Network Devices

Objectives

- Explain the uses, advantages, and disadvantages of repeaters
- Explain the uses, advantages, and disadvantages of hubs
- Define network segmentation
- Explain network segmentation using bridges

Repeaters

FireWire Repeater

Repeaters

- The number of **nodes** on a network and the length of cable used influence the quality of communication on the network
- Attenuation
  - Natural degradation of a transmitted signal over distance
- **Repeaters** work against attenuation by repeating signals that they receive on a network
  - Typically cleaning and regenerating the digital transmission in the process
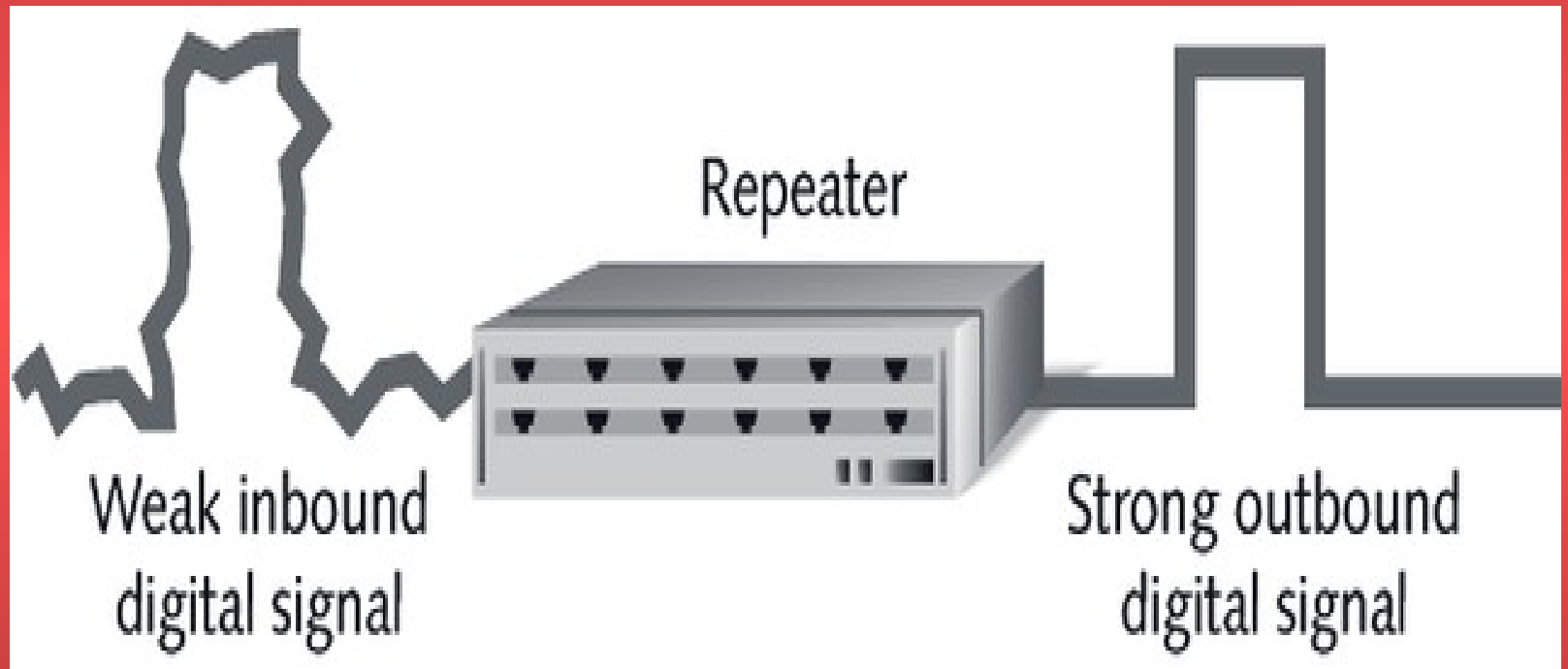
Repeaters

Figure 2-1:
Repeater

Repeaters

- Note that on **analog** networks, devices that boost the signal are called **amplifiers**
- These devices do not have the same signal regeneration capabilities as repeaters because they must maintain the shape of the received signal
    - Therefore, noise tends to amplified with the signal

Repeaters

- Repeaters work in the Physical layer (layer 1)
- On optical networks, signal amplification is handled by **optical repeaters**
- Some repeaters can be used to connect two physically different types of cabling
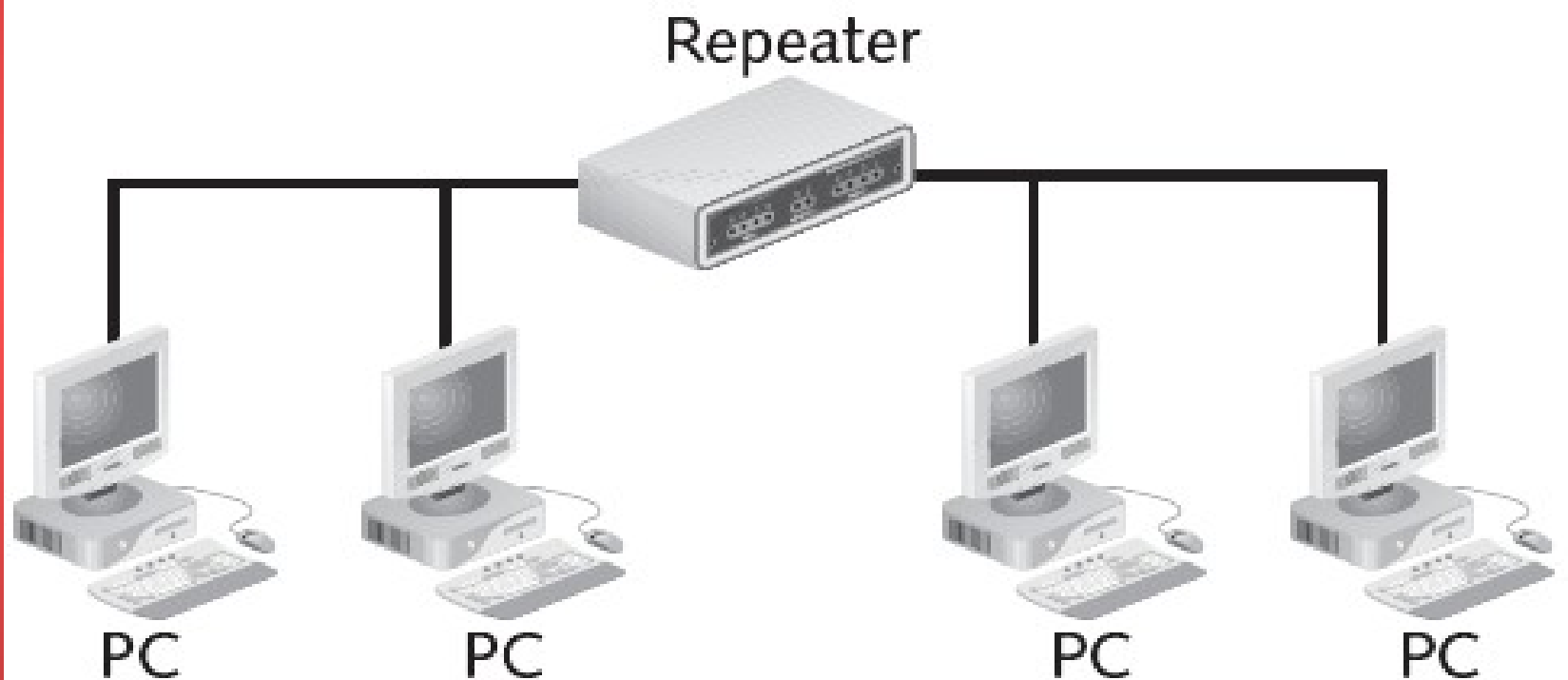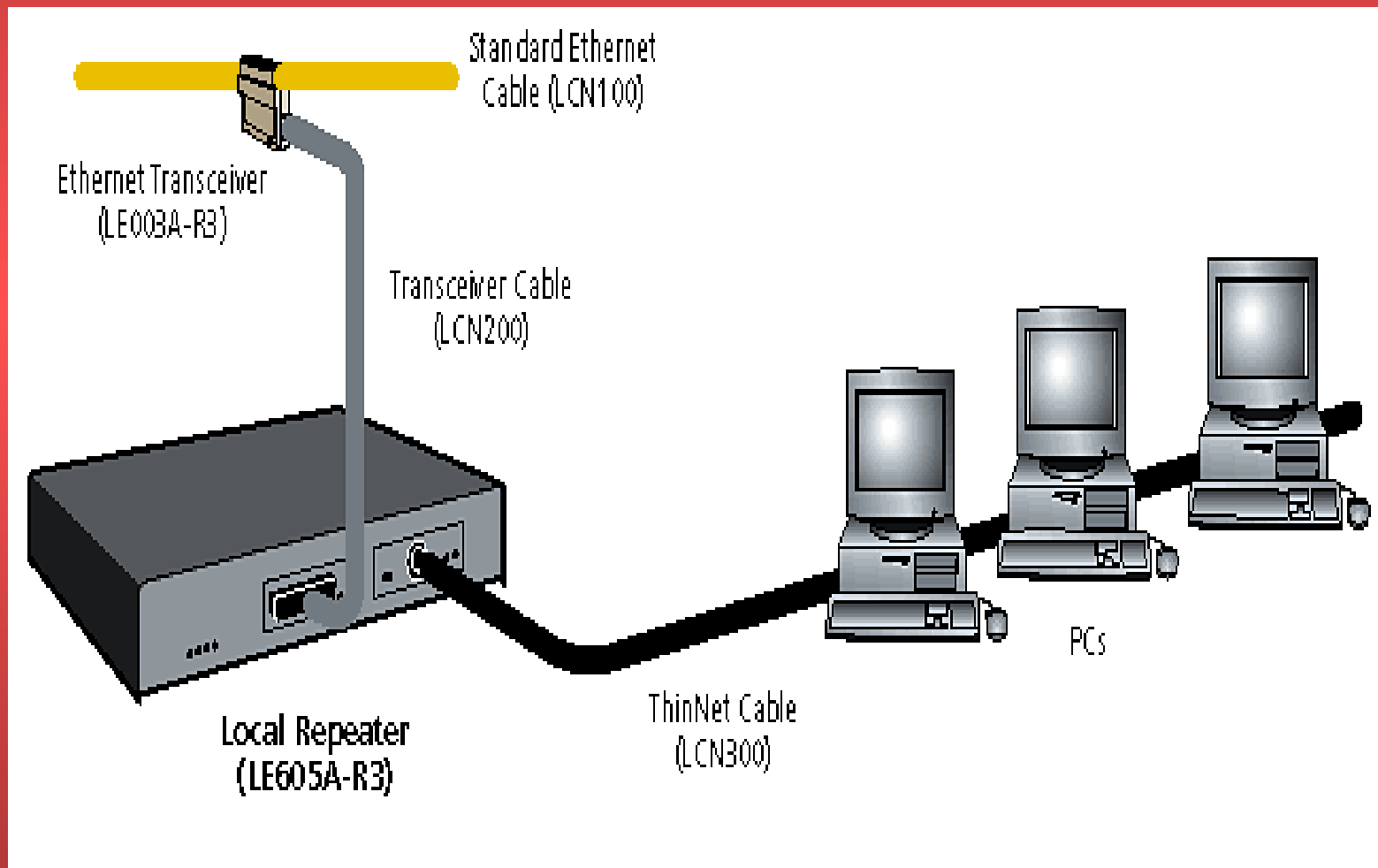
Repeater

Figure 2-2 Repeater in the network

Repeaters

Standard Ethernet Cable (LCN100)

Ethernet Transceiver (LE003A-R3)

Transceiver Cable (LCN200)

Local Repeater (LE605A-R3)

ThinNet Cable (LCN300)

PCs

Hubs

Cisco Hub

Hubs

- Generic connection device used to tie several networking cables together to create a link between different stations on a network

- Hubs that are plugged into electric power are called **active hubs**

- A hub that merely connects different cables on a network and provides no signal regeneration is called a **passive hub** and is not a repeater

Hubs

- **Active hubs**
  - Amplify or repeat signals that pass through them
- **Passive hub**
  - Merely connects cables on a network and provides no signal regeneration

Hubs

- "Hub" is a generic term applied to many different network-connection devices

- If a hub in some way **segments** or subdivides the traffic on a network, it is an intelligent, or switching, hub

Hubs

Hubs, are simple devices that interconnect groups of users.

Hubs forward any data *packet*s they receive over one port from one workstation—including e-mail, word processing documents, spreadsheets, graphics, or print requests—to all of their remaining ports.

All users connected to a single *hub* sharing the hub's *bandwidth* or data-carrying capacity.

Examples of Cisco hub products:
Cisco Micro Hub series
Cisco FastHub® series

Hubs

- Topology
  - Usually refers to the physical layout of network cable and devices
  - When all stations are connected to a central hub, the topology is known as a star because of its appearance
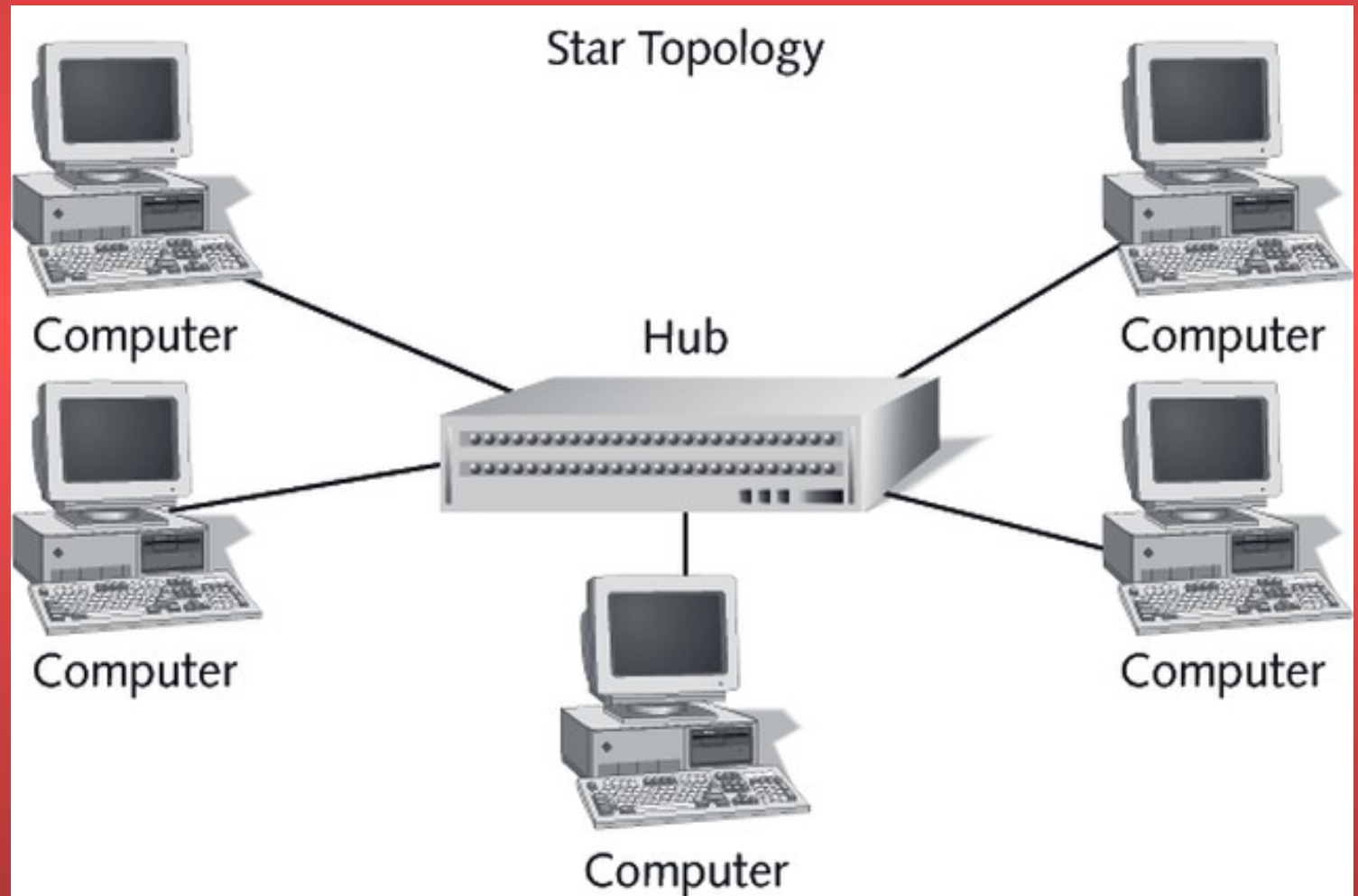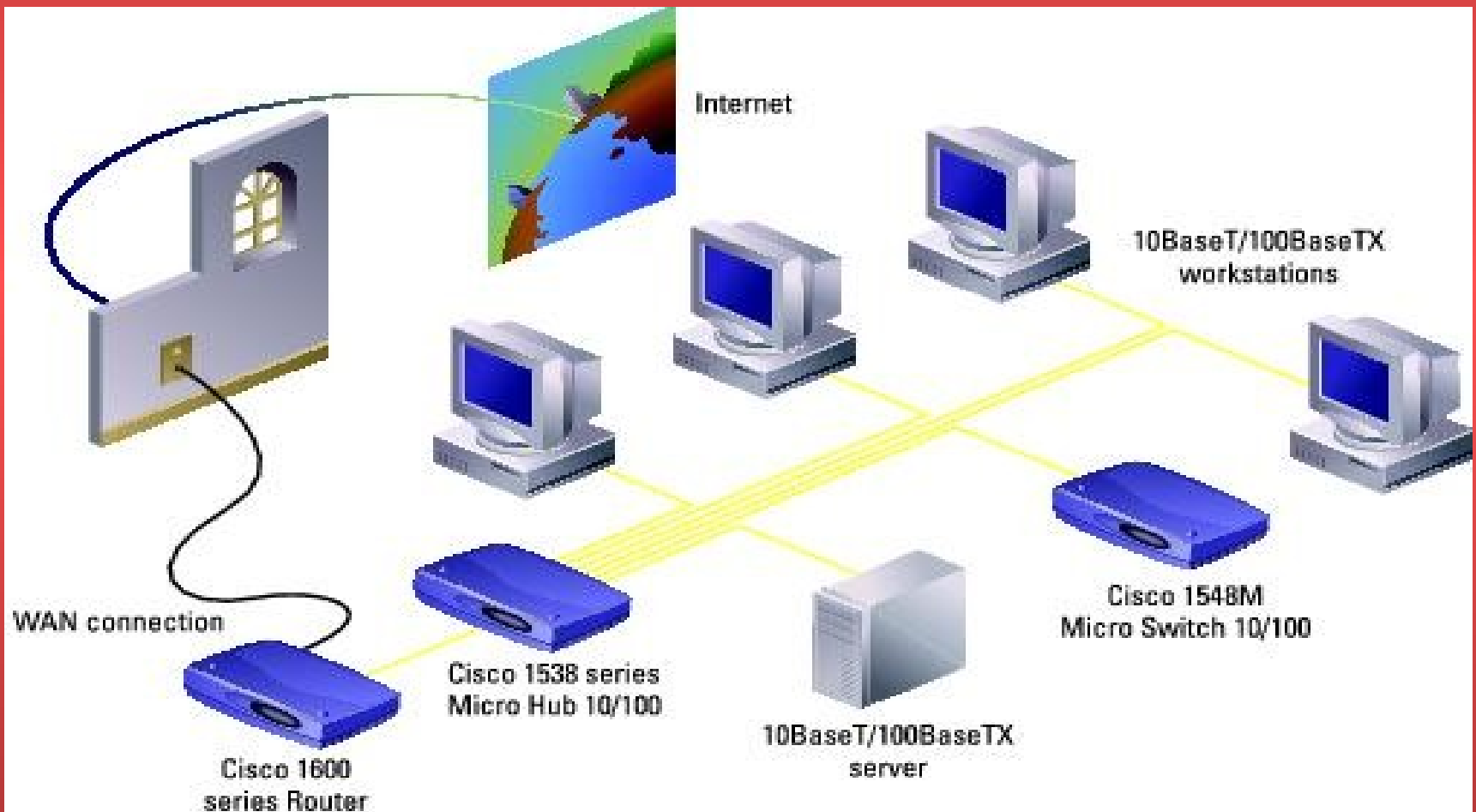
Hubs

Figure 2-2:
Star topology

Hubs

Internet

WAN connection

Cisco 1600
series Router

Cisco 1538 series
Micro Hub 10/100

10BaseT/100BaseTX
server

Cisco 1548M
Micro Switch 10/100

10BaseT/100BaseTX
workstations

Advantages and Disadvantages of Repeaters and Hubs

- Advantages of using repeaters on your network:
  - Repeaters can extend a network's total distance
  - Repeaters do not seriously impact network performance
  - Certain repeaters can connect networks using different physical media

Advantages and Disadvantages of Repeaters and Hubs

- Disadvantages of using repeaters on your network:
  - Repeaters cannot connect different network architectures, such as **Token Ring** and Ethernet
  - Repeaters do not reduce network traffic

    * They repeat everything they received
  - Repeaters do not segment the network
  - Do not reformat data structures
    - Cannot connect networks that require different types of frames

Advantages and Disadvantages of Repeaters and Hubs

- Because repeaters do not segment a network, devices separated only by a repeater are susceptible to data packet collision, since they are part of the same collision domain

- Collision domain
  - In Ethernet networking, a single segment on a network

Network Segmentation

- Segmentation
  - Process of breaking a network into smaller broadcast or collision domains
- **Segment**
  - Part of a network that is divided logically or physically from the rest of the network
- When network administrators place too many nodes on the same network segment
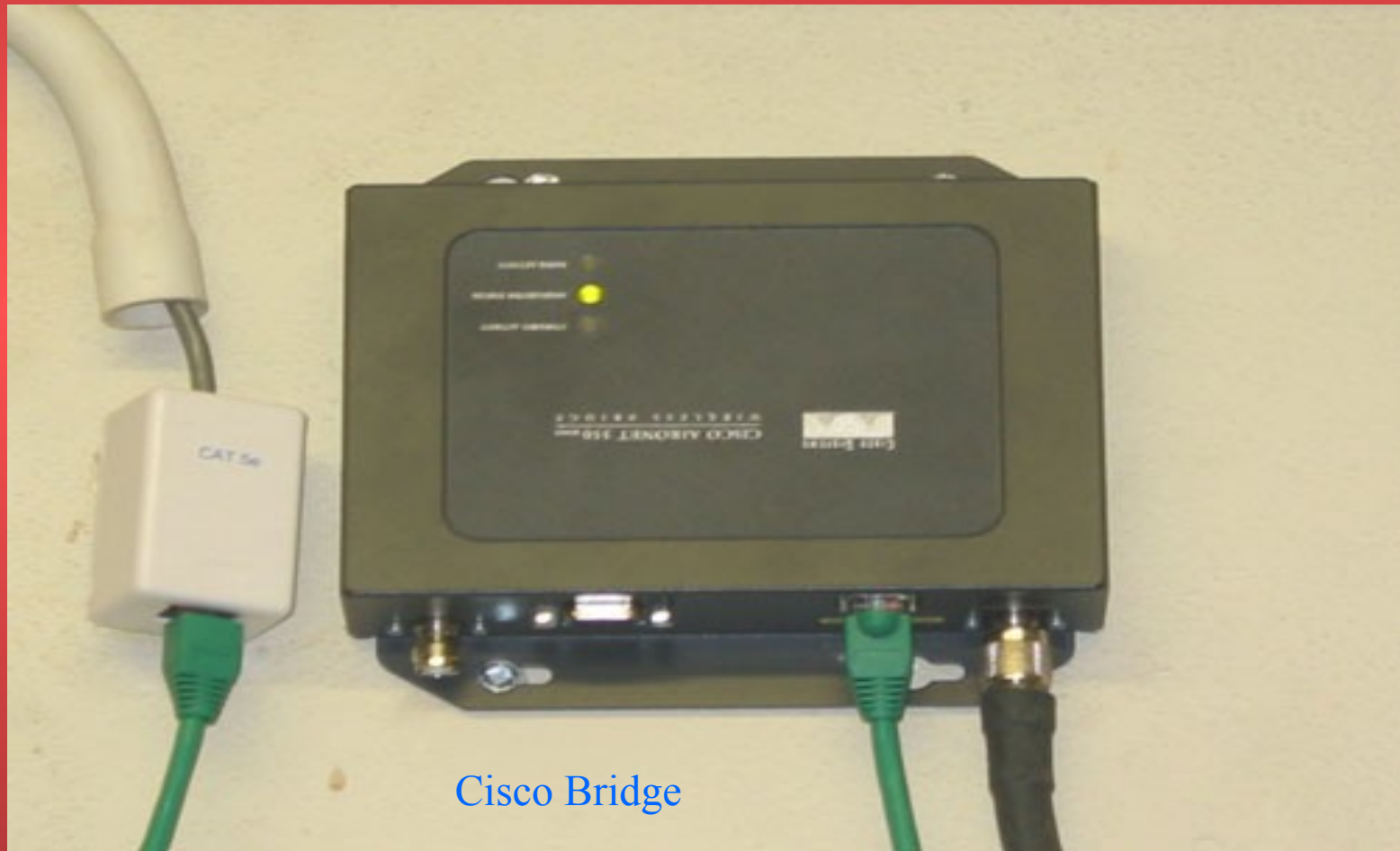 - Causes the number of collisions to increase

Network Segmentation
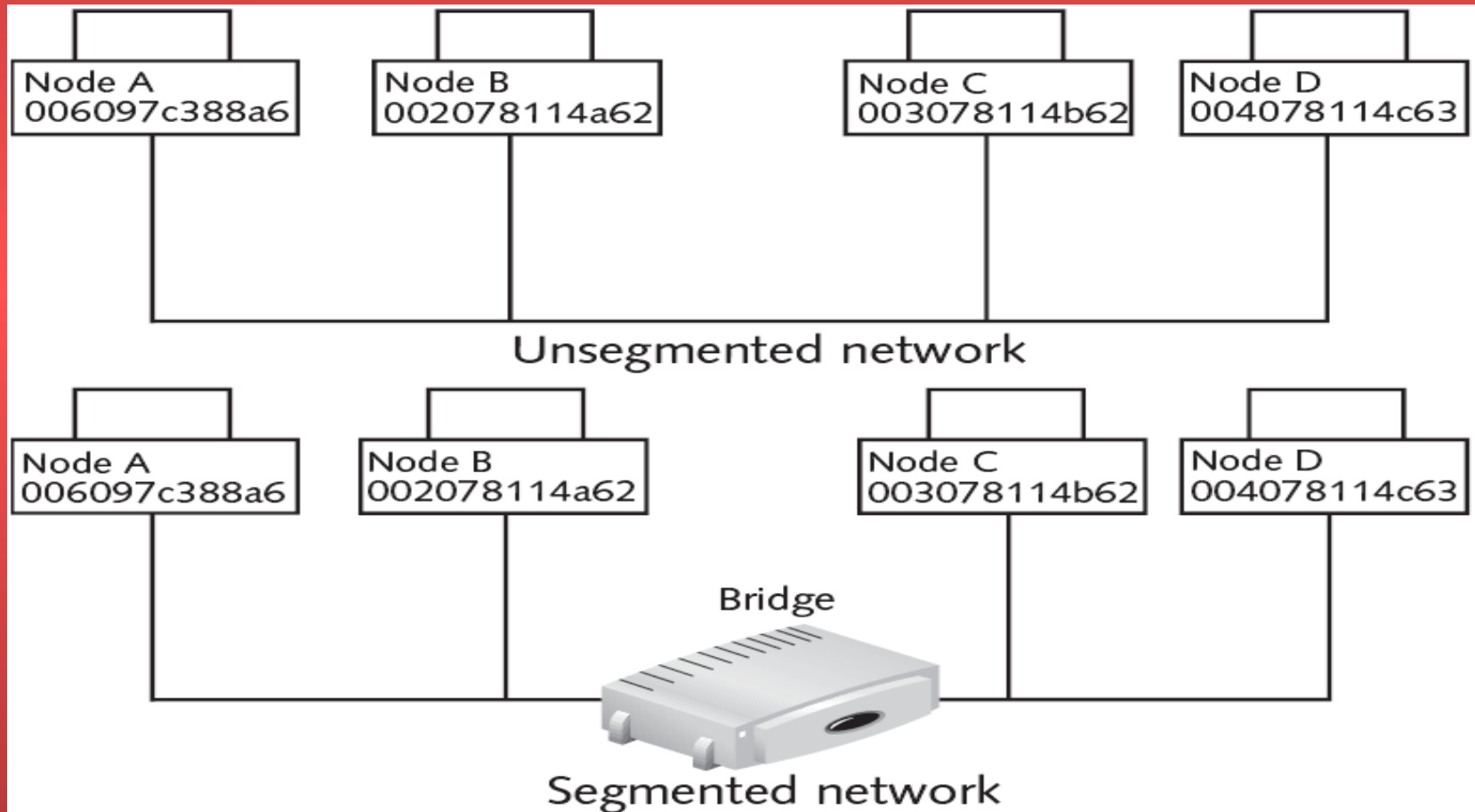
Figure 2-5   Network segmentation

Bridges

Cisco Bridge

Bridges

- Operate at the Data Link layer of the OSI model
- Filters traffic between network segments by examining the destination MAC address
  - Based on this destination MAC address, the bridge either forwards or discards the frame
  - When a client sends a **broadcast** frame to the entire network, the bridge will always forward the frame
  - Reduce network traffic by keeping local traffic on the local segment

Bridges

- **Broadcast** frame
  - Frame destined for all computers on the network
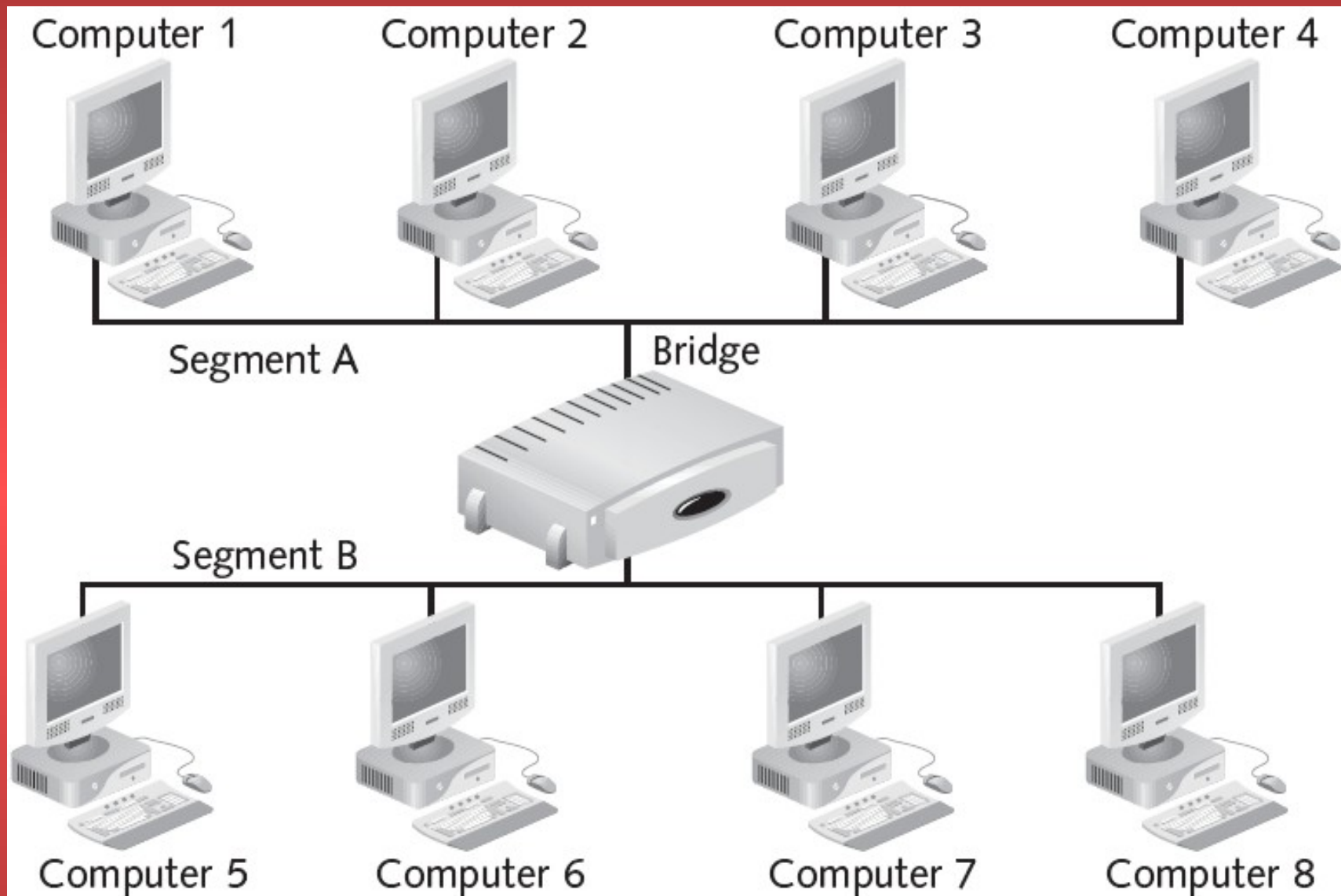
Figure 2-6 Bridge

Transparent Bridges

- Also called learning bridges because they build a table of MAC addresses as they receive frames
  - This means that they "learn" which addresses are on which segments
- The bridge uses the source MAC addresses to determine which addresses are on which segments
  - By determining a frame's origin, the bridge knows where to send frames in the future
- Ethernet networks mainly use transparent bridges

Advantages and Disadvantages of Bridges

- Advantages of using a bridge include:
  - Bridges can extend a network by acting as a repeater
  - Bridges can reduce network traffic on a segment by subdividing network communications
  - Bridges increase the available bandwidth to individual nodes because fewer nodes share a collision domain
  - Bridges reduce the likelihood of network collisions
  - Some bridges connect networks using different media types and architectures

Advantages and Disadvantages of Bridges

- Disadvantages of using a bridge include:
  - Because bridges do more than repeaters by viewing the MAC addresses, the extra processing makes them slower than repeaters

    * Extra processing by viewing MAC addresses
  - Bridges forward broadcast frames indiscriminately, so they do not filter broadcast traffic
  - Bridges are more expensive than repeaters

Advantages and Disadvantages of Bridges

- Because bridges forward broadcast traffic, it can be a major disadvantage on a network during a broadcast storm

- Broadcast storm
  - Excessive broadcast messages to every host on the network, launched by multiple computers
  - When two or more stations engage in the transmission of excessive broadcast traffic

Switches

Cisco Switch

Switches

- Increase network performance by reducing the number of packets transmitted to the rest of the network

- Like bridges, operate at the **Data Link** layer of the OSI model

- In an Ethernet network, computers are usually connected directly to a switch

Switches

- Switch opens a virtual circuit between the source and the destination
  - Prevents communications between just two computers from being broadcast to every computer on the network or segment
  - Called microsegmentation

Switches

- Bandwidth
  - Available capacity of a network
- Contention
  - Condition that occurs when computers on a network must share the available capacity of the network wire with other computers
- When machines must share a wire and compete for available bandwidth with other machines, they experience **contention**

Switches

- When two machines have a virtual circuit
  - They do not have to share the bandwidth with any other computers
- Multiple virtual circuits can be in use at the same time, each with its own full **bandwidth**
  - Called "switched bandwidth"
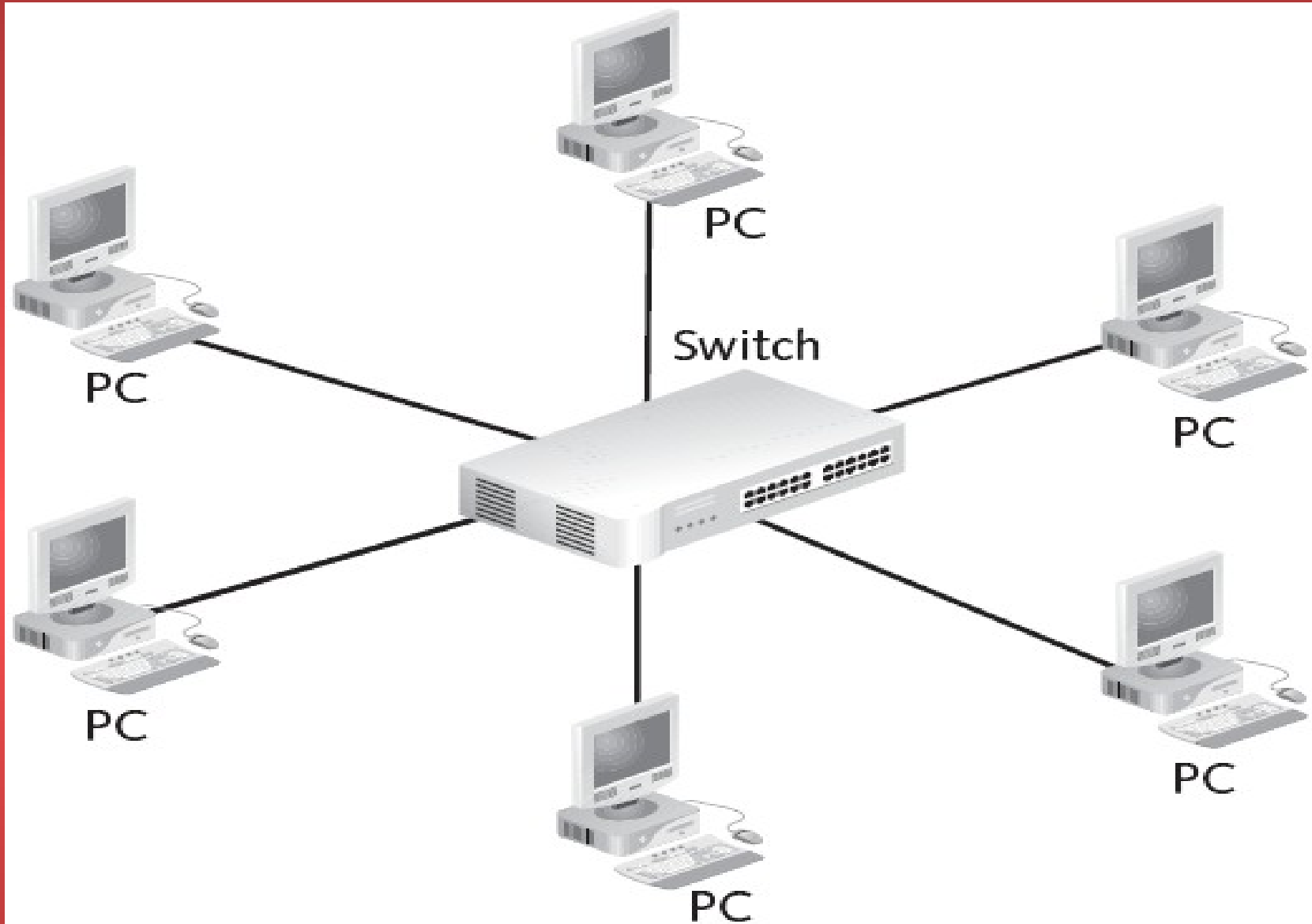
Figure 2-7   Star topology using a switch

Switches

- Advantages of switches include:
  - Switches increase available network bandwidth
  - With switches, there is reduced workload on individual computers
  - Switches increase network performance
  - There are fewer frame collisions because switches create collision domains for each connection (microsegmentation)
  - Switches connect directly to workstations
  - Switches have an unlimited number of ports

Switches

- Disadvantages of switches include:
    - Switches are significantly more expensive than bridges
    - Network connectivity problems can be difficult to trace through a switch
    - Broadcast traffic may be troublesome

Router

Cisco Router (Front)

Cisco Router (Back)

Cisco Router

Routers

- **Routers**
  - Operate at the Network layer of the OSI model
  - Provide filtering and network traffic control on LANs and WANs
  - Can connect multiple segments and multiple networks
- Networks connected by routers are called **internetworks** because they create a larger network of interconnected, smaller networks
- **Internetworks**
  - Networks connected by multiple routers

Routers

- Similar to switches and bridges in that they segment a network and filter traffic
  - Routers use the logical address

Routers

- When a router is introduced into a network, it creates more networks

- Routers create collision domains and they also create broadcast domains because a router will not pass broadcast traffic
  - A **broadcast domain** is a group of network devices that will receive LAN broadcast traffic from each other

Physical vs. Logical Addresses

- MAC address
  - Found at the Data Link layer of the OSI model
  - Used by bridges and switches to make forwarding decisions within a network or **subnetwork**

- Subnetwork
  - Portion of the network created by manipulating a network address and breaking it down into smaller parts

Physical versus Logical Addresses

- **IP address**
  - Logical address when TCP/IP is used on an internetwork
  - 32-bit binary address used on TCP/IP networks
  - Consists of a host portion and a network portion
- Routers use the IP address to route packets to the correct network segment

MAC Address /
Physical Address

IP Address / Logical
Address

Physical versus Logical Addresses

- Notice that each **port** (connection) on the router has its own unique IP address

Figure 2-5: Router

Router

192.168.1.1

192.168.3.1

199.10.1.1

199.10.2.1
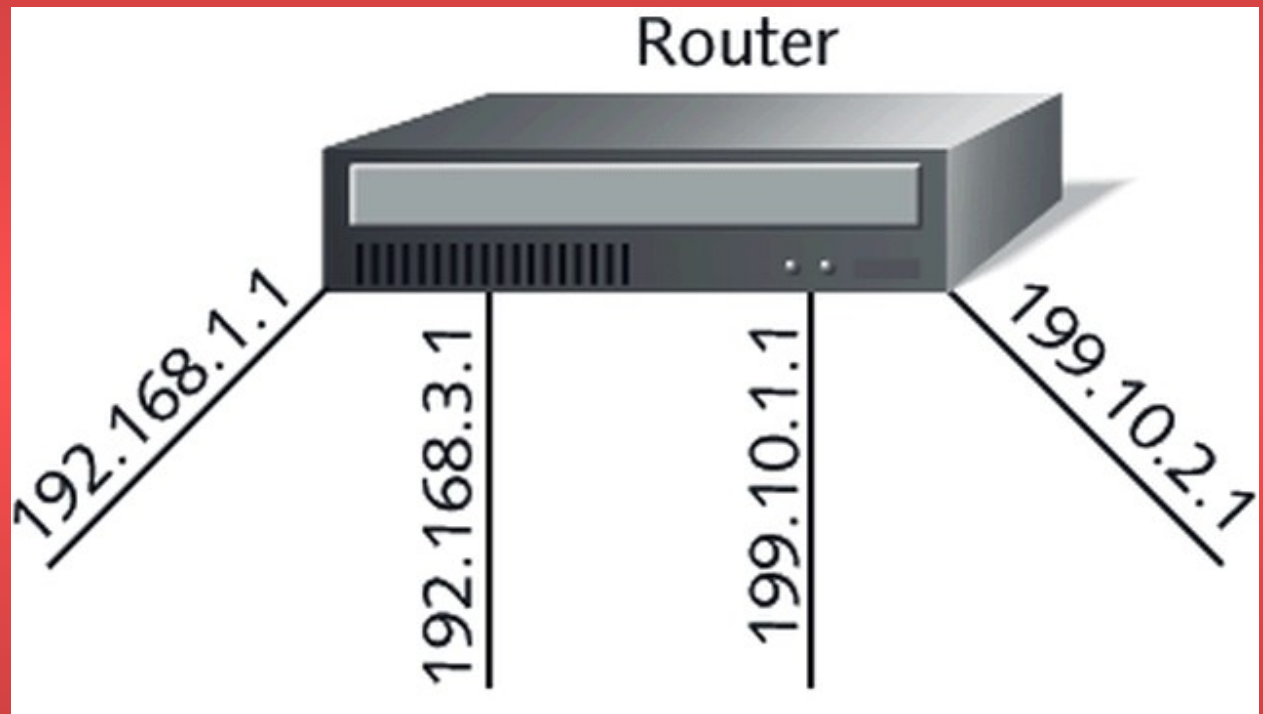
Routers not only connect networks in a single location or set of buildings, but they provide interfaces— or "sockets"—for connecting to wide-area network (WAN) services.

Examples of Cisco router products:
Cisco 700 series
Cisco 1000 series
Cisco 1600 series
Cisco 2500 series
Cisco 2600 series
Cisco 3600 series
Cisco 4500 series

Advantages and Disadvantages of Routers

- Advantages of routers:
    - Routers can connect different network architectures
    - Routes can choose the best path across the network using dynamic routing techniques
    - Routers can create collision domains by segmenting the network
    - Routers reduce network traffic because they do not retransmit network broadcast traffic

Advantages and Disadvantages of Routers

- Disadvantages of routers:
  - Routers work only with routable network protocols
  - Routers are more expensive than bridges or repeaters
  - Dynamic router communication causes additional network overhead
  - Routers are slower than bridges or switches because they must analyze a data transmission from the Physical through the Network layer
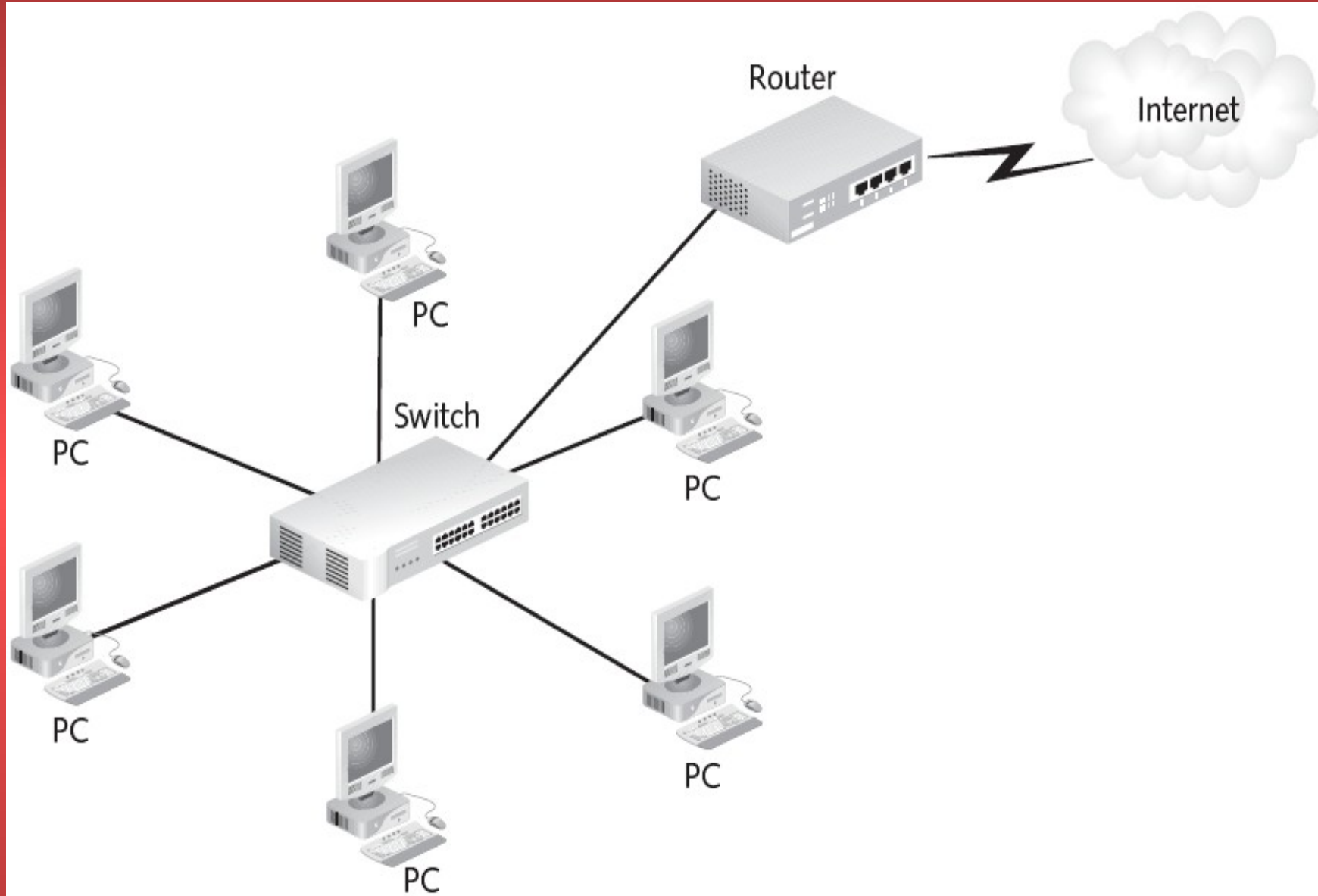
Figure 2-9 Router connecting network to the Internet

Cisco Router

Cisco Router

Cisco Router

- Cisco has released different series of routers from the 600 to the 12000 series, these includes the popular 1600, 2500 and 1600 series. They all run the Cisco equipment Internetwork Operating System (IOS) which separates the Cisco routers from the rest. They created what they call as the Cisco fusion where the goal is that all these devices will run at the same operating system.

Cisco Router

IOS

- Internetwork Operating System (IOS) is the Operating system where all Cisco routers run. IOS is the most important component of the router. Without the IOS, the router is practically useless. It provides the router its capabilities and this can be updated or downloaded for back up from the router.

- The IOS is around 5mb in size (or larger depending on the series) and is loaded up upon the boot up. Its current version is version 12 but Cisco releases minor versions for bug fixing and added functionalities.

Notes:

Routers

- Compared to switches and *bridge*s, routers are smarter.

- Based on a network roadmap called a "routing table," routers can help ensure that packets are traveling the most efficient paths to their destinations.

- If a link between two routers goes down, the sending router can determine an alternate route to keep traffic moving.

Brouters

- Device that functions as:
  - A bridge for nonroutable protocols
  - A router for routable protocols
- Provides the best attributes of both a bridge and a router
- Operates at both the Data Link and Network layers

Gateways

Cisco Gateway
MC3800

Gateways

- Gateways
  - Combination of hardware and software
  - Translate between different protocols on a network
  - Usually a combination of hardware and software
  - Translates between different protocol suites
  - Has the most negative effect on network performance
    - Packets must be rebuilt not just at the lower levels but at the very upper levels
      - So that actual data content can be converted into a format the destination can process
  - Creates the most **latency**

Gateways

- Latency
  - Delay on a network caused by a variety of factors

A gateway provides a LAN with access to a different type of network, an internetwork, a mainframe computer, or a particular type of operating environment.

A gateway serves to connect networks with very different architectures, for example, a LAN and an X.25 packet-switching service. Gateways are also used to provide access to special services, such as e-mail (electronic mail), fax, and Telex.

Gateways can operate at several of the higher OSI Reference Model levels, most notably at the session, presentation, and application layers.

In doing their work, gateways may change the representation of data before passing it on. For example, a gateway may convert from ASCII to EBCDIC on the way to an IBM mainframe, encrypting or decrypting data between the source and destination environments.

Gateways also must do protocol conversion, since the different environments
connected by a gateway will generally use different protocol families.

Chapter Summary

- Network administrators use devices to control and extend usable size of a network

- Repeaters work against attenuation by cleaning and repeating signals that they receive on a network

- A hub ties several networking cables together to create a link between different stations on a network

- Network segmentation is the process of isolating hosts onto smaller segments to reduce the possibility of collisions

Chapter Summary

- Bridges provide network segmentation by examining the MAC address that is sent in the data frame
- Switches increase network performance by reducing the number of frames transmitted to the rest of a network
- Routers operate at the Network layer of the OSI model and provide filtering and network-traffic control on LANs and WANs
- A brouter is a hybrid device that functions both as a bridge and as a router

Chapter Summary

- Gateways are usually a combination of hardware and software and are used to translate between different protocols
- Ethernet is the most commonly used LAN technology because it is the most efficient choice for most LANs
- Fast Ethernet (100 Mbps) and Gigabit Ethernet (1000 Mbps) are faster implementations of the Ethernet technology
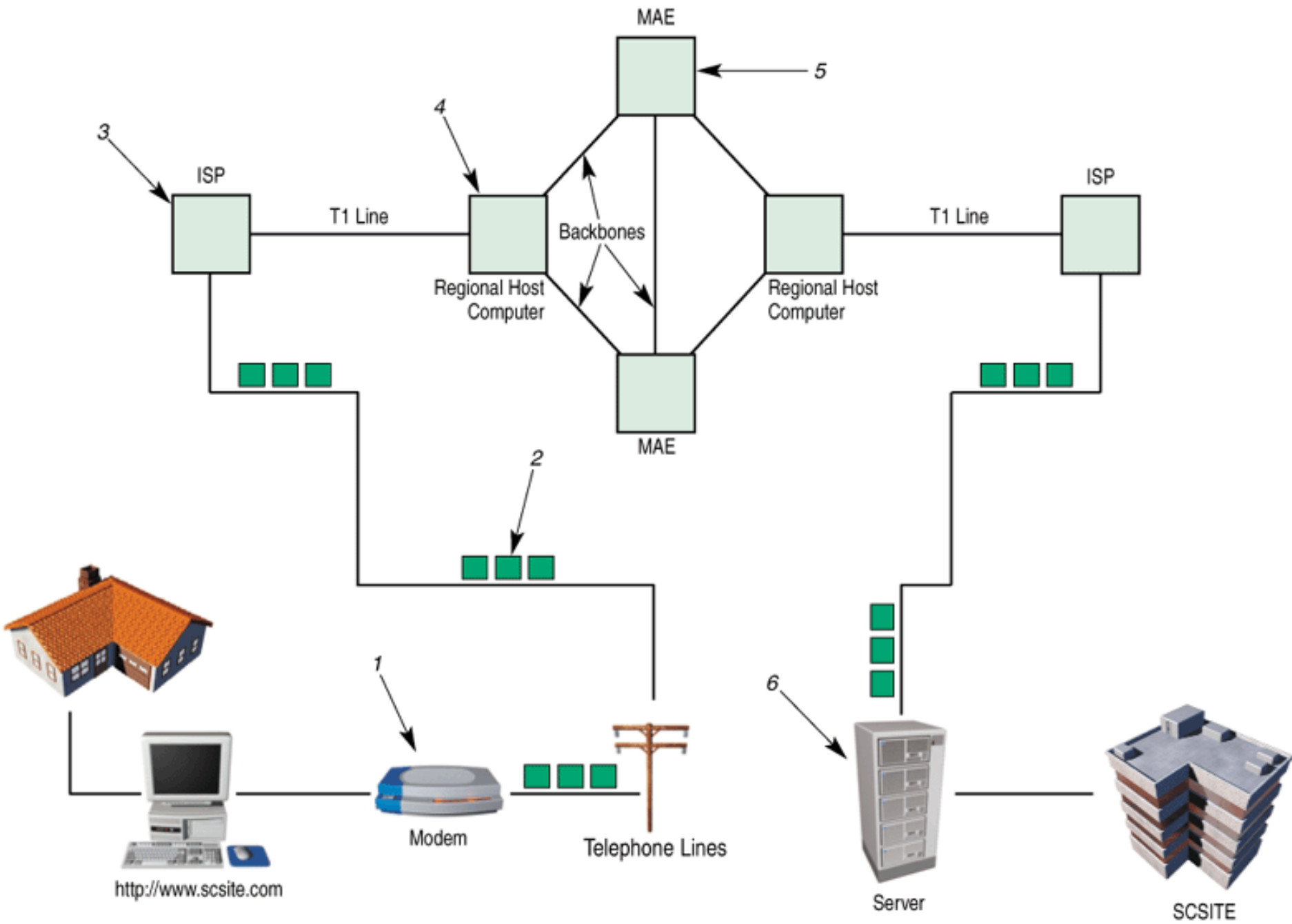- Most Ethernet networks can support either half- or full-duplex communications

Figure 10-10 How a request for data is sent over the Internet.