```
File  Edit  Shell  Debug  Options  Window  Help
Python 3.10.2 (tags/v3.10.2:a58ebcc, Jan 17 2022, 14:12:15) [MSC v.1929 64 bit (AMD64)] on win32
Type "help", "copyright", "credits" or "license()" for more information.
>>> ========== RESTART: C:\Users\Akash Prabhu\Desktop\8a.py ==========
thread locked for increment cur x= 0
1
2
3
4
5
6
7
8
9
10
thread release from increment cur x=thread locked for decrement cur x=  1010
9
8
7
6
5
4
3
2
1
0
thread release from decrement cur x= 0
>>>
```

```
File  Edit  Shell  Debug  Options  Window  Help
Python 3.10.2 (tags/v3.10.2:a58ebcc, Jan 17 2022, 14:12:15) [MSC v.1929 64 bit (AMD64)] on win3
Type "help", "copyright", "credits" or "license()" for more information.
>>> ========== RESTART: C:\Users\Akash Prabhu\Desktop\8a.py ==========
thread locked for increment cur x= 0
1
2
3
4
5
thread release from increment cur x=thread locked for decrement cur x=  55
4
3
2
1
0
thread release from decrement cur x= 0
>>>
```

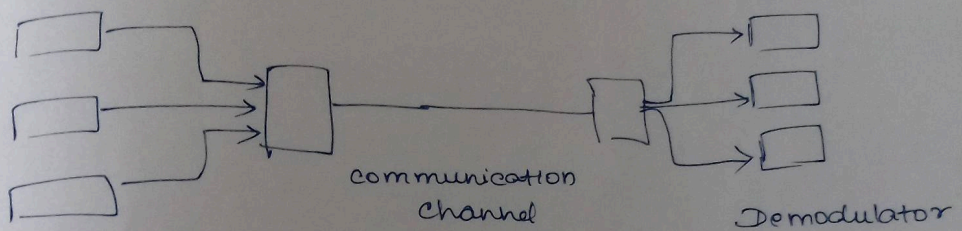
```
File  Edit  Shell  Debug  Options  Window  Help
Python 3.10.2 (tags/v3.10.2:a58ebcc, Jan 17 2022, 14:12:15) [MSC v.1929 64 bit (AMD64)] on win32
Type "help", "copyright", "credits" or "license()" for more information.
>>> ========== RESTART: C:\Users\Akash Prabhu\Desktop\8a.py ==========
1
2
3
4
5
6
7
8
9
10
9
8
7
6
5
4
3
2
1
0
0
>>>
```

```
File  Edit  Shell  Debug  Options  Window  Help
Python 3.10.2 (tags/v3.10.2:a58ebcc, Jan 17 2022, 14:12:15) [MSC v.1929 64 bit (AMD64)] on win32
Type "help", "copyright", "credits" or "license()" for more information.
>>> ========== RESTART: C:\Users\Akash Prabhu\Desktop\8a.py ==========
1
2
3
3
4
5
6
7
8
9
2
8
7
6
5
4
3
2
1
0
0
>>>
```

Modulation : varying carrier signal in accordance with message signal.

→ Delta modulation
→ Modulator
→ Demodulator.

Frequency - Division Multiplexing



Modulator. Demodulator

Wavelength - Division Multiplexing.

Digital to Analog Conversion

↓ discrete ↓ continuous

Amplitude Shift keying

→ frequency
→ phase
} constant

Binary ASK

→ OOK

$B = (1+d) * S$

B ↓ Band width.

n ↓ ranges [0, 1].

✓
* transmit digital data over optical fiber.
* inexpensive
* less bandwidth

✗
* low power efficiency
* noise interference causes damage.

FSK

$B = (1+d) * S + (L-1) * 2\Delta f \Rightarrow L \times S$

2^n → frequencies
n → bit (number)
} ⇒ 3 bit transfer needs 8 frequencies

✓
* avoid noise.
* low error.
* high signal to noise ration.

✗
* large bandwidth
* less bandwidth efficiency
* low power efficiency.

PSK

→ susceptible to noise

✓
* Power efficient
* Less error.

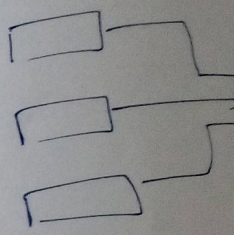
✗
* low bandwidth efficiency
* detection & recovery is complex.

Q PSK
↳ Quadrature

Modulation ... with message ...

→ Delta modulation
→ Modulator
→ Demodulator

Frequency - Di... Multiplexing



Modulator

Wavelength ... Multiplexi...

Unit 3

Line coding → code used for data transmission.

↳ (1) Unipolar

- On-Off Keying (OOK)
- Two variations
  - * Non return to zero
  - * Return to zero

Non-return to zero

✓
- *simple
- * less bandwidth

✗
- * No error correction
- * No clock

Return to zero

✓
- * simple
- * clock exist

✗
- * No error correction
- * Increased bandwidth.

↳ (2) Polar

NRZ

✓
- * simple
- * low frequency component

✗
- * No error correction
- * No clock

RZ

✓
- * simple
- * low frequency component

✗
- * No error correction.
- * Increased bandwidth

↳ (3) Bipolar

+ - 0.

↳ duo-binary signal.

+ to − } Alternate Mark Inversion
− to +

NRZ

✓
- * simple
- * low-frequency component

✗
- * No clock
- * Loss of synchronization

Connecting Devices

Hubs
→ outdated
→ work on first layer.

Routers
→ works on first 3 layers

Repeater
→ repeats by enhancing signal.

Switch
→ regenerates signal.

Bridges
→ divides big n/w to small sections.

- **Transparent** → unaware existence
- **Source route** → Token ring n/w

IPP

→ Input Port Processor.
→ Provides a buffer to match the speed b/w the input & the switch fabric.

- Packet fragmentation – Packets to smaller size.
- Main buffer
- multicast process – copying
- routing table – has available destinations.
- Packet encapsulator – inserts/changes in routing table.
- comprehensive QoS.
- congestion controller – traffic control.

Switch Fabric

→ packets routed from input ports to output ports

Switch Controller.

→ decision in leading the packets to the destination

OPP

→ Output Port processors.
→ packet resequencer, error checker.

Unit 3

line coding →

↳ (1) Unipolar

• On-Of
• Two v

Non-return to zero

✓
* simple
* less bandwid

↳ (2) P

NRZ

✓
* simple
* low frequ
compone

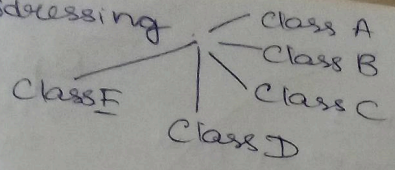
↳ (

+ - 0

↳ duo-
signal

+ to –
– to +

2) Classful Addressing



Subnetting

- → allows to break a large network into smaller networks.
- → reduces traffic / increases performance.

X
- → Needs Routers
- → wastage of IP.
- → Needs a middle man

Subnet mask

→ routers need it.

Supernetting

→ summary of many subnets.
→ route summarization
→ route aggregation.

✓
- reduces size
- better overview n/w

NAT

→ Multiple devices access the ~~net~~ internet through one public network.

→ Static NAT: 1 Private IP mapped to 1 Public IP.

Eg: web hosting

→ Dynamic NAT: 1 Private IP mapped to 1 Public IP through a pool of Public IP.

→ PAT: Port Address Translation

distinguish traffic.

✓
- → Privacy
- → legal registered IP
- → No renumbering

✗
- → NAT always doesn't work
- → complicates protocols.

UNIT - 2

IPV4 → assigning logical address to host

- binary form → 11000000 . 00000011 . 01010011 . 10000001
- decimal form → 117 . 123 . 10 . 11

Address space: range of logical space where data can be stored.

Eg: RAM.

Subnet mask: Used to designate subnets / Local LANs

Addressing Modes

1) Unicast : Sent to one destination host
2) Broadcast : Sent to all connected devices
3) Multicast : Combines both

Special IP address

1) IP: 0.0.0.0 - disengaged from network
2) IP: 240.0.0.0 - experimental use.
3) IP: 127.0.0.1 - loopback address
4) IP: 10.0.0.1 - default gateway address
5) IP: 224.0.0.0 – 244.0.0.255 } - multicast address.

Addressing Types

1) Classless Addressing

192.168.1.1/28

11111111111111111111111111110000

28 '1s 4 0's

CIDR :- 2 groups — network/subnet address
— host address.

2) Classful Addressing

Class

Subnetting
- → allows to break networks
- → reduces traffic

X
- → Needs Routes
- → wastage of
- → Needs a ma

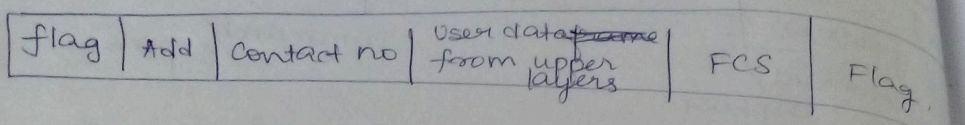
Subnet mask
→ routers need

Supernetting
- → summary
- → route su
- → route ad

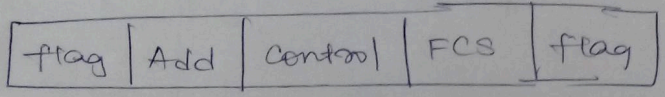
NAT
- → multiple d one public
- → Static NAT
  Eg: wo
- → Dynamic through
- → PAT: P
  - di

→ Privac
→ Legal
→ No

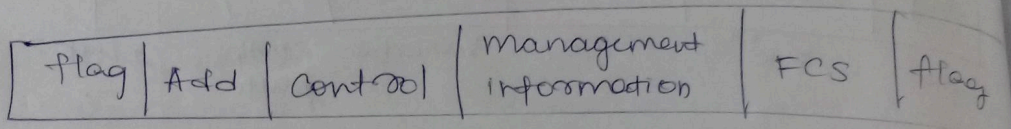
I-frame:



S-frame

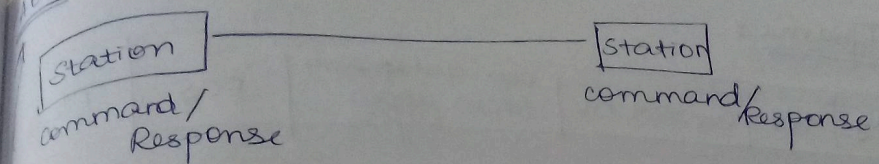


U-frame



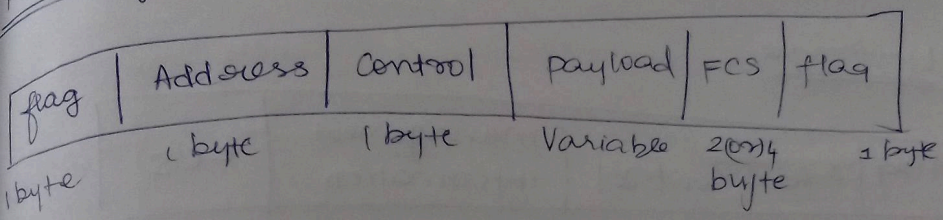
	HDLC	PPP
1.	bit oriented	byte oriented
2	point to point & multipoint	Only for point to point
3	Dynamic Addressing is not offered	Dynamic addressing is offered.
4.	Used in synchronous	Used in synchronous & Asynchronous.

not suitable for multipoint



Only for point to point

HDLC frame



Flag → beginning & end of frame

Add → Adress of the receiver

Control → flow control & errors control mechanism

payload → Data

FCFS – Frame Check sequence

Types of HDLC frames

I frame – Information frame

S frame – Supervisory frame

U frame – Unnumered frame

21

HDLC → PPP (Point to Point) → Protocols for Data link layer

H - High Level
D - Data
L - Link
C - Control

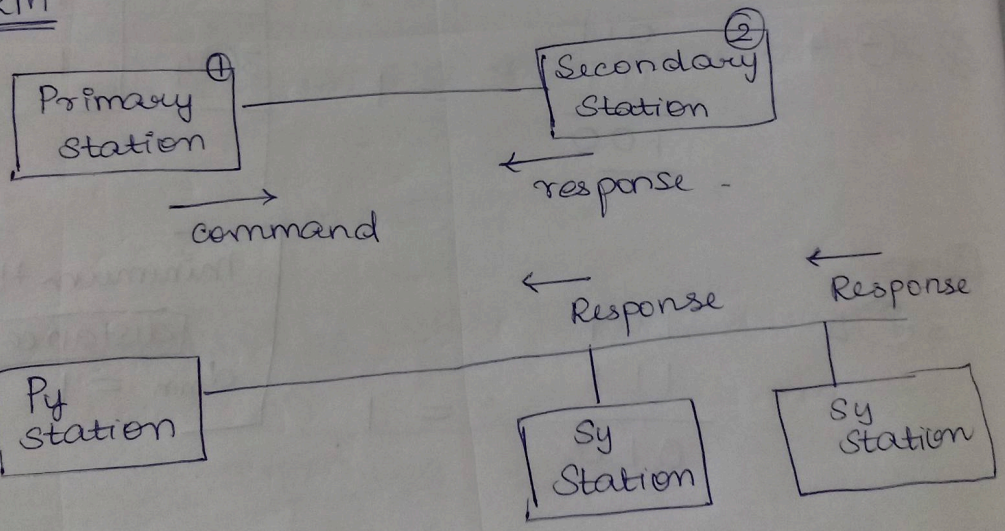
Group of communication protocols

~~NRM - Normal~~

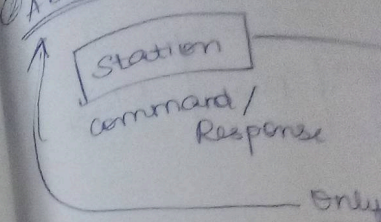
Types of transfer modes

1. NRM — Normal Response Mode
2. ABM — Asynchronous Balanced Mode

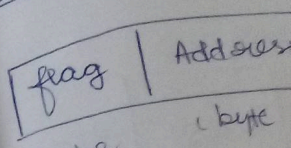
1. NRM



2. ABM



HDLC frame



Flag → begin
Add → Add
Control → fe mec

~~Data~~ payload →

FCFS

Types of

I fra
S fra
U fra

1 ⊕ 2

$$\begin{array}{r} 010 \\ 011 \\ \hline 001 \end{array} = 1$$

XOR

0	0	0
0	1	1
1	0	1
1	1	0

1 ⊕ 3

$$\begin{array}{r} 010 \\ 101 \\ \hline 111 \end{array} = 3$$

1 ⊕ 4

$$\begin{array}{r} 010 \\ 111 \\ \hline 101 \end{array} = 2$$

	HD
1⊕2	1
1⊕3	3
1⊕4	2
2⊕3	2
2⊕4	1
3⊕4	1

2 ⊕ 3

$$\begin{array}{r} 011 \\ 101 \\ \hline 110 \end{array} = 2$$

2 ⊕ 4

$$\begin{array}{r} 011 \\ 111 \\ \hline 100 \end{array} = 1.$$

3 ⊕ 4

$$\begin{array}{r} 101 \\ 111 \\ \hline 010 \end{array} = 1.$$

minimum HD = 1

distance

$d_{min} = 1$

Hamming distance

(*) Metric for comparing two binary strings.

(*) While comparing two binary strings of equal length, hamming distance is number of bit positions in which two bits are different

---

Calculation of Hamming distance

Two strings 1101 1001 & 1001 1101

$$\begin{array}{r} 1101\ 1001 \\ \oplus\ 1001\ 1101 \\ \hline 0100\ 0100 \end{array}$$ XOR

← Contains 2 1's.

HD = 2

d(1101 1001, 1001 1101) = 2

Minimum Hamming distance

(4) strings 010 011 101 111

Forward Error Correction (FEC)

Error Correction Codes (FEC)

1. Block Codes (add CRC)
2. Convolution Codes (add parity bits) (Trial & error basis)
   - Odd
   - even.

1. Hamming codes → block
2. Binary convolution Code → convolution
3. Reed - Solomon Code
4. Low - Density Parity check Code. } block.

1. detecting upto 2 simultaneous bit errors and correcting single bit errors.

2. an encoder process an input sequence of bit of arbitary length and generates a sesquence of output bits.

1 2 (3) 4 → error.

3. correcting burst errors

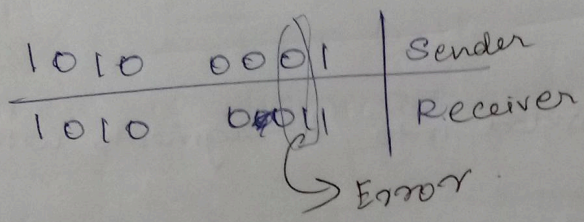
4. Parity check.

Types of error

1. Single Bit error

Only 1 bit of given data unit is changed from 1 to 0 (or) 0 to 1

↳ Parallel data transmission.



2. Burst error →

Two or more bits are changed from 0 to 1 & 1 to 0.

↳ Serial data transmission.

Forward error correction

Error detection

↓

Error correction

↓ not possible

Retransmission.

Check Sum ⇒ Error detection Scheme

Original Data

①	②	③	④
1001 1001	1110 0010	0010 0100	1000 0100

k = 4 m = 8

k = blocks m = Bits
or
segment

Original data divided into k segments with m bits.

Sender

1001 1001
1110 0010 (+)
0 1 1 1 1 0 1 1
1
0111 1100
0010 0100
1010 0000
1000 0100
0010 0100 (+)
1
0010 0101

Sum 0010 0101

Check Sum 1101 1010 (1's complement)

Receiver

1001 1001
1110 0010 (+)
0111 1011 (+)
1
0111 1100
0010 0100 (+)
1010 0000
1000 0100 (+)
0010 0100 (+)
0010 0101
0010 0110

Check Sum 1101 1010

0000 0000

1111 1111 1's comp

0000 0000

```
1001 | 1010 000 011
       1001
       ----
       0011 000 011
          1001
          ----
          0101 0 011
             1001
             ----
             0011 011
                1001
                ----
                0100 1
                   1001
                   ----
                   0000   } correct
                   ----
                   0001
```

means wrong

message received correctly.

⇒ Zero means data accepted.

Check Sum

original Da

1001

k = 4

k =

assign

m b

Send

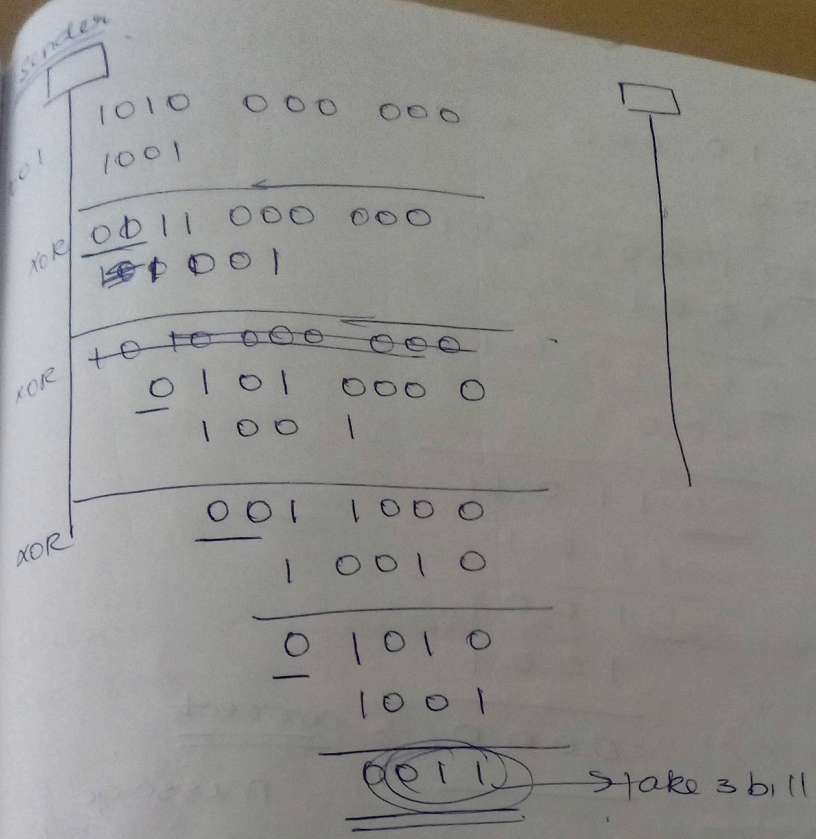
1 100

2 11

0

Sum

Check Sum



Message to be transmitted.

1010 000 000
011 CRC

1010 000 011

Receiver

org message 1010 000 011

→ CRC is mainly for error detection

orig message : 10100000 $\underbrace{000}_{\text{CRC}}$

x^3+1 (generated polynomial)

Same is used at SR & RR

(Anything)

$1x^3 + 0x^2 + 0x + 1$

⇒ 1001

4 bits

4 − 1 = 3 zeros.

XOR

A	B	Y
0	0	0
0	1	1
1	0	1
1	1	0

Sender

1010

1001

XOR

XOR

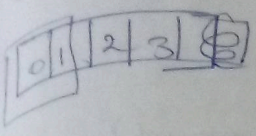
XOR

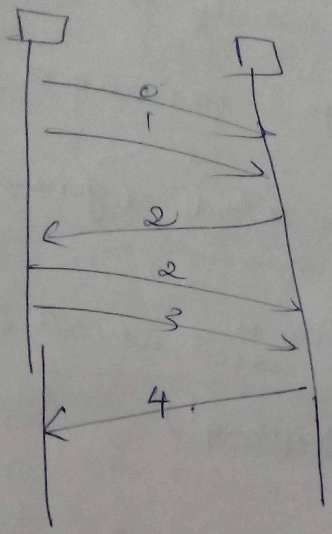
Message

Receive

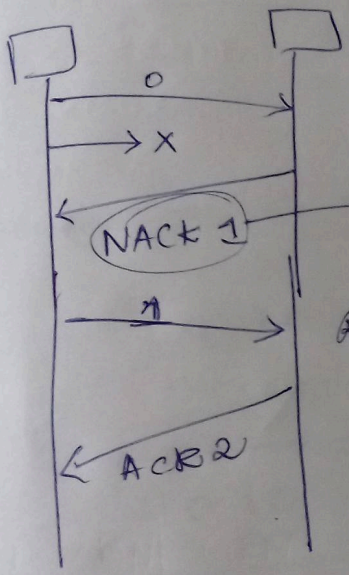
orig message

Selective Repeat





if

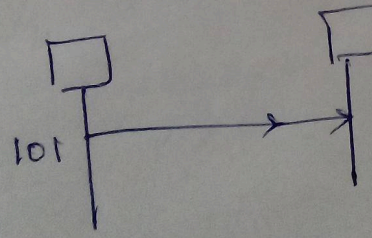


Lost Ack.

Retransmits 1. (Lost alone is sent)

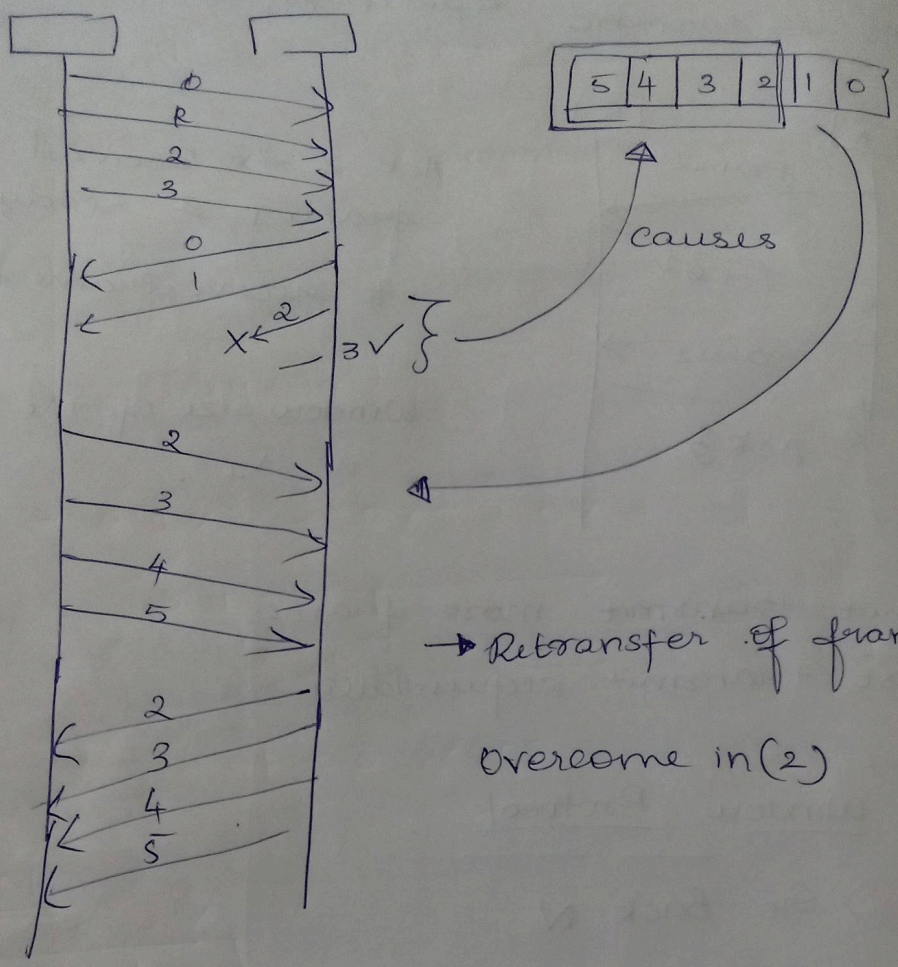
Cycle Redundang Check

Original message



} Error.

But



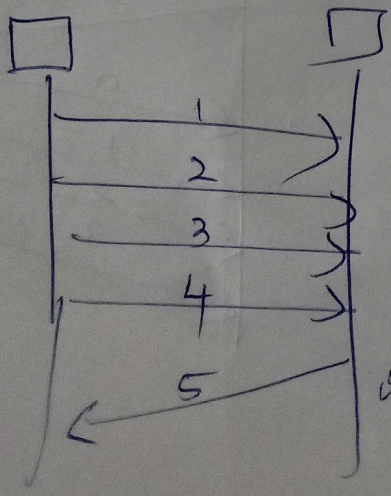
→ Retransfer of frames

overcome in (2)

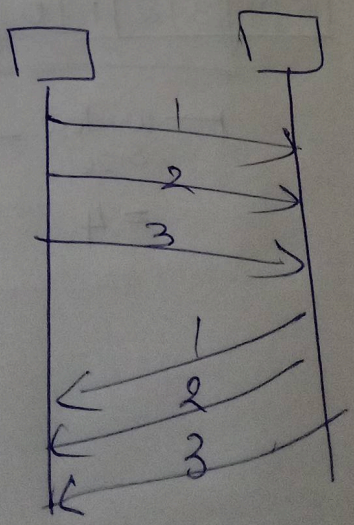
Acknowledgement

↓ Cummulation

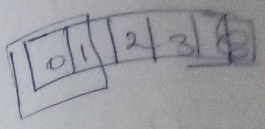
→ Independent



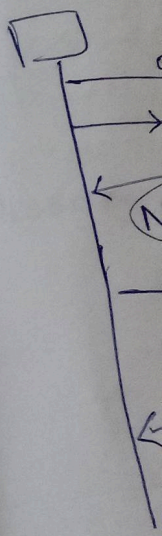
ready to receive 5



Selective Repeat



if

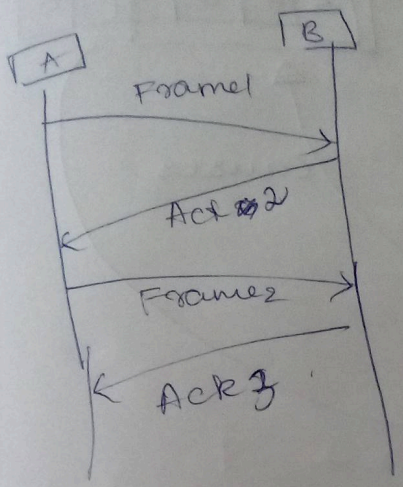


Cycle

Ou

Stop & wait ARQ

ARQ → Automatic Repeated Request



Ack 2 → Received frame 1 & ready to receive frame 2

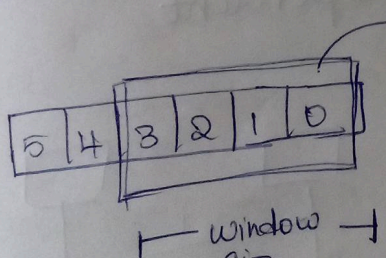
Window size of the ARQ is '1'.

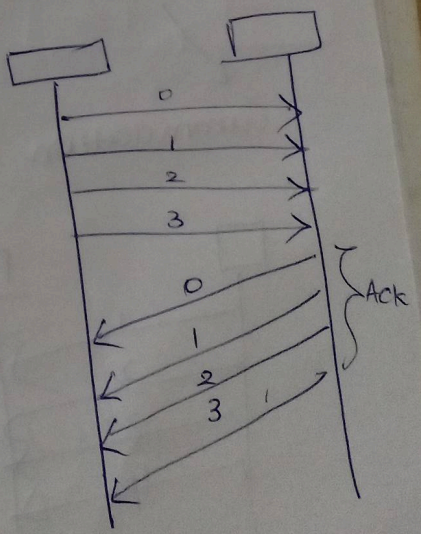
→ cannot transmit more frames.
→ Must transmit sequentially.

Sliding Window Protocol

1) Go Back N
2) Selective Repeat (SR)

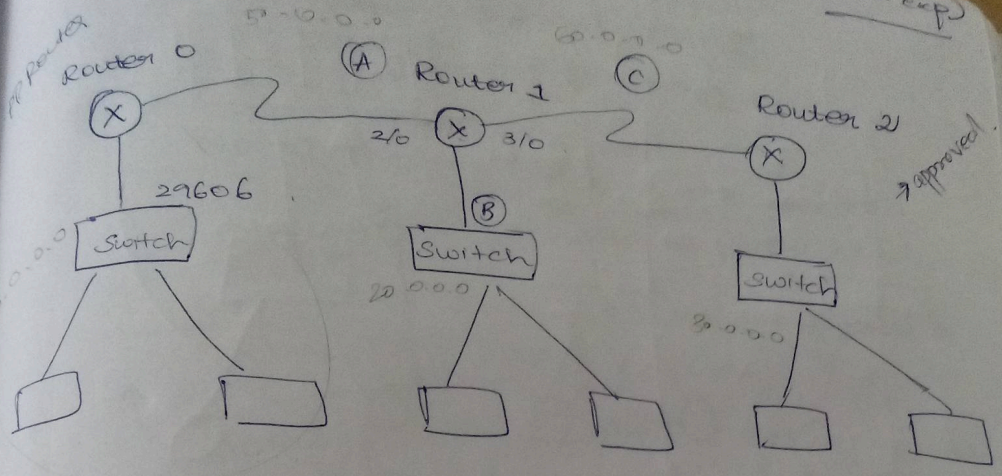
Go back N (GBN)





Single Area OSPF

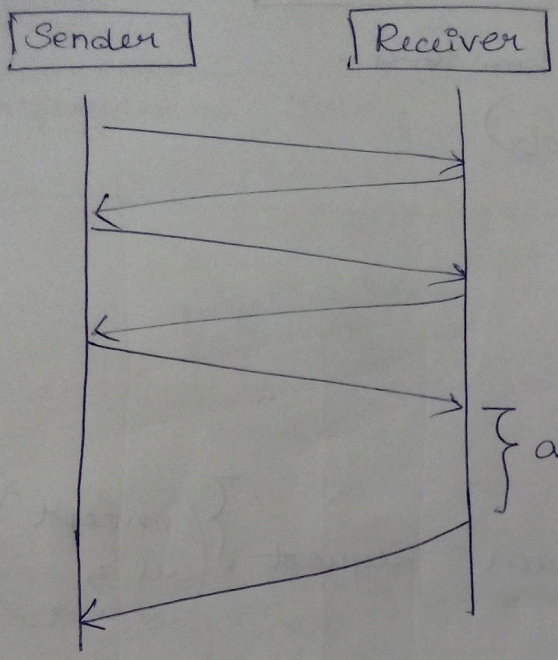
(12th exp)



Router

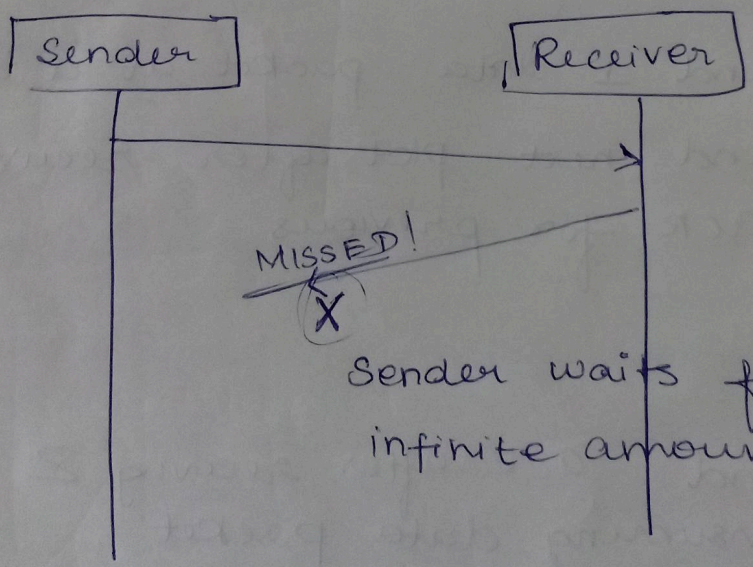
```
en
config t

interface fa0/0
ip address 10.0.0.3 255.0.0.0
no shut
exit

interface se 2/0
ip address ____ 255.0.0.0
clock rate 64000
no shut
exit

interface se 3/0
ip address ____ 255.000
Clock rate 64000
no shut
exit
```

```
router ospf 1

network
   A
0.255.255.255
  area 0

network
   B
0.255.255.255
  area 0

network
   C
0.255.255.255
  area 0

exit

exit
```



Lost Ack.

Demerits



Sender waits for Ack for infinite amount of time.

2) Time to Live (TTL) = 2 * TimeOut

↳ Data Lives for how long.

(Max : 180 seconds)

Error Control

3 Techniques

ARQ

Automatic Repeat Request } (concept all 3 same).

① Simple stop and wait

Sender:

Rule 1 : Send 1 data packet at a time

Rule 2 : Send next pkt after receiving ack for previous

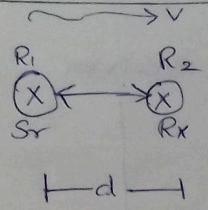
Receiver:

Rule 1 : Send ack after receiving & consuming data packet

Rule 2 : After consuming the packet ack needs to be sent.

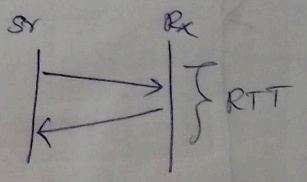
Terms

1) Propagation Delay = $\frac{\text{Distance between Routers}}{\text{Velocity of propagation}}$

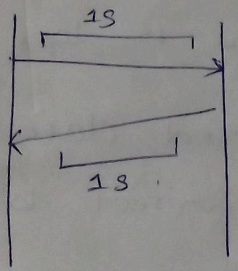


$\frac{m}{ms^{-1}} = (s)$ ↳ time

2) Round Trip Time (RTT) = 2 * Propagation Delay



3) Time Out = 2 * RTT



Takes (2s) to get acknowledgement.

↓

Time Out.

So there is an error — Data / Ack 0.

⇒ Retransmit data.

4) Time to Live (TTL)

↳ Data Live

(Max :

Error Control

3 Techniques

ARQ

Auto

① Simple stop

Sender:

Rule 1 :

Rule 2

Receiver

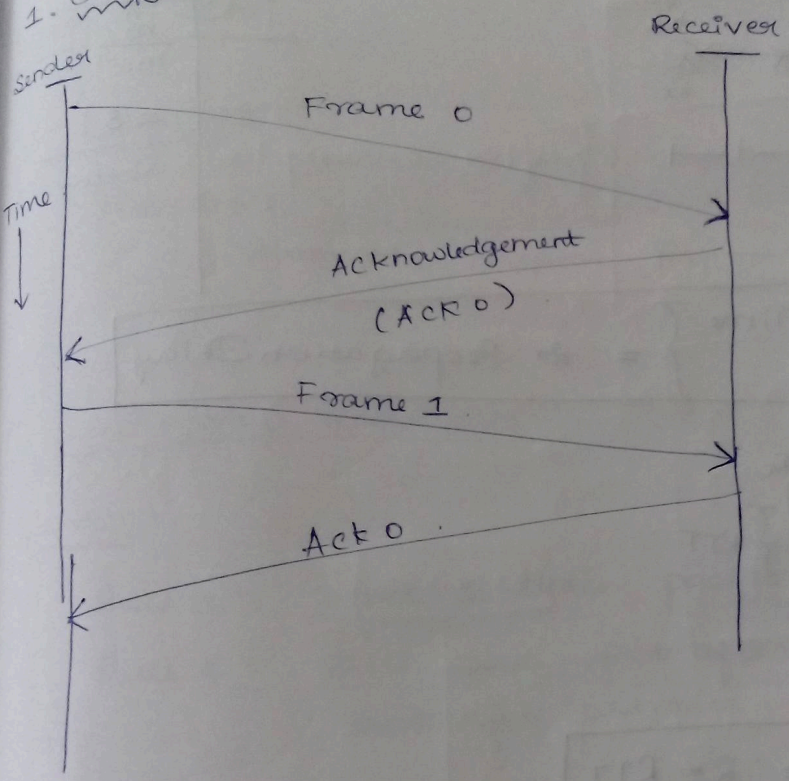
Rule

Ru

2 mechanism

1. Stop & wait
2. Error control

1. Stop and Wait



2. Error Control

Error occurs when there is loss of data.

Sender : Did I send correct data?

Receiver : Did I receive correct data?

To find error → error detection.

+ve Ack 0

-ve Ack 0

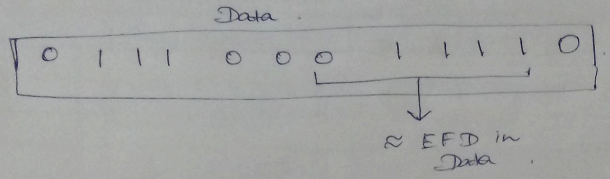
identified by

Error → Data Transmission

Rectification

↳ Retransmission.

Bit Stuffing



EFD = 0(1111)
continuous 1's
So bit Stuff 0

Stuff 0 after 3 1's.

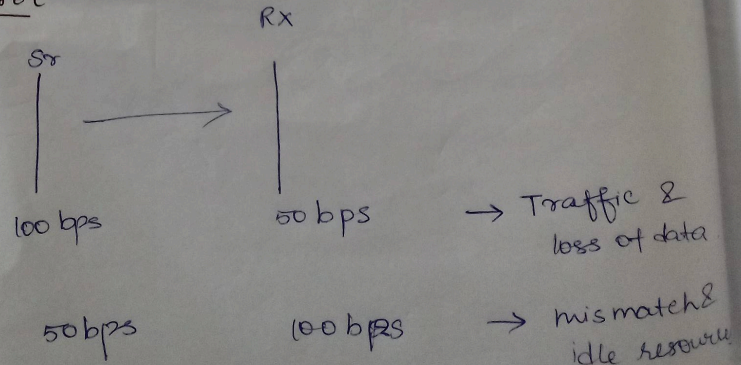
0 1 1 1 0 0 0 0 1 1 1 0 1 0
↑ Bit Stuffing
Bit Stuffing

Eg Data 11000100 1

EFD 1000
continuous 0's so bit stuff 1

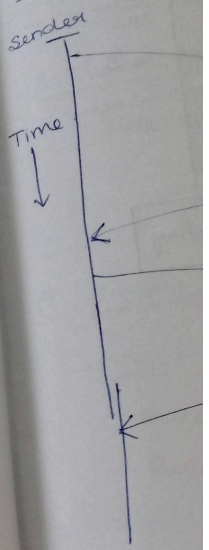
11 00 1 0 100 1 1
↑ Bit stuff

Flow Control



2 mechanism
1. Stop &
2. Error

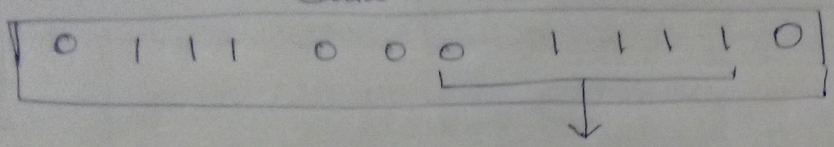
1. Stop and



2. Er
E
S
R
To
Recti

Bit Stuffing

Data



≈ EFD in Data

EFD = 0 1111

continuous 1's

So bit Stuff 0

Stuff 0 after 3 1's.

0 1 1 1 0 0 0 0 1 1 1 0 1 0

↑ Bit Stuffing

Bit Stuffing

Eg Data 1 1 0 0 0 1 0 0 1

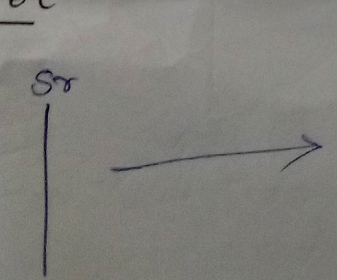
EFD 1000

continuous 0's so bit stuff 1.

1 1 0 0 1 0 1 0 0 1 1

↑ Bit Stuff

Flow Control



100 bps

50 bps → Traffic & loss of data

50 bps

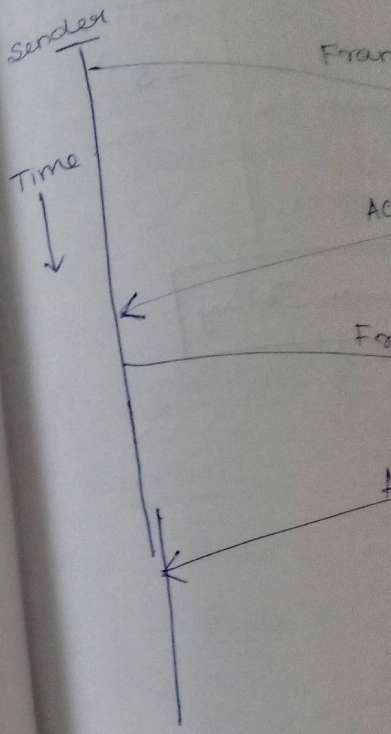
100 bps → mismatch & idle resource

2 mechanism

1. Stop & wait
2. Error control

---

1. Stop and Wait



2. Error

Error

Sender

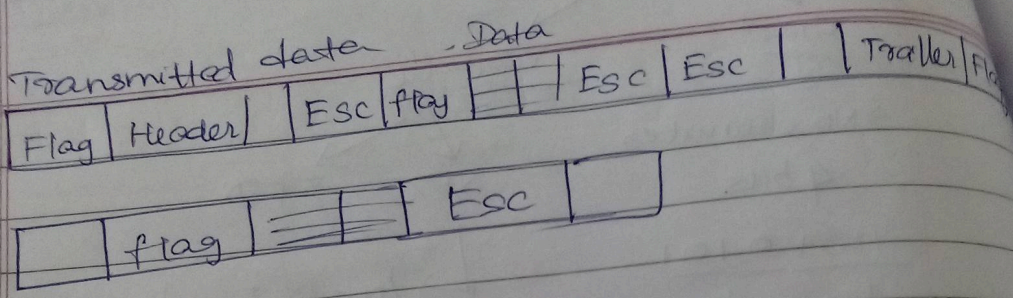
Receive

To fi

Rectificati

↳ Retr

Transmitted data - Data



Types of frames

Fixed

→ No delimiter

8 bits

1101 0101

↓ 1st frame ↓ 2nd frame

Variable

SFD EFD

→ Length Field

→ End delimiter

Bit Stuffing

→ Character Stuffing / Byte stuffing

Character Stuffing

$ 0111 1 #

If the data has $ or # it is a problem

Data

| flag | | Esc | |

Framing

| flag | Header | Esc | Flag | | | Esc | Esc | Trailer |

Esc → 1 Esc data

Esc Esc → 2 Esc End

Cont. flag

flag = 1 transmission ✓

" X

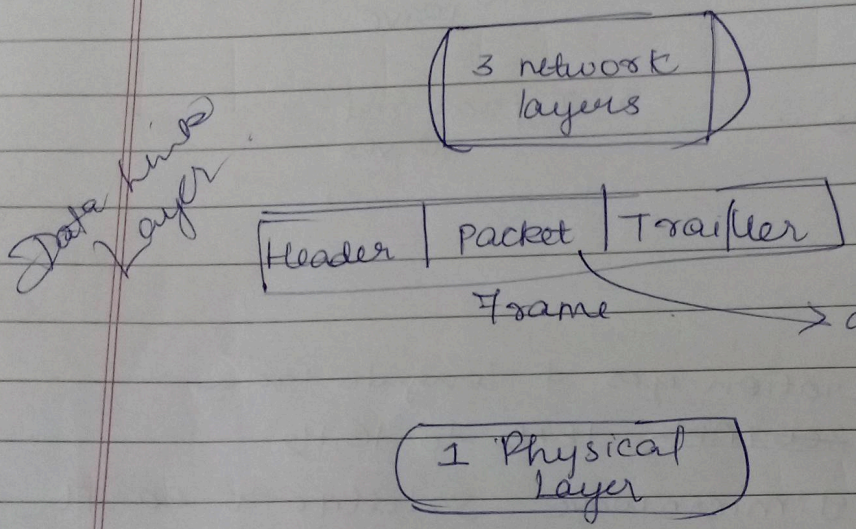
= 0

31

UNIT-4

Framing →

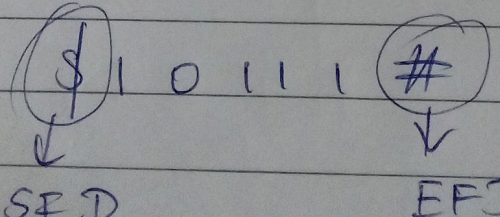
Point to point connection between computers



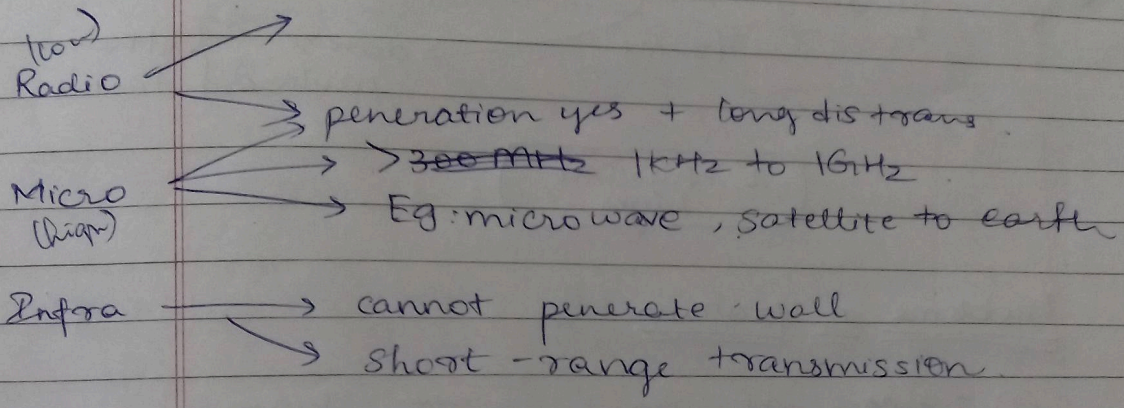
Problems in framing

① Detecting the start of the frame
(SFD) → Starting Frame Delimiter

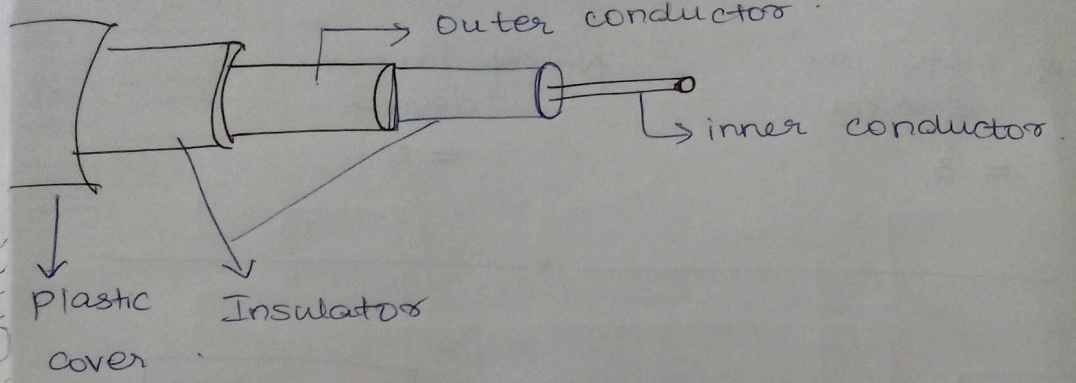
② Detecting the end of frame
(EFD) → End Frame Delimiter



Guided	Unguided
1. Twisted pair	1. Radio waves
2. Co-axial	2. Micro wave
3. Fiber optics	3. Infra-red waves



COAXIAL CABLE: Eg (TV cable)



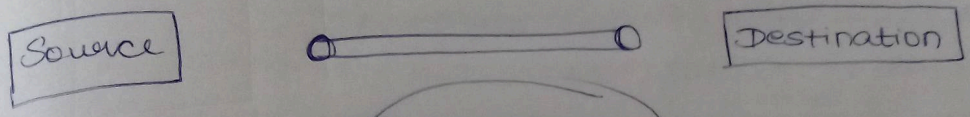
Guided
1. Twisted pair
2. Co-
3. Fib
(low) Radio
Micro (high)
Infra

If 4 packets are ready, fcfs is followed

↓

priority

No. of slots per frame = 3 ≠ No. of input devices = 5



Transmission medium

Guided

→ wired.

Eg: 1) Twisted Pair

2) Coaxial cable

3) Fibre optic cable.

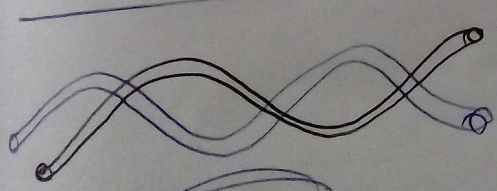
Unguided.

→ Radio waves

→ Micro waves

→ Infrared waves.

TWISTED PAIR



→ Red. } Avoids interference.

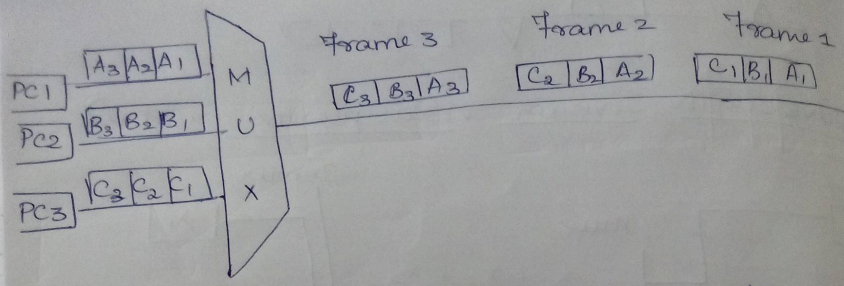
→ Blue.

Types

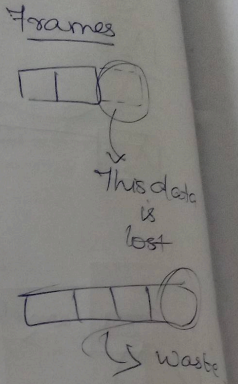
Unsheilded.

Sheladed

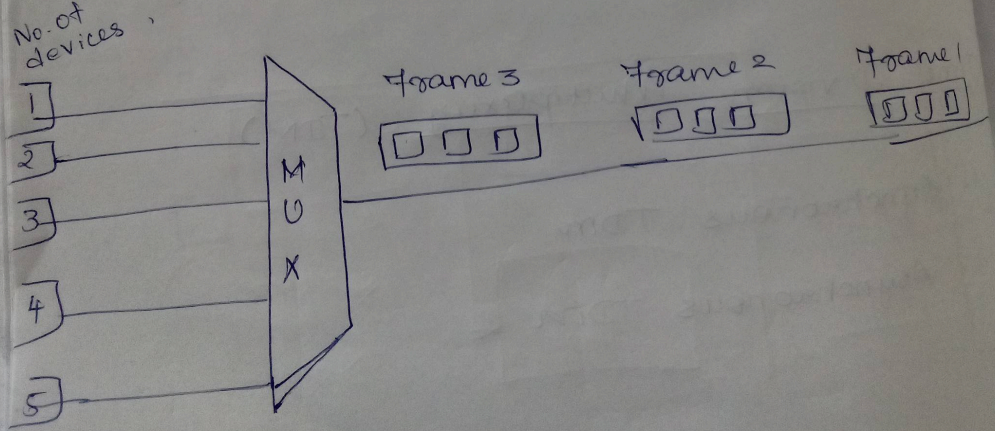
Synchronous TDM



equal (No. of input Device = 3
No. of slots per frame = 3



Asynchronous TDM



If 4 packets are

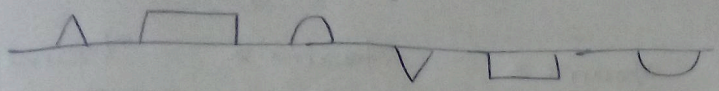
No. of slots p
fram
= 3

Source

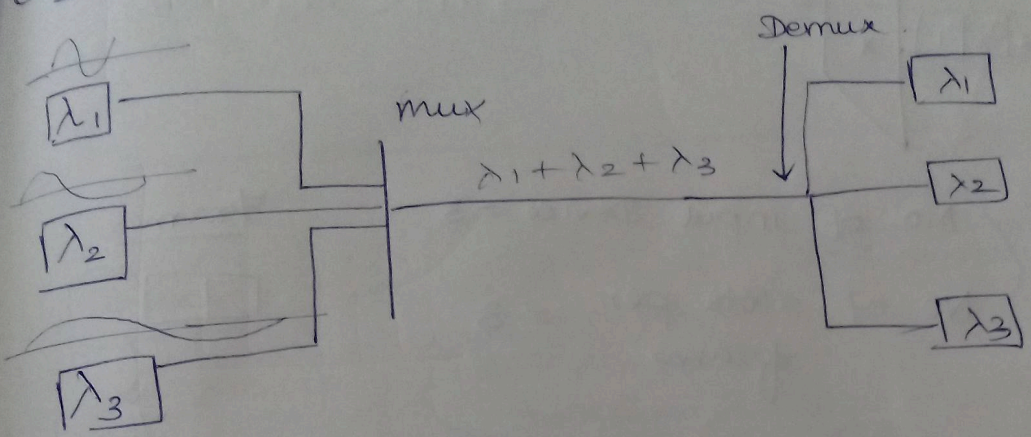
TWISTE

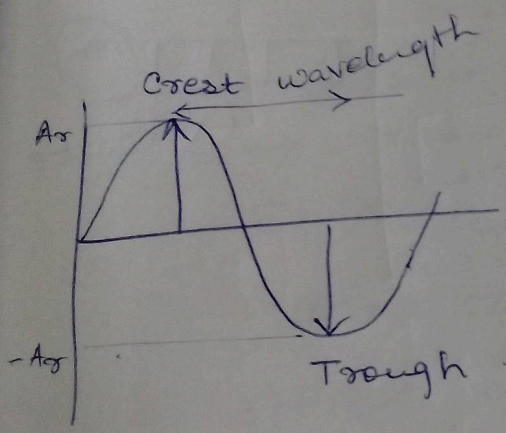
S

→ Adder causes interference. So spacing is done



② Wavelength Division Multiplexing (WDM)





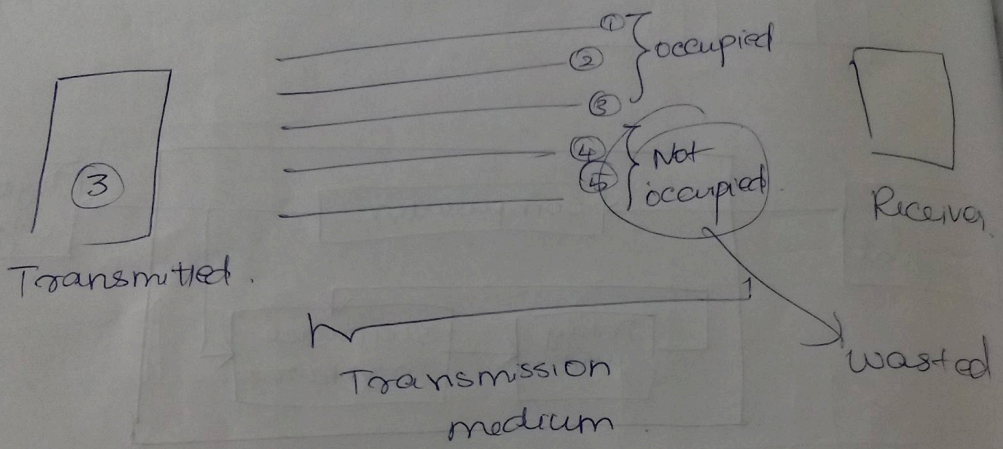
Crest Max to Trough Max.

Time Division Multiplexing (TDM)

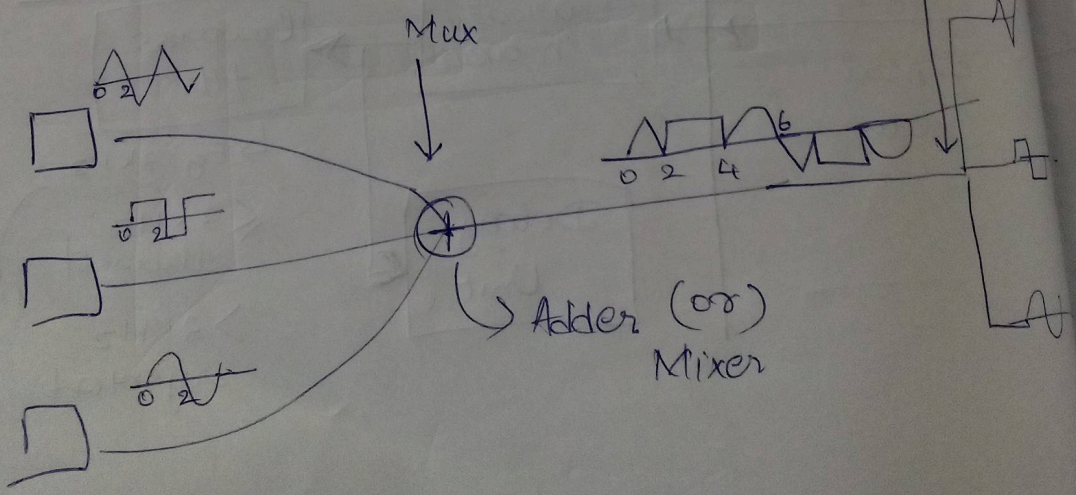
1. Synchronous TDM
2. Asynchronous TDM

Multiplexing

1. Frequency Division Multiplexing (FDM)
2. Time Division Multiplexing (TDM)
3. Wavelength Division Multiplexing (WDM)



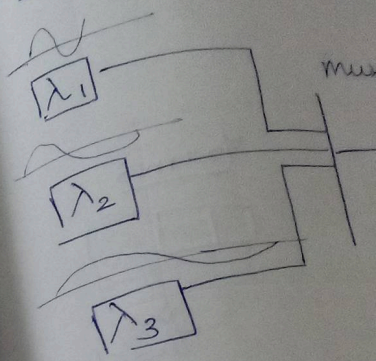
(1) Frequency Division Multiplexing

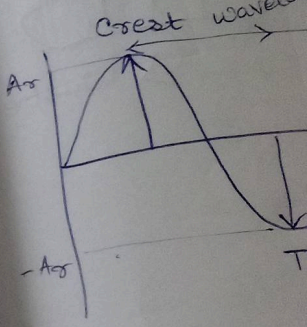


Frequency - no. of cycles per second.

→ Adder causes

(2) Wavelength Divisio

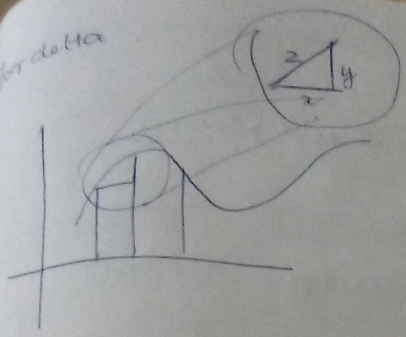




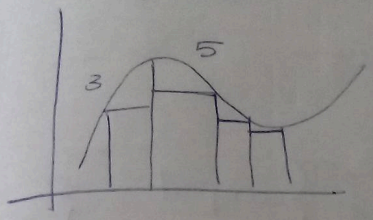
Time Div

1. Sync
2. Asy

for delta

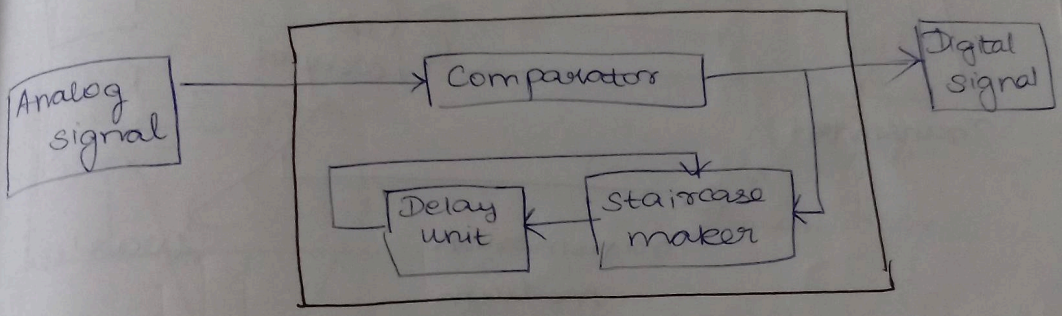


z alone is considered



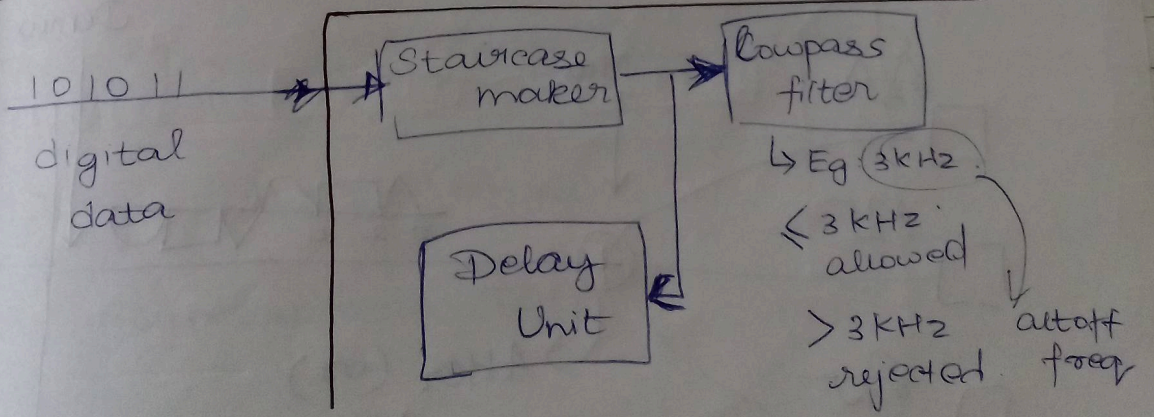
5 (3) = 2

↓ stored in delay unit.



Delta Demodulator

allows low freq higher rejected



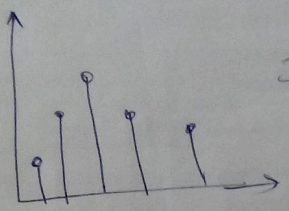
↳ Eg 3 kHz

≤ 3 kHz allowed

> 3 kHz rejected

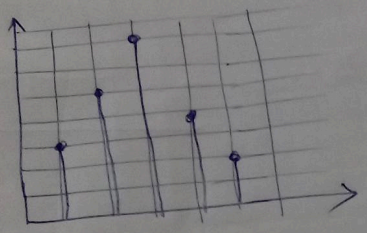
cutoff freq

② Sampling ⟶ Sampled O/P



Discrete signal

③ Quantizer ⟶ Quantized O/P

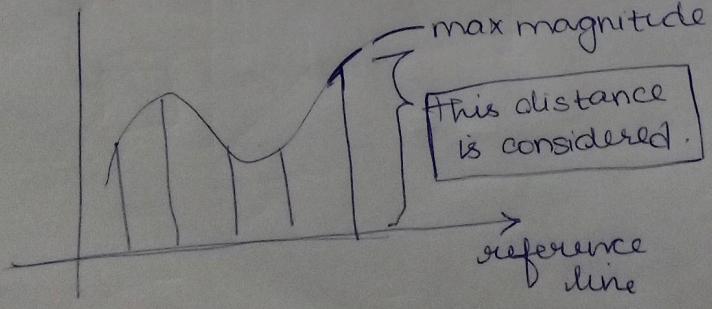


Digital S/L

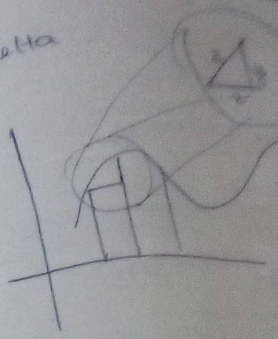
④ Encoding

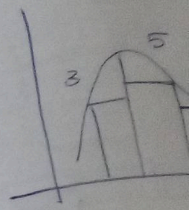
Delta Modulation

Pulse Mode Modulation



for delta





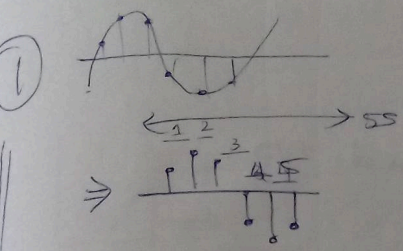
Analog signal

Delta D

1 0 1 0

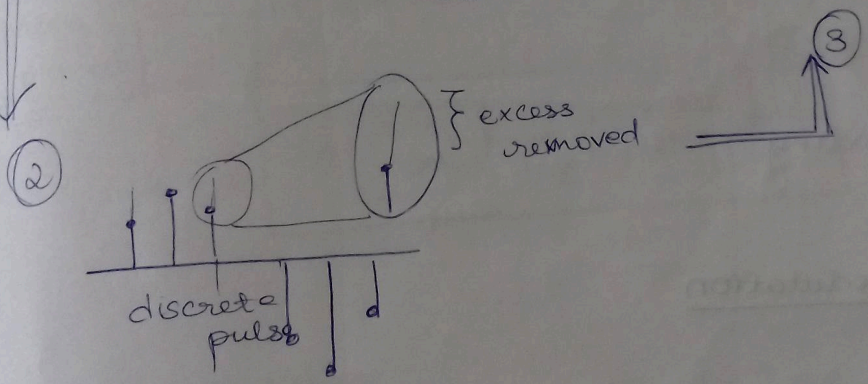
digi
d

Analog → Digital

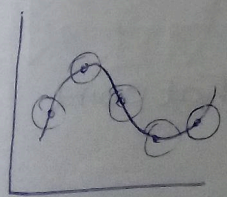


6 samples

- random interval
- regular interval
  Eg: every 1s



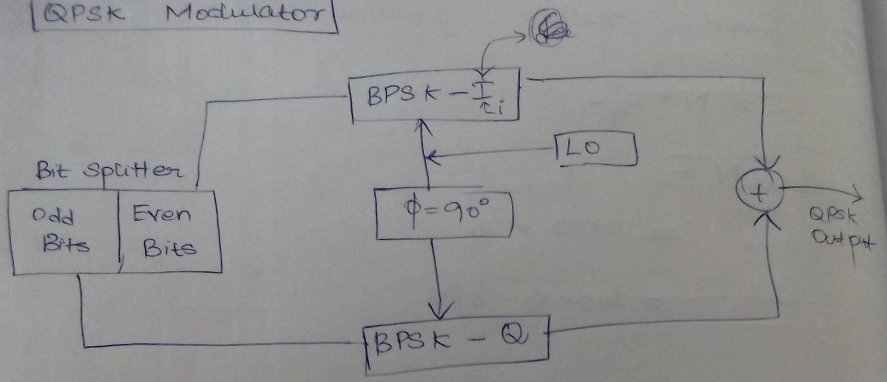
① Analog signal



Quadrature PSK

2 bits can be transmitted at a time.

QPSK Modulator



Phase shift can be done for $\phi = 90°$ (or)
$\phi = 180°$, $\phi = 270°$, $\phi = 0°$.

Analog to Digital Conversion

Pulse Code Modulation (PCM).

1. Sampling (Sampler) → 1. The analog signal is sampled
2. Quantizing (Quantizer) → 2. Sampled signal is quantized
3. Encoding (Encoder) → 3. Quantized values are encoded as a streams of bits

1) An analog signal carries 4 bits per signal element. If 1000 signal elements are sent per second find the bit rate

A) Given: $r = 4$ $S = 1000$ $N = ?$

$$S = N * \frac{1}{r}$$

$$\Rightarrow N = S * r$$

$$= 1000 * 4$$

$$= 4000 \text{ bps}$$

2) An analog signal has a bit rate of 8000 bps with a baud rate of 1000 baud. How many data elements are carried by each signal element? How many signal elements do we need.

$S = 1000$ $N = 8000$

r & L are unknown.

$$S = N * \frac{1}{r} \Rightarrow r = \frac{N}{S} = \frac{8000}{1000} = 8 \text{ bits/baud}$$

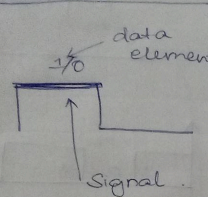
$$r = \log_2 L \Rightarrow L = 2^r = 2^8 = 256$$

Signal element.

No. of bits per second

→ bits/s

Bit rate ↳(bps)



1 ← data element

1 ← signal element

$r = \frac{1}{1} = 1$

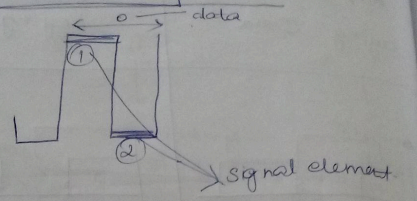
r = data element / signal element

Relationship b/w bit rate & baud rate

$S = N * \frac{1}{r}$ bauds

→ No. of signal elements per seconds

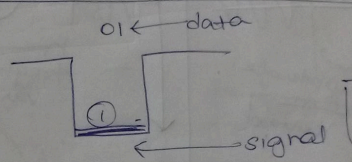
Baud rate



1 data

2 signal

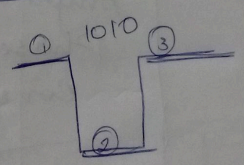
$r = \frac{1}{2}$



$r = \frac{2}{1} = 2$

2 ← data element

1 ← signal



$r = \frac{4}{3}$

4 ← data

3 ← signal

P1. GRACE HEPHZIBAH

1) An analog signal ... signal element. If ... sent per second ...

(A) Given: $r = 1$

$S = N * \frac{1}{r}$

$\Rightarrow N = S *$

$= 1$

$=$

2) An analog ... with a bau... elements a... element ? ... need.

$S = 1000$

r & L...

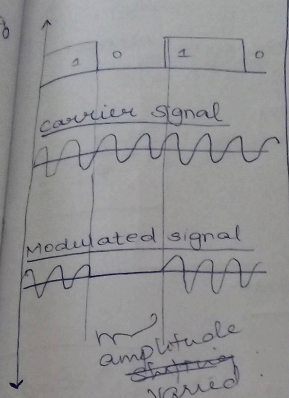
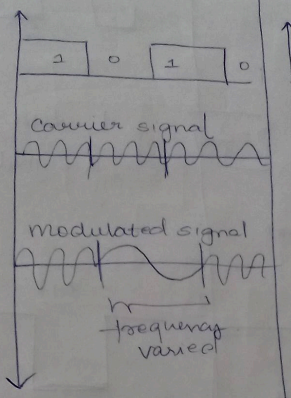
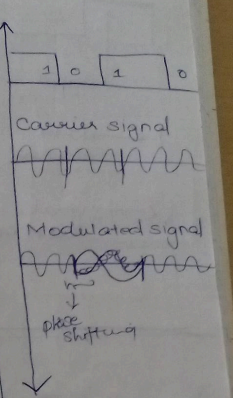
$S = N$

$r =$

Frequency Shift keying (FSK)

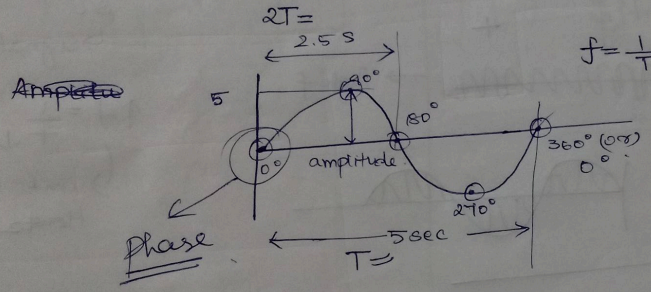
ying

Hz

Amplitude Shift keying Data	Frequency Shift Keying	Phase Shift Keying
		
Amplitude varied	Frequency varied	Phase varied
Frequency, Phase const	Amplitude, Phase Const	Amplitude Frequency const

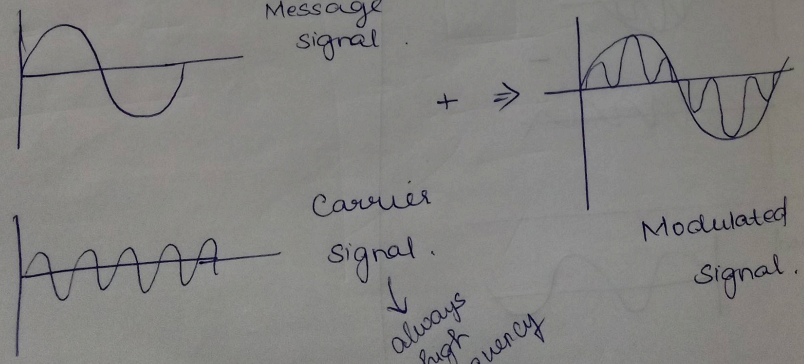
Modulation

- Analog
  - Amplitude modulation (AM)
  - Frequency modulation (FM)
  - Phase modulation (PM).
- Digital.
  - Amplitude Shift Keying (ASK)
  - Frequency Shift Keying (FSK)
  - Phase Shift Keying (PSK)

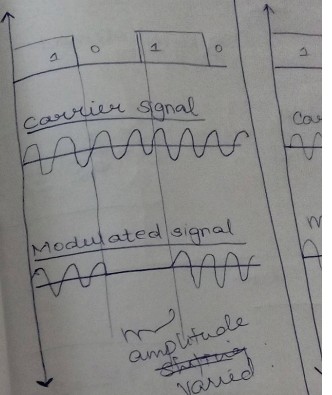


$f = \frac{1}{T} = \frac{1}{5} = 0.2\,Hz$

Amplitude Modulation



Amplitude Shift Keying Data

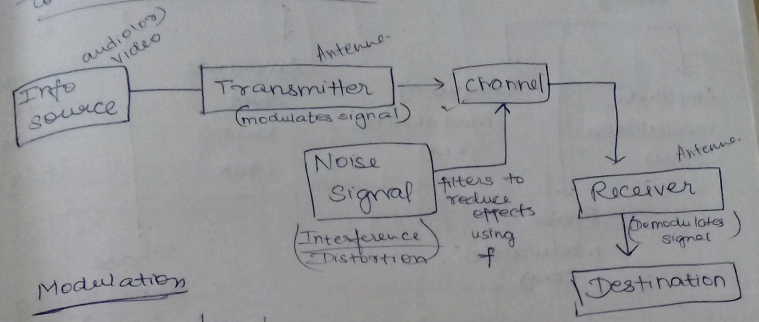


Amplitude varied

Frequency, Phase const.

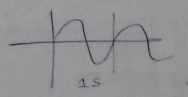
Digital to Analog Conversion

Block diag of communication system

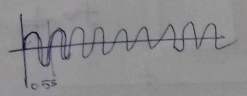


Modulation

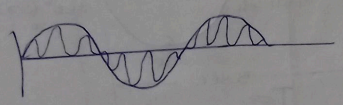
Info s/l : → low f



carrier s/l : → high f



Modulation:



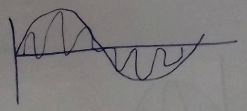
s/l
↳ signal.

$\uparrow f = \frac{1}{T} \downarrow$

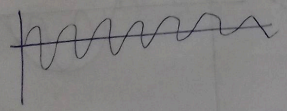
↳ unit Hertz

Demodulation

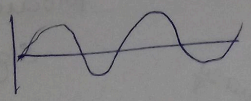
Mod.

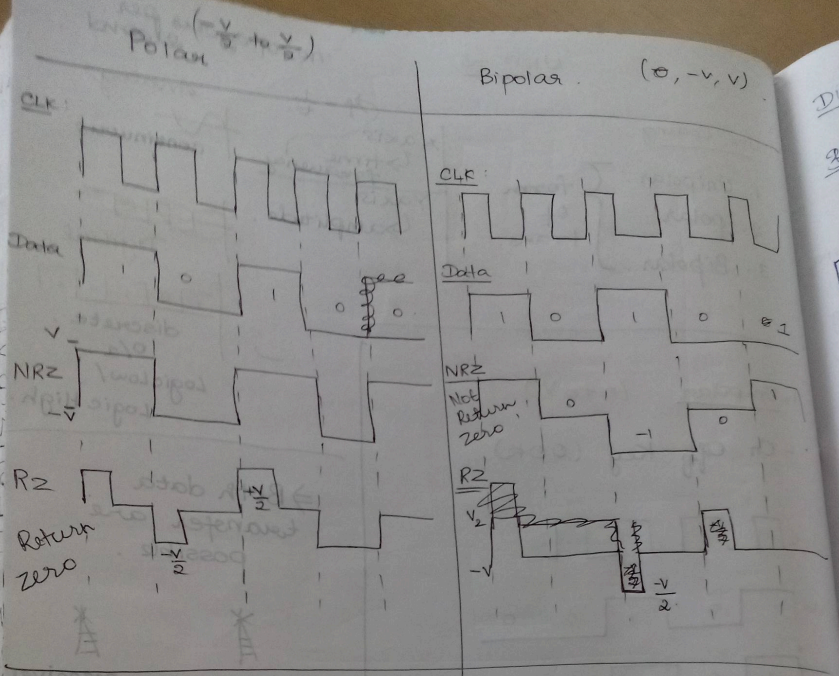


car



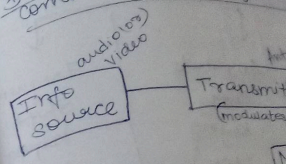
Demod.



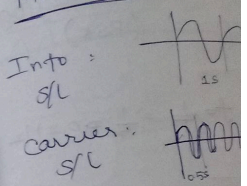


Digital to Analog

Block diag of communication System

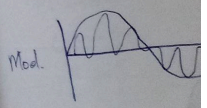


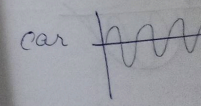
Modulation



Modulation

Demodulation





Demod.

UNIT-3

Line Coding

1. Unipolar.
2. polar
3. Bipolar.

} form of trans.

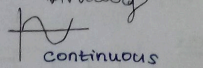
no. of cycles per second.

$f = \frac{1}{t}$.

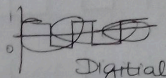
X axis → time frequency

Y axis → amplitude.

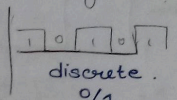
Analog



continuous



Digitial



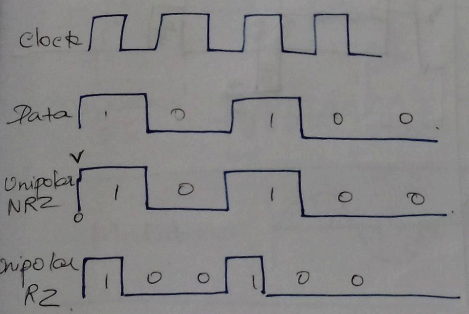
discrete.

0/1.

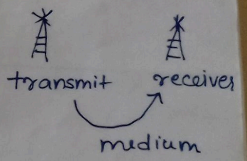
Logic Low / Logic High.

1. Unipolar (0 to V)

- On Off Key (OOK)



⇒ Both data transfer are possible.

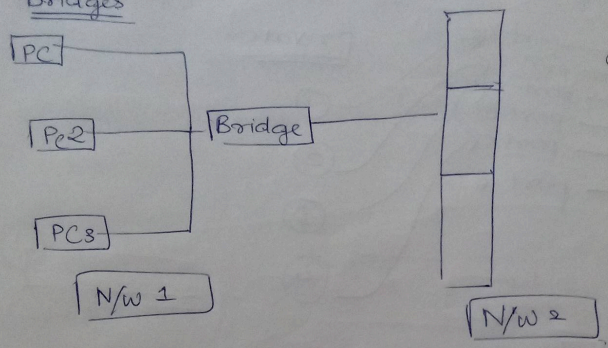


→ copper cable.

→ optic fibre.

③ ⇒ Used to convert networking data format to another.

Bridges



Can transfer 2 data blocks

③ ⇒ Used format

1. Larger n/w into smaller sections.
2. Sitting b/w 2 physical n/w segments & manage the flow of data b/w the 2
3. By using MAC Address.

Types of Bridges

1. Transparent Bridge.
2. Source route Bridge.
3. Translational Bridge

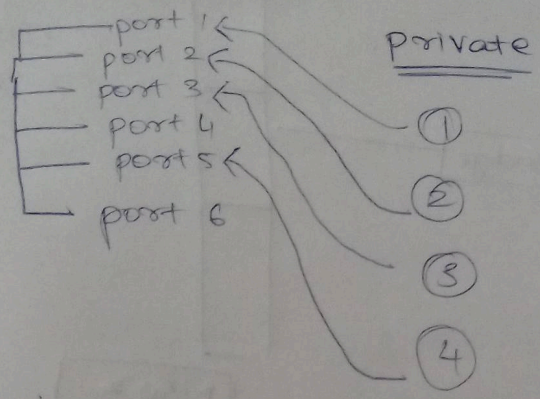
① ⇒ (i) Unaware of its existance

(ii) forward the data based on MAC address.

② ⇒ The entire path the packet is to take through the network is embedded with in the packet.

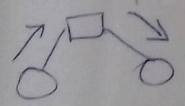
Demerit Loss of data due to excess waiting time.

③ public



Next Class: Interconnections

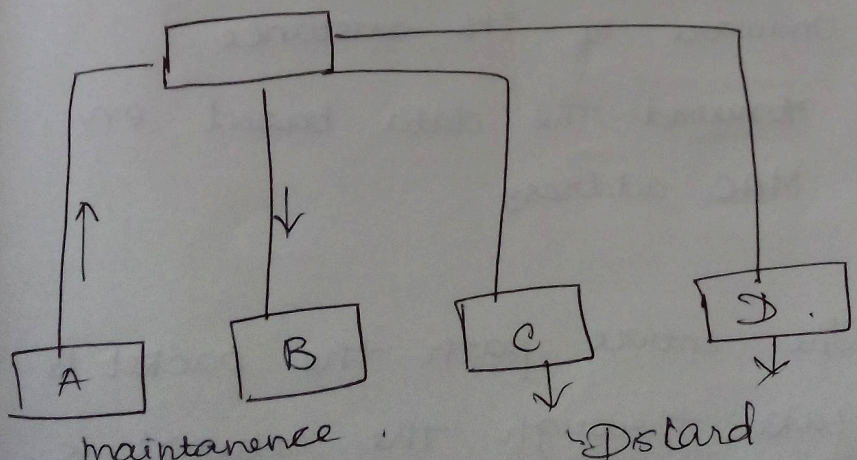
Hubs
→ no knowledge on destination
① Physical Layer (OSI)
→ Data repeater
→ gathers as frames and delivers



Switches
1. Physical Layer
2. Data Link layer

Bridges
1 Physical
2 Data Link

Routers
1. Physical
2 Data Link
3. N/w

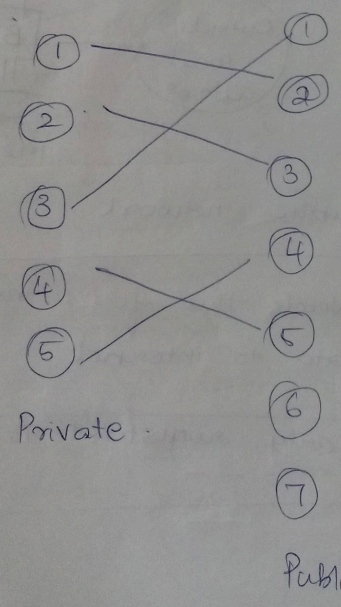


1. Static NAT (Private → Public)
2. Dynamic NAT
3. Port Address Translation (PAT)

(1) 1 Private → Mapped → 1 Public.

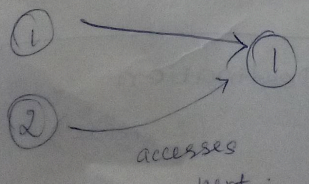
Demerit: Large amount of public address.

(2)



Allocated dynamically. Routing table does that.

Routing table is also updated regularly.



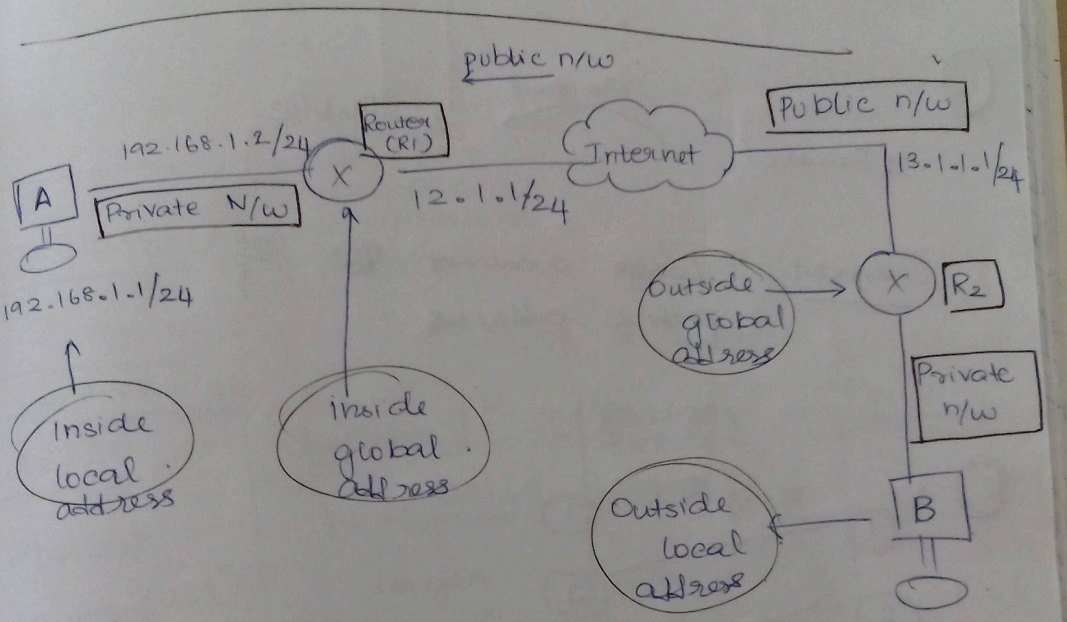
⇒ Sequential access.

Local IP address
Private

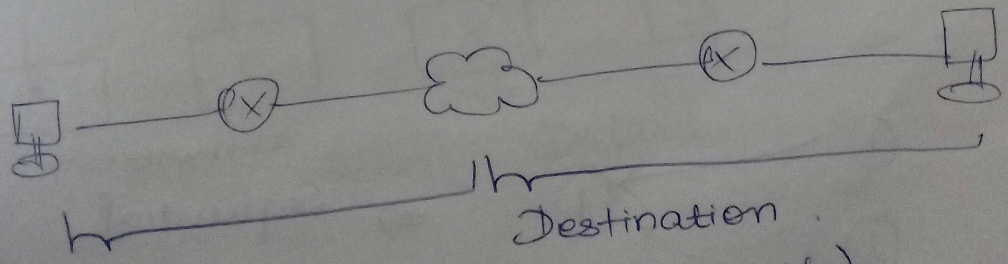
(Mapped) by router using NAT

Public IP address

early registration is must



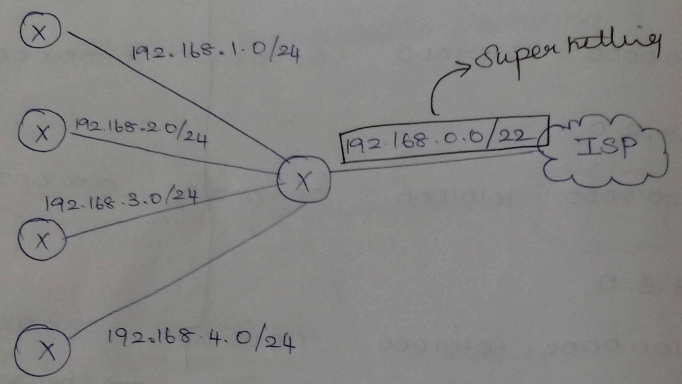
Private network	Public network
Cannot be transferred to net	Needs this for transferring data to internet
Local to system	Early registration



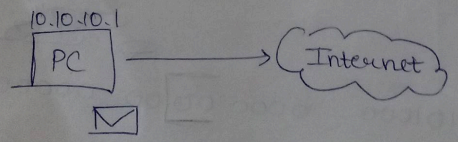
Step 4 New Subnet mask

1111 1111	1111 1111	1111 1100	0000 0000
255	255	252	0

⇒ 255.255.252.0/22



Network Address Translation (NAT)



While transfering data from PC to internet, the same address (10.10.10.1) is not used. Because it is private.

128 64 32 16 8 4 2 1

— — — — — — — —

192
128
64

168
128
40

192.168.0.0

↳ 1100 0000 . 1010 1000 0 0 .

step①

192.188.0.0 ⇒ 11000000 . 10101000 00000000 . 00000000

192.168.1.0

↳ 1100 0000 10101000 00000001 0000 0000

192.168.2.0

↳ 1100 0000 10101000 00000010 0000 0000

192.168.3.0

↳ 1100 0000 10101000 00000011 0000 0000

step②

→ changes.

all equal ←

22 bits

step④

Step ③ ⇒

1100 0000 10101000 0000 0000 00000000

Note

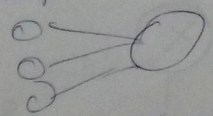
N/w ID:

1100 0000 10101000 00000000 0000 0000

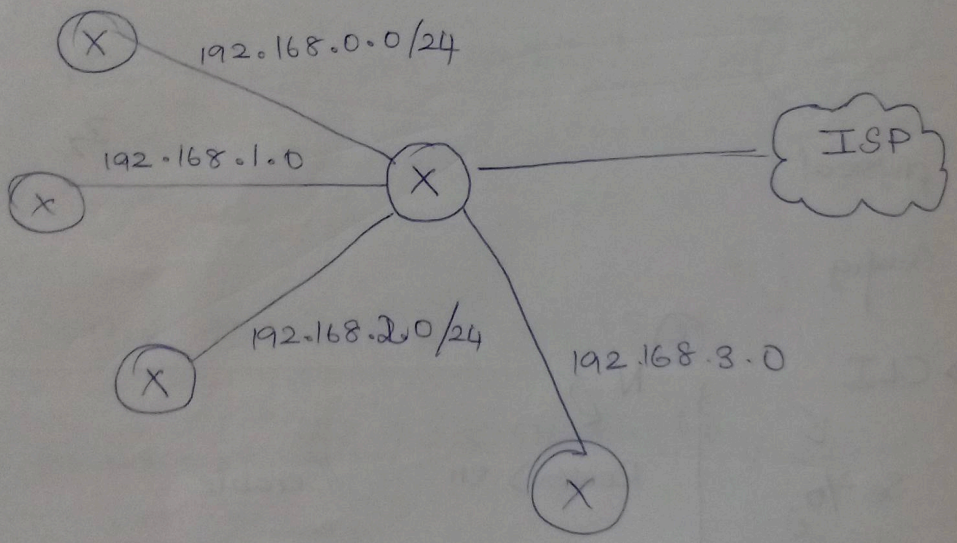
↳ 192.168.0.0 .

Supernetting

1. It is reverse of subnetting
2. Combining multiple networks to single network.



3. Converting from network bits into bit
4. Also known as CIDR (classless interdomain routing)



Step 1: Write all numbers into binary

Step 2: Find matching bits left to right upto match.

Step 3: Write upto match and '0' upto end (net ID).

Step 4: upto match put all '1's (subnet mask

128 64 32 16

192.168.0.0

↳ 1100 00

1010

step ①

192.188.0.0

192.168.1.0

↳ 1100 000

192.168

Step ③ =>

1100 000

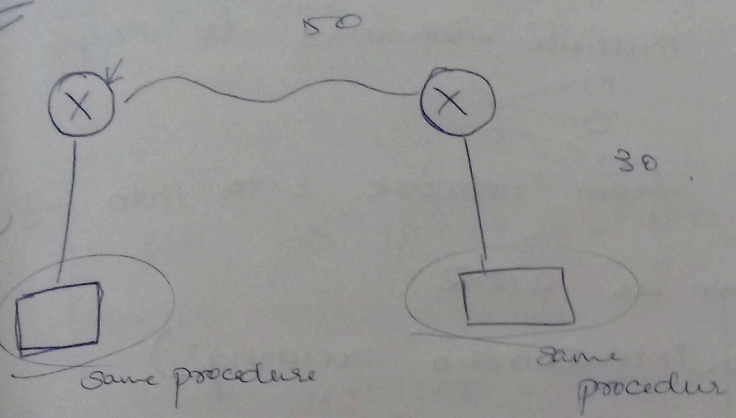
N/w ID:

1100

↳ 192

like this for 4 subnets

Lab



physical

Config

→ CLI

① N

Router> en // enable

Router# Config terminal

Router -Config # interface fa0/0

#ip address 10.10.10.2 (IP) 255.0.0.0 (Subnet)

#no shut // switching on

#exit

② interface Se2/0

ip address 5050.50.1 255.0.0.0

Clock rate 64000

no shut

exit

Router RIP

network 10.10.10.0

network 50.50.50.0

exit

exit

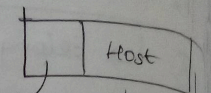
No. of subnets $= 2^n = 2^2 = 4$

No. of Host $= 2^n - 2$

$= 2^6 - 2$

$= 64 - 2$

$= 62$



1st

N/w : 205.150.65.0

Host ID 1 : 205.150.65.1

:

Host ID (last) : 205.150.65.62

Broadcast ID : 205.150.65.63

2nd

N/w : 205.150.66.0

Host ID 1 : 205.150.66.1

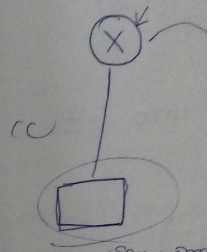
:

last Host ID : 205.150.66.62

Broadcast ID : 205.150.66.63

Like this for

Lab



Same pool

physic

Config

→ Cl

②

Interface address

505

255

Clock rate

no shut

exit

Subnetting example.
(problem)

128 64 32 16 8 4 2 1

1. 205.150.65.0 /26 question

(A) ↳ belongs to Class C.

(a) Subnet Mask

1111 1111 1111 1111 1111 1111 1100 0000

⇒ 255.255.255.192.

(b) Network ID

IP address

	205	.	150	.	65	.	0
IP :	1100 1101		1001 0110		0100 0001		0000 0000
Sub :	1111 1111		1111 1111		1111 1111		1100 0000
logical &	1100 1101		1001 0110		0100 0001		0000 0000

→ This gives Network ID.

⇒ 205.150.65.0

(c) No of Subnets

Subnet mask: 255.255.255.192.

1111 1111 1111 1111 1111 1111 1100 0000

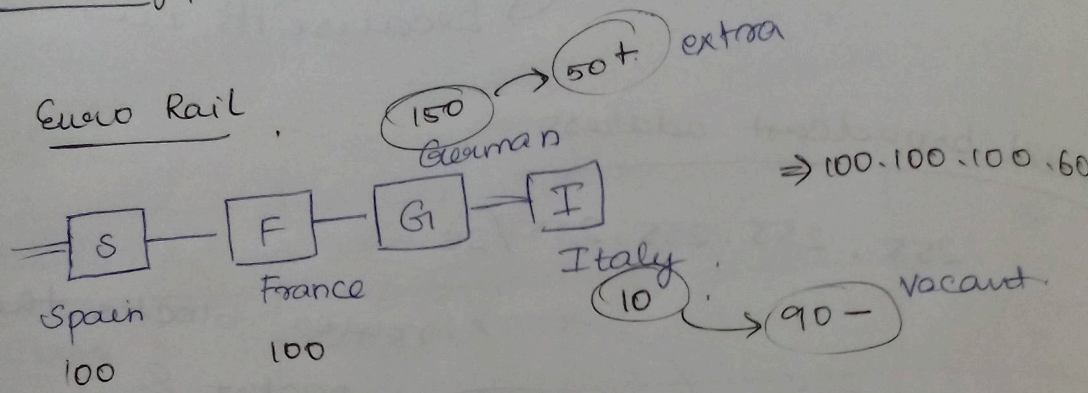
N/w Subnet Host.

Multicast add

224.0.0.0/4

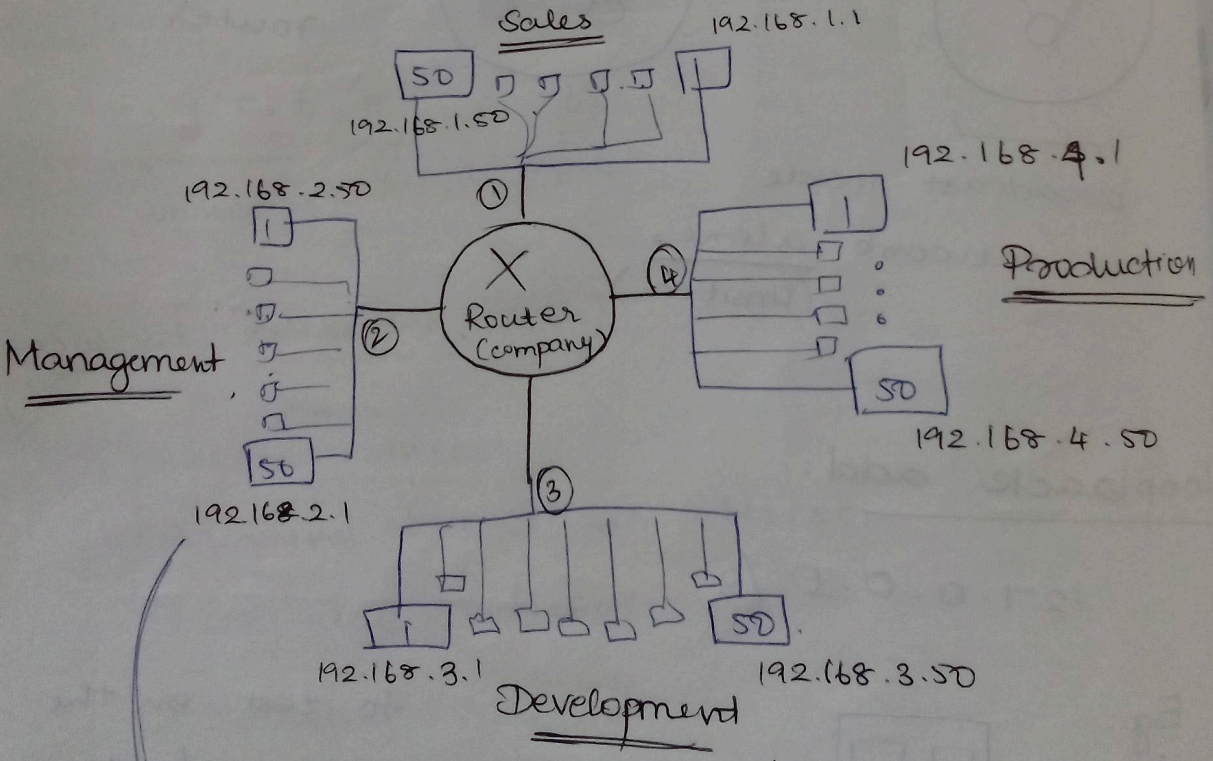
Subnetting.

Euro Rail.



⇒ 100.100.100.60.

→ is a coach that can accomodate 100 people.



192.168. .

N/w Host.

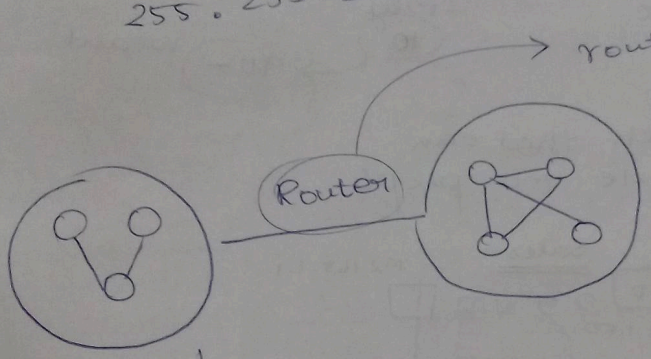
Host Add.

0.0.0.0 /32 → for new host.

When a host needs to send data (datagram) but doesn't knows its address
↳ because it's new

Limited broadcast address

255.255.255.255/32



→ router blocks the packet & it cannot pass the router.

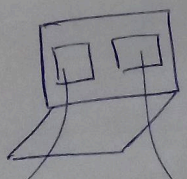
broadcast inside this network alone. (limited).

Loopback add.

127.0.0.0 /8

to test on the same host.

Eg:



client prog

server prog.

Classless Addressing System

CIDR → Protocol in

↳ Classless Inter Domain Routing.

Subnetting

		CIDR
Class A :	255.0.0.0.	/8
Class B :	255.255.0.0.	/16
Class C :	255.255.255.0.0.	/24

x.y.z.t/n

connection — subnet mask.

Special Addresses. (12m)

- ↳ host address
- ↳ Limited broadcast address
- ↳ Loopback address
- ↳ Private address
- ↳ Multicast address

class A $= 2^{31} = 50\%$

class B $2^{30} = 25\%$

class C $2^{29} = 12.5\%$

class D $2^{28} = 6.25\%$

class E $2^{27} = 3.125\%$

} Network Contribution/ distribution

Sums

Which class?

a. 0 0000001 00001011 00001011 11101111

↳ class A

b. 1100 0001 10000011 00011011 11111111

↳ class C

c. 14.23.120.8

↳ Class A.

$(14)_{10} = 0\,0\,0\,0\,1\,1\,1\,0$ (128 64 32 16 8 4 2 1)

d. 252.5.15.111

↳ class E.

$(252)_{10} = 1\,1\,1\,1\,1\,1\,0\,0$ (128 64 32 16 8 4 2 1)

252
128
114
64
50
32
18
16
2

2|252
2|126 — 0
2|63 — 0
2|31 — 1
2|15 — 1
2|7 — 1
2|3 — 1
1 — 1

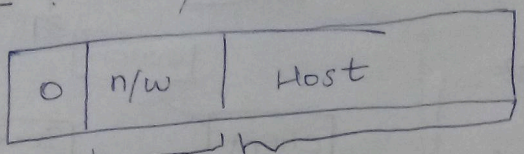
128
64
32
16
240
2

10.

$\Rightarrow (1111\ 1100)_2$.

Identification

Class A



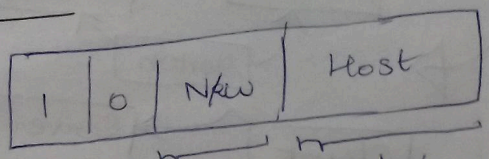
→ can vary from 0-127

0, 127

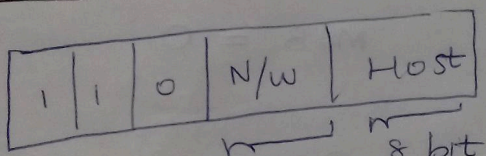
↳ special address

rest 126 are used

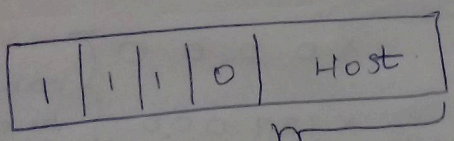
Class B



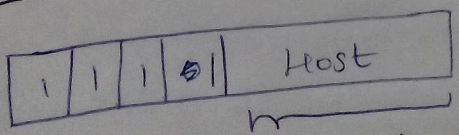
Class C



Class D



class E



class A

class B

class C

class D

class E

Sums

which cl

a. 0

b. 110

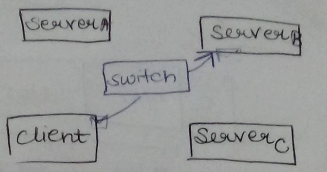
c. 14

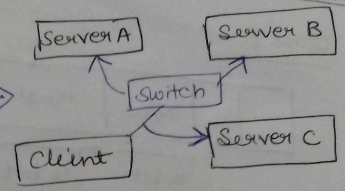
d.

3
2
128
114
64
50
32
18

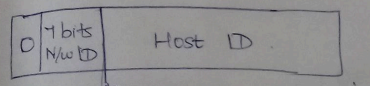
Transmission modes

- Unicast
- Broadcast
- Multicast
  - comb of unicast & broadcast





Class A



N/w → 8 bits

Host → 24 bits

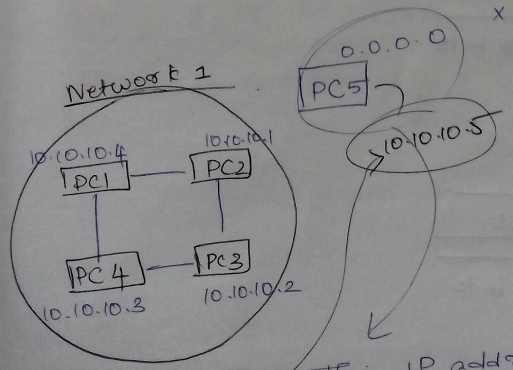
MSB = 0

0 _ _ _ _ _ _ _

1 to 127 N/w can be connected.

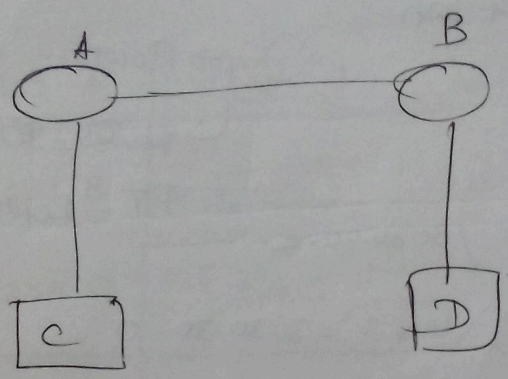
✗ 0.0.0.0 } cannot be used
✗ 127.0.0.0 }

Special address.



DHCP – Dynamic Host Control Protocol

This IP address says that it is a new Host and makes DHCP to allocate a new address



1st transfer will fail
then successful.

AC

IP : 10.10.10.1

Sub : 255.0.0.0

Gateway : 10.10.10.2

BD

IP : 30.30.30.1

Sub : 255.0.0.0

Gateway : 30.30.30.2

A

Static :

30.0.0.0 – Network

50.50.50.2 – Next Hop

255.0.0.0 – Mask

(on)

IP : 10.10.10.2

Sub 255.0.0.0

← Fa0/0 →

50.50.50.1 | IP

255.0.0.0 | Sub

(on)

D

Static

10.0.0.0 – Network

50.50.50.1 – Next Hop

255.0.0.0 – Mask

(on)

IP : 30.30.30.2

Sub 255.0.0.0

← Serial 2/0 →

50.50.50.2 IP

255.0.0.0 Sub

(on)

Class

0 | 7 bits N/w

1 byte

N/w

8 bits

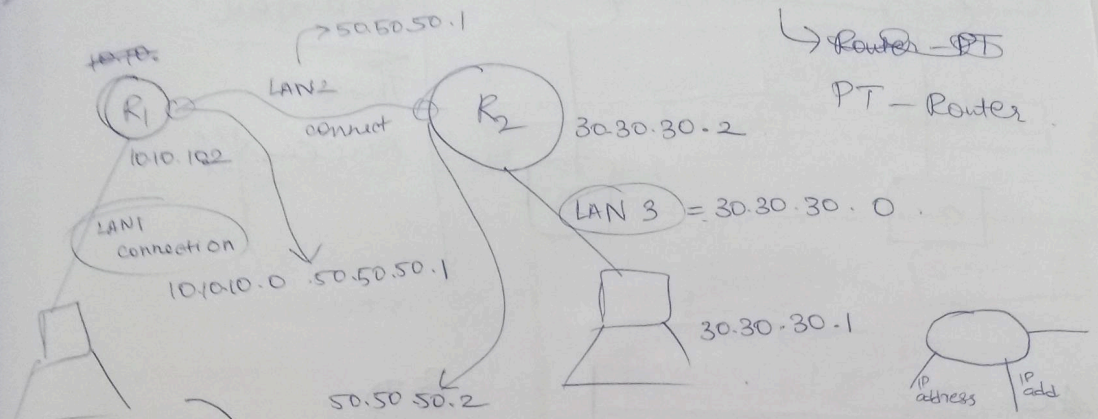
DHCP – Dynamic Host Control Protocol

Exp 7 Router Config ↗ interconnection of Lan

→ Router

↳ ~~Router-PT~~

PT – Router



every port = unique IP address.

Config

IP : 10.10.10.1

Sub Net : 255.255.255.0

gateway : 10.10.10.2

7a0 → switch on

↳ for router

Serial 2/0 ↗ clock rate 64,000

50.50.50.1

Fastthernet

↳

On it

Routing

↳ Static

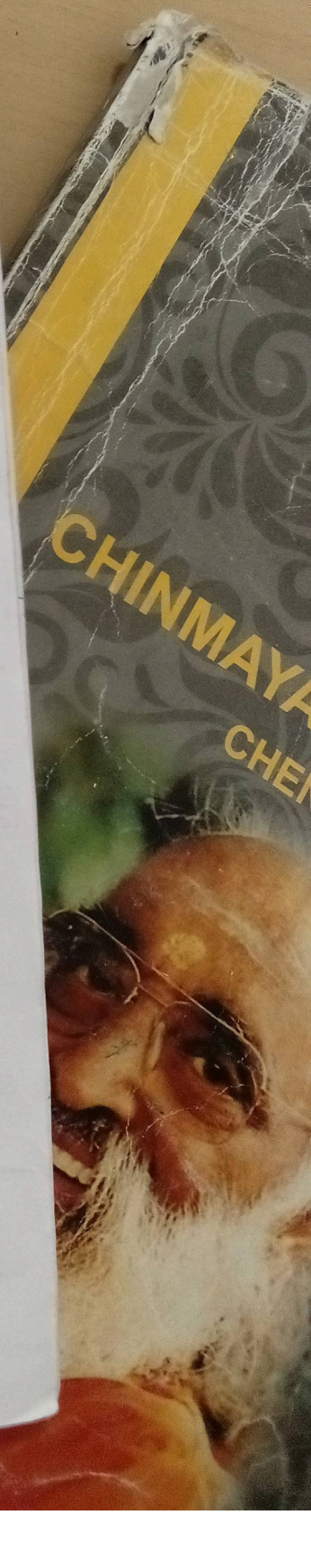
↳ RIP

Network : 30.0.0.0

mask : 255.0.0.0

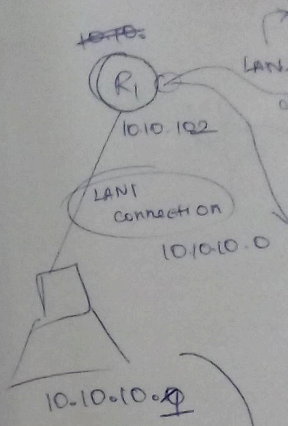
Next Hop : 50.50.50.2

Add ↙ click



Class A	N/W	Host	Host	Host
Class B	N/W	N/W	Host	Host
Class C	N/W	N/W	N/W	Host
Class D	→ Multicast address			
Class E	→ Reserved for future			

EXP 7 Router



Config

IP :
Sub Net :
gateway

Fa0 → su
↳ for ro

Routing

↳ Stati
↳ RIP

Subnet mask :

→ Sub part of Network

→ reducing addressing phase

255.255 . . . → host part alone is assigned.
fixed

Subnet mask hides/masks the network part of a systems IP address and leaves only the host part as the machine identifier.

Classful IP Addressing

10.10.10.1
N/w Host

(OR) 10.10.10.1
N/w Host

How to Know? ⚡ by subnet mask.

Subnet mask:

255.255.255.0
fixed variable

Subnet mask:

255.255.0.0
fixed variable

192.168.1.1/28 → 28 1's are written
IP Address Subnet mask.

16
32
64
128
240

255 . 255 . 255 . 240

1111 1111 1111 1111 1111 1111 1111 0000

only this is variable

IP address → (unique)

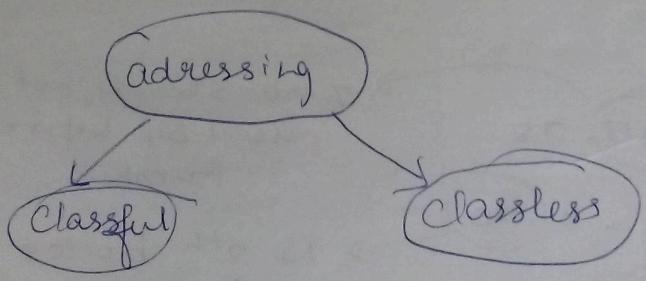
= Network part + Host part . = 4 blocks

Class	Network	Host
A	(1)	(3)
B	(2)	(2)
C	(3)	(1)

10 . 10 . 10 . 1
Network — Host

Protocols

DNS – Domain Name System → can be used instead of IP addresses.



↳ large part of address is wasted on N/w

Subnet mask

↳ Sub
↳ Netw

Subn
part of
only the

Classful

10 . 10 .
N/w

How to

Subn

25

255

1111

(a) 111 . 56 . 45 . 78 ~~128~~ ~~64~~ ~~32~~ ~~16~~ ~~8~~ 4 2 1

0110 1111 / 0011 1000 / 0010 1101 /

0100 1110 .

(b) 221 . 34 . 7 . 82

1101 1101 / 0010 0010 /

0000 0111 / 0101 0010 .

R W

111
64
47
32
15

45
32
13

64 78 56
64 64 32
14 24
16
8

221
128
93

82 64
-64 29
18 16
13

Ans:

111 . 56 . 45 . 78

⇒ 0110 1111 0011 1000 0010 1101 0100 1110 .

221 . 34 . 7 . 82

⇒ 1101 1101 0010 0010 0000 0111 0101 0010 .

Find errors

a) 111 . 56 . 045 . 78 → Zero should not be used by before decimal number .

b) 221 . 34 . 7 . 8 . 20 → No 5th blocks

c) 75 . 45 . 301 . 14 → only within 0 - 255

d) 1110 0010 . 23 . 14 . 67 → Out of bounds .

→ No binary & decimal mixture .

2) $(168)_{10}$ ⟶ binary.

2 | 168
2 | 84 – 0
2 | 42 – 0
2 | 21 – 0
2 | 10 – 1
2 | 5 – 0
2 | 2 – 1
1 – 0

$\Rightarrow (10101000)_2$.

Change the following IPV4 addresses from Binary notation to dotted decimal notation.

(a) 1000 0001 / 0000 1011 / 0000 1011 / 1110 1111

129 . 11 . 11 . 239.

(b) 1100 0001 / 1000 0011 / 0001 1011 / 1111 1111

193 . 131 . 27 . 255.

Chang the following IPV4 address from dotted decimal to binary.

UNIT - II

IPV4 Addressing:

↳ cannot retain / maintain the address for a long time.

32 bits

8 bits (or) 1 byte	8 bits (or) 1 byte	8 bits (or) 1 byte	8 bits (or) 1 byte

Forms

Binary 11000000 . 10101000 . 00001010 . 00000001

Dotted-Decimal 192 . 168 . 10 . 1

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

8
192
-128
64

168
128
40

0000 0000 → 0 min

1111 1111 → 255 max.

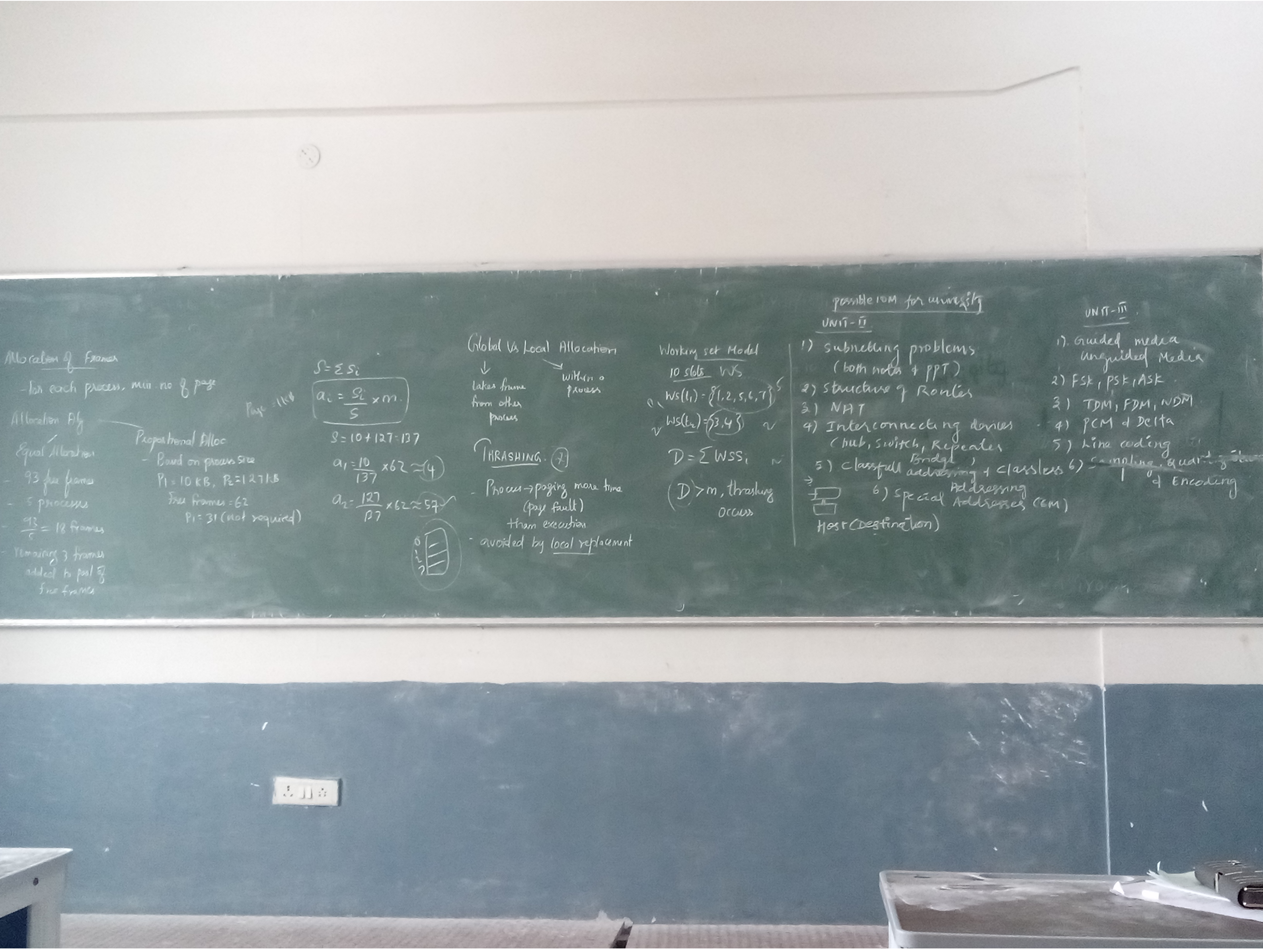
Convert binary to decimal.

1. $(11000000)_2$

128 64

$= 128 + 64 + 0$

$= (192)_{10}$



Allocation of Frames
- for each process, min. no of page
Allocation Alg
Equal Allocation
- 93 free frames
- 5 processes
- 93/5 = 18 frames
- remaining 3 frames added to pool of free frames
Proportional Alloc
- Based on process size
P1 = 10 KB, P2 = 127 KB
Free frames = 62
P1 = 31 (not required)
S = Σ Si
ai = Si / S × m.
S = 10 + 127 = 137
a1 = 10/137 × 62 ≈ 4
a2 = 127/137 × 62 ≈ 57
Global Vs Local Allocation
takes frame from other process
within a process
THRASHING
- Process → paging more time (page fault) than execution
- avoided by local replacement
Working set Model
10 slots WS
WS(t1) = {1,2,5,6,7}
WS(t2) = {3,4}
D = Σ WSSi
D > m, thrashing occurs
possible 10M for university
UNIT-II
1) Subnetting problems (both notes + PPT)
2) Structure of Routers
3) NAT
4) Interconnecting devices (hub, switch, Repeater, Bridge)
5) Classfull addressing + Classless Addressing
6) Special Addresses (6M)
Host (Destination)
UNIT-III
1) Guided media Unguided Media
2) FSK, PSK, ASK
3) TDM, FDM, WDM
4) PCM + Delta
5) Line coding
6) Sampling, Quantizing + Encoding