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Wireless Network Performance Handbook

- **CDMA2000 (1xRTT), GSM/GPRS, TDMA and iDEN**
 - **Practical Troubleshooting Guidelines**
 - **Call Flow Diagrams**
 - **Optimization techniques for Mobile Data (IP)**
- **Design and Forecasting Rules of Thumb**
- **Performance Metrics**
- **Capital Utilization Improvements**

➤ **Clint Smith & Curt Gervelis**

Wireless Network Performance Handbook

Clint Smith, P.E.

Curt Gervelis

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This book is dedicated to my wife, Mary, and our two children, Sam and Rose, without whom this effort would not have been possible.

C.S.

I would like to dedicate this book to my brother, Aric, for his inspiration and encouragement; and to my favorite teacher, Dr. Markley, for his guidance and patience, which I have remembered throughout my life.

C.G.

Preface

The wireless industry continues to be dynamic and invigorating, and we are glad to be part of it. For several years McGraw-Hill, via editor Steve Chapman, has been pursuing us to craft a wireless performance book. After much hemming and hawing the project was begun without our fully comprehending the level of complexity and number of variables that lay in front of us. In short order it became obvious that the book needed to focus on five wireless technology platforms (AMPS, IS-136, GSM/GPRS, CDMA, and iDEN), and so the amount of material it was to contain expanded greatly. Every attempt was made to make this book a very usable source of information by providing practical guidelines instead of the typical theory.

In this book we recorded real-life situations and solutions for wireless engineers, experienced and novice, to utilize. By conveying what has and has not been successful in engineering we hope to prevent many common mistakes. The information contained here is intended for the people who have to make a system work on a daily basis. As George Starace once said, "You must always concentrate on where you are getting your nickels from."

This book will cover both the RF and network aspects of the engineering efforts associated with a wireless mobile system. Design guidelines will be addressed and numerous troubleshooting examples will be given. The book will discuss how to monitor a system, put together a growth study, and organize engineering. The general format of this book is to introduce key topics first and then go over examples and/or case studies that can be used as general references. Since every system and situation is unique, we provide a process with which problems can be isolated, defined, and resolved. We have found that this seven-step process consistently brings about the technical excellence that achieves improvements in performance.

In short, system performance has always been the untold defense against churn in any market. With more consolidation taking place within the wireless industry, the valuation of a company is driven primarily by its revenue, value per pop, number of subscribers, and infrastructure. However, a fundamental assumption is that the technical performance of a wireless system will

improve with the introduction of more technology, new features, system growth, and fewer technical personnel to do the tasks that seem to increase at an exponential rate.

Improving system performance through optimization is a continuous process of refinements to not only the existing network but also to the future network design. Improvement also requires a holistic view of the network. The benefits of optimization are not only the bettering of service quality for the subscriber, but also the minimizing of capital and expense dollars to provide the better service.

The inclusion of packet data services with the multiple wireless access platforms that many wireless operators are using has done nothing but complicate the design and, of course, the operation of the networks. Presently, packet services are emerging, although, as we have been told for over 10 years regarding wireless data, the possibilities that this can bring are limited by the imagination, spectrum, and, of course, capital.

Performance improvements should begin at the design phase for both the network and radio aspects of the system. The design phase incorporates all the inputs from marketing, sales, customer service, and the technical community and then coagulates the ideas into a meaningful plan. This is then followed closely by implementation efforts, where the design is transformed into reality. The implementation of the design can be either physical, software, or both. The next phase involves the integration of the hardware or services into the existing network in a manner that enhances the performance of the network. The integration phase is followed by the operations and maintenance phase, where corrective and preventative maintenance is performed. The next phase is measuring the system against performance goals and making the necessary adjustments to improve the quality of the system. Last, the performance activities are fed back into the design phase for additional corrections and the process begins again.

The consideration of all system parts is essential in improving performance since any and every component of the network can influence overall performance. System performance improvements, therefore, are brought to fruition by good design practices, defined procedures and processes, and a continuous regimen of training for the existing technical staff.

Chapter 1 of this book is an introduction to wireless mobile and other wireless access platforms. Included in this chapter are overviews of a general cellular network, MTSO, cell site configurations, LMDS, 802.11, DSL, VoIP, and cable.

Chapter 2 addresses topics basic to radio frequency engineering. It covers modulation, propagation, receivers, antennas, transmitters, filters, ERP, link budgets, and tower-top amplifiers.

Chapter 3 focuses on the different wireless mobile technologies, including AMPS, IS-136, GSM, GPRS, IS-95, CDMA2000, iDEN, and CDPD.

Chapter 4 discusses the RF engineering design guidelines for AMPS, IS-136, GSM/GPRS, CDMA, and iDEN. This chapter goes over the requirements for design reviews, required signatures, design change orders, tracking mecha-

nisms, various design phases for a wireless mobile system, inbuilding and tunnel system guidelines, frequency planning, antenna selection and change, cell-site parameter setting and adjustment, and software and antenna system isolation calculations.

The performance aspects of an RF system and a network are covered in Chaps. 5 and 6. This is the area that tends to separate engineers into good, mediocre, and outright poor. These chapters focus on how you monitor and optimize the network on a continuous basis, and include recommended fixes that have worked, independent of vendor. Specific troubleshooting techniques are given in Chap. 5 related to AMPS, IS-136, CDMA, GSM, and iDEN systems.

Chapter 7 covers billing systems and their interaction with wireless mobile. Chapter 8 focuses on revenue assurance.

Chapter 9 addresses the important issue of which reports should be generated, how often, and who should be the recipient of each. A hierarchical approach to report generation is presented; for example, a report to an engineer should be different from the one a manager, director, or vice president uses. Reports that are discussed include network performance reports, RF performance reports, exception reports, reports for cross functional departments like operations engineering and construction, customer care reports, software configuration reports, and project reports (current and pending). Another focus of this chapter is meetings.

The methods and procedures needed to put together a network growth plan—specifically, what should be included, where you get the information, and how to actually do it, with a few examples—are covered in Chap. 10. Topics relating to circuit switch growth include defining the current growth of a switch's ports, CPU loading, subscriber database limits, and disaster recovery. Topics relating to cell-site growth include design criteria, frequency planning, physical equipment capacity, software loads, prioritization, and real estate acquisition.

Chapter 11 focuses on organization and training for an engineering department. It also suggests some basic resources and references for an engineering library.

The breadth and depth of the material contained in this book will greatly help the performance engineer, either used directly or augmenting existing knowledge, and we believe that we are doing our part to further the wireless engineering profession as it continues to mature and develop.

Acknowledgments

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*Clint Smith, P.E.
Curt Gervelis*

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