Select → [+] Application Supported profiles

Program steps

Program ①

Step ① : In the object pallet choose client - server [eth4 - slip4 - multihomed - client] 3 nodes

Step ② : Application config, Profile config

Step ③ : Choose ethernet cable with the 10base T cable make the connection of client server of 3 nodes.

Step ④ : Application config → Edit attributes → App" def " → rows → 1 → Name : video → Description : → video conferencing : High resultion video, apply the changes and save.

Step ⑤ : Profile config → rows → 1 → Profile Name : video p → Applications → rows → 1 → In the row → name : video → start time off set : constant (1) → Repeatibility → Inter - repeatation time → exponential (1) → repetation patter → Concurrent, Start time → Constant (1) → Repeatibility → Inter - repetition time → constant (1) → number repetition → exponential (0.1) repetition patter → concurrent

Step ⑥ : Right click : Select similar do → again " " → Edit att = "

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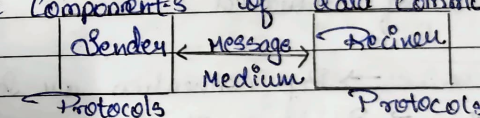
Data Communication and Networking

* Data communication is the exchange of the data between two devices by some form of transtion medium such as wired cable or electromagnetic waves.
→ The effectiveness data communication system depends on four fundamentals
① Delivery
② Accuracy
③ Timelines
④ Jitter - It is the delay between the Packets ~~btw~~ of messages
Delay is b/w the sender & reciver

* Five Components of data communication



* Protocols and Standards
It consist of set of rule that governs data communication. It determines
1] What is communicated
2] How it is communicated
3] When it is communicated

Any IP domain which does not uses internet

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* The key elements of a protocol are

1) Syntax → Structure or format of data (Text, image, audio, video etc)
   . Syntax indicates how to read the bits
2) Symmantics of protocols.
   a) Interprets the meaning of ~~of~~ bits in reciver side
   b) Knows which field defines what action.
   c) Timming determines when data should be sent and what. At what speed the data should be sent

* Standards

Categories of standard

① Defact → By convention or by fact
2) Dejure → By law or by government
   1) ISO [international standard organization] to ~~ftow~~ follow the standard for international transaction
   2) ITCU [international telecommunication union]
   3) IEEE [institute of ~~Eleter~~ Electrical and Electronic Engg]
   4) ANSI [American National Standard Institution]
   5) EIA [Electronics Industry association]
   6) TIA [Telecommunication Industry association]

VoLTE [voice over long Term]

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* Different types of Data representation

1) Text
2) Image
3) Audio
4) Video
5) Number

1) Simplex Single message at a single time. It is One way

Keyboard & monitor

Sender —message→ Recive

2) Half Duplex One message at a time one message sent after that reply is sent

Sender ⇄ Reciver (message →, ← Reply)

3) Full Duplex Both way messages Eg: call

Sender ⟷ Reciver (message)

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* Networks

A network is the interconnection of a set of devices capable of communication. Here in this definition a device can be a host [or an end system as it is sometimes called] such as a large computer, desktop, laptop, mobile workstations, or security system

⇒ The network criteria is
1) Performance ~~reliability~~
2) Reliability - frequency of failure & time taken to recover the failure
3) Security Shouldn't be able to breach from any system
1) Performance
a) Transmit time How fast we send (Speed)
b) Response time how fast it responds
c) Number of users Everyone can access, so [all users]
Support for hardware & software should support all type of systems

* Physical Structure
1) Point to Point connection : A point to point connection provides a dedicated link b/w two devices. The Entire capacity of the link is reserved for transmission between those two devices.

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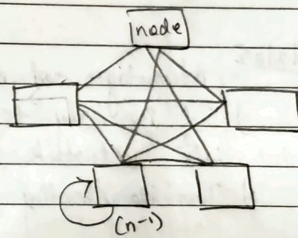
2) Multi point : A multi point or also called as multi drop connection is one in which more than two specific devices share a single link.

→ The term physical topology refers to the way in which a network is lead out physically. Two or more devices connect to a link or two or more links form a topology

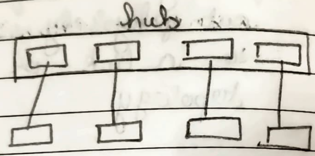
1) Mesh type
At any given time a node will receiving or sending by (n-1) node.



• Advantages
1) The use of dedicated links guarantees that each connection can carry its own data load (doesn't get divided)
2) Mesh topology is robust (Easy to replace the defective wire)
3) High privacy and security
4) Troubleshooting is Easy
5) Isolation of failure network is Easy

- Disadvantages
1) Installation and reconnection are difficult
2) Costly bcz of maintaing reduntit links
3) The hardware required to connection link is prohebtidly expensive
4) Difficult in reconfiguration

2) Star Topology
Individual connection

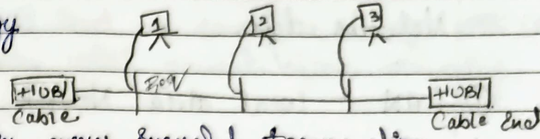


11/3/25
- Advantages of star topology
1) It is easy to modify and add new nodes to the a network
2) Trouble shooting ~~is~~ techiques are easy
Easy installation

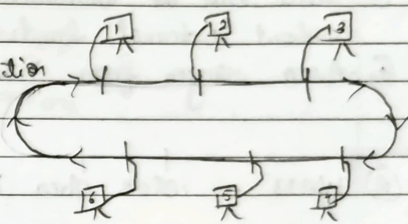
- Disadvantages
1) If the hub goes down, then the whole system is dead
2) Each device requires its own cable segment
3) Installation can be moderately difficult

3) Bus Topology

Transaction closure after every successful transcation.



4) Ring Topology
No backward transaction
It permous in cyclic manner



- Advantages
1) Cable failure is easily identified
2) Every node is given Equal access to the total no one node can monopolize the network
[It avoids starvation & dead lock].

- Disadvantages
1) Adding or removing the nodes disrupts the network.
2) It is ~~diff~~ difficult to troubleshoot the ring network.
3) Cost of cable is more in ring network

* Networks types.

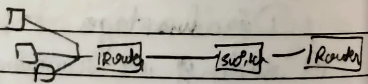
① LAN - Local Area Network

Features
① Data can be transmitted at a speed of 10 Gbps without external bandwidth or service provider
② Area ranges from >1 meter to $\overset{<}{>} 2$ km
(less than) (less than)

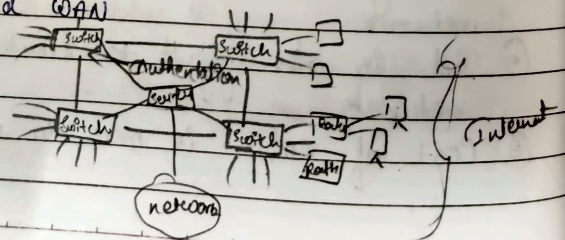
② WAN - Wide Area Network.

③ MAN - Metro

WAN is also interconnection of devices is capable of communication however a WAN has a vital geographical span, spanning a town a state a country or even the world. There are two types of WAN
a) Point - to point WAN



b) Switched WAN



At the switch level we can have a firewall (or) authentication which prevents from accessing the data.

Network Models
OSI Model - 5
1) Physical layer
2) Data link layer
3) Networking layer - Internet.
4) Transport layer
5) Application layer

Application	Data
Transport	TCP payload
DLL	IP payload
Physical	HTTPS payload
Encryption	Data payload

1 ↑ Decryption ↑ 2

Application & Transport layer are End to End rest 3 are ~~opt opt~~ hop - to - hop. They need certain boost after it reaches its limits to transfer the data.

TCP → transfer control protocols.

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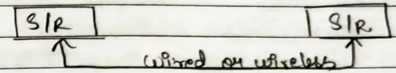
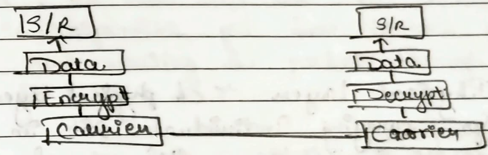
Network Models.

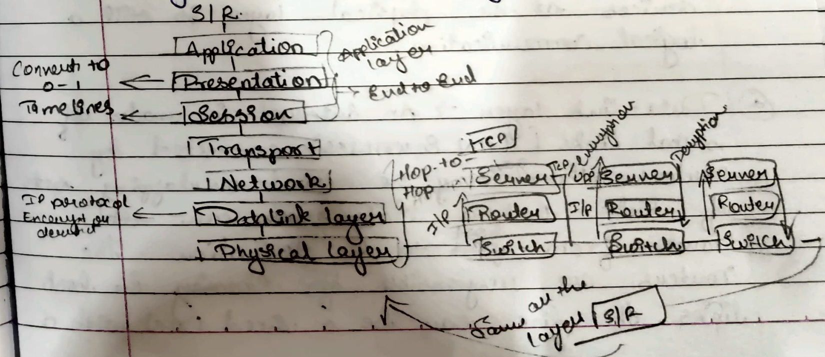
① Single layer Protocol



② Three layer Protocol



③ 7 layers of OSI (Open system interconnection) model



The I/P TCP & MAC address changes according to the systems

Data	Layer	
Data	Application	End-to-End
HTTPS | Data	Transport	Packets
TCP | HTTP | Data	Network	Datagrams — Hop-to-Hop
I/P | TCP | HTTP | Data	DLL	frames
MAC | IP | TCP | HTTP | Data	Payload / Physical layer	Also called as Bits, there-fore is in bits

① Physical layer → ~~A~~ physical layer is responsible for carrying individual bit in a frame across the links. Although the physical layer is the lowest layer in the TCP, IP protocol but the communication b/w the two devices at the physical layer is still a logical communication.

② Data-link layer → ~~A~~ An Internet is made of serval links (LAN & WAN's) connected by routers, there may be serval overlapping sets of links that a data gram can ~~set~~ travel from ~~post~~ host to the destination. The routers are responsible for choosing the best links. The line can be a wired (LAN) with a link layered switch or a wireless LAN. The data link layer takes a data gram and encapsulates it in a packet called a frame.

③ Network layer → ~~A~~ network layer is responsible for ~~eo~~ creating a connection b/w the source computer & the destination computer. The communication at the network layer is host-to-host. We can say that the network ~~is~~ layer is responsible for host-to-host communication and routing the packets through possible routers.

④ Transport layer → It is also called as end-to-end connection and is also ~~to~~ to called as logical connection.

FTP → File Transfer protocol.
Transmission control Protocol - TCP
IP - Internet Protocol
UDP → user data protocol.

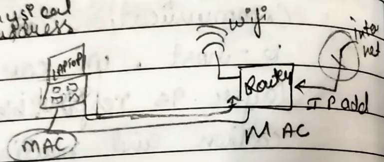
TCP/IP protocol ~~suitesuit~~

MAC
1A:2C:4B:5E:9F

4 Layers.

192.168.0.1 — IP
Port add act as

SMTP/HTTPS/DNS/FTP 1) Application layer → Specific address
TCP/UDP 2) Transport layer - Port address (last no of IP is port add)
IP/ARP/ICMP 3) Internet layer - logical/Virtual address
wifi/Ethernet 4) link layer → Physical address



Addressing :

MAC add is physical add.

ARP → address resolution Protocol
ICMP → Internet Control message protocol
HTTPS → Hyper text transfer Protocol Secured

14-18 June.

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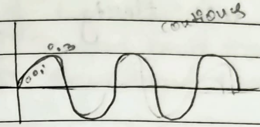
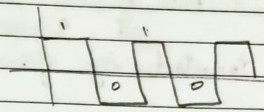
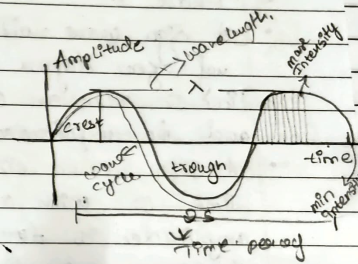
Unit - 2

Analog	Discrete
1) Analog signal's are contionus and	Discrete signals are
2) Analog signal uses contionus value for representing the info^nt	It uses discrete values for representing the info
3) Analog signals can be affected by noise during transmission	Discrete signal's cannot be affected by noise
4) Accuracy of the analog signals is affected by the noise	whereas in the discrete signal's are immune to noise
5) Devices which are using analog signals are less flexible	whereas discretee signals are flexible.
6) Analog signals consumes less bandwidth.	whereas discrete signal's signals consumes more bandwidth.
7) Analog signals are stored in a contionus wave form.	Discrete signals are stored in a :
8) Analog signals have low cost of trans-mission	Discrete signals have high cost of transmisson
8) Analog signals are portable.	Discrete signals are not portable.
9) Analog gives obser-vation error	It does not given any observational error





* Analog signals



1) Amplitude → x_0
   SI unit → (meters) m
   Ex → 10cm → height
   x_0 = 0.1 m

2) Wavelength. → Distance b/w 2 succesive crests is wavelength.
   Denoted by → λ
   SI unit → M (meters)

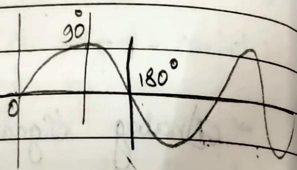
3) Time period - If one cycle complete with how much time taken is
   Denoted by → T
   SI unit → S (seconds)

* Wavecycle → One successful or a complete wave is called a wavecycle. (one crest & one trough)

* Frequecy : No of waves per second is frequecy. $f = \frac{1}{T}$, SI unit Hertz.

denoted by f.

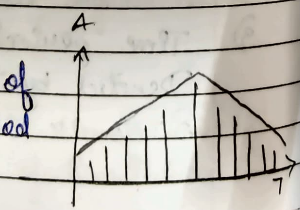
* Phase :



- A sign wave with a phase of zero degree starts at time 0 with an 0 amplitude and the amplitude is increasing.
- A sign wave with a phase of 90° starts at a time 0 with a peak amplitude and the amplitude is ~~too~~ decreasing
- A sign wave of with a phase of 180° ~~deg~~ starts at a time 0 with a 0 amplitude and the amplitude is still decreasing it goes in -ve manner

Band width

Bandwidth is the amount of data transfered in given period of time. It is shown in units.



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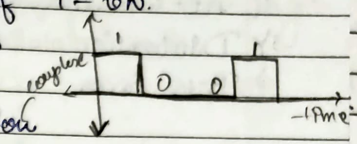
Digital Signals.

The discrete value of of the signals in the (0 & 1) 0 - off 1 - on.

From there is two ways of transmission.

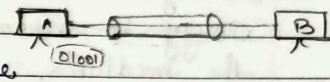


① Broad band transmission

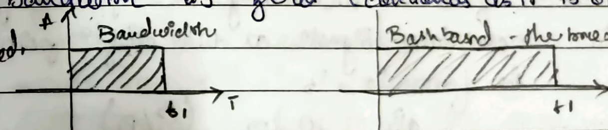
② Base band transmission - simple.

① Base band Transmission →

Transmission of data without converting the signals from digital to analog signals. Here bandwidth is zero (contineus as it is 010100) —.

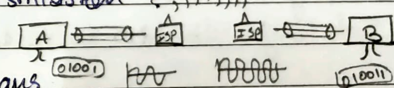


Can increase the band width and has high speed.

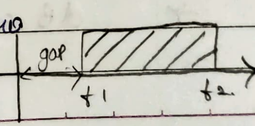


② Broad Band Transmission →

→ The Broad band or modulation means changing the digital siagnals to analog signals for transmission



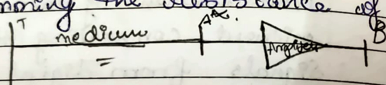
→ Modulation allows us to use band pass channel. It is a channel with a band width that does not starts from zero



~~Imp~~ Transmission Impairments

1) Noise
2) Attenuation
3) Distortion
4) Bits Error → digital signals

2) Attenuation means a loss of signal or energy when a signal, simple or composite travels through a medium it looses some of its energy in overcoming the resistance of the medium.



dB = If at all measuring the power of 2 signals or same signals at two diff^n points then the formula is

$$dB = 10 \log_{10} (P_2/P_1) \text{ — Power}$$

$$dB = 20 \log_{10} \left(\frac{V_2}{V_1}\right) \text{ — voltages}$$

(1) Suppose a signal travels through a transmission medium and its power is reduced to one-half. In this case the attenuation can be calculated as?

→ $dB = 10 \log_{10} \left(\frac{P_2}{P_1}\right)$ → $P_2 = \frac{1}{2} P_1$

$$10 \log_{10} \left(\frac{0.5 P_1}{P_1}\right) = 10 \log_{10} 0.5$$

$$= -3.01\, dB$$

(2) A signal travels through an amplifier and an ~~signal~~ its power increase by 10 times. In this case the amplification ~~and~~ or gain of power can be calculated as?

→ $db = 10 \log_{10} \left(\frac{P_2}{P_1}\right)$ $P_2 = 10 P_1$

$$= 10 \log_{10} \left(\frac{10 P_1}{P_1}\right)$$

$$= 10 \log_{10} (10)$$

$$= 10\, dB.$$

3) Distortion

→ Distortion means that the signal changes its form or shape

→ Distortion can occour in a composite signal made of diff^n frequencies.

→ Each signal component has its own propagation speed through a medium and therefore its own delay in arriving at the final destination

4) Noise

→ Noise is another cause of impairment Several type of noise such as

1) Thermal noise
2) Induced noise
3) Cross talk
4) Impulse noise.

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They corrupt the signals.
Signal to noise ratio (SNR) → defined as:

$$SNR = \frac{\text{Average signal power}}{\text{Average Noise Power}}$$

① Calculate SNR and SNRdB for the given signal which is transmitting at 10 mini watts of power and which is affected by 1 micro watt noise

→ $SNR = \frac{10 \times 10^{-3} \text{ watt}}{1 \times 10^{-6} \text{ w}} = 10^{+4}$ w

$SNRdb = 10 \log_{10} \left(\frac{P_2}{P_1}\right) \rightarrow SNR$

$= 10 \log_{10} (10^4)$

$= 10 \times 4$

$= 40$ db.

1/01/25

② The noise of a channel is absoulte zero and the signal strength is 10 mega watt. Find the SNR db.

→ $SNR_{DB} = 10 \log_{10} (SNR)$

$SNR = \frac{10 \text{ MW}}{0} = \infty$

$= \log_{10} \infty$

$= \infty$ " It cannot be achived

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Digital signals and its parameters.

1) The data rate depends on 3 factors

a) Bandwidth of channel
b) Signal level – Always in 2^n
c) Signal quality (level of noise)

Level of noise are:
- Noise less channel
- Noisy channel

Noiseless → Channel is also called as Nyquist bit rate.
For a noise less channel the nyquist bit rate formula defines the theoritical maximum bit rate

Bit rate $= 2 \times BW \times \log_2 L$

Bandwidth; signal level (always in 2^n)

① Bandwidth of 3000 htz transmitting a signal with two signal level. Calculate the maximum bit rate.

→ Bit rate $= 2 \times BW \times \log_2 L$

$= 2 \times 3 \times 10^3 \times \log_2 2$

$= 2 \times 3 \times 10^3 \times 1$

$= 6$ Kbps

BW = 3

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(2) Consider the same noise channel transmitting 4 signal level. Calculate the maximum bit rate.

→ $\text{Bit rate} = 2 \times BW \times \log_2 L$

$= 2 \times \cancel{10^3} \times 10^3 \times \log_2 4$

$= 2 \times \cancel{100} \; 3 \times 10^3 \times 2$

$= 12 \text{ Kbps}.$

(3) we need to send 265 kbps over a noise less channel with a bw of 20 khz. How many signal level do we need.

→ $\text{Transmission bit rate} = 265 \times 10^3$

$\text{Bit rate} = 2 \times BW \times \log_2 L$

$265 \times 10^3 = 2 \times 20 \times 10^3 \times \log_2 L$

$\log_2 L = \dfrac{265 \times \cancel{10^3}}{40 \times \cancel{10^3}} = 6.625$

$L = 2^{6.625}$

$= 98.76$

$2^6 = 64$

$2^7 = 128$

$280 \times 10^3 \quad 2^7$

$240 \times 10^3 - 6.26$

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Noisy channel it is called as channel capacity.

$\text{Capacity} = \cancel{BW \times [1 + SNR]}$

$BW \times \log_{10} [1 + SNR]$

(1) Consider a Externally noisy channel in which the value of the signal to noise ratio is almost zero. In other words the noise is so strong that the signal is faint calculate the capacity.

→ $\text{Capacity} = BW \times \log_2 (1 + SNR)$

$= BW \times \log_2 (1 + 0)$

$= BW \times \log_{10}(0)$

$= 0$

(2) BW of 3000 hz assigned to a telephone line. the signal to nois ratio usually 3162 calculate the channel capacity

→ $\text{Capacity} = BW \times \log_2 (1 + SNR)$

$= 3000 \times \log_2 (1 + 3162)$

$= 3000 \times \log_2 (3163)$

$= 3000 \times 11.622$

$= 34 \text{ Kbps}.$

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③ The signal to noise ratio is often given in decibles. the SNRdb = 36 and the channel bw is 2 Mhertz. Calculate the theoretical channel capacity.

Sol $SNR_{db} = 10\log_{10} SNR$

$\frac{36}{10} = 3.6 = \log_{10} SNR$

$SNR = 10^{3.6}$

$= 3981$

$\text{Capacity} = BW \times \log_2 (1+SNR)$

$= 2 \times 10^6 \times \log_2 (1+3981)$

$= 2 \times 10^6 \times 11.95$

$= 23$ Mbps

24 round off.

④ We have a channel with one mega hz bw the SNR for this channel is 63. what are the appropriated signal levels calculate.

Sol $\text{Capacity} = BW \times \log_2 (1+SNR)$

$= 1\times10^6 \times \log_2 (1+63)$

$= 1\times10^6 \times \log_2 (64)$

$= 1\times10^6\times6$

$= 6$ Mbps.

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$\text{Bit rate} = 2 \times BW \times \log_2 L$

$6\text{Mbps} = 2 \times 1\times10^6 \times \log_2 L$

$3 = \log_2 L$

$L = 8$

4 Mbps

8 Mbps

$8\text{Mbps} = 2\times10^6 \times \log_2 L$

$4 = \log_2 L$

$L = 16$

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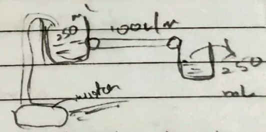
Here throughput is a measure of how fast we can actually send the data through a network, for Example : We may have a link with bandwidth of 1 Mbps But the device connected to the end of the link may handle only ~~two~~ 200 Kbps. This means that we cannot send more than 200 Kbps through this link.

Bandwidth is another char^st that measures another performance, However the term can be used in 2 diff content for measuring BW

① Hertz
② Bandwidth - bits per second



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(1) A network with a Bw of 10mbps can pass only average of 12000 frames/m with each frame carrying an average of 10,000 bits. Calculate throughput

Sol Throughput = $\frac{12000 \times 10000}{60}$

= 2 Mbps

* Latency : The latency or delay defines how long it takes for an Entire message to completely arrive at the destination from the time the first bit is sent out from the source. (Jitter)

We have 4 components of latency

1. Propagation time
2. Transmission time
3. Queuing time
4. processing delay

Latency / delay = All (4).

* Propagation time = $\frac{\text{Distance b/w}}{\text{propagation speed}}$

Time taken from point A to point B

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(1) What is the propagation time if the distance b/w 12000 km. Assume propagation speed to be 2.4×10^8

Sol. $\frac{12000 \times 1000}{2.4 \times 10^8}$

= 50 milisec.

* Transmission time = $\frac{\text{Message size}}{\text{Bandwidth}}$

taken b/w 1st packet & last packet

Diff b/w 2 packet

(2) What are the propagation time & transmission time 2.5 Kilo bites Message (email). If the Bw of the network is 1Gbps. Assume that the distance b/w sender & reciver is 12000 km and the light travels at 2.4×10^8 meter/sec in an optic fiber cable.

1 byte = 8 bits

Sol. Propagation time = $\frac{12000 \times 1000}{2.4 \times 10^8}$

= 50 mili/sec

Transmission time = $\frac{2.5 \text{ Kilo bites}}{1 \text{ Gps}}$

= $\frac{2500 \times 8}{1 \times 10^9}$

= 2×10^{-5}

= 0.02 m/sec.

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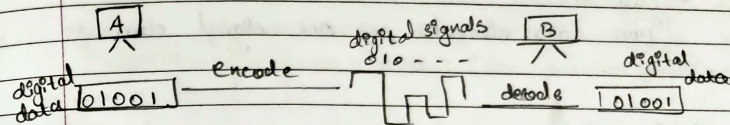
3) Queuing time
① The time needed for each intermediate or any device to hold the message before it can be processed.
② The Queuing time is not a fixed factor. It changes with the load imposed on the network.

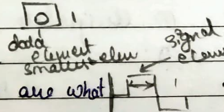
4) Jitter
Jitter is a problem if different packets of data encounter different delay's and application using the data at the reciver side is time sensitive.

Digital to Digital Conversion
Here, the conversion involves three techniques
a) ~~Bline~~ Line Coding
b) Block Coding
c) Scrambling

a) Line Coding
• It is a process of converting digital signals to
• we assume that the data is in the form of text, numbers, images, audio or video that are stored in computer memory as sequence of bits. Here line coding converts a sequence of bits to digital signals where sender is assumed to send digital data that are encoded into digital signals. And at the reciver end the digital data are ~~reco~~ recreated by decoding the digital signals



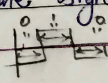
* Characteristic
1) A data element is the smallest entry that can represent a piece of information. ~~In di~~
2) In digital data comm=ⁿ a signal element carries data elements. In other words the data elements are what we need to send and signal elements are what we can send. Data elements are being carried and the signal elements are being carries



3) Here we need to find a ratio where

$$r = \frac{\text{data elements}}{\text{signal elements}}$$

* Case 1:
~~Dat~~ One data element per one signal elemet



for 010
$r = \frac{1}{1} = 1$

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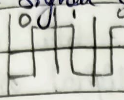
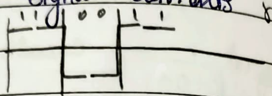
* Case 2:
One data element per two signal elements



$r = \frac{1}{2} = 0.5$

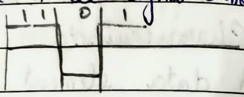
* Case 3:
Two data elements per one signal elements



110011

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

* Case 4:
four data elements per three signal elements



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

The last will be assigned two signal elements

right to left

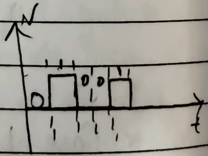
1101 ← right to left order

Line Coding scheme

① ~~Unipolar~~
② converting digital data into digital signals bit by bit

Line coding - unipolar	→ NRZ (non return zero)
polar	→ NRZ, RZ, Biphase (manchester, differential manchester)
Bipolar	→ AMI, Sudo turnenary
multilevel	→ 2B/1Q, 8B/6T, 4D-PAM5
multitransition	→ MLT-3

Unipolar
unipolar is the one where digital signals never goes into -ve amplitude or voltage



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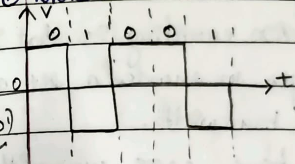
Polar
In polar scheme the voltages are on the both of the access for example, the voltage level for zero can be +ve and the voltage level for one can be -ve. There are two types of polar scheme NRZ L, NRZ I, NRZ L (Non-return zero - level) (Non-return zero invert)

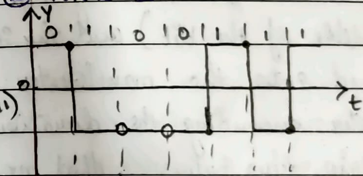
① NRZ L



(01001)

+ve voltage = 0 value
-ve voltage = 1 value

② NRZ I



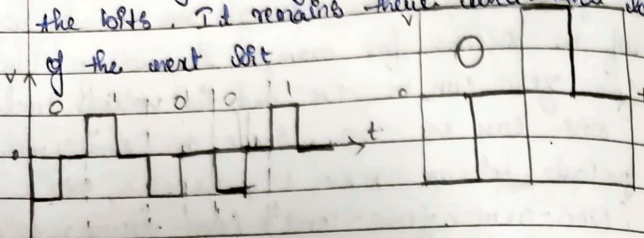
(0100111)

0 - No inversion
1 - Inversion
It changes its amplitude whenever "1" is present & not for zero.

Polar RZ (return zero)
The main problem with NRZ encoding occurs when the sender & reciever blocks are not synchronis

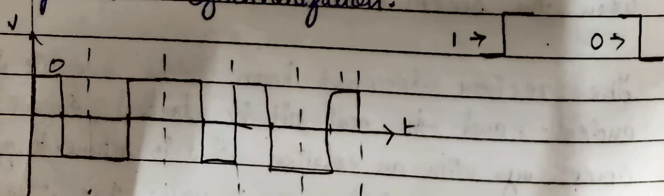
The reciever does not know when one bit has ended and the next bit is started, so we can come up with an solution that is return to zero RZ scheme which uses 3 value +ve, -ve, zero

In RZ signal changes not b/w the bits but during the bits. It remains there until the beginning of the next bit



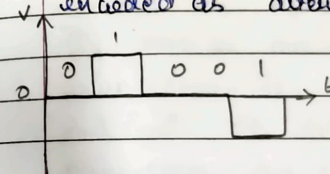
The main disadvantage of RZ encoding is that it requires two signal changes to encode a bit and ∴ it occupies a greater bandwidth.

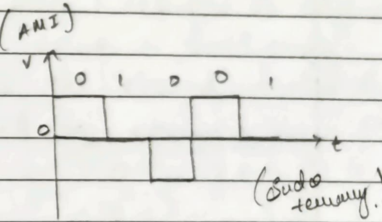
* To overcome this we have come up with biphase machnster scheme. The idea of RZ (transaction at the middle of the bit) and the idea of NRZ L are combined into the manchester scheme. In manchester encoding the duration of the bit is divided into two halves, that means the voltage remains at one level during the 1^{st} half and moves to the other level in the 2^{nd} half. This transaction at the middle of the bit provides synchronization.



AMI - Alternate Mark Inversion & Sudo ternary

Here in AMI a neutral zero voltage represents a binary zero and binary one are represented by alternating +ve & -ve voltages. A variation of AMI encoding is called sudo ternary in which the 1 bit is encoded as zero voltage and the 0 bit is encoded as alternating +ve -ve voltages

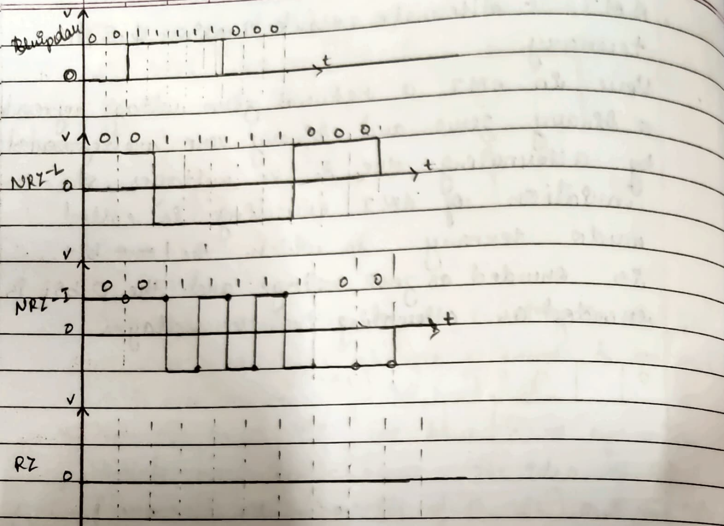




(1) Draw signal elements for 0011111000. Consider all line encoding schemes.

1) Unipolar
2) NRZ L
3) NRZ I
4) RZ
5) Bipolar Manchester
6) AMI
7) Sudo ternary

0011111000



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Unit - III

Error detection and Correction

Whenever bits flow from one point to another they are subjected to unpredictable changes because of interference. This interference can change the shape of the ~~sybols~~ symbols.
The interference chan change either 0 to 1 or 1 to 0 of a single bit then it is called as single bit error.
If two or more bits changes its original value then it is called as burst error And the bits which get changed during the transmission are called as corrupted bits

6 corrupted bits 0 1 1 1 0 0 0 1 1 0

0 1 0 1 1 0 0 0 1 0 corrupted single bits.

With reduclancy we can detect error or correct error. Detection of error is much simpler error than correction of error.

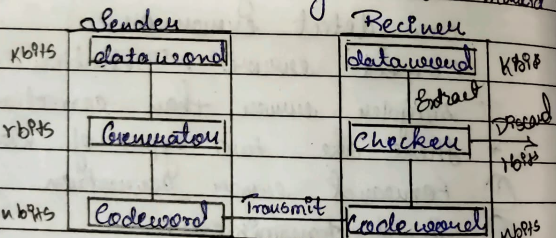
* There are two types of correction of error
① Forward error correction
② Read transmission.

In forward error correction process the reciver tries the ~~gin~~ guess the message using redundant bits. This error detection is prebsible if the number of error's is small that is only one bit (single bit error)

Coding : There are two ~~typ~~ broad categories
① Block coding ② Convolution coding

① $n = k + r$, there n is code blocks
Consider an entire message and message is divided into the multiple block. this blocks are called as k bits. Then we add r number of bits, [1|0|0] + [1|1|0|0|1|1|0] (r bits, k blocks)
Combing k & r n is the code word

How we will detect errors in block coding.
If the foll=ng two conditions are met the reciver can detect a change in original code word.
① The reciver has list of valid code words.
② The original code word has changed to an invalid one.



④ Let us assume that $k = 2$ and $n = 3$ table shows the list of data words & code word. Assume that the sender encodes 01 as 011 and send to the reciver.

Case A: reciver recives 011
Case B: reciver recive 111
Case C: " " 000

$n = k + r$. $n = 3$, $k = 2$
$011 = 01 + 1$
$000 = 00 + 0$
Burst error (as two bit error)

DW	CW
00	000
01	011
10	101
11	110

Block coding can detect only single bit, but cannot detect burst error

Hamming Distance b/w two pair of words can detect burst error

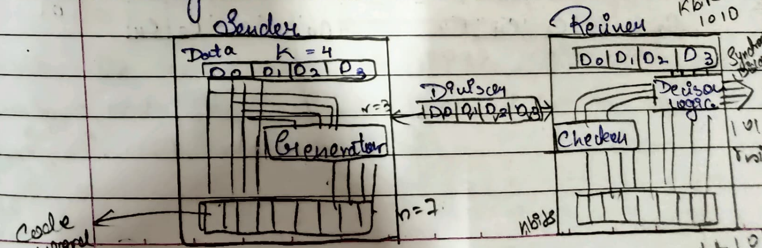
001 - sent
011 - reciver
010 = 1

1 0 1 0 0
1 1 1 1 0 $d = s + 1 = 4$
0 1 0 1 0 = 3

100100110
101000010
001100100

To guarantee the reduction upto s errors in all cases the minimum hamming distance must be $d_{min} = s + 1$

CRC [Cyclic Redundant Check]



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Linear Block Coding

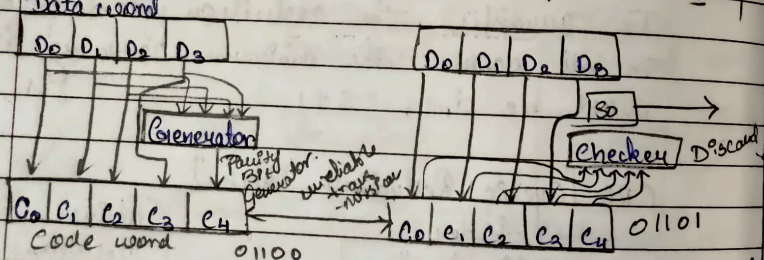
Almost all block codings are subset of linear block codes. There in linear block code we use the term called as simple parity check code. Perhaps the most familiar error detecting code is simple parity check code.

$n = k + 1$ ∴ $n = \in k + (0/1)$ — for even no of one's

Table – Dataword

Dataword	Codeword	Dataword	Codeword
0000	00000 (code word)	0110	01101
0001	00011	0111	01110 1
0010	00101	1000	10001
0011	00110	1001	10010
0100	01001	1010	10100
0101	01010	1011	1011 0 1

Data word



odd – discard
even – allow

$S_0 = (C_1 + C_2 + C_3 + C_4) \bmod 2$
$= (0 + 1 + 1 + 0 + 1) \bmod 2$

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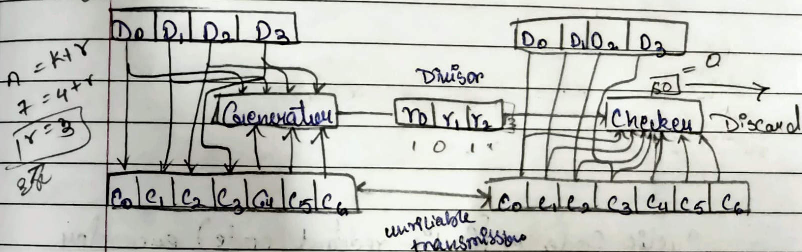
* Case 1: No error occurs the received code word is 10111, the syndrome is zero and the data word 1011 is created. $= (1+0+1+1+1)$
* Case 2: One single bit error changes C_1
* Case 3: One single bit error changes parity bit (C_4)
* Case 4: An error changes C_0 and C_3 $(0+0+1+0+1) = 0$
* Case 5: Three bits C_3 C_2 C_1 are changing that means parity checks applys only for even number of 1's rules but not for odd number of 1's

$(1+1+0+0+1)$

CRC encoder and decoder.

$n = k + r$
code word, data word



At the encoder side / checker side let us have data word as 1001 and divisor as 1011

remainder should always be zero.

```
1011 ) 1001000 ( 10110
       1011
       0100
       1011
       1111
       1011
```

```
1000
1011
0110
0110
000
```

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When we do multiply we use the ~~ADD~~ AND operation and when we use Substract we use Ex-OR operation.

Case 1:

```
1011 | 1001110 | 1010
       1011↓
       0 0101
         0000
       0 1011
         1011
       0 0000
          000
          0000
```

$n = k + r$

1001 | 1001 | 1010 → checker → cw

cw → cw

```
1011 | 1001000 | 1010
       + 1011↓
       0 0100
          0000
       0 1000
          1011
       0 0110
          0000
       0 110
```

$\underbrace{110}_{\text{code word}}$

Case 2:

```
1011 | 1000110 | 1011
       1011↓
       0 0111
          0000
       0 1111
          1011
       0 1000
          1011
       0 011
```

011 corrupted unreliable bit by transmission

further cannot divide by 4 bits and remainder is of 3 bits; so it is not zero

Cyclic Code or (Cyclic redundant code) encoder using polynomials

1011

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

$\boxed{x^3 + x + 1}$

$x^3 \; x^2 \; x^1 \; x^0$
1 0 0 1

$\boxed{x^3 + 1}$

1 0 0 0 1 1 0
$a^6 \; a^5 \; a^4 \; a^3 \; a^2 \; a' \; a^0$

$1 \times x^6 + 0 \times x^5 + 0x^4 + 0 \times x^3 + 1 \times x^2 + 1 \times x^1 + 0 \times x^0$

$\boxed{1x^6 + x^2 + x^1}$ — polynomial representation

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* When you add three zeros before the data word is called as agumented data word
* Add or Shifting of three bits. $1001 \rightarrow x^3+1$

8 bits adding $x^3 \times (x^3 + 1)$
$x^6 + x^3$

Ex:

$$x^3 + x + 1 \,\big)\, x^6 + x^3 \quad (x^3 - x$$

$x^3 + x + 1$ = 1011

$x^6 + x^3 \rightarrow 1001000$

$-\; x^6 + x^4 + x^3$

$0 \; - x^4$

$\mp x^4 \mp x^2 \mp x$

$0 \; + x^2 + x \rightarrow 0110$

Code word $= (x^6 + x^3) + (x^2 + x)$ or a

(need to mention this) data bit, redudant bit

In cyclic code analysis by using polynomials we define the following:

- Data word : It is represented by $d(x)$
- Code word : " " " $c(x)$
- Generator : " " " $g(x)$
- Syndrome : " " " $s(x)$
- error : " " " $e(x)$

In a cyclic code :-

Case 1: If $s(x)$ is not equal to zero then one or more bits are corrupted

Case 2: If $s(x)$ is equal to zero either no bits are corrupted or some bits are corrupted but the decoder failed to detect them

* To find single bit error.

If the generator has more than one term and coefficient of x^0 is 1 then all single bit errors can be caught.

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Q Find the ~~sigi~~ single bit errors in the foll^n when generator $g(x)$ values are given as. Case 1 →

$g(x) = x+1$, $s(x) = x^3$, $c(x) = 1$

→ only $g(x) = x+1$ can identify all the single bit errors

$\frac{x^i}{x+1}$

it can find all the errors

Two isolated single bit error

$x^t + 1$

x^5 x^1

1 0 0 1 1 0 0 1

1 0 $\boxed{1}$ 1 0 $\boxed{1}$ 1

burst error