RESEARCH OF LBS BASED ON JAVA AND AN APPLICATION SOLUTION

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ABSTRACT:

Geospatial applications will be woven into the fabric of the information society. Location based services (LBS) as a promising research field brings new opportunities and challenges to geographic information accessing, sharing and disseminating. The convergence of a number of technologies includes GIS, Internet, GPS, database, wireless communication and mobile computing. Through pull and push mode, the terminal users can access to required information – largely centre around their locations and surroundings. However, because of big variety of mobile devices, software of LBS has not typically been widely available for them. JAVA development environments provide a suitable method to gather requested information in an appropriate way. In this paper, some preliminary researches of LBS are introduced. A new architecture of LBS based on JAVA with Web Service is proposed and tested. These applications of LBS based on JAVA may be written once, and then deployed on any server platform that supports the Enterprise JavaBeans specification.

1. INTRODUCTION

Location-based services (LBS) provide users of mobile devices personalized services tailored to their current location. They open a new market for developers, cellular network operators, and service providers to develop and deploy value-added services: providing proximity information ("Where is the closet restaurant"), navigation directions ("How do I get there?"), or tracking (fleet management, find near friend), and many more. Putting the internet in the mobile devices will enable us to access to geospatial information anytime, anywhere and any-how. So it is prospected that LBS will be killer application in wireless internet services. The Standards of the Open GIS Consortium (OGC) are going to establish including the route determination services, directory services, location utility services, presentation services, and navigation services on LBS.

There are two basic approaches to implementing location-based services:
Applications based on pull mode: the clients send their location information to the server initiatively, and then pull the information what they need, for example, route map or nearby stores, etc.
Applications based on push mode: the Service Provider (SP) detects the clients close-by, and pushes the service, for instance, shopping stocks or ads. The key point of this application is how to protect the privacy of clients, for the location information may be highly sensitive. It is very important that the SP can only acquire information from the opt-in clients and provide service for them.
All of this demands distributed systems that are characterized by interoperability, scalability, security, integrity, and high availability.

In the next section, this paper will present a guide to developing LBS applications from design to implementation. The proposed LBS architecture based on Java overcome the platform dependency, closed system characteristics, and distributed computing environment.

2. LBS SYSTEM ARCHITECTURE BASED ON JAVA

The simplest LBS architecture is the Stand-Alone Client. In this architecture the application resides entirely on the mobile device. The device stores Geospatial data, client software to interpret and display that data, and the customized application. This architecture has some pretty major limitations. First, the hardware resources of the mobile device restrict the amount of geospatial data the application can support and have typically been inadequate to run sophisticated GIS applications, because of its limitations of mobile devices (limited power, memory and computational power). Second, this architecture does not allow for communication with any other applications or collaborators using the same application. To address these limitations, one might reasonably adopt a client-server architecture. Here the geospatial data is moved to a separate computer and stored in database, being served to the client by application server software. This has some advantages over the Stand-Alone Client. First, the geospatial data is constrained now by the virtually limitless resources of an enterprise server. Second, multiple mobile devices running the same application can access the server concurrently, making this a potentially multi-user architecture.

2.1 System Architecture based on Java

Figure 1 shows the physical environment of LBS running. A user submits a query from a client device (mobile, PDA, etc) to a server via wireless internet. The key idea of LBS is that a

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portable device sends its location information to a server, the server search through its database to find the most relevant information near the location and sends it back to the client for further use. In Figure1 the positioning module is responsible for acquiring the physical location of a mobile device. Positioning in client can either use GPS, if available on the mobile device, or be based on the location system of wireless infrastructures, namely GSM/CDMA. Positioning methods are known as the Cell of Origin (COO), the Global Position System (GPS), Time of Arrival (TOA), and Enhanced Observed Time Difference (E-OTD). Each method has its advantages and disadvantages. Mobile wireless internet is the General Packet Radio Service (GPRS) that allows information to be sent and received across a mobile telephone network. The communication gateway plays a role of portal which can transfer information from wireless internet to internet/intranet. In the server, there are some business application server and web server, DB server connected internet through firewall. These servers deal with request from clients.

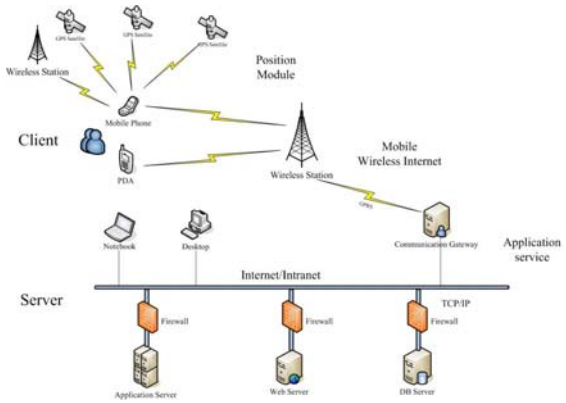

Figure1. The Physical Environment

The overall logical architecture of the system is shown in Figure.2. This system adopts a three-tier architecture. Proposed system is design to be a generic infrastructure that can be accessed by all kinds of LBS applications. For this reason a well-formed interface has to be provided that allows the appropriate use of the services for the different applications. This architecture will support most LBS applications in a robust, reliable way.

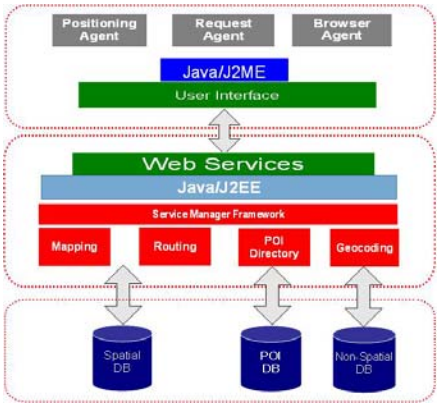

Figure2. Location Based Service Architecture

The first tier is a client side. It is user's terminal including three components: Positioning agent, Request agent, Browser agent. Positioning agent provides real location of an user to the server. Request agent allows user to select different service. Browser agent supports geographical view utilities which are developed to present a map and other texts in mobile device based on J2ME. User interface is a key component of the solution that makes it possible for subscribers to personally manage the content that appears on their handset via the Wireless Web service.

The second tier is the business mediator which provides web service based on J2EE for users. Whenever the mediator receives a request from a client, it first determines which service manager is selected. It then finds the corresponding map near user's location in its database. Service manager consists of four service modules.

Map Service tailors and renders geographic information for display on a Mobile Terminal. Other service may call upon this service to obtain a map of a desired area, with or without map overlays that depict some information, such as Route Geometry, Point of Interest information. The service may also be employed to render route directions.

POI Services provides subscribers with access to find the nearest or a specific place, product or service which they are interested in. The subscriber starts to input the search parameters in the service request, identifying the place, product or service that they seek by entering the name, type, category, keyword, phone number, or some other identifier. A position must also be employed in the request. Given the formulated request, the engine searches the POI database to fulfil the request, finding the nearest or specific place, product or service, depending on the search criteria and categorical data of POI. The service returns one or more responses to the query (with locations highlighted in map and complete descriptions of the place, product or service).

Route service determines a route for a subscriber. It is determining the path of a vehicle from one point to the other. The shortest distance and fastest travel time are two of the most commonly used criteria. The subscriber must indicate the start point (usually the position of their home, or their current location), and the endpoint (any location, like a place for to a POI). Route service uses a navigation application to compute in route network. It first identifies the nearest route node from the start point and then identifies another node nearest the end point. Route service computes distance of two nodes in route and highlights the result in map.

Geocoding Service performs as a geocoder by determining a geographic position, given a place name, street address or postal code. Geocoding is the process of assigning geographic coordinates (e.g. latitude-longitude) to street addresses, as well as other points and features. With geographic coordinates, the features can then be mapped and entered into Geographic Information Systems. The Way an address is geocoded is by comparing the number, street name and direction information of a location to an addressed roads network.

The third tier is the database side. It supports data management of spatial data, non-spatial data and point of interest information. Base map, route networks, address geocode sources, corporate information related to locations, Points of Interest, subscriber Information, all of these dates for LBS are stored in database. Business mediator can connect to the database through some interfaces, such as ODBC, JDBC, ADO, etc.

2.2 Service Procedure

In detailed service procedure of the system, perform an acquisition of the location information; a request from the client reaches the service manager with selected information and position information are sent to service manager. Process location data in a server and deliver results to the device. Figure3 demonstrates how the introduced service is operated.
① Mobile device performs an acquisition of the location information through GPS receiver. At the same time, user subscribes service;
②The client sends a request to the server in the way of XML SOAP/Socket protocol via the communication layer. Thus, selected information and position information are delivered to the server;
③The server identifies which service is selected by subscriber and then acts it.;
④ A search/query through JDBC is carried out in database according client selection, and results for the request is formed. The response information is now generated in the server;
⑤ The response result is passed to the client.

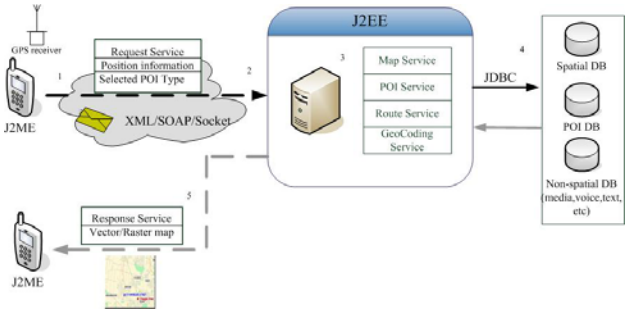

Figure3. Service Procedure

3. IMPLEMENTATION AND APPLICATION

In our model, components of the client and the server are implemented by Java language. Information of Spatial and non-spatial (POI) is constructed to relational database. These databases are defined and manipulated by Oralce9i.

3.1 The Client Site based J2ME

Java 2 Micro Edition (J2ME) is Sun's version of Java targeted at mobile devices. To deploy a J2ME application, the developer must first choose a configuration; the application may then be developed using a profile for that configuration. There are four configuration-profile options:

- Connected Limited Device Configuration (CLDC)
  - Mobile Information Device Profile (MIDP)
- Connected Device Configuration (CDC)
  - Foundation Profile (FP)
  - Personal Basis Profile (PFP)
  - Personal Profile (PP)

Spatial data and LBS, along with gaming and multimedia services, demand robust UIs in order to be useful for the average mobile consumer. J2ME is scalable, open, OS independent, and forward compatible with J2SE/EE. So, it is a better choice in mobile development application in LBS.

Figure4. Mapping Service in Mobile Client

Figure4 gives an impression of the mobile clients look a like. It supports zoom in/zoom out and full extent and provides simplified map data of PNG (Portable Network Graphics) image. For improving transfer speed, raster map near user's location will been tailored and limited in about 10KB. It requires mobile devices that are equipped with Bluetooth GPS receivers. Mobile clients is only responsible for acquiring location information and sending request of user's needing service, it doesn't take part in business computing, such as drawing map, shortest route analysing. These complicated computing is running in the server.

3.2 The Server Site based on J2EE

J2EE is a platform-independent, Java-centric environment from Sun for developing, building and deploying Web-based enterprise applications online. The J2EE platform consists of a set of services, APIs, and protocols that provide the functionality for developing multi-ply Web-based applications. Some of the key features and services of J2EE:

- At the client tier, J2EE supports pure HTML, as well as Java applets or applications. It relies on Java Server Pages and servlet code to create HTML or other formatted data for the client.
- Enterprise JavaBeans (EJBs) provide another layer where the platform's logic is stored.
- The Java servlet API enhances consistency for developers without requiring a graphical user interface.

Key feature of the platform based on JAVA are modularity, portability and scalability. It will not only standardize interaction, but also allows for more flexibility in the process. Figure 5 illustrates the service platform in the server. It is based on the open-source Eclipse3.0 project SDK. Communication between the service platform to the mobile user is achieved through socket proxy.

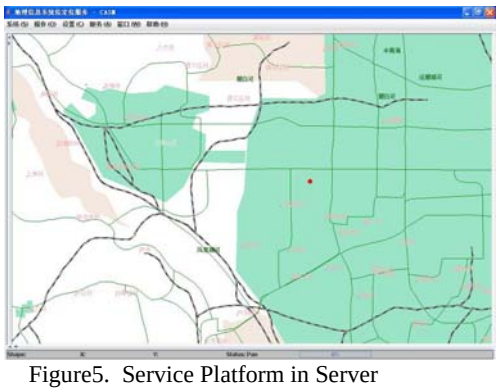

Figure5. Service Platform in Server

3.3 Database of LBS

As section 2.1 depicted, database of LBS include spatial database, POI database and non-spatial database. Geometrical objects, such as points, arc, polygons, are stored and managed in relational table. Service platform connect to database through

Java Database Connectivity (JDBC), which is the Java equivalent to ODBC, is the standard interface for Java databases.

4. CONCLUSION

LBS is an integrated technology of telecommunication and GIS. It should be recognized that location services in future will play a far more important role than what we find in today's wireless marketplace.

The Vision of LBS based on JAVA in this paper is to deliver open interfaces that interoperability and making possible delivery of actionable, multi-purpose, distributed, value-added location application services and content to a wide variety of service point, wherever they might be, on any device. It overcomes a platform dependency and enhances the distributed computing performance. The proposed core services are independent of a server platform.

The following list highlights some of the issues that need to be further researched for providing efficient and accurate location-based services for personal productivity:

- Development of efficient means to handle large data sets for LBS.
- Interoperability among content providers and interface standardization for efficient request-response services.
- Utilization of the real time data in its appropriate spatial-temporal context in LBS.

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