WIRELESS NETWORK DEPLOYMENTS

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WIRELESS NETWORK DEPLOYMENTS

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PREFACE

During the past decade, the wireless telecommunication industry's predominant source of income was cellular telephone service. At the start of the new millennium, data services are being perceived as complementing this prosperity. The cellular telephone market has grown exponentially during the past decade, and numerous companies in fierce competition to gain a portion of this growing market have invested heavily to deploy cellular networks. The main investment for deployment of a cellular network is the cost of the infrastructure, which includes the equipment, property, installation, and links connecting the Base Stations (BS). A cellular service provider has to develop a reasonable deployment plan that has a sound financial structure. The overall cost of deployment is proportional to the number of BS sites, and the income derived from the service is proportional to the number of subscribers, which grows in time. Service providers typically start their operation with a minimum number of sites requiring the least initial investment. As the number of subscribers grows, generating a source of income for the service provider, the investment in the infrastructure is increased to improve the service and capacity of the network to accept additional subscribers. A number of techniques have evolved to support the growth and expansion of cellular networks. These techniques involve methodologies to increase reuse efficiency, capacity, and coverage while maintaining the target quality of service (QoS) available to the subscriber.

Most of the available literature on wireless networks focusses on wireless access techniques, modem design technologies, radio propagation modeling, and design of efficient protocols for reliable wireless communications. These issues are related to the efficiency of the air interface to optimize the usage

of the available bandwidth and to minimize the consumption of power, consequently extending the lifetime of the batteries. An important aspect of wireless networks that has not received adequate attention is the deployment of the infrastructure. Most textbooks discuss the abstract mathematics employed in determining frequency reuse factors or the methodologies used in predicting radio propagation to determine the coverage of a radio system. The real issues faced in network deployments, which limit the theoretical capacity, coverage, voice quality, etc., or performance enhancements that take into account the current infrastructure, are not treated adequately. The objective of this book is to address this gap.

To visualize the complexity of a “green field” or an “overlay” deployment, one should first realize that (1) a wireless service provider’s largest investment is the cost of the physical site location (antenna, property, and maintenance), and (2) the deployment is an evolutionary process. The service provider starts with an available and potentially promising technology and a minimum number of sites to provide basic coverage to high-traffic areas. To support an increasing number of subscribers, a demand for increased capacity and better quality of service, the service provider also explores use of more sophisticated antennas (sectorized or smart), use of more efficient wireless access methods (TDMA or CDMA), and increasing the number of deployed sites and carriers. As a result, in addition to supporting the continual growth of user traffic with time, the service provider needs to be concerned about the impact of changes in the antenna, access technique, or number of sites on the overall efficiency and return on investment of the deployed network. All major service providers have a group or a division equipped with sophisticated and expensive deployment tools and measurement apparatus to cope with these continual enhancements made in the overall structure of the network.

In this book, we have invited a number of experts to write on a variety of topics associated with deployment of digital wireless networks. We have divided these topics into four categories, each constituting a part of the book. The first part, consisting of three chapters, provides an overview of deployment issues. Saleh Faruque of Metricom provides a step-by-step process for system design and engineering integration required in various stages of deployment. Jay Weitzen and Mark Wallace of NextWave Telecom address and compare the issues related to deployment of polarization diversity antenna systems with deployment of the classic two-antenna space diversity system. Michael Zhao, Yonghai Gu, Scott Gordon, and Martin Feuerstein of Metawave Communications Corp. examine the performance of deploying smart antenna architectures in cellular and PCS networks.

The next three parts of the book cover issues involved in deployment of CDMA, TDMA, and Wireless Data networks. The three chapters in Part II concern deployment of CDMA networks based on the IS-95 standard. Part II begins with a chapter by Vincent O'Byrne, Haris Stellakis, and Rajamani Ganesh of GTE that addresses the complex optimization of dual mode CDMA networks deployed in an overlaid manner over the legacy analog AMPS system. The second chapter, by Jin Yang of Vodafone AirTouch, discusses issues related to embedding a microcell to improve hot-spot capacity and dead-spot coverage in an existing macrocellular CDMA network. The last chapter in Part II, by Steven Gray and Giridhar Mandyam of Nokia Research Center in Texas, addresses detection and mitigation of intermodulation distortion in CDMA handset transceivers.

Part III deals with issues found in deployment of TDMA based networks. The first chapter, by Jerome Brouet, Vinod Kumar, and Armelle Wautier of Alcatel and Ecole Supérieure d'Electricité in France, develops the principle of hierarchical systems to meet the traffic demand in high density hot-spots and compares this technique with conventional methods used to enhance the capacity of TDMA networks. The second chapter in Part III, by R. Ramesh and Kumar Balachandran of Ericsson, derives a strategy to maximize the number of ANSI-136 users supported for a given number of AMPS users and considers reconfigurable transceivers at the base station to increase traffic capacity in a dual mode ANSI-136/AMPS network. The last chapter in Part III, by Anwar Bajwa of Camber Systemics Limited in UK, addresses the practical deployment of the frequency hopping feature in GSM networks to realize increased capacity with marginal degradation in QoS.

The final part, Part IV, of this book is devoted to Wireless Data Networks. Wireless data services are divided into (1) mobile data services, providing low data rates (up to a few hundred Kbps) with comprehensive coverage comparable to that of cellular telephones; and (2) Wireless LANs, providing high data rates (more than 1 Mbps) for local coverage and in-building applications. In the first chapter of Part IV, Hakan Inanoglu of Opuswave Network and John Reece and Murat Bilgic of Omnipoint Technologies Inc. discuss fixed deployment considerations of General Packet Radio Services (GPRS) as an upgrade to currently deployed networks and identify system performance for slow-moving and stationary terminal units. The last two chapters deal with deployment of wireless LANs (WLANs). Craig Mathias of Farpoint Group provides an overview of wireless LANs and talks about deployment issues related to placement of access points and interference management. The last chapter, by Anand Prasad, Albert Eikelenboom, Henri Moelard, Ad Kamerman and Neeli Prasad of Lucent Technologies in The

Netherlands, concentrates on coverage, cell planning, power management, security, data rates, interference and coexistence, critical issues for deploying an IEEE 802.11 based WLAN.

We graciously thank all the authors for their contributions and their help with this book, and we hope our readers will find the book's content both unique and beneficial.

Rajamani Ganesh

Kaveh Pahlavan