SUBJECT

WIRELESS NETWORKS

SESSION 5Network Topology/Case study

SESSION 5: Network Topology

Network Topology **you will be able to:**

- Identify the four standard topologies and their variations.
- Describe the advantages and disadvantages of each topology.
- Determine an appropriate topology for a given network plan.

Designing a Network Topology

The term topology, or more specifically, network topology, refers to the arrangement or physi Network Topology cal layout of computers, cables, and other components on the network. "Topology" is the standard term that most network professionals use when they refer to the network's basic design. In addition to the term "topology," you will find several other terms that are used to define a network's design:

- Physical layout
- Design
- Diagram
- Map

A network's topology affects its capabilities. The choice of one topology over another will have an impact on the:

- Type of equipment the network needs.
- Capabilities of the equipment.
- Growth of the network.
- Way the network is managed.

Developing a sense of how to use the different topologies is a key to understanding the capabilities of the different types of networks.

Before computers can share resources or perform other communication tasks they must be connected. Most networks use cable to connect one computer to another.

NOTE

Wireless networks connect computers without using cable. This technology is discussed in Chapter 2 in Lesson 3: Wireless Networking.

However, it is not as simple as just plugging a computer into a cable connecting other computers. Different types of cable—combined with different network

cards, network operating systems, and other components—require different types of arrangements.

To work well, a network topology takes planning. For example, a particular topology can determine not only the type of cable used but also how the cabling runs through floors, ceilings, and walls.

Topology can also determine how computers communicate on the network. Different topologies require different communication methods, and these methods have a great influence on the network.

Standard Topologies

All network designs stem from four basic topologies:

- Bus
- Star
- Ring
- Mesh

A *bus topology* consists of devices connected to a common, shared cable. Connecting computers to cable segments that branch out from a single point, or hub, is referred to as setting up a *star topology*. Connecting computers to a cable that forms a loop is referred to as setting up a *ring topology*. A *mesh topology* connects all computers in a network to each other with separate cables.

These four topologies can be combined in a variety of more complex hybrid topologies.

Bus

The bus topology is often referred to as a "linear bus" because the computers are connected in a straight line. This is the simplest and most common method of networking computers. Figure 1.15 shows a typical bus topology. It consists of a single cable called a *trunk* (also called a backbone or segment) that connects all of the computers in the network in a single line.
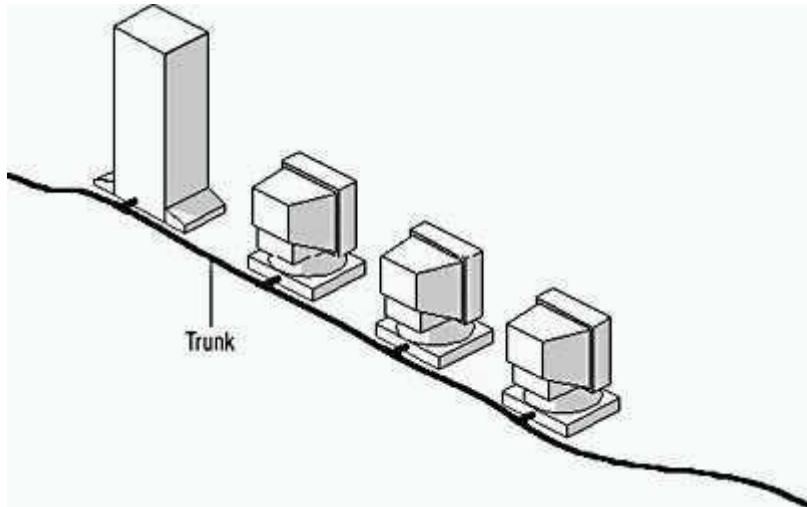
Figure 1.15 *Bus topology network*

Run the **c01dem01** video located in the **Demos** folder on the compact disc accompanying this book to view a demonstration of a bus-topology connection.

Communication on the Bus

Computers on a bus topology network communicate by addressing data to a particular computer and sending out that data on the cable as electronic signals. To understand how computers communicate on a bus, you need to be familiar with three concepts:

- Sending the signal
- Signal bounce
- Terminator

Sending the Signal Network data in the form of electronic signals is sent to all the computers on the network. Only the computer whose address matches the address encoded in the original signal accepts the information. All other computers reject the data. Figure 1.16 shows a message being sent from 0020af151d8b to 02608c133456. Only one computer at a time can send messages.

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Run the **c01dem02** video located in the **Demos** folder on the compact disc accompanying this book to view a demonstration of how data is transferred in a bus topology.
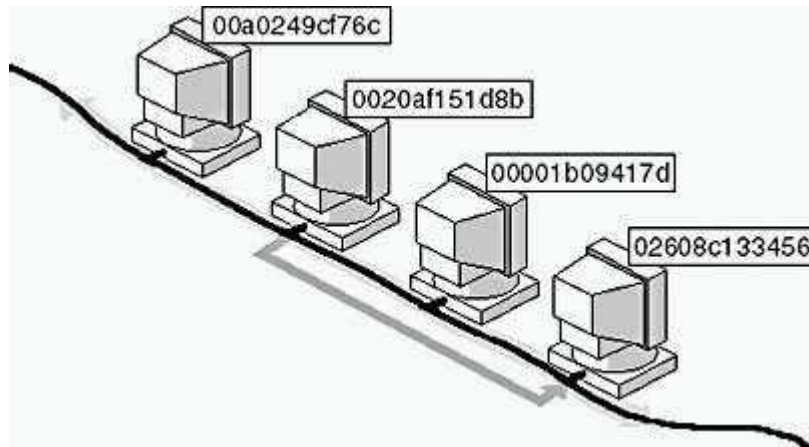
Figure 1.16 *Data is sent to all computers, but only the destination computer accepts it*

Because only one computer at a time can send data on a bus network, the number of computers attached to the bus will affect network performance. The more computers there are on a bus, the more computers will be waiting to put data on the bus and, consequently, the slower the network will be.

There is no standard way to measure the impact of a given number of computers on the speed of any given network. The effect on performance is not related solely to the number of computers. The following is a list of factors that—in addition to the number of networked computers—will affect the performance of a network:

- Hardware capabilities of computers on the network
- Total number of queued commands waiting to be executed
- Types of applications (client-server or file system sharing, for example) being run on the network
- Types of cable used on the network
- Distances between computers on the network

Computers on a bus either transmit data to other computers on the network or listen for data from other computers on the network. They are not responsible for moving data from one computer to the next. Consequently, if one computer fails, it does not affect the rest of the network.
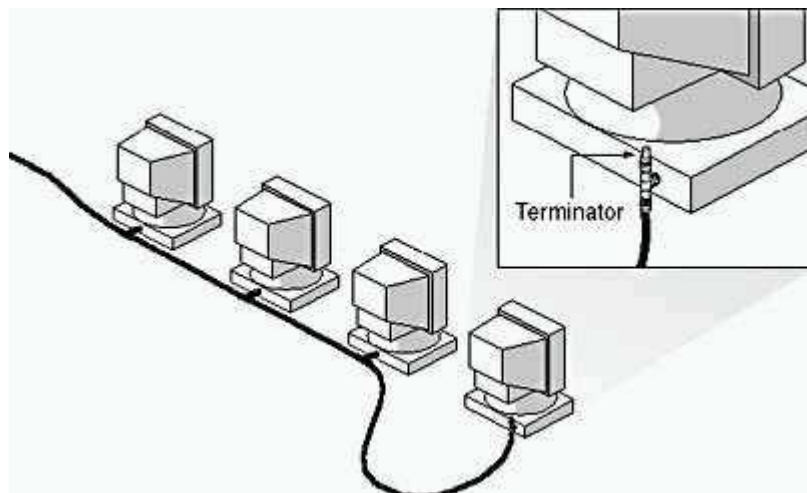
Run the **c01dem03** video located in the **Demos** folder on the CD accompanying this book to view a demonstration that shows how a failed computer does not affect data transmission in a bus topology.

Signal Bounce Because the data, or electronic signal, is sent to the entire network, it travels from one end of the cable to the other. If the signal is allowed to continue uninterrupted, it will keep bouncing back and forth along the cable and prevent other computers from sending signals. Therefore, the signal must be stopped after it has had a chance to reach the proper destination address.

Run the **c01dem04** video located in the **Demos** folder on the CD accompanying this book to view a demonstration of signal bounce.

Terminator To stop the signal from bouncing, a component called a *terminator* is placed at each end of the cable to absorb free signals. Absorbing the signal clears the cable so that other computers can send data.

Both ends of each cable segment on the network must be plugged into something. For example, a cable end can be plugged into a computer or a connector to extend the cable length. Any open cable ends not plugged into something must be terminated to prevent signal bounce. Figure 1.17 shows a properly terminated bus topology network.

Figure 1.17 *Terminators absorb free signals*

Run the **c01dem05** and **c01dem06** videos located in the **Demos** folder on the CD accompanying this book to view a terminator component and a demonstration of how a terminator eliminates signal bounce.

Disrupting Network Communication

A break in the cable will occur if the cable is physically separated into two pieces or if at least one end of the cable becomes disconnected. In either case, one or both ends of the cable will not have a terminator, the signal will bounce, and all network activity will stop. This is one of several possible reasons why a network will go "down." Figure 1.18 shows a bus topology with a disconnected cable. This network will not work because it now has unterminated cables.

The computers on the network will still be able to function as stand-alone computers; however, as long as the segment is broken, they will not be able to communicate with each other or otherwise access shared resources. The computers on the down segment will attempt to establish a connection; while they do so, workstation performance will be slower.
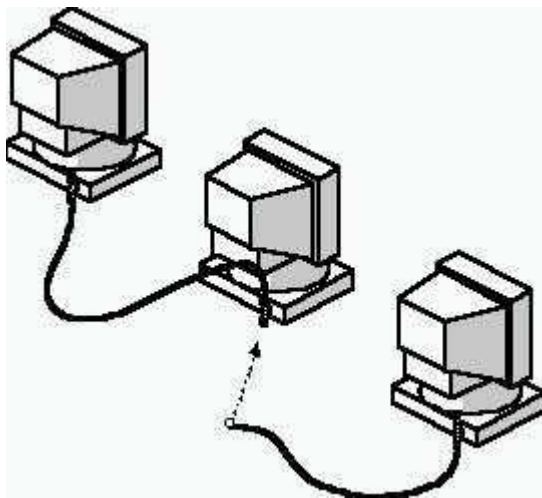

Figure 1.18 *An unplugged cable is not terminated and will take down the network*

Run the **c01dem07** and **c01dem08** videos located in the **Demos** folder on the CD accompanying this book to view a demonstration of what happens when there is a break in the cable of a bus-topology network.

Network Expansion

As the physical size of the site grows, the network will need to grow as well. Cable in the bus topology can be extended by one of the two following methods:

- A component called a *barrel connector* can connect two pieces of cable together to make a longer piece of cable (see Figure 1.19). However, connectors weaken the signal and should be used sparingly. One continuous cable is preferable to connecting several smaller ones with connectors. Using too many connectors can prevent the signal from being correctly received.
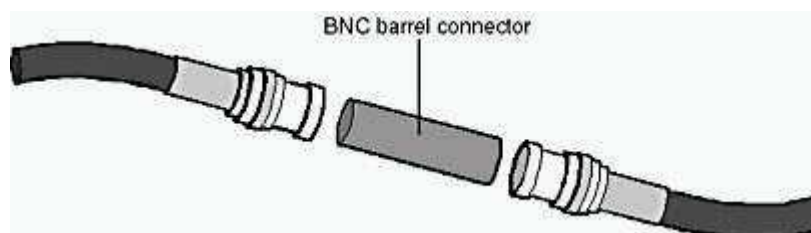
Figure 1.19 *Barrel connectors can be used to combine cable segments*

- A device called a *repeater* can be used to connect two cables. A repeater actually boosts the signal before it sends the signal on its way. Figure 1.20 shows a repeater boosting a weakened signal. A repeater is better than a connector or a longer piece of cable because it allows a signal to travel farther and still be correctly received.
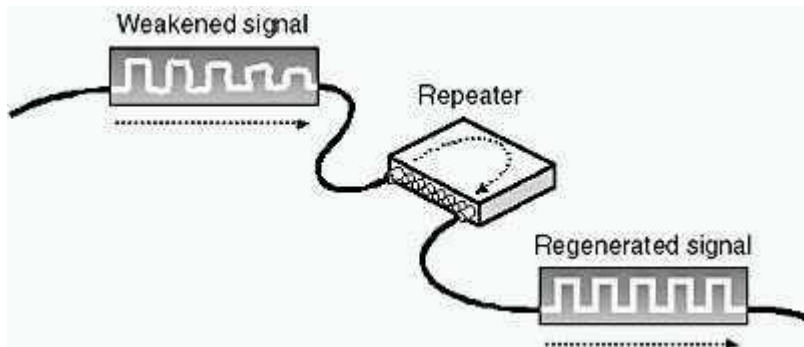
Figure 1.20 *Repeaters connect cables and amplify the signal*

Star

In the star topology, cable segments from each computer are connected to a centralized component called a *hub*. Figure 1.21 shows four computers and a hub connected in a star topology. Signals are transmitted from the sending computer through the hub to all computers on the network. This topology originated in the early days of computing when computers were connected to a centralized mainframe computer.
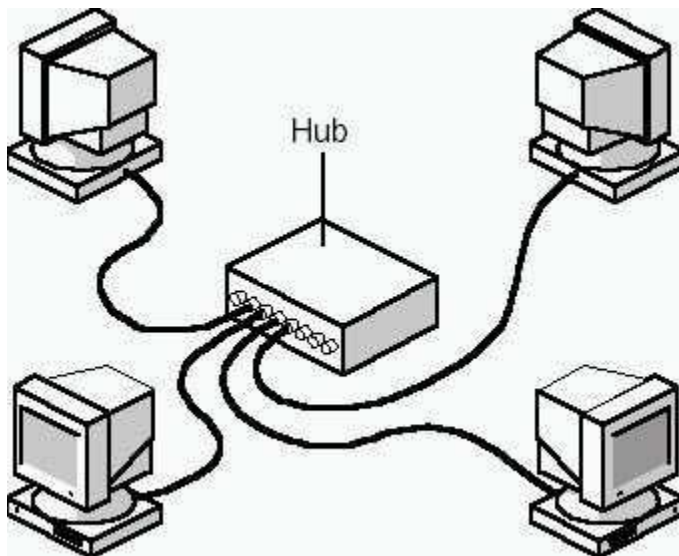
Figure 1.21 *Simple star network*

Run the **c01dem09** and **c01dem10** videos located in the **Demos** folder on the CD accompanying this book to view demonstrations of a star topology.

The star network offers the advantage of centralized resources and management. However, because each computer is connected to a central point, this topology requires a great deal of cable in a large network installation. Also, if the central point fails, the entire network goes down.

If one computer—or the cable that connects it to the hub—fails on a star network, only the failed computer will not be able to send or receive network data. The rest of the network continues to function normally.

Run the **c01dem11** video located in the **Demos** folder on the CD accompanying this book to view a demonstration of what happens when a computer on a star topology network goes down.
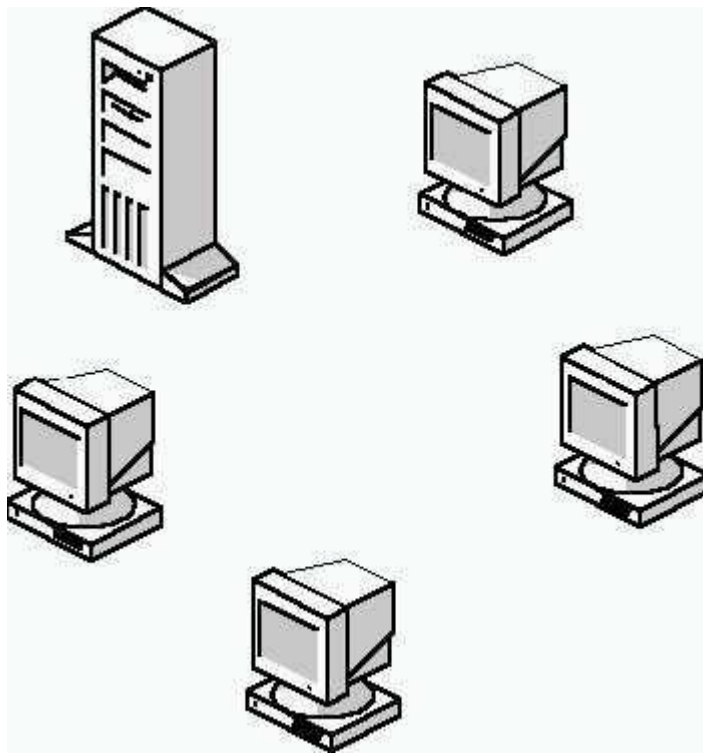
Ring

The ring topology connects computers on a single circle of cable. Unlike the bus topology, there are no terminated ends. The signals travel around the loop in one direction and pass through each computer, which can act as a repeater to boost the signal and send it on to the next computer. Figure 1.22 shows a typical ring topology with one server and four workstations. The failure of one computer can have an impact on the entire network.

NOTE

A network's physical topology is the wire itself. A network's logical topology is the way it carries signals on the wire.
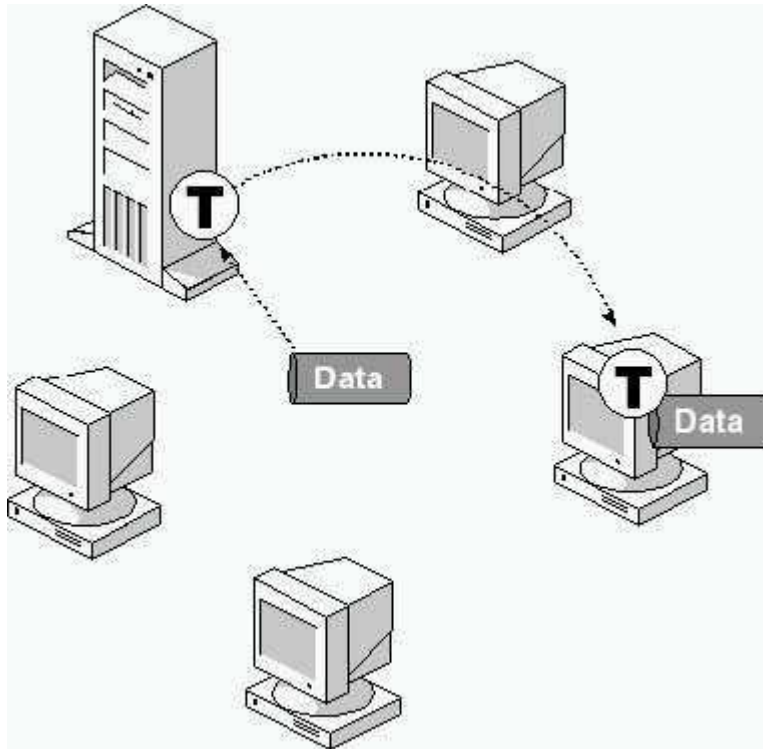
Figure 1.22 *Simple ring network showing logical ring*

Run the **c01dem12** and **c01dem13** videos located in the **Demos** folder on the CD accompanying this book to view demonstrations of logical and actual flows of data on a ring-topology network.

Token Passing

One method of transmitting data around a ring is called *token passing*. (A *token* is a special series of bits that travels around a token-ring network. Each network has only one token.) The token is passed from computer to computer until it gets to a computer that has data to send. Figure 1.23 shows a token ring topology with the token. The sending computer modifies the token, puts an electronic address on the data, and sends it around the ring.

Figure 1.23 *A computer grabs the token and passes it around the ring*

The data passes by each computer until it finds the one with an address that matches the address on the data.

The receiving computer returns a message to the sending computer indicating that the data has been received. After verification, the sending computer creates a new token and releases it on the network. The token circulates within the ring until a workstation needs it to send data.

Run the **c01dem14** and **c01dem15** videos located in the **Demos** folder on the CD accompanying this book to view demonstrations of both the logical and actual flows of token passing on a ring topology network.

It might seem that token passing would take a long time, but the token actually travels at roughly the speed of light. A token can circle a ring 200 meters (656 feet) in diameter about 477,376 times per second.

Run the **c01dem16** video located in the **Demos** folder on the CD accompanying this book to view a demonstration of what happens when a computer on a token ring_topology network goes down.

Mesh

A mesh topology network offers superior redundancy and reliability. In a mesh topology, each computer is connected to every other computer by separate cabling. This configuration provides redundant paths throughout the network so that if one cable fails, another will take over the traffic. While ease of troubleshooting and increased reliability are definite pluses, these networks are expensive to install because they use a lot of cabling. Often, a mesh topology will be used in conjunction with other topologies to form a hybrid topology.
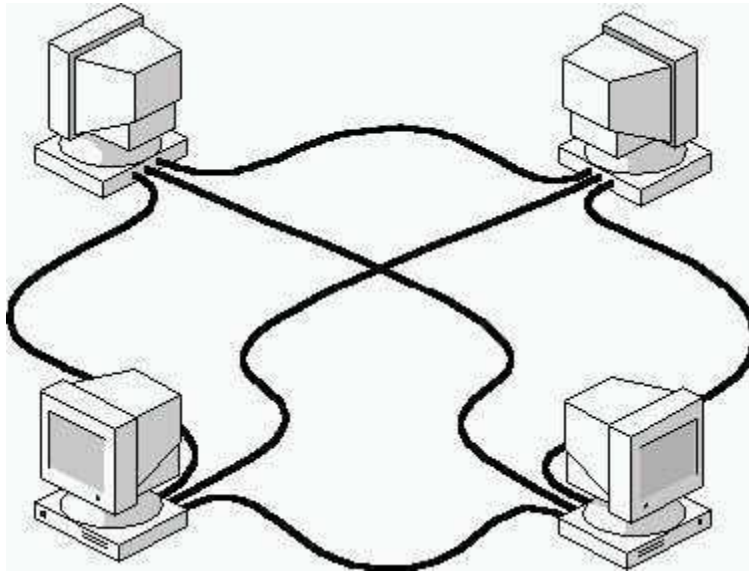
Figure 1.24 *In a mesh topology, all computers are connected to each other by separate cables*

Hubs

One network component that has become standard equipment in networks is the hub. Figure 1.25 shows a hub as the central component in a star topology.
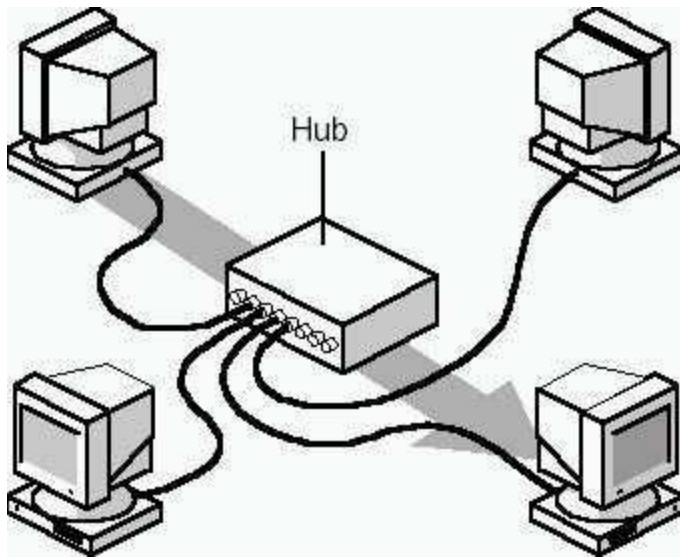
Figure 1.25 *A hub is the central point in a star topology*

Active Hubs

Most hubs are active; that is, they regenerate and retransmit signals in the same way as a repeater does. Because hubs usually have eight to twelve ports for network computers to connect to, they are sometimes called multiport repeaters. Active hubs require electrical power to run.

Passive Hubs

Some types of hubs are passive; examples include wiring panels or punch-down blocks. They act as connection points and do not amplify or regenerate the signal; the signal passes through the hub. Passive hubs do not require electrical power to run.

Hybrid Hubs

Advanced hubs that will accommodate several different types of cables are called *hybrid hubs*. Figure 1.26 shows a main hub (the hybrid) with three sub-hubs.
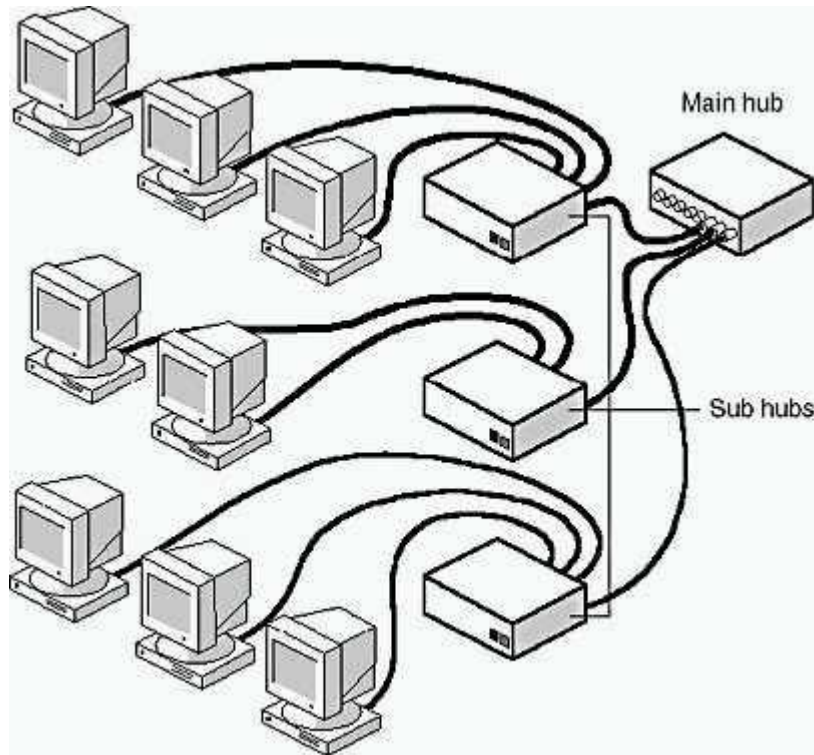
Figure 1.26 *Hybrid hub*

Hub Considerations

Hub-based systems are versatile and offer several advantages over systems that do not use hubs.

In the standard linear-bus topology, a break in the cable will take the network down. With hubs, however, a break in any of the cables attached to the hub affects only a limited segment of the network. Figure 1.27 shows that a break or disconnected cable affects only one workstation while the rest of the network keeps functioning.
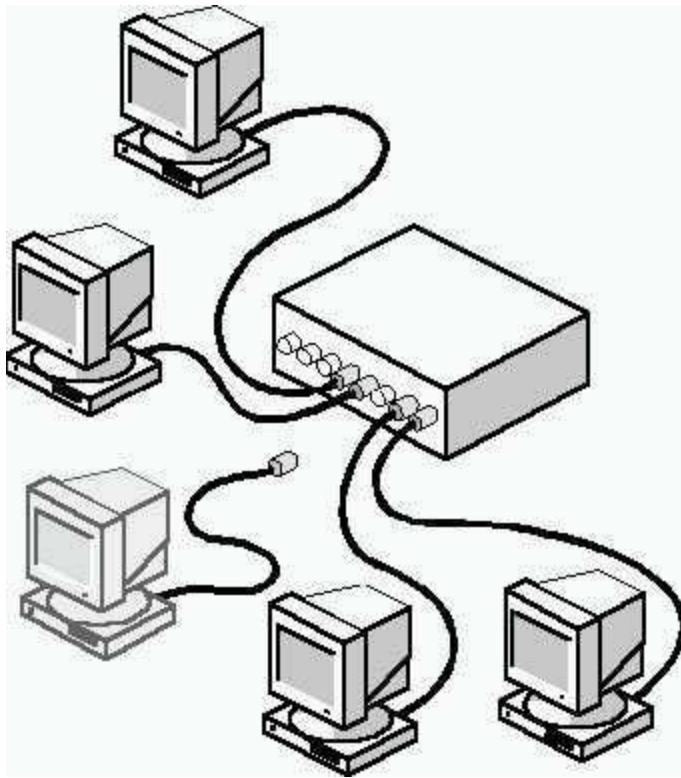
Figure 1.27 *A break or unplugged cable takes down only the unplugged computer*

Hub-based topologies include the following benefits:

- Wiring systems can be changed or expanded as needed.
- Different ports can be used to accommodate a variety of cabling types.
- Monitoring of network activity and traffic can be centralized.

NOTE

Many active hubs have diagnostic capabilities that can indicate whether or not a connection is working.

Run the **c01dem017** video located in the **Demos** folder on the CD accompanying this book to view a discussion and demonstration of the role of hubs in network topologies.
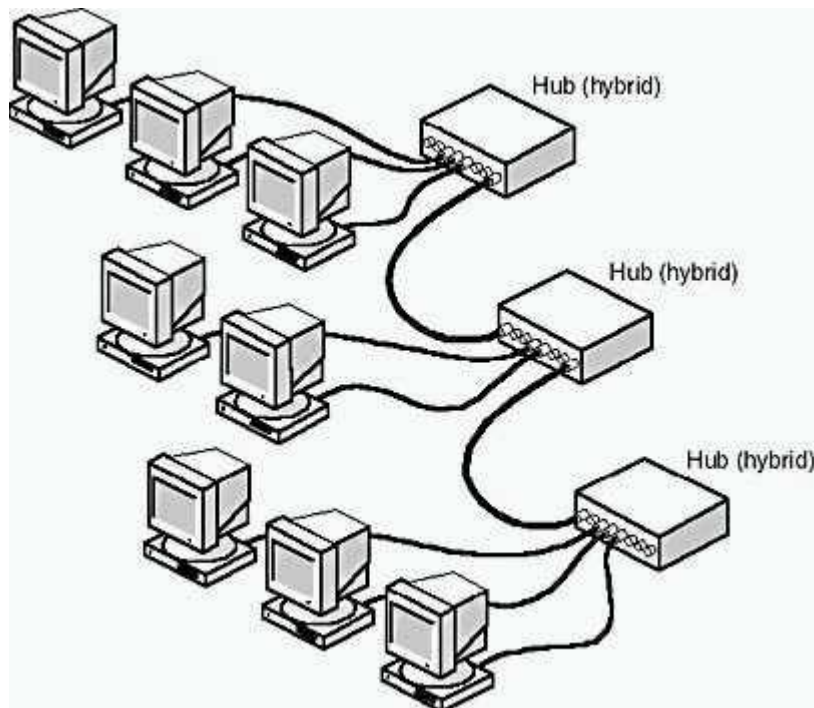
Variations on the Standard Topologies

Star Bus

If one computer goes down, it will not affect the rest of the network. The other computers can continue to communicate. If a hub goes down, all computers on that hub are unable to communicate. If a hub is linked to other hubs, those connections will be broken as well.


Figure 1.28 *Star-bus network*

Run the **c01dem018**, **c01dem19**, and **c01dem20** videos located in the **Demos** folder on the CD accompanying this book to view demonstrations of what happens when computers and hubs in a star-bus topology go down.

Star Ring

The *star ring* (sometimes called a star-wired ring) appears similar to the star bus. Both the star ring and the star bus are centered in a hub that contains the actual ring or bus. Figure 1.29 shows a star-ring network. Linear-bus trunks connect the hubs in a star bus, while the hubs in a star ring are connected in a star pattern by the main hub.
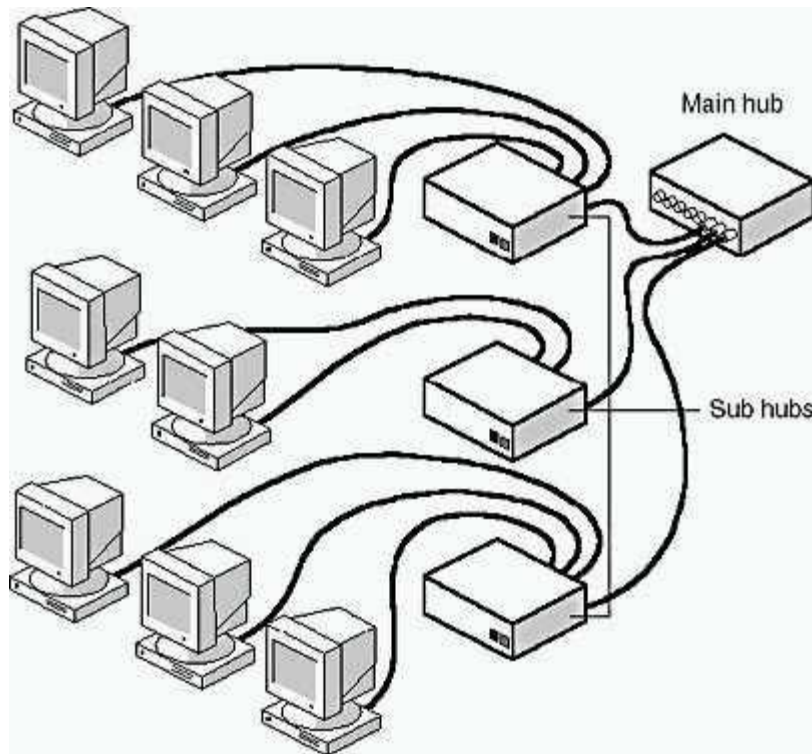
Figure 1.29 *Star-ring network*

Peer-to-Peer

Many small offices use a peer-to-peer network as described earlier in this chapter in Lesson 2: Network Configuration. Such a network can be configured as either a physical star or a bus topology. However, because all computers on the network are equal (each can be both client and server), the logical topology looks somewhat different. Figure 1.30 shows the logical topology of a peer-to-peer network.
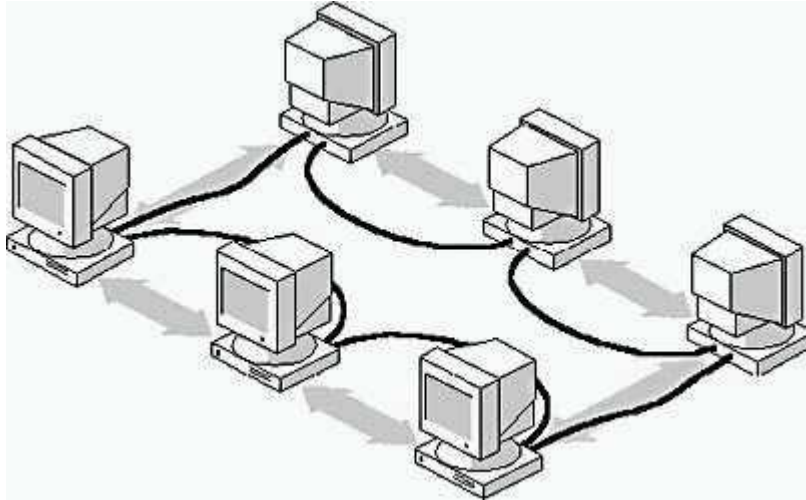
Figure 1.30 *Logical peer-to-peer topology*

Selecting a Topology

There are many factors to consider when deciding which topology best suits the needs of an organization. Table 1.2 provides some guidelines for selecting a topology.

Table 1.2 *Topology Advantages and Disadvantages*

Topology	Advantages	Disadvantages
Bus	Use of cable is economical.	Network can slow down in heavy traffic.
	Media is inexpensive and easy to work with.	Problems are difficult to isolate.
	System is simple and reliable.	
	Bus is easy to extend.	Cable break can affect many users.
Ring	System provides equal access for all computers.	Failure of one computer can impact the rest of the network.
	Performance is even despite many users.	Problems are hard to isolate.
		Network reconfiguration

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|		disrupts operation.
Star	Modifying system and adding new computers is easy.	If the centralized point fails, the network fails.
	Centralized monitoring and management are possible.	
	Failure of one computer does not affect the rest of the network.	
Mesh	System provides increased redundancy and reliability as well as ease of troubleshooting.	System is expensive to install because it uses a lot of cabling.

Exercise 1.1: Case Study Problem

A small, independent, business/home/life insurance company consisting of an owner, a business manager, an administrator, and four agents decides to implement a network. The company occupies half of a small building in an office park. Their volume of business had been stable for the past three years, but recently it has been increasing. To handle the increased business volume, two new agents will be hired.

Figure 1.31 illustrates the current arrangement.
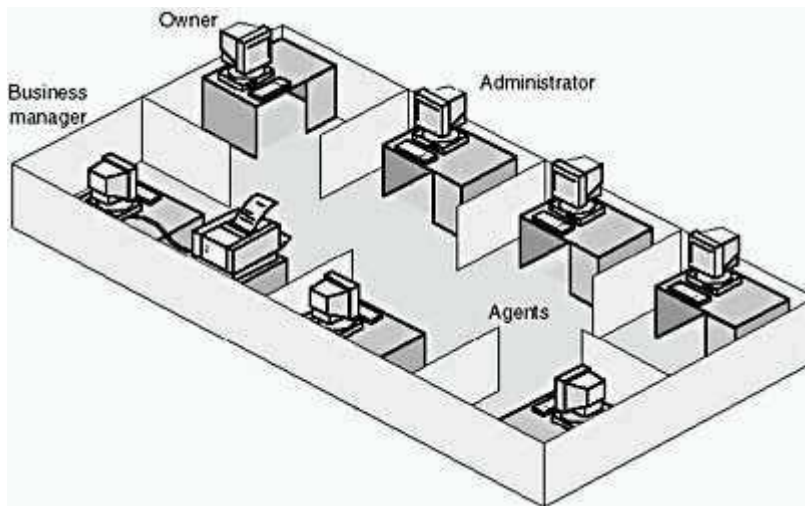
Figure 1.31 *Case study model*

Everyone in the company has a computer, but the business manager has the only printer. These computers are not connected by any form of networking. When agents need to print a document, they must first copy the file to a floppy disk, then carry it to the business manager's computer, where they are finally able to print it. Similarly, when staff members want to share data, the only means available is to copy the data on one computer to a floppy disk and insert the disk in another computer.

Recently, problems have arisen. The business manager is spending too much time printing other people's documents; and it is frequently unclear which copy of a given document is the current and authoritative version.

Your task is to design a network for this company.

To clarify the task of choosing a solution, you ask some questions.

Circle the most appropriate answers to the following questions:

1. Which type of network would you suggest for this company?
   - Peer-to-peer
   - Server-based
2. Which network topology would be most appropriate in this situation?
   - Bus
   - Ring
   - Star
   - Mesh
   - Star bus
   - Star ring

Answers

Part 1

Put a check mark on the line next to the choice that applies to your site. To determine which type of network would be most appropriate for your site, add up the number of peer-to-peer selections with check marks next to them, and compare the total with the number of server-based selections that have check marks next to them. The network with the most check marks should be the first option you consider.

1. Approximately how many users will the network at your site serve?

0-10 _____ Peer-to-peer

11 + _____ Server-based

2. Will data and resources on your network need to be restricted or regulated?

Yes _____ Server-based

No _____ Peer-to-peer

3. Will your computer be used primarily as a:

Client computer _____ Server-based

Server _____ Server-based

Both _____ Peer-to-peer

NOTE

If you want your computer to be used as both a client and a server, you might think you need to choose a peer-to-peer environment; however, in many server-

based networks today, client computers share in a peer-to-peer fashion. This type of combined network has become the most common kind of network used for new installations, primarily because networking capabilities are now an integral part of most client-computer operating systems.

4. Will the users on your network be able to meet their own network administration and management needs?

     Yes ____ Peer-to-peer

     No ____ Server-based

5. Will users be allowed to share their own resources and set other network policies for their own computer?

     Yes ____ Peer-to-peer

     No ____ Server-based

6. Will your network use centralized servers?

     Yes ____ Server-based

No _____ Peer-to-peer

7. Will your network have one central administrator who sets network policies?

Yes _____ Server-based

No _____ Peer-to-peer

8. Will your network have more than one server?

Yes _____ Peer-to-peer or server-based, depending on other issues

No _____ Server-based

Part 2

The following questions help you identify and resolve issues that arise in a server-based environment.

1. Check the tasks below that will apply to your servers:

Communication ____

Backup/redundancy ____

Application ____

Database ____

E-mail ____

Fax ____

Print ____

User directories ____

General data storage ____

2. Are some of the servers designated for special tasks?

    Yes ____

    No ____

3. Approximately how many servers does your network have?

0-5 ____

6-10 ____

11-50 ____

51-100 ____

4. Will your network's servers be centrally located or spread out in different locations?

Centrally located ____

Spread out ____

5. Will some of your network's servers be in a secure location?

Yes ____

No ____

If not, why not? _____

Answers

Part 3

Put a check mark on the line next to the choice that applies to your site. To determine which type of topology would be most appropriate for your site, add up the number of bus selections with check marks next to them, the number of star-bus selections with check marks next to them, and the number of star-ring selections with check marks next to them. The topology with the most check marks should be the option you consider first.

NOTE

Because the ring is more expensive than the bus, a star bus would be more economical than a star ring. In a case where both star bus and star ring would work, star bus would usually be the preferred choice.

1. Approximately how many users will the network at your site serve?

   0-10 _____ All

   11 + _____ Star bus, star ring

2. Is cost a consideration in choosing your network topology?

   Yes _____ Star bus

   No _____ All

3. Does your building have drop ceilings?

Yes ____ All

No ____ Star bus, star ring

4. Does your building afford easy access to crawl spaces or wiring conduits?

Yes ____ All

No ____ Star bus, star ring

5. Is ease of troubleshooting important?

Yes ____ Star bus, star ring

No ____ All

6. Does the physical layout of the computers and office spaces naturally lend itself to a particular topology?

Yes ____

No ____

7. If the answer to Question 6 is No, go on to Question 8. If the answer to Question 6 is Yes, which topology does the layout lend itself to using?

Circle one: bus   star bus

8. Is ease of reconfiguration important?

Yes ____ Star bus, star ring

No ____ All

9. Can the existing wiring in the building be used for your new network?

Yes ____

No ____

10. If the answer to question 9 is yes, which kind of topology could it be part of?

Circle one: bus   star bus

Exercise Summary

Based on the information generated in the three parts of this Network Planning Problem, your network components should be:

Type of network:

Type of topology:

Answers

Lesson Summary

The following points summarize the main elements of this lesson:

- The physical layout of computers on a network is called a topology.
- There are four primary topologies: star, bus, ring, and mesh.
- Topologies can be physical (actual wiring) or logical (the way they work).
- In a bus topology, the computers are connected in a linear fashion on a single cable.
- Bus topologies require a terminator on each end of the cable.
- In a star topology, the computers are connected to a centralized hub.
- Mesh topologies connect all computers in a network to one another with separate cables.
- In a token-ring topology, the computers are connected physically in a star shape, but logically in a ring or circle. The data is passed from one computer to another around the circle.

- Hubs are used to centralize the data traffic and localize failures. If one cable breaks, it will not shut down the entire network