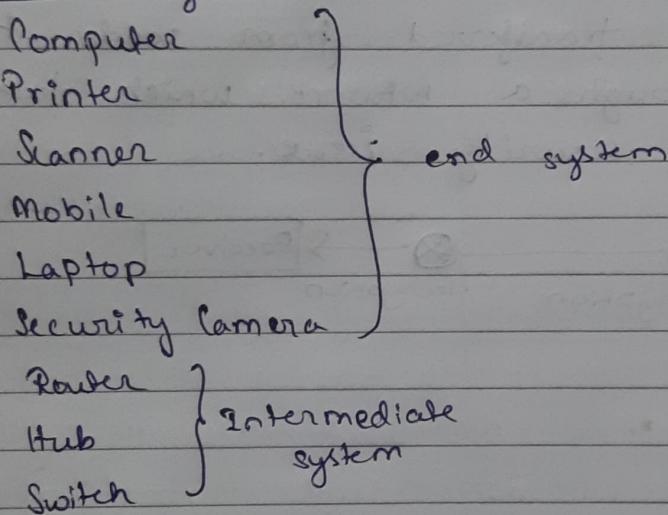


Computer Networking (CN)

- Computer Networking is the principle of operation where data communication and information sharing can happen over any distance.
- A computer Network is a connection between different system (nodes) which are connected by communication link.
 - wired
 - wireless

(Nodes) / System



- The communication medium for wired interconnection is a wire & for wireless system is air.

→ Basic characteristics of Computer Network :-

(i) Fault Tolerance System

It implies that if in a network one line of communication fails then the networking will not be hampered as it will be taken over by other communication link.

(ii) Scalability :-

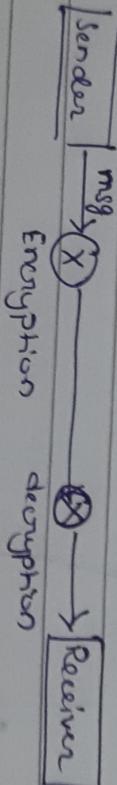
It implies that there must not be any restrictions on the amount of users connected to a network.

(iii) Quality of Service :-

Every fraction of second is important in a network related to financial or health sector.

(iv) Security

The message is transferred from sender to receiver through a network which takes care of the security issue.



→ Any network is define having two or more computing devices interconnected using the set of communication protocol which allows them to share a resource between themselves.

→ Any network protocol is governed by the rules and guidelines used by a device to allow communication or information exchange between the connected devices.

Data Communication

It is of 3 categories and involves exchange of data between different nodes using transmission medium.

(a) Simplex Data Communication :-

Here the communication is uni-directional and at a specific time one device can transmit and the other one can receive.

(b) Half Duplex communication :-

Here communication happens in both ~~one~~ direction but never at the same time.

(c) Full Duplex communication :-

Here communication happens in both directions simultaneously.

Switch

- It is a networking hardware that connects devices on a computer network to establish a LAN.
- It has hardware memory of its own and remembers the address of the node to which it is connected.
- It can perform unicasting, multicasting & broadcasting.
- It is a layer-2 device and always allows full duplex communication.

Hub

- It is a networking hardware for connecting devices to a network and has got no memory.
- Similar nodes in a network are connected through crossover cable whereas different components of the network are connected using straight through cable.
- Hub is a layer-1 device and allows only half duplex communication.

ClassificationClassification of Computer Network(i) LAN (Local Area Network)

This network interconnects computer within a limited area.

(ii) MAN (Metropolitan Area Network)

- This interconnects users in a geographical region.
- Usually MAN network are connected using Router or Bridge.
- MAN is connection between many LANs.

(iii) WAN (Wide Area Network)

- It is a telecommunication Network extending over large geographical region.
Ex:- Internet, satellite, etc.

Basics of IP Addressing

- IP → Internet Protocol
every ~~node~~ node in a network is identified by IP address.
- This address can be assigned manually or dynamically and is called as the logical address which can change depending on location.
- It is represented in decimal having 4 octet (a.b.c.d)
where the range goes from 0-255 for all the octet i.e. 32 bit.

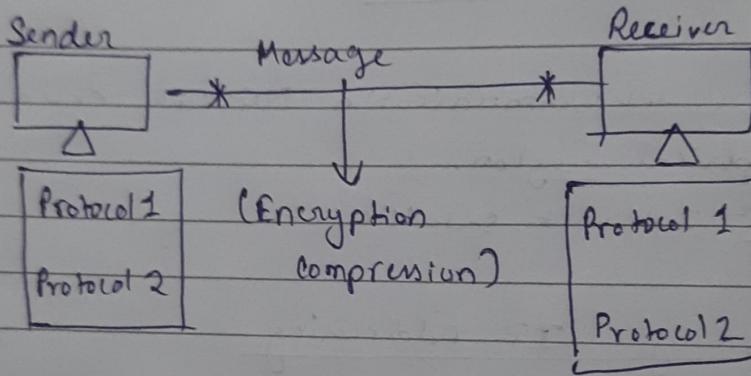
MAC address (48 bit) (Media Access Control)

- It is the physical address by manufacturer of size 48 bits represented in Hexadecimal.
- Router requires IP address whereas switch requires a MAC address.

Data Communication

Components of Communication

- Message
- Sender
- Receiver
- Transmission Medium
- Protocols



★ → Protocol implies a set of rules and regulations that will be governing the data communication. It is like an agreement between sender and receiver.

Network Attributes

- Attributes are the parameters important for computer networking.
- (i) Physical Attribute
communication can be either point to point or multi-point.

(ii) Network Topology

Topology implies the arrangement of the nodes and their placement inside a computer network.

Accordingly we can have physical ~~top~~ topology and logical topology.

⇒ Physical implies true placement of node whereas logical is how the data flow is happening ~~bet~~ within node.

There exist 5 different types of network topology :-

(a) Bus topology

(b) Ring topology

(c) Star topology

(d) Hybrid topology

(e) Mesh topology

(iii) Network Model

These are the standards required for heterogeneous networks to communicate with each other, are called network Model.

These standards are given by the international organization for standardisation and the two best

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These standards are given by the international organization for standardisation and the two best known

standards are :-

- (i) OSI model
- (ii) Internet Protocol (TCP/IP)

↳ Open System Interconnection

Transmission
Control
Protocol

OSI Model

→ Theoretical concept

→ This model works on the basis of principle of layering

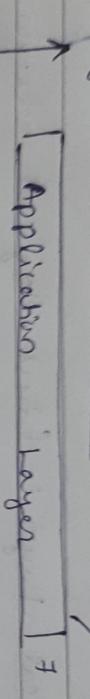
→ Layering implies decomposition of the problem to different component, therefore it helps in modular design of the network and easy trouble shoot of the network.

→ The two layered architectures are 'OSI (7-layer architecture)' and 'TCP/IP (5-layer architecture)'.

→ The purpose of OSI model is to facilitate communication between different network without changing the network architecture.

→ Layers of OSI model:-

↗ least technical



Presentation Layer

6

Goss

Session Layer

5

Downhill

Model

Upper

portion

receiver

Transport Layer

4

An

Network Layer

3

sender

Data Link Layer

2

Send

Physical Layer

1

Please Do Not Throw Pizza Since Away

sender

intermediate node

intermediate node

receiver

A

B

C

D

E

F

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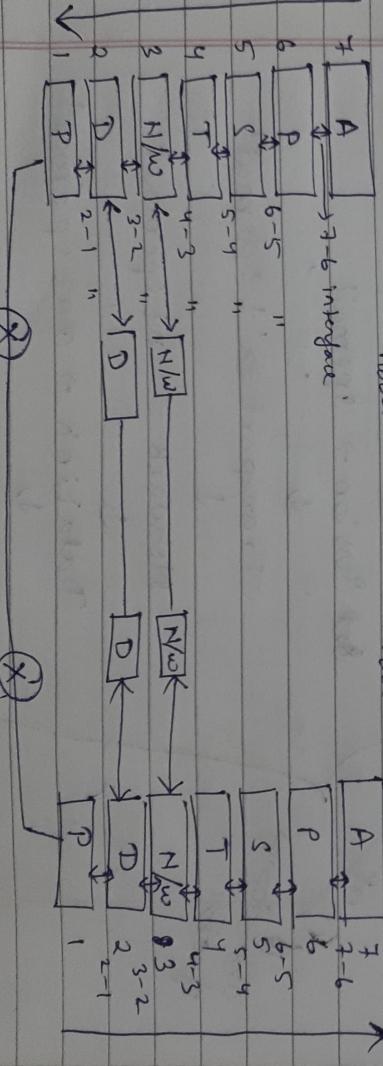
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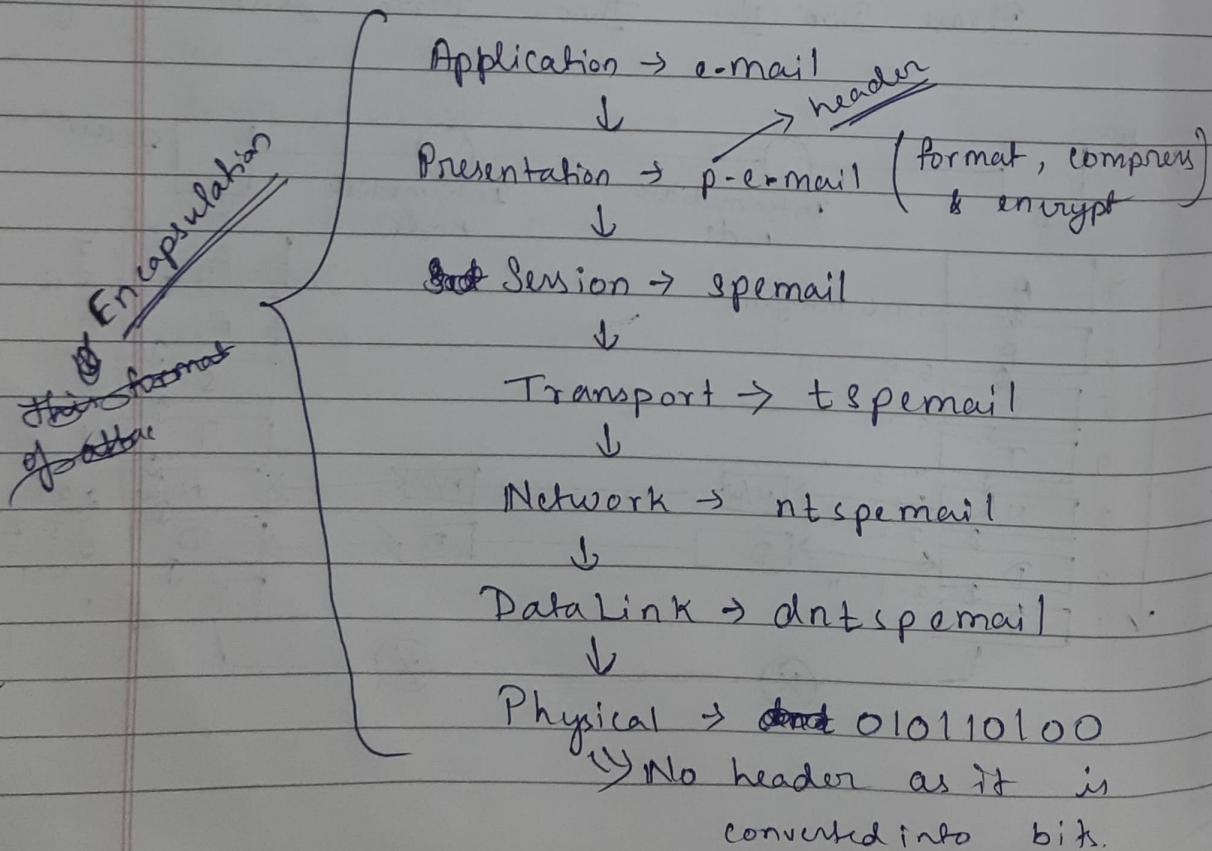


Date - 3/9/2024

OSI Model

* Physical Layer :- (first layer at receiver side)

- At every layer of the OSI model, the information is called as protocol data unit (PDU).
- A PDU is described as a single unit of information transmitted from sender to receiver.
- As the PDU is created at the application layer on the sender side, it goes through a series of transformation across seven layers and at every layer, a layer specific header is concatenated to it.



imp

- The procedure of attaching additional information corresponding to a layer inside a header at the starting of the message is called as "Encapsulation". It happens at each and every layer.
- The physical layer is responsible for converting the data into binary bits so that they can be transmitted through media like cable, fibre optic; air, etc.
- Every physical component on a network have a set of rules for sending and receiving data.
- The ~~is~~ services provided by this layer are :-
representation of data bit, synchronization of transmission time and maintenance of the physical topology.

① Application Layer:

- This is the first layer at the sender side and provides an interface for running the application on the host system.
- It helps the user to access the network resources.
- For using the application or Operating System there exist a set of services provided by

application layer, and they follow certain protocol like hyper text transfer protocol (http) and hyper text transfer protocol secure (https). Microsoft outlook utilizes the interface called SMTP (Simple mail transfer protocol), or FTP (File Transfer protocol).

→ At application layer protocol a PDU created by https is called as "data" which is transmitted to the presentation layer.

② ③ Presentation Layer

→ This layer is concerned with the syntax, ~~segmentation~~ semantics and formatting of the data before transmitting it to other layers.

→ The services provided are :-

- {
- (i) Data formatting / Data Translation
 - (ii) Data compression
 - (iii) Data encryption (Sender side)
 - (iv) Data decryption (Receiver)
- }

→ Here the data packet is referred to as "data". ~~through~~

③ ④ Session Layer

- It helps in establishing, maintaining and synchronizing the communication link between devices.
- The session layer is also responsible for terminating the connection between sender and receiver once communication is over.
- The services provided by the session layer are establishing, maintaining and ~~terminating~~ a terminating a session.

Eg:- Hotspot, session expiry of online meeting.

⑤ Transport Layer (most important)

- This layer is responsible for process to process delivery of the message.
- On cmd type (resmon), it will show you a series of processes currently running with their input port address, port address is allotted by transport layer.
- The transport layer is responsible for assigning a service ~~to~~ port number to the PDU such that the receiving system will understand the nature of the output process.

→ The transport layer follows the TCP/IP protocol for delivering the message and within an operating system supporting TCP/IP, there exist ~~65,535~~ 65,535 service port numbers which are distributed as follows :-

Port Range

Category

0 - 1023

Well Known ports

1024 - 49151

Registered ports

49152 - 65535

Private/dynamic ports

→ The services provided by transport layer are port addressing, connection control, error control and segmentation and reassembly.



Port Addressing

→ Computer networking is primarily dependent on 3 different addresses:-

(32 bits) (1)

IP address -

(to reach a network)

IP v4 ^{32 bits}
network

IP v6

subnet mask

(ii) MAC address (a.b.c.d.e.f) (48 bits)

(to reach a specific host)

(iii) Port Address

(to reach the target process)

→ It is very important that every process is represented by a port number which is a logical address. Any port is also

~~host~~ called as the communication end point and before sending the data, it is the task of the transport layer to decide the input and output port addresses.

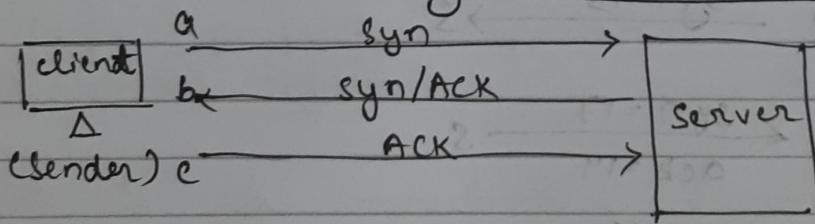
→ Transport layer has two protocols:-

- (i) Transmission control protocol (TCP) ✓ used
 - (ii) User datagram protocol (UDP)
- highly insecure

TCP

(handshake)

→ It is a connection oriented protocol that establishes a logical connection between source and destination using TCP three way handshake.



* syn → synchronize
* ACK → Acknowledge

line a → the client sends a synchronization message to the server to initiate a connection. After receiving the syn message, a random sequence number is created for initiating the begining.

Eg:- syn = 1234

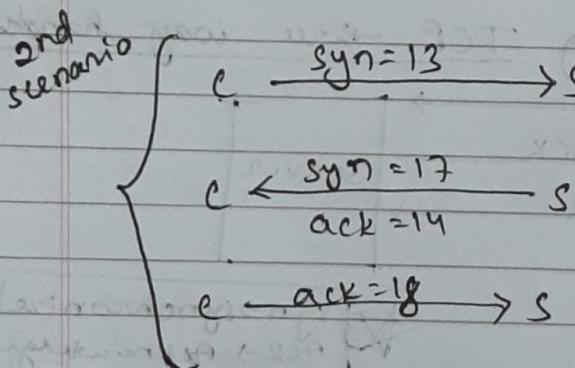
line b \rightarrow The server receives the message and generates an ack signal having the sequence number,
 $\boxed{\text{Ack} = \text{syn} + 1}$

Cyt: $\text{syn} = 1234$
 $\text{Ack} = 1234 + 1 = 1235$

line c \rightarrow After receiving receiving the syn message and ack message the client from the server, responds with a separate ack message,

$$\boxed{\text{ACK} = \text{syn} + 1}$$

Cyt: $\text{ACK} = 1234 + 1 = 1235$



UDP

\Rightarrow Unlike TCP, UDP is a connectionless protocol that doesn't establish a logical connection between source and destination.

→ Being a connectionless protocol, UDP doesn't guarantee the delivery of the message over a network and also doesn't provide any acknowledgement even when the message is received, that is why UDP is an unreliable transport protocol. In three way

handshake there exist a signal called FIN which finishes/terminates the connection between client & server.

⑥ Network Layer

→ This layer is responsible for delivering the data from source to destination using the internet protocol either version 4 or 6.

→ The services provided by this layer are :-

- (i) data routing
- (ii) Logical addressing

→ The data packet coming from the transport layer properly encapsulated is called as unipacket information in network layer.

→ IP is a connectionless layer-3 protocol that generates a session without any physical connection, also IP doesn't create a continuous logical connection between source and destination due to which ~~there~~ there are chances that the data packets will be lost or ~~corrupt~~ corrupted during transmission.

→ It also doesn't provide retransmission during packet loss and is unreliable.

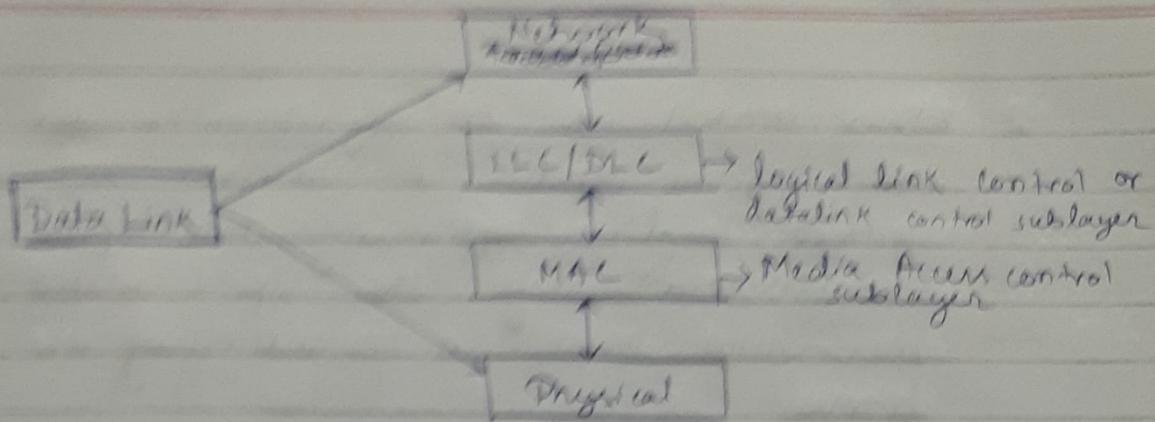
- In a network, every device is identified with a unique IP address and the task of network layer is to attach a header (source & destination IP) to the datagram of layer 4 and the process is called as logical addressing. For communication between different network, the layer 3 network device is called as "Router".
- IP permits the maximum size of the data transmitted as 1500 bytes ~~per time~~ (MTU: Max Transmissible Unit)
- This layer decides the pathway of transmission between different routers and the process is called routing.

⑥

Datalink Layer :-

- The layer 3 packet enters into layer 2 where the services offered are :-
 - (i) Physical addressing
 - (ii) framing
 - (iii) End-to-end
 - (iv) flow
 - (v) Error control

All these services are possible because of the sub-layers of datalink.



Q) MAC sublayer provides framing & physical addressing whereas LLC sublayer provides the control services.

(b) Framing :-

The packet from network layer is concatenated with source and destination MAC address as header and some extra information as trailer. This encapsulation process is called "framing" where physical addressing is performed.

(c) MAC addressing :- (organization unique)

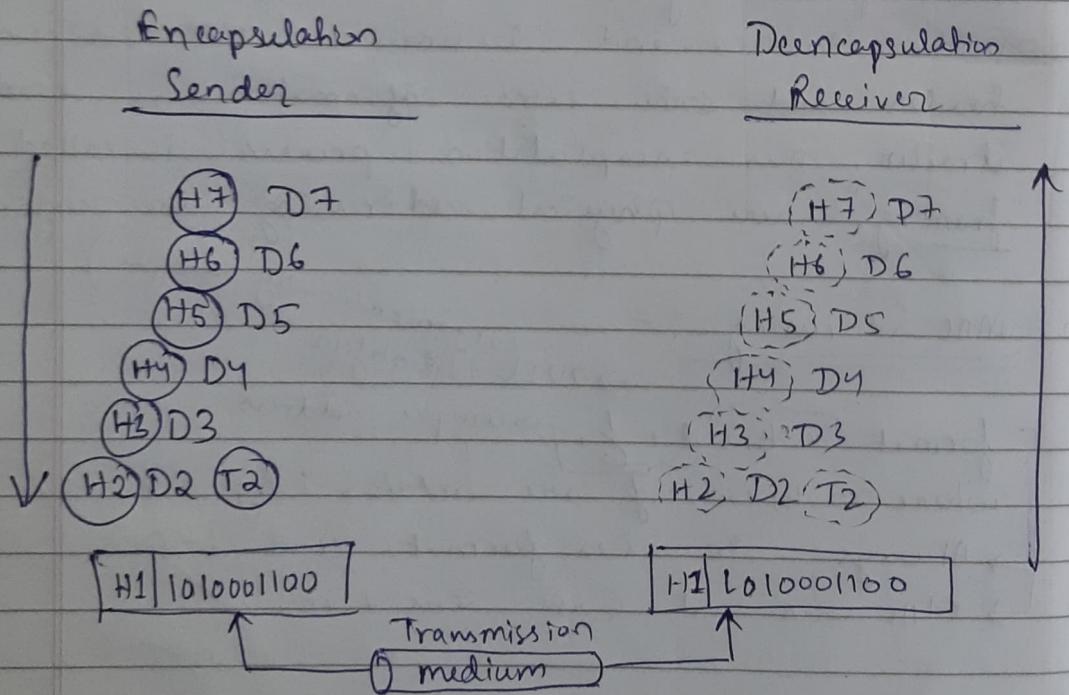
format a.b.c.d.e.f, f → unique address
 where a,b,c,d,e,f are octets = 1 byte = 8 bits
 → Always in hex format 0-9,a-f
 → MAC is not case sensitive.

(d) LLC/DLC :-

3) The task of LLC sublayer is to perform the control operations like end-to-end & flow control.

- Flow control is to synchronize the information coming from sender to receiver and end-to-end control implies optimizing the speed of transmission using the speed matching mechanism helps in co-ordinating the data frames.
- LLC sublayer also helps in error control by detecting & ~~so~~ correcting the error frame using FCS (frame check sequence) which includes CRC (cyclic Redundancy check).

Working of OSI Networking Model



(7) Physical Layer

- The primary responsibility is to transmit the data bits over the transmission medium and generate the corresponding header according to the transmission type.
- The bit conversion is the task of datalink layer.
- There exist a list of important organisation that governs the data sent over Physical Layer like:-
 - (i) ISO (International organisation for standardization)
 - (ii) ITU (International Telecommunication Union)
 - (iii) IEEE (Institute of Electrical and Electronics Engineers)
 - (iv) TIA (Telecommunication industry Association)
 - (v) FCC (Federal Communication commission)
 - (vi) ANSI (American National Standard Institute)
- The physical Layer addresses the following element for sending the data over a network like different physical devices, ~~or~~ encoding of the databit and signalling of the databit.
- Signalling implies conversion of the databits to corresponding electrical, wireless or optical signal.

TCP/IP Network Model

- This networking model is dependent on two protocol, TCP/IP of transport layer and IP of network layer. It is a 4-layer or 5-layer representation of OSI model.
- The working of TCP/IP is similar to OSI with the same encapsulation and deencapsulation principles.

OSI
7-layered
architecture

Application	HTTP, DNS,	Application	4
Presentation	DHCP, FTP		
session			
Transport	TCP / UDP	Transport	3
Network	IP ^{v4} , IP ^{v6} , ICMP ^{v4} , ICMP ^{v6}	Internet	2
Datalink	PPP, Frame	Network	1
Physical	Relay, Ethernet	Access	

TCP
layer
N/W
architecture

Physical (1)
Datalink (2)

Working of TCP/IP

(i) Application Layer

- It handles data representation, formatting, encoding, dialogue control and compression.

(ii) Transport Layer

→ This layer ~~do~~ support communication between devices across diverse network using ~~port~~ port addressing.

(iii) Network Layer

→ Its primary responsibility is to perform routing using IP address.

iv) Network Access Layer

→ Also called as Link Layer / Network interface Layer.

→ It controls the hardware devices and media that help in message transmission.

→ In a 5-layer TCP ~~do~~ architecture the Network access layer is divided into ~~Datalink & Physical~~ Datalink & Physical layer.

TCP / IP PDUs

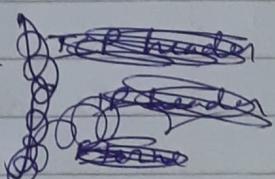
5 Application → Data

4 Transport → Segment → Port address

3 Network → Packet → IP "

2 Datalink → Frame → MAC "

1 Physical → Bits



There exist three classes of IP address in version 4, that is -

(i) Class A

In format a.b.c.d, the variation of the bits lies in between zero to 127. with the category of subnet mask 255.0.0.0 where a is indicating the network id and b,c,d are indicating the host id.

~~This~~ This class is utilised for larger network.

(ii) Class B

In format a.b.c.d, the values vary in between 128 to 191 with Subnet mask format, 255.255.0.0, where a,b are network id & c,d are host id.

This is used for medium sized network.

(iii) Class C

In format a.b.c.d, the first 24 bit are network id and last 8 bit is host id. (a,b,c → network id, d → host id) its subnet mask format is 255.255.255.0. The values vary from 192 to 255.

This is used for small network.