Computer Networks

Introduction (PPT)

- What is a network?

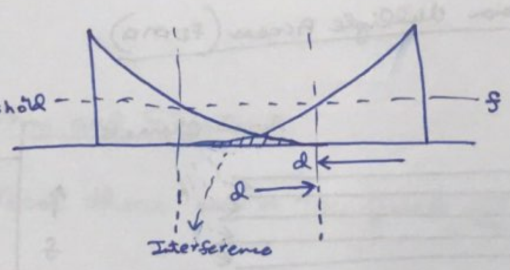
  Interconnected set of autonomous computers (Computer Network)

- Computer or Communication?

  Computer networks are convergence of
  - Computer and
  - Communication

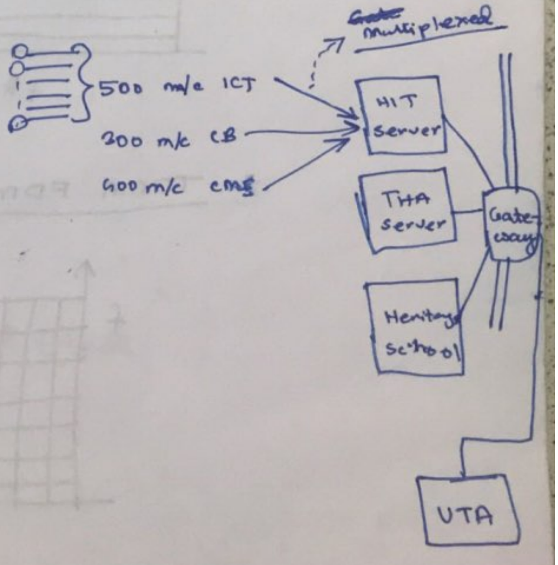
- Simple Communication Model
- Data Communication Model
- Transmission Line
- Transmission Line: Fiber Optics
- Transmission Line: Wireless Transmission

<u>Interference</u>: Signal that is meaningful, but not to us.
<u>Noise</u>: Signal that is absolutely unwanted.



- Frequency for both devices are same.

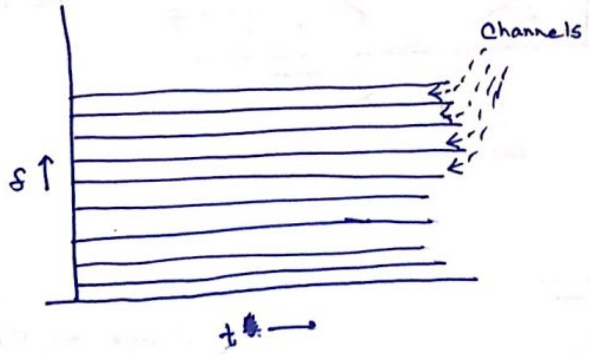
<u>Increasing efficiency</u> —
- Multiplexing
- Compression



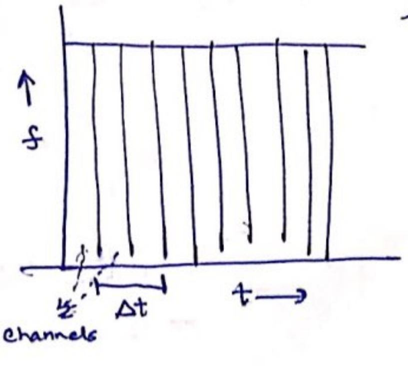
- Direction of Data Flow
  - Simplex (Keyboards, Monitors etc)
  - Half-duplex (Walkie-Talkie)
  - Full-duplex (Telephone line)
    - 2 seperate lines for uplink and downlink (Capacity is shared)

- Network Topology
  1) Transmission Technology:
     - Broadcast Networks
     - Point-to-point networks → • Broadcasting • Multicasting • Unicasting
       - Point to point
       - Multipoint
  2) Scale:
     - LAN (Bus, Star, Ring, Mesh, Hybrid)
     - MAN
     - WAN

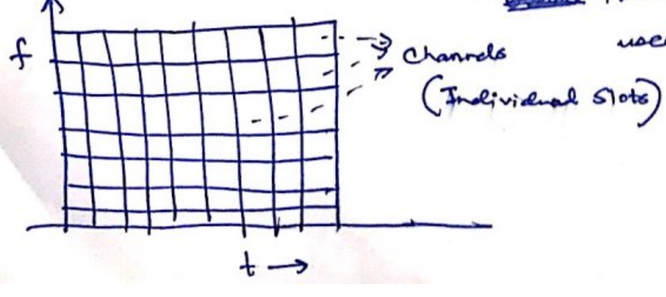
Frequency Division Multiple Access (FDMA)



TDMA (Time Division Multiple Access)



TDMA FDMA Combined (GSM) → TDMA FDMA is used here



• LAN Topologies

— Mesh: i) Costly → Disadv.

ii) If we want to add or remove a device, complexity is very high → Disadv.

iii) Every device has a ~~dis~~ dedicated P2P link to every other device → Adv.

iv) Robust → Adv

v) Secured → Adv

— Star: i) Less Costly → ~~Disadv~~. Adv.

ii) If Hub goes down, everything goes down

— ~~Star~~ Ring

Duplex   Unidirectional

— Bus: - - - . .

Protocol, Algorithm and Standard

• Protocol: (PPT)

In case of protocol there are no fixed set of inputs and outputs.

• Algorithm (PPT)

• Protocol vs Algorithm

• Standard

• Need for a protocol architecture

• Key features of a Protocol

• Layering in Computer Network

• Network Architecture and Protocol Stack

• Design Issues for the Layers

- TCP/IP Model, Protocols and Services, OSI Model (PPT)
  - Please do not throw sausage pizza away (bottom-up)
  - All people seem to need data processing (top-down)

	TCP/IP Model	Protocols and Services	OSI Model
ADPU	Application	HTTP, FTTP, NTP, Telnet, DHCP, PING	
Segments	Transport	TCP, UDP	
Packets	Network	IP, ARP, ICMP, IGMP	
Frames	Network Interface	Ethernet	Data Link Layer → Flow Control / Data Control Physical

TCP → Non-real time applications

UDP → Real time Applications (If a small bit of info gets lost, we are least bothered as we can still get to ~~too~~ understand the rest of ~~the whole~~ entire info)

- TCP/IP comes in ATIN

- Application Layer
- Session Layer
- Transport Layer
- Network Layer
- Data Link Layer
- Physical Layer

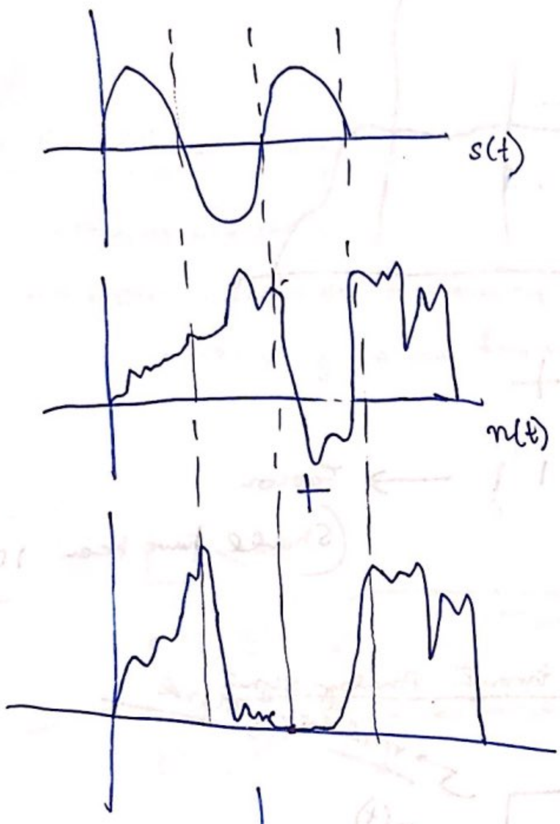
Data Signals

- Analog and Digital

- Low pass channell → Only lower frequencies are allowed to pass, rest are blocked.
- band ~~of~~ pass channell → A ban of frequency is passed.

Digital is advantageous than analog

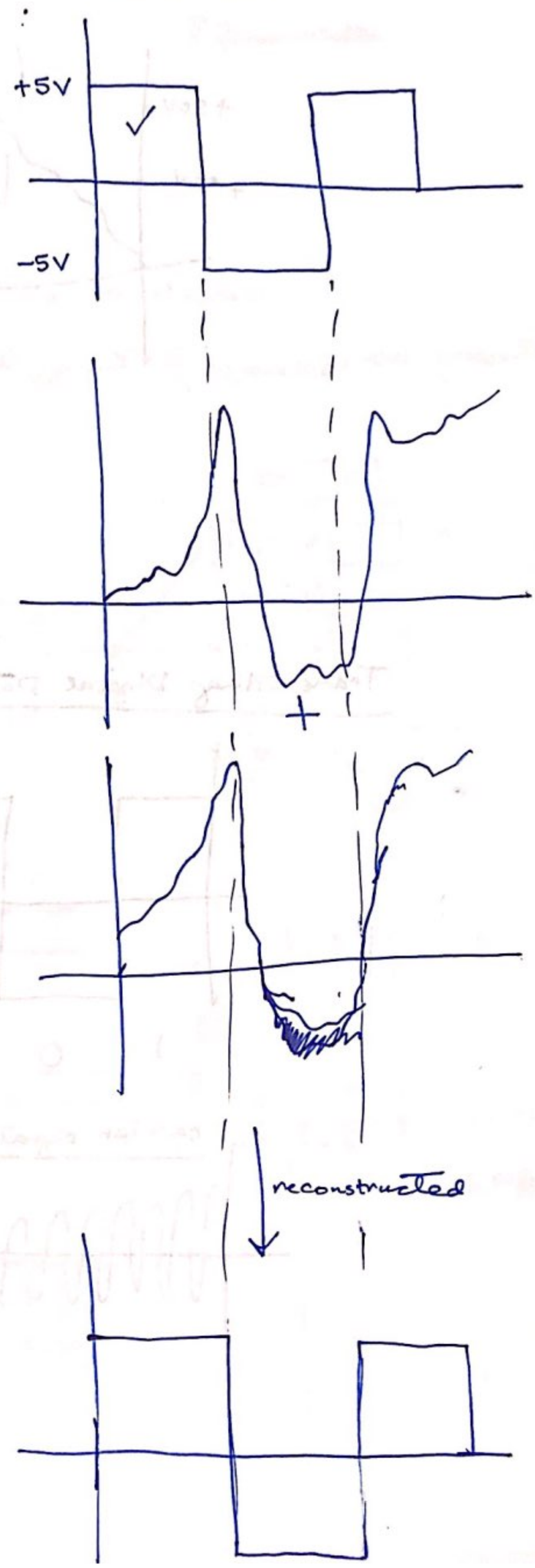
Analog



reconstruction

Difficult to get back

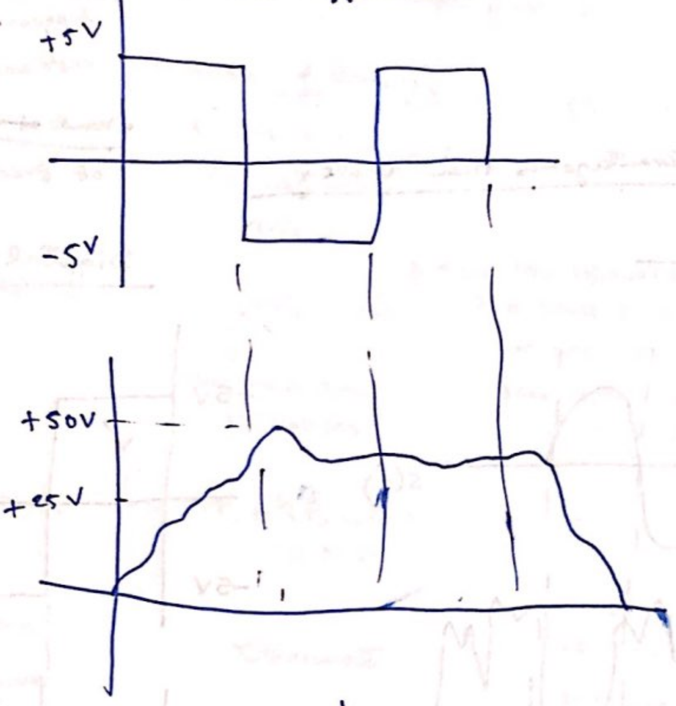
Digital



reconstructed

Even in a digital system, error might creep in.

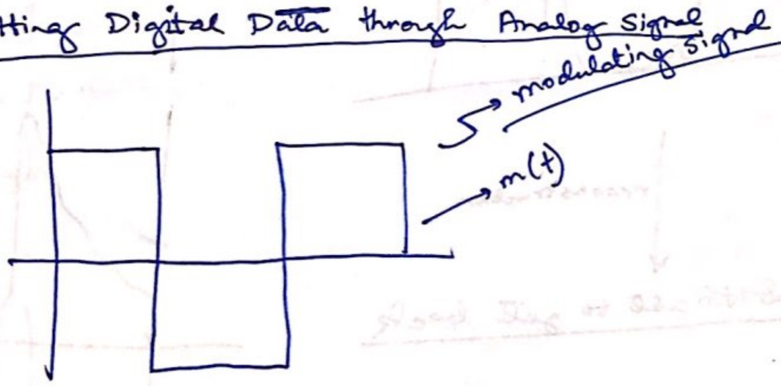
Error in Digital System



+

1 1 1 → Error
(Should have been 101)

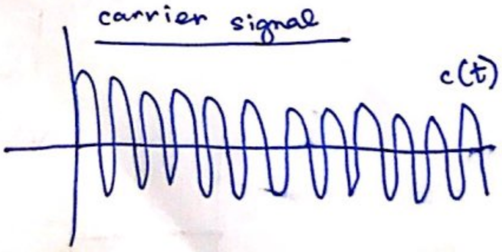
Transmitting Digital Data through Analog Signal



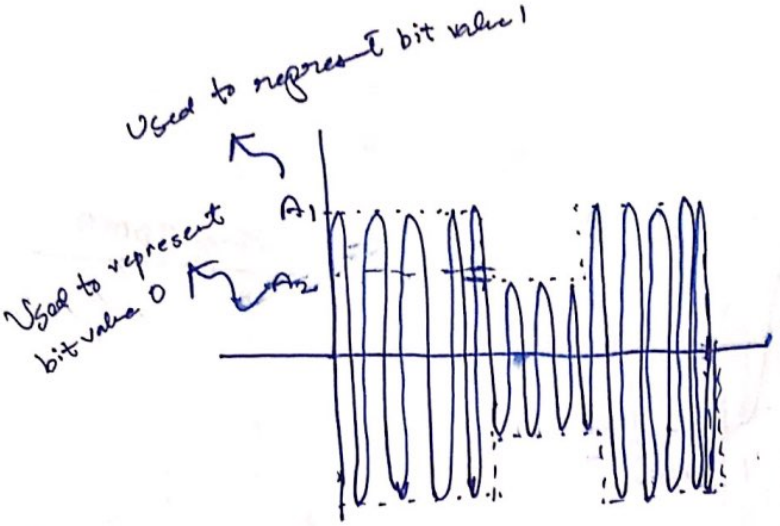
1 0 1 → Data

Analog Signal

carrier signal



— Amplitude Shift Key (ASK)

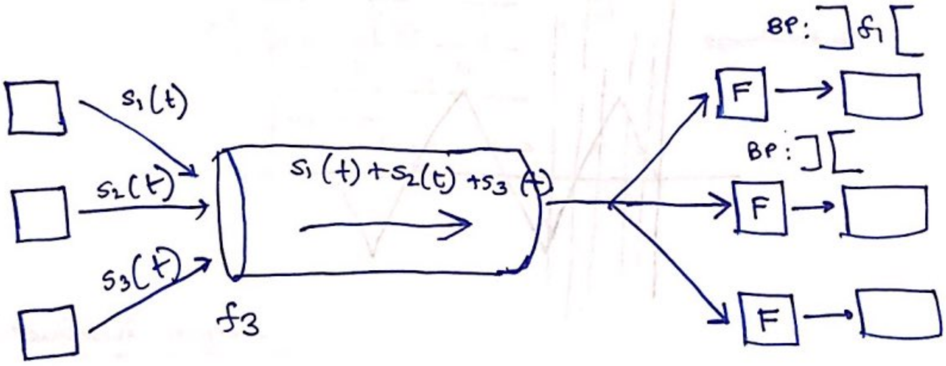


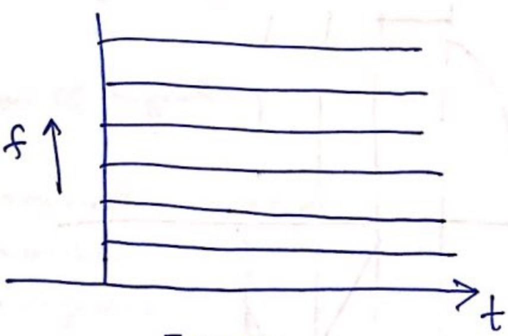
- **Broadband Signal**

  — Analog signalling

  — FDM used (Frequency Division Multiplexing)

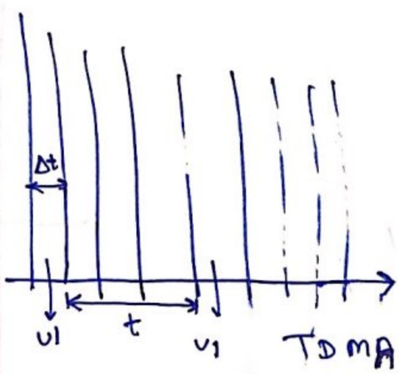
  ↳ Many users having different frequencies are present



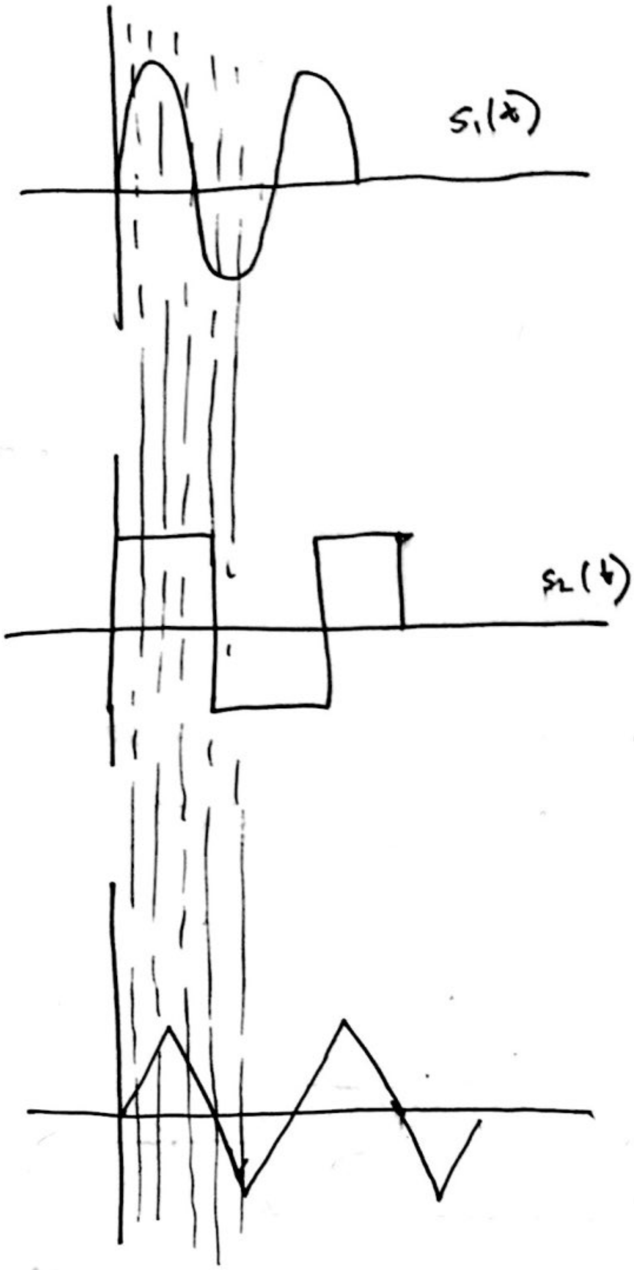


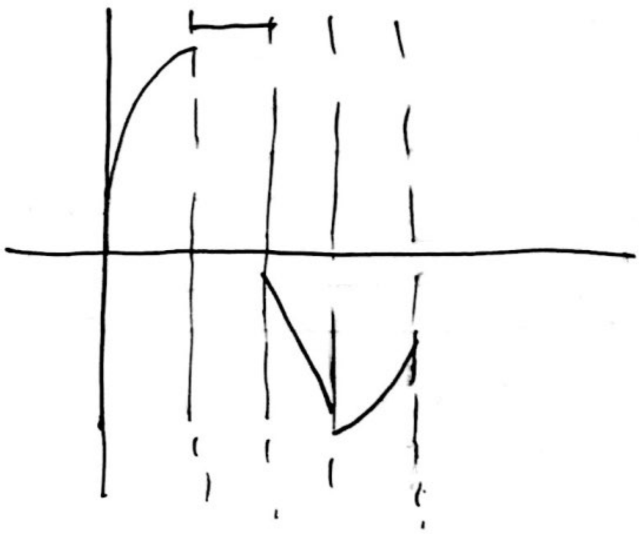
FDMA

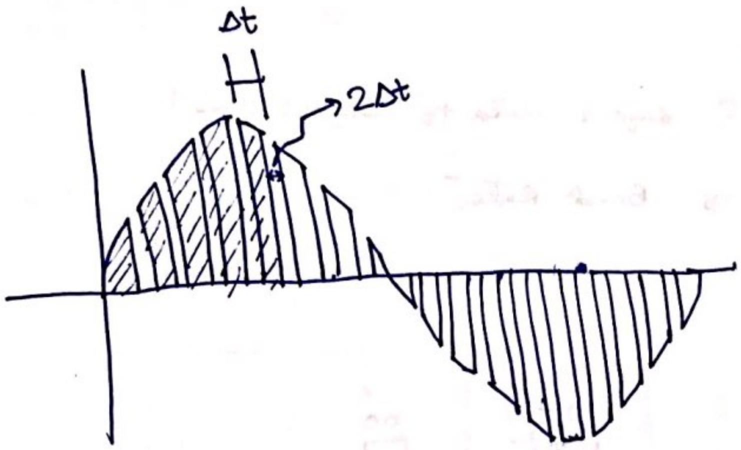
(Frequency ~~multiple~~ division multiple access)

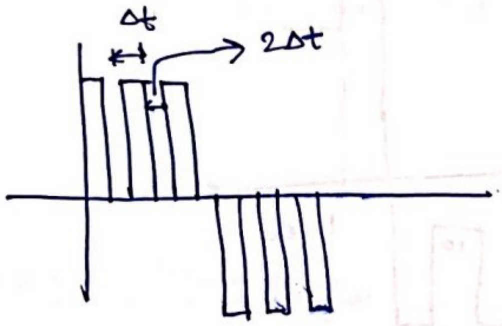


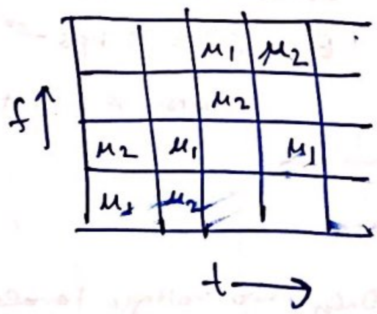
Using TDMA











- Baseband Signal

— Digital Signalling

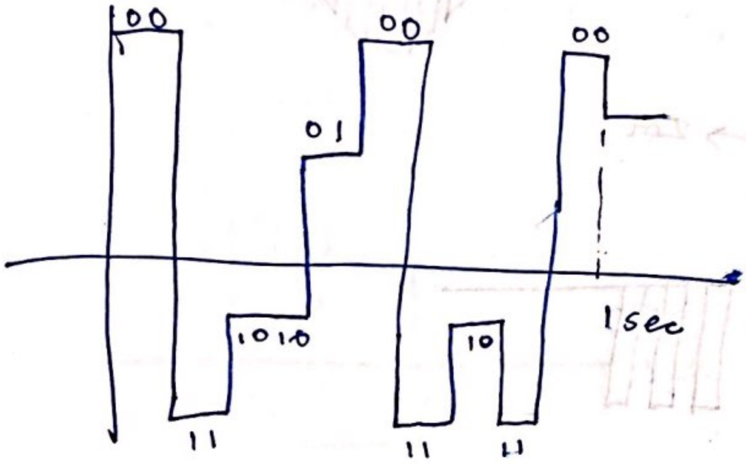
- Transmission of Signal

— Communication Media
  - Guided
  - Unguided

Line Coding

↳ Converts digital data to digital signal

— Bit rate vs Baud Rate



~~Baud rate~~ =

Baud rate = 10/5

Bit rate = 20 kps → 10×2 → bits per each

↳ No of bits transfered per seconds

Line Coding

→ Unipolar : Only two voltage levels are used

→ Polar :

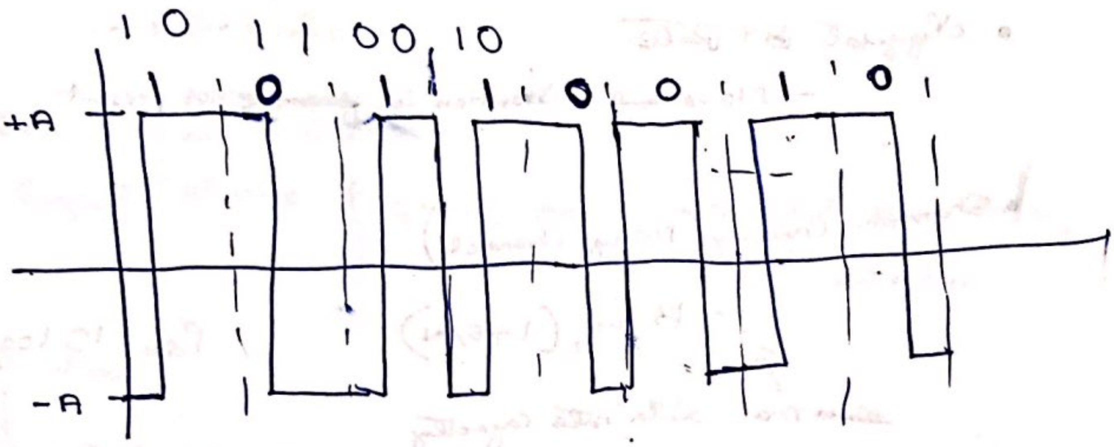
↳ Bipolar

Question

- Bit Patter Given

→ Write the signal form

Manchester Coding



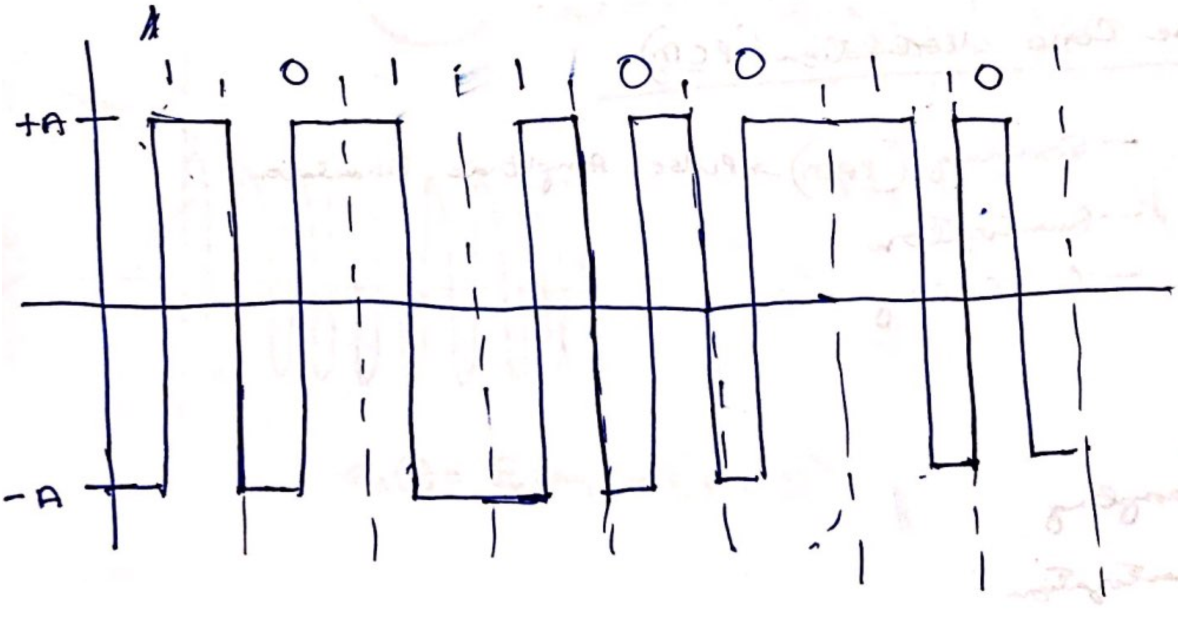
1 → low to high

0 → high to low

Differential Manchester

1 0 1 1 0 0 1 0 → 0 → Transition both at beg. and at middle

1 → Transition only at middle



Nyquist, Shannon and Channel Capacity

- Nyquist Bit Rate
  - Noise and distortion is ~~present~~ not present

- Shannon Capacity (Noisy Channel)

$$C = B \log_2(1 + S/N)$$

~~ ~~ max data rate capacity

$$P_{dB} = 10 \log_{10} \frac{P_2}{P_1}$$

Signal, Watt, Noise

$$P_{dBm} = 10 \log_{10} \frac{P_2}{P_1} \rightarrow mW$$

- Consider ~~the~~ minimum of the values found from Nyquist Bit Rate and Shannon Capacity.

Analog Data to Digital Signal

- Pulse Code Modulation (PCM)
  - Sampling (PAM) → Pulse Amplitude Modulation
  - Quantization
  - Line Coding

- Sampling
- Quantization
  - Quantization Error
- Limitations
  - Differential PCM

- Delta Modulation (DM)
  - Advantages

    Parameters
    - The size of the step
    - The sampling rate
  - Disadvantages

Analog Data To Analog Signal

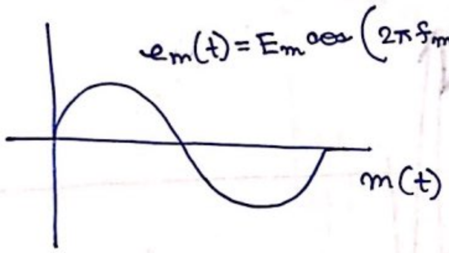
└→ Modulation

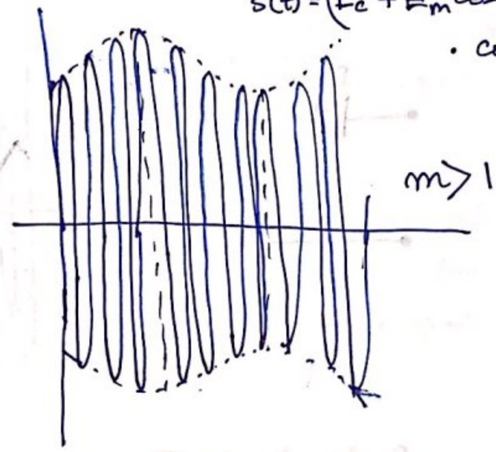
- Modulating Signal → data
- Carrier Signal → High frequency signal which actually does the modulation

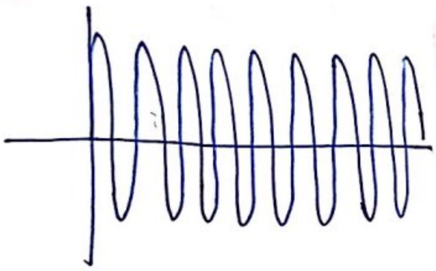
Modulation
- → Amplitude
- → Frequency
- → Phase

$s(t) = \left(E_c + E_m \cos 2\pi f_m t\right) \cdot \cos 2\pi f_c t$

$e_m(t) = E_m \cos\left(2\pi f_m t\right)$



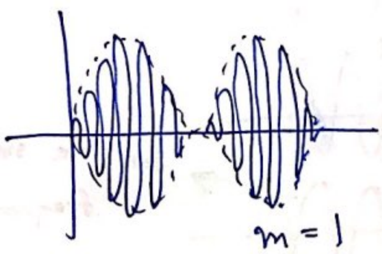




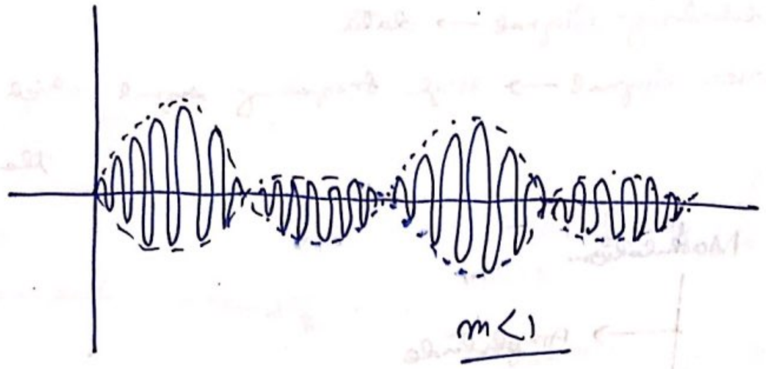
$e_c(t) = E_c \cos\left(2\pi f_c t + \phi_c\right)$

$$\text{Modulation Index } (m) = \frac{E_{max} - E_{min}}{E_{max} + E_{min}} = \frac{E_m}{E_c}$$

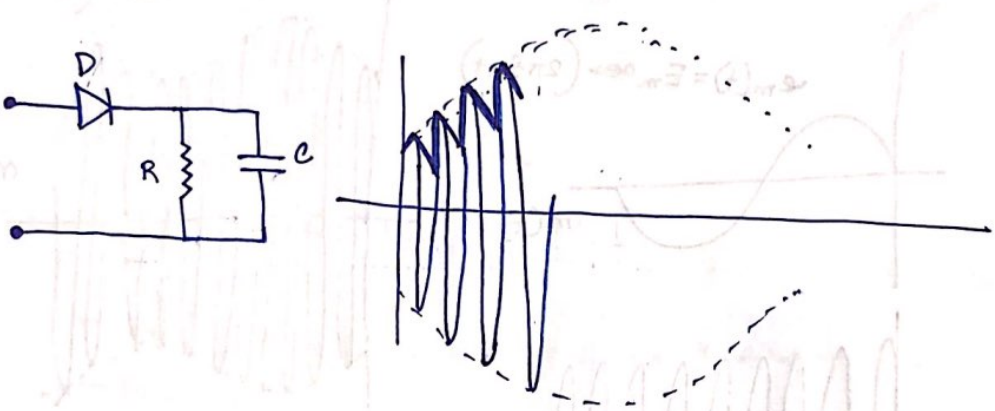
If $E_{max} = E_c + E_m$ and $E_{min} = E_c - E_m$



For m<1, we cannot recover the signal.



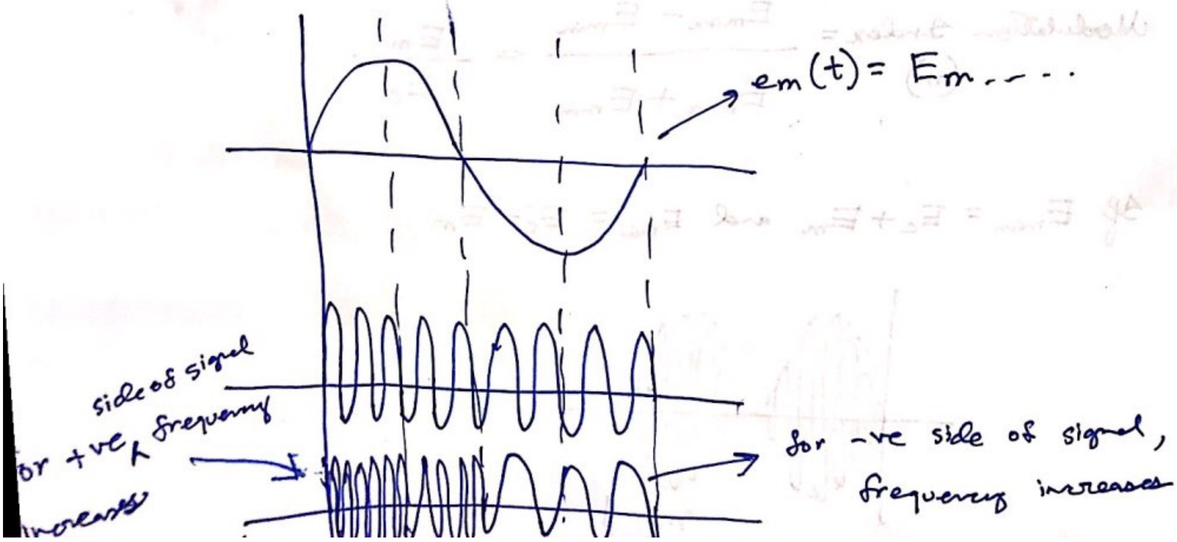
Demodulation



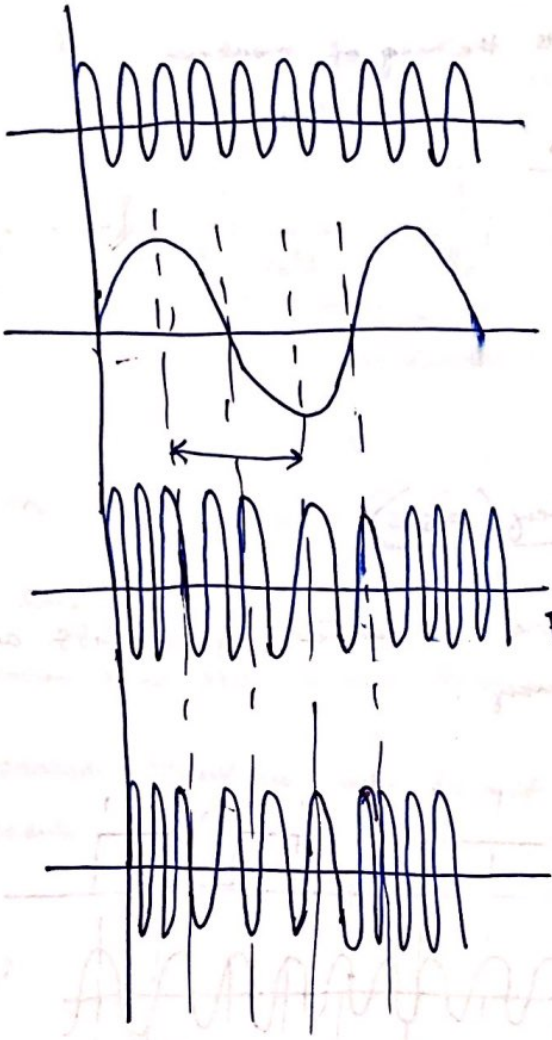
Angle Modulation

- freq
- phase

Frequency Modulation



Phase Modulation



Frequency Modulation
FM considers the amplitude of the signal

PM Phase Modulation
considers the phase of the signal

Digital Data to Analog Signal

eg. Telephone network

- conversion done with the help of modems

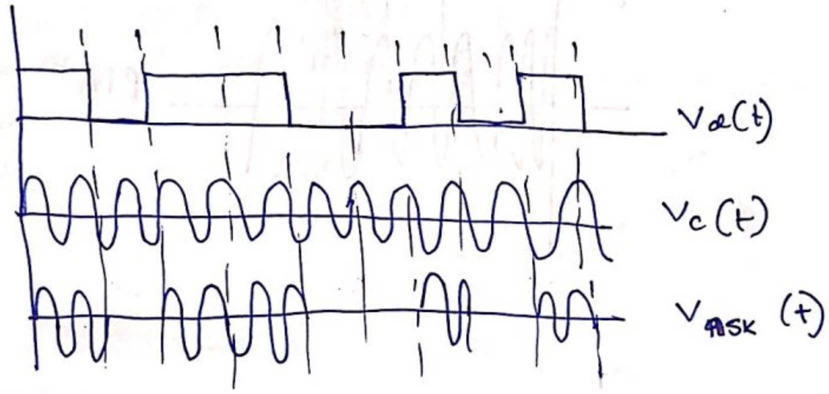
Modulation Techniques

- ASK
- FSK
- PSK

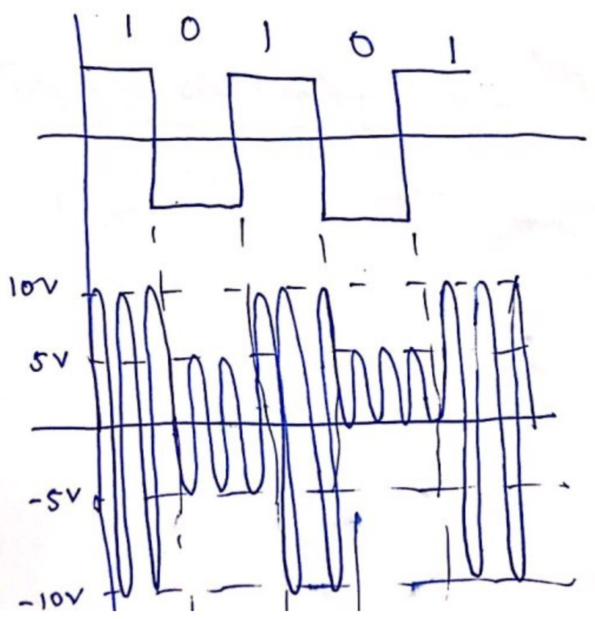
~~ASK~~

Amplitude Shift Key (ASK)

- 2 binary values are represented by 2 diff. amplitudes of the carrier frequency:

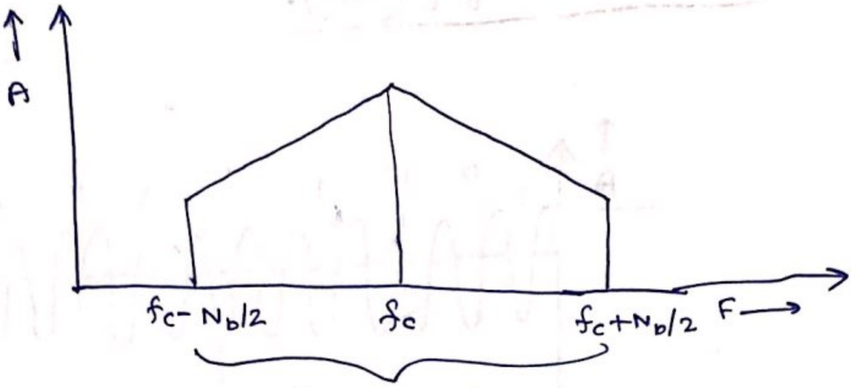


Special Case: On/Off Keying (OOK)



$A_1 = 10V \leftrightarrow 1$

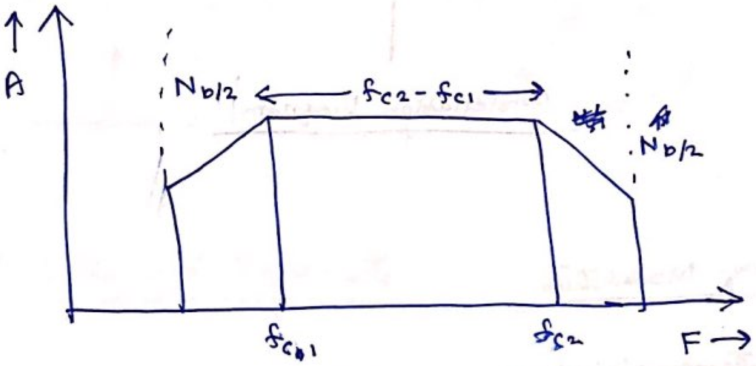
$A_2 = 5V \leftrightarrow 0$



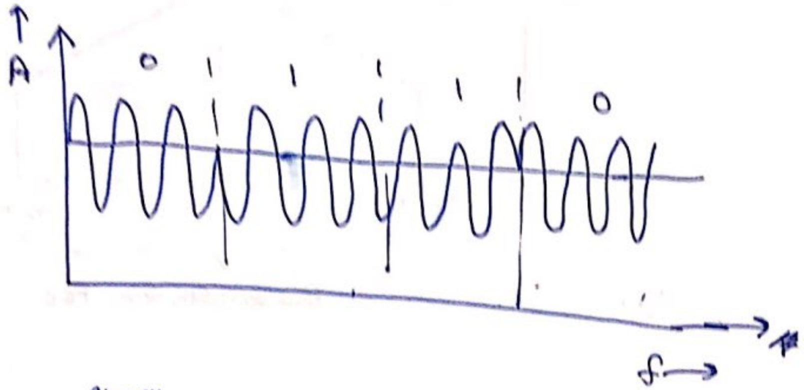
Bandwidth for FSK

Frequency - Shift Keying (FSK) :

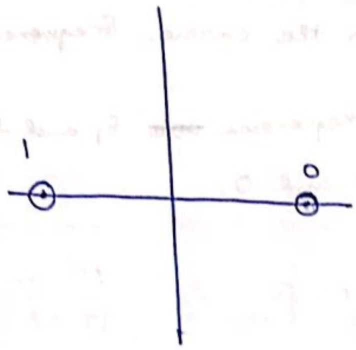
- Two binary values are represented by 2 different frequencies near the carrier frequencies.
- Two carrier frequencies ~~are~~ f_1 and f_2 are used to represent 1 and 0.



Phase Shift Keying (PSK):



2-PSK / B-PSK (Binary)



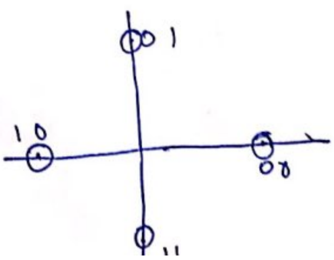
Constellation Diagram

M-ary Modulation

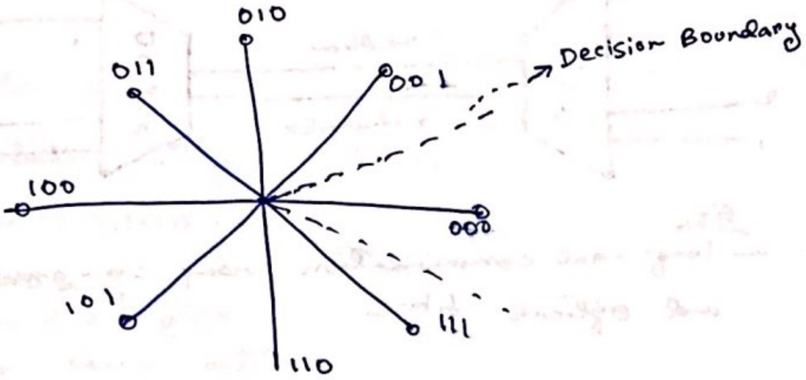
~~Instead of just varying phase, fre~~

Quadrature Phase Shift Keying (QPSK)

- QPSK can be used for more efficient use of bandwidth
- Here phase shift occurs in multiple of 90° as shown in constellation diagram.

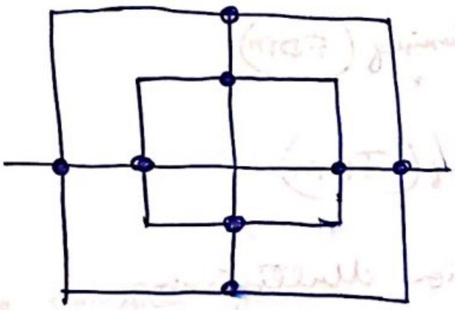


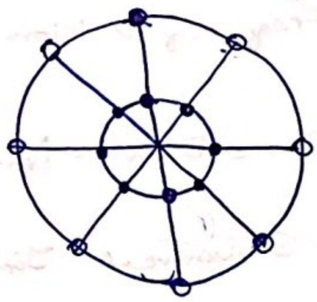
8- PSK



QAM (Quadrature Amplitude Modulation)

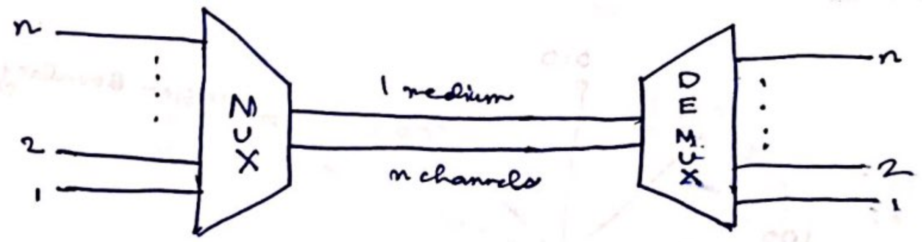
- The constellation diagram of a QAM signal with two amplitude levels and four phases is :





- Bit Rate and Baud Rate

Multiplexing of Signals



Eg:

- long haul communication using co-axial cable, microwave and optical fibre

Process of making the most effective use of the available channel capacity, by sharing a medium by more than one channel of signals is called Multiplexing.

Multiplexing

- Frequency Division Multiplexing (FDM)
- Time Division Multiplexing (TDM)
    - Statistical Time Division Multiplexing
- Orthogonal Frequency Division Multiplexing (OFDM)

• Spread Spectrum : PN Sequence

- FHSS

Switched Network

- Key features
- Categories
- Circuit Switching
- Circuit Switching: Stages involved
  - Circuit Establishment
  - Data Transfer
    - full-duplex
  - Circuit disconnect
- Structure of a switch
- Blocking and Non-blocking switches
- Crossbar Switch
- Multi Stage Switch

- Time division Switching
  - Uses TDM
  - Two methods ⇒ i) Time Slot interchange (TSI)
    ii) TDM Bus
- Public Switched Telephone Networks (PSTN)
- Issues with Circuit Switching

- Message Switching
  - Store-and-forward Technology
- Disadvantages of Message Switching
  - Solution: Packet Switching

- Packet Switching
  - Store-and-forward approach
- Main Difference with Circuit Switching
- Category:
  - Datagram Network
  - Virtual Circuit Switched Network
- Datagram Network
  - Conectionless Network
  - Routing Table
- Delay in Datagram Network
- Virtual-Circuit Networks
- Addressing
  - Global Addressing
  - Virtual-Circuit Identifier
- Connection of Virtual Circuit Networks: Teardown Phase
- Efficiency
- Structure of Packet Switches
- Banyan Switch
- Batcher-Banyan Switch

Read Farouzan { • Transmission Media
• Using Telephone and Cable Networks for Data Transmission }

• Data Link Layer
• Responsibilities
  — Framing
  — Addressing
  — Flow Control
  — Error Control
  — Media Access Control
• Error Detection and Correction
  — Types of Error
    — Single bit Error
    — Burst Error
• Detection VS Correction
• Forward Error Correction VS Retransmission
• Coding
  — Two Coding Schemes : i) Block Coding , ii) Convolution Coding
• Structure of Encoder and Decoder
• Modular Arithmetic
  — Modulo - 2 Arithmetic
    — Result is a XOR of two bits
• Block Coding
  — In block coding, messages are divided into k bits blocks, called datawords.
  — r redundant bits are added to each block to make the length $n = k + r$.
  — Resulting n bit [illegible] — codeword

- Error Detection

— The receiver can detect an error if —

— The receiver ~~to~~ has (or can find) a list of valid codewords.

— The original codeword has changed to an invalid one.

Let k=2 and n=3

Datawords	Codewords
00	000
01	011
10	101
11	110

Table 1

Suppose 011 is received as 000. This is a valid codeword. Hence ~~I~~ ~~it~~ this is unrecognised, and the receiver extracts 00. Thus two bit error leads to a problem, but 1 bit error can be detected.

Let k=2, n=5

Dataword	Codeword
00	00000
01	01011
10	10101
11	11110

- Hamming Distance

— no. of differences ~~between the~~ in the bits.

For Table 1

$d(000,011) = 2$ $\quad d(000,101) = 2$
↓
Hamming Dist.

- Hamming Distance and Error
- Minimum Dist. for Detection upto s bit Error
  - If s errors occur, Ham. Dist. between the sent codeword and received is s.
  - To detect s ~~errors~~ errors, the min. dist. between the valid codes must be s+1.
  - For $d_{min} = 3$, error upto 2 bit can be detected
- Minimum Distance for Error Correction
  - To correct upto t errors in all cases, the min. Hamming dist. in a block code must be $d_{min} = 2t+1$.

1st Interface

000	000
001	100
010	010
011	110
100	001
101	101
110	011
111	111

Mirror Image

2nd Interface

000	000
001	010
010	001
011	011
100	100
101	110
110	101
111	111

Interchage the last 2 bits

Problems

SNR

- dB
- ratio/unitless

#1. signal = 10 mW

noise = 1 μW

$$SNR = \frac{signal}{noise} = \frac{10\times10^{-3}}{1\times10^{-6}} = 10\times10^{3}\ W = 10,000 \quad (Ans)$$

$$SNR_{dB} = 10\log_{10} SNR = 10\times4\ dB = 40\ dB \quad (Ans)$$

For noiseless, ~~ch~~ channel, SNR = ∞ .

2. <u>Nyquist Bit Rate</u>

↳ Theoretical Bit Rate in a noiseless channel.

$$\text{Bit Rate} = 2B\log_2 L \leftarrow \text{no. of signal levels}$$

bandwidth (B) = 3,000 Hz

L (~~no.~~ no. of signal levels) = 2 .

$\therefore$ ~~Bit~~ Bit Rate $= 2\times3000\times\log_2 2^{\Rightarrow 1}$

$= 6000$ bps. (Ans)

$\therefore$ for 4 signal levels,

Bit Rate $= 2\times3000\times\log_2 4^{\Rightarrow 2}$

$= 12000$ bps (Ans)

3. data rate = 265 kbps

B = 20 KHz

~~to~~ find the no. of signal levels.

$\therefore$ ~~$B = 2\times B$~~

Bit Rate $= 2B\log_2 L$

$\Rightarrow 265\times\cancel{10^3} = 2\times20\times\cancel{10^3}\times\log_2 L$

$\Rightarrow L = 98.7$ ~~(Ans)~~

64 ~~4~~ 128 (Ans)

Noisy Channel

Shannon Capacity Equation

$$C = B\log_2(1+SNR)$$

i) If noise component is very high, then $C = 0$.

ii) $B = 3000 Hz$

$SNR = 3162$

Find C.

$$\therefore C = 3000 \log_2(1+3162)$$

$$= 34860 \text{ bps (Ans)}$$

iii) $SNR_{dB} = 36$

$B = 2 MHz$

$$SNR = 10^{SNR_{dB}/10}$$

$$\text{Capacity}(C) = 2\times 10^6 (1+10^{SNR_{dB}/10})$$

$$C = B \cdot \frac{SNR_{dB}}{3} \quad \left[\text{if SNR is very very high}\right]$$

- $SNR = 63$, $B = 1 MHz$

What is the appropriate bit rate of

$$C = B\log_2(1+SNR)$$

$$= 1\times 10^6 \times \log_2(1+64)$$

$$= 1\times 10^6 \times 6 = 6\times 10^6$$

bit rate $= 2B\log_2 L$

Parameters:

i) $B = 4$ KHZ

Ans: 112 mbps

Data Rate = 56000 bps

$\therefore$

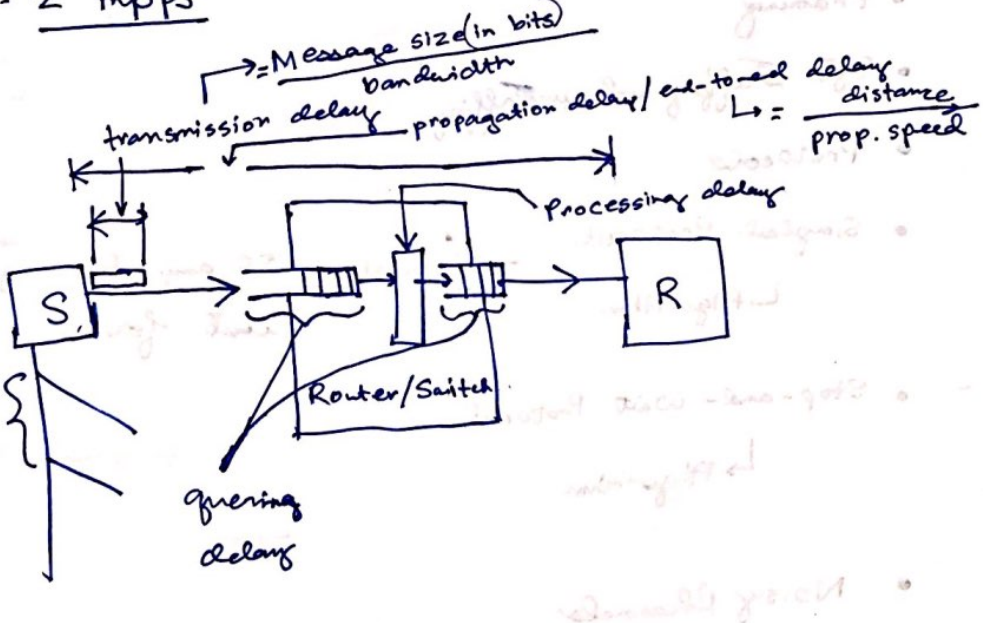
ii) $B = 10$ mbps

Avg. of 12000 frames / min with each frame carrying an avg. of 10,000 bits.

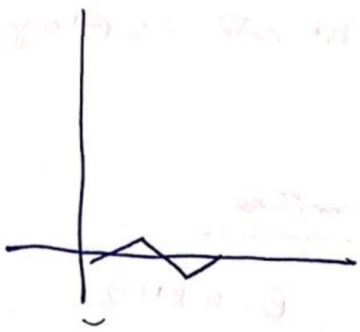
Find the throughput of the network.

Ans: 2 mbps

iii)



Jitter



1 → 0.0005

2 → 0.0004

3 → 0.0006

delay cannot be 0, but Jitter can be 0.

Data Link Control

- Framing
- Byte stuffing and unstuffing
- Protocols
- Simplest Protocol
  - └ Algorithm
  - → Limitation: If any frame gets corrupted, it is lost forever.
- Stop-and-Wait Protocol
  - ↳ Algorithm
- Noisy Channels
- Stop-and-~~Wait~~ Wait ARQ Protocol
  - └→ Algorithm
- The Go-Back-N ARQ Protocol
  - Stop-and-Wait ARQ is a special case of Go-Back-N ARQ in which the size of the send window is 1.

- Selective Repeat ARQ
  - → Algorithm

- Piggybacking
- Link Utilization : Stop and Wait

Link utilization $U = 1/(1+2a)$

a = Propagation Time (T_p) / Transmission Time (τ).

$$U = \frac{1}{1 + 2\frac{T_p}{\tau}}$$

$$\Rightarrow U = \frac{\tau}{\tau + 2T_p}$$

- Link Utilization : Sliding Window

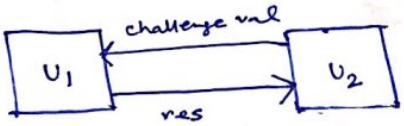
HDLC and PPP

- HDLC
- HDLC Frames
  - — Control Field

- Point to Point Protocol
- PPP Services

- Password Authentication Protocol (PAP)
- Challenge Handshake Authentication Protocol (CHAP)

res = f(cv)



res' = f(ch.val)

if res = res'

auth. successful

- Network Control Protocol
- Multilink PPP

Multiple Access

Multiple Access Protocols

- Random Access Protocols (everybody is peer)
  - ALOHA
  - CSMA
  - CSMA/CD
  - CSMA/CA
- Controlled Access Protocols
  - Reservation
  - Polling
  - Token Passing
- Channelization Protocols
  - FDMA
  - TDMA
  - CDMA

Random Access

ALOHA

- Frames in a pure ALOHA Network
- Procedure for pure ALOHA
- Vulnerable Time (time during which there is a possibility of collision) for pure ALOHA $\longrightarrow 2 \times T_{fr}$
- Frames in a slotted ALOHA
  - Vulnerable Time = T_{fr}

CSMA

- Vulnerable Time = Propagation Time
- Behaviour of three persistence methods
  - a) 1-persistent
  - b) Non-persistent
  - c) p-persistent
- Flow Diagram of Persistent Methods

• Collision in CSMA/CD

$T_{fr} = 2T_p$ → Condition to detect whether there has been any collision or not.

• Flow Diagram for the CSMA/CD

• Energy level during transmission, idleness, or collision

• Timing in CSMA/CA

• Flow Diagram for CSMA/CA

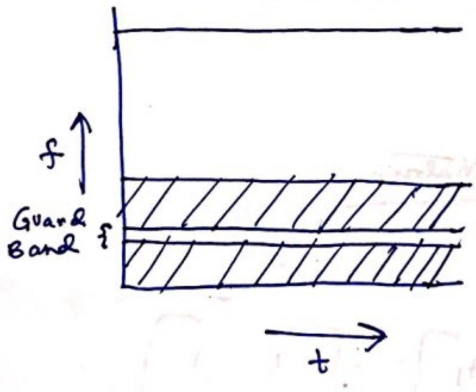
IFS → Inter Frame Space

Controlled Access

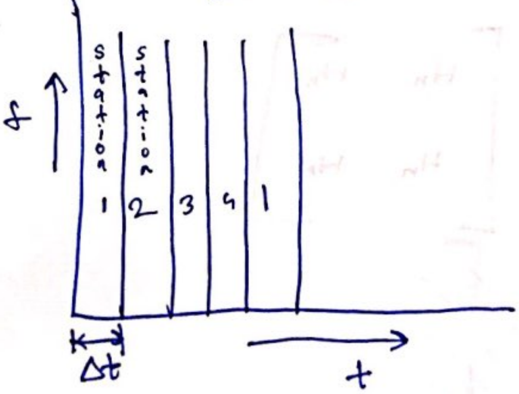
• Reservation Access Method
• Polling access method
• Logical ring and physical topology in token-passing access method

Channelization

• Frequency-division multiple access (FDMA)

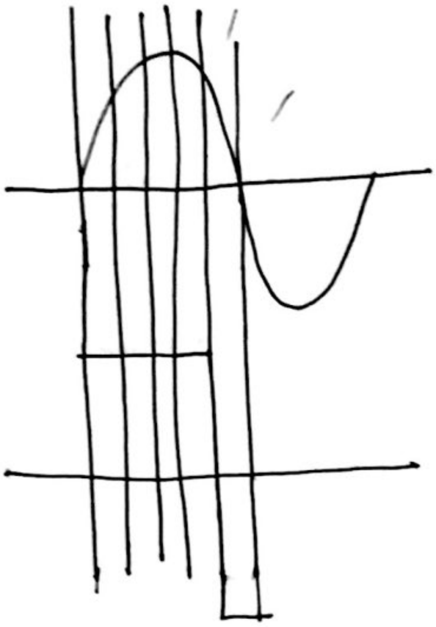


• Time-division Multiple Access (TDMA)



time slots for one station are separated by 3Δt.

$3\Delta t \ll f$



- Simple idea of communication with code

- Chip sequences

Walsh Hadamard Matrix

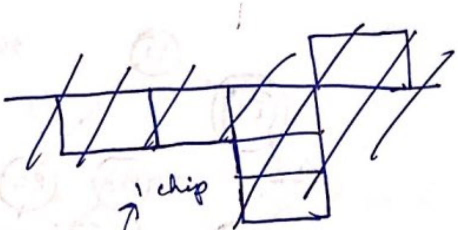
$$H_1 = 1$$

$$H_2 = \begin{bmatrix} H_1 & H_1 \\ H_1 & \overline{H_1} \end{bmatrix} = \begin{bmatrix} 1 & 1 \\ 1 & -1 \end{bmatrix}$$

$$H_{2n} = \begin{bmatrix} H_n & H_n \\ H_n & H_n \end{bmatrix}$$

$$H_4 = \begin{bmatrix} H_2 & H_2 \\ H_2 & \overline{H_2} \end{bmatrix} = \begin{bmatrix} 1 & 1 & 1 & 1 \\ 1 & -1 & 1 & -1 \\ 1 & 1 & -1 & -1 \\ 1 & -1 & -1 & 1 \end{bmatrix}$$

- Data representation in CDMA
- Sharing channel in CDMA
- Decoding of the composite signal for one in CDMA



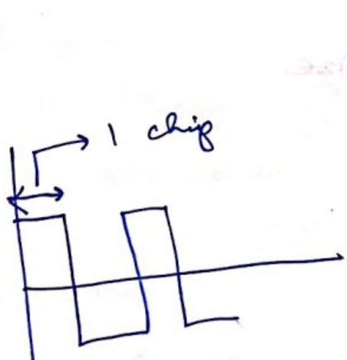
$$\begin{array}{rrrr} -1 & -1 & -3 & +1 \\ +1 & +1 & +1 & +1 \\ \hline -1 & -1 & -3 & +1 \end{array}$$

$= \frac{-4}{4} = -1 \rightarrow$ Bit 0

$$\begin{array}{rrrrr} & -1 & -1 & -3 & +1 \\ \times & +1 & -1 & -1 & +1 \\ \hline & -1 & +1 & +3 & +1 \end{array}$$

$= 4 \rightarrow$ sum

$\underbrace{\frac{4}{4}}_{\text{total stations}} = +1 \rightarrow$ Bit 1

* 

chip sequence / pn sequence

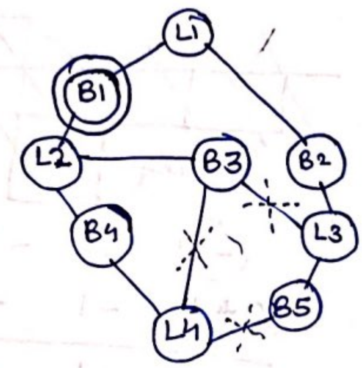
↓

pseudo noise

Connecting Devices

- Categories of Connecting Devices
- Repeater
- A hierarchy of hubs
- Bridge

- Loop problem in a learning ~~[illegible]~~ bridge



L → LAN
B → Bridge

- Source Routing Bridges
- Bridges connecting different LANs

Issues –

— Frame Format

— Maximum Data Size

— Data Rate

— Bit Order

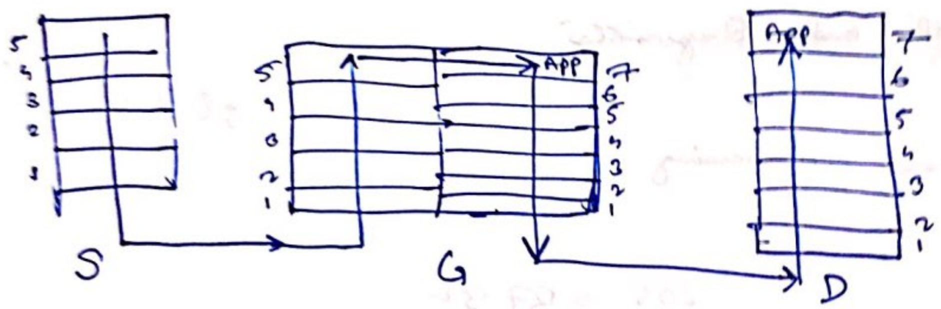
— Security

— Multimedia Support

- Two Layer Switch (Bridge)
  - Operates in a collision free domain
  - Use MAC Address (Forwarding Table)

- Three Layer Switch (Router)
  - Work with IP Addresses (Routing Table)
  - Routing is a ~~function~~ functionality of the Network layer
  - More functionality than the bridges

- Gateway
  - Application Layer
  - Highest capability of all
  - Interface between TCP Model and OSI Model



- Backbone Networks

  ~~Topo~~
  - Bus Backbone
  - Star Backbone

- Virtual LANs
  - VLAN software

Network Layer

Logical Address

IPV4 Address
↳ 32 bits long (4 octets)

- Dotted decimal and binary notation
- Classful Addressing
  ↳ Disadvantage: IP Addresses may get wasted.
- Default Masks for classful Addressing

CIDR → Classless Inter-Domain Routing

- Subnets and Supernets
- Classless Addressing

00010111

205.16.37.32

256^3 + 256^2 + 256^1 + 256^0

$$\underbrace{256^3 \quad 256^2 \quad 256^1}_{\text{Decimal Equivalent}}$$

x.y.z.t /n

205.16.37.32 /28 → last 4 bits will be 0

$(32-28) = 4$

n = 28, number of address = $2^{32-n} - 1$

$205.16.37.\cancel{39}^{32} / 2\cancel{\ }6$

∴ we have 6 bits for the hostid. ~~32-26=6~~

6

binary address

∴ Last 6 will be 0.

∴ block size $= 2^{32-26} - 1 = 2^{6} - 1 = 64 - 1$ ~~32 16 8 4~~

$= 63$

11001101 . 00010000 . 00100101 . ~~00~~11 000000

Dividing IP Address into 2 grps.

SubnetID

0 00000
0 11111

1 00000
1 11111

For dividing into 4 groups

00 0000
00 1111

01 0000
01 1111

10 0000
10 1111

11 0000
11 1111

1. In a block of address, the IP address of one of the host is 182.44.82.16/26.

Find the i) 1st address, ii) last address, iii) size of block.

32 − 26 = 6

∴ last 6 bits will be 0.

Bitwise & with original mask

∴ 1st address : 182.44.82.0 (Ans)

last address : 182.44.82.63 (Ans)

subnet mask :

11111111.11111111.11111111.11000000

∴ size = 2^6 = 64 (Ans)

Complement the subnet mask :

00000000.00000000.00000000.00111111

one of the host :

bitwise OR : 01110110.00101100.01010010.00010000

10110110.00101100.01010010.00111000

2. A network on the internet has a subnet mask of 255.255.240.0. What is max number of hosts it can handle?

192
+32
224

240

128 64 32 16 | 8 4 2 1

1111 | 0000 . 0000 0000

00
000

4

128 64 32 16 8 4 2 1
1 1 1 1 0 0 0 0

11110000

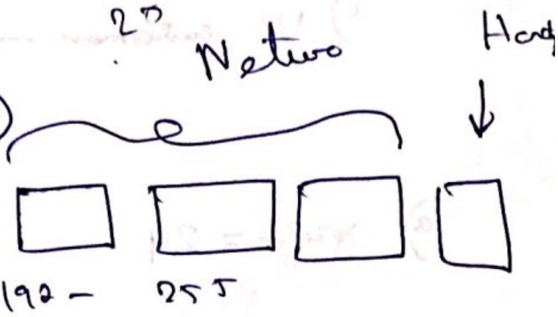
2^8

2^5

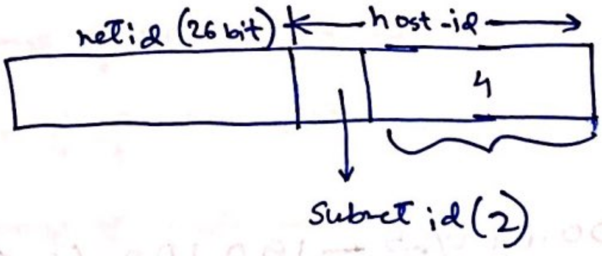
$8 + 4 = 12$

$\therefore 2^{12}$ hosts (Ans)

~~11110000 : 00000000~~



3. An organization is granted the block 130.34.12.64/26. The org. needs 4 subnetworks. What will be the subnet address? What will be the range of IP in each block?



01|00|0000

01 : 130.34.12.64 ⟶ 130.34.12.79

02 : 130.34.12.80 ⟶ 130.34.12.95

03 : 130.34.12.96 ⟶ 130.34.12.111

04 : 130.34.12.112 ⟶ 130.34.12.127

Scanned with CamScanner

4. Block of addr. starts from 190.100.0.0/16.

Divide into 3 groups —

a) 64 customers — each need 256 addresses.

b) 128 customers — each need 128 addresses.

c) 128 customers — each need 64 addresses.

a) prefix = 24

01: 190.100.0.0/24 — 190.100.0.255/24

02: 190.100.1.0/24 — 190.100.1.255/24

⋮

64: 190.100.63.0/24 — 190.100.63.255/24

b) prefix = 25

01: 190.100.64.0/25 — 190.100.64.127/25

02: 190.100.64.128/25 — 190.100.64.255/25

03: 190.100.65.0/25 — 190.100.65.127/25

04: 190.100.65.128/25 — 190.100.65.255/25

⋮

128: 190.100.127.128/25 — 190.100.127.255/25

c) prefix = 26

01: 190.100.128.0/26 — 190.100.128.63/26

02: 190.100.128.64/26 — 190.100.128.127/26

03: 190.100.128.128/26 — 190.100.128.191/26

04: 190.100.128.192/26 — 190.100.128.255/26

05: 190.100.129.0/26 — 190.100.129.63/26

128
+64
192

128: 190.100.159.192/26 — 190.100.159.255/26

5. An organization is granted a block of IP starting from 14.24.74.0/24. 3 subnets are required.

a) a group of 10 addresses

b) a group of 60 addresses

c) a group of 120 addresses.

c) Now 120 is not a power of 2.
So we need to consider $128 = 2^7$.

$\therefore$ prefix = 32 − 7 = 25

14.24.74.0/25 — 14.24.74.127/25

b) $64 = 2^6$

$\therefore$ prefix = 26

$\therefore$ 14.24.74.128/26 — 14.24.74.191/26

c) $16 = 2^4$

$\therefore$ prefix $= 32 - 4 = 28$

$\therefore$ 14.24.74.192/28 — 14.24.74.207/28

HW

1. A large no. of consecutive IP addresses are available starting at 198.16.0.0. Suppose the 4 org. A, B, C, D request for 4000, 2000, 4000, 8000 addresses respectively. What will be the 1st and last IP address ~~to~~ and mask required to satisfy their demand.

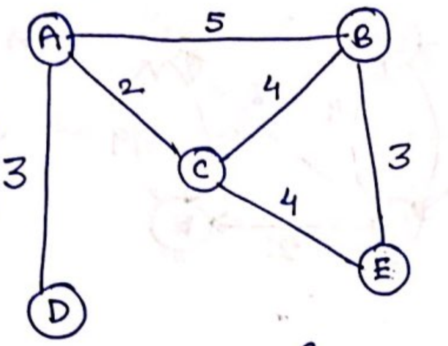
Routing Algorithms

Distance Vector Algorithm

A

To	Cost	Next Hop
B	5	B
D	3	D
C	2	C
E	~~∞~~ 6	~~-~~ C

3



B

To	Cost	NH
A	5	A
C	4	C
D	∞	—
E	3	E

D

To	Cost	NH
A	3	A
B	∞	—
C	∞	—
E	∞	—

C

To	C	NH
A	2	A
B	4	B
D	∞	—
E	4	E

E

To	C	NH
A	∞	—
B	3	B
C	4	C
D	∞	—

- Count to infinity problem
- Used in case of RIP.

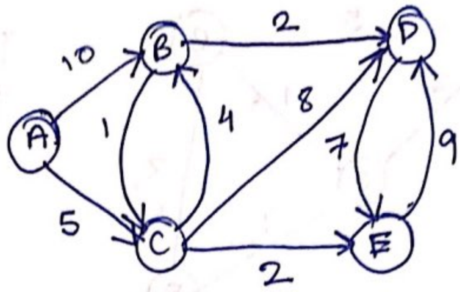
A	B	C	D	E
(a)	1	∞	∞	∞
	1	2	∞	∞
	1	2	3	∞
	1	2	3	4

If the link (a) is now broken,

3	2	3	4
3	4	3	4
3	4	5	4
3	4	5	6
⋮			
∞	∞	∞	∞

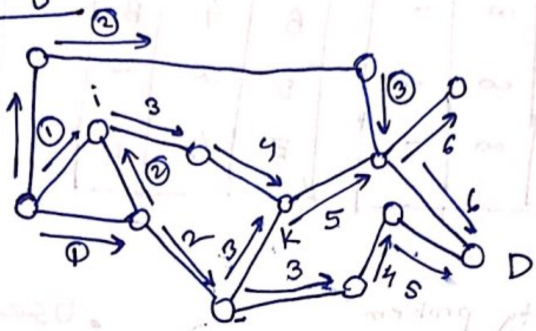
→ Takes huge no. of iterations

Bad news travels slow



	B	C	D	E
A	∞	∞	∞	∞
	10	5,A	∞	∞
	9,C	5	13	7,C
			11,C	

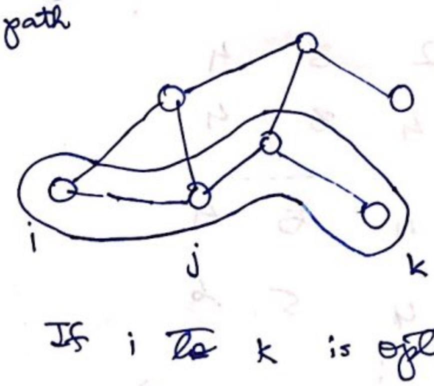
Flooding



The 2nd packet is considered as it is newer.

- Age → • Predefined value depending on the network.
  - Keeps on decrementing.
  - When it becomes 0, the ~~packet~~ corresponding packet is discarded.

- Optimal path

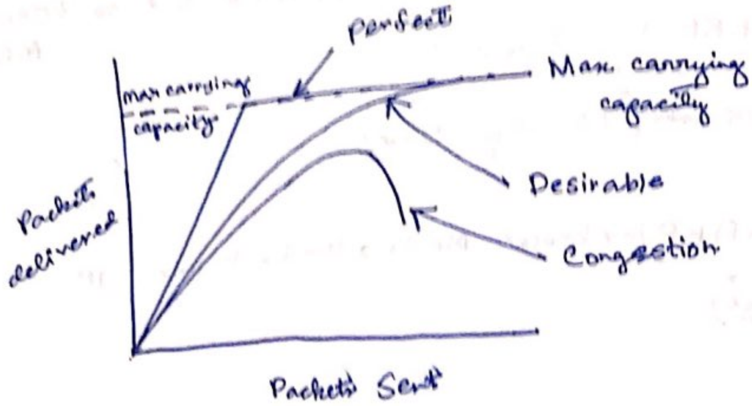


If i ~~to~~ k is optimal,

then j to k is optimal.

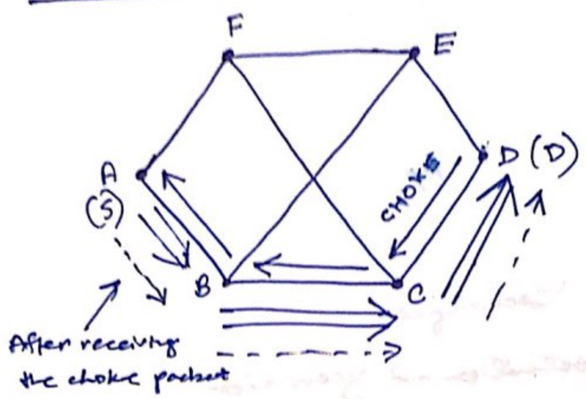
Congestion Control

~~Transport Layer~~



Methods of congestion control:

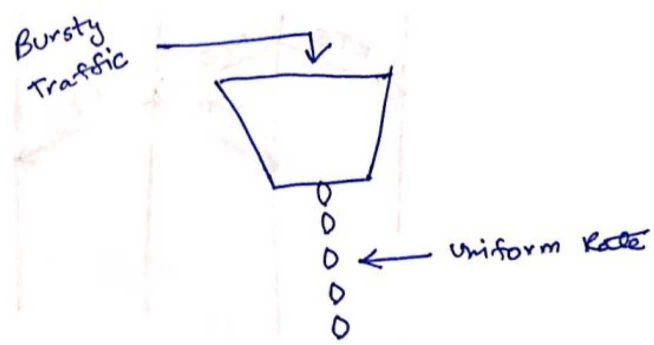
- Choke packet



- Load - ~~Shedding~~ Shedding
- Random early detection

Traffic Shaping

- Leaky Bucket Algorithm



- Network Address Translation

- Address Resolution Protocol (ARP) → Knows IP → Want to know MAC
  - Working of ARP: First Approach
  - Second Approach (Widely Used)

- Reverse ARP (RARP) → Knows MAC → Wants to know IP

(Internet control Message)

- ICMP Purpose

- ICMP Messages
  - Error reporting messages
  - Query

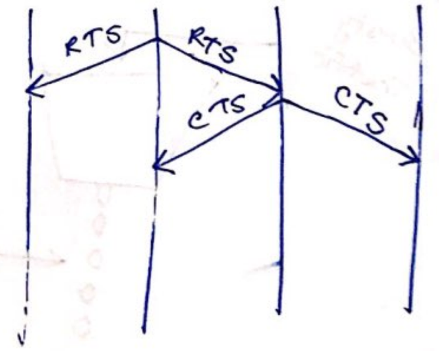
- Choke packet is an ICMP Packet

- Congestion
- Congestion Control
- Causes of Congestion

- Congestion Control Techniques
  - Open Loop : Detection and prevention
  - Close Loop : Detection and Removal

- WLAN

- Hidden Terminal Problem



• 802.11 – DFWMAC – RTS/CTS

– Sending Unicast packets

• NAV → Net Allocation Vector

– Fragmentation of user data

– DFWMAC – PCF I

– DFWMAC – PCF II

• MAC Address Format

Bluetooth

• Specification
• Transport Protocol group
• Middleware Protocol group
  – Service Discovery Protocol (SDP)
  – TCP/IP
  – RFCOMM
• Application group
• PICONETS
  – Point to Point Link
  – Piconet
• Master-Slave
• Physical Link Types
• Connection Establishment States