

UNIT-1

COMPUTER NETWORK

Introduction:

Network: Exchange of data between the devices..

Computer Network: It is a collection of communication devices connected to each other.

Network Topologies WAN, LAN, MAN:

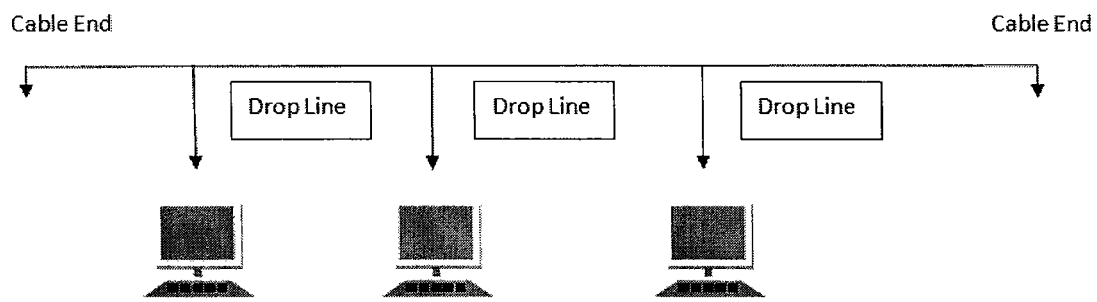
Network Topology:

Network topology is a logical connection of various computers in the network is known as topology..

Types of Network Topologies:

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

1. It transmits data only in one direction.

2. Every device is connected to a single cable

Advantages of Bus Topology

1. It is cost effective.
2. Cable required is least compared to other network topology.
3. Used in small networks.
4. It is easy to understand.
5. Easy to expand joining two cables together.

Disadvantages of Bus Topology

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

RING 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 neighbours for each device.

Features of Ring Topology

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

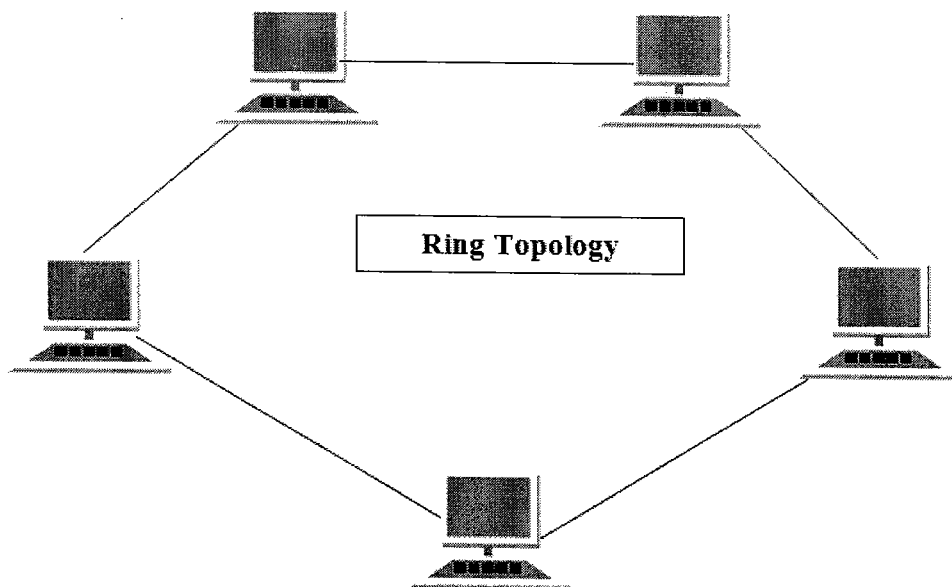
3. In Dual Ring Topology, two ring networks are formed, and data flow is in opposite direction in them. Also, if one ring fails, the second ring can act as a backup, to keep the network up.
4. Data is transferred in a sequential manner that is bit by bit. Data transmitted, has to pass through each node of the network, till the destination node.

Advantages of Ring Topology

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

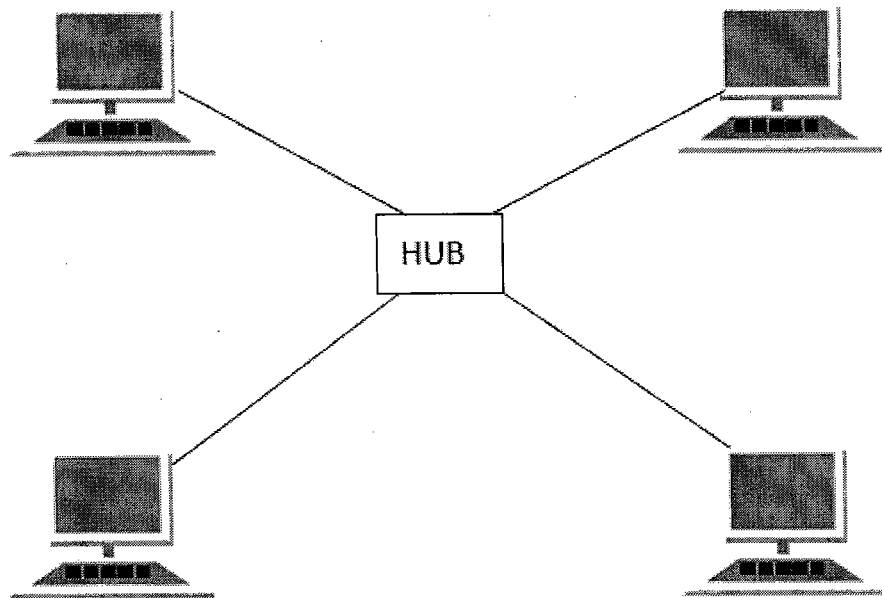
Disadvantages of Ring Topology

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



STAR 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 other nodes are connected to the central node.



Features of Star Topology

1. Every node has its own dedicated connection to the hub.
2. Hub acts as a repeater for data flow.
3. Can be used with twisted pair, Optical Fibre or coaxial cable.

Advantages of Star Topology

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

Disadvantages of Star Topology

1. Cost of installation is high.
2. Expensive to use.

3. If the hub fails then the whole network is stopped because all the nodes depend on the hub.
4. Performance is based on the hub that is it depends on its capacity

MESH Topology

It is a point-to-point connection to other nodes or devices. All the network nodes are connected to each other. Mesh has $n(n-1)/2$ physical channels to link n devices.

There are two techniques to transmit data over the Mesh topology, they are :

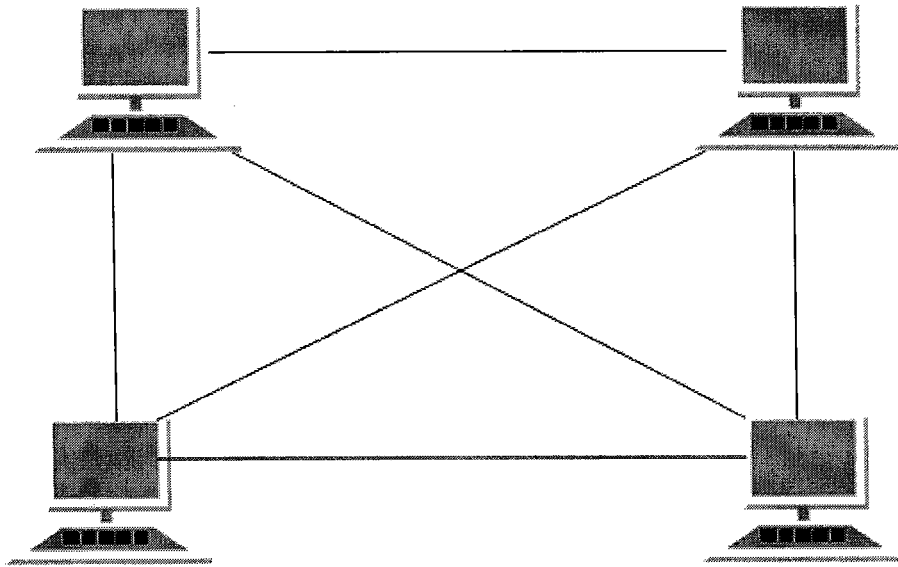
1. Routing
2. Flooding

MESH Topology: Routing

In routing, the nodes have a routing logic, as per the network requirements. Like routing logic to direct the data to reach the destination using the shortest distance. Or, routing logic which has information about the broken links, and it avoids those node etc. We can even have routing logic, to re-configure the failed nodes.

MESH Topology: Flooding

In flooding, the same data is transmitted to all the network nodes, hence no routing logic is required. The network is robust, and the its very unlikely to lose the data. But it leads to unwanted load over the network.



Types of mesh topology:

1. **Partial Mesh Topology** : In this topology some of the systems are connected in the same fashion as mesh topology but some devices are only connected to two or three devices.
2. **Full Mesh Topology** : Each and every nodes or devices are connected to each other.

Features of Mesh Topology

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

Advantages of Mesh Topology

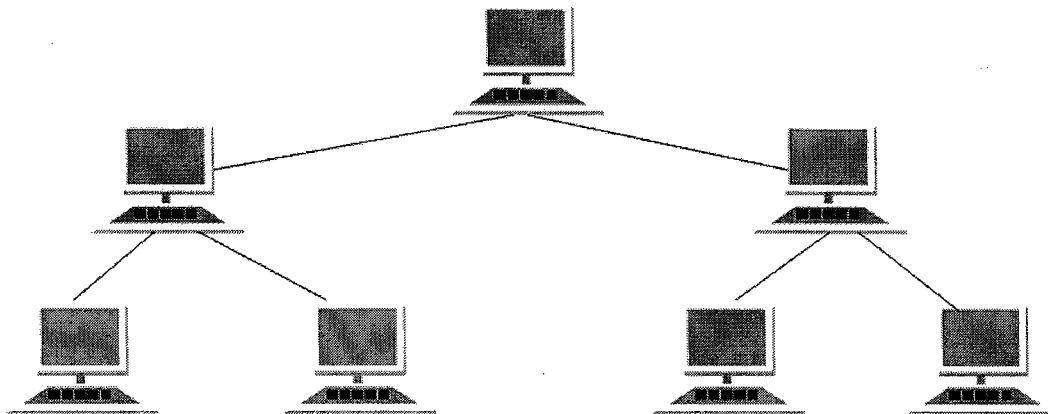
1. Each connection can carry its own data load.
2. It is robust.
3. Fault is diagnosed easily.
4. Provides security and privacy.

Disadvantages of Mesh Topology

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

TREE Topology

It has a root node and all other nodes are connected to it forming a hierarchy. It is also called hierarchical topology. It should at least have three levels to the hierarchy.



Features of Tree Topology

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

Advantages of Tree Topology

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

Disadvantages of Tree Topology

1. Heavily cabled.

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

HYBRID Topology

It is two different types of topologies which is a mixture of two or more topologies. For example if in an office in one department ring topology is used and in another star topology is used, connecting these topologies will result in Hybrid Topology (ring topology and star topology).

Features of Hybrid Topology

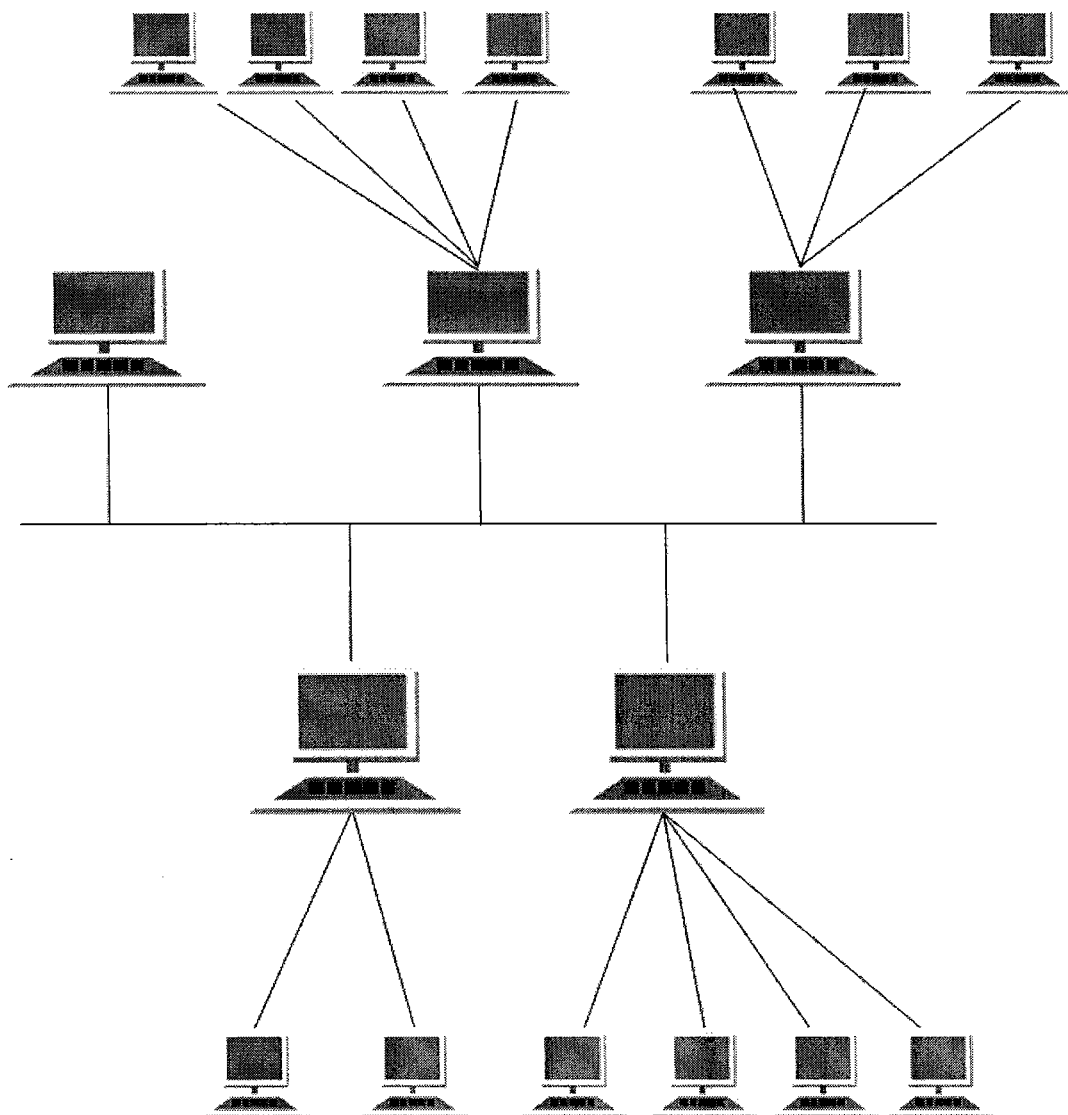
1. It is a combination of two or topologies
2. Inherits the advantages and disadvantages of the topologies included

Advantages of Hybrid Topology

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

Disadvantages of Hybrid Topology

1. Complex in design.
2. Costly.



Networks: WAN, LAN, MAN

The **Network** allows computers to **connect and communicate** with different computers via any medium. LAN, MAN and WAN are the three major types of the network designed to operate over the area they cover. There are some similarities and dissimilarities between them. One of the major differences is the geographical area they cover, i.e. **LAN** covers the smallest area; **MAN** covers an area larger than LAN and **WAN** comprises the largest of all.

Local Area Network (LAN) –

It is a privately owned network that operates within and nearby a single building like a home, office or factory.

It is used to connect personal computers.

Wireless LAN's are very popular these days.,these are placed where it is too much trouble to install cables.

In these systems, every computer has a radio modem and an antenna that it uses to communicate with other computers.

LAN or Local Area Network connects network devices in such a way that personal computer and workstations can share data, tools and programs. The group of computers and devices are connected together by a switch, or stack of switches, using a private addressing scheme as defined by the TCP/IP protocol. Private addresses are unique in relation to other computers on the local network. Routers are found at the boundary of a LAN, connecting them to the larger WAN.

Data transmits at a very fast rate as the number of computers linked are limited. By definition, the connections must be high speed and relatively inexpensive hardware (Such as hubs, network adapters and Ethernet cables). LANs cover smaller geographical area (Size is limited to a few kilometers) and are privately owned. One can use it for an office building, home, hospital, schools, etc. LAN is easy to design and maintain. A Communication medium used for LAN has twisted pair cables and coaxial cables. It covers a short distance, and so the error and noise are minimized.

Early LAN's had data rates in the 4 to 16 Mbps range. Today, speeds are normally 100 or 1000 Mbps. Propagation delay is very short in a LAN. The smallest LAN may only use two computers, while larger LANs can accommodate thousands of computers. A LAN typically relies mostly on wired connections for increased speed and security, but wireless connections can also be part of a LAN. The fault tolerance of a LAN is more and there is less congestion in this network. For example : A bunch of students playing Counter Strike in the same room (without internet).

Metropolitan Area Network (MAN) –

MAN or Metropolitan area Network covers a larger area than that of a LAN and smaller area as compared to WAN. It connects two or more computers that are apart but resides in the same or different cities. It covers a large geographical area and may serve as an ISP (Internet Service Provider). MAN is designed for customers who need a high-speed connectivity. Speeds of MAN ranges in terms of Mbps. It's hard to design and maintain a Metropolitan Area Network.

The fault tolerance of a MAN is less and also there is more congestion in the network. It is costly and may or may not be owned by a single organization. The data transfer rate and the propagation delay of MAN is moderate. Devices used for transmission of data through MAN are: Modem and Wire/Cable. Examples of a MAN are the part of the telephone company network that can provide a high-speed DSL line to the customer or the cable TV network in a city.

Wide Area Network (WAN) –

WAN or Wide Area Network is a computer network that extends over a large geographical area, although it might be confined within the bounds of a state or country. A WAN could be a connection of LAN connecting to other LAN's via telephone lines and radio waves and may be limited to an enterprise (a corporation or an organization) or accessible to the public. The technology is high speed and relatively expensive.

There are two types of WAN: Switched WAN and Point-to-Point WAN. WAN is difficult to design and maintain. Similar to a MAN, the fault tolerance of a WAN is less and there is more congestion in the network. A Communication medium used for WAN is PSTN or Satellite Link. Due to long distance transmission, the noise and error tend to be more in WAN.

WAN's data rate is slow about a 10th LAN's speed, since it involves increased distance and increased number of servers and terminals etc. Speeds of WAN ranges from few kilobits per second (Kbps) to megabits per second (Mbps). Propagation delay is one of the biggest problems faced here. Devices used for transmission of data through WAN are: Optic wires, Microwaves and Satellites. Example of a Switched WAN is the asynchronous transfer mode (ATM) network and Point-to-Point WAN is dial-up line that connects a home computer to the Internet.

Reference models

The OSI Reference Model:

OSI is acronym of **Open System Interface**. This model is developed by the **International organization of Standardization (ISO)** and therefore also referred as **ISO-OSI** Model in the year 1970..

The OSI model consists of seven layers as shown in the following diagram. Each layer has a specific function, however each layer provide services to the layer above.

Why OSI Model?

The purpose of the OSI reference model is to connect systems openly..

Seven Layers Of OSI Model

As discussed in the previous section, the OSI Model is composed of seven layers with the application layer, which is closest to the end user, at the top, going all the way down to physical layer, in which the actual data transfer happens with the use of a transmission medium.

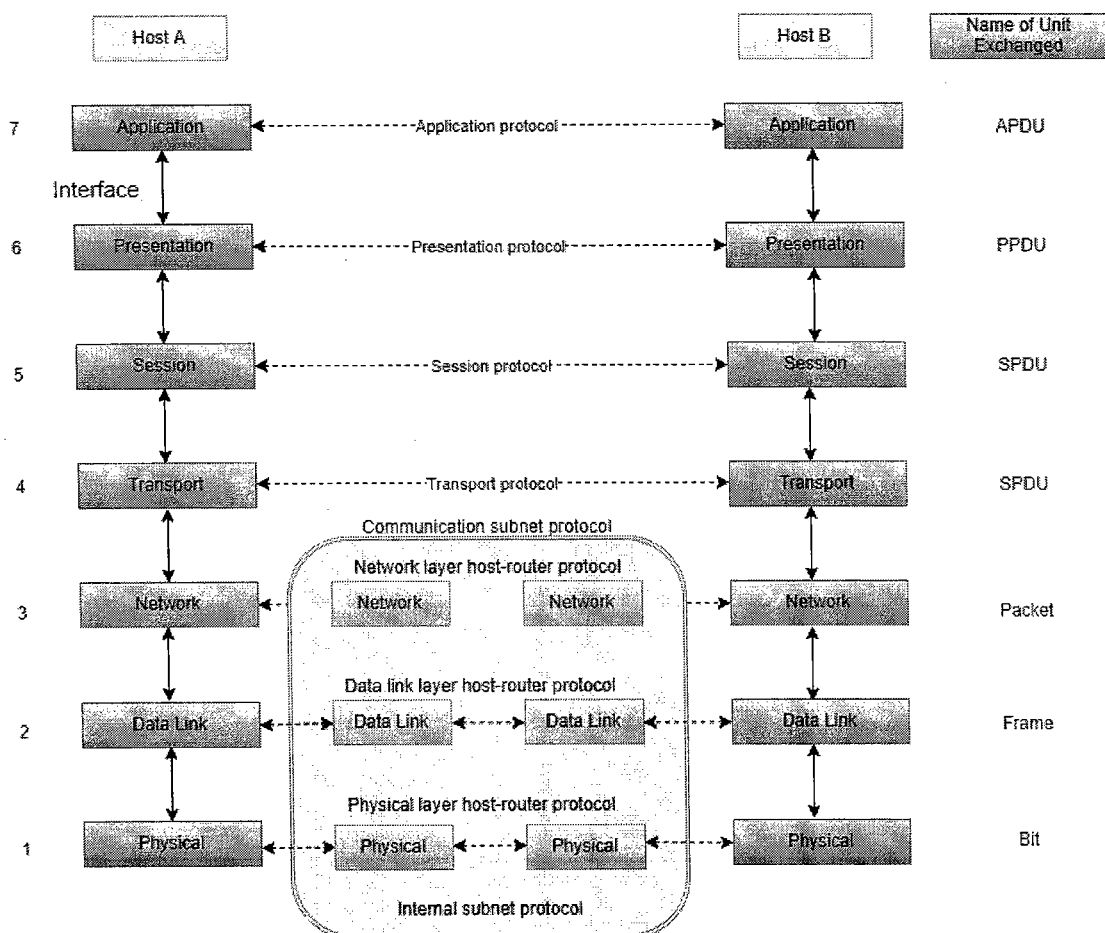


Fig: OSI reference model

7. Application Layer

This is the topmost layer in the seven OSI Layers. This is the layer that the end-user (can be a computer programmer, or a regular PC user) is actually interacting with. This layer allows access to network resources.

The Application layer performs the following functions:

- It provides different services such as manipulation of information in several ways, retransferring the files of information, distributing the results etc.
- The functions such as LOGIN or password checking are also performed by the application layer.

6. Presentation Layer

This is the layer in which the operating system operates with the data. Main functions of this layers includes translation, encryption and compression of data. Basically User interacts with Application layer, which sends the data down to Presentation layer.

The Presentation layer performs the following functions:

- This layer makes it sure that the information is delivered in such a form that the receiving system will understand and use it.

5. Session Layer

This layer has the job of maintaining proper communication by establishing, managing and terminating sessions between two computers. For example, whenever we visit any website, our computer has to create a session with the web server of that website.

The Session layer performs the following functions:

- Manages the messages and synchronizes conversations between two different applications.
- It controls logging on and off, user identification, billing and session management.

4. Transport Layer

This layer has a very important job. It decides how much information should be sent at a time. So, when you are communicating with a website, this layer will decide how much data you can transfer and

receive at a given point of time. Also, this layer provides reliable process to process message delivery and error recovery.

The Transport layer performs the following functions:

- It decides if the data transmission should take place on parallel paths or single path.
- It performs multiplexing, splitting on the data.
- It breaks the data groups into smaller units so that they are handled more efficiently by the network layer.

The Transport Layer guarantees transmission of data from one end to other end

3. Network Layer

The main job of this layer is to move packets from source to destination and provide inter-networking. This is the layer that the routers operate on. Since routers operate at the network level, hence we can say that the IP address is at the network level.

Following are the functions of Network Layer:

- To route the signals through various channels to the other end.
- To act as the network controller by deciding which route data should take.
- To divide the outgoing messages into packets and to assemble incoming packets into messages for higher levels.

2. Data Link Layer

This layer is responsible for organising bits into frames and ensuring hop to hop delivery. This is the layer on which the Switches operate on. Since routers operate at the network level, hence we can say that the MAC address resides at the data link layer. All the computers in a specific network get plugged into a switch so that they can communicate with each other.

The data link layer performs the following functions:

- Performs synchronization and error control for the information which is to be transmitted over the physical link.
- Enables error detection, and adds error detection bits to the data which are to be transmitted.

1. Physical Layer

This is the layer on which the real transmission of data bits takes place through a medium. This layer is, as the name suggests, all the physical stuff that connects the computers together.

The Physical layer is responsible for the following activities:

- Activating, maintaining and deactivating the physical connection.
- Defining voltages and data rates needed for transmission.
- Converting digital bits into electrical signal.
- Deciding whether the connection is simplex, half duplex or full duplex.

Advantages Of OSI Model

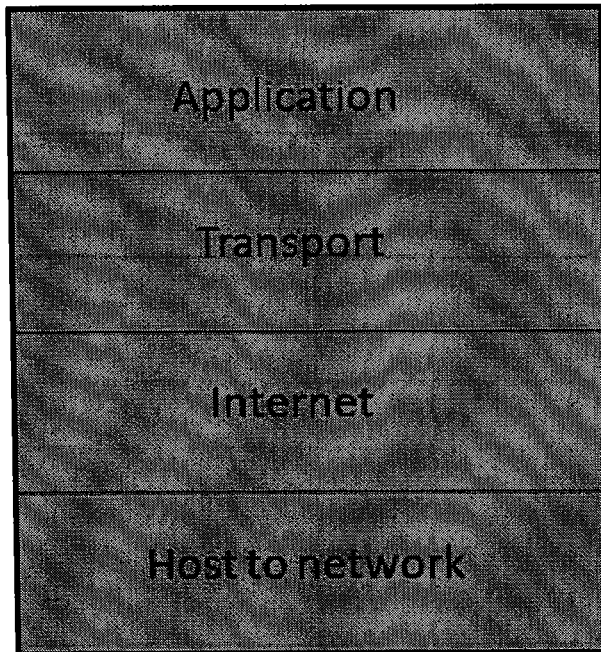
- It creates a common platform for software developers and hardware manufactures that encourage the creation of networking products that can communicate with each other over the network.
- It helps network administrators by dividing large data exchange process in smaller segments.
- Due to the independence of layers, it prevents changes in one layer from affecting other layers.
- Standardization of network components allows multiple-vendor development.
- It structures very well the functions particular to each layer.
- It reduces complexity and accelerates evolution
- It simplifies teaching and learning

TCP/IP Reference model:

TCP/IP model is practical model and is used in the Internet. TCP/IP is acronym of Transmission Control Protocol and Internet Protocol.

The **TCP/IP** model combines the two layers (Physical and Data link layer) into one layer i.e. **Host-to-Network** layer. The following diagram shows the various layers of TCP/IP model:

TCP/IP Model



Application Layer

This layer is same as that of the OSI model and performs the following functions:

- It provides different services such as manipulation of information in several ways, retransferring the files of information, distributing the results etc.
- The functions such as LOGIN or password checking are also performed by the application layer.

Protocols used: TELNET, FTP, SMTP, DN, HTTP, NNTP are the protocols employed in this layer.

Transport Layer

It does the same functions as that of transport layer in OSI model. Here are the key points regarding transport layer:

- It uses **TCP** and **UDP** protocol for end to end transmission.
- TCP is reliable and **connection oriented protocol**.
- TCP also handles flow control.

- The UDP is not reliable and a **connection less protocol** also does not perform flow control.

Protocols used: **TCP/IP** and **UDP** protocols are employed in this layer.

Internet Layer

The function of this layer is to allow the host to insert packets into network and then make them travel independently to the destination. However, the order of receiving the packet can be different from the sequence they were sent.

Protocols used: **Internet Protocol (IP)** is employed in Internet layer.

Host-to-Network Layer

This is the lowest layer in TCP/IP model. The host has to connect to network using some protocol, so that it can send IP packets over it. This protocol varies from host to host and network to network.

Protocols used: **ARPANET, SATNET, LAN, packet radio** are the protocols which are used in this layer.

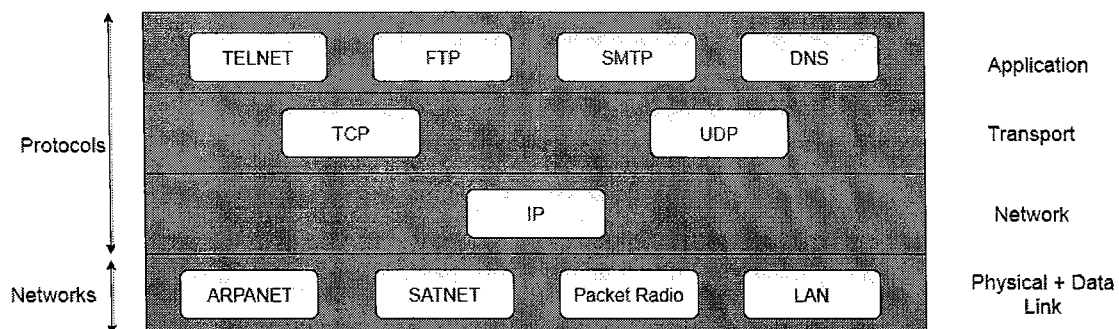


Fig: protocols and networks in TCP/IP reference model

A COMPARISON OF THE OSI AND TCP/IP REFERENCE MODEL.

OSI reference model:

- 1.OSI stands for open system inter communication
- 2.OSI was developed by(ISO) international standard organization
- 3.It is a theoretical model which is used for computing the system
- 4.OSI model having the seven layer architecture
- 5.In osi model,transport layer is connection oriented
- 6.In osi model the transport layer guarantees the delivery of the packets
- 7.OSI reference model have separate presentation and session layer
- 8.In osi model,network layer is the both connection oriented and connection less
- 9.OSI model defines services,interfaces and protocols very clearly and makes clear distictions
- 10.It is a protocol independent
- 11.It is never used

TCP/IP REFERENCE MODEL:

- 1.TCP/IP stands for transmission control protocol/internet protocol
- 2.TCP/IP was developed by department of defences project research agency
- 3.It is a client server model used for transmission of data over the internet
- 4.TCP/IP model having the four layer architecture
- 5.In TCP/IP reference model the transport layer is both connection oriented and connection less
- 6.In TCP/IP model the transport layer doesnot guarantees the delivery of packets
- 7.TCP/IP reference model doesnot have presentation layer and session layer
- 8.In TCP/IP model,thenetwork layer is only connectionless
- 9.In TCP/IP services,interfaces and protocols are not clearly supported
- 10.It is a protocol dependent
- 11.It is mainly used.