Chapter XVII
Wireless Networks Based on WiFi and Related Technologies

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ABSTRACT

Multihop wireless networks based on WiFi technology offer flexible and inexpensive networking possibilities. Applications of multihop wireless networks range from personal networks within consumer homes to citywide departmental networks to wide-area vehicular ad hoc networks. In this chapter, we focus on multihop ad hoc networks with communication among user devices and access points, where available, without the restriction that the user devices need to be within the radio range of access points. We first describe pure WiFi networks and their limitations. Next we discuss mixed networks based on WiFi and other wired and wireless technologies to provide robust city-scale networks. This chapter also explores security issues and vulnerabilities of wireless networks. An emerging application of WiFi ad hoc networks-RFID (radio frequency identification) networks based on the WiFi technology for warehouses and large retail stores-is presented. This chapter also presents another emerging application of WiFi-based networks: vehicular ad hoc networks for automobiles.

INTRODUCTION

Cellular and WiFi (wireless fidelity) are currently the most popular and actively pursued wireless technologies for consumer and business use. A cellular network consists of several base stations, each covering a small geographical region. Together the base stations cover a wide region such as a city. To be useful, the entire region of interest must be covered without gaps by these base stations. This requires billions of dollars of investment in network infrastructure consisting of wireless spectrum and base stations. An entirely different type of wireless network is made possible by the wireless fidelity (WiFi) technol-

ogy. This technology (based on the IEEE 802.11 standard (IEEE Computer Society LAN/MAN Standards Committee, 1999)) enables wireless communication on an ad hoc basis. In the simplest configuration, a wireless access point (denoted, *hotspot*) can be used to share an Internet connection among several tens of users in a small area such as a conference room or a coffee shop. The network connectivity is limited to the radio range (about 50 meters) of the hotspots, and communication among users must go through the access point. Such networks, called wireless local area networks (WLANs), are already extensively used by businesses and academic campuses. In this chapter, we focus on multihop ad hoc networks with communication among user devices and access points, where available, without the restriction that the user devices need to be within the radio range of access points.

The WiFi technology is inexpensive due to two factors: (a) the use of free, unlicensed radio spectrum at 2.4 GHz and 5.8 GHz bands obviates heavy investment in private, dedicated radio spectrum, and (b) the widespread use of WiFi equipped PDAs, laptops, and even phones provides significant business opportunities and justification for deploying ad hoc WiFi networks. Since all WiFi devices must comply with the IEEE standard, WiFi products from multiple vendors can be mixed and matched for seamless operation. This has driven the cost of individual WiFi devices low, which in turn, made deployment of WiFi-based networks covering medium to large areas an attractive and, even necessary, business investment.

In this chapter, we describe various trends in the design and deployment of wireless networks based on WiFi and other technologies (Gast, 2005; Macker & Corson, 1998; Murthy & Manoj, 2004). The rest of the chapter is organized as follows. The section "Ad Hoc Wireless Networks" describes pure WiFi networks and their limitations. "Mixed Wireless Networks" describes mixed networks based on WiFi and other wired

and wireless technologies to provide robust city-scale networks. "Security in Wireless Networks" describes security issues and vulnerabilities of wireless networks. "RFID Wireless Networks" describes an emerging application of WiFi ad hoc networks: RFID (radio frequency identification) networks based on the WiFi technology for warehouses and large retail stores. "Vehicular Ad Hoc Networks" describes another emerging application of WiFi-based networks: vehicular ad hoc networks for automobiles. The "Summary" section summarizes the chapter.

AD HOC WIRELESS NETWORKS

An ad hoc wireless network is an impromptu network formed by several wireless devices, such as PDAs, laptops, and phones, without relying on an existing network infrastructure (Perkins, 2000). These devices (denoted as nodes) may be mobile and use a common wireless technology such as WiFi. To facilitate communication among the nodes that are not directly in the radio range of one another, the other nodes act as intermediate routers, just like routers in the Internet. Such networks are useful in military combat situations, where a group of soldiers must be connected to exchange information, or in emergency rescue operations, where there is no network infrastructure or the existing infrastructure has been destroyed. Because of frequent topology changes due to node mobility and due to wireless interference, the existing networking software used for the Internet is not suitable for these ad hoc networks. Consequently, extensive research on routing protocols and transport protocols has been conducted to make ad hoc networks suitable for general-purpose use.

Routing protocols are broadly classified into proactive and reactive protocols. A proactive protocol keeps track of all possible routes within the ad hoc network, and disseminates routing information with others, periodically, or when-

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