A MOBILE LOCATION-BASED ARCHITECTURE FOR INTELLIGENT SELECTING MULTI-DIMENSION POSITION DATA OVER INTERNET

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ABSTRACT:

The mobile communication network is enabling a broad range of new applications that dynamically obtain information that is relevant to their current location. Among the terminals deployed, there will be hundreds of millions of Internet-enabled ones making Mobile Internet a reality for the big masses. The terminals and/or the mobile networks are now able to determine the position of the terminal on the earth with more and more precision. The paper describes a model for associating location scopes with services, an architecture to support the discovery of location-based services on the Internet, location-based guide, map object handles to one or more contact addresses, mobile user may choose different type data results for output according his/her current need.

1. INTRODUCTION

Along with the development of wireless communication technology, especial the application of the WAP (Wireless Application Protocol) (Sumi, 1998), the combination of wireless communication technologies, GIS (Geography Information System) and Internet technologies is to be a new technology --- Wireless Location Technology. As a result a new service---Wireless Location service comes true. Application of the Wireless Location Technology is very widely, people could query their current position through mobile station (handset or PDA); adopt spatial query and analyze function of GIS, find concerned information (Cheverst, 2000). For example, when you walk on the street, you can query where is the proximate restaurant, how to reach it; what is its feature food. And if you come to a strange city and lost your way, you can quickly search the map of your vicinity, marked the target position, the mobile station can automatically display the right route, guide you reach the destination.

Advances in wireless communication technologies and mobile Internet-enabled devices like smart phones and PDAs, have enabled global Internet connectivity and ubiquitous Web-based computing and service distribution (Dey, 2000). Mobile computing is the technology which provides the valid, precise information to the subscriber in time whenever and wherever (Hohl, 1999). People could connect mobile data with the information system to get useful information at any time through the new generation of intelligent equipments: mobile computer, vehicle, handset and so much as watch, which are of mobile computing function. What can meet the basic demand of people is that time, place and content information. What's more, the position is the most important information while people are under mobile condition, especially precise position information under urgent situation. Location-based applications would greatly benefit from generic mechanisms for supporting the association between network resources and physical space, but existing systems are typically based on vertical approaches valid only for narrow application scenarios.

This paper argues that a comprehensive solution to this issue should address the important challenges of heterogeneity and openness, and proposes an approach based on the concept of location-based service, i.e., a service whose usage is associated with physical space, as a generic abstraction to support the development of location-dependent systems.

Mobile information services or mobile applications, severally, can be subdivided into two categories depending on the way information access is controlled: general information services that access information without concerning the user' current location and location-based service (LBS) or mobile location-based applications with use the location information as one of the most important parameters (Clarke, 2001).

This paper comprises a Layered LBS structure and architecture of supporting to intelligently choose different type position data in section 2. In section 3, describes implement circumstance and applicability. Section 4 contains concluding remarks and an outlook on further research topics.

2. LOCATION BASED SERVICES

2.1 LBS Processing

LBS (Location-based Service) is emerged as mobile services based on the location information of mobile users, which is provided by carrier (Roth, 2002). Generally, LBS is composed of the following components: (1) Spatial location acquired (location platform), (2) LBS management, (3) Information transmittal, (4) Geometry information system (GIS), (5) Mobile station, (6) operation service supply. Being key technology of LBS, there are three types of mobile location technology, say, network unattached location, terminal unattached location and associated location (i.e., combine network unattached location and terminal unattached location). These technologies emphasize particularly on different direction, which satisfy the demand of carrier and user on precision, cost, covered scope, equipment terminal and so on. There are many kinds of value-added operation of LBS. For example, the user terminal will remind user of sale promotion information automatically

when user is drawing near emporium; the mobile station will provide the feature, quoted price, empty vehicle position, empty room information automatically while the mobile user is passing by restaurant, cinema, parking. While outside, the system will tell you the best route through considering every real-time traffic factors: traffic jam, one-way street, and trestle, and so on.

The general location-based service processes consist of two parts: (1) how equipment can get its geographical location information and send it to a location-based application server (i.e., Web server, mobile-commerce server) and (2) how the server can use the provided geographical information, either return the appropriate response or activate relevant operations according to the service. This response should include the user's request of the relevant location-based service information, such as"where is the shopping mall, bus stop, nearest restaurant, etc".

The part one realizes the series of mechanisms that provide the equipments with the geographical data. They include the positioning mechanisms, protocols, sensors, and equipments for calculating/transporting the actual geographic location. The case of positioning mechanism (i.e., GPS: Global Position System, GPS location method (see figure 1) utilize the independent GPS receiver to measure the pseudo-random phase etc., and eliminate the location error which is aroused by satellite clock, location model, ionosphere time delay, troposphere time delay and SA (Selective Availability), etc. through time correction process.) is embedded in the mobile station itself; it is no need for those additional protocols. On account of costs of those calculations, extra equipments may be required for obtaining and processing location information, which requires those extra protocols and communications between the equipment and the positioning entities. In the next generation of wireless communications (3G, 4G or UMTS (The UMTS Forum)), these additional entities and mechanisms are standardized and they are know as Location Services (LCS) (3GPP TS 03.71 V 8.8.0 (2003-06)). The part two realizes the transaction between the device and the application server.

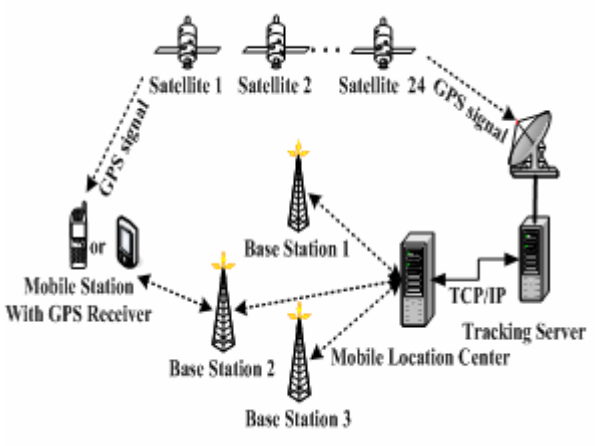

Figure 1: GPS Location Process

2.2 Layer LBS Structure

Lots of location information can be expressed in very many different ways. The various expressing way of the location information reflects the needs of the application domain where the specific information is going to be used. This paper categorizes the location information into three types according to the users' demand: geographic position data, spatial-temporal position data and semantic position data. *Geographic position data* is used to describe the information of static spatial position and can get the precise location of the mobile users by the localization technology. It's the basic data used for positioning in LBS system. *Spatial-temporal position data* is the spatial position information which gathered or computed at some special time or during a period. It is not only made of points, but also lines and curves, polygons and volumes as well as data modeled as grid structure. *Semantic position data* get very wide applications, it do not provide the concrete physical position coordinate, but the abstract position. It can be a bus station or airport, a city centre square or a room inside a mansion, a mountain or a river or a villa. Note that a user can reside at different semantic locations at the same time, i.e., being in a bus station, a user may be in a city centre as well. It is relative to the partition granularity. Lots of applications can analyze and process semantic position data much easier than geographic ones, semantic position data can easily be used as a search key for traditional databases.

Mobile users select which one type of data determinate by user current requirement. (i.e., a navigation system for sailors needs physical position data (spatial-temporal position data or geographic position data) not but a semantic position data). Otherwise, when a tourist arrive at Beijing first time, he want to himself position belong to which concrete region and where concrete block of this region (i.e., international finance mansion D# Fuxingmen block 156# Xicheng region, etc.), here, he should select to get a semantic position data. Even if the system returns a precise physical position coordinates to him, to the user reservation, shopping, travel, and order for food, etc. that's fruitless effort. To returning a position data to user conveniently, this data could be formulated by speech, SMS or electronic map according to the requirement of user.

A location-based service demands flexibility and scalability from the system architecture, so the architecture should be provided with the following characteristic:

- The service has to provide information of different types (geographic, spatial-temporal, and semantic). Coordinates make the instrument to integrate any data set and convert them into one model of the reality, covering different geographic regions. This information could possibly be acquired from different sources.
- The service possibly has to provide dynamic information (through URL link to internet).
- Interoperability of LBS components has to be managed.

Due to the above-mentioned reason, we design the layer structure (see figure 2) of location based services consists of four main levels (from bottom to top):

- Foundation positioning level
- Advanced position estimation level
- Select positioning data type level
- LBS application level

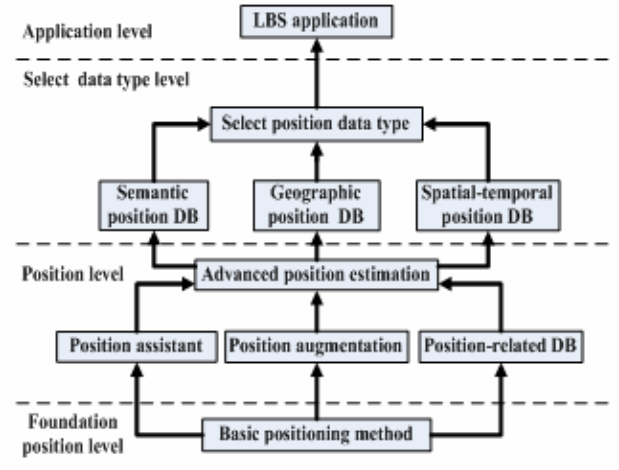

Figure 2: The structure of LBS layer

2.3 Architecture

Many existing frameworks either rely on a specific positioning system such as GPS or only provide a very high-level concept to integrate other positioning systems. Especially, these frameworks don't considered that the relation of physical to semantic locations, spatial-temporal locations and the mapping of local sensor-data to global location information have a high influence on how location-based applications perform their service.\

We proposed an architecture (see figure 3) to support the discovery of location-based services on the Internet, location-based guide, map object handles to one or more contact addresses, mobile user may intelligently choose different type data results for output according his/her current need. This architecture – a framework for Internet/Web LBS application development is introduced as collection, analyse and processing of spatial-temporal position data, semantic position data and geographic position data modeling and management tools. Internet/Web LBS functionality is now through Internet/Web available to wide audience of non-expert users, possessing minimal browser technology to zoom into their spatial-temporal data, or semantic data. The architecture is fully based on a standard Web (HTTP) server, LBS application and database server and a Web browser, used to generate requests to a Web server and display the results in HTML format.

The architecture of the LBS applications system is a client-sever application based on five main elements:

- Mobile device (i.e., handset or PDA, etc.)
- Location server (Position-related database, spatial-temporal database, semantic database, general-geographic database)
- 3G/4G mobile communications network(3G/4G/HTTPS)
- Internet
- Remote server (map server, info server, navigation server, message server)

When a user need some location-based service, firstly, the user send location request (It includes the symbol of location data type which the user need to output.). GPS receiver supplies geographic location data to 3G/4G mobile devices, and then these data transmit to location agent through 3G/4G mobile communication network. Through the symbol of location data type that the user sends, the location agent selects fit location data from the spatial-temporal position database, semantic position database and geographic position database which has been supplied, and do relevant disposals. Then it sends relevant information to the mobile user by LBS application interface in the form of text, voice or map etc. Location agent also connects with message engine at the same time. It will be more convenient to visit the remote server (including message server, map server, information server, navigation server) through the internet. These servers supply different kinds of location-based services according to the users' location-based service type and return relevant information to the message engine according to users' request through the internet. Finally, the location agent returns the relevant information about location through LBS application interface.

This architecture support spatial-temporal data (i.e., *x-coordinate/ y-coordinate, time* [this time maybe the time of a day or the time slice. If it is the former, it denotes the location at the time of a day; if it is the later, it denotes the movement trajectory.]), semantic data (i.e., Sino-Korea Chongqing GIS Researcher Center, Chongqing Univ. of Posts & Telecom, China), generic geographical data (i.e., GPS coordinates *N23º07.13635 / E120º16.43733/10:36:08AM*).Geographic information systems and spatial-temporal databases provide powerful mechanisms to store and retrieve, insert, delete, query, index location data. Such systems primarily concentrate on accessing large amounts of spatial-temporal data. In our intended scenarios, however, we have to address issues such as connectivity across a network and mobility of clients, thus we have to use data distribution concepts, which are only rarely incorporated into existing GIS approaches.

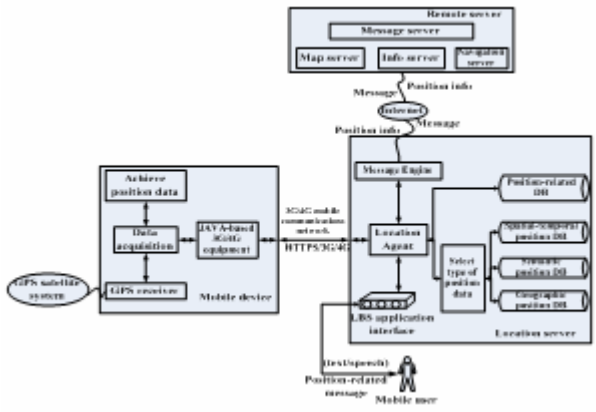

Figure 3: An architecture of supporting to intelligent choose different type position data

3. IMPLEMENT CIRCUMSTANCE AND APPLICABILITY

We discussed environment of location-based services which are services operating in mobile communication networks, 3G and intended mostly for public at large. The mobile environment provides good opportunities for new services; however it sets also restrictions and limitations that have to be taken into account in designing the services. The infrastructure of this LBS applications support the 3G/4G network, the next generation communication network, and the WLAN network. The different Location Service (LCS) specifications for 3G/4G and GSM networks are standardized by the Third Generation Partnership Project (3GPP).

In the context of LBS, positioning techniques give coordinates

mainly in global WGS 84 coordinates. However, a lot of data are available in different projections and coordinate systems worldwide. Among LBS a rich amount of different data collection and digitization methods are used and new methods are all the time developed. GPS was a remarkable advancement in its time, and at the moment laser scanning gives a lot of new possibility especially for 3D model generation.

On the other hand, a mobile environment imposes strictly restrictions on LBS thus creation a demand for information relevance:

- Mobile networks have high cost, high latency, and limited bandwidth.
- Mobile terminals have limited memory, limited computational power, and limited display screen size.
- When LBS is sometimes used in emergency and special environment, such as emergent call services, positioning-tracking of criminal escaped from prison etc, it requires highly in precision of service responding time and mobile users' location information.

4. CONCLUSION AND FUTURE WORK

In this article, we have presented the structure of LBS layer and the architecture to support the discovery of location-based services on the Internet, location-based guide, map object handles to one or more contact addresses, mobile user may choose different type data results for output according his/her current need.

Future research will focus on further development of this system. In designing the MLS (Mobile Location Service) system, we ought to take into account these above conflicting demands (Section 3. mentioned restrictions). Additionally, the usability of the service was considered. MLS system has the following important features:

- It is based on different type data
- It is XML –based
- Most computations are handled by mobile networks, few computations are delegated to the client
- The user application of MLS system is implemented in Java
- It uses an intelligent algorithm for selection of relevant and requirement data and data type
- It supports transactions management.

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REFERENCES

Cheverst, K.; Davies, N.; Mitchell, K.; Friday, A.; Efstratiou, C., 2000. Developing a Context-aware Electronic Tourist Guide. *Some Issues and Experiences, in Proceedings of CHI'00* (Netherlands, 2000), ACM Press.

Dey, A., K.; Abowd, G., D., 2000. CybreMinder: A Context-aware System for Supporting Reminders. *Second International Symposion on Handheld and Ubiquitous Computing 2000* (HUC2K), Bristol (UK), Sept. 25-27, 2000, LNCS 1927, Springer-Verlag, 187-199.

Hohl, F; Kubach, U.; Leonhardi, A.; Schwehm, M.; Rothermel, K., 1999. Nexus - an open global infrastructure for spatial-aware applications. *In Proceedings of The Fifth Annual International Conference on Mobile Computing and Networking* (MobiCom '99), Seattle, WA, USA. ACM Press.

K.C. Clarke, August 2001. Cartography in a Mobile Internet Age, *Proceedings of the 20th International Cartographic Conference*, Beijing, China, pp.1481-1488.

Roth, J. Nov. 13-15 2002. Context-aware Web Applications Using the PinPoint Infrastructure, *IADIS International Conference WWW/Internet 2002*, Lisbon, Portugal , IADIS press, 3-10

Sumi, Y.; T. Etani, S. Fels, N. Simone, K. Kobayashi and K. Mase, June 1998. C-MAP: Building a Context –Aware Mobile Assistant for Exhibition Tours. *Social Interaction and Communityware*, Japan.

The UMTS Forum, www.umts-forum.org (accessed 18 Feb.2005)

3GPP TS 03.71 V 8.8.0 (2003-06), 3rd Generation Partnership Project; Technical Specification Group Services and System Aspects; Digital cellular telecommunications system (phase 2+); Location Services (LCS); (Functional description) Stage 2.