(b) another way to solve,

$$2^n = 128$$
$$n = \log_2(128)$$
$$= \frac{\ln 128}{\ln(2)} = 7 \text{ bits}$$

(d)

Modulation.

Modulation is a technique. used to send information by modyfying the Characteristic of a basic electromagnetic signal.

basic signal = a carrier signal

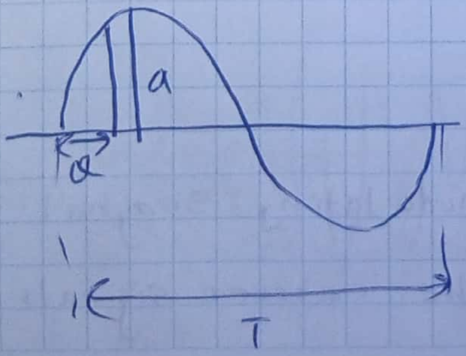
* Characteristic of signals

1. amplitude
2. frequency
3. phase.

signal can reprensent

$$a \sin(\omega t + \theta).$$

a = amplitude.
$\omega = 2\pi f$ $\quad f$ = frequency $\quad \omega$ = angular velocity
θ = phase.



Modulation can be used to.

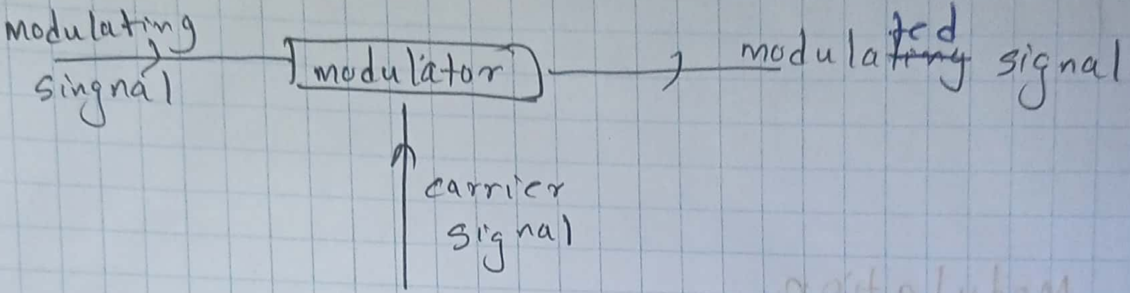
✓ Analog Modem

low frequency analog signal → high frequency analog signar

Or

Digital modem

digital signal → analog signal



- modulating signal - analog signal or a digital signal
  - * if the modulating signal is analog → analog modulating sign~
  - * " " " " " digital → digital modulating
- Carrier signals ⇒ high frequency analog signals
- Modulated signals ⇒ three characteristics of any signals are amplitude, frequency and phase.

Change these ch~stics shape of the input analog or digital signal.

Modulation Method

- * Amplitude Modulation (AM)
- * Frequency " (FM)
- * Phase " (PM)

Amplitud modulation

Carrie ~~varies~~ signal varies of modulating signal

frequency or phase of the carrier signals not changed watch tbute for you can note with ~~im~~ images

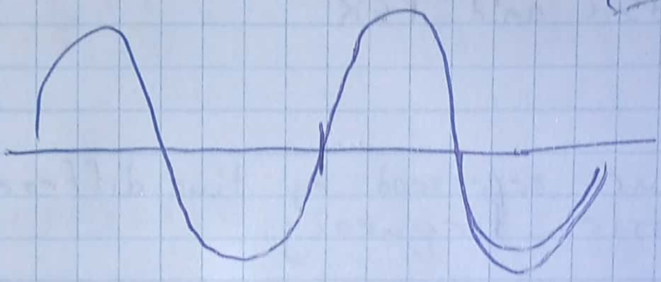
* frequency modulation.

only change frequency of the carrier signal a phase and ~~amtid~~ amplitud not change.

* phase modulation.

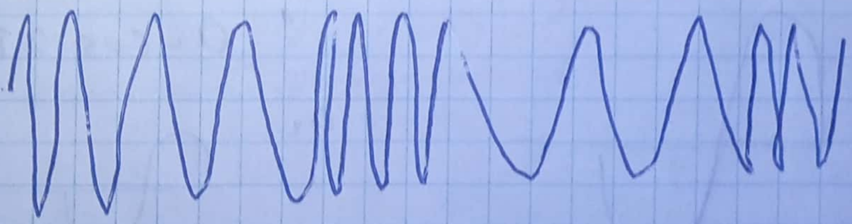
Only change phase of carrier signals.

(1) consider the following waves pattern for the Analog modulation. High frequency signals used as carrier signals for the modulator

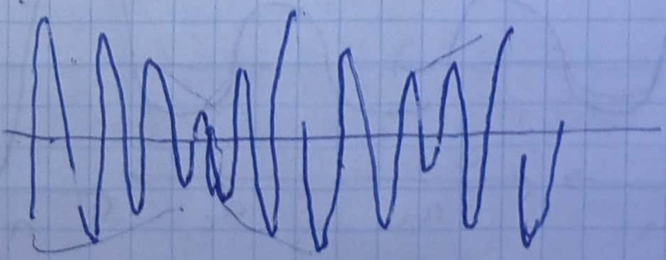


~~Draw~~ waves pattern for,

* ~~i~~ frequency modulation. ($t = 1/5$) [illegible]



*. Amplitude modulation.



Digital Modulation.

$f = \frac{1}{T}$ A

Date: ___/___/___

* { Modulator or demodulator – help for this ~~conve~~ conversion (Digital to analog)

* One or more ~~char~~ characteristics of carrier signal ~~[illegible]~~ involve for that

~~Three~~ 3 technique.

1. Amplitude shift keying (ASK)
2. frequency " " (FSK)
3. Phase " " (PSK)

* Quardrature Amplitue Modulation (QAM) – combine ASK and PSK

ASK

* 2 binary values repersend by two different amplitude of the carrier frequency.

1 0 0 0 1 0 0 1 1 1 1 0 Draw the ASK pattern

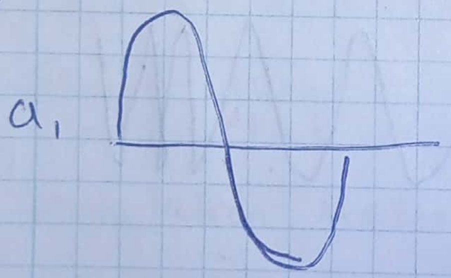
$a_1 = 1$, $a_2 = 0$ (f_c) carrie frequency are same.

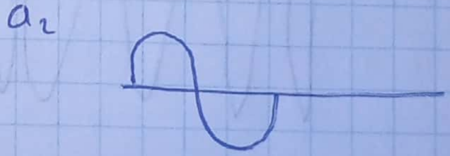
$a_1 > a_2$

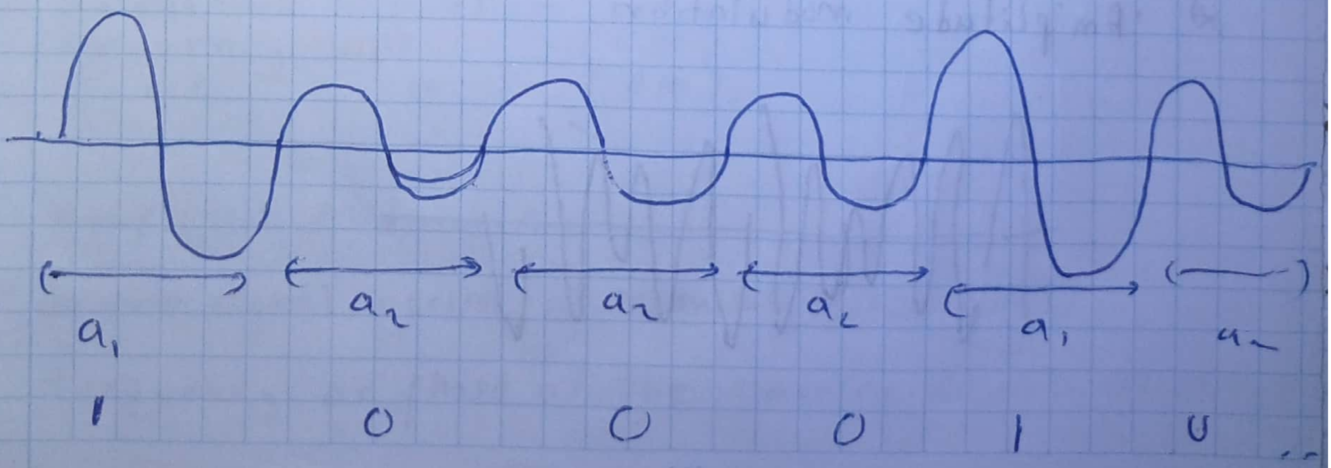
* $a_1 \cos 2\pi f_c t$

* $a_2 \cos 2\pi f_c t$

[illegible] [illegible] function [illegible]







(2) FSK

- 2 binary values are represented by two different frequencies near the carrier frequency.

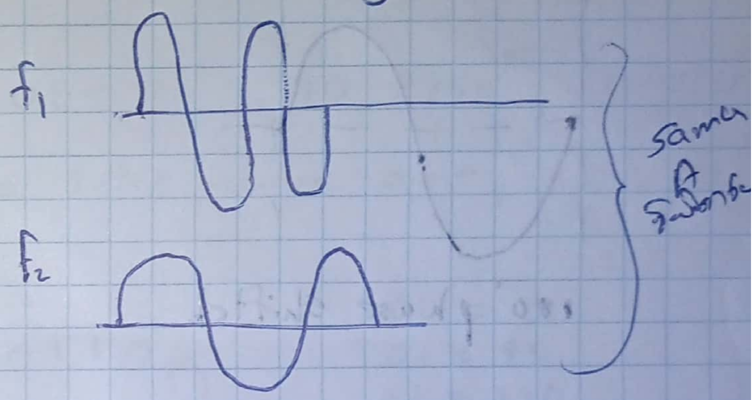
$$s(t) = A\cos 2\pi f_{c_1} t$$
$$s(t) = A\cos 2\pi f_{c_2} t$$

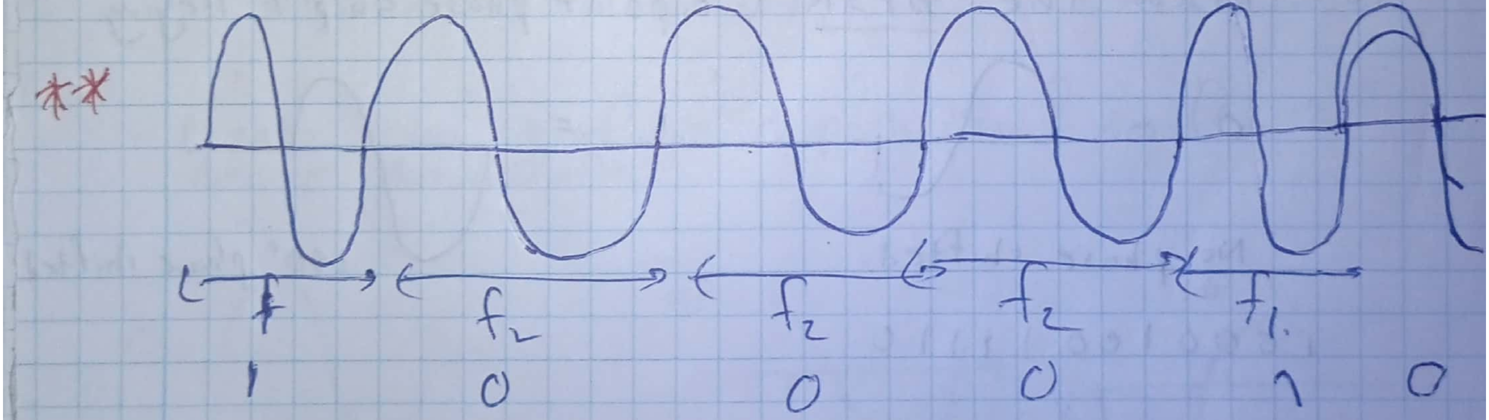
less error than ASK, used higher frequency radio transmission.

- Draw the FSK pattern for following

$f_1 = 1$
$f_2 = 0$

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



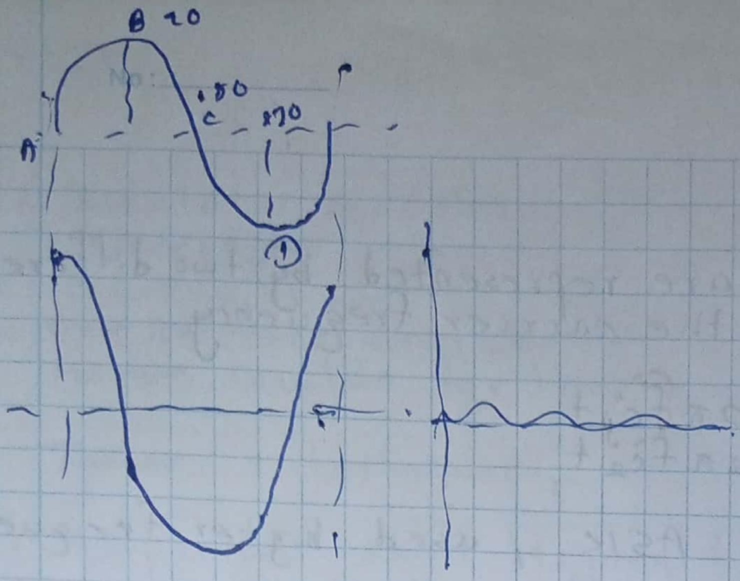


(3) PSK

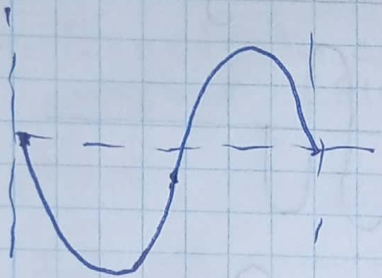
the phase of the carrier signal $_\wedge$ phase is shifted.

$$s(t) = A\cos(2\pi f_c t + \pi) \quad \text{for } 1$$
$$s(t) = A\cos(2\pi f_c t +) \quad \text{for } 0$$

bandwidth - Maximum possible data transfer rate of a network or internet connection



90 phase shifted.



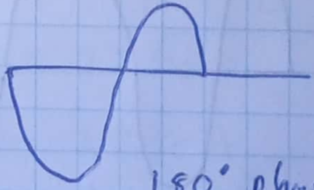
180° phase shifted.

(c) Draw the BPSK (Bipolar phase shipft keying

0 -

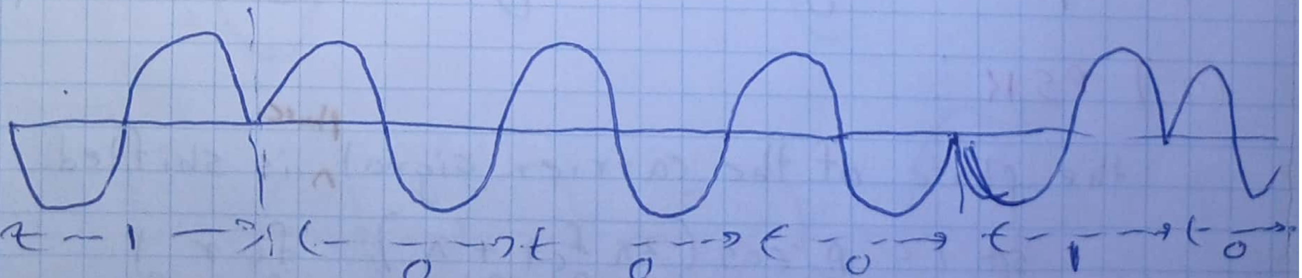
No phase shifted.

1 =



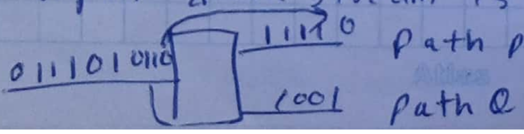
180° phase shifted.

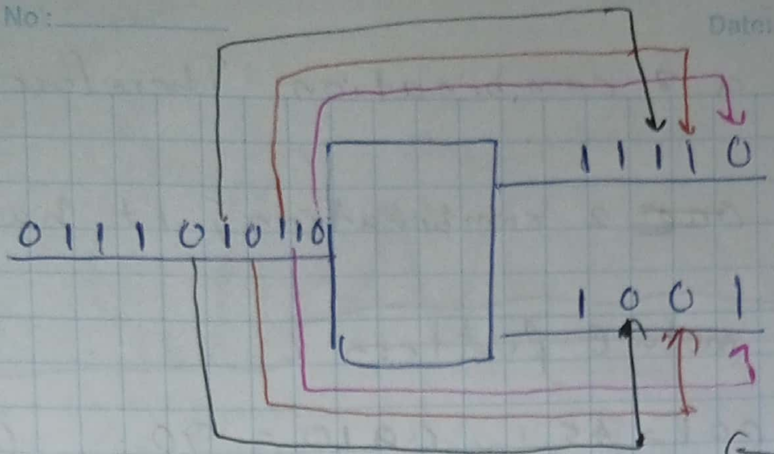
1 0 0 0 1 0 0 1 1 1 1 0



Quadrature Phase Shift keying (QPSK or 4PSK)

first the input data stream is divided into 2 parallel streams





← take like this

~~B~~ BPSK have 2 phases 0 - 0' හා 1-180

QPSK ~~This~~ have,

00 → 0' , 01 - 90° , 10 → 180° , 11-270

first should create 2 like above one,

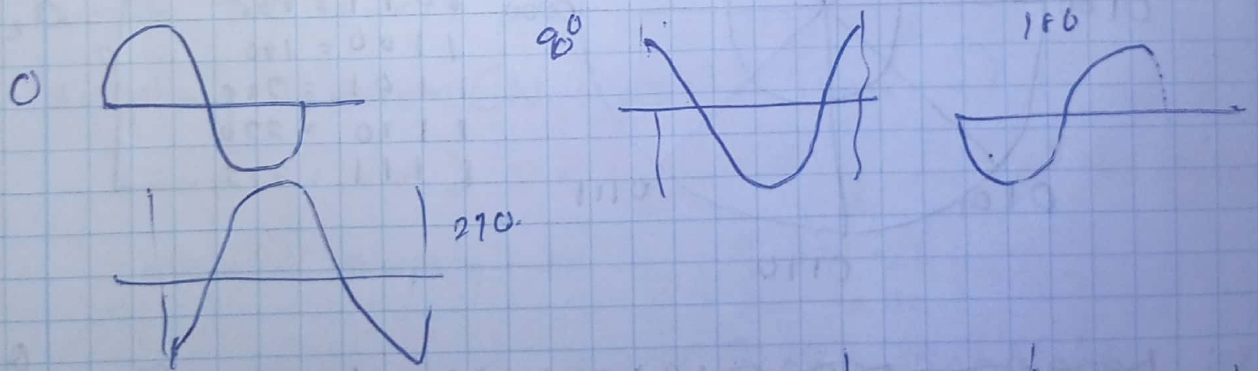
** 100010001110

- P path 000110

Q path 101011

00 = 0
01 = 90
10 = 180
11 = 270

P path එකෙන් 1 ක් සහ Q path එකෙන් එකක් බැගින් ගත්තම degre එක ලැබෙනවා.



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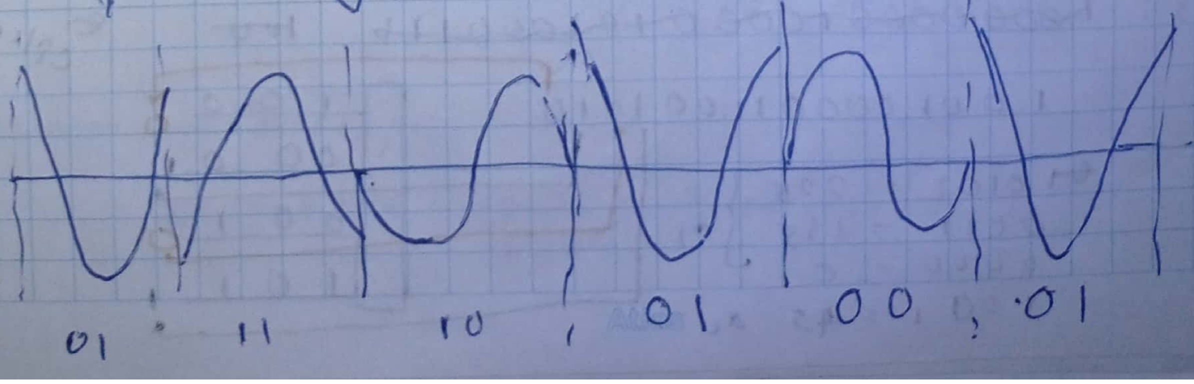


- 4 Psk (Qpsk) has 4 combination so that have 2 bit.
- 8 Psk has a 8 combination Therefore it ha
  3 bit
- BPsk has ~~one~~ 2 combination, it has 1 bit

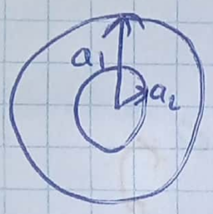
~~draw 8Psk module pattern~~

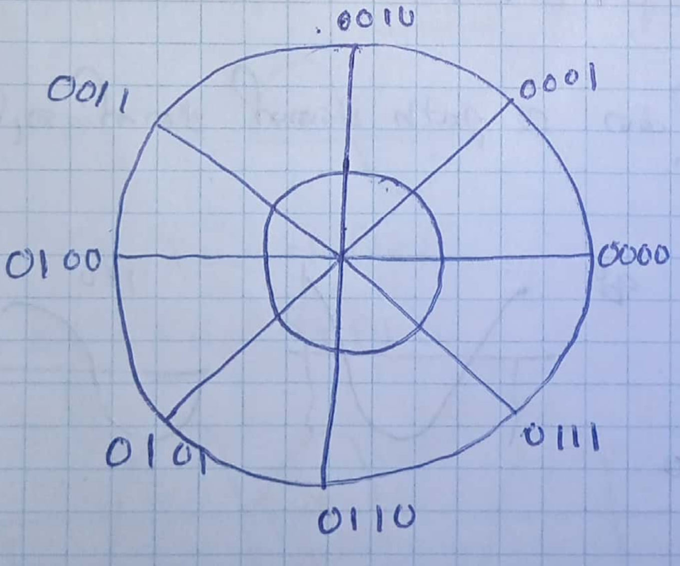
000 = 0
100 = 180,
001 = 45
101 = 225
010 = 90
110 = 270
011 = 135
111 = 315.

we can divide like this.

~~Hybri~~ Hybrid modulation

This is combination of ASK and PSK





0000 = 0
0001 = 45
0010 = 90
0011 = 135
0100 = 180
0101 = 225
0110 = 270
0111 = 315
} a1

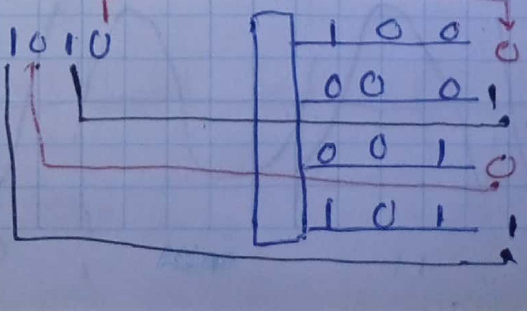
$a_1 > a_2$

1000 = 0
1001 = 45
1010 = 90
1011 = 135
1100 = 180
1101 = 225
1110 = 270
1111 = 315
} a2

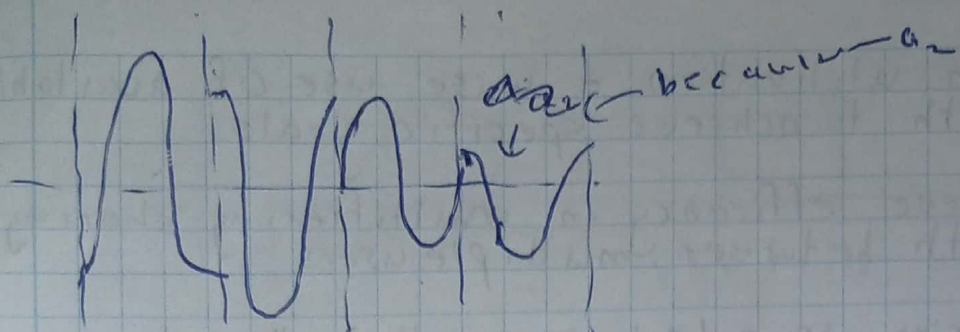
E3:- ~~10000000100000101000111~~ ~~100~~

cilic Qpsk

1 0 01 0000 1100 1010



~~01~~ 0101 = 225
0011 = 135
0000 = 0
} a1
1001 = 45 a2



* when digital signal we can seperate signal and noise.

* Crossover cable - that cables can be used to connect sagma device.

ex. PC to PC
hub to hub
switch to switch

* Straight-through cable - this cables can be used to connect different device.

ex :- PC to hub
PC to switc

~~what is nois~~

* In PCM process the bandwi~~dth~~dth of the analog signal is 22 - 25 kHz and samples are quantized with 700 levels

Sampling Theorem (Nyquist's Theorem)

Sampling rate ⩾ 2 × highest frequency of the signal

minimum sampling rate = 2 × 25kHz
= 50 kHz
= 50,000 samples /s

Minimum ~~levels~~ bit rate., 700 level in there.,

2^{10} →

bit rate = $\frac{50000}{10 b}$ = 5000kb/s

Multiplexing

- Bandwidth utilization - wise use of available bandwidth to achieve specific goals

- Can achieve efficency in multiflexing sharing bandwidth between multiple users

- Multiplexing is a technique. that allows the transmission of multiple signals across a signal data link

Category of the multiflexing.

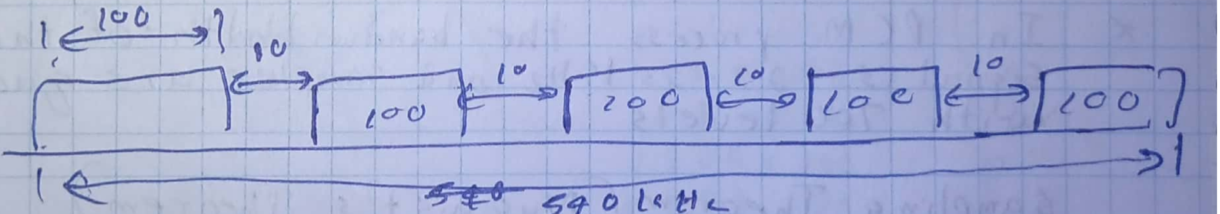
(1) frequency - division multiplexing (Analog).

(2) Wavelength - division Multiplexing (Analog).

(3) Time - division multiplexing (Digital)

Frequency - division multiplexing (FDM)

① 5 channels, each with 100 kHz bandwidth, are to be ~~fr~~ multiplexed together. What is the minimum bandwidth of the link if there is a need for a guard band of 10 kHz between the channels to prevent interference.



we need at least 4 guard bands.

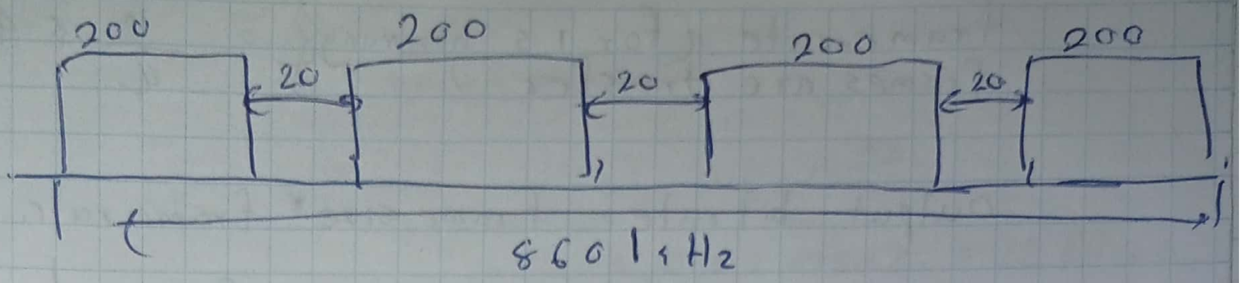
$\therefore \quad 5 \times 100 + 10 \times 4 = 540 \text{ kHz}$

② A frequency division multiplexer is combined for 4 channels and each contains 200 kHz bandwidth, it required 20 kHz guard band to prevent interference.

(i) Draw the output bandwidth in a frequency domain

(ii) What is the minimum bandwidth of the output domain.

(i)



(ii) minimum ~~an~~ bandwidth = $200 \times 4 + 20 \times 3 = 860$ kHz

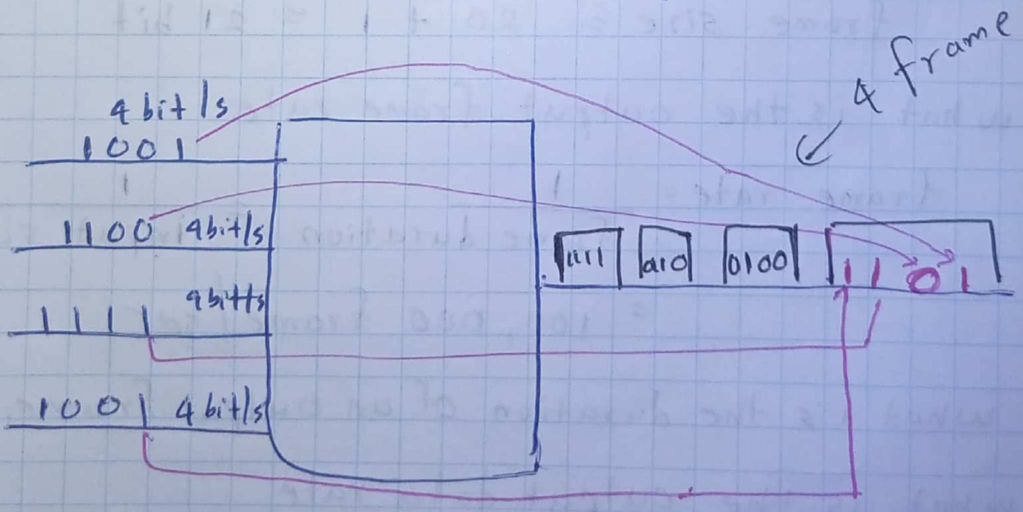
Time Division Multiplexing (TDM)

* TDM is a digital multiplexing technique, combine several low rate digital channels ~~to~~ into high rate one.

FDM that operate all the signals at the same time with difference frequency.

this (TDM) one is operating all the different f single at different time.

*. in synchronous TDM - the data rat is n time faster, the unit duration n times shorter



$1\,s \rightarrow 4$ bit   fram size = 4bit

1 bit $\rightarrow \frac{1}{4}\,s$ frame duration = $\frac{1}{4}\,s$

$\therefore$ bit duration = $\frac{1}{4}\,s$ //

frame.rate. (for 1 s how many frames are transfer) $= \frac{h}{4}$ 4 frams/s

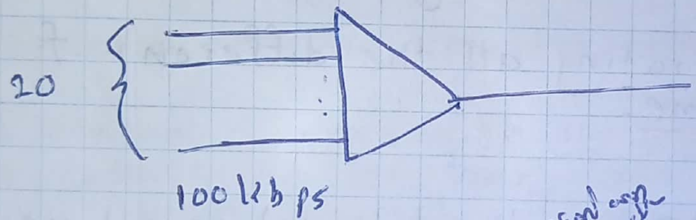
output bitrate = frame size * frame rate.

= 4 bit × 4 frames/s ← channel [illegible] send

= 16 bits/s

② Synchronous TDM and combine 20 digital source. each of 100kbps. Eeach output slot carries 1 bit from each digital sources, but one extra bit is added to each frame for synchronization.

(a) What is the size of an output frame in bits.



frame size = 20 + 1 = 21 bit

← 20 [illegible]
← extra [illegible]

(b) what is the output frame rate.

$$\text{frame rate} = \frac{1}{\text{frame duration}} = \frac{1}{\text{Input slot duration}}$$

= 100,000 frame/sec.

(c) what is the duration of an output frame.

(d) what is the output data rate

(e) what is the efficieny of the system (ratio of useful bits to the total bits)

(c) frame duration $= \frac{1}{\text{frame rate.}}$

$= \frac{1}{100000} = 0.01 \times 10^{-3}$

$= 0.01$ msec. $= 10$ M sec

(d) Output data rate = frame rate × frame size.

$= 100 \times 10^{3} \times 21$

$=$ 2100 kbps $=$ 2.1 Mbps

(e) efficency $= \frac{\text{useful bits}}{\text{total}\overset{\text{seat}}{\wedge}\text{bits}} = \frac{20}{21} = 0.9523$

20 bit of each frame is useful
21 bit one actually seat per fram

percentage $= 0.9523 \times 100$

$=$ 95.23%. of the seat dato ~~of~~ is useful

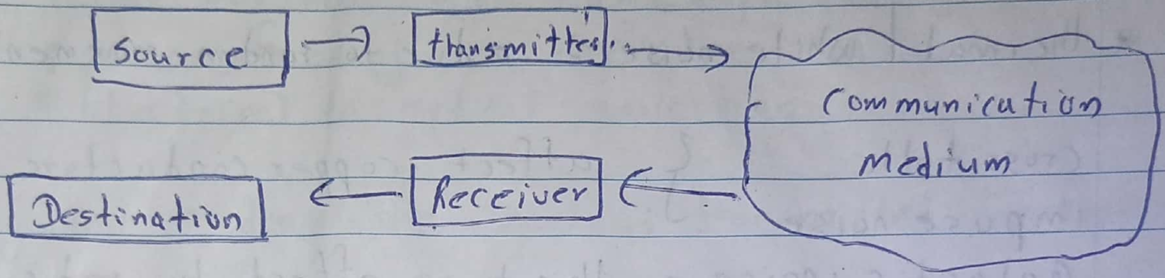
Networking

No :.............................   Date:............/......./.......

~~Source - simple data comunication media.~~

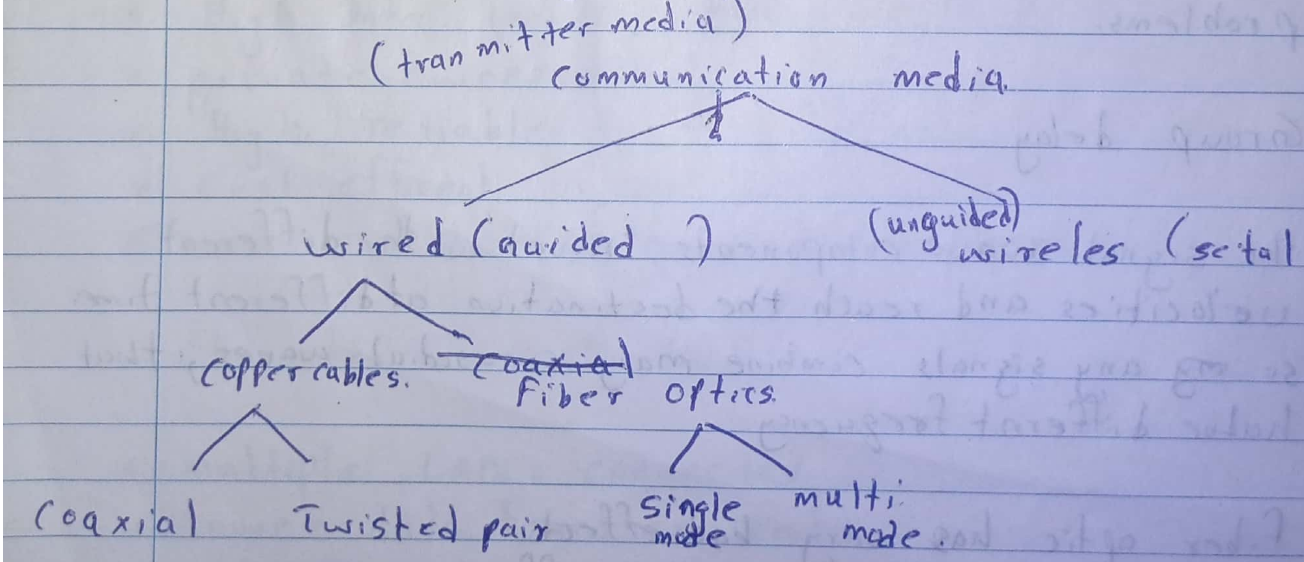
* Source is where the data is originated. (computer, telephone handset, video, camera)

Simply data communication system.



* transmitter ~~is~~ such as modem, it conver data to signal. (signal sent by transmitter)

* Communication medium - signal can be sent reciver through the communication medium.



* Receive - they recieves the signals and convert it back to the data before forwading destination.

* Destination :- that is where the data is absorbed. (computer, system, telephone handset, ...)

The major problems is any transmission

1. Noise. -
2. Attenuation
3. Group delay.
4. Interference.

Noise. - unwanted electrical signals (voltage or curren)

* thermal | white noise → due to random movement of electro

cross talk }
impuse noise } affect copper conductors

Galactic noise - this type affect by radio signals.

2 Attenuation - signal strength can reduces when it travel through the media.

copper, fiber and radia waven can have attenuation problems.

(3) Group delay

the signal wave components travel with different velocities and reach the destination at different time.

{so ~~my~~ any signals combine many sinusodial waves, that halve differnt freqeuncy

fiber optic has very bad effect
radio waves has considerable effect.
copper cables ~~dictego~~ can avoid.

(4) Interference. - many frequencies transmitted through the free space. (Radio signals, copper cable can occure, Fiber optics does not occure.

Guided media - it is a point to point communication. the signals can be transmitted without changing frequency

Function of LTE

- * Line coding.
- * Add overhead bits for supervisory purposes.
- * power feeding for repeaters.
- * Electrical to optical conversion

unguided media - The signals is transmitted into free space.

*. Standalone computer - A computer that is not connected to a network

Characteristics of LAN.

- *. High Data Transfer rate.
- *. private ownership
- *. High reliable.
- *. Cost efficent
- * users can shares file and peripherals

Characteristics of WAN.

- *. multiple LANs connected.
- * Lower data transfer rate
- *. public and private ownership.
- *. support various media
- *. use routers and switches.

*. Client server network has a central computer that provide services tto the rest of the network shared resources such as file, application, the or data and respond to client

peer to peer network is decenterlized network, it has ~~same~~ equal status for all the device, directly communicate and share with other peers in the network

- * it hasn't central server.
- * each device can act as client and server.
- * direct communicat and resource sharaing device.

Benifits of that

- * reducing the risk of a single point of failure.
- * it has a simple easy setup.
- * No need expensive hardware.
- * efficent resource utilization.

Router - forwards data packets along a network

Power ratio (Normally measured (dB))

* signal of power P_1 and another signal of power P_2

$$\text{Power ratio} = P_1 / P_2$$
$$= \log (P_1 / P_2) \text{ Bell}$$
$$= 10 \log (P_1 / P_2) \text{ dB.}$$

$$\therefore \boxed{\text{Power ratio} = 10 \log (P_1 / P_2) \text{ dB}}$$

$$\boxed{\text{Quality of } \overset{\text{Signal}}{\cancel{\text{ratio}}} = S / N}$$

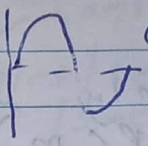
① Singnal has 100mw power, noice power - 1mw. siggnal to noise ratiun.

Singal noise rati

$$\rightarrow SNR = \frac{100\ mw}{1\ mw} = 100$$

$$SNR\ in\ dB = 10 \log 10(100) = 20dB$$

*. Sinusoidal signal


← sin curve.

Basic characteristies of a sinusoidal signal.

*. Amplitude (විස්තාරය)
*. frequency (සංඛ්‍යාතය).
* phase.

$$\boxed{f = \frac{1}{T}}$$

$$velocity\ (v) = \frac{\lambda}{T}$$

$$\boxed{v = f\lambda}$$

② signal has fundemental frequency of 1000 Hz, what is its period.

$$T = 1/F$$

$$T = \frac{1}{10^3}$$

$$T = 10^{-3}\ s$$ //

③. what is the wave length of a signal, with 100 MHz frequency velocity of free space.

travel free space.

$$v = f\lambda$$

$$3 \times 10^8 = 10^5 \times \lambda$$

$$\lambda = 3 \times 10^3\ m$$

Hz

speed of radio signal is 3×10^8, wave length is 3m
what is frequency.

$$v = f\lambda$$
$$3 \times 10^8 = f \times 3$$
$$f = 10^8$$

How to convert analog signal to a digital signal

*. most commonly used method is Pulse code Modulation (PCM). all voice telephone channel Is use

There are 3 step this method.
(i) sampling
(ii) Quantizing
(iii) Encoding

- sampling - the samples of an analog signal are taken.

* sampled signal is calle "pulse amplitude modulated signal"

- Quantizing - sample divided many discrete level, that & each sample. numbered corresponding level

- Encoding - After quantizing the corresponding letvel that represent in some manner.

ex- level is 50,

Decimal - 50
Hexa - 32
octal - 62
binary = 110010

we can decided How many quantizing levels are required

* The standard number of levels 256.

$2^8 = 256$.

in order to represent 256 level, 8 bits are required, each pulse is encoded to 8 bits.

1 sample = 8 bits.

sampaling rate.

signal = 8000 samples/sec.

= 8000 × 8 bit/sec

= 64000 bit/sec

= 64 kb/s.

∴ bit rate of a digital telephone channel is 64 kb/s

First calculat sampaling rate.

sampaling rate ≥ 2 × highest frequency.

* highes frequency telephone chamel is 3.4 kHz.

∴ sampaling rate ≥ 2 × 3.4

≥ 6.8 kHz

Actual rate is 6.8 kHz but we get 8 kHz is selected.

An analog signal is sampled at a rate of 8000 sanpers per second.

Digitization is conversion of analog data into digital data.

~~pcm~~ PCM tutorial ——

① Bandwith (w) = 4.5 MHz

As per (Nyquist rate) ~~sampling rate f_s~~ f_s = 2w

= 9 MHz

$\frac{120}{100} \times$

But f_s should be 20% higher than Nyquist rate }

$$\therefore f_s = \frac{120}{100} \times 9 = 10.8 \text{ MHz}$$

$$Q = 2^n$$

$$1024 = 2^n$$

$$n = 10$$

System bit rate $= n f_s$

$= 10 \times 10.8$ MHz

② 7 bit encoder.

bit rate = 50 Mbit/s.

bit rate = $n f_s$

$$50 = 7 f_s$$

$$\frac{50}{7} \text{ MHz} = f_s.$$

$\therefore$ maxium bandwith $= \frac{50}{7} \times \frac{1}{2}$ $\leftarrow \left(\frac{f_s}{2} \right)$

$$BW = \frac{25}{7} \text{ MHz}$$

Problem 01 (***)

(a) Nyquist rate = ~~ban~~ maxium bandwith × 2

$= 10 \times 2$ MHz

$= 20$ MHz

(b) Sample are encoded = 128 Level.

$\therefore$ no of binary pulse (bits) required $= 2^7$
N $= 7$ bit

c. system bit rate $= f_s \times N$

$= 7 \times 2$ MHz

$= 14$ ~~b~~ megabit/s

Subnetting - එක ජාලයක් කුඩා කුඩා උප ජාලවල බෙදාහැරීම.

Subnet mask - network එකට තියෙන maximum value එකක් වගේ.

Subnet mask is 32 bit number that use in computer networking, divide ip address into network and hosts.

Class C -> 195. 45. 10. 210 <- subnet 4 කට කඩනවනම්,

Network = 24+2 = 26
Host = 6 bit
= $2^6 - 2$

① What is the principal difference between connectionless Communication and Connection oriented communication.

Connection-oriented	connectionless
there is a prior setup	there is no prior setup
statefful ~~(Packet is transmitted without establishing a dedicate connection)~~	stateless (Connection state ·
has higher overhead.	low overhead.
more reliable.	less reliable.

② Discuss the advantages and 2 disadvantages of having international standard for network protocol.

Advantage ->
- * when everyone follow standard, then they can intelerconnect easially.
- * A common benchmark for other to build upon

Disadvantage ->
- * Standard has been adopted world wide, It woul be dificult to modify.
- * Every standard has its own ~~inherent~~ limitation
- * lesser focus new development & technique.

128
69
32
229

frame duration = $\frac{1}{\text{fram rate.}}$
input slot duration.

① No of needed usable hosts 25
Network address 172.50.0.0.

(1) Class → B
(2) Default subnet mask = 255.255.0.0
(3) Custom subnet mask = 255.255.255.224

32 → 2^5 → 11100000

Total no of subnets = 8+3 = 11 ∴ 2^{11}

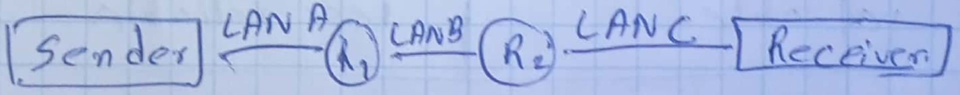
(4) Total No of hosts addresses : 2^5 = 32

(5) usable = $2^5 - 2$ = 32 − 2 = 30 //

(6) No of bits borrowed = 11 ← subnet වලට bit ගාන

(7) What is 2nd subnet range?
වෙනස් 32 න් 32 ගානේ ~
1st → 172.50.0.0 to 172.50.0.31
2nd → 172.50.0.32 to 172.50.0.63

3rd Question IP Protocol



please follows

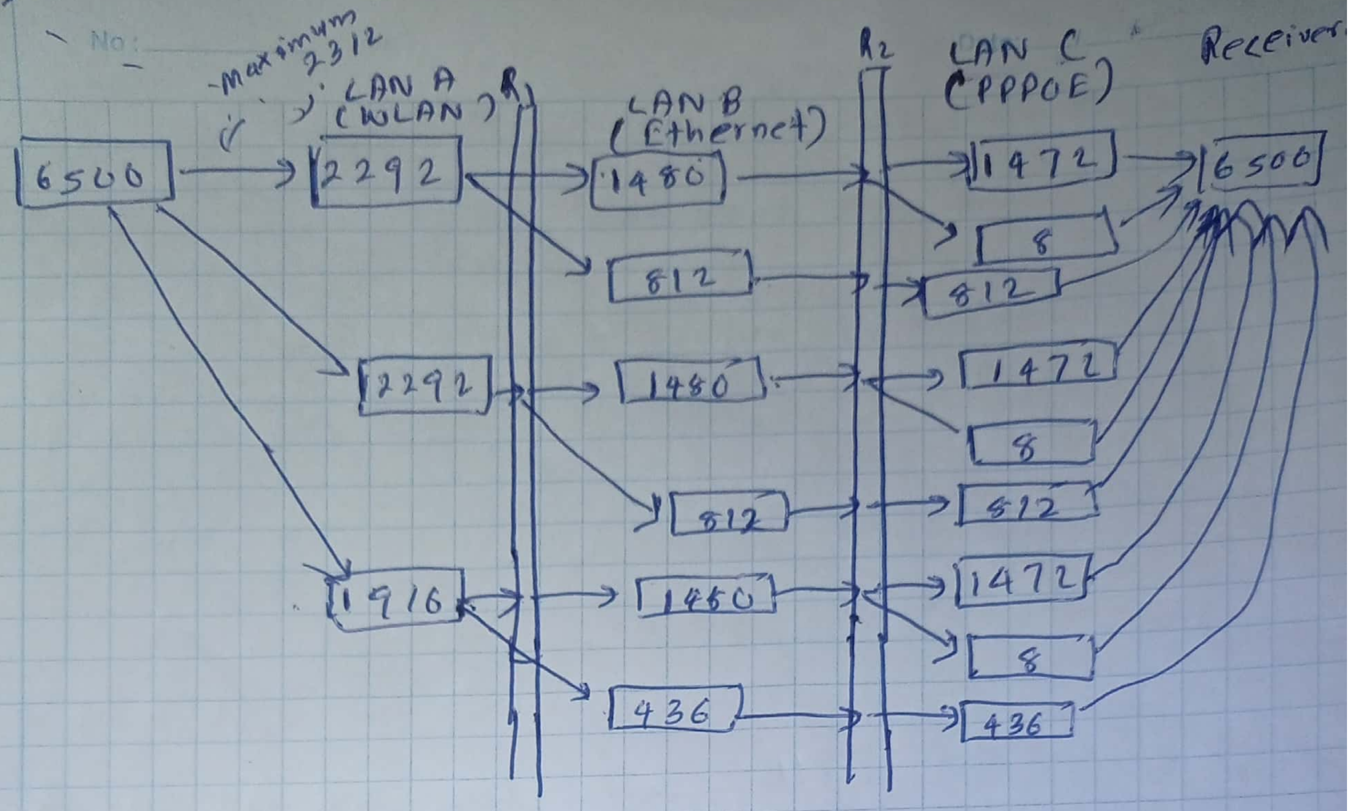
6500 bytes Payload need to be transmitted via the IP Protocol.

	LAN A	LAN B	LAN C
Network te-	WLAN	Ethernet	PPPoE
MTU (byte)	2312	1500	1492
IP header (")	20	20	20
Max. payload (byte)	2292	1480	1472

WLAN Max → 2312, එකෙන් 20ක් අඩු කරාම 2292, ඊට පස්සේ [illegible] ඉතුරු [illegible] ඒකයි. 3 පාර [illegible] තියෙනවා
* [illegible]

12-20

No:



Root bridge → අඩුම priority එක, සමාන වුනොත් අඩුම mac address එක (මෙහි ~~3~~ hexa decimal value එක සලකන්නේ.)

Root ports → root bridge එකට තියෙන lowest cost පාරවල් (අදාළ bridge එකේ ඉඳන් වෙන වෙන බලන්නේ) (හැබැයි දෙකක් තියෙන පාරවල් වල cost එක සමාන වුනොත් lowest port id එක තියෙන එක root ~~bridg~~ port එක වෙනවා.

cost එක බලනකොට දීල තියෙනවා.

Fa port → 19 cost
G'0 → port → 4 cost ලෙස සලකයි.

designated port → හැම bridge එකකම designated port එකක් තියෙනවා (මෙහිදී හැම priority එකේ ඉඳලා අඩු priority ~~එකක්~~ තමයි සලකන්නේ) අඩුම lowest priority එක තියෙන ~~එක~~ ~~des~~ bridge එක ඇතිවෙ තියෙන port එක designated port වෙනවා ∴ තමයි. root bridge එකේ හැම port එකක්ම designated bridge වෙනවා.

root ports සහ designate Ports වලට සෑ ඉතිරි ඒවා, block ports