Network Models: Server-Based and Peer-to-Peer

PC networks generally fall within one of these two network types:

- **Server-based:** A server-based network consists of a group of user-oriented PCs called ***clients*** that request and receive network services from specialized computers called ***servers***. Servers are generally higher-performance systems; optimized to provide network services to other PCs. (Some common server types include file servers, mail servers, print servers, fax servers, and application servers). See figure 1and 2.

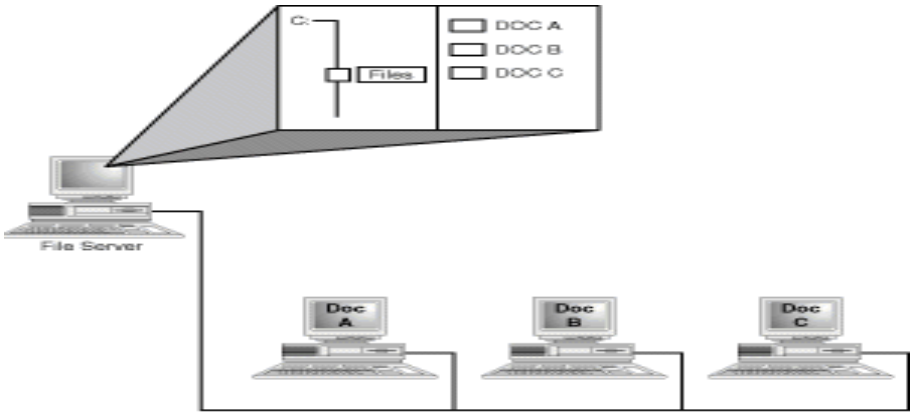

Figure 1: A file server stores files for users on other network machines

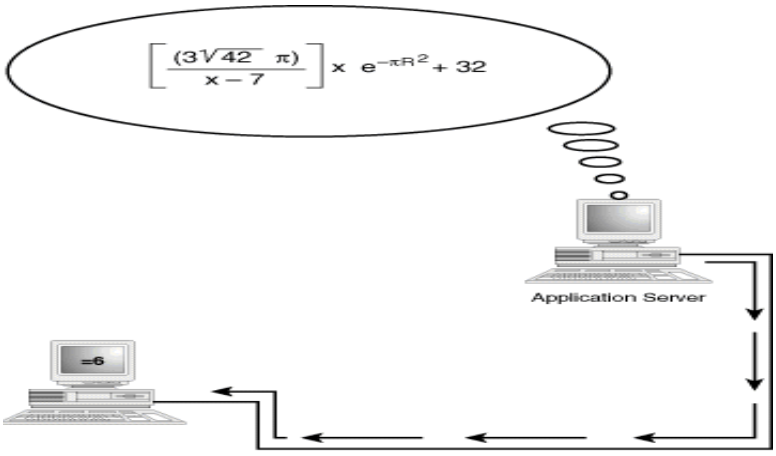

Figure 2: An application server runs all or part of an application

- **Peer-to-peer:** A peer-to-peer network is a group of user- oriented PCs that basically operate as equals. Each PC is called a ***peer***. The peers share resources, such as files and printers, but no specialized servers exist. Each peer is responsible for its own security.

  Each peer is both a client (because it requests services from the other peers) and a server (because it offers services to the other peers).

  Small networks—usually under 10 machines—may work well in this configuration. See figure 3.

Figure 3: Sample of three peer's computers

Local and Wide Area Networks

Networks come in all shapes and sizes. Mainly, they are as the following:

- Local area networks (LANs)
- Wide area networks (WANs)

Local Area Networks (LANs)

A local area network (LAN) is a group of computers and network communication devices interconnected within a geographically limited area, such as a building or campus. A LAN tends to use only one type of transmission-medium-cabling. See figure 4.

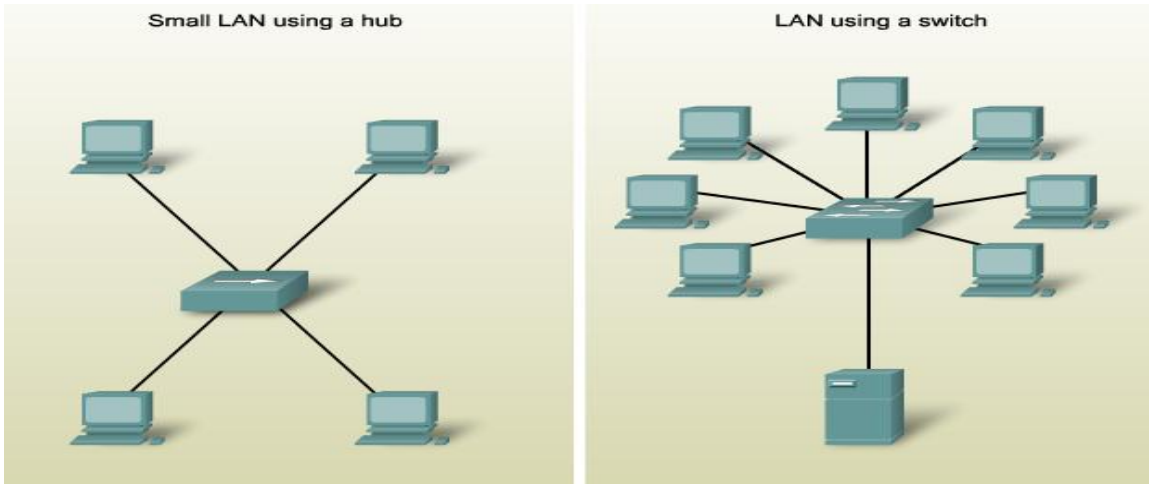

Figure 4: Two samples of LAN

LANs are characterized by the following:

- They transfer data at high speeds.
- They exist in a limited geographical area.

Wide Area Networks (WANs)

A wide area network (WAN) interconnects LANs. A WAN may be located entirely within a state or country, or it may be interconnected around the world.

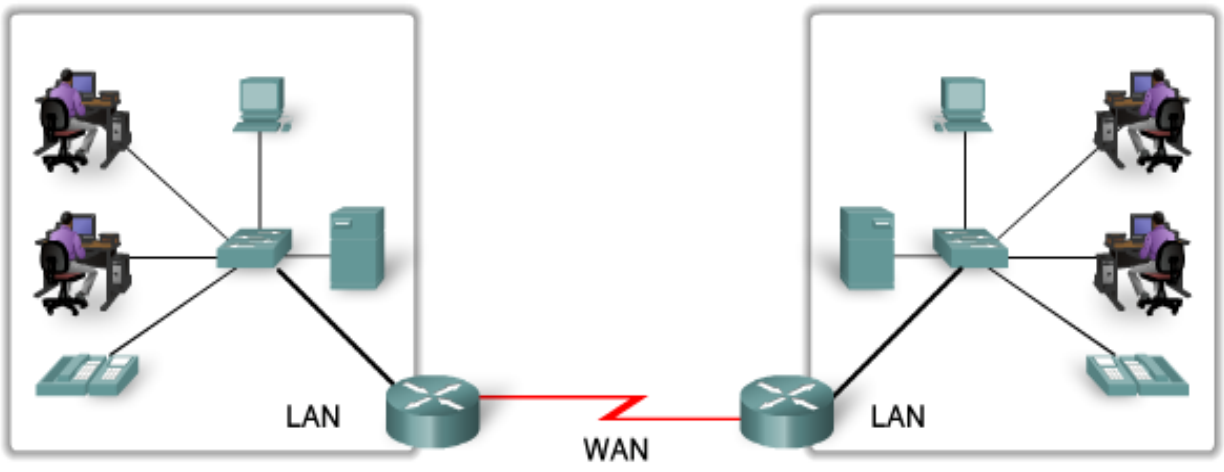

Figure 5: Sample of WAN

WANs are characterized by the following:

- They exist in an unlimited geographical area.
- They are more susceptible to errors due to the distances data travels.
- They interconnect multiple LANs.
- They are more sophisticated and complex than LANs.

WANs can be further classified into two categories:

Enterprise WAN: is a WAN that connects the widely separated computer resources of a single organization. An organization with computer operations at several distant sites can employ an enterprise WAN to interconnect the sites.

Global WAN: interconnects networks of several corporations or organizations. An example of a global WAN is the Internet.

Network Topologies and Architectures

A topology is a map of the network; it is a plan for how the cabling will interconnect the nodes and how the nodes will function in relation to one another. There are two basic categories of topologies:

Physical topology: Describes the actual layout of the network transmission media. (The way the network looks)

Logical topology: Describes the logical pathway a signal follows as it passes among the network nodes. (The way the data passes among the nodes or how the systems communicate across the physical topologies).

There are two main types of logical topologies:

• Shared media topology.

• Token-based topology.

- **Shared Media**

In a shared media topology, all the systems have the ability to access the physical layout whenever they need it. The main advantage in a shared media topology is that the systems have unrestricted access to the physical media. Of course, the main disadvantage to this topology is collisions. If two systems send information out on the wire at the same time, the packets collide and kill both packets. Ethernet is an example of a shared media topology.

To help avoid the collision problem, Ethernet uses a protocol called Carrier Sense Multiple Access/Collision Detection (CSMA/CD). In this protocol, each system monitors the wire, listening for traffic. If traffic is detected, the system waits until it hears no traffic before it sends packets out. If a situation occurs where two systems send out packets at the same time and a collision occurs, each system waits for a period of time before it retries. This time period is different for each system, so that the collision does not occur again.

For small networks, the shared media topology works fine; however, as you begin to add more systems to the network, there is a greater opportunity for collisions. To help reduce the number of collisions, many networks are broken up into several smaller networks with the use of switches or hubs, and each network is then referred to as its own collision domain.

Shared media networks are typically deployed in a bus, star, or hybrid physical topology.

- **Token Based**

The token-based topology works by using a token to provide access to the physical media. In a token-based network, there is a token that travels around the network. When a system needs to send out packets, it grabs the token off of the wire, attaches it to the packets that are sent, and sends it back out on the wire. As the

token travels around the network, each system examines the token. When the packets arrive at the destination systems, those systems copy the information off of the wire and the token continues its journey until it gets back to the sender. When the sender receives the token back, it pulls the token off of the wire and sends out a new empty token to be used by the next machine.

The most common topologies are:

- Bus Topologies.
- Ring Topologies.
- Star Topologies.
- Hybrid or tree.
- Mesh.

Bus Topologies

A bus ***physical*** topology is one in which all devices connect to a common, shared cable (sometimes called the backbone). A bus physical topology is shown in figure 6.

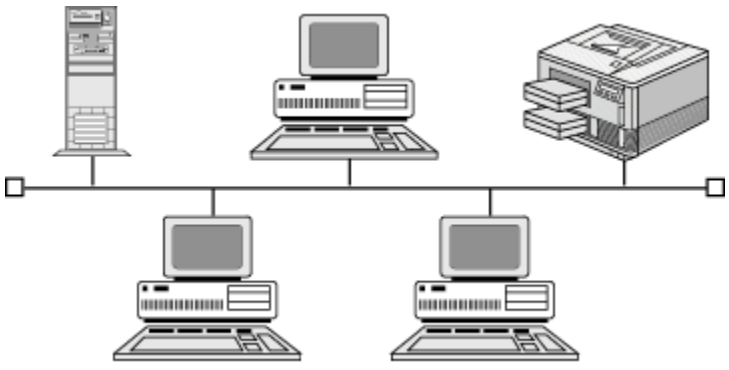

Figure 6: Physical Bus Topology

Most bus networks broadcast signals in both directions on the backbone cable, enabling all devices to directly receive the signal. ***Therefore*** a special connector called a ***terminator*** must be placed at the end of the backbone cable to prevent signals from reflecting back on the cable and causing interference (collision).

When a packet is sent in a bus topology, there is no intermediary to determine who the packet should go to. Because of this, every packet that is sent in a bus topology is received by all systems on the network. Normally, if the packet is not for a particular system, the computer would simply disregard the packet; however, you can see the security implications of this type of network. If a malicious user were on this network and utilized a packet capture program, he could see every conversation that occurred between machines.

Advantages	Disadvantages
Easy to install	Out-of-date technology
Costs are usually low	If cable breaks, whole network is down
Easy to add systems to network	Can be difficult to troubleshoot
Great for small networks	Unmanageable in a large network

Ring Topologies

Ring topologies are wired in a circle. Each node is connected to its neighbors on either side, and data passes around the ring in one direction only. Each device incorporates a ***receiver (R)*** and a ***transmitter (T)*** and serves as a repeater that passes the signal on to the next device in the ring. Ring physical topologies are quite rare. It is almost always implemented as a logical topology.

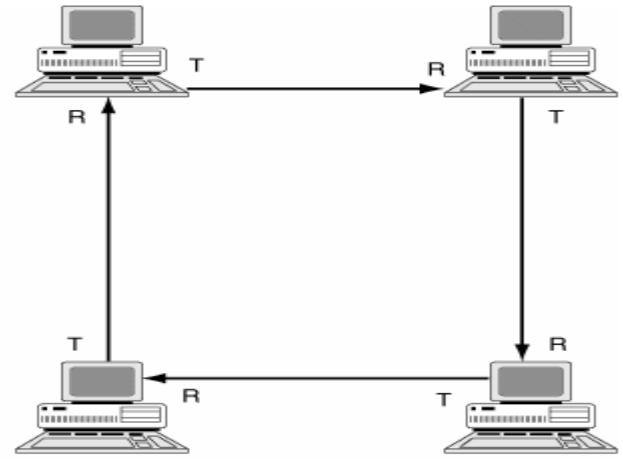

Figure 7: Physical Ring Topology

Token Ring, for example, always arranges the nodes in a physical star (with all nodes connecting to a central hub) but passes data in a logical ring.

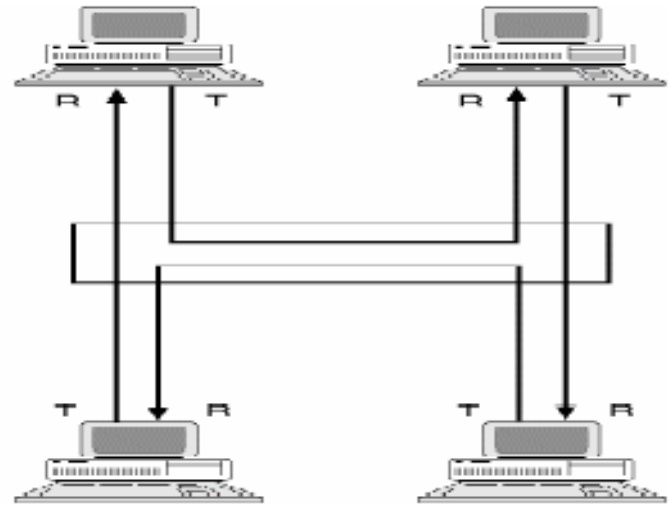

Figure 8: Logical Ring Physical Star Topology

Advantages	Disadvantages
Easy to install	Out-of-date technology
Costs are usually low	If cable breaks, whole network is down
Easy to add systems to network	Can be difficult to troubleshoot
Great for small networks	Unmanageable in a large network

Star Topologies

A star physical topology means that the nodes are all connected to a central hub. The path the data takes among the nodes and through that hub (the logical topology) depends on the design of the hub or the switch, the design of the cabling, and the hardware and software configuration of the nodes. See figure 13

Advantages	Disadvantages
Easy to install	Costs are usually higher than with bus or ring networks
Easy to add devices to network	If you have only one central device and it fails, it brings the network down
One break does not bring whole network down	
Easier to troubleshoot	
Widely used	
Centralized management	

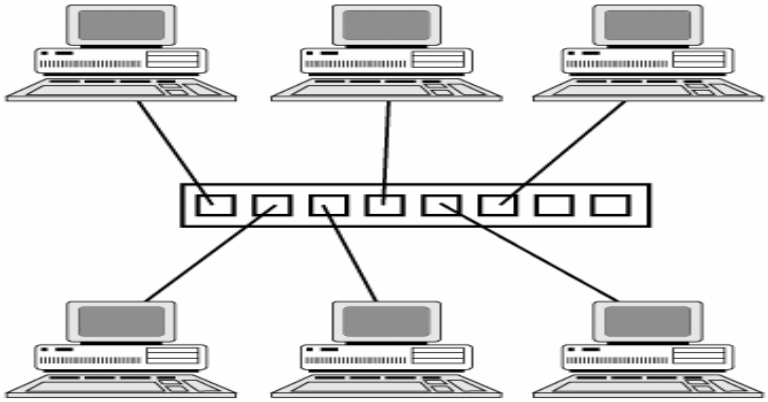

Figure 9: Physical Star Topology

Hybrid

The hybrid or tree topology is simply a combination of the other topologies. Figure 14shows an example of a hybrid network. In this layout, we have three star networks that are connected to each other through a bus topology shown by the red line.

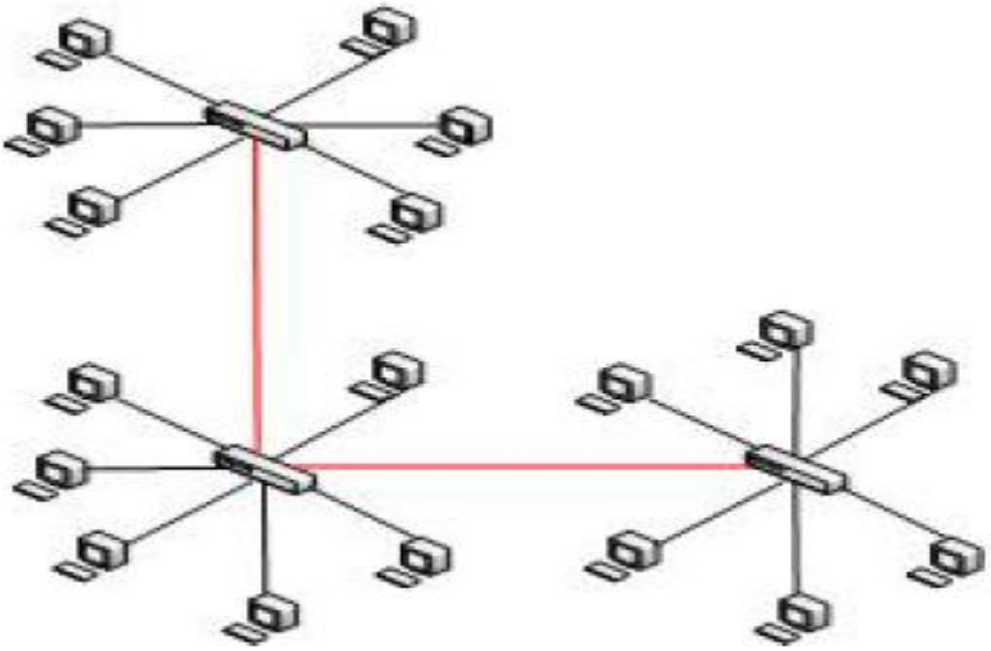

Figure 10: Hybrid topology

Mesh

The mesh topology is the last topology we discuss. In this layout, every system is connected to every other system. The main advantage of this topology is high availability. The main disadvantage of this topology is cost, both administrative and physical. Because each system is connected to each other, the amount of cabling and maintenance necessary can be prohibitive, especially in larger networks. The formula for determining the amount of cable needed in a mesh network is: **(N * (N – 1))/2**

Where N is the number of systems to be interconnected. In our example in Figure 11, we have six systems that require 15 cables to create a mesh network. This topology is mainly used in Wide Area Network environments or in environments where high availability outweighs the costs associated with this amount of interconnection.

Advantages	**Disadvantages**
Extremely fault tolerant	Expensive
	Difficult to implement
	Difficult to administer
	Difficult to troubleshoot

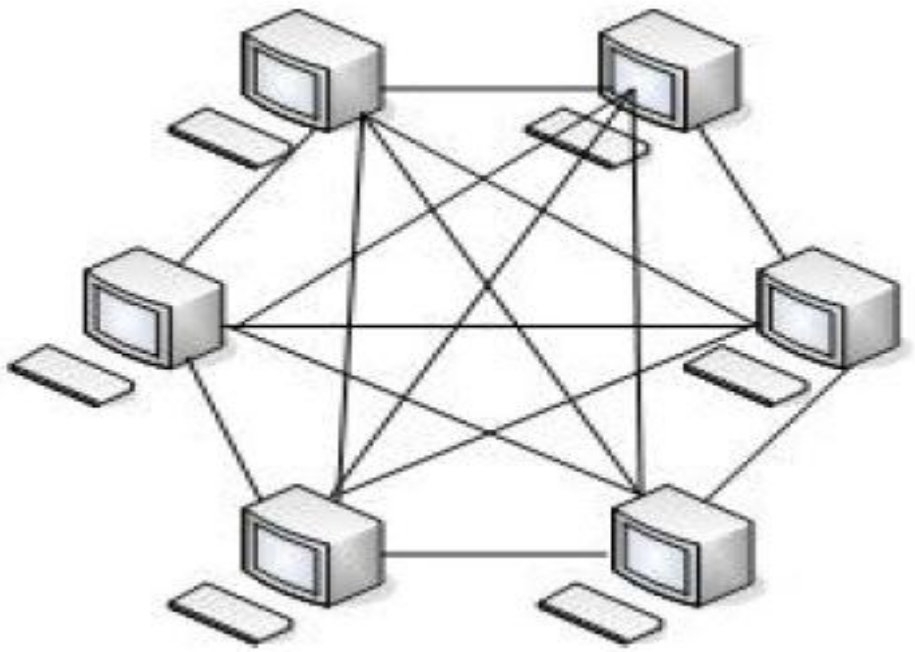

Figure 11: Mesh topology