

Lec # 8

Data Communication & Networking

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WHAT IS A NETWORK?

A **network** is a collection of computers, servers, mainframes, **network** devices, peripherals, or other devices connected to one another to allow the sharing of data. An excellent example of a **network** is the Internet, which connects millions of people all over the world

- ✓ A **network** is simply two or more computers that are linked together.
- ✓ The most common types of networks are:
 - **Local Area Networks (LANs)** and
 - **Wide Area Networks (WANs)**.
- ✓ The primary difference between the two is that a **LAN** is generally confined to a limited geographical area, whereas a **WAN** covers a large geographical area. Most **WANs** are made up of several connected

LANs.

BENEFITS OF A NETWORK:

The Uses of a Network

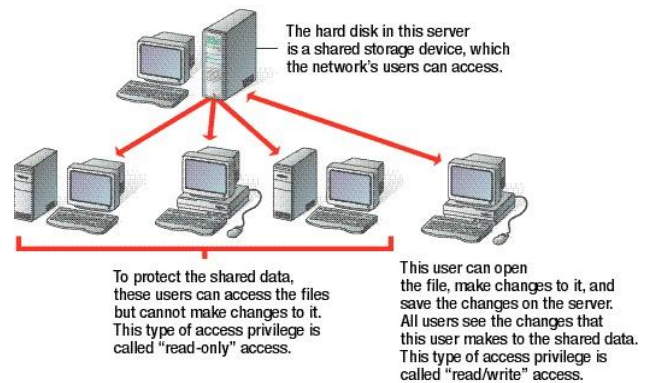
A network connects computers so they can communicate, exchange information, and share resources.

The main benefits of using a network are:

- Simultaneous Access
- Shared Peripheral Devices
- Personal Communication
- Easier Backup

The Uses of a Network - Simultaneous Access

- In organizations, many people may need to use the same data or programs. A network solves this problem.
- Shared data and programs can be stored on a central network server. A server that stores data files may be called a file server.
- Managers may assign access rights to users. Some users may only be able to read data, others may be able to make changes to existing files.

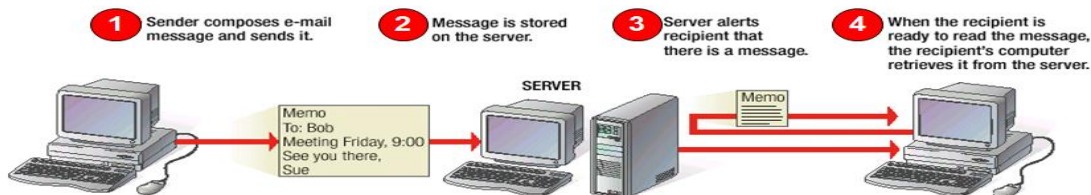


The Uses of a Network - Shared Peripheral Devices

- Because peripheral (external) devices like printers can be expensive, it is cost-effective to connect a device to a network so users can share it.
- Through a process called spooling, users can send multiple documents (called print jobs) to a networked printer at the same time. The documents are temporarily stored on the server and printed in turn.

The Uses of a Network - Personal Communication

- One of the most common uses of networks is for electronic mail (e-mail).
- An e-mail system enables users to exchange written messages (often with data files attached) across the local network or over the Internet.
- Two other popular network-based communications systems are teleconferencing and videoconferencing.



- **Networks enable managers to easily back up (make backup copies of) important data.**
- **Administrators commonly back up shared data files stored on the server, but may also use the network to back up files on users' PCs**
- **Information sharing:** Authorized users can use other computers on the network to access and share information and data. This could include special group projects, databases, etc.
- **Hardware sharing:** One device connected to a network, such as a printer or scanner, can be shared by many users.
- **Software sharing:** Instead of purchasing and installing a software program on each computer, it can be installed on the server. All of the users can then access the program from a single location.
- **Collaborative environment:** Users can work together on group projects by combining the power and capabilities of diverse equipment.

TYPES OF NETWORKS

- **Local Area Network (LAN)** – a network that spans a small area such as a building or an office.
 - Software applications and other resources are stored on a **file server**.
 - **Print servers enable** multiple users to share the same printer.
- **Wide Area Network (WAN)** – a network that spans a wide geographical area; there are several types of WANS
 - Metropolitan area network (MAN)
 - Public access network (PAN)
 - Virtual private network (VPN)
- **Hybrid Network**
 - CAN (**Campus Area Network**)
 - MAN (**Metropolitan Area Network**)
 - HAN (**Home Area Network**)
- **Peer-to-peer** – Computers connect with each other in a workgroup to share files, printers, and Internet access. This is used to connect a small number of computers.
- **Client/server** – sends information from a client computer to server, which then relays the information back to client computer, or to other computers on the network

RISKS OF NETWORK COMPUTING

The security of a computer network is challenged everyday by:

- Equipment malfunctions
- System failures

Note: equipment malfunctions and system failures may be caused by natural disasters such as floods, storms, or fires, and electrical disturbances

- Computer hackers
- Virus attacks

COMMUNICATIONS MEDIA

COMMUNICATIONS CHANNEL:

- To transfer data from one computer to another requires some type of link through which the data can be transmitted. This link is known as the *communications channel*.
- To send data through the channel requires some type of **transmission media**, which may be either physical or wireless

(a) PHYSICAL MEDIA

- **Twisted-pair cable** – consists of two independently insulated wires twisted around each other (least expensive type of cable—the kind that is used in many telephone systems)
- **Coaxial cable** – consists of an insulated center wire grounded by a shield of braided wire (the primary type of cabling used by the cable television industry; it is more expensive than twisted pair)
- **Fiber-optic cable** – contains hundreds of clear fiberglass or plastic fibers (threads) (made from thin, flexible glass tubing; bandwidth is greater, so it can carry more data; it is lighter than metal wires and is less susceptible to interference; it is fragile and expensive)
- **ISDN line** – a special digital telephone line that transmits and receives information at very high speeds

(b) WIRELESS MEDIA

- **Microwave system** – transmits data via high-frequency radio signals through the atmosphere
- **Satellite system** – receive transmitted signals, amplify them, and then transmit the signals to the appropriate locations
- **Cellular technology** – uses antennae resembling telephone towers to pick up radio signals within a specific area (cell)
- **Infrared technology** – transmits data as infrared light waves from one device to another, providing wireless links between PCs and peripherals

Note: The type selected is determined by the type of network, the size of the network, and the cost

TYPES OF COMMUNICATION CHANNELS:

Hub – electronic device (with a number of ports) used in a LAN to link groups of computers

Switch A network switch is a computer networking device that is used to connect many devices together on a computer network. A switch is considered more advanced than a hub because a switch will only send message to device that needs or request it.

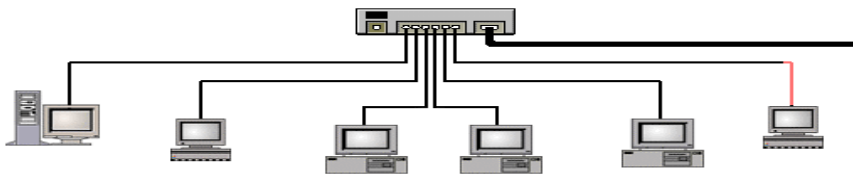
Routers - electronic devices used to ensure messages are sent to their intended destinations

Gateway – consists of hardware and/or software that allows communications between dissimilar networks

Bridge – consists of hardware and/or software that allows communication between two similar networks

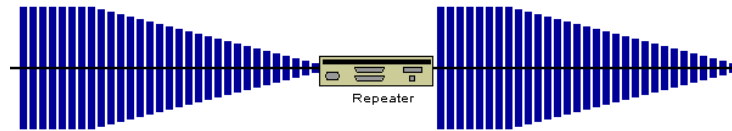
HUB:

- ✓ Simply put, the hub's major function is to replicate data it receives from one device attached to it to all others.



REPEATERS

- ✓ A common problem in the networking world is that of weakening electrical signals.
- ✓ A repeater is connected to two cable segments. Any electrical signal reaching the repeater from one segment, will be amplified and retransmitted to the other segment.

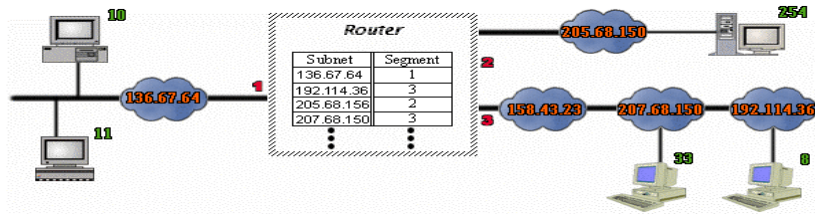


An illustration of a repeater at work

The electrical signal entering the repeater at one end is weakened.
The repeater amplifies the electrical signals and resends the data

ROUTERS

- ✓ Routers **connect** two or more networks and **forward data** packets between them.



GATEWAY:

- ✓ The term gateway now refers to special-purpose devices, that perform **protocol conversions**. Gateways implement application layer conversions of information received from various protocols therefore help different network to communicate.



HOW ARE NETWORKS CATEGORIZED?

Networks are usually classified using three properties:

- *Topology*
- *Protocol*
- *Architecture*

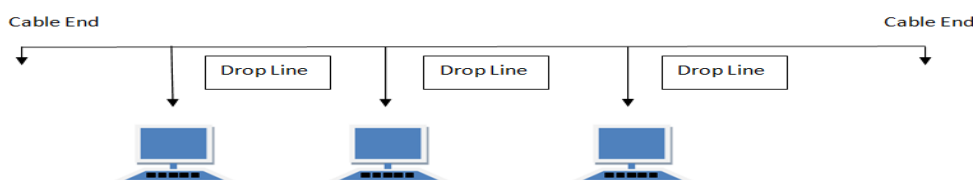
TYPES NETWORK TOPOLOGIES

Network Topology is the schematic description of a network arrangement, connecting various nodes (sender and receiver) through lines of connection

- **Network Topology (or layout)** – refers to the way computers and peripherals are configured to form networks
 - **Bus topology** – all computers are linked by a single line of cable
 - **Star topology** – multiple computers and peripheral devices are linked to a central computer, called a *host*
 - **Ring topology** – each computer or workstation is connected to two other computers, with the entire network forming a circle
 - **Hybrid topology** – combine network layout types to meet their needs

BUS Topology

Bus topology is a network type in which every computer and network device is connected to single cable. When it has exactly two endpoints, then it is called **Linear Bus topology**.



Features of Bus Topology

1. It transmits data only in one direction.
2. Every device is connected to a single cable

Advantages of Bus Topology

1. It is cost effective.
2. Cable required is least compared to other network topology.
3. Used in small networks.

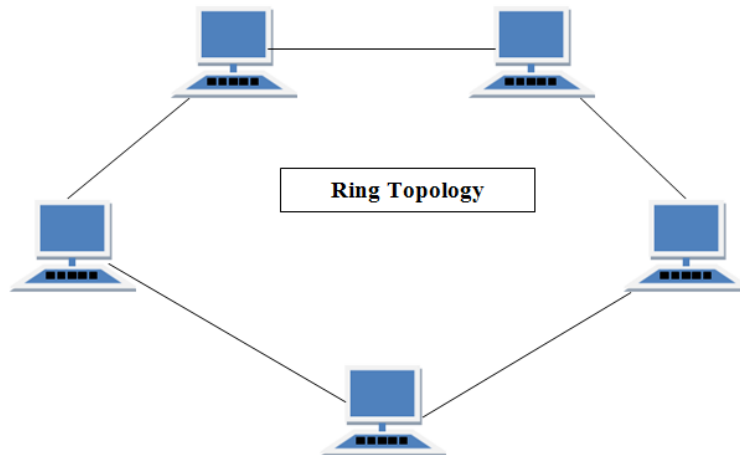
4. It is easy to understand.
5. Easy to expand joining two cables together.

Disadvantages of Bus Topology

1. Cables fails then whole network fails.
2. If network traffic is heavy or nodes are more the performance of the network decreases.
3. Cable has a limited length.
4. It is slower than the ring topology

RING Topology

It is called ring topology because it forms a ring as each computer is connected to another computer, with the last one connected to the first. Exactly two neighbours for each device.



Features of Ring Topology

1. A number of repeaters are used for Ring topology with large number of nodes, because if someone wants to send some data to the last node in the ring topology with 100 nodes, then the data will have to pass through 99 nodes to reach the 100th node. Hence to prevent data loss repeaters are used in the network.
2. The transmission is unidirectional, but it can be made bidirectional by having 2 connections between each Network Node, it is called **Dual Ring Topology**.
3. In Dual Ring Topology, two ring networks are formed, and data flow is in opposite direction in them. Also, if one ring fails, the second ring can act as a backup, to keep the network up.
4. Data is transferred in a sequential manner that is bit by bit. Data transmitted, has to pass through each node of the network, till the destination node.

Advantages of Ring Topology

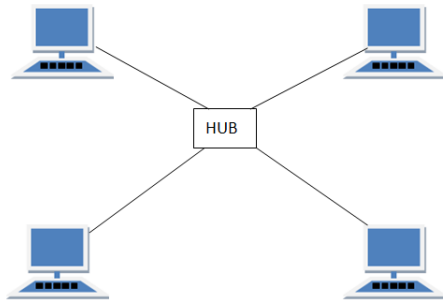
1. Transmitting network is not affected by high traffic or by adding more nodes, as only the nodes having tokens can transmit data.
2. Cheap to install and expand

Disadvantages of Ring Topology

1. Troubleshooting is difficult in ring topology.
2. Adding or deleting the computers disturbs the network activity.
3. Failure of one computer disturbs the whole network.

STAR Topology

In this type of topology all the computers are connected to a single hub through a cable. This hub is the central node and all others nodes are connected to the central node.



Features of Star Topology

1. Every node has its own dedicated connection to the hub.
2. Hub acts as a repeater for data flow.
3. Can be used with twisted pair, Optical Fibre or coaxial cable.

Advantages of Star Topology

1. Fast performance with few nodes and low network traffic.
2. Hub can be upgraded easily.
3. Easy to troubleshoot.
4. Easy to setup and modify.
5. Only that node is affected which has failed, rest of the nodes can work smoothly.

Disadvantages of Star Topology

1. Cost of installation is high.
2. Expensive to use.
3. If the hub fails then the whole network is stopped because all the nodes depend on the hub.
4. Performance is based on the hub that is it depends on its capacity

MESH Topology

It is a point-to-point connection to other nodes or devices. All the network nodes are connected to each other. Mesh has $\frac{n(n-1)}{2}$ physical channels to link n devices.

There are two techniques to transmit data over the Mesh topology, they are :

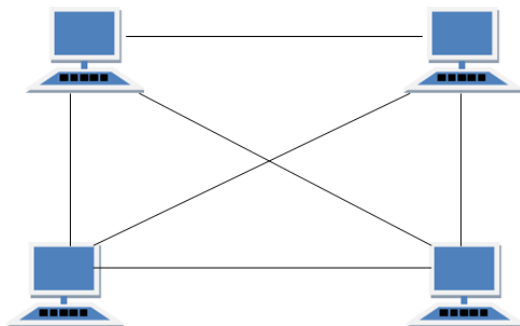
1. Routing
2. Flooding

MESH Topology: Routing

In routing, the nodes have a routing logic, as per the network requirements. Like routing logic to direct the data to reach the destination using the shortest distance. Or, routing logic which has information about the broken links, and it avoids those node etc. We can even have routing logic, to re-configure the failed nodes.

MESH Topology: Flooding

In flooding, the same data is transmitted to all the network nodes, hence no routing logic is required. The network is robust, and it's very unlikely to lose the data. But it leads to unwanted load over the network.



Types of Mesh Topology

1. **Partial Mesh Topology** : In this topology some of the systems are connected in the same fashion as mesh topology but some devices are only connected to two or three devices.
2. **Full Mesh Topology** : Each and every nodes or devices are connected to each other.

Features of Mesh Topology

1. Fully connected.
2. Robust.
3. Not flexible.

Advantages of Mesh Topology

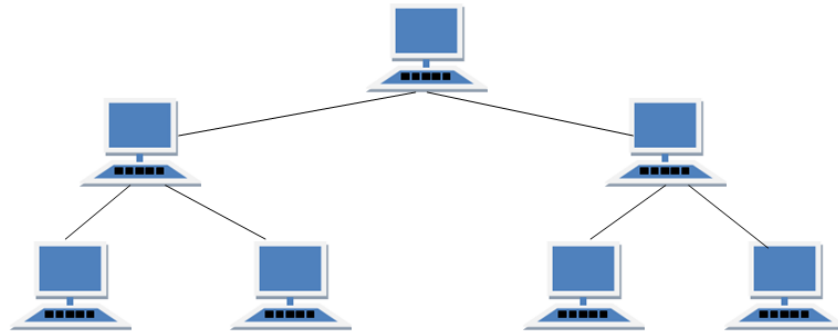
1. Each connection can carry its own data load.
2. It is robust.
3. Fault is diagnosed easily.
4. Provides security and privacy.

Disadvantages of Mesh Topology

1. Installation and configuration is difficult.
2. Cabling cost is more.
3. Bulk wiring is required.

TREE Topology

It has a root node and all other nodes are connected to it forming a hierarchy. It is also called hierarchical topology. It should at least have three levels to the hierarchy.



Features of Tree Topology

1. Ideal if workstations are located in groups.
2. Used in Wide Area Network.

Advantages of Tree Topology

1. Extension of bus and star topologies.
2. Expansion of nodes is possible and easy.
3. Easily managed and maintained.

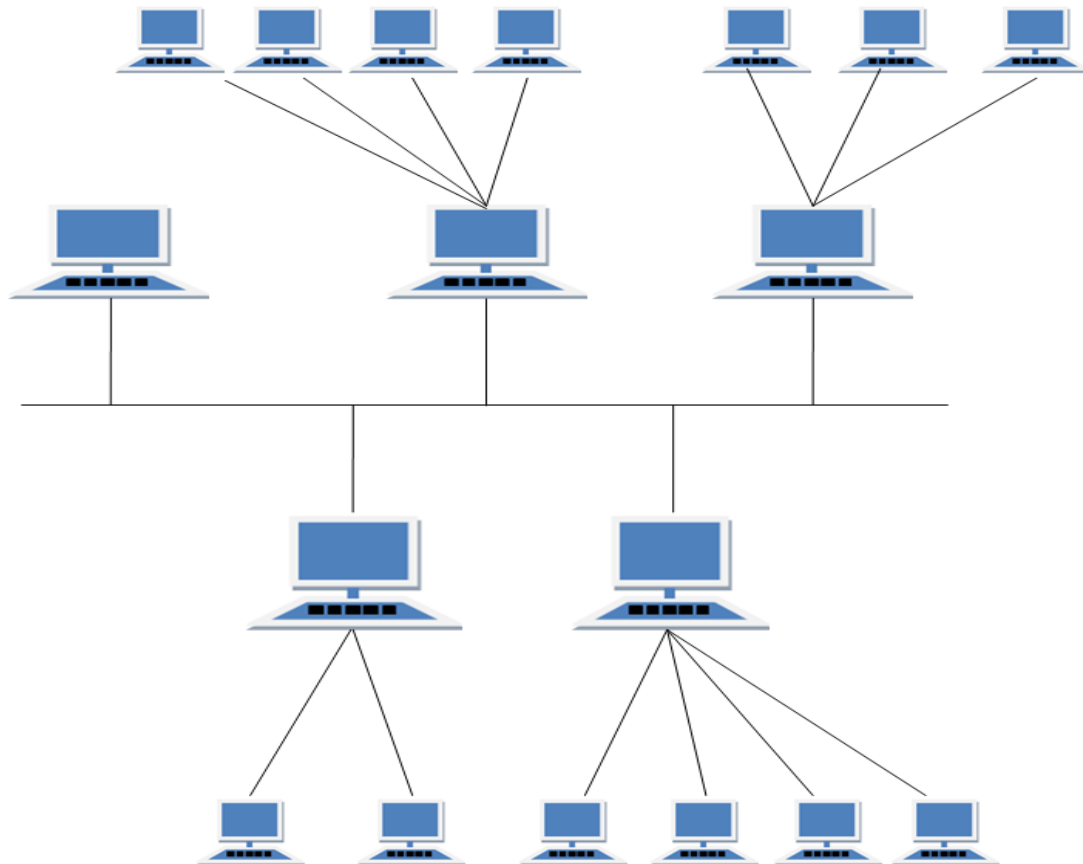
4. Error detection is easily done.

Disadvantages of Tree Topology

1. Heavily cabled.
2. Costly.
3. If more nodes are added maintenance is difficult.
4. Central hub fails, network fails.

HYBRID Topology

It is two different types of topologies which is a mixture of two or more topologies. For example if in an office in one department ring topology is used and in another star topology is used, connecting these topologies will result in Hybrid Topology (ring topology and star topology).



Features of Hybrid Topology

1. It is a combination of two or topologies
2. Inherits the advantages and disadvantages of the topologies included

Advantages of Hybrid Topology

1. Reliable as Error detecting and trouble shooting is easy.
2. Effective.
3. Scalable as size can be increased easily.
4. Flexible.

Disadvantages of Hybrid Topology

1. Complex in design.
2. Costly.

NETWORK/COMMUNICATION PROTOCOLS

A **protocol** is simply an agreed-on set of rules and procedures for transmitting data between two or more devices.

Features determined by the protocol are:

- ❑ How the sending device indicates it has finished sending the message.
- ❑ How the receiving device indicates it has received the message.
- The type of error checking to be used

COMMUNICATION PROTOCOLS

- ✓ **File transfer protocol (FTP)** – used to transmit files.
- ✓ **Simple mail transfer protocol (SMTP)** – used to transmit e-mail messages.
- ✓ **Post office protocol (POP)** – allows the recipient to retrieve messages.
- ✓ **Wireless application protocol** – enables wireless devices to access and use the Internet using a client/server network.
- ✓ **802.11 – protocol** for wireless LAN technology

DATA TRANSMISSION CHARACTERISTICS

- ❑ **Bandwidth** (rate of transmission)
- ❑ **Analog or Digital** (type of signal)
 - ✓ **Analog transmission** – takes the form of continuous waves transmitted over a medium at a certain frequency range
 - ✓ **Digital transmission** – sends data in the form of bits
- ❑ **Serial or Parallel** (order of bits)
 - ✓ **Serial transmission** – all of the data bits are transmitted one bit after another in a continuous line
 - ✓ **Parallel transmission** – data bits are sent at the same time along multiple paths

COMMUNICATIONS SOFTWARE

- ❑ **E-Mail Software** – used to send and receive electronic messages using the Internet
- ❑ **Web Browser** – allows users to access and view Web pages
- ❑ **Groupware** – allows groups of people on a network to share information and to collaborate on various projects