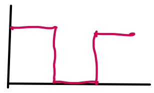
Data Communication Basics

→ Stallings Ch 3 & 4

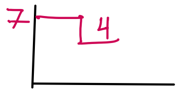
Data vs Signal

0 1 1 0 → bit stream

Encoding {
Scheme 1:- 0 ⇒ 5V
1 ⟶ 0V



Scheme 2:- 00 → 10V
01 → 7V
10 → 4V
11 → 0V
}



Assume:-

1) Full Duplex
2) Digital Data

Attenuation:-

Transmitted Power = P_1 watts
Received Power = P_2 —"—
attenuation in dB is $10 \log\left(\frac{P_1}{P_2}\right)$

Noise:-

→ Thermal Noise will always be there but it is very predictable (White Noise)

→ Crosstalk: Design with distance

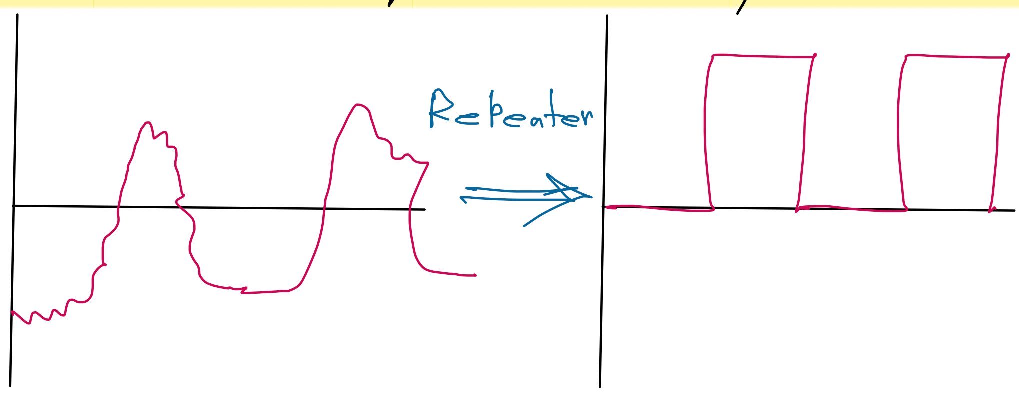
→ Impulse: Not predictable (like lightning rod)
Try to minimize the effect
Use metal shield and connect to ground (high cost)

SNR:-

$$SNR\,(\text{in dB}) = 10 \log\left(\frac{S}{N}\right)$$

Analog:- Use optical wire

Repeater:- Knows signal data is digital

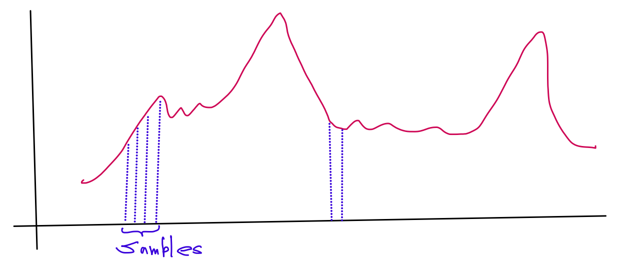


Where is data generated?

— digital data: doc file, email

— Analog data: audio

⟹ Comp N/W's nowadays carry only digital data

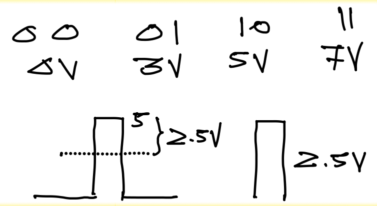


Each sample = 1 value in a continuous range encode each sample in K-bits

Send the bit pattern for each values.

Q. What is a good sampling rate?

⟹ Nyquist Sampling Theorem $\geq 2f$



$$<= 2B \log_2 M \text{ bits/sec}$$

Shannon's Law

$$<= B \log_2 \left(1 + \frac{S}{N}\right)$$

☆ $\frac{S}{N}$ is not in dB

Transmission Medium

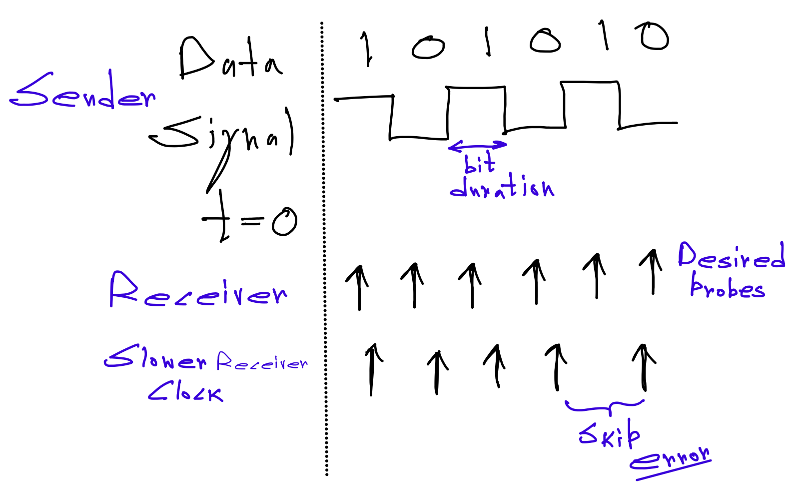
Twisted Pair, Optical Fibers.

Data transfer b/w two machines

Synchronization

Framing

Synchronous Transmission



0 — 0V
1 — 5V

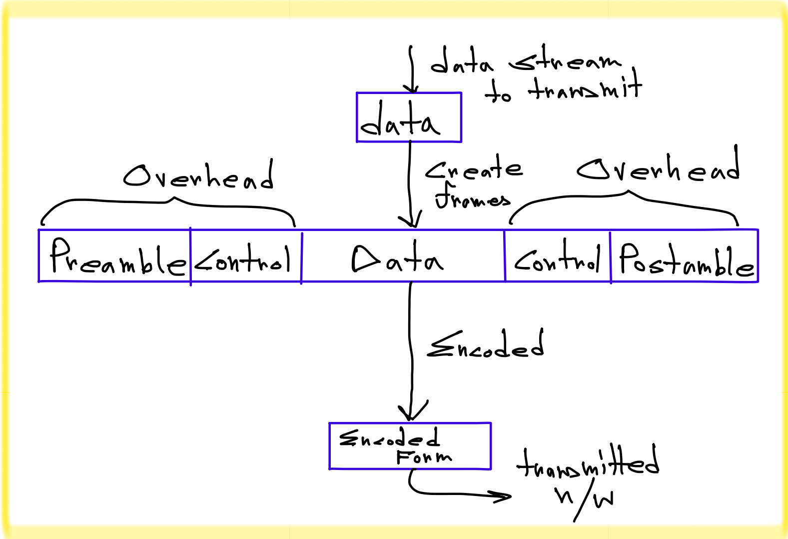
Suppose

0101 → no problem

0000 → ______ problem

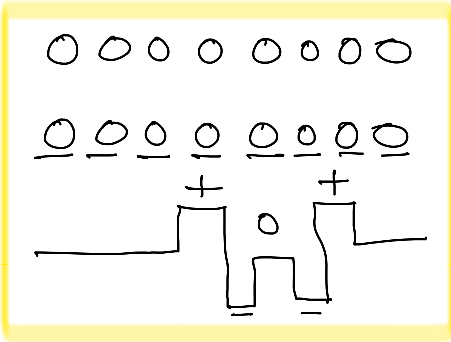
1111 → ______ problem

Bad encoding



Scrambling

→ On Encoded Data



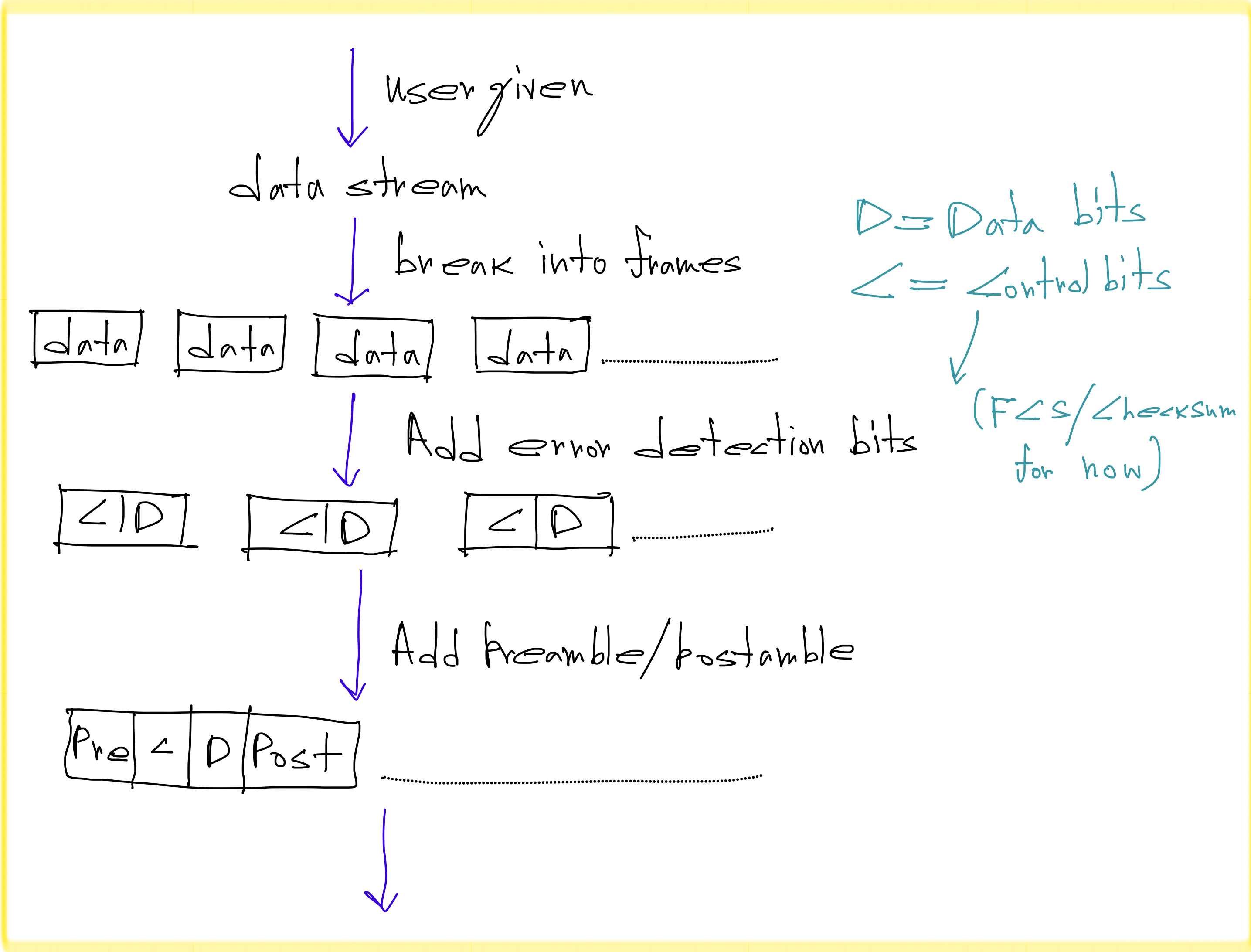
Preamble:-

1) Indicate start of frame
2) Synchronize the clock.

→ Stop bit used to forcibly bring back to idle voltage.

Error Detection

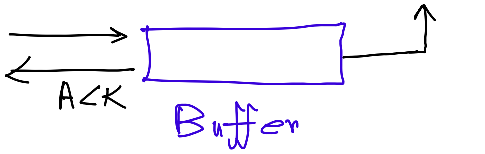
→ Error detecting bits put in control



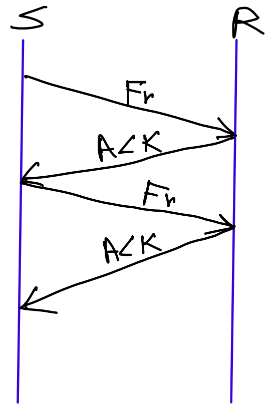
Flow Control

Send & Wait

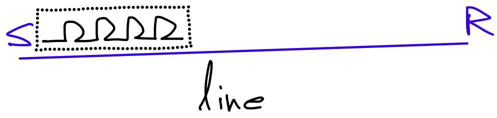
Sender — **Receiver**



ACK here ⇒ Delivered to user
So buffer is free



Assume: Sender knows the buffer size of receiver

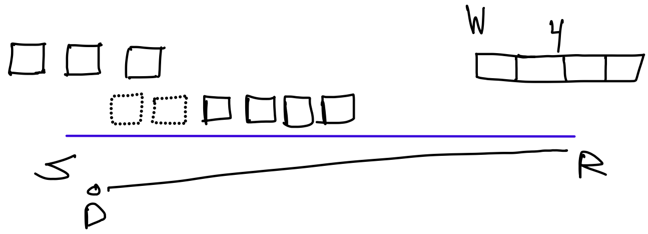


S & W to work well

1. Large frame
2. Small Length
3. Low Data Rate

S & W especially bad for long fat pipes
↓ large D ↓ large R

⟹ Increase Buffer Size



Sliding Window:–

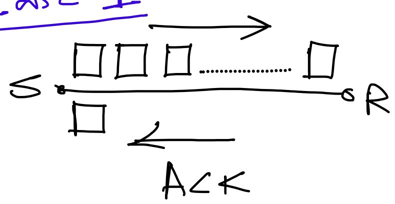
Window size = no of frames that can be sent without receiving ACK.

Assumptions so far:–

1. No Error

Line utilization:

Case-1

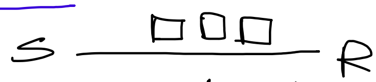


1 bit frame

W here = # of frames that can be sent out in 1 RTT

Link utilization = 1

Case-2



W run out before 1 RTT

link utilization = W × link utilization of S&W

$$= \frac{W \times L}{\left(\frac{L}{R} + \frac{2D}{V}\right) R}$$

Error Control:–

Line utilization of S&W ARQ

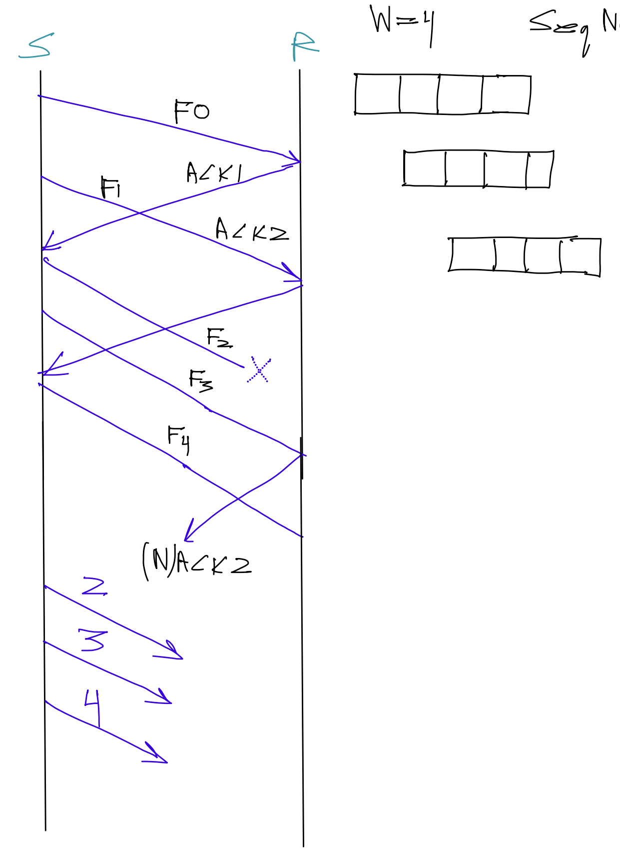
$$= \frac{\text{line utilization of S\&W with no error}}{\text{Expected no of transmission per frame}} = (1-p) \text{ lineout of S\&W}$$

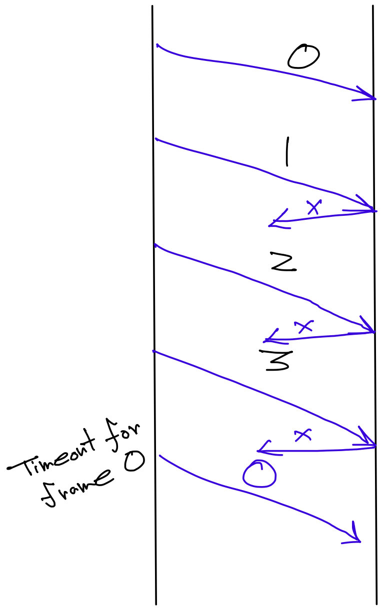
Suppose p = prob that a frame will be lost/damaged

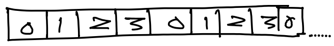
Expected # of transmission $= (1-p)\sum_{i=1}^{\infty} i p^i = \frac{1}{(1-p)}$

Go-back-N-ARQ :-

W=4 Seq No = 3 bit







Cons of $2^2 = 4$ size Buffer

Q) When should the receiver send an ACK?
— On Receipt
or
— On Delivery to user

It depends!!

Flow Control:—

Purpose of ACK = Indicate Buffer avaiability

So, we sent ACK on delivery to user

Error Control:—

Purpose of ACK = indicate frame is received correctly at receiver

So, should ACK on receipt (before delivery even)

But then what about buffer?

— Send additional info with Buffer info

Go-back-N Wait to receive a msg

Receiver:-

On receive of a frame X

Case-I:- X is next expected frame. Send ACK X+1
update next frame to expect

☆ Case-II:- X is not the expected frame. Drop X. Send NACK X
Okay to not send

Sender:- Send initial frame after window. Wait to receive
Automatic Timeout
a frame. On receipt of frame.

Case I:- frame is ACK X.
Move window. Send new frame if applicable

☆ Case II:- frame is NACK X.
Send X & all frames sent after X

On timeout, Resend Y & all frames after Y

Data Frame

header

seq	CRC	Data

Ack Frame

header / data

type	CRC	Seq No

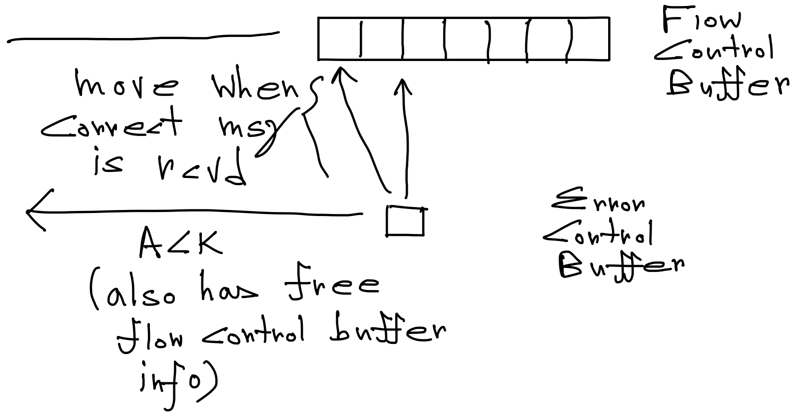
Assumption:-

Error Control:- ACK sent when receiver recives it
(So how to handle flow control with error control?)

Ex:- Go-back-N

Sender:-

Send Window = min (Go-back-N Window, for buffer at receiver)



Scenario:-

ACK 2, Buff=0. When buffer available send ACK 2, Buff=1

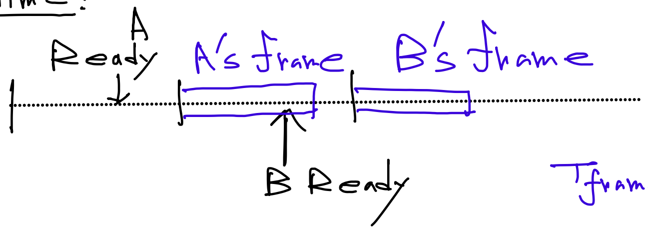
Transmission through Shared Medium

Mutiblexing:- FDM, TDM, WDM

Contention Based Protocols:-

ALOHA:-

Time:-

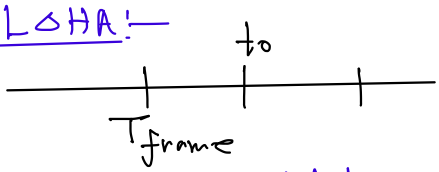


Vulnerable Time:-
Time duration in which another frame Transmission will cause a collison.

Say, a is transmitting a frame starting from t_0

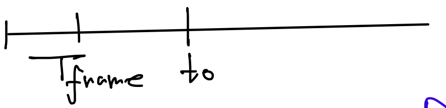
T_{frame} = Time for transmission of 1 frame

ALOHA:-

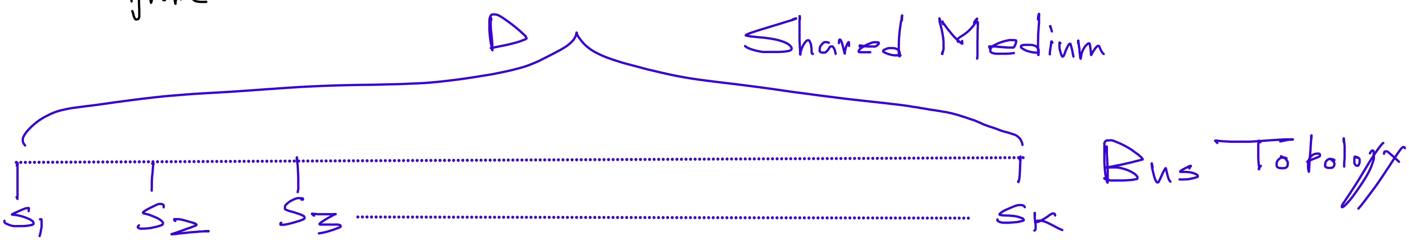


Vulnerable Time = $2T_{frame}$

SLOTTED ALOHA:-



V. Time = T_{frame}



S_1 — S_K farthest station

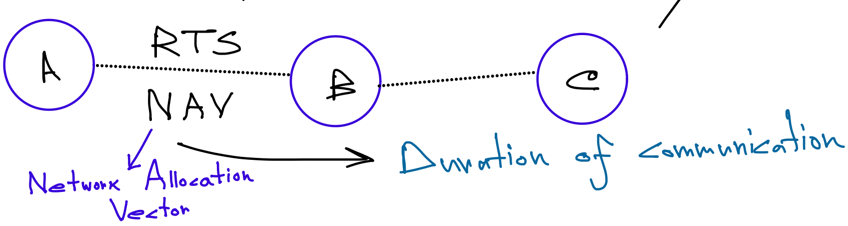
Q.) Network with multible nodes. Identify destination from Source

⟹ i) Send a packet looking for the destination of the form $(2^i, timeout)$ to neighbours

2) Every Receiver of it reduces the value by 1. If 0, then don't retransmit.

3) Try with $i = 0, 1, 2, \ldots\ldots$ Expanding Horizon

Collison Avoidance:- IFS ⟶ Encode Priority



Header → Source | Destination | (RTS|CTS)

Data Layering:- → Ensure Reliable communication

TCP/IP Stack:-

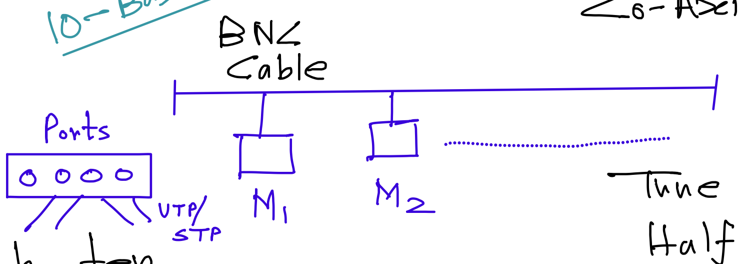
Application
Transport
Network
Data Layer
Physical

} LAN Specification
De-facto standard Ethernet

First Ethernet

10-Base-5

Co-Axial Cable



Next:- 10-Base-3 etc

True Shared
Half-Duplex
CSMA/CD

Exactly as Studied

Hubs:- Basically a repeater with Added features

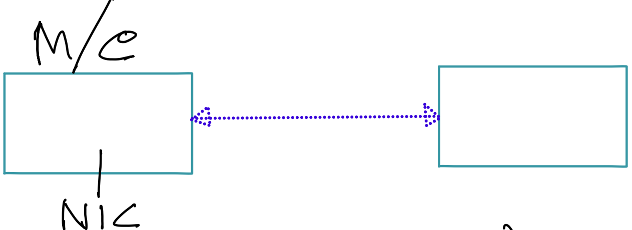
Physical Layer Devices

→ Will receive a signal on one port, amplify it & send to all other ports (broadcast) (take out 0-1 & resend with correct Voltage)

⇒ Collison Detection at hub

Frame Format:-
Ethernet

1010... 10101011 → Start of Data



(Network Interface Card)

Each Ethernet NIC has a MAC Address.

IP → DA, SA