

Chapter 3.17

Location-Based Services

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INTRODUCTION

The past decade has seen advances in wireless network technologies and an explosive growth in the diversity of portable computing devices such as laptop computers, handheld personal computers, personal digital assistants (PDAs), and smart phones with Internet access. Wireless networking technologies and portable devices enable users to access information in an “anytime, anywhere” fashion. For example, a mobile user (MU) on the highway may query local weather, traffic information, nearby gas stations, next rest areas, or restaurants within 10 miles. Such new demands introduce a new type of services, **location-based services** (LBS), where certain location constraints (e.g., the user’s current location) are used in the service provision.

The idea of queries with location constraints is originally introduced by Imielinski and Badrinath (1992), in which mobile users are likely to query information relating to their current positions, leading to the need for LBS. Such services are also termed as location dependent information services (LDIS)

in Lee, Lee, Xu, and Zheng (2002). LBS system is the context sensitive systems in a mobile computing environment that consider the user’s location as a significant and dynamic factor affecting the information and services delivered to the users. The major LBS applications include:

- Destination guides with maps, driving directions, and real time prompt
- Location-based traffic and weather alerts
- Wireless advertising and electronic coupons to nearby mobile devices
- Movie, theatre and restaurant location and booking
- Store locating applications helping users to find the desired services
- Telematics-based roadside assistance (e.g., OnStar from General Motors)
- Personal content and messaging (Live Chat with friends)
- Mobile Yellow Pages provide local information
- Information Services (News, Stocks, Sports)

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- E911: (Wireless carriers provide wireless callers' numbers and locations.)

Generally, LBS services can be classified into three general categories: telematics LBS, Internet LBS, and wireless LBS (Telc).

Telematics LBS is the integration of wireless communications, vehicle monitoring systems, and location devices. Telematics LBS applications include automated vehicle location, fleet tracking, online navigation, and emergency assistance. For example, a trucking company can track all their fleet, proactively warn about traffic ahead, and estimate the arrival time. Commercial LBS providers are beginning to offer important management applications that help direct vehicle fleets and ensure optimal usage of key assets. Telematics LBS is a multibillion dollar service industry and is currently the largest segment of the LBS market (Telc).

Internet LBS provide Internet users the services relevant to their specified locations. Because they use a user-specified location instead of the user's current location, no positioning technology is required. For example, one can find turn-by-turn driving direction from one location to another and search for tour information about the destination. These services are targeting applications with stationary users, relatively powerful computers, and reliable network connections. As a result, Internet LBS support sophisticated services, such as local business searching and comparison, trip planning, online virtual tours, and so forth.

Wireless LBS deliver location relevant content to cell phones, PDAs, and other wireless devices. Equipped with automated positioning technologies, MUs can query local weather, nearby traffic information, and local businesses close to them. For example, a user can search neighboring post office or coffee shop from the PDA. The wireless LBS market is currently in a nascent stage, but it will potentially become the largest segment of the LBS market. The deployment of third generation (3G) mobile network, which support handsets

that are both mobile and location sensitive, will lead to more wireless LBS subscribers and more useful LBS applications.

This article focuses on the discussion on wireless LBS system, and the term LBS refers to wireless LBS in the rest of this article. It compares LBS and traditional database system, introduces existing LBS systems, and reviews the related research works. Next, it describes a representative LBS system model and explains the functionality of the LBS system. It introduces the major components, their roles, and interactions. The discussion also covers issues related to mobile devices, positioning technologies, spatial databases, location aware queries, and so forth. In particular, this article will provide a detailed review on location dependent query processing and caching. Issues such as query processing algorithms, validity region, and query result caching are discussed. Then, it foresees the new service demands, emerging applications, and trends in future LBS systems. Finally, the article provides a summary on the above discussion and concludes this article.

BACKGROUND

Compared to traditional database (DB) services, new characteristics of LBS lead to significant differences between LBS databases and traditional databases. A database in LBS is a *spatial database* (SDBS) (Guting, 1994), which is capable of representing, querying, and manipulating spatial data (such as point, line, and region) to efficiently process queries with spatial restrictions and support applications such as the *geographical information system* (GIS). An SDBS is required to handle continuously changing data, locations of moving objects, and provide location aware services to mobile users. LBS also face other research challenges (Jensen et al., 2001) in order to support the following features: nonstandard dimension hierarchies in database; imprecision and varying precision; movement constraints and

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