CHAPTER 1

Introduction to Computer Network

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Computer Network

- A network is a set of devices (often referred to as nodes) connected by communication links. A node can be a computer, printer, or any other device capable of sending and/or receiving data generated by other nodes on the network

There may be 2 kinds of devices in the network

1. Host:- also called end system. (desktop, laptop, cell phone)
2. Connecting Devices:- connects to other devices(modem, router, switch)

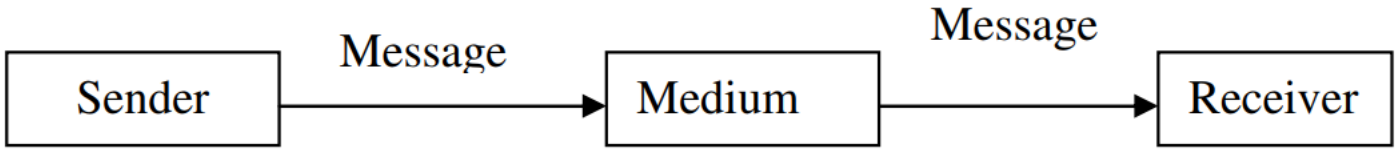
1.1 Why Computer Network

- To enable multiple users to share a single hardware device like a printer or scanner
- To enable file sharing across the network
- To facilitate communication via email, video conferencing, instant messaging, etc.
- To allow for the sharing of software or operating programs on remote systems
- To make information easier to access and maintain among network users.

Basic Communication System:

Basic Concepts: Components of data communication:

Communication: To convey any message, data or thoughts from one place to another place using some medium is termed as a communication.



Application of Computer Network

1. Business Application
   a) Resource Sharing
   b) High Reliability
   c) Saving Money
2. Home Application
   a) Access to Remote Information(WWW)
   b) Person to Person communication
   c) Interactive Entertainment(Live TV, Games)

Advantages and Disadvantages

- Allows File Sharing/ Resource Sharing
- Inexpensive System
- Flexible to be Used
- Increase in Storage Capacity of the Software

- **Security Difficulties(Hacking)**
- **Presence of Computer Viruses and Other Malwares**

Network Models

- There are several classification for networks

  Classification based on Scale(size)

  Classification based on Topology

  Classification based on Architecture

1.2 Network Models(Based on Scale)

1. PAN (Personal Area Network)
2. LAN (Local Area Network)
3. CAN (Campus Area Network)
4. MAN (Metropolitan Area Network)
5. DAN (Desert Area Network)
6. CAN* (Country Area Network)
7. WAN (Wide Area Network)
8. GAN (Global Area Network)

1. Personal Area Network (PAN)

- Used for data transmission among devices such as computers, mobile phones, PDA etc.
- Within few meters like 10 meters only
- Medium : Bluetooth, Infrared
- Only very few connections will be available

2.Local Area Network (LAN)

- It is a computer network that spans a relatively small area
- Most LANs are confined to a single building or group of buildings
- One LAN can be connected to other LANs over any distance via telephone lines and radio waves (WAN)
- Medium: optical fibers, coaxial cables, twisted pair, wireless.
- Low latency (except in high traffic periods).
- High speed networks (0.2 Mb/sec to 1Gb/sec).
- Speeds adequate for most distributed systems

3. Campus Area Network (CAN)

- Computer network that links the buildings and consists of two or more local area networks (LANs) within the limited geographical area
- It can be the college campus, enterprise campus, office buildings, military base, industrial complex
- CAN is one of the type of MAN (Metropolitan Area Network) on the area smaller than MAN
- The Campus networks usually use the LAN technologies, such as Ethernet, Token Ring, Fibber Distributed Data Interface (FDDI), Fast Ethernet, Gigabit Ethernet, Asynchronous Transfer Mode (ATM)

4.Metropolitan Area Network(MAN)

- Metropolitan Area Network, are data networks designed for a town In terms of geographic breadth
- MANs are larger than local area networks (LANs), but smaller than wide-area networks s)
- MANs are usually characterized by very high-speed connections using fiber optical cable or other digital media

Features:

- Generally covers towns and cities (50 kms)
- Medium: optical fibers, cables.
- Data rates adequate for distributed computing applications.
- Access to a MAN is usually trough a network provider who sells the service to the users
- MAN often acts as a **high speed network** to allow sharing of regional resources

5.Country Area Network(CAN)

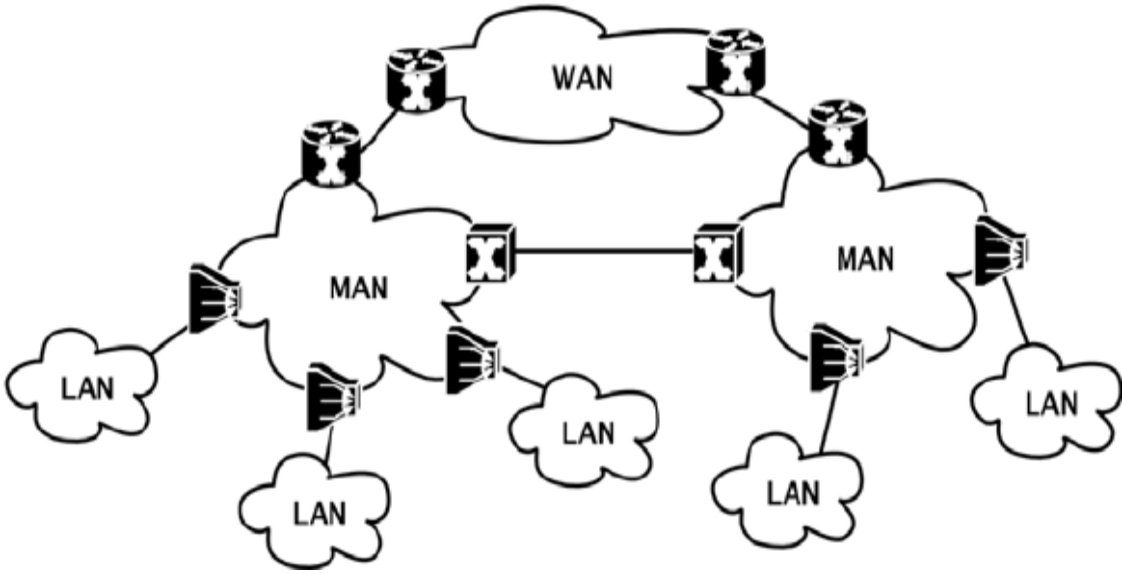
- It's wide area network which is limited to country
- It consist of more than one MAN
- It may be extended up to thousands kms
- It is more public network owned by some public organization or governments
- Example: In Nepal NTC have CAN*

6.Wide Area Network (WAN)

- A computer network that spans a relatively large geographical area
- WAN consists of two or more local-area networks (LANs).
- Computers connected to a wide-area network are often connected through public networks, such as the telephone system
- They can also be connected through leased lines or satellites
- The largest WAN in existence is the **Internet**

7. Global Area Network (GAN)

- A global area network (GAN) refers to a network composed of different interconnected networks that cover an unlimited geographical area.
- The term is loosely synonymous with Internet, which is considered a global area network.



1.3 Network Models Based on Topology

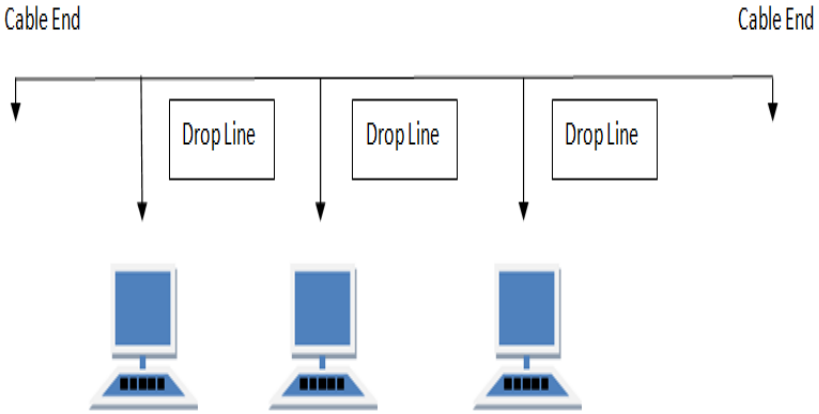
Topology :- Physical inter connection between different node

Node:- End device in computer network(Laptop, mobile, desktop, PDA, tablet etc.)

Various Topologies are:-

- Bus
- Ring
- Star
- Mesh
- Tree
- Hybrid

1.BUS Topology

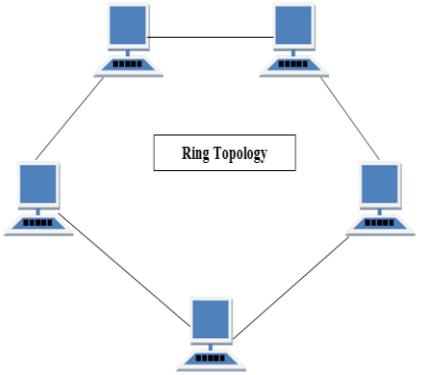


- **Features of Bus Topology**
  - It transmits data only in one direction.
  - Every device is connected to a single cable
- **Advantages of Bus Topology**
  - It is cost effective.
  - Cable required is least compared to other network topology.
  - Used in small networks.

- **Disadvantages of Bus Topology**
  - Cables fails then whole network fails.
  - If network traffic is heavy or nodes are more the performance of the network decreases.

2.RING Topology

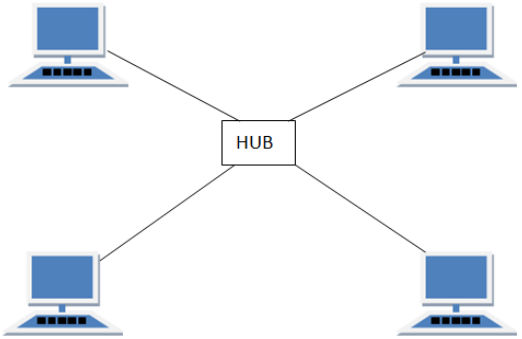
- **Features of Ring Topology**
  - A number of repeaters are used for Ring topology with large number of nodes, because if someone wants to send some data to the last node in the ring topology with 100 nodes, then the data will have to pass through 99 nodes to reach the 100th node. Hence to prevent data loss repeaters are used in the network.
  - The transmission is unidirectional, but it can be made bidirectional by having 2 connections between each Network Node, it is called **Dual Ring Topology**.



- **Advantages of Ring Topology**
  - Transmitting network is not affected by high traffic or by adding more nodes, as only the nodes having tokens can transmit data.
  - Cheap to install and expand
- **Disadvantages of Ring Topology**
  - Troubleshooting is difficult in ring topology.
  - Adding or deleting the computers disturbs the network activity.
  - Failure of one computer disturbs the whole network.

3.STAR Topology

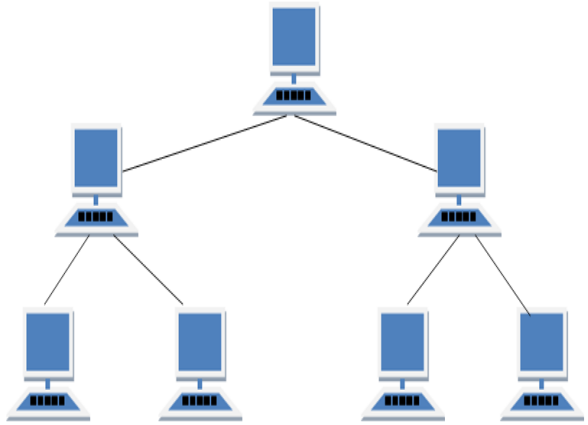
- **Features of Star Topology**
  - Every node has its own dedicated connection to the hub.
  - Hub acts as a repeater for data flow.



- **Advantages of Star**
  - Fast performance with few nodes and low network traffic.
  - Easy to troubleshoot, setup and modify.
  - Only that node is affected which has failed, rest of the nodes can work smoothly.
- **Disadvantages of Star Topology**
  - Cost of installation is high.
  - Expensive to use.
  - If the hub fails then the whole network is stopped because all the nodes depend on the hub.
  - Performance is based on the hub that is it depends on its capacity

5.TREE Topology

- **Features of Tree Topology**
- Ideal if workstations are located in groups.
- Used in Wide Area Network.

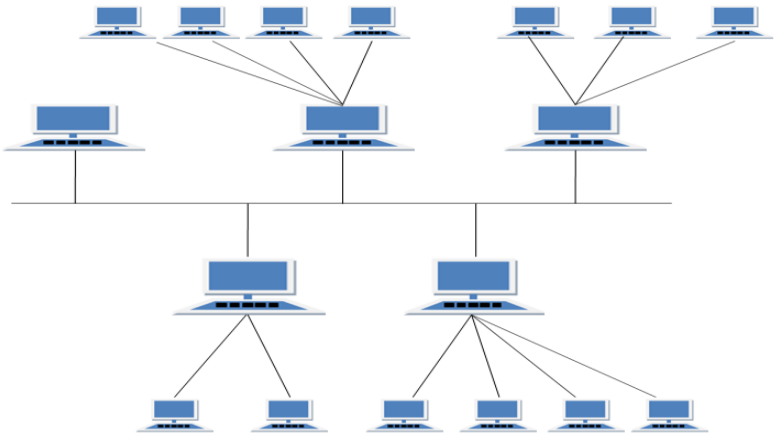


- **Advantages of Tree Topology**
  - Extension of bus and star topologies.
  - Expansion of nodes is possible and easy.
  - Easily managed and maintained.
  - Error detection is easily done.

- **Disadvantages of Tree Topology**
  - Heavily cabled.
  - Costly.
  - If more nodes are added maintenance is difficult.
  - Central hub fails, network fails.

6.HYBRID Topology

- **Features of Hybrid Topology**
  - It is a combination of two or topologies
  - Inherits the advantages and disadvantages of the topologies included



- **Advantages of Hybrid Topology**
  - Reliable as Error detecting and trouble shooting is easy.
  - Effective.
  - Scalable as size can be increased easily.
  - Flexible.
- **Disadvantages of Hybrid Topology**
  - Complex in design.
  - Costly.

1.3 Network Model Based on Architecture or Networking Types

- Network architecture refers to how computers are organized in a network and how tasks are allocated between these computers
- Two of the most widely used types of network architecture are
  1. **Peer-to-Peer(P2P)**
  2. **Client/Server**

1. Peer to Peer (P2P)

Network computers act as equal partners, or peers. Each computer can take on the client function or the server function. Computer A may request for a file from computer B, which then sends the file to Computer A. Computer A acts like the client and Computer B acts like the server. At a later time, Computer A and B may reverse roles.

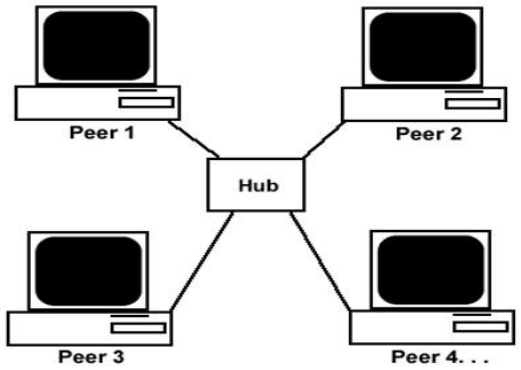
Individual users control their own resources. The users may decide to share certain files with other users. The users may also require passwords before they allow others to access their resources. Since individual users make these decisions, there is no central point of control or administration in the network. When a computer acts as a server, the user of that machine may experience reduced performance as the machine serves the requests made by the other systems.

Advantages:

- Less expensive to implement.
- Doesn't require additional specialized network administration software.
- Doesn't require a dedicated network administrator.

Disadvantages:

- Less secure.
- Doesn't scale well to large networks and administration becomes unmanageable.
- Each must be trained to perform administrative tasks.
- All machines sharing resources negatively impact the performance.



P2P Network

2. Client/Sever

Each client is assigned an account name and password that is verified by an authentication service. The authentication service guards access to the network. With the centralization of user accounts, security, and access control, server based networks simplify the administration of large networks.

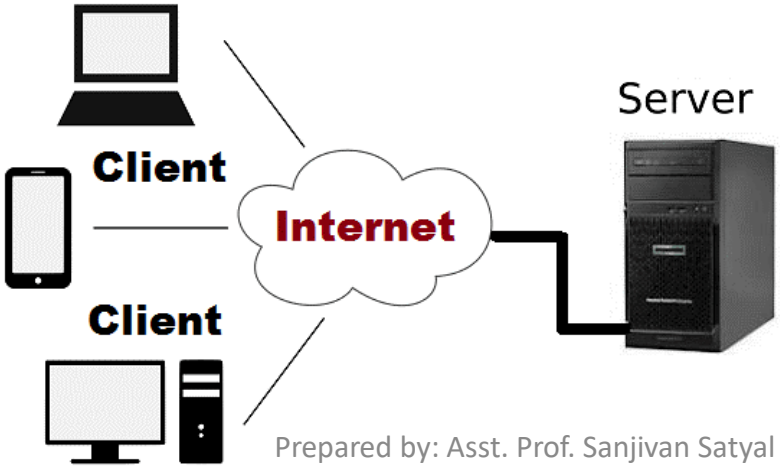
The concentration of network resources such as files, printers and applications on servers also make it easier to back-up and maintain the data. Resource can be located on specialized, dedicated servers for easier access.

Advantages:

- Easier to administer when the network is large.
- All data can be backed up on one central location.
- Provides better security.

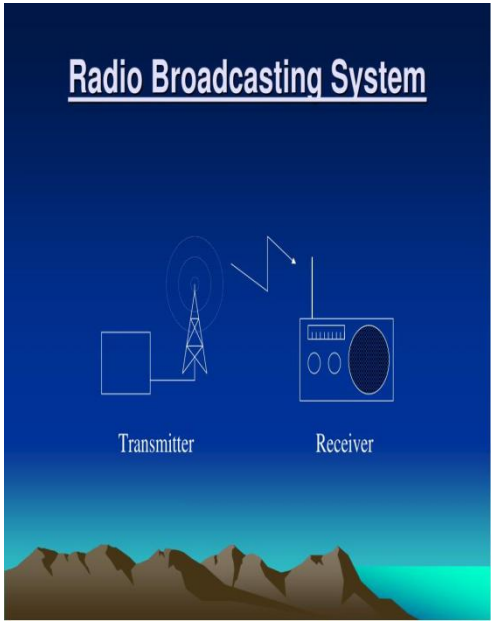
Disadvantages:

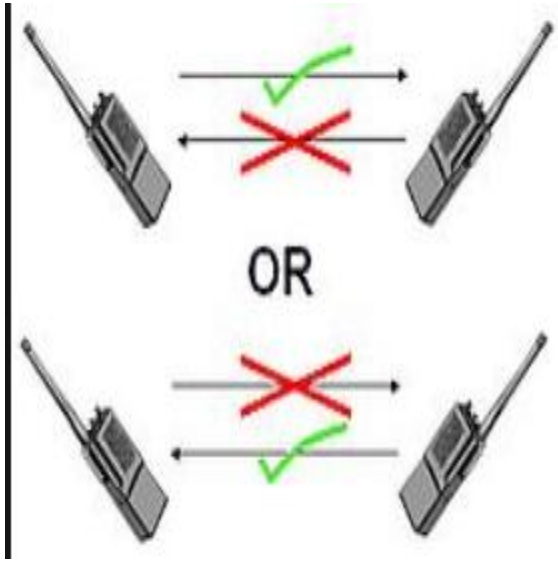
- Require expensive, more powerful hardware for the server machine.
- Has a single point of failure. User data is unavailable when the server is down.
- Requires expensive specialized network administrative and operational software.
- Requires a professional administrator.

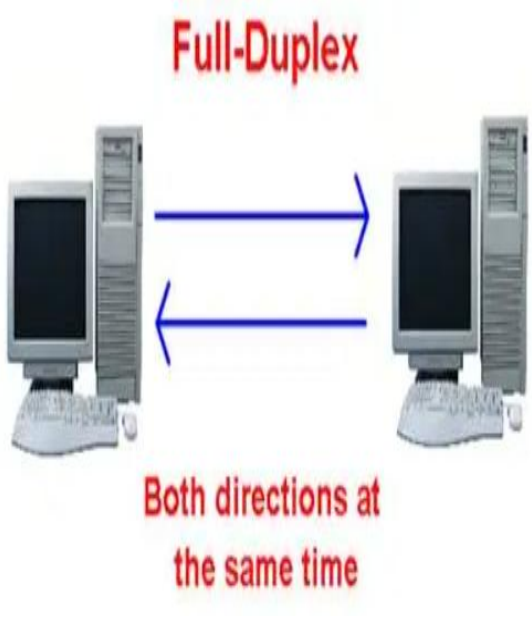


Transmission Mode

1. Simplex Communication
2. Half Duplex
3. Full Duplex







Reference Model

- 2 important model
  - OSI Reference Model
  - TCP/IP Reference Model
  - Also called protocol architecture or layered architecture

Protocol

- Protocols define format, order of msgs sent and received among network entities, and actions taken on msg transmission, receipt

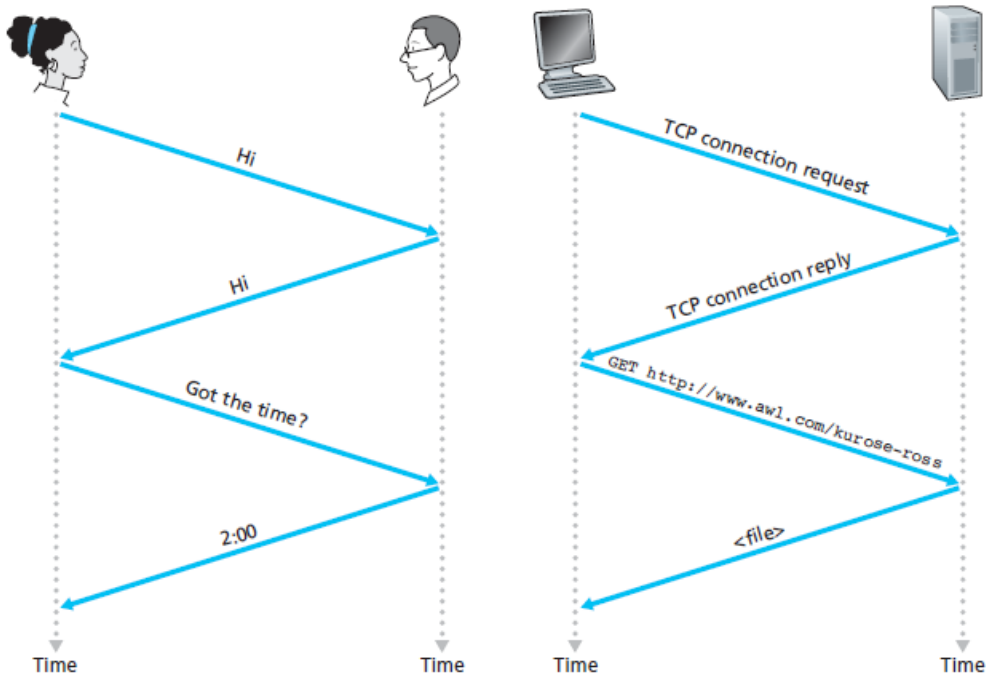


Figure 1.2 ♦ A human protocol and a computer network protocol

Syntax, Semantics and Timing

Syntax

- Structure or format of the data
- Indicates how to read the bits - field delineation
- Syntax should be same in sender and receiver for to communicate

Semantics

- Interprets the meaning of the bits
- Knows which fields define what action
- Interpretation of the syntax should be same

Timing

- When data should be sent and what
- Speed at which data should be sent or speed at which it is being received

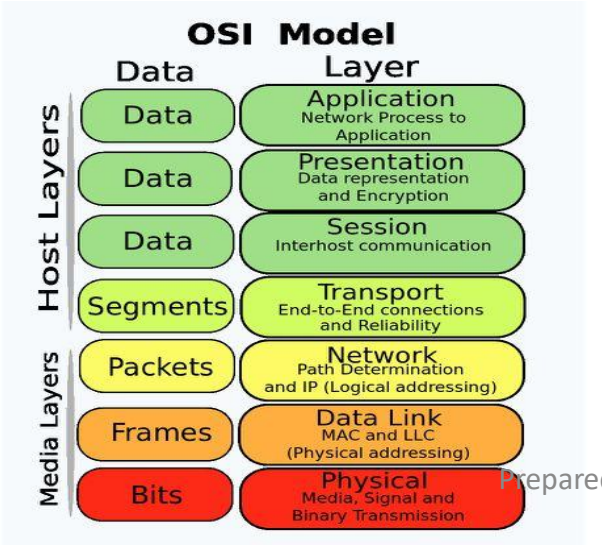
ISO-OSI Reference Model

- ISO- International Organisations for Standard
- OSI- Opens System Interconnections
- Stats developing in late 1970s
- Approved by 1984
- The term “Open” in Open System Interconnections denotes **“to communicate with any 2 systems”**
- There are 7 layers in OSI Reference model
- It is also called OSI layered architecture /OSI Protocol architecture

- The process of breaking up the functions or tasks of networking into layers reduces complexity.
- Each layer provides a service to the layer above it in the protocol specification.
- Each layer communicates with the same layer's software or hardware on other computers.
- The lower 4 layers are concerned with the flow of data from end to end through the network
- The upper Three layers of the OSI model are orientated more toward services to the applications
    - Layer 7 –Application Layer
    - Layer 6 –Presentation Layer
    - Layer 5 –Session Layer
    - Layer 4 –Transport Layer
    - Layer 3 –Network Layer
    - Layer 2 –Data Link Layer
    - Layer 1 –Physical Layer

    # OSI Consider a receiver system hence Layer 1 at bottom

Group	Layer Number	Layer Name	Description
Top Layers	7	Application	Provide user interface to send and receive the data
	6	Presentation	Encrypt, format and compress the data for transmission
	5	Session	Initiate and terminate session with remote system
Bottom Layers	4	Transport	Break data stream in smaller segments and provide reliable and unreliable data delivery
	3	Network	Provide logical addressing
	2	Data Link	Prepare data for transmission
	1	Physical	Move data between devices



- **The Application Layer**

  Top layer of OSI model is application layer. It provides the protocols and services that are required by the network-aware applications to connect with the network. FTP, TFTP, POP3, SMTP and HTTP are the few examples of standards and protocols used in this layer.

- **The Presentation Layer**

  The sixth layer of OSI model is the Presentation layer. Applications running in local system may or may not understand the format that is used to transmit the data across the network. The presentation layer works as the translator in OSI model

  Convert, compress and encrypt are the main functions which presentation layer performs in sending computer while in receiving computer there are reconvert, decompress and decrypt. ASCII, BMP, GIF, JPEG, WAV, AVI, and MPEG are the few examples of standards and protocols which work in this layer.

- **The Session Layer**

  The session layer is the fifth layer of OSI model. The session layer is responsible establishing, managing, and terminating communications between two computers. RPCs and NFS are the examples of the session layer.

  If network connection is available, it establishes a session with remote system. For each individual request, it uses a separate session. This allows multiple applications to send or receive data simultaneously. When data transmission is completed, it terminates the session.

- **The Transport Layer**

  The transport layer is the fourth layer of OSI model. Main functionalities of transport layer are segmentation, data transportation and connection multiplexing. For data transportation, it uses TCP and UDP protocols. TCP is a connection-oriented protocol. It provides reliable data delivery.

  Main difference between a connection-less and connection-oriented protocol is that a connection-oriented protocol provides reliable data delivery. For reliable data delivery, it uses several mechanisms such as, three way handshake process, acknowledgments, sequencing and flow control

- **The Network Layer**

  The third layer of OSI model is the Network Layer. This layer takes data segment from transport layer and adds logical address to it. A logical address has two components; network partition and host partition. Network partition is used to group networking components together while host partition is used to uniquely identity a system on a network. Logical address is known as IP

  address. Once logical address and other related information are added in segment, it becomes packet.

  Defining logical addresses and finding the best path to reach the destination are the main functions of this layer. Router works in this layer. Routing also takes place in this layer. IP, IPX and AppleTalk are the examples of this layer.

- **The Data Link Layer**

  The Data Link Layer is the second layer of OSI model. This layer defines how networking components access the media and what transmission methods they use. This layer has two sub-layers; MAC and LLC.

  Defining physical addresses, finding host in local network, specifying standards and methods to access the media are the primary functions of this layer. Switching takes place in this layer. Switch and Bridge work in this layer. HDLC, PPP and Frame Relay are the examples of this layer.

  ### MAC (Media Access Control)

  This sub layer defines how the data packets are placed in media. It also provides physical addressing. Physical address is known as MAC address. Unlike logical addresses which need to be configured, physical addresses are pre-configured in NIC. MAC address is used to uniquely identify a host in local network.

  ### LLC (Logical Link Control)

  This sub layer identifies the network layer protocol. On sending computer, it encapsulates the information of the Network Layer protocol in LLC header from which the Data Link layer receives the data packet. On receiving computer, it checks the LLC header to get the information about the network layer protocol. This way a data packet is always delivered to the same network layer protocol from which it was sent.

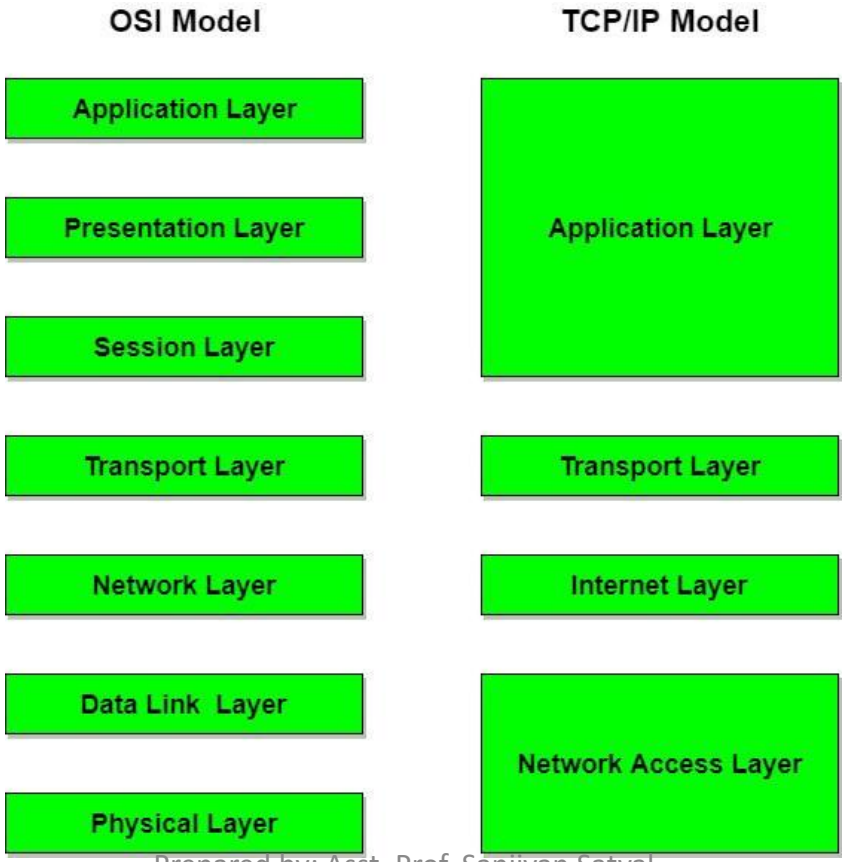
- **The Physical Layer**

  The Physical Layer is the first layer of OSI model. This layer specifies the standards for devices, media and technologies which are used in moving the data across the network such as:-

  - Type of cable used in connecting the devices
  - Patterns of pin used in both sides of cable
  - Type of interface card used in networking device
  - Type of connector used to connect the cable with network interface
  - Encoding of digital signals received from the Data Link layer based on the attached media type such as electrical for copper, light for fiber, or a radio wave for wireless.

TCP/IP Protocol Architecture

- The Internet is built on the foundation of the TCPIIP suite. The dramatic growth of the Internet, and especially the World Wide Web, has cemented the victory of TCPIIP over OSI.
- It is useful to characterize the protocol suite as involving four layers



TCP FOUR LAYERS

Application Layer

- Similar to Application Presentation and Session layer in OSI
- Application programs using the network

Transport Layer (TCP/UDP)

- Similar to Transport Layer in OSI
- Only TCP protocol works
- Management of end-to-end message transmission,
- error detection and error correction

Internetwork Layer (IP)

- Similar to Network layer in OSI
- IP Address
- Handling of packets : routing and congestion

Network Access Layer

- Similar to Datalink and physical layer in OSI
- Management of cost effective and reliable data delivery,
- access to physical networks
- Physical Media

TCP/IP	OSI
Implementation of OSI model	Reference model
Model around which Internet is developed	This is a theoretical model
Has only 4 layers	Has 7 layers
Considered more reliable	Considered a reference tool
Protocols are not strictly defined	Stricter boundaries for the protocols
Horizontal approach	Vertical approach
Combines the session and presentation layer in the application layer	Has separate session and presentation layer
Protocols were developed first and then the model was developed	Model was developed before the development of protocols
Supports only connectionless communication in the network layer	Supports connectionless and connection-oriented communication in the network layer
Protocol dependent standard	Protocol independent standard

Connectionless and Connection Oriented Network Services

Connection oriented

- There is a sequence of operation to be followed by the user of connection oriented system
  - Connectionless is established
  - Information is sent
  - Connection is released

In connection oriented service we have to establish a connection before starting the communication. When connection is established, we send the message or the information and then we release the connection.

Connection oriented service is more reliable than connectionless service. We can send the message in connection oriented service if there is an error at the receivers end. Example of connection oriented is TCP (Transmission Control Protocol)

Connectionless Services

•It is similar to the postal services, as it carries the full address where the message (letter) is to be carried.

•Each message is routed independently from source to destination.

• The order of message sent can be different from the order received. In connectionless the data is transferred in one direction from source to destination without checking that destination is still there or not or if it prepared to accept the message. Authentication is not needed in this.

•Example of Connectionless service is UDP (User Datagram Protocol) protocol

Difference: Connection oriented and Connectionless service

1. In connection oriented service authentication is needed, while connectionless service does not need any authentication.
2. Connection oriented protocol makes a connection and checks whether message is received or not and sends again if an error occurs, while connectionless service protocol does not guarantees a message delivery.
3. Connection oriented service is more reliable than connectionless service.
4. Connection oriented service interface is stream based and connectionless is message based.

Thank you