UNIT-I
Chapter-1

1-1. Define the following terms: *data, information, data communications network protocol, Connection-oriented protocols, connectionless protocol,* data communications standards, syntax and semantics?

ANSWER:

Data:-*Data* generally are defined as information that is stored in digital form. The word *data* is plural; a single unit of data is a *datum.*

Information: - *Information* is defined as knowledge or intelligence. Information that has been processed, organized and stored is called data.

Data communications network protocol: - *Data communications protocols* are sets of rules governing the orderly exchange of data within the network or a portion of the network, whereas network architecture is a set of layers and protocols that govern the operation of the network.

The list of protocols used by a system is called ***protocol stack,*** which generally includes only one protocol per layer.

Connection-oriented protocols:- Protocols can be generally classified as either *connection oriented* or *connectionless.* With a connection- oriented protocol, a logical connection is established between the endpoints (e.g.. a *virtual circuit)* prior to the transmission of data.
A connection-oriented protocol is depicted in Figure a.

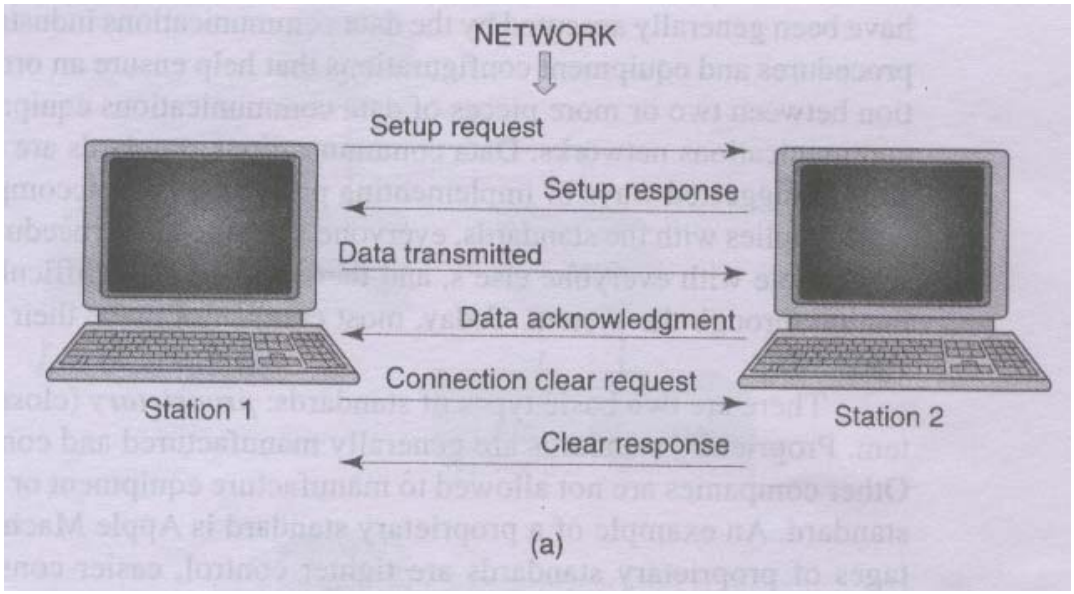
Characteristics of connection-oriented protocols include the following:

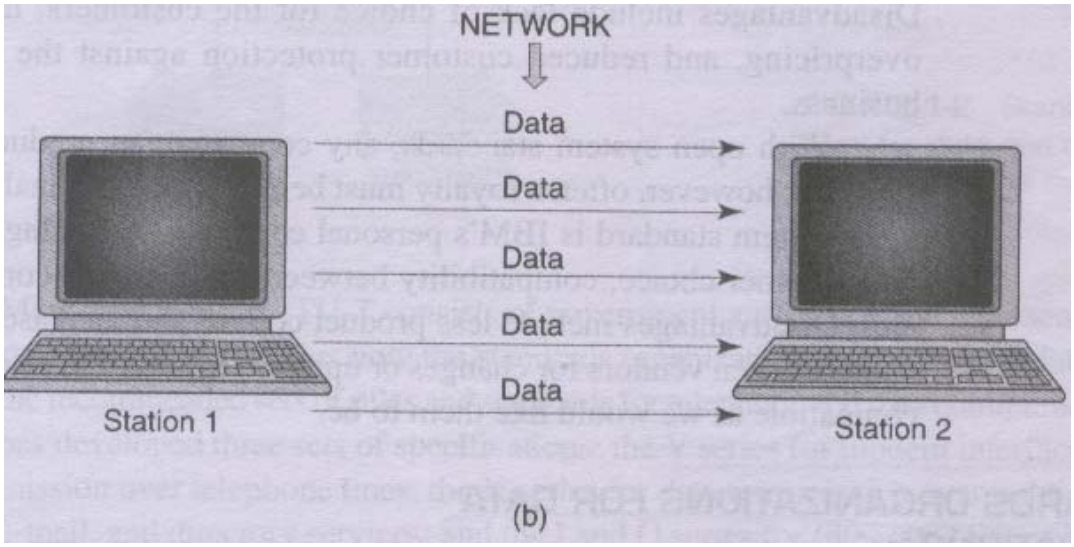
1. A connection process called a *handshake* occurs between two stations before any data are actually transmitted. Connections are sometimes referred to as *sessions, virtual circuits,* or *logical connections.*
2. Most connection-oriented protocols require some means of acknowledging the data as they are being transmitted. Protocols that use acknowledgment procedures provide a high level of network reliability.
3. Connection-oriented protocols often provide some means of error control (i.e., error detection and error correction). Whenever data are found to be in error, the receiving station requests a retransmission.
4. When a connection is no longer needed, a specific handshake drops the connection.

Connectionless protocols: **-** Connectionless protocols are protocols where data are exchanged in an unplanned fashion without prior coordination between endpoints (e.g., a datagram).connectionless protocols offer significant advantage in transmission speed.
A connectionless protocol is depicted in Figure b.

Characteristics of connectionless protocols are as follow:

1. Connectionless protocols send data with a source and destination address without a handshake to ensure that the destination is ready to receive the data.
2. Connectionless protocols usually do not support error control or acknowledgment procedures, making them a relatively unreliable method of data transmission.
3. Connectionless protocols are used because they are often more efficient, as the data being transmitted usually do not justify the extra overhead required by connection-oriented protocols.





Data communications standards:- *Data communications standards* are guidelines that have been generally accepted by the data communications industry. The guidelines outline procedures and equipment configurations that help ensure an orderly transfer of information on between two or more pieces of data communications equipment or two or more data communications networks.

Syntax:- Syntax refers to the structure or format of the data within the message, which includes the sequence in which the data are sent.

Semantics:- Semantics refers to the meaning of each section of data. For example, does a destination address identify only the location of the final destination, or does it also identify the route the data take between the sending and receiving locations?

1-2. List and describe the nine primary standards organizations for data communications.

ANSWER:-

A consortium of organizations, governments, manufacturers, and users meet on a regular bas is to ensure an orderly flow of information within data communications networks and systems by establishing guidelines and standards. Standards organizations generate, control, and administer standards. Often, competing companies will form a joint committee to create a compromised standard that is acceptable to everyone.

1. **International Standards Organization (ISO)**

Created in 1946, the *International Standards Organization* (ISO) is the international organization for standardization on a wide range of subjects. The ISO is a voluntary, non-treaty organization whose membership is comprised mainly of members from the standards committees of various governments throughout the world. The ISO creates the sets of rules and standards for graphics and document exchange and provides models for equipment and system compatibility, quality enhancement, improved productivity, and reduced costs. The ISO is responsible for endorsing and coordinating the work of the other standards organizations. The member body of the ISO from the United States is the American National Standards Institute (ANSI).

2. **International Telecommunications Union-Telecommunications Sector**

The *International Telecommunications Union-Telecommunications Sector* (ITU-T), formerly the Comité Consultatif Intemationale deTélégraphie etTdléphonie (CCI1T), is one of four permanent parts of the International Telecommunications Union based in Geneva, Switzerland. Membership in the ITU-T consists of government authorities and representatives from many countries.

The ITU-T is now the standards organization for the United Nations and develops the recommended sets of rules and standards for telephone and data communications. The ITU-T has developed three sets of specifications: the V series for modem interfacing and data transmission over telephone lines; the X series for data transmission over public digital networks, e-mail, and directory services; and the I and Q series for integrated services& digital Network (ISDN) and its extension Broadband ISDN.

The ITU-T is separated into 14 study groups that prepare recommendations on the following topics:

1. Network and service operation
2. Tariff and accounting principles
3. Telecommunications management network and network maintenance
4. Protection against electromagnetic environment effects
5. Outside plant
6. Data networks and open system communications
7. Characteristics of Telematics systems
8. Television and sound transmission
9. Language and general software aspects for telecommunications systems
10. Signaling requirements and protocols
11. End-to-end transmission performance of networks and terminals
12. General network aspects
13. Transport networks, systems, and equipment
14. Multimedia services and systems

3. **Institute of Electrical and Electronics Engineers**

The *Institute of Electrical and Electronics Engineers* (IEEE) is an international professional organization founded in the United States and is comprised of electronics, computer and communications engineers. The IEEE is currently the world's largest professional society with over 200,000 members. The IEEE works closely with ANSI to develop communications and information processing standards with the underlying goal of advancing theory, creativity, and product quality in any field associated with electrical engineering.

4. **American National Standards Institute**

The *American National Standards Institute* (ANSI) is the official standards agency for the United States and is the U.S. voting representative for the ISO. However, ANSI is a completely private, nonprofit organization comprised of equipment manufacturers and users of data processing equipment and services. Although ANSI has no affiliations with the federal government of the United States, it serves as the national coordinating institution for voluntary standardization in the United States. ANSI membership is comprised of people from professional societies, industry associations, governmental and regulatory bodies, and consumer groups.

5. **Electronics Industry Association**

The *Electronics Industry Associations* (EIA) is a nonprofit U.S. trade association that establishes and recommends industrial standards. EIA activities include standards development, increasing public awareness, and lobbying. The EIA is responsible for developing the RS (recommended standard) series of standards for data and telecommunications.

6. **Telecommunications Industry Association**

The *Telecommunications Industry Association* (TIA) is the leading trade association in the communications and information technology industry. The TIA facilitates business development opportunities and a competitive marketplace through market development, trade promotion, trade shows, domestic and international advocacy, and standards development. The TIA represents manufacturers of communications and information technology products and services providers for the global marketplace through its core competencies. The TIA also facilitates the convergence of new communications networks while working for a competitive and innovative market environment.

7. **Internet Architecture Board**

In 1957, the Advanced Research Projects Agency (ARPA), the research arm of the Department of Defense, was created in response to the Soviet Union's launching of *Sputnik.* The original purpose of ARPA was to accelerate the advancement of technologies that could possibly be useful to the U.S. military. When ARPANET was initiated in the Late 1970s, ARPA formed a committee to oversee it. In 1983, the name of the committee was changed to the *Internet Activities* Board (IAB). The meaning of the acronym was later changed to the I*nternet Activities Board.*
Today the IAB is a technical advisory group of the Internet Society with the following responsibilities:

1. Oversees the architecture protocols and procedures used by the Internet
2. Manages the processes used to create Internet standards and serves as an appeal board for complaints of improper execution of the standardization processes
3. Is responsible for the administration of the various Internet assigned numbers
4. Acts as representative for Internet Society interests in liaison relationships with other organizations concerned with standards and other technical and organizational issues relevant to the worldwide Internet

5. Acts as a source of advice and guidance to the board of trustees and officers of the Internet Society concerning technical, architectural. Procedural and policy matters pertaining to the internet and its enabling technologies

8. **Internet Engineering Task Force**

The *Internet Engineering Task Force* (IETF) is a large international community of network designers, operators. Vendors and researchers concerned with the evolution of the Internet architecture and the smooth operation of the Internet.

9. **Internet Research Task Force**

The *Internet Research Task Force* (IRTF) promotes research of importance to the evolution of the future Internet by creating focused, long-term and small research groups working on topics related to Internet protocols, applications, architecture, and technology.

1-3. Briefly describe the seven layers of the OSI protocol hierarchy.

ANSWER:

Open systems interconnection (OSI) is the name for a set of standards for communicating among computers. The primary purpose of OSI standards is to serve as a structural guideline for exchanging information between computers, workstations, and networks. The ISO seven-layer open systems interconnection model is shown in Figure 1-6.

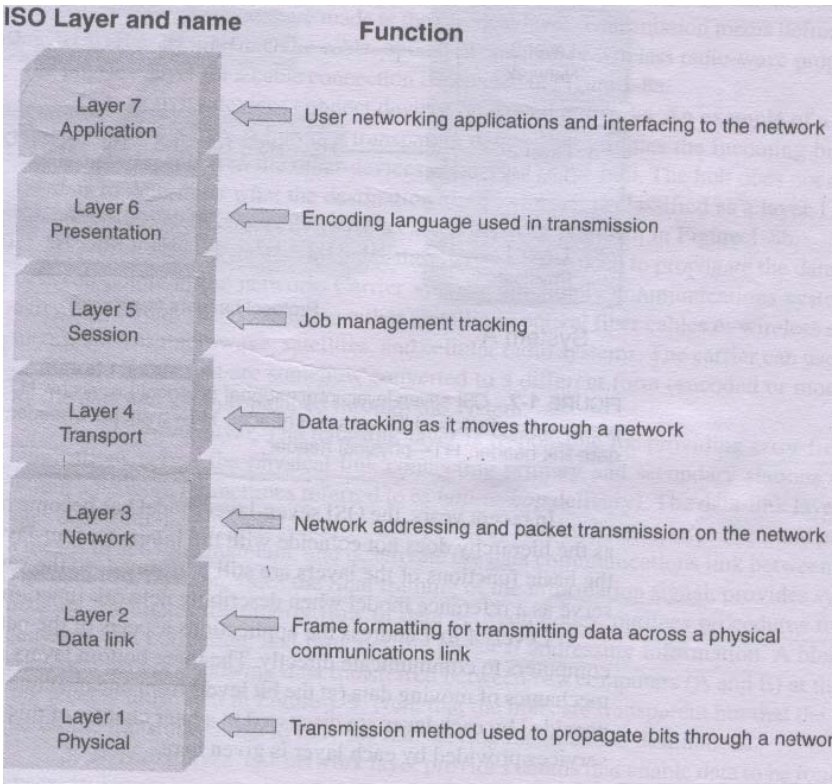


FIGURE 1-6 OSI seven-layer protocol hierarchy

1. ***Physical layer:***- The physical layer is the lowest level of the OSI hierarchy and is responsible for the actual propagation of unstructured data bits (1 s and 0s) through a transmission medium, which includes how bits are represented, the bit rate, and how bit synchronization is achieved. The physical layer specifies the type of transmission medium and the transmission mode (simplex, half duplex. or full duplex) and the physical, electrical, functional, and procedural standards for accessing data communications networks.

2. ***Data-link layer*** :-The data-link layer is responsible for providing error-free communication across the physical link connecting primary and secondary stations (nodes) within a network (sometimes referred to as *hop-to-hop d*elivery). The data-link layer packages data from the physical layer into groups called blocks, frames, or packets and provides a means to activate, maintain, and deactivate the data communications link between nodes. The data-link layer provides the final framing of the information signal provides synchronization facilitates orderly flow of data between nodes, outlines procedures for error detection and correction, and provides the physical addressing information.

3. ***Network layer:***- The network layer provides details that enable data to be routed between devices in an environment using multiple networks, sub networks, or both. Networking components that operate at the network layer include routers and their software. The network layer determines which network configuration is most appropriate for the function provided by the network and addresses and routes data within networks by establishing, maintaining, and terminating connections between them. The network layer provides the upper layers of the hierarchy with independence from the data transmission and switching technologies used to interconnect systems. It accomplishes this by defining the mechanism in which messages are broken into smaller data packets and routed from a sending node to a receiving node within a data communications network. The network layer also typically provides the source and destination network addresses (logical addresses), subnet information and source and destination node addresses.

4. ***Transport 1ayer:***- 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, transparent transfer of data between two endpoints. Transport layer responsibilities include 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 comm*unications and may provide data tracking, connection flow control, sequencing of data, error checking and application addressing and identification.

5. ***Session layer:***- The session layer is responsible for network availability (i.e.. data storage and processor capacity). Session layer protocols provide the logical connection entities at the application layer. These applications include file transfer protocols and sending e-mail. Session responsibilities include network log-on and log-off procedures and user authentication. A session is a temporary condition that exists when data are actually in the process of being transferred and does not include procedures such as call establishment, setup, or disconnect. The session layer determines the type of dialogue available (i,e., simplex, half duplex, or full duplex). Session layer characteristics include virtual connections between applications entities, synchronization of data flow for recovery purposes, creation of dialogue units and activity units, connection parameter negotiation, and partitioning services into functional groups.

6. ***Presentation layer***:-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. The presentation layer specifies how end-user applications should format the data.This layer provides for translation between local representations of data and the representation of data that will be used for transfer between end users. The results of encryption, data compression, and virtual terminals are examples of the translation service. The presentation layer translates 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.

7. ***Application layer:***- 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 an application and also the sequence of events between the computer application and the user of another application.

1-4. List and briefly describe the basic functions of the five components of a data communications circuit.

ANSWER:

The underlying purpose of a data communications circuit is to provide a transmission path between locations and to transfer digital information from one station to another using electronic circuit.

Figure 1- l5shows a simplified block diagram of a two-station data communications circuit. The fundamental components of the circuit are source of digital information, transmitter, transmission medium, receiver, and destination for the digital information.

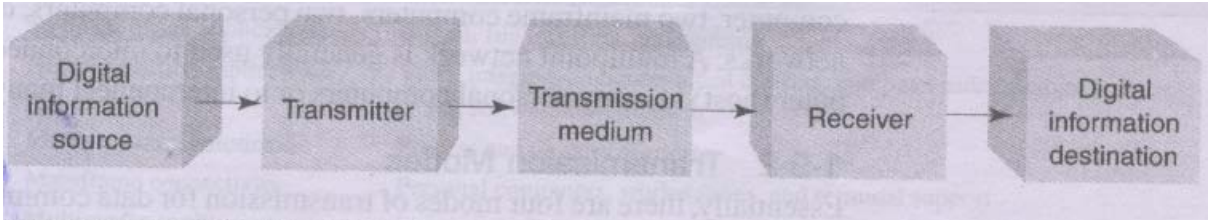


FIGURE 1-15 Simplified block diagram of a two-station data communications circuit

Source:-The information source generates data and could be a mainframe computer, personal computer, workstation, or virtually any other piece of digital equipment. The source equipment provides a means for humans to enter data into the system.

Transmitter:- Source data is seldom in a form suitable to propagate through the transmission medium. For example, digital signals (pulses) cannot be propagated through a wireless radio system without being converted to analog first. The transmitter enc odes the source information and converts it to a different form, allowing it to be more efficiently propagated through the transmission medium. In essence, the transmitter acts as an interface between_the source equipment and the transmission medium.

Transmission medium:- The transmission medium carries the encoded signals from the transmitter to the receiver. There are many different types of transmission media, such as free-space radio transmission (including all forms of wireless transmission, such as terrestrial microwave, satellite radio, and cellular telephone) and physical facilities, such as metallic and optical fiber cables. Very often, the transmission path is comprised of several different types of transmission facilities.

Receiver:- The receiver converts the encoded signals received from the transmission medium back to their original form (i.e.. decodes them) or whatever form is used in !e destination equipment. The receiver acts as an interface between the transmission medium and the destination equipment.

Destination:-. Like the source, the destination could be a mainframe computer, personal computer, workstation, or virtually any other piece of digital equipment.

1-5. Briefly describe the differences between serial and parallel data transmission.

ANSWER:

Binary information can be transmitted either in **parallel** or **serially**.

Figure 1-16a shows how the binary code 0110 is transmitted from station A to station B in parallel. As the figure shows, each bit position (A0 to A3) has its own transmission line. Consequently, all four bits can be transmitted simultaneously during the time of a single clock pulse ***(Ta).*** This type of transmission is called *parallel by bit* or ***serial by character***

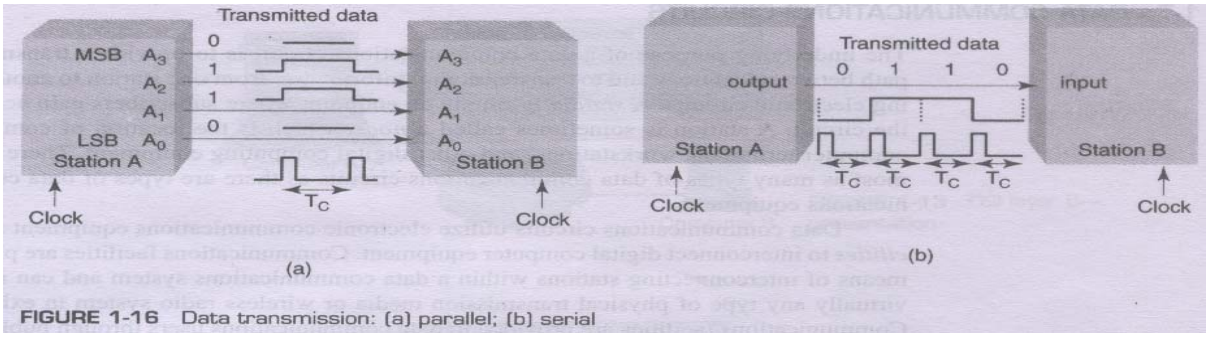


FIGURE 1-16 Data transmission: (a) parallel; (b) serial

Figure l-16b shows the same binary code transmitted serially. As the figure shows, there is a single transmission line, and thus only one bit can be transmitted at a time. Consequently, it requires four clock pulses ***(4Tc)*** to transmit the entire four-bit code. This type of transmission is called *serial by bit.* Obviously, the principal trade-off between parallel and serial data transmission is speed versus simplicity. Data transmission can be accomplished much more rapidly using parallel transmission; however, parallel transmission requires more data lines. As a general rule, parallel transmission is used for short-distance data communications and within a computer, and serial transmission is used for long-distance data communications.

1-6. List and briefly describe the four transmission modes.

ANSWER:

Simplex:- In the simplex (SX) mode, data transmission is unidirectional. Simplex lines are also called *receive-only, or transmit -only,* or *one-way-only* lines. Commercial radio broadcasting is an example of simplex transmission, as information is propagated in only one direction—from the broadcasting station to the listener.

Half duplex:-. In the half-duplex (HDX) mode, data transmission is possible in both directions but not at the same time. Half-duplex communications lines are also called *two-way-alternate* or *either-way* lines. Citizens band (CB) radio is an example of half-duplex transmission because to send a message, the *push-to-talk* (PTT) switch must be depressed, which turns on the transmitter and shuts off the receiver. To receive a message, the PTT switch must be off, which shuts off the transmitter and turns on the receiver.

Full duplex:- In the full-duplex (FDX) mode, transmissions are possible in both directions simultaneously, but they must be between the same two stations. Full duplex lines are also called t*wo-way simultaneous, duplex,-or bath-way* lines.

A local telephone call is an example of full-duplex transmission. Although it is unlikely that both parties would be talking at the same time, they could if they wanted to.

Full/full duplex:- In the full/full duplex (F/FDX) mode, transmission is possible in both directions at the same time but not between the same two stations (i.e., one station is transmitting to a second station and receiving from a third station at the same time). Full/full duplex is possible only on multipoint circuits. The U.S. postal system is an example of full/full duplex transmission because a person can send a letter to one address and receive a letter from another address at the same time.

1-7. List and describe the functions of the most common components of a computer network.

ANSWER:

Computer networks all share common devices, functions, and features, including servers, clients, transmission media, shared data, shared printers and other peripherals, hardware and software resources, network interface card (NIC), local operating system (LOS), and the network operating system (NOS).

Servers:- *Servers* are computers that hold shared files programs, and the Network Operating System. Servers provide access to network resources to all the users of the network. There are many different kinds of servers, and one server can provide several functions. For example, there are file servers, print servers, mail servers, communications servers, database servers, directory/security servers, fax servers, and Web servers, to name a few.

Clients:- *Clients* are computers that access and use the network and shared network resources. Client computers are basically the customers (users) of the network, as they request and receive services from the servers.

Transmission media:- *Transmission media* are the facilities used to inter connect computers in a network, such as twisted-pair wire, coaxial cable, and optical fiber cable. Transmission media are sometimes called channels, links, or lines.

Shared data:- *Shared data* are data that file servers provide to clients, such as data files, printer access programs, and e-mail.

Shared printers and other peripherals:- *Shared printers* and *peripherals* are hardware resources provided to the users of the network by servers. Resources provided include data files, printers, software, or any other items used by clients on the network.

Network interface card:- Each computer in a network has a special expansion card called a *network interface* card (NIC). The NIC prepares (formats) and sends data, receives data, and controls data flow between the computer and the network. On the transmit *side,* the NIC passes frames of data on 10 the physical layer, which transmits the data to the physical link. On the receive side, the NIC processes bits received from the physical layer and processes the message based on its contents.

Local operating system:- A *local operating system* (LOS) allows personal computers to access files, print to a local printer, and have and use one or more disk and CD drives that are located on the computer. Examples of LOSs are MS-DOS. PC-DOS, Unix, Macintosh, OS/2, Windows 3.11, Windows *95,* Windows 98, Windows 2000, and Linux.

Network operating system:- The *network operating system* (NOS) is a program that runs on computers and servers that allows the computers to communicate over a network. The NOS provides services to clients such as log-in features, password authentication, printer access, network administration functions, and date file sharing. Some of the more popular network operating systems are Unix, Novell NetWare, AppleShare, Macintosh System 7, IBM LAN Server, Compaq Open VMS, and Microsoft Windows NT Server. The NOS is software that makes communications over a network more manageable.

1-8. List and briefly describe the five basic data communications network topologies.

ANSWER:

Star topology:- A *star topology* is a multipoint data communications network where remote stations are connected by cable segments directly to a centrally located computer called a *hub,* which acts like a multipoint connector. With a star topology, remote stations cannot communicate directly with one another, so they must relay information through the hub. Hubs also have store-and-forward capabilities, enabling them to handle more than one message at a time.

Bus topology:- A *bus topology* is a multipoint data communications circuit that makes it relatively simple to control data flow between and among the computers because this configuration allows all stations to receive every transmission over the network. With a bus topology, all the remote stations are physically or logically connected to a single transmission line called a *bus.* The two ends of the transmission Line never touch to form a complete loop. A bus topology is sometimes called *multi drop* or *linear bus,* and all stations share a common transmission medium. The bus topology is sometimes called a *horizontal bus*.

Ring topology:- A *ring topology* is a multipoint data communications network where all stations are interconnected in tandem (series) to form a closed loop or circle. A ring topology is sometimes called a *loop.* Each station in the loop is joined by point- to-point links to two other stations (the transmitter of one and the receiver of the other). Transmissions are unidirectional and must propagate through all the stations in the loop. Each computer acts like a repeater in that it receives signals from down-line computers and then retransmits them to up-line computers. The ring topology is similar to the bus and star topologies, as it generally involves one centrally located host computer that controls data flow to and from the other stations.

Mesh topology:- In a *mesh topology,* every station has a direct two- point communications link to every other station on the circuit. The mesh topology is sometimes called *fully connected.* A disadvantage of a mesh topology is a fully connected circuit requires $n(n-1)/2$ physical transmission paths to interconnect n stations and each station must have $n-1$ input output ports. Advantages of a mesh topology are reduced traffic problems, increased reliability, and enhanced security.

Hybrid topology:- A *hybrid topology* is simply combining two or more of the traditional topologies to form a larger, more complex topology. Hybrid topologies are sometimes called *mixed topologies.*

1-9. Briefly describe the TCP/IP protocol model.

ANSWER

The functional layers of the OSI seven-layer protocol hierarchy do not line up well with certain data communications applications, such as the Internet. Because of this, there are several other protocols that see widespread use, such as TCP/IP and the Cisco three-layer hierarchical model.

TCP/IP Protocol Suite:-

The *TCP/IP protocol suite (transmission control protocol/Internet protocol)* was actually developed by the Department of Defense before the inception of the seven-layer OSI model. TCP/IP is comprised of several interactive modules that provide specific functionality without necessarily operating independent of one another. The OSI seven layer models specifies exactly which function each layer performs, whereas TCP/IP is comprised of several relatively independent protocols that can be combined in many ways, depending on system needs. Depending on whose definition you use, TCP/IP is a hierarchical protocol comprised of either three or four layers.

The three-layer version of TCP/IP contains the *network, transport,* and *application* layers that reside above two lower-layer protocols that are not specified by TCP/IP (the physical and data link layers).

The network layer of TCP/IP provides internetworking functions similar to those provided by the network layer of the OSI network model. The network layer is sometimes called the *internetwork layer* or *internet layer.*

The transport layer of TCP/IP contains two protocols: TCP (transmission control protocol) and UDP (user datagram protocol). TCP functions go beyond those specified by the transport layer of the OSI model, as they define several tasks defined for the session layer.

The applications layer of TCP/IP contains several other protocols that users and programs utilize to perform the functions of the three uppermost layers of the OSI hierarchy (i.e.. the applications, presentation. and session layers).

The four-layer version of TCP/IP specifies the network access, Internet, host-to-host, and process layers:

Network access layer Provides a means of physically delivering data packets using frames or cells

Internet layer Contains information that pertains to how data can be routed through the *network*

Host-to-host layer Services the process and Internet layers to handle the reliability and session aspects of data transmission

Process layer Provides applications support TCP/IP is probably the dominant communications protocol in use today. It provides a common denominator, allowing many different types of devices to communicate over a network or system of networks while supporting a wide variety of applications.

1-10. Briefly describe the Cisco three-layer protocol model.

ANSWER:

Cisco Three-Layer Model

Cisco defines a three-layer logical hierarchy that specifies where things belong, how they fit together, and what functions go where. The three layers are the core, distribution, and access: ***Core layer:-*** The core layer is literally the core of the network, as it resides at the top of the hierarchy and is responsible for transporting large amounts of data traffic reliably and quickly. The only purpose of the core layer is to switch traffic as quickly as possible.

Distribution layer:-. The distribution layer is sometimes called the ***workgroup layer.*** The distribution layer is the communications point between the access and the core layers that provides routing, filtering, WAN access, and how many data packets are allowed to access the core layer. The distribution layer determines the fastest way to handle service requests; for example, the fastest way to forward a file request to a server. Several functions are performed at the distribution level:

1. Implementation of tools such as access lists, packet filtering, and queuing
2. Implementation of security and network policies, including firewalls and address translation
3. Redistribution between routing protocols
4. Routing between virtual LANs and other workgroup support functions
5. Definition of broadcast and multicast domains

Access layer:- The access layer controls workgroup and individual user access to internetworking resources, most of which are available locally. The access layer is sometimes called the ***desktop layer.*** Several functions are performed at the access layer level:

1. Access Control
2. Creation of separate collision domains (segmentation)
3. Workgroup connectivity into the distribution layer