Guide to Wireless Communications 4th edition Olenewa Solutions Manual

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Chapter 1

Introduction to Wireless Communications

At a Glance

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Lecture Notes

Overview

This chapter serves as an introduction to wireless communication technologies. Several different types of wireless networks are discussed. Students will also learn about the advantages and disadvantages of wireless technology.

Chapter Objectives

After reading this chapter and completing the exercises, the student will be able to:

- Describe the various types of wireless communications technologies used today
- Discuss some trends in wireless data communications
- Outline the advantages and challenges of wireless communications technology

Teaching Tips

How Wireless Technology Is Used

1. Give an overview of how wireless technology is used in the modern world, and define wireless communications as the transmission of data without the use of a physical medium.

Wi-Fi (Wireless LAN)

1. The Wi-Fi term should be explained as another way to indicate a wireless LAN network.

2. Provide students with examples of uses for a wireless network, such as with Voice over Internet Protocol (VoIP).
3. Define a wireless local area network (WLAN) as an extension of a wired LAN, which allows devices with wireless NICs to connect through a wireless access point (AP).

4. Introduce the IEEE 802.11n-2009, or IEEE 802.11n, as a recent WLAN standard that can offer up to 600 Mbps transmission speed. Note that typical network speeds are much slower than this, and discuss some of the ranges 802.11n is capable of.

5. Note that smartphones, tablets, and laptop computers have come to rely on Wi-Fi networks for network connectivity, but point out that many of these devices have mobile broadband connectivity.

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Bluetooth

1. Introduce the Bluetooth technology, and describe its role in providing short range data communication between devices.

2. Define radio modules as small transceivers used by wireless devices to communicate with low-power usage.

3. Explain how the Bluetooth link manager works to identify and establish communications with other Bluetooth devices.

4. Discuss some of the devices that use Bluetooth to connect to other devices.

5. Introduce students to iBeacon, which was originally developed by Apple. Discuss how iBeacon uses Bluetooth transmitters to assist retailers in delivering coupons and offers to loyal customers.

6. Describe a piconet as a type of wireless personal area network (WPAN), and use the connection between multiple Bluetooth devices as an example of this type of network.

Teaching Tip	Bluetooth is commonly used for game system controllers, keyboards and mice, and other peripherals.

ZigBee

1. Explain that ZigBee is a wireless communications specification based on IEEE standard 802.15.4, intended for short-range transmissions.

2. Discuss some implementations of ZigBee devices, such as home automation, commercial building automation, medical data collection, smoke detectors, and security systems.

WiGig

1. Discuss other short range wireless technologies used for data transmission, and specifically introduce the WiGig technologies. Students should be aware of the types of data that WiGig is capable of handling, as well as max transmission speeds.

2. Explain how the Ultra Wide Band (UWB) radio technology can be used with the WiGig technologies.

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RFID and NFC

1. Define Radio Frequency Identification (RFID) as a technology similar in use to barcode labels that allows the use of RF waves to read product codes.

2. Describe how RFID utilizes information stored in electronic tags, and educate students on the construction of this tag, which contains an antenna and an integrated circuit chip.

3. Describe how readers (or interrogators) can retrieve data from RFID tags.

4. Point out that one of the most common uses for RFID today is for inventory control.

5. Define Near Field Communications (NFC) as a technology used by mobile devices such as smartphones or tablets to provide very short range wireless communication, which is activated automatically when two devices are brought within 2 to 4 inches of each other.

Wireless Metropolitan Area and Wide Area Networks

Satellite Networks

1. Outline how satellite networks provide wireless connectivity using repeaters and earthbound transmitters.

2. Point out that the Global Positioning System (GPS) is based on satellite technology.

Cellular Networks

1. Explain the concept of a cellular network, which uses cells to handle multiple users at a time.

2. Discuss how most smartphones allow wireless tethering, which creates a Wi-Fi hotspot that allows other wireless devices to connect to the Internet.

3. Describe the 4G (fourth generation) data transmission technology, and compare its speeds to the previous generation, 3G.

4. Explain a wireless wide area network (WWAN) as a network for cellular or mobile devices.

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Fixed Broadband Wireless

1. Explain that fixed broadband wireless was originally intended for communications between fixed points like buildings or towers, however the IEEE 802.16 standard include an amendment for mobile communications as well.

2. Discuss how optical fiber is used in high-speed communications, such as T1s, but also point out that fiber is incredibly expensive.

3. Teach students about cable modems and Digital Subscriber Lines (DSL), and explain how each uses a different access medium (cable service or telephone) to connect to the Internet.

4. Define a wireless metropolitan area network (WMAN) as a wireless network that typically spans different areas within a city, often within a limited area of about 25 square miles.

5. List the IEEE 802.16 WiMAX Fixed Broadband Wireless standard as an example of a WMAN standard, and discuss some of the transmission speeds available.

Teaching Tip	Both DSL and cable technologies have the advantage of being able to use pre-existing cable plant, since most homes have access to phone or cable television services.

The Wireless Landscape

1. List some different wireless technologies, their ranges, and their typical transmission speeds. Use Figure 1-4 in your discussion.

Quick Quiz 1

1. What is the name given to a small network that consists of Bluetooth devices communicating with each other?
   Answer: piconet

2. True or False: The use of RFID tags requires large amounts of bandwidth and significant power.
   Answer: False

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3. Which component emits electromagnetic waves that produce a small amount of current in an RFID tag antenna?
   A. RFID frequency
   B. RFID interrogator
   C. NFC reader
   D. NFC tag
   Answer: B

4. What is the central device in a wireless network called?
   A. Wireless Switch
   B. Access Switch
   C. Access Point
   D. Wireless Point
   Answer: C

5. In satellite based communications, where is the repeater located?
   A. On a tower
   B. On a receiver
   C. On an access point
   D. On a satellite
   Answer: D

Digital Convergence and Future Trends

1. Explain how digital convergence occurs when devices gain the ability to perform multiple functions and fulfill different roles at any given moment, depending on the needs of a user.

2. Provide details on some future applications for wireless networking technologies.

Wireless Advantages and Challenges

Advantages of Wireless Networking

1. Describe to students how wireless networking has increased the mobility of those who use it, and explain how increased mobility can assist productivity.

2. Emphasize that wireless networking has a cost and time advantage when compared to the process of installing a wired network.

3. Explain how reliability can be increased by the use of a wireless network, in that it reduces the possibility of failure caused by physical defects.

4. The use of wireless networks for quickly restoring network connectivity for business and emergency communications should be covered.

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Disadvantages of Wireless Networking

1. Explain how radio signal interference can prevent a wireless network from functioning properly, and list typical sources of signal interference, such as from wireless phones or machinery.

2. Give students information on the difficulty of securing wireless signals from interception, and preventing outside intruders from gaining access to a network.

3. Discuss what health risks may exist from the use of wireless devices, and detail what studies have been performed on the dangers of RF exposure.

Teaching Tip	Other wireless networks can be a source of wireless interference. This can cause problems, because without coordination, several wireless networks in a single area may end up using less than optimal settings.

Quick Quiz 2

1. Devices that use which technology are often used for managing home environment settings, such as temperature or lights within the home?
   A. ZigBee
   B. RFID
   C. hotspot
   D. NFC
   Answer: A

2. True or False: Even when using cables to connect network devices, interference form fluorescent light fixtures and electric motors can sometimes disrupt the transmission of data.
   Answer: True

3. What term refers to the power of digital devices to combine voice, video, and text-processing capabilities as well as to be connected to business and home networks and to the Internet.
   Answer: digital convergence

4. True or False: Bluetooth, WLAN 802.11b/g/n, and ZigBee devices all operate in different radio frequencies.
   Answer: False

5. What can be worn by a cell phone user while talking on a cellular device to alleviate the danger of any adverse health effects caused by using a cell phone?
   Answer: headset

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Class Discussion Topics

1. Have students discuss what they use wireless technology for. Students will most likely have some experience with wireless devices they may own.

2. Get students to research how RFID tags are being used in conjunction with inventory management systems. They should note some of the different kinds of RFID tags in use.

Additional Projects

1. Task students with researching some of the studies done on the health effects of RF signal exposure. Have students record what actions other nations have taken in response to potential health effects.

2. Encourage students to research wireless usage in other fields not mentioned in this chapter. For example, how does NASA utilize wireless technology in communication with space objects or probes?

Additional Resources

1. ZigBee Technology Tutorial:
   http://www.radio-electronics.com/info/wireless/zigbee/zigbee.php

2. Additional info on how mobile broadband services work:
   http://computer.howstuffworks.com/mobile-broadband-service.htm

Key Terms

- **3G (third generation)** A digital cellular technology that can send data at up to 21 Mbps over the cellular telephone network.
- **4G (fourth generation)** A digital cellular technology that can transmit and receive data at theoretical speeds up to 20 Mbps when users are moving fast and up to 150 Mbps (theoretically) when users are moving slowly or are stationary.
- **Bluetooth** A wireless standard that enables devices to transmit data at up to 721.2 Kbps over a typical maximum distance of 33 feet. Bluetooth can transmit data farther, but devices that can use this capability are rare.
- **cable modem** A technology used to transmit data over a television cable connection.
- **digital convergence** The power of digital devices such as desktop computers and wireless handhelds to combine voice, video, and text-processing capabilities as well as to be connected to business and home networks and to the Internet.
- **digital subscriber line (DSL)** A technology used to transmit data over a telephone line.

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- **fixed broadband wireless** A group of wireless technologies intended for communications between fixed points such as buildings or communication towers.
- **IEEE 802.16 (WiMAX)** A set of standards for fixed and mobile broadband wireless communications that allows computers to communicate at up to 75 Mbps and at distances of up to 35 miles (56 kilometers) in a point-to-point configuration. This set of standards also allows the use of both licensed and unlicensed frequencies.
- **Institute of Electrical and Electronics Engineers (IEEE)** A nonprofit organization that creates standards related to electrical and electronics products and devices that are adopted by manufacturers worldwide. IEEE's core purpose is to foster technological innovation and excellence for the benefit of humanity.
- **near field communication (NFC)** A technology similar and sometimes compatible with RFID that can store data that can be used to configure and activate a connection between two devices over Bluetooth or Wi-Fi. NFC tags are similar to RFID tags and can also store web addresses and may contain commands to be executed by a smartphone or tablet, such as opening a web browser and automatically entering an address
- **link manager** Special software in Bluetooth devices that helps identify other Bluetooth devices, creates the links between them, and sends and receives data.
- **optical fiber** A glass strand, about the thickness of a human hair, that carriers data signals encoded in a laser beam.
- **piconet** A small network composed of two or more Bluetooth devices that are exchanging data with each other.
- **radio frequency identification (RFID)** A technology developed to replace barcodes that uses small tags placed on product packaging and boxes that can be remotely activated and read by sensors. The data about the product is then transferred directly to an information processing system for inventory control, location tracking, and item counting.
- **radio module** Small radio transceiver built onto microprocessor chips and embedded into Bluetooth devices, which enable them to communicate.
- **repeater** A device commonly used in satellite communications that simply "repeats" the signal to another location.
- **RFID reader or RFID interrogator** A device that emits electromagnetic energy to power a typical RFID tag and can transmit to and read the data stored in the tag's memory.
- **RFID tag Device** embedded in or attached to an object that contains a chip and antenna. The chip is powered by the energy emitted by an RFID reader and can then transmit information contained in its memory back to the reader.
- **smartphone** A device that combines a cellular phone with the capabilities of a personal digital assistant (PDA). These devices provide the user with the ability to enter appointments in a calendar, write notes, send and receive email, play games, watch videos, and browse websites, among other functions.
- **smartwatch** Device that functions as a regular watch but also connects via Bluetooth to the owner's smartphone. Some of these devices can run applications that link directly to the same app on the smartphone, while others only display email messages, notifications, and calls from the smartphone. A few models are equipped with speakers and microphones that allow you to answer a call without having to use the smartphone

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and others give you the ability to respond to text messages using your voice, directly from the watch.

- **T1** An older wired technology used to transmit data over special telephone lines at 1.544 Mbps.
- **Ultra Wide Band (UWB)** A wireless communications technology that allows devices to transmit data at hundreds of megabits or even gigabits per second at short distances—up to 6 feet (2 meters) at the higher speeds and up to 150 feet (50 meters) at lower speeds.
- **USB** A common way of connecting peripherals such as flash drives, Wi-Fi NICs, printers, and other peripherals to a computer. Stands for Universal Serial Bus.
- **Voice over Internet Protocol (VoIP)** A technology that allows voice telephone calls to be carried over the same network used to carry computer data.
- **Wi-Fi** A certification label awarded to IEEE 802.11 WLAN-compatible wireless devices that pass all interoperability tests performed by an organization called the Wi-Fi Alliance. The acronym is often thought to stand for Wireless Fidelity, but this is a common misconception. The name was chosen by the alliance purely for marketing reasons and is not an acronym at all.
- **Wi-Fi hotspot** A public Wi-Fi network that is available at many stores, coffee shops, auto repair shops, fast-food outlets, etc., for use by its customers. Individuals can also use some smartphones to create a private Wi-Fi hotspot.
- **WiGig** A specification for connecting computers, communication, and entertainment devices over short ranges, using the 60 GHz band at multi-gigabit speeds, developed by an alliance of companies.
- **wireless access point (wireless AP or just AP)** A device that receives the signals and transmits signals back to wireless network interface cards (NICs), typically in a WLAN. APs connect wireless devices to a wired network such as the Internet.
- **wireless communications** Generally refers to any type of communications that does not require the use of wires or cables. In this sense, smoke signals and police radio may be understood as forms of wireless communications, but for the purpose of this book, wireless communications is defined as the wireless transmission of digital data while connected to some type of network.
- **wireless local area network (WLAN)** A local area network that is not connected by wires but instead uses wireless technology. Its range extends to approximately 330 feet (100 meters) and has a data rate of 600 Mbps and higher. Today's WLANs are based on EEE 802.11a/b/g/n/ac/ad standards.
- **wireless metropolitan area network (WMAN)** A wireless network that covers a large geographical area such as a city or suburb. The technology is usually based on the IEEE 802.16 (WiMAX) set of standards and can span an entire city, covering distances of up to 35 miles (56 kilometers) between transmitters and receivers or repeaters.
- **wireless network interface card (wireless NIC)** A device that connects to a computer or other digital device to transmit and receive network data over radio waves. It includes an antenna for wireless communication between networked devices.
- **wireless personal area network (WPAN)** A very small network that typically extends to 33 feet (10 meters) or less. Due to its limited range, WPAN technology is used mainly as a replacement for cables. See also piconet and Ultra Wide Band.

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- **wireless residential gateway (often called a wireless router)** Device used to set up a Wi-Fi network in a home or small office. These devices are used to connect a home or small office to the Internet and are often supplied by the service provider, integrated with a cable modem.
- **wireless wide area network (WWAN)** A WAN that uses cellular phone technologies and encompasses any geographical region, including the entire globe.
- **ZigBee** A specification based on IEEE 802.15.4 developed by the ZigBee Alliance, an organization that creates protocols and specifications for devices used for home automation that can wirelessly control lighting, as well as security and energy systems, in homes and industries.

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Chapter 1

Review Questions

1. Ultra Wide Band transmission technology is used primarily for _____.
   a. displaying webpages on a cellular phone
   b. connecting devices installed close together at very high speeds
   c. finding the location of a car within a city
   d. transmitting data at distances of up to 35 miles
2. Bluetooth devices communicate using small radio transceivers called _____ that are built onto microprocessor chips.
   a. receivers
   b. transponders
   c. radio modules
   d. link managers
3. ZigBee devices transmit data at rates of up to _____.
   a. 250 kbps
   b. 1 Mbps
   c. 721.3 kbps
   d. 3 Mbps
4. IEEE 802.11n equipped devices can be as far as 375 feet (114 meters) apart and can send and receive data at rates over _____ Mbps, accordng to the IEEE standard.
   a. 75
   b. 600
   c. 100
   d. 54
5. Each Bluetooth device uses a _____, which is a special software that helps identify other Bluetooth devices.
   a. frame
   b. link manager
   c. repeater
   d. bridge
6. Bluetooth can send data through physical barriers, like walls. True or False?
7. Bluetooth devices can transmit at maximum data at rates 75 Mbps. True or False?
8. A wireless network interface card performs basically the same functions and looks similar to a traditional network interface (NIC) card. True or False?
9. An Earth station transmits to a satellite at one frequency, and the satellite regenerates and transmits the signal back to Earth on the same frequency. True or False?
10. Eliminating cable installation costs is a advantage of a wireless technogies. True or False?
11. The automatic connection between various Bluetooth devices creates a network called a(n) _____.
    a. micronet
    b. small net
    c. piconet

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d. Intranet

12. 4G (fourth generation) cellular technology allows data connections at a maximum rate of over _____ in fast-moving vehicles.
    a. 2 Mbps
    b. 1 Gbps
    c. 20 Mbps
    d. 100 Mbps
13. An 802.11 wireless NIC, when configured to communicate with a wired network, sends its signals through invisible radio waves to _____.
    a. another computer directly
    b. an access point
    c. a wireless server
    d. the Internet
14. _____ is a wireless technology that can be used for data communications and transmit as far as 35 miles.
    a. Wi-Fi
    b. Microwave
    c. WiGig
    d. WWAN
15. How can a ZigBee network be extended beyond its maximum range?
    a. By using network cables
    b. It can't, you would have to use Wi-Fi or another kind of wireless network.
    c. ZigBee devices can pass information through to other devices.
    d. By installing a ZigBee AP
16. Explain the role of an access point (AP) in a WLAN. APs connect wireless networks to the wired infrastructure (or network).
17. Describe the difference between WPANs, WLANs, WMANs, and WWANs with a single word. Distance or range.
18. What could you use a WLAN for, in a classroom setting? For Internet access, to display the class presentation content, to allow students to answer short quizzes, and a large number of other uses.
19. Pick one of the types of wireless networks described in this chapter, and describe how it can reduce installation time. Wi-Fi dramatically reduces or completely eliminates the need for installing and routing cables. It also allows for desks to be moved without the need for moving the cabling infrastructure.
20. Write a paragraph about how implementing a wireless network can be helpful in case of disaster recovery. Answers will vary.

Chapter 2

Review Questions

1. Which range of the electromagnetic spectrum is less susceptible to interference from sources of visible light?
    a. ultraviolet

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