without requiring changes to the logic of the underlying hardware and software. (The OSI model is not a protocol: It is a model for understanding and designing a network architecture that is flexible, robust and interoperable.)

("ISO is the organization. OSI is the model")

=> [The Open System Interconnection (OSI) model is a ~~layed~~ layered framework for the design of network systems that allows for communication across all types of computer systems. It consists of seven separate but related layers, each of which defines a segment (part) of the process of moving information across a network.]

Layered Architecture: The OSI model is built of seven ordered layers.

(i) Physical layer
(ii) Data link layer
(iii) Network layer
(iv) Transport layer
(v) Session layer
(vi) Presentation layer
(vii) Application layer

The layers involved when a message is sent from device A to device B.

travels from A to B, it may pass through many intermediate nodes. These intermediate nodes usually involve only the first three layers of the OSI model.

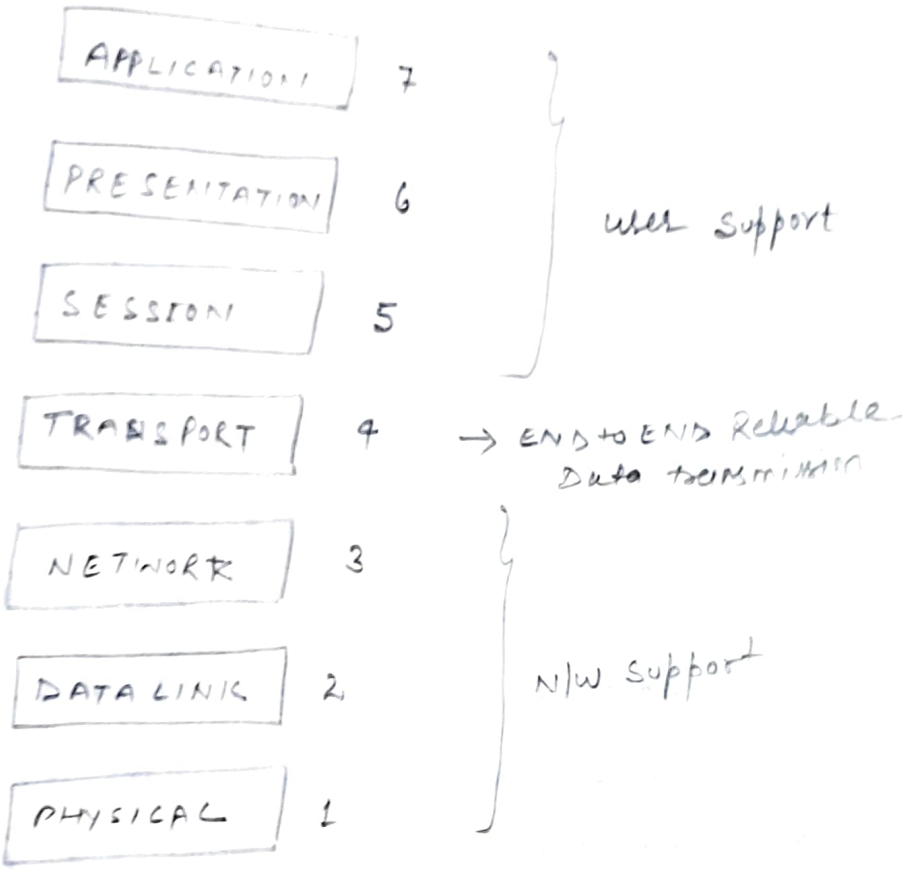



fig: The OSI model

Peer-to-Peer Processes: Within a single machine, each layer calls upon the services of the layer just below it. Layer 3, for example, uses the services provided by layer 2 and provides services for layer 4. Between machines, layer x on the machine communicates with layer x on another machine. This

Communication is governed by an agreed-upon series of rules and conventions called protocols. The processes on each machine that communicate at a given layer are called "PEER-TO-PEER PROCESSES". Communication between machines is therefore a peer-to-peer process using the protocols appropriate to a given layer.

At the physical layer, communication is direct: Machine A sends stream of bits to machine B. At the higher layers, however, communication must move down through the layers on machine A, over to machine B, and then back-up through the layers. Each layer in the sending machine adds its own information to the message it receive from the layer just above it and passes the whole package to the layer just below it. This information is added in the form of headers or trailers (control data added to the beginning or end of a data parcel). Headers are added to the message at layers 6, 5, 4, 3, 2. A trailer is added at layer 2.

At layer 1 the entire package is converted to a form that can be transferred

to the receiving machine. At the receiving machine, the message is unwrapped layer by layer, with each process receiving and removing the data meant for it. For example, Layer 2 removes the data meant for it, then passes the rest to layer 3. Layer 3 removes the data meant for it and passes the rest to layer 4, and so on.

[Interfaces between Layers:- The passing of the data and network information down through the layers of the sending machine and back-up through the layers of the receiving machine is made possible by an interface between each pair of adjacent layers. Each interface defines what information and services a layer must provide for the layer above it.]

[Organization of the Layers:- Layers 1, 2 and 3 - (Physical, data link and network - are the network support layers; they deal with the physical aspects of moving data from one device to another (such as electrical specification, physical connections, physical addressing, and transport timing and reliability)." Layer 5, 6, & 7 (session, presentation and application) - can be thought of as the are the user support layers) they allow interoperability among unrelated software systems."

Layer 4, the transport layer, ensure end to end reliable data transmission, while layer 2 ensure reliable transmission on a single link.) The upper OSI layers are almost always implemented in software; lower layers are a

combination of Hardware and software, except for the Physical layer, which is mostly Hardware. ]//

Sending Machine x

Processing Machine y

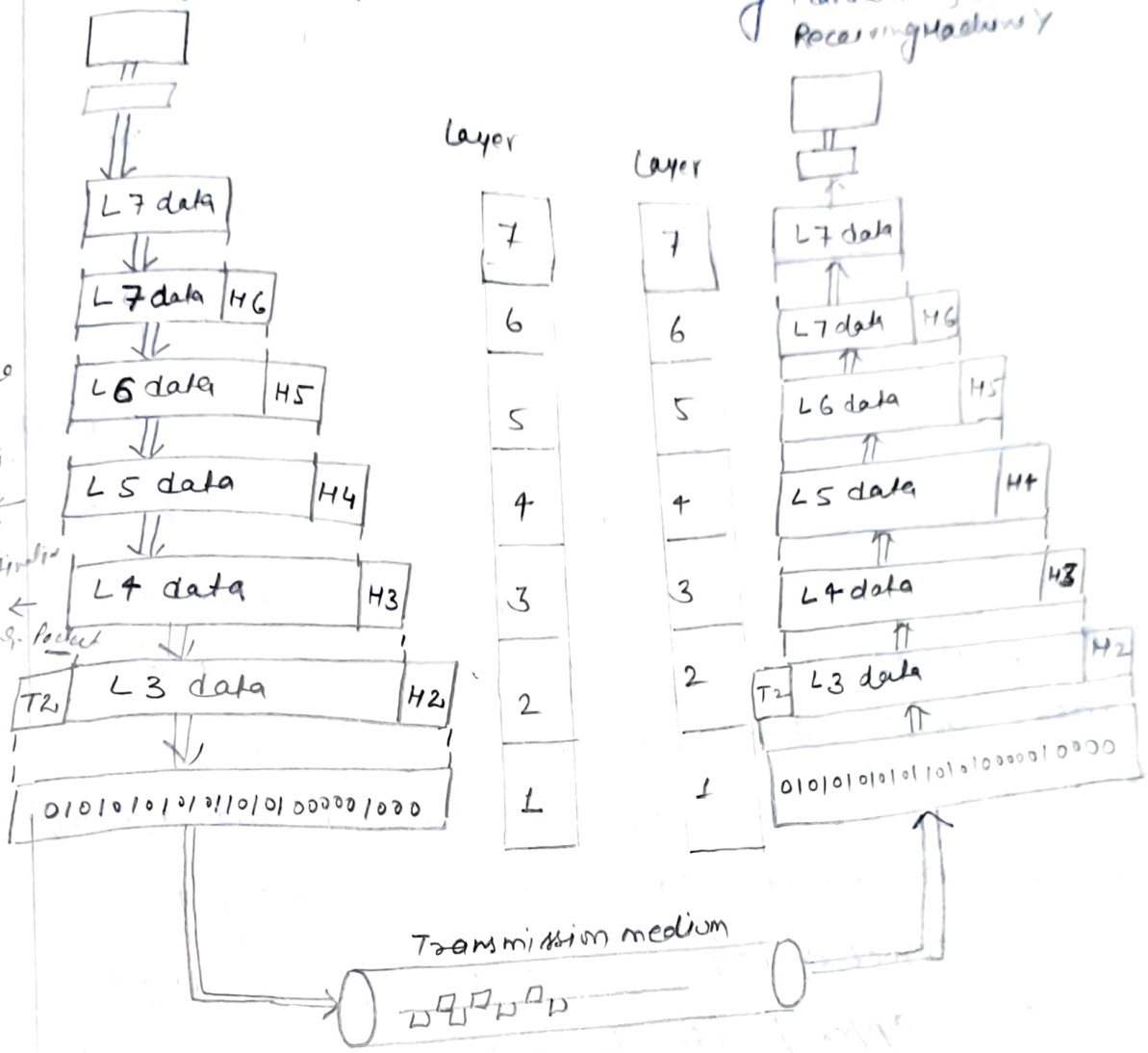



fig An exchange using the OSI model

Exchange of Info. using the OSI model:

[In this figure, which gives an overall view of the OSI Layers, L7 data means the data unit at layer 7, L6 data means the data unit at layer 6, and so on. The process starts out at layer 7 (Application layer), then moves from layer to layer in descending

sequential order. At each layer (except layer 7 & 1), a header is added to the data unit. At layer 2, a trailer is added as well. (Control data added to the beginning & ending of a data parcel.) When the formatted data unit passes through the physical layer (layer 1), it is changed into an electromagnetic signal and transported along a physical link.

Upon reaching its destination, the signal passes into layer 1 and is transformed back into bits. The data unit then move back up through the OSI layers. At each block of data reaches the next higher layer, the headers and trailers attached to it at the corresponding sending layer are removed, and actions appropriate to that layer are taken. By the time it reaches layer 7, the message is again in a form appropriate to the application and is made available to the recipient. (Receiver device)

FUNCTIONS of the Layers (Services) Are as follows:

1) Physical Layer:- The physical layer coordinates the functions required to transmit a bit stream over a physical medium. It deal with the mechanical and electrical specifications of the interface and transmission medium.

## Functions of Physical layer

(i) Physical Characteristics of Interfaces and media: The Physical layer defines the characteristics of the interface between the devices and the transmission medium. It also defines the types of transmission medium.

(ii) Representation of bits: The physical layer data consist of a stream of bits (sequence of 0's & 1's) without any interpretation. To be transmitted, bits must be encoded into signals - electrical or optical. The physical layer defines the type of encoding (how 0's and 1's are changed to signals).

(iii) Data Rate :- The transmission rate - the number of bits sent each second - is also defined by the physical layer.

(iv) Synchronization of bits: The sender and receiver must be synchronized at the bit level. In other words, the sender and the receiver clocks must be synchronized.

(v) Line Configuration: The physical layer is concerned with the connection of devices to the medium. In a point to point configuration, two devices are connected together through a dedicated link. In a multipoint configuration, a link is shared between several devices.

(vi) Physical topology :- The Physical topology defines how devices are connected to make a network. For such that Mesh, Star, Bus & Ring.

(vii) Transmission Mode :- The Physical layer also defined the direction of transmission between two devices : simplex, half duplex or full duplex.

(2) Data link Layer :- 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 (N/w layer).

Functions of D.L.L :

(i) Framing :- The data link layer devides the stream of bits received from the network layer into manageable data units called frames.

(ii) Physical addressing :- If frames are to be distributed to different systems on the network, the data link layer adds a header to the frame to define the Physical address of the sender (source address) and/or receiver (destination address) of the frame. If the frame is intended for a System outside the sender's network, the receiver address is the address of the device that connects one network to the next.

(iii) Flow Control: If the rate at which the data are absorbed by the receiver is less than the rate produced in the sender, the data link layer imposes a flow control mechanism to prevent overwhelming the receiver.

(iv) Error Control: The data link layer adds reliability to the physical layer by adding mechanism to detect and retransmit damaged or lost frames. It also uses a mechanism to prevent duplication of frames. Error control is normally achieved through a trailer added to the end of the frame.

(v) Access Control: When two or more devices are connected to the same link, data link layer protocols are necessary to determine which device has control over the link at any given time.

(3) Network Layer: The network layer is responsible for the source-to-destination delivery of a packet possibly across multiple networks (links). Whereas the data link layer oversees the delivery of the packet between two systems on the same network (links), the network layer ensure that each packet gets from its point of origin to its final destination.

## Functions of Network Layer:

(i) **Logical addressing**:- The network layer adds a header to the packet coming from the upper layer that, among other things, includes the logical addresses of the sender and receiver.

(ii) **Routing**:- When independent networks or links are connected together to create an internetworks (a network of networks) or a large network, the connecting devices (called routers or gateways) route the packets to their final destination. One of the functions of the network layer is to provide this mechanism.

④ **Transport Layer**:- The transport layer is responsible for source-to destination (end to end) delivery of the entire message. Where as the network layer oversees end-to-end delivery of individual packets, it does not recognize any relationship between those packets.

## functions of Transport Layer:-

(i) **Service-point addressing**:- The transport layer header therefore must include a type of address called a service-point address (or Port address). The network layer gets each packet to

the correct computer: the transport layer gets the entire message to the correct process on that computer.

(ii) Segmentation and Reassembly: A message is divided into transmittable segments, each segment containing a sequence number. These numbers enable the transport layer to reassemble the message correctly upon arriving at the destination and to identify the replace packets that were lost in the transmission.

(iii) Connection Control: The transport layer can be either connectionless or connection-oriented. A connectionless transport layer treats each segment as an independent packet and delivers it to the transport layer at the destination machine.

A connection oriented transport layer makes a connection with the transport layer at the destination machine first before delivering the packets. After all the data are transferred, the connection is terminated.

(iv) Flow Control: Like the DLL, the transport layer is responsible for flow control. However, flow control at this layer is performed end-to-end rather than across a single link.

(v) Error Control: Like the data link layer, the transport layer is responsible

for error control. However, error control at this layer is performed end-to end rather than across a single link. The sending transport layer makes sure that the entire message arrives at the receiving transport layer without error (damage, loss or duplication).

(ii) Session Layer: The services provided by the first three layers (physical, data-link and network) are not sufficient for some processes. The session layer is the network dialog controller. It establishes, maintains and synchronizes the interaction between communicating systems.

Functions of Session layer:

(i) Dialog Control: The session layer allows two systems to enter into a dialog. It allows the communication between two processes to take place either in half-duplex or full duplex.

(ii) Synchronization: The session layer allows a process to add checkpoints (synchronization points) into a stream of data.

For example, if a system is sending a file of 2000 pages, it is advisable to insert checkpoints after every 100 pages to ensure that each 100 page unit is received and acknowledged independently. In this case, if a crash happens during the transmission

of page 523, Retransmission begins at Seq. 501, Page 5
1 to 500 need not be retransmitted.

(6) Presentation Layer: The presentation layer is concerned with the syntax and semantics of the information exchanged between two systems.)

functions of Presentation Layer:

(i) Translation: The processes (running programs) in two systems are usually exchanging information in the form of character strings, numbers, and so on. The information should be changed to bit streams before being transmitted. because different computers use different encoding systems, the presentation layer is responsible for interoperability between these different encoding method.

(ii) Encryption:- To carry, sensitive information, a system must be able to assure privacy. Encryption means that the sender transforms the original information to another form and sends the resulting message out over the network. Decryption reverses the original process to transform the message back to its original form.

(iii) Compression: Data compression reduces the number of bits to be transmitted. Data compression becomes particularly important in the transmission of multimedia such as text, audio and video.

7) Application Layer: The application layer enables the user, whether human or software to access the network. It provides user interfaces and support for services such as electronic mail, remote file access and transfer, shared data base management, and other types of distributed information services.

Functions of Application Layer:

(i) Network virtual terminal: A network virtual terminal is a software version of a physical terminal and allows a user to log on to a remote host.

(ii) file transfer, Access, and Management: The application allows a user to access files in a remote computer (to make change or read data), to retrieve files from a remote computer, and to manage or control files in a remote computer.

(iii) Mail Services: This application provides the basis for e-mail forwarding and storage. (T.1)

(iv) Directory Services: This application provides distributed data base sources and access for global information about various objects and services.

TCP/IP Reference model: The TCP/IP protocol, used in the internet, was developed prior to the OSI model. Therefore, the layers in the Transmission Control protocol/Internetworking Protocol (TCP/IP) protocol do not match exactly with those in the OSI model. The TCP/IP protocol is made of five layers:

(i) Physical layer
(ii) Data link layer
(iii) Network layer
(iv) Transport layer
(v) Application layer.

The first four layer provide physical standards, network interface, internetworking and transport functions that correspond to the first four layers of the OSI model.

The three topmost layers in the OSI model, however are represented in TCP/IP by a single layer called the application layer.

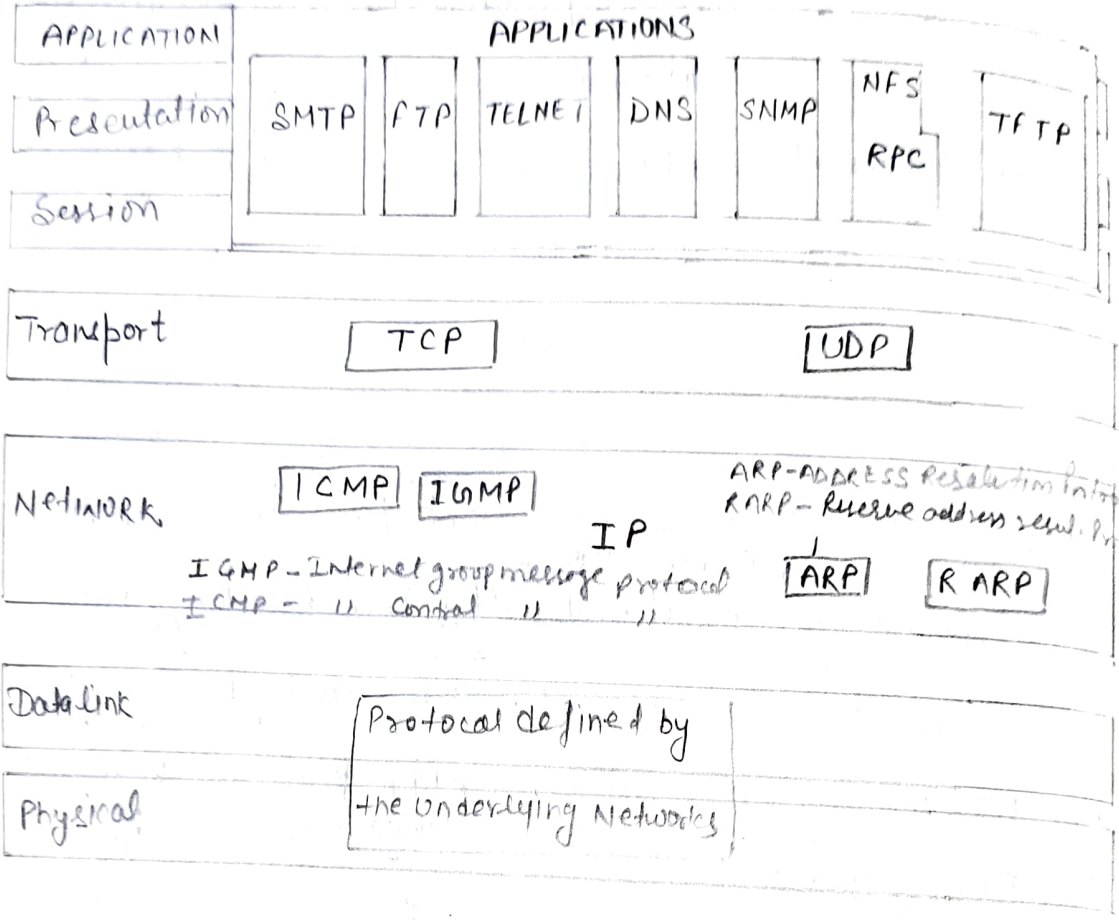



fig TCP/IP and OSI model

TELNET : Terminal NW
SMTP : Simple mail transfer Protocol
FTP : file transfer Protocol
DNS : Domain Name System
SNMP : Simple Network Mang't
RPC : Remote Procedure call
TFTP : Trivial file transfer Prot
UDP : user datagram Protocol

At the transport layer, TCP/IP defines two protocols TCP and UDP. At the Network layer the main protocol defined by TCP/IP is internetworking protocol (IP);

The layered protocal stack and communications and networking today is the five layer Internet model, sometimes called the TCP/IP protocal suite. The model is composed of five or seven layers:

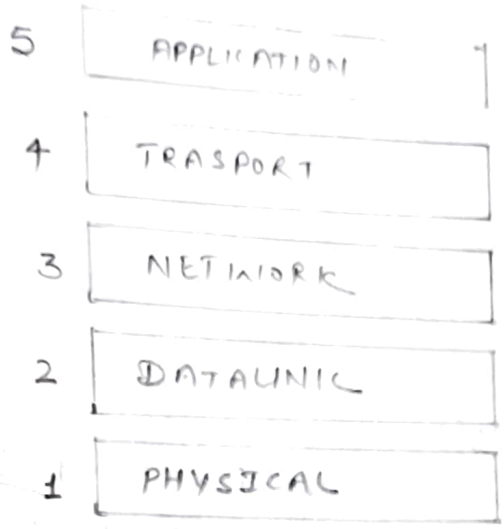



fig Internet model (Layer) or TCP/IP model

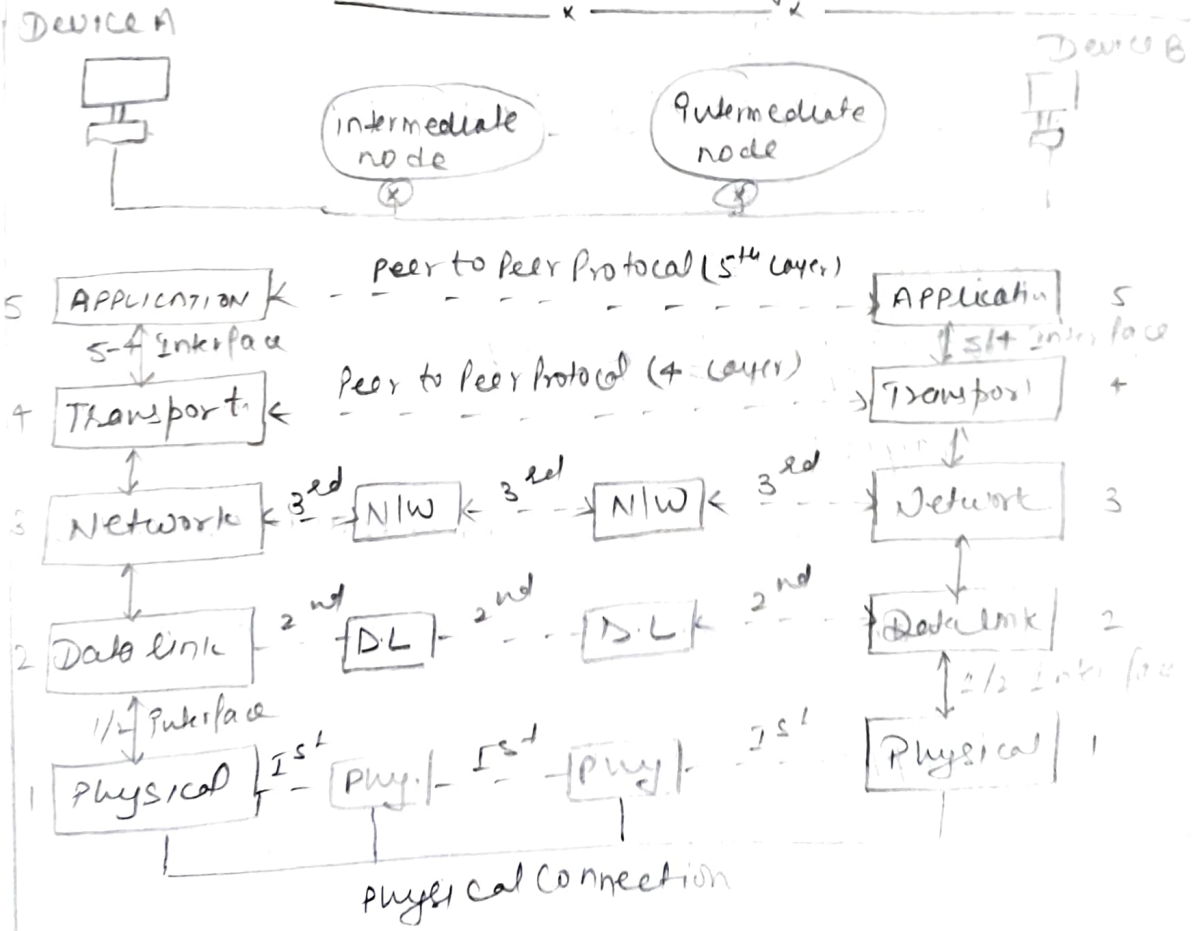



fig: Peer to Peer processes

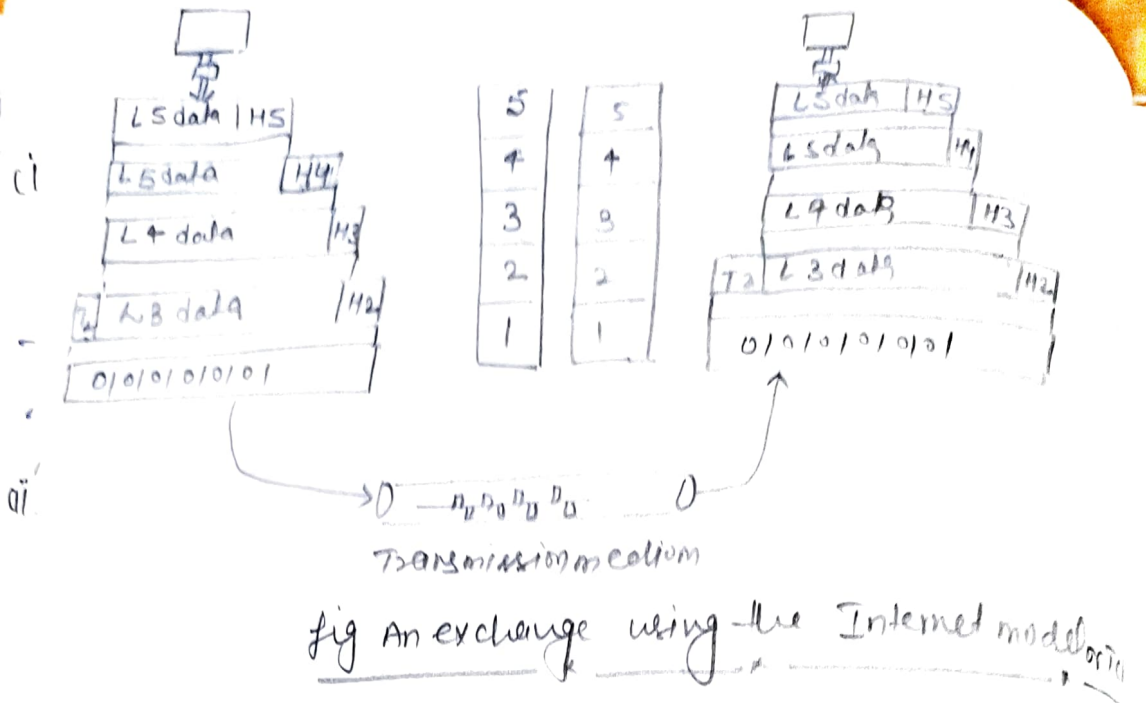



fig An exchange using the Internet model

① Functions of Physical layer:

(i) Physical characteristics of Interface and media (ii) Representation of bits (iii) Data Rate (iv) Synchronization of bits.

② Functions of Data link layer:

(i) framing (ii) Physical addressing (iii) Flow control (iv) Error control (v) Access control

③ Functions of Network layer:

(i) Logical addressing (ii) Routing

④ Transport layer:

(i) Port addressing (ii) Segmentation and Reassembly (iii) Flow control (iv) Connection control (v) error control.

⑤ functions of Application layer:

(i) Mail services (ii) file transfer & Access

(iii) Remote log in (iv) Accessing the world wide

## Integrated Services digital Network:

[ISDN was developed in 1976. It is a set of protocals that combines digital telephony and data transport services. The whole idea is to digitize the telephone network to permit the transmission of audio, video, and text over existing telephone lines.]

(ISDN is a state of the art public switched digital Network (PSDN) for provisioning of different services - voice, data and image transmission over the telephone line through the telephone network.)

The Goal of ISDN is to form a wide area network that provides universal end-to-end connectivity over digital media. This can be done by integrating all of the separate transmission services into one without adding new links or subscriber lines.

Services: The purpose of the ISDN is to provide fully integrated digital services to users. These services are as follows:

(i) Bearer Services

(ii) Tele services

(iii) Supplementary services

(1) Bearer Services: (Bearer services) provide the means to transfer information (voice, data and video) between users without the network manipulating the content of that information. The network does not need to process the information and therefore does not change the content. (Bearer services belong to the first three layers of the OSI model. Example of Bearer Services: is Circuit switching, Packet switching & Frame switching, Cell switching.

(2) Teleservices: (In teleservicing, the network may change or process the contents of the data. These services correspond to layers 4-7 of the OSI model.) Teleservices rely on the facilities of the bearer services and are designed to accommodate complex user needs without the user having to be aware of the details of the process. (Example of Teleservices: Telephony, Telefax, & Tele conferencing.)

(3) Supplementary Services: (Supplementary services are those services that provide additional functionality to the bearer services and teleservices. Examples of these services are Call waiting and message handling.)

Uses of ISDN:-

(1) Voice call (2) Fax transmission (3) Linking to the internet
(4) Data transmission & voice at same time
(5) video conferencing
(6) Play online games to relax.
(7) Connecting to the office N/w from home (small N/w)

## Integrated digital Network (IDN):

Customers began to require access to a variety of networks, such as packet switch networks and ckt switched networks. To meet these needs, the telephone companies created Integrated digital Networks (IDN). [An IDN is a combination of networks available for different purpose. Access to these networks is by digital pipes, which are time-multiplexed channels sharing very-high speed paths.

Customers can use their local loops to transmit both voice and data to their telephone company's central office. The office then directs these calls to the appropriate digital networks via the digital pipes.]

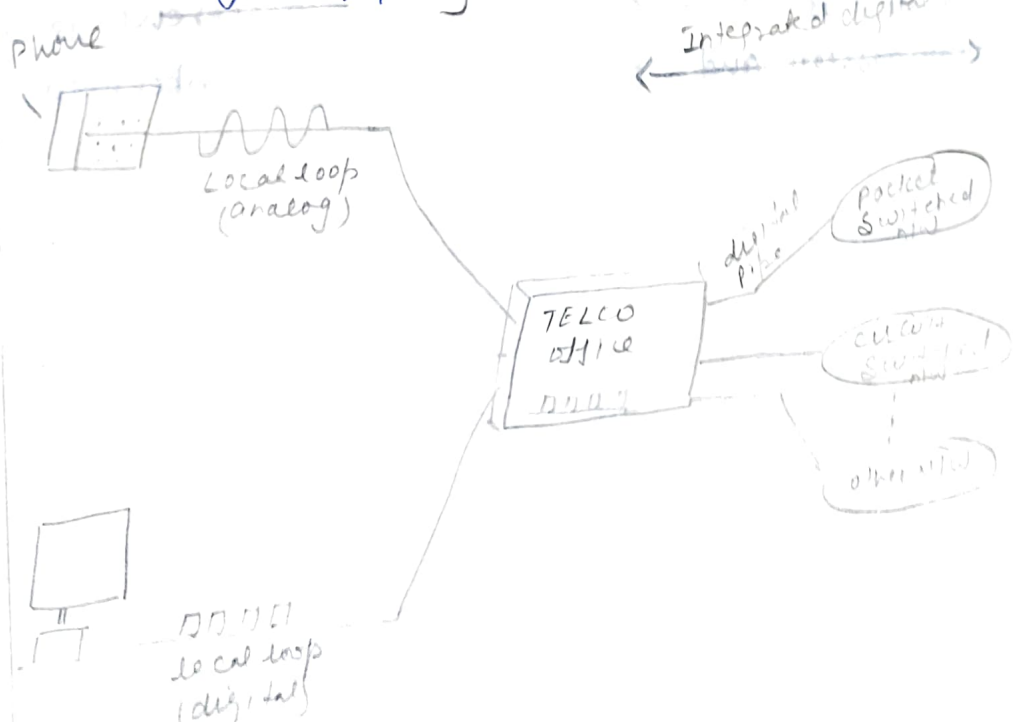
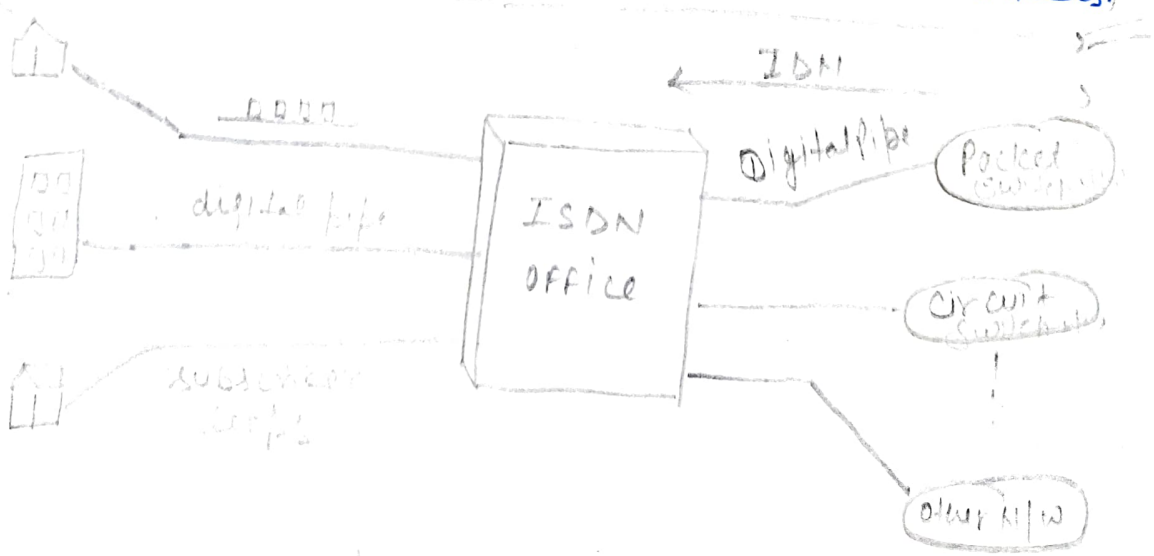



fig IDN

The ISDN integrates customers services with the ISDN. Fully digital services are much more efficient and flexible than analog services. To receive the maximum benefit from the integrated digital network, the next step is to replace the analog local loops with digital subscriber loops. voice transmissions can be digitized at the source, thereby removing the final need for analog carriers.

It then becomes possible to send data, voice & image and so on over any digital network with ISDN all customer services will become digital rather than alalog. ISDN will allow all communication connections in a home or building to occur via a single interface.

A conceptual view of the connections between users and an ISDN central office. Each user is linked to the central office through a digital pipe. These pipe can be of different capacities to allow different rates of transmission and support different subscriber needs.



Subscriber Access to the ISDN: To allow flexibility, digital pipes between customers and the ISDN office are organized into multiple channels of different sizes. The ISDN standard defines three channel types, each with a different transmission rate.

(i) B Channels: A bearer channel (B-channel) is define at a rate 64 Kbps. It is the basic user channel and can carry any type of digital information in full duplex mode as long as the required transmission rate does not exceed 64 Kbps. For example, a B channel can be used to carry digital data, and digitized voice.

(ii) D channels: A data channel (D channel) can be either 16 or 64 Kbps, depending on the needs of the user. Although the name says data, the primary function of a D channel is to carry control signaling for the B channels.

Up to this point, the transmission protocols we have examined all use in channel (in-band) signaling. (Control information) such as call establishment, ringing, call interrupt or synchronization) is carried by the same channel that carries the message data.

(iii) H channels: Hybrid channels (H channels) are available with data rates of 384 Kbps, 1536 Kbps or 1920 Kbps. These rates suit H channels for high data-rate applications, such as (for example) video, teleconferencing etc.)

Benefits of ISDN

(i) Single connection can support both voice and data.

(ii) Eight terminals can be connected on a single line.

(iii) Two call can be established simultaneously on a single pair of wires.

(iv) The call set time is very short (1-2 seconds).

How is ISDN line superior to the phone line!

(i) The signal on the ISDN line - voice or data, is sent in digital mode.

(ii) The ISDN subscriber can establish two simultaneous independent calls which could be voice, data, image as combination of any two whereas only one call is possible on ordinary telephone lines.)

(iii) The call set-up time between two ISDN subscribers is extremely short.