



computer

A TOP-DOWN APPROACH
FEATURING THE INTERNET

networking

third edition

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THIRD EDITION

Computer Networking

A Top-Down Approach Featuring the Internet

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Wireless and Mobile Networks

In the telephony world, the past 10 years have arguably been the decade of cellular telephony. The number of worldwide mobile cellular subscribers increased from 34 million in 1993 to more than 1 billion in 2003; with the number of cellular subscribers now surpassing the number of main telephone lines [ITU Statistics 2004]. The many advantages of cell phones are evident to all—anywhere, anytime, untethered access to the global telephone network via a highly portable lightweight device. With the advent of laptops, palmtops, PDAs and their promise of anywhere, anytime, untethered access to the global Internet, is a similar explosion in the use of wireless Internet devices just around the corner?

Regardless of the future growth of wireless Internet devices, it's already clear that wireless networks and the mobility-related services they enable are here to stay. From a networking standpoint, the challenges posed by these networks, particularly at the data link and network layers, are so different from traditional wired computer networks that an individual chapter devoted to the study of wireless and mobile networks (i.e., *this* chapter) is appropriate.

We'll begin this chapter with a discussion of mobile users, wireless links and networks, and their relationship to the larger (typically wired) networks to which they connect. We'll draw a distinction between the challenges posed by the *wireless* nature of the communication links in such networks, and by the *mobility* that these wireless links enable. Making this important distinction—between wireless and

mobility—will allow us to better isolate, identify, and master the key concepts in each area. Note that there are indeed many networked environments in which the network nodes are wireless but not mobile (e.g., wireless home or office networks with stationary workstations and large displays), and limited forms of mobility that do not require wireless links (e.g., a worker who uses a wired laptop at home, shuts down the laptop, drives to work, and attaches the laptop to the company's wired network). Of course, many of the most exciting networked environments are those in which users are both wireless *and* mobile—for example, a scenario in which a mobile user (say in the back seat of car) maintains a voice-over-IP call and multiple ongoing TCP connections while racing down the autobahn at 160 kilometers per hour. It is here, at the intersection of wireless and mobility, that we'll find the most interesting technical challenges!

We'll begin by first illustrating the setting in which we'll consider wireless communication and mobility—a network in which wireless (and possibly mobile) users are connected into the larger network infrastructure by a wireless link at the network's edge. We'll then consider the characteristics of this wireless link in Section 6.2. We include a brief introduction to Code Division Multiple Access (CDMA), a shared-medium access protocol that is often used in wireless networks, in Section 6.2. In Section 6.3, we'll examine the link-level aspects of the IEEE 802.11 (Wi-Fi) wireless LAN standard in some depth; we'll also say a few words about Bluetooth. In Section 6.4 we provide an overview of cellular Internet access, including the emerging 3G cellular technologies that provide both voice and high-speed Internet access. In Section 6.5, we'll turn our attention to mobility, focusing on the problems of locating a mobile user, routing to the mobile user, and “handing off” the mobile user who dynamically moves from one point of attachment to the network to another. We'll examine how these mobility services are implemented in the mobile IP standard and in GSM, in Sections 6.6 and 6.7, respectively. Finally, we'll consider the impact of wireless links and mobility on transport-layer protocols and networked applications in Section 6.8.

6.1 Introduction

Figure 6.1 shows the setting in which we'll consider the topics of wireless data communication and mobility. We'll begin by keeping our discussion general enough to cover a wide range of networks, including both wireless LANs such as IEEE 802.11 and cellular networks such as a 3G network; we'll dive down into a more detailed discussion of specific wireless architectures in later sections. We can identify the following elements in a wireless network:

- ◆ *Wireless hosts.* As in the case of wired networks, hosts are the end-system devices that run applications. A **wireless host** might be a laptop, palmtop, PDA, phone, or desktop computer. The hosts themselves may or may not be mobile.

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