

Mod 41.1 Data Communication

Networks

Internet

Protocols & standards

Uses of computer networks

1.2

Network Models:~~OSI Models~~Layers in OSI Models~~TOP / IP protocols suite.~~~~Layer 7 services to applications~~

#

Network:(enables data flow) ~~enables~~

- Network is interconnection of set of devices capable of communication.
- A device can be a computer or a router, switch, modem. Devices are connected using ~~wireless~~ or wirelessly.

Local Area Network (LAN):

- Usually privately owned, it connects some hosts in single office, building, etc.

- LAN can be as 2 PC's or a connection of some audio-video devices.
- Each host in a LAN has a identifier, an address, that uniquely identifies the host in LAN.

- A packet sent by host to another host carries both addresses of source host & destination host address.

6.9.24

- When all hosts are connected using a cable, packet sent by one host is delivered to all other hosts.
- But now, most LAN's use a smart connecting switch which is able to recognize destination address.
- Switch reduces the traffic ~~bandwidth~~ & allows more than one pair to communicate with each other at same time.
- * LANs today are connected to each other & to WANs to create communication at a wider level.

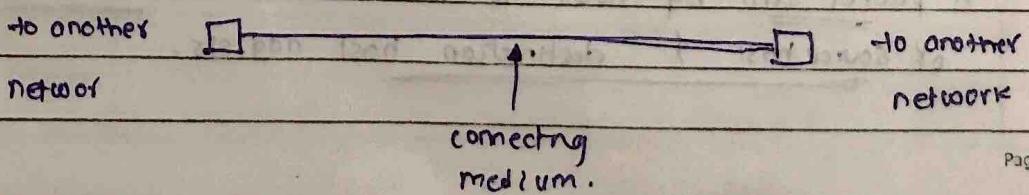
* WANs (Wide Area Network)

- Interconnection of devices that are capable of communication
- Some differences in LAN & WAN, WAN has a wider geographical area, spanning a city or town.
- A LAN interconnects hosts, whereas A WAN, interconnects connecting devices, e.g. router, modem.

- A WAN is created & ran by communication companies
- Two types of WAN's, Point to point and switched.

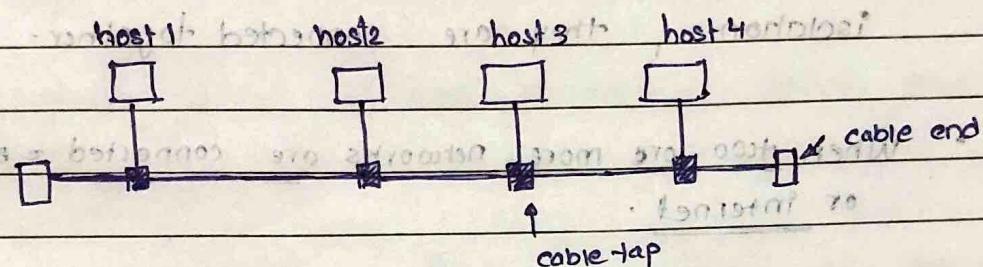
* Point to point WAN:

- Connects two connecting devices using cable or air.

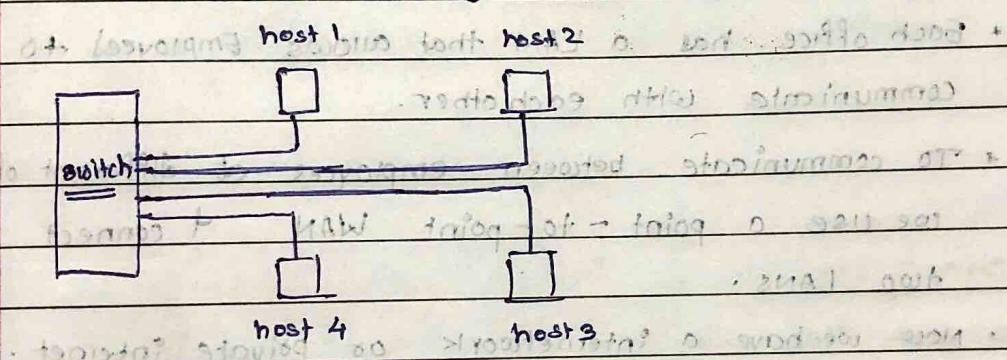


* LAN - Diagram

(a) In past → common cable MA!



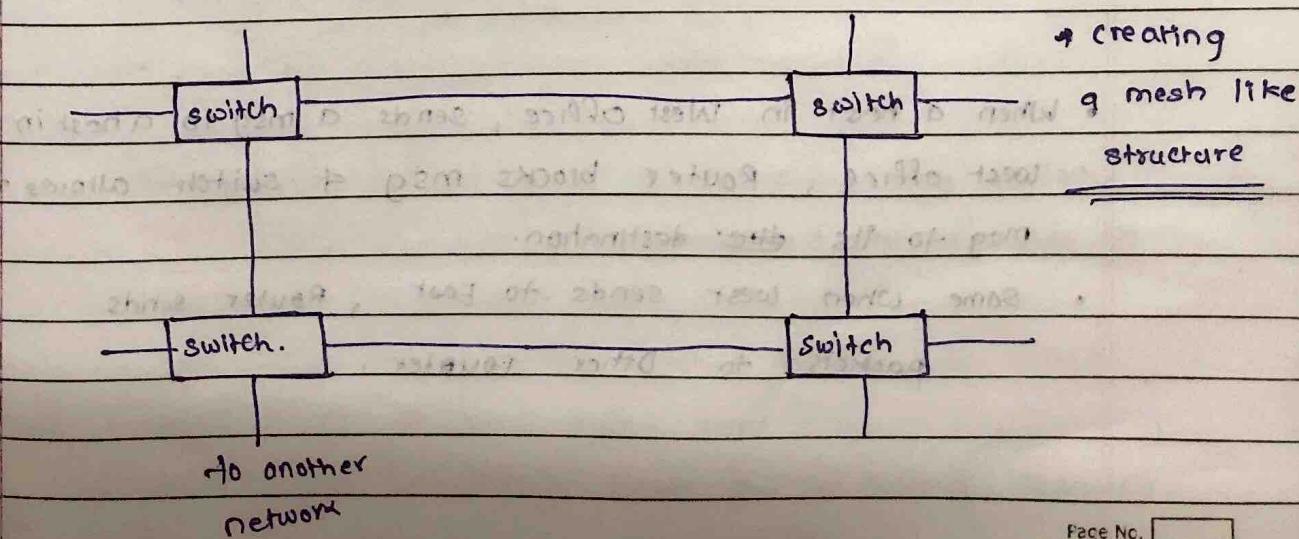
(b) In present → using switch fast to switch



* Switched WAN

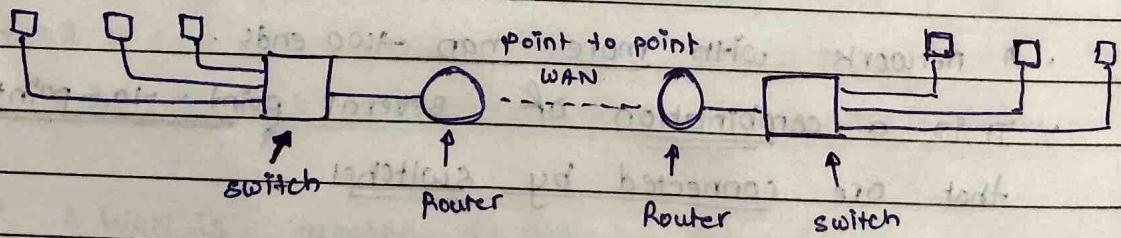
A network with more than two ends.

It is a combination of several point-to-point WANs that are connected by switches.



* Internetwork :

- In today, LAN & WAN can't be seen in isolation, they are connected together.
- When two or more networks are connected = internetworks or internet.
- Fg: organization has 2 offices, one at East coast & other at west coast. Each office has a LAN that allows employees to communicate with each other. To communicate between employees at different offices, we use a point-to-point WAN & connect two LANS. Now we have a internetwork or private internet.

LAN 1

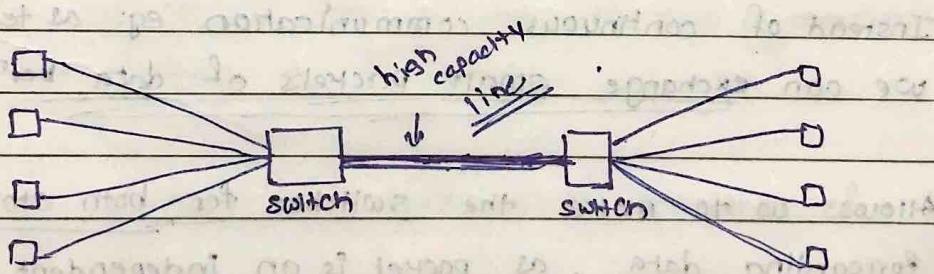
- When a host in West office sends a msg to a host in West office, Router blocks msg & switch allows the msg to its ~~des~~ destination.
- Same, when West sends to East, Router sends packets to other router.

* Switching:

- Internet is a combination of links & switches.
- Internet is a switched network, switch connects at least two links together.
- A switch needs to forward data from one link to another.
- Two most common types of switches are:
circuit-switched & packet-switched

* Circuit Switch Network:

- In circuit switch Network, a dedicated connection, called a circuit, is always available b/w two end systems.
- The switch will make circuit active or inactive.
- Circuit switched network is common in telephones.



- 4 telephones are connected at each side using switch.
- The switch connects a telephone set at one side to telephone set at other side.
- The high capacity line can handle 4 voice communication at the same time.
- Switch has forwarding task but no storing capacity.

- In 1st case, all telephone sets are busy, 4 pers. at one side are talking to 4 pers. at other side.

The capacity of thickline is fully used.

In 2nd case, only one telephone set at one side is connected to telephone set at other side, only one fourth of thickline capacity is used.

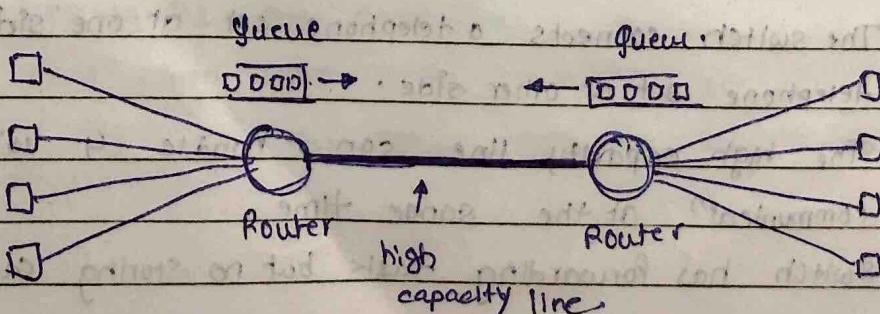
- Thus, through this we get to know, circuit-switch network is efficient only when it is working at full capacity.

- The reason to make capacity of thick line = capacity of 4 voice lines, is to make sure, all get connected to each other at once.

* Packet-switched Network:

In computer based network, communication is done in by sending & receiving blocks of data \rightarrow packets.

- Instead of continuous communication eg: as telephone, we can exchange small packets of data betn 2 computers.
- Allows us to make the switches for both storing & forwarding data, as packet is an independent entity & can be stored.

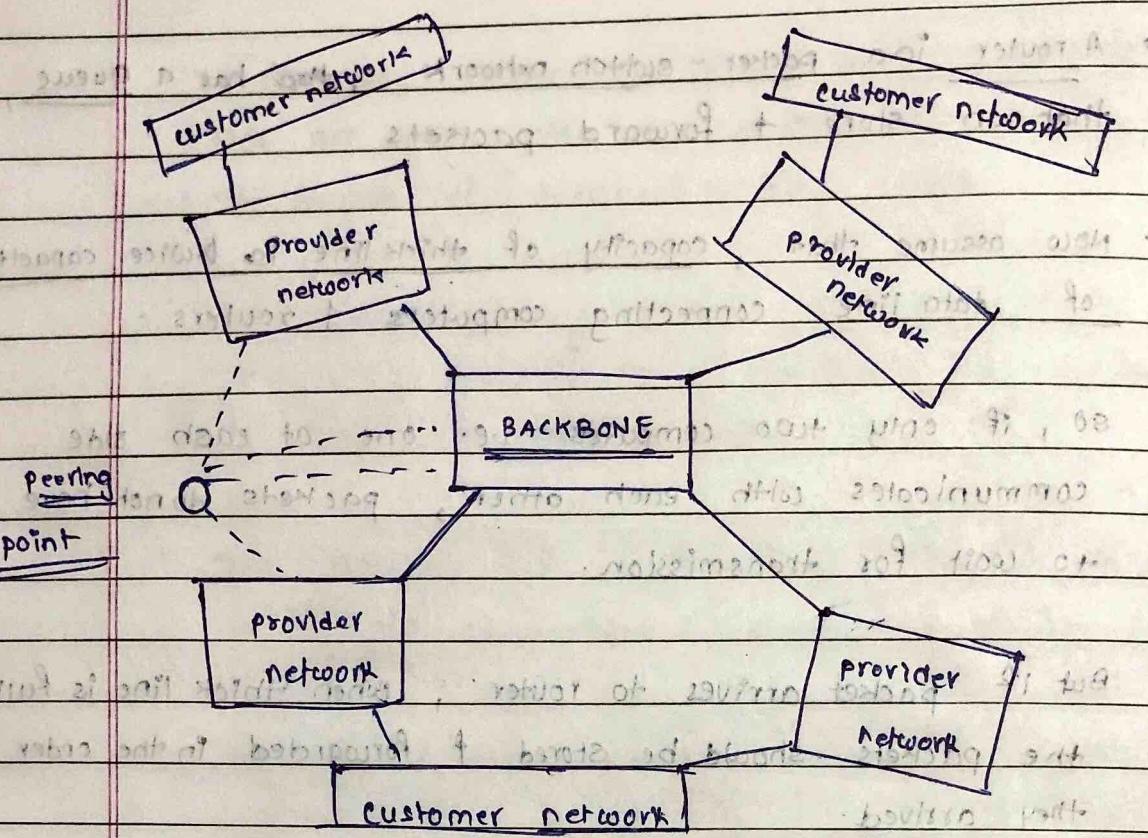


- A router in a packet-switch network, that has a queue, that can store & forward packets.
 - Now assume that, capacity of thick line is twice capacity of data line connecting computers & routers.
So, if only two computers i.e. one at each side communicates with each other, packets do not have to wait for transmission.
- But if packet arrives to router, when thick line is full, the packets should be stored & forwarded in the order they arrived.
- * Packet-switch network is more efficient than Circuit switch networks.

* The Internet:

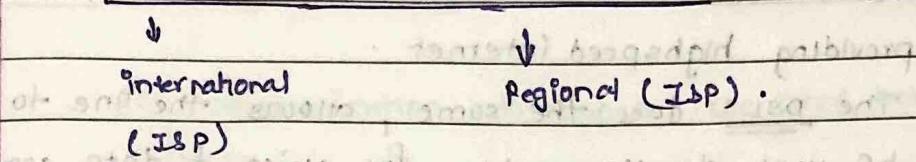
- The internet is the connection of two or more networks & communicating with each other.
- The Internet is composed of thousands of interconnected networks.
- There is a difference in internet \rightarrow Connectn of 2 or more networks.
 - . Internet \rightarrow thousands of interconnected networks.

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- Internet is a backbone, provider network & several customer networks.
- ① • At the toplevel is the backbone. Are large networks owned by companies eg: (AT&T)
- ② • The backbone are connected through some strong complex switching system called peering.
- ③ • At second level are provider networks, that use service of the backbone. For a fee.
- ④ • Provider networks are connected to backbone & sometimes, other provider networks.
- ⑤ • The customer networks are at the edge of Internet that use the service provided by Internet

* Backbone & provider network are Internet service providers



Accessing the Internet: Telephone, wire/cable, wireless
Dial, DLS, TV, WAN

- Internet today The physical connection b/w user & provider (ISP) is done using (point-to-point WAN)

* Using telephone networks: (Telephone me internet).

Today most of business have telephone services, i.e. they already have a network of telephone system.

Now since most of telephones are already connected to internet for internet, we can change the voice line b/w house & telephone center to a point-to-point WAN.

This changing voice line to point-to-point WAN can be done by 2 ways:

① Dial up- services: to add a modem to telephone that converts data to voice.

The software on computer dials ISP & imitates making a telephone connection.

→ needs user may Very slow service & can either be used for telephone voice or internet.

badly → add a modem to telephone to convert ~~data~~ to voice.

→ computer will call / dial to ISP to get internet.

* → can either use internet or voice.

② DSL Service: telephone companies have started providing highspeed internet.

- The DSL does the same, allows the line to be used simultaneously for voice + data comm.

* Using cable Networks (TV cable → internet)

As we use ~~cable~~ cable TV services for broadcasting, providers have included high speed Internet to their cables.

(They providers are changing cables to connect to internet.
Upgrading cables)

Speed of Internet depends upon how many are using same cable.

snapshot to monitor a user activity unit

* Using wireless Networks:

of between 1000 mbps to 2000 mbps to 100 mbps to 10 mbps

recently become much popular, as we can get internet

through a combination of wired & wireless connections.

Can get internet through a wireless WAN.

* Direct connection to Internet:

A large organization can itself be an ISP & connected to Internet.

Lease a WAN & connect it to ISP.

Eg: Large university with several campuses, create an

internetwork & then connect internetwork to internet.

Hardware & software:

- For communication to happen, we need both hardware & software.
- Combination of hardware & software can be done through protocol layering.

Protocol layering

- A protocol ~~is~~ defines the rules that a sender & receiver needs to follow for communication.

~~When~~ When communication is simple we may need only one simple protocol. But when communication is complex, we may need to divide tasks betw layers.

- When we divide, we need to give protocol to each layer,
→ Protocol layering.

* Complex tasks → several simple tasks. ⇒ Protocol layering.

* Modularity → independent layers, can be changed easily (only one layer).

* Advantage is → it allows us to separate services from implementation [Services = layers].

* A layer needs to get data from the lower layer to give services to upper layer.

* Advantage: communication does not always use only two ends systems, there are intermediate systems, that need only some layers. Not all.

Principles of protocol layering: (opposite task, object at corresponding layer identical).

- First → if we want bidirectional communication, we need to make each layer, so that it can do two opposite tasks.
- Second → two objects under each layer at both sides should be identical.

logical connections:

logical connection between layers so we can have layer-to-layer communication.

logical connection between peer layers.

Maria

→ protocol for Anna ←

layer 3. protocol listen / talk. ← logical connection → listen / talk → layer 3

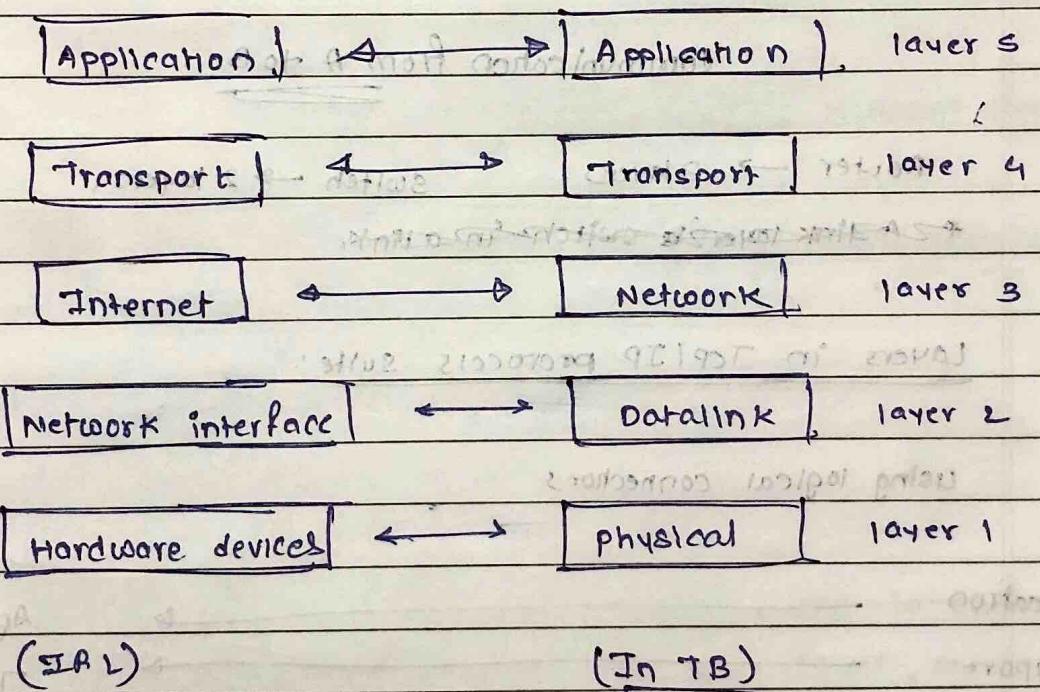
layer 2 Encrypt / Decrypt ← → Encrypt / Decrypt → layer 2

layer 1 send / receive ← → send / receive → layer 1

Protocol = (P_1, P_2, \dots, P_n) - combination

TCP / IP protocol : (Transmission Control protocol / Internet protocol)

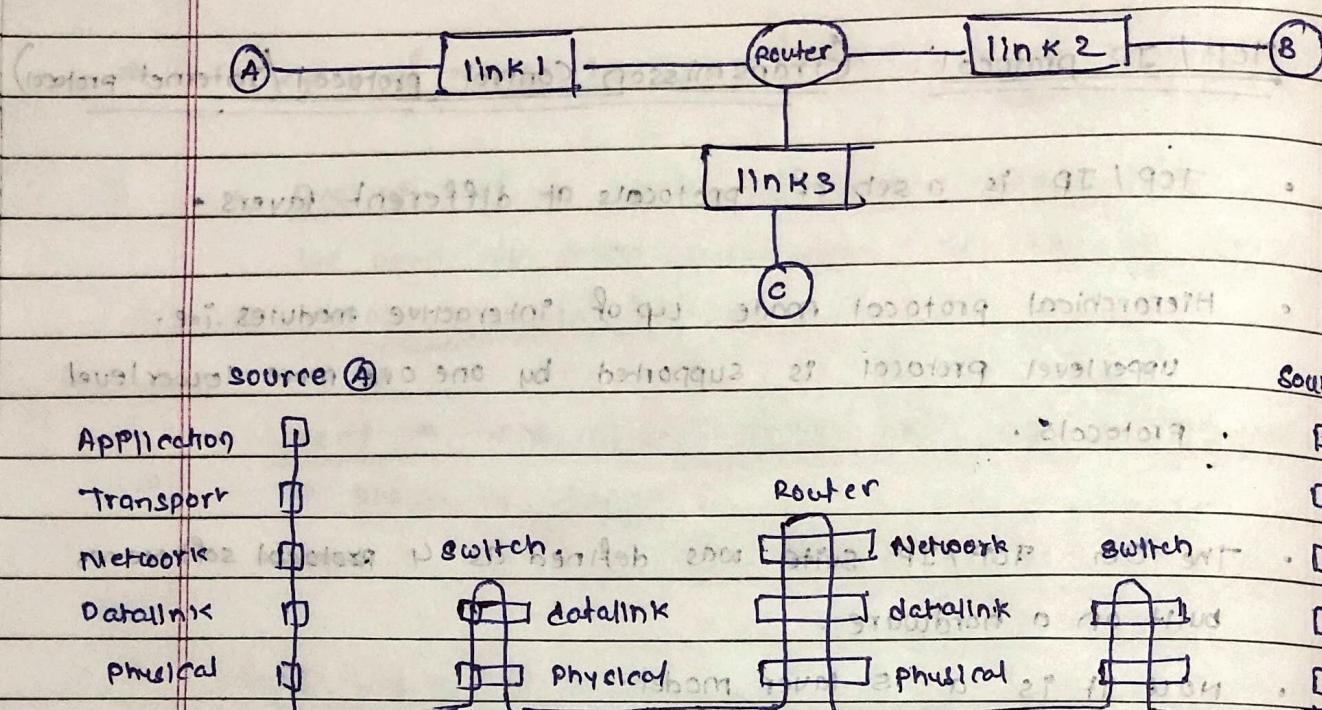
- TCP / IP is a set of protocols at different layers.
- Hierarchical protocol made up of interactive modules i.e. upper level protocol is supported by one or more lower level protocols.
- The OSI TCP / IP suite was defined as 4 protocol softwares built on a hardware.
- Now it is a 5 layer model.



Layered Architecture:

- To show, how layers of TCP / IP are involved in communication betn 2 hosts, we will use suite in 3 LAN (links)

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source ④ → source ⑧

Application

Transport

Network

DataLink

Physical

Router

Network

switch

Physical

datalink

Physical

switch

Physical

Physical

communication from A to B

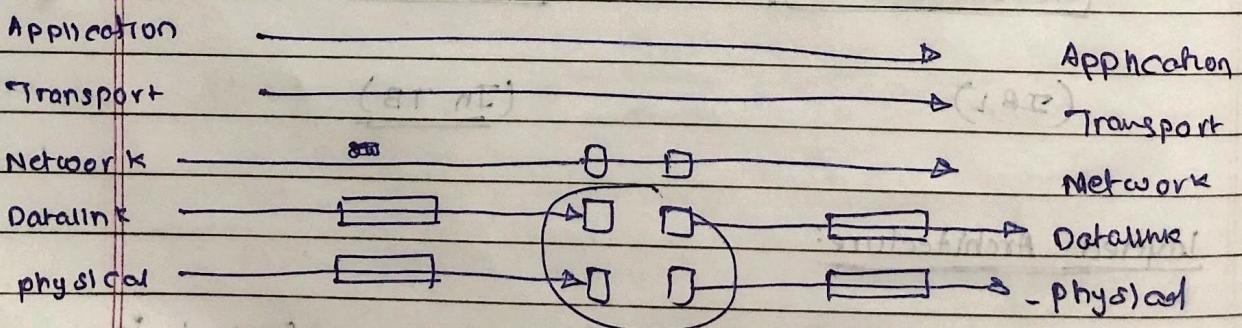
Router → 3 layers ← switch → 2 layers

* 2 layers of Router & 2 layers of switch in a link.

Layers in TCP/IP protocols suite:

Application → DataLink → Physical

Using logical connections

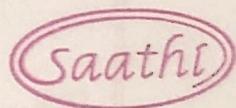


* domain of top 3 layers = Internet

* last 2 layers = link, i.e., MAC

though identical obj are in betw 2 host, they also exist in betw hops.

each layer is independent.



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(Process to communicate with other process)

Application layer: (HTTP, FTP, SMTP, SNMP, SSH TELNET, DNS)

* logical connectn betn 2 application layer is end-to-end.

* * To communicate in application layer:

→ processor sends a request to other processor & receives a response.

→ Process to process communication is the duty of app. layer

• The (HTTP) is the vehicle for accessing WWW

• The Simple mail transfer p. (SMTP) is main protocol used in e-mail service.

• The File T.P. (FTP) is used for transferring files to other hosts.

• The TELNET & SSH are used for remotely accessing site.

• The SNMP to manage internet.

• Domain Name System (DNS) is used by other protocols to find network layer address of computer.

Transport layer: TCP UDP

* logical connection at transport layer is end-to-end.

* Transport layer receives msg from app. layer, encapsulates it in transport layer packet & sends through the logical connection to transport layer of destination.

* Transport layer gives services to app. layer.

* We need end-to-end transport layer, to separate task & duties.

* More than one protocol in transport layer.

- We have more than one protocol in transport layer, each is designed for some specific task.

→ main → TCP Transmission control.

- TCP is a connection oriented protocol, first establishes a connection betn. transport layers of 2 hosts.

• TCP creates a logical pipe for transferring stream of data.

- TCP provides flow control, error control & congestion control to reduce the loss.

→ other common protocol is : User Datagram Protocol (UDP)

- A connectionless protocol, each UD is an entity independent of travelling without being related to previous or next.

- UDP is simple protocol that does not provide flow, error & congestion control.

- sctp is present to respond to new applications.

Network layer: (IP, routing, auxiliary - DHCP, ARP, ICMP, ICMP)

- Responsible for creating connection betn source host & destination host.
- Communication at network layer is host to host.
- Since there can be several routers in the path, the routers decide which path is the best suitable.
- We need network layer because routers do not need application & transport layer.

Network layer responsible for sending packets to destination.

- The network layer in Internet includes main protocols, IP, that defines the format of packet, ie. datagram at network layer.
- IP also defines format & structure of address in this layer.
- IP is also responsible for routing a packet from source to destination.
- * IP is a connectionless protocol, that provides no flow, error & congestion control.
- Network layer has unicast (1-1) & (1-m) @multicast routing protocols.
- * Routing is responsibility of IP. Routing Protocol creates tables for routers to help them in routing.

DNS & DHCP → network layer address of host

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- The Network layer has some auxiliary protocols that help IP to do its routing task.

① The Internet Control Message P (ICMP) to report problems with routing of packets.

② The Internet Group Management P (IGMP) to help IP in multitasking.

③ The Dynamic Host Config (DHCP) helps IP to get Network layer address for host.

④ The Address resolution protocol (ARP) helps IP to find IP, link layer of host or a router when network layer layer address is given.

Data link layer (encapsulate data into frame)

In internet, it is connected by various links that are connected by routers.

The routers are responsible for best route / path.

The next link is found by the routers ; but the data link layer is responsible for moving data across the link.

Link can be wired LAN with link layer switch, wireless LAN,

wired WAN or wireless WAN.

* Data link layer is responsible for moving packets through links.

- The data link layer takes the datagram & encapsulates it in a packet called frame.

Physical layer:

- Physical layer is responsible for carrying individual bits in frame across link

- The communication betn 2 devices at physical layer is logical.
because there is another hidden layer \rightarrow transmission media under physical layer.

- The transmission two devices are connected by a trans. medium (air/wire)

- * Transmission medium does not carry bits it carries electrical signals / optical signals

- So bits received in frame from datalink layer are transformed & then sent through transmission media.

- * convert bit to signal \rightarrow send through transmission media.

#

EncapsulationDecapsulation

- We show encapsulation in source host
decapsulation in destination host

& encapsulation & decapsulation in router.

* Encapsulation at source host

① At app. layer data ^{to be exchanged} is referred as

message. A message does not have a header & footer generally, if it has, the entire is considered as message.

Message is passed to transport layer.

② Transport layer takes msg) as payload, that it has to transport it to the destination.

Transport layer adds header to the message, that contains identifiers of source & destination.

+ some info that is required for end-to-end

delivery. Info for flow, error & congestion control.

The result is transport layer packet = segment (in TCP)

③ The network layer takes transport layer packets as payload & add its own header. Header has info about address of source & destination.

The result of network layer packet = Datagram

④ Datalink layer takes over the packet of network layer and adds its own header, that contains linklayer address of host or next hop (router).
The result of linked layer packet = frame.

Frame is passed through physical layer for transmission.

* Decapsulation & Encapsulation of Router:

① After the set of bits are delivered to datalink layer, it decapsulates the datagram from from and passes it to network layer.

② The network layer only inspects the address in datagram header & sends it to next table to find the next hop & destination.

The contents are not changed.

The datagram is then passed to next datalink layer of next link.

③ Datalink layer encapsulates ~~the~~ datagram in a frame & passes it to physical layer.

* Decapsulation at Destination Host: [Involves error checking]

* each layer only decapsulates the packets received, removes the payload & delivers the payload to next high layer protocol, until it reaches applayer.

- # Addressing
- * Any communication that involves two parties needs to be addressed.
 - source address & destination address.
 - * Except for physical, every layer does addressing.

because, in physical layer, operation is done on bit.

Packets layers port address

a) message Application layer Names
 b) segment Transport layer Port no.

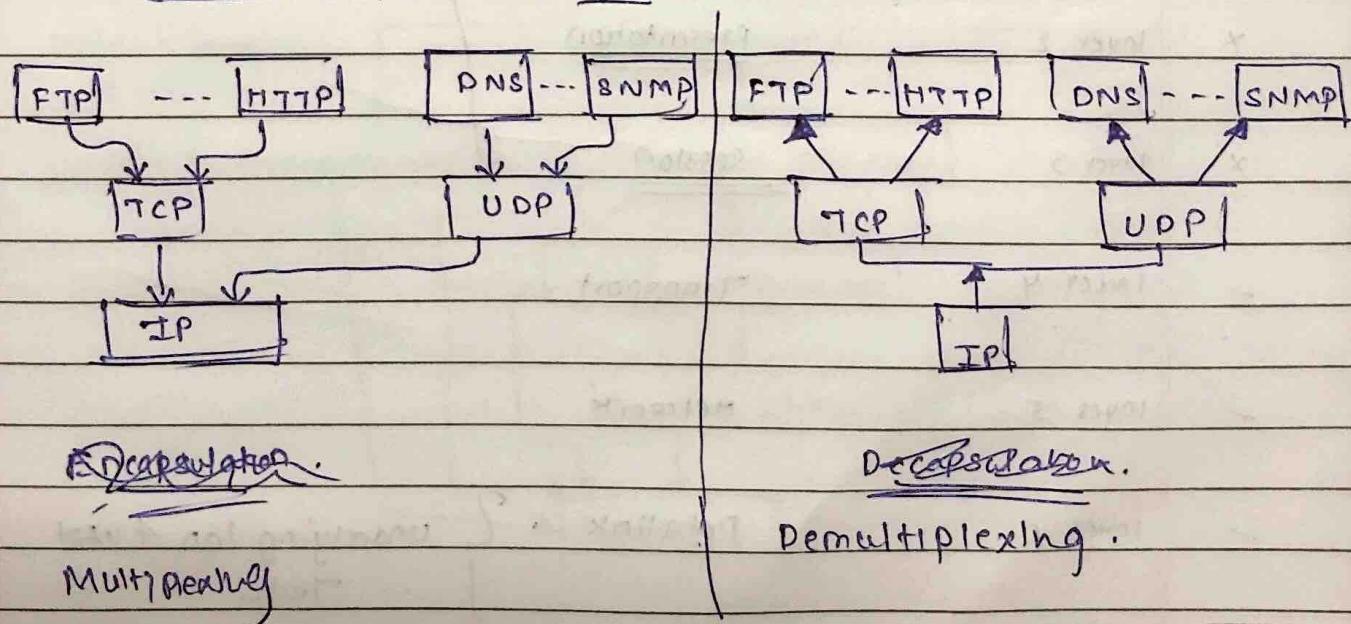
Datagram Networks logical address (global)

frame Datalink layer
bits Physical
 link layer address (MAC address)

- * network layer address uniquely defines connection of source to Internet.

Multiplexing & Demultiplexing :

- Multiplexing : In this case means → protocol at a layer can encapsulate a packet from several next higher layers protocol.
- Demultiplexing : protocol at a layer can decapsulate a packet and deliver a packet to several next higher level protocol.
- * To be able to multiplex & demultiplex, protocols needs to understand, to which protocol the encapsulated packet belong.
- * At transport level either UDP or TCP can accept msg from several app. layer protocols.
- * At network layer, IP can accept a segment from TCP or from UDP.
- * In DataLink layer, frame may carry payload from IP or other protocols ARP.



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The OSI MODEL(Open System Interconnections)

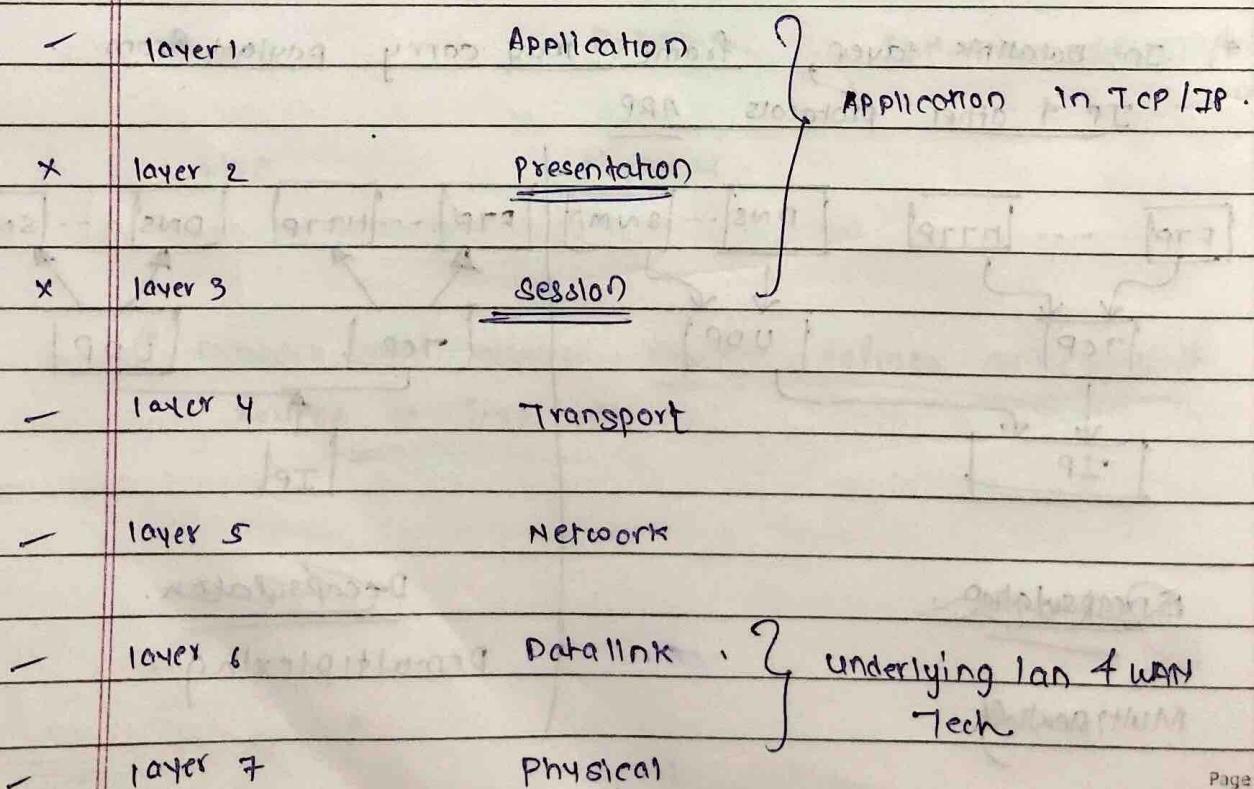
* An open system is a set of protocols that allow systems to communicate regardlessly their architecture.

* Purpose of OSI is to show, how communication can be done, without changing the underlying hardware or software.

* OSI model is the basis of creation of protocol.

* Used for understanding & designing a network architecture.

OSI is a layered framework that allows communication between all types of computer systems. It consists of 7 separate but related layers.

OSI Model & layers (Interconnected)

* OSI vs TCP/IP

- In TCP/IP, application layer is the combination of application, session & presentation layer of OSI.
- Reason for not adding presentation & session were:
 - TCP/IP has more than one transport protocol.
 - Application layers is not only one piece of software.
many app. may be developed at this layer.

Lack of success of OIS Model:

reasons

- TCP/IP was fully used so no chance of again changing.
- Presentation & session were not fully defined layers, actual protocols were not defined nor described.
- Not good enough performance.

#

Maturity level
of RFC.

Internal-draft

informational

experimental

proposed standard

Draft standard

internet standard

Historic