Introduction to Data Communications:

In Data Communications, *data* generally are defined as information that is stored in digital form. *Data communications* is the process of transferring digital information between two or more points. *Information* is defined as the knowledge or intelligence. Data communications can be summarized as the transmission, reception, and processing of digital information. For data communications to occur, the communicating devices must be part of a communication system made up of a combination of hardware (physical equipment) and software (programs). The effectiveness of a data communications system depends on four fundamental characteristics: delivery, accuracy, timeliness, and jitter.

A data communications system has five components:

1. **Message:** The message is the information (data) to be communicated. Popular forms of information include text, numbers, pictures, audio, and video.
2. **Sender:** The sender is the device that sends the data message. It can be a computer, workstation, telephone handset, video camera, and so on.
3. **Receiver:** The receiver is the device that receives the message. It can be a computer, workstation, telephone handset, television, and so on.
4. **Transmission medium:** The transmission medium is the physical path by which a message travels from sender to receiver. Some examples of transmission media include twisted-pair wire, coaxial cable, fiber-optic cable, and radio waves.
5. **Protocol**: A protocol is a set of rules that govern data communications. It represents an agreement between the communicating devices.

Standards Organizations for Data Communications

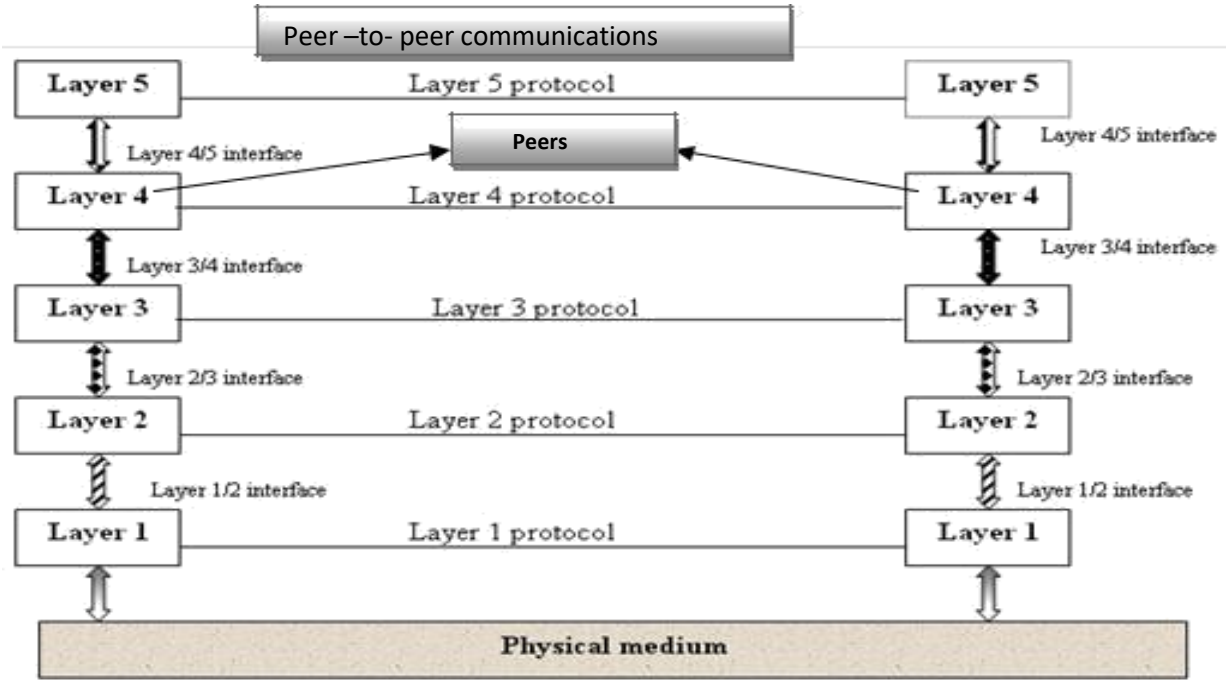
An association of organizations, governments, manufacturers and users form the standards organizations and are responsible for developing, coordinating and maintaining the standards. The intent is that all data communications equipment manufacturers and users comply with these standards. The primary standards organizations for data communication are:

1) International standard organization (ISO)
2) Consultative committee for international telephony and telegraphy (CCITT)
3) American national standard institute (ANSI)
4) Institute of electrical and electronic engineering (IEE)

5) Electronic industries association (EIA)
6) Telecommunications industry association (TIA)
7) Internet architecture board (IAB)
8) Internet Engineering Task Force (IETF)
9) Internet Research Task force (IRTF)

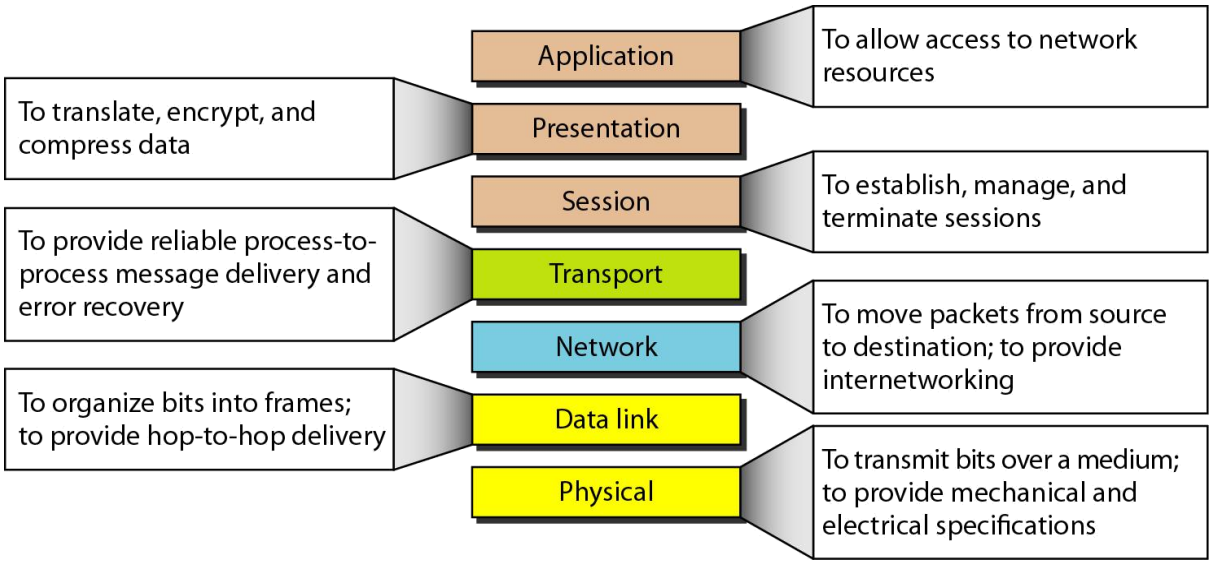
Layered Network Architecture

To reduce the design complexity, most of the networks are organized as a series of **layers** or **levels**, each one build upon one below it. The basic idea of a layered architecture is *to divide the design into small pieces*. Each layer adds to the services provided by the lower layers in such a manner that the highest layer is provided a full set of services to manage communications and run the applications. The benefits of the layered models are modularity and clear interfaces, i.e. open architecture and comparability between the different providers' components. A basic principle is to ensure independence of layers by defining services provided by each layer to the next higher layer without defining how the services are to be performed. This permits changes in a layer without affecting other layers. The basic elements of a layered model are services, protocols and interfaces. A ***service*** is a set of actions that a layer offers to another (higher) layer. ***Protocol*** is a set of rules that a layer uses to exchange information with a peer entity. These rules concern both the contents and the order of the messages used. Between the layers service interfaces are defined. The messages from one layer to another are sent through those interfaces.

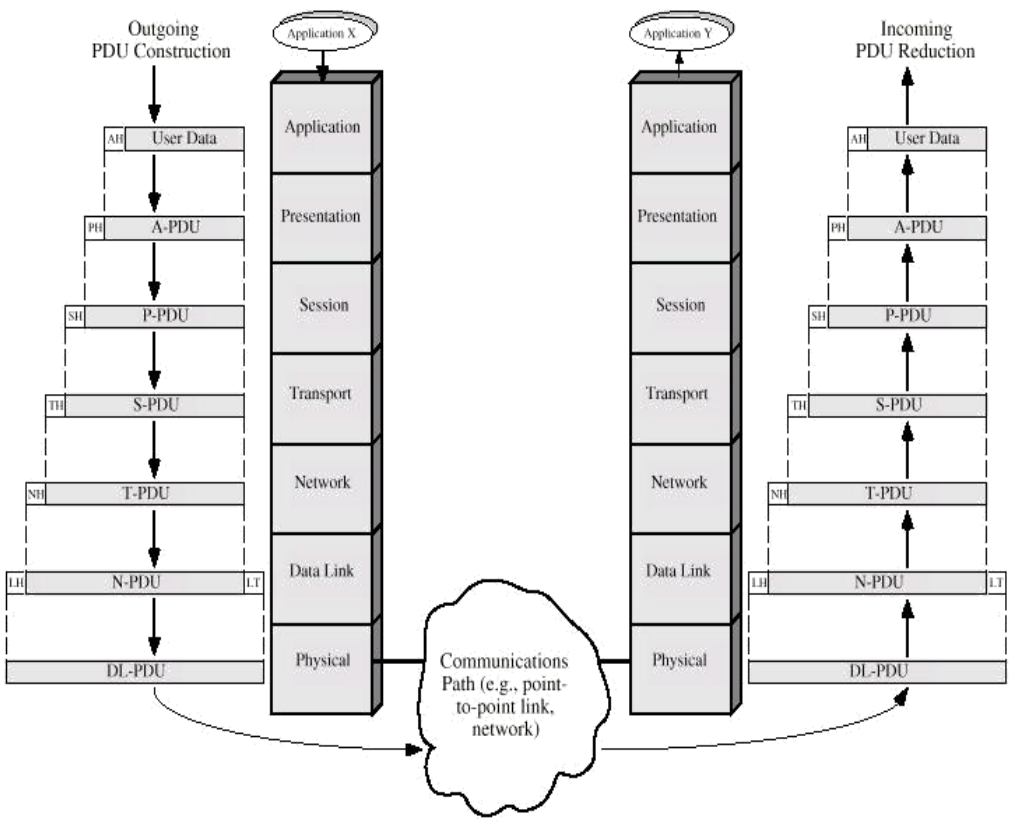


Open Systems Interconnection (OSI)

International standard organization (ISO) established a committee in 1977 to develop architecture for computer communication and the OSI model is the result of this effort. In 1984, the Open Systems Interconnection (OSI) reference model was approved as an international standard for communications architecture. The term "*open*" denotes the ability to connect any two systems which conform to the reference model and associated standards. The OSI model describes how information or data makes its way from application programmes (such as spreadsheets) through a network medium (such as wire) to another application programme located on another network. The OSI reference model divides the problem of moving information between computers over a network medium into **SEVEN** smaller and more manageable problems. The seven layers are:



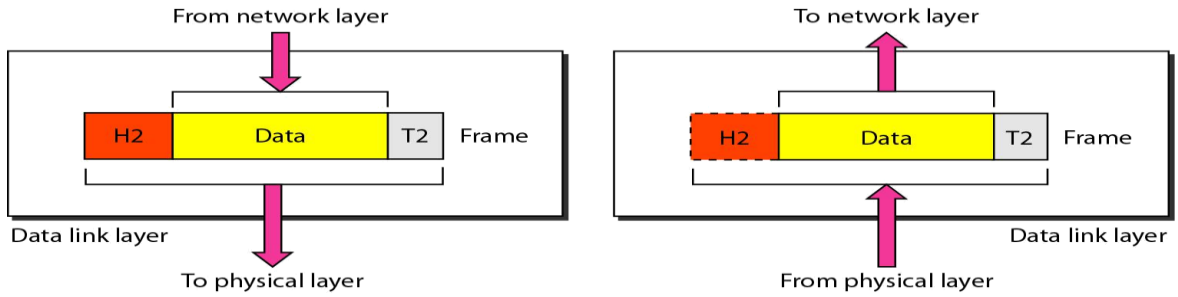
The lower 4 layers (transport, network, data link and physical —Layers 4, 3, 2, and 1) are concerned with the flow of data from end to end through the network. The upper four layers of the OSI model (application, presentation and session—Layers 7, 6 and 5) are orientated more toward services to the applications. Data is Encapsulated with the necessary protocol information as it moves down the layers before network transit.



As with any layered architecture, overhead information is added to a PDU in theform of headers and trailers. Each layer provides a service to the layer above it in the protocol specification. Each layer communicates with the same layer's software or hardwareon other computers.

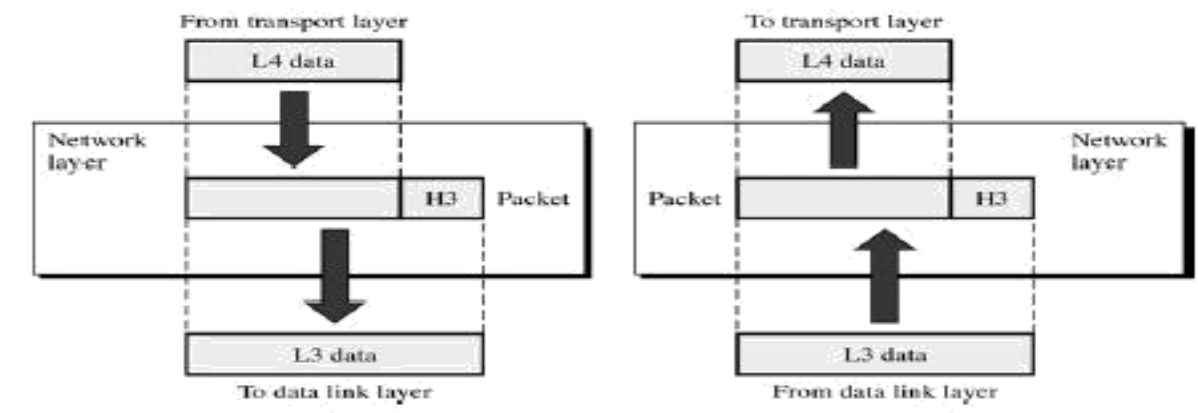
Data-link Layer ***{the data link layer is responsible for transmitting frames from one node to the next}***

The data link layer transforms the physical layer, a raw transmission facility, to a reliable link and is responsible for node-to-node delivery. It makes the physical layer appear error free to the upper layer (network layer).



Network Layer **{is responsible for the delivery of individual packets from the source host to the destination host}**

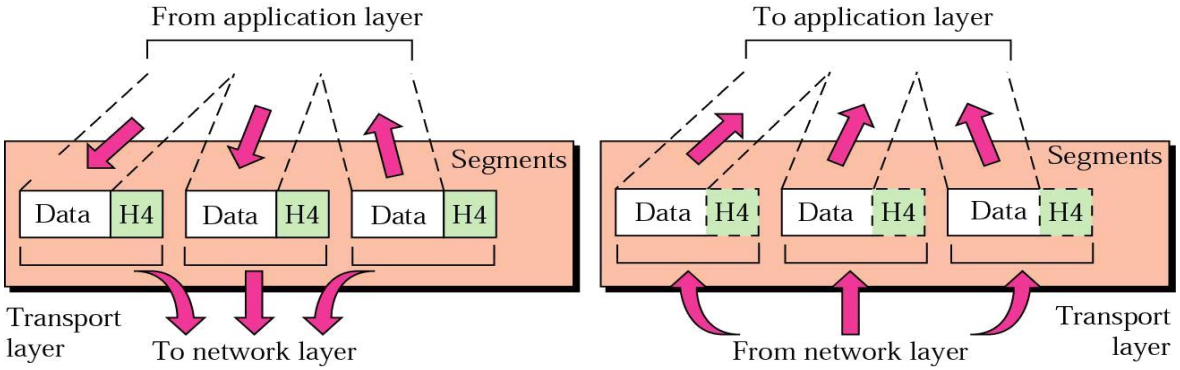
The network layer provides details that enable data to be routed between devices in an environment using multiple networks, subnetworks or both. This is responsible for addressing messages and data so they are sent to the correct destination, and for translating logical addresses and names (like a machine name FLAME) into physical addresses. This layer is also responsible for finding a path through the network to the destination computer.



The network layer provides the upper layers of the hierarchy with independence from the data transmission and switching technologies used to interconnect systems. Networking components that operate at the network layer include routers and their software.

Transport Layer {***is responsible for delivery of a message from one process to another}***

The transport layer controls and ensures the end-to-end integrity of the data message propagated through the network between two devices, providing the

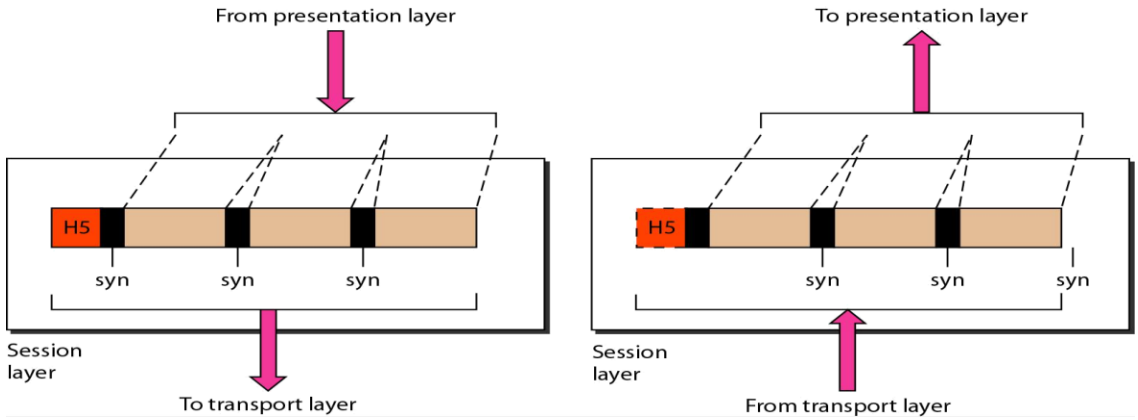


reliable, transparenttransfer of data between two endpoints.

Transport layer responsibilites includes message routing, segmenting, error recovery and two types of basic services to an upper-layer protocol: connection oriented and connectionless. The transport layer is the highest layer in the OSI hierarchy in terms of communicatons and may provide data tracking, connection flow control, sequencing of data, error checking, and application addressing and identification.

Session Layer {responsible for dialog control and synchronization}

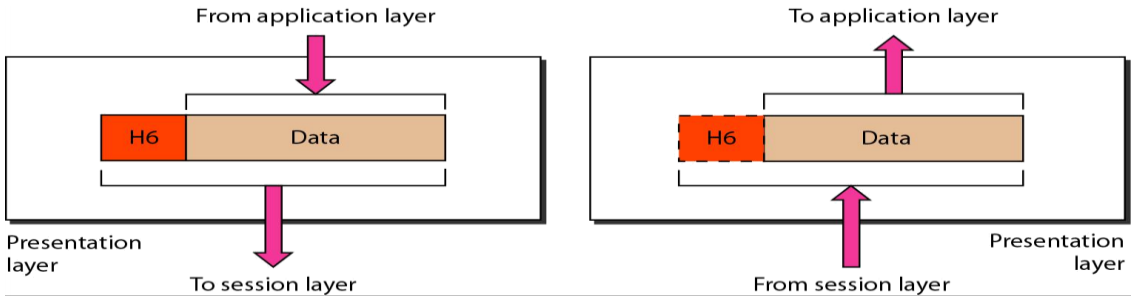
Session layer, some times called the dialog controller provides mechanism for controlling the dialogue between the two end systems. It defines how to start, control and end conversations (called sessions) between applications.



Session layer protocols provide the logical connection entities at the application layer. Theseapplications include file transfer protocols and sending email. Session responsibilities include network log-on and log-off procedures and user authentication. Session layer characteristics include virtual connections between applications, entities, synchronization ofdata flow for recovery purposes, creation of dialogue units and activity units, connection parameter negotiation, and partitioning services into functional groups.

Presentation Layer {responsible for translation, compression, and encryption}

The presentation layer provides independence to the application processes by addressing any code or syntax conversion necessary to present the data to the network in a common communications format. It specifies how end-user applications should format the data.

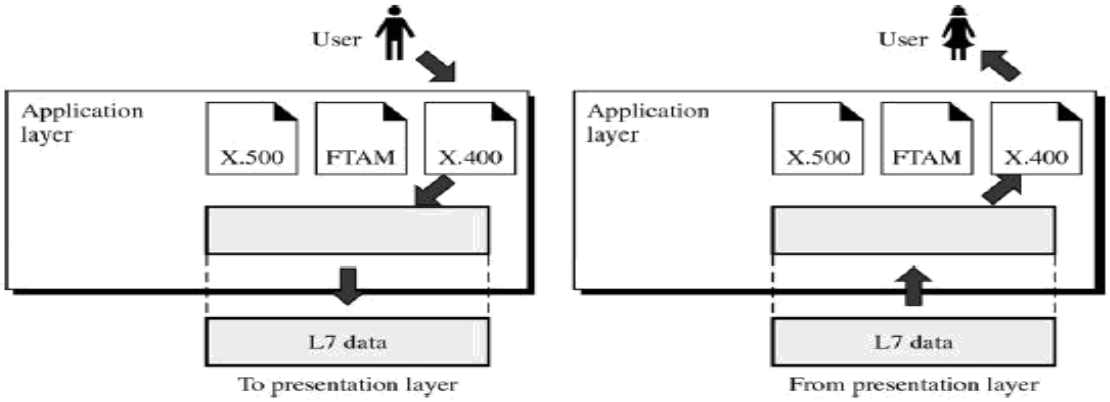


The presentation layer translated between different data formats and protocols.

Presentation functions include data file formatting, encoding, encryption and decryption of data messages, dialogue procedures, data compression algorithms, synchronization, interruption, and termination.

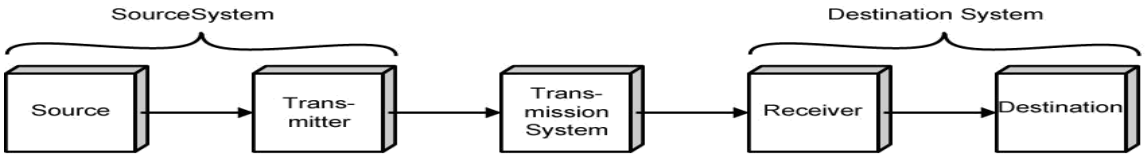
Application Layer {**responsible for providing services to the user**}

The application layer is the highest layer in the hierarchy and is analogous to the general manager of the network by providing access to the OSI environment. The applications layer provides distributed information services and controls the sequence of activities within and application and also the sequence of events between the computer application and the user of another application.



Data Communication Circuits

The underlying purpose of a digital communications circuit is to provide a transmission path between locations and to transfer digital information from one station (node, where computers or other digital equipment are located) to another using electronic circuits. Data communications circuits utilize electronic communications equipment and facilities to interconnect digital computer equipment



(a) General block diagram

(b) Example

Source: - This device generates the data to be transmitted; examples are mainframe computer, personal computer, workstation etc. The source equipment provides a means for humans to enter data into system.

Transmitter: - A transmitter transforms and encodes the information in such a way as to produce electromagnetic signals that can be transmitted across some sort of transmission system. For example, a modem takes a digital bit stream from an attached device such as a personal computer and transforms that bit stream into an analog signal that can be handled by the telephone network.

Transmission medium: - The transmission medium carries the encoded signals from the transmitter to the receiver. Different types of transmission media include free-space radio transmission (i.e. all forms of wireless transmission) and physical facilities such as metallic and optical fiber cables.

Receiver: - The receiver accepts the signal from the transmission medium and converts it into a form that can be handled by the destination device. For example, a modem will accept an analog signal coming from a network or transmission line and convert it into adigital bit stream.

Destination: - Takes the incoming data from the receiver and can be any kind of digitalequipment like the source.

Network topologies :

The network topologies are four types they are listed below

- Star topology
- Bus topology
- Ring topology
- Mesh topology
- Hybrid topology

Star topology: star topology is a network topology where each individual piece pf a network is attached to a central node component ism usually represented in a form similar to a star. Star topology is also known as star

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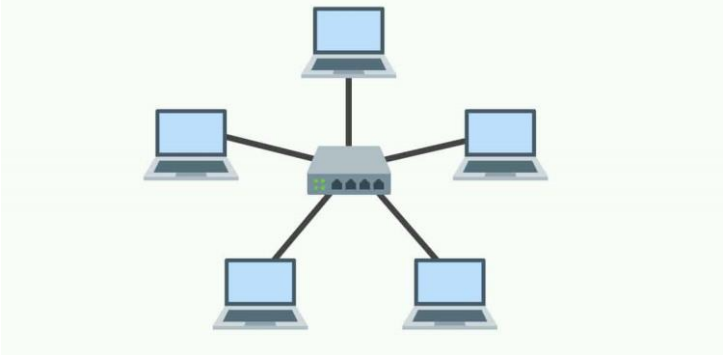


Fig : star topology

Bus topology : Bus networks use a common backbone to connect all devices. A single cable (the backbone) functions as a shared communication medium that devices attach or tap into with an interface connector.

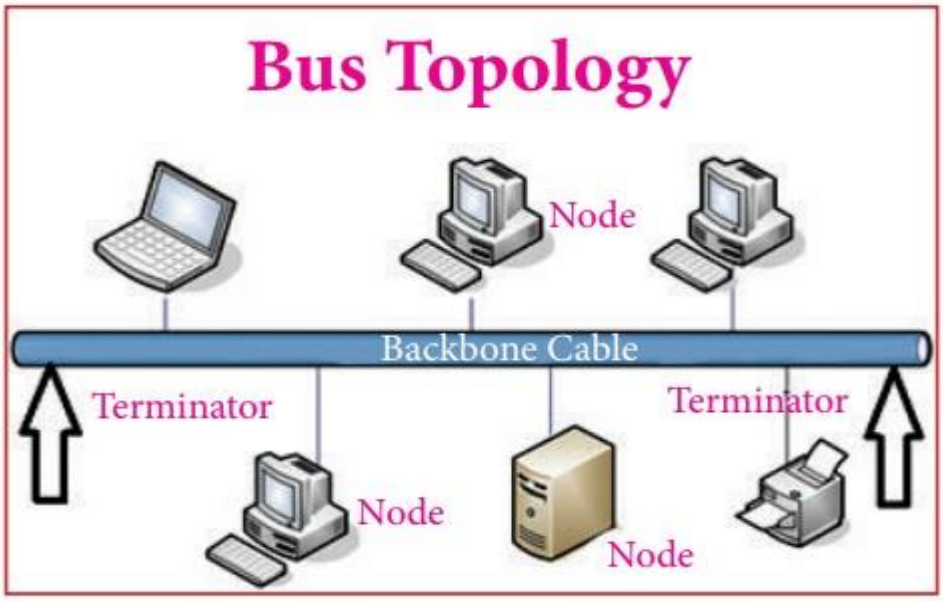


Figure 14.2 Bus Topology

Ring topology: In a ring network (sometimes called a loop), every device has exactly two neighbours for communication purposes. All messages travel through a ring in the same direction (either "clockwise" or "counter clockwise"). All the stations are interconnected in tandem (series) to form a closed loop or circle.

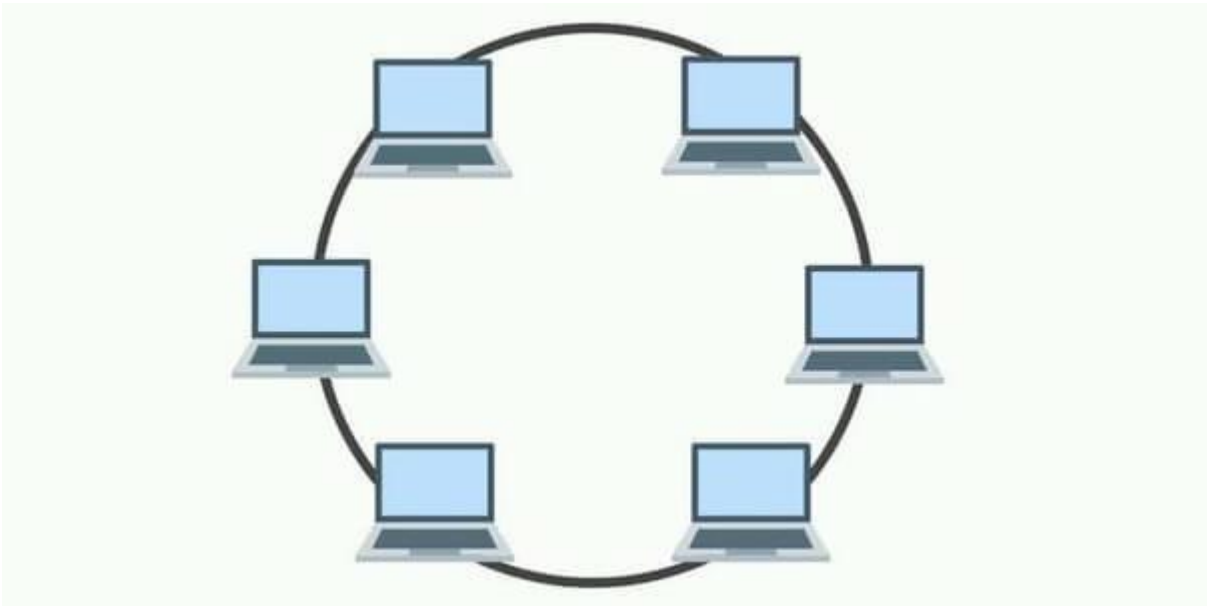


Fig : ring topology

Mesh topology: The *mesh* topology incorporates a unique network design in which each computer on the network connects to every other, creating a point-to-point connection between every device on the network. Unlike each of the previous topologies, messages sent ona mesh network can take any of several possible paths from source to destination

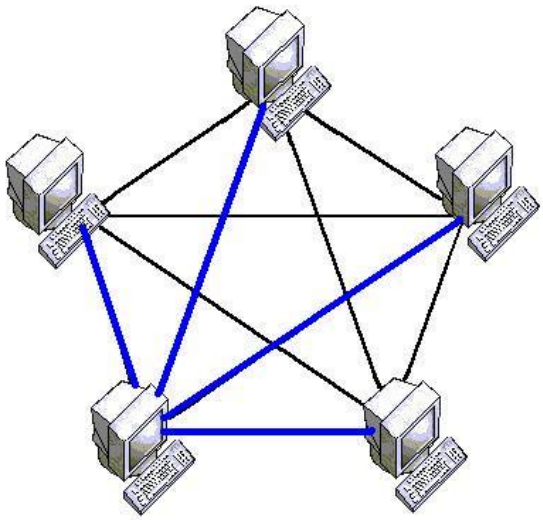
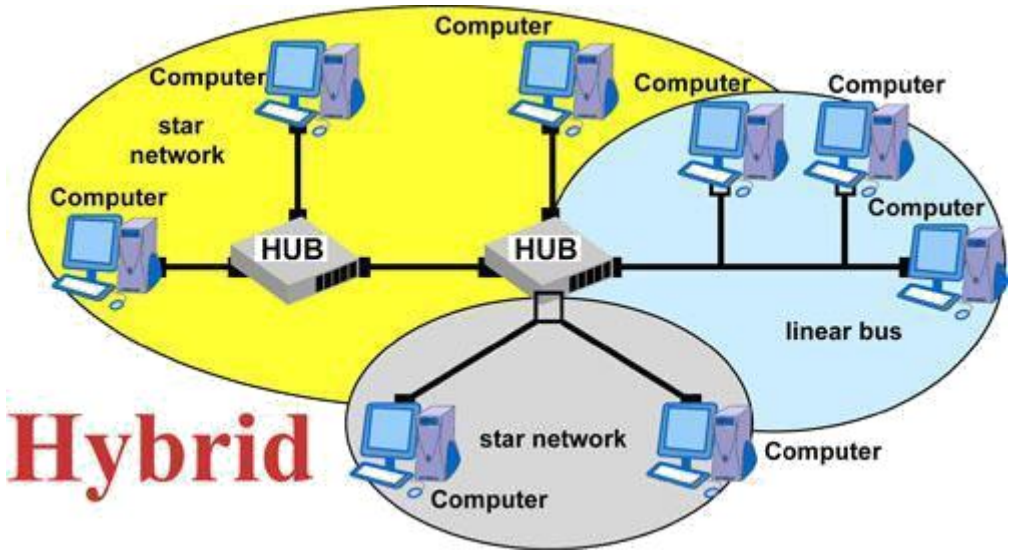


Fig : mesh topology

Hybrid topology: This topology (sometimes called mixed topology) is simply combining two or more of the traditional topologies to form a larger, more complex topology. Main aim is being able to share the advantages of different topologies.



Network Classifications

One way to categorize the different types of computer network designs is by their scope orscale. The network allows the c omputer to connect and communicate with different computers via medium. The three major types of the network designed to operate over the area they cover. These are the similarities and dissimilarities between them.

- Personal Area network (PAN)
- Local area network (LAN)
- Wireless local area network (WLAN)
- Campus area network (CAN)
- Metropolitan area network (MAN)
- Wide area network (WAN)
- Storage area network (SAN)
- System area network (SAN)

TCP/IP Protocol suite : The U.S. Department of Defense (*DoD*) created the TCP/IP reference model because it wanted a network that could survive any conditions, even a nuclear war. Transmission Control Protocol/Internet Protocol (TCP/IP) {commonly known as internet suite} model is a set of communication protocols that allow communication across multiple diversenetworks. TCP/IP is a hierarchical protocol comprised of either three or four layers.

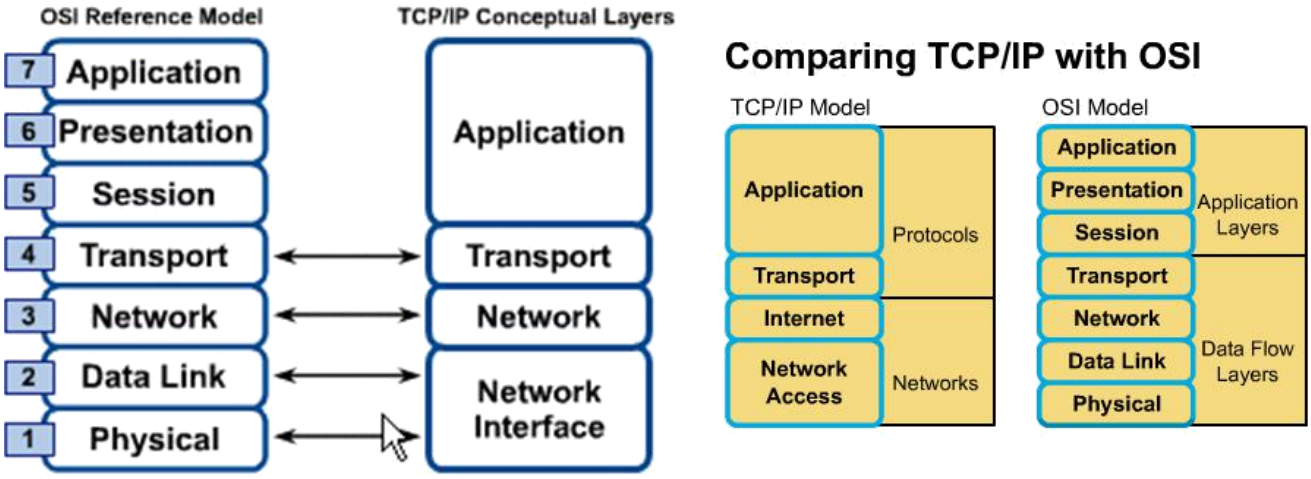


Fig: **TP/IP Protocol**