CHALAPATHI Institute of Technology

UNIT-I
Computer Networks

Introduction

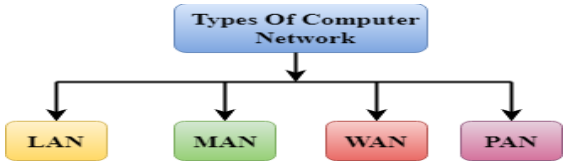
1. Define Computer Network? Need of computer Network?

A Group of computers which are communicated to each other for the purpose of sharing their resources is Called computer network. These computers can exchange information with each other through the Communication channels like copper wire, fiber optics, microwaves, infrared, and communication satellites can also be used.

Need of computer Networking

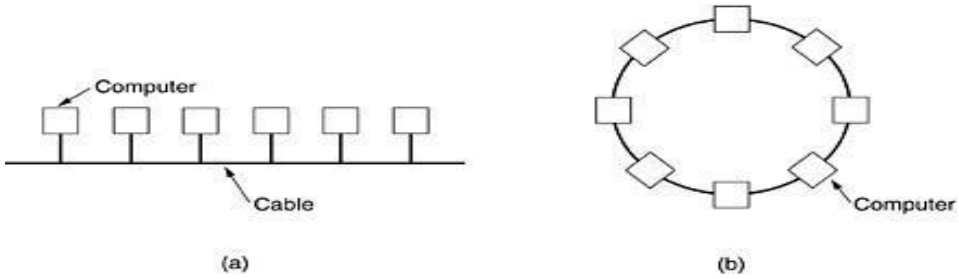
- To shared a files and folders from one computer to another computer in network
- To shared a hardware equipment like printers, CD-Rom and so on
- To shared the software applications over network and this allows implementing
- Client server applications to improve the communication between to computers
- To improved speed and accuracy
- To reduce the cost of data transfer
- High reliability

Types of Networks



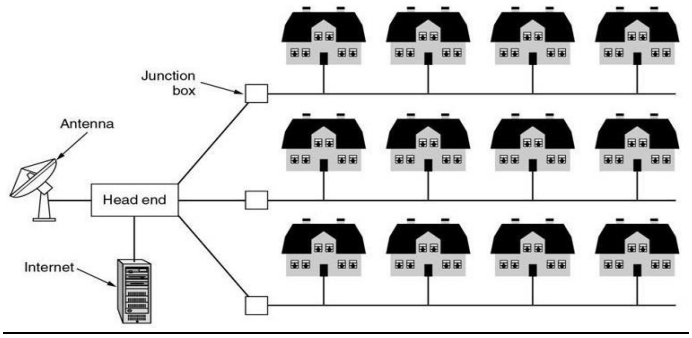
Local Area Network (LAN)

- A local area network is generally called as LANs; these are privately-owned networks within a single Building or campus of up to a few kilometers in size.
- LANs are widely used to connect personal computers and work stations in company Offices and factories to share resources like printers, and to exchange information.
- LANs are different from other networks by three characteristics (1).With their size, (2).With their transmission technology. (3).their topology.
- LANs run at a speed of 10 to 100 Mbps (mega bits/sec)
- LANs use a transmission Technology consisting of a single cable to which all the systems are attached, Like a telephone lines.
- Here it uses IEEE 802.3 popularly known as Ethernet, and IEEE 802.5 IBM Token ring
- Various Topologies are used for broadcasting the LANs. The most common LAN topologies are bus, ring, and star.



Metropolitan Area Network (MAN)

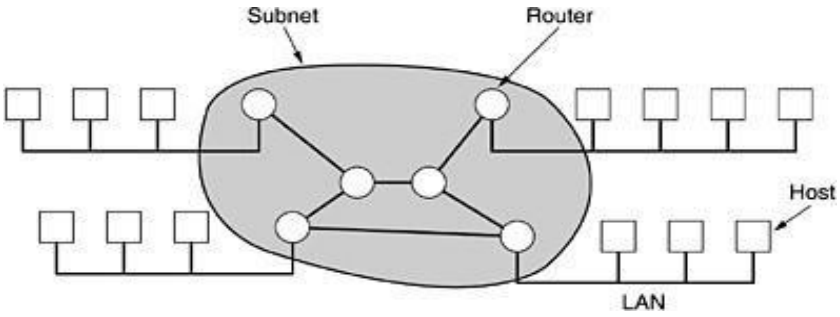
- A metropolitan area network (MAN) is a network with a size between a LAN and a WAN.
- Both the buses contain Head-End which initiates the tran*smission. The traffic of right Side of the sender uses upper bus. And to send left side uses lower one.
- It is designed for customers who need a high-speed connectivity.
- The range of MAN is 100M to 10KM
- These are private and public owned networks



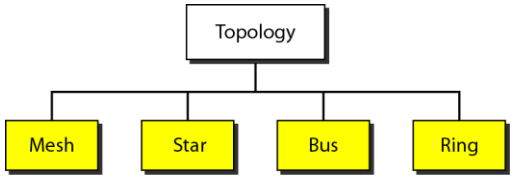
Wide Area Network (WAN)

- WAN spans large geographical area
- The range of WAN is different countries
- WAN provides long-distance transmission of data, voice, image and information over Large geographical areas that may comprise a country, continent or even the whole world. In WANs systems are connected by a communication subnet or subnet.

- The job of the subnet is to carry messages from system to the system, just like a Telephone which carries Words from speaker to speaker in most wide area networks the subnet consists of two distinct components transmission lines and switching elements. Transmission lines are also called as circuits, channels or trunks move bits between machines. The switching elements are specialized computers used to connect two or more transmission lines connecting multiple networks known as routers.



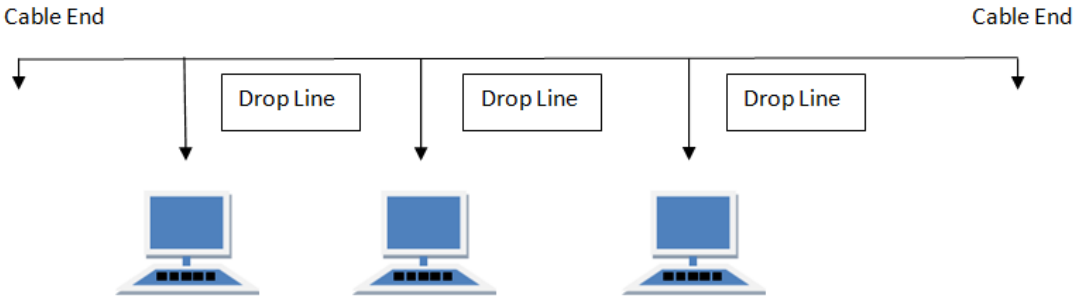
Network Topologies



Topology: The Physical arrangement of computers which are connected to each other through via communication channel is called topology.

Bus Topology:

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



Features of Bus Topology

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

Advantages of Bus Topology

- It is cost effective.
- All nodes are easily add or remove
- Used in small network
- It is easy to understand.
- Easy to expand joining two cables together.

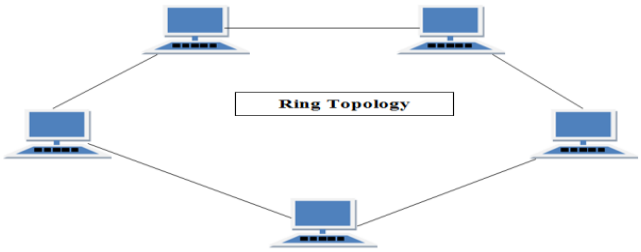
Disadvantages of Bus Topology

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

- Cable has a limited length.

2. RING Topology

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



Features of Ring Topology

- Numbers 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
- Data is transferred in a sequential manner that is bit by bit

Advantages of Ring Topology

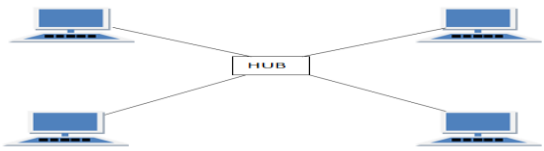
- Transmitting network is not affected by high traffic or by adding more nodes, as only the nodes having tokens can transmit data.
- Cheap to install and expand

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

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



Features of Star Topology

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

- Can be used with twisted pair, Optical Fiber or coaxial cable.

Advantages of Star Topology

- Hub can be upgraded easily.
- Easy to troubleshoot.
- Easy to 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.

4. MESH Topology

- It is point–to-point connection to other nodes traffic is carried only between two devices to which it is connected. Mesh has n(n-2)/2 physical channels.

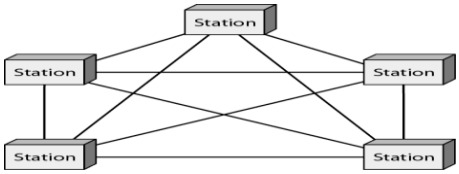


Figure: A fully connected mesh topology (five devices)

Feature of Mesh Topology

- Fully connected
- Robust
- Not flexible

Advantages of mesh topology:

- Each connection can carry its own data load
- It is robust
- Provides security and privacy

Disadvantages of mesh topology:

- Cable cost is more
- Installation and configuration is difficult
- Bulk wiring is required

HYBRID Topology

- It is two different types of topologies which is a mixture of two or more topologies.
- It is combination of two or more topologies
- Inherits the advantages and disadvantages of the topologies included

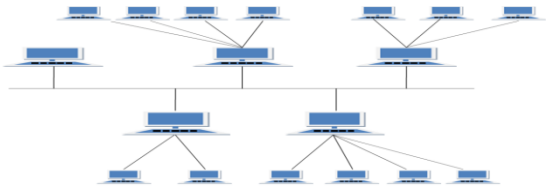
Advantages of Hybrid Topology Feature of Hybrid Topology

- Reliable as error detecting and trouble shooting is easy
- Effective
- Flexible

Disadvantages of Hybrid Topology

- Complex in design

- costly



Reference model

It describes how information from a software application in one computer moves through a physical medium to the software application in other computer.

Reference models are two types 1. OSI 2.TCP/IP

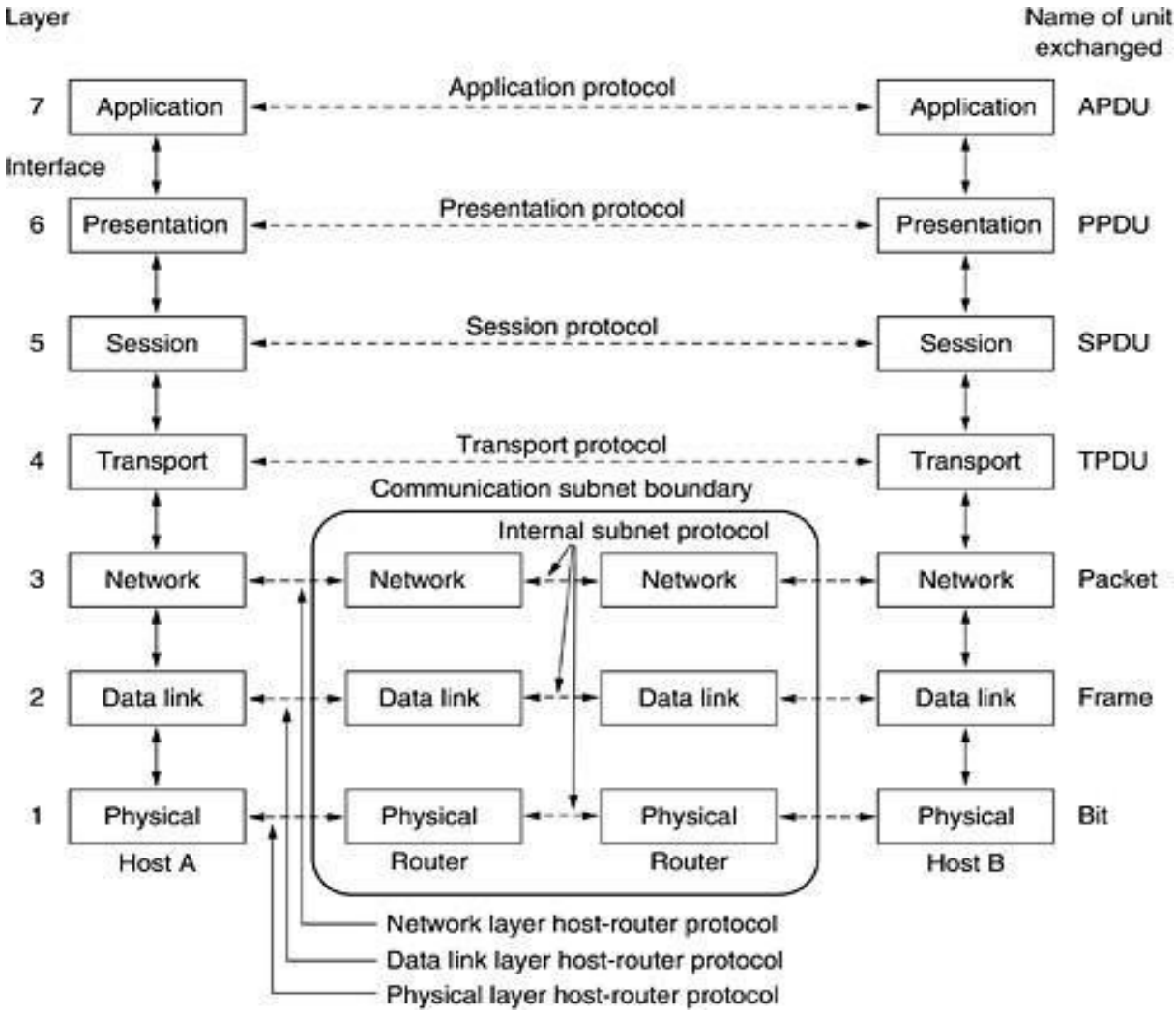
OSI Reference Model

It stands for open system inter connection. It was developed by International standard organization in 1984.It consist of 7 layers.

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

Layers 1, 2, and 3-physical, data link, and network layers are known as **Networksupport** layers

Layers 5, 6, and 7-session, presentation, and application layers are known as the **Usersupport** layers



1. Physical Layer

- The main functionality of the physical layer is to transmit the individual bits from one node to another node.
- It is the lowest layer of the OSI model.
- It establishes, maintains and deactivates the physical connection.
- It transmit the raw bits over a communication channel
- If system at one side sends one bit and other side receive one bit

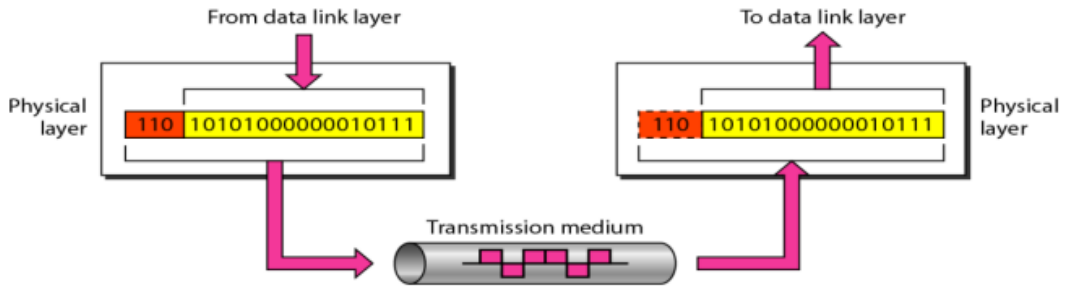
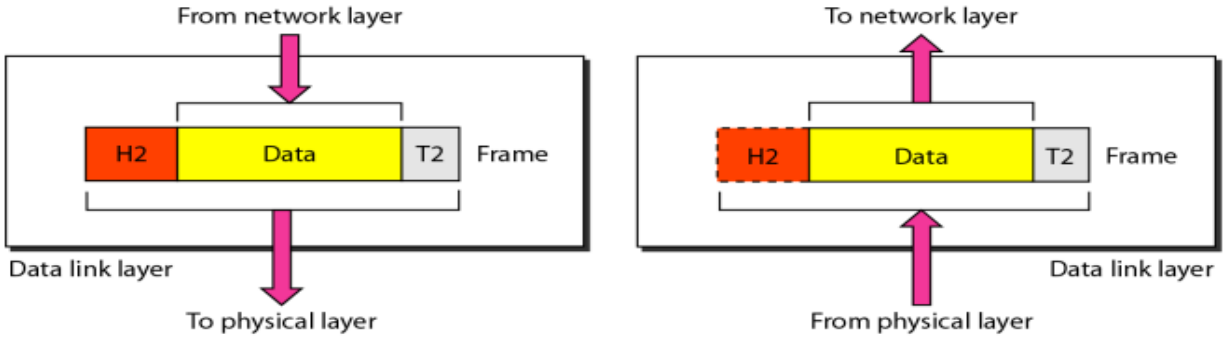


Figure: *Physical layer*

Functions of a Physical layer:

- **Representation of bit:** This layer data consist of a bits with no interpretation.
- **Data Rate:** It represents how many number of bits can be transfer in each second also defined by physical layer
- **Synchronization:** The sender and receiver both side must have to use the same bit rate.
- **Line configuration:** It is concerned with connection of devices to the media in point to point or multi configuration.
- **Topology:** It defines how devices are connected to make a network
- **Transmission media:** It defines the direction of transmission between the devices as simplex, half duplex and full duplex.

2. Data Link Layer:



Functions of a Data Link layer:

- **Framing:** It divides the stream of bits received from network layer into data units called **Frame.** It contains header, Data and trailer.

- **Physical addressing:** The data link layer adds a header to the frame that

consists of a destination address.

- **Flow control**: It is the main function of the data link layer. The constant data rate is maintained on both sender and receiver so no data get corrupted.
- **Error Control:** It is achieved by adding calculated value CRC (Cycle Redundancy Check) it is placed to data link layer. The trailer which is added to message to frame before it is sending to physical layer. if any error seems to occur the receiver sends acknowledgement to retransmit of the corrupted frame.
- **Access Control**: When two or more devices are connected to the same communication channel then the data link layer protocols are used to determine which device control over the link at has given time.

3. Network Layer:

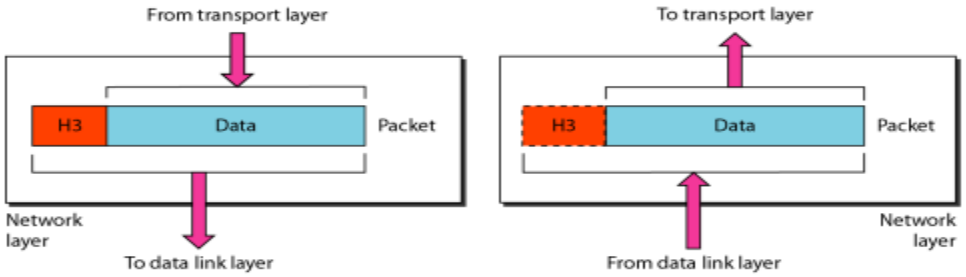


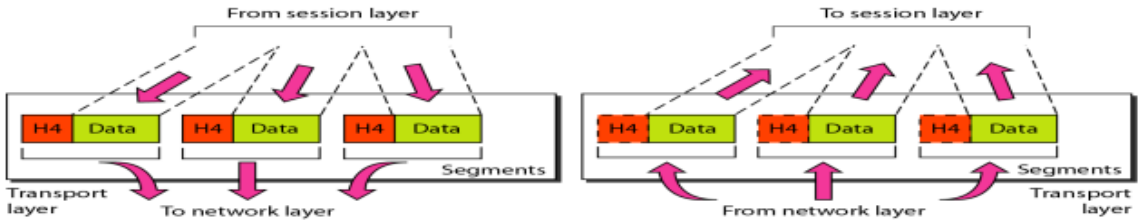
Figure: ***Network layer***

- It is the third layer of the OSI model
- The Data link layer is responsible for routing and forwarding the packets.
- This layer of data is transfer from source to destination through packet

Functions of a Network layer:

- **Internetworking**: An internet working is the main responsibility of the network layer. It provides a logical connection between different devices.
- **Addressing**: A Network layer adds the source and destination address to the header of the frame. Addressing is used to identify the device on the internet.
- **Routing**: Routing is the major component of the network layer, and it determines the best optimal path out of the multiple paths from source to the destination
- **Packetizing**: A Network Layer receives the packets from the upper layer and converts them into packets. This process is known as Packetizing. It is achieved by internet protocol (IP)

4. Transport Layer:



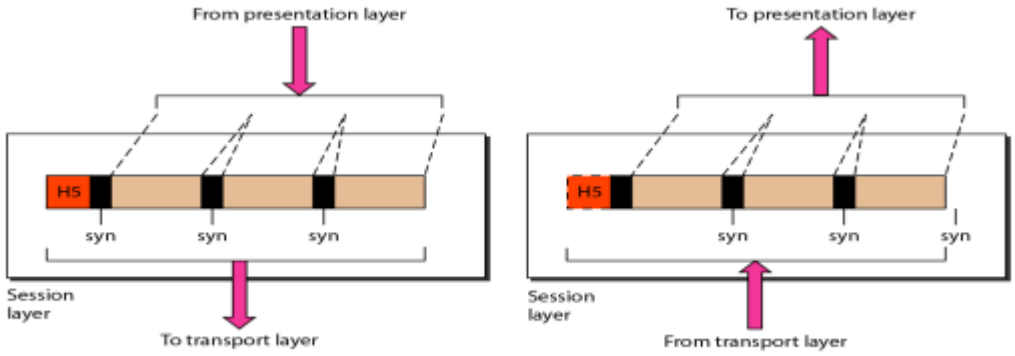
Transport layer

- The Transport layer is a fourth layer of OSI reference model.
- The main responsibility of the transport layer is to transfer the data completely.
- It receives the data from the upper layer and converts them into smaller units known as segments.
- This layer can be termed as an end-to-end layer as it provides a point-to-point connection between source and destination to deliver the data reliably. This layer used two protocols are TCP and UDP

Functions of a Transport Layer:

- **Segmentation**: When the transport layer receives the message from the upper layer, it divides the message into multiple segments, and each segment is assigned with a sequence number that uniquely identifies each segment. When the message has arrived at the destination, then the transport layer reassembles the message based on their sequence numbers.
- **Connection control**: Transport layer provides two services Connection-oriented service and connectionless service. A connectionless service treats each segment as an individual packet, and they all travel in different routes to reach the destination. A connection-oriented service makes a connection with the transport layer at the destination machine before delivering the packets. In connection-oriented service, all the packets travel in the single route.
- **Flow control**: The transport layer also responsible for flow control but it is performed end-to-end rather than across a single link.
- **Error control**: The transport layer is also responsible for Error control. The sender transport layer ensures that message reach at the destination without any error.

5. Session Layer:



Session layer

- It is a layer 5 in the OSI model.
- The Session layer is used to establish, maintain and synchronizes the interaction between communicating devices.

Functions of Session layer:

- **Dialog control**: Session layer acts as a dialog controller that creates a dialog between two processes or we can say that it allows the communication between two processes which can be either half-duplex or full-duplex.

- **Synchronization**: Session layer adds some checkpoints when transmitting the data in a sequence. If some error occurs in the middle of the transmission of data, then the transmission will take place again from the checkpoint. This process is known as Synchronization and recovery.

6. Presentation Layer:

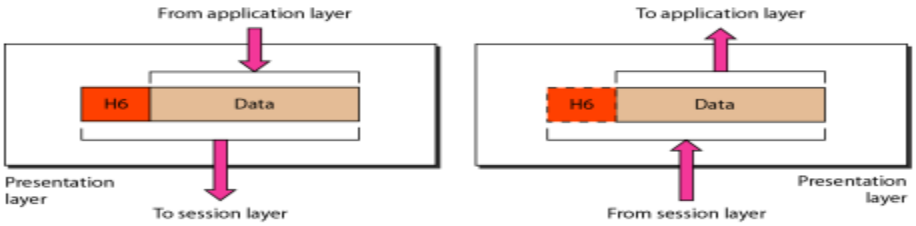


Figure: *Presentation layer*

- A Presentation layer is mainly concerned with the syntax and semantics of the information exchanged between the two systems.

- It acts as a data translator for a network.
- This layer is a part of the operating system that converts the data from one presentation format to another format.
- The Presentation layer is also known as the syntax layer.

Functions of Presentation layer:

Encryption: Encryption is needed to maintain privacy. Encryption is a process of converting the sender-transmitted information into another form and sends the resulting message over the network.

Compression: Data compression is a process of compressing the data, i.e., it reduces the number of bits to be transmitted. Data compression is very important in multimedia such as text, audio, video

7. Application Layer

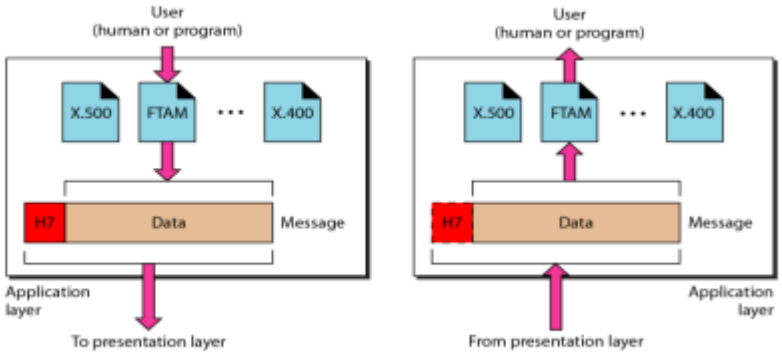


Figure: *Application layer*

- It is the 7th and top most layer of OSI reference model
- It handles issues such as network transparency, resource allocation, etc.
- This layer provides the network services to the end-users.

Functions of Application layer:

- **File transfer, access, and management**: An application layer allows a user to access the files in a remote computer, to retrieve the files from a computer and to manage the files in a remote computer.
- **Mail services**: An application layer provides the facility for email forwarding and storage
- **Directory services**. This application provides distributed database sources and access for global information about various objects and services.
- **Eg: HTTP, FTP, TELNET, SMTP etc...**

Lack of OSI Models Success

Advantages

- It is a truly generic model
- The OSI model works as a standard model in data communication
- OSI model is helpful if you want to buy the required software or hardware to build your own network
- Layers in the OSI model architectures can be distinguished and every layer has its own importance according to their interfaces, services, and protocols.
- The OSI divides the all process of data communication into simpler and smaller
- The protocols are hidden in the OSI model, so any protocols can be implemented in the OSI model. OSI model is a standard model, so it can adapt all features of other protocols.
- The OSI model can facilitate the followings;
  Component development
  Concept of Modularity

Design of the network
Troubleshooting of the network

- The OSI model increases the learn ability of the network.

Disadvantages

- The OSI model is a theoretical model. Sometimes it can be a difficulty if the appropriate technology is not available.
- The OSI restricts its practical implementation.
- The OSI model is a very complex model.
- The initial implementation of the OSI model is slow.
- The initial implementation of the OSI model is costly.
- There is inter dependence among the OSI layers. OSI layers cannot work in parallel. Each upcoming layer needs to wait to receive the data from its predecessor layer. For an example the application layer receives the data from the presentation layer and the presentation layer needs to wait to receive the data from the session layer and so on.
- The duplication of services in various layers is a problem in the OSI model. Some Services are offered by multiple layers. Some of these services are mentioned below;

  Flow control
  Error control
  Addressing etc.

TCP/IP Reference Model

TCP/IP stands for transmission control protocol and internet protocol .It was developed **Department of defense** .It has 4 layers.

- These Layers are
- Application Layer
- Transport Layer
- Internet Layer
- Host- to –Network Layer

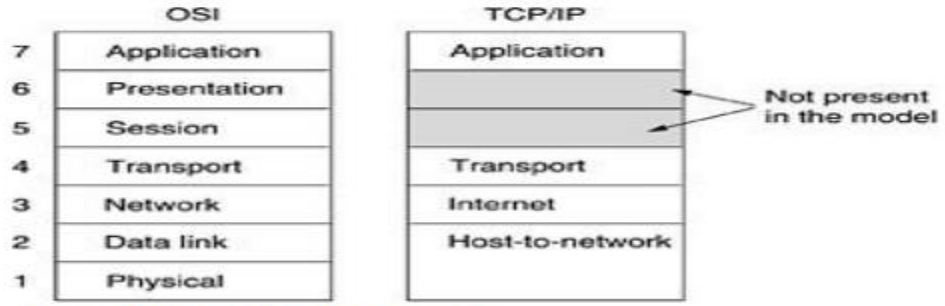


Fig: TCP/IP reference model

1. Host-to-Network Layer:

- This is the Lowest Layer
- Protocol is used to connect the host, so that the packets can besent over it.
- Varies host to host and network to network

2. Internet Layer:

- Selection of a packet switching network which is based on a connection less
- Internetwork layer is called internet layer.
- It helps the packets to travel independently to the destination
- It allows the host to insert the packets
- Internet protocol is used in this layer
- This layer holds the whole architecture

3. Transport Layer:

- It decides if data transmission should be on parallel path or single path
- It breaks the message into small units called segments. So that they are handled more efficiently by the network layer.
- Functions of transport layer are same as the OSI model
- It also arranges the packets sent in sequence.
- This is a third layer of TCP/IP model

4. Application Layer:

Protocols used in this layer are high level protocols such as TELNET, FTP, SMTP, DNS etc..

- **TELNET** is a two-way communication protocol, which allows connecting to a remote machine and run applications on it.
- **FTP** (File Transfer Protocol) is a protocol that allows File transfer amongst computer users connected over a network. It is reliable, simple and efficient.
- **SMTP** (Simple Mail Transport Protocol) is a protocol, which is used to transport electronic mail between a source and destination, directed via a route.
- **DNS** (Domain Name Server) resolves an IP address into a textual address for Hosts connected over a network. It allows peer entities to carry conversation.
- It defines two end-to-end protocols: TCP and UDP
- **TCP** (Transmission Control Protocol): It is a reliable connection-oriented protocol which handles byte-stream from source to destination without error and flow control.
- **UDP** (User-Datagram Protocol): It is an unreliable connection-less protocol that do not wants TCPs, sequencing and flow control.

TCP/IP PROTOCOL SUITE

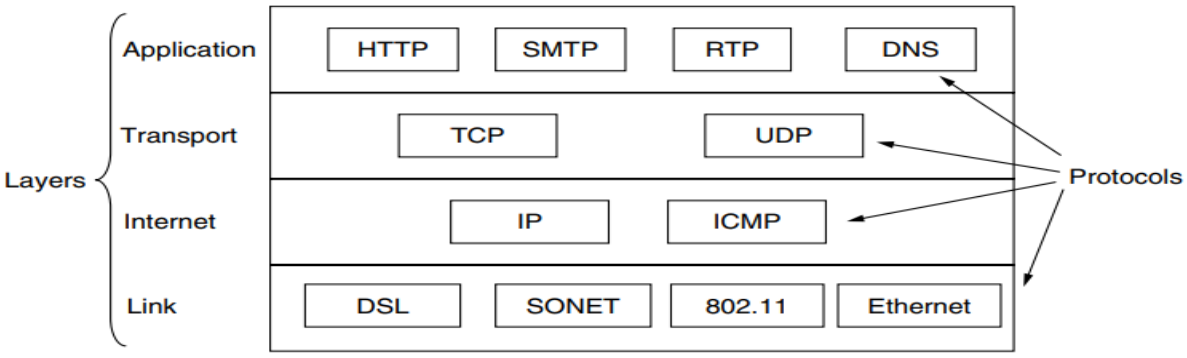


Figure 1-22. The TCP/IP model with some protocols we will study.

Compare OSI Reference model and TCP /IP

OSI	TCP/IP
OSI represents **Open System Interconnection**.	TCP/IP model represents the **Transmission Control Protocol / Internet Protocol**.
OSI is a generic, protocol independent standard.	TCP/IP model depends on standard protocols about which the computer network has created.
The OSI model was developed first, and then protocols were created to fit the network architecture's needs.	The protocols were created first and then built the TCP/IP model.
It provides quality services.	It does not provide quality services.
The OSI model represents defines administration, interfaces and conventions. It describes clearly which layer provides services.	It does not mention the services, interfaces, and protocols.
It provides both connection and connectionless oriented transmission in the network layer	It provides connectionless transmission in the network layer
It uses a horizontal approach.	It uses a vertical approach.
The smallest size of the OSI header is 5 bytes.	The smallest size of the TCP/IP header is 20 bytes.
It contains 7 layers	It contain 4 Layers

INTERNET HISTORY

ARPANET: **Advanced Research Projects Agency**

- It was started and developed by the United states
- It was wide area network linking many universities
- It was first to use **packet switching** which was suggested by **Paul Baran** and was the beginning of what we consider the internet today
- It was created to make it easier for people to access computers ,improved computer equipment
- It is used to have more effective communication method of military
- It was started when two nodes are established between **UCLA**(**University of California and Loss Angles**) and **Stanford Research Institute** in 1969 .
- **ARPANET** completed its transits to TCP/IP on January 2,1983

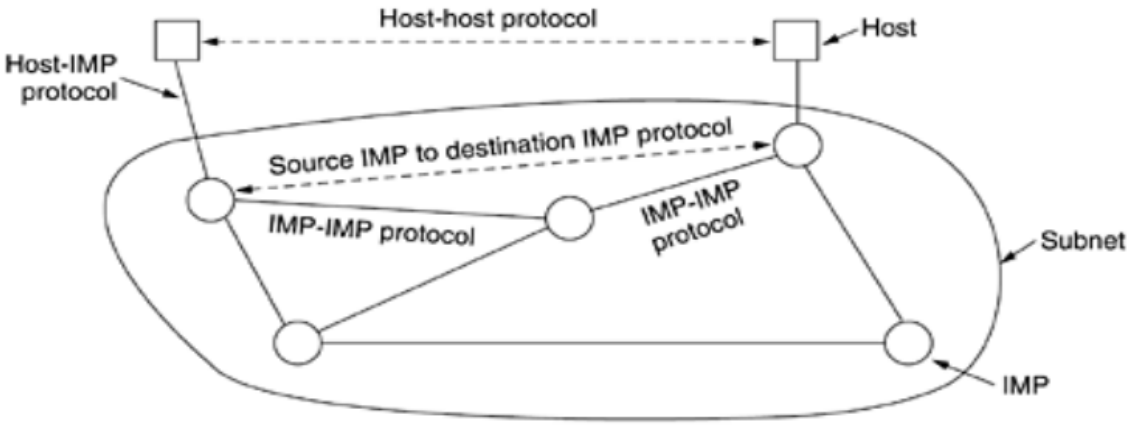


Fig 3: The original ARPANET design

- It consist of subnet host computers
- The subnet would consist of minicomputers called IMPs (**Interface Message Processors**) connected by 56-kbps transmission lines.
- Each IMP would be connected to at least two other IMPs. The subnet was to be a datagram subnet, so if some lines and IMPs were destroyed, messages could be automatically rerouted along alternative paths.
- The software was split into two parts: subnet and host. The subnet software consisted of the IMP end to the host IMP connection, the IMP-IMP protocol, and a source IMP to

destination IMP protocol designed to improve reliability.

NSFNET (National Science Foundation)

- NSF (the U.S. National Science Foundation) saw the enormous impact that the ARPANET was having on university research, allowing scientists across the country to share data and collaborate on research projects. This lack of universal access prompted NSF to set up a virtual network.
- NSF decided to build a backbone network to connect its six supercomputer centers; each supercomputer was given a little brother, consisting of an LSI-11 microcomputer called a fuzz ball. The fuzzballs were connected with 56-kbps leased lines and formed the subnet, the same hardware technology as the ARPANET used. The software technology was different however: the fuzzballs spoke TCP/IP right from the start, making it as a first TCP/IP WAN.
- NSF also funded some 20 regional networks that connected to the backbone to allow users at thousands of universities, research labs, libraries, and museums to access any of the supercomputers and to communicate with one another. The complete network, including the backbone and the regional networks, was called NSFNET. It connected to the ARPANET through a link between an IMP and a fuzz ball.
- Consequently, NSF encouraged MERIT, MCI, and IBM to form a nonprofit corporation. **ANS** (**Advanced Networks and Services**). In 1990, ANS took over NSFNET and upgraded the 1.5-Mbps links to 45 Mbps to form ANSNET.

INTERNET:

The number of networks, machines, and users connected to the ARPANET grew rapidly after TCP/IP became the only official protocol on January 1, 1983. When NSFNET and the ARPANET were interconnected, the growth became exponential.

Traditionally the Internet and its predecessors had four main applications:

1. **E-mail**. The ability to compose, send, and receive electronic mail has been around since the early days of the ARPANET and is enormously popular. Many people get dozens of messages a day and consider it their primary way of interacting with the outside world, far outdistancing the telephone and snail mail. E-mail programs are available on virtually every kind of computer these days.

2. **News.** Newsgroups are specialized forums in which users with a common interest can exchange messages. Thousands of newsgroups exist, devoted to technical and

nontechnical topics, including computers, science, recreation, and politics. Each newsgroup has its own etiquette, style, and customs, and woe betide anyone violating them.

3. **Remote login.** Using the telnet, rlogin, users anywhere on the Internet can log on to any other machine on which they have an account.

4. **File transfer.** Using the FTP program, users can copy files from one machine on the Internet to another. Vast numbers of articles, databases, and other information are available this way.