# A MODEL OF MOBILE GEOGRAPHIC INFORMATION SERVICE AND APPLICATIONS

Zhongya WEI[1, 3], Suning XU[2], Lun WU[1]

[1]Institute of Remote Sensing and GIS
weizhongya@ccermail.net,
[2]Department of Geography,Peking University Beijing 100871, China
xusuning@ccermail.net
[3]Center for Environmental Airborne Survey and Remote Sensing
Shijiazhuang 050002, China

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**ABSTRACT:**

The purpose of this manuscript is to research the integration of geographic information technology and mobile telecommunication technology, and to provide a technical model for LBS (Location-Based Service) and key techniques. First, from a theoretic point of view, discuss the existent mode of GI (geographic information), the conception and structure of the integration of GI technology and telecommunication technology, and the standout mode of natural language in GI mobile service. Next, construct an antitype based on SMS（Short Message Service） technology for GI service system. After that, discuss SMS technology and its application in the GI service field, and present a SMS-SDB gateway system to link the short message and spatial database, the programming method of SMS, analytic method of command based on the rules.

## 1. INTRODUCTION

Personal Information Service based on wireless telecommunication has been becoming more and more popular and it has become an important part of everyday life. It is well known that more than eighty percent information in human society relates to spatial position. Thus, the information for individual service can takes more effects only when it contains spatial located data. Undoubtedly GI service supported by GIS plays an advantaged role. We have been looking forward to using our researched production—spatial data to serve civilians. More of our previous productions were provided as urban traffic touring map. And now although there are some small-scare electronic maps serving civilians on Internet, a majority of our productions still just serve governmental departments and enterprises, and our GIS productions are not popular yet. According to this, we put forward the conception of mobile service model of geographic information, which integrates GI technology and mobile telecommunication technology. We research a technical model through wireless telecommunication system to provide position information and some key techniques (Zhongya Wei, Lu Wu, 2001). In order to achieve further research on GI mobile service, we setup two main experiments: 1) A SMS-based GI service model; 2) A WAP-based GI mobile service model. This manuscript provides one of them.

The organization of this manuscript is as follow: The second part discusses the existent mode of GI, the conception and structure of the integration of GI technology and telecommunication technology, and the expression mode of natural language in GI mobile service. The third part introduces the construction of GI service model based on SMS technology and the interface protocol of SMS. The fourth part introduces the way to systemic prototype of GI mobile service. The fifth part, finally give conclusion and discussion.

## 2. THE MOBILE SERVICE MODE OF GI

### 2.1 The Existent Mode of GI

We divide the informational service into three types according to its form: (1) voice/graphics /image, (2) characters/ number, (3) geographic position.

### 2.2 The Integrated Model of GI and Telecommunication

The developing telecommunication greatly benefits the contact of the society. Especially the development of the new generation of telecommunication technology, such as the appearance of 3G(CDMA), provides a technique basis for GIS entering thousands of families. The applications of GIS also change the original mode and enter a completely new era, Mobile GIS age. The scholar, Laurini,Servigne and Tanzi etc.(2000,2001)generalized this integrated way as a new research field, Telegeoprocessing/ Telegeomonitoring, which also will be the theme of this conference. At the mobile end add some accessorial equipment and researched a series of applications(Tanzi，1999；Boulmakoul，1999；Fritsch，2001).

Yet, the hotspot of the integration of GIS and telecommunication industry should be LBS (Location Based Services), through which, you can search addresses, postcodes, stations, restaurants, hotels and various road signs in the map. Indeed LBS is a new branch of GIS, which is a product integrating GIS, telecommunication and other technologies, providing the users positional information service. (Fig.1).

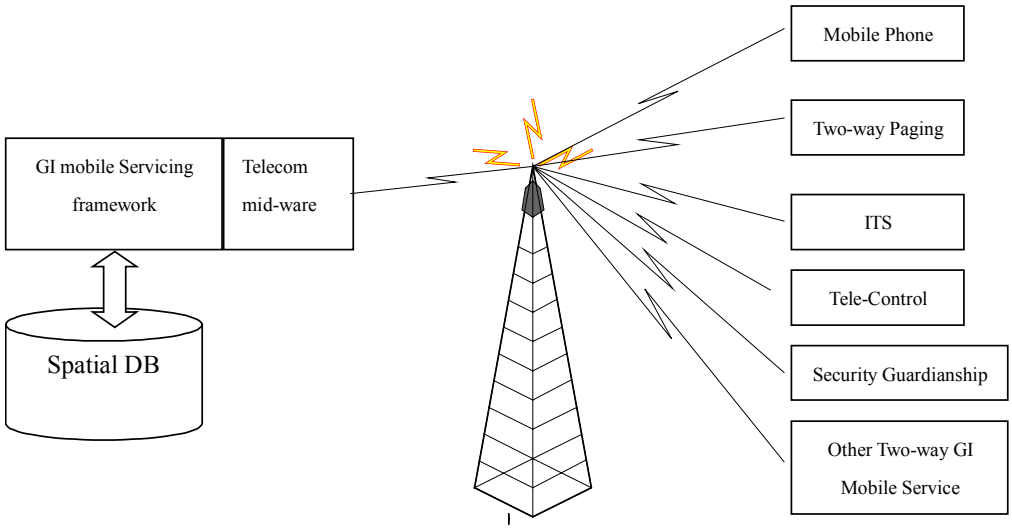


Figure 1. Mobile geographic Information System --a scheme of the integrating system of geographic information and telecommunication technology

### 2.3 The Natural Language Expression Model of GI

As yet, the philological models, developed in the spatial information field, approximately may be divided into completely different but tightly relevant two kinds: one starts with analyzing spatial conceptions of natural language, to improve the shortages of the present spatial information conception model. A representative harvest is the research on "Spatial Relation Language", N0.2 research motion (Mark, 1988-1992;Frank, 1991;Egenhofer, 1998); the other borrows semiotic and philological models to explain and resolve the problems of maps and spatial information. Namely regard 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 (Youngmann, 1978; Taketa, 1979; Nyerges, 1991).

The expression of spatial relation has three methods: Relation Table, Two-Dimensional String (2D-String) and Voronoi-Based Expression. The traditional Relation Table specializes in data organizing and index, but it's difficult to update and maintain spatial relation. Hence, it can't meet the demand of dynamically rebuilding spatial relation for GI mobile service.Although Two-Dimensional String can express direction relation well, it expresses topological relation more complexly.

Voronoi model can be used for qualitative spatial relation queries and search (Gold, 1989-1995). It unambiguously defines the spatial neighboring relation， constructing the topologic networks that can encapsulate the spatial relations between objects. Using Voronoi function library may define map operation, realizing philological many spatial conceptions, such as "near", "between" etc (Li Chengming, Chen Jun, Zhu Yinghao, 1998). For example, the function StolenArea() may pick up the area that a certain new spatial object occupies its neighboring object. The ratio of the result and the area of the former object may reflect the near extent of the both. The detailed algorithm may refer to related papers (Hu Zhiyong,2001;Liu Hui,1999;Li Chengming,1998； Zhongya Wei&Suning Xu,2002).

Because people with different language, culture, sex and age have different language expression (Mark D. and Egenhofer M.1995), in this experiment, the expression form of spatial query language is given some restriction. The SMS-based query includes two:

1) Route query, querying the traffic path between spatial two place names

define querying command string as: SP(Search Path): Parameter1,（placename1）Parameter2（placename2）.

Returned information is road string linking the two place names

2) Service facility query, querying postcode, station, restaurant, hotel and various main roads and signs.

define querying command string as: SS(Search service): Parameter（place name）.

Returned information is text string of postcode, station, restaurant, hotel and various main roads and signs, near querying place.

## 3. A SMS-BASED EXPERIMENTAL MODEL OF GEOGRAPHIC INFORMATION FOR MOBILE SERVICE

This section will describe a SMS-SDB gateway system. The objective is through the short messages to connect the mobile users with the spatial database so as to provide GI query service anywhere anytime. This application will be more significative when the mobile telecommunication provides the additional location service(Zhang Ling,2001).

### 3.1 Systemic Structure

Figure 2 shows the SMS-SDB gateway system. Its one end connects with some SMS facilities (GSM mobile phone) as telecommunication equipment of the short messages between the system and the mobile users; the other end connects with the spatial database server of the Internet to access the spatial data. The SMS agent is used to control the reception and transmission of the short messages and the conversion between the short messages' format and their records' format. The M2TA (map to text agent) is used to connect the databases and realize the conversion operations of the map language and the natural language. Command parsing module analyzes the content of message queue and parses query command and parameters;

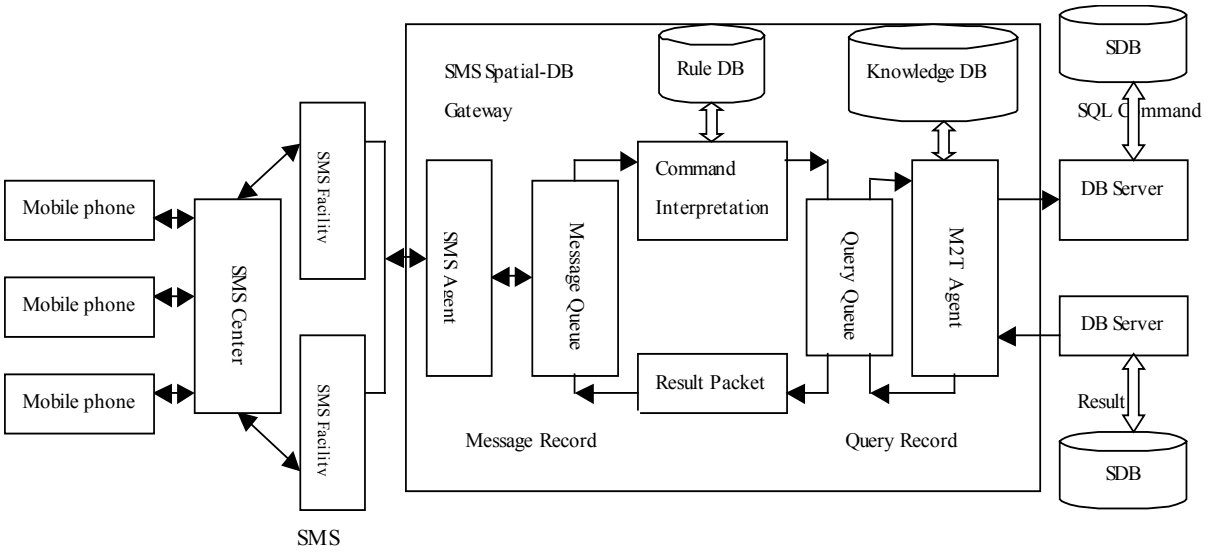


Figure 2. The system construction of SMS-SDB gateway

result-processing module transforms query result to short message for transmission.

The typical query process is as follow: First, through the SMS center, the mobile users use mobile phones to transmit short messages to the SMS facilities connected with the system, showing the contents they want to query. Next, the SMS agent constructs a message record according to the short message they have received, putting it in the message queue. Then, the command interpreter module analyzes the message record according to the predefined rules, recognizing the target database and query operation so as to form an information record and put it in the query queue. After that, M2TA collects the information record, connecting with the target database, to realize the conversion from map description to natural language, and fills the result in the information record. Afterward, the result reduction module changes the query result to message text and fills it in a corresponding message record. Finally, the SMS agent reads the message record and transmits it to the GSM phone number query user.

This solution can be applied not only to GSM-SMS, but also to CDMA-SMS, and can develop various high-speed operations at the SMS platform of the intending 3G mobile telecommunication systems. Moreover, it can also provide intellectualized diversiform incremental services through mobile phones.

### 3.2 Protocol Structure

Figure 3 is a network structure of SMS service system, and a hiberarchy of communication protocol between them. The network structure includes MS（Mobile Station，namely mobile phone）, SC( Short Message Service Center), MSC (Mobile Switch Center), SMS-GMSC（SMS- Gateway Mobile Switch Center）and SMS-IWMSC （SMS-Interactive Wireless Mobile Switch Center）. SM-LL and SM-RL, the two protocols are ascertained by manufacturer and network proprietor together. ETSI (1996) just defined SM-TL protocol standard, SM-TL services at the ends of MS and SC and SM-RL service.

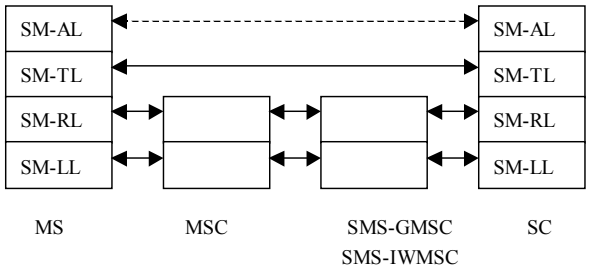


Figure 3. The protocol model of SMS

SM-TL (transport layer) protocol regulates the commutative TPDU format of the intercommunication between MS and SC, and its reply modes. The standard defines six kinds of TPDU, of which SMS-SUBMIT transmits message from MS to SC, and SMS-DELIVER transmits message from SC to MS. SMS-COMMAND is used to transfer functions of SC from MS. The user data is made up of two parts: user data head and user data content, which is defined and used according to SM-AL.

SM-AL (application layer) constructs on SM-TL, providing many kinds of short message transportation service. The existing application protocols transferring non-text message are Narrow Band Socket (NBS)of Nokia and Wireless Datagram Protocol（WDP）of IANA. Each of their user data heads contains a port number to identify the types of the data contents such as ring, picture, telephone directory and mail notifying. In this example, we just transfer text message, thus may directly use TPDU of SM-TL to realize short message communication.

## 4. THE REALIZATION OF THE EXPERIMENTAL MODEL

### 4.1 The Development Method for Using AT Command Set

The SMS facilities (GSM mobile phones) may connect with computers through serial port or Ir (Infrared ray) port. The system regards the SMS facilities as a MODEM, controlling

diversified operations of the facilities through a set of special AT commands. For example, the AT command for Nokia GSM mobile phones to transmit short messages is AT+CMGS=<length><CR>PDU<ˆ Z>. The PDU is the hexadecimal SC number plus TPDU that will be transmitted. An example using AT command to transmit SMS-SUBMIT is as follow: the recipient port number is "+8613901122334"; the SMSC number is "+8613800100500"; the content is "This is testing！".

AT+CMGF=0
AT+CMGS=30<CR>
089l683l08l00005F0l1000D9l683l08ll2233F4000
A7l154747A0E4ACF4lF4F29C9E769F4l2l<ˆ Z>

This example adopts a seven bits coding scheme (The byte marks with underline is 00). If unicode coding scheme is adopted, the byte will be 08.

Using AT command set to program is more agile, which can realize various complicated functions, but it is more inconvenient and complex.

### 4.2 The Development Method for Using SDK

In order to simplify the development process, some manufactures provide software package for application development, such as the PC connectivity SDK（PCC SDK）of Nokia (2000). PCC SDK aims at SMS programming interface of Nokia GSM mobile telephones （Nokia，200l）, including several independent libraries, each of which completes a group of given operations. Thereinto, Sms3aS.dll is dynamic link libraries for short message, which is used in transmitting and receiving the short messages and storage management. Sms3aS.dll is a component library, providing a group of components possessing binary system interface standard. Hence, it may be used in diversified programming languages sustaining object libraries, such as VB, VC++, VJ++, Delphi etc. The application transfers COM object interface of Sms3aS.dll with users/ components programming mode.

Sms3aS.dll contains three components: Short Message, SMS_Suite_Adapter and GMS Picture. The SMS_Suite Adapter provides several interfaces to transmit messages with mobile phones: ISMSSend is used to transmit messages; ISMSMemory is used to manage SMS storages of mobile phones; ISMS Settings is used to adjust SMS setting of mobile phones; ISMSReceiveNotify is used to notify message reception of SMS. There is a section of VB program using ISMSSend interface, whose function is as the same as the example using AT command in the last section. First use CreateshortMsg method to build a short message. Then transfer Send method to send it out:

```
Private SMSSend As SMS3AsuiteLib.SMS_SuiteAdapter
Private Sub Form_Load（）
    Dim ShortMsg As SMS3ASuiteLib.ShortMessage
        Set MSSend=new
SMS3AsuiteLib.SMS_SuiteAdapter
            Set ShortMsg=SMSSend.CreatShortMsg
ShortMsg.UserDataText= "This is testing！"
                ShortMsg.SCAddress= "+8613800100500"
                ShortMsg.OtherEndAddress=
 "+8613811122334"
                Call SMSSend.Send（ShortMsg）
End Sub
```

### 4.3 Definition of Query Operation

In order to complete database query operation, a M2T agent needs have knowledge related to the connected database and specific query operation. The information cannot be taken with simple query request, thus it needs to be set and be saved in a repository in advance. The knowledge database includes a database connection table and a SQL script library. Each item of the database connection table has saved diversified information connecting with a database, such as name, type, drivers, alias and password of the database. The script library has deposited preestablished SQL scripts for certain spatial query operation. The scripts designate the applicable database, the tables that will be queried, the fields and SQL operating commands. In the scripts, we may use variable parameter so as to assure agility of query operations.

Having these definitions, we may describe query operations with query records. The query records include the fields as follow: message number, state, name of the database connection, name of the SQL script, parameters, and SQL result. Thereby, a query record can ensure a whole query operation.

### 4.4 SMS Command Parsing and Parameter Extracting

Limited by message length, the query request through short message should be brief, agile and exact. Using rule-based analyzing method may meet these requests. Rules are a set of operating norms predefined by a system or a user, being a foundation of the module of command parsing that extracts message records and forms query records. Rules may be added, deleted and modified. Contrasted with the modes of fixed commands aggregation or port number, the regular analytical approach endues the system with higher agility and applicability.

The rules are made up of two parts: match terms and actions. The part of match terms is used to define the conditions that the message records, matched with the rules, need to meet. The part of actions designates the operation to build query records. In the rule as follow, SP is used to build query records that query route between two points in an urban road network database.

Rules name SP；
match terms {command name = 'SP' }
action { connection name =ROADDB； script name =PATHSEARCH；
parameter =（position 1）（position2）}

Practical rules should have more operating meanings, such as error handling and user identification etc. After the position service for mobile phones users is provided, users need not to input their positions.

Rules-based query and analysis process is: message contents in the records are character strings as follow: <String>：<String>，……<String>. Command parsing module first analyzes them as <Command name>：<Parameter 1>，……<Parameter n>.Then carries through matching according to command name and rule name. Falling across the matching rules, command parsing module will perform according to the appointed actions in the rules and will fill out the query record. Hence, after a message record of short message "SP: Peking University, West Railway Station" is matched according to the rule, it will form a query record that queries the route from Peking University to West Railway Station in the ROADDB.

## 5. CONCLUSION

Through this research, we have concluded the three rationales of the GI for mobile services，they are： 1) Formal representation of GI is an important harvest of spatial cognition. To some extent, it realizes the unlimitedly complex spatial information expression, using natural language in the limited resources. Hence it is one of most effective methods for semantic-level compression of geographic information, having become a key to realizing GI mobile service; 2) the bottleneck of GI mobile service depends on infrastructure. The limited communication bandwidth restricts any large data volume Geographic data (vector and raster) Real-time transmission on the wireless network; 3) Telegeoprocessing, the conception which is formed through the integration of GIS and telecommunication technology, is an important rationale of the GI for mobile service. Having broad applied area, the GI mobile service will become a GI research hotspot.

Through this experiment, we have got the firsthand experimental result. According to the 50 SMS spatial queries, we find the average processing time of the gateway is nineteen seconds, but indeed, the average time that users really get a query result is longer than it: reaching to 67 seconds. From the time viewpoint, there is still a distance from such an experimental system to practical application. From the applied viewpoint, the gateway of GI mobile service should have high capacity, abiding by the telecommunication running GSM standard. Its gateway and control software, designed according to the telecommunication standards, should meet the requirements for no more than three-minute malfunction per year to telecommunication on the net, needing a high security. Hence, the model in this manuscript is just an experimental model. There is still farther research effort needed.

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