CHAPTER

1

Introduction to Wireless LANs

CWNA Exam Objectives Covered:

- Identify the technology roles for which wireless LAN technology is an appropriate application:
  - Data access role
  - Extension of existing networks into remote locations
  - Building-to-building connectivity
  - Last mile data delivery
  - Flexibility for mobile users
  - SOHO Use
  - Mobile office, classroom, industrial, and healthcare

In This Chapter

In this section, we will discuss the wireless LAN market, an overview of the past, present, and future of wireless LANs, and an introduction to the standards that govern wireless LANs. We will then discuss some of the appropriate applications of wireless LANs. In closing, we will introduce you to the various organizations that guide the evolution and development of wireless LANs.

The knowledge of the history and evolution of wireless LAN technology is an essential part of the foundational principles of wireless LANs. A thorough understanding of where wireless LANs came from and the organizations and applications that have helped the technology mature will enable you to better apply wireless LANs to your organization or your client's needs.

The Wireless LAN Market

The market for wireless LANs seems to be evolving in a similar fashion to the networking industry as a whole, starting with the early adopters using whatever technology was available. The market has moved into a rapid growth stage, for which popular standards are providing the catalyst. The big difference between the networking market as a whole and the wireless LAN market is the rate of growth. Wireless LANs allow so many flexibilities in their implementation that it's no wonder that they are outpacing every other market sector.

History of Wireless LANs

Spread spectrum wireless networks, like many technologies, came of age under the guidance of the military. The military needed a simple, easily implemented, and secure method of exchanging data in a combat environment.

As the cost of wireless technology declined and the quality increased, it became cost-effective for enterprise companies to integrate wireless segments into their network. Wireless technology offered a relatively inexpensive way for corporate campuses to connect buildings to one another without laying copper or fiber cabling. Today, the cost of

wireless technology is such that most businesses can afford to implement wireless segments on their network, if not convert completely to a wireless network, saving the company time and money while allowing the flexibility of roaming.

Households are also benefiting from the low cost and subsequent availability of wireless LAN hardware. Many people are now creating cost-effective wireless networks that take advantage of the convenience of mobility and creating home offices or wireless gaming stations.

As wireless LAN technology improves, the cost of manufacturing (and thus purchasing and implementing) the hardware continues to fall, and the number of installed wireless LANs continues to increase. The standards that govern wireless LAN operation will increasingly stress interoperability and compatibility. As the number of users grows, lack of compatibility may render a network useless, and the lack of interoperability may interfere with the proper operation of other networks.

Today's Wireless LAN Standards

Because wireless LANs transmit using radio frequencies, wireless LANs are regulated by the same types of laws used to govern such things as AM/FM radios. The Federal Communications Commission (FCC) regulates the use of wireless LAN devices. In the current wireless LAN market there are several accepted operational standards and drafts in the United States that are created and maintained by the *Institute of Electrical and Electronic Engineers (IEEE*).

These standards are created by groups of people that represent many different organizations, including academics, business, military, and the government. Because standards set forth by the IEEE can have such an impact on the development of technology, the standards can take many years to be created and agreed upon. You may even have an opportunity to comment on these standards at certain times during the creation process.

The standards specific to wireless LANs are covered in greater detail in Chapter 6 (Wireless LAN Organizations and Standards). Because these standards are the basis upon which the latest wireless LANs are built, a

brief overview is provided here.

IEEE 802.11 - the original wireless LAN standard that specifies the slowest data transfer rates in both RF and light-based transmission technologies. This standard was ratified by IEEE in 1997.

IEEE 802.11b – describes somewhat faster data transfer rates and a more restrictive scope of transmission technologies. This standard is also widely promoted as Wi-Fi™ by the Wi-Fi Alliance. This standard was ratified by IEEE in 1999 as an amendment to the original IEEE 802.11 standard.

IEEE 802.11a - describes much faster data transfer rate than (but lacks backwards compatibility with) IEEE 802.11b, and uses the 5 GHz UNII frequency bands. This standard was ratified by IEEE in 1999 as an amendment to the original IEEE 802.11 standard.

IEEE 802.11g - the most recent draft based on the 802.11 standard that describes data transfer rates equally as fast as IEEE 802.11a, and boasts the backward compatibility to 802.11b required to make inexpensive upgrades possible. This draft has not been ratified by the IEEE, but should be early in 2003.

Emerging technologies will require standards that describe and define their proper behavior. The challenge for manufacturers and standards-makers alike will be bringing their resources to bear on the problems of interoperability and compatibility.

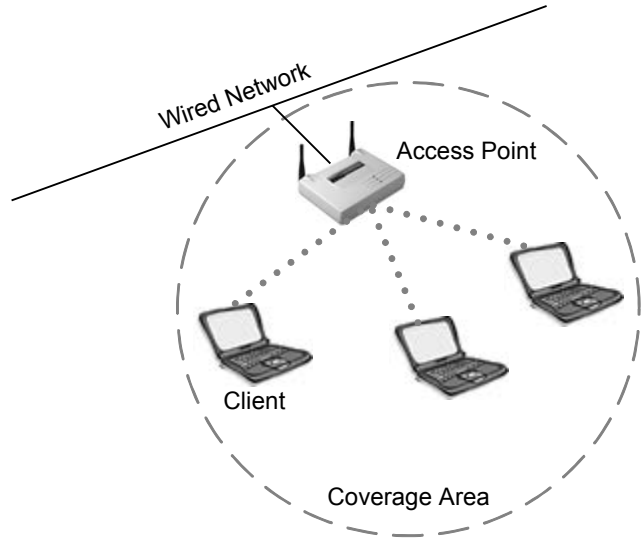
Applications of Wireless LANs

When computers were first built, only large universities and corporations could afford them. Today you may find 3 or 4 personal computers in your neighbor's house. Wireless LANs have taken a similar path, first used by large enterprises, and now available to us all at affordable prices. As a technology, wireless LANs have enjoyed a very fast adoption rate due to the many advantages they offer to a variety of situations. In this section, we will discuss some of the most common and appropriate uses of wireless LANs.

Access Role

Wireless LANs are mostly deployed in an access layer role, meaning that they are used as an entry point into a wired network. In the past, access has been defined as dial-up, ADSL, cable, cellular, Ethernet, Token Ring, Frame Relay, ATM, etc. Wireless is simply another method for users to access the network. Wireless LANs are Data-Link layer networks like all of the access methods just listed. Due to a lack of speed and resiliency, wireless networks are not typically implemented in Distribution or Core roles in networks. Of course, in small networks, there may be no differentiation between the Core, Distribution, or Access layers of the network. The Core layer of a network should be very fast and very stable, able to handle a tremendous amount of traffic with little difficulty and experience no down time. The Distribution layer of a network should be fast, flexible, and reliable. Wireless LANs do not typically meet these requirements for an enterprise solution. Figure 1.1 illustrates mobile clients gaining access to a wired network through a connection device (access point).

FIGURE 1.1 Access role of a wireless LAN



Wireless LANs offer a specific solution to a difficult problem: mobility. Without a doubt, wireless LANs solve a host of problems for corporations

and home users alike, but all of these problems point to the need for freedom from data cabling. Cellular solutions have been available for quite some time, offering users the ability to roam while staying connected, at slow speeds and very high prices. Wireless LANs offer the same flexibility without the disadvantages. Wireless LANs are fast, inexpensive, and they can be located almost anywhere.

When considering wireless LANs for use in your network, keep in mind that using them for their intended purpose will provide the best results. Administrators implementing wireless LANs in a Core or Distribution role should understand exactly what performance to expect before implementing them in this fashion to avoid having to remove them later. The only distribution role in a corporate network that is definitely appropriate for wireless LANs is that of building-to-building bridging. In this scenario, wireless *could* be considered as playing a distribution role; however, it will always depend on how the wireless bridging segments are used in the network.

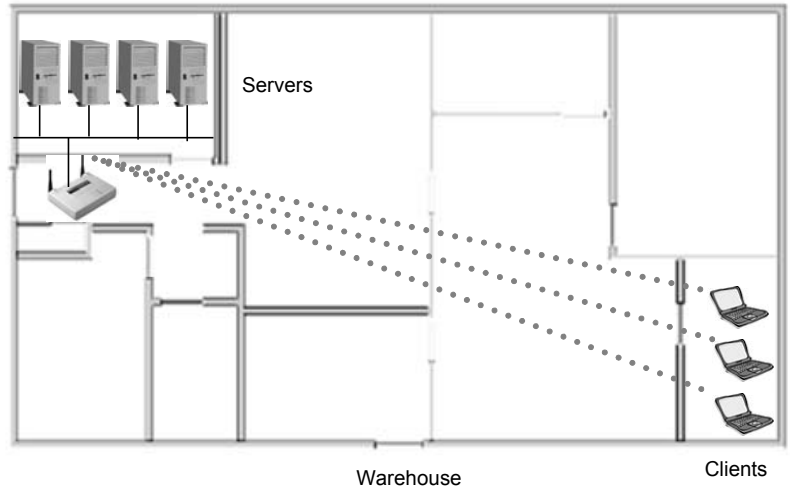
There are some Wireless Internet Service Providers (WISPs) that use licensed wireless frequencies in a distribution role, but almost never unlicensed frequencies such as the ones discussed at length in this book.

Network Extension

Wireless networks can serve as an extension to a wired network. There may be cases where extending the network would require installing additional cabling that is cost prohibitive. You may discover that hiring cable installers and electricians to build out a new section of office space for the network is going to cost tens of thousands of dollars. Or in the case of a large warehouse, the distances may be too great to use Category 5 (Cat5) cable for the Ethernet network. Fiber might have to be installed, requiring an even greater investment of time and resources. Installing fiber might involve upgrades to existing edge switches.

Wireless LANs can be easily implemented to provide seamless connectivity to remote areas within a building, as illustrated by the floor plan image in Figure 1.2. Because little wiring is necessary to install a wireless LAN, the costs of hiring installers and purchasing Ethernet cable might be completely eliminated.

FIGURE 1.2 Network Extension



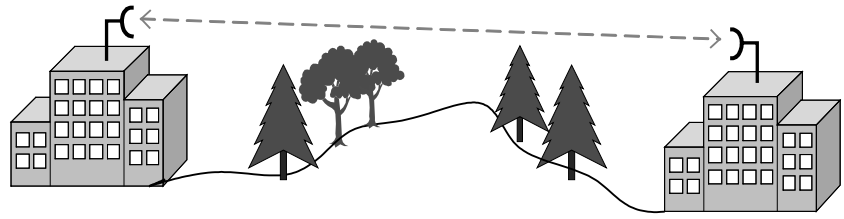
Building-to-Building Connectivity

In a campus environment or an environment with as few as two adjacent buildings, there may be a need to have the network users in each of the different buildings have direct access to the same computer network. In the past, this type of access and connectivity would be accomplished by running cables underground from one building to another or by renting expensive leased-lines from a local telephone company.

Using wireless LAN technology, equipment can be installed easily and quickly to allow two or more buildings to be part of the same network without the expense of leased lines or the need to dig up the ground between buildings. With the proper wireless antennas, any number of buildings can be linked together on the same network. Certainly there are limitations to using wireless LAN technology, as there are in any data-connectivity solution, but the flexibility, speed, and cost-savings that wireless LANs introduce to the network administrator make them indispensable.

There are two different types of building-to-building connectivity. The first is called point-to-point (PTP), and the second is called point-to-multipoint (PTMP). Point-to-point links are wireless connections between only two buildings, as illustrated in Figure 1.3. PTP connections almost always use semi-directional or highly directional antennas at each end of the link.

FIGURE 1.3 Building-to-building connectivity



Point-to-multipoint links are wireless connections between three or more buildings, typically implemented in a "hub and spoke" or star topological fashion, where one building is the central focus point of the network. This central building would have the core network, Internet connectivity, and the server farm. Point-to-multipoint links between buildings typically use omni-directional antennas in the central "hub" building and semi-directional antennas on each of the outlying "spoke" buildings. Antennas will be covered in greater detail in Chapter 5.

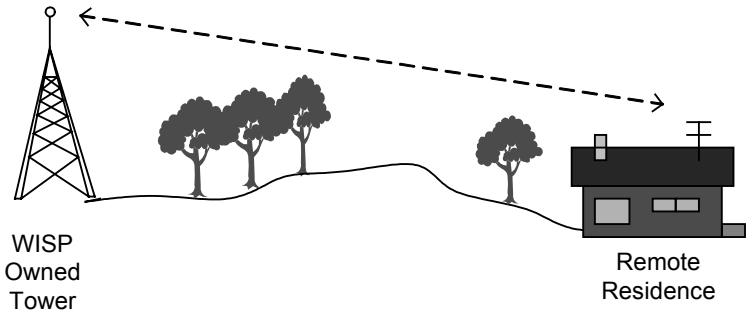
There are many ways to implement these two basic types of connectivity, as you will undoubtedly see over the course of your career as a wireless LAN administrator or consultant. However, no matter how the implementations vary, they all fall into one of these two categories.

Last Mile Data Delivery

Wireless Internet Service Providers (WISPs) are now taking advantage of recent advancements in wireless technology to offer last mile data delivery service to their customers. "Last mile" refers to the communication infrastructure—wired or wireless—that exists between the central office of the telecommunications company (telco) or cable company and the end user. Currently the telcos and cable companies own

their last mile infrastructure, but with the broadening interest in wireless technology, WISPs are now creating their own wireless last mile delivery service, as illustrated in Figure 1.4.

FIGURE 1.4 Last Mile Service



Consider the case where both the cable companies and telcos are encountering difficulties expanding their networks to offer broadband connections to more households or businesses. If you live in a rural area, chances are you do not have access to a broadband connection (cable modem or xDSL), and probably will not for quite some time. It is much more cost effective for WISPs to offer wireless access to these remote locations because WISPs will not encounter the same costs a cable company or telco would incur in order to install the necessary equipment.

WISPs have their own unique set of challenges. Just as xDSL providers have problems going further than 18,000 feet (5.7 km) from the central office and cable providers have issues with the cable being a shared medium to users, WISPs have problems with rooftops, trees, mountains, lightning, towers, and many other obstacles to connectivity. Certainly WISPs don't have a fail-proof solution, but they have the capability to offer broadband access to users that other, more conventional technologies cannot reach.

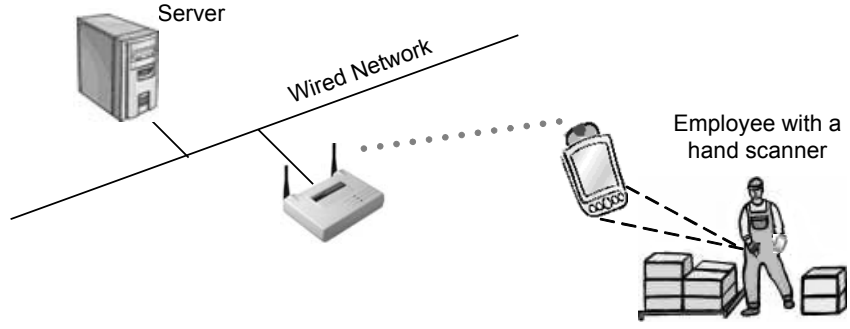
Mobility

As an access layer solution, wireless LANs cannot replace wired LANs in terms of data rates (100BaseTx at 100Mbps versus IEEE 802.11a at 54Mbps). A wireless environment uses intermittent connections and has

higher error rates over what is usually a narrower bandwidth. As a result, applications and messaging protocols designed for the wired world sometimes operate poorly in a wireless environment. The wireless expectations of end users and IT manager are set by the performance and behaviors of their wired networks. What wireless LANs do offer is an increase in mobility (as can be seen in Figure 1.5) as the trade off for speed and quality of service.

For example, a parcel delivery company uses wireless technology to update parcel-tracking data immediately upon the arrival of the delivery vehicle. As the driver parks at the dock, the driver's computer has already logged onto the network and transferred the day's delivery data to the central network.

FIGURE 1.5 Mobility



In warehousing facilities, wireless networks are used to track the storage locations and disposition of products. This data is then synchronized in the central computer for the purchasing and shipping departments. Handheld wireless scanners are becoming commonplace in organizations with employees that move around within their facility processing orders and inventory.

In each of these cases, wireless networks have created the ability to transfer data without requiring the time and manpower to input the data manually at a wired terminal. Wireless connectivity has also eliminated the need for such user devices to be connected using wires that would otherwise get in the way of the users.

Some of the newest wireless technology allows users to *roam,* or move physically from one area of wireless coverage to another without losing connectivity, just as a mobile telephone customer is able to roam between cellular coverage areas. In larger organizations, where wireless coverage spans large areas, roaming capability has significantly increased the productivity of these organizations, simply because users remain connected to the network away from their main workstations.

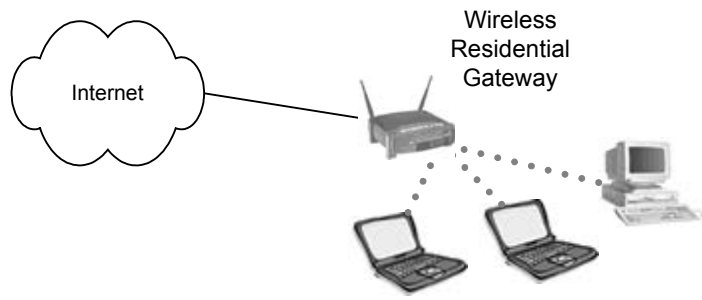
Small Office-Home Office

As an IT professional, you may have more than one computer at your home. And if you do, these computers are most likely networked together so you can share files, a printer, or a broadband connection.

This type of configuration is also utilized by many businesses that have only a few employees. These businesses have the need for the sharing of information between users and a single Internet connection for efficiency and greater productivity.

For these applications – small office-home office, or SOHO – a wireless LAN is a very simple and effective solution. Figure 1.6 illustrates a typical SOHO wireless LAN solution. Wireless SOHO devices are especially beneficial when office workers want to share a single Internet connection. The alternative of course is running wires throughout the office to interconnect all of the workstations. Many small offices are not outfitted with pre-installed Ethernet ports, and only a very small number of houses are wired for Ethernet networks. Trying to retrofit these places with Cat5 cabling usually results in creating unsightly holes in the walls and ceilings. With a wireless LAN, users can be interconnected easily and neatly.

FIGURE 1.6 SOHO Wireless LAN

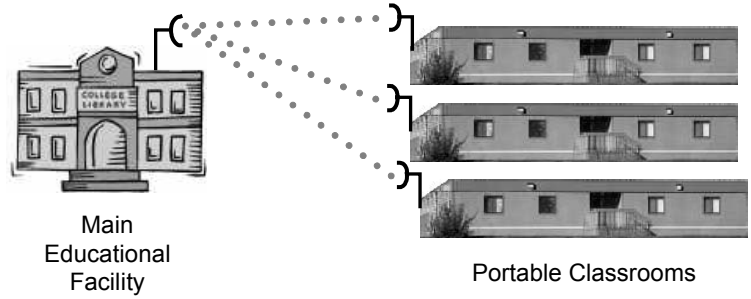


Mobile Offices

Mobile offices or classrooms allow users to pack up their computer equipment quickly and move to another location. Due to overcrowded classrooms, many schools now use mobile classrooms. These classrooms usually consist of large, movable trailers that are used while more permanent structures are built. In order to extend the computer network to these temporary buildings, aerial or underground cabling would have to be installed at great expense. Wireless LAN connections from the main school building to the mobile classrooms allow for flexible configurations at a fraction of the cost of alternative cabling. A simplistic example of connecting mobile classrooms using wireless LAN connectivity is illustrated in Figure 1.7.

Temporary office spaces also benefit from being networked with wireless LANs. As companies grow, they often find themselves with a shortage of office space, and need to move some workers to a nearby location, such as an adjacent office or an office on another floor of the same building. Installing Cat5 or fiber cabling for these short periods of time is not cost-effective, and usually the owners of the building do not allow for the installed cables to be removed. With a wireless network, the network components can be packed up and moved to the next location quickly and easily.

FIGURE 1.7 A school with mobile classrooms



There are many groups that might use movable networks effectively. Some of these include the Superbowl, the Olympics, circuses, carnivals, fairs, festivals, construction companies, and others. Wireless LANs are well suited to these types of environments.

Hospitals and other healthcare facilities benefit greatly from wireless LANs. Some valuable uses of wireless LANs within these facilities include doctors using wireless PDAs to connect to the networks and mobile diagnostic carts that nurses can move from room to room to connect to the patient and the network. Wireless networks allow doctors and nurses to perform their jobs more efficiently using these new devices and associated software.

Industrial facilities, such as warehouses and manufacturing facilities, utilize wireless networks in various ways. A good example of an industrial wireless LAN application is shipping companies whose trucks pull into the dock and automatically connect to the wireless network. This type of networking allows the shipping company to become automated and more efficient in handling the uploading of data onto the central servers.

Summary

Wireless technology has come a long way since its simple military implementations. The popularity and level of technology used in wireless LANs continues to grow at an incredible rate. Manufactures have created a myriad of solutions for our varying wireless networking needs. The

convenience, popularity, availability, and cost of wireless LAN hardware provide us all with many different solutions.

With the explosive expansion of wireless technology, manufacturers, and hardware, the role of organizations such as the FCC, IEEE, the Wi-Fi Alliance, and WLANA will become increasingly important to the removal of barriers of operation between solutions. The laws put in place by regulatory organizations like the FCC along with the standards provided by promotional and other organizations like IEEE, WLANA, and the Wi-Fi Alliance will focus the wireless LAN industry and provide a common path for it to grow and evolve over time.

Key Terms

Before taking the exam, you should be familiar with the following terms:

access layer

core layer

distribution layer

FCC

IEEE

IEEE 802.11

IEEE 802.11a

IEEE 802.11b

IEEE 802.11g

last mile

SOHO

WISP

Review Questions

1. Which one of the following does a wireless LAN provide that a wired network does not?
   A. Mobility
   B. Centralized security
   C. Reliability
   D. VPN security

2. Which one of the following would not be an appropriate use of a wireless LAN?
   A. Connecting two buildings together that are on opposite sides of the street
   B. Connecting two computers together in a small office so they can share a printer
   C. Connecting a remote home to a WISP for Internet access
   D. Connecting two rack-mounted computers together

3. Why is a wireless LAN a good choice for extending a network? Choose all that apply.
   A. Reduces the cost of cables required for installation
   B. Can be installed faster than a wired network
   C. Hardware is considerably less expensive than wired LAN hardware
   D. Eliminates a significant portion of the labor charges for installation

4. Wireless ISPs provide which one of the following services?

   A. Small office/home office services

   B. Connectivity for large enterprises

   C. Last mile data delivery

   D. Building-to-building connectivity

5. Wireless LANs are primarily deployed in which one of the following roles?

   A. Backbone

   B. Access

   C. Application

   D. Core

6. Why would a mobile office be a good choice for using a wireless LAN? Choose all that apply.

   A. Wireless LANs take less time to install than wired LANs

   B. Wireless LAN equipment could be easily removed if the office moves

   C. Wireless LANs do not require administration

   D. Wireless LANs take a more centralize approach over wired LANs

7. Which one of the following is the IEEE family of standards for wireless LANs?

   A. 802.3

   B. 803.5

   C. 802.11

   D. 802.1x

8. As a consultant, you have taken a job creating a wireless LAN for an office complex that will connect 5 buildings in close vicinity together. Given only this information, which one of the following wireless LAN implementations would be most appropriate for this scenario?

   A. Last mile data service from a WISP

   B. Point-to-point bridge links between all buildings

   C. Point-to-multipoint bridge link from a central building to all remote buildings

   D. One central antenna at the main building only

9. Which of the following are challenges that WISPs face that telephone companies and cable companies do not? Choose all that apply.

   A. Customers located more than 18,000 feet (5.7 km) from a central office

   B. High costs of installing telephone lines or copper cabling

   C. Trees as line of sight obstructions

   D. Rooftop access for antenna installation

10. In what organization did the use of spread spectrum wireless data transfer originate?

    A. The Wi-Fi Alliance

    B. WLANA

    C. FCC

    D. U.S. Military

11. Which one of the following is the most recently approved IEEE standard for wireless LANs?

    A. 802.11a

    B. 802.11b

    C. 802.11c

    D. 802.11g

12. Which one of the following IEEE standards for wireless LANs is *not* compatible with the standard currently known as Wi-Fi™?

    A. 802.11

    B. 802.11g

    C. 802.11a

    D. 802.11b

13. Which one of the following IEEE 802.11 standards for wireless LANs utilizes the 5 GHz UNII bands for its radio signal transmissions?

    A. 802.11b

    B. Bluetooth

    C. 802.11

    D. 802.11g

    E. 802.11a

14. A WISP would take advantage of which one of the following applications for wireless LANs?

    A. Last Mile data delivery

    B. Building-to-building bridging

    C. Classroom connectivity

    D. Home network connectivity

15. Who makes the regulations that govern the technical requirements, licensing, and usage of wireless LANs in the United States?

    A. IEEE

    B. The Wi-Fi Alliance

    C. FCC

    D. ETSI

Answers to Review Questions

1. A. The most alluring feature of a wireless network is the freedom to move about while remaining connected to the network. Wired networks cannot offer this feature.
2. D. Generally speaking, computers that are rack-mounted together are servers, and servers should be connected to a high-speed, wired backbone. Wireless networks are meant for mobile access rather than server room connectivity.
3. A, B, D. Cabling a facility is a time-consuming and expensive task. Wireless networks can quickly and inexpensively be installed and configured.
4. C. Wireless Internet Service Providers (WISPs) provide last mile data delivery service to homes and businesses. In this fashion, they compete directly against wired ISPs such as telephone and cable companies.
5. B. The *access* layer of the industry standard design model is where users attach to the network. Wireless network devices are most generally installed in this capacity. There are times when wireless networks may be used in a distribution role, such as building-to-building bridging, but a very large percentage of wireless networks are used strictly for access.
6. A, B. In the setup and teardown of a mobile office, cabling is the most significant task. In a small office, many of the common problems of a wireless network are not experienced so time-consuming tasks such as site surveys are not required. Centralized connection points (called access points) are minimal so wiring is minimal.
7. C. The 802.11 family of standards specifically address wireless LANs. There are many flavors of standards addressing many types of wireless technologies and various topics related to wireless technologies. For example, 802.11, 802.11b, 802.11g, and 802.11a are all specifications of wireless LANs systems whereas 802.11f addresses inter-access point protocol and 802.11i addresses wireless LAN security. The 802.1x standard is for port-based network access control.

8. C. Since using a single antenna would likely have severe problems with coverage and many point-to-point bridge links (forming a partial or full mesh) would be highly expensive, the only logical alternative is to use point-to-multipoint bridge connectivity between buildings. This is an economically sound and highly effective solution.

9. C, D. Wireless Internet Service Providers (WISPs) face problems with line of sight limitations of 2.4 GHz and 5 GHz wireless LAN systems. Antennas must be installed on rooftops or higher if possible in most cases. Trees and hills both pose problems to WISPs for the same reason.

10. D. During WWII, actress Hedy Lamarr and composer George Antheil co-invented the frequency hopping communications technique. The U.S. military began using frequency hopping spread spectrum communications in 1957 well before the broad commercial use that spread spectrum systems enjoy today.

11. A. The first wireless LAN standard was the 802.11 standard using the 2.4 GHz ISM band, approved in 1997. Following 802.11 was 802.11b raising the top speed to 11 Mbps and limiting use to DSSS technology only. Following 802.11b was 802.11a, which uses the 5 GHz UNII bands. The 802.11g standard is in draft form, and has not yet been completed.

12. C. Wi-Fi is the hardware compatibility standard created and maintained by the Wi-Fi Alliance for 802.11b devices. IEEE 802.11g devices use the 2.4 GHz ISM band are backwards compatible with 802.11b. 802.11a devices use a different set of frequencies and a different modulation type from 802.11b, and are thus incompatible.

13. E. The IEEE 802.11, 802.11b, 802.11g, Bluetooth, and HomeRF all use the 2.4 GHz ISM bands, whereas the 802.11a standard uses the 5 GHz UNII bands.

14. A. WISPs are direct competitors for telephone companies and cable companies in providing last mile connectivity to businesses and residences in the broadband Internet services market.

15. C. The Federal Communications Commission (FCC) makes the laws regarding frequency band usage (licensed and unlicensed) in the United States. The IEEE makes standards regarding wireless LANs, which use RF frequencies. The Wi-Fi Alliance makes the hardware compatibility standard called Wi-Fi, and ETSI publishes communications standards for Europe.