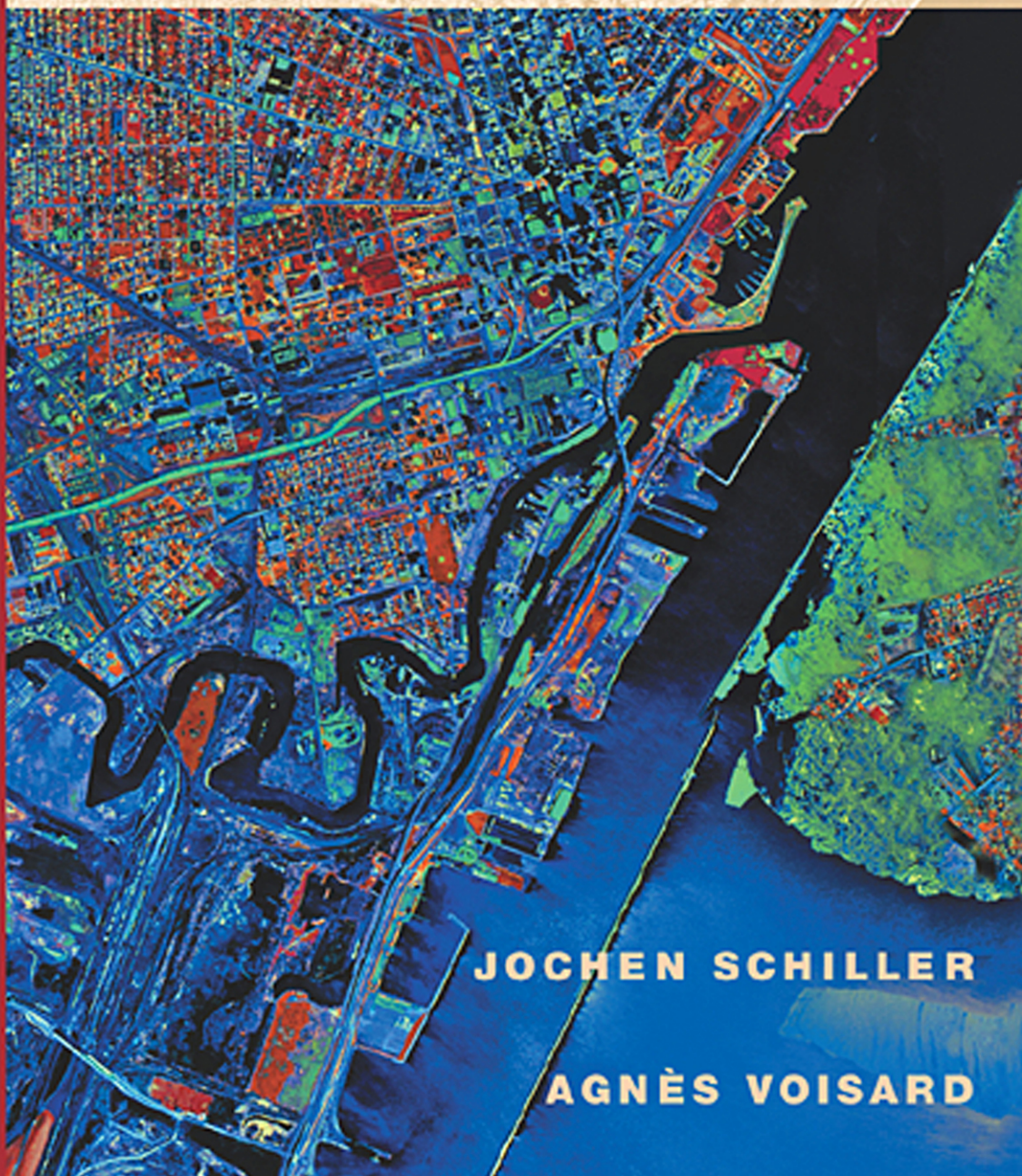




LOCATION-BASED SERVICES



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Foreword

Jim Gray, Microsoft Research/San Francisco

There is an explosion of technologies to communicate with mobile and occasionally-connected devices and sensors. Wireless networking (WiFi), cellular telephone (GSM), packet radio, radio frequency identifiers (RFID), smart personal object technology (SPOT), global positioning systems (GPS), and sensor networks are already with us. Many completely new communication innovations are on the horizon.

These technologies enable new applications. They allow mobile users to query their environment and they allow applications to monitor and track remote objects. People can ask about nearby services – for example a restaurant, and how to get there from here. Police, hospital, and taxi dispatchers can send the closest vehicle to where it is needed. Conversely, monitoring systems can track the flow of goods and monitor environmental parameters. Railroads, airfreight, wholesalers, retailers, and other transportation industries can track goods from their source to their final destination on the retail shelf. Environmental systems can monitor air quality, noise, streamflow, and other environmental parameters.

All these applications have strong spatial components – object location, proximity, and connectivity are the central organizing principle of these applications. This book takes a pragmatic approach to representing, organizing, and searching spatial data and object location. It views the problem from top to bottom. It starts with descriptions of

some real applications and their requirements. It then explains ways to represent spatial information and explores algorithms to efficiently find nearby objects and paths to them. It then segues to a very informative description of the basic location and communication technologies for wireless communication (like GSM) and location (like GPS).

Location-based services are a vibrant and rapidly evolving application area with many active research groups, many products, and many interesting applications. This book provides a good picture of the current state of the art. It is a great introduction to this exciting field of location-based services.

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Introduction

Jochen Schiller, Freie Universität Berlin

Agnès Voisard, Fraunhofer Institute for Software and Systems Engineering (ISST)
and Freie Universität Berlin

The term *location-based services (LBS)* is a recent concept that denotes applications integrating geographic location (i.e., spatial coordinates) with the general notion of services. Examples of such applications include emergency services, car navigation systems, tourist tour planning, or “yellow maps” (combination of yellow pages and maps) information delivery.

With the development of mobile communication, these applications represent a novel challenge both conceptually and technically. Clearly, most such applications will be part of everyday life tomorrow, running on computers, personal digital assistants (PDAs), phones, and so on. Providing users with added value to mere location information is a complex task. Given the variety of possible applications, the basic requirements of LBS are numerous. Among them we can cite the existence of standards, efficient computing power, and friendly yet powerful human–computer interfaces.

This book aims at understanding and describing in an accessible fashion the various concepts that serve as a support to mobile LBS. It is written by experts in the relevant topics. Major issues to be considered when dealing with LBS, together with their current solutions, are described formally and illustrated through a case study given as a reference at the beginning of the book.

The field of LBS, which emerged a few years ago, presents many challenges in terms of research and industrial concerns. This book focuses on some of the arising issues. Other important issues are not covered by the book, among them security, privacy, data availability, and pricing. Location-based services are often used via Web browsers and are in this case considered as a particular type of Web services. With this perspective, the major challenges to consider are the personalization of services, the ubiquity of services to the mobile user, and the chaining of services with the transmission of context, such as time, location, and possibly other dimensions like the user profile. The user profile typically includes basic user-related data, such as name and address, but possibly also preferences that have been set by the user or inferred by the system. Such aspects are not addressed in great detail in this book. For a thorough study of Web services the reader is referred to [ACKM03] and [B03], for mobile location services to [J03], and for common approaches supported by the World-Wide Web Consortium (W3C)—for instance in the context of the Semantic Web—to [WWW04]. A description of promising approaches for information delivery and exchange among many users who may be geographically grouped can be found in [JV04].

Note that a representative application example is that of ‘Personalized Web Services for the Olympic Games in Beijing in 2008’, carried out by the Fraunhofer Institute for Software and Systems Engineering in Dortmund and Berlin, Germany, and the Institut of Computing Technology (ICT) of the Chinese Academy of Sciences, located in Beijing, China in the SigSit joint-laboratory [SIGSIT04].

This book has two potential audiences: practitioners and researchers. The former will find solutions to many questions that may arise when handling such applications, both from a high-level viewpoint (the user’s side) and from a technical viewpoint (e.g., which protocols are adapted to which situation). Researchers will discover the breadth and depth of the numerous research challenges in the different areas concerned.

The concepts described in this book range from general application-related concepts to technical aspects. We use a top-down approach, reaching from a high level of abstraction—the application—down to the various technical levels. The same set of concepts is studied at each level: requirements, services, data, and scalability. Moreover, all of the concepts described in this book are illustrated using a reference application given at the beginning of the book.

The book is structured in three major parts: application, data management and services, and communication, each of which is composed of two or three chapters. Following is a succinct description of each of them.

Part 1, composed of three chapters, is devoted to the general notion of LBS applications. Chapter 1, by Sarah Spiekermann from Humboldt-Universität zu Berlin, aims at setting the basis (vocabulary, concepts) of LBS, namely the various categories of applications and the requirements for an operational system. The interaction with end users (e.g., possible devices, GUI aspects) and the notions of horizontal and vertical services are also discussed.

Chapter 2, by Mark Strassman from Autodesk Inc. and Clay Collier from Kivera Inc., describes an example application, which actually became quite popular as a reference to LBS: the Find Friends application. The example is meant to illustrate most concepts seen so far as well as the chaining of services that exists in such applications.

Chapter 3, by Shashi Shekhar, Ranga Raju Vatsavai, Xiaobin Ma, and Jin Soung Yoo from the University of Minnesota, deals with navigation systems. It details the functionalities of intelligent navigation systems as well as their main algorithms.

Part 2, also composed of three chapters, is concerned with data management and services, which are at the core of such systems. Data organization and management, as well as system interoperability, are the prime focuses of this system.

Chapter 4, by Hans-Arno Jacobsen from the University of Toronto, focuses on middleware issues. It describes the requirements for LBS middleware platforms and the actual solutions in this area.

Chapter 5, by Christian Jensen from Aalborg University, deals with database aspects of LBS, and more precisely with database-centered management of static and dynamic data, data formats, and storage strategies.

Chapter 6, by Lance McKee from the Open GIS Consortium, Inc. (OGC), describes interoperability through standards. This chapter reports on the objectives and achievements of the special-interest group Open Location Services of the OGC.

Part 3, composed of two chapters, is devoted to the communication aspect of LBS (i.e., to technical aspects of wireless data information exchange).

Chapter 7, by Jörg Roth from the University of Hagen, relates to data collection, such as locating people and devices, locating services,