Module - ②

① Data Link Layer (DLL)
→ 2nd layer of OSI model.
→ Main Job: Ensure error-free and reliable data transfer btw 2 directly connected nodes.
It has 2 sublayers:
1. Logical Link Control (LLC) - Deals with error control and flow control.
2. Media Access Control (MAC) - Manages how devices access the shared medium (cable, air, etc.)

② Error Detection and correction
Error Detection → To find errors that may occur during data transmission.
Method →
- Block coding :- Adds extra bits (redundancy) to detect errors.
- Hamming Distance :- The no. of bit positions in which 2 codewords differ. It helps in detecting & correcting errors.
- CRC (Cyclic Redundancy Check) :- Sender sends code using polynomial division. Receiver recalculates CRC; if it doesn't match, error is detected.

Error correction → To fix the errors after detecting them.
Uses techniques like Hamming code to not just detect but also correct errors automatically.

Flow control Protocols :- To prevent a fast sender from overwhelming a slow receiver.
1. Stop and wait → Sender sends one frame, waits for ACK.
→ Simple but slow.

DDNS (Dynamic Domain System)
- automatically updates IP add. linked to a domain name whenever the IP change.

Why?
Most home internet connections use dynamic IP add., meaning IP add changes from time to time.

without DDNS → you won't know your current IP, so remote access (eg. CCTV, server) will break.

with DDNS ⇒ your domain (like myhome.dyndns.org) always points to the correct IP, even if it changes.

Ex:
You set up a security camera at home & want to access it from anywhere:-
- your ISP gives you a changing (dynamic) IP add.
- you use DDNS to link your domain name to your changing IP.
- Now, you can access the camera using a fixed name (like mycamera.ddns.net

MOD-5

Application Layer - Layer-7 of OSI model.
- topmost layer
- directly interacts with the user / software
- provides services like browsing, email, file transfer

Domain Name System Space (DNS)
- like phonebook of the Internet.
- converts website name (like www.google.com) into IP addresses like (142.250.182.4) that computers use to find each other.
- Why DNS imp. → Humans remember names not numbers.
→ Computers use IP add. to communicate
→ DNS helps bridge the gap b/w humans & computers.

How DNS Works:-
1) you type www.example.com in your browser.
2) The comp. asks the DNS server. "What is the IP add. of this website?"
3) DNS server replies with IP (like 93.184.216.34)
4) Your browser uses that IP to connect to website.

DNS Str. (Hierarchy)

Level	Ex.
Root Domain	(invisible)
Top-level "	.com, .org, .in
2nd-level "	google, amazon
Subdomain	mail.google.com

DoS Improving Techniques :-

1) Leaky Bucket Algorithm.
- Think of a bucket with a small hole.
- Data enters the bucket at any speed, but leaks out at a steady rate.
- Controls data flow to prevent network overload.

2) Token Bucket Algorithm
- Tokens are generated at a fixed rate.
- Each token allows sending a packet.
- If you have enough tokens, you can send data quickly (good for bursts of data).
- More flexible than ~~Leaky~~ Leaky Bucket.

SCTP (Stream Control Transmission Protocol)
- A mix of TCP and UDP features.
- Supports multiple streams in one connection.
- Message oriented - unlike TCP which is byte-oriented, SCTP is msg oriented like UDP.
Each msg is kept intact - no merging or breaking.
- Multi-Homing Support - SCTP use multiple IP addresses for a single connection.
- Commonly used in ~~telephone networks~~.
(SS7 over IP)

Congestion control :- Technique to prevent too much data from being sent over the network, which can access slowness, packet loss, & delays.
Goal → Avoid overloading the network.
→ Ensure fair usage of bandwidth.
→ Maintain good performance (low delay, low loss)
Used in TCP.
Control techniques → Slow start
→ Congestion Avoidance.
→ Fast Recovery.

QoS (Quality of Services)
- Managing network traffic in a way that ensures imp. data gets better speed, less delay, more reliability.

- Not all data is equal.
Some need to be delivered quickly & ~~steadily~~ smoothly, like :- Video calls
Online gaming
Live Streaming.

MOD-4

Transport Layer - Layer 4 of the OSI model)
- ensures reliable or fast delivery of data b/w programs (called processes) running on diff. computers.

Process-to-Process communication
While the network layer sends data from comp. to comp., the transport layer sends data from one application (process) to another.
Ex:- Your browser (a process) comm^n. with a web server process using the transport layer.

UDP (User Datagram Protocol)
1. connectionless Protocol → UDP doesn't establish a connection before sending data.
2. Faster but Unreliable → It is faster that TCP but doesn't guarantee delivery, order, or error checking.
3. Used for Real-Time Application → common in video calls, Online games, live streaming, where speed matters more than accuracy.
4. No Acknowledgement → The sender doesn't ~~no~~ wait for a response from the receiver.
5. Lightweight Header → UDP has a simple str. with less overhead, making it suitable for fast comm^n.

TCP (Transmission Control Protocol)
- A reliable protocol.
- Establishes a conn^n. before sending data.
- Ensures all data is delivered in the st. order & without errors.
- Slower than UDP, but faster.
- Ex:- Web browsing, email, file downloads.

4. DHCP (Dynamic Host Configuration Protocol).
- Automatically assigns IP addresses to devices when they connect to a network.

Delivery	Forwarding
• Sending the packet to the final destination device.	• Sending the packet to the next hop/router on the path.
• End-to-End delivery (Source to destination)	• Hop-by-hop movt. (one router to the next)
performed by: • The Source device / final router	• Routers along the path.
• Ex: Laptop sends a mssg. to a server	• A router checks the pkt. and sends it to the next router.
• Type: Direct & Indirect delivery	• No types, just routing-based.

Delivery → direct delivery → within same network
→ indirect delivery → goes through one/more routers.

Unicast Routing Protocols
Unicast = sending data to one specific device.
Routing Protocols help find the best path.

1. RIP (Routing Infor. Protocol)
Simple, uses no. of hops (shortest path by hops).
2. OSPF (Open Shortest Path First)
More advanced, uses link cost (better performance)
3. BGP (Border Gateway Protocol)
- Used on internet b/w big networks like b/w ISPs.

MOD-4

Transport L
- ensures pr
b/w progra
diff. com

Process-to-
while the
comp. to
data from
Ex:- Your
a web S
layer.

UDP (Us
1. connectionl
a connec
2. Faster but
but does
checking.
3. Used for
calls, Onl
matters
4. No Ackn
for a rec
5. Lightweigh
less overhe

TCP ("T
• It reliab
• Establish
• Ensures
& witho
• Slower t
• Ex:- G

MOD-3

① Network Layer :-

- 3rd layer in OSI model.
- delivers data from one computer to another across different networks.
- decide where the data goes & how it gets there.

Switching :

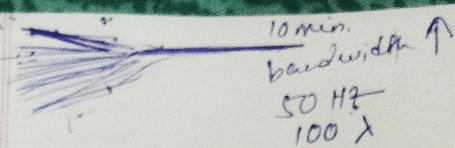
- how data is sent b/w devices in a network.
- 3 main types :-
  1. Circuit switching - Like a phone call : a dedicated path is set
  2. Packet switching - data is split into small packets & sent separately (like the internet).
  3. Message Switching - Entire message is sent & stored at each step (less common now).

Logical Addressing - IPv4 & IPv6

- IP addresses used to identify devices on a network.
- IPv4 : 32-bit address (eg. 192.168.1.1)
  - Limited number of addresses.
- IPv6 : 128-bit address (eg. 2001:0db8:85a3::8a2e:0370:7334)
  - Much larger no. of addresses
  - Used for to replace IPv4.

Address Mapping - used to convert one type of address to another.

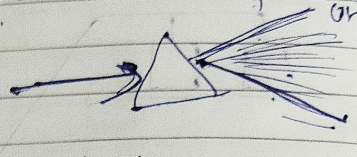
1. ARP (Address Resolution Protocol)
   - converts IP address → MAC add. (for sending data within the same network).
2. RARP (Reverse ARP)
   - converts MAC address → IP address (used by some old systems).
3. BOOTP (Bootstrap Protocol)
   - Helps computers get an IP address when they boot up (an older version of DHCP)



I, 2, λ

WDM (Wavelength Division Multiplexing) :- used in fibre optics, each signal is transmitted on a diff. wavelength (color) of light.

Ex:- High-Speed internet over fibre optic cable.



Spread spectrum:-

Spread spectrum is a technique that spreads the signal across a wider frequency band than necessary for better security, reliability, and resistance to interference.

Types:-

Type	Description
FHSS (Frequency Hopping spread spectrum)	Signal jumps between frequencies based on a predefined pattern Ex:- Bluetooth
DHSS (Direct Sequence Spread Spectrum)	Signal is spread using a pseudo-random code Ex:- Wifi (802.11b) Spread data signal over wider range of frequencies using a special code.

* Importances:-

=) Maximizes the use of available bandwidth.
=) Increases data transmission efficiency.
=) Reduces transmission cost.
=) Improves network performance and quality of Service (QoS)

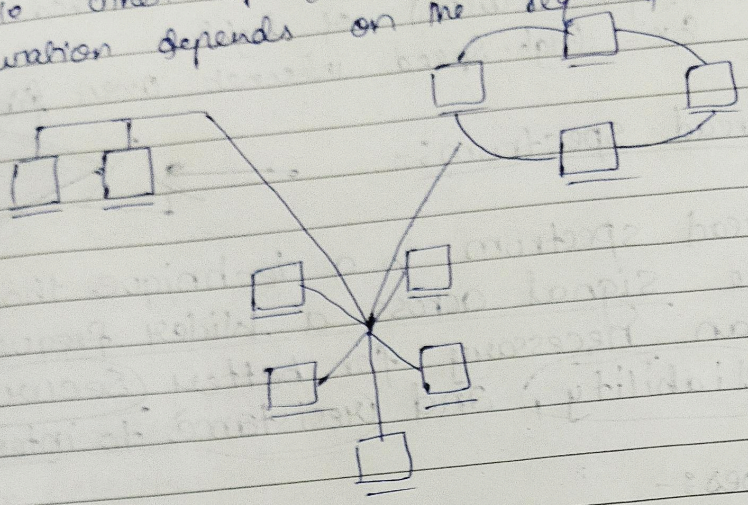
① Data Lin
→ 2nd Laye
→ Main Job
transfer
It has 2
1. Logical
control
2. Media
access

② Error
Error
during
Method
• Block
• Hamm
• CRC

Erro
dete
uses
just
aut

Flow
from
1.

7) Hybrid topology: ~~A hybrid~~ features characteristics of multiple other topologies. The creation of such a configuration depends on the req. of the network.



5) Protocols and Standards

↓

Set of rules for communication (eg. TCP/IP, HTTP)

10) Technique for Bandwidth Utilization: (previous)

- Efficient use of available bandwidth of a comm^n. link
- how much of the total bandwidth is being used effectively to transmit data.

→ how much data can be sent/ recieved in certain amount of time through internet or network.

Techniques → Multiplexing

→ Spread Spectrum.

Multiplexing: Technique that combines multiple signals for transmission over a single comm^n. channel, thus maximizing the use of available bandwidth.

i) FDM (Freq. Division Multiplexing) → Diff. signals are assigned diff. freq. bands within the same channel.

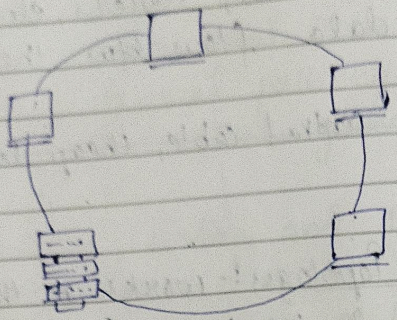
Ex. Radio & TV broadcasting.

ii) TDM (Time Division Multiplexing) → Each signal is assigned a time slot on the channel in a rotating manner.

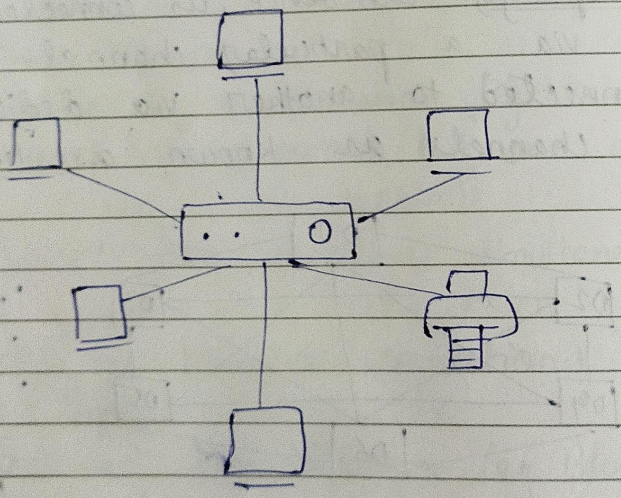
Ex. Digital telephony.

Delhi

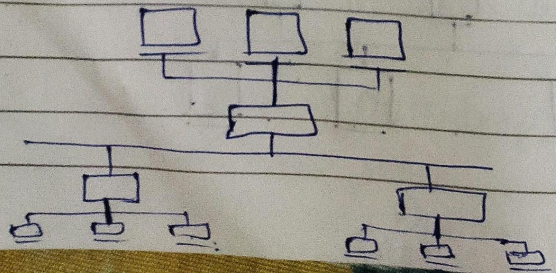
4) Ring Topology - Each node is linked with its neighbor to form a closed network. Data move from one node to another, either unidirectionally or bidirectionally.

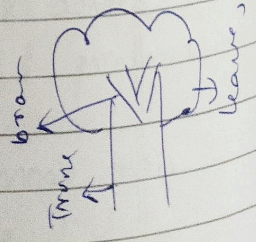


5) Star Topology - All nodes are connected to a central hub using a communication link. Each node needs a separate wire to establish a point-to-point connection with the hub

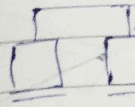


6) Tree Topology - nodes are arranged in a configuration that resembles a tree's leaves, branches & trunk. Endpoints / leaves are connected to mid-level nodes / branches linked to the tree's trunk.





7) Hybrid topolog
multiple othe
configuration



(5) Protocols
↓
Set of rules
(eg. TCP / I

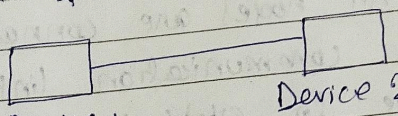
(10) Technique
- Efficient
- how mu
used e
Techniques

Multiplexing:
transmission
the use of
i) FDM (Freq.
Diff. freq
&
ii) TDM (Tim
a time sl
&

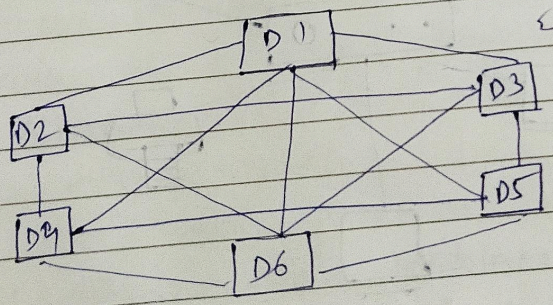
(4) Topology :- Physical or logical layout of devices (nodes) & cables (communication links) in a computer Network. It shows how devices like computers, switches, routers, etc., are interconnected and how data flow b/w them.

~~-Bus :- Single central cable, cheap but hard to troubleshoot~~
~~-Star :-~~

1) Point-to-Point Topology :- works on the functionality of the sender & receiver. Simplest comm^n b/w 2 nodes.



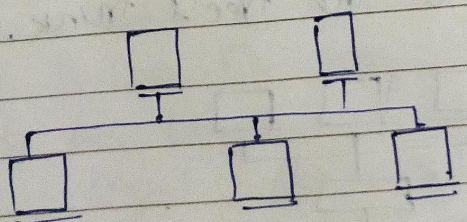
2) Mesh Topology :- Each device is connected to another device via a particular channel. Every device is connected to another via dedicated channels. These channels are known as links.



Advantages :
- Fast comm^n.
- is robust.
- Provides security & privacy.

Disadv.
Installation cost ↑
~~configuration difficult~~

3) Bus Topology :- All nodes are linked using a single cable with a terminator on both ends.



CN
Module - ①

Date 27/05/25

① Data communication components :-
5 fundamental components :-
i) Message - Data to be communicated.
ii) Sender - Device that sends message.
iii) Receiver - Device that receives message
iv) Medium - Physical path by which a mgg. travels (cable, air)
v) Protocol - Rules that govern data communication.

② Representation of Data and its flow :-
Data Representation :-
- Text : Represented as sequence of bits (ASCII, Unicode)
- Numbers : Binary form.
- Images : Pixels encoded in binary.
- Audio : Sampled & converted to binary.
- Video : combination of image frames & audio.

Data Flow Direction :-
- Simplex : One-way communication (eg. Keyboard to CPU)
- Half-Duplex : Both directions, but one at a time (eg. walkie-talkie).
- Full-Duplex : Both directions simultaneously (eg. telephone)

③ Network and various connections
Network Type :
- PAN (Personal Area Network (eg. Bluetooth)
- LAN (Local Area Network) eg. office network.
- MAN (Metropolitan Area Network) eg. city-wide.
- WAN (Wide Area Network) eg. Internet.

Connection Type :
- Point-to-Point → Direct connection b/w 2 devices.
  ex- Connection b/w Laptop & printer using USB cable.
- Multipoint connection (Multidrop) → more than 2 devices share a single link.
  ex- Shared Ethernet network using a Hub (not a switch).

④ Topology (nodes) computer computers and ho
- Bus : S
- Star :

1> Point-to- the de

2> Mesh device is co These

3> Bus cable