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B.Tech

Computer Networks

KCS-603

With Notes

UNIT-1

Introduction

(Computer Networks)

(in one video)

AKTU Exam

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Topics to be covered...

Introduction concepts
Categories of networks
ISP(Internet Service Provider)
The OSI reference model
TCP/IP protocol suite
TCP/IP vs OSI
Network devices and components
Network topology design
Transmission media
Classification Of Transmission Media
Switching techniques and multiplexing
Happy Ending!

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Introduction concepts

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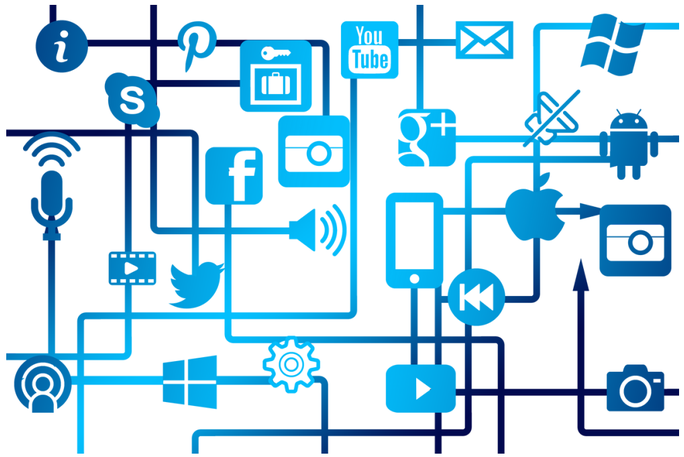
Introduction

What is Network?

- A network consists of two or more Computer that are linked in order to share resources, exchange files or communication.
- The Computer on a network may be linked through cables, telephone lines, radio waves, satellites, infrared light beams.



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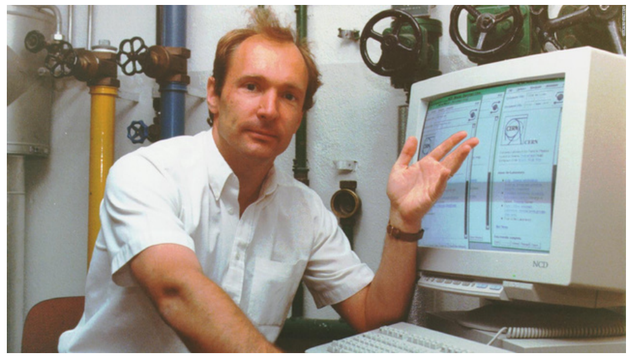
Introduction

What is Internet?

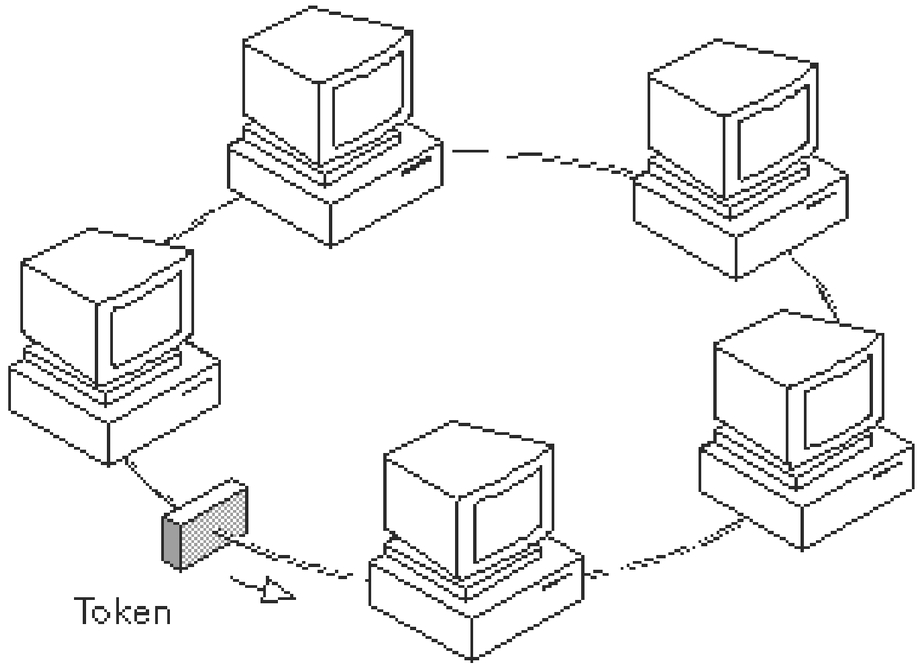
Collection of Networks is Internet. The first workable prototype of the Internet came in the late 1960s with the creation of ARPANET which was designed for US defence . Later Sir Tim Berners Lee introduced WWW concept and starts web.

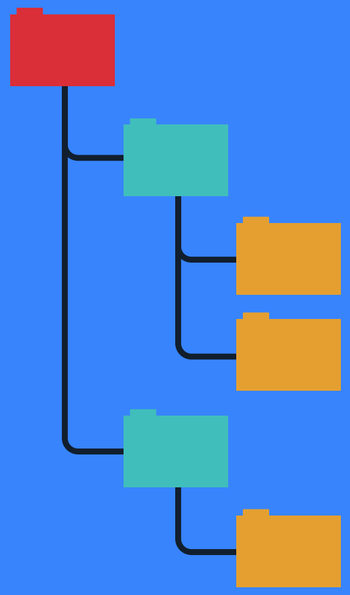


Introduction

Message or Token

- Token used for creating connection before the communication.
- Only one token for each token ring network.





Categories of networks

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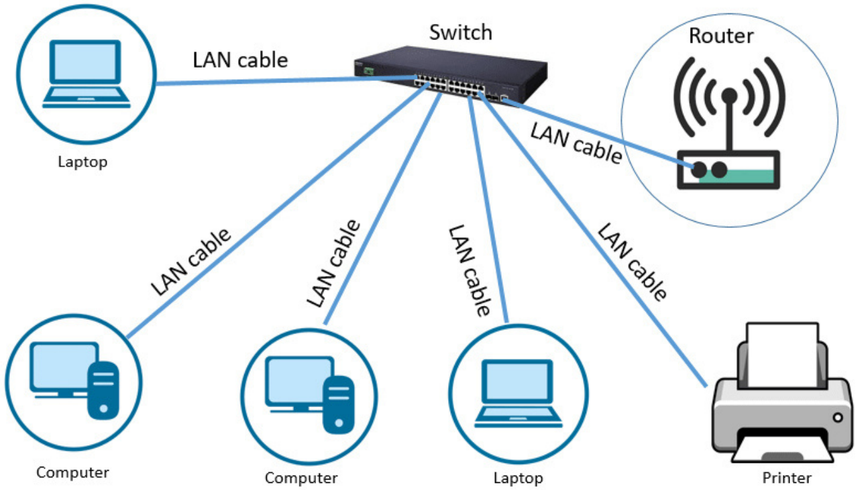
Categories of networks

Basic Types of Networks:

- LAN (Local Area Network)
- WAN (Wide Area Network)
- WLAN (Wireless Local Area Network)
- PAN (Personal Area Network)
- MAN (Metropolitan Area Network)

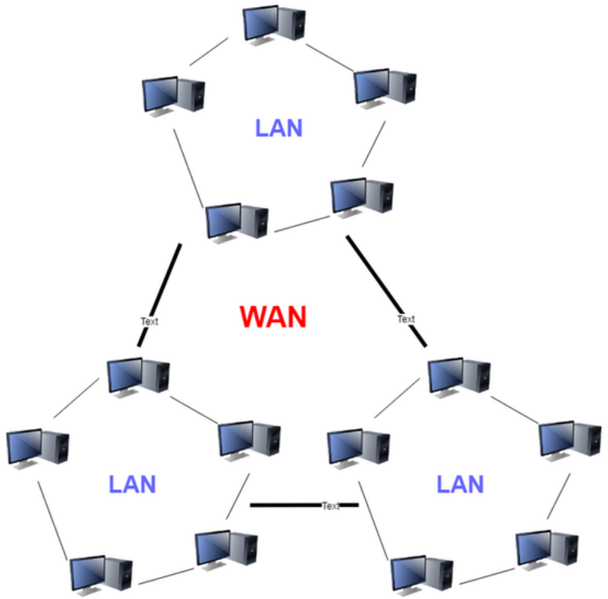
LAN (Local Area Network)

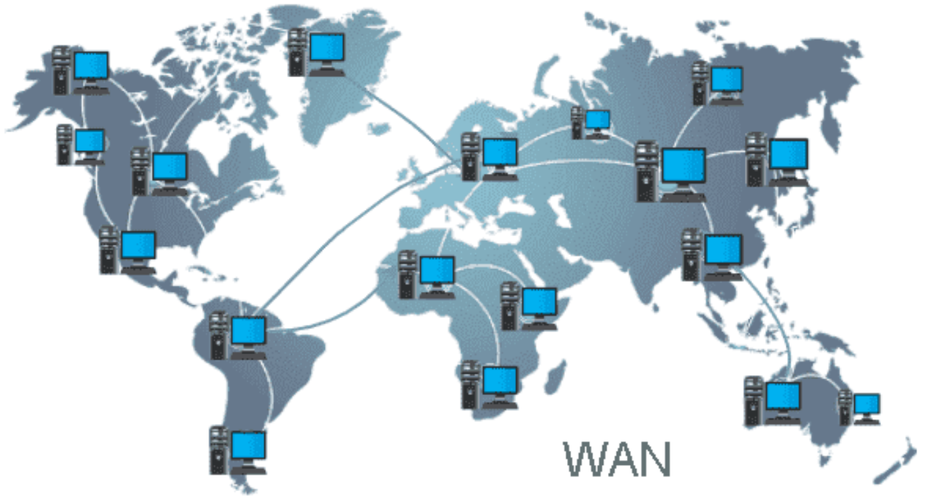
- LAN is the most frequently used network.
- A LAN is a computer network that connects computer together through a common communication path, contained within a limited area.
- The two important technologies involved in this network are Ethernet and Wi-Fi.
- A local area network (LAN) is a collection of devices connected together in one physical location, such as a building, office, or home.



WAN (Wide Area Network)

- WAN connects computers over a large geographical area such as states or countries.
- In its simplest form, a wide-area network (WAN) is a collection of local-area networks (LANs) or other networks that communicate with one another.
- A wide area network (also known as WAN), is a large network of information that is not tied to a single location. WANs can facilitate communication, the sharing of information and much more between devices from around the world through a WAN provider.



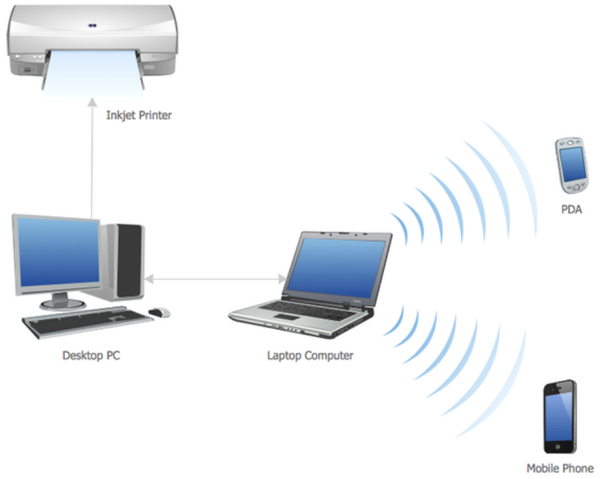


WLAN (Wireless Local Area Network)

- WLAN is a type of Computer Network that acts as a local area network but makes use of wireless network technology like wi-fi.
- WLANs use high-frequency radio waves and often include an access point to the Internet.
- WLAN allows users to move around the coverage area, often a home or small office, while maintaining a network connection.
- A WLAN is sometimes called a local area wireless network (LAWN).

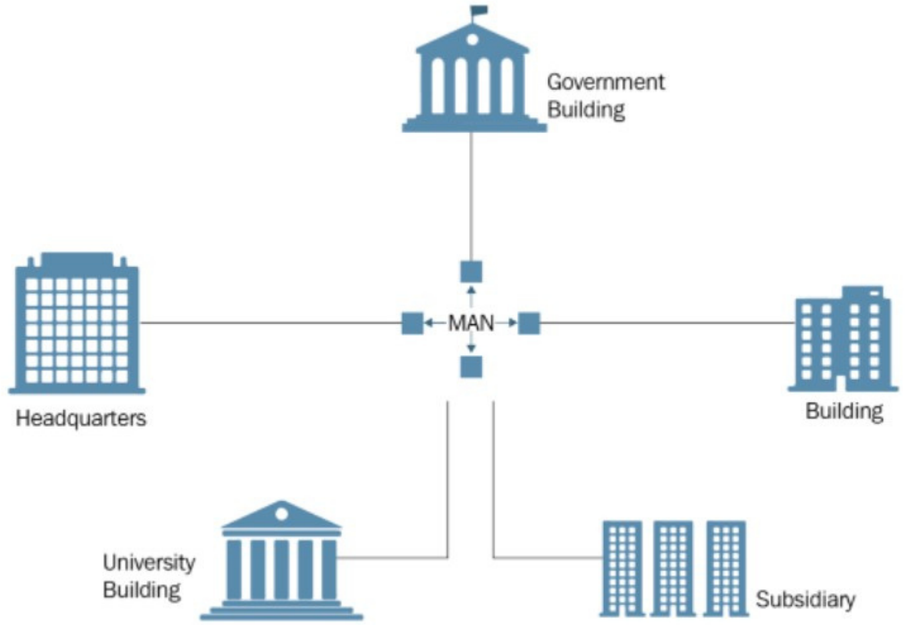
PAN (Personal Area Network)

- A personal area network (PAN) connects electronic devices within a user's immediate area.
- The size of a PAN ranges from a few centimeters to a few meters.
- One of the most common real-world examples of a PAN is the connection between a Bluetooth earpiece and a smartphone.
- PANs can also connect laptops, tablets, printers, keyboards, and other computerized devices.
- PAN network connections can either be wired or wireless.
- Wired connection methods include USB and FireWire; wireless connection methods include Bluetooth (the most common), WiFi.



MAN (Metropolitan Area Network)

- A metropolitan area network (MAN) is a computer network that connects computers within a metropolitan area, which could be a single large city, multiple cities and towns, or any given large area with multiple buildings.
- A MAN is larger than a local area network (LAN) but smaller than a wide area network (WAN).



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ISP
(Internet Service Provider)

ISP (Internet Service Provider)

- The term Internet service provider (ISP) refers to a company that provides access to the Internet to both personal and business customers.
- ISPs make it possible for their customers to surf the web, shop online, conduct business, and connect with family and friends—all for a fee.
- ISPs may also provide other services including email services, domain registration, web hosting, and browser packages.

ISP (Internet Service Provider)

- **Tier 1 ISPs:** These ISPs have the most global reach and own enough physical network lines to carry most traffic on their own.

- **Tier 2 ISPs:** These ISPs have regional or national reach and are service providers that connect tier 1 and tier 3 ISPs. Tier 2 networks focus on consumer and commercial customers.

- **Tier 3 ISPs:** These ISPs connect customers to the internet using another ISP's network. Tier 3 ISPs use and pay higher-tier ISPs for access to internet services. They focus on providing internet access to local businesses and consumer markets.

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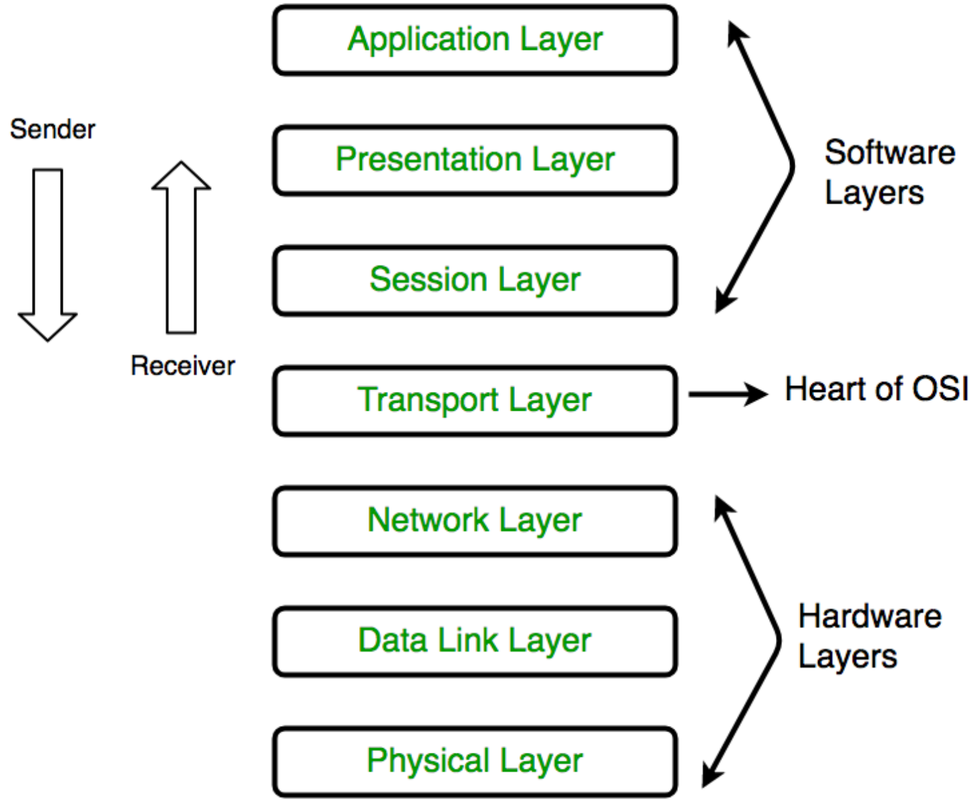
The OSI reference model

The OSI reference model



The OSI reference model

- OSI stands for Open System Interconnection is a reference model that describes how information from a software application in one computer moves through a physical medium to the software application in another computer.
- OSI consists of seven layers, and each layer performs a particular network function.
- OSI model was developed by the International Organization for Standardization (ISO) in 1984, and it is now considered as an architectural model for the inter-computer communications.
- OSI model divides the whole task into seven smaller and manageable tasks. Each layer is assigned a particular task.
- Each layer is self-contained, so that task assigned to each layer can be performed independently.

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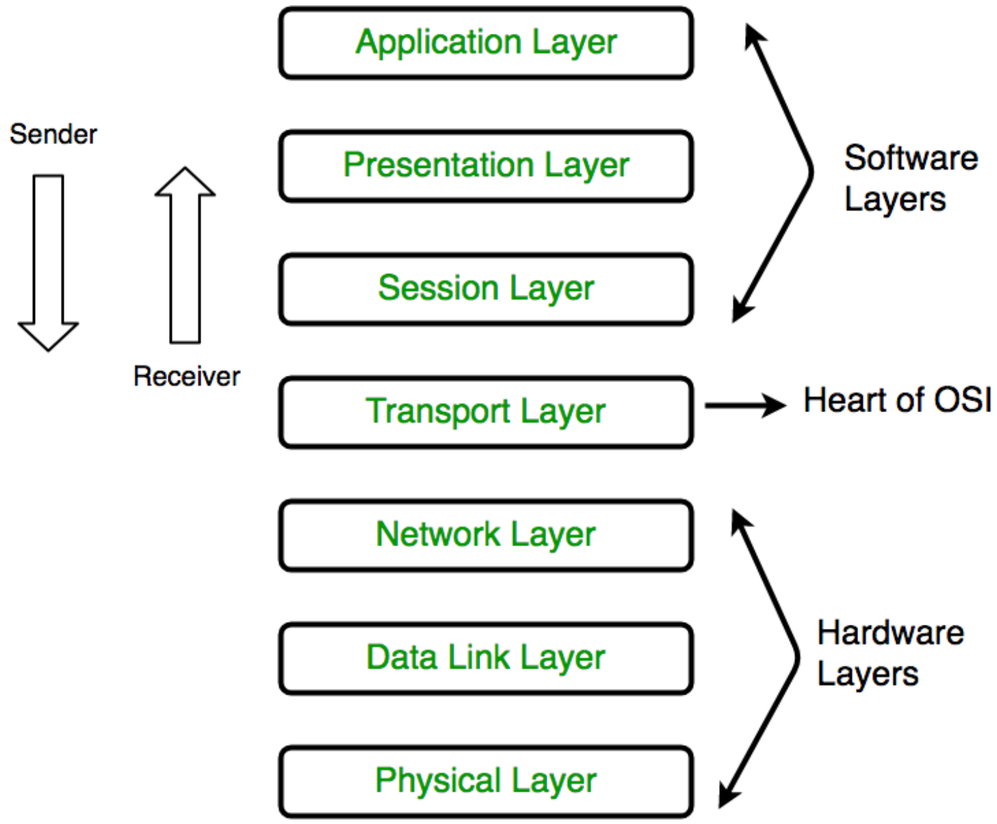
The OSI reference model



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The OSI reference model

1. **Physical Layer:** Bit by Bit Transfer, Ethernet.

2. **Data-Link Layer:** Used for error free transfer of data frames, Node to Node delivery.

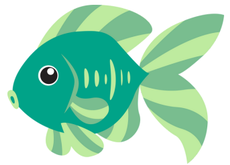
3. **Network Layer:** Responsible for moving the packets from source to the destination, IPv4/6.

4. **Transport Layer:** Heat of OSI, Segmentation, TCP/UDP, Error Control.

5. **Session Layer:** Dialog control, Synchronization.

6. **Presentation Layer:** Encryption/Decryption, Compression, Translation, Syntax and Semantic.

7. **Application Layer:** Provide service to the user, HTTP, TELNET, FTP, DNS.



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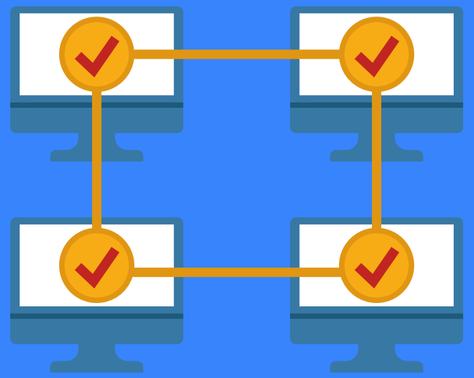
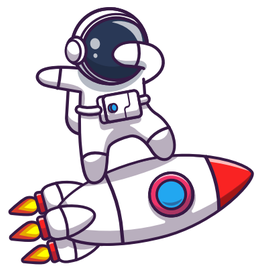
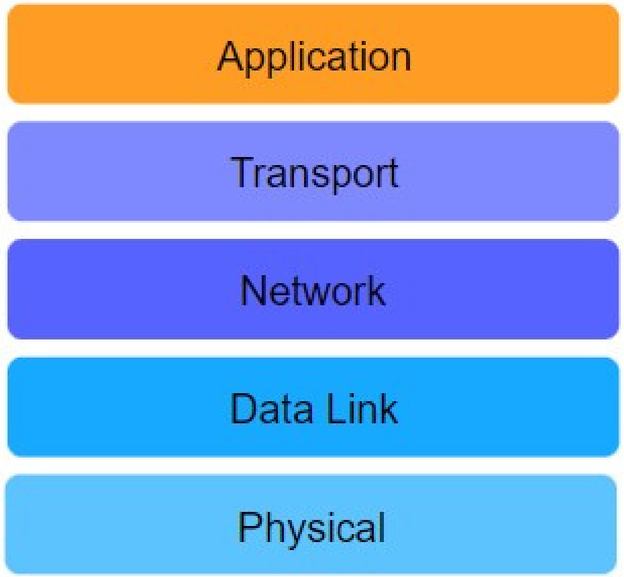


TCP/IP protocol suite

TCP/IP protocol suite

- The TCP/IP Model, also known as the Internet protocol suite, was developed in 1989.
- Its development was funded by Advanced Research Projects Agency (ARPA).
- This model is primarily based upon the most protocols of the Internet, namely the Internet Protocol (IP) and the Transmission Control Protocol (TCP).
- It consists of 5 layers.





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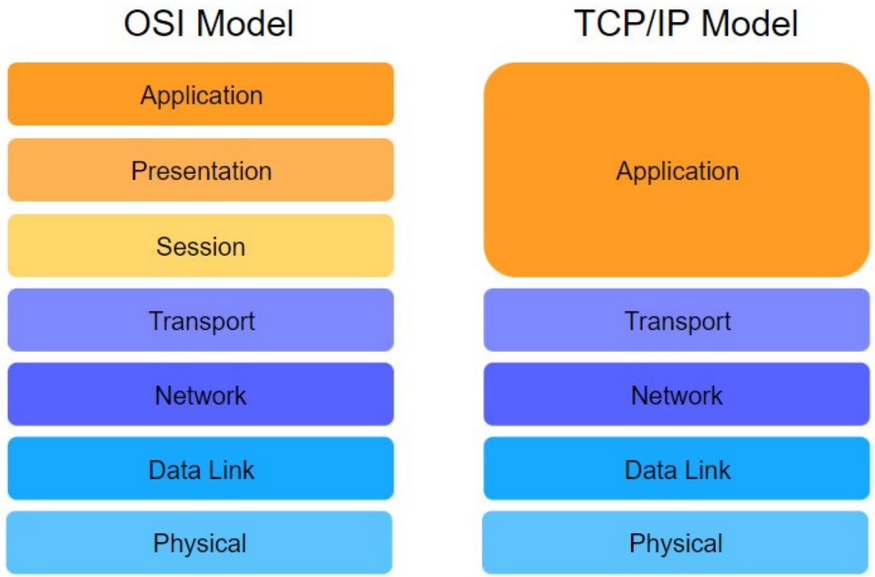
TCP/IP protocol suite



TCP/IP MODEL
Application Layer
Transport Layer
Internet Layer
Network Access Layer

OSI MODEL
Application Layer
Presentation Layer
Session Layer
Transport Layer
Network Layer
Data Link Layer
Physical Layer

1. Network Access Layer

- A network layer is the lowest layer of the TCP/IP model.
- This layer corresponds to the combination of Data Link Layer and Physical Layer of the OSI model.
- It looks out for hardware addressing and the protocols present in this layer allows for the physical transmission of data.
- It defines how the data should be sent physically through the network.
- The protocols used by this layer are ethernet, token ring, FDDI, X.25, frame relay.

2. Internet Layer

- An internet layer is the second layer of the TCP/IP model.
- An internet layer is also known as the network layer.
- The main responsibility of the internet layer is to send the packets from any network, and they arrive at the destination irrespective of the route they take.

Following are the protocols used in this layer are:

1. IP (Internet Protocol):

- It is responsible for delivering packets from the source host to the destination host by looking at the IP addresses in the packet headers.
- IP has 2 versions: IPv4 & IPv6

2. ARP (Address Resolution Protocol):

- Used to convert an IP Address into a physical address.
- A host wishing to claim a physical address broadcasting ARP request onto the TCP/IP network.

2. Internet Layer

3. RARP (Reverse Address Resolution Protocol):

- It allows a host a discover its internet address when its physical address is known.

4. ICMP (Internet Control Message Protocol):

- It is a mechanism used by the hosts or routers to send notifications regarding datagram problems back to the sender.
- **ICMP Test:** ICMP Test is used to test whether the destination is reachable or not.
- **ICMP Reply:** ICMP Reply is used to check whether the destination device is responding or not.

5. IGMP (Internet Group Message Protocol):

- IGMP is a protocol that allows several devices to share one IP address so they can all receive the same data. IGMP is a network layer protocol used to set up multicasting on networks that use the Internet Protocol version 4 (IPv4).

3. Transport Layer

It is responsible for end-to-end communication and error-free delivery of data.

1. Transmission Control Protocol (TCP):

- Connection oriented.
- It provides a full transport layer services to applications.
- TCP is a reliable protocol as it detects the error and retransmits the damaged frames.
- At the sending end, TCP divides the whole message into smaller units known as segment, and each segment contains a sequence number which is required for reordering the frames to form an original message.
- At the receiving end, TCP collects all the segments and reorders them based on sequence numbers.

3. Transport Layer

It is responsible for end-to-end communication and error-free delivery of data.

2. User Datagram Protocol (UDP):

- Not Connection oriented.
- It is an unreliable protocol as it discovers the errors but not specify the error.
- UDP discovers the error, and ICMP protocol reports the error to the sender that user datagram has been damaged.

UDP consists of the following fields:

- **Source port address**
- **Destination port address**
- **Total length:** It defines the total number of bytes of the user datagram in bytes.
- **Checksum:** The checksum is a 16-bit field used in error detection.
- UDP does not specify which packet is lost. UDP contains only checksum; it does not contain any ID of a data segment.

4. Application Layer

- An application layer is the topmost layer in the TCP/IP model.
- This layer allows the user to interact with the application.
- **Protocols are:**
  - HTTP
  - SMTP
  - FTP
  - TELNET
  - DNS

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TCP/IP vs OSI

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CONNECT, LEARN AND GROW

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TCP/IP vs OSI

- It is developed by ARPANET (Advanced Research Project Agency Network).
- TCP refers to Transmission Control Protocol.
- TCP/IP has four layers.
- A layer of the TCP/IP model is both connection-oriented and connectionless.
- It is defined before the advent of the internet.
- The minimum header size is 20 bytes.

- It is developed by ISO (International Organization for Standardization)
- OSI refers to Open Systems Interconnection.
- OSI layers have seven layers.
- In the OSI model, the transport layer is only connection-oriented.
- It is defined after the advent of the Internet.
- The minimum size of the OSI header is 5 bytes.

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Network devices and components

Network devices and components

- Repeater
- Hub
- Bridge
- Switch
- Routers
- Gateway
- NIC Card
- Modem
- Access Point
- Server

Network devices and components

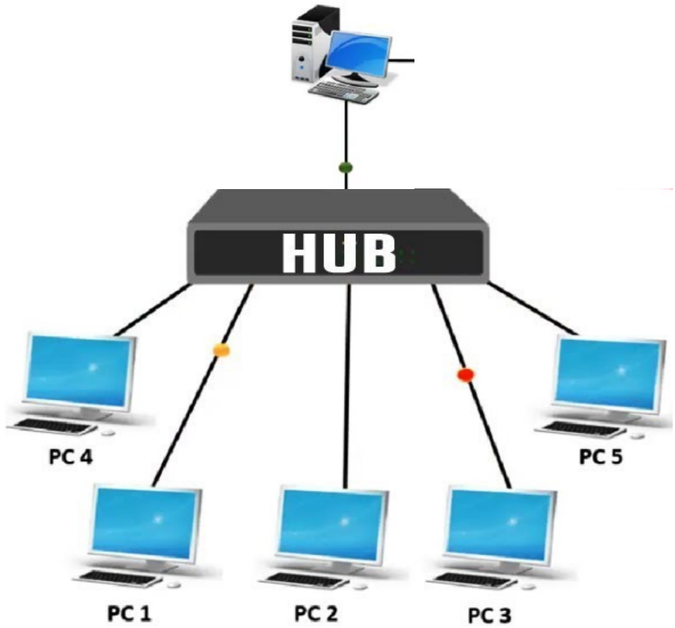
Repeater:

- Its job is to regenerate the signal over the same network before the signal becomes too week.
- Repeater do not amplify the signal.
- When the signal becomes week, they copy the signal bit-by-bit and regenerate it at the original strength.

Network devices and components

HUB:

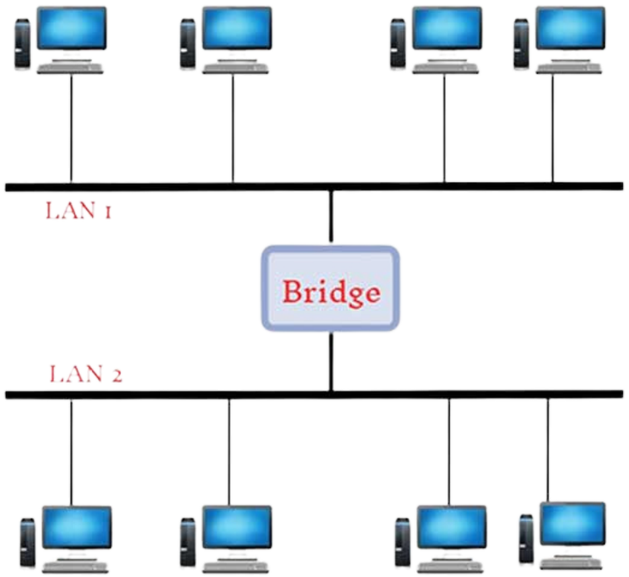
- A Hub is basically a multiport repeater.
- Which is used to connect multiple devices in a network.
- Hubs can't filter data.
- **For Input:** One hole
- **For Output:** Multiple hole



Network devices and components

Bridge:

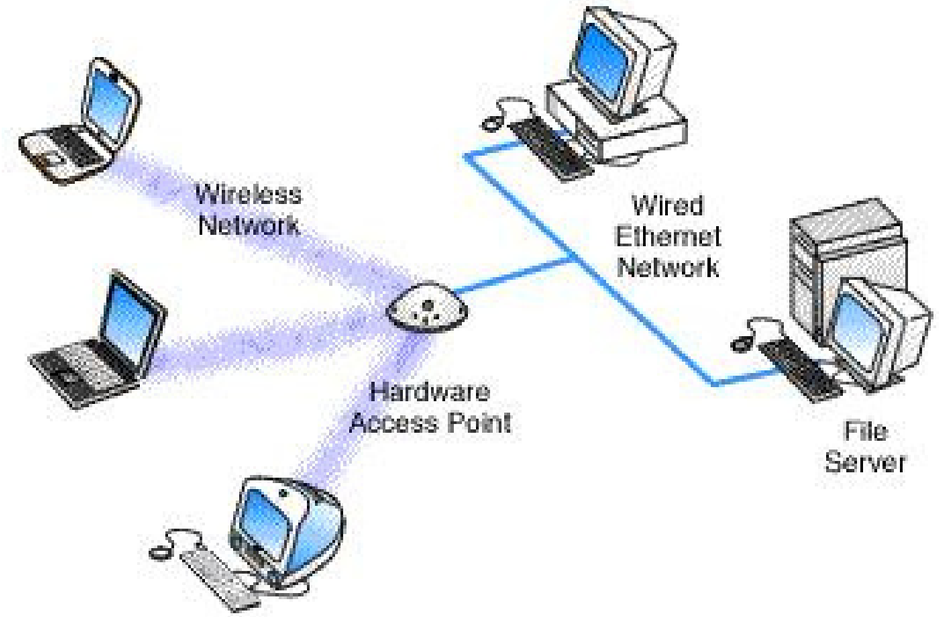
- A Bridge is a repeater with add on the functionality of filtering content by reading the Mac Address of source and destination.
- It is also used for interconnecting two LANs working on the same protocol.
- It has a single input and single output port.



Network devices and components

Access Point:

- An access point is a device that creates a wireless local area network.
- Usually in a office or large building an Access Point connects to a wired router, switch or hub via a Ethernet cable and device that allows other Wi-Fi devices to connect to a wired network.



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Network topology design

Network topology design

Topology:

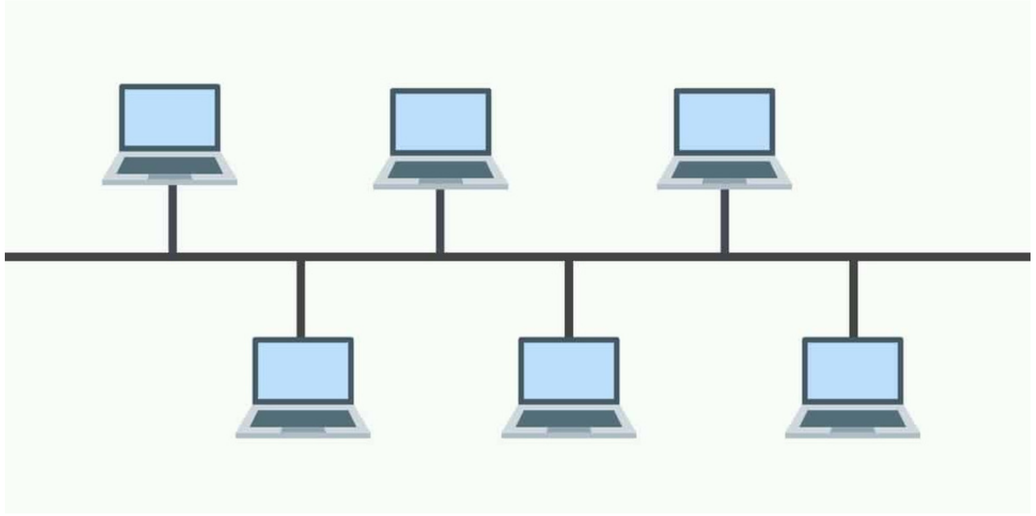
- It is a method of creating a network structure.

Topology Types:

1. Bus Topology
2. Star Topology
3. Ring Topology
4. Star Topology
5. Mesh Topology
6. Tree Topology
7. Hybrid Topology
8. Daisy chain Topology

1. Bus(Line) Topology

- All the stations are connected through a single cable known as a backbone cable.
- When a node wants to send a message over the network, it puts a message over the network. All the stations available in the network will receive the message whether it has been addressed or not.
- The backbone cable is considered as a "single lane" through which the message is broadcast to all the stations.



1. Bus(Line) Topology

Advantages:

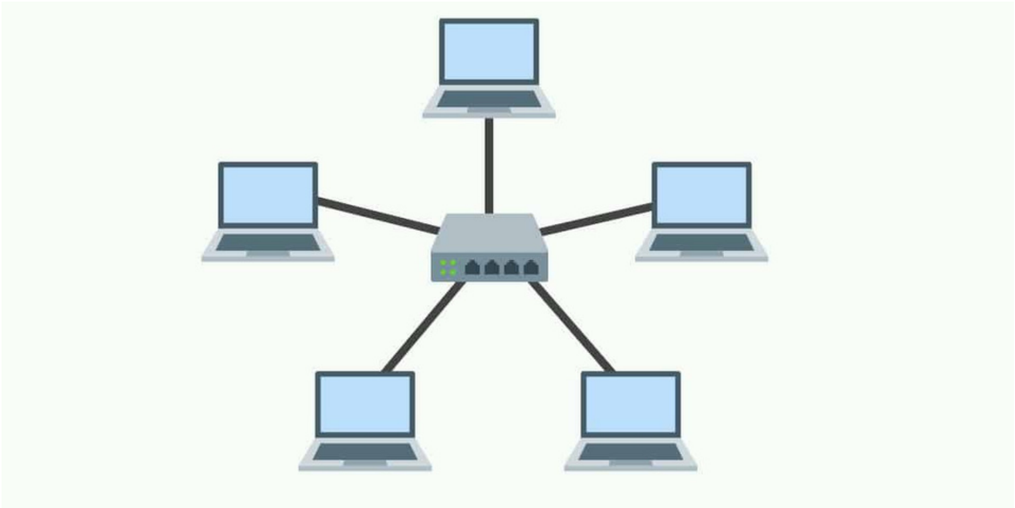
- **Low-cost cable:** The initial cost of installation is low.
- **Moderate data speeds:** Coaxial or twisted pair cables are mainly used that support upto 10 Mbps.
- **Limited failure:** A failure in one node will not have any effect on other nodes.

Disadvantages:

- **Difficult troubleshooting:** If any fault occurs in the cable, then it would disrupt the communication for all the nodes.
- **Signal interference:** If two nodes send the messages simultaneously, then the signals of both the nodes collide with each other.
- **Reconfiguration difficult:** Adding new devices to the network would slow down the network.

2. Star Topology

- Star topology is an arrangement of the network in which every node is connected to the central hub, switch.
- The central computer is known as a server, and the peripheral devices attached to the server are known as clients.
- Coaxial cable or RJ-45 cables are used to connect the computers.
- Star topology is the most popular topology in network implementation.



2. Star Topology

Advantages:

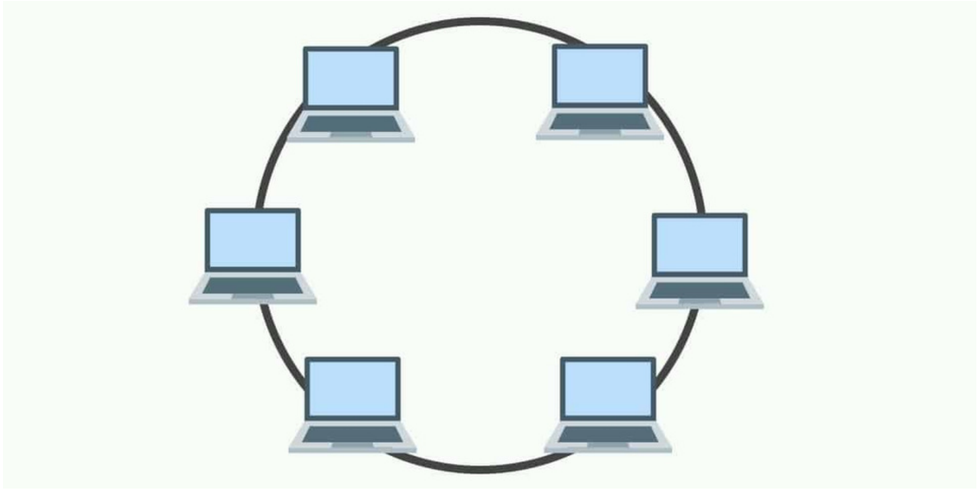
- **Efficient troubleshooting**
- **Limited failure:** As each station is connected to the central hub with its own cable, therefore failure in one cable will not affect the entire network.
- **Easily expandable:** It is easily expandable as new stations can be added to the open ports on the hub
- **High data speeds:** It supports a bandwidth of approx 100Mbps. Ethernet 100BaseT is one of the most popular Star topology networks.

Disadvantages:

- **A Central point of failure**
- **More expensive cabling**

3. Ring Topology

- Ring topology is like a bus topology, but with connected ends.
- The node that receives the message from the previous computer will retransmit to the next node.
- The data flows in a single loop continuously known as an endless loop.
- It has no terminated ends.
- The data in a ring topology flow in a clockwise direction.
- Every device has exactly two neighbours for communication process.



3. Ring Topology

Advantages:

- **Network Management**
- **Cost:** Twisted pair cabling is inexpensive and easily available. Therefore, the installation cost is very low.
- **Speed :** Data packet travel at a greater speed.

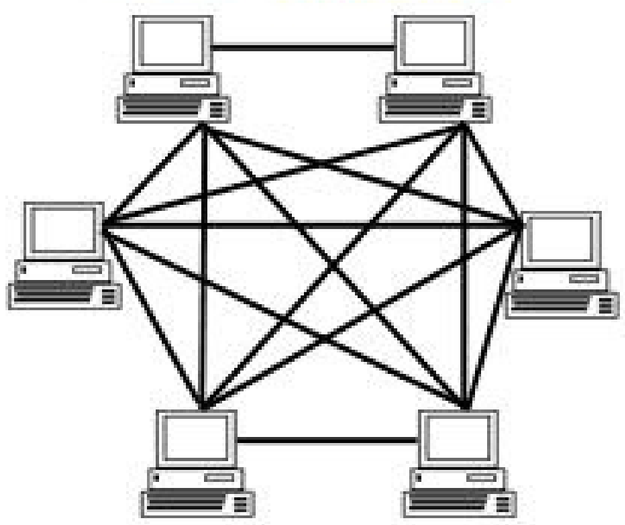
Disadvantages:

- **Difficult troubleshooting**
- **Failure:** The breakdown in one station leads to the failure of the overall network.
- **Reconfiguration difficult:** Adding new devices to the network would slow down the network.

4. Mesh Topology

- Computers are interconnected with each other through various redundant connections.
- There are multiple paths from one computer to another computer.
- It does not contain the switch, hub or any central computer which acts as a central point of communication.
- The Internet is an example of the mesh topology.
- Mesh topology can be formed by using the formula:

Number of cables = (n*(n-1))/2;



4. Mesh Topology

Advantages:

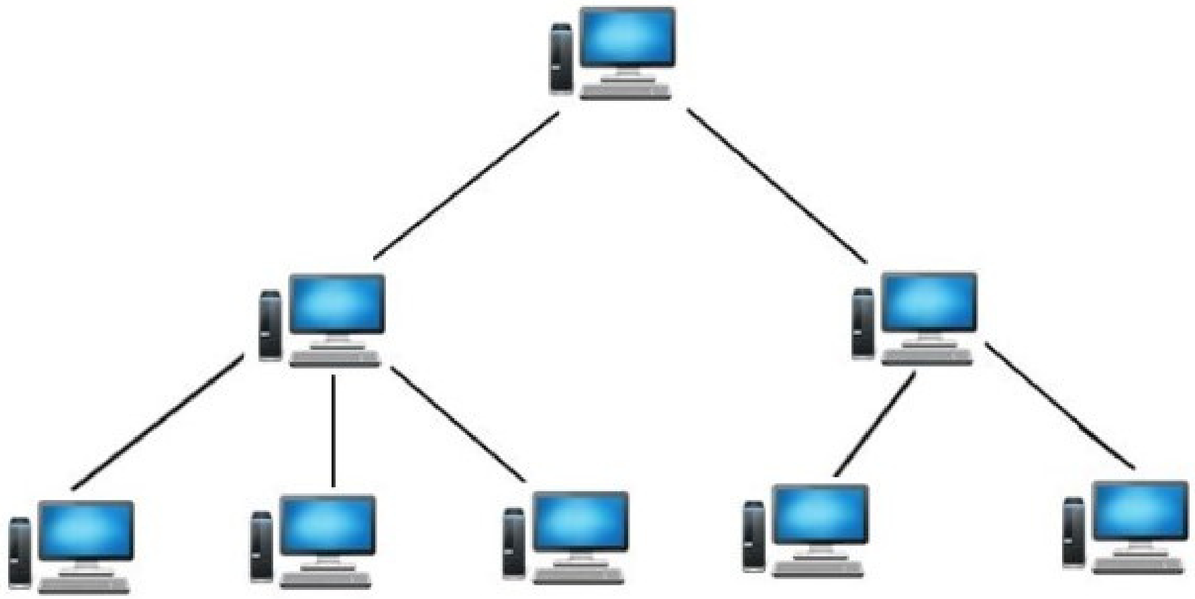
- **Reliable:** The mesh topology networks are very reliable as if any link breakdown will not affect the communication between connected computers.
- **Fast Communication**
- **Easier Reconfiguration:**

Disadvantages:

- **Cost**
- **Management**
- **Efficiency:** In this topology, redundant connections are high that reduces the efficiency of the network.

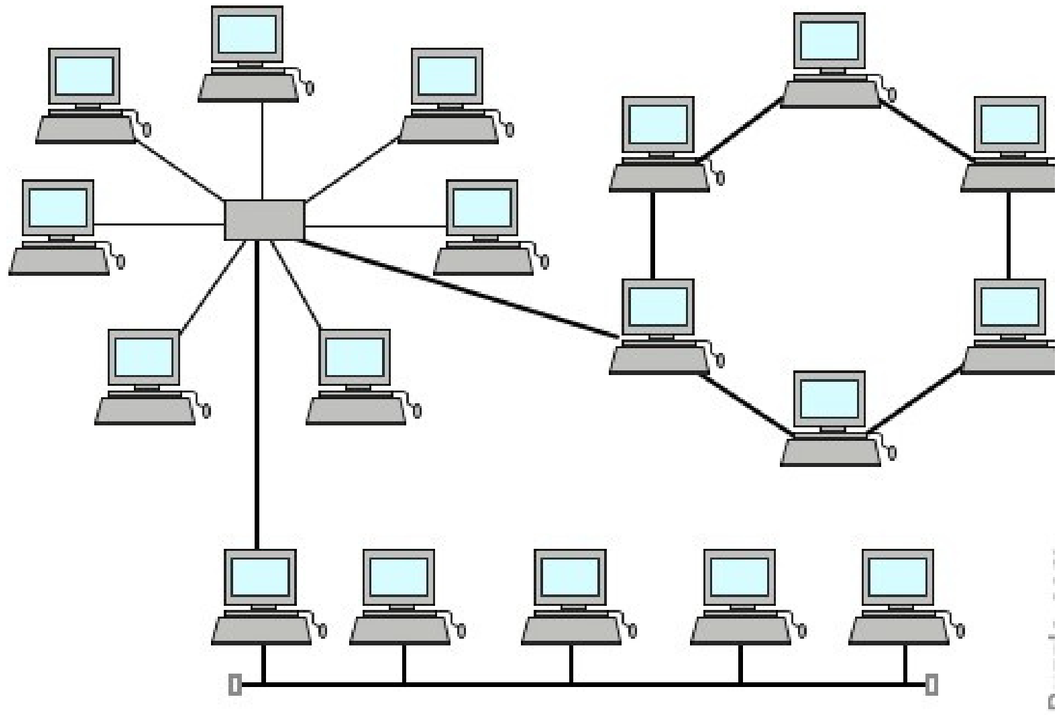
5. Tree Topology

- Bus + Star Topology.
- If central hub gets fails then entire system fails.



6. Hybrid Topology

- Combination of different topologies.
- Star + Ring + Bus



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Transmission media

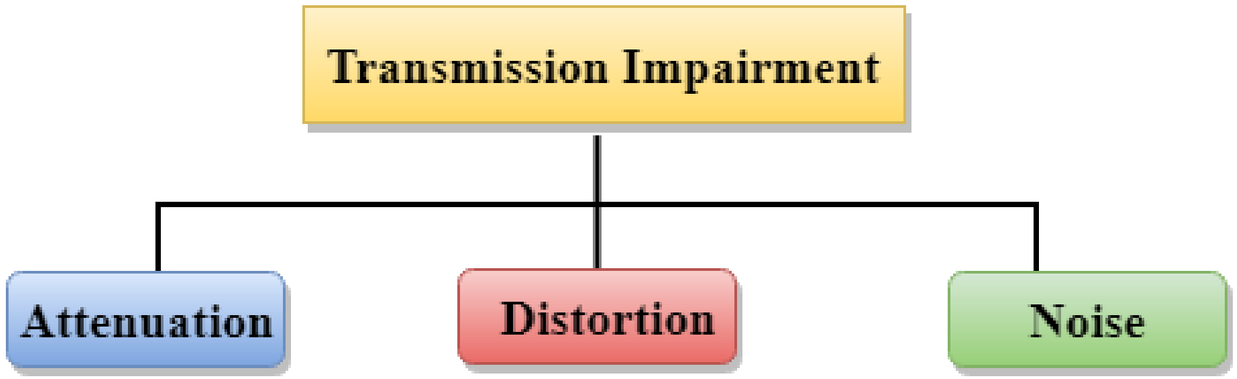
Transmission media

- Transmission media is a communication channel that carries the information from the sender to the receiver. Data is transmitted through the electromagnetic signals.
- The main functionality of the transmission media is to carry the information in the form of bits through **LAN**(Local Area Network).
- The electrical signals can be sent through the copper wire, fibre optics, atmosphere, water, and vacuum.
- In a copper-based network, the bits in the form of electrical signals.
- In a fibre based network, the bits in the form of light pulses.
- The transmission media is available in the lowest layer of the OSI reference model, i.e., **Physical layer**.

Transmission media

Some factors need to be considered for designing the transmission media:

- **Bandwidth:** The greater the bandwidth of a medium, the higher the data transmission rate of a signal.
- **Transmission impairment:** The quality of the signals will get destroyed due to transmission impairment.
- **Interference:** Process of disrupting a signal when it travels over a communication medium on the addition of some unwanted signal.



Transmission media

- **Attenuation:**
  - Loss of energy, Strength of the signal decreases with increasing the distance.

- **Distortion:**
  - Occurs when there is a change in the shape of the signal.
  - This type of distortion is examined from different signals having different frequencies. Each frequency component has its own propagation speed, so they reach at a different time which leads to the delay distortion.

- **Noise:**
  - When data is travelled over a transmission medium, some unwanted signal is added to it which creates the noise.

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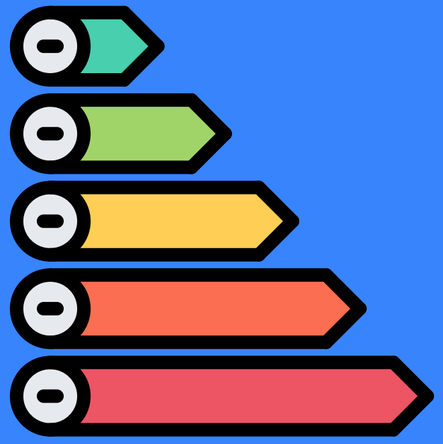
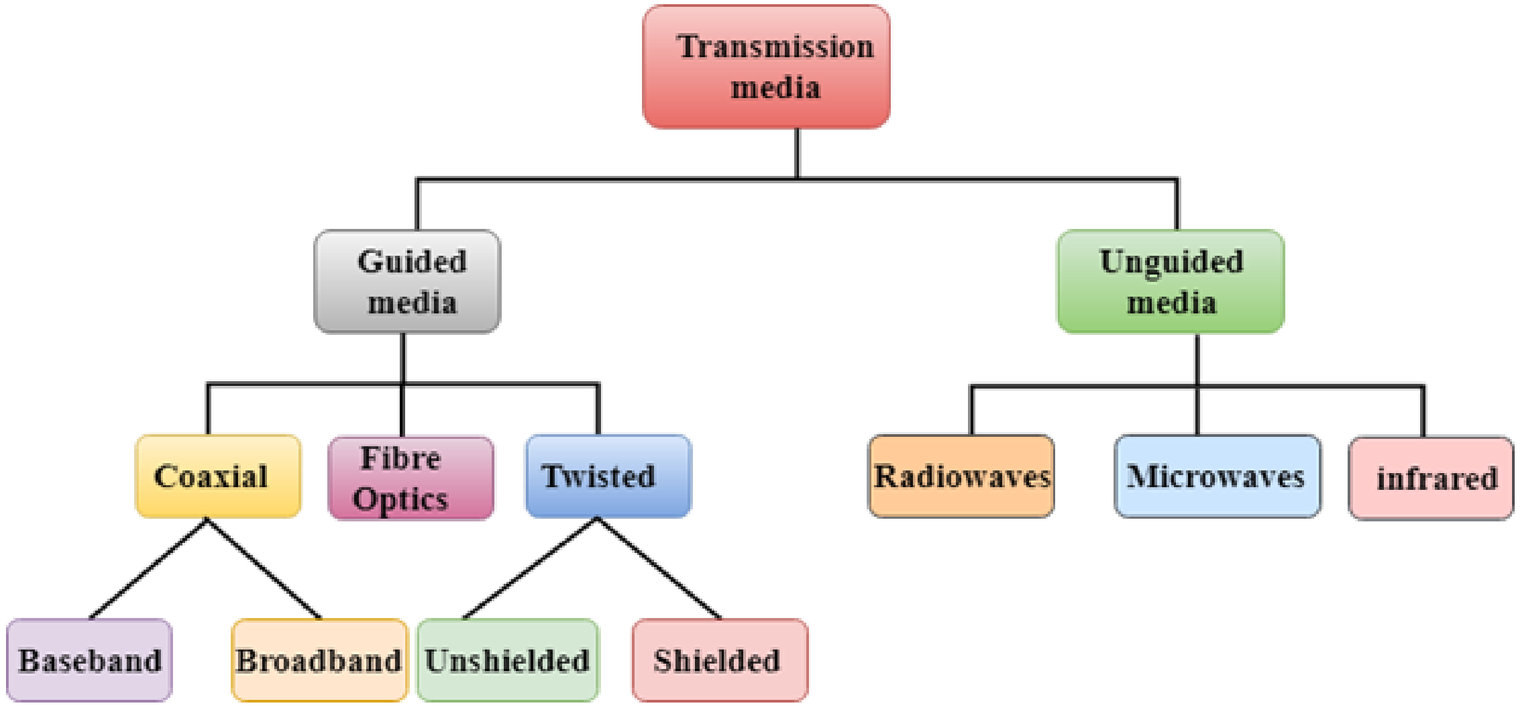


Classification Of Transmission Media

Classification Of Transmission Media



Classification Of Transmission Media

Guided Media(Wired Media)

- It is defined as the physical medium through which the signals are transmitted.

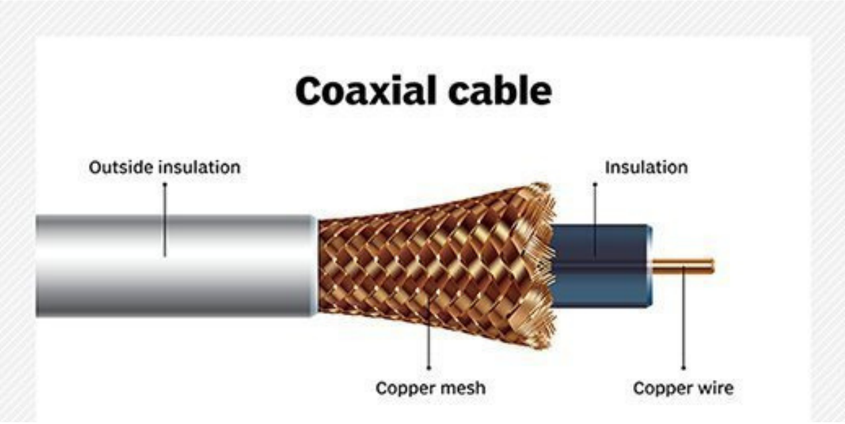
1. Twisted pair cable:

- Consists of two insulated copper wires twisted together.
- Transmit data in the form form of an electric signal.
- The frequency range for twisted pair cable is from 0 to 3.5KHz.
- **Example:** Telephone lines, Local area networks etc.

Classification Of Transmission Media

2. Coaxial Cable:

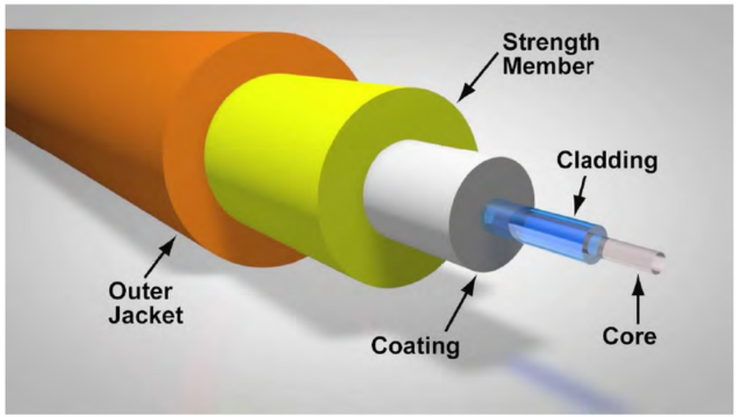
- Very commonly used transmission media, for example, TV wire is usually a coaxial cable.
- It has a higher frequency as compared to Twisted pair cable.
- The inner conductor of the coaxial cable is made up of copper, and the outer conductor is made up of copper mesh. The middle core is made up of non-conductive cover that separates the inner conductor from the outer conductor.
- The middle core is responsible for the data transferring whereas the copper mesh prevents from the **EMI**(Electromagnetic interference).
- **Example:** Distribution of cable television signals.



Classification Of Transmission Media

3. Optical Fiber:

- Uses electrical signals for communication.
- Used to send the data by pulses of light.
- The plastic coating protects the optical fibers from heat, cold, electromagnetic interference from other types of wiring.
- Faster data transmission than copper wires.
- **Example:** Providing Gigabit internet speeds to users.



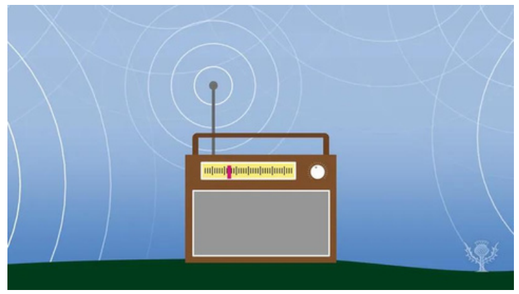
Classification Of Transmission Media

UnGuided Media(Unwired Media)

- Transmits the electromagnetic waves without using any physical medium. Therefore it is also known as wireless transmission.

1. Radio waves:

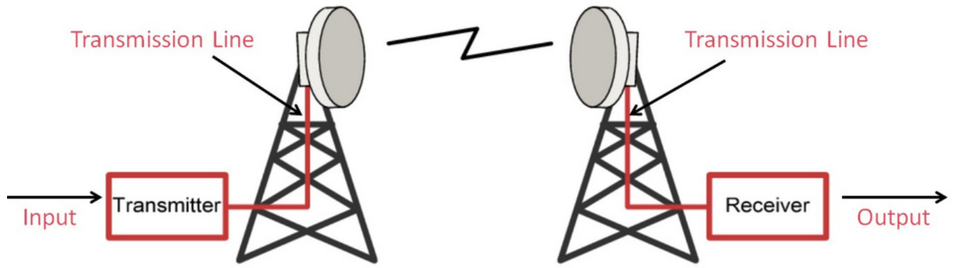
- Radio waves are the electromagnetic waves that are transmitted in all the directions of free space.
- Radio waves are omnidirectional, i.e., the signals are propagated in all the directions.
- The range in frequencies of radio waves is from 3Khz to 1 khz.
- Example: **FM radio.**



Classification Of Transmission Media

2. Microwaves:

- **Frequency range:** The frequency range of terrestrial microwave is from 4-6 GHz to 21-23 GHz.
- **Bandwidth:** It supports the bandwidth from 1 to 10 Mbps.
- **Short distance:** It is inexpensive for short distance.
- **Long distance:** It is expensive as it requires a higher tower for a longer distance.
- **Attenuation:** Attenuation means loss of signal. It is affected by environmental conditions and antenna size.



Classification Of Transmission Media

3. Infrared:

- An infrared transmission is a wireless technology used for communication over short ranges.
- The frequency of the infrared in the range from 300 GHz to 400 THz.
- It is used for short-range communication such as data transfer between two cell phones, TV remote operation.

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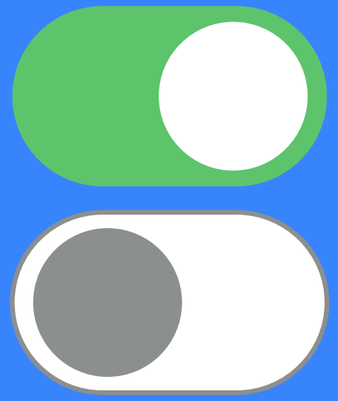

Switching techniques

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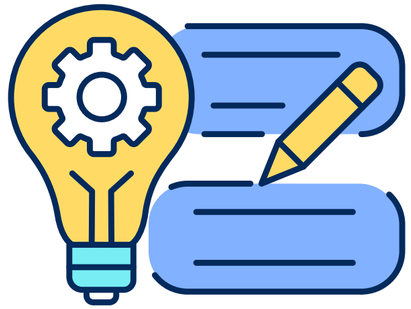
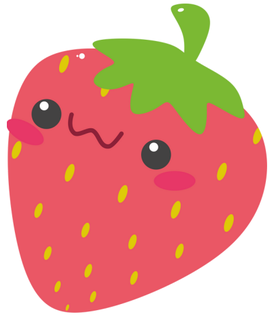
Switching techniques

In large networks, there can be multiple paths from sender to receiver. The switching technique will decide the best route for data transmission.

There are 3 common switching techniques:

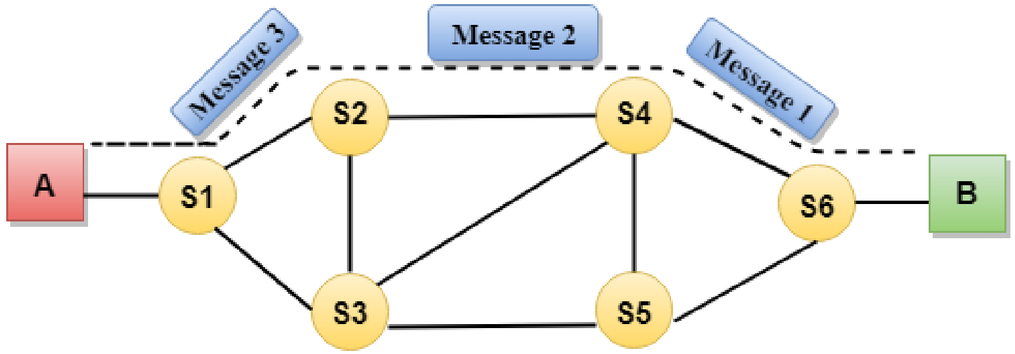
1. Circuit Switching
2. Packet Switching
3. Message Switching





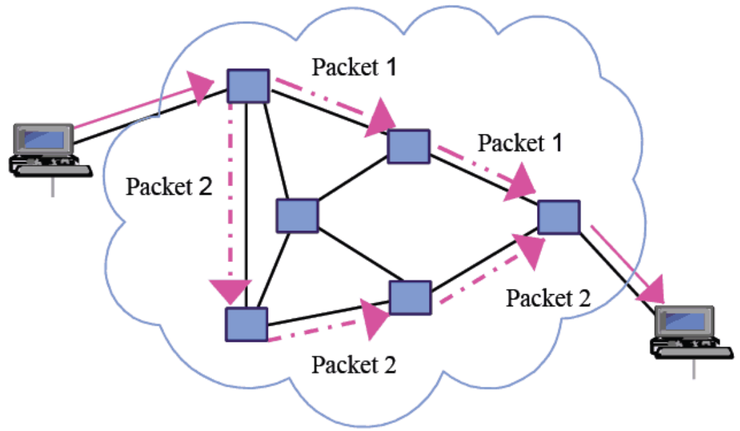
1. Circuit Switching

- Circuit switching is a switching technique that establishes a dedicated path between sender and receiver.
- Once the connection is established then the dedicated path will remain to exist until the connection is terminated.
- When any user wants to send the data, voice, video, a request signal is sent to the receiver then the receiver sends back the acknowledgment to ensure the availability of the dedicated path. After receiving the acknowledgment, dedicated path transfers the data.
- Circuit switching is used in public telephone network. It is used for voice transmission.
- Fixed data can be transferred at a time in circuit switching technology.



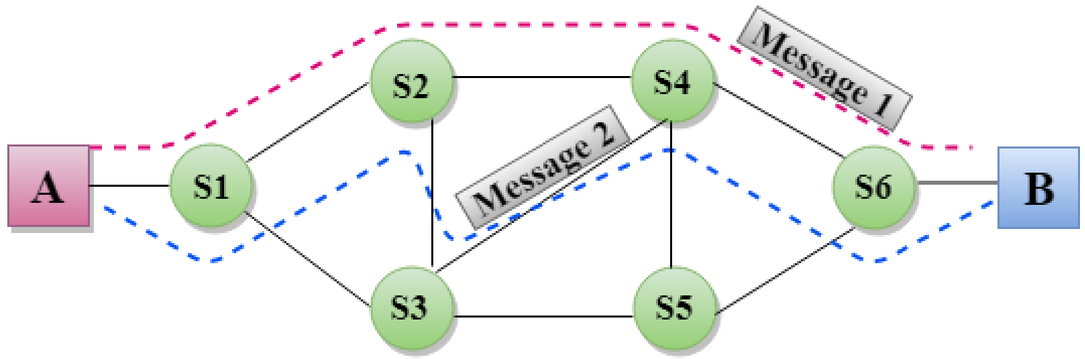
2. Packet Switching

- Message is sent in one go, but it is divided into smaller pieces, and they are sent individually.
- The message splits into smaller pieces known as packets and packets are given a unique number to identify their order at the receiving end.
- Every packet contains some information in its headers such as source address, destination address and sequence number.
- Packets will travel across the network, taking the shortest path as possible.
- If any packet is missing or corrupted, then the message will be sent to resend the message.
- If the correct order of the packets is reached, then the acknowledgment message will be sent.



3. Message Switching

- 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.
- 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.**



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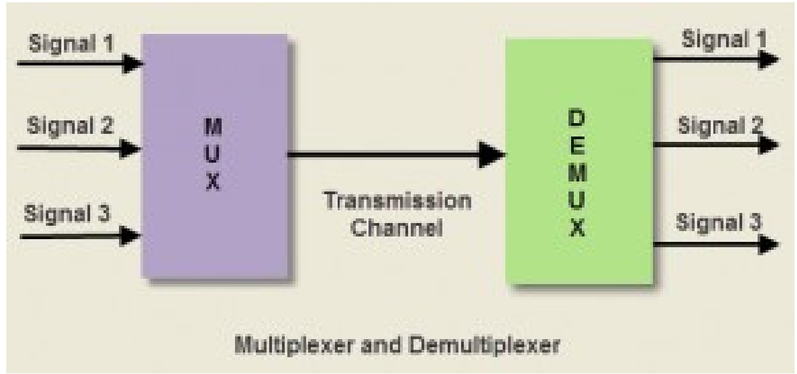
Multiplexing

Multiplexing

- Multiplexing is a technique used to combine and send the multiple data streams over a single medium.
- The process of combining the data streams is known as multiplexing and hardware used for multiplexing is known as a multiplexer.
- Demultiplexing is achieved by using a device called Demultiplexer (DEMUX) available at the receiving end.

Why Multiplexing?

- When multiple signals share the common medium, there is a possibility of collision. Multiplexing concept is used to avoid such collision.
- Transmission services are very expensive.



Multiplexer and Demultiplexer

Happy Ending!

Congratulations!