



**Wollo University**  
**Kombolcha Institute of Technology**  
**Department of Information System**

*Data Communication and Computer Networks*

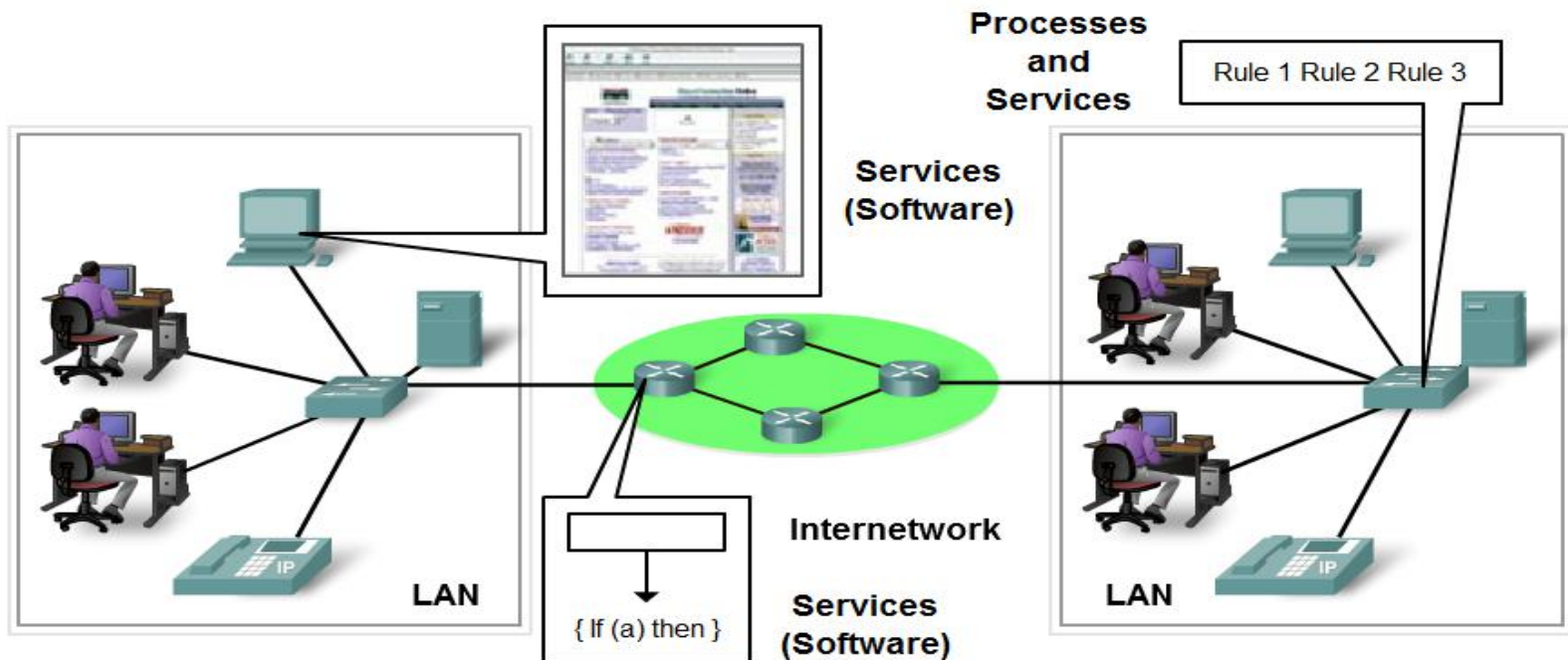
# CHAPTER 03

## COMPONENTS OF THE NETWORK

### 3.1 Network Components

Hardware  
Software

Networks use devices, media and services.



# Components of the network

- Network infrastructure is the platform that supports the human network.
  - Provides the stable and reliable channel over which communications can occur
- As a component Data Network consists *Devices, Media & Services*
  - *Devices and media* are the physical elements or hardware of the network
  - *Services and processes* are the communication programs, called software, that run on the networked devices
- **Service** provides information in response to a request
  - network applications like *e-mail hosting services and web hosting services*
- **Processes** provide the functionality that directs and moves the messages through the network

# Components of the network

## ■ End Devices and their Role in the Network

End devices form interface with human network & communications network

Example of end devices...

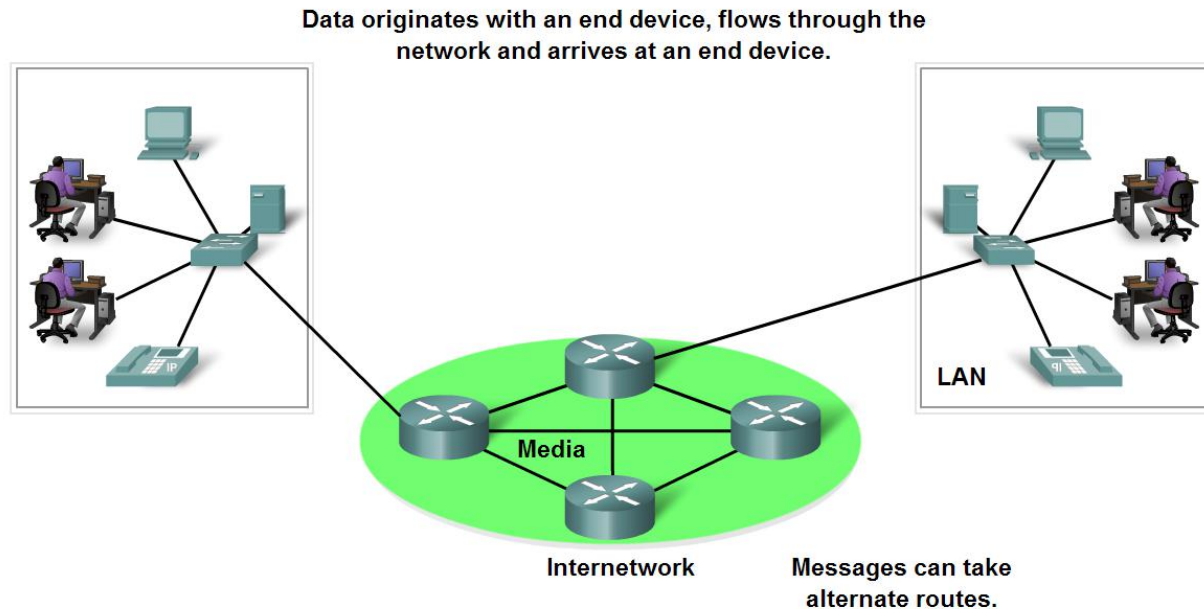
∞ Role of end devices:

end devices are referred to as *hosts*, and can act as:

**Client**

**Server**

**Both client and server**



# Components of the network

## ▪ End Devices and their Role in the Network

### • Example of end devices

Computers (work stations, laptops, file servers, web servers)

Network printers

VoIP phones

Security cameras

Mobile handheld devices (wireless barcode scanners, PDAs)

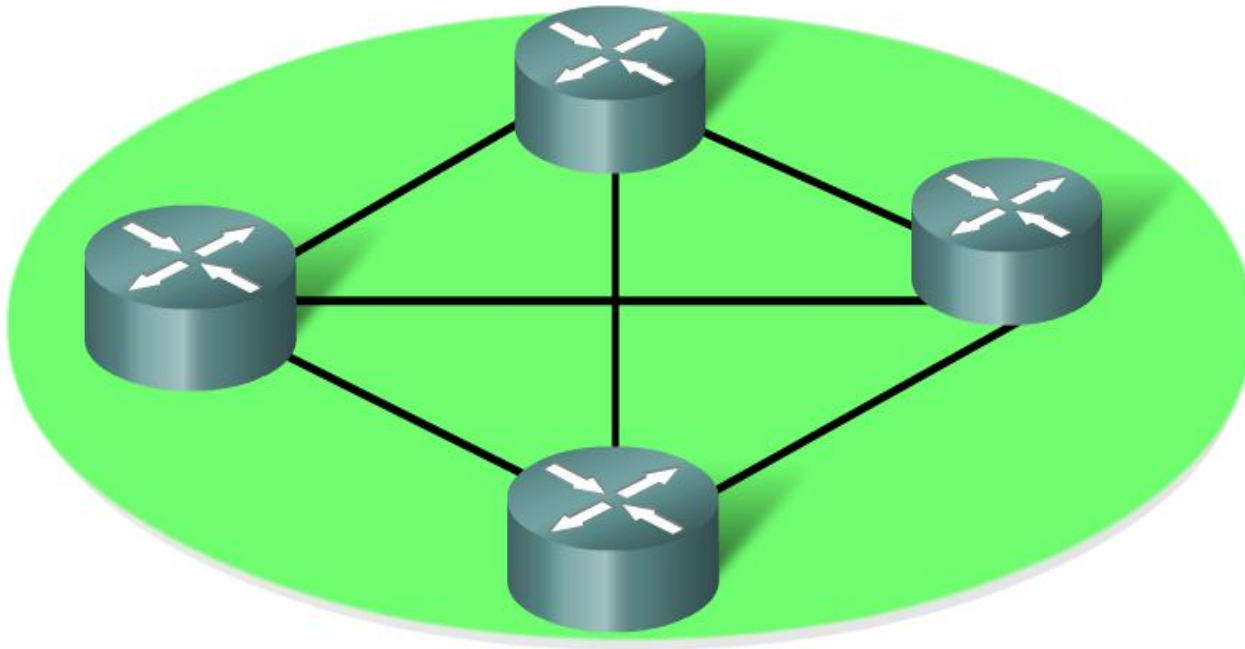
▪ Software installed on the host determines which role it plays

▪ **Servers** are hosts that have software installed that enables them to provide information and services, like e-mail or web pages, to other hosts on the network.

▪ **Clients** are hosts that have software installed that enables them to request and display the information obtained from the server.

# Components of the network

- Intermediary device & their role
  - ✓ Provides connectivity and ensures data flows across network
  - ✓ Networks rely on intermediary devices to provide connectivity



# Components of the network

## ■ Intermediary device & their role

Example of intermediary devices:

- Network Access Devices (**Hubs, switches, and wireless access points**)
- Internetworking Devices (**Routers**)
- Communication Servers and Modems
- Security Devices (firewalls, IDS(Intrusion Detection System), IPS(Intrusion Prevention Systems))

## ■ Functions

- **Regenerate and retransmit** data signals
- **Maintain information** about what pathways exist
- **Notify other devices of errors** and communication failures
- **Direct data along alternate pathways** when there is a link failure
- **Classify and direct messages** according to QoS priorities
- **Permit or deny the flow of data**, based on security settings

## 3.2 Network Types

### Network Criteria

- **Performance**: can be measured using
  - ✓ **Transit time** - amount of time required for a message to travel)
  - ✓ **Response time** - elapsed time between an inquiry and the response
- **Reliability**: measured by the frequency of failure, the time it takes a link to recover from failure, and the network's robustness in a catastrophe
- **Security**: protecting data and network infrastructure from unauthorized access



## Local Area Network(LAN)

- ❑ Networks infrastructures can vary greatly in terms of:
  - The size of the area covered
  - The number of users connected
  - The number and types of services available
- ❑ An individual network usually spans a single geographical area, providing services and applications to people within a common organizational structure, such as a single business, campus or region.
- ❑ This type of network is called a Local Area Network (LAN).
- ❑ A LAN is usually administered by a single organization.
- ❑ The administrative control that governs the security and access control policies are enforced on the network level.

# Metropolitan Area Network

- ❑ A **metropolitan area network (MAN)** is a computer network that usually **spans a city or a large campus**.
- ❑ A MAN usually **interconnects a number of local area networks (LANs) using a high-capacity backbone technology**, such as fiber-optical links, and provides **up-link services to wide area networks(or WAN) and the Internet**.
- ❑ A MAN is optimized for a larger geographical area than a LAN, ranging from **several blocks of buildings to entire cities**.
- ❑ MANs can also depend on communications channels of **moderate-to-high data rates**.
- ❑ A MAN might be owned and operated by a single organization, but it usually will be used by many **individuals and organizations**.
- ❑ MANs might also be owned and operated as public utilities.
- ❑ They will often provide means for internetworking of local networks

# Wide Area Network

- ❑ When a company or organization has locations that are separated by large geographical distances, it may be necessary to use a telecommunications service provider (TSP) to interconnect the LANs at the different locations.
- ❑ Telecommunications service providers operate large regional networks that can span long distances.
- ❑ Traditionally, TSPs transported voice and data communications on separate networks.
- ❑ Increasingly, these providers are offering converged information network services to their subscribers.
- ❑ Individual organizations usually lease connections through a telecommunications service provider network.
- ❑ These networks that connect LANs in geographically separated locations are referred to as Wide Area Networks (WANs).

## WAN(cont...)

- ❑ Although the organization maintains all of the policies and administration of the LANs at both ends of the connection, the policies within the communications service provider network are controlled by the TSP.
- ❑ WANs use specifically designed network devices to make the interconnections between LANs.
- ❑ Because of the importance of these devices to the network, configuring, installing and maintaining these devices are skills that are integral to the function of an organization's network.
- ❑ LANs and WANs are very useful to individual organizations. They connect the users within the organization.
- ❑ They allow many forms of communication including exchange e-mails, corporate training, and other resource sharing.

# Internet: A network of Networks

- ❑ Although there are benefits to using a LAN or WAN, most of us need to communicate with a resource on another network, outside of our local organization.
- ❑ Examples of this type of communication include:
  - Sending an e-mail to a friend in another country
  - Accessing news or products on a website
  - Getting a file from a neighbor's computer
  - Instant messaging with a relative in another city
  - Following a favorite sporting team's performance on a cell phone

## Internetwork

- ❑ A global mesh of interconnected networks (internetworks) meets these human communication needs.
- ❑ Some of these interconnected networks are owned by large public and private organizations, such as government agencies or industrial enterprises, and are reserved for their exclusive use.

## Internet(cont...)

- ❑ The most well-known and widely used publicly-accessible internetwork is the Internet.
- ❑ The Internet is created by the interconnection of networks belonging to Internet Service Providers (ISPs).
- ❑ These ISP networks connect to each other to provide access for millions of users all over the world.
- ❑ Ensuring effective communication across this diverse infrastructure requires the application of consistent and commonly recognized technologies and protocols as well as the cooperation of many network administration agencies.

## Intranet

- ❑ The term intranet is often used to refer to a private connection of LANs and WANs that belongs to an organization, and is designed to be accessible only by the organization's members, employees, or others with authorization.

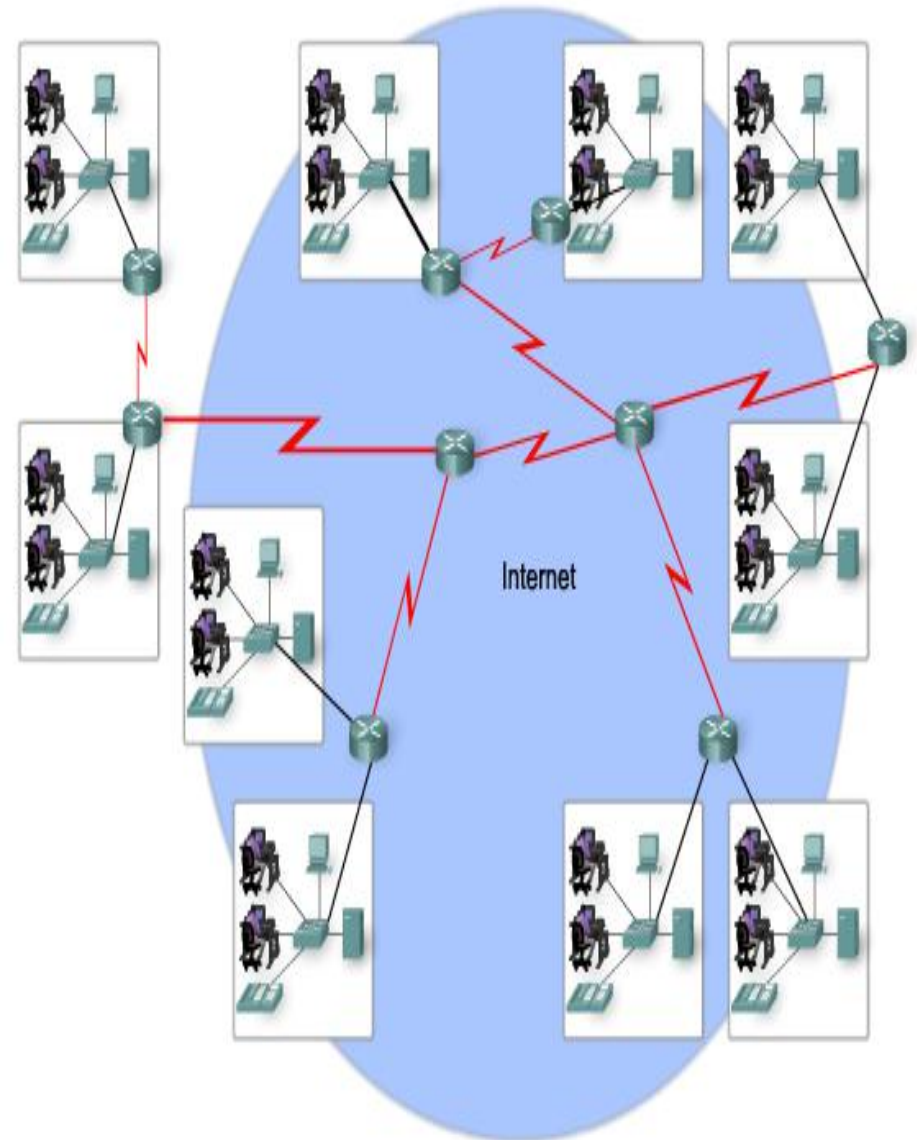
## Internet(cont...)

**Extranet** is part of an Intranet, which is also categorized as a “Private Network”.

- ❑ It is controlled and managed by an organization, to provide secure access to Intranet from the outside world.
- ❑ Many business organizations need their business partners and customers to connect to Intranet to enhance communication and efficiency.
- ❑ Since the Intranet permits only internal members to gain access, external members (partners and customers) use Extranet to access the network
- ❑ system administration/management can decide which users should allow through Extranet. Generally, external users are given limited access over the Intranet.
- ❑ Not only external users, sometimes members of the organization itself who may need to access the network over the Internet can use Extranet.

LANs and WANs may be connected into internetworks.

- ❑ Note: The following terms may be interchangeable: internetwork, data network, and network.
- ❑ A connection of two or more data networks forms an internetwork - a network of networks.
- ❑ It is also common to refer to an internetwork as a data network - or simply as a network - when considering communications at a high level. The usage of terms depends on the context at the time and terms may often be interchanged.

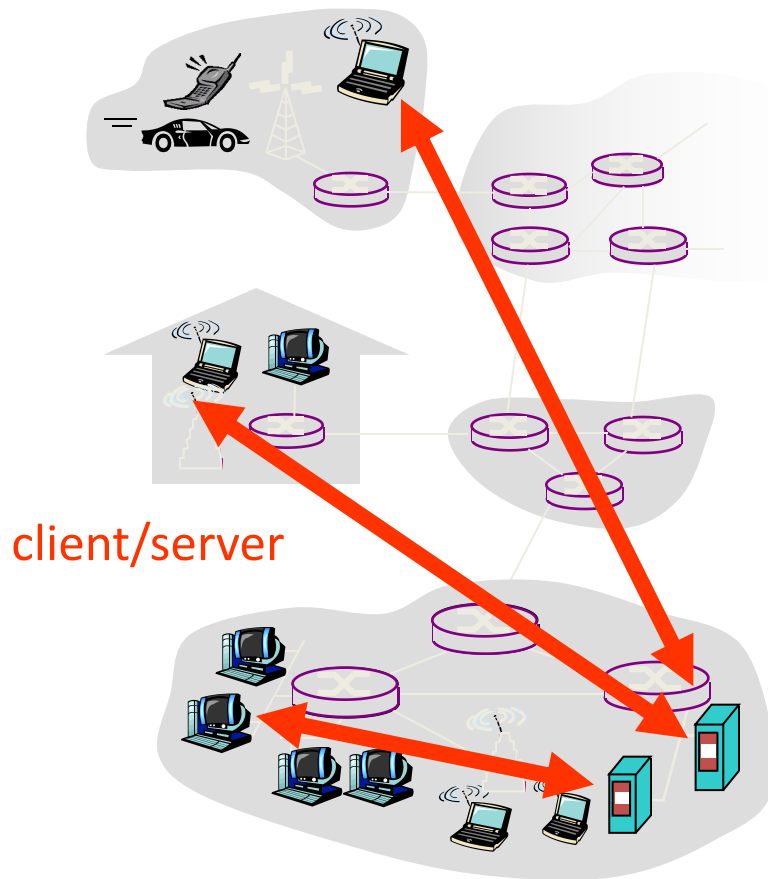




# Network Application Architecture

- Application architecture is designed by the application developer and dictates how the application is structured over the various end systems.
- When choosing the developer can choose among the two predominant architectural paradigms used in modern network application.
  - Client server architecture and
  - Peer to peer architecture
  - Hybrid of client-server and P2P

# Client-server architecture



## server:

- always-on host
- permanent IP address
- server farms for scaling

## clients:

- communicate with server
- may be intermittently connected
- may have dynamic IP addresses
- do not communicate directly with each other

# Cont...

❑ Often in client server application, a single host server is incapable of keeping up with all the request from its clients.

❑ For example **Facebook** or **Google** will quickly be overwhelmed if it has only one server handling all of its requests.

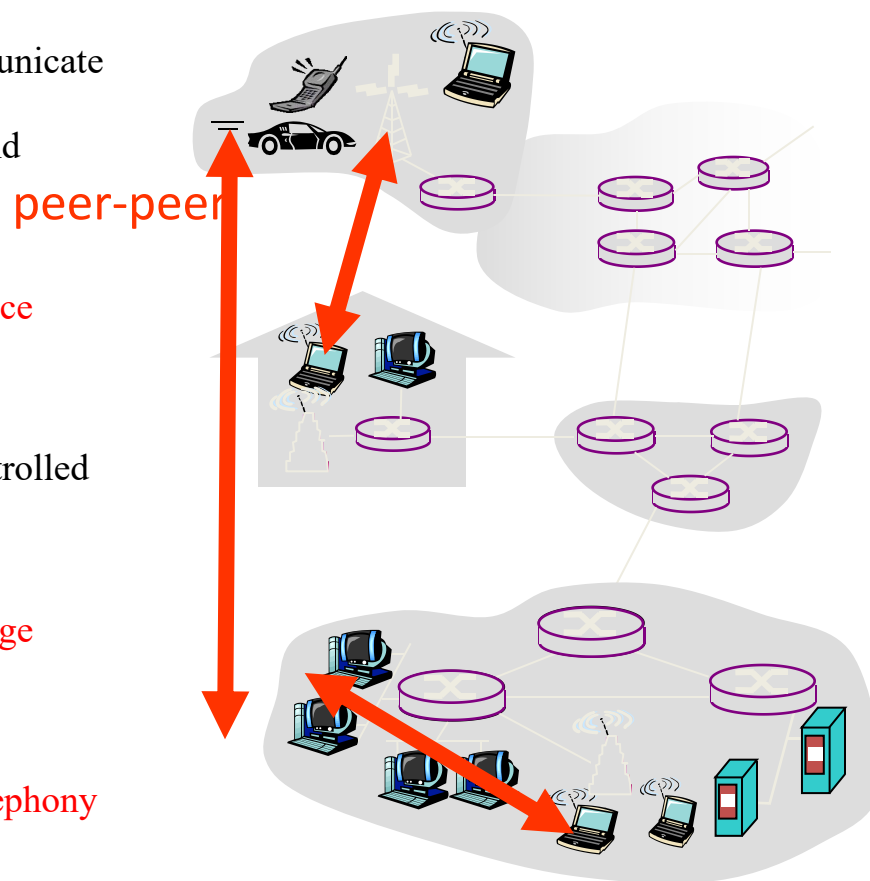
❑ For this reason, a large cluster of hosts- some times referred as data centers are often used to create a powerful virtual server.



Fig. One of Google data center

# Pure P2P architecture

- *no* always-on server
- arbitrary end systems directly communicate
- peers are intermittently connected and change IP addresses
- They are not owned by **internet service providers**
- They are simple desktop, laptop controlled by users
- **Highly scalable but difficult to manage**
- **Peer to peer application examples**
  - Emule , bit torrent, internet telephony



# Hybrid of client-server and P2P

## Skype

- voice-over-IP P2P application
- centralized server: finding address of remote party:
- client-client connection: direct (not through server)

## Instant messaging

- chatting between two users is P2P
- centralized service: client presence detection/location
  - user registers its IP address with central server when it comes online
  - user contacts central server to find IP addresses of buddies

# Network Topologies

## What is a Topology?

The term *topology*, or more specifically, network topology, refers to the arrangement or physical 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.

Topology describes how the network is constructed.

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.



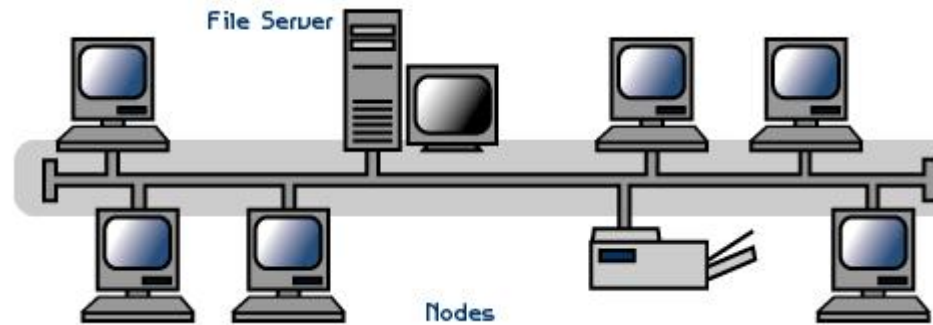
# Types of topologies

1. Linear Bus Topology
2. Star Topology
3. Ring Topology
4. Mesh Topology
5. By modifying and combining some of the characteristics of these “pure” network topologies , “hybrid” topologies result that can often provide greater efficiency.  
eg. Tree, star-star, hybrid topology.



# 1. Linear Bus (Bus)

A linear bus topology consists of a main run of cable with a terminator at each end (See fig. All nodes (file server, workstations, and peripherals) are connected to the linear cable.



# Advantages of a Linear Bus Topology

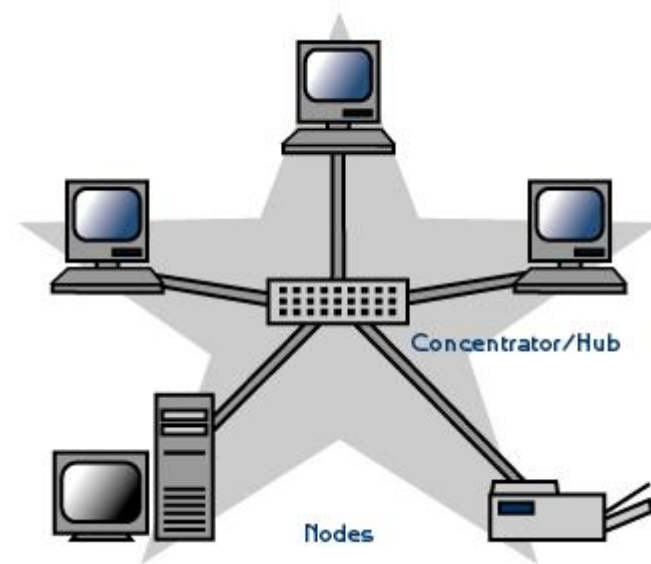
- ❑ Easy to connect a computer or peripheral to a linear bus.
- ❑ Requires less cable length than a star topology.
- ❑ Very easy to extend

# Disadvantages of a Linear Bus Topology

- ❑ Entire network shuts down if there is a break in the main cable.
- ❑ Terminators are required at both ends of the backbone cable.
- ❑ Difficult to identify the problem if the entire network shuts down.
- ❑ The trunk can be bottle neck to the network when network traffic is very heavy.

## 2. Star

- ❑ A star topology is designed with each node (file server, workstations, and peripherals) connected directly to a central network hub or Switch.
- ❑ Data on a star network passes through the hub before continuing to its destination.



# Advantages of a Star Topology

- ☐ Easy to install and wire.
- ☐ No disruptions to the network then connecting or removing devices.
- ☐ Easy to detect faults and to remove parts.

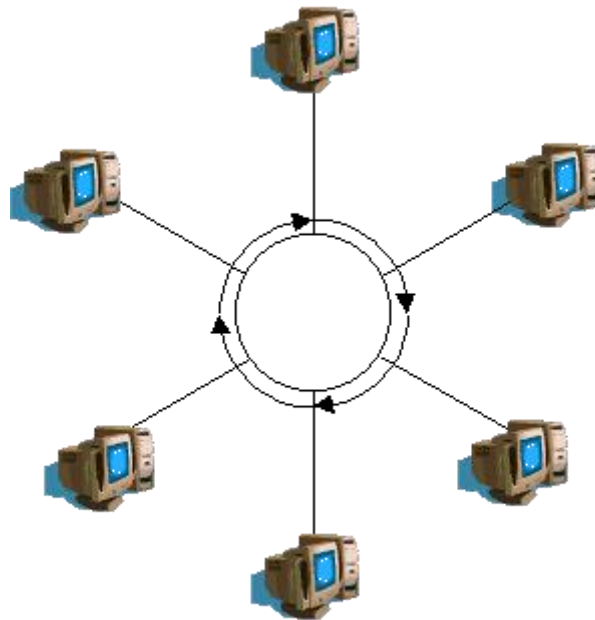
# Disadvantages of a Star Topology

- ❑ Requires more cable length than a linear topology.
- ❑ If the hub or fails, nodes attached are disabled.
- ❑ More expensive than linear bus topologies because of the cost of the hubs and cable.

# 3. Ring Topology

- ❑ 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.
- ❑ The failure of one computer can have an impact on the entire network.
- ❑ A star-wired ring topology may appear (physically) to be the same as a star topology. Logically, the MAU (multistation access unit) of a star-wired ring contains wiring that allows information to pass from one device to another in a circle or ring.

# Ring topology





# 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.
- ❑ The sending computer modifies the token, puts an electronic address on the data, and sends it around the ring.

# Advantages of a Ring Topology

- ❑ Fault diagnostic and isolation are relatively easy
- ❑ The modular design results in a network that is easy to expand

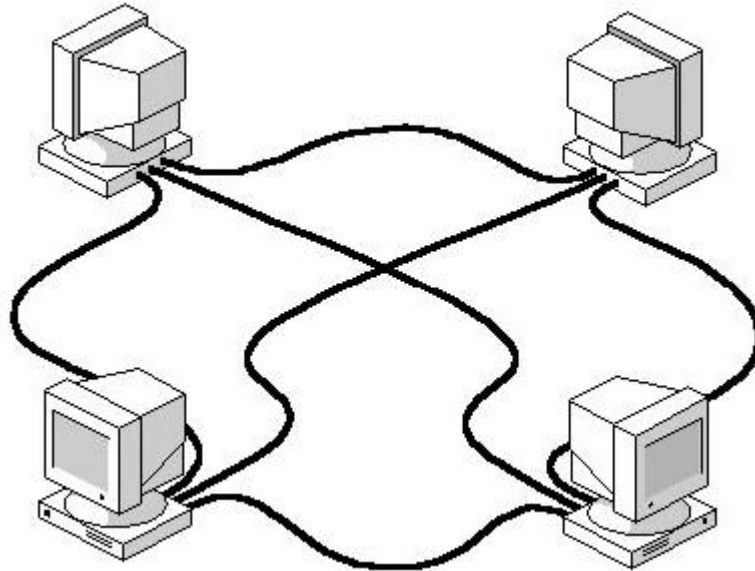
# Disadvantages of a Ring Topology

- ❑ Network configuration can be technically complicated
- ❑ The cabling system is complicated

## 4. Mesh Topology

- ❑ 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 things, these networks are expensive to install because they use a lot of cabling.

# Mesh topology

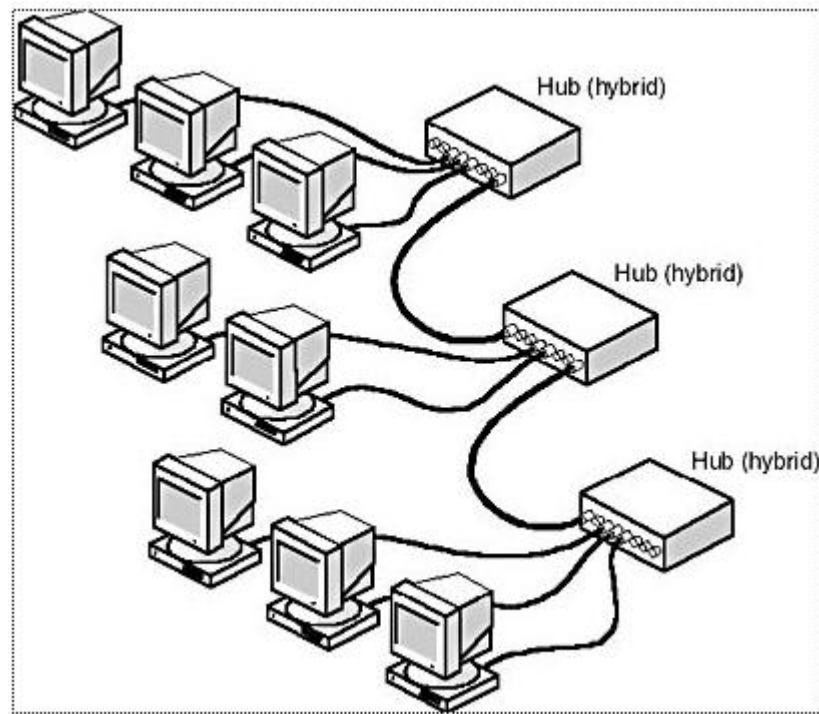


# 5. Hybrid Topologies

## 5.1 Star Bus

- ❑ The *star bus* is a combination of the bus and star topologies.
- ❑ In a star-bus topology, several star topology networks are linked together with linear bus trunks.
- ❑ 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.

## 5.2 Star Bus

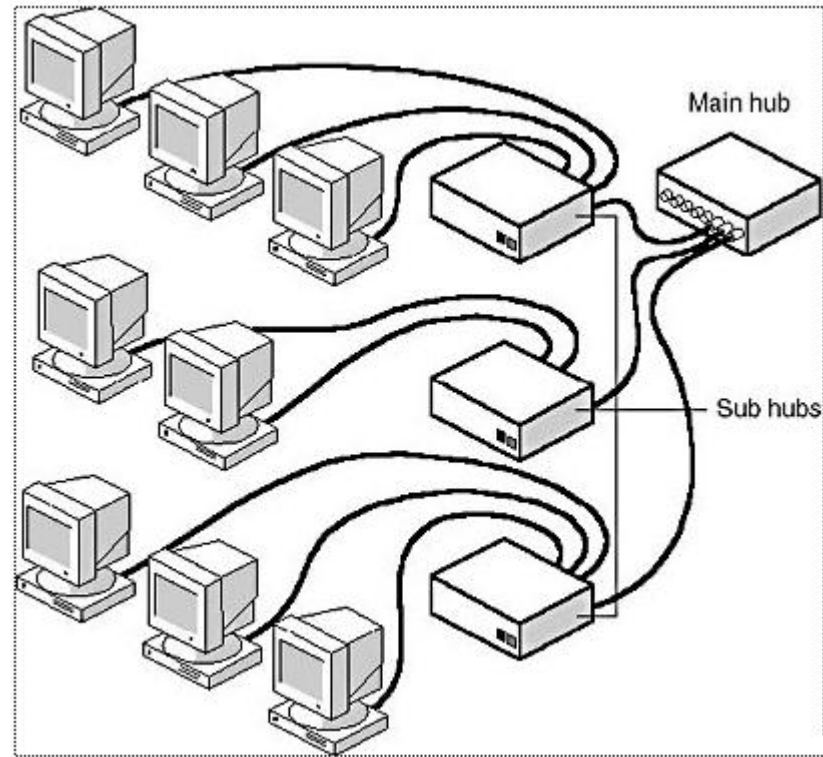


## 5.3 Star Ring

- ❑ 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.
- ❑ 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.

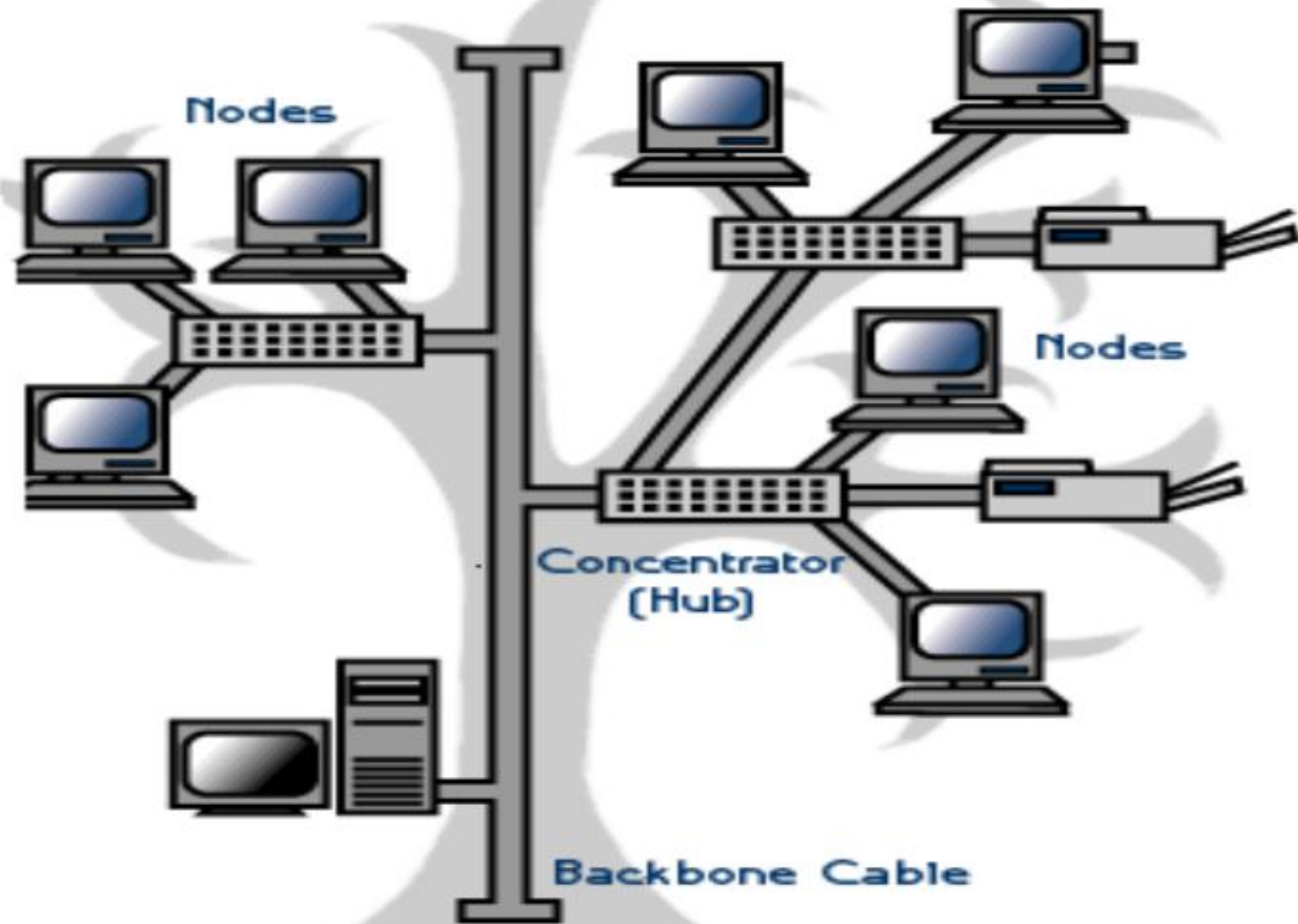


# Star Ring



## 5.3 Tree

- ❑ A tree topology combines characteristics of linear bus and star topologies.
- ❑ It consists of groups of star-configured workstations connected to a linear bus backbone cable .
- ❑ Tree topologies allow for the expansion of an existing network, and enable organizations to configure a network to meet their needs.



## **Advantages of a Tree Topology**

- ❑ Point-to-point wiring for individual segments.
- ❑ Supported by several hardware and software vendors.

## **Disadvantages of a Tree Topology**

- ❑ Overall length of each segment is limited by the type of cabling used.
- ❑ If the backbone line breaks, the entire segment goes down.
- ❑ More difficult to configure and wire than other topologies.

# Summary

Topology	Advantages	Disadvantages
Bus	Use of cable is economical.  Media is inexpensive and easy to work with. System is simple and reliable. Bus is easy to extend.	Network can slow down in heavy traffic. Problems are difficult to isolate.  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. Problems are hard to isolate.
Star	Modifying system and adding new computers is easy. Centralized monitoring and management are possible. Failure of one computer does not affect the rest of the network.	If the centralized point fails, the network fails.
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.

**CHAPTER END**  
**???**