Location-Based-Service Roaming based on Web Services

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Abstract

Due to the rapid growth of personal mobile communication devices, more and more wireless mobile applications are developed. Location-based mobile application, one of the wireless mobile applications, will become the future trend. However, the application execution environment is not complete. How to integrate the services among multiple telecommunication service providers? How to support the original location-based services for the mobile roaming users? This project is aimed at solving these problems efficiently.

This paper proposes to integrate the roaming services into web services infrastructure. In this case, the mobile users could get the location-based service during roaming. Integrating the location-based application into the web services will also solve the mobile roaming problem.

1. Introduction

In various Add-On services, Location Based Services (LBS) are services based on the location of user and/or some targets. Location Service (LCS) provides the location information about one object. In general, there are two approaches to obtain the location: network-based approach and handset-based approach. The existing positioning technologies (such as AOA, EOTD, GPS, Cell-ID, TDOA, and aGPS) have different accuracy and limitations [1-3]. Because LBS is based on LCS, the results generated by LBS are dependent on specific location and time of certain device. So the investigation of LBS has to consider both spatial and temporal properties.

At present, the LBS, provided by most service providers, are only bounded with their own system. Although this model guarantees privacy, security and the convenience of billing, it limits the extensibility and scalability of services. Most of all, roaming of LBS does not work in this model. We can break roaming operations of LBS into two parts: LCS and LBS. As we mention earlier, LBS are based on LCS. If LCS roam, LBS will be able to roam. The standards of LCS roaming are currently under development. When the LCS roams successfully, the LBS roaming becomes the critical task. But the service providers do not provide personal and customized LBS for users in today's tele-operators infrastructure.

For example, a user uses a LBS, i.e. Dining Guide Service that provides restaurants information in Taiwan. The interface of services is familiar to the user in Taiwan. One day, the user goes to France with his personal device and wants to find a restaurant. The Dining Guide Service may not work, or it works with an unfamiliar interface under current operating environment. However, LCS and voice service can roam successfully. The reason why LBS can not roam is that LBS is still provided by French services providers under current operating environment.

The standard of LCS roaming between different tele-operators is instituted in near future [4]. Then, we consider the problem of LBS roaming. We adopt the widespread standard, Web Services, to solve the problem. Because the communication of services in wireless network also changes rapidly from WAP to various Internet protocols, the Web Service, based on standards like XML and SOAP, can be used on different platforms to achieve interoperability [5,6]. Hence, LBS under the Web Services environment make different service providers collaborated and LBS roaming worked.

Since LBS works under the Web Services environment, the LBS provider develops a new service integrated with others very quickly. The efficiency becomes a critical issue. We use caching to cope with this problem. We make an in depth study of caching under our environment. Since LBS is related to time and space, traditional caching algorithms, such as least recently used (LRU), may not work well. There are researches about caching of location-based data [7-12].

We indicate the motivation of this paper as the mention earlier and present a solution to make LBS

roam. The rest of paper is organized as follow. We describe the details of proposed architecture and how LBS roaming is achieved in Section 2. Finally, Section 3 gives conclusion and future work.

2. System Architecture

Web Services has standardized communication, description, integration, and discovery among service providers, users and discovery agencies. It also provides a way to communicate for services executing on different platforms. Next, the architecture and the operation model we proposed are presented in Section 2.1~2.2. LBS roam under Web Service architecture is described in Section 2.3.

2.1. Architecture

The LBS Operation model is similar to Web Services. Basic components of LBS architecture can be transformed to service providers in Web Services. Each provider publishes the service description to UDDI business registry on UDDI server. Users or other providers discover services from marketplaces, search engines or business applications. According to the description in the business registry, they facilitate integration with each other over the Web. This model makes LBS easy to integrate and roam. When LBS works under Web Services environment, system components have slight modifications. Functions of each component are described as follow:

Location Service (LCS). Every provider in web services must register on UDDI registry, including LCS. Considering the functionality of LCS, the infrastructure of positioning in a cellular network is always owned by tele-operators. In our architecture, LCS becomes a Web Services. The LCS Server accepts requests, estimates location, and returns locations to clients. Clients specify user name, password and one or more MSIDs in positioning requests. Then, LCS server shall translate geographical location into a well-defined universal format.

For security and billing, LCS servers are usually owned and maintained by the local tele-operator. To charge on location service, LCS server records user's access log and puts it into *call detail records (CDR)*. The balance of the customer is calculated according to the CDRs. On the other hand, the location of somebody or an objective is private and sensitive in most situations. If LCS server resides in tele-operators' domain, it will be protected by the enterprise firewall.

Geographic Information System (GIS) Provider. GIS provider receives search requests and returns geographical information with standardized format. After receiving requests, the provider process spatial data according to locations in the requests. The core of any GIS is a database which holds and describes spatial data. GIS needs professionals to build and maintain it. This procedure is expensive and time-consuming. Neither LBS providers nor tele-operators could provide GIS services. It is reasonable to build GIS as Web Services. If LBS providers publish a new LBS, they will choose suitable GIS web services in a UDDI search portal and make a contract with GIS provider. The cooperation and integration under web services between services is convenient and flexible.

Location Based Service (LBS) Provider. The working model of LBS is the same as original architecture. First, LBS receives requests from clients in Internet or WAP. The LBS queries LCS about geographic locations of targets, identified by MSIDs. Then, LBS gets geographic information from GIS based on the location calculated by LCS. Finally, the responses are sent to clients. (Showed in Figure 1)
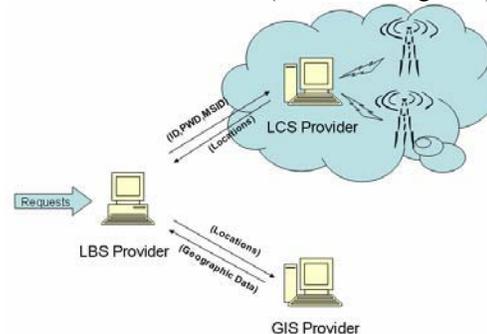

Figure 1. Working Model of LBS.

The coordinate data of returned locations is expressed as the latitude, longitude and altitude system. If the geodetic coordinate of LCS does not match that of GIS, LBS is responsible for transformation of geodetic datum and coordinate.

UDDI Registry. In our proposed model, the UDDI registry plays a critical role. When a business develops a new LBS, it searches UDDI registries for cooperative LCS and GIS providers. Users find a LBS in a web services portal, then contact with the service provider. After users install applications and provide the account information, LBS is ready to be used. The UDDI registry is like the phone book for web services. It facilitates the interoperability between providers and clients.

LBS Client. The LBS client in our architecture is also a web services client. When Web services clients communicate with services providers, the application in the client could be generated in design time or run time. The generating time is dependent on resources of clients and services types. In LBS operation model, the client run-time environment is always personal devices. The computing power and network resources are limited because of the light weight and power-consumption limitations. So the client application could be generated in design-time, or may be built automatically at first-time execution. If services are not changed, the application generated at first-time execution will be still executed under client environment. This approach can decrease the overhead of computing power.

The LBS client needs to specify essential information when client applications communicate with LBS. The information includes user identity, user password and located objects. User identity and password may be stored in client's storage. The located objects are dependent on services types. All these information are stored in client applications and automatically sent to servers when the client uses LBS.

Web services are designed to standardize the interoperability of various applications. Legacy applications, including LBS, can be transformed to web services. In our proposed system, services providers concentrate on developing creative services and tele-operators focus on voice and network business. Users can use large number of miscellaneous LBSs in Internet.

2.2. Operation Model

As users search favorite LBS, they can get services descriptions from UDDI registries or other ways. The LBS users and providers communicate each other based on SOAP. The LBS servers integrate with back-end services not only on SOAP in the Web Services architecture but also on *Remote Method Invocation* (RMI) *with the interoperability of the Internet Inter-ORB Protocol* (RMI/IIOP) in the traditional enterprise architecture. Those standard protocols facilitate the interoperability and communication of services.

From LBS provider's perspective, LBS developers find cooperative services in UDDI registries or search portals before developing new LBSs. LBS developers get contact with cooperative services providers. Then, they get service descriptions of cooperative services and integrate all of necessary services into a new LBS. In our proposed architecture, LBS providers can find a

variety of services in UDDI registries. The procedure of developing new LBSs is straightforward.

From LBS client's perspective, users execute client applications to communicate with a LBS at first time. If client applications are generated in design-time, users specify authenticating information (user identity and password) and the located object. On the other hand, client applications are generated in run-time. The client needs service descriptions of LBS to generate client applications. The descriptions are available in LBS providers or WSDL servers. After obtaining the description, users specify authentication information and execute LBS. In figure 2, clients execute LBS under web services environment.
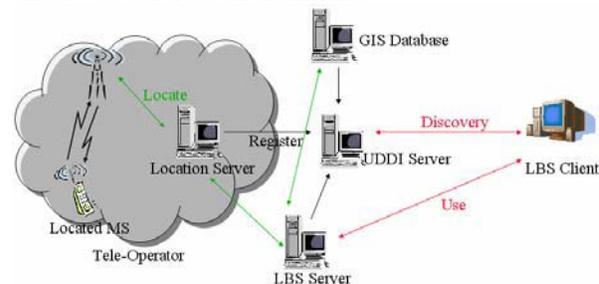

Figure 2. LBS under Web Services Environment.

When LBS works under Web Services environment, the problems of billing and security are critical. The billing problem is investigated under our proposed architecture. The tele-operator makes profits from LCS and network services. The LBS providers can charge for LBS usage. The GIS providers cooperate with LBS providers and share with the profits. Every provider could focus on their own services and make profits for services. The cooperation opportunities among providers are tremendous.

2.3. Roaming

In our proposed architecture, the LBS roaming problem is solved intuitively. When users roam in the places out of their own tele-operators, they get services descriptions of the original LBS from UDDI, and may execute LBS with the same interface. Most of all, the back-end cooperative services, LCS and GIS, operate in roaming areas, not in the area where users come from. Because the location and geographic information which users need are local, the back-end services integrated with the LBS are in the roaming area.

For example, we mentioned earlier that a user in Taiwan uses LBSs under the web services architecture. When a user roams in France, he finds LBS descriptions from UDDI registries in France or from cache in handheld devices. The user has the service

interface in France as same as in Taiwan. From LBS provider's perspective, back-end services providers (LCS and GIS) must be in France. The user gets local information in France, such as dinning guide and navigation information. The roaming procedure under web services is shown in Figure 3. No matter where users roam, they use the same LBS.
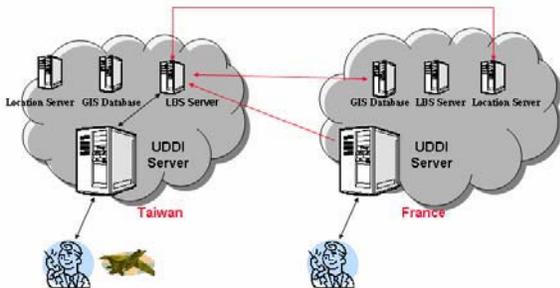

Figure 3. Roaming under Web Services Environment.

3. Conclusion and Future Work

As Add-On Services play an important role in tele-operators, location services (LCS) and location based services (LBS) are two of principal Add-On services type. If LCS can roam as voice, services based on LCS may roam also. Then, the users will have the service roaming and voice roaming at same time.

This paper proposes a scheme of services roaming. Location Based Services include several important parts: LBS Providers, LCS Providers and GIS Providers. The integration model is analogous to Web Services. Our proposal combines LBS with Web Services. Hence, the problem of service roaming is solved. When LBS is running under the Web Services environment, users use the same services and don't need any configuration.

We design an experiment environment and collect data from the original architecture and web services architecture. Through the experimental analysis, our proposed scheme achieves the LBS roam with tolerable overhead [13].

Under the Web Services environment, tele-operators can pay attention only to Location services (LCS) and network providers. The development of location based services (LBS) is handled by third-party service providers. Furthermore, the location based services are not limited in their own tele-operstors and the services roaming problem is solved. Tele-operators, service providers and users are mutually beneficial in the web services architecture. Location Based Services can roam in any place with the same user interface.

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