CHAPTER 18

Introducing Networking Components

Networks are an important part of computing today. Large businesses have used networks for decades, but today it's also common to find a network in small businesses and homes. They allow people to easily share resources with other users in the same room and even with other users anywhere in the world.

Exam 220-801 objectives in this chapter:

- 2.7 Compare and contrast Internet connection types and features.
  - Cable
  - DSL
  - Dial-up
  - Fiber
  - Satellite
  - ISDN
  - Cellular (mobile hotspot)
  - Line of sight wireless Internet service
  - WiMAX
- 2.8 Identify various types of networks.
  - LAN
  - WAN
  - PAN
  - MAN
- 2.9 Compare and contrast network devices and their functions and features.
  - Hub
  - Switch
  - Router

- Access point
- Bridge
- Modem
- NAS
- VoIP phones

Exam 220-802 objectives in this chapter:

- 1.2 Given a scenario, install and configure the operating system using the most appropriate method.
  - Workgroup vs. domain setup
- 1.6 Set up and configure Windows networking on a client/desktop.
  - Workgroup vs. domain setup

REAL WORLD **NETWORKING KNOWLEDGE IS VALUABLE**

A+ technicians need to have a solid understanding of networks. You don't need to be an expert, but you should understand the basics. This chapter (along with Chapters 19 through 24) will help you create a foundation for networking.

You'll find that the A+ exams don't go very deep into networking, but don't underestimate its importance. The knowledge you gain about networking for A+ will help you with other career paths. Almost every computer is connected to a network, so this knowledge will help in many information technology jobs. You might also choose to follow your A+ certification with another certification on networking, such as Network+, and you'll be a step ahead in earning those certificates.

I have taught Microsoft classes where some students had a difficult time mastering the material in the class, often because they had to spend extra time trying to understand networking basics. They were certainly intelligent and able to learn the material, but it was like trying to learn algebra without learning multiplication and division. I helped them fill in the holes with basic networking, but the advanced topics often overwhelmed them.

In comparison, the students that came with a solid understanding of networking were able to advance their knowledge.

Types of Networks

Computers are connected together in networks. Some networks are small, such as two computers connected together in a small office. Other networks are huge, including thousands or even tens of thousands of computers spread over multiple cities or regions. However, the common theme of all networks is that they connect computers together.

The primary benefit of networks is that users can access and share resources over the network. For example, instead of requiring a printer for every user, you can have one printer on a network shared by multiple users. Users can also share data such as files over the network.

You probably use the Internet and email regularly. This is possible only because you're connected to a network. You might be connected directly to the Internet or connected through another network. Without network connectivity, you'd have no access to the Internet.

> ***NOTE*** **INTERNET IS A NETWORK OF NETWORKS**
>
> **The Internet is also a network or, more specifically, a group of interconnected networks. It's often referred to as a network of networks. It is accessible by billions of users around the world.**

Some networks are identified based on their connectivity. The following sections describe some common networks.

Local Area Network

A *local area network (LAN)* is a group of computers and other devices that are connected together. It can include just a few users or thousands of users, but the key is that the devices connected to the network are relatively close to each other.

> ***NOTE*** **NETWORK DEVICES**
>
> **A network device is any device that can connect to a network. Typical examples are end user computers, servers, and printers. There are many more devices that can be connected to a network.**

For example, a *small office/home office (SOHO)* refers to a business with between one and 10 users. Devices connected to a SOHO network are in the same office. In contrast, larger businesses can have LANs that take up multiple offices in a building or even an entire building.

Figure 18-1 shows an illustration of a local area network. In the figure, users have access to resources on the network. They can use the fax/copier, the scanner/printer, share data on the

file server, send email through the email server, and access the Internet, all through the LAN. This figure also shows a router, which is explained in greater depth later in this chapter.

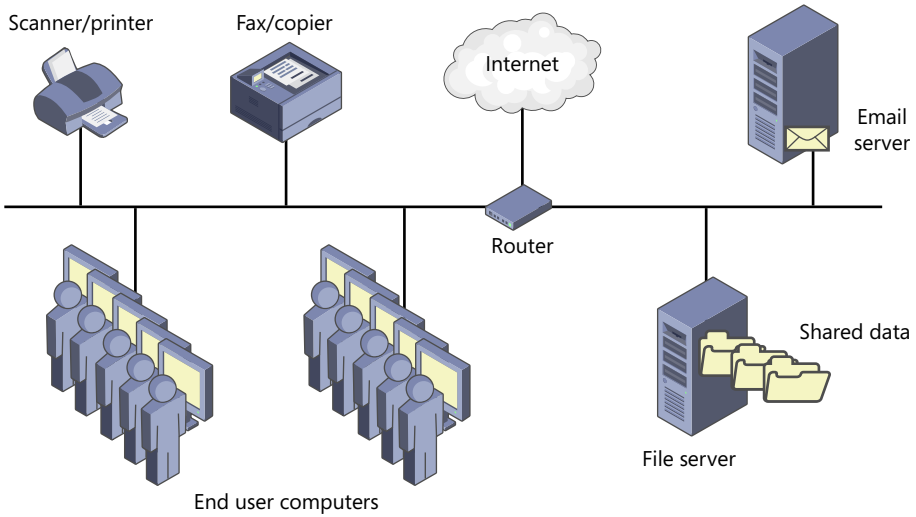


FIGURE 18-1 Local area network (LAN).

LANs can be smaller. For example, if you set up two computers in your home with a printer, this is a LAN. You don't need to have a router, servers, or Internet access.

One of the key characteristics of a LAN is that devices are relatively close to each other. In contrast, a wide area network (WAN) includes multiple LANs that aren't close to one another.

Wide Area Network

A *wide area network (WAN)* includes two or more LANs in separate geographic locations. Each LAN is local for users in the LAN, but other LANs are located elsewhere.

For example, Figure 18-2 shows a WAN for a company with its main offices in Virginia Beach, Virginia, and a small remote office in Raleigh, North Carolina. Connecting the two LANs creates a WAN.

EXAM TIP

Routers (described later in this chapter) are used to connect multiple networks together. This includes connecting networks in the same geographical location in a LAN, and connecting networks in separate locations as a WAN.

Most WAN connections are slower than the LAN connections. In the figure, you can see that the main office has a 1,000-Mbps (megabits per second) LAN, and the remote office has a 100-Mbps LAN. The WAN connection is considerably slower at 128 Kbps (kilobits per second).

Companies usually own all the hardware and cables within their company. However, instead of creating their own connections between two cities, they will often lease access to connections for WAN links. Telecommunications companies already have connection links in place, and they lease access to them. Fast connections are available, but faster connections are more expensive.

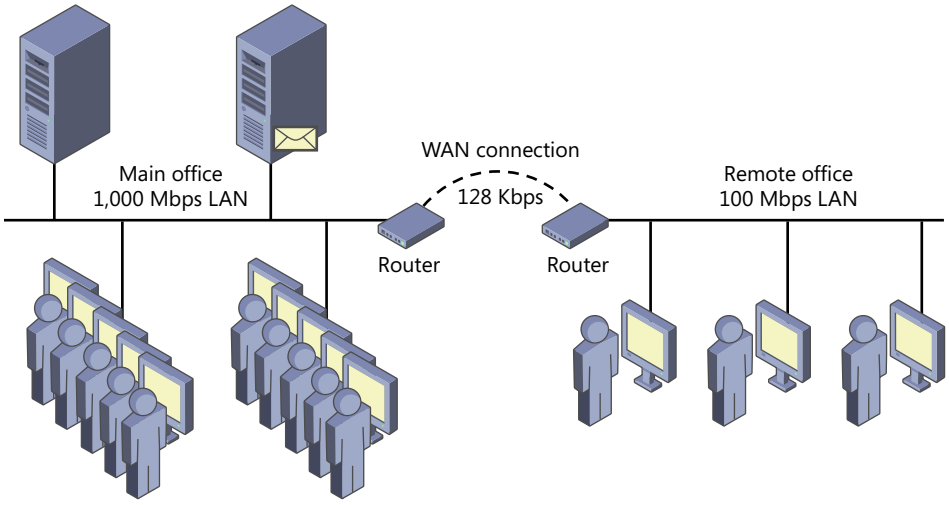


FIGURE 18-2 Wide area network (WAN).

Personal Area Network

A *personal area network (PAN)* is a network organized around a person. It includes mobile devices such as smartphones, earpieces for the smartphones, and personal digital assistants. It can also include handheld computers such as tablets and netbooks. A PAN will often use wireless technologies, so it is sometimes referred to as a *wireless PAN* (*WPAN*).

The range of a PAN is often identified as 10 meters or less (about 33 feet). This corresponds to the range of Class 2 Bluetooth devices, which also have a range of 10 meters. Chapter 9 discusses Bluetooth in the context of connecting mobile devices.

EXAM TIP

Bluetooth classes are related to their power output. Class 1 Bluetooth has the highest power output and has a range of about 100 meters. Class 3 Bluetooth has a range of about 5 meters (about 17 feet).

Metropolitan Area Network

A *metropolitan area network (MAN)* connects multiple LANs within a single metropolitan area. A MAN can be a large university campus or large organization with multiple buildings, or it can even encompass an entire city. Worldwide Interoperability for Microwave Access (WiMAX) is used for many MANs and is discussed later in this chapter.

Virtual Private Network

A *virtual private network (VPN)* provides access to a private network over a public network such as the Internet. Organizations often use VPNs to give employees access to internal network resources even when they're away. Some employees travel, and some employees work from home. With a VPN, they can easily connect to their company's network as needed.

The Internet is a public network accessible to anyone. Because of this, VPN connections over the Internet must be protected, and VPNs use tunneling protocols to encrypt traffic. If unauthorized individuals intercept the transmission, they won't be able to read the data.

Figure 18-3 shows a VPN. In this figure, Susan uses her laptop to connect to the Internet and then connects into the VPN server through a secure tunnel over the Internet. With some software, this is often as easy as connecting to a website. Susan is prompted to enter a user name and password, and her account is checked to ensure that she's authorized to use the VPN. When she's connected, she has access to the internal network.

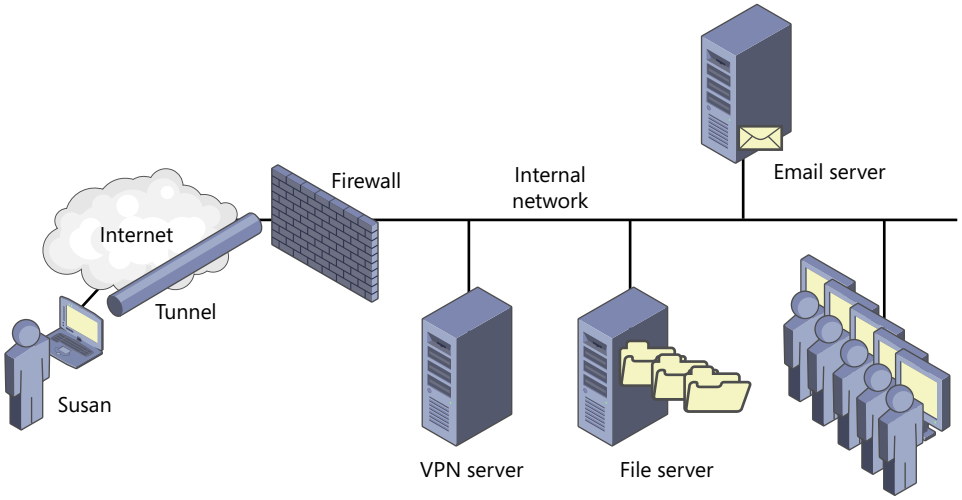


FIGURE 18-3 Virtual private network (VPN).

EXAM TIP

VPNs use tunneling protocols to protect VPN connections. These connections protect data transmitted over the Internet by using encryption.

In Figure 18-3, you can see that a firewall is separating the internal network from the Internet. Firewalls are explained in greater depth in Chapter 22, but in short, they provide a layer of protection for the internal network. They use access control lists (ACLs) to block or allow certain traffic.

When connected to a VPN, users have access to resources on the internal network. The figure shows an email server, a file server, and other users on the internal network. If users can access these resources while connected inside the company, they can usually access them through the VPN.

Quick Check

1. What is a network called when it connects two networks from different locations?
2. What is used to protect VPN connections?

Quick Check Answers

1. Wide area network (WAN).
2. Tunneling protocols.

Identifying Basic Network Hardware

Any network has basic hardware used to connect devices to the network and to connect networks together. Network devices can be computers, printers, servers, network hard drives, or anything else you can connect to the network. This section describes network interface cards, hubs, switches, and routers, but it's important to remember the following points:

- Hubs and switches connect devices to a network.
- Routers connect networks together.

Network Interface Card

A *network interface card (NIC)* provides connectivity for a computer to a network. The most common connection you'll see in NICs is an RJ-45 connector. The RJ-45 connector is similar to an RJ-11 connector used in phones except that the RJ-11 connector is smaller.

MORE INFO **CHAPTER 19**

Connections and cables are described in more depth in Chapter 19. As an introduction, twisted-pair cable is commonly used in networks, and it uses RJ-45 connectors at each end of the cable. These RJ-45 connectors plug into RJ-45 ports. When connecting a computer to the network, one end of the cable plugs into the NIC on the computer, and the other end plugs into the RJ-45 port on a hub (or a switch, if used instead).

Most computers have built-in NICs on the motherboard, but you can also install an adapter card into an available expansion slot on the motherboard. You might want to add a NIC for the following reasons:

- The motherboard doesn't include a NIC.
- The built-in NIC developed a fault.
- You want to install a faster NIC.
- You want to add fault tolerance.

Other devices often have built-in NICs too. For example, many printers have NICs that allow you to connect them directly to the network.

Hub

A *hub* provides connectivity to several devices. For example, you can connect several computers and a printer to a hub, and all of these devices will be able to communicate with each other. Any computer can print to the printer. Users can share files such as pictures, music, and other documents from their computer, and other users can access them through the hub.

Most hubs have RJ-45 ports, and you can run twisted-pair cables from each of the network devices to the hub. For example, Figure 18-4 shows several computers configured in a LAN through a hub.

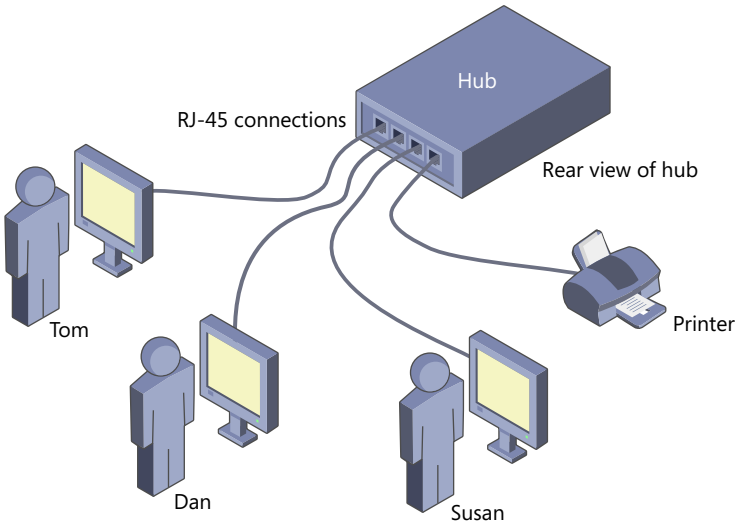


FIGURE 18-4 LAN connected through a hub.

A hub is not intelligent and has no ability to learn. If Tom is sending a print job to the printer, the same data is being sent to Dan's and Susan's computers. Dan's and Susan's computers won't process the data, but it does add traffic to their connection. If Dan was downloading pictures from Susan's computer, it would take longer than if Tom wasn't printing.

Similarly, Tom's print job will take longer than it would if Dan wasn't downloading pictures from Susan's computer.

The more traffic any connection has, the slower it becomes. You can think of this just like a road or highway. If you're the only person on the road, you can easily go the speed limit. If it's rush hour in a big city, traffic can slow to a crawl. If you have a lot of traffic going through a hub, network traffic can slow to a crawl.

NOTE **MOST HUBS REPLACED BY SWITCHES**

Hubs aren't common in network environments anymore. Many organizations replace them with switches to provide better performance. Also, the price of a basic switch is often the same as a hub, so you'll commonly see switches in smaller networks too.

Switch

Switches connect computers and other network devices just as hubs do. The big difference is that switches have some intelligence and have the ability to learn. With just a little bit of time, they identify the devices connected to each port. They then send data addressed to a device only through the port associated with the device. In contrast, the hub sends traffic to all ports.

EXAM TIP

Switches connect network devices together on a network. Switches are more efficient than hubs because they direct traffic to specific ports instead of sending traffic to all ports.

For example, compare Figure 18-4 with Figure 18-5. If Tom sends a print job to the printer, the switch creates an internal connection between Tom's computer and the printer. This traffic doesn't reach Dan's or Susan's computers and doesn't impact the performance of their network connections. If Dan is downloading a file from Susan's computer, the print job traffic doesn't slow him down. Similarly, transferring files between Dan's and Susan's computers doesn't slow down Tom's print job.

The switch dynamically connects different devices depending on the traffic. For example, if Dan decides to print a picture he received from Susan's computer, the switch will make an internal connection from Dan's computer to the printer. Similarly, if Susan wants to download shared documents from Tom's computer, the switch connects the ports for these two computers.

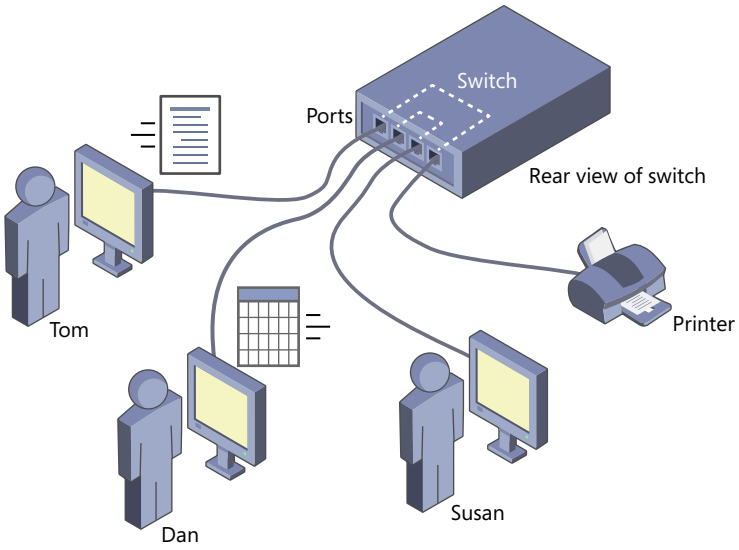


FIGURE 18-5 LAN connected through a switch.

Router

Routers connect networks together. In contrast, hubs and switches connect computers and other networking devices together. You can have multiple networks using switches to connect the devices together, and then connect these networks with a router.

> ***MORE INFO*** **CHAPTER 23**
>
> **Chapter 23 covers wireless networks. In that chapter, you'll see how many wireless routers include a switch component. The switch component connects devices together in a network, and the router component connects networks together. Many SOHOs use wireless routers for connectivity within the office and for Internet access.**

For example, WANs were described previously as two or more networks connected together over a large geographical distance. Each network would use a router to connect to other networks. You can also connect networks together within a single LAN using a router.

Consider Figure 18-6. It shows two separate networks (Network 1 and Network 2) connected together with the router. The router also provides access to all the users in both networks to the Internet.

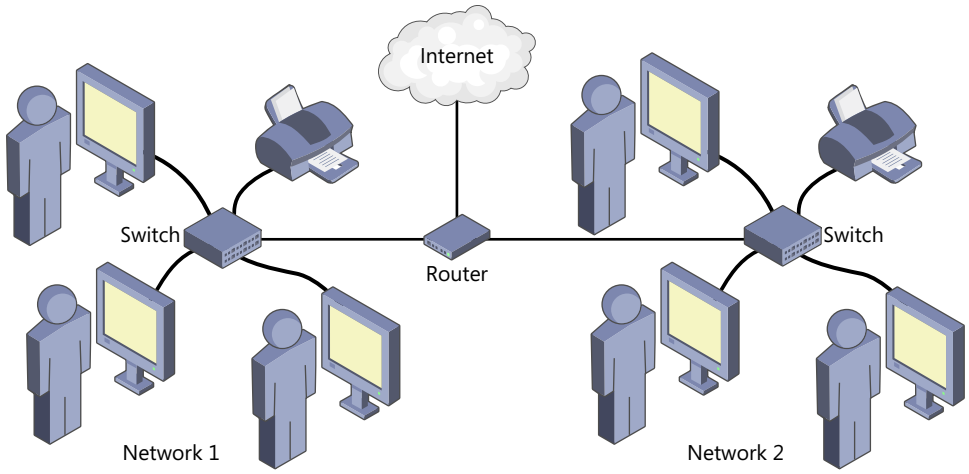


FIGURE 18-6 Connecting networks with a router.

EXAM TIP

Routers connect two or more networks together into a common network. A network with Internet access will have one or more switches (or hubs) connecting the computers together in a network. The router connects the networks together and provides access to the Internet.

Some advanced switches can function like a router. However, for the A+ exam, you won't see any questions on advanced capabilities of switches.

Bridge

A bridge performs like a switch with one basic difference: instead of having separate connections for each computer or device, it uses a single connection to connect two groups of devices.

For example, imagine that you had four computers connected with one hub and four computers connected with a second hub. It's possible to connect the hubs together simulating one larger hub. The problem with this is that each computer can now have up to twice the traffic. If you connect the two hubs with a bridge in the middle, the majority of the traffic in each hub is now passed to the other hub.

While bridges were used with hubs to reduce traffic, they are rarely used in this way today. Switches have replaced them, and many switches are referred to as *multiport bridges*. However, you might run across a wireless bridge.

A wireless bridge is often used to connect two separate networks that are separated by distance. For example, you might have a LAN in one area of a building and want to set up a temporary LAN in a different area of the building. Instead of running wires to the temporary

LAN, you can set up wireless access points in each LAN and use these to bridge the two networks together.

Modem

A *modulator-demodulator (modem)* is a device used to add digital data onto an analog signal through modulation. It can retrieve digital data from an analog signal through demodulation.

Analog data is transmitted as a sine wave similar to the alternating current (AC) sine wave described in Chapter 1. Modulation adds data to this sine wave in the form of variations, and the sine wave acts as the carrier signal for the data. Demodulation removes the carrier signal to read the data. The analog carrier wave can be transmitted over long distances more easily than digital data, especially with certain types of cable.

Users can connect to the Internet by using a standard telephone line and modem through an *Internet Service Provider (ISP)*. The speeds are very slow, so it isn't common to use telephone modems for Internet access except in rural areas where other methods aren't available.

Broadband Internet connections are discussed later in this chapter, and they also use a modem. Cable TV companies have cable running to homes and businesses to provide TV signals, and they use this same cable for an Internet connection. The Internet signal is modulated and demodulated with a cable modem.

Network Attached Storage (NAS)

Network attached storage (NAS) is a dedicated computer system used to provide disk storage on a network. It is often packaged as a small device or appliance that is very easy to connect and use.

For example, I have a Western Digital 1-TB NAS. I turned it on, plugged it into a port on my wireless access point, and with just a little configuration I soon had a 1-TB drive accessible to all the computers on the network. It's running Linux and includes a web-based management program for configuration. Figure 18-7 shows a screen shot from one of the setup pages. This device supports controlling access to specific users and groups with folder permissions.

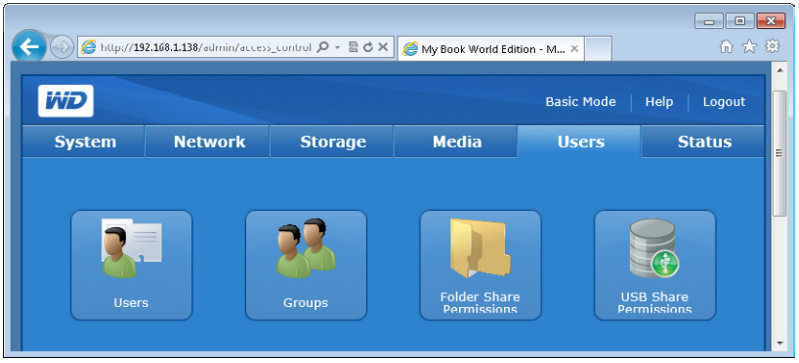


FIGURE 18-7 Managing a NAS device with a web browser.

Larger organizations use NAS devices, but these devices are often more sophisticated. For example, a NAS device in an organization can include multiple drives configured as one or more RAID arrays. These drives are usually hot-swappable, allowing you to replace a failed drive without powering the system down. On a larger scale, organizations use *storage area networks (SANs),* which are entire networks of storage devices.

EXAM TIP

One of the benefits of NAS is that it can be accessed by different operating systems. Users in the network could be running Windows, Linux, or Mac systems and still access the files.

VoIP Phones

Instead of traditional phone lines, a *Voice over Internet Protocol (VoIP) phone* uses an IP network to make telephone calls. Many people use these with an Internet connection to make phone calls instead of using a regular phone line.

VoIP phones look like typical phones, but instead of plugging into a telephone jack with an RJ-11 connector, they plug into a network port on a switch or a router with an RJ-45 connector. Some VoIP phones have wireless capabilities and can connect to a wireless network. You'll need a subscription with a VoIP provider such as Vonage to make phone calls.

EXAM TIP

You can use VoIP as an alternative to a traditional phone without a specialized VoIP phone. One way is with an analog telephone adapter that you connect between your computer and your traditional phone. You can also use a regular computer with a microphone, speakers, a sound card, and some software.

Link, Activity, and Speed Lights

NICs, hubs, routers, and switches have light emitting diode (LED) lights to show connectivity and provide information on the connection.

One LED might be labeled Link to indicate the status of the connection link. Another LED might be labeled *ACT* (for *activity*) to indicate whether any traffic is being transmitted or received on the link. It's common to have a combination Link/Act LED instead of two separate LEDs. These lights can have slightly different meanings for different vendors or models, but some common meanings are the following:

- **Solid green.** The link is connected.
- **Blinking green.** The link is connected, and data activity is occurring on the link.
- **Not lit.** Either nothing is connected or the device can't sense the connection. If you have a cable connected, this often means that the cable is faulty, the device on the other end of the cable is not connected, or the other device is faulty.

EXAM TIP

Many switches and routers allow you to disable a port. When it's disabled, it will not be lit even if you have a good connection. You need to use the device's documentation to enable the port.

Chapter 19 talks about speeds of different connections in more depth, but in short, network devices are rated for specific speeds. Many can also operate using multiple speeds.

For example, a switch might be able to communicate at either 100 Mbps or 1,000 Mbps. Devices that can communicate at different speeds will usually have autosense or auto-negotiation. That is, they automatically determine the fastest speed of the other connected devices and use that speed. A switch might be using 100 Mbps for an older, slower computer connected to one port and 1,000 Mbps for a newer computer connected to a different port. Autosense is built into most NICs and network devices today, and it's best to leave it enabled.

EXAM TIP

Some devices do not have autosense capabilities and might default to a slower speed. If the connection speeds are slower than they should be, you might need to manually configure the devices to use the faster speed.

Devices often include lights to indicate the speed of the link. Again, different vendors might have slightly different meanings for the lights, but some common meanings are as follows:

- **Solid green.** The connection is using the fastest speed (such as 1,000 Mbps).
- **Amber.** The connection is using the slowest speed (such as 100 Mbps).
- **Not lit.** Nothing is connected.

Switches and routers are similar to computers. Occasionally, things go wrong and they don't work as expected. A reboot on a computer is often a good step, as it cures many ills. If a switch or a router stops passing traffic, you can occasionally just power cycle the device and get it to work.

EXAM TIP

If all the activity light LEDs change to a solid green even though you know they should be blinking green to show activity, turn the switch off and then back on. If all the LED lights are off, check the power to ensure that it is on.

Quick Check

1. Name a device used to connect computers together in a network.
2. Name a device used to connect networks together.

Quick Check Answers

1. Hub or a switch.
2. Router.

Comparing Workgroups and Domains

Most networks need both authentication and authorization to control who can access resources. The differences between these two are as follows:

- **Authentication.** Users prove who they are with credentials. A common method of authentication requires use of a user name and password.
- **Authorization.** Users are authorized access to resources based on their proven identity. For example, Dan might be granted authorization to files on a file server. However, just because he can log on and authenticate doesn't mean he has access to all resources in the network. Authorization is granted with permissions.

NOTE **AUTHENTICATION REQUIRED FOR AUTHORIZATION**

Just because someone can authenticate by logging on doesn't mean they are authorized to do anything and everything on the computer. However, you cannot restrict access to resources without users having different authentication credentials. If everyone logs on with the same account, everyone will have the same access.

There are two primary ways that users are authenticated in networks: workgroups and domains. The following sections describe them in more depth, but the distinguishing points between the two are as follows:

- Workgroups are typically for ten or fewer computers.
- In a workgroup, users need separate accounts to access different computers in a workgroup.
- In a domain, users have a single account that they can use to access different domain computers.

Workgroup

A *workgroup* is a group of computers configured in a network with separate account databases. For example, Windows-based computers have a security account manager (SAM) database. This database holds the user names and passwords for all users that can access the computer.

Figure 18-8 shows a workgroup with three users and a printer. Each computer includes a separate SAM. If Tom wants to log on to his computer, he authenticates with a user name and password contained in the SAM on his computer.

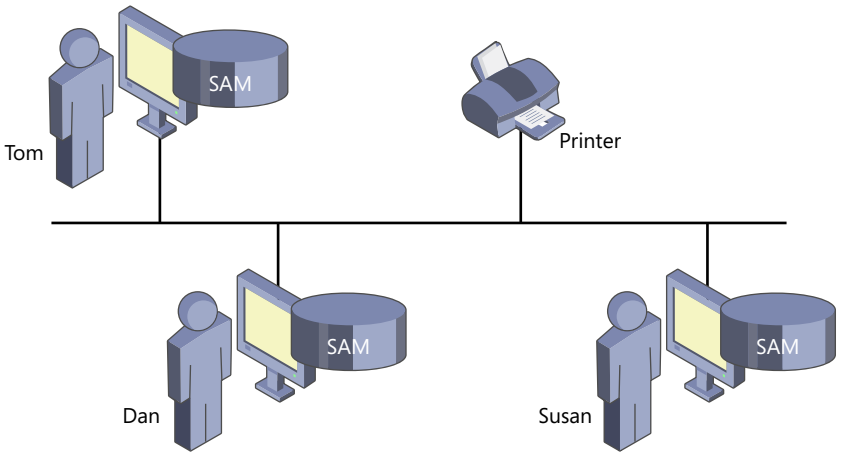


FIGURE 18-8 Computers connected in a workgroup.

> ***NOTE*** **HUBS AND SWITCHES NOT ALWAYS SHOWN ON DIAGRAMS**
>
> **Hubs and switches often aren't shown on logical network diagrams. Instead, the computers are shown connected in a line diagram similar to Figure 18-8. This diagram implies connectivity with a hub or a switch. You can compare Figure 18-8 to Figures 18-4, 18-5, and 18-6, which specifically identify switches and hubs.**

Tom's account on Tom's computer won't allow him to log on to Dan's or Susan's computers. If Tom wants to log on to Dan's computer, he needs another account stored on the SAM on Dan's computer. Tom would need three user names and three passwords to log on to each of the computers shown in Figure 18-8.

One reason to switch over to a domain is when users need to access multiple computers in the network. If they need multiple user accounts and passwords, they are more likely to write them down. They will have only a single account with a domain, and they'll be less likely to write them down.

Windows desktop–based systems limit how many users can connect at the same time. For example, if Susan is sharing pictures from her computer, there is a limit to how many other users can connect to her computer to access these pictures. This limit is technically known as the maximum number of concurrent connections allowed. Table 18-1 shows the maximum concurrent connections identified by the licensing terms of many common Windows-based systems.

TABLE 18-1 Windows Maximum Concurrent Connections

Operating System	Maximum Concurrent Connections
Windows XP Home	5
Windows XP Professional	10
Windows Vista Home Basic	5
Windows Vista Home Premium and Ultimate	10
Windows 7 Starter, Home Premium, Professional, and Ultimate	20

EXAM TIP

The maximum number of concurrent connections for Windows XP Professional is 10, but the maximum has been increased to 20 for all editions of Windows 7.

It is possible to add servers into a workgroup if you need to provide services to more than 10 or 20 users. However, after you add a server, it does not require much more to create a domain.

Domain

A *domain* has a central server that holds accounts used for authentication. For example, a Microsoft domain includes a server configured as a domain controller, and this server hosts Active Directory. Active Directory is similar to the SAM in that it includes user accounts, but it also has many more capabilities. However, the most important point for the A+ exam is that the domain provides centralized authentication.

Figure 18-9 shows a domain controller configured in a domain. Users log on using one account, and they can use this account to access resources they're authorized to use. Therefore, users don't need a different account even if they log on to a different computer in the domain.

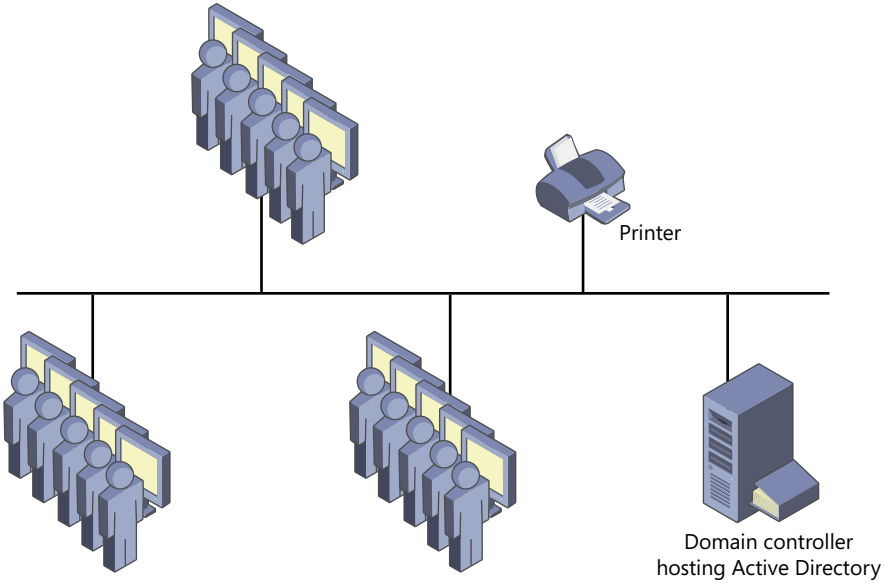


FIGURE 18-9 Computers connected in a domain.

The domain controller can also be configured for other server roles. For example, a small company using a domain controller will often use it as a file server and a print server.

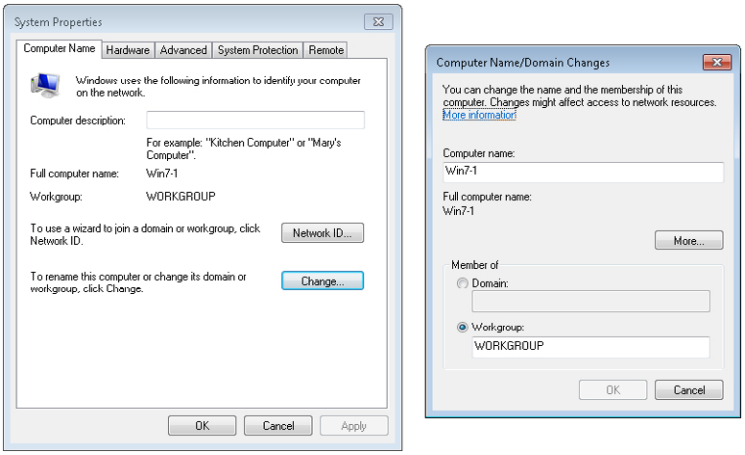
Joining a Workgroup or a Domain

You can use the following steps on a Windows 7–based system to join a computer to a workgroup or a domain. You need to know the name of the domain and have an account that is authorized to join the domain.

EXAM TIP

By default, any user with an account in the domain has permissions to join up to 10 computers to the domain. Administrative permissions are not needed.

1. Click Start, right-click Computer, and select Properties.
2. Select Advanced System Settings.
3. Click the Computer Name tab and click Change. Your display will resemble the following graphic.



4. If you want to join a different workgroup, enter the name of the workgroup and click OK.
   - **A.** After a moment, you'll see a message welcoming you to the workgroup.
   - **B.** Click OK, and you'll be prompted to restart the computer. After restarting, the computer will be a member of the workgroup.
5. If you want to join a domain, select Domain and enter the name of the domain. Click OK.
   - **A.** You'll be prompted to enter the user name and password of an account that has permission to join the domain. Enter the name and password, and click OK.
   - **B.** After a moment, you'll be prompted to restart the computer. Click OK. After restarting, the computer will be a member of the domain.

Connecting to the Internet

Most people who have a computer today want to access the Internet. They use it for email, research, news, sharing information with friends and family, and much more. However, everyone doesn't connect to the Internet in the same way. The following sections describe some common methods of connecting to the Internet.

Cable and Fiber Broadband Connections

In the context of an Internet connection, broadband connections refer to connections that have much greater bandwidth than connections using a phone line. More bandwidth means that you can download or upload data quicker than connections with less bandwidth. As a comparison, a dial-up connection (discussed later in this section) is much slower than a broadband connection.

For example, many people use Netflix to stream movies to their home computers. If you have a broadband connection, the movie is usually clear without distortion in the picture or sound. However, if you use dial-up, the movie will constantly stop and start and be highly distorted. You probably won't even be able to watch the movie over a dial-up connection.

Broadband cable service is usually offered by the same company that provides cable TV services. These companies have run cable to homes and business for TV connections in many city areas. One single cable can carry hundreds of TV channels, and users can simply change channels to watch whatever they want.

Telecommunications companies realized that they could also put a signal for the Internet onto the same cable. Just as a TV tuner can tune to the correct channel and block all other channels, cable modems can tune to the Internet connection and block the TV signals.

Figure 18-10 shows a basic connection path for a broadband cable connection for a home user. The telecommunications company provides both the TV signal and the connection to the Internet as an Internet Service Provider (ISP). The signal is split at the user's home with one cable going to the TV and the other cable going to a cable modem and then to the user's computer.

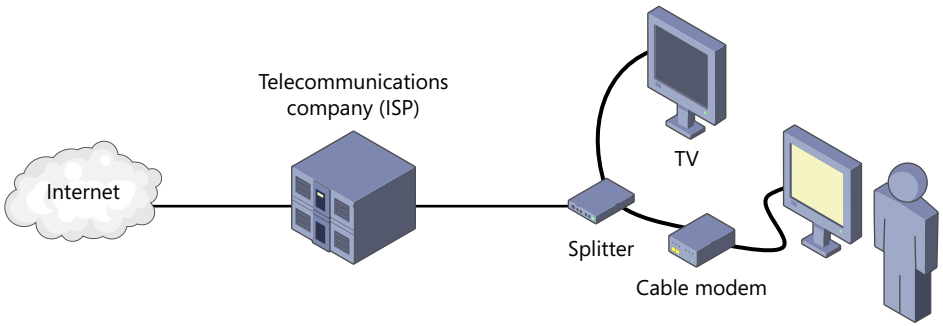


FIGURE 18-10 Cable broadband connection for a home user.

NOTE **MODEMS**

Cable providers often sell or rent cable modems, or you can buy one from an electronics store such as Best Buy.

The ISP provides the user with a public Internet Protocol (IP) address usable on the Internet. Of course, users can do more with their connection. It's a short leap to add a switch to connect multiple users in the home network and to add a router to provide Internet access to all the users in the home network.

Broadband cable has traditionally used coaxial cables. However, some telecommunications companies have been using fiber optic cables more and more. For example, where I live, Verizon provides FIOS service over fiber. It includes TV, Internet access, and telephone service.

Fiber optic cable provides the most available bandwidth, so users can often get faster speeds with fiber.

Phone Connections

Unfortunately, broadband connections aren't available everywhere. Many areas are too far from a city for telecommunications companies to run cable. Sometimes the cost of a broadband connection is just too high for a user, even when it is available. A cheaper alternative that is available almost anywhere is a phone connection.

Phone connections require modems, similar to how cable connections require cable modems. The signal going to a computer is digital and compatible with a computer. The signal from a phone line is often analog and compatible with phones. The modem ensures that the input and output signals are translated correctly.

EXAM TIP

Phones and modems use cables with RJ-11 connections. The cables and RJ-11 connections are smaller than the RJ-45 connections used with NICS, hubs, switches, and modems.

Most modems allow you to split the phone line. You can connect the phone line directly into the modem input jack. The modem then has another port that you can connect to your phone. With traditional phone lines, you can either talk on the phone or connect with the computer, but you can't do both at the same time.

Dial-up

The typical phone connection to the Internet is simply a dial-up connection. The *plain old telephone service (POTS)* provides voice-grade communications to users in most places in the world and can be used for Internet access. Users subscribe through an ISP for dial-up access, and when they want to connect, they connect through the modem.

Phones and phone lines are connected through a *public switched telephone network (PSTN)*. The PSTN includes all the connections throughout the world and allows us to easily make phone calls. Telecommunications companies have been steadily upgrading the PSTN, and it can often support digital signals instead of just analog.

A benefit of dial-up access is that it is available almost anywhere. If you have access to a phone line, you can connect. The drawback is the speed; dial-up connections are painfully slow.

The maximum speed you can get from a single phone line connection is 56 Kbps. In the United States, this maximum is limited by regulations to 53.3 Kbps. In comparison, I performed a speed test on my broadband cable connection and it showed a download speed of 33.02 Mbps.

ISDN

Integrated Services Digital Network (ISDN) is a special type of dial-up connection that uses a telephone network. Since the signals are digital, a traditional modem isn't used but instead ISDN lines use terminal adapters in the place of modems. There are two primary types of ISDN connections:

- **Basic Rate Interface (BRI).** A BRI uses two 64-Kbps channels providing a maximum speed of 128 Kbps. This is used by homes and small businesses. It also has a 16-Kbps signal control channel.
- **Primary Rate Interface (PRI).** A PRI uses 23 64-Kbps data channels and one 64-Kbps data channel. In North America, this is called a *T1* and provides a total of about 1.5 Mbps. In Europe, a PRI uses 30 data channels and one 64-Kbps signal control channel and is called an *E1*. T1 and E1 lines are typically used only by businesses, not home users.

You can make and receive phone calls while you're connected to most ISDN lines. However, ISDN will disconnect one of the channels, reducing the speed of the Internet connection.

DSL

Digital subscriber lines (DSLs) are another alternative that uses a PSTN. Similar to ISDN, DSLs send signals over the lines using digital signals instead of the analog connections used by traditional dial-up connections. There are several versions of DSL, and they are sometimes referred to as xDSL.

The two most common types of DSL are ADSL and SDSL:

- **ADSL.** Asymmetric DSL uses different speeds for uploads and downloads. Home users can often get ADSL lines with upload speeds of around 500 Kbps and download speeds of around 1 Mbps.
- **SDSL.** Symmetric DSL uses the same speed for uploads and downloads. It is often used for businesses, and they can lease lines at varying speeds, such as 384 Kbps or 500 Kbps. Faster speeds are more expensive.

EXAM TIP

***Asymmetric* indicates that something doesn't have balance or has differences, while *symmetric* indicates that it is similar in size and shape. Asymmetric DSL has differences; specifically, it has different speeds for uploads and downloads. Symmetric DSL has similarities; specifically, the upload and download speeds are the same.**

DSL connections use a transceiver to send and receive data. This transceiver isn't technically a modem, but you'll often hear it referred to as a DSL modem.

A drawback with DSL is that users must be relatively close to the phone company's equipment. This limits DSL to large city areas.

Cellular

Cellular telephones have been around for a while, and you probably have one or know someone who does. Traditionally, a cellular phone allowed you only to make phone calls using the phone company's cellular network. Many cellular networks are on the third generation (3G) and fourth generation (4G); cellular networks are spreading rapidly.

> ***MORE INFO*** **CHAPTER 9**
>
> **Chapter 9 includes a comparison of different generations of cellular networks in the cellular connectivity section.**

Telecommunications companies have been steadily upgrading their cellular towers and cellular networks to support data in addition to voice. It's now common to have a cellular phone that you can use to make traditional phone calls and access the Internet.

Cellular providers now sell devices that are specifically designed for mobile computers. For example, I have an air card modem from Verizon, shown in Figure 18-11 plugged into a laptop USB port. When I'm on the road, I plug it in, connect, and then I have Internet access. Just as you need a subscription for the cell phone, you also need a subscription for the wireless Internet card.

FIGURE 18-11 Wireless air card plugged into laptop computer.

Additionally, most smartphones have wireless capabilities built into them. For example, if you have a smartphone and a wireless network at your home, you can configure the smartphone to connect to the Internet through the wireless network. Similarly, you can connect through public hotspots using wireless.

WiMAX

Worldwide Interoperability for Microwave Access (WiMAX) is a wireless standard that is expanding the range of many wireless networks. The goal is to deliver high-speed Internet access for large geographical areas without physical connectivity.

EXAM TIP

WiMAX is not the same as a wireless network, commonly called Wi-Fi. Wi-Fi (covered in Chapter 23) includes several 802.11 standards used for wireless LANs (WLANs). WiMAX is used for long-range networks, such as a MAN.

Figure 18-12 shows the basics of a WiMAX network. An ISP is connected to the Internet and has a wired connection to a WiMAX tower. The tower has a transmitter and receiver with a clear line of sight to another tower with another transmitter and receiver. Data is transmitted via microwave between the two towers.

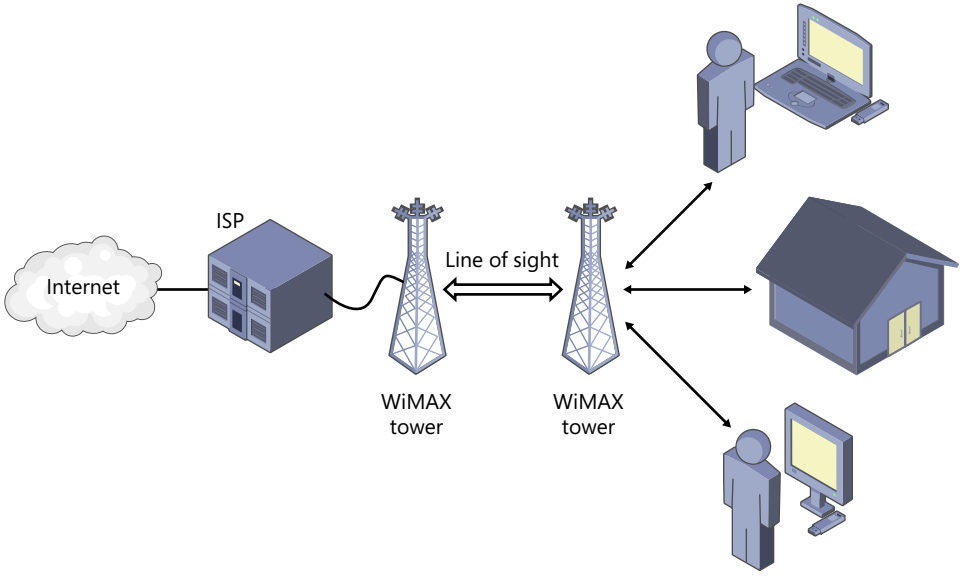


FIGURE 18-12 WiMAX network.

Users connect to the WiMAX network with subscriber stations. These are commonly *USB dongles,* which plug into a PC similarly to the air card shown in Figure 18-11. They act as a modem to connect to the WiMAX tower. Users can also use a gateway that can be installed outside the building or located close to a window. The gateway connects to the WiMAX tower and can provide a signal to multiple devices within the building.

Connections to the user systems or gateways do not require a line-of-sight connection.

Satellite

Another alternative available for users in rural areas is satellite access. This is sometimes a good alternative for users who don't have access to cable providers or don't have cellular access.

Figure 18-13 shows a typical configuration for a satellite-based Internet connection. The ISP maintains a satellite and has a connection to the Internet through its own satellite dish. Users have a satellite dish at their home with a satellite modem connected to their computer.

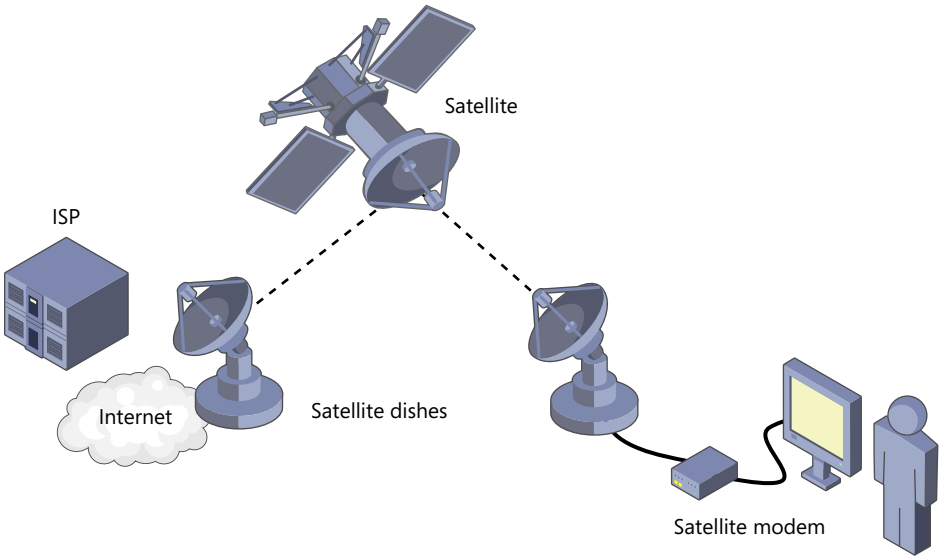


FIGURE 18-13 Satellite connection for a home user.

In older configurations, the user was required to have a phone connection and the user's satellite dish was able to only download data. That is, the user had a downlink from the satellite but not an uplink to the satellite. When a user clicked a link in a web browser, the signal was sent through the phone line to the ISP. The ISP then sent the data to the user through the satellite. In most current configurations, the user's equipment provides both an uplink and a downlink to the satellite.

Satellites are placed in a geostationary orbit. Even though the earth is spinning and the satellite is moving in space, the satellite always appears to be in the same location from any location on earth.

Users must have a clear line of sight to the satellite from their satellite dish. Obstructions from buildings and trees will block the connection. Additionally, moisture from rain and clouds can sometimes absorb the signal, reducing or blocking the connection.

Another drawback to satellites is that the signals have to travel so far. Satellites are over 22,000 miles above earth, and each signal must go up to the satellite and come back down. Then the reply has to travel up to the satellite and come back down. It's not unusual for a

signal to take half a second or longer for a one-way trip. This results in high latency times for users. After a user clicks, it can take a second or longer to get a reply.

EXAM TIP

Satellite connections travel over the greatest distance compared to any other type of Internet connection, resulting in latency issues. The biggest limitation is that they require a clear line of sight between the satellite and each of the satellite dishes used for uplinks and downlinks.

Quick Check

1. **Considering Internet connectivity, what does broadband indicate?**
2. **What is unique to ADSL compared to SDSL?**

Quick Check Answers

1. **Greater bandwidth and higher speeds.**
2. **ADSL has different upload and download speeds. SDSL speeds are the same.**

Standards Organizations

As you study networking topics, you'll come across some acronyms and names representing standards or standards organizations. You don't need to be an expert on them, but you should have a basic idea of what they are.

- **IEEE (Institute of Electrical Engineers).** This is a standards organization that has defined a wide assortment of standards. For example, IEEE 802.3 is a collection of standards for wired networks, and IEEE 802.11 is a collection of standards for wireless networks. It is commonly pronounced as "I Triple E."
- **ISO (International Organization for Standardization).** An international standards organization headquartered in Switzerland. Some standards are developed with the International Electrotechnical Commission (IEC) and designated as ISO/IEC. According to ISO, ISO is not an acronym but instead based on the Greek word *isos*, meaning equal.
- **IETF (Internet Engineering Task Force).** A standards organization that develops and promotes Internet standards. Its focus is on the TCP/IP protocol suite used on the Internet.
- **RFC (Request for Comment).** When the IETF develops standards, it first publishes them as an RFC with a number. For example, RFC 1918 defines what IP addresses should be reserved for private networks. An RFC is never modified after it is published. If a change is needed, a new RFC is published with a new number.

Chapter Summary

- A local area network (LAN) is a group of computers and other network devices connected together in a single location.
- Wide area networks (WANs) connect two or more LANs that are in separate geographical locations.
- A virtual private network (VPN) provides access to a private network over a public network such as the Internet. Tunneling protocols are used to protect data in a VPN.
- A personal area network (PAN) is a network organized around a person. Bluetooth-enabled devices are commonly used. A switch connects devices together in a network.
- A router connects networks together. Routers are needed to provide access from a network to the Internet and to connect networks together over a WAN.
- Network attached storage (NAS) is a network appliance that provides access to disk storage over a network.
- Voice over IP (VoIP) phones use network connections to make phone calls and can be used instead of a phone line.
- Network devices have link and activity lights that identify how they are working. Link lights are usually solid green to show a connection. Activity lights blink to show activity.
- A workgroup is a small group of computers in a network with separate account databases used for authentication.
- The maximum number of concurrent connections on Windows 7 is 20. On Windows XP Professional, the maximum is 10.
- A domain includes a centralized server used for accounts. In a Microsoft domain, a domain controller hosts Active Directory, which includes accounts. Users need to have only one account to access multiple computers.
- Broadband connections provide users with higher bandwidth and faster download times.
- Traditional dial-up connections use plain old telephone service (POTS) and a modem. The maximum speed is 56 Kbps.
- Digital subscriber lines (DSLs) provide faster speeds over phone lines than does traditional dial-up service. Asymmetric DSL has different speeds for uploads and downloads. Symmetric DSL uses the same speed for uploads and downloads.
- Cellular connections to the Internet use connections through cellular networks. Users can subscribe with a company and access the Internet with a phone, or they can use USB modems to connect to the cellular network.

- WiMAX is used for long-range wireless networks in MANs. Users connect with subscriber stations.
- Satellite Internet connections use satellite dishes for uploads and downloads. A drawback is that they require line-of-sight connections and have high latency times. Signals can be blocked by buildings, trees, and even rain.

Chapter Review

Use the following questions to test your knowledge of the information in this chapter. The answers to these questions, and the explanations of why each answer choice is correct or incorrect, are located in the "Answers" section at the end of this chapter.

1. You want to connect a network in one office to a network in an office in a separate city. What are you creating, and what device do you need to connect the two offices?
   - **A.** You're creating a WAN, and you need routers.
   - **B.** You're creating a WAN, and you need switches.
   - **C.** You're creating a LAN, and you need routers.
   - **D.** You're creating a PAN, and you need switches.
2. After replacing a faulty switch with an older switch on their 100-Mbps network, users complain that the network connections are slow. Of the following choices, what is the most likely problem?
   - **A.** The switch is configured to use 1 Gbps.
   - **B.** The switch's ports are disabled.
   - **C.** The switch is not autosensing the speed of the network.
   - **D.** The switch is running in WAN mode.
3. Computers connected on a network through a switch can no longer communicate with each other. You notice all the lights are steady. What should you do?
   - **A.** Replace all the computers.
   - **B.** Replace all the cables.
   - **C.** Reboot the computers.
   - **D.** Turn the switch off and then back on.

4. After adding a new computer to a network, you realize the computer is the only one that can't communicate with other devices on the network. You verified the cable to the switch is good. Of the following choices, what should you do next?

   A. Replace the NIC.

   B. Replace the computer.

   C. Verify the port on the switch is enabled.

   D. Power cycle the switch.

5. Which of the following Internet connections uses different speeds for uploads and downloads?

   A. DSL

   B. ADSL

   C. SDSL

   D. Dial-up

6. Which of the following connections requires a clear line of sight for devices?

   A. Dial-up

   B. ISDN

   C. Cellular

   D. Satellite

Answers

1. **Correct Answer:** A
   - **A. Correct:** A wide area network (WAN) is two or more local area networks (LANs) located in separate locations. WANs are connected together with routers.
   - **B. Incorrect:** This is a WAN, but routers are needed to connect the LANs.
   - **C. Incorrect:** Each office network is a LAN, but when you connect them you're creating a WAN.
   - **D. Incorrect:** A personal area network (PAN) is on or around a person and typically uses Bluetooth.
2. **Correct Answer:** C
   - **A. Incorrect:** If it is configured to use 1 Gbps, it would try to run faster, not slower.
   - **B. Incorrect:** Disabling ports on a switch will block all traffic, not slow it down.
   - **C. Correct:** If a switch doesn't have autosense or auto-negotiation, it needs to be manually configured for the speed of the network. In this case, it's likely the switch is configured for a slower speed, such as 10 Mbps.
   - **D. Incorrect:** There is no such thing as WAN mode for a switch. Additionally, routers are used to connect networks over a WAN.
3. **Correct Answer:** D
   - **A. Incorrect:** It's unlikely all the computers suddenly developed faults at the same time.
   - **B. Incorrect:** It's unlikely all the cables suddenly developed faults at the same time.
   - **C. Incorrect:** Rebooting a computer is often a good troubleshooting step, but it's unlikely all the computers suddenly developed faults at the same time.
   - **D. Correct:** The switch is the common point of failure here, and you can often correct a problem like this by power cycling the switch.
4. **Correct Answer:** C
   - **A. Incorrect:** Replacing the network interface card (NIC) shouldn't be done first. A sound troubleshooting practice is to do the easy things first. If this answer was "Check the link light on the NIC," it would be easier than verifying the port on the switch, and a better answer.
   - **B. Incorrect:** If network connectivity is the only problem, replacing the computer isn't necessary.

C. **Correct:** If the computer is the only one not working, the problem is with the computer's NIC, the cable, or the port on the switch. The cable has been checked, and it's easier to check the port than replace the NIC or the computer.

D. **Incorrect:** Power cycling the switch might be appropriate if all devices can't communicate. However, if other devices are working, this will interrupt their connectivity and is not appropriate in this scenario.

5. **Correct Answer:** B

A. **Incorrect:** There are different types of digital subscriber lines (DSLs) and not all of them use different speeds.

B. **Correct:** Asymmetric digital subscriber lines (ADSLs) have different speeds for uploads and downloads.

C. **Incorrect:** Symmetric digital subscriber lines (SDSLs) use the same speed for uploads and downloads.

D. **Incorrect:** Dial-up connections use the same speed for uploads and downloads.

6. **Correct Answer:** D

A. **Incorrect:** Dial-up uses cables and does not require a clear line of sight.

B. **Incorrect:** ISDN uses cables and does not require a clear line of sight.

C. **Incorrect:** Cellular uses radio frequency transmissions and does not require a clear line of sight.

D. **Correct:** Satellite connections require a clear line of sight from the satellite disk to the satellite. Obstructions such as buildings or trees block the connection. While not listed, Worldwide Interoperability for Microwave Access (WiMAX) requires a clear line of site between WiMAX towers.