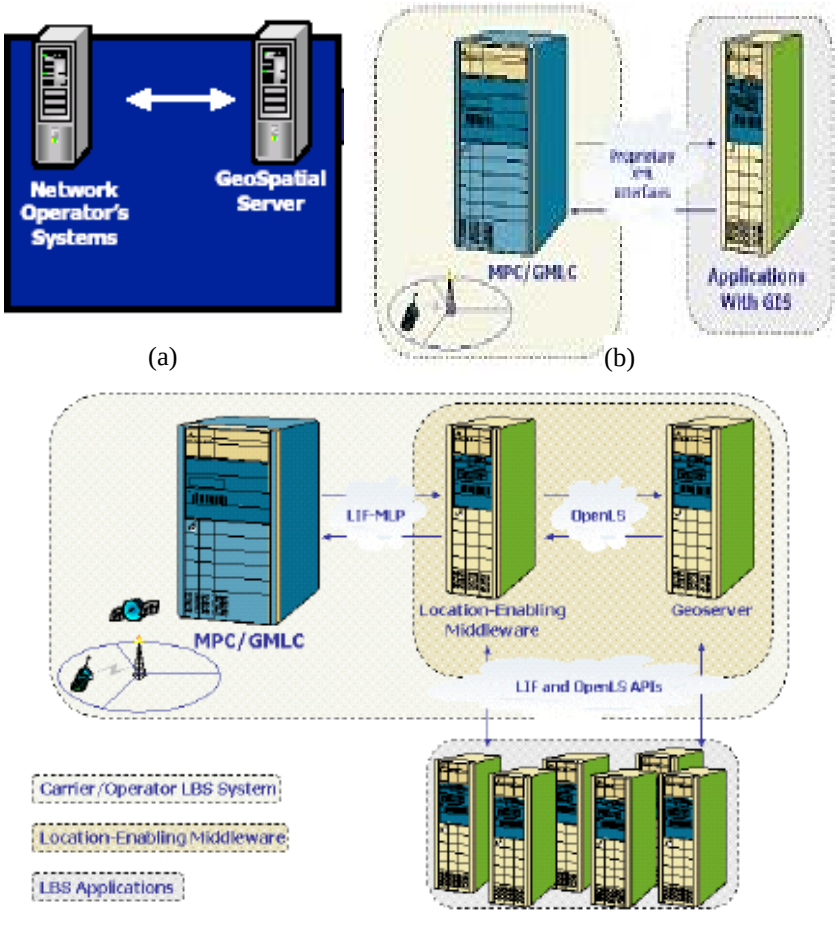

Fig. 7 Approaches to build server side of MGS

The advantage of an internally hosted Geospatial Platform is that the network provider has complete control over the content and services provided and can make use of elements of an existing GIS installation within their systems. The disadvantage is that the responsibility for content/service development and maintenance falls entirely on the provider and may demand an additional skills and tool set. In the second approach, external Web based GeoSpatial Service centers are are developed and managed by an independent third party, usually called SpatialASP. The wireless operator simply contracts a spatial service centre to provide data or functionality which are made available through standard XML or SOAP interfaces. With the second architecture, the MGS industry was plagued with an abundance of nonstandardized proprietary interfaces to closed systems that were neither extensible nor portable. These situations will change complete In the third approach. Standards are considered very important. There are two standards proposals that promise to expedite integration and stimulate application development. These are the Location Interoperability Forum-Mobile Location Protocol (LIF-MLP) API for location and the Open GIS Consortium (OGC) OpenLS API for spatial processing. The LIF-MLP and OpenLS APIs have solved a majority of the integration challenges that slowed down the MGS market in its formative years and help network carrier/operator to provide a one-stop-shop Web services API development environment for application providers.

Now in China most applications was built by using approach 1or approach 2. The practice of approach 3 calls for being implemented to really promote the MGS industry.

4.5 Spatial Data Service and Update

The consistent high-quality “electronic Map ” is the bottleneck that restricts the development of MGS industry. Up to now, Chinese government has finished establishing digital map database of the whole country with the scale of 1:250000 and 1:50000. The 1:10000 map database is also available in most provinces. But, 1)the map data may not always be the latest because of the high speed of construction;2)the larger scale map data is necessary for some application, such as urban navigation, but it is not always available.

Therefore much research work must be done on real-time data update and high-speed data capture to ensure the currency. In addition the distributed spatial database should be established first to store and manage base map data, and then a variety of professional database can be built based on them according to the principle of data share .

5. Promise and Conclusion

China already has the world’s greatest number of mobile users, and the potential is still vast. It is predicted the MGS products（including AVL，LBS，Intelligent Device）in China in 2005 will be over 11 billion RMB. “there is no market which does not suit technology, but technology which does not suit the markets”. Technologies that support this are evolving, and have not yet been fully finalized. As long as we recognize this fact and pay high enthusiasm to both the research and implementation of MGS,I believe that both market demand and technology available in China will ensure that this region continues to be at the forefront of exploring and benefiting from the potential offering from MGS.

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