Mobile Location Services

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INTRODUCTION

The term "mobile era" as a characterization of the 21st century can hardly be considered an exaggeration (Kalakota & Robinson, 2001). Mobile phones are the fastest penetrating technology in the history of mankind, and global mobile phone ownership has surpassed even the ownership of fixed phones. Mobile applications, despite potentially being very different in nature from each other, all share a common characteristic that distinguishes them from their wire-line counterparts: they allow their users to move around while remaining capable of accessing the network and its services. In the mobility era, *location identification* has naturally become a critical attribute, as it opens the door to a world of applications and services that were unthinkable only a few years ago (May, 2001).

The term "mobile location services" (MLS) [or "location-based services (LBS), as they are sometimes also referred to] has been coined to group together applications and services that utilize information related to the geographical position of their users to provide value-adding services to them (Rao & Minakakis, 2003). This article provides a concise introduction to the major types of MLS and also introduces the reader to the most important positioning technologies that render the provision of MLS possible. Finally, the article also introduces a number of issues that are critical for the future of MLS, including privacy protection, regulation, and standardization.

CATEGORIES OF MOBILE LOCATION SERVICES

Mobile networks are quickly becoming ubiquitous. The ability to reach mobile phone users regardless of their location and, even more importantly, the ability to reach mobile phone users *based* on their location has created a new world of exciting and promising applications. While the possibilities for providing innovative MLS are limited only by one's imagination, we will outline the most important categories of such services in this section.

Emergency Management

Perhaps the clearest market application of MLS is the ability to locate an individual who is either unaware of his or her exact location or is not able to reveal it because of an emergency situation (injury, criminal attack, and so on). MLS are even applicable as a means of overcoming one of the most common problems of motorists, namely, the fact that, most often than not, they are unaware of their exact location when their vehicle breaks down. The ability of a mobile user to call for assistance and at the same time automatically reveal his or her exact location to the automotive assistance agency is considered one of the prime motivators for signing up subscribers to MLS (Hargrave, 2000).

Navigation Services

Navigation services are based on mobile users' needs for directions within their current geographical locations. The ability of a mobile network to locate the exact position of a mobile user can be manifested in a series of navigation-based services:

1. By positioning a mobile phone, an operator can let users know exactly where they are as well as give them detailed *directions* about how to get to a desirable destination.
2. Coupled with the ability to monitor traffic conditions, navigation services can be extended to include destination directions that take account of current *traffic conditions* (for example, traffic congestion or a road-blocking accident) and suggest alternative routes to mobile users.
3. The possibility to provide detailed directions to mobile users can be extended to support *indoor routing* as well. For example, users can be assisted in their navigation in hypermarkets, warehouses, exhibitions, and other information-rich environments to locate products, exhibition stands, and other points of interest.
4. Similarly, *group management* applications can be provided to allow mobile users to locate friends, family, coworkers, or other members of a particular group that are within close range and, thus, create *virtual communities* of people with similar interests.

Information Provision

Location-sensitive information services mostly refer to the digital distribution of content to mobile terminal devices based on their location, time specificity, and user behavior. The following types of services can be identified within this category:

1. *Travel services*, such as guided tours (either automated or operator-assisted), notification about nearby places of interest (for example, monuments), transportation assistance, and other services that can be provided to tourists moving around in unfamiliar surroundings.
2. *Mobile yellow pages* that provide a mobile user, upon request, with knowledge regarding nearby facilities.
3. *Infotainment services*, such as information about local events, location-specific multimedia content, and so on.

Advertising and Marketing

Mobile advertising is among the first trial applications of MLS, due to its promising revenue potential and its direct links to mobile-commerce activities. Furthermore, mobile advertising has gained significant attention because of the unique attributes, such as *personalization* (Kalakota & Robinson, 2001), that offer new opportunities to advertisers to place effective and efficient promotions on mobile environments. There are various mechanisms for implementing mobile advertising coupled with MLS. Examples of mobile advertising forms include *mobile banners*, *alerts* (usually dispatched as SMS messages), and *proximity-triggered advertisements*.

Tracking

Tracking services can be equally applicable to the consumer and the corporate markets. As far as consumers are concerned, tracking services can be utilized to monitor the exact whereabouts of, for example, children and elderly people. Similarly, tracking services can be effectively applied in corporate situations as well. One popular example refers to tracking vehicles so that companies know where their fleet and goods are at any time. A similar application allows companies to locate their field personnel (for example, salespeople and repair engineers) so that they are able, for example, to dispatch the nearest engineer and provide their customers with accurate personnel arrival times. Finally, the newfound opportunity to provide accurate product tracking within the supply chain offers new possibilities to mobile supply chain management (m-SCM) applications (Kalakota & Robinson, 2001).

Billing

Location-sensitive billing refers to the ability of a mobile service provider to dynamically charge users of a particular service depending on their location when using or accessing the service. For example, mobile network operators may price calls based on the knowledge of the location of the mobile phone when a call is made. Location-sensitive billing includes the ability to offer reduced call rates to subscribers who use their mobile phone when at their home, thereby allowing mobile operators to compete more effectively with their fixed telephony counterparts.

POSITIONING TECHNOLOGIES

The applications and services that were discussed in the previous section are based on underlying technological capabilities that enable the identification of the location of a mobile device, thereby making the provision of MLS possible. Positioning techniques can be implemented in two ways: *self-positioning* and *remote positioning* (Zeimpekis et al., 2003).

In the first approach (self-positioning), the mobile terminal uses signals, transmitted by the gateways/antennas (which can be either terrestrial or satellite) to calculate its own position. More specifically, the positioning receiver makes the appropriate signal measurements from geographically distributed transmitters and uses these measurements to determine its position. A self-positioning receiver, therefore, "knows" where it is, and applications collocated with the receiver can use this information to make position-based decisions, such as those required for vehicle navigation.

In the case of remote positioning, the mobile terminal can be located by measuring the signals travelling to and from a set of receivers. More specifically, the receivers, which can be installed at one or more locations, measure a signal originating from, or reflecting off, the object to be positioned. These signal measurements are used to determine the length and direction of the individual radio paths, and then the mobile terminal position is computed from geometric relationships.

Self-Positioning Techniques

Global Positioning System (GPS) and Assisted GPS (A-GPS): GPS is the worldwide satellite-based radio navigation system, consisting of 24 satellites, equally spaced in six orbital planes 20,200 kilometres above the Earth, that transmit two specially coded carrier signals: one for civilian use and one for military and government use (Djuknic & Richton, 2001). The system's satellites transmit navigation messages that a GPS receiver uses to determine its position.