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A Java-Based Wireless Framework Network for Area-Based Services and Applications

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ABSTRACT- Location Based Services (LBS) applications are a category of new emerging and fast growing applications. Potential LBS applications are enormous including vehicle Navigation, fleet management, real estate, and travel services. Objected-Oriented (OO) application framework technology is an efficient and easy-to-use tool for application developers to promote software reuse. Moreover, OO application framework technology has its unique advantage in support of the development of wireless communication software. The framework can also enhance the maintenance, readability and modifiability of the developed software. To facilitate the LBS application developers to take advantages of the fast-evolving wireless communication technologies, a wireless framework has been developed to host some of the most popular wireless technologies available in the market. The wireless framework, based on an open structure, which already supports wireless modems and wireless Internet, is easy and friendly to incorporate new technologies into existing infrastructures. The wireless framework employs a pure Java solution to increase the platform-independency and life span of the software.

Keywords: Location Based Services, OOP, wireless communication, Platform-independency

1.Introduction

A category of applications, which is known variously as Location-Based Services (LBS), Location Commerce (or L-commerce), mobile commerce, mobile location services,wireless location, and similar terms, is now emerging rapidly in the Geospatial Information marketplace. By any name, the purpose and character of LBS remains the same: employing accurate real-time position information of users to connect them to nearby points of interest (such as retail businesses, public facilities, or travel destinations), to advise them of current conditions (such as traffic and weather), or to provide routing and tracking services. For example, a person at shopping mall calls for information on the nearest restaurant with an economy budget. He/She needs only names and addresses of those restaurants that are within his reach, say within one square-kilometer, out of the database of, say 2000 restaurants in the city spread over 1600 square kilometers [Prasad, 2001]. At the intersection of Web, wireless communication and Geographic Information System (GIS) technologies, Location Based Services are aimed at giving everyone the ability to exploit location information anywhere, anytime, and on any device. LBS are expected to create a new global market ─ in both business-to-business and business-to-consumer services ─ with annual revenues well into double-digit billions of dollars within a few years

The applications for LBS are numerous, such as E911, logistics, vehicle automation, real estate, field service, travel service, real-time navigation, and so on [Winter et al., 2001]. LBS technology is creating an emerging market with huge revenue potential. The Location Based Services revenue forecast from 2000 to 2005 is shown in Figure 1.1. According to the research firm Analysys Inc., revenues from the provision of Location Based Services will be worth $18 billion worldwide by 2006 [Analysys Inc., 2001]. The report of Allied Business Intelligence Inc (ABI) indicates that global LBS revenues will grow from approximately $1 billion in 2000 to over $40 billion in 2006. This growth will represent a compound annual average growth rate of 81% [Prasad,2001].

2. Location Based Services

2.1 Concept of Location Based Services

Location Based Services (LBS) use location to deliver targeted applications to users at their moment of need [Autodesk, 2000]. The applications for LBS are numerous. They include logistics, vehicle automation, real estate, field service, travel service, and E911.Progressive industry leaders are building solid foundations today to support well-conceived solutions for new location applications and value-added services. The foundation of Location Based Services was laid by the FCC (Federal Communications Commission) in the US. FCC required wireless network operators to supply public emergency services with the caller™s location and callback phone number.

This generated the emergence of a new and dynamic field called LBS, where the service was based on the geographical location of the calling device. Further, advances in the field of Positioning Systems, Communications and GIS fueled the imagination of the industry people with regards to LBS.

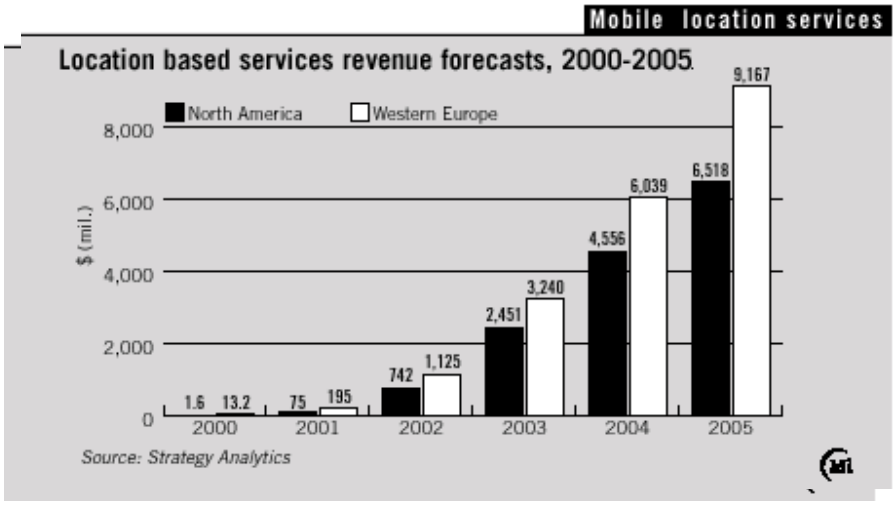

Figure 1.1: Location Based Services Revenue Forecasts, 2000-2005

2.2 LBS System Architecture

All of the LBS applications are similar in nature. They usually have a client/server structure and can be further abstracted into three parts: Client, Server, and Wireless Communication to connect Client and Server (Figure 2.1). These three parts are highly dynamic and interactive, since they are changed by the fast-advancing technologies almost daily, and the advancement in one part will dramatically affect the development of there. Generally speaking, Client is responsible for sending the user's request and the geographical location of the mobile device to Server, and Server is responsible for providing services based on the geographical location of the mobile device. The role definitions of Client and Server, however, are not always reasonable considering the fact Client can make contributions to information acquisition by collecting data in the field or on the spot.

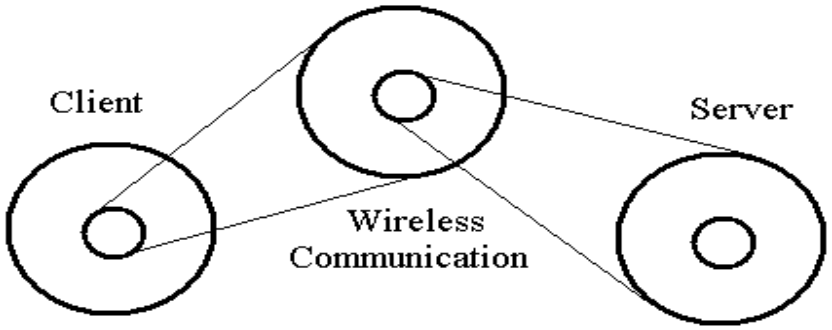

Figure 2.2 : Location Based Services Components

For example, the Client side of a radio-based mobile equipment management system prototype developed at the University of Calgary [Ramsaran, 2000] is capable of collecting the working status information of the equipment deployed in a mining company and sending the information with location information of the equipment to Server via radio. Server will put the information collected from the field into the database and will then provide services for all clients based on the database. In fact, the role definitions of Server and Client are becoming more and vaguer. In the future, Location Based Services will benefit from real-time information acquisition at the Client side.

Client will be equipped with sensors to collect information automatically and send it back to Server. Server can analyze this vital information and put it into the database for service. The possible applications for information collecting at the Client side include Equipment Management, Asset Track, Intelligent Distribution, Dynamic Working Plan, Traffic Control, On-line Survey and so on. Although it is a trend for Location Based Services to collect information at the Client side, there are still some problems caused by wireless communication. Information acquisition at Client side is likely to be more popular in the near future when 3G is fully implemented.

2.3 Wireless Communication Methods for LBS Applications

After carefully reviewing the currently available Terrestrial Wireless Communication Systems, CDPD, GSM, Radio Modem in UHF commercial band, Dedicated Mobile Data Network have been chosen as the best candidates for Location Based Services. The Wireless Communication candidates to improve software reusability for Location Base Services applications have been selected based on their popularity, compatibility, and complementary ability. Popularity is determined by both the network factors and the handset factors. Important network factors include service charges, data rates, coverage, protocols supports, and roaming supports which determine the underlying functions of Location Based Services. Important handset factors include size, weight, and battery life. All these factors affect the application of Location Based Services. Compared to Terrestrial Wireless Communication, Satellite Wireless Communication usually has a better coverage, but needs more bulky and battery-consuming user equipment to exchange signals with satellites.

3. Field Test Results of Wireless Internet-based RTK GPS Positioning Without RTCM Messages Compression

The field test of wireless Internet-based RTK GPS positioning without RTCM messages compression was carried on June 26th, 2002. Two Ashtech GPS+GLONASS single frequency receivers were used as the base and rover receivers. Two regular geodetic antennae were used as the base and rover antennae. The base antenna was setup on a pillar whose coordinates were precisely known. The rover antenna was mounted on the roof of a vehicle. The base station comprised the base receiver and antenna, a desktop computer with Pentium II inside, one serial port to receive RTCM messages, also called differential RTK data, from the base receiver, another serial port to log GPS NMEA data and raw data, a fixed Internet access via campus LAN, and Windows NT4.0 OS.The rover comprised the rover receiver and antenna, a Toshiba Laptop with Windows NT4.0 OS, a wireless Internet access via CDPD modem, one serial port to send RTCM messages to the rover receiver, another serial port to log GPS NMEA data and raw data, and a battery for power supply.

CONCLUSIONS AND RECOMMENDATIONS

This research has been focused on the development of an Objected-Oriented (OO) application framework to promote software reuse in wireless communication software for Location-Based Services (LBS) applications. Major contributions include the investigation, design and development of a wireless framework to support the development of highly reusable wireless communication software system for LBS applications and the successful application of the developed wireless framework to two prototype systems, namely, a Real-Time Kinematic (RTK) GPS Positioning System and a Mobile Equipment Management System.

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