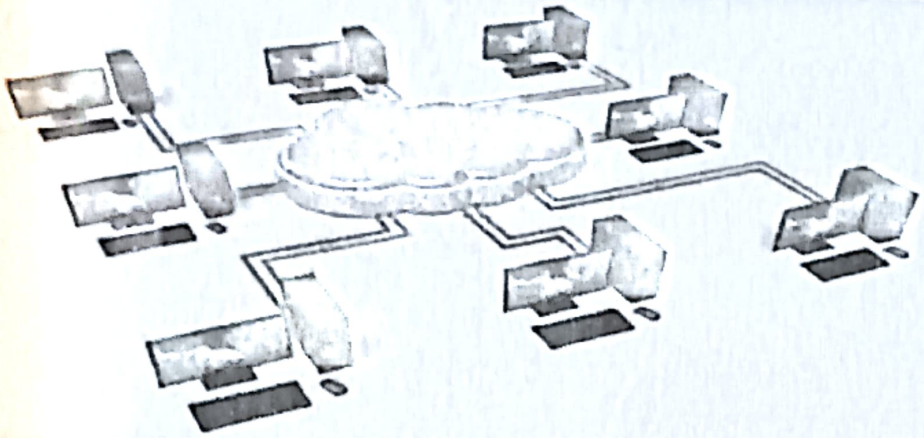

2

REFERENCE MODELS OF NETWORK

INTRODUCTION

- The Problem of getting a computer of one brand to accept the data created by another manufacture's machine has confornted users of these machine since their earlier days.
- At that time the only practical way around this barrier was to retype the data from the computer into the second.
- This is very time consuming procedure and has the chance of lot of errors.
- As the computer proliferated, interfaces or adapters we are inverted that translated one machines code into a form that other could understand altering a variety of computers to be hooked together in a network.
- But these interfaces were expensive both in agreegate because a subsantial number of them needed to establish a large network, and singly, because each type of computer needed an interface of its own.
- As a result there was little opportunity to spread the cost of developing given interfaces by selling many copies of it.
- Networking would be facilitated and the expense much reduced if computer manufactures could agree on how to construct their products, so that each could communicate with the other.

- Toward the end, in 1977, the Genva-based international organization for standardization set forth the open system interconnection (OSI) model.
- A master plan computer to computer dialogue, the OSI model devides the communications process into seven layer.
- The model sets standards that permit a wide variety in the design of computer hardware and software.

OSI MODEL

- An open system interconnection (OSI) covers all the aspects of ISO (International standard organisation).
- An open system is a model that allows any two different system to communicate regardless of their underlying architecture.
- OSI model is not a protocol but it is a model for understanding and designing the network architecture that is flexible robust and inter-operable.

2.1 NETWORK ARCHITECTURE MODELS

- The layered concept of network architecture was built into many systems but the protocols used and interface standards were different for them.
- The layered partitioning were also different and were not matching in all of them. So there was an integration in compatibility of architectures developed by different vendors. It was realised later that standardization of network architecture can solve many problems and save a lot of effort required for developing interfaces for networking different architectures.
- Several network architectures were developed by standardization organizations by manufacturers.
- Some of the important standard architectures are :
  * Open system Interconnection (OSI) reference model developed by ISO and CCITT.
  * Prime computers Network (PRIMENET)
  * IBM's System Network Architecture (SNA)

* Digitals Digital Network Architecture (DNA)
* Burroughs Networks Architecture (BNA)

- Among various layered architectures the OSI model has been accepted as an international standard. Let us discuss it in more detail.

2.2 OSI REFERENCE MODEL

- This layered network architecture model was developed by International Organization for standardization (ISO) and consultative committee for international Telephone and Telegraph (CCITT).
- The development of open system interconnection was the first step towards standardization.
- It provides a general concept of inter process communication in such a way that any open system may communication with anther open system technically without any problems.
- Here open system means a system that can be inter connected to other system according to established standards i.e. architecture and protocols.
- It is a seven layered architecture model. In the model the communication process is decomposed into hierarchical functional layers.
- It also identifies the standards necessary for open system interconnections and provides a common basis for co-ordination of standards development.
- In this model the LAN communications are divided into seven layers and each layer is insulated from the others by a well defined interface.
- Fig. 2.1 shows the seven layered Architecture of OSI models along with protocols and interfaces.
- The seven layers of ISO model of OSI model are
  * Physical layer
  * Data link layer
  * Network layer
  * Transport layer
  * Session layer

* Presentation layer
* Application layer

The model is designed in a highly structured way. It defines a separate set of protocols for each layer and hence each layer has a specific independent function. The goals of OSI model are.

2.2.1 Goals of OSI Model

* To provide Standards for communications between computers/ systems.
* To remove technical hindrance and stammering of communication between systems.
* To define points of interconnection for the exchange of information between systems.
* To increase ability to communicate.

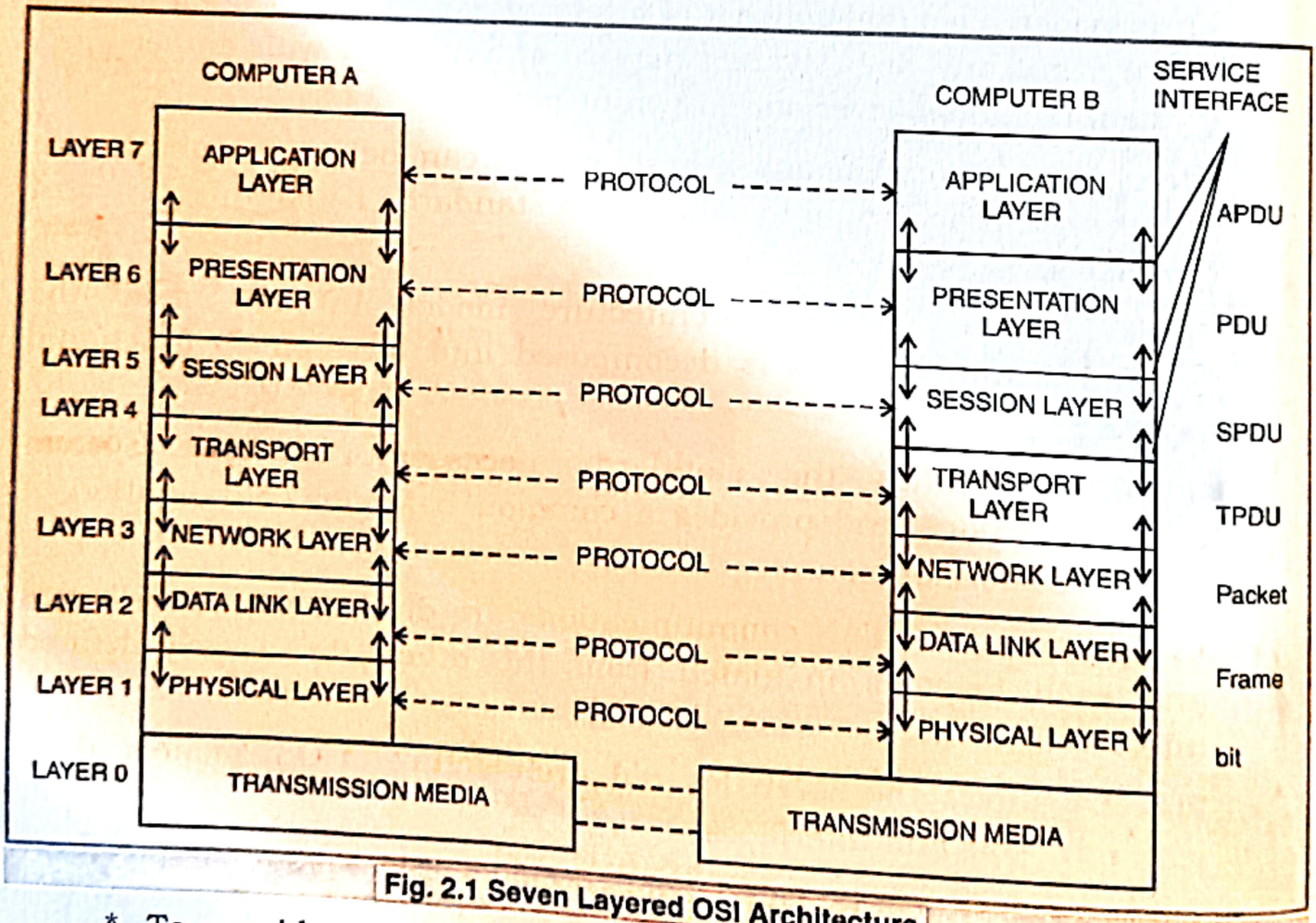

Fig. 2.1 Seven Layered OSI Architecture

* To provide a reasonable point of departure from the standards in case they do not meet all needs.
* To prevent user from description of internal operation during communication, of a single system.

- The International Organization for standardization (ISO) began developing the open system interconnection (OSI) references in1977.
- It has become the most widely accepted model for understanding network communication.
- In the OSI model nothing is tangible; it is simply conceptual framework which can be used to better understand the complex interaction taking place among the various devices on a network.
- The OSI model does not perform any function in the communication process.
- The actual work is done by the appropriate software and hardware. The OSI model simply defines which tasks need to be done and which protocols will handle those tasks.
- The OSI model divides communication tasks into smaller pieces called subtasks.
- Protocols implementations are computer processes that relate to these subtasks.
- Specific protocols fulfill subtasks at specific layers of the OSI model.
- When these protocols are grouped together to complete the a whole tasks, is "protocol stack." A protocols stack is a group of protocols arranged on top of each other as part of communication process.
- Each layer of OSI model has different protocols associated with it.
- Each layer in the protocol stack receives services from the layer below and provides services to the layer above.

Let us discuss the seven layers in brief.

1. Physical Layer :

- This is the lowest layer in the model.
- This layer is responsible for activating, maintaining and deactivating a physical circuit between two end systems.
- It specifies the mechanical (Physical) and electrical characteristics of interfaces and connections composing the network.
- It deals with mechanical, procedural, electrical and functional characteristics of transmission media. Thus it can be think of as a hardware layer.
- The layer exists as chips, network adapters (PCB's) and cables.

- The actual data transfer takes place between physical layers of sender and receiver stations.
- The Physical Layer is simply responsible for sending bits (bits are binary 1's and 0's of a digital communication) from one computer to another.
- The physical layer is not concerned with the meaning of bits; instead it deal with the physical connection to the network and with transmission and reception of the signal.
- This level defines physical and electrical details, such as what will represent 1 or 0, how many pins a network connector have, how data will be synchronized and what the network adapter may or may not transmit the data.
- "Passive hubs", simple active hub, terminators, couplers , cables, connectors, repeater, multiplexers, transmitter and Tran receives are devices associated with physical layer.

The following are the items are addressed at the physical layer:

- Network connection types, including multipoint and point to point connection.
- Physical topologies, which are physical layouts of the networks, such as bus, start or ring.
- Analog and digital signaling, which include several methods for encoding data in analog and digital signals.
- Bit synchronization, which deals with synchronization between sender and receiver.

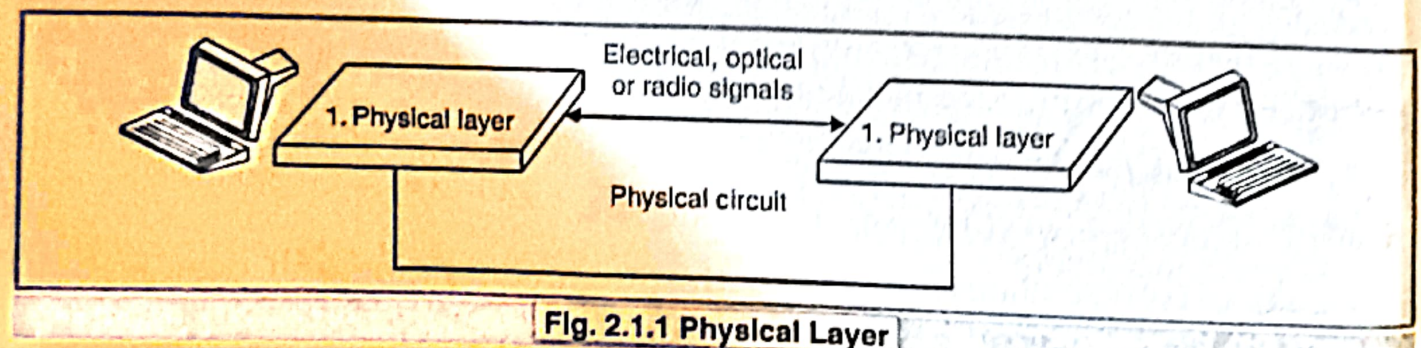

Fig. 2.1.1 Physical Layer

- Baseband and broadband transmission, which are different methods for using media bandwidth.
- Multiplexing which involves combining several data channels into one.
- Termination, which prevents signals from reflecting back through the cable and causing signal and packets errors. It also indicates the last in a network segment.

2. Data link layer :

- This layer is responsible for the transfer of data over the channel.
- At this stage of processing the electrical impulses enter or leave the transmission media or cable.
- The electrical representation of data message i.e. bit patterns, tokens, frames, encoding methods etc. are known to this layer only.
- This layer is responsible for establishing an error free communications path between systems over the physical channel.
- It provides synchronization and identity of bits.
- It also ensures safe arrival of data at receiving end.
- It also provides flow control and prevents overburdening of receiver with too much data at any instant.
- It detects the transmission errors and provides mechanism for recovery of the lost erroneous or duplicated data.
- **It splits data packet into data frames which are transmitted by sender. Acknowledgements are transmitted by receivers for data frames. Error detections and error correction are performed at this layer.**
- Two sub layers of this layer are Media Accessed Control (MAC) and Logical Link Control (LLC).
- The data link layer provides for the flow of data over a single link from one device to another .
- It accepts packets from the network layer and packages the information into data units called frames to be presented to physical layer for transmission.
- The data link layer adds control information, such as frame type, routing and segmentation information to data being sent.
- This layer provides for error free transfer of frames from one computer to another.
- A Cyclic Redundancy Check(CRC) added to the data frame can detect damaged frames and the data link layer in the receiving computer can request that the information be present.
- The data link layer can also detect when frames are lost and request that those frames be sent again.
- The data link layer recognizes frames for which the destination ID matches the computer and discards other packets.

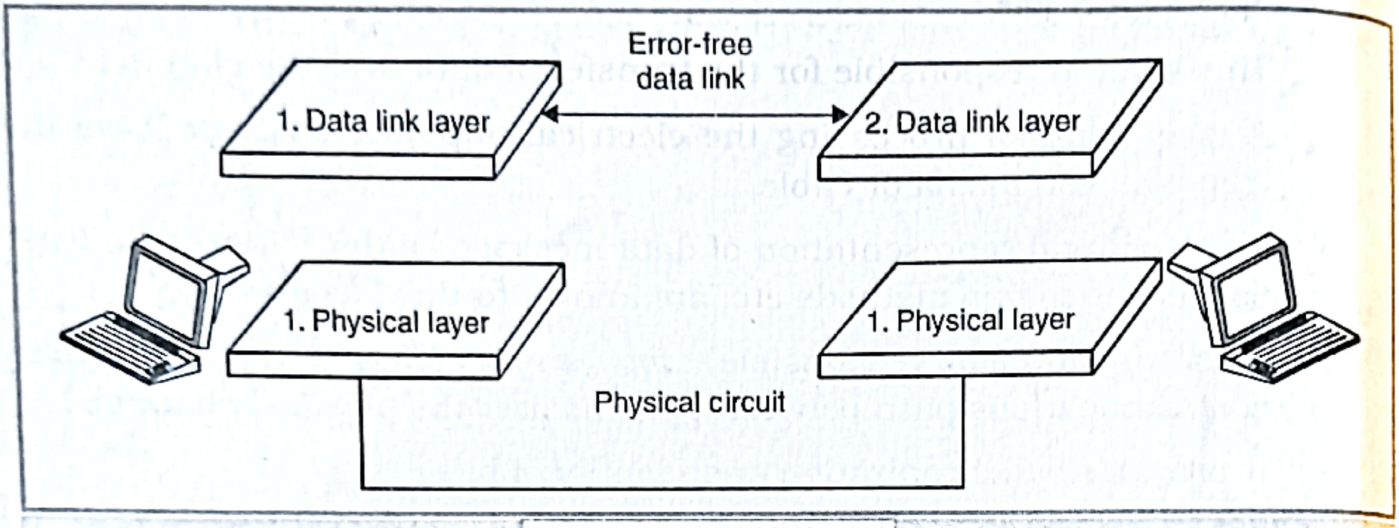

Fig. 2.1.2 Data Link Layer

"Bridges, intelligent hubs and network interface cards are devices typically associated with data link layer."

The data link layer splits into two sublayers.

- Logical Link Control(LLC), which controls establishes and maintains links between the communicating devices.
- Media Access Control (MAC), which controls the way multiple devices share the same media channel.

- The logical link control sub-layer provides Service Access Points(SAP) that other computers can refer to and use to transfer information from the logical link control sub-layer to upper ISO layer.
- The media access control sub layer, the lower of the two sub layers, provides for shared access to the network adapter and communication directly with network interface cards.
- Network interface cards have a unique 12 hexadecimal MAC address assigned. The MAC addresses are used to establish the logical link between computers on the same LAN.

3. Network Layer :

- The network layer establishes a logical connection between sender and user by providing a logical path between them.
- This layer switches and routes message packets as necessary to get them to their destination. The layer is responsible for addressing and delivering message packets.
- The layer is rich in functions.
- **Network layer makes routing decisions and forwards the packets for devices that are farther away than a single link.**

- A link connects two networks devices and is implemented by the data link layer.
- Two devices connected by a link communicate directly with each other and not through a direct third device.
- In larger networks there may be intermediate systems between the two systems, and the network layer make possible for the transport layer and the layer above it to send packets without being concerned about whether the end system is immediately adjacent or several hops away.
- The network layer translates logical network address into physical machine addresses.
- This layer also determines the quality of service and route a message will take if there are several ways a message can get to its destination.
- The network layer also may break large packets into small chunks if the packet is larger than the largest data frame the data link layer accept.
- The network reassembles the chunks into packets at receiving end.
- Intermediate systems that perform only routing and relaying functions and do not provide an environment for executing user program can implement just the first three OSI network layers.
- The network layer performs several important functions that enable data to arrive at its destination.

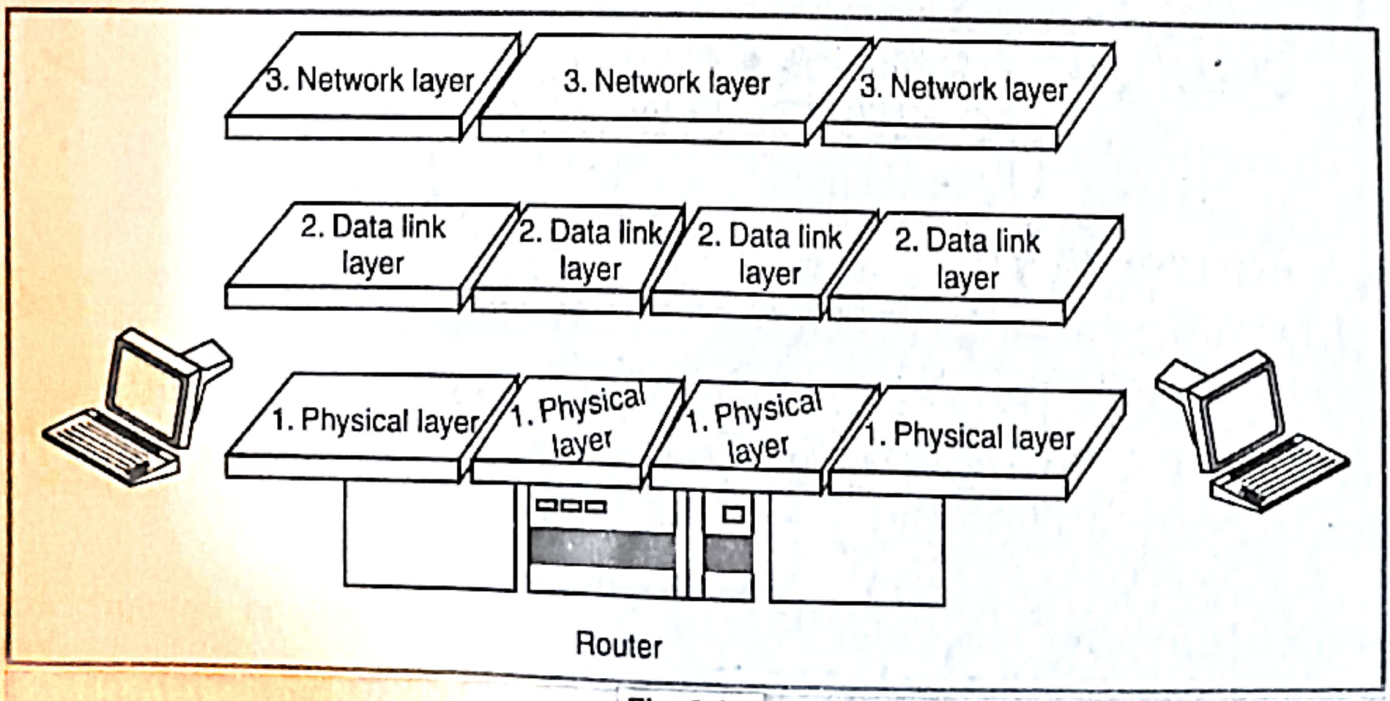

Fig. 2.1.3

- The protocol at this layer may choose a specific route through an inter network to avoid the excess traffic caused by sending data over network and segments that do not need to access to it. "routers and gateways operate in the network layer."
- The network layer serves to support communication between logically separate networks. This layer is concerned with the following.
  - Addressing, including logical network addresses and services addresses.
  - Circuit, message and packet switching.
  - Connection services including network layer flow control, network layer error control, and packet sequence control.
  - Gateway services.

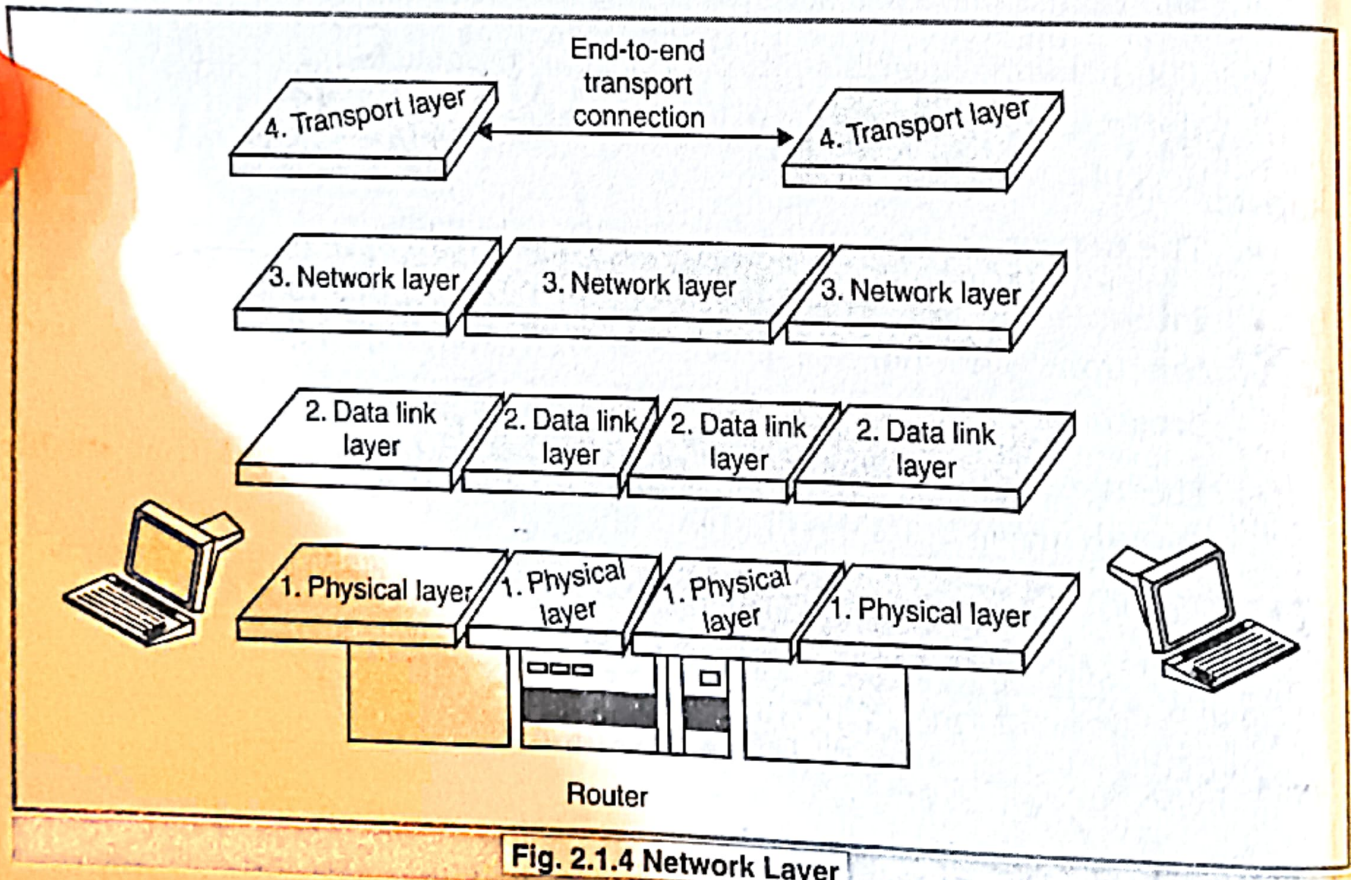

Fig. 2.1.4 Network Layer

4. Transport Layer :

- This layer provides control standards for a communication session for enabling processes to exchange data reliably and in a sequential manner.
- It provides interfacing between data communications network and upper three layers.

- It gives the user option in obtaining certain levels of quality and cost from the network layer.
- It isolates the user from physical and functional aspects of the packet network.
- It controls the sequencing of the message components and regulates in bound traffic flow during processing of more than one packets at a time.
- At the same time if a duplicate packet arrives the layer recognizes it and discards it.
- The transport layer ensures that packets are delivered error free in sequence and with no losses or duplication.
- The transport layer breaks large messages from the session layer into packets to be sent to the destination computer and reassembles packets into messages to be presented to the session layer.
- The transport layer typically sends an acknowledgement to the originator for the message received.

5. Session Layer :

- This layer provides establishing maintaining and terminating a session or dialogue between two end systems.
- It enables the applications running at two work stations to co-ordinate into a single session.
- It creates the session, manages the packets sent back and forth during the session and terminates the session.
- The dialogue type/session type is also specified by it i.e. whether simplex, duplex or half duplex.
- It also regulates the direction of message flow. It also defines synchronization points for intermediate checks and recovery for file transfers.
- The session layer allows applications on separate computers to share a connection called a session.
- This layer provides services such as name look up and security to allow two programs to find each other and establish the communication link.

- The session layer also provides for data synchronization and check pointing so that in the event of the network failure, only the data sent after the point of failure need be resent.
- This layer also the controls the dialog between two processes determining who can transmit and who can receive at what point during the communication.

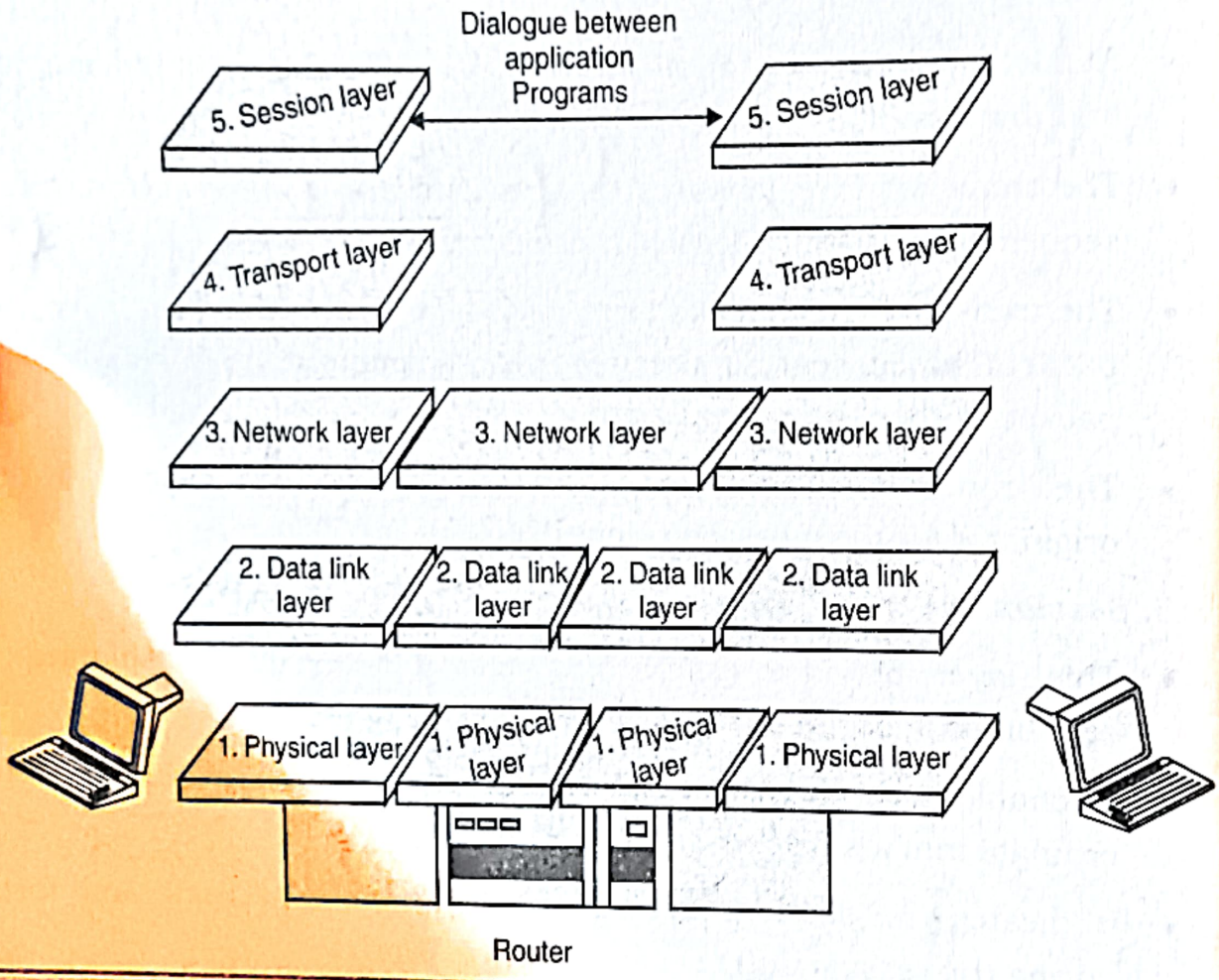

Fig. 2.1.5 Session Layer

6. Presentation Layer :

- This layer converts data received from application layer into machine's native internal numeric format and encoded transmitted data into displayable form for output. It performs code conversions, text compressions, security encryption etc. on the message.
- The layer consists of many tables of syntax and its functions are limited.
- The Presentation layer translates data between the formats the network require and the formats the computers expects.

- The presentation does the protocol conversion, data translation, compression and encryption, character set conversion and the interpretation of graphics commands.

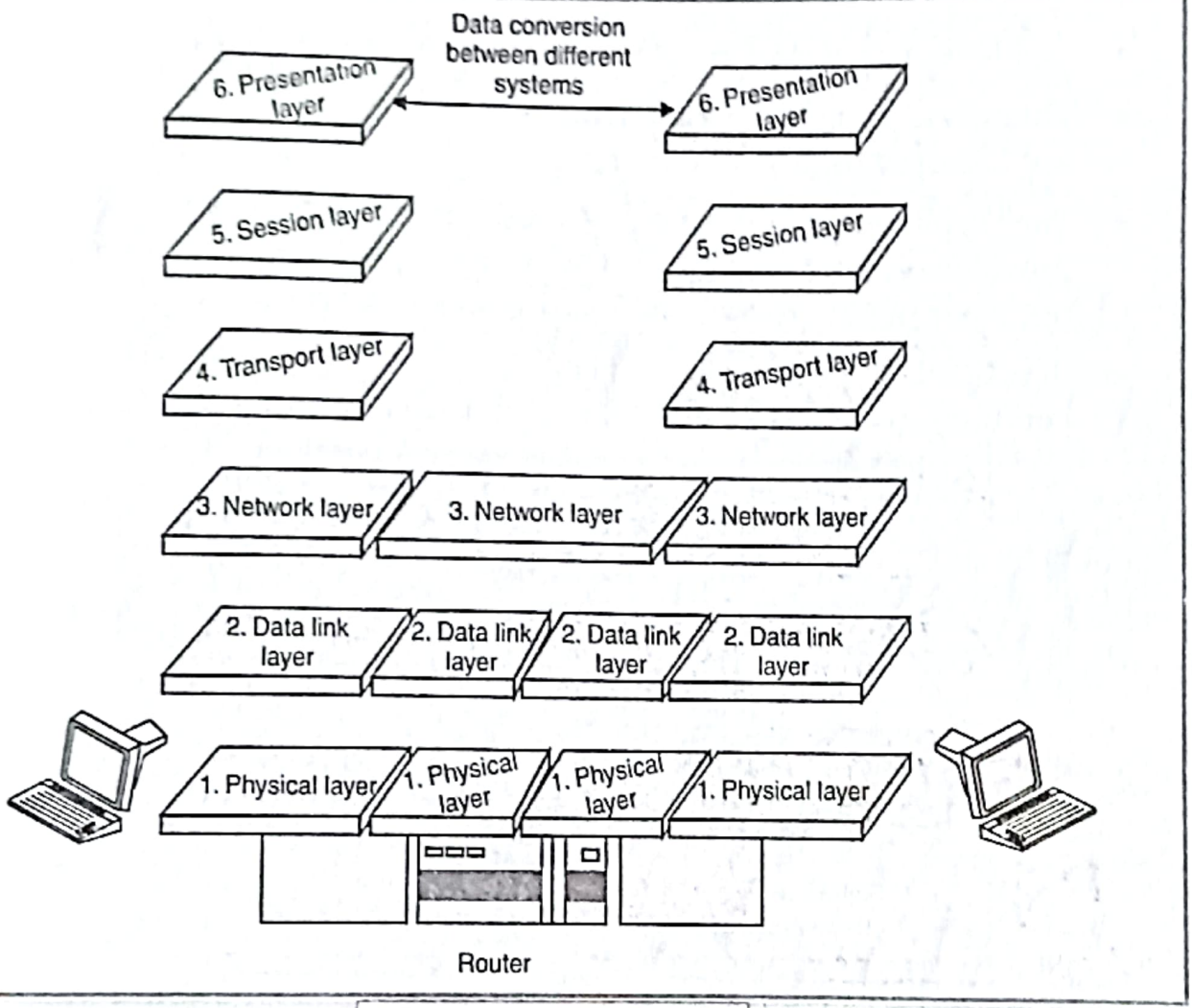

Fig. 2.1.6 Presentation Layer

- The network redirector operates at this layer.
- The network redirector is what makes the files on a file server visible to the client computer.
- The network redirector also makes remote printers as though they are attached to the local computer.
- The network redirector in an important part of the networking.

7. Application Layer :

- This is the topmost layer of OSI architecture. It is the layer seen by the application program and hence is user oriented layer which provides services to support end user of network directly.
- A message to be sent across network enters the OSI model at this point and then travels down ward unto physical layer then through

transmission line unto physical layer of destination & then upwards up to application layer of receiver end system.

- The layer is concerned with semantics of data.
- The layer supports virtual terminals and virtual file concepts.
- This also provides network transparency to the end users so that they are ignorant of physical distribution of resources of network.
- The Application layer is the topmost layer of the OSI model and it provides services that directly support user applications such as database access, email and file transfer.
- It also allow application to communicate with application on other computer as though they were on the same computer.

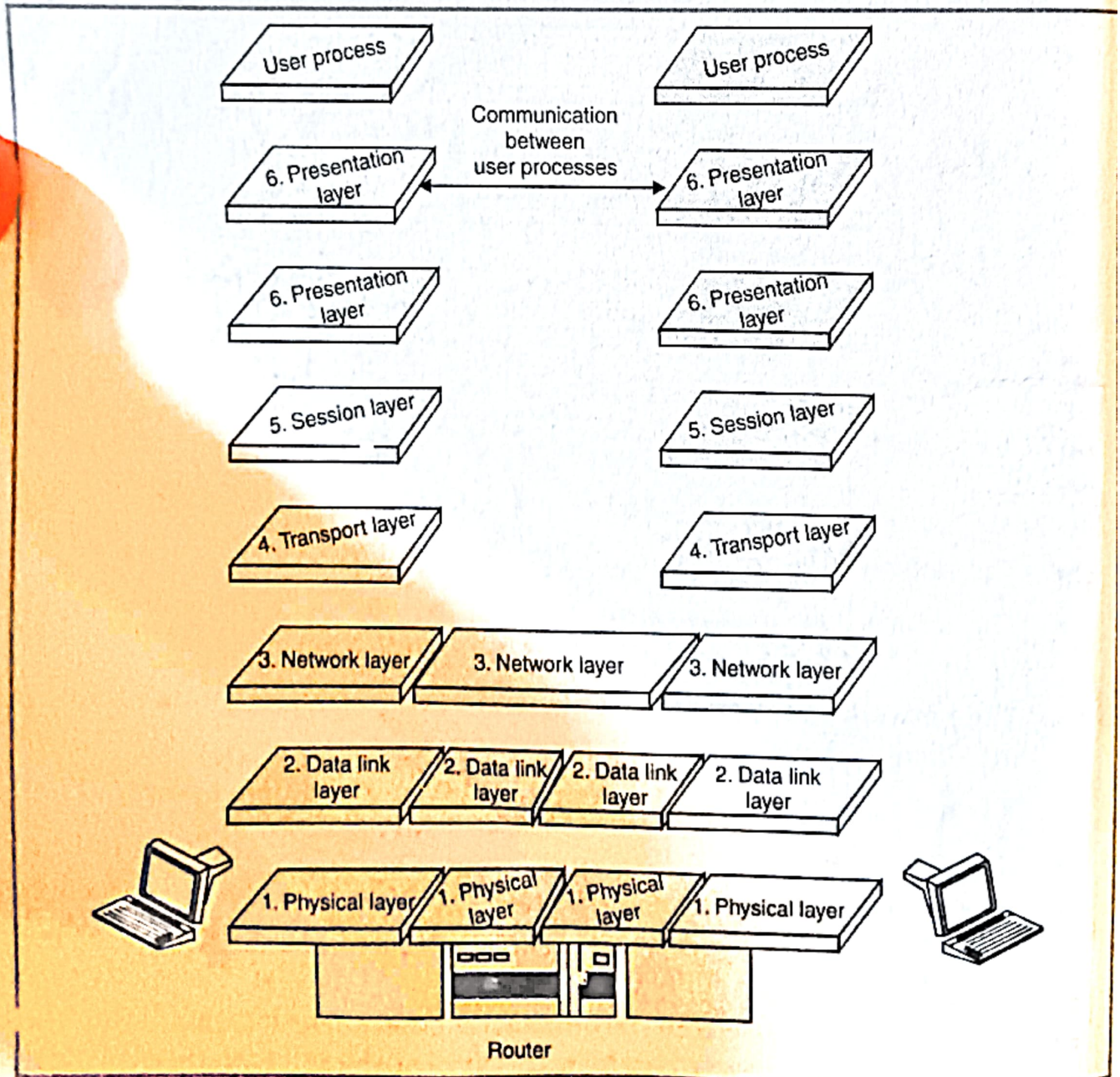

Fig. 2.1.7 Complete OSI Reference Model

- When a programmer writes an application program that use network services, this is the layer the application program will access.
- Among these seven layers the application layer, presentation layers, session layer and transport layer are application oriented layers, while network layer data link layer and physical layer are network dependent layers.

2.3 TABULAR FORM OF OSI REFERENCE MODEL AND VARIOUS PROTOCOLS USED

LAYER	FUNCTIONALITY	PROTOCOLS
1. PHYSICAL [Lowest layer of the OSI Model]	It explained about mechanical, electrical and procedural interfaces and physical transmission medium between stations. It deals with electrical and physical requirements of a system. Puts the information on to the physical network and receives packets (or frames) from the network.	1. RS 232C- It addresses the physical layer within the ISO model. 2. IEEE 802 3. CCITT X.25
2. DATA LINK LAYER [the lowest protocol layer]	It deals with forming of the information sent on the wire. It is responsible for gaining access to the network and transmitting the physical block of data from one device to other. It defines the rules for node to node data transfer. Data format, sequence, acknowledgement process, bit-error detection used by the network to handle row digital data, etc. are explained in this year.	1. BISYNC 2. HDLC/SDLC 3. IEEE 802
3. NETWORK LAYER	It keeps track which MAC [media access control the unique number that each network card] has address to send to *i.e.*, decides	Protocols are responsible for the delivery of frames in some sequence they were sent.

	which system receives the information. It makes routing of data through network from source to destination. Virtual circuits are established in this layer. Packets are formalised into frames to include virtual circuit routing and other pertinent data. It translates logical network address into physical machine address. It determines the Quality of service (namely, priority of the manage). It breaks large packets into smaller chunks so that these will be accepted by frame of data link year. Flow control of packetised information and congestion avoidance is main concern of this protocol.	1. Ethernet or DECNET 2. X.25 link connection for optimizing the network. Class 3 : It combines the better feature of class 1 and 2 Class 4 : It is the highest level of error recovery. Besides the basic error recovery there are requirements for checking damaged data and out of sequence packets, or even lost packets.
4. TRANSPORT LAYER	Puts the information into a "language" that the other system understands. It converts or manages messages into the structures required for transmission over the network. Interfacting between the application software and the available hardware. The mapping of transport address on to the network. Error detection and recovery to minimize data loss and time lost due to retransmission of bad frames. Segmentation or fragmentation of message to miximize transmission efficiency. Flow control between layers below the transport layer	Five classes of transport layer protocols. They differ in the degree of error recovery and were designed to allow the most flexibility to the network system designer. Class 0-Lowest class. It includes minimized error recovery and is used primarily for straight text transmission. Class-1-Increases the amount of error recovery ability, expanding is to networks that is X.25 packet switch at the network level. Class-2-Increases error

	(specifically the network layer) and the session layer.	recovery to the point that network becomes very reliable, requiring very few retransmission to handle errors. Multiplexing of data connections into a single data.
5. SESSION LAYER	This layers allows an application on separate computers to share an actual connection between systems called a session. It permits multiple application to share a virtual circuit. Its main function is related to file management and overhead functions. It takes care of connection and disconnection from the network and authentication of users access. It provides access availability and system time allocation, the binding of processes names to network address. It maintains the order of data packets and bidirectional (two way) communication. It provides look up and security to allow the programs to find each other and establish the communication link. It provides data synchronization and check pointing so that in the event of network failure, only the data sent after the point of failure need to be resent. It controls dialogue between the processes or the application program to determine who can transmit data and who can receive data at what point during the communication. It provides for correcting and maintaining a logical connection between the host. It also keep	1. NETBIOS [Network Basic Input Output Services Interface] Working : 1. Name management 2. Connection oriented data transfer 3. Connectionless data transfer 4. Session management.

	tracks the resource currently in use.	
6. PRESENTATION LAYER	This layer deals with the different systems representing data namely, what will happen when it tries to display UNIX-style data on an MS-DOS screen. This layer creates SMB (Server Message Block) in NT's case that tells the other system what is requested or contains the response to the requested. It provides several functionally on data used in this layer, These are (a) data compression (b) data (type) conversion between the format when the communication hosts are different. (c) data encryption (d) character set conversion (e) format and systems resolution (f) data transformation It provides interpretation of graphics commands.	Devices are treated as virtual circuit in this layer. Three basic forms of protocols are : 1. Virtual Terminal protocol– It is used to allow different types of terminals to support different application. 2. Virtual File Protocol-It handles code conversion within files, file communication and file formatting. 3. Job transfer and Manipulating Protocol-It controls the structure of jobs and records.
7. APPLICATION LAYER (Top most level/ human interfaced level) provides 1. email, 2. query languages 3. FTP software 4. Telnet software	It defines user interface to lower level layers and various application processes. It provides for the connection of application programs on separate machine. It generates the requests and processes the requests that it receives. It deals with handling large amount of data, data-base access, bulk data transfer, remote job entry and actual user requirement for the network. It is highest level of security since it deals with the user entry point into the system. Some typical uses are credit checks, Inventory and point of sales terminals.	Deals with identification, authentication and determination of availability of combined end user Protocols 1. NETWARE 2. DECENT (digital equipment corporations networking).

SUMMARY

- Computer networks can be used for numerous services, both for companies and for individuals. For companines, networks of personal computers using shared servers often provide flexibility and a good price/preformance ratio. For individuals, networks offer access to a variety of information and entertainment resources.
- Roughly speaking, networks can be divided upinto LANs, MANs, WANs, and internetworks, each with their own characteristics, technologies, speeds, and niches. LANs cover a building, MANs are cover a city, and WANs cover a country or continent. LANs and MANs are unswitched (i.e., do not have routers); WANs are switched.
- Network software consists of protocols, or rules by which processes can communicate. Protcols can be either connectionless or connection-oriented. Most networks support protocol hierarchies, with each layer providing services to the layers above it and insulating them from the details of the protocols used in the lower layers. Protocol stacks are typically based either on the OSI model or the TCP/IP model. Both of these have network, transport, and application layers, but they differ on the other layers.
- Well-known networks have included Novell's Net Ware, the ARPANET (now defunet), NSFNET, the Internet, and various gigabit testbeds. Network services have included DQDB, SMDS, X.25, frame relay, and broadband ISDN. All of these are available commercially, from a variety of suppliers. The marketplace will determine which ones will survive and which ones will not.

EXERCISE

1. FILL IN THE BLANKS :

(*a*) Physical (*b*) control (*c*) data frames (*d*) Networks (*e*) Presentation (*f*) Appliecation (*g*) Addressing (*j*) Seven

1. The OSI model divides network acitivity into_____ layers.
2. The Purpose of each layer is to provide serivces to the next layer and shielded the upper layer from the detail of how the sevices are actually implemented.
3. At each layer the software adds some additional formatting or_____to the packet.

4. Each layer on the one computer acts as through it is communicating directly with the_____layer on the other computer.
5. The top or_____layer handles general network access, flow control and error recovery.
6. At the sending computer, the_____layer translates data from a format sent down from application layer.
7. The_____layer determines the route from the source to the destination computer.
8. The data link layer is responsible for sending_____from the Network layer to the Physical layer.
9. The_____Information in a data frame is ued for frame is used for frame type, routing and segmentation information.
10. The_layer defines how the cable is attached to the network adapter card.

2. MATCHING WORDS/PHRASES IN TWO COLOUMS.

1. Application Layer	a. Ensures messages are delivered error free.
2. Data link Layer	b. Determines route from source to destination computer.
3. Network Layer	c. Provides synchronization between us tasks by placing checkpoint in the data stream.
4. Presentations Layer	d. Verifies that all address, links and end nodes are functioning.
5. Transport Layer	e. Represents services that directly support user application.
6. Physical Layer	f. Packages raw bits from the Physical layer into data frames.
7. Session Layer	g. Responsible for transmitting the data format.
8. CSMA/CD	h. Token Passing
9. Token Ring Arcent	i. Broadcast based
10. TCP/IP	j. Internetworking.

3. DESCRIPTIVE QUESTIONS

(a) Show various layer is the ISO-OSI model and the functions of the each layer.

(*b*) Explain the term 802 Project Model. What are the enhancements to the OSI Model.

(*c*) Write Short notes :

(*i*) Transmission impairment

(*ii*) Bandwidth

(*iii*) Network layer of the OSI Model.

(*d*) Differance between OSI and TCP/IP? Also mention its simmiliarties.

4. SHORT ANSWER TYPE QUESTIONS

1. What are the various goals of OSI reference model ?
2. Which layers are concerned with the hardware ?
3. What are the layers which are concerned with software ?
4. What are the two sublayer present in Data link layer.
5. What layer is concequed with the syntax and semantics?
6. What are in different types of services are associated with various layer?

□□□□□