OBJECTIVES

This chapter helps you to prepare for the Core Hardware module of the A+ Certification examination by covering the following objectives within the "Domain 6.0: Basic Networking" section.

6.3 Identify common technologies available for establishing Internet connectivity and their characteristics.

Technologies include

- **LAN**
- **DSL**
- **Cable**
- **ISDN**
- **Dial-up**
- **Satellite**
- **Wireless**

Characteristic include

- **Definition**
- **Speed**
- **Connections**

One of the most widely used facets of the personal computer is its ability to function as an interface to the Internet. There are various methods of connecting the computer to the Internet, so the technician must be aware of the different Internet connectivity technologies and be able to implement them as required by the employer or customer.

CHAPTER 21

Internet Connectivity

Outline

Study Strategies

To prepare for the Basic Networking objective of the Core Hardware exam:

- ***Use all the traditional study tools we've placed in the chapter***—Pay attention to the Objectives, Challenges, and end-of-chapter questions and use them to learn the material.
- ***Use the pedagogy in this chapter to focus on the exam-specific material***—We've included lots of features geared expressly to the A+ exam. The Exam Tips scattered throughout the chapter are placed there to point to known exam-related materials. The same is true of the embedded Challenge items.
- ***Key in on Exam Tips in the chapter***—While reading through the chapter, make sure to concentrate on the following test-related items:
  - Be aware of common services that ISPs provide their Internet customers.
  - Be able to state the difference between simplex, half-duplex, and full-duplex transmissions. Also, be able to identify which communications systems use each type.
  - Be aware of the consequences of placing a line filter inline with the computer and network equipment in a DSL installation.
  - Be aware that ADSL provides different upload and download speeds.
  - Know that the maximum distance specified between the subscriber location and local office for ADSL is less than 20,000 feet.

Study Strategies

- Be aware that ADSL has the slowest upstream rate and VDSL has the fastest upstream rate.
- Know that SDSL has the slowest downstream rate and VDSL has the fastest downstream rate.
- Remember that HDSL does not use phones and data on the same lines.

INTRODUCTION

One of the fastest growing uses of personal computers in both the home and business environments is accessing and navigating the Internet. Along with the explosion of PC-based Internet users, several different technologies are available to connect the computer to an Internet access provider.

This chapter examines the various technologies commonly used to provide Internet connectivity. The first sections of the chapter provide an introduction to the organizational structure of the Internet, including the role and purpose of Internet service providers in the scheme of the Internet.

The remainder of the chapter deals with the various Internet access technologies. These technologies include dial-up access performed across the telephone system using an analog modem. Afterward, the discussion turns to more advanced, high-speed technologies that provide users with faster access and usage. These technologies include ISDN, DSL, cable, and wireless technologies.

After completing the chapter, you should be able to identify common technologies available for establishing Internet connectivity. You should also be able to describe the characteristic differences between the technologies.

THE INTERNET

The most famous *wide area network (WAN)* is the Internet, which is actually a network of networks, working together. The main communication path for the Internet is a series of networks, established by the U.S. government, to link supercomputers together at key research sites.

This pathway, referred to as the *backbone*, is affiliated with the National Science Foundation (NSF). Since the original backbone was established, the Internet has expanded around the world and offers access to computer users in every part of the globe.

The TCP/IP protocol divides the transmission into packets of information, suitable for retransmission across the Internet. Along the way, the information passes through different networks that are orga-

nized at different levels. Depending on the routing scheme, the packets may move through the Internet using different routes to reach the intended address. At the destination, however, the packets are reassembled into the original transmission. This concept is illustrated in Figure 21.1.

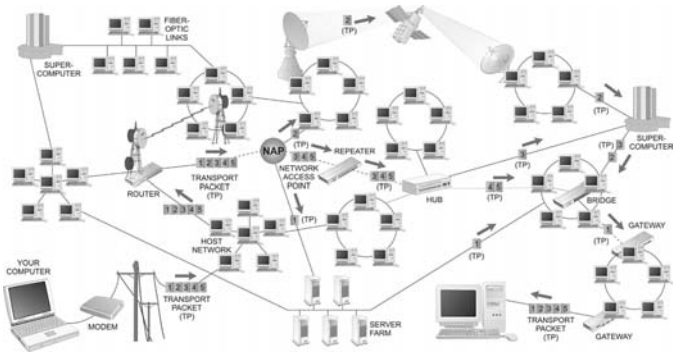


FIGURE 21.1
Packets moving through the Internet.

As a message moves from the originating address to its destination, it may pass through local area networks (LANs), mid-level networks, routers, repeaters, hubs, bridges, and gateways. A *mid-level network* is simply another network that does not require an Internet connection to carry out communications.

A *repeater* receives messages, amplifies them, and retransmits them to keep the messages from deteriorating as they travel. *Hubs* are used to link networks together so that nodes within them can communicate with each other. *Bridges* connect networks together so that data can pass through them as it moves from one network to the next.

Routers are similar to bridges in that they connect networks together. However, routers have built-in intelligence that permits them to calculate the best path for forwarding packets to their specified destinations. They also employ special protocols that enable them to communicate with each other to configure the best route between network addresses.

Routers are often referred to as *gateways* because they are used as the passageway between one network and another (formerly, the term *gateway* was used instead of *router*). They work independently from the LAN protocol, so they can be used with different types of networks (for example, Novell, Apple, and PC networks). However, for

this to occur, all the different networks must use a common *internetworking protocol*.

INTERNET SERVICE PROVIDERS

Connecting all the users and individual networks together are *Internet service providers (ISPs)*. ISPs are companies that provide the technical gateway to the Internet. These companies own blocks of access addresses that they assign to their customers to give each customer an identity on the network.

Some service providers, such as America Online (AOL) and Earthlink, have become very well known. However, thousands of lesser-known, dedicated Internet access provider companies offer services around the world. Figure 21.2 illustrates the service provider's position in the Internet scheme and shows the various connection methods used to access the Net.

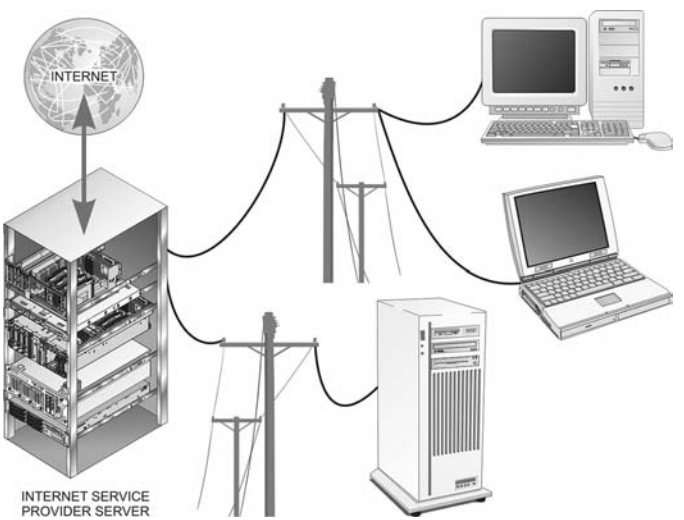


FIGURE 21.2
Service provider's position.

When you connect to a service provider, you are connecting to its computer system, which in turn is connected to the Internet through devices called routers. A *router* is a device that intercepts network transmissions and determines for which part of the Internet they are intended. It then determines what the best routing scheme is for

delivering the message to its intended address. The routing schedule is devised based on the known available links through the Internet and the amount of traffic detected on various segments. The router then transfers the message to a *Network Access Point (NAP)*.

Services that most ISPs deliver to their customers include the following:

- Internet identity through IP addresses
- Email services through POP3 and SMTP servers
- Internet News Service through Usenet archive servers
- Internet routing through DNS servers

EXAM TIP

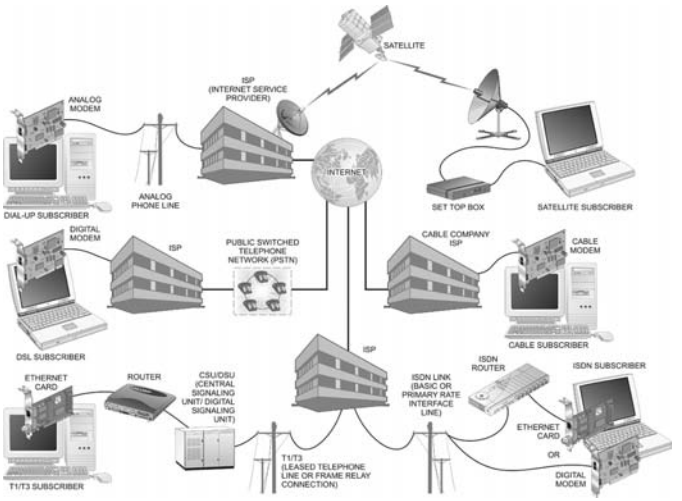
Be aware of common services that ISPs provide their Internet customers.

INTERNET ACCESS METHODS

Most users connect to the Internet and other wide area networks via standard telephone lines, using dial-up modems. Dial-up connections are generally the slowest way to connect to a network, but they are inexpensive to establish and use. Other users who require quicker data transfers contract with the telephone company to use special, high-speed *Digital Subscriber Line (DSL)* or *Integrated Service Digital Network (ISDN)* lines. Still other users contract with a cable television provider for fast Internet access connections. All these connectivity types require a digital modem to conduct data transfers. Because the modems used with these technologies are digital, no analog conversion is required. These technologies are covered in detail later in this chapter.

Users who require very high volumes lease dedicated T1 and T3 lines from the telephone company. These applications generally serve businesses that put several of their computers or networks online. After the information is transmitted, it may be carried over many types of communications links on its way to its destination. These interconnecting links can include fiber-optic cables, satellite up- and down-links, UHF, and microwave transmission systems. Figure 21.3 illustrates different ways to access WANs.

FIGURE 21.3
Methods of accessing wide area networks.



LAN Access to the Internet

As Figure 21.3 illustrates, there are several methods of contacting an ISP to gain access to the Internet. You can dial up directly using an analog modem and the *plain old telephone system (POTS)*. Or you can make special arrangements with service providers for special always-on services such as DSL, ISDN, cable, or satellite services. These services can be obtained through direct links to the phone company or an ISP that represents such services. Most residential users access the Internet in this manner.

In commerce and industrial settings, however, it is more common for users to work in a LAN environment. In these environments, Internet access is generally provided through the existing local area network structure. One or more of the LAN's network devices are used to provide some type of gateway to the Internet, as illustrated in Figure 21.4. This arrangement may involve a third-party ISP, or in large organizations, the company may act as its own ISP.

The network device that offers the gateway service may be a stand-alone router, or it could be one of the LAN's servers acting as a router for the LAN. The example of using a router as a gateway to the outside world has led to the terms router and gateway being used interchangeably. When the router is used as the gateway, the outside world sees only the router—not the individual computers attached to the LAN.

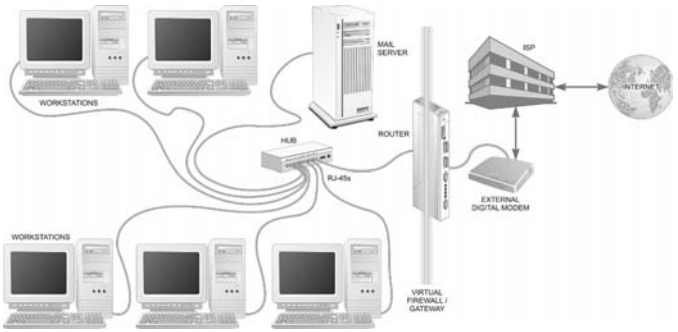


FIGURE 21.4
Internet gateways.

When a computer is used to serve as the gateway, it may actually be configured to perform several connection functions. Of course, the server's first function is to perform all the routing services for the LAN. These services include properly routing incoming messages to the proper node on the LAN and forwarding outgoing messages to the Internet. To accomplish these tasks, the server must possess an *Internet connection-sharing* utility that enables it to represent the other computers on the LAN.

The server may also act as a *proxy server* for the LAN. A proxy server is a computer used to perform services locally; it then forwards requests for services that it cannot fulfill to an appropriate server. In this case, the proxy server function of the gateway computer could be used to *cache* (store) Web pages that have recently been accessed from the Internet; this way, if they are needed again, the computer can access them locally instead of trying to reach them over the Internet. Caching improves network performance by reducing the load placed on the bandwidth capabilities of the link between the company and the Internet. If the requested page is not in the proxy cache, the server forwards the request to the Internet for resolution.

The gateway computers may also act as a *firewall*. A firewall is a combination of hardware and software components that provide a protective barrier between networks with different security levels (for example, the LAN and the Internet). Rules for transmitting and receiving information to and from the other network can be established for the firewall so that specific types of items or addresses are not allowed to pass between the networks.

In some versions of this LAN connection scheme, a router is placed between the gateway computer and the Internet. In this case, the

router is the only device seen by the outside world, but its function is single-ended in that the LAN server still represents the other computers on the LAN. However, the router can still be used to provide the firewall services referred to earlier.

The physical connection between the LAN and the Internet can be a dial-up connection using the telephone network, or it may involve one of the newer, faster, *always-on* access methods: ISDN, DSL, cable, or satellite. Corporate customers and large organizations may lease special multichannel T1 or T3 telephone lines for direct access to the Internet or ISP. The following sections of this chapter deal with these various Internet connectivity technologies.

Dial-Up Access

As the distance between terminals increases, it soon becomes impractical to use dedicated cabling to carry data. Fortunately, a very extensive communications network is already in existence: the public telephone network. Unfortunately, the phone lines were designed to carry analog voice signals instead of digital data. The design of the public phone system limits the frequency at which data may be transmitted over these lines.

The world's largest communications network is the public telephone system. When computers use this network to communicate with each other, it is referred to as *dial-up networking (DUP)*. Computers connect to the phone system through devices, called *modems*, and communicate with each other using audio tone signals. To use the telephone system, the modem must duplicate the dialing characteristics of a telephone and be able to communicate within the frequencies that occur within the audible hearing range of human beings (after all, this is the range that telephone lines are set up to accommodate).

To overcome this signal deterioration, a modem (short for *modulator/demodulator*) is used to convert the parallel, digital signals of the computer, into serial, analog signals, which are better suited for transmission over wire. A modem allows a computer to communicate with other computers through the telephone lines, as depicted in Figure 21.5.

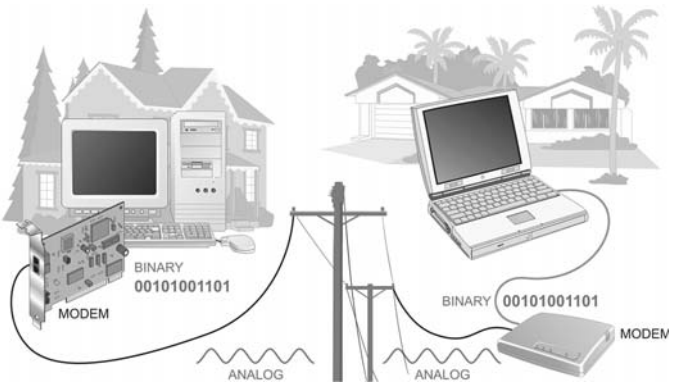


FIGURE 21.5
Modem communications.

In its simplest form, a modem consists of two major blocks: a modulator and a demodulator. The *modulator* is a transmitter that converts the parallel, digital computer data into a serial, analog format for transmission. The *demodulator* is the receiver that accepts the serial, analog transmission format and converts it into a parallel, digital format usable by the computer, or peripheral.

When a modem is used to send signals in only one direction, it is operating in *simplex mode*. Modems capable of both transmitting and receiving data are divided into two groups, based on their mode of operation. In *half-duplex mode*, both modems can exchange data, but only in one direction at a time, as illustrated in Figure 21.6. Walkie-talkies operate in half-duplex mode. *Multiplexing* the send and receive signal frequencies allows both modems to send and receive data simultaneously. This mode of operation is known as *full-duplex mode* (telephones operate in this mode).

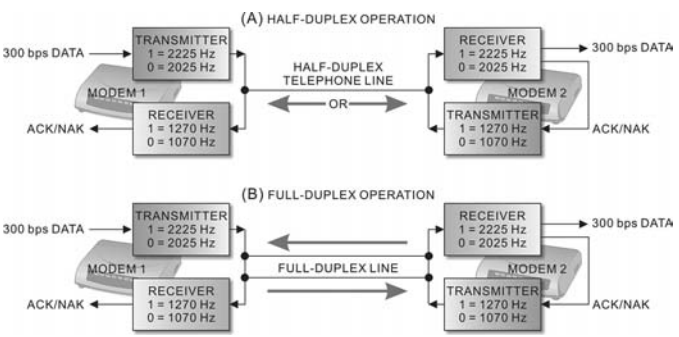


FIGURE 21.6
Half-duplex and full-duplex communications.

A modem can be either an internal or external device, as illustrated in Figure 21.7. An internal modem is installed in one of the computer's expansion slots and has its own interfacing circuitry. The external modem is usually a box that resides outside the system unit and is connected to one of the computer's serial ports by an RS-232 serial cable. These units depend on the interfacing circuitry of the computer's serial ports. Most PC-compatible computers contain two serial-port connections. External modems also require a separate power source.

In both cases, the modem typically connects to the telephone line through a standard 4-pin RJ-11 telephone jack. The *RJ* designation stands for *Registered Jack*. A second RJ-11 jack in the modem allows an additional telephone to be connected to the line for voice usage. A still smaller 4-pin RJ-12 connector is used to connect the telephone handset to the telephone base. Be aware that an RJ-14 jack looks exactly like the RJ-11, but it defines two lines to accommodate advanced telephone features such as caller ID and call waiting.

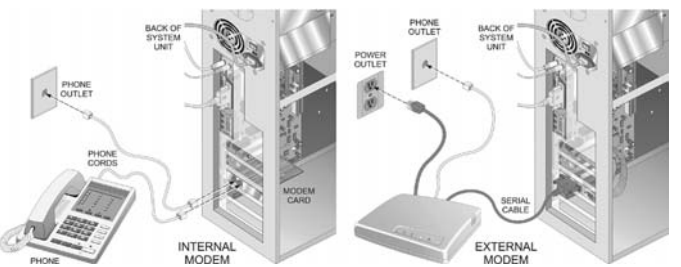


FIGURE 21.7
Internal and external modems.

ISDN Connections

As discussed earlier in the chapter, ISDN service offers high-speed access to the public telephone system. However, ISDN service requires digital modems (also referred to as *terminal adapters*, or *TA*s). Not only does the end user require a digital modem, but the telephone company's switch gear equipment also must be updated to handle digital switching. This fact has slowed implementation of ISDN services until recently.

Three levels of ISDN service are available: *Basic Rate Interface (BRI)* services, *Primary Rate Interface (PRI)* services, and *Broadband ISDN (BISDN)* services.

BRI services are designed to provide residential users with basic digital service through the existing telephone system. The cost of this service is relatively low, although it is more expensive than regular analog service. In addition, BRI service is not available in all areas of the country.

Typical residential telephone wiring consists of a four-wire cable. Up to seven devices can be connected to these wires. Under the BRI specification, the telephone company delivers three information channels to the residence over a two-wire cable. The two-wire system is expanded into the four-wire system at the residence through a network terminator. The ISDN organizational structure is depicted in Figure 21.8.

The BRI information channels exist as a pair of 64Kbps channels and a 16Kbps control channel. The two 64Kbps channels, called *bearer channels* or *B channels*, can be used to transmit and receive voice

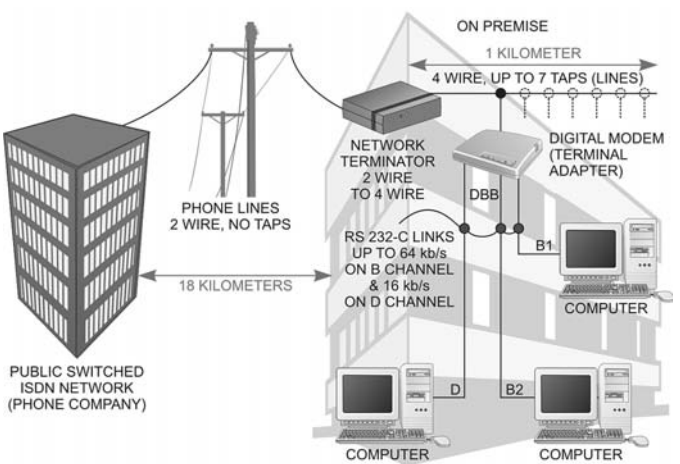


FIGURE 21.8
ISDN organizational structure.

and data information. The 16Kbps D channel is used to implement advanced control features such as call waiting, call forwarding, caller ID, and others. The D channel also can be used to conduct packet-transfer operations.

PRI services are more elaborate ISDN services that support the very high data rates needed for live video transmissions. This type of transmission is accomplished using the telephone company's existing

wiring and advanced ISDN devices. The operating cost of PRI service is considerably more expensive than BRI service. The higher costs of PRI tend to limit its usage to larger businesses.

The fastest, most expensive ISDN service is broadband ISDN. This level of service provides extremely high transfer rates (up to 622Mbps) over coaxial or fiber-optic cabling. Advanced transmission protocols are also used to implement broadband ISDN.

ISDN modems are available in both internal and external formats. In the case of external devices, the analog link between the computer and the modem requires a D-to-A and A-to-D conversion process at the computer's serial port and then again at the modem. Of course, with an internal digital modem, these conversion processes are not required.

Digital Subscriber Lines

Telephone companies have begun to offer a new high-bandwidth connection service to home and business customers in the form of *Digital Subscriber Lines (DSL)*. This technology provides high-speed communication links by using the existing telephone lines to generate bandwidths ranging up to 9Mbps or more. However, distance limitations and line-quality conditions can reduce the actual throughput that can be achieved with these connections.

DSL Modems and Splitters

As with ISDN connections, DSL communications require a special *DSL modem*, also known as an *ADSL Terminal Unit (ATU)*, to provide the interface between the computer (or the computer network) and the DSL phone line. DSL modems are available in both internal and external configurations. Internal DSL modems are installed in one of the host computer's expansion slots similar to an analog dial-up modem. External DSL modems, like the one depicted in Figure 21.9, connect to the computer through a USB port or network adapter card. They typically also require an additional external power source. In many cases, an Ethernet router is installed between the DSL modem and the LAN to provide equal access to the Internet connection. Normally, a CAT5 UTP cable is used to connect the DSL modem to a port on the router.

CHALLENGE #1

A client complains that after replacing his DSL modem, his home DSL connection isn't working. When you inspect his computer, you note that none of the lights on the DSL modem are on. You notice that the only two cables that plug into the DSL modem connect via the RJ-11 and RJ-45 connectors. You are able to ping port 127.0.0.1. What is the most likely problem with the DSL?

Refer to the "Challenge Solutions" section at the end of this chapter for the resolution to the challenge.

Installing a device called a *POTS splitter* in the DSL connection separates the telephone voice band (0–4KHz) and the DSL band used to transmit digital information. This way, the DSL phone line connection can be used for both telephone/voice and data communications.

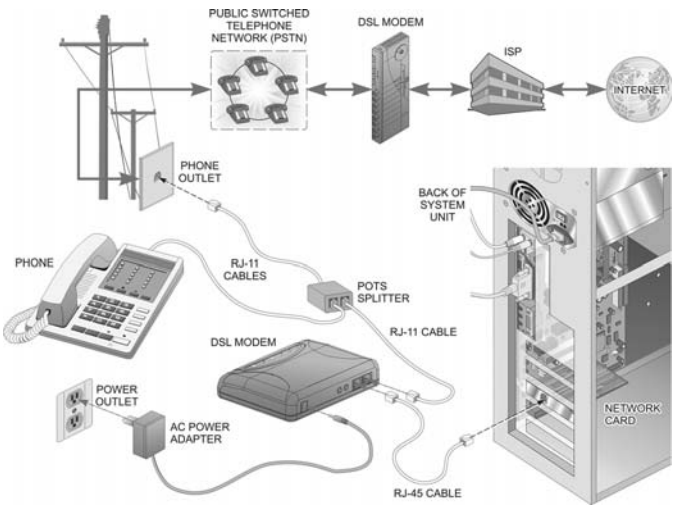


FIGURE 21.9
DSL modem connections.

Depending on the DSL service provider, the splitter may be manually installed at the subscriber location (*splitter-based DSL*), or the signal splitting may be provided remotely from the telephone exchange carrier local office (*splitter-less DSL*). A splitter variation referred to as

Distributed Splitter DSL service lowers the complexity at the subscriber location but is more complex to implement at the local office.

EXAM TIP

Be aware of the consequences of placing a line filter inline with the computer and network equipment in a DSL installation.

With most new DSL installations, line splitters are not required. Instead, telephone line filters are used to separate voice information from communications data. This is achieved by placing line filters on all the lines used by telephones. These filters are placed inline with the phones, as illustrated in Figure 21.10, so that users do not hear the sound of the digital communications going on. Note that no line filter should be placed inline with the network and computer equipment because it will prevent the digital data from reaching it.

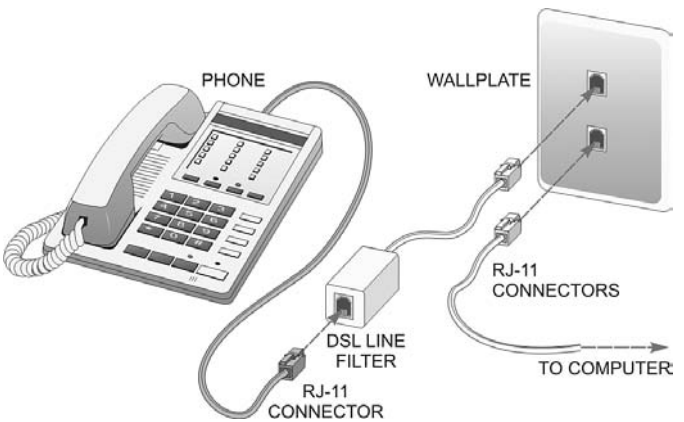


FIGURE 21.10
DSL line filters.

CHALLENGE #2

Your company moves to a new location. Because the company is very small, you use a DSL connection to connect all users to the Internet. When setting up the network, you connect the DSL modem using an RJ-11 connector to the phone outlet, connect the DSL modem to a router using a CAT5 cable, and plug the DSL modem into a power source.

You connect all the workstations to the router using CAT5 cable, and you put line filters on all phone lines and the phone line used for the DSL modem. When you test the system, however, you discover no users can connect to the Internet. When you unplug the DSL modem and remove all the line filters, the phone line is still operational. What is the most likely solution to this situation?

Refer to the "Challenge Solutions" section at the end of this chapter for the resolution to the challenge.

There are several advantages to using DSL connections over standard dial-up connections. Some of these advantages are as follows:

- The speed of DSL connections (1.5Mbps) is much higher than that of dial-up connections using regular modems (56Kbps).
- The Internet connection can remain open while the phone line is used for voice calls.
- DSL service employs existing telephone wires between the home and the telephone-switching center (referred to as the *local office*).
- The local exchange carrier that offers DSL normally provides the DSL modem as part of the installation.

However, there are disadvantages associated with using DSL technologies:

- A DSL connection works better when the user is closer to the provider's central office.
- The ADSL connection is faster for receiving data than it is for sending data over the Internet.
- DSL service is not available in all locations.

DSL Versions

The term *xDSL* is used to refer to all types of DSL collectively. There are two main categories of DSL: *Asymmetric DSL (ADSL)* and *Symmetric DSL (SDSL)*.

SDSL is referred to as *symmetric* because it supports the same data rates for upstream and downstream traffic. Conversely, ADSL (also known as *rate-adaptive DSL*) supports different data-transfer rates when receiving data (referred to as the *downstream rate*) and transmitting data (known as the *upstream rate*). SDSL supports data-transfer rates up to 3Mbps in both directions, whereas ADSL supports data-transfer rates from 1.5 to 9Mbps downstream and from 16 to 640Kbps upstream. Both forms of DSL require special modems that

EXAM TIP

Be aware that ADSL provides different upload and download speeds.

Know that the maximum distance specified between the subscriber location and local office for ADSL is less than 20,000 feet.

employ sophisticated modulation schemes to pack data onto telephone wires. However, you should be aware that access speeds may also vary from provider to provider, even if they are using the same central office to provide service.

xDSL is similar to the ISDN arrangements just discussed in that they both operate over existing copper POTS (plain old telephone system) telephone lines. Also, they both require short geographical cable runs (less than 20,000 feet) to the nearest central telephone office. However, as we've just stated, xDSL services offer much higher transfer speeds. In doing so, the xDSL technologies use a much greater range of frequencies on the telephone lines than the traditional voice services do. In addition, DSL technologies use the telephone lines as a constant connection so users can have access to the Internet and e-mail on a 24/7 basis. Users do not need to connect with an ISP each time they want to go online.

Asymmetric DSL Versions

Asymmetric DSL (ADSL) works by splitting the phone line into two frequency ranges. The frequencies below 4KHz are reserved for voice, and the range above that is used for data. This makes it possible to use the line for phone calls and data network access at the same time. This type of DSL is called *asymmetric* because more bandwidth is reserved for receiving data than for sending data. Asymmetric variations include ADSL, G.lite ADSL, RADSL, and VDSL. The collection of ADSL standards facilitates interoperability between all standard forms of ADSL.

- *Asymmetric DSL (ADSL)*—Full-rate ADSL offers differing upload and download speeds and can be configured to deliver up to 6 megabits of data per second (6,000K) from the network to the customer; that is up to 120 times faster than dial-up service and 100 times faster than ISDN. ADSL enables voice and high-speed data to be sent simultaneously over the existing telephone line.
- *G.lite ADSL*—The *G.lite* standard was specifically developed to meet the Plug-and-Play requirements of the consumer market. It is a medium bandwidth version of ADSL that provides Internet access at up to 1.5 megabits downstream and up to 500 kilobits upstream.
- *Rate Adaptive DSL (RADSL)*—RADSL is a nonstandard version of ADSL, although standard ADSL also permits the ADSL modem to adapt speeds of data transfer.

- *Very-high-bit-rate DSL (VDSL)*—VDSL offers transfer rates of up to 52Mbps, over distances up to 50 meters on short loops such as from fiber to the curb. VDSL lines are normally served from neighborhood cabinets that link to a central office through fiber-optic cabling. This type of DSL is particularly useful for campus-type environments.

EXAM TIP

Be aware that ADSL has the slowest upstream rate and VDSL has the fastest upstream rate.

Table 21.1 illustrates the downstream performance of ADSL as a function of the distance from the subscriber to the local office.

TABLE 21.1

ADSL PERFORMANCE VERSUS LOCAL LOOP LENGTH

CABLE LENGTH (Feet)	BANDWIDTH AVAILABILITY (Kbps)
18,000	1,544
16,000	2,048
12,000	6,312
9,000	8,448

One disadvantage of ADSL service is that when the local loop length increases, the available bandwidth decreases for both upstream and downstream traffic. These numbers assume 24-gauge wire; performance decreases significantly if 26-gauge wire exists on the local loop.

Symmetric DSL Versions

As with ADSL, there are several varieties of *Symmetric DSL*. These versions include SHDSL, HDSL, HDSL-2, and IDSL. The equal upstream and downstream speeds make Symmetric DSL versions useful for LAN access, videoconferencing, and for locations that host their own Web sites.

- *Symmetric DSL (SDSL)*—SDSL is a vendor-proprietary version of symmetric DSL that may include bit rates to and from the customer ranging from 128Kbps to 3Mbps. SDSL is an umbrella term for a number of supplier-specific implementations over a single copper pair providing variable rates of symmetric service.

- *Symmetric HDSL (SHDSL)*—Also known as G.shdsl, SHDL is the newest, industry standard Symmetric DSL version. This service can operate at bit rates ranging from 192Kbps up to 2.3Mbps, depending on the type of customer and installation parameters. Overall, it achieves 20% better useful distance than previous versions of Symmetric DSL (for example, 1.2Mbps transmissions at distances over 20,000 feet using 26 AWG wire).

  SHDSL is designed for data-only applications that require high upstream bit rates. Though SHDSL does not carry voice like ADSL, new *voice-over-DSL* techniques permit these services to be used for transmitting digitized voice and data.

- *High-data-rate DSL (HDSL)*—This DSL variety delivers symmetric service at speeds up to 2.3Mbps in both directions. Available at 1.5 or 2.3Mbps, this symmetric fixed-rate application does not provide standard telephone service over the same line.

EXAM TIP

Be aware that HDSL does not use phones and data on the same lines.

- *High-data-rate DSL, 2nd generation (HDSL2)*—This HDSL version delivers 1.5Mbps service each way, supporting voice, data, and video using either ATM (Asynchronous Transfer Mode), private-line service, or frame relay over a single copper pair. The standard for this symmetric service gives a fixed 1.5Mbps rate both up and downstream. HDSL2 does not provide standard voice telephone service on the same wire pair. The HDSL2 standard employs one pair of wires to transmit data at 1.5Mbps, whereas HDSL requires two pairs.

- *Integrated Services Digital Network DSL (IDSL)*—This DSL type supports symmetric data rates of up to 144Kbps using existing phone lines. It is unique in that it can deliver services through a remote device, called a *Digital Loop Carrier (DLC)*, that is a positioned in planned neighborhoods to simplify the distribution of cable and wiring from the phone company.

Cable Modems

Another competitor in the high-speed Internet connection market involves the local cable television service companies. These companies act as ISPs and provide Internet access through their existing broadband cable television networks. To accomplish this, the cable companies offer special *cable modems* that attach the computer to an existing *cable TV (CATV)* network connection in the home.

The *cable modem* typically features two main connections: one to the host computer's USB port or 10/100 Ethernet network adapter and the other to the CATV coaxial cable outlet on the wall. A CAT5 UTP cable normally provides the communication path between the cable modem and the NIC card. The cable modem employs an *F-Type connector* (similar to a BNC connector) to attach the coaxial cable from the cable system to the cable modem. Figure 21.11 illustrates this connection scheme.

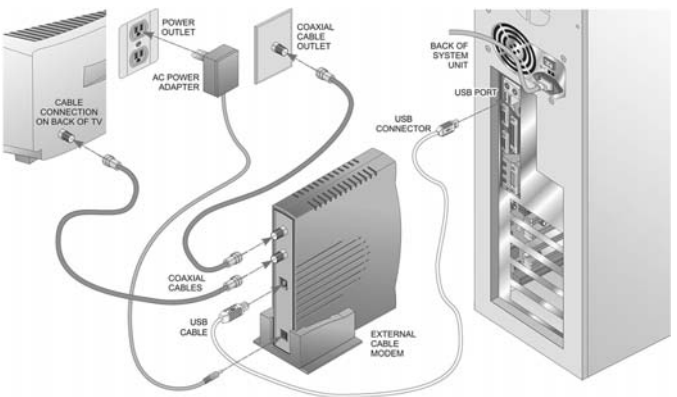


FIGURE 21.11
A cable modem configuration.

When a cable modem subscriber configures multiple computers in a LAN environment, the connection between the cable modem and the network may be made through a gateway/router. This places the router between the modem and the other computers on the network. As with the LAN/Internet connection scheme described earlier, the router provides each computer on the LAN with equal access to the Internet through the modem.

The cable modem is similar to an ADSL modem because it establishes two different transmission rates. They provide for uploading data (information leaving the subscriber PC to the server) to have a slight-

ly slower speed than downloading information (the server sending information to the subscriber). The typical cable modem transfers data at speeds up to 38Mbps downstream and 10Mbps upstream. For comparison, this is about 1,000 times faster than the fastest analog modem connections using dial-up service. However, these rates vary depending on the number of users on the cable (because cable Internet access is a shared service).

In North America, the standard for cable modems is called *Data Over Cable Service Interface Specification (DOCSIS)*. To deliver DOCSIS data services over a cable television network, one 6MHz radio frequency (RF) channel is typically allocated for downstream traffic to residential subscribers. Another frequency channel is used to carry upstream signals.

The DOCSIS standard specifies downstream data rates between 27 and 36Mbps using radio frequencies in the 50 to 750MHz range. The upstream rates are specified between 320Kbps and 10Mbps using RF ranges between 5 and 42MHz.

Satellite Internet Access

Two major companies (DirecTV and Dish Network) have successfully entered the market for television distribution using signals delivered to the customer via *satellite*. In these distribution systems, television signals are transmitted up to a satellite in orbit around the earth (up-linked) and then retransmitted to satellite receiver dishes installed in residences and offices (down-linked). These companies have not been content to simply compete for television distribution markets. They have also taken on the cable distribution companies by providing Internet access via satellite link.

These services have been provided using two methods: two-way satellite link and separate up- and down-link channels using satellite and dial-up telephone lines. In most systems, the satellite dish has no up-link capabilities, so it cannot send data to retrieve information from the Web. This function must be supplied through the telephone connection. Download speeds are very good (up to 1.5Mbps), but upload speeds are limited to the 56Kbps speed of the dial-up modem.

In other satellite systems, the dish is equipped with multiple transceivers that provide both up- and down-links through the satellite link.

Figure 21.12 depicts a typical satellite/Internet communications configuration.

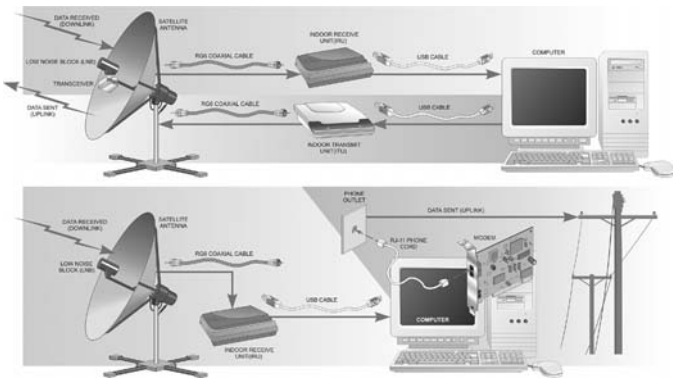


FIGURE 21.12
Satellite Internet access.

As Figure 21.12 illustrates, the satellite dish is the transmitter and receiver for both the television and Internet signals. The dish holds a device known as a *Low Noise Block (LNB)* converter that receives the satellite signal, removes the noise from it, and converts it into a digital signal that is compatible with the *satellite receiver*. RG-6 coaxial cable is used to connect the LNBs and the satellite receiver.

The receiver unit separates the received demodulated signal into the individual television and Internet channels. It typically furnishes multiple methods for connecting to the television sets in the facility, including through RG-59 coaxial cabling and S-video/Optical audio cabling options.

Most receiver models employ a dial-up connection for the up-link portion of the Internet operation but employ the satellite channel to provide very high speed downloads and streaming media service. However, some more expensive models provide an "always on" up-link through the satellite system as well. On the down-link side, the Internet access signal is considered just another channel coming from the satellite that gets filtered out and sent to the computer system, normally through a standard USB port.

However, when the satellite up-link method is included, two USB satellite units are required. These units include the receiver (also called the *Indoor Receive Unit*, or *IRU*) and an additional *Indoor Transmit*

Unit (ITU). The ITU unit is connected to a digital-to-Rf converter mounted on a dish that performs the up-link function. The IRU unit shares the USB connection to the computer with the ITU unit.

Wireless Internet Access

In a wireless network environment, the *access point* is the key component of the *wireless* network. As described earlier in this chapter, the access point can be connected to a hub or computer in the LAN that will act as its host for the wired network.

Several industries are beginning to employ this concept to provide Internet services to their customers who carry Internet-ready wireless computing devices. In these settings, service providers, such as restaurants, hotels, and airports, install access points that provide their customers with Internet access within the hot spot they establish. Customers with wireless-equipped portable computers can connect to the Internet while in a *WiFi-enabled* hot spot such as an airport, hotel lobby, fast-food restaurant, or coffee shop. *WiFi (Wireless Fidelity)* is a trademark used by wireless LANs that operate on unlicensed radio spectrum and are therefore restricted to limited transmitter power covering an area of 200–300 feet from the antenna. In most cases, this Internet connectivity is a for-pay service that the customer signs up for.

A number of computing devices have moved into the wireless Internet access market. In particular, cellular telephones, personal digital devices, and Tablet PCs have become major technologies involved in the wireless Internet market. Cell phones are widely used to send and receive text messages, email, graphics transmissions, and Internet downloads.

Many PDA manufacturers have included wireless Internet access capabilities with their devices. Tablet PCs are small computer systems that offer a trade-off between PDAs and notebooks. They feature touch-screen operation like a PDA but tend to include items such as multiple-gigabyte hard drives and USB ports. They typically work with docking stations just like a laptop to provide removable drives and usually have built-in wireless networking. National ISPs or telephone providers typically supply the actual Internet access service.

CHAPTER SUMMARY

This chapter examined different technologies used to access the Internet. These technologies included access from a local area network environment; dial-up connections using analog modems and the telephone system; access through digital ISDN, DSL, and cable modems; and access through radio frequency wireless and satellite systems

The chapter provided descriptions of the different technologies and their connection schemes. The dial-up networking section builds on the modem installation materials found in Chapters 2 and 7. A major part of the chapter focused on the different types of Digital Subscriber Line (DSL) connections. The wireless Internet access section continued the wireless discussions found in Chapters 2, 3, and 19.

At this point, review the objectives listed at the beginning of the chapter to be certain that you understand each point and can perform each task listed there. Afterward, answer the review questions that follow to verify your knowledge of the information.

KEY TERMS

- ADSL
- Cable modem
- Dial-up networking
- DSL
- F-Type connector
- ISDN
- LAN
- Satellite
- SDSL
- Wireless

APPLY YOUR KNOWLEDGE

Review Questions

1. What services do all ISPs provide to their Internet customers? (Select all that apply.)

   A. spam filtering

   B. Internet identity through IP addresses

   C. DNS routing

   D. email services

2. When two devices can send signals to each other at the same time over the same wire, this is called _____ communication.

   A. simplex

   B. half-duplex

   C. full-duplex

   D. multi-quadraplex

3. What type of communication is possible with an IEEE-1284 parallel cable?

   A. bidirectional, half-duplex

   B. bidirectional, full-duplex

   C. simplex

   D. selectable half- or full-duplex

4. In most satellite systems, the dish has _____ capabilities.

   A. no downlink

   B. both uplink and downlink

   C. no dial-up networking

   D. no uplink

5. Download speeds in satellite Internet systems range up to _____.

   A. 1.5Mbps

   B. 622Mbps

   C. 2.3Mbps

   D. 9Mbps

6. A _____ is a computer used to perform services locally; it then forwards requests for services that it cannot fulfill to an appropriate server.

   A. proxy server

   B. firewall

   C. router

   D. gateway

7. A client complains that she cannot get her DSL Internet connection working. On the phone, she mentions that the Ethernet cable that plugs into the DSL modem will not plug properly into the computer's 56K modem. What should you tell the customer about her connection problem?

   A. A DSL modem plugs into a workstation via a network interface card, not a 56K modem.

   B. She needs to replace the Ethernet cable with a phone line.

   C. She needs to change the modem settings using the Control Panel Wizards to enable DSL.

   D. She needs to add a DSL line filter to the phone outlet that the DSL modem plugs into.

8. You are looking at wireless network cards because you travel frequently and want to have one to provide Internet access in airports and other hotspots. You see one that is labeled as Wi-Fi compatible, and you wonder what type of

APPLY YOUR KNOWLEDGE

range you can expect to have with it. What is the most likely range for this card?

A. 50 to 100 feet

B. 200 to 300 feet

C. 500 to 1000 feet

D. 2,500 to 3,000 feet

9. Modems used in dial-up networking applications produce _____ signals that are compatible with the telephone system.

A. digital/parallel

B. analog/parallel

C. digital/serial

D. analog/serial

10. A customer calls to ask your advice about getting DSL service for his computer. You know there is a distance limit that applies to DSL installations so you find that the customer lives 4.1 miles from the nearest telephone office. What should you tell him about the service?

A. He needs to live within 2.8 miles (15,000 feet) of the telephone company office, so he should consider another form of Internet connectivity.

B. He needs to live within 3.7 miles (20,000 feet) of the telephone company office, so he should consider another form of Internet connectivity.

C. He needs to live within 5.7 miles (30,000 feet) of the telephone company office, so he should have no problem using DSL services for Internet connectivity.

D. He needs to live within 7.5 miles (40,000 feet) of the telephone company office, so he should have no problem using DSL services for Internet connectivity.

Answers and Explanations

1. **B**, **C**, **D**. Services that most ISPs deliver to their customers include Internet identity through IP addresses, email services through POP3 and SMTP servers, Internet news services through Usenet archive servers, and Internet routing through DNS servers.

2. **C**. When a modem is used to send signals in only one direction, it is operating in simplex mode. Modems capable of both transmitting and receiving data are divided into two groups, based on their mode of operation. In half-duplex mode, modems exchange data, but only in one direction at a time. Multiplexing or full-duplex modems send and receive signal frequencies that allow both modems to send and receive data simultaneously.

3. **A**. Because both of the advanced parallel port modes operate in a bidirectional, half-duplex manner, they require an IEEE-1284–compliant cable. Standard parallel cables designed for older SPP operations may not support these qualities.

4. **D**. In most satellite systems, the dish has no uplink capabilities, so it cannot send data to retrieve information from the Web. This function must be supplied through the telephone connection.

5. **A**. Download speeds in satellite systems are very good (up to 1.5Mbps), but upload speeds are limited to the 56Kbps speed of the dial-up modem (unless an RF transmitter is installed in the dish).

APPLY YOUR KNOWLEDGE

6. **A**. A proxy server is a computer used to perform services locally; it then forwards requests for services that it cannot fulfill to an appropriate server.
7. **A**. A DSL modem plugs into a workstation via a network interface card, which uses an RJ-45 connector. A 56K modem connects directly into a phone line and does not interact with a DSL modem in any fashion.
8. **B**. WiFi (Wireless Fidelity) is a trademark used by wireless LANs that operate on unlicensed radio spectrum and are therefore restricted to limited transmitter power covering an area of 200–300 feet from the antenna.
9. **D**. A modem is used to convert the parallel, digital signals of the computer into serial, analog signals, which are better suited for transmission over wire.
10. **B**. DSL connectivity requires short geographical cable runs (less than 20,000 feet) to the nearest central telephone office.

Challenge Solutions

1. DSL modems require an external power source to function.
2. If a filter is put on the DSL connection, the Internet connection may not work correctly.

Suggested Readings and Resources

1. ISDN

   `http://www.ralphb.net/ISDN/`

   `http://www.alumni.caltech.edu/~dank/isdn/`

2. DSL

   `http://www.dslcenter.com/`

   `http://www.xdsl.com/`

   `http://www.dsllife.com/`

   `http://www.dslforum.org/`

3. Cable Modems

   `http://www.cablemodeminfo.com/`