Chapter I
A Brief Overview of Wireless Systems and Standards

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ABSTRACT

This chapter provides a brief overview of wireless systems and standards. The evolution of wireless systems from voice-centric circuit-switched systems to data-centric packet-switched systems is discussed. The first- and second-generation wireless systems were designed primarily for voice service. The data rate supported by these systems is very limited. The 2.5G systems were developed to retrofit second-generation systems to support higher data rate applications. The third-generation systems are designed to meet the demands of the Internet era. A wide range of IP-based services is provided using these systems. IEEE 802.16 standard-based systems, commonly referred to as WiMAX, are being proposed as an alternative to third-generation systems for carrying data traffic. Popular wireless LAN and wireless PAN standards are also discussed.

INTRODUCTION

Wireless systems have been around for over a century. Guglielmo Marconi successfully transmitted Morse code from Cornwall, England to St-John's, Canada in 1901. The wireless technology has come a long way since then. The proliferation of Internet in every aspect of life resulted in rapid convergence of computing and communication industries fueling an explosive growth of wireless

communication in the mid-1990s. Now, mobile computing—the use of a portable computing device capable of wireless networking—is a reality. For example, today's PDAs and cell phones have the capability for Internet surfing. Consequently, one can use the PDAs and cell phones to do everything from stock trading to finding driving directions. WiFi enabled laptops allow the users to connect to Internet from WiFi hotspots, which are becoming ubiquitous. Emerging standards such as WiMAX aim to provide high-speed wireless data access from anywhere at anytime. This chapter describes various wireless standards that have made mobile computing a reality.

FIRST- AND SECOND-GENERATION CELLULAR SYSTEMS

The first-generation cellular systems, developed in the late 1970s, use analog modulation techniques. These systems are designed primarily to carry analog speech. Very low-rate data transmission is possible in these systems. The advance mobile phone service (AMPS) system, developed by AT&T Bell Labs, is an example of first-generation wireless systems. A good fraction of cellular systems currently deployed around the world are based on AMPS. For example, AMPS is still being used in some rural parts of the U.S.

Starting in the early 1990s, wireless operators started deploying second-generation cellular systems that use digital modulation (Yacoub, 2001). The second-generation systems use advanced digital-signal-processing algorithms to process signals. The transition to digital from analog allowed the second-generation cellular systems to offer higher capacity[1] than the first-generation analog systems. The second-generation systems offer services such as text messaging, also known as short message service (SMS), and circuit switched data (CSD), in addition to legacy voice service.

Some of the popular second-generation cellular systems include global system mobile (GSM), interim standard 136 (IS-136), and interim standard 95 (IS-95). The GSM system (Mouly, 1992) was originally designed and deployed in Europe to solve the fragmentation problems[2] of the first cellular systems in Europe. Now, GSM is the most widely deployed wireless system in the world, with deployments in Europe, Asia, Australia, South America, and some parts of the U.S. IS-136, the American counterpart of GSM, is a digital evolution of the first-generation AMPS system. It is often, albeit imprecisely, referred to as the TDMA standard since it uses time division multiple access (TDMA) air interface. However, it should be noted that many other standards, including GSM, use TDMA. The IS-136 systems are widely deployed in North America. IS-95, pioneered by Qualcomm, is the popular second-generation system based on code division multiple access (CDMA). It is also known as *cdmaOne*. These systems are in wide use in North America, South Korea, India, and China.

The second-generation cellular systems were rolled out before the dawn of the Internet era. Consequently, these systems are not efficient in carrying data: these systems transfer data with circuit switching, which is not as efficient as packet switching, used by systems of later generation. Furthermore, the data rate provided by these systems is very limited. For example, GSM systems provide a maximum data rate of 14.4 kbps.

EVOLUTION FROM SECOND GENERATION TO 2.5G

New 2.5G technologies were developed in an effort to retrofit the second-generation systems to be able to support the higher data rates that are required by modern Internet applications. These technologies enable cellular service providers to support features such as Web browsing,