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# **GPRS and 3G Wireless Applications**



*Professional Developer's Guide*

# GPRS and 3G Wireless Applications



Christoffer  
Andersson

Wiley Computer Publishing



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# Acknowledgments

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In a book this packed with knowledge it is very hard to trace the source of many of the ideas and conclusions. I have read many documents and books in this area and the digested content has been one source of input for this book. None mentioned and none forgotten, I hope that those other authors in the industry can feel that they contributed to this book by documenting their ideas and giving me a head start. The mobile Internet industry is forming and we all need to share our knowledge to take it all to the next level. This thinking is especially used within the Mobile Applications Initiative (MAI), where the aim from the start has been to grow the knowledge among developers and ensure that wireless applications function smoothly when deployed. With over 30 centers and a dedicated global organization, I would not dare start pointing at individual contributors to express my thanks. This MAI knowledge network has built a large portion of the knowledge that I have today and many of those contributors would have been as appropriate to write this book.

In addition, the support from Ericsson has been amazing. Some of the company's leading executives and experts have helped a lot in developing and reviewing the material. I especially want to mention Mats Dahlin and Göran Skyttvall, who have been initiators and strong drivers along the way. The many junctions where decisions were needed were promptly and decisively handled.

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Finally, I strongly believe that growing up with the loving family I did and meeting a wonderful person like Malin is what makes the world a sunny place, even in the dark Swedish winter.



# Introduction

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**T**he mobile Internet—the marriage between today’s Internet and the increasing urge for mobility—is about to take off. Independent sources all estimate incomprehensible markets for these new services and applications. With the mobile Internet, there is a screaming need for applications (in other words, things to do with the new technologies). In other words, we dearly need the software developer and Internet communities in order to use their expertise for developing software and content. These developers know about programming and Web design but do not know much about the wireless technologies of today and of the future. This book provides a broad guide to the networks, devices, and other items that surround the applications (such as positioning, security, and how to deploy applications in the field).

This book is primarily intended for those who know about software development and who want to do it for wireless networks and devices, but this book should also appeal to anyone who is interested in these new and exciting topics. Although some chapters assume knowledge about development, you can read most of them as a technician’s guide to wireless technologies.

The telecommunications industry has traditionally been a walled garden where no one but the insiders knows much about the technology. This situation



is rapidly changing, however, now that players are entering the arena and are contributing to the growth of this new and exciting market. This book is an invitation to you to join the mobile Internet revolution.

## Overview of This Book and the Technology

---

When you are trying to make things work with a new technology, you need to combine many forces. Infrastructure and handset manufacturers such as Nokia, Ericsson, Motorola, and so on and the wireless operators Vodafone/Airtouch, Sonera, and AT&T have set the groundwork for the mobile Internet. They are all committed to deploying *General Packet Radio Services* (GPRS) and *third-generation* (3G) networks. Now, these players feel confident that their parts of this new market (technologies such as WAP, Bluetooth, GPRS, and 3G) will be in place and that it will all work. This situation raises a need to mobilize other players to contribute: the applications (mail, games, chat, Java applets, and so on) and content developers (Web, the Wireless Access Protocol or WAP, and so on). These players are dying to move into this space, and there is a need to gain the knowledge about these wireless technologies and how it affects their products. Today, we see too many developers ignoring these properties, failing to make the applications tolerant to scenarios of going through tunnels and being in areas of weak signal strengths. Every developer who creates applications (WAP or others) for GPRS and 3G wireless systems needs a handbook that clearly illustrates how you can overcome difficulties and leverage the new possibilities of the mobile Internet.

Having worked with software and Internet developers over the past couple of years (helping them optimize their applications for wireless networks), I find that many questions occur over and over again. I did not anticipate many of these questions when I was designing the 3G systems. These questions could, for instance, be as follows:

- How do I make my application cope with difficult radio conditions, such as going through a tunnel?
- How can my application access the features of the network, such as signal strength and the *Quality of Service* (QoS) that is used?
- How will my application typically be implemented in a mobile operator's network now and in the future?
- What is required if I want to add location dependence to my product?

At first, I found it difficult to find answers to these questions, because most resources do not always convey the big picture, and lots of information on the

Internet is even incorrect. The books that are available to date are about 300–400 pages long for each technology described. The problem arises when the average developer needs to know a bit about GPRS, *Enhanced Data rates for GSM and TDMA Evolution* (EDGE), *Wideband Code Division Multiple Access* (WCDMA), cdma2000, WAP, Bluetooth, EPOC, and kJava (to name just a few). Reading a book about each of maybe 10 to 20 technologies can be pretty overwhelming just to get started. My approach is to gather the parts of these technologies that are relevant to application developers, which means 20 to 30 pages about the main technologies and a bit less about the peripheral ones. I then complement this information with concrete advice about how to create successful applications that are optimized in order to work on wireless networks. This book is very technology focused, and I have left most of the business aspects until the last chapter. In the other chapters, I only mention a topic if it affects the technology decisions. One example is the discussion about the number of subscribers for the different technologies.

In essence, after reading this book the reader should have a very good understanding of the different mobile technologies and how they are related. This knowledge should be enough to make the necessary initial decisions in the development process, such as choosing the application architecture (for example, putting software on the device or just using a browser). Once the development is underway, the book will provide valuable advice about how to get the most from the mobile Internet and how to overcome some of its inherent difficulties. Once the desired platform is chosen, there are other good books that complement this one and that go deeper into the actual coding of the product. While great books exist about the programming languages and the operating systems, it is harder to find a book about mobile networks. This situation partly depends on the rapid pace of standardization, where small changes frequently occur. The standards are sometimes tricky to find and to understand, but the small guide at the end of this chapter should make you confident. When developing things that interact intimately with the networks and devices, you should always use the standards as the authoritative source of information. In the text, I make reference to the document numbers of the standards that provide a deeper discussion about the topic.

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## How This Book Is Organized

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This book is divided into three parts:

Part One, “The Mobile Networks,” explains how the wireless networks work and how they complement each other. In the beginning, we explain the

basic terminology in order for people who are not from the telecommunications industry to understand the acronyms (and there are many of those). The descriptions are consistently from the developer's point of view, rather than from the point of view of the mobile operator or the handset vendor. The application developer who wants to succeed needs to know the basics of the networks and how the properties look at the application level. After going through this part, you will be able to talk fluently with the people in the business (who have forgotten how little they knew in the beginning). This knowledge makes it possible to ask the right questions and to start discussions with potential partners. The first part includes Chapters 1 through 5.

Part Two, "Optimizing the Transmission," then talks about how all of these items affect the applications. The starting point is the existing datacom networks and the most commonly used protocols. This section analyzes shortcomings as well as opportunities and compares them with newer additions (such as WAP). This part also includes my experiences from working with developers over the years, helping them optimize applications. The most common mistakes appear over and over again when applications are tested, and we hope you will avoid the mistakes that others have made. The information in this part is incredibly valuable to any developer, no matter whether a new application is developed or whether an old one is optimized for wireless. Many of the companies with which I have worked have also found that the optimized application now functions better on fixed networks such as *Local Area Networks* (LANs). The second part includes Chapters 6 through 8.

Part Three, "Applications and Their Environments," digs deeper into the actual applications and other components that interact directly with them. The chapters in this part are generally shorter, and we cover more technologies in less space. The average developer maybe gets involved with half of the technologies; therefore, a more superficial coverage level is appropriate. Some of the chapters also involve topics where standardization is still underway, such as positioning and kJava. As with the rest of the book, we try to paint a picture of what you can do now and when you can expect standardization. The last chapter includes some of the experiences that I have had on the business side and what it takes to succeed all the way. The third part includes Chapters 9 through 15.

You can read the parts independently (the same goes for the individual chapters).

Chapter 1, "Basic Concepts," sets the stage and examines some of the basic concepts. Here, I also go through some of the naming conventions that I use in

order to clarify how I see the meanings of the concepts that I use frequently. People who are familiar with cells, base stations, and *Time Division Duplex* (TDD) should probably just skim through this chapter in order to catch the definitions of words such as *application* and *fixed Internet*.

Chapter 2, “The Mobile Evolution,” draws the big picture of the mobile systems of yesterday, today, and tomorrow. This chapter provides a better understanding of why we have several different *second-generation* (2G) networks and why it has been hard to get one unified 3G standard. We describe the steps for each migration path into 3G and provide an understanding of the expected timelines as well as the challenges that operators face.

Chapter 3, “GPRS—Wireless Packet Data” explains how *General Packet Radio Services* (GPRS) works and why it is such an important part of the mobile Internet. Although this chapter provides a description of a specific system, it also covers many generic aspects that you can apply to other wireless packet data networks. Despite the existence of a specific chapter concerning devices, we have chosen to include some specific information about the GPRS handsets here. This information includes how to connect other devices to the phone via the R-reference point and how to use AT-commands to access the network properties.

Chapter 4, “3G Wireless Systems,” dives into the *third-generation* (3G) wireless systems and how they affect developers. This chapter proved much more difficult to write than originally anticipated. There are four main standards for mobile networks (not counting satellite-borne ones), and the terminology varies a lot depending on whom you ask. There is ongoing work here to harmonize the different standards and to free up spectra in countries where standards were not previously available. Even the last week before the deadline for this book, there were interesting developments—and more things are likely to occur. The main messages and descriptions of the systems should be stable, however.

Chapter 5, “Bluetooth—Cutting the Cord!” describes short-range radio technology and how it greatly complements the *Wide Area Networks* (WANs) in the previous chapters. The focus is again on how Bluetooth can help developers create exciting applications by using the technology. We expect Bluetooth to be extremely pervasive; consequently, it is also mentioned in many of the other chapters. This chapter, however, concentrates on how Bluetooth works and how it appears to the end user.

Chapter 6, “Unwiring the Internet,” examines the fixed Internet as we know it and explores its associated protocols (primarily, the *Transmission Control Protocol* or TCP, the *Internet Protocol* or IP, and the *Hypertext Transport Protocol*, or HTTP). We discuss some of the problems that we have found

when running these protocols over wireless networks, and we explain what to do in order to cope with these issues. This chapter not only covers the traditional view of TCP/IP over wireless but also expands it to include some issues that we found when running high-speed networks such as Universal Mobile Telecommunication System (UMTS) and retransmitting lost packets.

Chapter 7, “The Wireless Application Protocol,” talks about WAP and describes its properties. While most of the existing literature on the topic focuses on the markup language, this description looks more beneath the application’s environment. We investigate and compare the underlying protocols that ensure that information is transferred in a robust and efficient way with the TCP/IP protocols of the previous chapter. This information should be a new and refreshing angle on a suite of protocols that we have intensively discussed on a superficial level. We also touch upon the future of WAP and Extensible Hypertext Markup Language (XHTML) at the end.

Chapter 8, “Adapting for Wireless Challenges,” includes the bulk of experience that I have gathered from testing dozens of wireless applications and helping developers optimize them. Not only do we describe the most common issues, including interruptions, long latency, and low bandwidth, but we also propose solutions to these problems. This chapter is a must-read for anyone who is developing applications for wireless networks.

Chapter 9, “Application Architectures,” describes how you can implement applications on the networks of today and tomorrow. We place emphasis on the upcoming service network architecture, where applications can access the features of the mobile networks by using open *Application Programming Interfaces* (APIs). This functionality will open amazing possibilities for developers who now can use features such as positioning, call control, and charging in order to enhance their products.

Chapter 10, “Mobile Internet Devices,” is an introduction to the devices that we can use with the mobile Internet. The most important part is setting the stage for future device constellation and for integrated and divided concepts. In addition, there is plenty of advice that is useful for getting the most from the platform that you use and for saving battery and *central processing unit* (CPU) power. While no one knows what the future of devices will look like, this chapter illustrates some of the changes that are happening and how to adapt one’s thinking.

Chapter 11, “Operating Systems and Application Environments,” goes one step further than the previous chapter and looks at the items that you can add to

devices in order to make application implementation easier. This chapter includes the operating systems Palm OS, Windows CE (Pocket PC), EPOC, and Linux. We also question the role of the operating system and explain the bright future of Java for mobile devices.

Chapter 12, “Security,” tries to illustrate the wide concept of security for mobile Internet applications. The reader who is unfamiliar with the concepts will learn the basics of cryptography and how to use it in products. The emphasis is on the big picture and how to weigh the desired security level against the added complexity in order to make the right decisions.

Chapter 13, “Location-Based Services,” goes one step further toward describing one of the most important parts of the service network mentioned in Chapter 9: location-based applications. We describe different positioning techniques, both handset based and network based, in order for the reader to realize the consequence of using each one. This description, of course, includes the accuracy for each technology and also some aspects that affect the operator’s decision for positioning method. One important aspect that we often forget, however, is the issue of delay that the positioning requests give to an application.

Chapter 14, “Testing the Wireless Applications,” adds one of the most important parts of the development process and explains the different parts of the testing process. While the focus is on testing the wireless properties, we also stress the importance of testing for usability and user friendliness. One of the keys to being successful in testing is to work with those people who are experienced and who can give objective feedback. We provide a list of such resources at the end of the chapter.

Chapter 15, “Getting It All Together,” summarizes some of the most important nontechnical aspects of creating successful mobile Internet applications. The most obvious part is, of course, how to make money from the application. While we provide no definitive answer to that question, the chapter still provides some valuable leads on where to look. Getting prototypes out early and using the right partners has proven successful for companies with which I have worked. Hopefully this chapter will make you even more successful.

These descriptions only show the topics at a very high level, and due to the many components of the area, the insights will occur in different places for everyone. While the chapters are sufficiently detached in order to enable you to read them in any order, it is highly beneficial to read them through consecutively first. Then, you can use them as independent references when needed.

## Keeping Things Objective

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My focus when talking to developers is first and foremost to explain what the standard in question says and how they should interpret it. When starting this book, I had the clear objective to keep this view as far-reaching as possible, but sometimes this challenge proved difficult.

The information in this book is very hard to collect for an outsider, and reading the standards will only get you so far. Things such as how implementation issues are commonly solved and what the consumer experience will be regarding technologies that are not on the market are almost impossible for the common man to find out. Because most of my experiences have come from working for Ericsson, it is inevitable that I have researched some topics by using Ericsson material (with loss of objectivity as a result). I also have to grab the opportunity to thank the senior management of Ericsson for letting me share things that are normally not spread outside a limited audience. I am certain that the developer community will find this information helpful.

In those cases where a standard is not finalized, such as positioning, I try to emphasize that we are describing a proprietary solution. I chose to include this information because these things are so important to developers, and the upcoming standard will resemble the existing *software development kits* (SDKs). My general philosophy is that every developer should adhere to the standard if there is one, such as with WAP. When there is no standard ready and migrating from a proprietary solution provides a first-mover advantage, it might be wise to get things going as quickly as possible. Once the standard is available, it is vital for the entire developer community to strive toward using common methods. When designing the application, the developer will find this goal fairly easy because he or she can isolate the API communication and change it easily.

In describing the mobile systems, I explain the standard as far as possible and the Ericsson implementations where there are multiple options. In those cases where there are multiple choices, I mention what the options are and some of the pros and cons associated with each of them. This solution was the best that I could think of, and the reasons for this description are many. First of all, Ericsson has by far the largest market share of 2G systems, and it does not look like it will be less for 3G systems. Second, I have not been part of the system development of Nokia, Lucent, or another system, and getting all of the details would be difficult. The standard leaves many things open, and its description is often too flexible to be easily understood.

When compiling the figures, I have scanned the Internet for high-resolution images of the devices and other components of the future. To me, it appeared that this information was hard to find from all vendors except Nokia and Ericsson. These are the reasons for having most of the device photographs from these companies.

## Who Should Read This Book?

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The primary audience of this book is the developer community and those who will create the future applications of the mobile Internet. This book is ideal for those who know a bit about software/Web development and who want to get into the wireless field. The book is technical in nature, and those who have a technical background are likely to benefit the most while others can gain a brief overview of the technologies that are involved. This target group benefits from reading the book from start to finish, because it builds the solid wireless competence that is necessary in order to be successful.

Students who want to gain a solid overview of the main driving technologies of the mobile Internet can read those chapters that are appropriate and get a good starting point for further studies. Most likely, the knowledge in this book will be a fundamental part of many software developer and data communications programs at universities.

After having people from the telecommunications industry proofread the content of this book, I found that all of the involved experts have found the book useful. Those who know all about positioning rarely know everything about Bluetooth and all of the other areas that we describe. Wireless experts can probably browse through the first part and hit Part Two and Part Three fairly quickly.

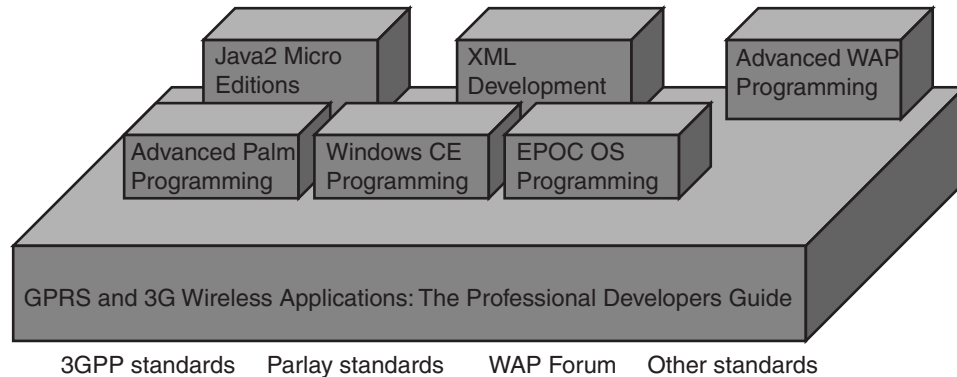
## Tools You Will Need

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This book provides the foundation for developers of mobile applications in that it describes the components and their interaction. There are, however, very few concrete code samples and example programs. The reason is because you need more than this book to create the application.

While this book provides introductions to the topics illustrated in Figure I.1, we need more in order to go all the way. The aim of this book is to provide a complete guide to the mobile networks and their importance in application development. The number of possible platforms for development is too big, and providing many examples would only limit the usability of this book.





**Figure I.1** This book and how it relates to others.

The CD-ROM that accompanies this book contains a number of valuable tools and examples for those who are eager to get started, and by using this CD-ROM, you can get started right away.

## What Is on the Web Site and CD-ROM?

The Web site [www.wirelessdevnet.com/GPRSand3Gapps](http://www.wirelessdevnet.com/GPRSand3Gapps) contains links to the sites mentioned below and to the latest versions of the tools on the CD-ROM. In addition, there are many tools and SDKs that either had licensing issues attached to them or simply were not available at the time of printing.

The CD-ROM contains a number of useful tools that will get you started. The WAP development kits enable you to quickly get started with developing WAP applications and also contain valuable guides and advice. To complement those features, there are a number of emulators of current mobile devices that are useful for testing the application.

Due to the current state of standardization, the attached Java SDKs are likely to be replaced by updated versions by the time you read this book. The SDKs are still useful and show a bit of what the future will look like. The 3GPP standards (at [www.3gpp.org](http://www.3gpp.org)) can be a bit difficult to read for beginners, although they are freely available on the Web. The page [www.3gpp.org/3G\\_Specs/3G\\_Specs.htm](http://www.3gpp.org/3G_Specs/3G_Specs.htm) explains the structure and links to the relevant document databases. On the *File Transfer Protocol* (FTP) site, there are directories for the different workgroups and the specifications are grouped by Releases (e.g., <ftp://ftp.3gpp.org/Specs/2000-12/>). The status file (e.g., [ftp://ftp.3gpp.org/Specs/2000-12/status\\_2000-12.zip](ftp://ftp.3gpp.org/Specs/2000-12/status_2000-12.zip)) contains the document numbers for the standards, and you can use it to locate the correct documents on the FTP site.

cdma2000 is standardized in 3GPP2, and you can find the technical information directly below the main Web page.

The WAP Forum Web site, [www.wapforum.org](http://www.wapforum.org), contains all of the WAP standardization documentation. Most of the information is under the “Technical Information” link.

The Bluetooth specifications are available at [www.bluetooth.com](http://www.bluetooth.com). There are two documents for Version 1.0: the main specification and the profiles specification. Note that these files are big, and choosing “Print target” in your browser might make you unpopular among people who are using the same printer.

Parlay is an organization that drives the standardization of open APIs, as we will mention in Chapter 9, “Application Architectures.” You can find the Parlay specifications at [www.parlay.org](http://www.parlay.org).

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## What Now?

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Those who feel unfamiliar with the wireless terminology or who just want to know how I define the different concepts should move on to Chapter 1. Others can dive directly into Chapter 2 and start learning about the mobile evolution and mobile systems.

I hope that many of you will find this book not only useful but also inspiring, and I hope that this information will spur you on to create great applications. The wireless industry needs your contribution to the success of the mobile Internet.



# The Mobile Networks







# CHAPTER 1

## Basic Concepts

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**F**or those who enter the world of the mobile Internet for the first time, coming fresh into the business or having some previous experience from the Internet or computer software worlds, it might appear to be a very strange place. The terminology is a mixture of legacies from times that are as distant as the early days of telephony and early twenty-first century wireless nomenclature. The ultimate wireless application developer does not have to master every part of the mobile system and its history, but some basic knowledge is required in order to understand the market, the technology, and most of all the people. Many of the mobile operators that you will encounter as you take your upcoming successes to the market will be deeply rooted in the history of mobile/cellular systems, and you must understand their thinking. This chapter will briefly describe the basics of the technologies that are involved and that are needed to understand the following descriptions. In addition, we will go through some of the concepts that we will use and try to define concepts such as applications and services.

### How a Mobile Phone System Works

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How much does an applications developer have to know about wireless systems? Understanding how the networks and handsets will affect the performance of the application is crucial, but it is also important to have a basic understanding of the components of the system. In the same way, most *personal computer* (PC) and Internet programmers have a basic understanding (and often more than that) of the hardware and network with which they are working.