Chapter 15
Teaching Wireless Network Fundamentals Using Low-Cost Wi-Fi Devices

Nurul I. Sarkar
Auckland University of Technology, New Zealand

ABSTRACT
Teaching wireless networking fundamentals is often difficult because many students appear to find the subject technical, and dry when presented in traditional lecture format. To overcome this problem, we provide an opportunity for experiential learning where students can learn wireless networking fundamentals by hands-on practical activities using low-cost Wi-Fi (wireless fidelity) devices such as wireless cards and access points. Students can easily set up and configure networks using wireless cards and access points more effectively. By measuring network performance such as throughput and end-to-end delays, students are able to gain a deeper understanding of wireless networking. The effectiveness of Wi-Fi-based practical activities has been evaluated by students and the teaching team. This chapter reports on the overall effectiveness of teaching and learning of wireless network using radially available low-cost Wi-Fi cards and access points.

INTRODUCTION AND MOTIVATION
Wireless networks are gaining in popularity, both in business and in home networking applications (Hiertz et al., 2010; Sarkar, 2014; Sarkar, Kuang, Nisar, & Amphawan, 2015a; Sarkar, Kuang, Nisar, & Amphawan, 2014; Verma, Fakharzadeh, & Sung Hyun, 2013; Yun, 2012). Due to the huge growth of mobile applications and technologies, the popularity of wireless networking is continuing worldwide. It is therefore important that undergraduate networking students should be exposed to wireless network fundamentals as part of the tertiary curriculum.

Many students find that understanding the key concept of wireless networking is often difficult because they find the topic full of technical jargon, and dry when presented. Research has shown that students learn computer networks better, and feel more engaged with their courses if they are given hands-on
experience that illustrates theoretical concepts (Kumar, Fernando, & Panicker, 2013; Lim, Jang, & Sichtitiu, 2015; Muoka, Haque, Gargoom, & Negnevitsky, 2015; Qinran, Fangxing, & Chien-fei, 2015). The apparently overwhelming complexity of the underlying concepts of wireless often intimidates students. This perception can easily discourage the students from learning in-depth this otherwise exciting and rewarding subject.

This chapter addresses some of the issues and challenges about student learning of introductory wireless networking courses and provides hands-on learning activities using Wi-Fi gear such as wireless cards and access points (APs). It provides a tutorial to guide students in setting up networks using relatively cheaper Wi-Fi cards and access points (APs). Although a variety of problems are to be expected, given the technical limitations of commercially available network hardware, students are encouraged to gain a hands-on practical learning experience in setting up and configuring Wi-Fi networks. The chapter also reports on the effectiveness of student learning and comprehension using Wi-Fi based learning.

Wi-Fi technologies are rapidly expanding over the last few years. To meet the users demand for high performance Wi-Fi, 802.11n has been standardized by IEEE committee in 2009. The 802.11n working group has focused on increasing network throughput and the overall system capacity (IEEE 802.11n-2009 Amendment 5: Enhancements for Higher Throughput). Prasad and Prasad (2002) highlighted the potential applications of Wi-Fi such as teleconferencing, tele-surveillance, and video-on-demand operating on wireless network backbones. Further developments in network capacity and reliability will push these technologies to be used as next generation wireless networks (Ray, Sarkar, Deka, & Ray, 2015; Sarkar, Kuang, Nisar, & Amphawan, 2015b; Thompson et al., 2014).

The further research and development in high-speed Wi-Fi networking will open an opportunity for students to gain a thorough knowledge and understanding of the technology (IEEE 802.11ac). An overview of the Wi-Fi technology is presented to help students to develop better understanding and significance of Wi-Fi networking from a technical point of view. While Wi-Fi brings many benefits to corporate and home network users, the four main benefits of Wi-Fi are highlighted as follows.

- **Mobility**: Wi-Fi can provide users with real-time information within the organization without the restrictions inherent with physical connections.

- **Flexibility**: The W-Fi installation does not involved the tedious work of pulling cables through walls and ceilings. It allows access from places unreachable by network cables.

- **Cost**: Overall the installation cost of Wi-Fi is lower than wired networks. The discrepancy is even higher in dynamic environments requiring frequent moves and changes.

- **Scalability**: W-Fi can be configured relatively easily because there is no physical network cables are required.

Although wireless networks may never completely replace wired networks, they will gain in importance as business assets in recent years. Many network researchers report that wireless networks for mobile Internet access are becoming big business and is also indicated by the rising number of wireless internet service providers in the United States and the rest of the world (Comer, 2014; Kurose & Ross, 2013; Theoleyre et al., 2015). The increasing use of public hotspots also opens the possibility of providing continuous connection to a roaming business traveler (Vaughan-Nichols, 2003).
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