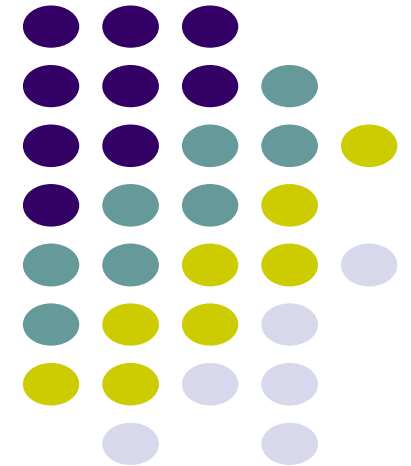


I 8ECC303J – Computer Communication Networks

Course Credit : 4

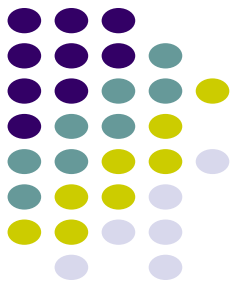
Theory : 9 Hours



1. Behrouz A. Fehrouzan, “Data communication & Networking”, Mc-Graw Hill, 5th Edition Reprint, 2014.

2. Andrew S. Tanenbaum, “Computer Networks”, Pearson Education India, 5th Edition, 2013.

3. William Stallings, “Data & Computer Communication”, Pearson Education India, 10th Edition, 2014.



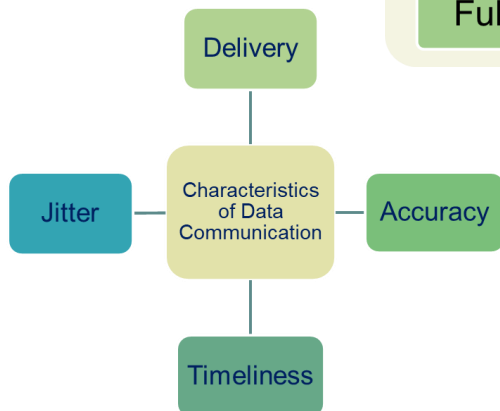
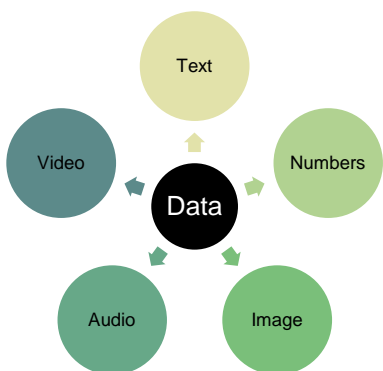
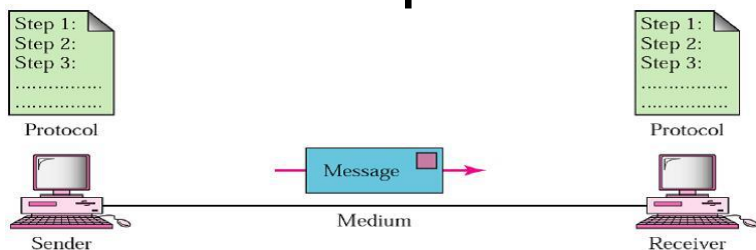
Unit 1 – Data Communication and Networking Basics

- ❖ Introduction to Data Communication and Networking
- ❖ Data transfer modes-Serial and Parallel transmission
- ❖ Protocols & Standards
- ❖ Layered Architecture; Principles of Layering & Description
- ❖ Brief description of concepts in OSI & TCP/IP model
- ❖ Switching Types: Circuit & Packet switching, Message switching, Comparison of switching types
- ❖ LAN, MAN & WAN
- ❖ Network topologies-Types, Comparison of topologies
- ❖ IEEE standards for LAN-Ethernet; Types of Ethernet
- ❖ Token Bus, Token Ring and FDDI

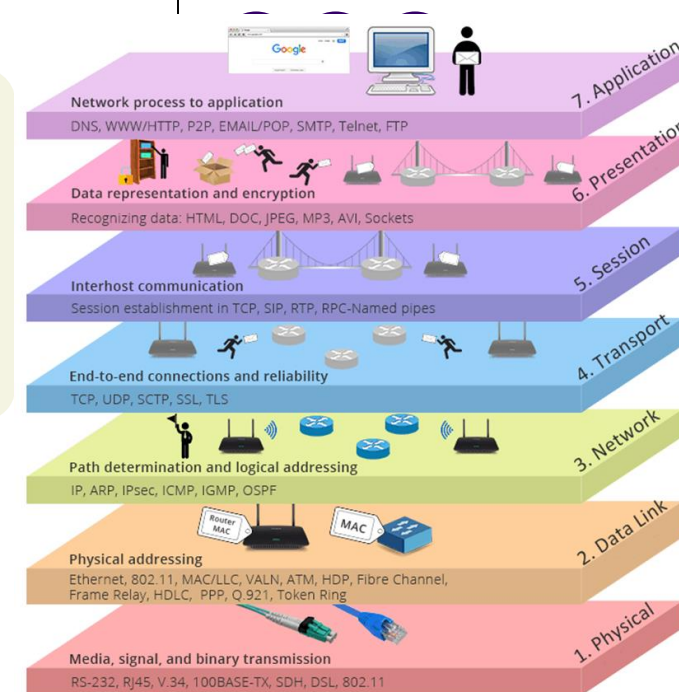
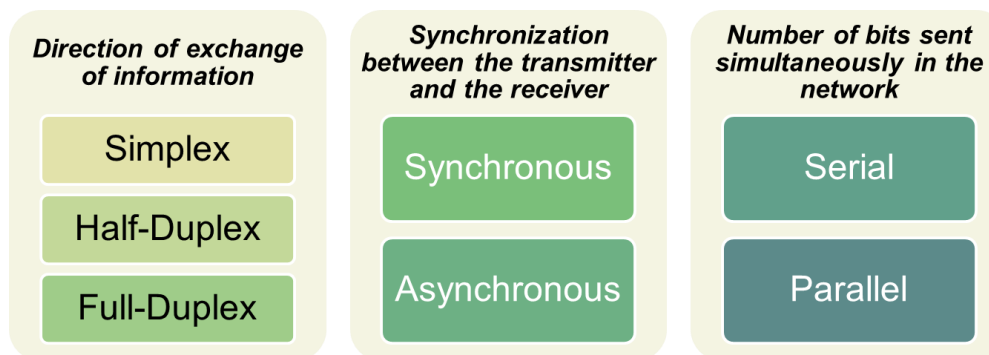
Unit 1 – Week 1-Review



Components



Data Transfer modes



OSI Model

Unit 1 – Week 2



Session 4

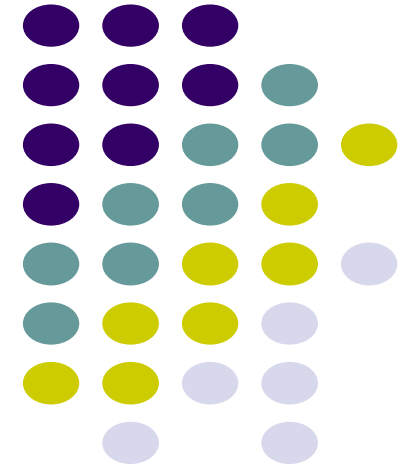
- ❖ Switching Types- Circuit & Packet switching, Message Switching
- ❖ Comparison of switching types

Session 5

- ❖ LAN – Local Area Network
- ❖ MAN – Metropolitan Area Network
- ❖ WAN – Wide Area Network

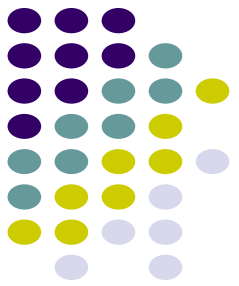
Session 6

- ❖ Network Topology - Types
- ❖ Comparison of Network Topologies



Reference Text Books:

1. Behrouz A. Fehrouzan, “Data communication & Networking”, Mc-Graw Hill, 5th Edition Reprint, 2014.
2. Andrew S. Tanenbaum, “Computer Networks”, Pearson Education India, 5th Edition, 2013.

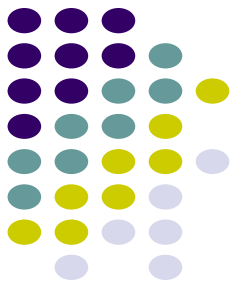


Introduction to Data Communication and Networking

Objectives :

- ✓ To Introduce the students to Switching Types, Network Categories and Network Topology

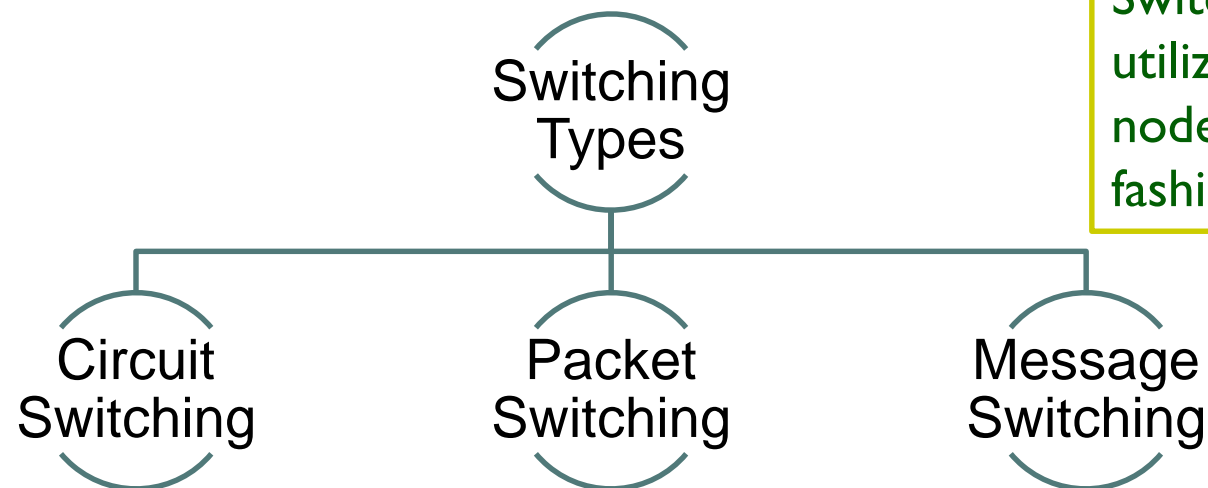
- The main objective of data communication and networking is to enable seamless exchange of data between any two points in the world.
- This exchange of data takes place over a computer network.
- To understand the concepts of various switching techniques, types of networks and topology.



Switching Types

Switching is the generic method for establishing a path for point-to-point communication in a network.

- One of the most important functions of the network layer is to employ the switching capability of the nodes in order to route messages across the network.
- In a switched network, some of these nodes are connected to the end systems and others for routing.



Switching involves the nodes in the network to utilize their direct communication lines to other nodes so that a path is established in a piecewise fashion.



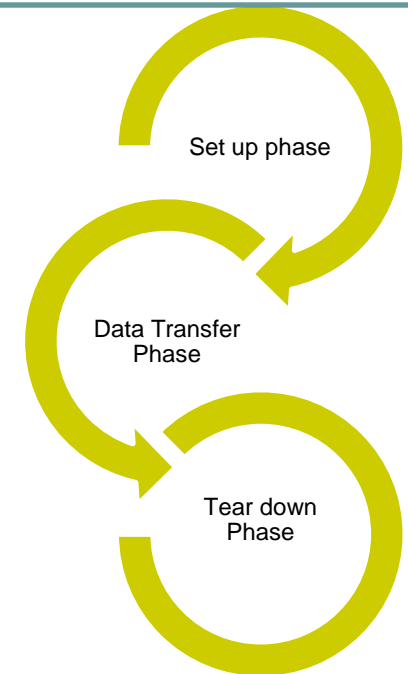
Circuit Switching

In circuit switching, two communicating stations are connected by a dedicated communication path, which consists of intermediate nodes in the network and the links that connect these nodes.

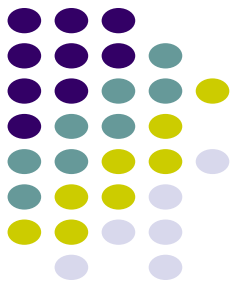
A circuit-switched network consists of a set of switches connected by one or more dedicated physical links.

The end systems such as computers or telephones are directly connected to a switch.

Three phases to connect and transfer the information



Each link is normally divided into n channels by using FDM or TDM.



Circuit Switching



Connection Establishment / Setup :

Connection is established by a dedicated circuit (combination of channels in links) for communication between devices



Data transfer

It is from the source to the destination of the network.

The data may be analog or digital, depending on the nature

The connection is generally full-duplex

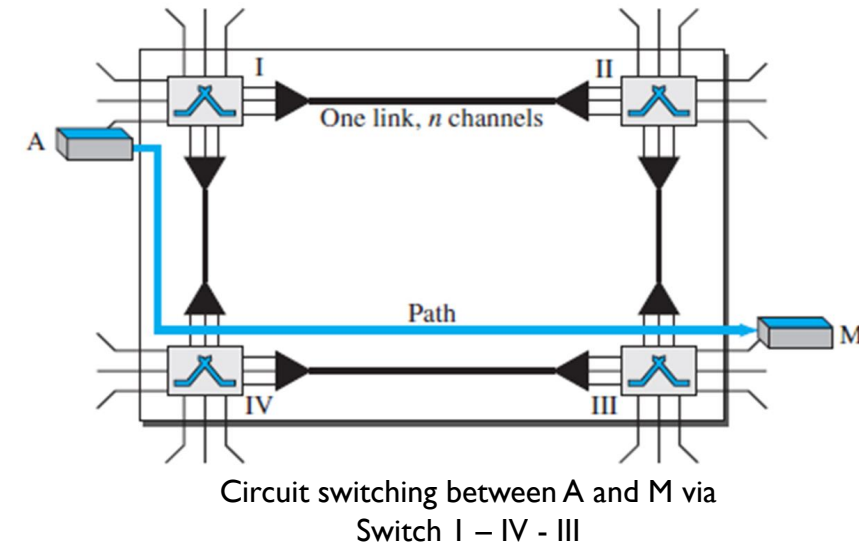


Connection Release / Tear down

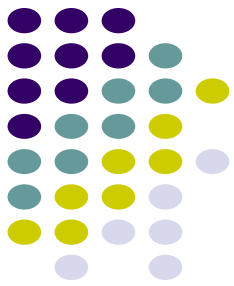
When one of the parties needs to disconnect, a signal is sent to each switch to release the resources.

Phases in Circuit Switching

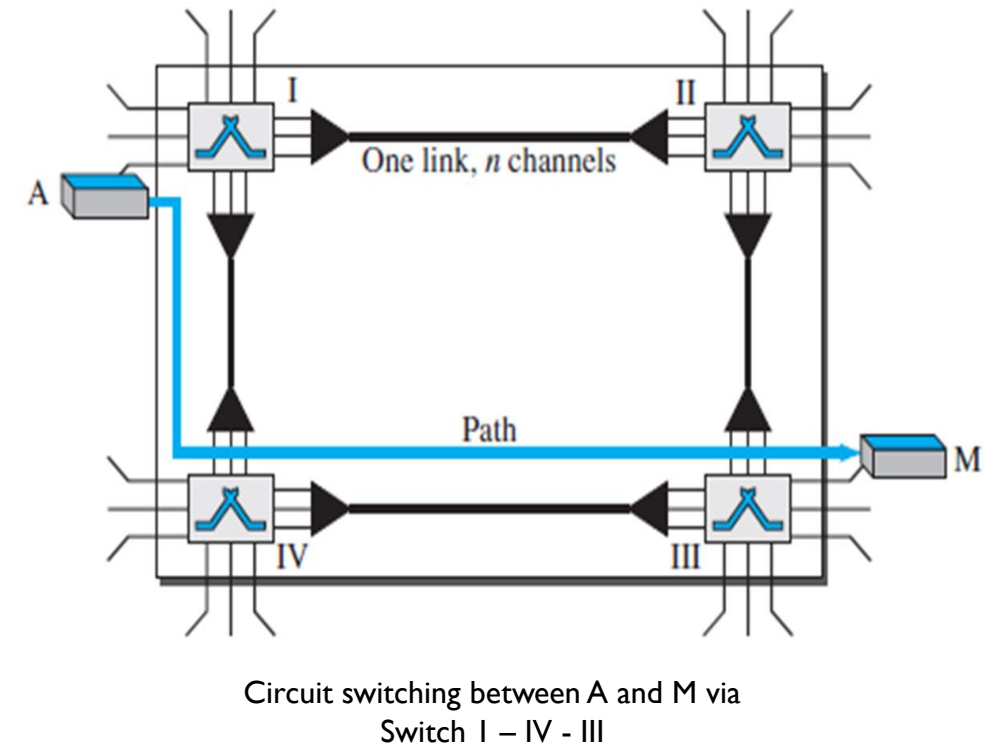
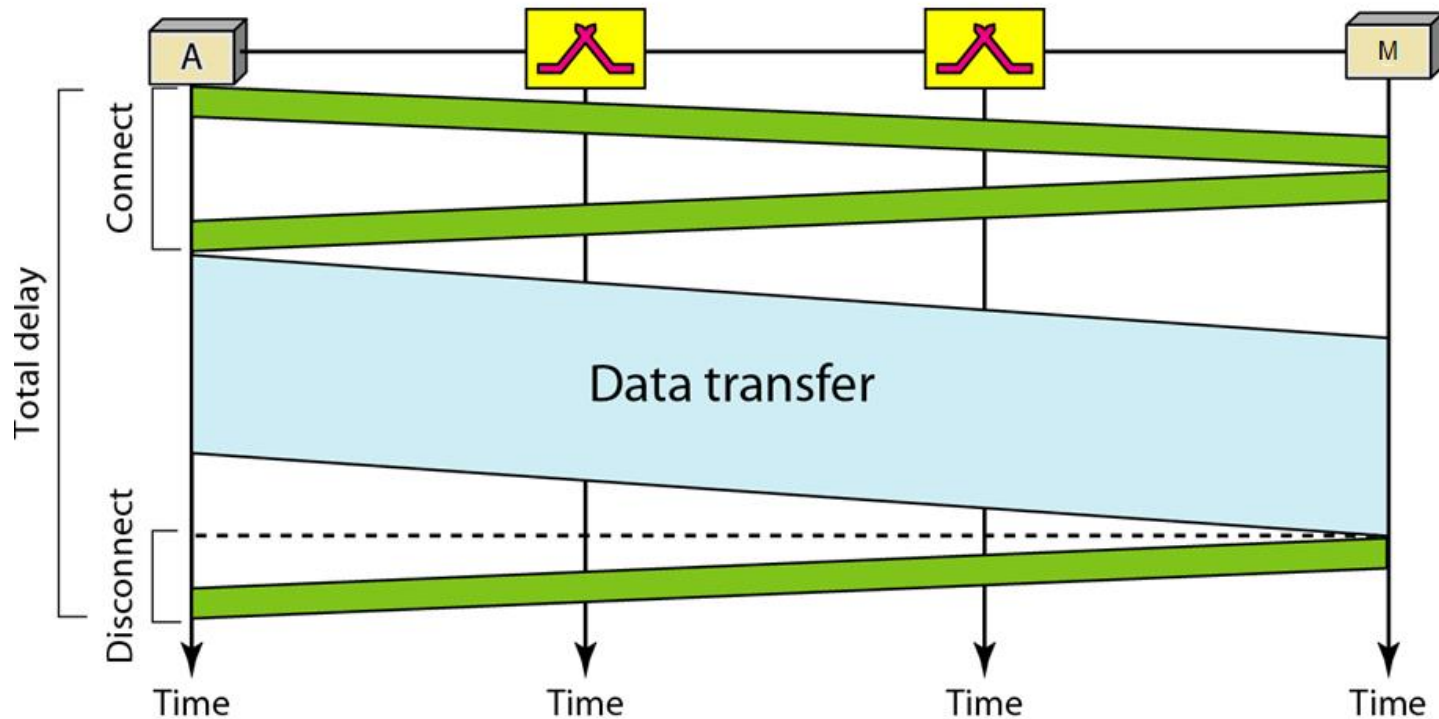
Circuit switching - technique used in **telephony**, where the caller sends a special message with the address of the callee (i.e. by dialing a number) to state its destination.



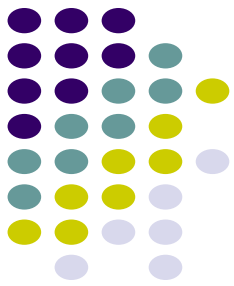
An end-to-end addressing is required for creating a connection between the two end systems. It could be addresses of the computers in a TDM network, or telephone numbers in an FDM network



Circuit Switching Technique



when system A needs to connect to system M, it sends a setup request that includes the address of system M, to switch I, which find the route to destination.



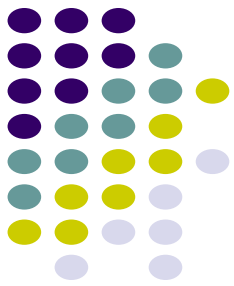
Circuit Switching Technique

Efficiency :

- The resources are allocated during the entire duration of the connection, so not efficient.
- These resources are unavailable to other connections.
- In a telephone network, people normally terminate the communication when they have finished their conversation.
- However, in computer networks, a computer can be connected to another computer even if there is no activity for a long time

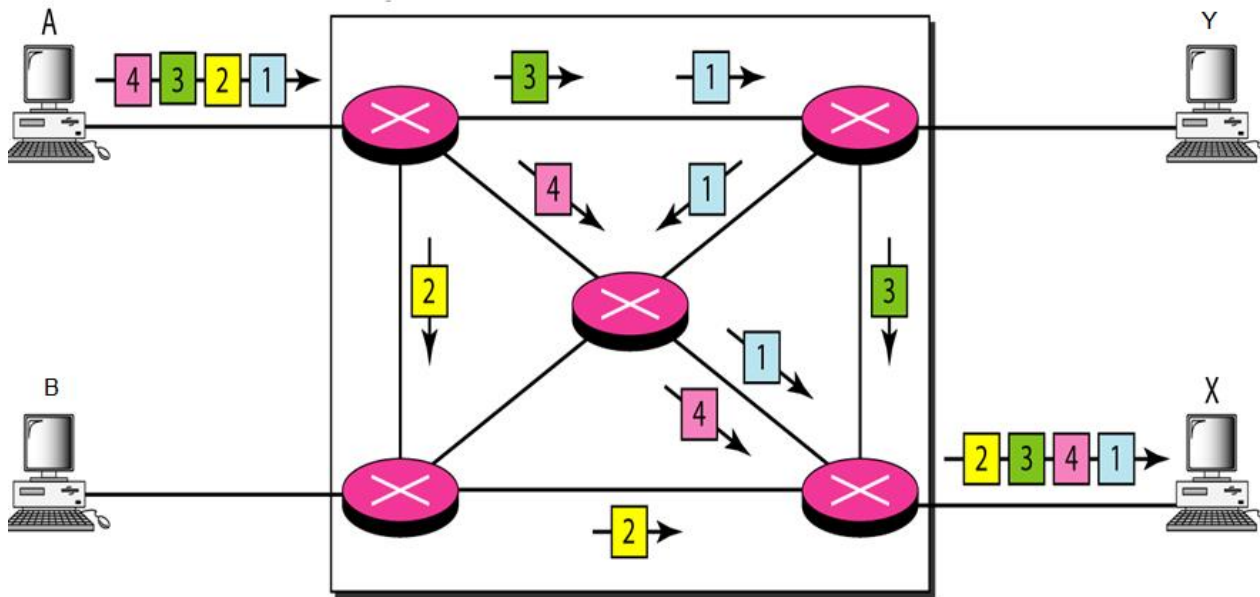
Delay:

- Minimal delay (coz of dedicated resources).
- The total delay is due to the time needed to create the connection, transfer data, and disconnection.
 - ❖ The **delay caused by the setup** is the sum of propagation time of the source computer request, the request signal transfer time, the propagation time of the acknowledgment from the destination computer, and the signal transfer time of the acknowledgment.
 - ❖ The **delay due to data transfer** is the sum of : the propagation time and data transfer time.
 - ❖ The **delay due to tear down** is maximum, If the receiver requests disconnection.



Packet Switching

A packet is handed over from node to node across the network. Each receiving node temporarily stores the packet, until the next node is ready to receive it, and then passes it onto the next node. This technique is called **store-and-forward** and overcomes one of the limitations of circuit switching..



Packet
Switching

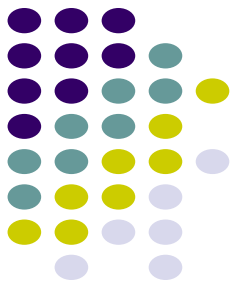
Virtual Circuit Switching -

Connection oriented. Route is established before data via connection request packet to the destination.

Datagram Switching –

Connectionless. Does not require pre-established route. Each packet is treated independently and it travel along different routes in the network to reach destination.

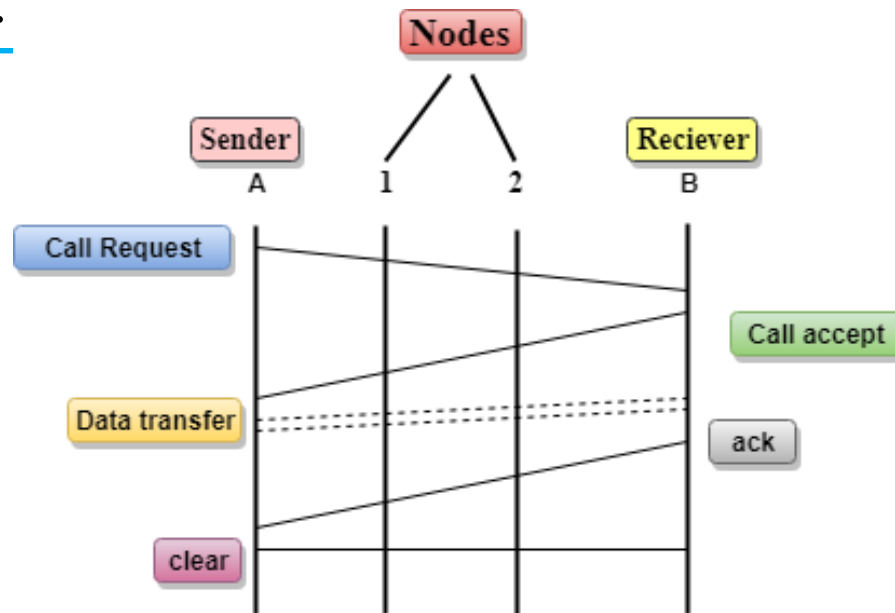
In a packet-switched network, there is no resource reservation; resources are allocated on demand.



Packet Switching Technique

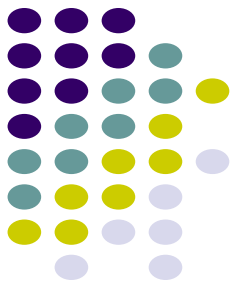
Virtual Circuit Switching

- In Virtual circuit switching, a preplanned route is established before the messages are sent.
- Call request and call accept packets are used to establish the connection between sender and receiver.



Datagram Packet switching:

- Packet is known as a datagram, is considered as an independent entity.
- Each packet contains the information about the destination and switch uses this information to forward the packet to the correct destination.
- The packets are reassembled at the receiving end in correct order.
- The path is not fixed. Intermediate nodes take the routing decisions to forward the packets.



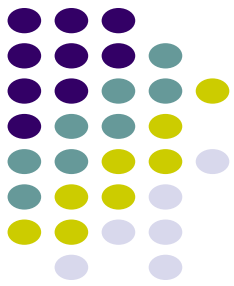
Packet Switching Technique

Advantages of Packet Switching:

- **Cost-effective:** In packet switching technique, switching devices do not require massive secondary storage to store the packets, so cost is minimized to some extent.
- **Reliable:** If any node is busy, then the packets can be rerouted.
- **Efficient:** As it does not require any established path prior to the transmission, and many users can use the same communication channel simultaneously, hence makes use of available bandwidth very efficiently.

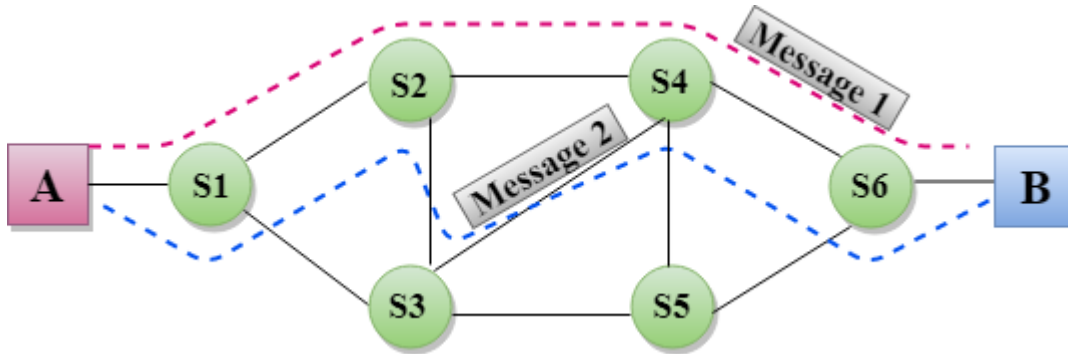
Disadvantages of Packet Switching:

- Cannot implemented in those applications that require **low delay and high-quality services**
- The protocols used are very complex and requires high implementation cost.
- If the network is overloaded or corrupted, then it requires retransmission of lost packets.
- It can also lead to the loss of critical information if errors are not recovered.



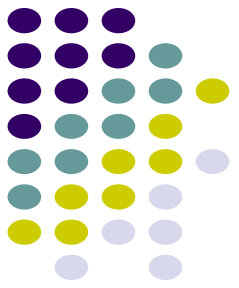
Message Switching

Message Switching is a switching technique in which a message is transferred as a complete unit and routed through intermediate nodes at which it is stored and forwarded.



- There is no establishment of a dedicated path between the sender and receiver.
- The destination address is appended to the message.
- Message switches are programmed in such a way so that they can provide the most efficient routes.
- Each and every node stores the entire message and then forward it to the next node. This type of network is known as **store and forward network**.

Message switching treats each message as an independent entity.



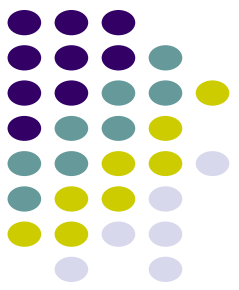
Message Switching

Advantages of Message Switching:

- Efficient utilization of resources: Data channels are shared among the communicating devices.
- Traffic congestion can be reduced because the message is temporarily stored in the nodes.
- Message priority can be used to manage the network.
- The size of the message which is sent over the network can be varied. Therefore, it supports the data of unlimited size.

Disadvantages of Message Switching:

- The message switches must be equipped with sufficient storage to enable them to store the messages until the message is forwarded.
- The Long delay can occur due to the storing and forwarding facility provided by the message switching technique.

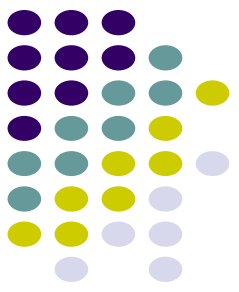


Review Questions

Q1. Mark “YES” or :NO”

Comparison between Switching Techniques	Circuit Switching	Message Switching	Packet Switching
Path established in advance	YES / NO	YES / NO	YES / NO
Store and Forward Technique	YES / NO	YES / NO	YES / NO
Message Follows Multiple Routes	YES / NO	YES / NO	YES / NO

Comparison between Packet Switching Techniques	Virtual Circuit Switching	Datagram Switching
Nodes takes the routing decision	YES / NO	YES / NO
Congestion Occurs	YES / NO	YES / NO

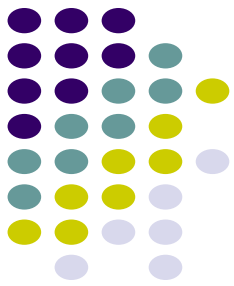


Answers

Q1. Mark “YES” or :NO”

Comparison between Switching Techniques	Circuit Switching	Message Switching	Packet Switching
Path established in advance	YES	NO	NO
Store and Forward Technique	NO	YES	YES
Message Follows Multiple Routes	NO	YES	YES

Comparison between Packet Switching Techniques	Virtual Circuit Switching	Datagram Switching
Nodes takes the routing decision	NO	YES
Congestion Occurs	YES	NO



Categories of Network - LAN, MAN & WAN

Networks are categorized on the basis of their size.

The three basic categories of computer networks are: LAN, MAN & WAN

Local Area Network (LAN)

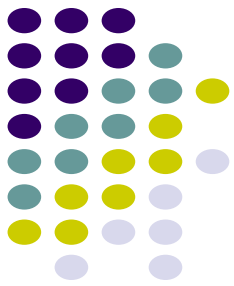
- Limited to a few kilometers of area. Privately owned (Ex. Office building)

Metropolitan Area Network (MAN)

- Size between LAN & WAN. It is larger than LAN but smaller than WAN. (Ex. Network connecting City)

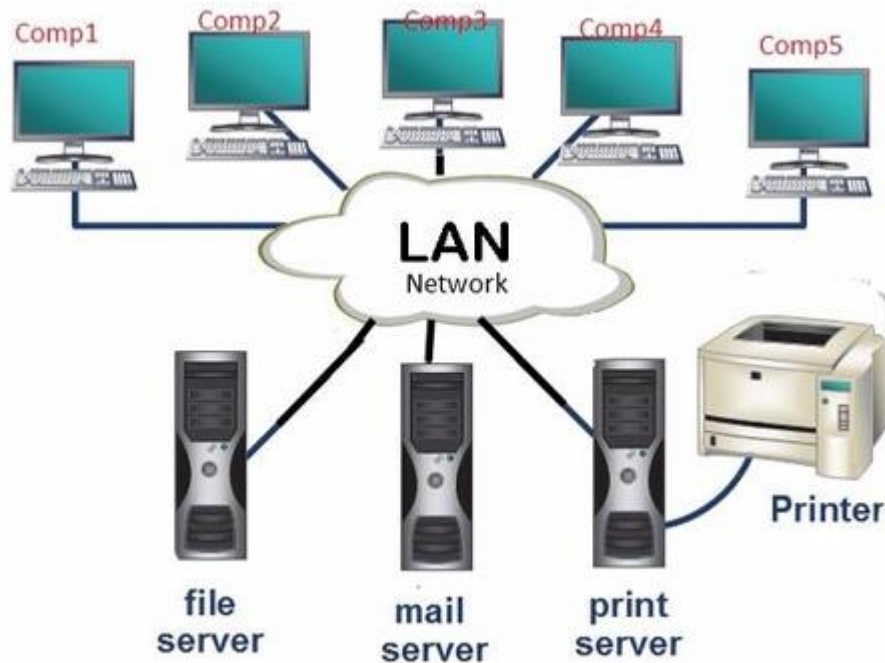
Wide Area Network (WAN)

- Made of all the networks in a (geographically) large area. (Ex. Network connecting the entire State)



Local Area Network - LAN

- Local Area Network (LAN) is a computer network spanned inside a building and operated under single administrative system.
- LAN covers an organization offices, schools, colleges or universities.
- Number of systems connected in LAN may vary from as least as two to as much as 16 million.
- LANs are composed of inexpensive networking and routing equipment.

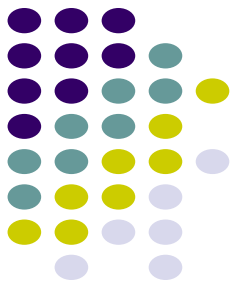


Features of LAN

- LAN provides a useful way of sharing the resources between end users
- LAN uses either Ethernet or Token-ring technology. Ethernet is most widely employed and uses Star topology, while Token-ring is rarely used.
- LAN can be wired, wireless, or in both forms at once

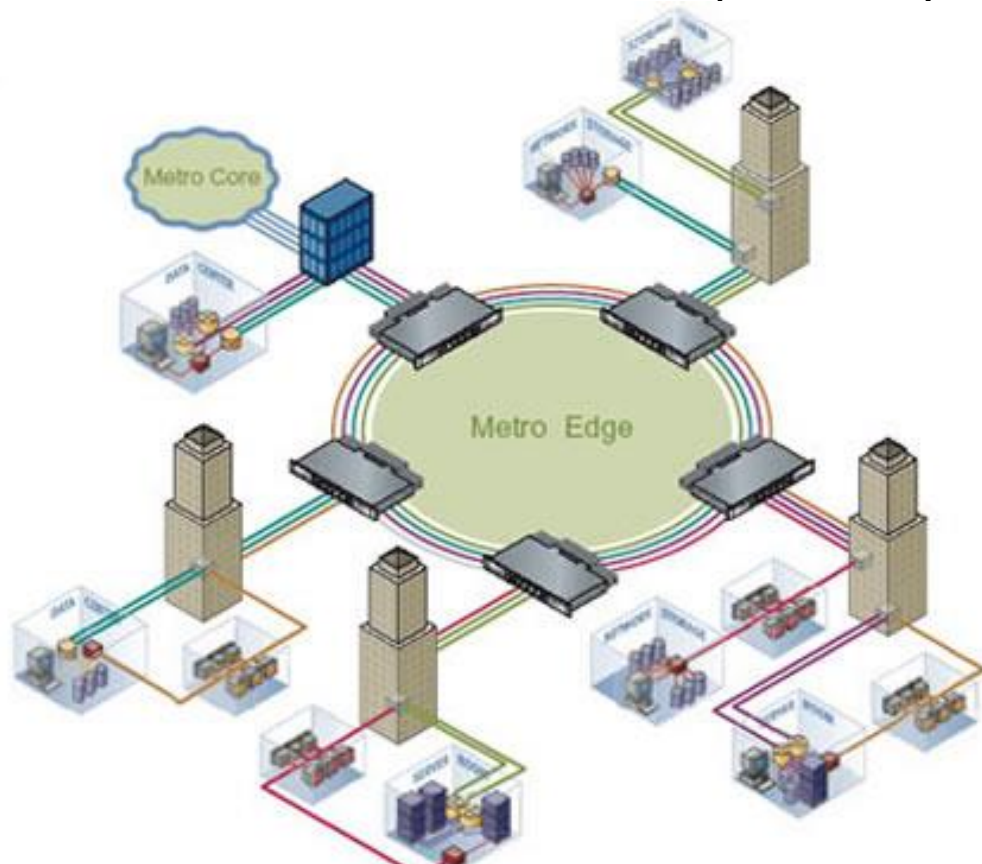
LAN Services:

LAN can help to connect all of its offices in a building premises.



Metropolitan Area Network - MAN

- Metropolitan Area Network (MAN) generally expands throughout a city such as cable TV network.
- It can be in the form of Ethernet, Token-ring, ATM, or Fiber Distributed Data Interface (FDDI).
- Metro Ethernet is a service which is provided by ISPs. This service enables its users to expand their LANs.

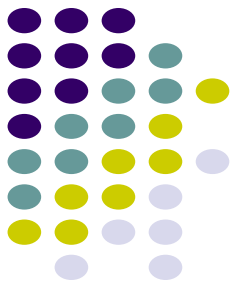


Features of MAN

- Backbone of MAN is high-capacity and high-speed fiber optics.
- MAN works in between Local Area Network and Wide Area Network.
- MAN provides uplink for LANs to WANs or internet

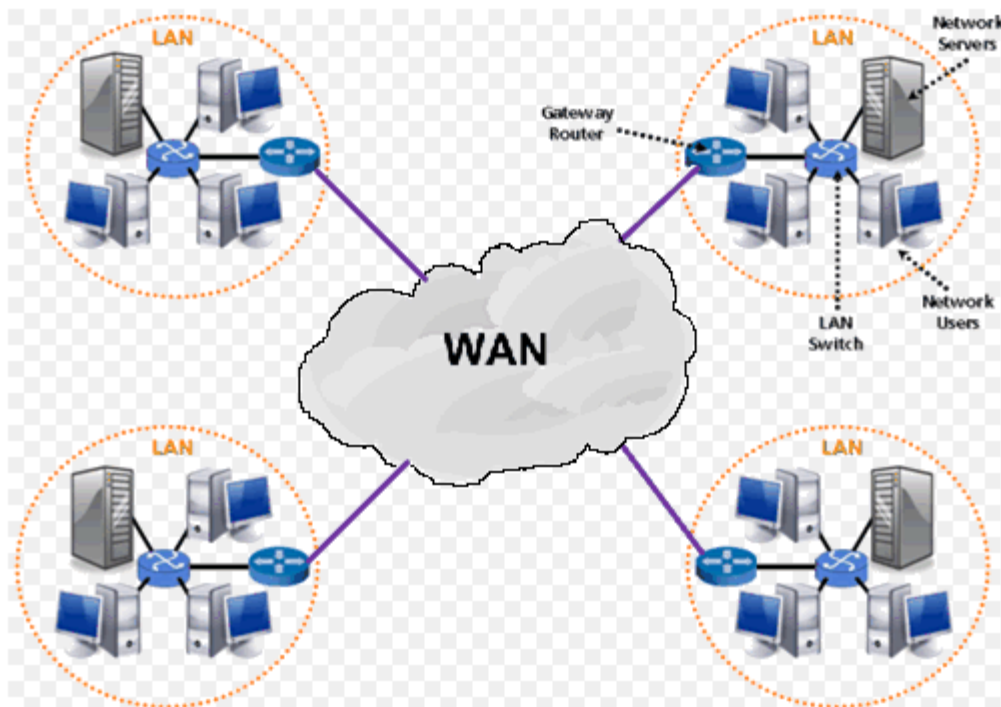
MAN Services:

MAN can help an organization to connect all of its offices in a city.



Wide Area Network - WAN

- Computer network that covers a large geographical area comprising a region, a country, a continent or even the whole world.
- WAN includes the technologies to transmit data, image, audio and video information over long distances and among different LANs and MANs.

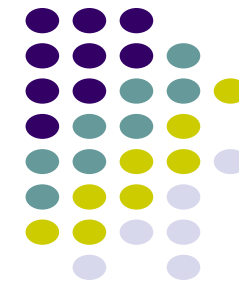


Features of WAN

- WANs have a large capacity, connecting a large number of computers over a large area, and are inherently scalable.
- They facilitate the sharing of regional resources.
- They provide uplinks for connecting LANs and MANs to the Internet.
- Communication links are provided by public carriers like telephone networks, network providers, cable systems, satellites etc.
- Typically, they have low data transfer rate and high propagation delay.
- They generally have a higher bit error rate.

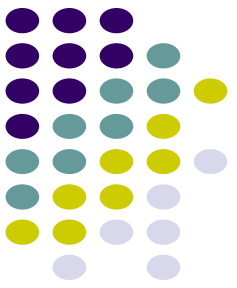
WAN Services:

- The Internet
- 4G Mobile Broadband Systems
- A network of bank cash dispensers



Comparison- LAN, MAN & WAN

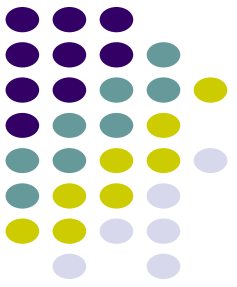
Key Parameters	LAN	MAN	WAN
Ownership	Owned by private organizations.	Ownership can be private or public.	Ownership can be private or public.
Speed	LAN speed is quite high.	MAN speed is average.	WAN speed is lower than that of LAN.
Delay	Network Propagation Delay is short.	Network Propagation Delay is moderate.	Network Propagation Delay is longer.
Congestion	LAN has low congestion as compared to WAN.	MAN has higher congestion than LAN.	WAN has higher congestion than both MAN and LAN.
Fault Tolerance	Fault Tolerance of LAN is higher than WAN.	Fault Tolerance of MAN is lower than LAN.	Fault Tolerance of WAN is lower than both LAN and MAN.
Maintenance	Designing and maintaining LAN is easy and less costly than WAN.	Designing and maintaining WAN is complex and more costly than LAN.	Designing and maintaining WAN is complex and more costly than both.




Review Questions


- Q1. Computer that spans a limited physical area, usually ranging from a small office to a building is known as _____.
- Q2. Multiple LANs can be connected to form a single MAN (Metropolitan Area Network).
State TRUE/FALSE.
- Q3. To form a WAN or MAN network, public networks can be used in between.
State TRUE or FALSE.
- Q4. Which cable between Twisted-Pair-Cable (TPC) and Coaxial-Cable (CC) work for transmitting data to more distances?
- Q5. Mr. John is a small business man that run a Hardware, he have been experiences problem with his small accounting department which he depends on to provide him with the sales reports. Mr John wants to share information between his 7 computer station and have on central printing area, what type of network would you recommend to Mr. John?

Answers




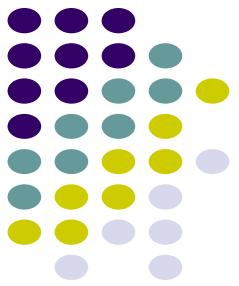
 1. Local Area Network

 2. True

 3. True

 4. Coaxial Cable

 5. LAN



Network Topology

Network

A network is a set of devices (often referred to as nodes) connected by communication links.

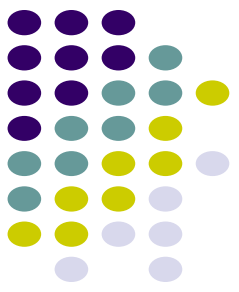
Node: Computer, printer, or any other device capable of sending and/or receiving data generated by other nodes on the network.

Link: Cable, air, optical fiber, or any medium which can transport a signal carrying information.

Network Topology

Network Topology is the arrangement with which computer systems or network devices are connected to each other.

- Topologies may define both physical and logical aspect of the network.
- Both logical and physical topologies could be same or different in a same network.



Network Topology

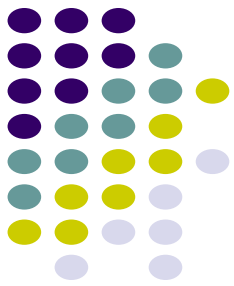
Physical topology:

Refers to the physical design of a network including the devices, location and cable installation.

Logical topology

Refers to how data is actually transferred in a network as opposed to its physical design.

In general physical topology relates to a core network whereas logical topology relates to basic network



Network Criteria

Performance

- Depends on
 - Network Elements and number of users
 - Type of transmission medium
 - Capabilities of connected hardware
 - Efficiency of the Software
 - Evaluated by networking metrics : Delay and Throughput

Performance can be measured in many ways, including transit time and response time.

Transit Time: Amount of time required for a message to travel from one device to another

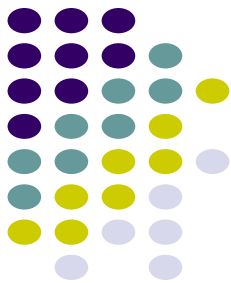
Response Time: Elapsed time between inquiry and response.

Reliability

- Accuracy of delivery
- Frequency of Failure
- The time it takes a link to recover from a failure
- Network robustness

Security

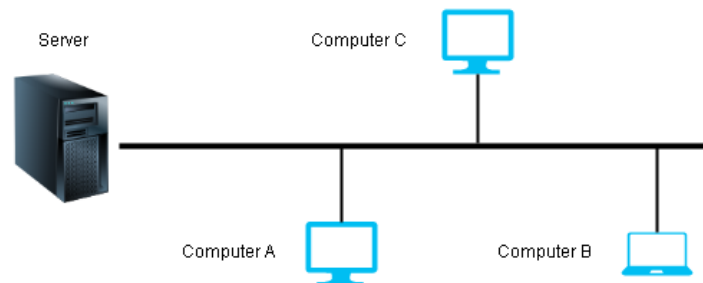
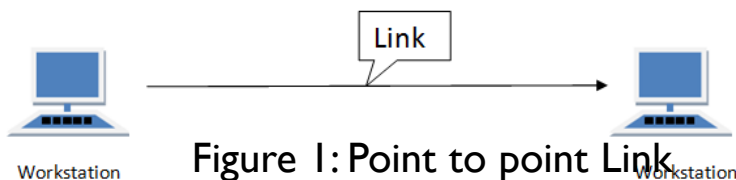
- Data protection against corruption/loss of data due to errors and malicious users
- Protecting data from unauthorized access, damage and development
- Protecting data from damage and development
- Implementing policies and procedures for recovery from breaches and data losses



Physical Structures

Type of Connection

- Point to Point - single transmitter and receiver (ex. Computer directly connected to Printer)
- Point to Multipoint - multiple recipients of single transmission-



Physical Topology

- Connection of devices
- Type of transmission - Unicast, Multicast, Broadcast

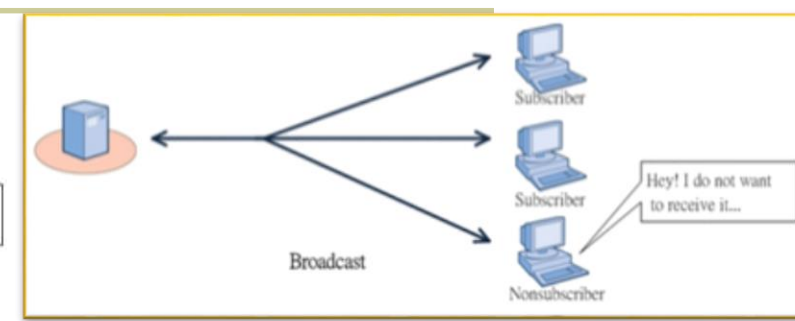
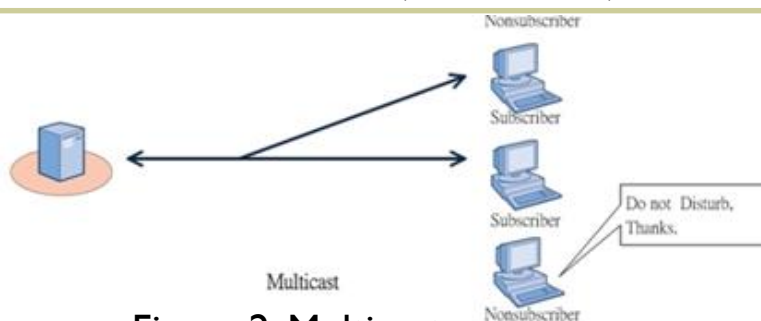


Figure 3: Broadcast



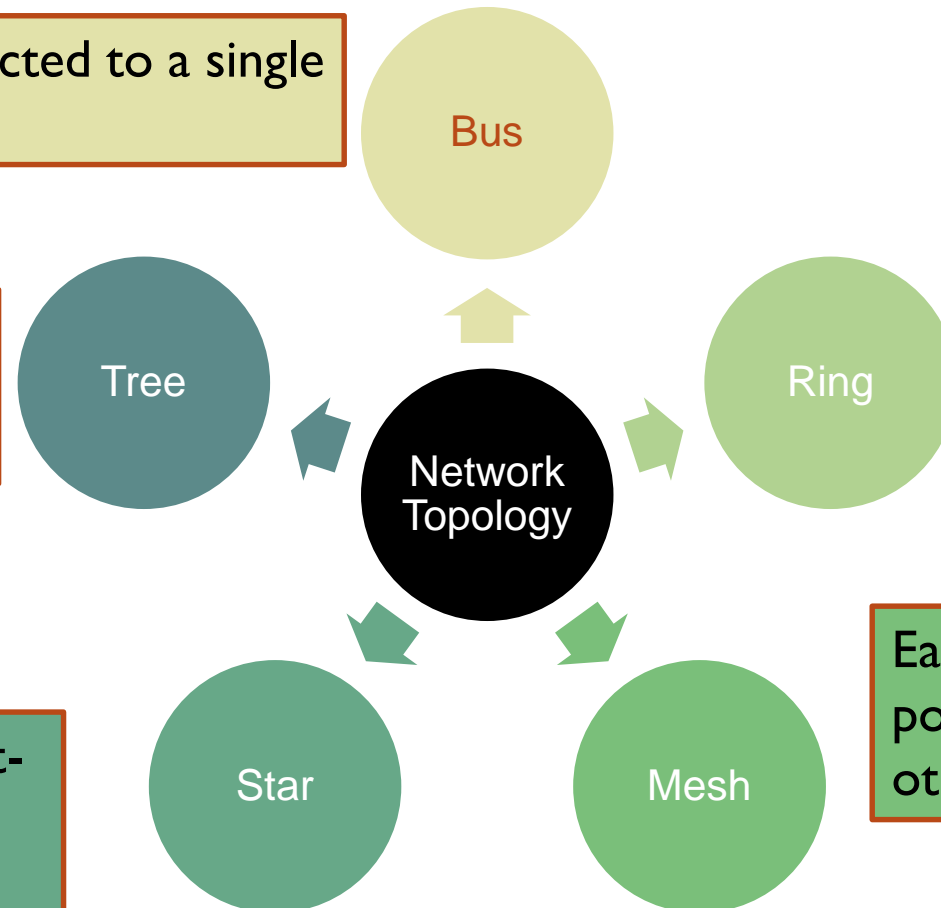
Categories of Network Topology

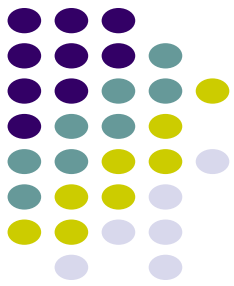
Network topology is the layout pattern of interconnections of the various elements (links, nodes, etc.) of a computer network.

Each node or device is connected to a single cable.

Special type of structure where many connected devices are arranged like the branches of a tree

Each device has a dedicated point-to-point link only to a central controller (Hub)

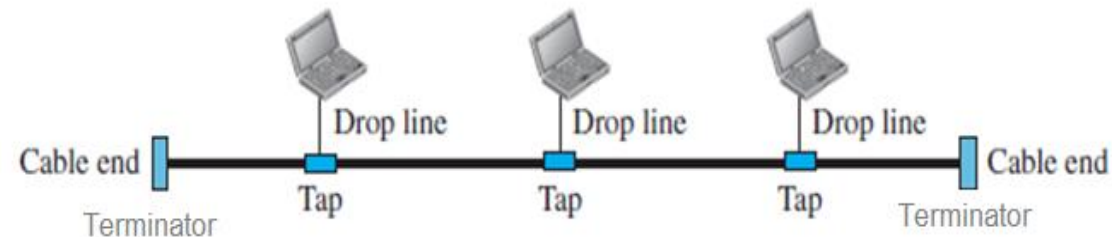




Bus Topology

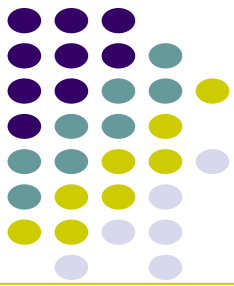
Each node or device is connected to a single cable.

A bus topology uses one long cable (backbone) to which network devices are either directly attached or are attached by using short drop cables.



- As signal travels along the backbone, some of its energy is transformed into heat. Because all workstations share this bus, a workstation checks for any information that might be coming down the backbone before sending their messages.
- All messages pass the other workstations on the way to their destinations.
- Each workstation then checks the address of each message to see if it matches its own.

The backbone (cable) must be terminated at both ends to remove the signal from the wire after it has passed all devices on the network.



Bus Topology

Each node or device is connected to a single cable.

Linear Bus

- ⑩ If all network nodes are connected to a combine transmission medium that has two endpoints the Bus is Linear.

Distributed Bus

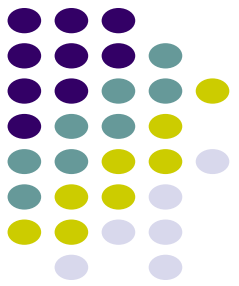
- ⑩ If all network nodes are connected to a combine transmission medium that has more than two endpoints created by branching the main section of the transmitting medium

Advantages of Bus Topology

- Easy to connect a computer or peripheral to a linear bus. (Ease of Installation)
- Requires less cable length than a star or mesh topology.

Disadvantages of Bus Topology

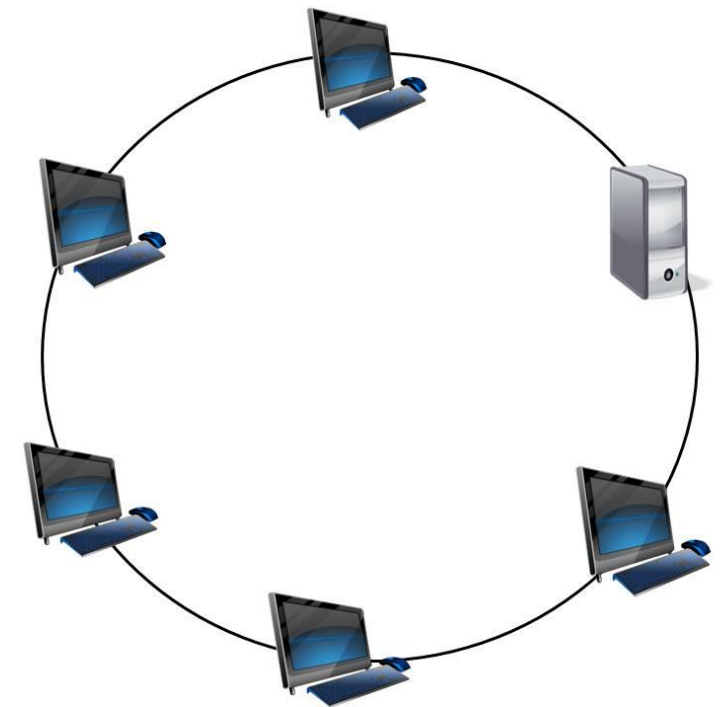
- Entire network shuts down if there is a break in the main cable.
- Terminators are required at both ends of the backbone cable.
- Difficult in fault detection when the entire network shuts down.
- Not meant to be used as a stand-alone solution in a large building
- Adding new devices require modification or replacement of the backbone



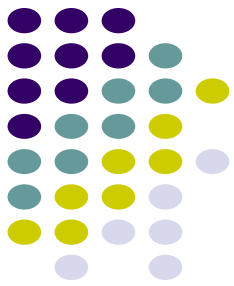
Ring Topology

Each device has a dedicated point-to-point connection with only the two devices on either side of it.

- A signal is passed along the ring in one direction, from device to device, until it reaches its destination.
- When a device receives a signal intended for another device, its repeater regenerates the bits and passes them along
- All messages pass the other workstations on the way to their destinations.
- Each workstation then checks the address of each message to see if it matches its own.



Each device in ring topology has a repeater, if the received data is intended for other device then repeater forwards this data until the intended device receives it..



Ring Topology

Each device has a dedicated point-to-point connection with only the two devices on either side of it.

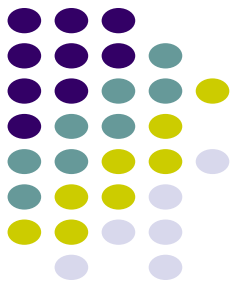
- FDDI, SONET or Token Ring technologies are used to build ring technology.
- Mostly, this topology is used in schools or office buildings.

Advantages of Ring Topology

- Easy to install.
- Managing is easier as to add or remove a device from the topology only two links are required to be changed.

Disadvantages of Ring topology

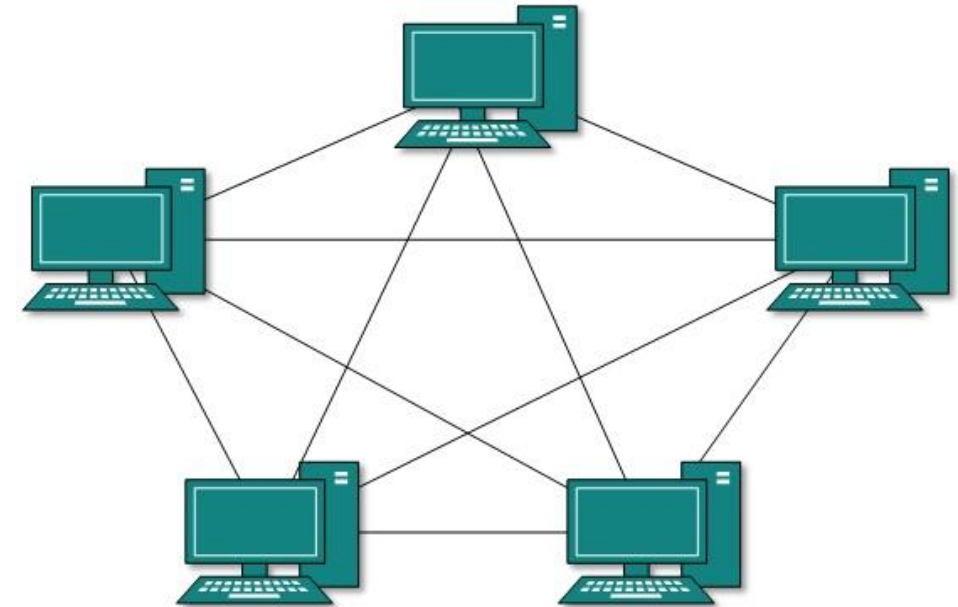
- A link failure can fail the entire network as the signal will not travel forward due to failure.
- Data traffic issues, since all the data is circulating in a ring.



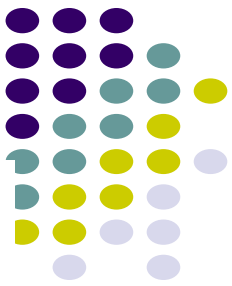
Mesh Topology

Each device has a dedicated point-to-point link to every other device.

- The term dedicated means that the link carries traffic only between the two devices it connects.
- The use of dedicated links eliminates traffic problems that occur when link is shared.
- A mesh topology is robust.
- If one link becomes unusable, it does not incapacitate the entire system.
- Privacy or security is maintained.



A mesh network with n nodes has $n(n-1)$ links [$n(n-1)/2$ in case of duplex].



Mesh Topology

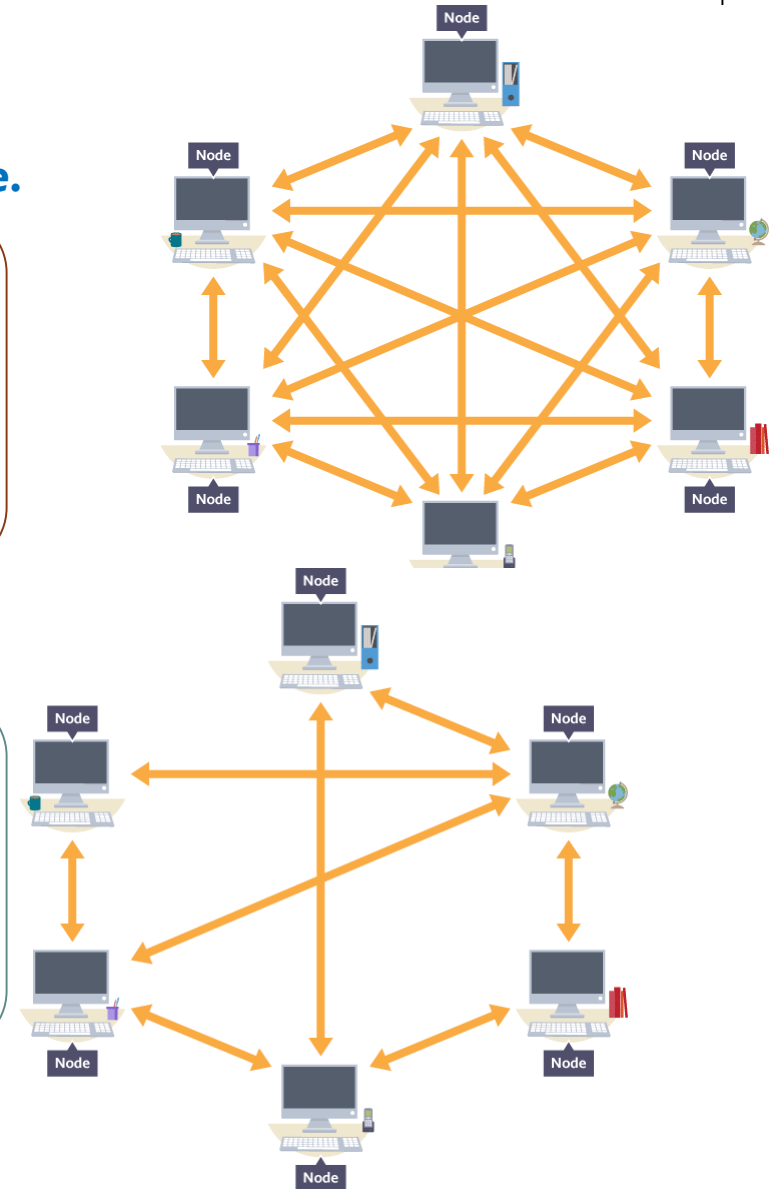
Each device has a dedicated point-to-point link to every other device.

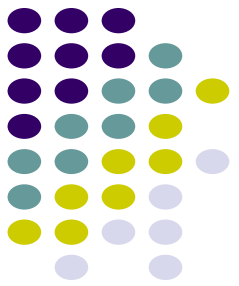
Fully
Connected

- ⑩ All the nodes within the network are connected with every other node.
- ⑩ For 'n' nodes, each node will have an n-1 number of connections. backbones.

Partially
Connected

- ⑩ Not all nodes are connected directly to each other.





Mesh Topology

Each device has a dedicated point-to-point link to every other device.

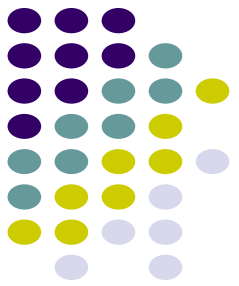
- Example for mesh topology - It is the connection of telephone regional offices in which each regional office needs to be connected to every other regional office.

Advantages of Mesh Topology

- Multiple connections mean each node can transmit to and receive from more than one node at the same time
- new nodes can be added without interruption or interfering with other nodes

Disadvantages of Mesh topology

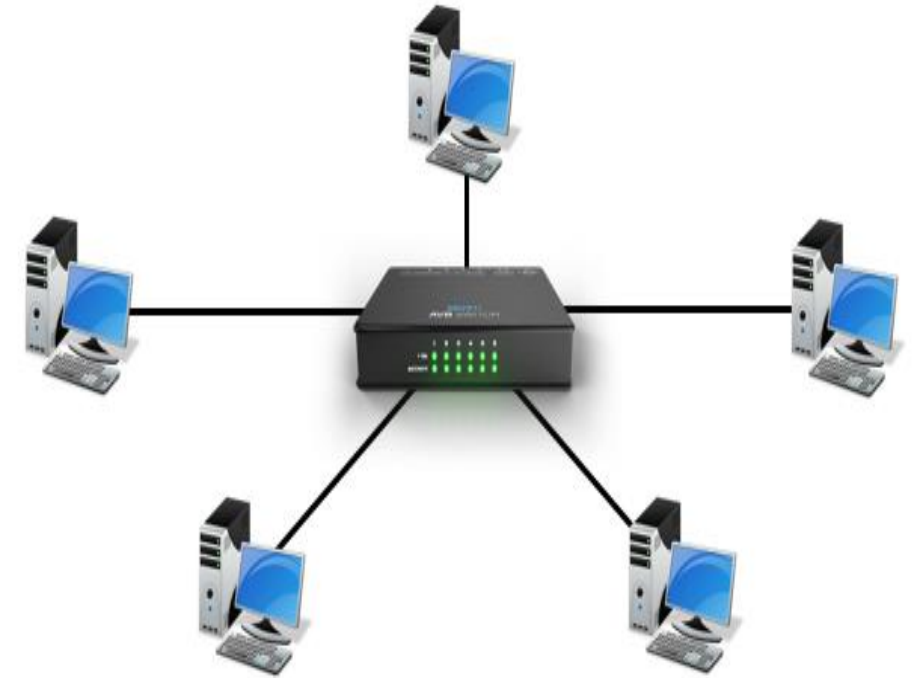
- Installation and reconnection are difficult.
- The sheer bulk of the wiring can be greater than the available space.
- The hardware required to connect each link (I/O ports & cable) is expensive.



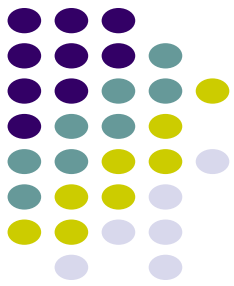
Star Topology

Each device has a dedicated point-to-point link only to a central controller, usually called a hub.

- The devices are not directly linked to one another.
- The switch or hub acts as a central point through which all communications are passed.
- The controller acts as an exchange.
- If one device wants to send data to another, it sends the data to the controller, which then relays the data to the other connected device.



Unlike mesh, a star topology does not allow direct traffic between devices.

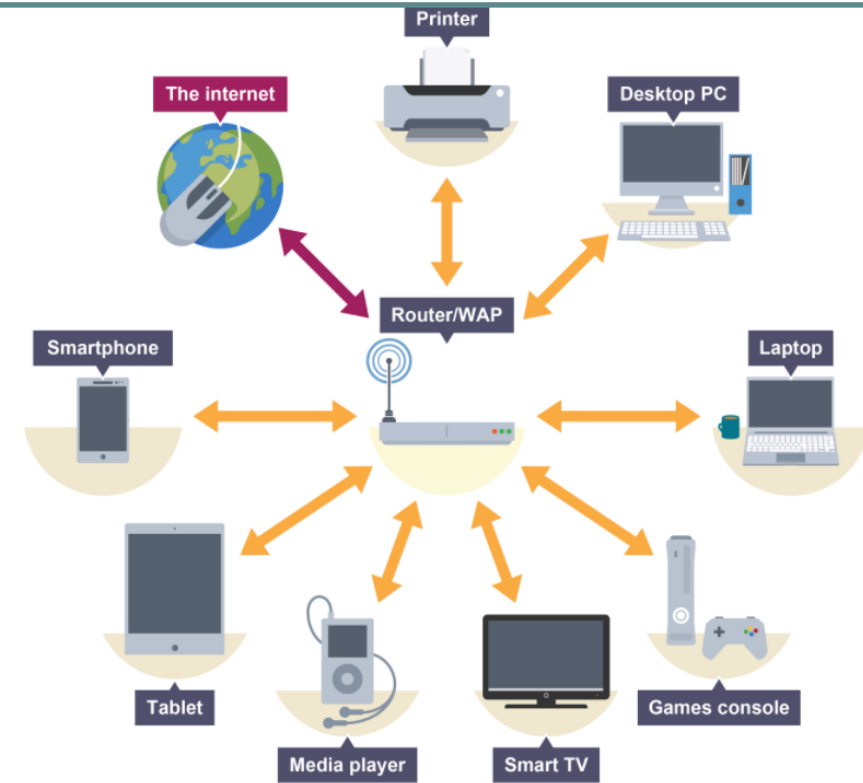
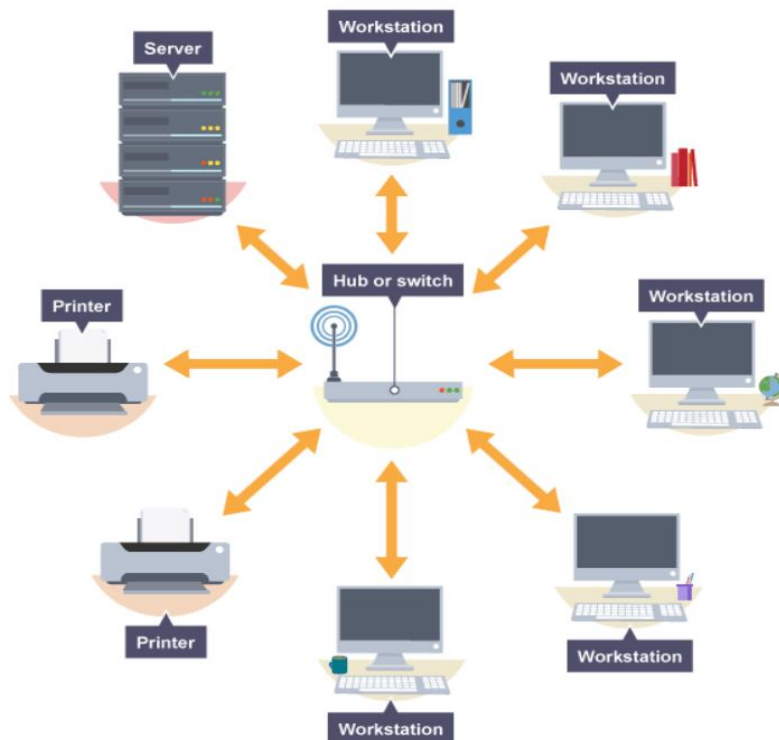


Star Topology

Each device has a dedicated point-to-point link only to a central controller, usually called a hub.

Star topologies tend to be found in large organizations, such as educational establishments and businesses, where high performance is required.

In home networks, especially those that are wireless. **In this case, a router with a wireless access point (WAP)** provides the central connection for all nodes.





Star Topology

Each device has a dedicated point-to-point link only to a central controller, usually called a hub.

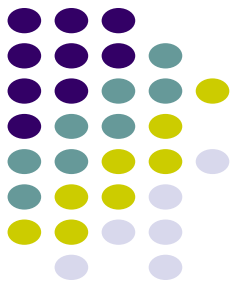
- Star topology is mainly used to connect devices in LANs.

Advantages of Star Topology

- Less expensive than a mesh topology.
- Easy to install and reconfigure. (each device needs only one link and one I/O port)
- Star topology is also robust i.e., when one link fails, only that link is affected.
- As long as the hub is working, it can be used to monitor link problems and bypass defective links.

Disadvantages of Star topology

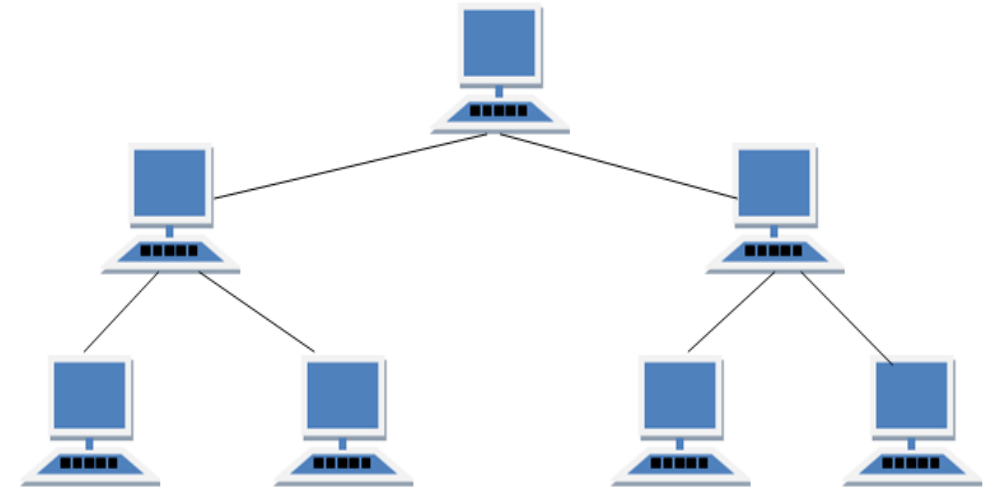
- Star topology is the dependency of the whole topology on one single point, the hub. If the hub goes down, the whole system is dead.



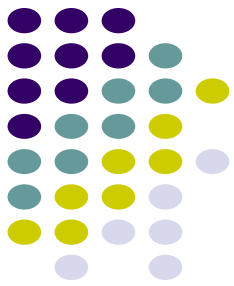
Tree Topology

A tree topology is a special type of structure in which many connected elements are arranged like the branches of a tree

- The top level of the hierarchy, is the central root node.
- The central root would be the only node having no higher node in the hierarchy.
- The tree hierarchy is symmetrical.
- Physical Linear Tree Topology would be of a network whose Branching Factor is one.



The **BRANCHING FACTOR** is the fixed number of nodes connected to the next level in the hierarchy



Tree Topology

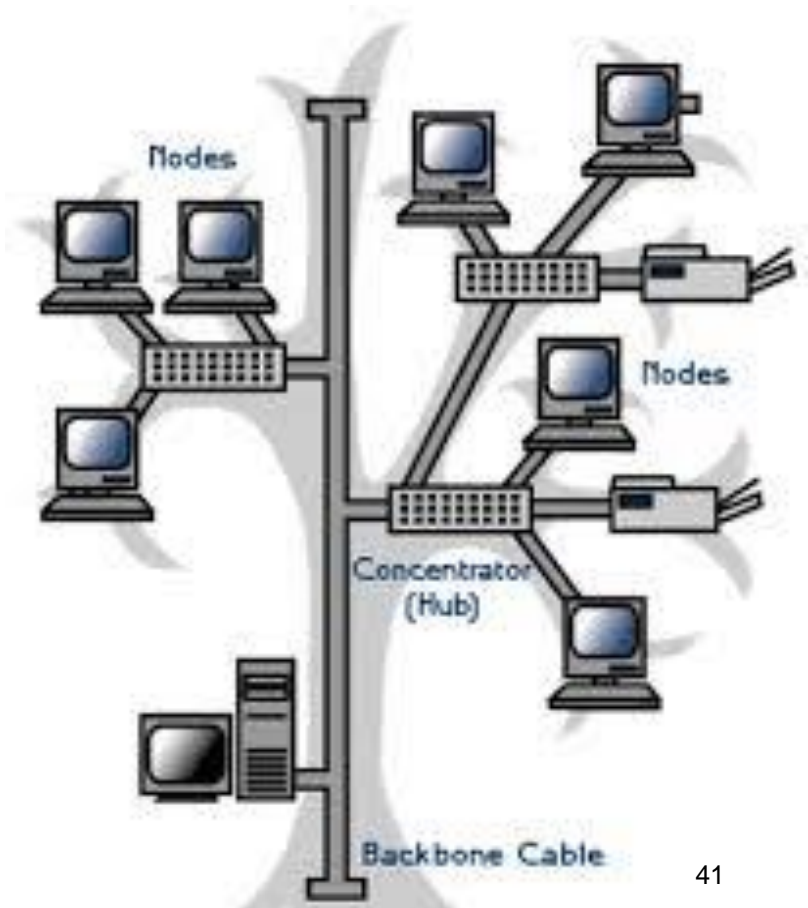
A tree topology is a special type of structure in which many connected elements are arranged like the branches of a tree

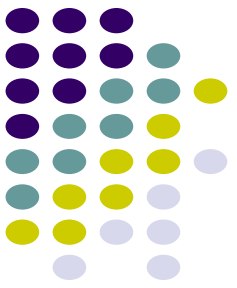
Advantages of Tree Topology

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

Disadvantages of 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.





Review Questions

Q1. _____ refers to the way a network is laid out, physically or logically.

Q2. In a _____ relationship, the link is shared equally between devices.

Q3. Seven devices are arranged in a mesh topology, _____ physical channel links these devices.

a) Six

(b) Seven

(c) Thirty

(d) Twenty One

Q4. In a _____ topology, a secondary hub can connect to a central hub.

Q5. Which one of the following is not a network topology?

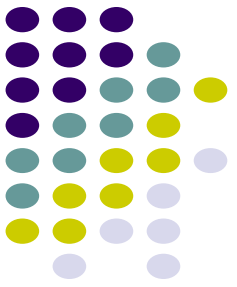
a) Star

b) Ring

c) Bus

d) Peer to Peer

Answers



- ~~✍~~ 1. Topology
- ~~✍~~ 2. Peer-to-Peer
- ~~✍~~ 3. Twenty One ($n(n-1)/2$)
- ~~✍~~ 4. Tree
- ~~✍~~ 5. Peer to Peer