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Providing Location-Based Services under Web Services Framework

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INTRODUCTION

Location-based services (LBSs) provide personalized services to the subscriber based on his or her current position. By combining information on the location of a mobile user, services can be tailored exactly to the user's situation. These powerful location-based services are the keys to the growth of the mobile Internet in both the consumer and business markets. The geographical location of mobile phones can be used by operators and service providers to create and offer location-based mobile services, which employ accurate, real-time positioning to connect users to nearby points of interest, advise them of current conditions such as traffic and weather, or provide routing and tracking information—all via wireless devices. For subscribers, this means access to attractive, convenient, value-added services that will make their lives easier and more fun, save time, enhance business efficiency, and increase personal safety (Anckar & D'Incau, 2002).

To meet the demands of efficient, stable, and scalable architecture and implementation techniques of location-based mobile services, adjusting for various multi-platforms, multiple applications, and sustainable development environment, we propose an architecture of LBS based on Web services technologies—that is, Web service-based LBS (WS-LBS). WS-LBS has multi-layers and consists of a database server, global spatial information servers, local spatial information servers, and mobile clients. Web services technologies are adopted in WS-LBS. UDDI is used to publish global spatial information services, and URL address is used for local spatial information services publishing. At the mobile client site, SOAP client technology is adopted for end users to access remote spatial information services. Two kinds of WS-LBS clients are implemented: J2ME client and WinCE client. A WS-LBS prototype is implemented by Java and c# languages, providing transparent access to distributed spatial information services for various mobile end users.

BACKGROUND

Mobile terminals such as cellular phones, PDAs, palmtops, and so forth emerge as a new class of small-scale, ad-hoc service providers and consumers. And location-based services have been a rapidly growing concept in telecommunication industry. Market research companies predict a huge market for services to be delivered to mobile users. Strategy Analytics, a leader in providing strategic and tactical support for business planners, recently concluded that: "Demand for mobile information services is skyrocketing and interest in coupling them with positioning technologies [is] at an all time high" (Raskind, 2000). Location technologies are expected to augment existing wireless applications as well as spawn a host of entirely new services, including alerts, advertisements, and personal location and guidance services. LBSs are services that are triggered by the current geographic location of the mobile user and his surroundings. According to ARC Group Consultants (2003), it is expected that LBSs will be the most widely used mobile services by 2007.

LBSs can be categorized into three main classes (Beinat, 2001):

- **Information Services:** Providing information about objects close to the user—services like "Where is an ATM nearby" or "Find the nearest parking lot."
- **Interaction Services:** Based on the interaction between mobile users/objects and which do not require a "mobile Internet" component or content sources.
- **Mobility Services:** Supporting smart mobility and revolving around navigation capabilities. An example may be: "How to get to the nearest hospital?"

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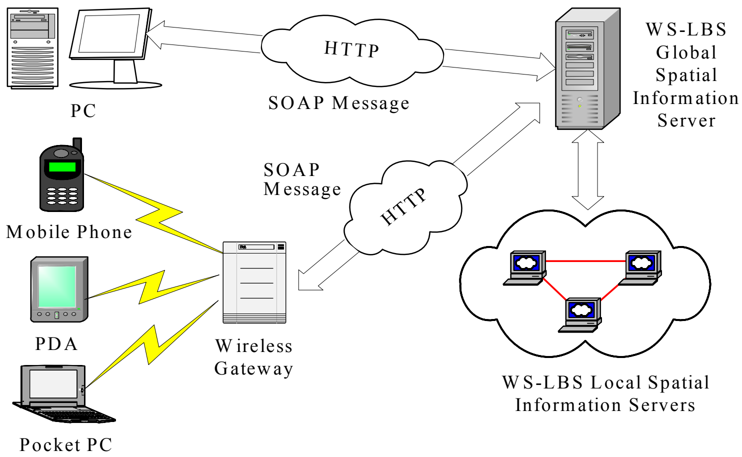
Figure 1. An overview of the WS-LBS architecture



Location-based services provide personalized services to the subscriber based on his or her current position (Searby, 2003). By combining information on the location of a mobile user, services can be tailored exactly to the user's situation. These powerful location-based services are the keys to the growth of the mobile Internet in both the consumer and business markets. For subscribers, this means access to attractive, convenient, value-added services that will make their lives easier and more fun, save time, enhance business efficiency, and increase personal safety.

Many GIS enterprises bring forth their wireless schemes: ESRI ArcPad is integrated with GPS module to provide mobile users functions similar to desktop GISs; ArcLocation gives a set of wireless solutions; and MapInfo's miAware, Intergraph's IntelliWhere, and Oracle's Mobile Location Services on Oracle8 and Oracle 10g are all conformed with OpenLS specifications of OGC. Mobile terminal providers such as Nokia, Ericsson, and Motorola are also competitive to develop added-value businesses for mobile users. However, the architecture, platforms, standards, and application background of these systems and applications are quite different (Adams, Ashwell, & Baxter, 2003). To keep sustainable development of LBSs, urgent need exists for efficient, stable, and scalable architecture and implementation techniques of location-based mobile services, adjusting for various multi-platforms, multiple applications, and sustainable development environment (Hermann & Heidmann, 2002).

Web services as a language-neutral and platform-independent technology can be adopted in constructing flexible and loosely coupled business systems. It is easy to apply Web services as wrapping technology around existing applications and information technology assets, and new solutions can be deployed quickly and recomposed to address new opportunities under a Web services framework (Gottschalk, Graham, Kreger, & Snell, 2002). Hence, we propose a Web services-based LBS architecture: Web service-based LBS (WS-LBS).

WS-LBS ARCHITECTURE

The WS-LBS system consists of four components: client site, server site, Internet or intranet connecting the client sites and server sites, and SOAP messages among the sites. Figure 1 is an overview of the WS-LBS architecture.

In the WS-LBS system, a client is referred to a client machine that can be a desktop or a notebook computer, or a PDA or a mobile phone, which usually does not provide functions of spatial information processing. A user can submit a query request and obtain the final results via a client machine, and only if the user wants to connect to WS-LBS to get spatial information needed, then the client machine can be a part of system. A server in WS-LBS usually refers to a spatial information server that can provide spatial services for local and remote users. When a user submits a query via a client, the query is encapsulated in a SOAP message after initial analysis, and the message is sent to a related server. After receiving this SOAP message, the server makes further analysis and optimization on the requirement, and decomposes the query into sub-queries. Then one or multiple SOAP messages will be sent to related server(s) for the required information or services. The search results will return to the original server within SOAP messages and be merged into final results back to the client.

The Framework of the WS-LBS Server

The framework of the WS-LBS server has two layers: the global spatial information services (GSIS) layer and the local spatial information service (LSIS) layer. GSIS consists of three components: agent of LSIS, manager of LSIS, and query decomposer and coordinator. LSIS is composed of two components: common spatial information services interfaces (CSISI) and thematic spatial information services interfaces (TSISI).

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