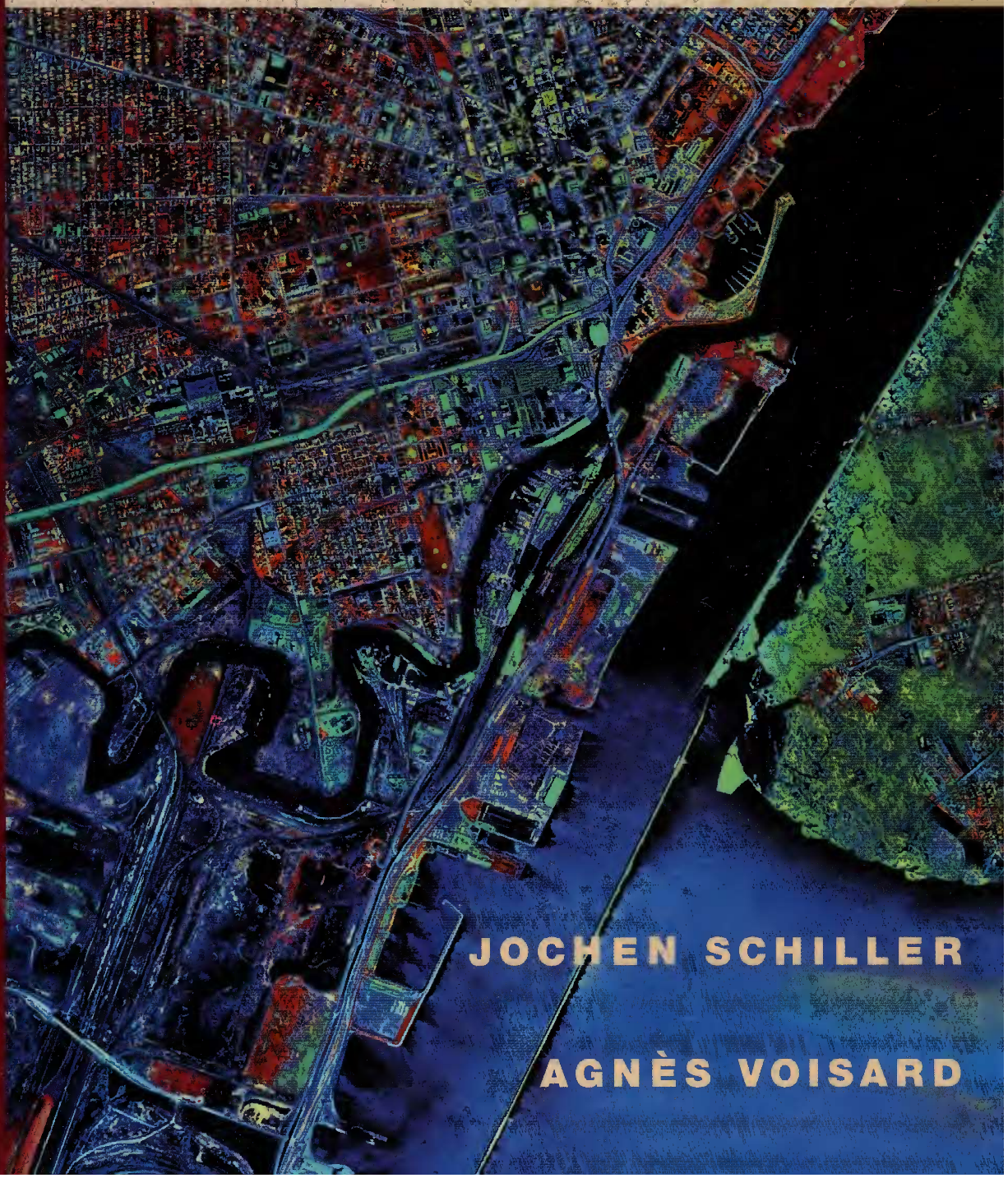
LOCATION-BASED SERVICES



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This chapter focuses on the development and deployment of a mobile friend finder application, showing a mass consumer use of LBS and the first live LBS application by any carrier in North America.

This chapter first introduces some background on mobile LBS applications and then delves further into the requirements and constraints of defining and building the application.

2.1 BACKGROUND

Location-based applications are one of the most anticipated new segments of the mobile industry. These new applications are enabled by GPS-equipped phones and range from Emergency 911 (E-911) applications to buddy finders (e.g., "let me know when my friend is within 1000 feet") to games (e.g., treasure hunt) to location-based advertising (e.g., "enter the Starbucks to your left and get $1.00 off a Frappuccino"). These services are designed to give consumers instant access to personalized, local content. In this case, local content is local to the consumer's immediate location. Some of these applications will couple LBS with notification services, automatically alerting users when they are close to a preselected destination. LBS proponents believe that these services will create new markets and new revenue opportunities for device manufacturers, wireless providers, and application developers.

The next generation of GPS devices *are* cell phones, and GPS features will probably be an invisible part of your next phone upgrade. In the United States, these GPS phone features were motivated by an FCC mandate, which required that wireless carriers provide E-911 service comparable to wireline 911. Traditional 911 services automatically deliver a caller's location to the appropriate public safety entity, based on the phone's fixed address. E-911 uses GPS and other technologies to detect the caller's location.

E-911 features require that wireless carriers make additional equipment investments. Although, at first glance, E-911 sounds like an expense with no obvious return, in reality it is an exceptional opportunity for carriers to offer new revenue-generating LBS.

In spring 2001, AT&T Wireless communicated to Kivera its goal of offering a mobile friend finder service, taking advantage of its new, location-aware GPRS service called mMode.

location information about a mobile terminal to offer highly customized information content to the mobile user or to third parties (i.e., other mobile terminals or static users and applications). Many early location application services were based on the user providing the necessary position information voluntarily by submitting a street name or a zip code to the application.

This chapter focuses on location application services and the middleware technology required for supporting their operation. No distinction is made between the two categories, and we uniquely refer to this kind of application as location-based services or location-based applications, always assuming that the required location information exploited by the ulterior information service is made available somehow. To back up this assumption, state-of-the-art location position identification technology is reviewed as follows.

We define middleware (aka middleware platform or middleware system) as a set of services that facilitate the development and deployment of distributed applications in heterogeneous environments. Middleware consists of a set of services exposing interfaces, a programming model, and an interaction model to the application developer. For the context of LBS, this refers to the services, abstractions, and models that implement mobile user coordination, information correlation, and information dissemination. A major component of LBS is the integration of location or position information. Thus it is important to understand the capabilities and limitations of existing position localization technologies and how they enable and constrain application development and deployment.

The objective of this chapter is to identify LBS application categories, identify requirements they impose on underlying middleware platforms, understand capabilities and limitations of position localization technology and their implications for middleware and the applications that can be offered, and survey standard middleware models applicable in this space.

4.2 APPLICATIONS

Location-based services are often broken down into two main categories: business-to-consumer (B2C) and business-to-business (B2B) applications (e.g., see Durlacher Research [DRL01], A. Sanchez and L. Telleria

Table 4.1 Classification and characterization of location-based services applications.

Service category	Example application	Characteristics
Infotainment services	Finder applications (e.g., route, location, friend, store, restaurant, gas station, and parking) Information requests (e.g., tourist, travel, news) Games, see below	Mobile user-initiated, query-based, and request-driven Pull-based model Location information is either transmitted with request or assessed by service
Tracking services	Goods, vehicle, and fleet People (e.g., child care, elderly, sick, and offenders) Security of entities (e.g., cars) Maintenance and assistance Workforce dispatching Supply-chain and inventory	Tracking requests are often initiated by a remote monitoring entity and not by the mobile entity per se State-based nature of application (i.e., often a state is kept between requests about objects tracked) Pull-based and push-based
Selective information dissemination	Targeted content dissemination (e.g., advertisements, information)	Proactive, event-based, and condition triggered A priori stateless
Location-based games	Treasure hunts Territory defense and claiming Scavenger hunts	Proactive, event-based, and condition triggered Correlation of location of multiple mobile terminals Maintenance of state between subsequent location requests
Emergency support services	Emergency 911 Ambulance, fire, police dispatching Roadside assistance	Mobile-user-initiated and pull-based A priori stateless
Location-sensitive billing	Call billing Toll payment Purchase of goods and services	Proactive, event-based, and condition triggered A priori stateless

[ST03], and Zeimpekis et al. [ZGL03]). Table 4.1 presents a classification that introduces a further division into subcategories. To better understand the requirements imposed by different applications on the underlying middleware model a finer-grained classification of application is helpful. This classification is as follows:

1. *Infotainment services.* Services to meet user requests on how to reach a given destination; where to find a particular service (e.g., automated teller machine, restaurant, parking, or gas station); how to find another mobile user (see friend finder application presented in Chapter 2); and

how to localize the current position (on a map) of a lost user are commonly referred to as infotainment services. A service request can often be further refined by correlating it with dynamic information about the environment, such as road and weather condition, traffic information, or other events of interest to the requester. Infotainment services are a valuable asset for travelers and tourists alike.

Characteristic for most of these services is their pull-based nature; the mobile user submits a request to receive information (i.e., actively pulls information from the service). The location of the mobile user drives the request evaluation at the server side. Mobile terminal location information, user context, and any other profile information may be used to derive personalized content returned to the user; however, detailed personalization is not a prerequisite for these kinds of services.

2. *Tracking services.* These services track the geographic whereabouts of, with mobile terminals equipped, entities (e.g., users, trucks, and packages) and support requests to establish the location of these entities, their progress and state change along a route, or perspective future location. Applications include fleet tracking, taxi monitoring and dispatching, workforce management, mobile supply-chain management, child support and security, tracking of elderly and sick persons, and goods and package tracking. This latter example is often supported by tracking the object as it passes through a statically fixed control point (i.e., a bar code reader). Active badge systems fall in this category as well [WHGF92].

   Characteristic for these kinds of applications is the potentially very large number of entities that must be tracked simultaneously, the need to maintain state between different tracking points, and the inverse nature of the tracking request initiator (i.e., a remote monitoring entity is tracking the objects). Applications are pull- and push-based in nature.

3. (*Selective*) *information dissemination services.* This category refers to services that disseminate content to mobile users correlated with the subscriber's location, context, and profile. A prime example is (selective) advertisement dissemination. Disseminated content may include e-coupons or simply advertisements. At one extreme, all users entering the range of a particular dissemination source could receive notifications. At the other extreme, highly selective correlations

between a user's interests and the advertisement content could selectively target individual users.

Characteristic for this category is the push-based character of the application. That is, the dissemination is initiated by the supporting middleware technology, with little or no user intervention. The support of selective content correlation requires a user profile and requires user identification information to be available for each user location quote.

4. *Location-based games.* Essentially part of the infotainment category, location-based games are mostly targeted at the young mobile user market and aim at getting users on the air. Gaming models include visiting different parts of a city (i.e., network cells) to retrieve information or further direction requests and finding peer-mobile users. This category of services is presently under intense development. No distinct characterization from the previous service classes is obvious.

5. *Emergency support services.* These services have driven the development and deployment of location positioning technology in North America and are referred to as the E-911 services. The E-911 mandate, imposed by the Federal Communications Commission (FCC), requires that network operators be able to provide position information of a mobile 911 caller with a specified accuracy. This information serves police, fire fighters, ambulances, and automotive support crews.

   These services rely entirely on the available position location technology and do not, by themselves, impose any specific requirements on the middleware technology.

6. *Location-sensitive billing.* Location-sensitive billing refers to the potential to dynamically bill a mobile user based on its present location. Calls that originate within the close vicinity of a wired phone or the user's home line are charged as wired calls versus entirely mobile calls.

   From a middleware perspective, no special support is required for this kind of service. A call is classified as being wired or mobile, and different accounting records are generated.

Table 4.1 classifies location-based services and lists example applications for each category.