LESSON 1

Introduction to Computer Networks

COMPUTER NETWORKS

Define Computer network-A computer network is interconnection of various computer systems located at different places.

Purpose of networks

At its essence, a network's purpose is to make connections. These connections might be between a PC and a printer or between a laptop and the Internet e.t.c

COMPUTER NETWORKS CONT…

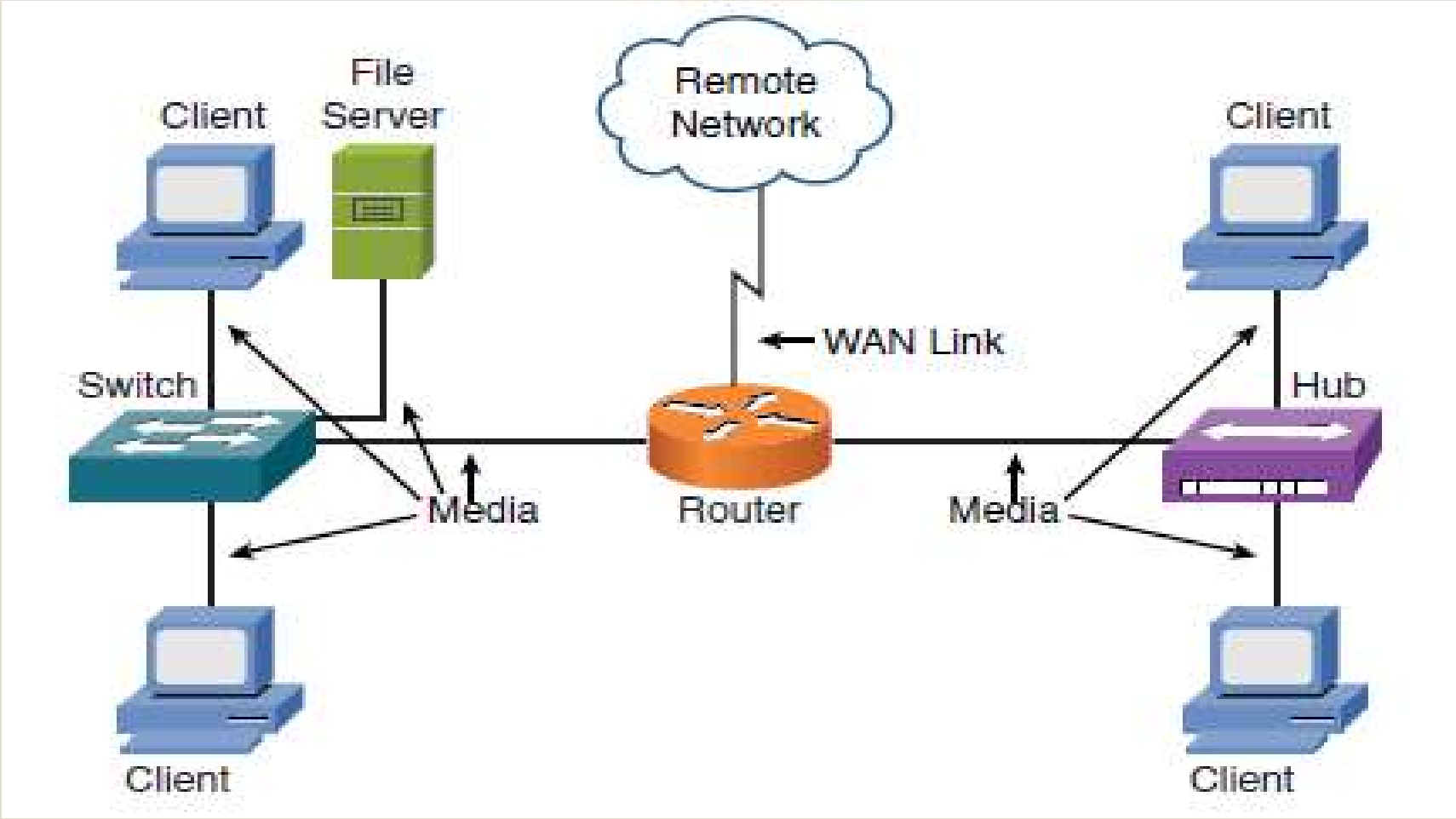
Network applications

- File sharing between two computers
- Video chatting between computers located in different parts of the world
- Surfing the web (for example, to use social media sites, watch streaming video,
- listen to an Internet radio station,
- E-mail

OVERVIEW OF NETWORK COMPONENTS

- Designing, installing, administering, and troubleshooting a network requires the ability to recognize various network components and their functions.
- The components to consider for now are client, server, hub, switch, router, media, and wide-area network (WAN) link.

DIAGRAMMATIC REPRESENTATION OF NETWORK COMPONENTS



DESCRIPTION OF THE NETWORK COMPONENTS

Client: The term *client defines the device an end user uses to access a network. E.g* workstation, laptop, smartphone with wireless capabilities

Server: A *server , as the name suggests, serves up resources to a network.*

Hub: A *hub is an older technology that interconnects network components,* such as clients and servers.

DESCRIPTION OF THE NETWORK COMPONENTS CONT…

Switch: Like a hub, a *switch interconnects network components, and they are* available with a variety of port densities.

When traffic comes in a switch port, the switch interrogates the traffic to see where it is destined. Then, based on what the switch has learned, the switch forwards the traffic out of the appropriate port.

A switch is considered a *Layer 2 device*.

DESCRIPTION OF THE NETWORK COMPONENTS CONT…

Router: a *router is considered to be a Layer 3 device*, which means that it makes its forwarding decisions based on logical network addresses. Most modern networks use *Internet Protocol (IP) addressing.*

Media: The previously mentioned devices need to be interconnected via some sort of *media* .

WAN link: Today, most networks connect to one or more other networks.

NETWORK CLASSIFICATIONS

Networks can be defined by:

- *Geography*
- *Topology*
- *Resource Location*

NETWORKS DEFINED BY GEOGRAPHY

We can classify networks by how geographically dispersed the networks components are.

- Local-area network (LAN)
- Wide-area network (WAN)
- Campus-area network (CAN)
- Metropolitan-area network (MAN)
- Personal-area network (PAN)

NETWORKS DEFINED BY GEOGRAPHY CONT…

LAN

- A LAN interconnects network components within a local region (for example,within a building). Examples of common LAN technologies you're likely to encounter include Ethernet (that is, IEEE 802.3) and wireless networks (that is, IEEE 802.11).

WAN

- A WAN interconnects network components that are geographically separated. For example, a corporate headquarters might have multiple WAN connections to remote office sites..

NETWORKS DEFINED BY GEOGRAPHY CONT…

CAN

- If university covers several square miles and has several dozen buildings and within many of these buildings there is a LAN. When, these building-centric LANs are interconnected, they form another network type called, a CAN.
- Besides an actual university campus, a CAN might also be found in an industrial park or business park.

MAN

- More widespread than a CAN and less widespread than a WAN, a MAN interconnects locations scattered throughout a metropolitan area.

NETWORKS DEFINED BY GEOGRAPHY CONT…

PAN

- A PAN is a network whose scale is even smaller than a LAN. As an example, a connection between a PC and a digital camera via a *universal serial bus (USB) cable* could be considered a PAN.
- A PAN, however, is not necessarily a wired connection. A Bluetooth connection between your cell phone and your car's audio system is considered a wireless PAN (WPAN). The main distinction of a PAN, however, is that its range is typically limited to just a few meters.

NETWORKS DEFINED BY TOPOLOGY

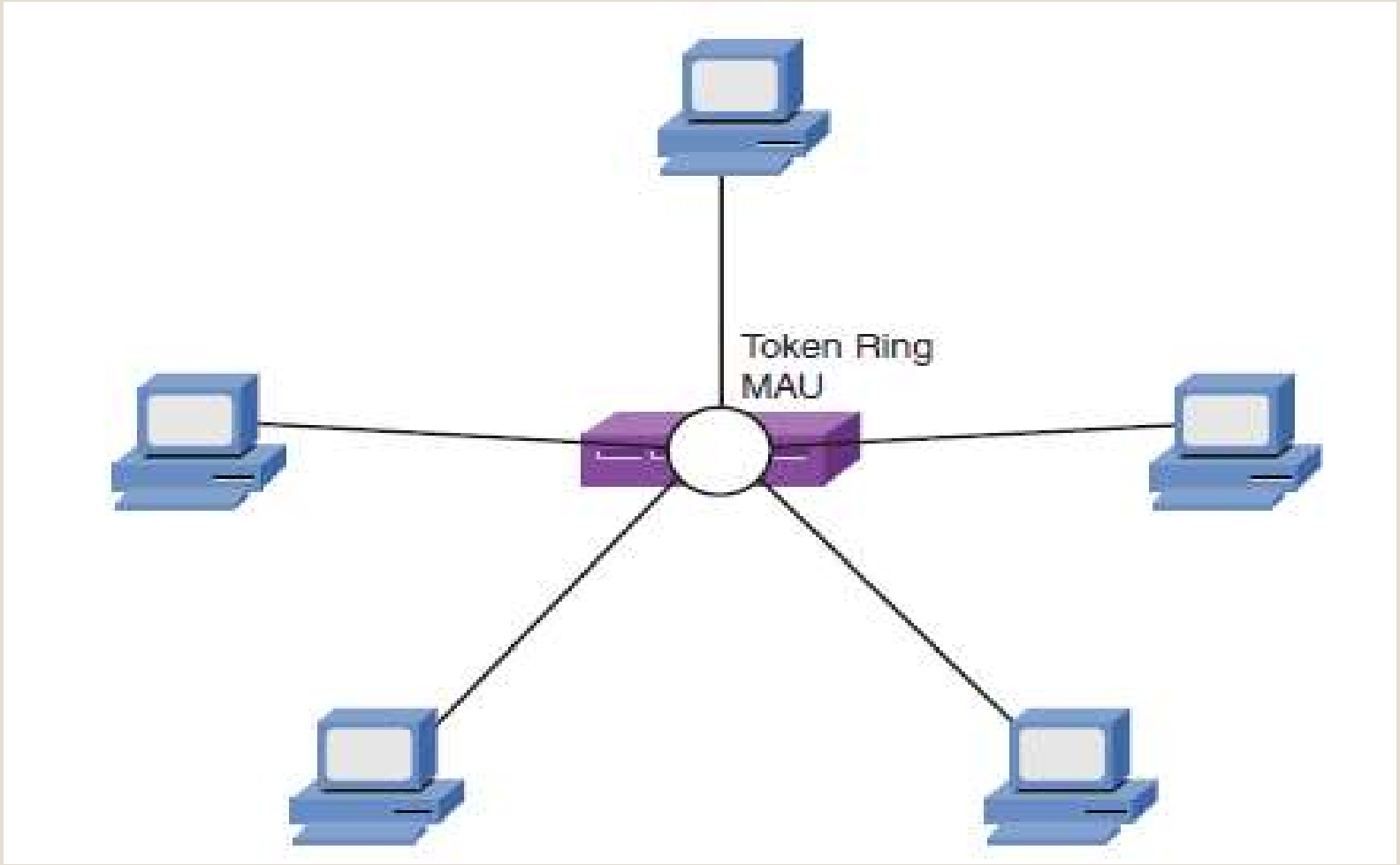
Physical Versus Logical Topology

- How components are physically interconnected determines the *physical topology*
- The actual traffic flow determines the *logical topology*

NETWORKS DEFINED BY TOPOLOGY

Just because a network appears to be a star topology (that is, where the network components all connect back to a centralized device, such as a switch), the traffic might be flowing in a circular pattern through all the network components attached to the centralized device.

(***See diagram below***)

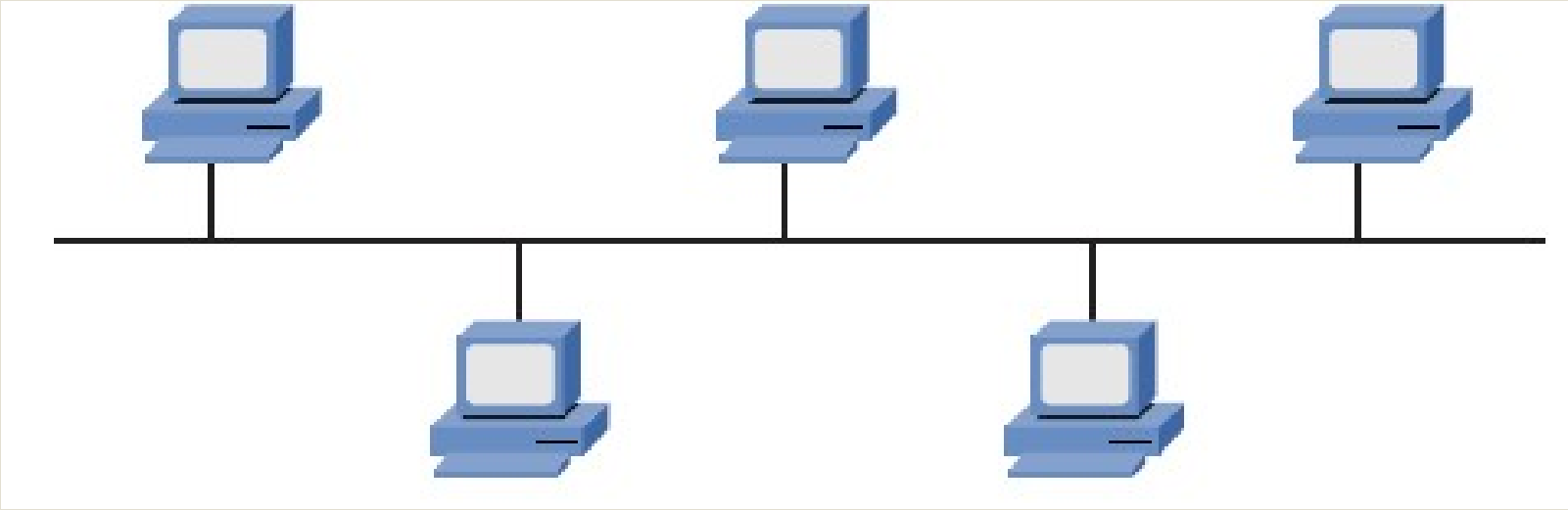

Token Ring
MAU

PHYSICAL TOPOLOGY

- Bus Topology
- Ring Topology
- Star Topology
- Hub and Spoke Topology
- Full mesh Topology
- Partial Mesh Topology

BUS TOPOLOGY

- It typically uses a cable running through the area requiring connectivity. Devices that need to connect to the network then tap into this nearby cable. Early Ethernet networks commonly relied on bus topologies.



BUS TOPOLOGY CONT...

- A network tap might be in the form of a T connector. (commonly used in older 10BASE2 networks) or a vampire tap (commonly used in older 10BASE5 networks).
- An example of a T connector.

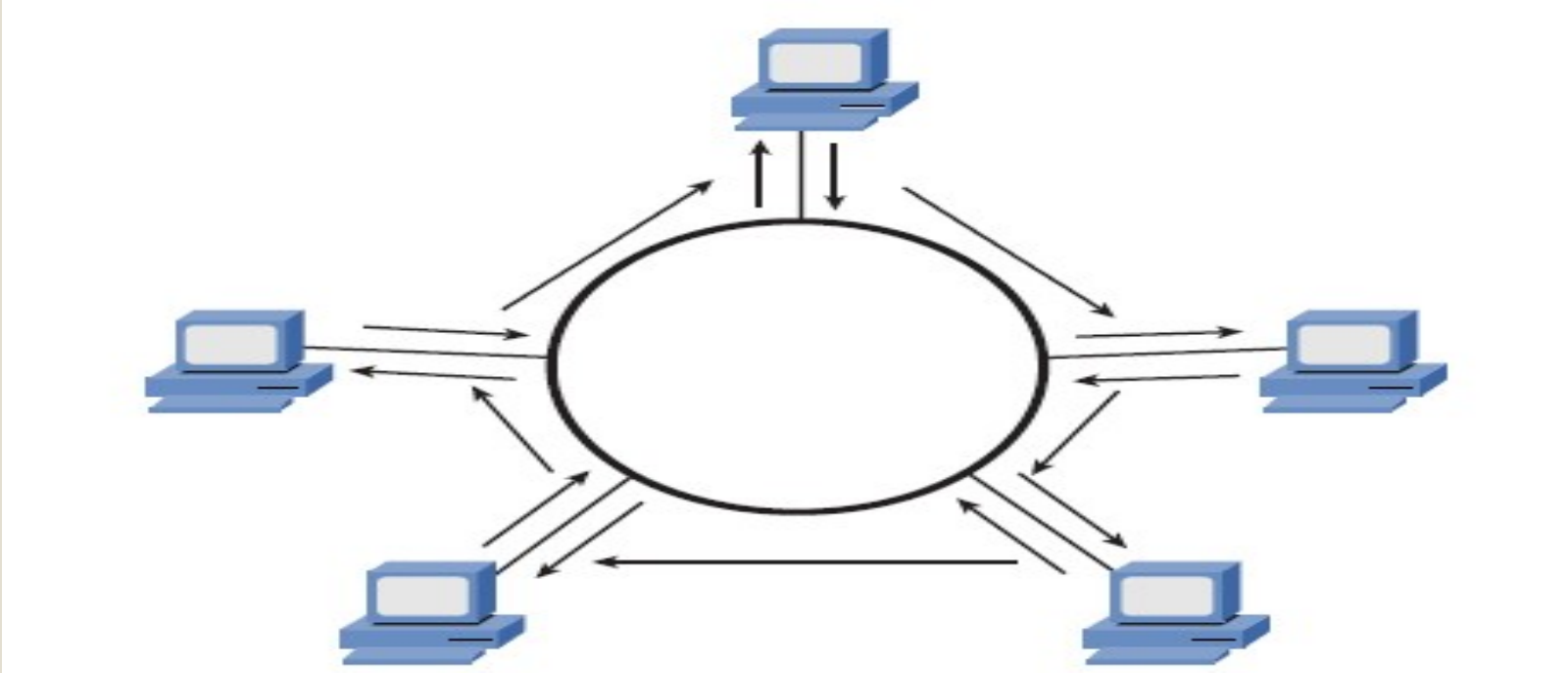
BUS TOPOLOGY CONT…

- A bus and all devices connected to that bus make up a *network segment* .
- *A* single network segment is a single collision domain, which means that all devices connected to the bus might try to gain access to the bus at the same time, resulting in an error condition known as a ***collision***.

Characteristics	Benefits	Drawbacks
To maintain appropriate electrical characteristics of the cable, the cable requires a terminator (of a specific resistance) at each end of the cable.	Depending on the media used by the bus, a bus topology can be less expensive.	Troubleshooting a bus topology can be difficult because problem isolation might necessitate an inspection of multiple network taps to make sure they either have a device connected or they are properly terminated.
Bus topologies were popular in early Ethernet networks.	Installation of a network based on a bus topology is easier than some other topologies, which might require extra wiring to be installed.	Adding devices to a bus might cause an outage for other users on the bus.
Network components tap directly into the cable via a connector such as a T connector or a vampire tap.		An error condition existing on one device on the bus can impact performance of other devices on the bus.
		A bus topology does not scale well, because all devices share the bandwidth available on the bus.

RING TOPOLOGY

- Typically, a ring topology sends data, in a single direction, to each connected device in turn, until the intended destination receives the data.



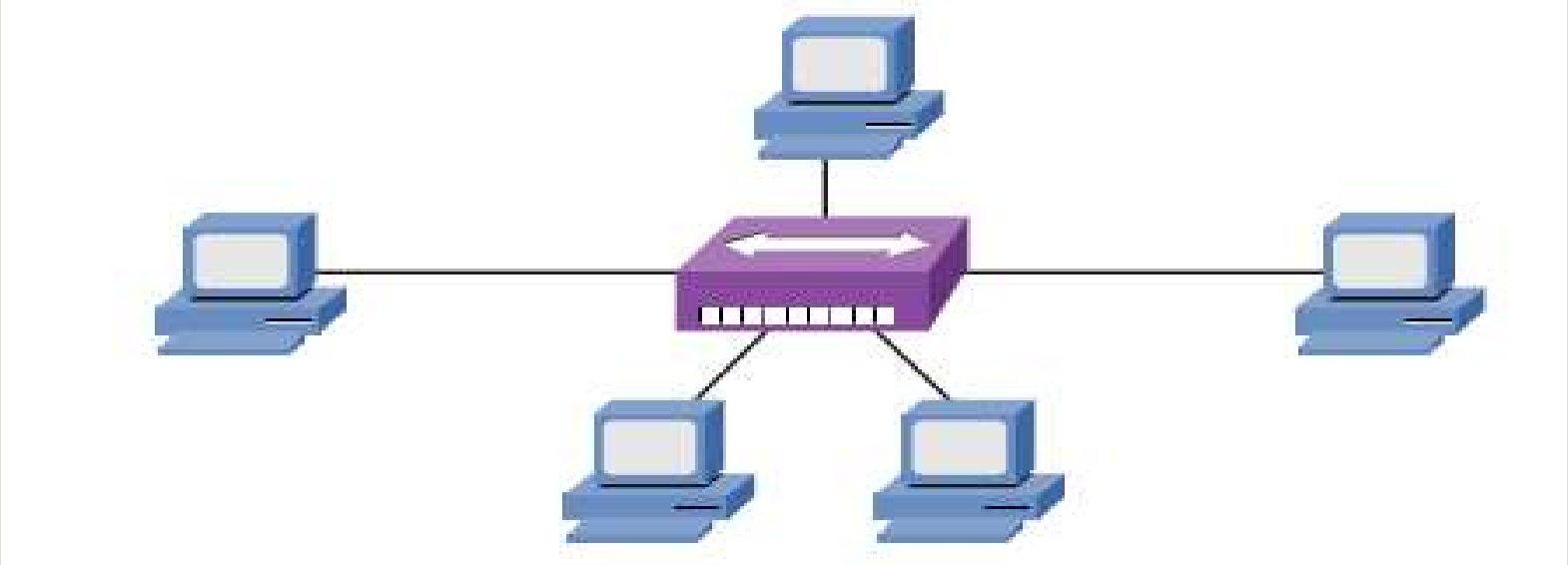
RING TOPOLOGY CONT…

- Fiber Distributed Data Interface (FDDI) is a variant of a ring-based topology.
- Most FDDI networks (which, as the name suggests, have fiber optics as the media) used not just one ring, but two. These two rings sent data in opposite directions, resulting in *counter-rotating rings*.
- *One benefit of* counter-rotating rings was that if a fiber broke, the stations on each side of the break could interconnect their two rings, resulting in a single ring capable of reaching all stations on the ring.

Characteristics	Benefits	Drawbacks
Each device on a ring includes both a receiver (for the incoming cable) and a transmitter (for the outgoing cable)	Troubleshooting is simplified in the event of a cable break, because each device on a ring contains a repeater. When the repeater on the far side of a cable break doesn't receive any data within a certain amount of time, it reports an error condition (typically in the form of an indicator light on a network interface card [NIC]).	Rings have scalability limitations. Specifically, a ring has a maximum length and a maximum number of attached stations. Once either of these limits is exceeded, a single ring might need to be divided into two interconnected rings. A network maintenance window might need to be scheduled to perform this ring division.
Each device on the ring repeats the signal it receives		Because a ring must be a complete loop, the amount of cable required for a ring is usually higher than the amount of cable required for a bus topology serving the same number of devices.

STAR TOPOLOGY

- A star topology has a central point from which all attached devices radiate. In LANs, that centralized device was typically a hub back in the early 1990s.
- Modern networks, however, usually have a switch located at the center of the star.



STAR TOPOLOGY CONT…

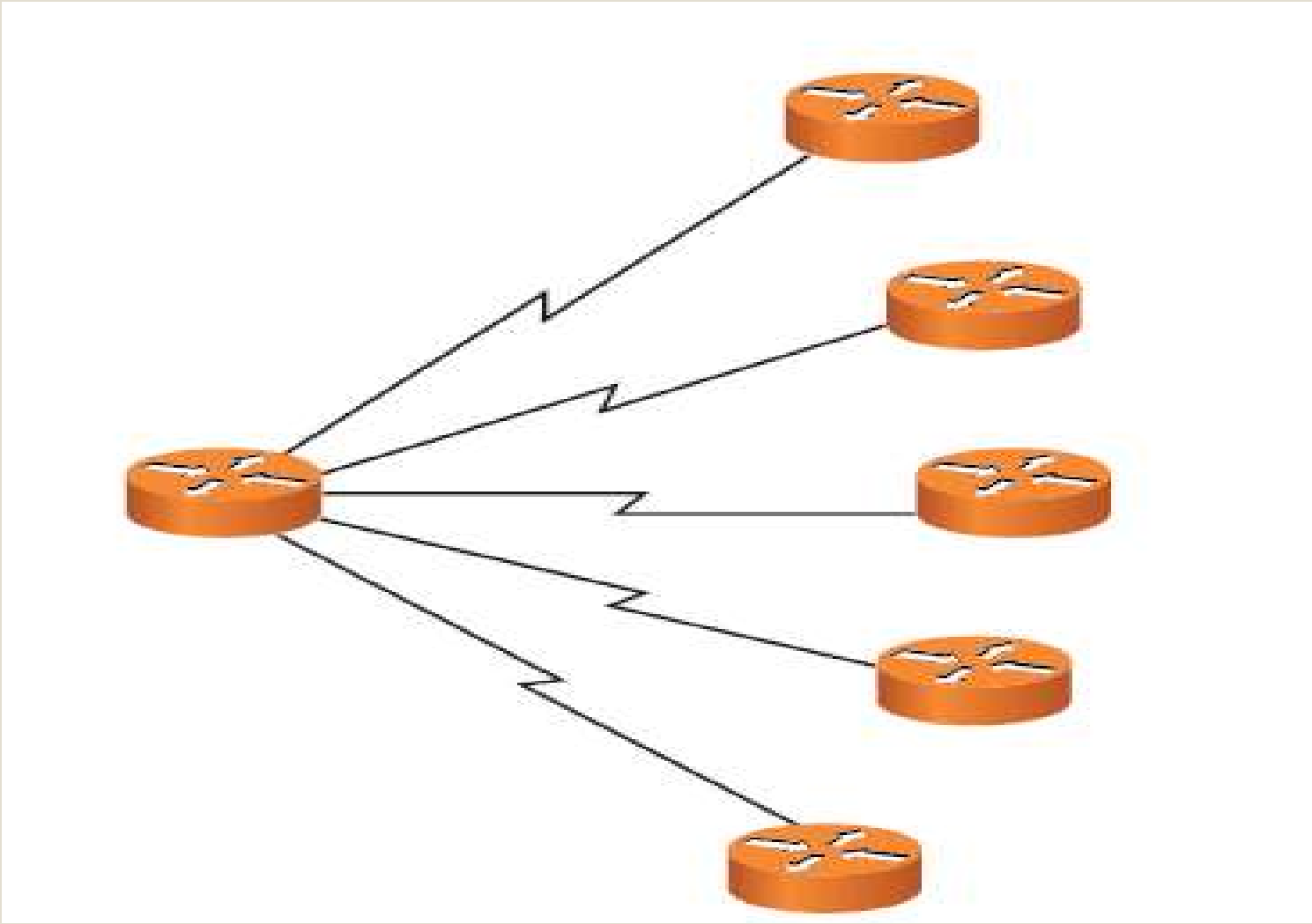
- The star topology is the most popular physical LAN topology in use today.
- An Ethernet switch at the center of the star and unshielded twisted-pair cable (UTP) IS used to connect from the switch ports to clients.

Characteristics	Benefits	Drawbacks
Devices have independent connections back to a central device (for example, a hub or a switch).	A cable break only impacts the device connected via the broken cable, and not the entire topology	More cable is required for a star topology, as opposed to bus or ring topologies, because each device requires its own cable to connect back to the central device
Star topologies are commonly used with Ethernet technologies	Troubleshooting is relatively simple, because a central device in the star topology acts as the aggregation point of all the connected devices.	Installation can take longer for a star topology, as opposed to a bus or ring topology, because more cable runs that must be installed.

HUB-AND-SPOKE TOPOLOGY

- When interconnecting multiple sites (for example, multiple corporate locations) via WAN links, a hub-and-spoke topology has a WAN link from each remote site (that is, a *spoke site) to the main site (that is, the hub site).*
- With WAN links, a service provider is paid a recurring fee for each link
- Therefore, a hub-and-spoke topology helps minimize WAN expenses by not directly connecting any two spoke locations.

(See Diagram below)



Characteristics	Benefits	Drawbacks
Each remote site (that is, a spoke) connects back to a main site (that is, the hub) via a WAN link.	Costs are reduced (as compared to a full-mesh or partial-mesh topology) because a minimal number of links are used.	Suboptimal routes must be used between remote sites, because all intersite communication must travel via the main site.
Communication between two remote sites travels through the hub site.	Adding one or more additional sites is easy (as compared to a full-mesh or partial-mesh topology) because only one link needs to be added per site	Because all remote sites converge on the main site, this hub site potentially becomes a single point of failure.
		Because each remote site is reachable by only a single WAN link, the hub-and-spoke topology lacks redundancy.

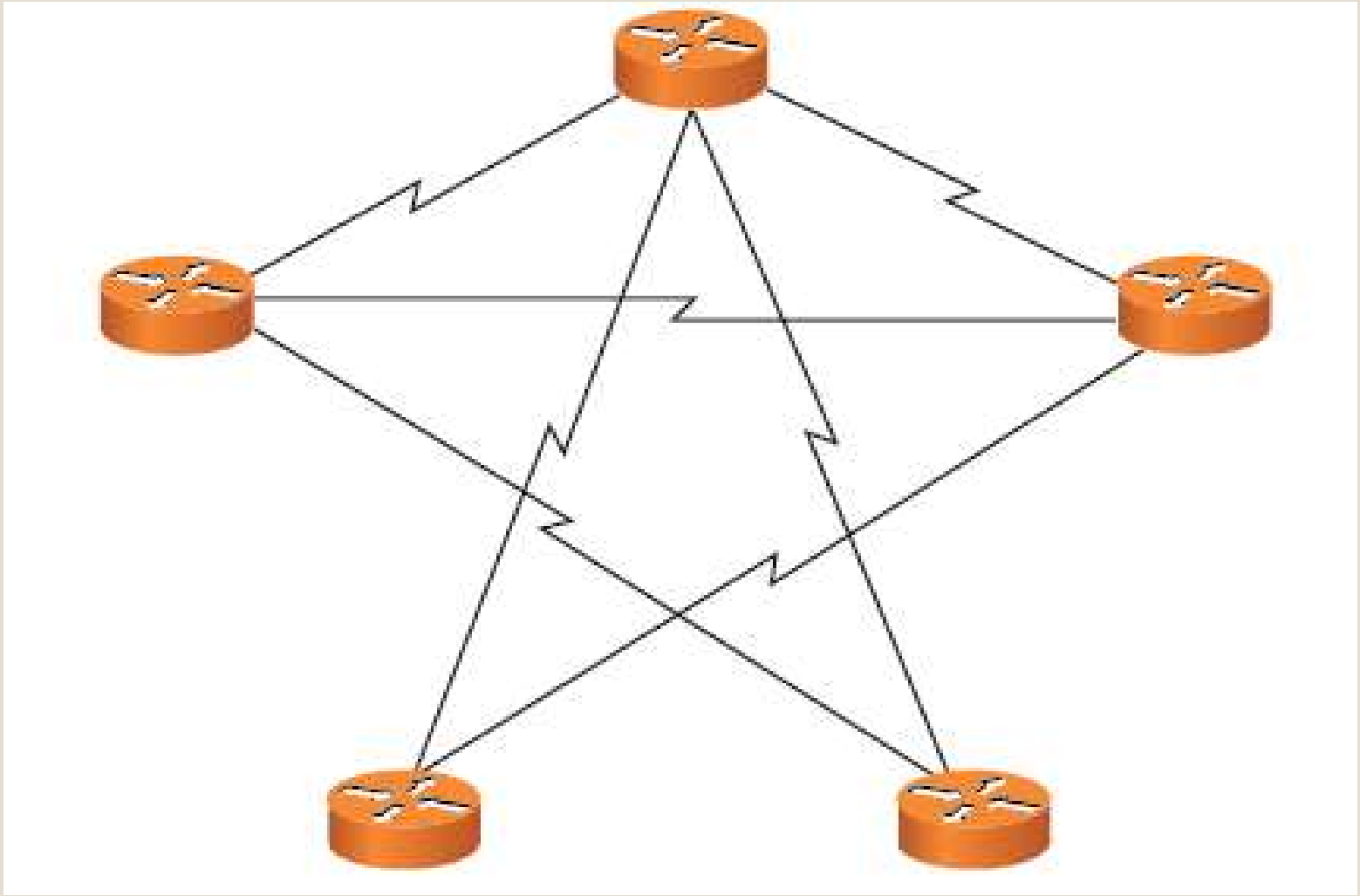
FULL-MESH TOPOLOGY

- Although a hub-and-spoke WAN topology lacked redundancy and suffered from suboptimal routes, a full-mesh topology, directly connects every site to every other site.
- Because each site connects directly to every other site, an optimal path can be selected, as opposed to relaying traffic via another site.

Characteristics	Benefits	Drawbacks
The number of required WAN connections can be calculated with the formula *w = n * (n-1) / 2 , where w = the* number of WAN links and *n = the number of sites.* *For* example, a network with 10 sites would require 45 WAN connections to form a fully meshed network: 45 = 10 * (10-1) / 2.	A full-mesh network is fault tolerant, because one or more links can be lost, and reachability between all sites might still be maintained.	
	Troubleshooting a full mesh network is relatively easy, because each link is independent of the other links.	

PARTIAL-MESH TOPOLOGY

- Specifically, a partial-mesh topology can be designed to provide an optimal route between selected sites, while avoiding the expense of interconnecting every site to every other site.
- When designing a partial-mesh topology, a network designer must consider network traffic patterns and strategically add links interconnecting sites that have higher volumes of traffic between themselves



Characteristics	Benefits	Drawbacks
Selected sites (that is, sites with frequent intersite communication) are interconnected via direct links, while sites that have less frequent communication can communicate via another site.	A partial-mesh topology provides optimal routes between selected sites with higher intersite traffic volumes, while avoiding the expense of interconnecting every site to every other site.	A partial-mesh topology is less fault tolerance than a fullmesh topology.
A partial-mesh topology uses fewer links than a full-mesh topology and more links than a hub-and-spoke topology for interconnecting the same number of sites.	A partial-mesh topology is more redundant than a hub and-spoke topology.	A partial-mesh topology is more expensive than a hub and- spoke topology.

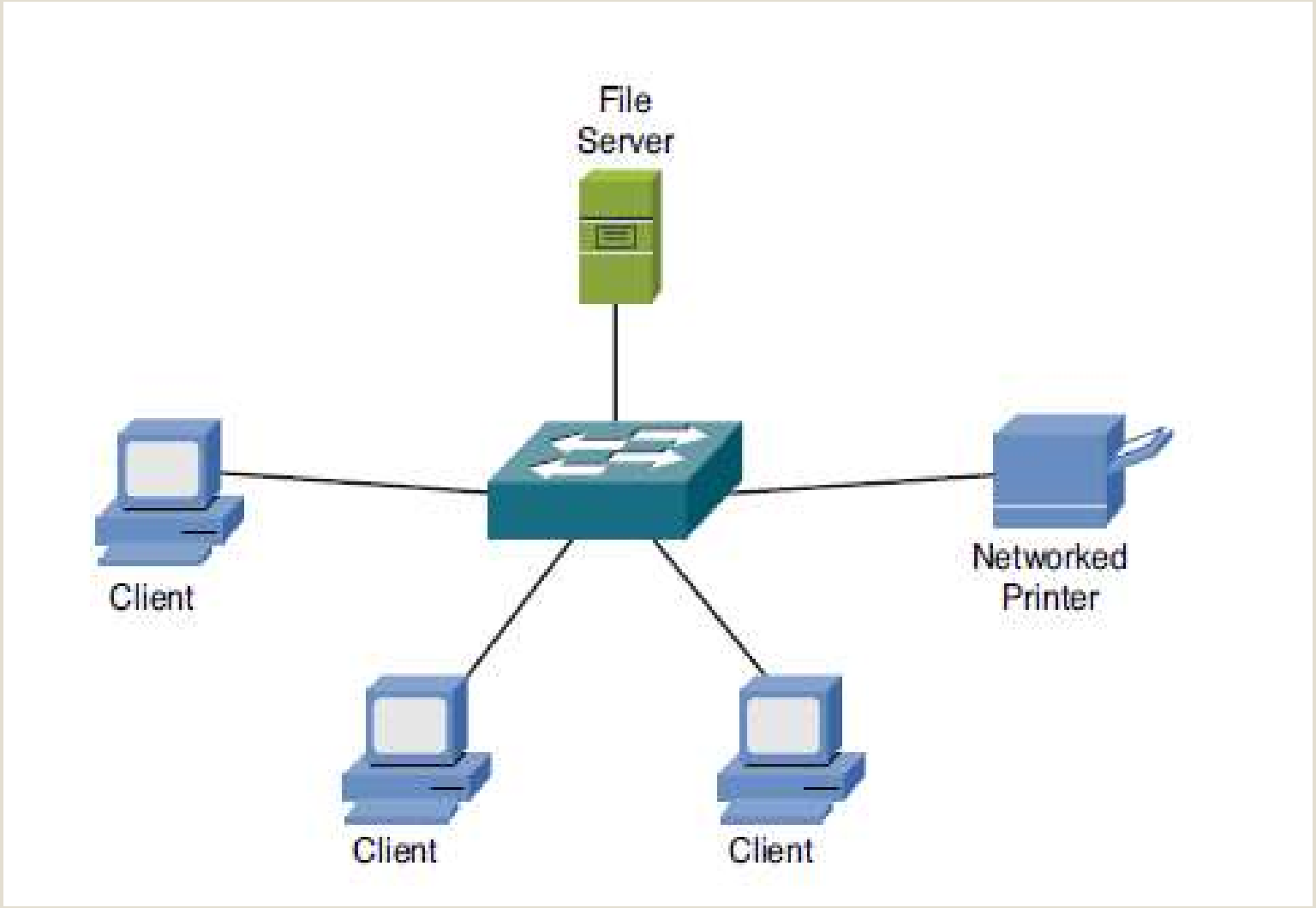
NETWORKS DEFINED BY RESOURCE LOCATION

- Client-Server Networks
- Peer-to-Peer Networks
- Hybrid Networks

CLIENT-SERVER NETWORKS

- A dedicated file server provides shared resources e.g files, a networked printer.
- Client-server networks are commonly used by businesses.
- Because resources are located on one or more servers, administration is simpler than trying to administer network resources on multiple peer devices.

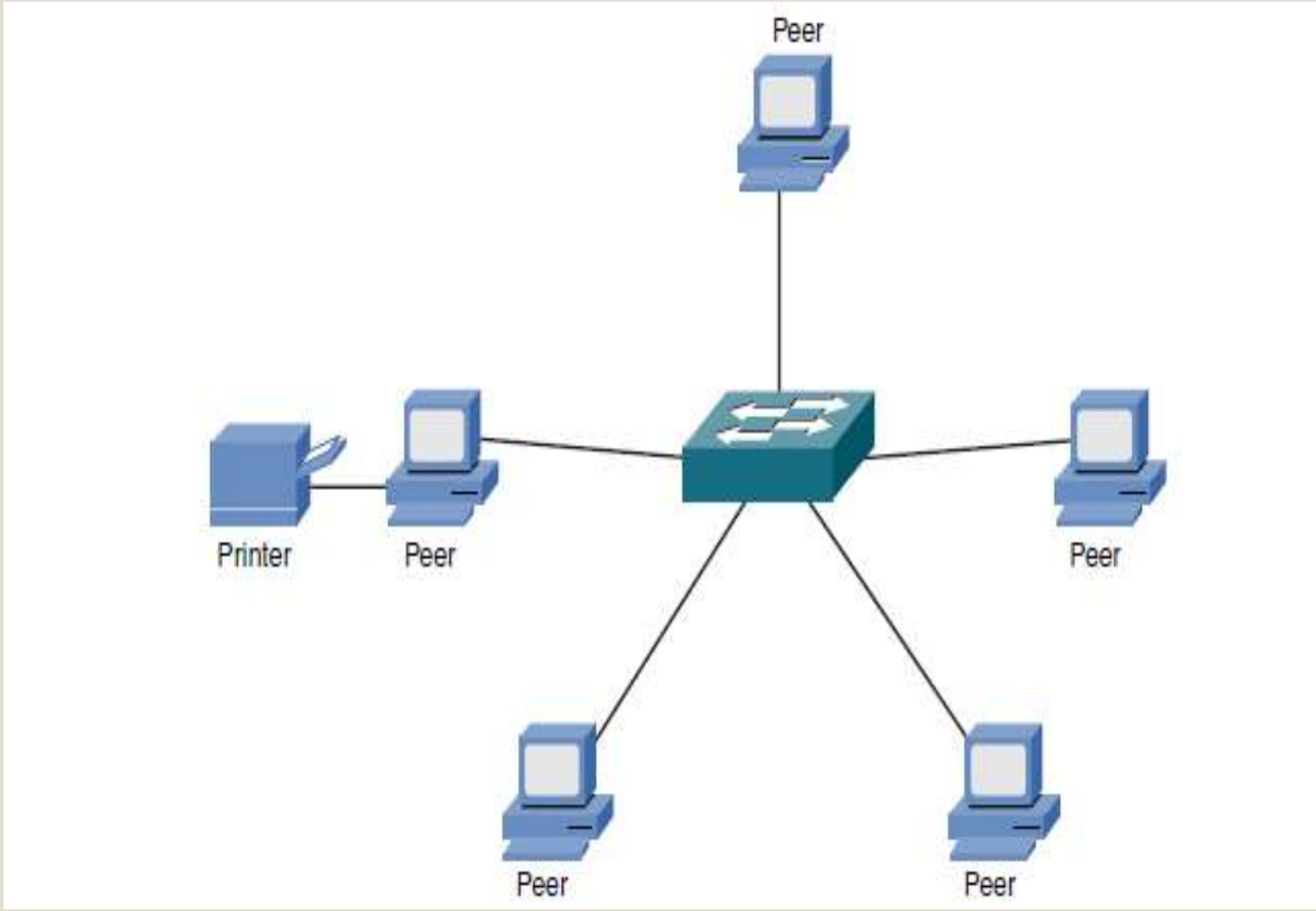
(See Diagram below)


File
Server
Client
Networked
Printer
Client
Client

Characteristics	Benefits	Drawbacks
Client devices (for example, PCs) share a common set of resources (for example, file or print resources) located on one or more dedicated servers.	Client-server networks can easily scale, which might require the purchase of additional client licenses	Because multiple clients might rely on a single server for their resources, the single server can become a single point of failure in the network.
Resource sharing is made possible via dedicated server hardware and network OSs.	Administration is simplified, because parameters, such as file sharing permissions and other security settings, can be administered on a server as opposed to multiple clients	Client-server networks can cost more than peer-to-peer networks. For example, client-server networks might require the purchase of dedicated server hardware and a network OS with an appropriate number of licenses.

PEER-TO-PEER NETWORKS

- Peer-to-peer networks allow interconnected devices (for example, PCs) to share their resources with one another.
- Those resources could be, for example, files or printers.
- Each of the peers can share files on their own hard drives, and one of the peers has a directly attached printer that can be shared with the other peers in the network.


Peer
Printer
Peer
Peer
Peer
Peer

Characteristics	Benefits	Drawbacks
Client devices (for example, PCs) share their resources (for example, file and printer resources) with other client devices.	Peer-to-peer networks can be installed easily because resource sharing is made possible by the clients' OSs, and knowledge of advanced NOSs is not required.	Scalability is limited because of the increased administration burden of managing multiple clients.
Resource sharing is made available through the clients' OSs.	Peer-to-peer networks typically cost less than client-server networks because there is no requirement for dedicated server resources or advanced NOS software.	Performance might be less than that seen in a client-server network because the devices providing network resources might be performing other tasks not related to resource sharing (for example, word processing).

HYBRID NETWORKS

- A mixture of client-server and peer-to-peer characteristics, is called a *hybrid network*.
- For example, PCs in a company might all point to a centralized server for accessing a shared database in a client-server topology.
- However, these PCs might simultaneously share files and printers between one another in a peer-to-peer topology.

Q & A

END