WiMAX CRASH COURSE

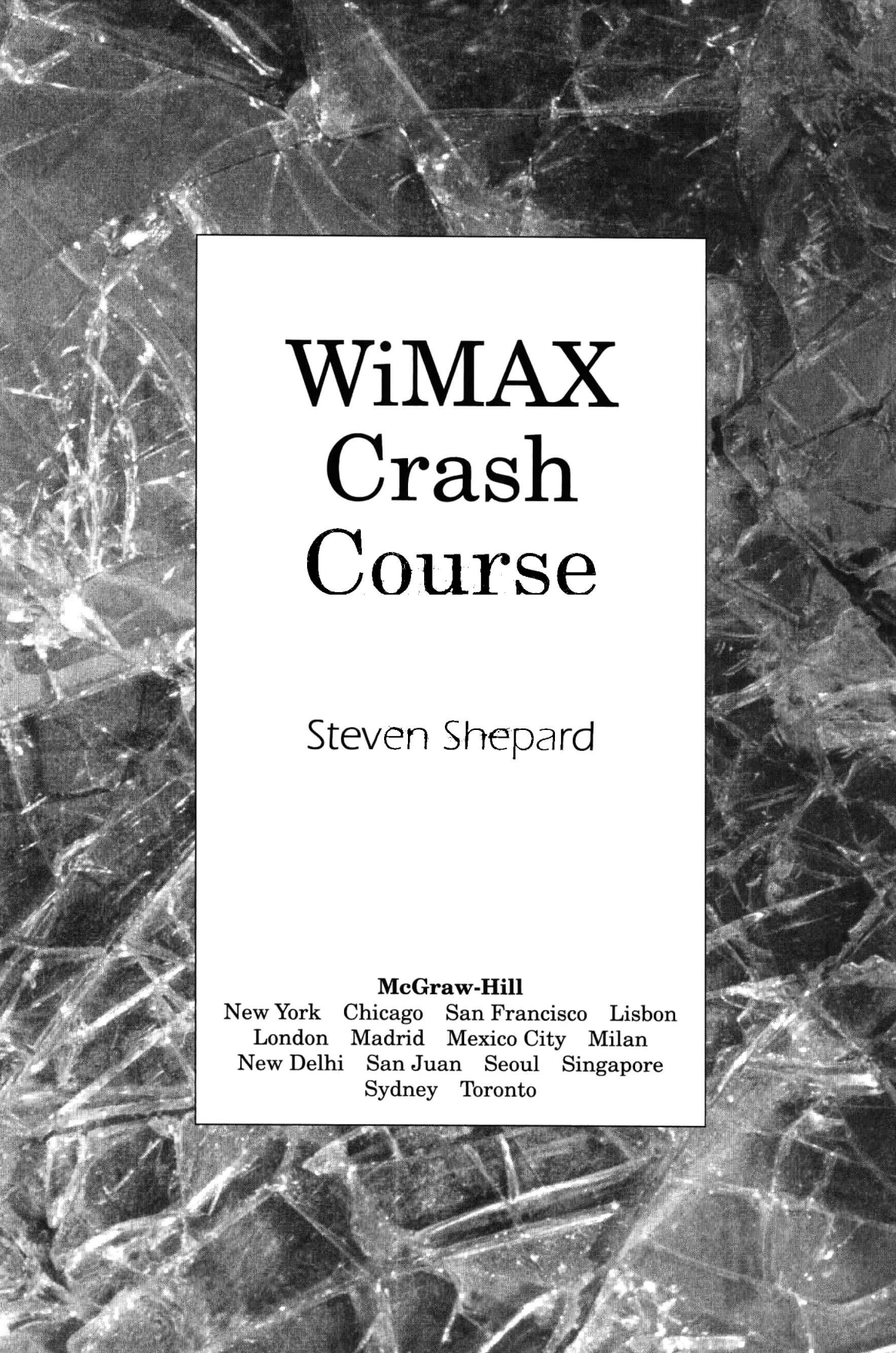
Network architecture and protocols

Successful deployment strategies from industry leaders

Implementation issues, challenges, and pitfalls

Potential WiMAX sevices and their enablement

STEVEN SHEPARD



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This book is for my good friend and colleague,
Phil Cashia. Thanks for your friendship,
your kindness, and the many hours of engaging
conversation. As always, LOFOG.

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Sabine, Steve, and Cristina, thank you for being my family. I am so proud of all of you.

FOREWORD

Once more, and this time with feeling.

I write this book as a complement to the small collection of good technology-focused WiMAX books that are already in circulation. This title, like my other books, contains plenty of technology, but its primary focus is on markets, applications, revenue impacts, and integration. In reality, it's a business book more than a technology book. Embryonic though the technology is at the time of this writing (the current standard is still in draft form, and the next one isn't due for months), it has a growing base of supporters that includes component manufacturers, systems manufacturers, and a significant number of service providers. Prestandard hardware is on the market, numerous global trials are under way, and an industry standards group, the WiMAX Forum (www.wimaxforum.org), has been constituted by key influencers, including Intel, Proxim, BT, Alvarion, AT&T, and Samsung.

I have monitored the evolution of WiMAX for the last two years with great interest not because of how it works or what it does but because of what it catalyzes. WiMAX is an accelerator, and it wields its influence on the areas where businesses focus *their* attentions: revenue enhancement, cost containment, competitive advantage, and risk mitigation. Properly deployed, it will have far-reaching, global impacts—and that's where I focus *my* attention.

With 50 clients operating in more than 90 countries, I am blessed with the opportunity to see firsthand the impact that new technologies have on the developed, developing, and undeveloped worlds. I have watched as problems of conduit congestion, infrastructure disruption, and onerous permitting processes in major cities have been resolved through the judicious selection of broadband wireless as an alternative to optical

infrastructure. I have watched the frenzy in the developing world that occurs when liberalization and privatization take effect, bringing on a spate of competitive positioning by emergent players and the attendant deployment of innovative technologies. I also have watched magic happen: the arrival of a small town's first phone in Africa and the buzz of potential that it creates among vendors and shopkeepers who crave connections to the global market and everything that access to the Internet promises.

We are a big industry, so big that it's easy to get lost in the mundane daily grind of "doing telecom." There are chips to be manufactured, systems to be assembled, code to be debugged, standards to be written, networks to be managed, and customers to be billed. Working in the middle of that operational maelstrom, it's easy to forget why we do what we do.

For a long time I unwittingly operated under the belief that the telecom industry exists for the telecom industry, that it is an end unto itself. That assumption came to a jarring and abrupt halt when I began working in the third world and had an opportunity to see firsthand what we *really* do. Yes, we satisfy shareholders and employ large numbers of people because of the products we make and sell, the services we offer, and the targeted solutions we craft. However, beyond that, at the critical customer touchpoint where magic happens and sparks fly, we empower commerce, create markets, build businesses, and motivate thought leadership. Our networks make it possible to consider what could be, and our services and applications make it happen. In many ways we are the ultimate change agent, and in the years to come our influence will be felt most strongly in the realm of globalization.

In *The Lexus and the Olive Tree*, Tom Friedman describes a phenomenon that he calls "the Golden Arches Theory." That theory eerily and accurately observes that no two countries with a McDonald's have ever waged war against each other. As silly as that observation sounds, its implications are quite serious: When a country reaches a stage of economic development at which its citizens have enough disposable income to spend some of it at McDonald's, that country becomes a paid member of the global economic team. When that happens, when national economies become interlinked into a single global economy, the Golden Arches Theory is lived out: If I attack *you*, I attack *me*. As the checker-playing, Armageddon-bent supercomputer said to Matthew Broderick's character in the movie *War Games*, "An interesting game, Professor Falken. The only winning move is not to play."

This book is about WiMAX, but more than that, it is about the *promise* of WiMAX. Numbers as large as $500 billion[1] have been tossed about as being indicative of the upward economic impact of broadband; imagine what happens when broadband mixes with global roaming. That, among other things, is the value that WiMAX brings to the table.

We begin with the vision: What will be possible when WiMAX arrives? We then discuss application scenarios before walking through the technology's brief history (it hasn't been around long enough to have a *real* history). Next, we dive into the inner workings of WiMAX and explain how it interworks with other technologies. Then we introduce the evolving application set that WiMAX enables before discussing the increasingly chaotic but very interesting world of regulation as it relates to broadband wireless. We conclude with a brief discussion about the players in the WiMAX game, followed by a peek into the future. WiMAX has the potential to be highly disruptive, but like all capable technologies, it can be enormously facilitative. We wrap up the book with a discussion of strategies for integrating and deploying WiMAX.

All my books include a comprehensive acronym list and a glossary. Thanks to all the readers who have lobbied for its inclusion; this book has it as well.

Thank you, readers, for your continued support. This book is for you.

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[1] Crandall, Robert W., and Charles L. Jackson, *The $500 Billion Dollar Opportunity: The Potential Economic Benefit of Widespread Diffusion of Broadband Internet Access*. Criterion Economics, LLC, July 2001.

ABOUT THE AUTHOR

Steven Shepard is the president of the Shepard Communications Group in Williston, Vermont. A professional author and educator with 24 years of varied experience in the telecommunications industry, he has written books and magazine articles on a wide variety of topics. His books include:

- *Telecommunications Convergence: How to Profit from the Convergence of Technologies, Services and Companies* (McGraw-Hill, New York, 2000)
- *A Spanish-English Telecommunications Dictionary* (Shepard Communications Group, Williston, Vermont, 2001)
- *Managing Cross-Cultural Transition: A Handbook for Corporations, Employees and Their Families* (Aletheia Publications, New York, 1997)
- *An Optical Networking Crash Course* (McGraw-Hill, New York, February 2001)
- *SONET and SDH Demystified* (McGraw-Hill, New York, 2001)
- *Telecom Crash Course* (McGraw-Hill, New York, October 2001)
- *Telecommunications Convergence, Second Edition* (McGraw-Hill, New York, February 2002)
- *Videoconferencing Demystified* (McGraw-Hill, April 2002)
- *Metro Networking Demystified* (McGraw-Hill, New York, October 2002)
- *RFID Demystified* (McGraw-Hill, New York, July 2004)

- *Managing Supply Chain Technology* (with Jack Garrett; in progress)
- *Telecom Crash Course, Second Edition* (McGraw-Hill, New York, June 2005); and
- *VoIP Crash Course* (McGraw-Hill, New York, July 2005)

How to Do Everything with VoIP will be published by McGraw-Hill in early 2006.

Steve is also the Series Advisor of the McGraw-Hill *Portable Consultant* book series.

Mr. Shepard received his undergraduate degree in Spanish and Romance Philology from the University of California at Berkeley and his master's degree in International Business from St. Mary's College. He spent eleven years with Pacific Bell in San Francisco in a variety of capacities including network analysis, computer operations, systems standards development, and advanced technical training, followed by nine years with Hill Associates, a world-renowned telecommunications education company, before forming the Shepard Communications Group. He is a fellow of the Da Vinci Institute for Technology Management of South Africa, a member of the Board of Directors of Champlain Community Television, a Founding Director of the African Telecoms Institute, and a member of the Board of Trustees of Champlain College in Burlington, Vermont. He is also the Resident Director of the University of Southern California's Executive Leadership and Advanced Management Programs in Telecommunications, and adjunct faculty member at the University of Southern California, The Garvin School of International Management (Thunderbird University), the University of Vermont, Champlain College and St. Michael's College. He and his wife Sabine have two children.

Mr. Shepard specializes in international issues in telecommunications with an emphasis on strategic technical sales; services convergence; the social implications of technological change; the development of multilingual educational materials; and the effective use of multiple delivery media. He has written and directed more than 40 videos and films and written technical presentations on a broad range of topics for more than 70 companies and organizations worldwide. He is fluent in Spanish and routinely publishes and delivers presentations in that language. Global clients include major telecommunications manufacturers, service providers, software development firms, multinational corporations, universities, professional services firms, advertising firms, venture capital firms, and regulatory bodies.

CONTENTS

CHAPTER 1

Introduction to Wireless and WiMAX

I am in a car in Raleigh-Durham, traveling at 70 miles per hour. On my lap is a rather heavy laptop with a strange little pigtail antenna sticking out of the side. I'm wearing a headset that is plugged into the laptop.

I suppose it's a good idea to tell you that I am not driving. My friend William, who owns the car and works in Research Triangle Park, has that responsibility. My job is to be impressed with what is going on with the laptop. At this moment, as we round the curve on the highway, heading for the airport, I am chatting with four people online, downloading my e-mail, surfing the Web for information about a nearby camera store, talking on the headset over a Skype connection, and occasionally going to a Web window that is showing a scene from the webcam in William's laboratory: "If you see Walter come in, let me know so that I can call him and tell him not to get Rick at the airport since we're doing it already." All these applications are working well, all of them are working simultaneously, and all of them are sharing access to a trial Worldwide Interoperability for Microwave Access (WiMAX) radio cell that William's company has built and installed on top of a building near his office. I am impressed.

Now the scene shifts: I am standing beside a dusty African crossroads in Limpopo province in the northernmost reaches of South Africa. Vendors beside me are selling melons, cell phone chargers, mousetraps, and ironwood animal carvings. Just across the street a family of baboons sits on the guardrail, closely watching the small pile of melons, waiting for an opportunity to dash across the street and steal one. The owner watches the baboons equally closely (during the three hours I was there, I saw five melons snatched).

I am not here to buy melons or watch thieving baboons. I am here to visit the telephone company central office, which is just behind me (Figure 1-1). Housed in a shipping container, it is one of several hundred exchanges that have been deployed rapidly throughout the region as a way to bring connectivity services to rural Africa. Along the back wall of the container are arrayed several standard racks of switching equipment that provide service to mobile callers in the area; along one side wall hang telephones for the use of anyone with a prepaid calling card but no mobile phone. Facing the phones is a small administrative desk. The shipping container is at once a central office exchange, a public phone office, and a business office where bills can be paid and assistance can e requested for setting up small businesses.

On the roof of the shipping container, hidden from view by the leftmost ventilation globe, a high-gain antenna points off into the bush to an invisible receiver across the plains. The signal that runs between the two

Figure 1-1
A central office in northern South Africa made from a shipping container.

is a WiMAX backhaul connection, part of a trial being conducted by the incumbent carrier in that country.

The scene shifts again: The power industry in most countries has one of the most widely deployed distribution infrastructures in the world. Those long, looping catenaries, strung between pylons, carry power from generation facilities to substations where the power is stepped down, filtered, and distributed to subscribers.

One of the challenges power companies face is the fact that the cable strung between the towers is extraordinarily heavy in spite of the fact that it is made of aluminum. To reduce its dead weight, the cable is hollow, and to make the cable more useful without adding to the weight, it is filled with ribbons of optical fibers: terabits of bandwidth. For years the power industry has been its own best bandwidth customer, using its wholly owned optical capacity to move load-sharing and telemetry data.

Of course, commodity industries such as power and telecommunications providers are always looking for the next great thing they can offer to enhance their revenues. It didn't take long for the engineers in the industry to realize that their internal requirements used only a fraction of the available bandwidth. The second conclusion they quickly reached was that the leftover bandwidth could be sold to enterprise or residence customers as long as they had a way to connect (a local loop) to those customers. The local loop problem was solved in two ways. The first was through the creation of an out-of-band transport scheme called Broadband over Power Line (BPL), sometimes called Power Line Transport (PLT) (see Figure 1-2). The range of frequencies set aside for this technology lies between 3 and 30 MHz, which is far above the 50- or 60-Hz frequency band within which AC power is transported. Unfortunately,