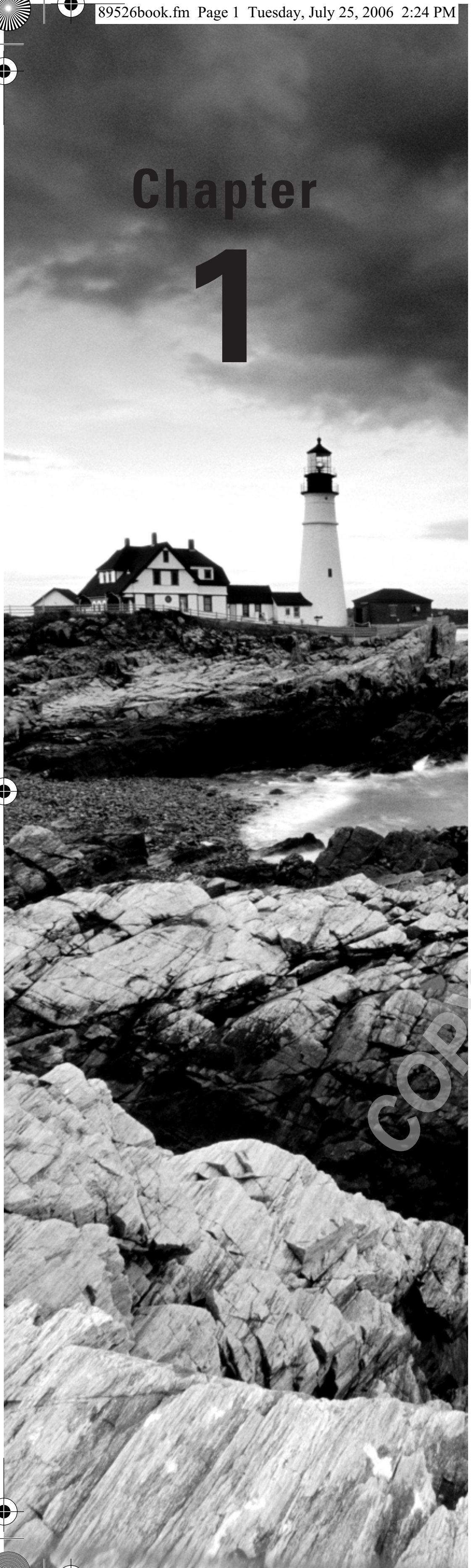


Chapter 1

Overview of Wireless Standards and Organizations

IN THIS CHAPTER, YOU WILL LEARN ABOUT THE FOLLOWING:

✓ **Standards Organizations**

- Federal Communications Commission
- International Telecommunication Union Radiocommunication Sector
- Institute of Electrical and Electronics Engineers
- Wi-Fi Alliance

✓ **Communications Fundamentals**

Learning a new technology can seem like a daunting task. There are so many new acronyms, abbreviations, terms, and ideas to become familiar with. One of the keys to learning any subject is to learn the basics. Whether you are learning to drive a car, fly an airplane, or install a wireless computer network, there are basic rules, principles, and concepts that, once learned, provide the building blocks for the rest of your education.

IEEE 802.11, also referred to as Wireless Fidelity (Wi-Fi), is the standard for providing local area network (LAN) communications using radio frequencies (RF). IEEE 802.11 is actually a group of standards that work together to provide wireless networking. There are numerous standards organizations and regulatory bodies that help govern and direct the IEEE 802.11 technology and industry. Having an understanding of these different organizations can help provide you with insight as to how IEEE 802.11 functions, and sometimes even how and why the standards have evolved the way they have.

As you become more knowledgeable about wireless networking, you may want to or need to read some of the standards that are created by the different organizations. Along with the information about the standards bodies, this chapter includes a brief overview of their documents.

In addition to reviewing the different standards organizations that guide and regulate Wi-Fi, this chapter will review some fundamentals of communications and data keying that are not part of the CWNA exam but may help you better understand wireless communications.

Identifying Standards Organizations

Each of the standards organizations discussed in this chapter help to guide a different aspect of the wireless networking industry.

The International Telecommunication Union Radiocommunication Sector (ITU-R) and local entities such as the Federal Communications Commission (FCC) set the rules for what the user can do with a radio transmitter. Frequencies, power levels, and transmission methods are managed and regulated by these organizations. These organizations work together to help guide the growth and expansion that is being demanded by wireless users.

The Institute of Electrical and Electronics Engineers (IEEE) creates standards for compatibility and coexistence between networking equipment. The IEEE standards must adhere to the rules of the communications organizations, such as the FCC.

The Wi-Fi Alliance performs certification testing to make sure wireless networking equipment conforms to IEEE standards.

The International Organization for Standardization (ISO) created the Open Systems Interconnection (OSI) model, which is an architectural model for data communications.

We will look at each of these organizations in the following sections.

Federal Communications Commission (FCC)

To put it simply, the *Federal Communications Commission (FCC)* regulates communications to and from the United States. The task of the FCC in wireless networking is to regulate the radio signals that are used for wireless networking. The FCC is an independent United States government agency that is answerable to the United States Congress. It was established by the Communications Act of 1934 and is responsible for regulating interstate and international communications by radio, television, wire, satellite, and cable. The FCC's jurisdiction covers all of the 50 states, the District of Columbia, and U.S. possessions. Most countries have governing bodies that function similarly to the FCC.

The FCC and the respective controlling agencies in the other countries typically regulate two categories of wireless communications: licensed and unlicensed. Whether the wireless communications is licensed or unlicensed, the user is still regulated on what they can do. The difference is that unlicensed users do not have to go through the license application procedures before they can install a wireless system. Both licensed and unlicensed communications are typically regulated in the following five areas:

- Frequency
- Bandwidth
- Maximum power of the intentional radiator
- Maximum equivalent isotropically radiated power (EIRP)
- Use (indoor and/or outdoor)

Essentially, the FCC and other regulatory bodies set the rules for what the user can do regarding the RF transmissions. From there, the standards organizations create the standards to work within these guidelines. These organizations work together to help meet the demands of the fast growing wireless industry.

The FCC rules are published in the Code of Federal Regulations (CFR). The CFR is divided into 50 titles that are updated yearly. The title that is relevant to wireless networking is Title 47, *Telecommunications*. Title 47 is divided into many parts; Part 15, "Radio Frequency Devices," is where you will find the rules and regulations regarding wireless networking related to 802.11. Part 15 is further broken down into subparts and sections. A complete reference will look like 47CFR15.3.

NOTE

More information can be found at `www.fcc.gov` and `wireless.fcc.gov`.

International Telecommunication Union Radiocommunication Sector (ITU-R)

A global hierarchy exists for management of the RF spectrum worldwide. The United Nations has tasked the *International Telecommunication Union Radiocommunication Sector (ITU-R)* with global spectrum management. The ITU-R maintains a database of worldwide frequency assignments and coordinates spectrum management through five administrative regions.

The five regions are broken down:

Region A: North and South America Inter-American Telecommunication Commission (CITEL)

`www.citel.oas.org`

Region B: Western Europe European Conference of Postal and Telecommunications Administrations (CEPT)

`www.cept.org`

Region C: Eastern Europe and Northern Asia Regional Commonwealth in the field of Communications (RCC)

`www.rcc.org`

Region D: Africa African Telecommunications Union (ATU)

`www.atu-uat.org`

Region E: Asia and Australasia Asia-Pacific Telecommunity (APT)

`www.aptsec.org`

Within each region, local government RF regulatory bodies such as the following manage the RF spectrum for their respective countries:

- Australia, Australian Communications Authority (ACA)
- Japan, Association of Radio Industries and Businesses (ARIB)
- New Zealand, Ministry of Economic Development
- United States, Federal Communications Commission (FCC)

NOTE More information about the ITU-R can be found at `www.itu.int/ITU-R/`.

Institute of Electrical and Electronics Engineers (IEEE)

The *Institute of Electrical and Electronics Engineers*, commonly known as the *IEEE*, is a global professional society with over 350,000 members. The IEEE's mission is to "promote the engineering process of creating, developing, integrating, sharing, and applying knowledge about electro and information technologies and sciences for the benefit of humanity and the profession." To networking professionals, that means creating the standards that we use to communicate.

The IEEE is probably best known for its LAN standards, the IEEE 802 project.

NOTE: The 802 project is one of many IEEE projects; however, it is the only project that will be addressed in this book.

IEEE projects are subdivided into working groups to develop standards that address specific problems or needs. For instance, the IEEE 802.3 working group was responsible for the creation of a standard for Ethernet, and the IEEE 802.11 working group was responsible for creating the wireless standard. The numbers are assigned as the groups are formed, so 11 was assigned to the wireless group since it was the 11th working group that was formed under the IEEE 802 project.

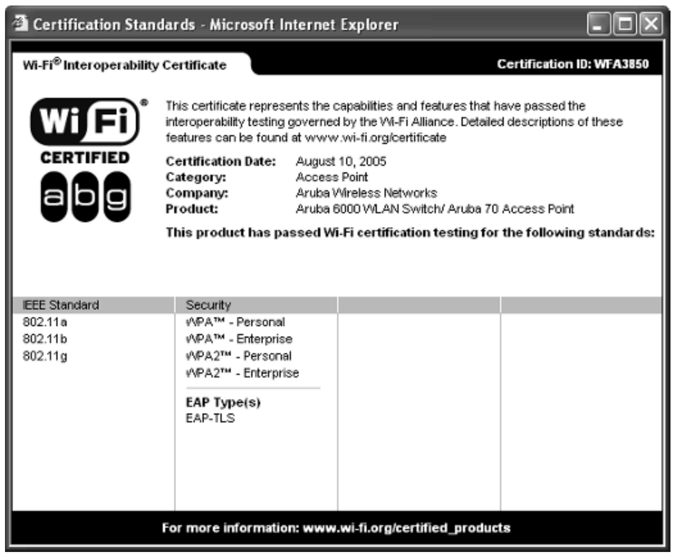
As the need arises to revise existing standards created by the working groups, task groups are formed. These task groups are assigned a sequential single letter (multiple letters are assigned if all single letters have been used) that is added to the end of the standard number (for example, 802.11a, 802.11g, and 802.3af). Some letters such as *o* and *l* are not assigned. This is done to prevent confusion with the numbers 0 and 1. Other task group letters may not be assigned to prevent confusion with other standards. For example, 802.11x has not been assigned because it can be easily confused with 802.1X and because 802.11x has become a common casual reference to the 802.11 family of standards.

NOTE: More information can be found at `www.ieee.org`.

It is important to remember that the IEEE standards, like many other standards, are written documents describing how technical processes and equipment should function. Unfortunately, this often allows for different interpretations when the standard is being implemented, so it is common for early products to be incompatible between vendors, as was the case with the early 802.11 products.

Wi-Fi Alliance

The *Wi-Fi Alliance* is a global, nonprofit industry trade association with over 200 member companies. The Wi-Fi Alliance is devoted to promoting the growth of wireless LANs (WLANs). One of the Wi-Fi Alliance's primary tasks is to ensure the interoperability of WLAN products by providing certification testing. During the early days of the 802.11 standard, the Wi-Fi Alliance further defined it and provided a set of guidelines to assure compatibility between different vendors. Products that pass the Wi-Fi certification process receive a Wi-Fi Certified certificate:



The Wi-Fi Alliance was founded in August 1999 and was known as the Wireless Ethernet Compatibility Alliance (WECA). In October 2002, the name was changed to what it is now, the Wi-Fi Alliance.

The Wi-Fi Alliance has certified over 1,500 Wi-Fi products for interoperability since testing began in April 2000. Certification includes three categories:

Wi-Fi products based on IEEE radio standards 802.11a, 802.11b, 802.11g in single-mode, dual-mode (802.11b and 802.11g), and multiband (2.4 GHz and 5 GHz) products

Wi-Fi wireless network security Wi-Fi Protected Access (WPA), Personal and Enterprise; Wi-Fi Protected Access 2 (WPA2), Personal and Enterprise

Support for multimedia content over Wi-Fi networks Wi-Fi Multimedia (WMM)

It is important to note that the Wi-Fi Alliance's WPA2 security standard mirrors the IEEE's 802.11i security standard. Additionally, the Wi-Fi Alliance's WMM standard mirrors the IEEE's 802.11e Quality of Service (QoS) standard.

NOTE

More information can be found at `www.wi-fi.org`. Several white papers from the Wi-Fi Alliance are also included on the CD.

International Organization for Standardization

The *International Organization for Standardization*, commonly known as the *ISO*, is a global, nongovernmental organization that identifies business, government, and society needs and develops standards in partnership with the sectors that will put them to use. The ISO is responsible for the creation of the Open Systems Interconnection (OSI) model, which has been a standard reference for data communications between computers since the late 1970s.

The OSI model is the cornerstone of data communications, and learning to understand it is one of the most important and fundamental tasks a person in the networking industry can undertake.

The layers of the OSI model are as follows:

- Layer 7, Application
- Layer 6, Presentation
- Layer 5, Session
- Layer 4, Transport
- Layer 3, Network
- Layer 2, Data-Link
- Layer 1, Physical

NOTE

You should have a working knowledge of the OSI model for both this book and the CWNA exam. Make sure you understand the seven layers of the OSI model and how communications take place at the different layers. If you are not comfortable with the concepts of the OSI model, spend some time reviewing it on the Internet or from a good networking fundamentals book prior to taking the CWNA test.

NOTE

More information can be found at `www.iso.org`.

Why Is It ISO and not IOS?

ISO is not a mistyped acronym. It is actually a word derived from the Greek word *isos*, meaning *equal*. Since acronyms can be different from country to country due to varying translations, the ISO decided to use a word instead of an acronym for its name. With this in mind, it is easy to see why a standards organization would give itself a name that means equal.

Communications Fundamentals

Although the CWNA certification is considered one of the entry-level certifications in the Certified Wireless Network Professional (CWNP) wireless certification program, it is by no means an entry-level certification in the computing industry. Most of the candidates for the CWNA certificate have experience in other areas of information technology. However the background and experience of these candidates varies greatly.

Unlike professions for which knowledge and expertise is learned through years of structured training, most computer professionals have followed their own path of education and training.

When people are responsible for their own education, they typically will gain the skills and knowledge that are directly related to their interests or their job. The more fundamental knowledge is often ignored because it is not directly relevant to the tasks at hand. Later, as their knowledge increases and they become more technically proficient, people realize that they need to learn about some of the fundamentals.

Many people in the computer industry understand that in data communications, bits are transmitted across wires or waves. They even understand that some type of voltage change or wave fluctuation is used to distinguish the bits. When pressed, however, many of these same people have no idea what is actually happening with the electrical signals or the waves.

In the following sections, we will review some fundamental communications principles that directly and indirectly relate to wireless communications. Understanding these concepts will help you to better understand what is happening with wireless communications and to more easily recognize and identify the terms used in this profession.

Understanding Carrier Signals

Since data ultimately consists of bits, the transmitter needs a way of sending both 0s and 1s to transmit data from one location to another. An AC or DC signal by itself does not perform this task. However, if a signal is fluctuated or altered, even slightly, the data can be properly sent and received. This modulated signal is now capable of distinguishing between 0s and 1s and is referred to as a *carrier signal*.

Three components of a wave that can be fluctuated or modified to create a carrier signal are amplitude, frequency, and phase.

NOTE This chapter will review the basics of waves as they relate to the principles of data transmission. Chapter 2, "Radio Frequency Fundamentals," will cover radio waves in much greater detail.

All radio-based communications use some form of modulation to transmit data. To encode the data in a signal sent by AM/FM radios, cellular telephones, and satellite television, some type of modulation is performed on the radio signal that is being transmitted.

The average person typically is not concerned with how the signal is modulated, only that the device functions as expected. However, to become a better wireless network administrator, it is useful to have a better understanding of what is actually happening when two stations communicate. The rest of this chapter will introduce you to the fundamentals of encoding data. Chapter 2 will provide much more detail about waves and wave propagation, whereas this chapter provides an introduction to waves as a basis for understanding carrier signals and data encoding.

Amplitude and Wavelength

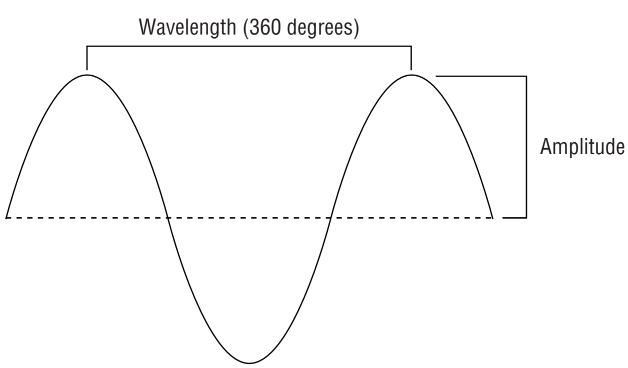
RF communication starts when radio waves are generated from an RF transmitter and sent to a receiver at another location. RF waves are similar to the waves that you see in an ocean or lake. Waves are made up of two main components: wavelength and amplitude (see Figure 1.1). *Amplitude* is the height, force, or power of the wave. If you were standing in the ocean as the waves came to shore, you would feel the force of a larger wave much more than you would a smaller wave. Antennas do the same thing, but with radio waves. Smaller waves are not as noticeable as bigger waves. A bigger wave generates a much larger electrical signal in an antenna, making the signal received much more easily recognizable.

Wavelength is the distance between similar points on two back-to-back waves. When measuring a wave, the wavelength is typically measured from the peak of a wave to the peak of the next wave. Amplitude and wavelength are both properties of waves.

Frequency

Frequency describes a behavior of waves. Waves travel away from the source that generates them. How fast the waves travel, or more specifically, how many waves are generated over a 1-second period of time, is known as frequency. If you were to sit on a pier and count how often a wave hits it, you could tell someone how frequently the waves were coming to shore. Think of radio waves in the same way; however, they travel much faster than the waves in the ocean. If you were to try to count the radio waves that are used in wireless networking, in the time it would take for one wave of water to hit the pier, several billion radio waves would have also hit the pier.

FIGURE 1.1 This drawing shows the wavelength and amplitude of a wave.

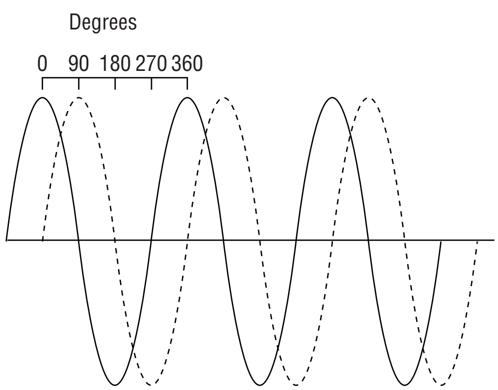


Phase

Phase is a relative term. It is the relationship between two waves with the same frequency. To determine phase, a wavelength is divided into 360 pieces referred to as degrees (see Figure 1.2). If you think of these degrees as starting times, then if one wave begins at the 0 degree point and another wave begins at the 90 degree point, these waves are considered to be 90 degrees out of phase.

In an ideal world, waves are created and transmitted from one station and received perfectly intact at another station. Unfortunately, RF communications do not occur in an ideal world. There are many sources of interference and many obstacles that will affect the wave in its travels to the receiving station. In Chapter 2, we'll introduce you to some of the outside influences that can affect the integrity of a wave and your ability to communicate between two stations.

FIGURE 1.2 This drawing shows two waves that are identical; however, they are 90 degrees out of phase with each other.



Time and Phase

Suppose you have two stopped watches and both are set to noon. At noon you start your first watch, and then you start your second watch 1 hour later. The second watch is 1 hour behind the first watch. As time goes by, your second watch will continue to be 1 hour behind. Both watches will maintain a 24-hour day, but they are out of synch with each other. Waves that are out of phase behave similarly. Two waves that are out of phase are essentially two waves that have been started at two different times. Both waves will complete full 360-degree cycles, but they will do it out of phase, or out of synch with each other.

Understanding Keying Methods

When data is sent, a signal is transmitted from the transceiver. In order for the data to be transmitted, the signal must be manipulated so that the receiving station has a way of distinguishing 0s and 1s. This method of manipulating a signal so that it can represent multiple pieces of data is known as a *keying method*. A keying method is what changes a signal into a carrier signal. It provides the signal with the ability to encode data so that it can be communicated or transported.

There are three types of keying methods that will be reviewed in the following sections: Amplitude Shift Keying (ASK), Frequency Shift Keying (FSK), and Phase Shift Keying (PSK). These keying methods are also referred to as *modulation* techniques. Keying methods use two different techniques to represent data:

Current State With current state techniques, the current value (the current state) of the signal is used to distinguish between 0s and 1s. The use of the word *current* in this context does not refer to current as in voltage but rather to current as in the present time. Current state techniques will designate a specific or current value to indicate a binary 0 and another value to indicate a binary 1. At a specific point in time, it is the value of the signal that determines the binary value. For example, you can represent 0s and 1s using an ordinary door. Once a minute you can check to see if the door is open or closed. If the door is open it represents a 0, and if the door is closed it represents a 1. The current state of the door, open or closed, is what determines 0s or 1s.

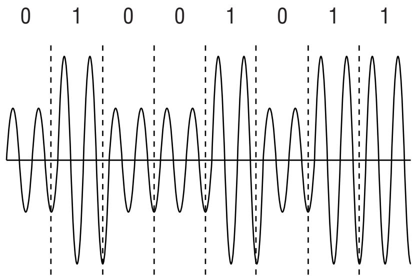
State Transition With state transition techniques, the change (or transition) of the signal is used to distinguish between 0s and 1s. State transition techniques may represent a 0 by a change in the phase of a wave at a specific time, whereas a 1 would be represented by no change in the phase of a wave at a specific time. At a specific point in time, it is the presence of a change or the lack of presence of a change that determines the binary value. The section on Phase Shift Keying will provide examples of this in detail, but a door can be used again to provide a simple example. Once a minute you check the door. In this case, if the door is moving (opening or closing), it represents a 0, and if the door is still (either open or closed), it represents a 1. In this example, the state of transition (moving or not moving) is what determines 0s or 1s.

Amplitude Shift Keying

Amplitude Shift Keying (ASK) varies the amplitude or height of the signal to represent the binary data. ASK is a current state technique, where one level of amplitude can represent a 0 bit and another level of amplitude can represent a 1 bit. Figure 1.3 shows how a wave can modulate an ASCII letter *K* using Amplitude Shift Keying. The larger amplitude wave is interpreted as a binary 1, and the smaller amplitude wave is interpreted as a binary 0.

This shifting of amplitude determines the data that is being transmitted. The way the receiving station performs this task is to first divide the signal being received into periods of time known as symbol periods. The receiving station then samples or examines the wave during this symbol period to determine the amplitude of the wave. Depending upon the value of the amplitude of the wave, the receiving station can determine the binary value.

FIGURE 1.3 An example of Amplitude Shift Keying (ASCII Code of an Upper Case K)



As you will learn later in this book, wireless signals can be unpredictable and also subject to interference from many sources. When noise or interference occurs, it usually affects the amplitude of a signal. Since a change in amplitude due to noise could cause the receiving station to misinterpret the value of the data, ASK has to be used cautiously.

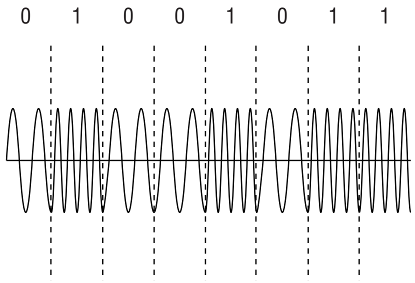
Frequency Shift Keying

Frequency Shift Keying (FSK) varies the frequency of the signal to represent the binary data. FSK is a current state technique, where one frequency can represent a 0 bit and another frequency can represent a 1 bit (Figure 1.4). This shifting of frequency determines the data that is being transmitted. When the receiving station samples the signal during the symbol period, it determines the frequency of the wave, and depending upon the value of the frequency, the station can determine the binary value.

Figure 1.4 shows how a wave can modulate an ASCII letter *K* using Frequency Shift Keying. The faster frequency wave is interpreted as a binary 1, and the slower frequency wave is interpreted as a binary 0.

FSK is used in some of the earlier 802.11 standards. With the demand for faster communications, FSK techniques would require more expensive technology to support faster speeds, making it less practical.

FIGURE 1.4 An example of Frequency Shift Keying (ASCII Code of an Upper Case K)



Real World Scenario

Why Haven't I Heard about Keying Methods Before?

You may not realize it, but you have heard about this before. AM/FM radio uses Amplitude Modulation (AM) and Frequency Modulation (FM) to transmit the radio stations that you listen to at your home or in your automobile. The radio station modulates the voice of music into its transmission signal, and your home or car radio demodulates it.

Phase Shift Keying

Phase Shift Keying (PSK) varies the phase of the signal to represent the binary data. PSK is a state transition technique, where one phase can represent a 0 bit and another phase can represent a 1 bit. This shifting of phase determines the data that is being transmitted. When the receiving station samples the signal during the symbol period, it determines the phase of the wave and the status of the bit.

Figure 1.5 shows how a wave can modulate an ASCII letter *K* using Phase Shift Keying. A phase change at the beginning of the symbol period is interpreted as a binary 1, and the lack of a phase change at the beginning of the symbol period is interpreted as a binary 0.

PSK is used extensively in the 802.11 standards. Typically, the receiving station samples the signal during the symbol period and compares the phase of the current sample with the previous sample and determines the difference. This degree difference, or differential, is used to determine the bit value. More advanced versions of PSK can encode multiple bits per symbol. Instead of using two phases to represent the binary values, four phases can be used. Each of the four phases is capable of representing two binary values (00, 01, 10, or 11) instead of one (0 or 1), thus shortening the transmission time. When more than two phases are used, this is referred to as Multiple Phase Shift Keying (MPSK). Figure 1.6 shows how a wave can modulate an ASCII letter *K* using a Multiple Phase Shift Keying method. Four possible phase changes can be monitored, with each phase change now able to be interpreted as 2 bits of data instead of just 1. Notice that there are fewer symbol times in this drawing than there are in the drawing in Figure 1.5.

FIGURE 1.5 An example of Phase Shift Keying (ASCII Code of an Upper Case K)

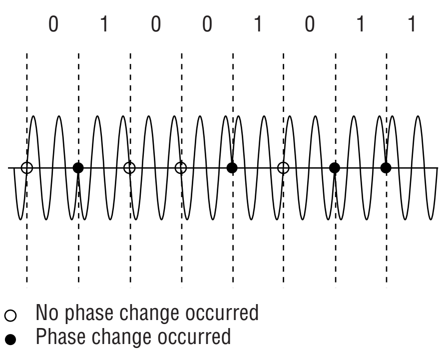
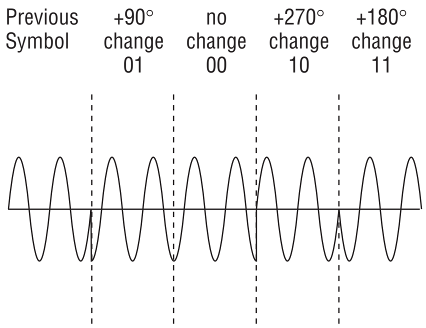


FIGURE 1.6 An example of Multiple Phase Shift Keying (ASCII Code of an Upper Case K)



Summary

This chapter explained the roles and responsibilities of the three key organizations involved with the wireless networking industry:

- FCC
- IEEE
- Wi-Fi Alliance

To provide a basic knowledge of how wireless stations transmit and receive data, we introduced some of the components of waves and modulation:

- Carrier signals
- Amplitude
- Wavelength
- Frequency
- Phase
- Keying methods
- ASK
- FSK
- PSK

When troubleshooting RF communications, having a solid knowledge of waves and modulation techniques can help you understand the fundamental issues behind communications problems and hopefully assist with leading you to a solution.

Exam Essentials

Know the three industry organizations. Understand the roles and responsibilities of the FCC, IEEE, and Wi-Fi Alliance.

Understand wavelength, frequency, amplitude, and phase. Know the definitions of each RF characteristic.

Understand the concepts of modulation. ASK, FSK, and PSK are three carrier signal modulation techniques.

Key Terms

Before you take the exam, be certain you are familiar with the following terms:

amplitude	International Telecommunication Union Radiocommunication Sector (ITU-R)
Amplitude Shift Keying (ASK)	keying method
carrier signal	modulation
Federal Communications Commission (FCC)	phase
frequency	Phase Shift Keying (PSK)
Frequency Shift Keying (FSK)	wavelength
Institute of Electrical and Electronics Engineers (IEEE)	Wi-Fi Alliance
International Organization for Standardization (ISO)	

Review Questions

1. IEEE is an abbreviation for what?
   - A. International Electrical and Electronics Engineers
   - B. Institute of Electrical and Electronics Engineers
   - C. Institute of Engineers - Electrical and Electronic
   - D. Industrial Electrical and Electronics Engineers
2. FCC is an abbreviation for what?
   - A. Frequency Communications Commission
   - B. Frequency Communications Chart
   - C. Federal Communications Commission
   - D. Federal Communications Corporation
3. ISO is the short name of which organization?
   - A. International Standards Organization
   - B. International Organization for Standards
   - C. International Organization for Standardization
   - D. Organization for International Standards
4. The 802.11 standard was created by which organization?
   - A. IEEE
   - B. OSI
   - C. ISO
   - D. Wi-Fi Alliance
   - E. FCC
5. What organization ensures interoperability of WLAN products?
   - A. IEEE
   - B. ITU-R
   - C. ISO
   - D. Wi-Fi Alliance
   - E. FCC

6. What type of signal is required to carry data?
   - **A.** Communications signal
   - **B.** Data signal
   - **C.** Carrier signal
   - **D.** Binary signal
   - **E.** Digital signal

7. Which keying method is most susceptible to interference from noise?
   - **A.** FSK
   - **B.** ASK
   - **C.** PSK
   - **D.** DSK

8. Which keying method is used for some of the slower, earlier 802.11 standards but not used for the faster standards?
   - **A.** FSK
   - **B.** ASK
   - **C.** PSK
   - **D.** DSK

9. Which keying method is used extensively in the 802.11 standards?
   - **A.** FSK
   - **B.** ASK
   - **C.** PSK
   - **D.** DSK

10. The Wi-Fi Alliance is responsible for which of the following standards? (Choose all that apply.)
    - **A.** WPA2
    - **B.** WEP
    - **C.** 802.11
    - **D.** WMM
    - **E.** PSK

11. Which wave properties can be modulated to encode data? (Choose all that apply.)
    - **A.** Amplitude
    - **B.** Frequency
    - **C.** Phase
    - **D.** Wavelength

12. EIRP is an abbreviation for what?

A. Effective isotropically radiated power

B. Electronic information regulatory panel

C. Equivalent isotropic radiated power

D. Equivalent isotropically radiated power

13. The height or power of a wave is known as what?

A. Phase

B. Frequency

C. Amplitude

D. Wavelength

14. Global spectrum management is tasked to what organization?

A. FCC

B. Wi-Fi Alliance

C. ITU-R

D. IEEE

15. A modulated signal capable of carrying data is known as what?

A. Data transmission

B. Communications channel

C. Data path

D. Carrier signal

16. Which of the following wireless communications parameters and usage are typically regulated? (Choose all that apply.)

A. Frequency

B. Bandwidth

C. Maximum power

D. Maximum EIRP

E. Indoor/outdoor usage

17. The IEEE 802.11g name is broken down into three components. 802 is the ________________, .11 is the ___________________, and g is the _______________.

A. Project, working group, task group

B. Committee, project, group

C. Project, working group, committee

D. It is not broken into separate components. It is known solely as the 802.11g committee.

18. A wave is divided into degrees. How many degrees make up a complete wave?

A. 100

B. 180

C. 212

D. 360

19. RF noise usually affects which property of a wave?

A. Amplitude

B. Wavelength

C. Frequency

D. Phase

20. The OSI model consists of how many layers?

A. 4

B. 6

C. 7

D. 9

Answers to Review Questions

1. B. IEEE stands for Institute of Electrical and Electronics Engineers.
2. C. FCC stands for Federal Communications Commission.
3. C. Remember that ISO is not an abbreviation or an acronym. It is actually a word derived from the Greek word *isos*, meaning *equal*.
4. A. The IEEE is responsible for the creation of all of the 802 standards.
5. D. The Wi-Fi Alliance provides certification testing, and when a product passes the test, it receives a Wi-Fi Certified certificate.
6. C. A carrier signal is a modulated signal that is used to transmit binary data.
7. B. Due to the effects of noise on the amplitude of a signal, Amplitude Shift Keying (ASK) has to be used cautiously.
8. A. With the demand for faster communications, FSK techniques would require more expensive technology to support faster speeds, making it less practical.
9. C. Phase Shift Keying (PSK) is used extensively in the 802.11 standards. Amplitude Shift Keying (ASK) is not typically used due to the effects of noise on the amplitude of the signal. Frequency Shift Keying (FSK) would require expensive technology to support faster speeds. DSK does not exist.
10. A, D. 802.11 and WEP (Wired Equivalent Privacy) are part of the IEEE 802.11 standard. PSK is not a standard, it is an encoding technique.
11. A, B, C. The three keying methods that can be used to encode data are Amplitude Shift Keying (ASK), Frequency Shift Keying (FSK), and Phase Shift Keying (PSK).
12. D. Although some books define EIRP as effective isotropically radiated power, the proper term is equivalent isotropically radiated power.
13. C. Height or power are two terms that describe the amplitude of a wave. Frequency is how often a wave repeats itself. Wavelength is the actual length of the wave, typically measured from peak to peak. Phase refers to the starting point of a wave in relation to another wave.
14. C. The International Telecommunication Union Radiocommunication Sector (ITU-R) has been tasked with global spectrum management.
15. D. A carrier signal is a signal that has been modulated to carry data.
16. A, B, C, D, E. All of these are typically regulated by the local or regional RF regulatory body.
17. A. 802 is the project, which is subdivided into working groups. Working groups are further subdivided into task groups.

18. D. A wave is divided into 360 degrees.
19. A. RF noise typically affects the amplitude, or height, of a wave.
20. C. The OSI model is sometimes referred to as the seven layer model.