Date.......................

Unit - 4

* Datalink layer

- → MAC
- → LLC

- ALOHA → Access Protocol

- framing
- Error control
- flow control
- Access control

- Error Detection & Error Correction
- CRC
- Check Sum
- Parity Check
- Hamming Code

} Error Control.

- HDLC
- ATM

} General Protocols.

* Multiple Access Control

Random Access
- → ALOHA
- → CSMA
- → CSMA/CA
- → CSMA/CD

Controlled Access
- → Token Parsing (7th Oct)
- → Reservation (Not in Syllabus)

(Not in Syllabus) Channelization
- → FDMA
- → TDMA
- → CDMA

* ALOHA

- Pure
- Slotted.

→ It is the most elegant protocol.

→ It was the first to be developed.

→ Rules –
1. Any station can transmit data to a channel at any time.
2. It is not require any carrier sensing.
3. Collision & data frames may be lost during transmission.

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(4) No collision detection.

(5) It requires re-transmission after some random amount of time.

→ It was designed for radio [wireless lan] in 1970.

→ Vulnerable time - In which there is possibility of collision. We assume stations sent fixed length with each frame taking T_{fr}, s, to send.

↓ Frame Transmission time.

$$\boxed{V_T = 2 \times T_t}$$

$$\boxed{\eta = G \times e^{-2G}}$$ efficiency → Maximum throughput.

$e = 2.71$

$$\frac{\partial \eta}{dG} = G \times e^{-2G}(-2) + e^{-2G} \times (1)$$

$$= e^{-2G}(-2G+1)$$

$$= -2G + 1 = 0$$

$$\boxed{G = 1/2}$$

$$\eta = \frac{1}{2} \times e^{-2(1/2)}$$

$$= \frac{1}{2} \times e^{-1}$$

$$\boxed{0.184} \approx \boxed{\eta = 1/2 \times 1/e}$$

$$\boxed{T_t = \frac{M}{BW}}$$

M → Message (in frames)

BW → Bandwidth (bps)

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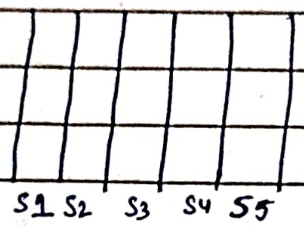
* Slotted ALOHA



$\boxed{V_T = T_t}$ $\boxed{\eta = G \times e^{-G}}$

$$\frac{\partial \eta}{dG} = G \times e^{-G}(-1) + e^{-G} \times (1)$$

$$= e^{-G}(-G+1)$$

$$= -G + 1 = 0$$

$$\boxed{G = 1}$$

$$\eta = e^{-1} \times 1$$

$$\boxed{\eta = \frac{1}{e}} \boxed{\approx 0.368}$$

* CSMA → Persistent methods -

① 1-Persistent
② Non-persistent
③ p-persistent

(1) After station finds line idle, it ~~sets~~ sends its frame immediately with prob = 1 -

(2) → Station has frame to send, it senses ~~Light~~ line.

(3) → If line is idle, it sends immediately. If not it waits random amount of time & then again senses line.

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③ If station finds line idle, it follows these steps—

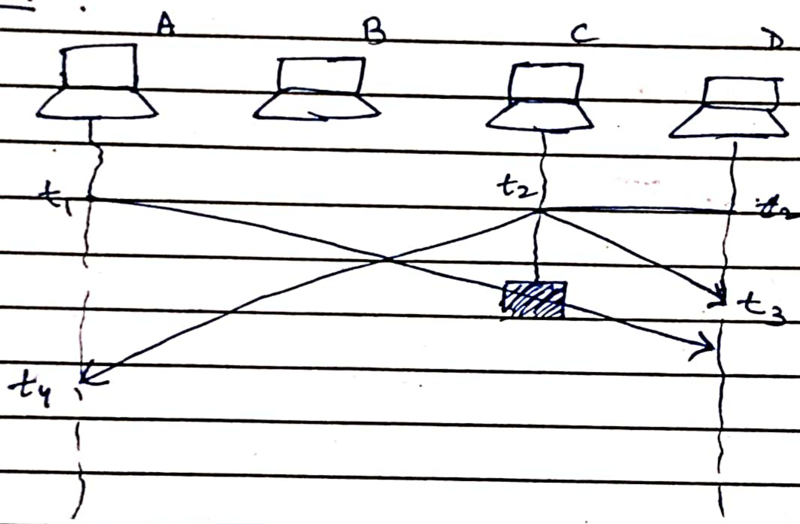
Step 1- With probability p, the station sends its frame.

Step 2 → With probability $q = 1-p$, the station waits for begining of next time slot & checks line again.

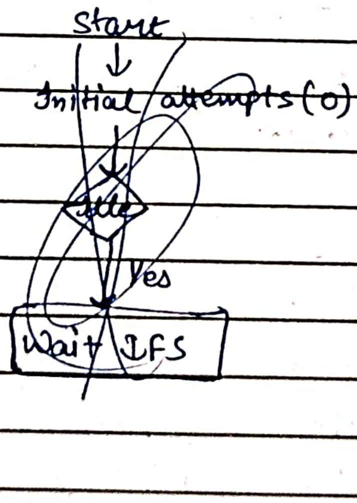
(a) If line is idle go to step 1.

(b) If line is busy, it acts as collision has occured & uses the back off procedure.

* CSMA/CD



* CSMA/CA



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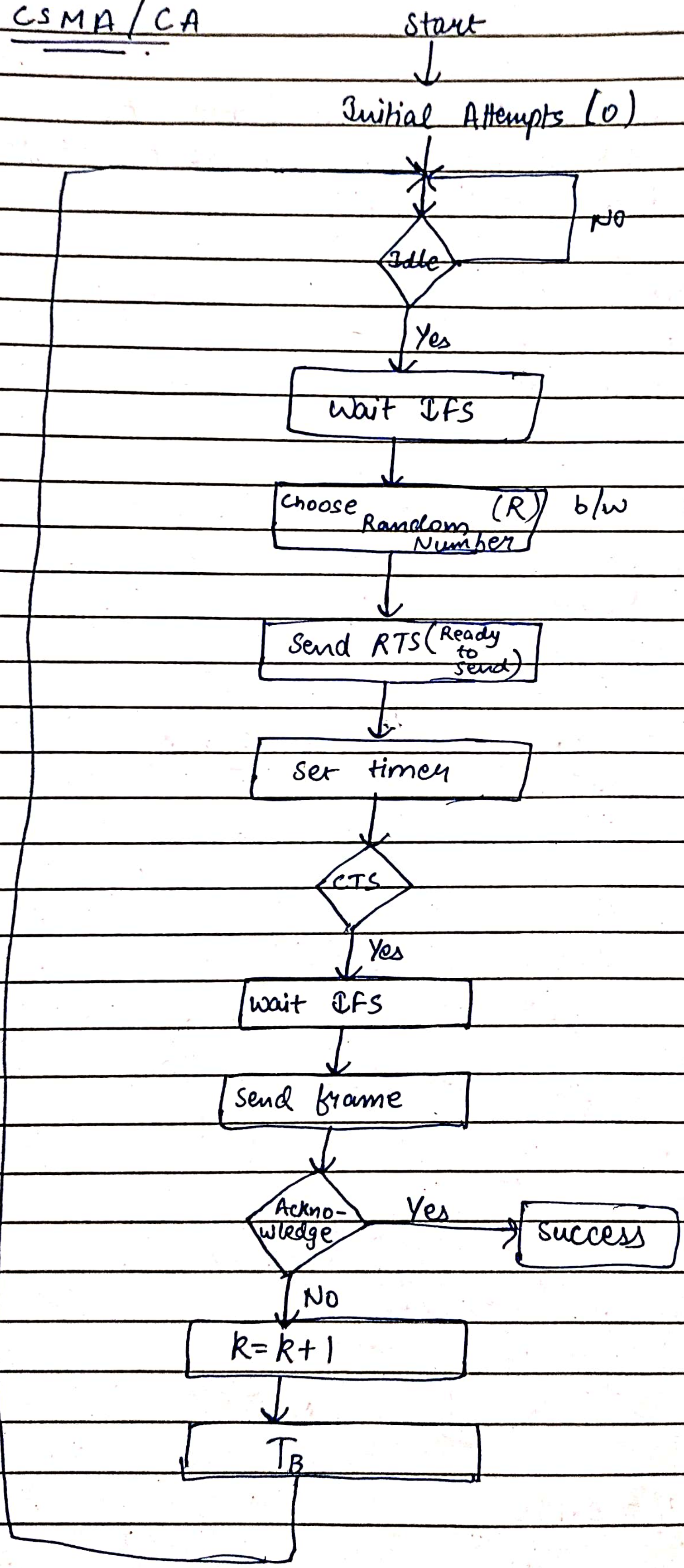
* CSMA/CA



b/w 0 to 2^R-1

If R=4
0 to 3 → It will wait for 3-time slots.

CTS → Clear to send

T_B = Backoff Population time.

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ALOHA

Q. A pure aloha n/w transmits 200 bit frames on a shared channel of 200 kbps. What is a throughput of a station [of all station together] produces :-

(i) 1000 frames per sec
(ii) 500 frames per sec.
(iii) 250 frames per sec.

Soln. (i) $\eta = G \times e^{-2G}$

Message = 200 bits
BW = 200 kbps

$$T_t = \frac{200}{200 \times 10^3} = \frac{1}{10^3} = 10^{-3}$$

1 sec = 1000 fram

$$1 \text{ milli sec} = \frac{1000}{10^3} = \cancel{\frac{10^3}{10^3}} = 1$$

$G = 1$

$$\eta = 1 \times e^{-2}$$

$$\eta = e^{-2} = \frac{1}{e^2} = 0.135$$

$\boxed{\eta = 0.135}$

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Throughput = $1000 \times 0.135 = 135$ frames

(ii) 500 frames/sec

$1 \text{ sec} = 500$

$1 \text{ mili sec} = \frac{500}{10^3} = \frac{1}{2}$

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

$\eta = \frac{1}{2} \times e^{-2(1/2)}$

$\eta = \frac{1}{2} \times \frac{1}{e}$

$\boxed{\eta = 0.184}$

Throughput = 500×0.184

= 92 frames

(iii) 250 frames/sec

$1 \text{ sec} = 250$

$1 \text{ mili sec} = \frac{250}{1000}$

$G = \frac{1}{4}$

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$$\eta = \frac{1}{4} \times e^{-2(1/4)}$$

$$\cancel{\eta = \frac{1}{4} \times}$$

$$\boxed{\eta = 0.152}$$

Throughput = 250×0.152

= 38 frames

Q. A slotted aloha n/w transmitts 200 bit frames using a shared channel with 200 kbps bandwidth. Find the throughput if the system [all station ~~together~~ together] produces:

(a) 1000 frames per sec
(b) 500 — " —
(c) 250 — " —

Solⁿ. $T_t = \frac{200}{200 \times 10^3} = \frac{1}{10^3} = 10^{-3}$

1 sec = 1000 frames

1 milli sec $= \frac{1000}{10^3} = 1$

G = 1

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(i) $\eta = \cancel{e}\, G \times e^{-G}$

$\eta = e^{-1} = 0.368$

Throughput $= 1000 \times 0.368$

$= 368$ frames.

(ii) $\cancel{\eta =}\ G = \frac{500}{1000} = \frac{1}{2}$

$\eta = \frac{1}{2} \times e^{-1/2}$

$=$

Throughput $= 500 \times$

$=$

(iii) $G = \frac{250}{1000} = \frac{1}{4}$

$\eta = \frac{1}{4} \times e^{-1/4}$

$=$

Throughput $= \cancel{500}\ 250 \times$

$=$

hello world

* LLC

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* Flow Control & Error Control
  - Detection
  - Correction

→ Two types of error → Single bit
→ burst error.

→ Error is detected with help of redundant bits.

→ 3 methods to check error
→ Parity bit
→ CRC (Cyclic Redundancy Check)
→ Check Sum

* Parity bit

→ We add a single bit at the end of the message.

→ Two types of parity → even (No. of 1's should be even)
→ odd (

⇒ ODD Parity → Total no. of 1's in code, including parity bit should be odd.

⇒ Even Parity → Total no. of 1's in code, including parity bit should be even.

odd

1	1	0	0	1	0

odd Parity bit

1	0	1	1	0	0	1	1

1	1	0	1	0	1	1	

→ Suitable for single bit.

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Note.

1	0	0	1	1				

Payload — Redundant bits

m + r

D + R = Code word.

* CRC

→ It is based on binary division.

→ It detects all errors which include single bit ~~or~~ burst error of ~~the~~ length equal to polynomial degree.

→ Total bits equal to m + r, where

m = no. of bits in message.
r = ~~redundant~~ no. of redundant bits.

→ To divide we use XOR.

→ In question, it may be in binary or in polynomial eqn.

→ Eg:- 11001 divisor

1010101010 dividend.

- $1 \cdot x^3 + 1 \cdot x^2 + 1 \cdot x + 1$

1111

- $x^5 + x^3 + x^2$.

1011

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Total bits in divisor

Eg:- 11001 divisor $5 - 1 = 4$

↳ Itni bit append karni hai divident ke saath.

1010101010, divident
$\underbrace{0000}_{\text{Data word}}$

In polynomial highest degree ~~ ~~ jitne 0 add ~~ ~~ hai.

Step 1:

→ In first step of CRC, we need to append at the sender's side.

→ If remainder is zero, then no error. If at least one 1 then error found.

(XOR use kiya hai)

~~1010101010, 0000~~

```
11001 ) 1010 10 10 10 , 0000
        11001
        011000
         11001
         0000011010
              11001
              00011000
                 11001
                 00 0010
```

→ 4 bits add kari thi, toh remainder bhi 4 bits lenge.

$\boxed{1010101010, 0010}$ DW + R

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Step 2 →

```
11001 ) 10 10 10 10 10, 0010
        11001
        011000
         11001
         0000011010
              11001
              00011001
                 11001
                 000000
```

∴ Hence, there is no error.

Q. Divisor has 10011 & divident 1101011111.

✱ Hamming Code

→ It is a error detection & error correction code.
→ Data can be of any length
→ No of parity bit is decided by,

$$2^r \geq m+r+1$$

→ eg:- $m = 1001$

$2^0 = 1$ ✓
$2^1 = 2$ ✓
$2^2 = 4$ ✓
$2^3 = 8$ ✓

$$2^3 \geq 4+3+1$$

3 PB

P_1
P_2
P_3

D_7	D_6	D_5	P_4	P_3	P_2	P_1
7	6	5	4	3	2	1

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Q. 1001 is to be transmitted. Construct even parity 7 bit hamming code for this data.

D_7^1	D_6^0	D_5^0	P_4	D_3^1	P_2	P_1

→ P_1 parity bit is deduced by checking all the bits with 1's in the least significant location.
→ P_2 parity bit is deduced by checking all the bits with 1's in the second significant location.
→ P_4 Parity ~~b~~ bit is deduced by checking all the bits with 1's in the third significant location.
→ P_8 parity bit is deduced by checking all bits with 1's in the most significant location.

$P_1 = 0$: $D_3\ D_5\ D_7$ = 1 0 1
$P_2 = 0$: $D_3^1\ D_6^0\ D_7^1$
$P_4 = 1$: $D_5\ D_6\ D_7$ = 0 0 1

	P_4	P_2	P_1
0	0	0	0
1	0	0	~~0~~
2	0	1	0
3	0	1	1
4	1	0	0
5	1	0	1
6	1	1	0
7	1	1	1

~~Step~~ Step 2. Error Detection

1	1	0	1	1	0	0
D_7	P_6	D_5	P_4	D_3	P_2	P_1

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Check

P_1	D_3	D_5	D_7	✓
0	1	0	1	
P_2	D_3	D_6	D_7	
0	1	1	1	
P_4	D_5	D_6	D_7	
1	0	1	1	

$\boxed{\begin{matrix} P_4 & P_2 & P_1 \\ 1 & 1 & 0 \end{matrix}}$

= 6

Correction

1001100

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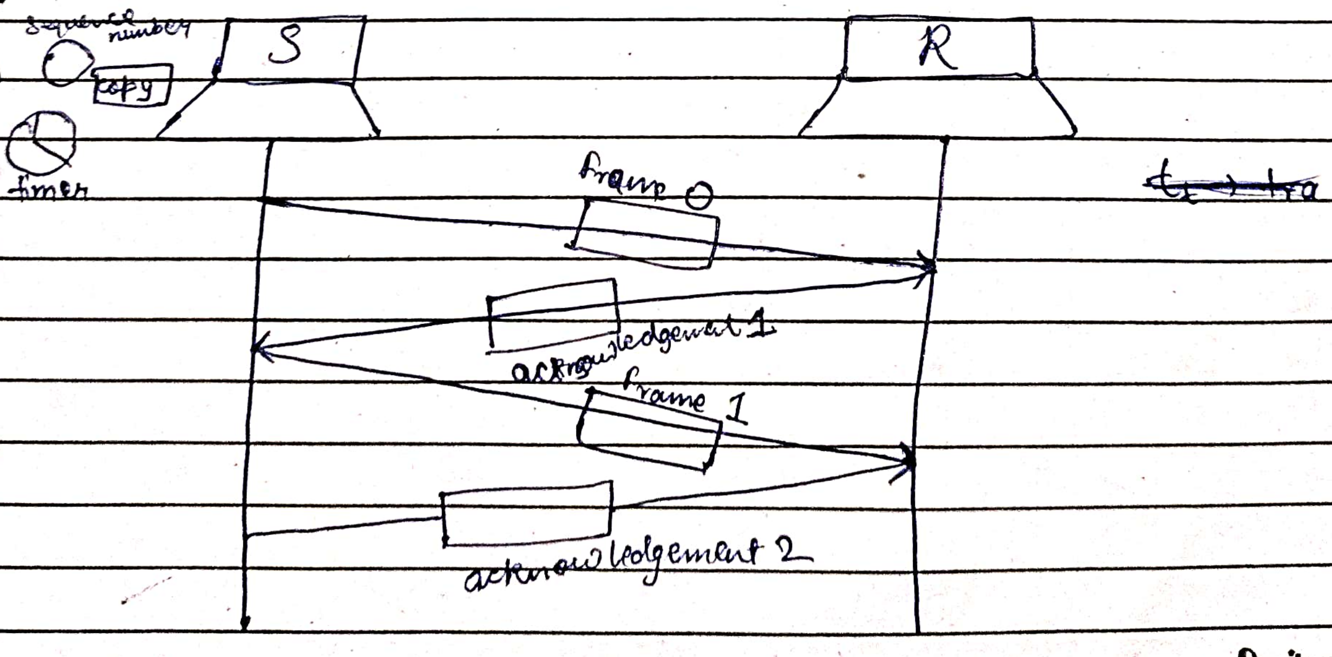
* Flow control

- Slide
- Stop & wait
- stop & wait ARQ (Automatic Repeat Request)
- Goback N
- Selective Repeat ARQ

⇒ Stop & Wait ARQ



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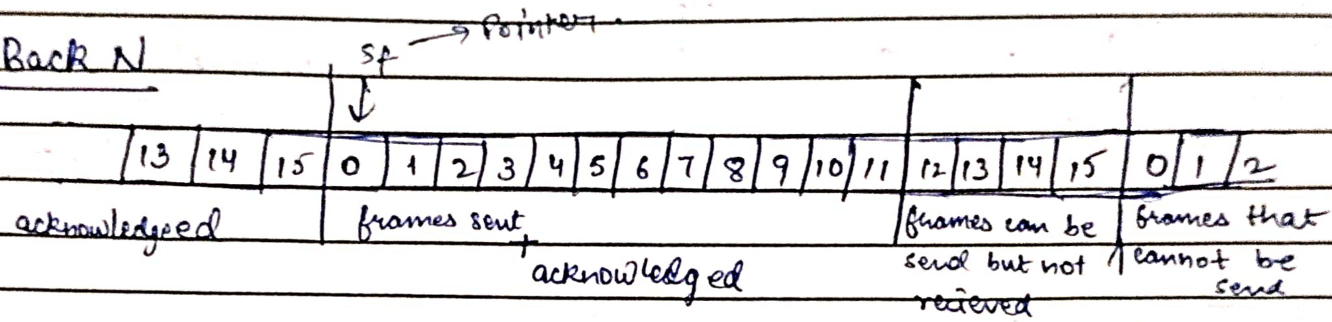
→ Total time $= T_t(\text{data}) + T_p(\text{data}) + T_{t(\text{ack})} + T_{p(\text{ack})}$

$= T_t(\text{data}) + T_p(\text{data}) + T_p(\text{ack})$

$= T_t(\text{data}) + 2 * T_p$

⇒ GoBack N



Window size

$= 2^m = 2^4 = 16$

$= 0 \text{ to } 2^{m-1}$

0 to 15