Location-Based Services

Péter Hegedüs
Budapest University of Technology and Economics, Hungary

Mihály Orosz
Budapest University of Technology and Economics, Hungary

Gábor Hosszú
Budapest University of Technology and Economics, Hungary

Ferenc Kovács
Budapest University of Technology and Economics, Hungary

INTRODUCTION

The basically two different technologies, the location-based services in the mobile communication and the well-elaborated multicast technology, are joined in the multicast over LBS solutions. As the article demonstrates, this emerging and new management area has many possibilities that have not been completely utilized.

Currently an important area of mobile communications is the *ad-hoc computer networking,* where mobile devices need base stations; however, they form an overlay without any Internet-related infrastructure, which is a virtual computer network among them. In their case the selective, location-related communication model has not been elaborated on completely (Ibach, Tamm, & Horbank, 2005). One of the various communication ways among the software entities on various mobile computers is the one-to-many data dissemination that is called *multicast.* Multicast communication over mobile ad-hoc networks has increasing importance. This article describes the fundamental concepts and solutions, especially focusing on the area of *location-based services* (LBSs) and the possible multicasting over the LBS systems. This kind of communication is in fact a special case of the multicast communication model, called *geocast,* where the sender disseminates the data to that subset of the multicast group members in a specific geographical area. The article shows that the geocast utilizes the advantages of the LBS, since it is based on the location-aware information being available in the location-based solutions (Mohapatra, Gui, & Li, 2004).

There are several unsolved problems in LBS, in management and low surfaces. Most of them are in quick progress, but some need new developments. The *product managers* have to take responsibility for the software and hardware research and development part of the LBS product. This is a very important part of the design process, because if the development engineer leaves the product useful out of consideration, the whole project could possibly be led astray. Another import question is that of LBS-related *international* and *national laws,* which could throw an obstacle into LBS's spread. These obstacles will need to be solved before LBS global introduction.

The article presents this emerging new area and the many possible management solutions that have not been completely utilized.

BACKGROUND

Location-based services are based on the various distances of mobile communications from different base stations. With advances in automatic position sensing and wireless connectivity, the application range of mobile LBS is rapidly developing, particularly in the area of geographic, tourist, and local travel information systems (Ibach et al., 2005). Such systems can offer maps and other area-related information. The LBS solutions offer the capability to deliver location-aware content to subscribers on the basis of the positioning capability of the wireless infrastructure. The LBS solutions can push location-dependent data to mobile users according to their interests, or the user can pull the required information by sending a request to a server that provides location-dependent information.

LBS may have many useful applications in homeland security (HLS). A few of the more significant of these applications are security and intelligence operations, notification systems for emergency responders, search and rescue, public notification systems, and emergency preparedness (Niedzwiadek, 2002). Mobile security and intelligence operatives can employ LBS to aid in monitoring people and resources in space and time, and they can stay connected with emergency operations centers to receive the necessary updates regarding the common operating picture for a situation. Emergency operations centers can similarly coordinate

search and rescue operations. Call-down systems can be employed to notify the public in affected disaster areas. In this application the multicast communication is preferable, since it uses in an efficient way the communication channels, which can be partly damaged after a disaster. Location-based public information services can give time-sensitive details concerning nearest available shelters, safe evacuation routes, nearest health services, and other public safety information (Niedzwiadek, 2002).

Location-based services utilize their ability of location-awareness to simplify user interactions. With advances in wireless connectivity, the application range of mobile LBSs is rapidly developing, particularly in the field of tourist information systems—telematic, geographic, and logistic information systems. However, current LBS solutions are incompatible with each other since manufacturer-specific protocols and interfaces are applied to aggregate the various system components for positioning, networking, or payment services. In many cases, these components form a rigid system. If such system has to be adapted to another technology, for example, moving from *global positioning system* (GPS)-based positioning to in-house *IEEE 802.11a*-based *wireless local-area network* (WLAN) or *Bluetooth*-based positioning, it has to be completely redesigned (Haartsen, 1998). In such a way the ability of interoperation of different resources under changeable interconnection conditions becomes crucial for the end-to-end availability of the services in mobile environments (Ibach, & Horbank, 2004).

There are a lot of location determination methods and technologies, such as the satellite-based GPS, which is widely applied (Hofmann-Wellenhof, Lichtenegger, & Collins, 1997). The three basic location determination methods are *proximity, triangulation* (lateration), and *scene analysis* or *pattern recognition* (Hightower & Borriello, 2001). Signal strength is frequently applied to determine proximity. As a proximity measurement, if a signal is received at several known locations, it is possible to intersect the coverage areas of that signal to calculate a location area. If one knows the angle of bearing (relative to a sphere) and distance from a known point to the target device, then the target location can be accurately calculated. Similarly, if somebody knows the range from three known positions to a target, then the location of the target object can be determined. A GPS receiver uses range measurements to multiple satellites to calculate its position. The location determination methods can be *server based* or *client based* according to the locus of computation (Hightower & Borriello, 2001).

Chen et al. (2004) introduce an enabling infrastructure, which is a middleware in order to support location-based services. This solution is based on a *location operating reference model* (LORE) that solves many problems of constructing location-based services, including location modeling, positioning, tracking, location-dependent query processing, and smart location-based message notification. Another interesting solution is the mobile yellow page service.

The LBS is facing technical and social challenges, such as location tracking, privacy issues, positioning in different environments using various locating methods, and the investment of location-aware applications.

An interesting development is the *Compose* project, which aims to overcome the drawbacks of the current solutions by pursuing a service-integrated approach that encompasses *pre-trip* and *on-trip services,* considering that on-trip services could be split into *in-car* and *last-mile services* (Bocci, 2005). The pre-trip service means the 3D navigation of the users in a city environment, and the on-trip service means the in-car and the last-mile services together. The in-car service is the location-based service and the satellite broadcasting/multicasting. In this case, the user has wireless-link access by PDA to broadcast or multicast. The last-mile service helps the mobile user with a PDA to receive guidance during the final part of the journey.

In order to create applications that utilize multicast over LBS solutions, the middleware platform of LocatioNet Systems provides all required service elements such as end-user devices, service applications, and position determination technologies, which are perfectly integrated (LocatioNet, 2006). The middleware platform of LocatioNet has an open API and a *software development kit* (SDK). Based on these, the application developers are able to easily implement novel services, focusing on comfortable user interface and free from complex details of the LBS (LocatioNet, 2006).

The article focuses on the multicast solutions over the current LBS solutions. This kind of communication is in fact a special case of the multicast communication model, called geocast, where the sender disseminates the data to a subset of the multicast group members that are in a specific geographical area.

MULTICASTING

The models of the multicast communication differ in the realization of the multiplication function in the intermediate nodes. In the case of the datalink level, the intermediate nodes are switches; in the network level, they are routers; and in the application level, the fork points are applications on hosts.

The datalink-level-based multicast is not flexible enough for new applications therefore it has no practical importance. The *network-level multicast* (NLM)—named IP-multicast—is well elaborated, and sophisticated routing protocols are developed for it. However, it has not been deployed widely yet since routing on the whole Internet has not been solved perfectly. The application-level solution gives less efficiency compared to the IP-multicast, however