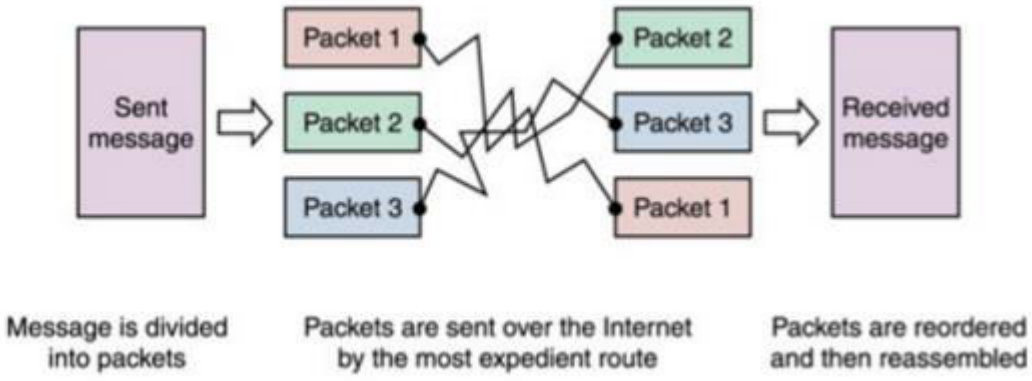
UNIT 2

PACKETS

- A network packet is a formatted unit of data carried by a packet-switched network. Computer communications links that do not support packets, such as traditional point-to-point telecommunications links, simply transmit data as a bit stream
- It is a unit of transfer, bits carried over the network
- To improve the efficiency of transferring information over a shard communication line, messages are divided into fixed-sized, numbered "Packets"
- Network devices called 'Routers' are used to direct packets between networks
- Routers handle them 1 by 1
- The network transports bytes grouped into packets



SWITCHING TECHNIQUES

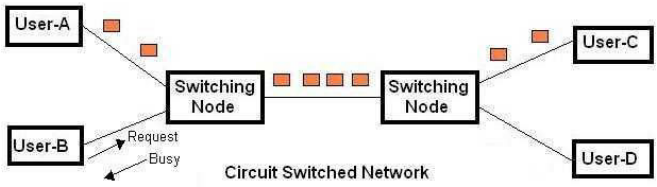
DATAGRAM

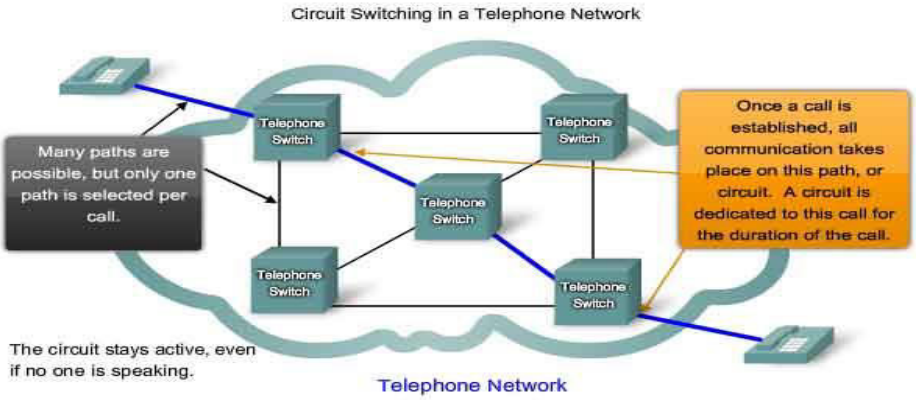
- **Packet Switched Network -** A network in which all data messages are transmitted using short packages (size not more than 1000 Bytes), called "Packets"
- Breaks long message into packets
- Packets sent one at a time to the network
- Packets handles in two ways

- Datagram
- Virtual circuit

- In large networks there might be multiple paths linking sender and receiver. Information may be switched as it travels through various communication channels. Three different switching techniques
    1. Circuit switching
    2. Message switching
    3. Packet switching

Circuit Switching





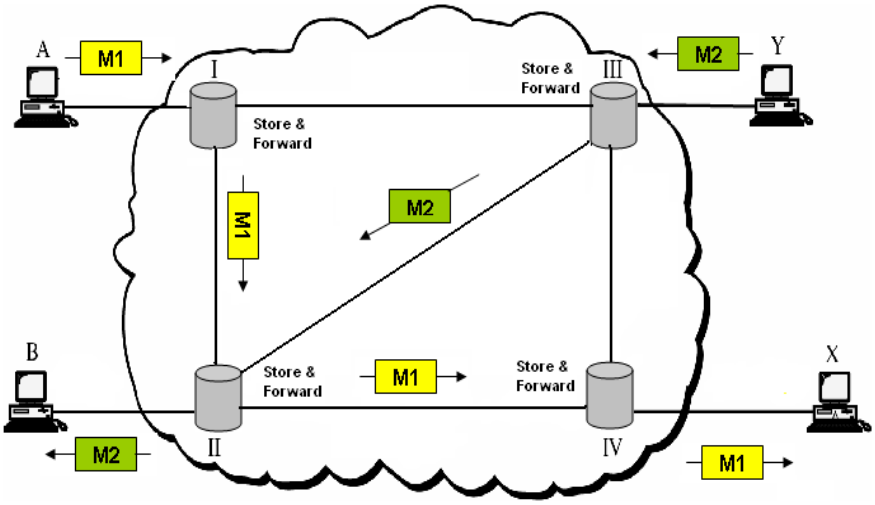
- Circuit switching is a technique that directly connects the sender and the receiver in an unbroken path.
- With this type of switching technique, once a connection is established, a dedicated path exists between both ends until the connection is terminated.
- Routing decisions must be made when the circuit is first established, but there are no decisions made after that time.
- Dedicated communication path (physical connection) is established between two stations (such as phones or computers).
- Three phases
    1. Establish

2. Transfer
3. Disconnect

- Advantages:
  - ✓ The communication channel (once established) is dedicated.
- Disadvantages:
  - ✓ Possible long wait to establish a connection, (10 seconds, more on long-distance or international calls.) during which no data can be transmitted.
  - ✓ More expensive than any other switching techniques, because a dedicated path is required for each connection.
  - ✓ Inefficient use of the communication channel, because the channel is not used when the connected systems are not using it.

Message switching

- ✓ **Message switching** is a **network switching** technique in which data is routed in its entirety from the source node to the destination node, one hope at a time. During **message** routing, every intermediate **switch** in the **network** stores the whole **message**.
- ✓ Best known by term **store and forward**.
- ✓ It was common in the 1960s and 1970s.
- ✓ A node receives a message, stores it until the appropriate route is frees, and then it sends along.
- ✓ The messages are stored and relayed from secondary storage (disk).
- ✓ Requirement of large capacity storage media at each node.



Message Switching

Advantages:

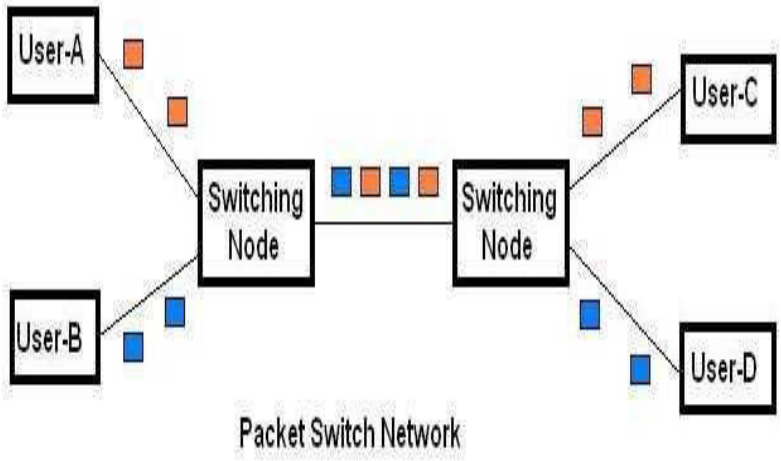
- Channel efficiency can be greater compared to circuit-switched systems, because more devices are sharing the channel.
- Traffic congestion can be reduced, because messages may be temporarily stored in route.
- Message priorities can be established due to store-and-forward technique.
- Message broadcasting can be achieved with the use of broadcast address appended in the message.

Disadvantages:

- Message switching is not compatible with interactive applications.
- Store-and-forward devices are expensive, because they must have large disks to hold potentially long messages

Packet switching

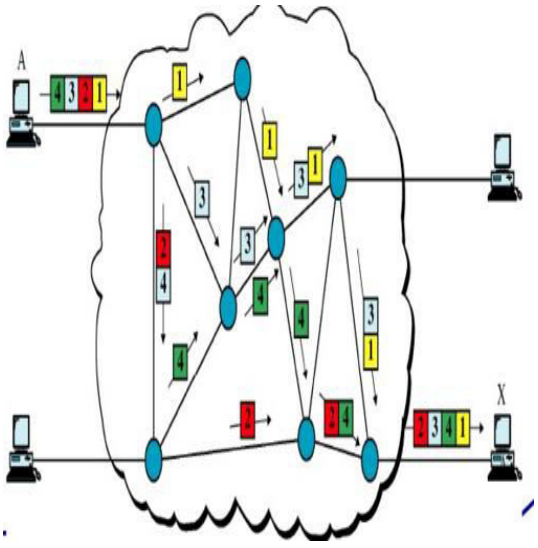
- Circuit switching is designed for voice communication. It is less suited to data and other non-voice data.
- *Packet switching* can be seen as a solution that tries to combine the advantages of message and circuit switching and to minimize the disadvantages of both.

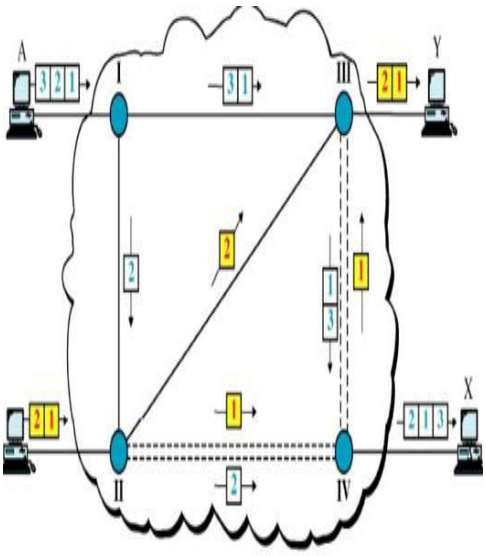


- There are two methods of packet switching:
    1. Datagram
    2. Virtual circuit.

Datagram packet switching

- It is one of the packet switching network
- With datagram, each packet is on its own and may follow its own path
- Each packet is treated independently
- Packets may arrive out of order
- Packets may go missing
- Up to receiver to re-order packets and recover from missing packets





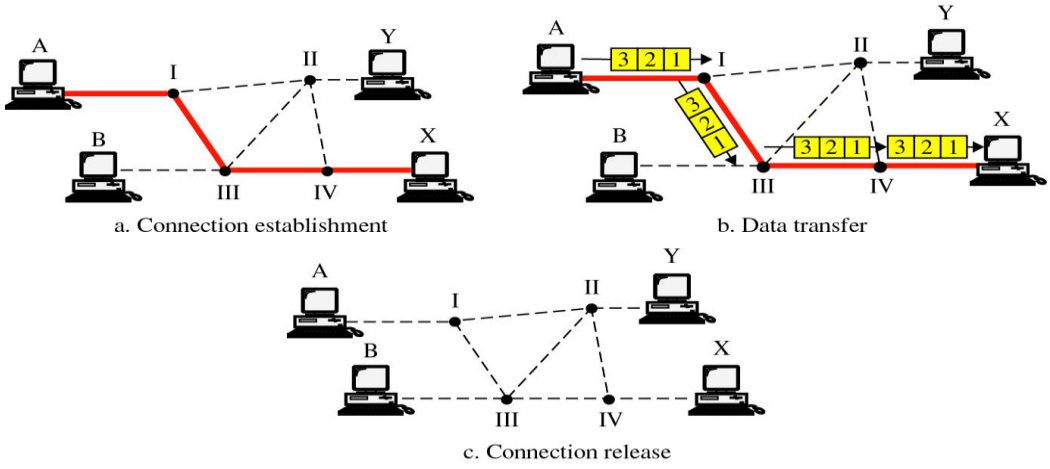
- A **datagram** is a basic transfer unit associated with a packet-switched network. Datagram's are typically structured in header and payload sections.
- Datagram's provide a connectionless communication service across a packet-switched network. The delivery, arrival time, and order of arrival of datagram's need not be guaranteed by the network.

Virtual Circuit Packet Switching

- Relation between all packets belonging to same message is preserved.
- Route is selected at the beginning of the session.
- Packets of same message travel along the same route one after another.
- Implemented in two ways: **Switched Virtual Circuit (SVC)** and **Permanent virtual circuit (PVC)**.

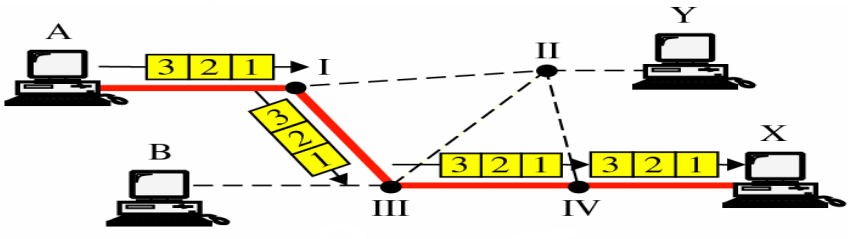
Switched Virtual Circuit (SVC):

- Like dial up lines in circuit switching.
- Circuit is created whenever needed and exist only for the duration of specific exchange.



Permanent virtual circuit (PVC)

- Like leased lines in circuit switching.
- In this same virtual circuit is provided between two users on a continuous basis.
- Circuit is dedicated to specific users and no one else can use it.
- It can be used without connection establishment and connection termination.



Permanent Connection (PVC) for the duration of lease

Advantages:

- Packet switching is cost effective, because switching devices do not need massive amount of secondary storage.
- Packet switching offers improved delay characteristics; because there are no long messages in the queue (maximum packet size is fixed).
- The advantage of packet switching is that many network users can share the same channel at the same time. Packet switching can maximize link efficiency by making optimal use of link bandwidth.

Disadvantages:

- Protocols for packet switching are typically more complex.
- It can add some initial costs in implementation.
- If packet is lost, sender needs to retransmit the data.

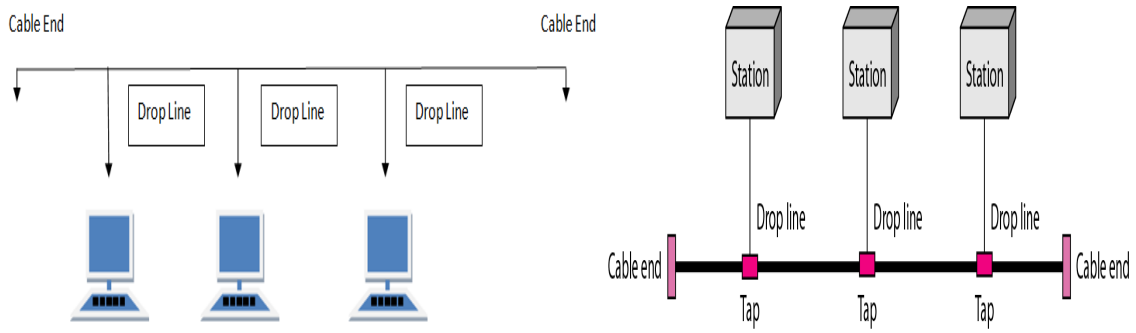
Computer network is **always** packet switching,
occasionally circuit-switching, and
never message-switching.

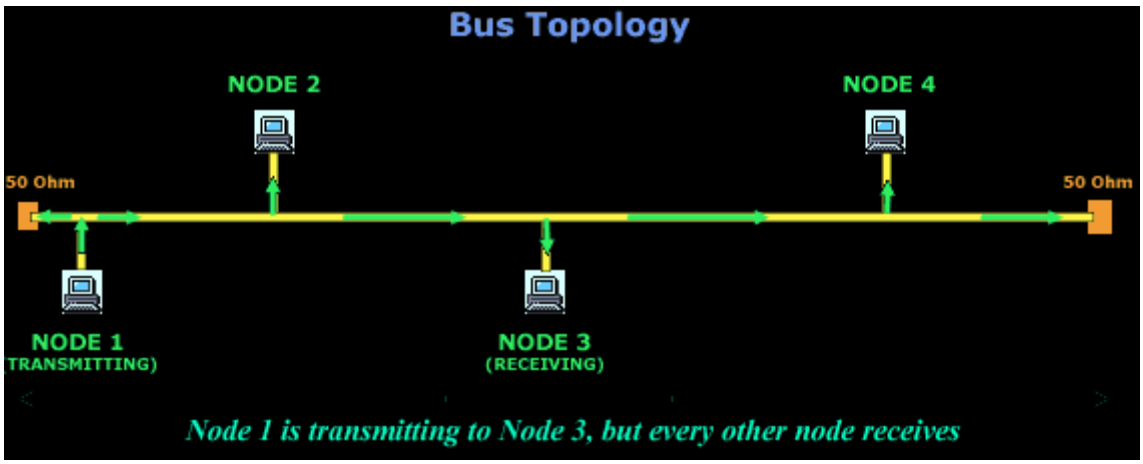
NETWORK TOPOLOGIES

- Network topology is the arrangement of the various elements (links, nodes, etc.) of a computer network. Essentially, it is the topological structure of a network and may be depicted physically or logically
- Network Topology is the schematic description of a network arrangement, connecting various nodes(sender and receiver) through lines of connection
- Types
    - Bus
    - Ring
    - Star
    - Mesh
    - Tree
    - Hybrid

Bus

- 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**.
- Multiple computers are connected to a long cable





Features

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

Advantages

1. It is cost effective.
2. It is cheap
3. Used in small networks.
4. It is easy to understand.
5. Easy to expand joining two cables together.

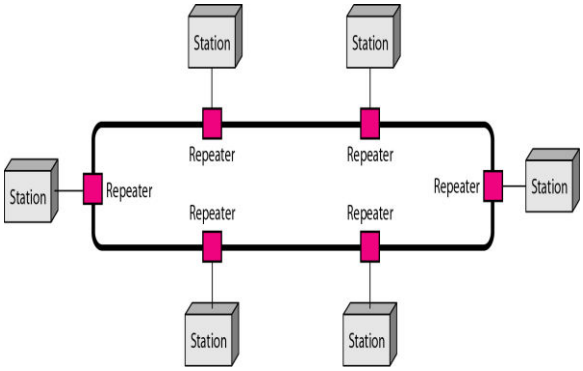
Disadvantages

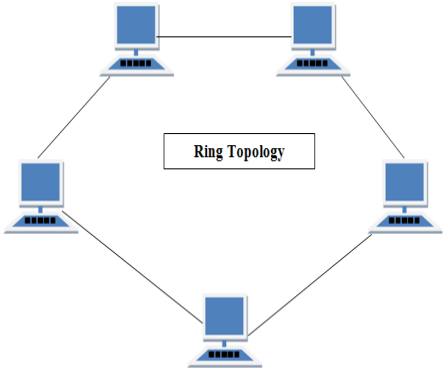
1. Cables fails then whole network fails.
2. If network traffic is heavy or nodes are more the performance of the network decreases.
3. Cable has a limited length.

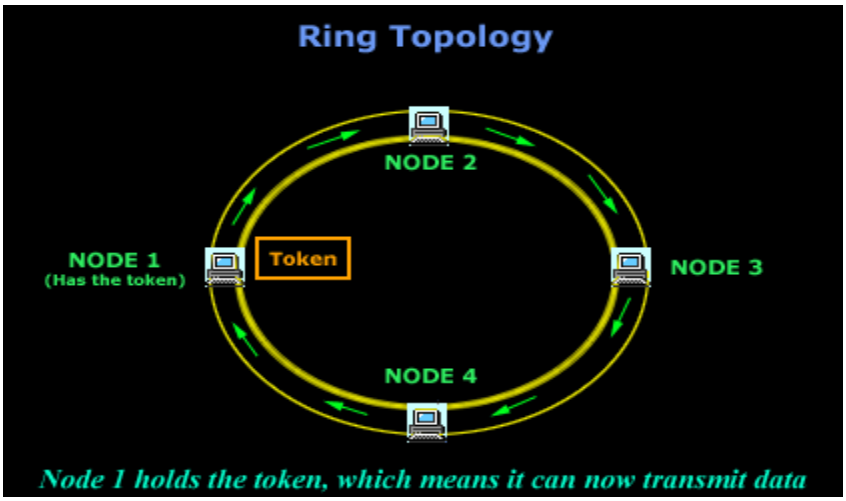
4. It is slower than the ring topology.

Ring

- 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 neighbors for each device.
- Multiple computers are in the form of ring







Features

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. 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

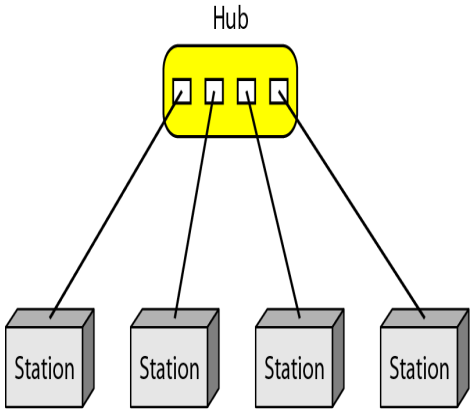
1. Transmitting network is not affected by high traffic or by adding more nodes, as only the nodes having tokens can transmit data.
2. Cheap to install and expand

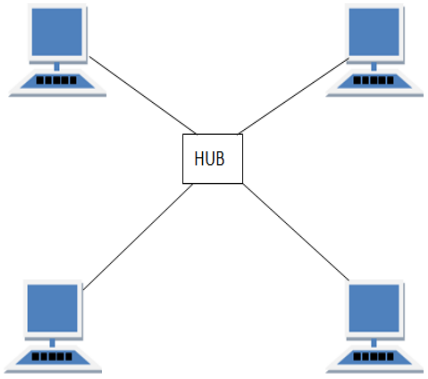
Disadvantages

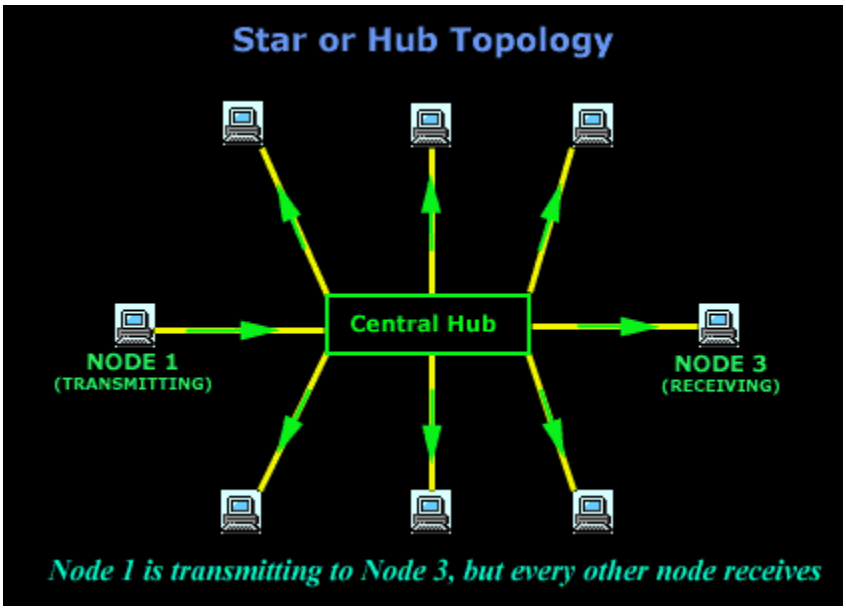
1. Troubleshooting is difficult in ring topology.
2. Adding or deleting the computers disturbs the network activity.
3. Failure of one computer disturbs the whole network.

Star

- 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

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

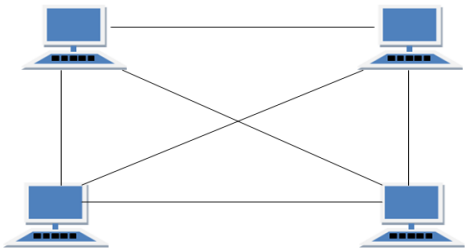
1. Fast performance with few nodes and low network traffic.
2. Hub can be upgraded easily.
3. Easy to troubleshoot.
4. Easy to setup and modify.
5. Only that node is affected which has failed, rest of the nodes can work smoothly.

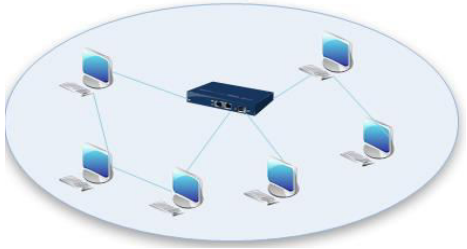
Disadvantages

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

- It is a point-to-point connection to other nodes or devices. All the network nodes are connected to each other
- There are two techniques to transmit data over the Mesh topology, they are:
    1. 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.
    2. 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.





Features

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

Advantages

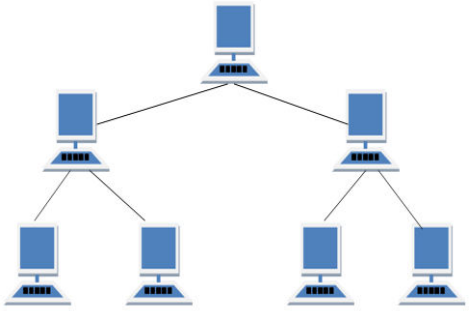
1. Each connection can carry its own data load.
2. It is robust.
3. Fault is diagnosed easily.
4. Provides security and privacy

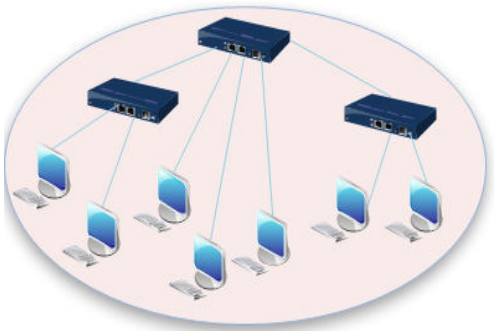
Disadvantages

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

Tree

- 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

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

Advantages

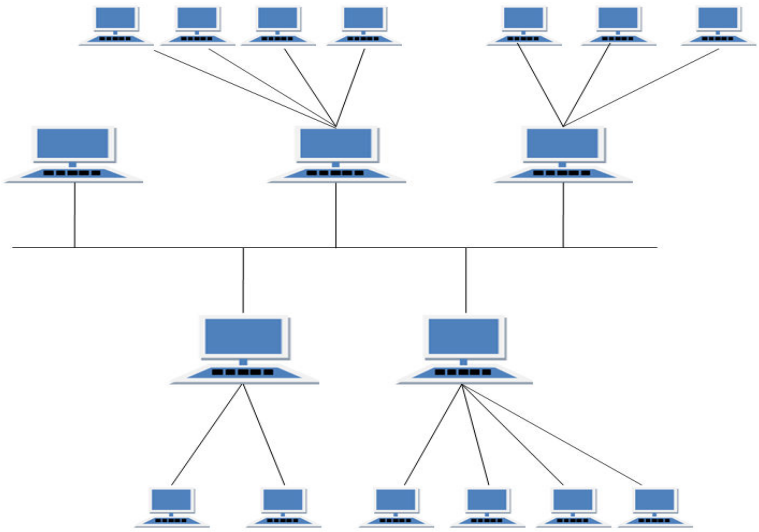
1. Extension of bus and star topologies.
2. Expansion of nodes is possible and easy.
3. Easily managed and maintained.
4. Error detection is easily done.

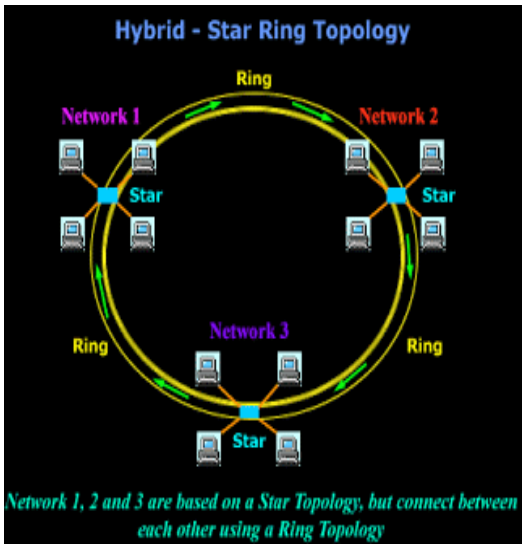
Disadvantages

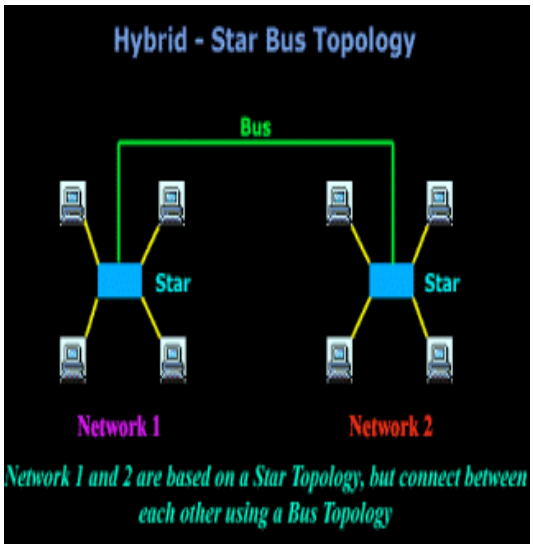
1. Heavily cabled.
2. Costly.
3. If more nodes are added maintenance is difficult.
4. Central hub fails, network fails.

Hybrid

- 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

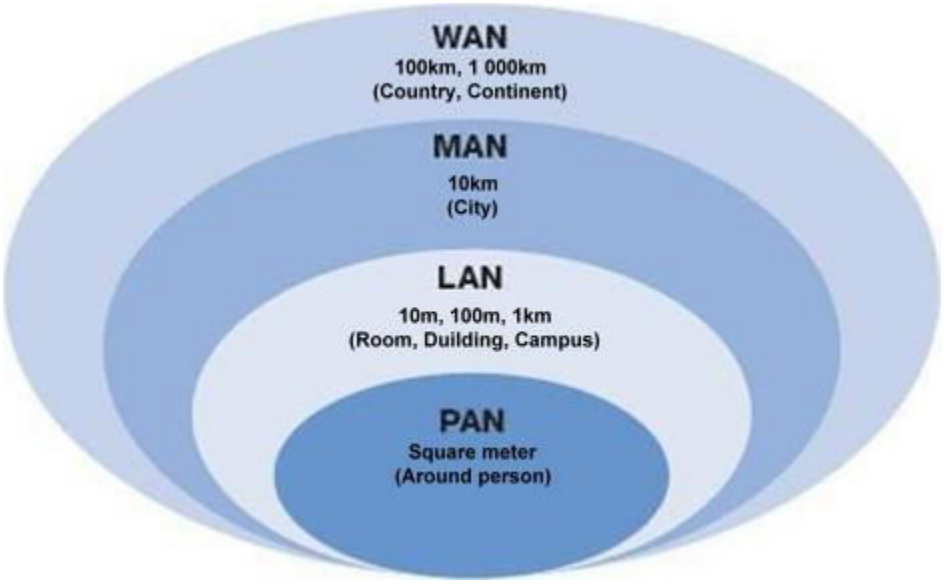
1. It is a combination of two or topologies
2. Inherits the advantages and disadvantages of the topologies included

Advantages

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

Disadvantages

1. Complex in design.
2. Costly.



Classification of Computer Networks by Scale

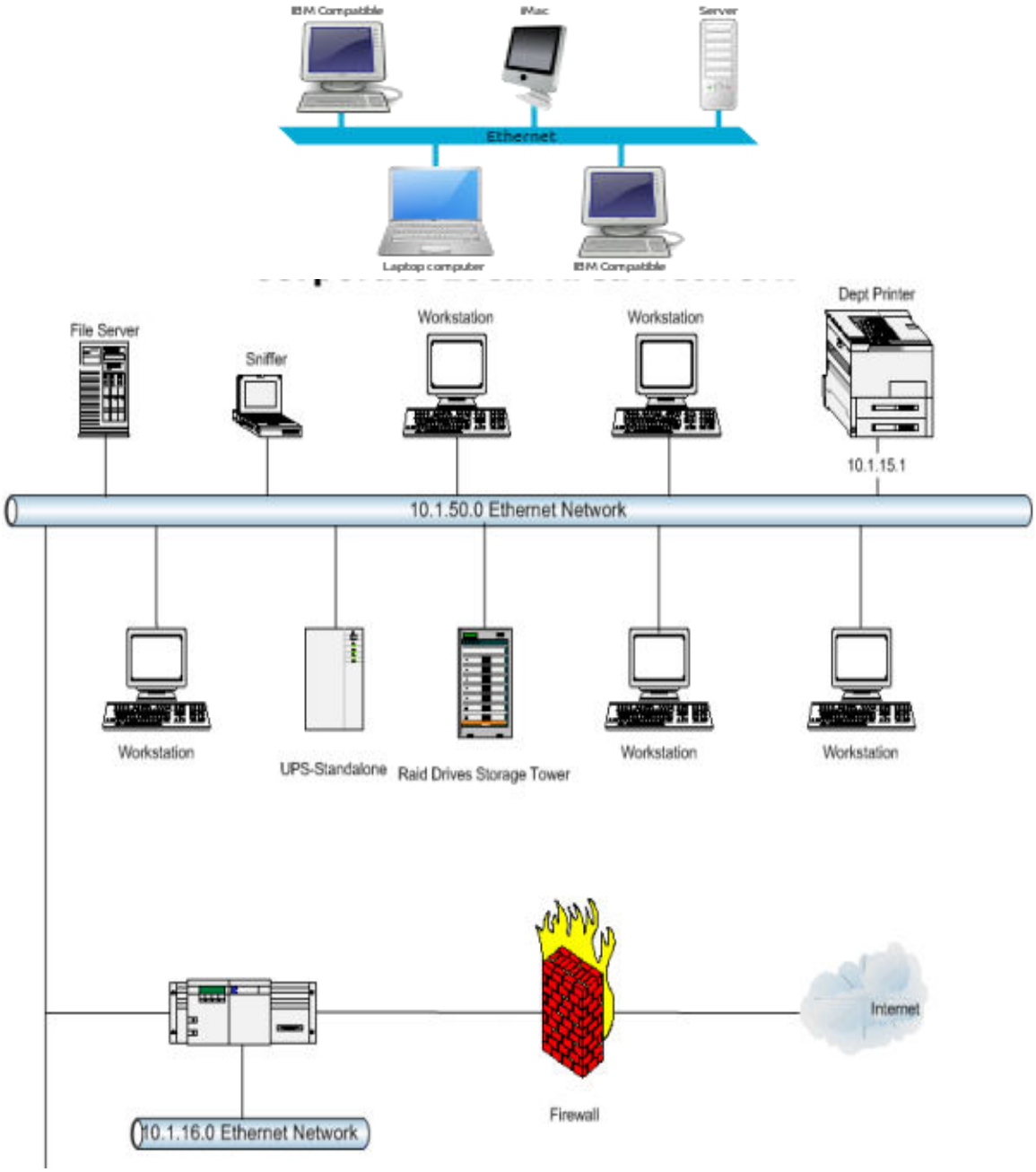
Inter-processor distance	Processors located in same	Example
1 m	Square meter	PAN
10 m	Room	LAN
100 m	Building	LAN
1 km	Campus	LAN
10 km	City	MAN
100 km	Country	WAN
1000 km	Continent	WAN
10000 km	Planet	The Internet

- A **personal area network** (**PAN**) is a computer network used for data transmission amongst devices such as computers, telephones, tablets and personal digital assistants

- A wireless personal area network (WPAN) is a low-powered PAN carried over a short-distance wireless network technology such as:
  - Wireless USB
  - Bluetooth
  - ZigBee

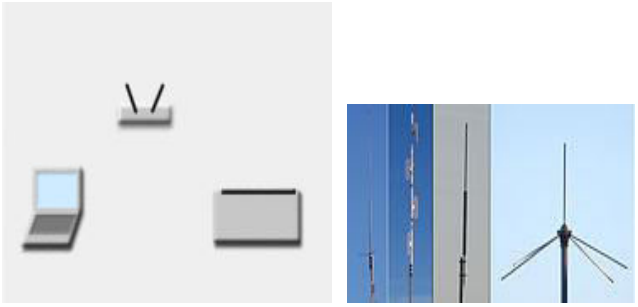
- Bluetooth uses short-range radio waves over distances up to approximately 10 meters. For example, Bluetooth devices such as keyboards, pointing devices, audio head sets, printers may connect to personal digital assistants (PDAs), cell phones, or computers wirelessly.

A **local area network** (**LAN**) is a computer network that interconnects computers within a limited area such as a residence, school, laboratory, university campus or office building[1] and has its network equipment and interconnects locally managed.



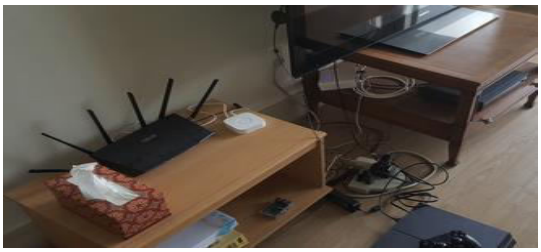
Ethernet and Wi-Fi are the two most common transmission technologies in use for local area networks

Ethernet



wi-fi

A **home network** or **home area network** (**HAN**) is a type of computer network that facilitates communication among devices within the close vicinity of a home. Devices capable of participating in this network, for example, smart devices such as network printers and handheld mobile computers, often gain enhanced emergent capabilities through their ability to interact



A **storage area network** (**SAN**) is a network which provides access to consolidated, block level data storage.

A **metropolitan area network** (**MAN**) is a computer network that interconnects users with computer resources in a geographic area or region larger than that covered by even a large local area network (LAN) but smaller than the area covered by a wide area network (WAN).

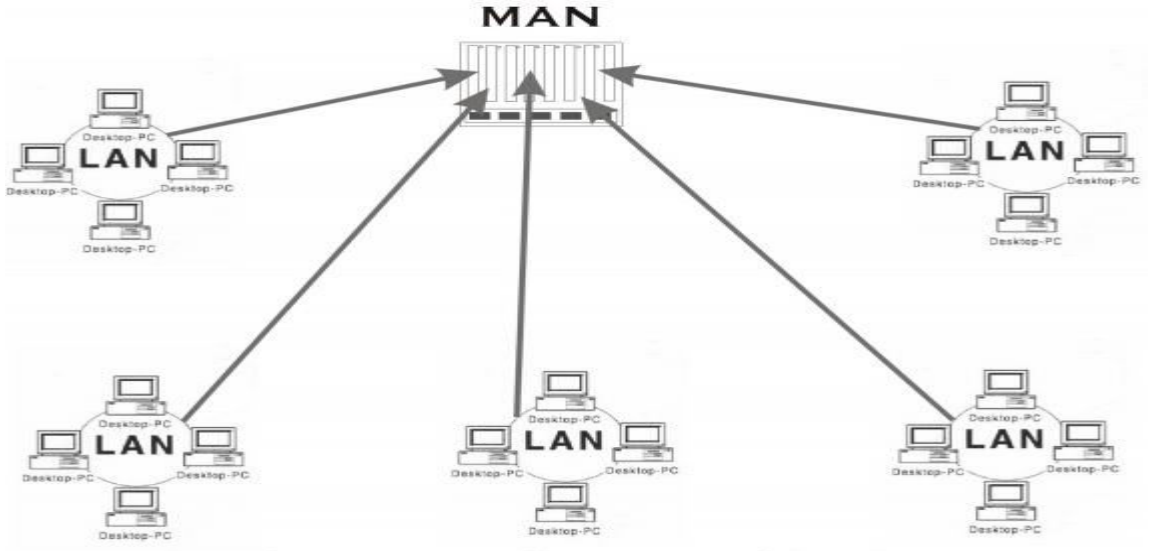


Figure Metropolitan Area Networks (MAN)

A **wide area network** (**WAN**) is a telecommunications network or computer network that extends over a large geographical distance. Wide area networks are often established with leased telecommunication circuits.

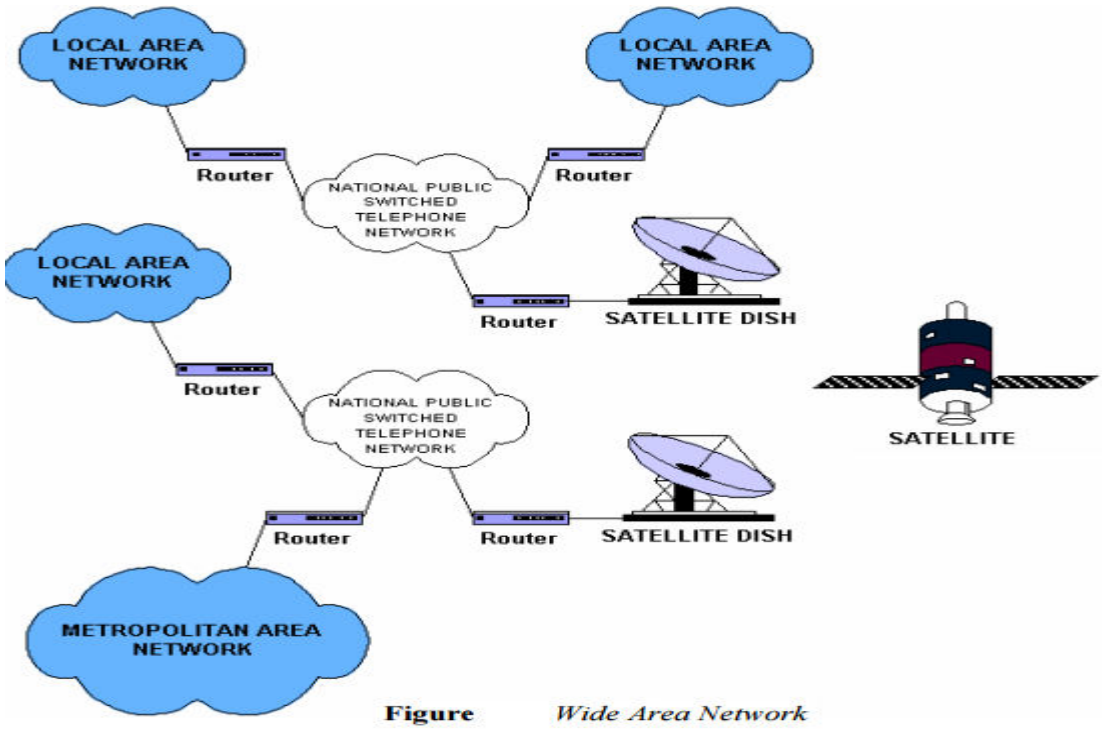
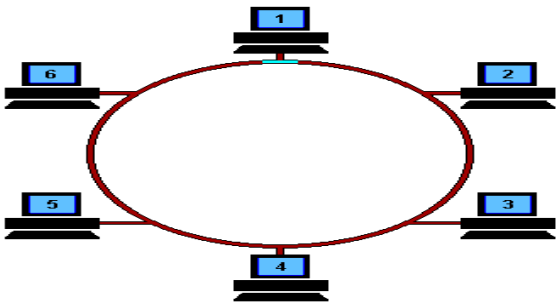


Figure *Wide Area Network*

LAN	MAN	WAN
It covers small area	It covers relatively large area	No limit area
It is used in home offices and with in buildings	Used in large organizations	Used over regions
It uses Wi-Fi and Twisted pair	It uses ATM	It uses GPRS
Two computers are interconnected	Cable television network	Internet
Do not link networks	It links more than one LAN	It links more than one LAN
It is private	It is private and public	It is private and public
It is cheap	It is expensive	It is highly expensive
It is easy to manage	It is complex to manage	It is highly complex to manage

Token Ring

- Token ring local area network (LAN) technology is a communications protocol for local area networks. It uses a special three-byte frame called a "token" that travels around a logical "ring" of workstations or servers.
- Unlike Ethernet, Token Ring uses a ring topology whereby the data is sent from one machine to the next and so on around the ring until it ends up back where it started.
- It also uses a token passing protocol which means that a machine can only use the network when it has control of the Token; this ensures that there are no collisions because only one machine can use the network at any given time.
- Token Ring networks are now very rare because the cost and flexibility of Ethernet

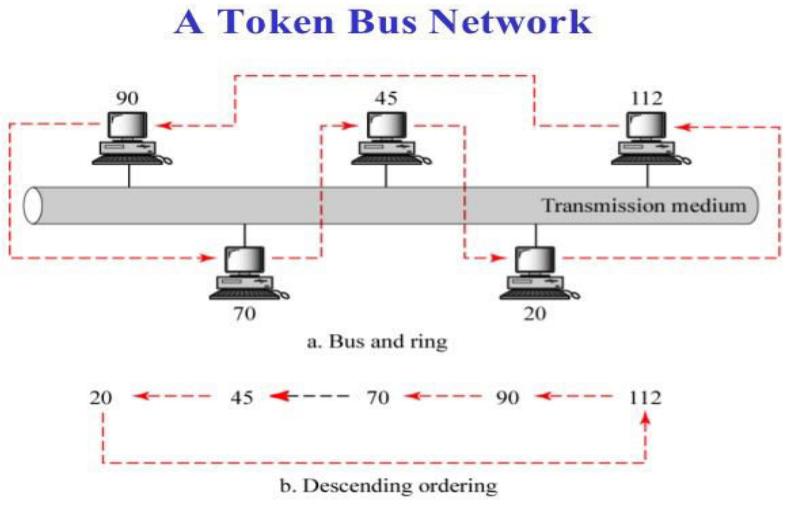


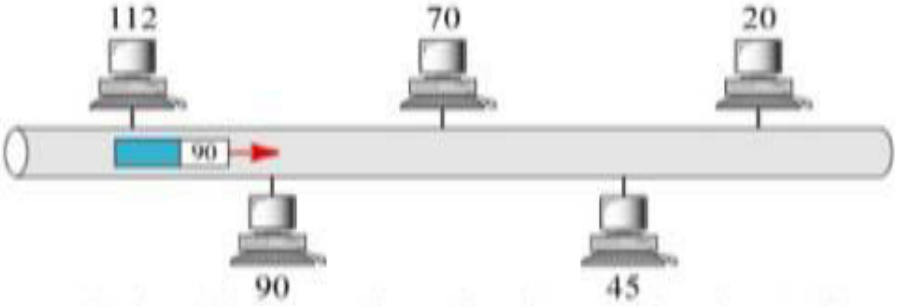
- At the start, a free Token is circulating on the ring; this is a data frame which to all intents and purposes is an empty vessel for transporting data.
- To use the network, a machine first has to capture the free Token and replace the data with its own message.
- In the example above, machine 1 wants to send some data to machine 4, so it first has to capture the free Token. It then writes its data and the recipient's address onto the Token (represented by the yellow flashing screen).
- The packet of data is then sent to machine 2 who reads the address, realizes it is not its own, so passes it on to machine 3. Machine 3 does the same and passes the Token on to machine 4.This time it is the correct address and so number 4 reads the message (represented by the yellow flashing screen).

- It cannot, however, release a free Token on to the ring, it must first send the frame back to number 1 with an acknowledgement to say that it has received the data (represented by the purple flashing screen).
- The receipt is then sent to machine 5 who checks the address, realizes that it is not its own and so forwards it on to the next machine in the ring, number 6.Machine 6 does the same and forwards the data to number 1, who sent the original message.
- Machine 1 recognizes the address, reads the acknowledgement from number 4 (represented by the purple flashing screen) and then releases the free Token back on to the ring ready for the next machine to use.
- That's the basics of Token Ring and it shows how data is sent, received and acknowledged, but Token Ring also has a built in management and recovery system which makes it very fault tolerant.

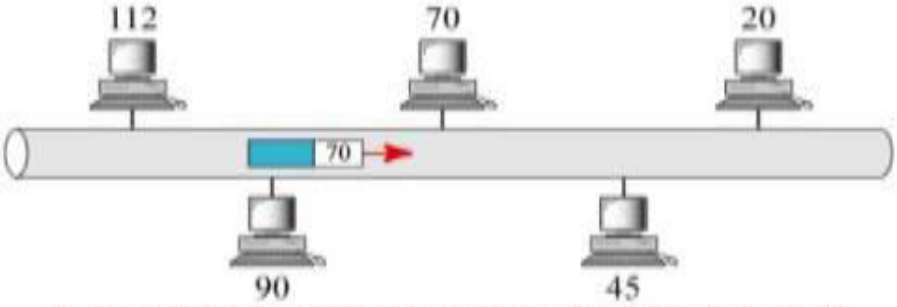
Token Bus

- **Token bus** is a network implementing the **token** ring protocol over a "virtual ring" on a coaxial cable. A **token** is passed around the network nodes and only the node possessing the **token** may transmit. If a node doesn't have anything to send, the **token** is passed on to the next node on the virtual ring.

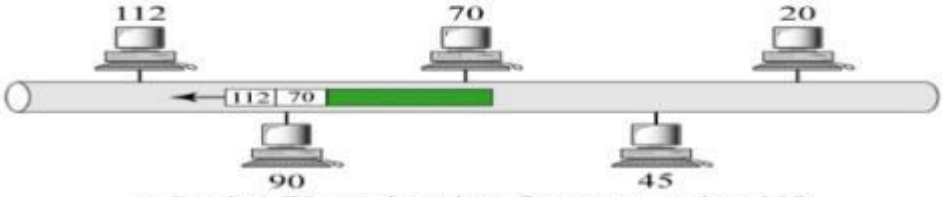




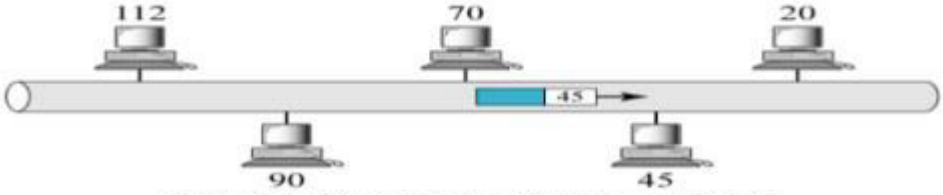
a. Station 112 does not have data; it sends the token to 90



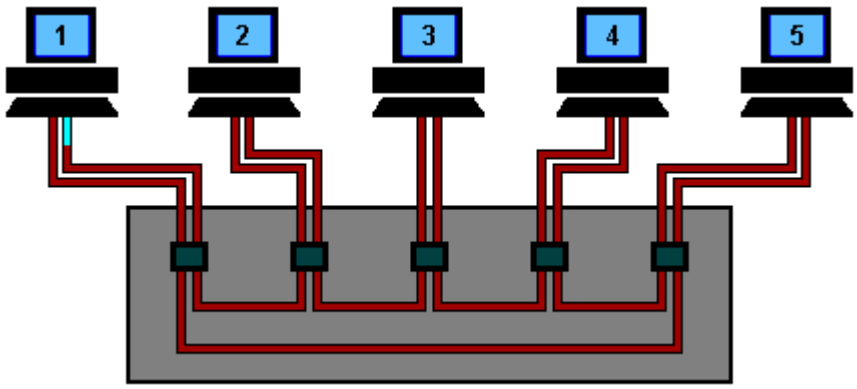
b. Station 90 does not have data; it sends the token to 70



c. Station 70 sends a data frame to station 112

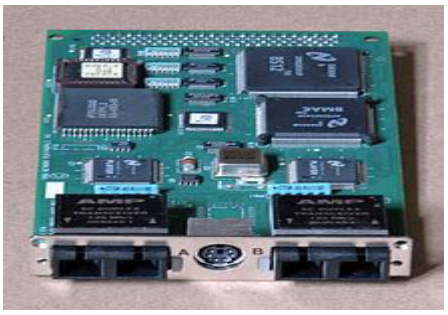


d. Station 70 sends the token to station 45

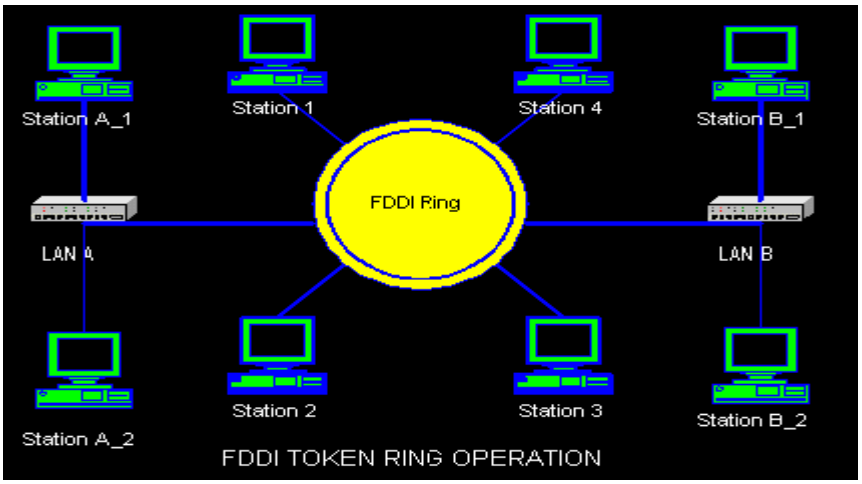


FDDI

- **Fiber Distributed Data Interface** (**FDDI**) is a standard for data transmission in a local area network.
- It uses optical fiber as its standard underlying physical medium, although it was also later specified to use copper cable, in which case it may be called **CDDI** (Copper Distributed Data Interface), standardized as **TP-PMD** (Twisted-Pair Physical Medium-Dependent), also referred to as TP-DDI (Twisted-Pair Distributed Data Interface).



FDDI (Fiber Distributed Data Interface) is a set of ANSI and ISO standards for data transmission on fiber optic lines in a local area network (LAN) that can extend in range up to 200 km (124 miles). The FDDI protocol is based on the token ring protocol.



The diagram on the left shows an FDDI network connects 4 high speed workstations, and, through bridges, 2 LANs.

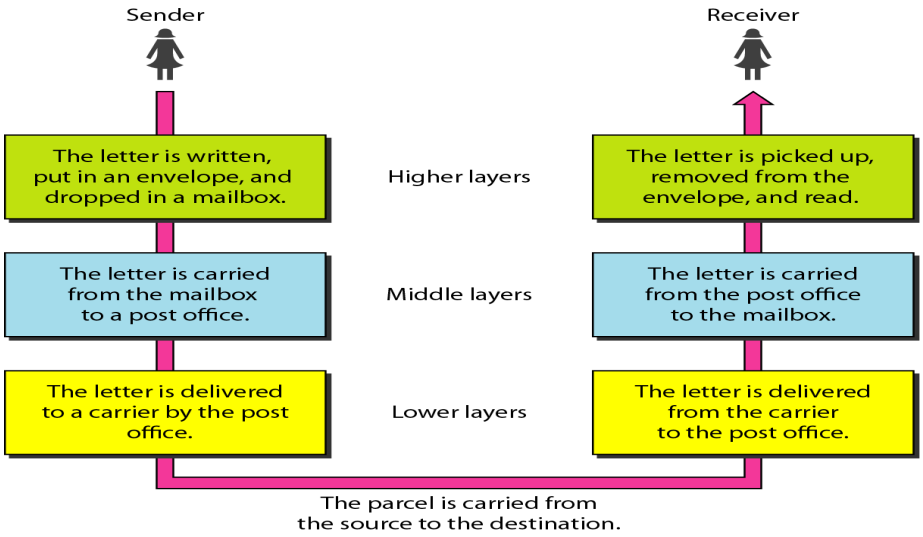
- Station A_1 on LAN A has a frame to send, with Station 4 as the destination .
- The FDDI port on the bridge sharing with LAN A waits for the token. It holds the token, sends the frame, and releases the token. (Depending on the time the token takes to go around the ring, asynchronous traffic may or may not be allowed.)
- Station 4 copies the frame.
- The frame returns to the originating port.
- The token continues.

NETWORK MODELS

LAYERED TASKS

The process of sending a letter to a friend would be complex if there were no services available from the post office

- Sender,
- Receiver
- Carrier

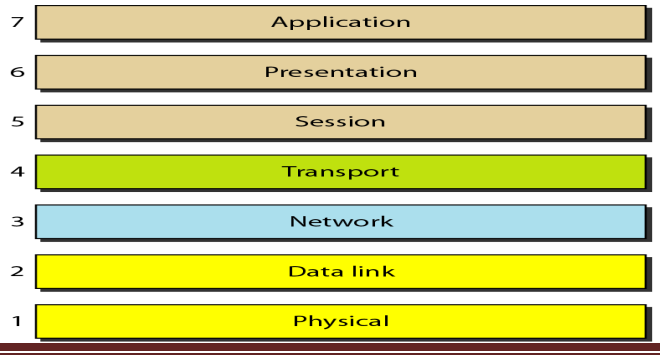


THE OSI MODEL

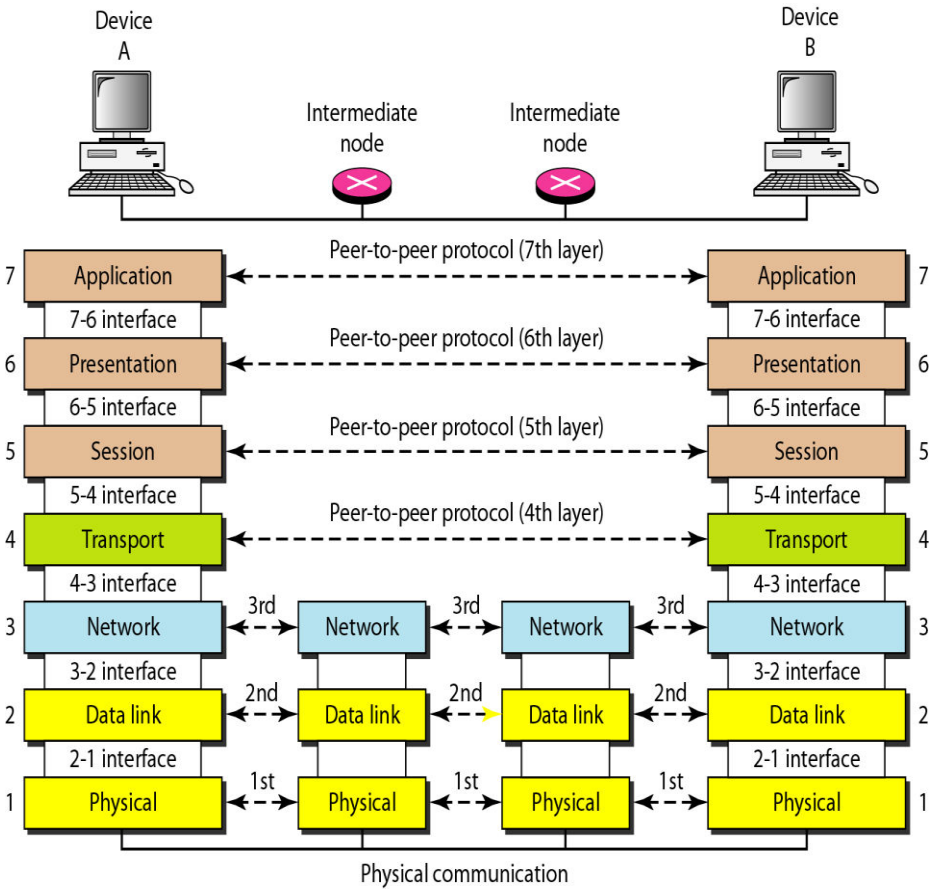
- Introduced in 1970

ISO is the organization.
OSI is the model.

Seven layer of OSI Model

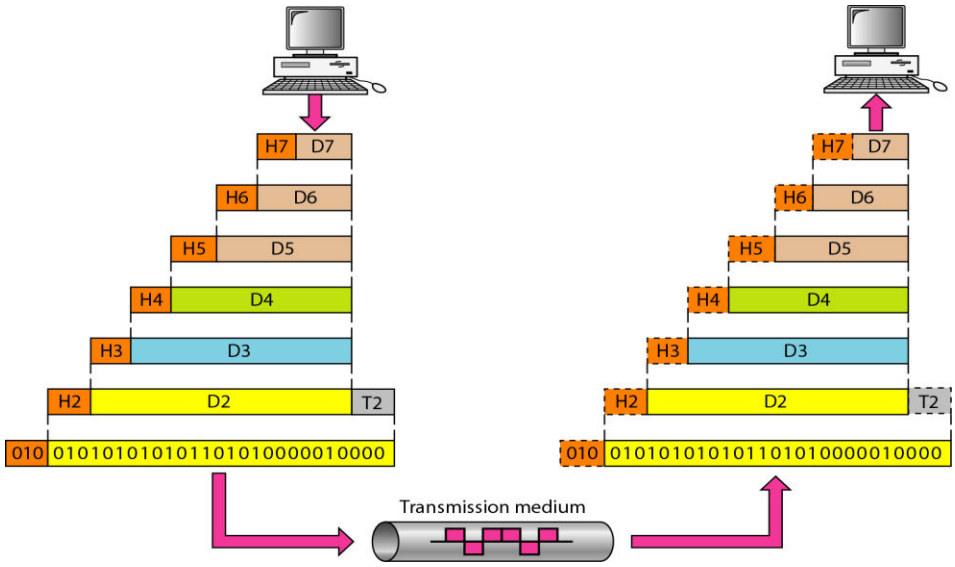


The interaction between layers in the OSI model



l

An exchange using the OSI model



LAYERS IN THE OSI MODEL***

1. Physical Layer
2. Data Link Layer
3. Network Layer
4. Transport Layer
5. Session Layer
6. Presentation Layer
7. Application Layer

Physical Layer

- The physical layer is responsible for movements of individual bits from one hop (node) to the next.

Data Link Layer

- The data link layer is responsible for moving frames from one hop (node) to the next.

Network Layer

- The network layer is responsible for the delivery of individual packets from the source host to the destination host.

Transport Layer

- The transport layer is responsible for the delivery of a message from one process to another.

Session Layer

- The session layer is responsible for dialog control and synchronization

Presentation Layer

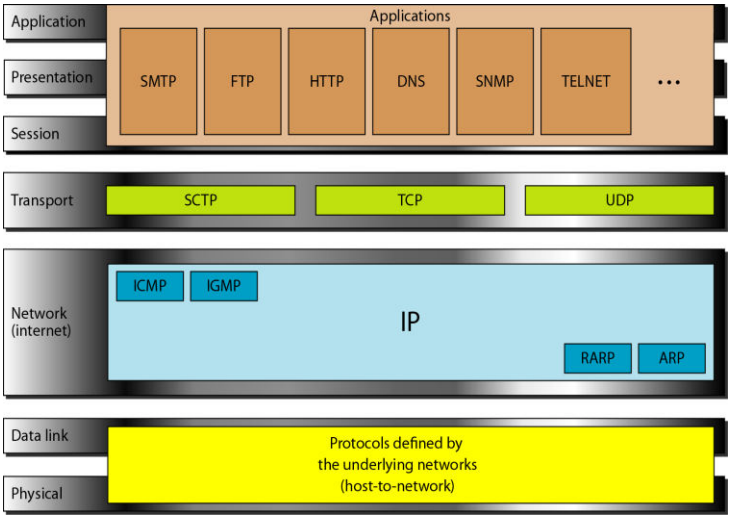
- The presentation layer is responsible for translation, compression, and encryption

Application Layer

- The application layer is responsible for providing services to the user

TCP / IP PROTOCOL SUITE

- The layers in the TCP/IP protocol suite do not exactly match those in the OSI model.
- The original TCP/IP protocol suite was defined as having four layers
    1. Host-to-network
    2. Internet
    3. Transport
    4. Application



OSI Model	TCP/IP
Reference model	Implementation of OSI model
Has 7 layers	Has only 4 layers
Separate presentation layer	Separate session layer No session layer characteristics are provided by transport layer
No session layer characteristics are provided by transport layer	No presentation layer, characteristics are provided by application layer
Transport layer does not guarantee delivery of packets.	Transport layer guarantees delivery of packets.
Considered a reference tool	Considered more reliable
Stricter boundaries for the protocols	Protocols are not strictly defined
Vertical approach	Horizontal approach
The protocols are better hidden and can be easily replaced as the technology changes.	It is not easy to replace the protocols.
Model was developed before the development ofprotocols	Protocols were developed first and thenthe model was developed
Supports connectionless and connection-orientedcommunication in the network layer	Supports only connectionlesscommunication in the network layer
Protocol independent standard	Protocol dependent standard