CN - Computer networking
Cse306

Networks (Lovely Professional University)

CSE 306
Computer Networks

→ Collection of computers & devices interconnected by communication channels.

Channels
- Wired
- Wireless

→ IOT - Internet of things, eg: three pin plug

what is computer network?

Collection of Nodes

Nodes
- Data communication equipment (DCE) ⇒ Eg: Router, switch, Multilayer switch.
- Data terminal equipment (DTE)

→ Cloud storage: Lending storage

Eg: Google cloud is lending storage (certain MB) for free.

Components of Computer Network:

- Message
- Sender
- Receiver
- Transmission medium
- Protocol

Data flow

→ Simplex (single direction)
→ half duplex
→ full duplex

* **Simplex:** Data flows in one direction only

Eg: Computer to printer

* **Half Duplex:** It is a connection in which data flows in one direction or other, but not both at the same time.

Eg: Bluetooth

* **Full Duplex:**

Connection in which data flow in both directions simultaneously

Eg: Download, upload

→ Physical Structures:

- Point to Point: Single receiver and transmitter
- Multipoint: Multiple receipents of single transmission.

→ Topology: Arrangement of various elements like links, node
- Connection of devices

- Mesh
- Star
- Bus
- Ring
- Tree
- Hybrid

Physical Topology: Layout of Cabling

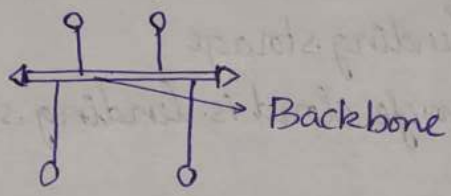
Logical Topology: Data flow in the network.

Star Topology:

Adv:
- Less expensive than mesh
- Less Cabling

Dis:
- Dependency issues
- More cabling as Compared to other Topologies.

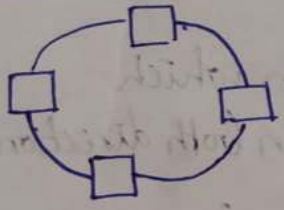
Bus Topology:



Adv:
- Well suited for temporary networks
- Cheap

Dis:
- Difficult to troubleshoot
- Limited Cable length

Ring Topology:



Adv:
- Quickly transferred without a bottleneck (very fast)
- Adding additional nodes has little impact on bandwidth.

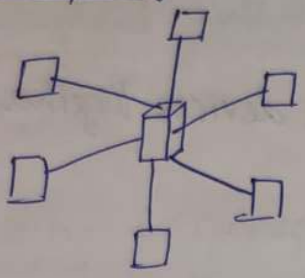
Dis:
- Data packets must pass through every computer - so slow.

→ A fully connected mesh can have $\frac{n(n-1)}{2}$ physical channels to link 'n' devices

'n' ⟹ nodes

→ One node must be connected with (n-1) nodes.

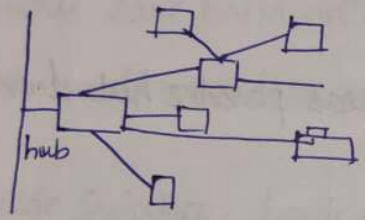
Star Topology:



Adv:
- good performance
- Scalability (easy to setup & expand)
- non-centralized failure is okay to handle.

Disadv:
- Expensive
- Extra hardware required

Tree Topology:



Hybrid Topology:

- Combo of two or more topologies
  one or more
  (different)

Networking Devices:

five categories of connecting devices are,

- Application
- Transport
- Network
- Data link
- Physical

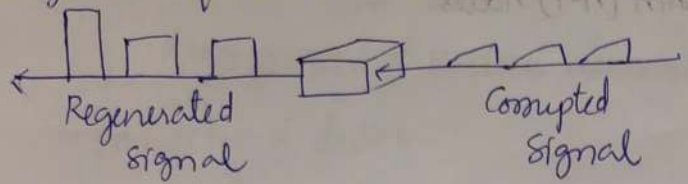
Repeater:

- repeats signal
- forwards every frame it receives
- not an amplifier (it removes noise & regenerates signal).

Function of a repeater

→ ~~Corrupted signals~~

→ Right to left transmission



similarly vice versa.

Hub: It is a device for connecting multiple ethernet devices together and making them act as a single network system.

Eg: ethernet hub, active hub etc...

Passive hub - serves simply as a medium for data, enabling it to go to one to another.

Active hub:
- multiport repeater
- It regenerates the signal whereas passive hub doesn't.
- also called Concentrators

Smart hub:
- management software to help determine possible network problems and isolate them.
- uses protocols like SNMP to communicate with various network devices. and obtain statistics like bandwidth, uptime etc...

Bridge: one step up on a hub in that it looks at destination of packet before sending

- If destination address is not on the other side, it cannot send

Adv:
- prevent unnecessary traffic
- reduces amount of network traffic

Throughput: rate of successful message delivery over a communication channel

Switch: for connecting multiple ethernet devices together.
- multiport bridge
- they are faster than hubs
- managed switches can let you control a lot more about what's happening on LAN.

→ Switches save bandwidth, hubs don't.
→ Switch won't send data packets to computers on various networks.

Symmetric Switches: having all ports of same bandwidth.

Asymmetric switches: having atleast one port of different bandwidth

Manageable Switches: Can be configured that is programmed according to need by network administrator.
- Can only transmit the data to specific port or host

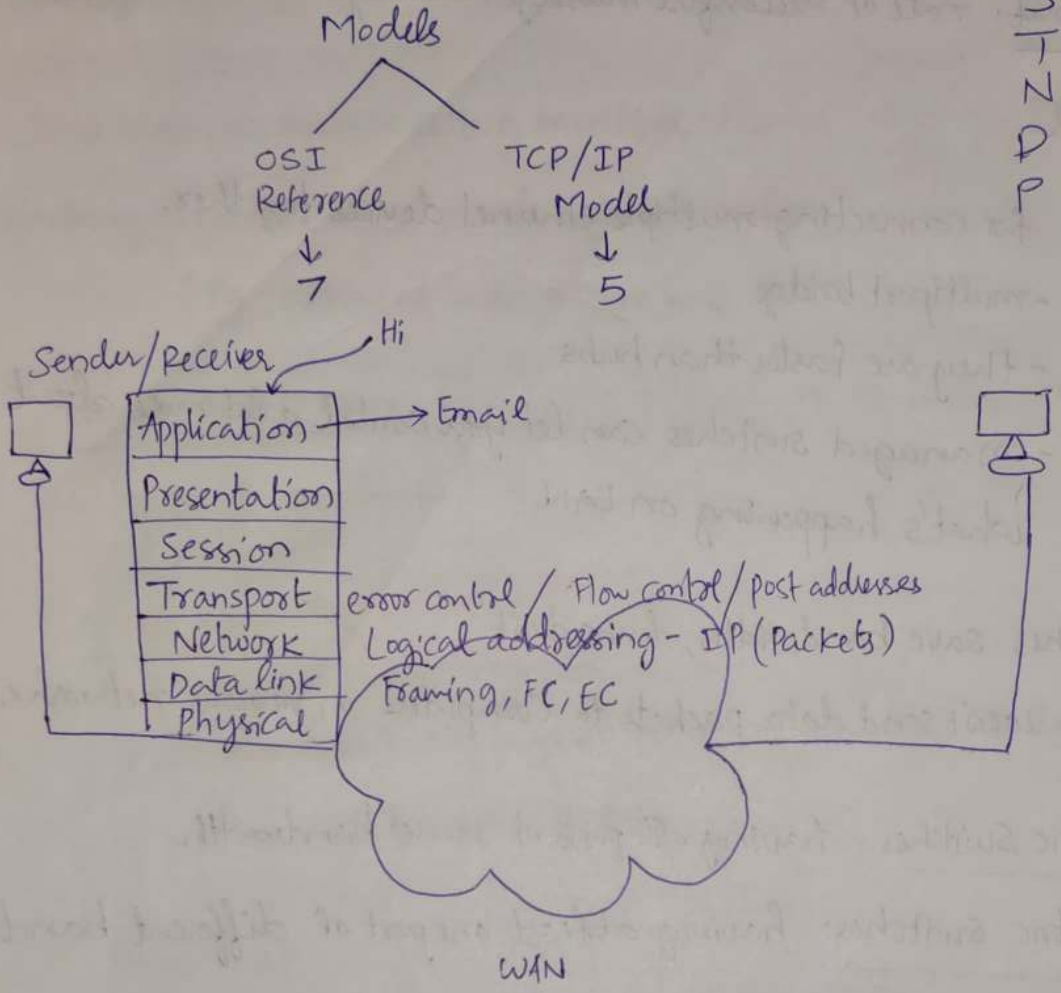
Non manageable Switches
- these are like hubs,
Cannot be configured.

Router: device that forwards data packets b/w computer networks.

- data packets are forwarded from one router to another, until it gets to it's destination node

LAYERS

APSTNDP



OSI Model:

- Open system Interconnection model is fundamental to all Communications between network devices.
- now, theoretical model.

Layers: Physical
Datalink
Network
Transport, Session, Presentation, Application

Layer 1: Transmits the data on the medium - physical (signal to bits bits to signal)

Adds MAC address to packets - Datalink

Adds appropriate network addresses to packets - Network (Router)

Acknowledges the flow of data including re-transmission where required - Transport

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Physical Layer:

- lowest, bottom layer responsible for physical connection b/w devices.
- NICs, repeaters, hubs and concentrators.
- responsible for transmitting individual bits from one node to next

functions:

- Data Rate: Speed with which data is transmitted
- Synchronization of bits: bits should be synchronized
- Line configuration
- Physical Topology
- Transmission mode

Line coding is the process of converting digital data to digital signals.

Encoder: Converts digital data to signal

Decoder: Converts digital signal to data

Signal Element vs Data Element:

A data element is the smallest entity that can represent a piece of info this is bit

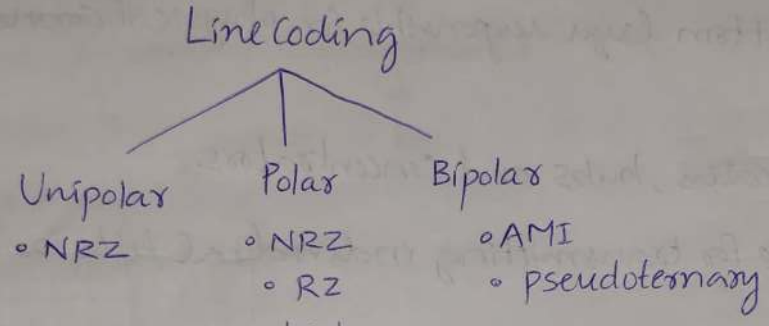
→ signal element carries data elements

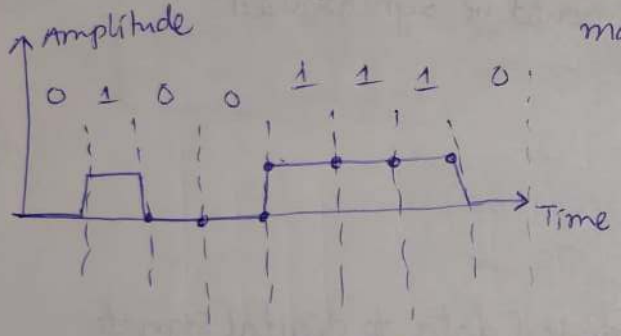
→ Signal element is [illegible]

→ $r = \frac{\text{no. of data elements}}{\text{no. of signal elements}}$

→ Data rate defines the number of data elements (bits) sent in 1 s
(bit rate)/modulation rate)
unit: (bps) bits per sec

→ Signal rate is no. of signal elements sent in 1 s
(pulse rate)/baud rate)
unit: baud



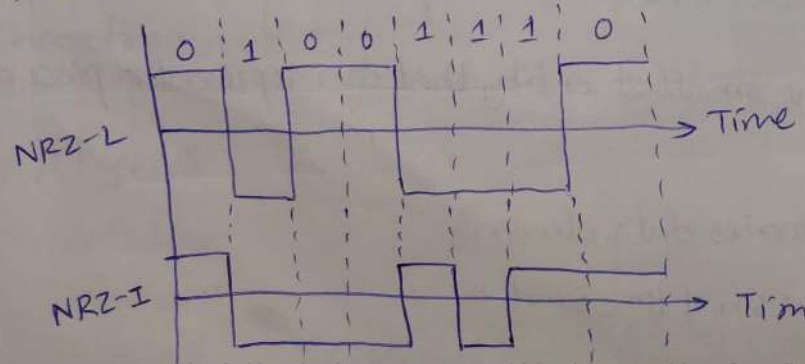


'0' is indicated on x-axis (Time)

Polar encoding uses two voltage levels (+ve and -ve)

→ NRZ-L the level

NRZ-I, is inverted if a 1 is encountered.



0: positive
1: negative

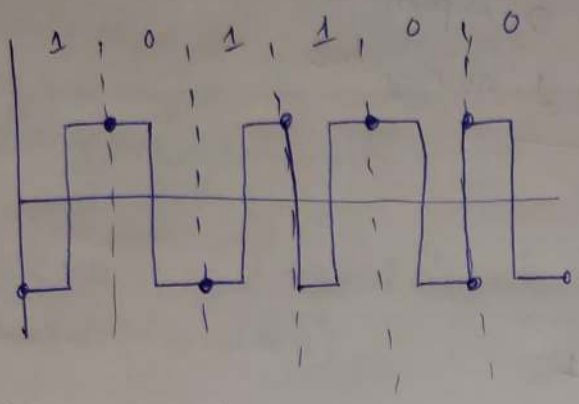
Manchester :

one: ⌐¬

0: ¬⌐

(in b/w 1 and 0)

101100



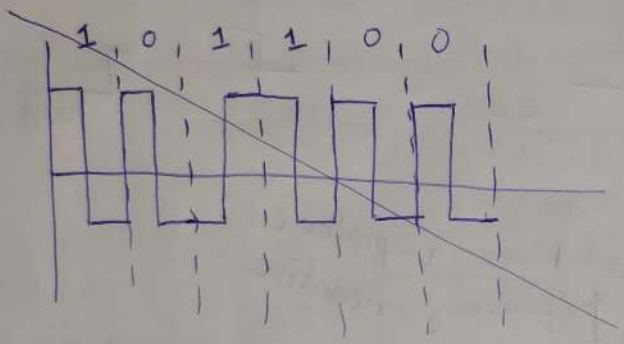
Differential Manchester:

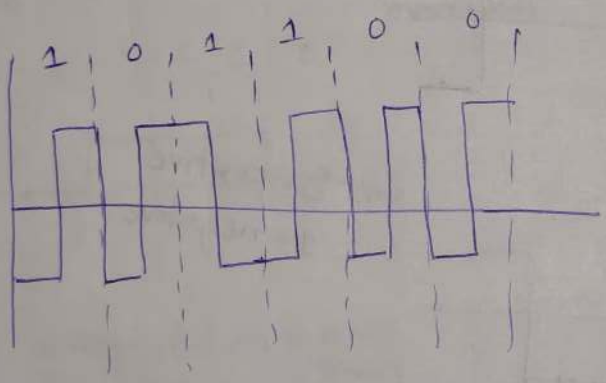
(transition occurs when '0' is encountered)

101100

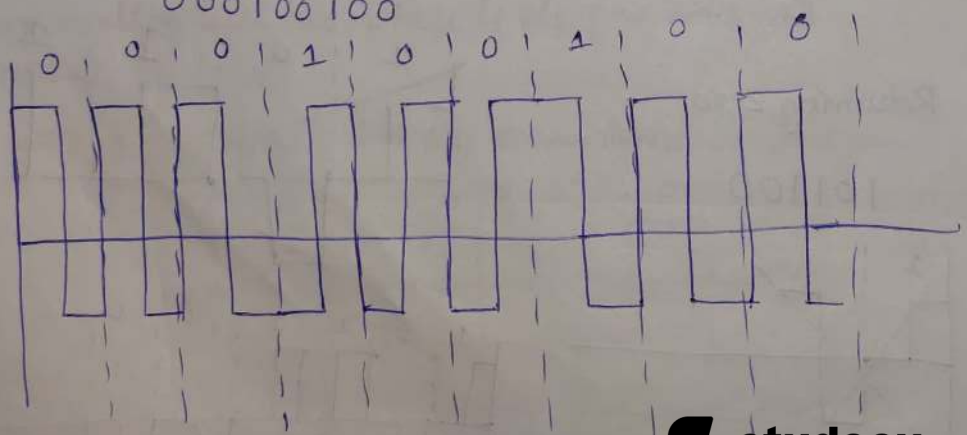
0 → ⌐¬

1 → ⌐





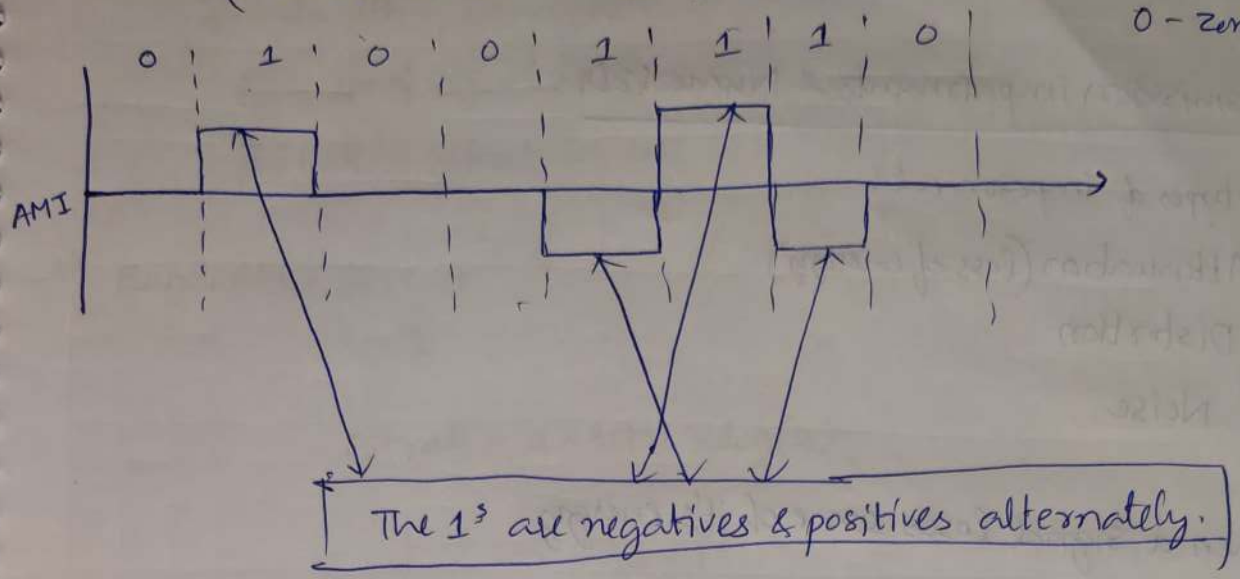
000100100



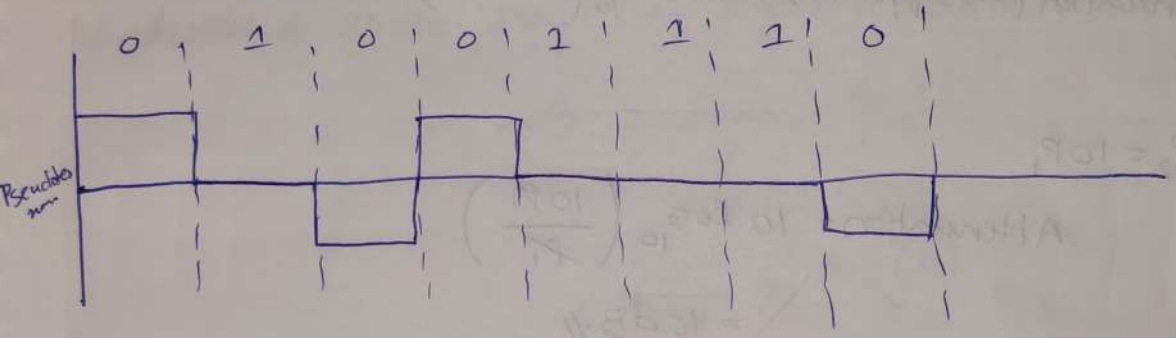
In bipolar encoding, we use three levels: positive, zero and negative

Bipolar AMI Encoding
(Alternate mark inversion)

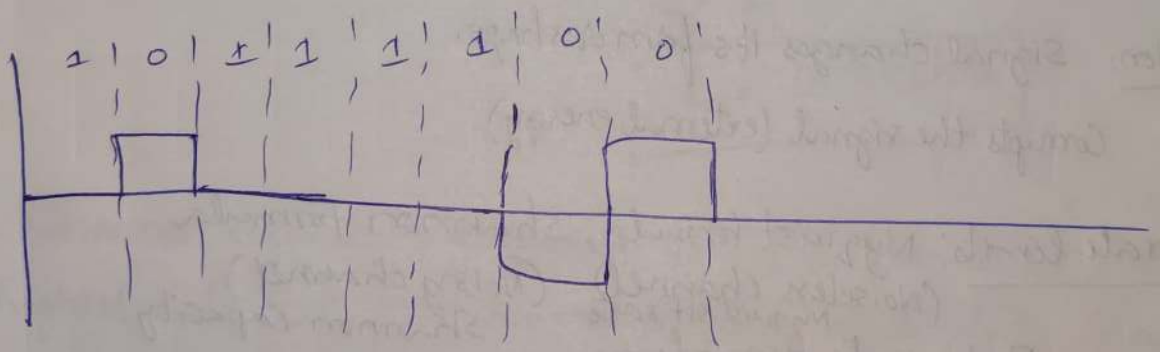
1 - positive
0 - zero level



Pseudoternary



10011100



Bit rate is the number of binary bits transmitted per second.

- refers to rate at which data is processed or transferred

Transmission impairments & Numericals :

three types of impairment:

1) Attenuation (loss of energy)
2) Distortion
3) Noise

1) when a signal loses some of it's energy

Attenuation (loss of power): $10 \log_{10} (P_2/P_1)$

#

$P_2 = 10 P_1$

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

$$= 10 \text{ dB} //$$

2) Distortion: Signal changes its form or shape..

3) Noise: Corrupts the signal (external energy)

Datarate limits: Nyquist formula, Shannon Formula
(Noiseless channel) (Noisy channel)
Nyquist Bit rate Shannon capacity.

Data rate depends on

- bandwidth
- level of signals
- Quality of the channel (level of noise)

Nyquist's theorem states:

$$\text{Bit Rate} = 2 \times \text{Bandwidth} * \log_2(L) \text{ bit/sec.}$$

bandwidth – bandwidth of channel

L – No. of signal levels used to represent data

Bit Rate – Bitrate in bits per second.

Bandwidth = 3000 Hz

$L = 2$

$$\text{Bitrate} = 2 \times 3000 \times \log_2(2)$$

$$= 6000 \text{ bps.}$$

we need to send 265 kbps over a noiseless channel with a bandwidth of 20 kHz. How many signal levels?

$$\frac{265}{53} = 2 \times \frac{20}{4} \times 10^3 \times \log_2(L)$$

$$\frac{54}{8000} = \log_2(L)$$

$$L = 2^{6.625}$$

$$\boxed{L = 98.7 \text{ levels}}$$

Shannon Capacity is a formula used to determine the theoretical highest data rate for a channel through which data is passing/transferring

$$C = B \log 2 \left(1 + S/N\right)$$

consider an extremely noise channel,

Signal to noise ratio is almost zero. In otherwords,

Noise is too much, that signal is faint.

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

$$= B \log_2(1+0) = B \log_2(1) = 0$$

$$= B \times 0$$

Data Link Layer:

- Logical Link Control (LLC)
  Media Access Control (MAC)

LLC acts b/w protocols such as IP (Internet protol) and MAC method

MAC is responsible for the connection to the physical media (eg: cable)

functions:

Framing

Physical Addressing

Flow control

Error control

Access Control

Network Layer:

- Responsible for correct addressing & delivery packets of data
- These are known as datagrams.
- Uses the network address (~~this is a logical address~~)

→ Adds the address to packet (encapsulation)

→ Determines the best path for packet (routing)