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Computer Networks

- Communication ⟷ Broadcast / point to point] Need communication channel
  ↳ Needs ip address
- Internet :- Network of networks (has multiple protocols) (like http)
- Protocol :- Rules governing a network
- Computer Network :- Graph with nodes as computing devices & edges indicating communication possibility

5 Layer protocol (Internet layering protocol)

entry/exit luggage gate runway flying

- Application Layer :- enables communication on network (HTTP / FTP etc)
- Transport Layer :- Segmentation & reassembly (end to end layer) (TCP)
- Network Layer :- Routing from source to destination (IP)
- Data Link Layer :- Framing, flow control, collision resolving, error handling
- Physical Layer :- Physical transfer of bits

7 Layer protocol (OSI - Open Systems interconnection)

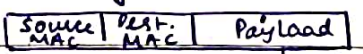
Bag packing

Application Layer
↕
Presentation " :- encryption, compression, ensuring interoperability of data
↕
security??

Session Layer :- Manages session → dialogue control, token management, synchronization
↕
~~Physical~~ Physical Layer

Note

- Physical layer :- has no media management (can collide)
  - signals sent as electronic / electromagnetic transmissions
  - radio - first form of networking
  - physical layer only detects connectivity (might broadcast)
- Data link layer :- Sends data as frames



↳ ~~Payload~~ is converted as bits and transmitted
Frame

Frame is broadcasted :- if dest matches kept else discarded

Mac address :- unique for every system, contains manufacturers code

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→ steps : establishment of connection, communication, ending of channel

physical layer

- **Circuit Switching** :- fixed channel created then only communication

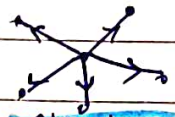
Ad:- • Consistant • Fast • Secure • Routing eleminated | Telephone

Dis :- • High connection complexity ($O(n^2)$ for n people) • Loss of Bandwidth

- **Packet Switching** :- • Data broken down in small pieces and potentially broadcasted (every packet chooses best path) ↳ Routing

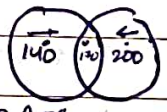
• Tight upper limit on packet size to make resource available for all
• queing & reassembly delay • Packets need dest address

Graph Theory :- (1) $G(V, E)$ (2) directed (3) path (directed/undirected)
(4) loop (5) cycle (6) connected
(7) planar (8) complete (K_n) (Mesh topology)



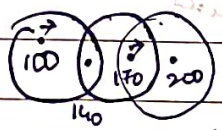
- **Communication over shared Medium**

CSMA (Carrier Sense Multiple Access Protocol)



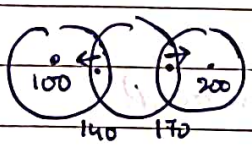
→ Hidden station problem 1

140 RTS
170 CTS 200 wait as CTS heard from 170



→ Hidden station pb 2.

~~100 RTS~~; 170 RTS; 100 RTS;
200 CTS; 140 wait

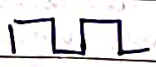


→ exposed station Problem

170 RTS; 200 CTS;
140 RTS; 100 CTS;

Physical Layer

Analog (cont)



~~Discrete~~ Digital (Discrete)

Freq $\propto \frac{1}{\lambda}$

- **Bandwidth** :- ~~# of~~ Range of freq that can go through a channel

- Processing power ↑ 20 times a decade
Communication speed ↑ 12 " " "

__/__/____

Telephone ↑ Cell phone ↑ TV, satellite phone ↑

Types of comm:- Wired, Terestrial wireless, Satellite

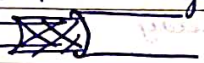
Cu | Optic — Broadcasting

Point to point

Point to point Media

→ Magnetic (Harddisk, CD, usb etc)

→ Twisted pair (More twists → higher speed & bandwidth)

→ Coaxial Cable & 

→ Fibre optics → More bandwidth → but delicate
→ Fast install
→ Long range

Wireless

10^4 10^8 10^{10} 10^{14} 10^{16} 10^{22} 10^{24}

Radio | Micro wave | Infrared | UV | X ray | Gamma

Visible

Higher

Rich Men in Vegas use expensive girls

Radio → small freq → penetrates solids → travels longer

Microwave (Mobile/TV) → All prop of radio hold → More dangerous

Infrared (TV remote) → cant penetrate solids

Visible light (Sometimes use in LAN)

Satellite Communication

Farthest → Geostationary (Appears fixed)

→ Medium Earth orbiting satellite (slowly moving)

closest → Low earth orbit

Mobile Phone characteristics

1G:- Analog Voice (Freq div multiplexing)

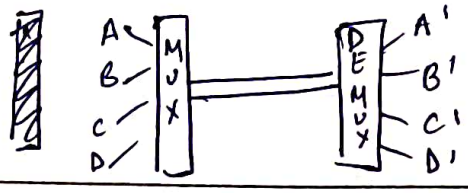
2G:- Code divising Multiplexing, Digital Voice, Secure SMS

3G:- Voice + Media Digital

Multiplexing:- Communication through same line

1) **Freq Division Multiplexing (Analog)**:- each user → separate bandwidth with space in b/w

for fibre optics → Wavelength Div Multiplexing



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2) Time division multiplexing. (for digital)

- Synchronous TDM → order of sending = order of recieving

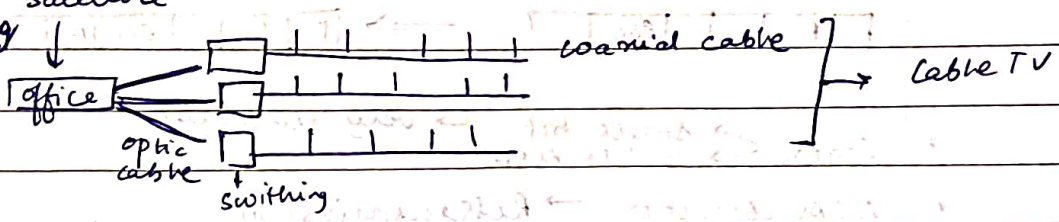
[A1] [B1] [ ] [D1] Memory wasted if any slot blank

- Statistical TDM → saves slot but msg required adress

[A1] [B1] [D1] sent if C1 is blank

Satellite

Switching



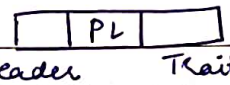
#! Note :- • ~~Packet Switching :- cost per amount of data~~

Note • Circuit Switching :- cost per length

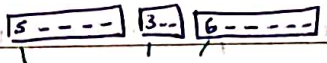
• Packet " :- " " amount of data

Note :- Google page rank $r_j = \sum_{i \to j} \frac{r_i}{d_i}$ (d_i - out degree of i) → uses eigen value to manage complexity

Data Link Layer



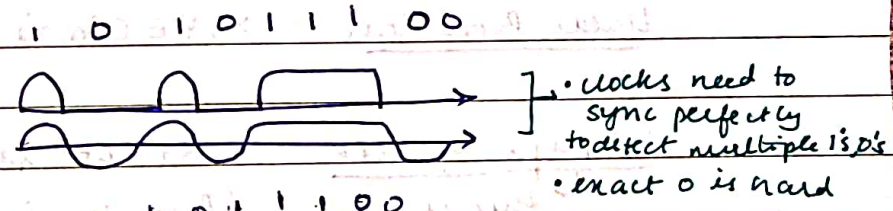
Frame

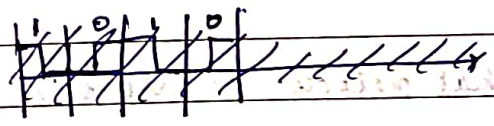


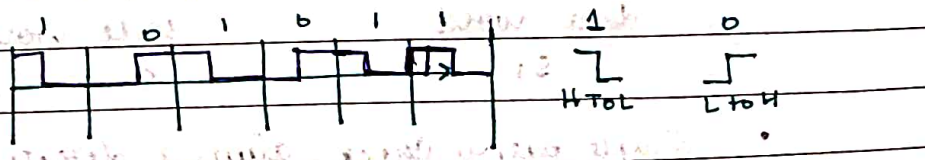
→ if data represented in this form, the error in 5, 3, 6 can lead to discarding of whole string

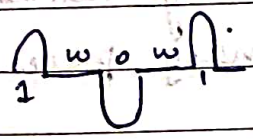
Modulation :- Signal → digital | Demodulation → opp

Types









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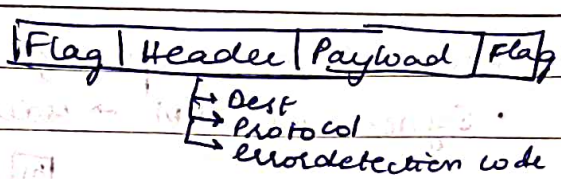
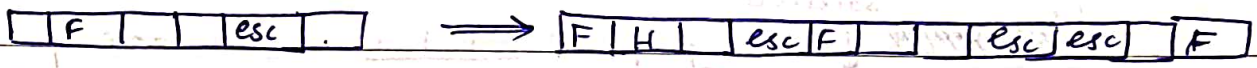
Framing :- ⟷ Fixed / Variable



Variable sized framing

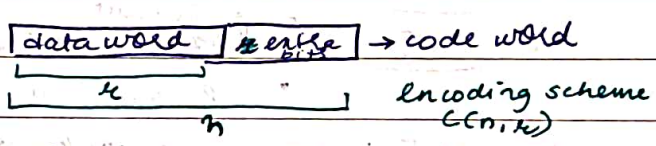
Character oriented protocol (Byte setup)
↳ ASCII



- error ⟷ single bit → very unlikely / burst error
- error correction → Retransmission
  ↘ Forward error correction

Page 40?

Forward error correction



encoding scheme encodes all 2^k possibilities

Hamming dist :- # of position differ in X & Y = # 1s in # X xor Y

Thm :- min hamming dist $\geq s+1$ ensures upto s-bit errors detected

Thm :- " " " $\geq 2s+1$ " " s- " " corrected

Linear Block Code :- $X, Y \in C(n,r)$ if $X \text{ XOR } Y \in C(n,R)$, $C(n,r)$ is LBC

Simple parity check :- $n = r+1$ st last bit is XOR of all bits
↳ this is LBC ! (Proof by induction)
# of 1s in X xor Y = # 1s in X + # 1s in Y − 2 (# common 1s)

an LBC that detects 2 errors is given by

data word	code word
s_1	$s_1\ s_1$ (XOR of all bits of s_1)

- Simple parity check always detects odd errors but cannot tell how many places it happend