



Fundamentals of WiMAX: Understanding Broadband Wireless Networking

By Jeffrey G. Andrews, Arunabha Ghosh, Rias Muhamed

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The Definitive Guide to WiMAX Technology

WiMAX is the most promising new technology for broadband wireless access to IP services. It can serve an extraordinary range of applications and environments: data, voice, and multimedia; fixed and mobile; licensed and unlicensed.

However, until now, wireless professionals have had little reliable information to guide them. *Fundamentals of WiMAX* is the first comprehensive guide to WiMAX—its technical foundations, features, and performance.

Three leading wireless experts systematically cut through the hype surrounding WiMAX and illuminate the realities. They combine complete information for wireless professionals and basic, accessible knowledge for non-experts. Professionals will especially appreciate their detailed discussion of the performance of WiMAX based on comprehensive link- and system-level simulations.

Whether you're a wireless engineer, network architect, manager, or system designer, this book delivers essential information for succeeding with WiMAX—from planning through deployment.

Topics include

- Applications, history, spectrum options, technical and business challenges, and competitive technologies of WiMAX
- 802.16 standards: physical and MAC layers, channel access, scheduling services, mobility, advanced antenna features, hybrid-ARQ, and more
- Broadband wireless channels: pathloss, shadowing, cellular systems, sectoring, and fading—including modeling and mitigation
- OFDM: from basic multicarrier concepts to synchronization, PAR reduction, and clipping
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Editorial Review

From the Back Cover

Praise for Fundamentals of WiMAX

"This book is one of the most comprehensive books I have reviewed ... it is a must-read for engineers and students planning to remain current or who plan to pursue a career in telecommunications. I have reviewed other publications on WiMAX and have been disappointed. This book is refreshing in that it is clear that the authors have the in-depth technical knowledge and communications skills to deliver a logically laid out publication that has substance to it."

–Ron Resnick, President, WiMAX Forum

"This is the first book with a great introductory treatment of WiMAX technology. It should be essential reading for all engineers involved in WiMAX. The high-level overview is very useful for those with non-technical background. The introductory sections for OFDM and MIMO technologies are very useful for those with implementation background and some knowledge of communication theory. The chapters covering physical and MAC layers are at the appropriate level of detail. In short, I recommend this book to systems engineers and designers at different layers of the protocol, deployment engineers, and even students who are interested in practical applications of communication theory."

–Siavash M. Alamouti, Chief Technology Officer, Mobility Group, Intel

"This is a very well-written, easy-to-follow, and comprehensive treatment of WiMAX. It should be of great interest."

–Dr. Reinaldo Valenzuela, Director of Wireless Research, Bell Labs

" ***Fundamentals of WiMAX*** is a comprehensive guide to WiMAX from both industry and academic viewpoints, which is an unusual accomplishment. I recommend it to anyone who is curious about this exciting new standard."

–Dr. Teresa Meng, Professor, Stanford University, Founder and Director, Atheros Communications

"Andrews, Ghosh, and Muhamed have provided a clear, concise, and well-written text on 802.16e/WiMAX. The book provides both the breadth and depth to make sense of the highly complicated 802.16e standard. I would recommend this book to both development engineers and technical managers who want an understating of WiMAX and insight into 4G modems in general."

–Paul Struhsaker, VP of Engineering, Chipset platforms, Motorola Mobile Device Business Unit, former vice chair of IEEE 802.16 working group

" ***Fundamentals of WiMAX*** is written in an easy-to-understand tutorial fashion. The chapter on multiple antenna techniques is a very clear summary of this important technology and nicely organizes the vast number of different proposed techniques into a simple-to-understand framework."

–Dr. Ender Ayanoglu, Professor, University of California, Irvine, Editor-in-Chief, IEEE Transactions on Communications

" ***Fundamentals of WiMAX*** is a comprehensive examination of the 802.16/WiMAX standard and discusses how to design, develop, and deploy equipment for this wireless communication standard. It provides both insightful overviews for those wanting to know what WiMAX is about and comprehensive, in-depth chapters on technical details of the standard, including the coding and modulation, signal processing methods, Multiple-Input Multiple-Output (MIMO) channels, medium access control, mobility issues, link-layer performance, and system-level performance."

–Dr. Mark C. Reed, Principal Researcher, National ICT Australia, Adjunct Associate Professor, Australian National University

"This book is an excellent resource for any engineer working on WiMAX systems. The authors have

provided very useful introductory material on broadband wireless systems so that readers of all backgrounds can grasp the main challenges in WiMAX design. At the same time, the authors have also provided very thorough analysis and discussion of the multitudes of design options and engineering tradeoffs, including those involved with multiple antenna communication, present in WiMAX systems, making the book a must-read for even the most experienced wireless system designer."

—Dr. Nihar Jindal, Assistant Professor, University of Minnesota

"This book is very well organized and comprehensive, covering all aspects of WiMAX from the physical layer to the network and service aspects. The book also includes insightful business perspectives. I would strongly recommend this book as a must-read theoretical and practical guide to any wireless engineer who intends to investigate the road to fourth generation wireless systems."

—Dr. Yoon Chae Cheong, Vice President, Communication Lab, Samsung

"The authors strike a wonderful balance between theoretical concepts, simulation performance, and practical implementation, resulting in a complete and thorough exposition of the standard. The book is highly recommended for engineers and managers seeking to understand the standard."

—Dr. Shilpa Talwar, Senior Research Scientist, Intel

" ***Fundamentals of WiMAX*** is a comprehensive guide to WiMAX, the latest frontier in the communications revolution. It begins with a tutorial on 802.16 and the key technologies in the standard and finishes with a comprehensive look at the predicted performance of WiMAX networks. I believe readers will find this book invaluable whether they are designing or testing WiMAX systems."

—Dr. James Truchard, President, CEO and Co-Founder, National Instruments

"This book is a must-read for engineers who want to know WiMAX fundamentals and its performance. The concepts of OFDMA, multiple antenna techniques, and various diversity techniques—which are the backbone of WiMAX technology—are explained in a simple, clear, and concise way. This book is the first of its kind."

—Amitava Ghosh, Director and Fellow of Technical Staff, Motorola

"Andrews, Ghosh, and Muhamed have written the definitive textbook and reference manual on WiMAX, and it is recommended reading for engineers and managers alike."

—Madan Jagernauth, Director of WiMAX Access Product Management, Nortel

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About the Author

Jeffrey G. Andrews is an assistant professor at The University of Texas at Austin. He has developed CDMA systems for Qualcomm and consulted with many organizations including the WiMAX Forum, Microsoft, and NASA. He is a recipient of the NSF CAREER Award and holds a Ph.D. from Stanford University.

Arunabha Ghosh, a principal member of technical staff at AT&T Labs, specializes in wireless communication theory and signal processing and has been involved in standardization efforts in the WiMAX Forum. He holds a Ph.D. from the University of Illinois at Urbana-Champaign.

Rias Muhamed is a lead member of technical staff at AT&T Labs. He has led several research and technology assessment projects in fixed wireless broadband at AT&T Labs. He is a senior member of the

IEEE and holds an M.S. from Virginia Tech.

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Fundamentals of WiMAX was consciously written to appeal to a broad audience, and to be of value to anyone who is interested in the IEEE 802.16e standards or wireless broadband networks more generally. The book contains cutting-edge tutorials on the technical and theoretical underpinnings to WiMAX that are not available anywhere else, while also providing high-level overviews that will be informative to the casual reader. The entire book is written with a tutorial approach that should make most of the book accessible and useful to readers who do not wish to bother with equations and technical details, but the details are there for those who want a rigorous understanding. In short, we expect this book to be of great use to practicing engineers, managers and executives, graduate students who want to learn about WiMAX, undergraduates who want to learn about wireless communications, attorneys involved with regulations and patents pertaining to WiMAX, and members of the financial community who want to understand exactly what WiMAX promises.

Organization of the Book

The book is organized into three parts with a total of twelve chapters. Part I provides an introduction to broadband wireless and WiMAX. Part II presents a collection of rigorous tutorials covering the technical and theoretical foundations upon which WiMAX is built. In Part III we present a more detailed exposition of the WiMAX standard, along with a quantitative analysis of its performance.

In Part I, Chapter 1 provides the background information necessary for understanding WiMAX. We provide a brief history of broadband wireless, enumerate its applications, discuss the market drivers and competitive landscape, and present a discussion of the business and technical challenges to building broadband wireless networks. Chapter 2 provides an overview of WiMAX and serves as a summary of the rest of the book. This chapter is written as a standalone tutorial on WiMAX and should be accessible to anyone interested in the technology.

We begin Part II of the book with Chapter 3, where the immense challenge presented by a time-varying broadband wireless channel is explained. We quantify the principal effects in broadband wireless channels, present practical statistical models, and provide an overview of diversity countermeasures to overcome the challenges. Chapter 4 is a tutorial on OFDM, where the elegance of multicarrier modulation and the theory of how it works are explained. The chapter emphasizes a practical understanding of OFDM system design and discusses implementation issues for WiMAX systems such as the peak-to-average ratio. Chapter 5 presents a rigorous tutorial on multiple antenna techniques covering a broad gamut of techniques from simple receiver diversity to advanced beamforming and spatial multiplexing. The practical considerations in the application of these techniques to WiMAX are also discussed. Chapter 6 focuses on OFDMA, another key-ingredient technology responsible for the superior performance of WiMAX. The chapter explains how OFDMA can be used to enhance capacity through the exploitation of multiuser diversity and adaptive modulation, and also provides a survey of different scheduling algorithms. Chapter 7 covers end-to-end aspects of broadband wireless networking such as QoS, session management, security, and mobility management. WiMAX being an IP-based network, this chapter highlights some of the relevant IP protocols used to build an end-to-end broadband wireless service. Chapters 3 through 7 are more likely to be of interest to practicing engineers, graduate students, and others wishing to understand the science behind the WiMAX standard.

In Part III of the book, Chapters 8 and 9 describe the details of the physical and media access control layers

of the WiMAX standard and can be viewed as a distilled summary of the far more lengthy IEEE 802.16e-2005 and IEEE 802.16-2004 specifications. Sufficient details of these layers of WiMAX are provided in these chapters to enable the reader to gain a solid understanding of the salient features and capabilities of WiMAX and build computer simulation models for performance analysis. Chapter 10 describes the networking aspects of WiMAX, and can be thought of as a condensed summary of the end-to-end network systems architecture developed by the WiMAX Forum. Chapters 11 and 12 provide an extensive characterization of the expected performance of WiMAX based on the research and simulation-based modeling work of the authors. Chapter 11 focuses on the link-level performance aspects, while Chapter 12 presents system-level performance results for multicellular deployment of WiMAX.

Users Review

From reader reviews:

Enrique Flora:

Nowadays reading books become more and more than want or need but also be a life style. This reading habit give you lot of advantages. Associate programs you got of course the knowledge the particular information inside the book in which improve your knowledge and information. The data you get based on what kind of guide you read, if you want attract knowledge just go with training books but if you want experience happy read one along with theme for entertaining for instance comic or novel. Typically the Fundamentals of WiMAX: Understanding Broadband Wireless Networking is kind of e-book which is giving the reader unforeseen experience.

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