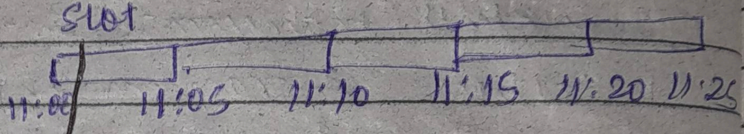
Stations are allowed to transmit at the beginning of any slot. Here time is slotted & let us say 1 slot is of 5 minutes. — SLOTTED ALOHA

time is continuous

जब frame है तब send
↓
Pure Aloha



11:01
यहाँ frame
Ready
Wait till 11:05 (beginning of slot)

Slotted Aloha

Definations:

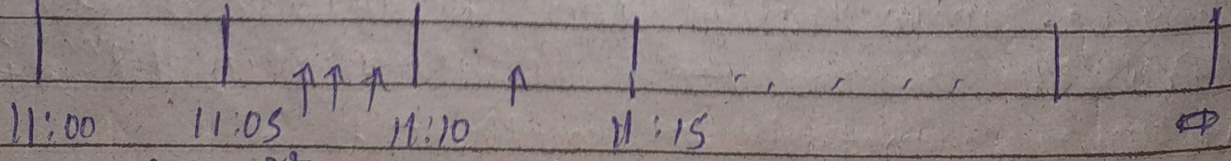
① Frame Time:- Time required to pump a standard size frame into the satellite channel.

Framesize = 1000 bits
Channel capacity = 200 bits/s
Frame time = 1000/200 = 5 s

② Channel Load ('G'):- mean no. of stations attempting for transmission per frame time, (not per second)

or

mean no. of newly & retransmitted frames arrives for transmission per frame time.



Avg. लगता है 1

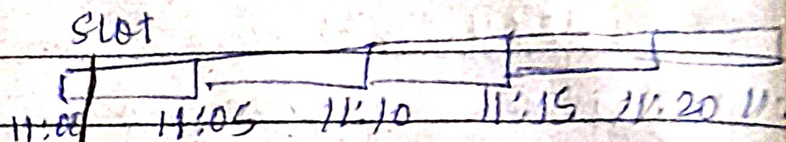
Stations are allowed to transmit at the beginning of any slot. Here time is slotted & let us say 1 slot is of 5 minutes. - SLOTTED ALOHA

time is continuous

जब frame है तब send

↓

Pure Aloha



11:01

यह frame Ready

Wait till 11:05 (beginning of slot)

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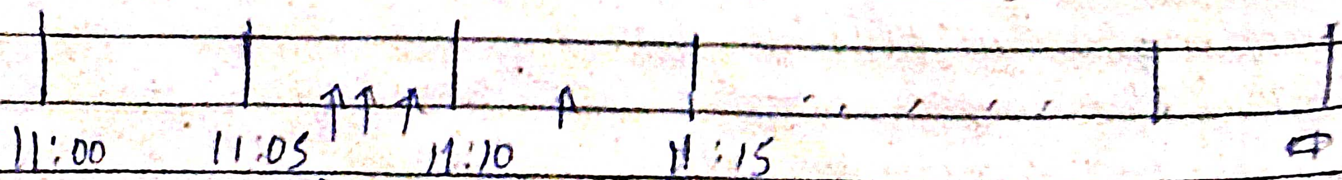
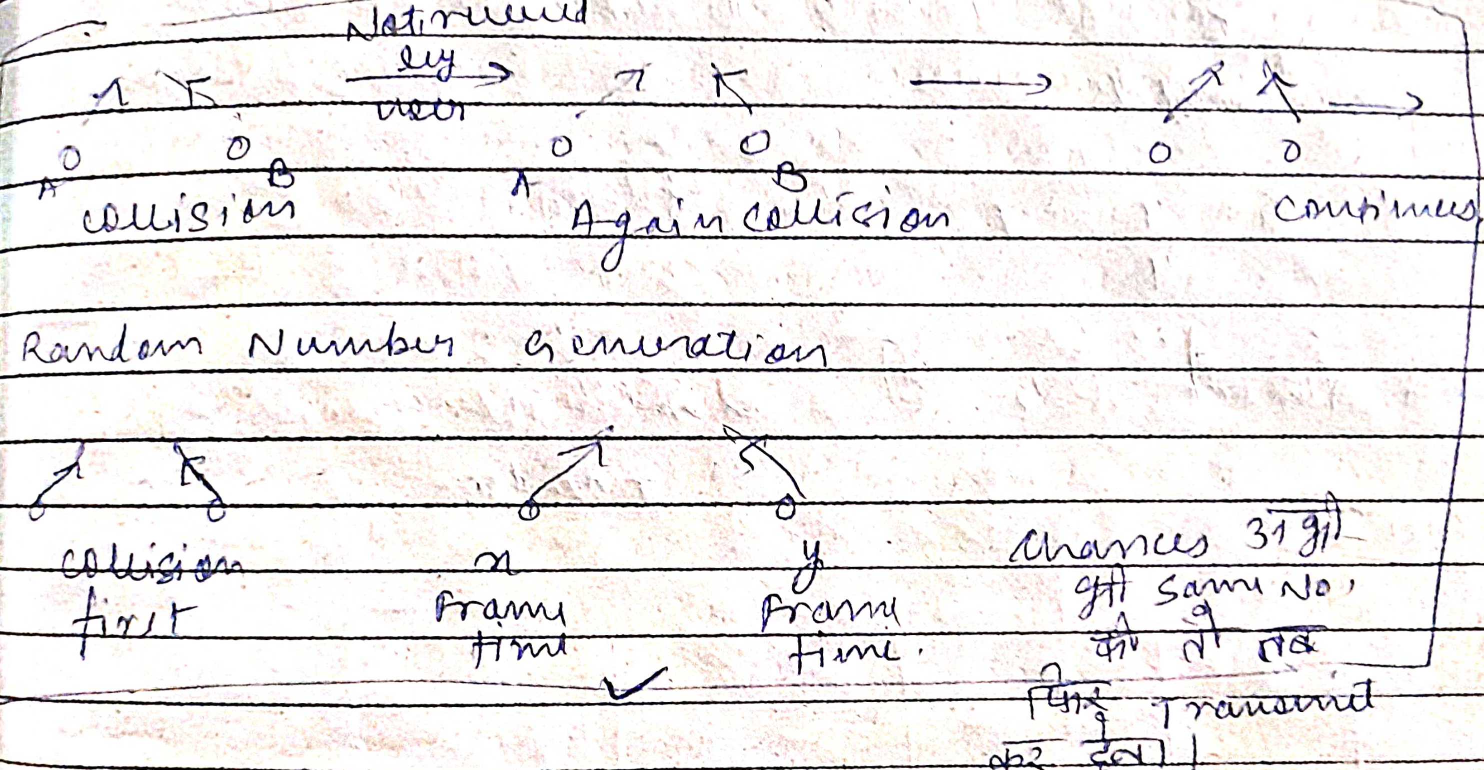
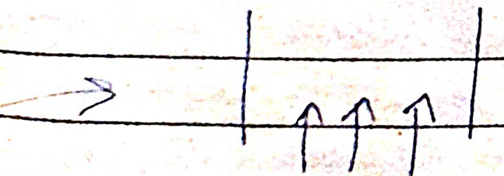


Avg. लगता है 1

06.09.2023
Wednesday

Aloha : Mother of all protocol.





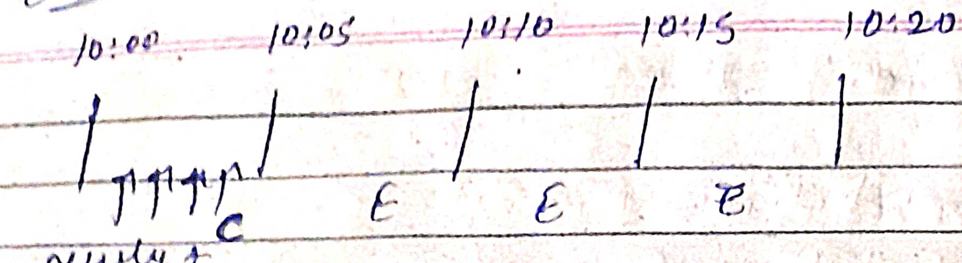
newly + retransmitted : जो तो जो पहले पर wait तो दोनों के कारण Collision रहा Transmission time आया आ रहा ∴ दोनों newly + transmitted are in defination.

③ ~~Channel~~ Throughput ('S') :- Mean no. of successful transmissions per frame time.

or

Mean no. of newly generated frames per frame time.

Case I :



E : Empty
C : Collisions

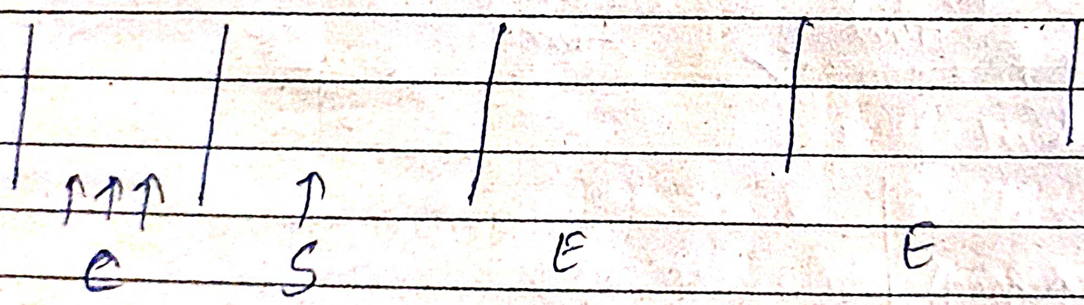
Really retransmitted

$G = \frac{4}{4} = 1$ $S = 0$

एक बार में एक ही collisions No one success

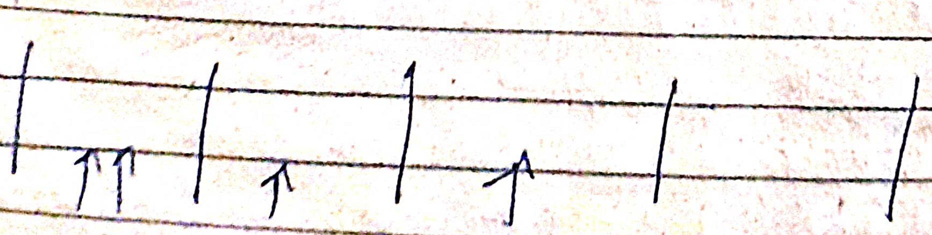
random no. > 10:20

Case II :



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

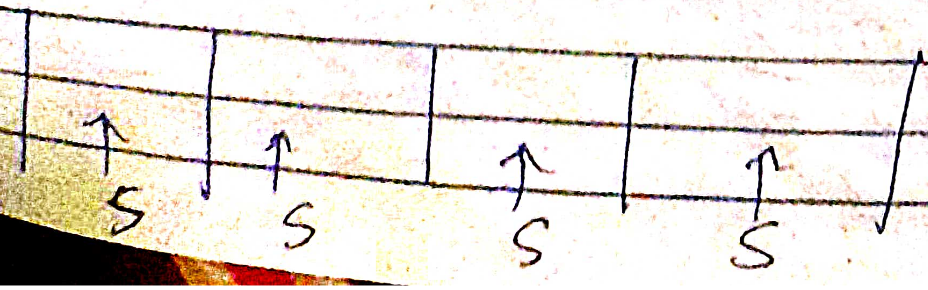
Case III :



$G = 1$

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

Case IV :



$G = 1$

$S = 1$

Turing test

Date:________ Page:________

$\boxed{S <= G}$

S == G — कितना load उतनी Successes

be or not

S > 1 ✗

G > 1 ✓

G = 0 ✓

$\boxed{S <= 1}$

Utilization → No unit

throughput → rate (per unit time)

Utilization = $\frac{\text{~~Channel~~ throughput}}{\text{~~Channel capacity~~}}$ → fixed

per unit कितने इससे successfully ~~भेज रहा~~ है

per unit कितना channel में send कर रहा है।

Utilization ∝ channel throughput

Sufficient load

x x x x x x

है

Stn Generate कर रहे हैं frames

जिसका successful transmission उसका है। Newly transmitted ~~है।~~ होगा

जिसका successful transmission हो ही buffer से पुराना frame हटा कर दूसरा frame रख सकता है।

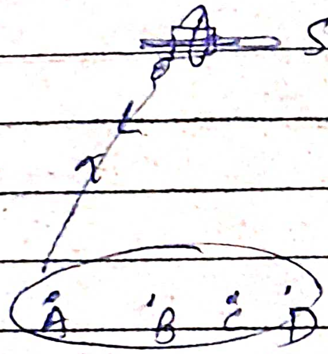
इस लिये S को दो Definition कर रहे हैं।

8) foot print ... is No effect on
we are not looking delivery error

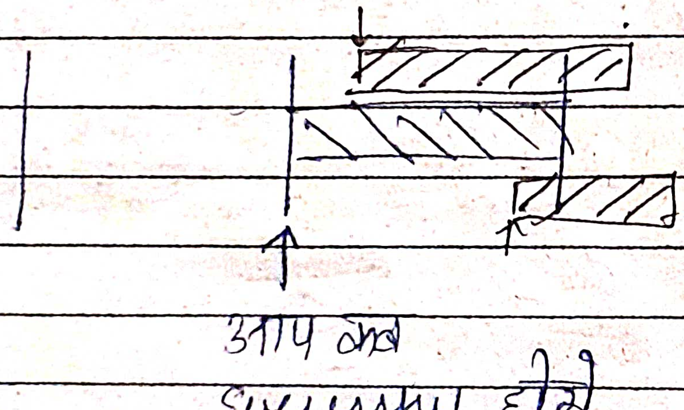
Date: Page:

Infinite Population Pure Aloha

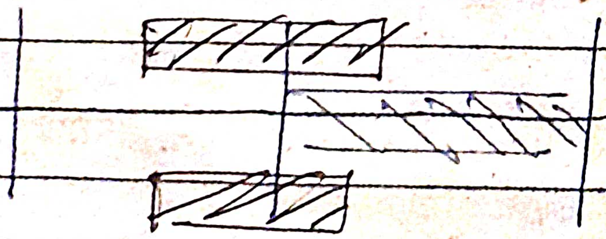
No concept of acknowledgement to check ~~corr~~ successful delivery



A अपना echo सुनेगा
If मिलता है तो
तो same होना चाहिये
∴ successful.



Vulnerable Period = Two frame time
Risk



$\boxed{S = G.P_0}$

↳ Probability of Success
↳ Channel load
→ Channel throughput

Intuition: Pass %age दिया है
And total student दिये हो
→ तो Pass students का Number : { Multiply of both }

Monday

Queuing Theory] Markov

Date: Page:

How "P_0" is calculated?

There is irregularity in C (on an average)

C C

C (on an average)

Random Distribution

Markov's Arrival Pattern M
Markov's Service Pattern m

(कौन आ रहा है कोई fix नहीं है)

M / m / 1

Type Type → No. of servers

(कितने Bank clerks service provide कर रहे हैं)

FIFO

Aloha can be considered as (M)/(m)/(1)

Modelling: Data Channel
Random Arrival & Random Source

Poisson's Formula:-

$$\boxed{P_n(t) = \frac{e^{-\lambda t}(\lambda t)^n}{\lfloor n}}$$

$P_n(t)$: probability that in time duration 't', there are exactly 'n' arrivals

λ: Mean Arrival rate

Long time तक Mean निकाला

लंबा समय For a long time observe करके देखना

Assume mean of

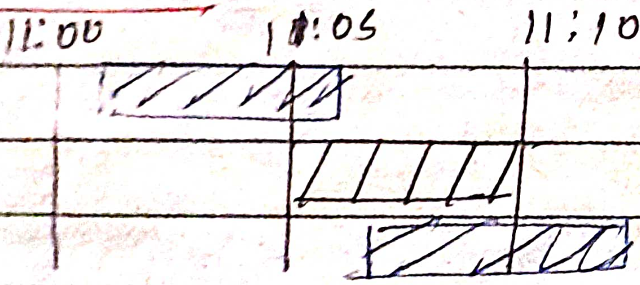
$\lambda = 10$ person / hr : 10 person in queue in 1 hour

P_{15} (2 hours) = ?

In time duration 2 hrs, what is the prob. of exactly 15 arrivals

$$P_{15}(2) = \frac{e^{-10\times 2}(10\times 2)^{15}}{\lfloor 15}$$

Pure Aloha



Vulnerable ~~time~~ Period = 2 frame time

Only एक instance पर होगा

P_0 (Pure Aloha) = No body should transmit in two frame time

$$P_0(\text{Two Frame Time}) = \frac{e^{-2G}(2G)^0}{\lfloor 0} = e^{-2G}$$

No of arrivals in 2 frame time

~~Vuln~~ $\boxed{P_0 = e^{-2G}}$ Pure Aloha Prob. of success

Only 1 in two frame time

इसका ही Answer होता उसका।

Q: Why this diff

$\boxed{S = G\, e^{-2G}}$ Pure Aloha

Channel utilization in pure or slotted Aloha depends upon load only.

What value of G will maximize S

$$\frac{dS}{dG} = \frac{d}{dG}\left(G e^{-2G}\right)$$

$$-2G e^{-2G} + e^{-2G} = 0$$

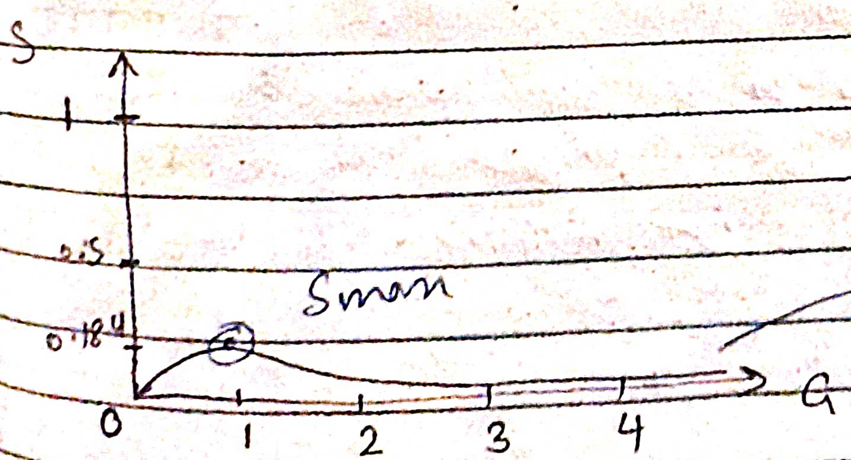
$$\Rightarrow -2G + 1 = 0 \qquad e^{-2G} = 0 \; ✗$$

$$\Rightarrow \boxed{G = +\frac{1}{2}}$$

→ ? ↓ जरता vulnerable period Type ↓ Only 1 load in 2 frame Time

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

$$\Rightarrow \boxed{S_{max} = 0.184}$$ frame / frame time



→ Asymptotic

S vs G graph

SLOTTED

12.09.2023
Tuesday

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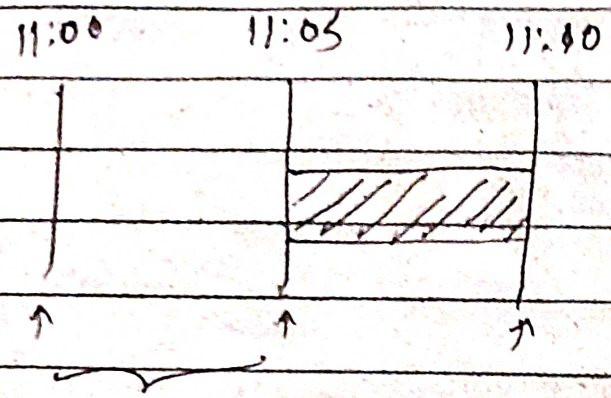
SLOTTED ALOHA

Assumption :- $\boxed{\text{Slot time} = \text{frame time}}$



· On start of each slot there is a ring.

ये वाले नहीं होने चाहिये ⇒ To be alone to send in 11:05 to 11:10

$\boxed{\text{Vulnerable Period} = 1 \text{ frame time}}$

$P_0(\text{one frame time}) = \dfrac{e^{-G}(G)^0}{\lfloor 0} = e^{-G} \Rightarrow \boxed{P_0^{(1\,\text{frame time})} = e^{-G}}$

G → avg. load in 1 frame time

$\boxed{S = G e^{-G}}$ Slotted Aloha

Q) What value of G will maximise S

$\dfrac{dS}{dG} = -G e^{-G} + e^{-G} = 0$

$\Rightarrow \boxed{G = 1}$

$\boxed{S_{max} = e^{-1}}$ at $G = 1$

$\simeq 0.368$

$(S_{max})_{slotted} = 2\,(S_{max})_{pure}$?

$\Downarrow$

$(P_0)_{slotted} = 2\,(P_0)_{pure}$

$\Downarrow$

$\left(\frac{\text{Vulnerable}}{\text{time}}\right)_{slotted} = \frac{1}{2}\left(\frac{\text{Vulnerable}}{\text{time}}\right)_{Pure}$

Channel Utilization is better in slotted rather in Pure Aloha.

But for comparision we need to compare ~~it wi~~ Delay also

$(\text{Delay})_{slotted} > (\text{Delay})_{pure}$ [extremely light wt load]

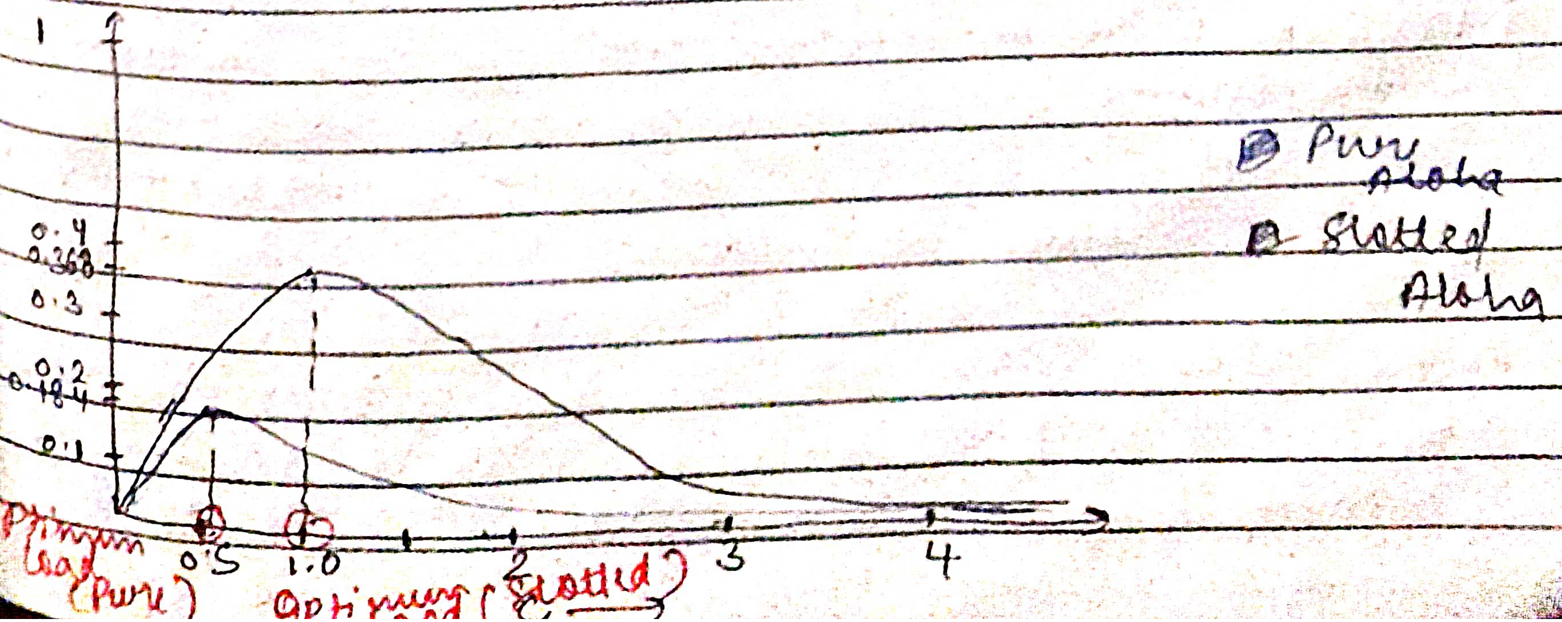
↓ Delay = 1 frame time

↓ तुरंत भेजना पड़ेगा ।

Delay = 0

There is tradeoff btn Slotted vs Pure

(TC vs SC type btn Channel Utilization vs Delay)



G > Optimum Load ⇒ Overload ⇒ S ↓ses
(Collision ↑ses)

G < Optimum Load ⇒ Underload ⇒ S ↓ses
(Not enough Load)

Q) Why curve is asymptotic ?
Sol: G कितना भी बड़ा हो। There is a possibility of frame having only 1 transmission ∴ Success (only at ∞)

Q) What is S in Slotted ?
Sol: ~~0.368~~ it is at Optimum Load
∴ It can be anything betn [0, 0.368]

Mean Number of transmission attempts for given value of G. (Slotted Aloha)
or Expected Number of transmission —"—

Let P_K is the probability that exactly K attempts are required to transmit a frame.

$$\underbrace{1, 2, \ldots K-1}_{\text{Failure}},\ \underset{\text{Success}}{K} \rightarrow K \text{ attempts}$$

Prob. of success $= e^{-G}$
Prob. of 1 Failure $= (1-e^{-G})$
∴ Prob. of (K-1) consecutive Failure $= (1-e^{-G})^{K-1}$

$$\therefore P_K = (1-e^{-G})^{K-1} \times e^{-G}$$

Mean number of attempts $= \sum_{K=1}^{\infty} K P_K$

$$= \sum_{K=1}^{\infty} K (\underbrace{1-e^{-G}}_{x})^{K-1} e^{-G}$$

$$y = x^0 + 2x^1 + 3x^2 + 4x^3 + \dots \infty$$

$$xy = x + 2x^2 + 3x^3 + \dots \infty$$

$$y(1-x) = x^0 + x + x^2 + x^3 + \dots \infty$$

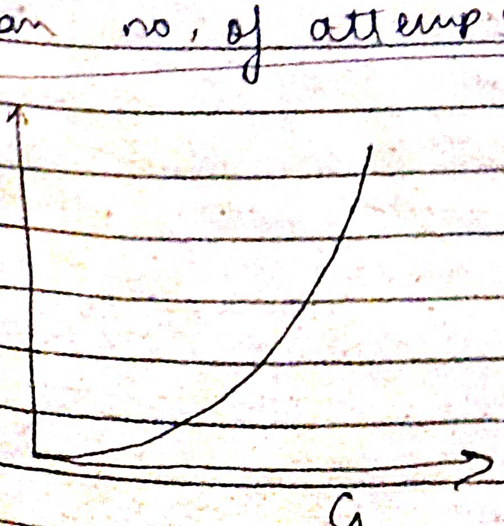
$$= \cancel{1} \quad \cancel{(1} \quad \frac{1}{1-x} \quad \cancel{1-x} \quad \frac{1}{(1-x)^2}$$

$$\Rightarrow y = \frac{1}{(1-x)^2} \Rightarrow \frac{1}{(1-1+e^{-G})^2} = \frac{1}{e^{-2G}}$$

$$\boxed{\text{Mean number of attempts} = \frac{e^{-G}}{\cancel{(1-e^{-G})^2}\; e^{-2G}}}$$

$$\boxed{\text{Mean no. of attempts} = e^{G}}$$

S



G

Growth is exponential

Q) Consider a slotted Aloha protocol & calculate % slots which are empty, which are in collisions and which are successful for $G = 0.5$, 1 and 2

Sol: $S = Ge^{-G}$

~~(i) $G = 0.5$~~

~~$S = 0.5\,e^{-0.5} = 0.3032$~~ ~~30.32~~ (in %)

~~(ii)~~

~~69.67 %~~

C E

P_E (one fram

G	S	C	E
0.5	30.32	9.8	60.60
1	36.8	26	36.8
2	27	59	13.5

S

~~exactly~~
+
exactly
1

P_E(one frame) = P_0(1 frame)
$= e^{-G}$

P_1(frame time) $= P_S = \dfrac{e^{-G}G}{1!}$
$= Ge^{-G}$

$P_C = 1 - (P_E + P_S)$

(i) $G = 0.5$
$P_E = e^{-1/2} = 0.606$
$P_S = 0.303$
$P_C = 0.098$
Underload
$P_E \uparrow$ and $P_C \downarrow$

(ii) $G = 1$
$P_E = e^{-1} = \frac{1}{e} = 0.368$
$P_S = 1 \cdot e^{-1} = \frac{1}{e} = 0.368$
$P_C = 0.26$
Optimum load
$(P_S)_{max}$

(iii) $G = 2$
$P_E = e^{-2} = 0.135$
$P_S = 2e^{-2} = 0.27$
$P_C = 0.59$
Overload
$P_E \downarrow$ and $P_C \uparrow$

.1.2023
Wednesday

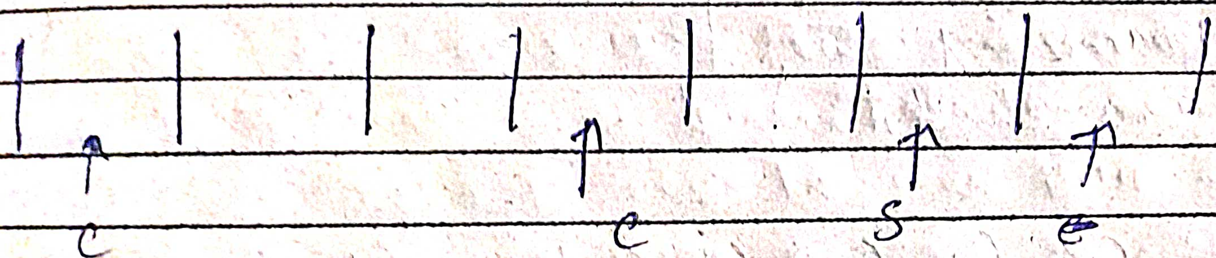
G : Channel load

Date:________ Page:________

FINITE POPULATION SLOTTED ALOHA

Let no. of stations are N.

Load of Station 'i' (G_i) :- ① Mean no. of frames generated by station 'i' per frame time. It includes new & retransmission frame.



$G_i = \frac{4}{7}$

$\boxed{(G_{max})_i = 1}$ Rare but prob. is there.

(only 1 Buffer & one transmission per buffer)

$\boxed{G_i \le 1}$

G prob

or

② It is the prob. that station 'i' will transmit in a particular frame time.

Throughput of Station 'i' (S_i) :- ① Mean no. of successful transmissions per frame time of station 'i'.

$S_i = \frac{1}{7}$

$\boxed{S_i \le G_i}$ Equality when continuous successes

$(S_{max})_i = 1$

② It is the prob. that station 'i' will transmit successfully in a frame time.

Date: Page:

$G_1 + G_2 + G_3 + \ldots + G_i + \ldots + G_N = G \longrightarrow$ (I)

(Summation of individual station loads) (Channel load)

Similarly,

$S_1 + S_2 + S_3 + \ldots + S_i + \ldots + S_n = S \longrightarrow$ (II)

Individual का जोड़ा तो total,

When we pass? (Successful)

- मैं Transmit करूं।
- बाकी Transmit ना करें।

$$S_i = \underset{\substack{\downarrow \\ i\text{th will transmit}}}{G_i} \underbrace{(1-G_1)\cdot(1-G_2)\ldots(1-G_n)}_{\text{Others will not transmit}}$$

$$\Rightarrow \boxed{S_i = G_i \prod_{\substack{j=1 \\ j \neq i}}^{N} (1 - G_j)} \longrightarrow \text{(III)}$$

Let $G_1 = G_2 = G_3 = \ldots = G_n \longrightarrow$ (IV)

$S_1 = S_2 = S_3 = \ldots = S_n \longrightarrow$ (V)

Using (III), (IV) in (I) & (II):

$G_i = G/N \longrightarrow$ (VI)

$S_i = S/N \longrightarrow$ (VII)

equal load & success

put in (III):

$$\frac{S}{N} = \frac{G}{N} \prod_{\substack{j=1 \\ j \neq i}}^{N} \left(1 - \frac{G}{N}\right) \Rightarrow \boxed{S = G\left(1 - \frac{G}{N}\right)^{N-1}}$$

जब Slotted वा Pure किया हो &
किया Number of Stations नहीं हो Then Infinite.

Date:______ Page:______

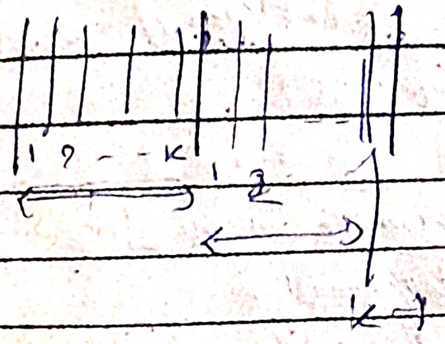
If we put $N \to \infty$ (Infinite Population Slotted Aloha)

$$\boxed{S = G e^{-G}}$$

Assignment

Q) In a slotted Aloha system, frame time is divided into k-slots, Station can start its transmission at the beginning of any slot, Develop the relation b/w S & G. And also discuss the cases when $k \to \infty$ & $k = 1$.

Sol.



$(2k-1)$ slots

1 frame G

k slots G

$1 \text{ slot} = \frac{G}{k}$

$(2k-1)\frac{G}{k}$

$$S = G e^{-(2k-1)G/k}$$

$$-\left(\frac{2k}{k} - \frac{1}{k}\right)$$

$k = \infty$

$S = G e^{-2G}$

Pure

$k = 1$

$S = G e^{-G}$

Slotted

$$\frac{dS}{dG} = \cancel{G(N-1)\left(1 - \frac{G}{N}\right)^{N-2} \times \left(-\frac{G}{N^2}\right) = 0}$$

$$= -G\left(\frac{N-1}{N}\right)\left(1 - \frac{G}{N}\right)^{N-2} + \left(1 - \frac{G}{N}\right)^{N-1} = 0$$

$$\left(1 - \frac{G}{N}\right)^{N-2}\left[-G\left(\frac{N-1}{N}\right) + 1\right] = 0$$

$\frac{N-1}{N} + 1$

$\frac{1}{N} =$

18.09.2023
Monday

Date: Page:

CARRIER SENSE MULTIPLE ACCESS (CSMA) PROTOCOL

Two reasons of ~~major~~ collisions :-
1. Wireless channel in Aloha
2. Network span is of very large area

CSMA designed for LAN (Local Area Network)
1. Network span is of few kms (0.5km, 1 km, 2km) (दूर न जाएंगे ।)
2. Copper cable is used for transmission. (Wired Chan

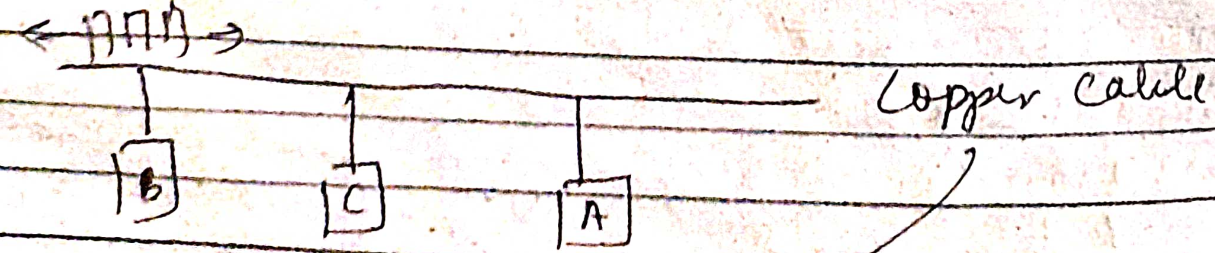
Multiple Access → multiple stations are sharing common channel.

Carrier Sense → Any station should sense the channel for carrier before transmission & if somebody is transmitting signal (Carrier), then do not transmit yours.

↳ voltage के through पता चल जाएगा ।

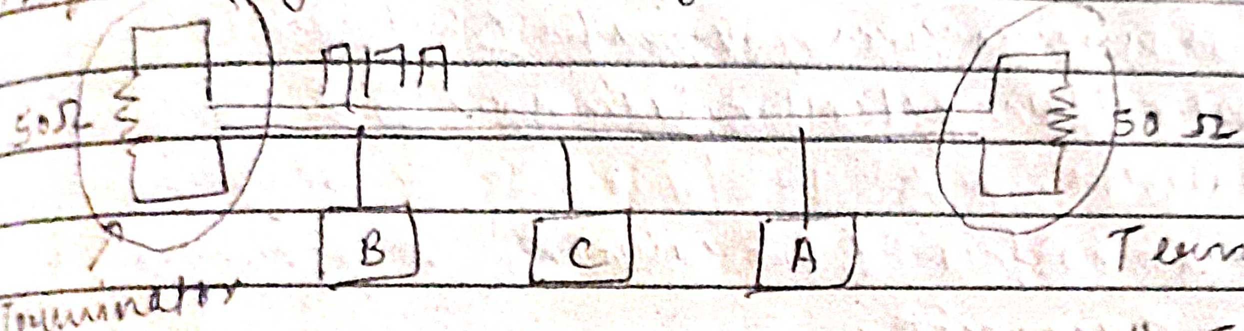
Collision is reduced but not zero.
Contention Protocol

In Aloha, we can sense carrier.



copper cable (2 wires)
(230V) (Signal level) ——— 6V) (230V
0V (~~Neutral~~ Ground) ——— Ground Neutral

These 2 ~~ree~~ wires are not
open circuited or short circuited at end
They are joined using Resistance



I^2R
Losses
Heat Sink
to Engine

At end of bus we are connecting

Internal Impedance $= 50\Omega$ of wire
Load (Terminator Resistance) $= 50\Omega$
By Max. Power (transfer) Theorem,
$R_i = R_L$
$\therefore$ 50Ω is kept $R_{Terminator}$

B will send data along with address bits of A
then all will get this data.
After reading add^n of A, A will accept the
data & other will ignore it.
To prevention collision of bits after returning
from ends we use terminator to end those
signals

① Non Persistent CSMA ② One — " — ③ P-Persi...
— " —

① **Non Persistent CSMA :-**

Before transmission, ~~signal~~ stations should sense the channel for ~~transmission~~ carrier and if

(i) channel is free (No carrier ~~is~~ present)

Then transmit.

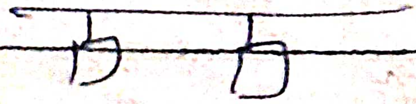
(ii) If channel is busy then wait for random amount of time. & goto step (i)

(iii) (optional step) If collision is found (because of lack of acknowledgement) then wait for random amt of time & goto step (i)

Ack. वाला concept नहीं है और हो भी सकता है
collision हो तो Receiver should inform sender to transmit again.

Collision can occur

दोनों को free मिला



If 2 or more stations find channel free
- Then 100% collision

② **ONE Persistent CSMA** (Greedy Approach)

Before transmission, Station should sense the channel for carrier & if

(i) channel is free (No carrier)

Then transmit.

Date:______ Page:______

(i) If channel is busy, then continuously sense the channel until it becomes free & then transmit.

(ii) (Optional step) If collision is found (because of lack of acknowledgment) then wait for random amt. of time & goto step (i).

Ex- Busy (देखा) → more Alert.

If 2 or more ~~find~~ stations find channel free → Then, 100% collision

If 2 or more stations find busy then too 100% collision

Reason - ~~सब~~ सब के लिए same Rules.

∴ Sensing increases collision.

Practically not used.

In light load, One persistent better than Non persistent

But in CN, Burst Load is maximum no of times.
↳ (Heavy + light Load)

Non Persistent CSMA is better than One persistent CSMA

③ P-persistent CSMA -

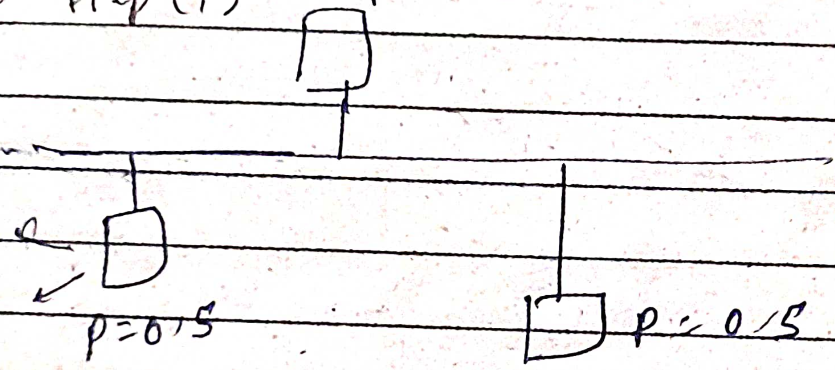
Before transmissions, station should sense the channel for carrier & if

(i) Channel is free then transmit with probability 'p'
(P: probability of success)

and defer the operation by 1 slot with probability
1-p (prob. of failure)

② If channel is busy, then continuously sense the channel until it becomes free & then goto step 1.

③ (optional step) If collision is found (because of lack of acknowledgement) then wait for random amt of time & goto step (1)



random number from 0 to 1

↙ ↘

<=0.5 — Then transmit

>0.5 — wait for 1 slot

No transmission
T — random no > 0.5
H — random no <= 0.5

~~Resolution = 0.01~~
~~can be any~~ any

0.43 — pvalue

0.76 → random no. — pvalue

pvalue < random no
∴ Success

	A	B	
	T	T	E 1/4
only one is transmitting	T	H	S 1/2
	H	T	S
	H	H	C 1/4

Total no rand

Whether the channel is free or busy, there are chances of success

Better results of channel utilization in this case.

If 4 channels are transmitting then do p = 0.25
considering "equal probability" i.e.,

Non Persistent CSMA

$<= 0.25$
$0.25 < p <= 0.5$
$0.5 < p <= 0.75$
$0.75 < p <= 1$

most probable

For 10 station
do
$n = 0.1$

Set value of 'p' correctly

$p = \frac{1}{n}$
n: No. of ready stations

p

0.7 — 0.1

बहुत Stations आएंगे
ज्यादातर Collision

Overestimation of p

Load ↓se
ज्यादातर Empty
Delay ↑ses

Underestimation of p

→ Since, we can't implement this practically, as we can't find no. of ready stations.

In computer Networks, Load is bursty (continuous changing)

There are certain networks which you can study. (months / years / days)

Pattern study of computer networks

कब कम है कब ज्यादा।
↳ p ज्यादा
↳ p कम

कुछ Pattern हो तो तभी हम लगा सकते हैं।

Office heirarchy

Boss के लिए → p value ज्यादा → better prob. of success

Least priority के लिए → p value कम → more no. of tries

$$S = G(1 - G/N)^{N-1}$$

$$\frac{\partial S}{\partial G} = (1 - G/N)^{N-1} - G\frac{(N-1)}{N}\left(1 - \frac{G}{N}\right)^{N-2} = 0$$

$$1 - \frac{G}{N} = \frac{G(N-1)}{N}$$

$$\frac{N-G}{\cancel{N}} = \frac{G(N-1)}{\cancel{N}}$$

$$N - \cancel{G} = GN - \cancel{G}$$

$$\boxed{G = 1}$$

Acknowledgement is not implemented practically. CSMA/CD is used.

CSMA/CD ⟶ practically implemented

Collision Detection

↳ each station has electronic based circuitory (collision detection circuitory) which can sense voltage fluctuation but this is activated only when for station which are transmitting.

On collision is detected — (Aftermath

(1) ~~Both~~ immediately stations, should stop their transmission ~~[illegible]~~ of remaining data of frame [saving time of channel] System performance

Date: Page:

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CSMA/CD

→ practically implemented

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(1) ~~Both~~ immediately stations should stop their transmission ~~there~~ of remaining data of frame [saving time of channel] system performance ↑

→ thin wire

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Jamming signal (Analog signal)

↳ Low BW required

↳ These are transmitted by stations those were transmitting

↳ Termination circuitory would end this too

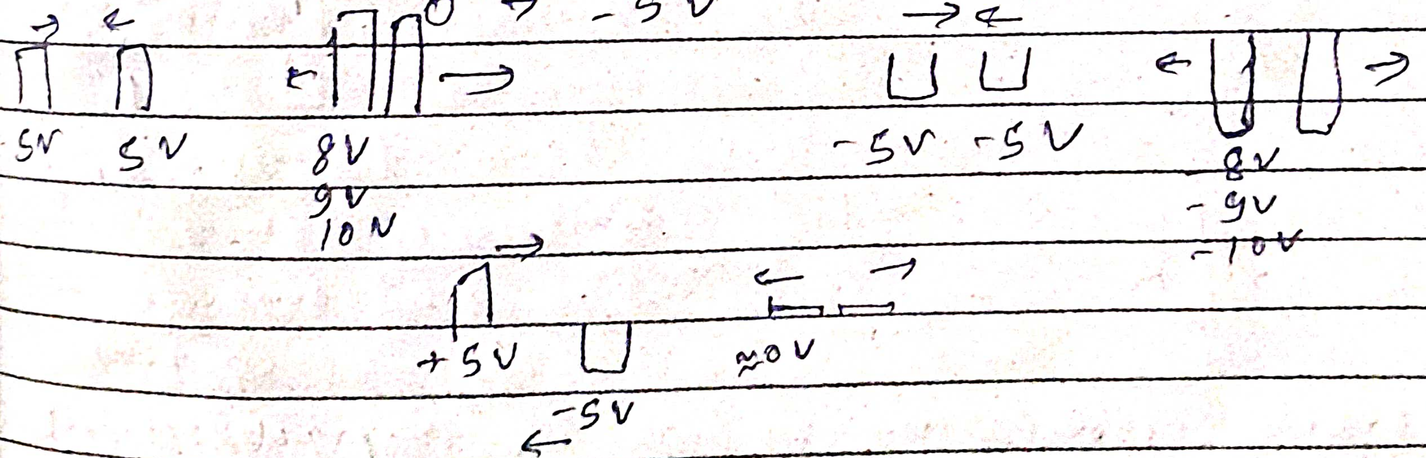
even if they overlapped then too it is jammed

wait for random amount of time & then follow CSMA rules.

voltage fluctuation — two signals collide

1 → +5V

0 → -5V



How to select range of random numbers?

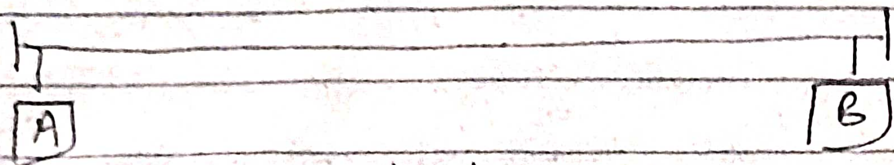
→ Practically implemented in all CSMA protocols.

BINARY EXPONENTIAL BACKOFF ALGO

Collision count 'n' = 1

Range of random number = 2^n → Binary exponentiation

n changes (↑ses) ∴ 2^n ↑ses



dist : 'd' metres

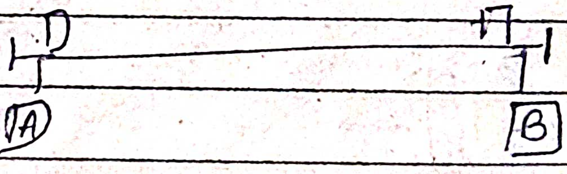
Speed of light : 'v' m/s

Frame size : 'L' bits

Channel capacity : 'R' bps

Q) Worst case time for station A or B to detect the collision

Sol: $\frac{2d}{v}$



Just before reaching B

B transmits

$$\boxed{\frac{L}{R} \geq \frac{2d}{v}}$$

$\boxed{\text{Frame Transmission time} \geq 2 \times \text{Propagation Delay}}$

only d is can change, v is same

2/3 (C)

No protocol can be used in "Real Time Applications"

Giving the guarantee of upper bound of time when the work will ...

(पुराना DLC)

Data Link Layer { | LLC | → Logical link Sub layer
| MAC | → Medium Access Control Sub layer (common channel)

LAN ~~का~~ ~~are~~ standard's is made by IEEE 802 series

802.1 :→ Just definations of terms of LAN

802.2 :→ LLC (Logical Link Layer)

802.3 : Ethernet (CSMA/CD) more than 90% LAN

802.4 : Token Bus

802.5 : Token Ring

⋮

802.11 : Wireless

⋮

CONTENTION FREE PROTOCOLS

TOKEN RING (802.5)

→ Physical Ring Topology

Repeaters :- Repeaters ~~are~~ is a device which is used to retain amplitude & shape of the transmission symbol by regenerating it. It is a physical layer device.

10 base 5 → Thick cable → हर Segment के बाद Repeater

10 Mbps ↓ Base band

5 → Segment length (500m)

max length = 2.5km

2 ends के बीच मे 4 Repeater हो सकते है

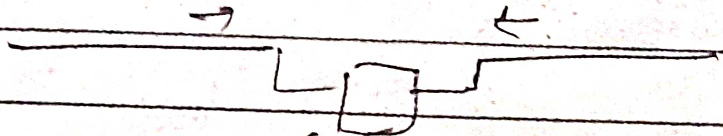
p positions not a good idea
for hospital case
prob. of collision.

10 base 2
↳ 200m segment

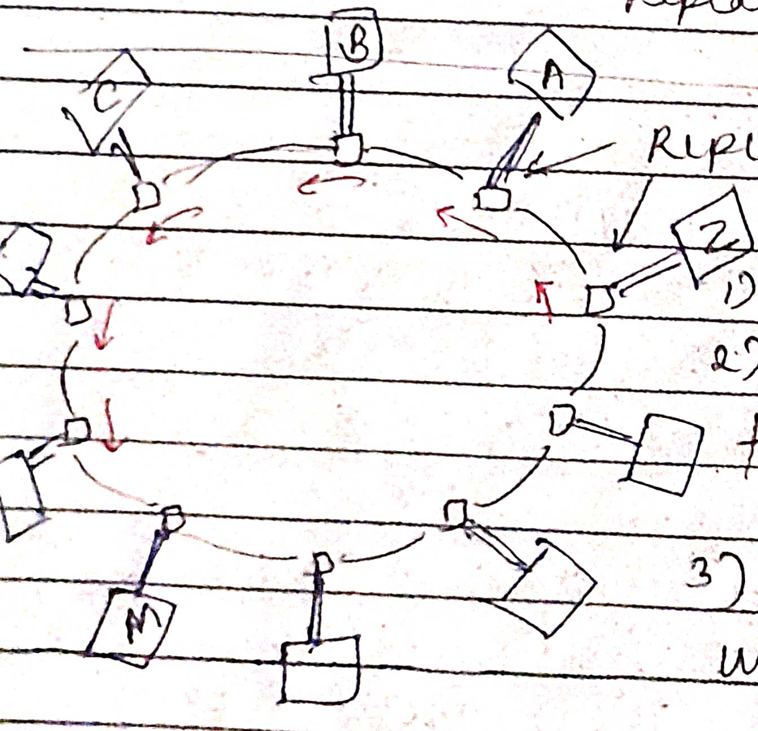
(Beneficial) even when length ↓ses

Coaxial cable
(Hub & Switch in place of repeater)

* Repeaters are bidirectional in Bus.

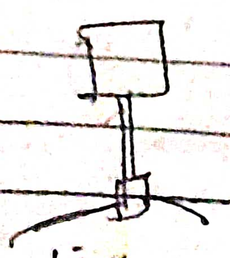


Repeaters

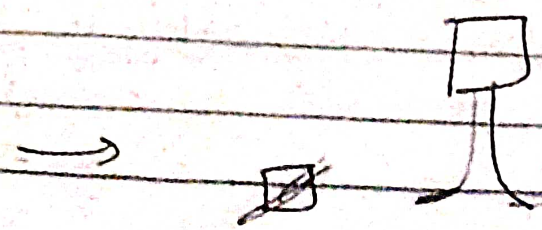


1) Repeaters are unidirectional
2) All repeators are aligned to follow either clockwise / anticlockwise
3) Repeaters have two mode of working, connected ~~connected~~ computer will decide the mode of repeater
(i) Listen mode (Default)
(ii) Transmit mode

All computers are connected through repeaters.



Listen mode



Transmit mode

जब हो Transmit करना And
जो हो data हो
Not accept करना

(Src & Sink behind)

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Only station can change the mode of Repeater.

Token : Token is a ~~special~~ bit pattern that will never be a part of any frame.

Let Token be 11111

↳ That means 5 1's can never be part of frame.

To ensure that no data contains this token we use technique — Bit Stuffing

In one segment only 1 bit will be there ↳
↳ Basic Token Ring.

Say M is master station (say)

Additional duties

When ~~sw~~ network is switched ON

M has to make itself in Transmit mode

& transmit Token bits.

& after transmitting ~~has to go in~~ listen mode.

A has grabbed the token

A will corrupt the token by inverting the last bit

& change its mode to transmit mode.

Send the fixed size Data Frame.

(first Destination address)

in S/W

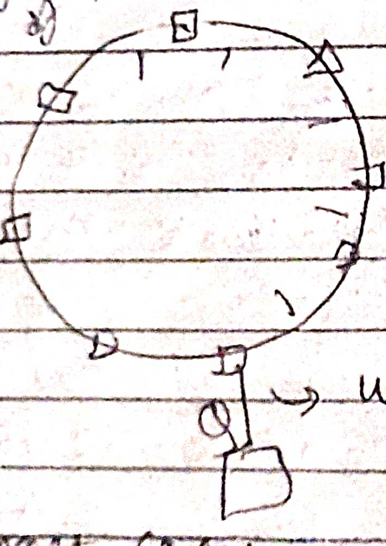
Then after sending, regenerate Token.

When to regenerate Token

1) Immediately after last bit of data frame
2) Release token after getting back 1st bit of data frame.
3) Release token after draining out entire data frame.

Real time systems: Gives upperbound of time

A grabs



→ When last bit of token passes Q, ~~A~~ then Q wants to transmit

Worst case: सब को Transmit करेंगे।

⊙ Utilization is good.
Reason: Heavy load, सब transmit करना चाहते हैं। Then there will be min. overhead of transmission token bits, max. time in Data transmission

⊙ Delay is bad.
Reason:- If last token bit passes & then you are ready for transmission,

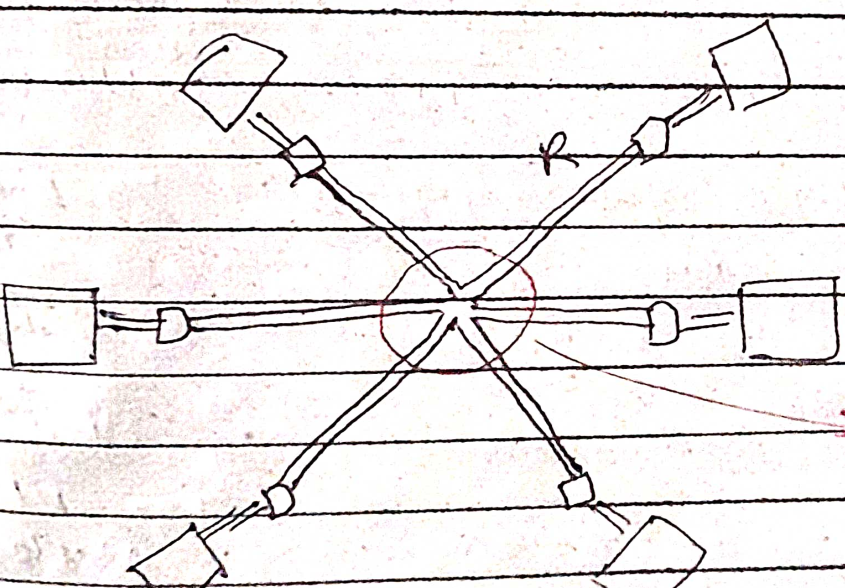
10. 202
Tuesday

Date:________ Page:________

WIRE CENTRE

It is used for early detection & early isolation of faults (Not for improving performance (~~throu~~ utilization & delay))

Repeaters are not that reliable (practically)
even if एक भी Repeater खराब हुआ तो पूरा N/W बंद हो जाएगा।
Engineer (N/W) को हर जगह पर check करना पड़ेगा।



Ring topology only

→ Wire centre

...ly
initial
cost

~~Advantage~~:
Uses:- ① Checks ~~to~~ which repeater is fault

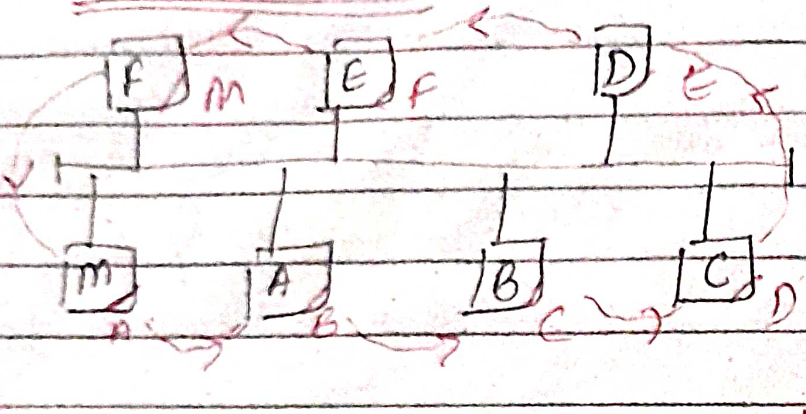
Test

② Isolate this repeater by joining other wires

Disadvantage: Wire cost bright
length of channel (traditional) $= 2\pi R$
Let 'N' stations are there.
Then length of channel $= 2NR$
Clearly $2NR > 2\pi R$

Although Robustness increases

TOKEN BUS (802.4)



Although Bus but Logical Ring is formed.

each station stores addr of other stations (one only) (stored in memory space initially)

M is a master station

Token Packet → | DA | Token |

Destn addr — Bit pattern

created by master when n/w is ON

Broadcast this message.

Only entertain by A here & others ignore.

Bit stuffing concept is there

→ predefined for all stations in a n/w

If A wants to send message then A will send fixed size data packet

DA ⇒ can be of any station

Data ⇒ Standard size

Data packet | DA | Data |

Once done, A will transmit "Token Packet" further

| DA | Token |

B 11111

Token Ring के Repeater → Complex Circuitory

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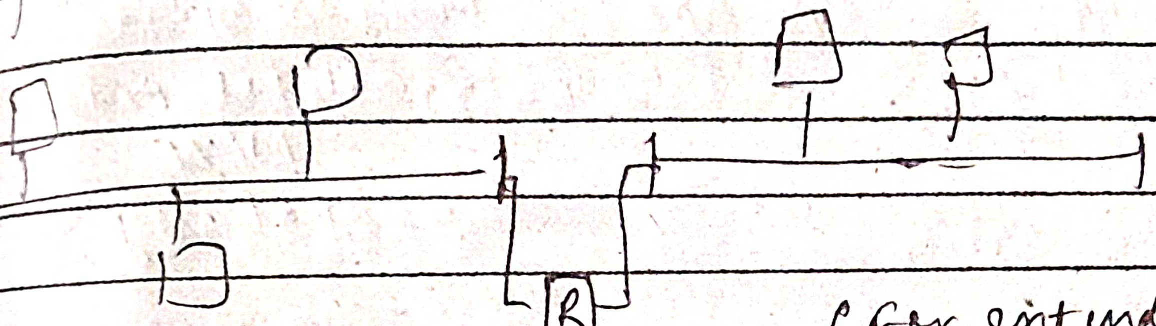
Token Bus physically is a Bus for data transmission only & logically a Ring for token transmission.



Repeaters (for extending network cable lengths)

↳ Normal circuitory

इसमें Repeater बहुत कम है चार ही हैं

problem आती है stations में | ② stations खराब हो जाएं |

M के अंदर Time out mechanism (worst case)

M में Table है (master) — हर station पर कहाँ से Token आना है And हर station कहाँ पर Token

Control Packet

M सबको CP भेजेगा Hello Packet "Hello how are you"

तो सबको बताना पड़ेगा "I am fine"

FDDI Fiber Distributed Digital Interface
(IEEE 802.6)

Token Ring

It is used in MAN (across cities) & not LAN
↳ Metropolital Area N/W (Bhopal city)

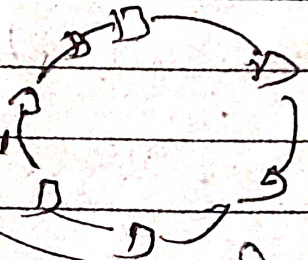
Optical Fiber Cable is used

Dis Advantage:

① It is used in point to point N/W
[Reason: there are light signals]

Ring physically is several point to point lines but overall it serves as multipoint.

② Delicate ③ Costly ④ Complicated maintenance



Splicing (Trained people equipment more time)

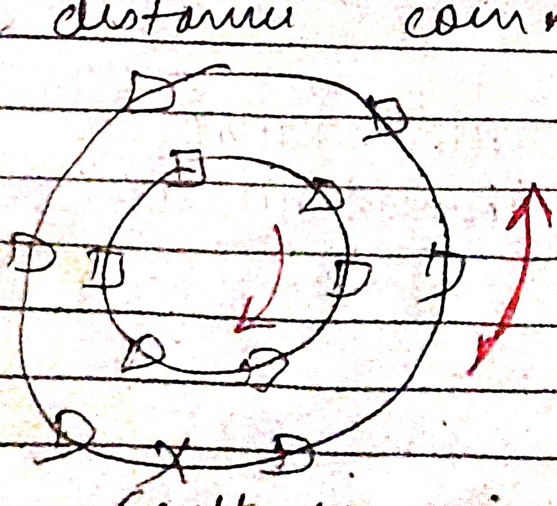
Advantage

① Very less error / noise

② High data rate in OFC

③ Long distance communication

Same can be OFC implemented

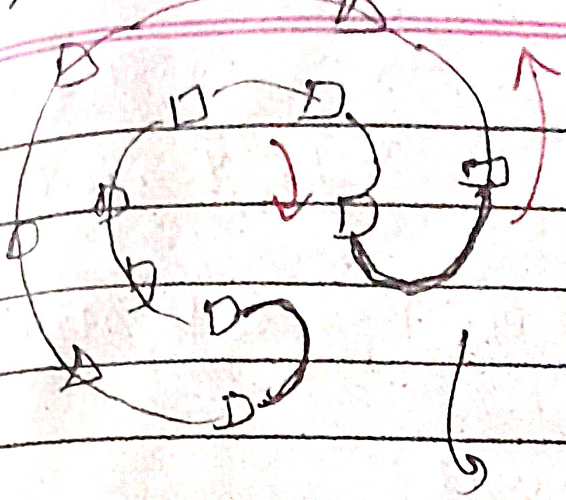


Fault in wire

We use two rings.

→ Reason: To improve reliability. To reduce downtime.

2023 wednesday



Single Ring

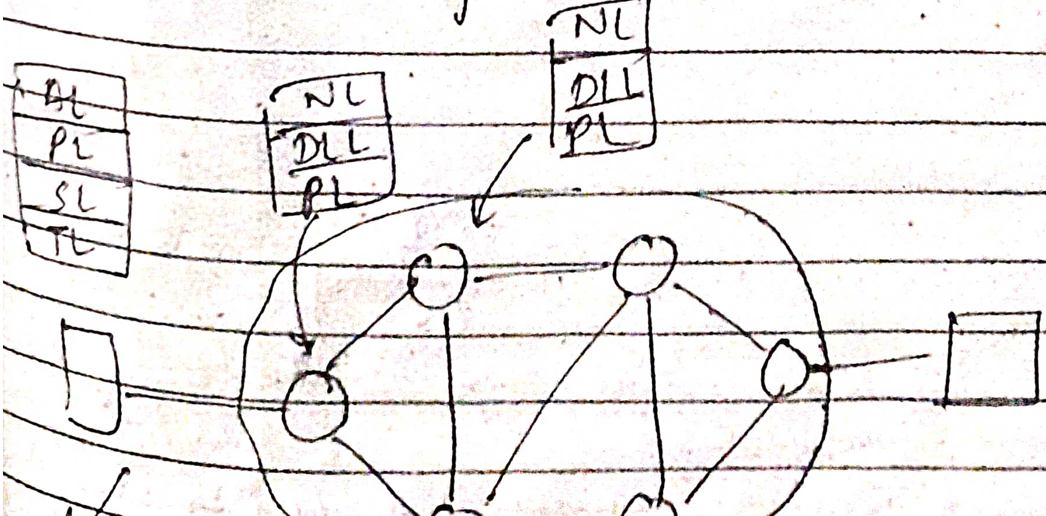
, keep token flow in outside & inside ring as opposite

एक ही Direction में है तरह ।

~~WAN & protocols~~ so far...

Wide Area N/W does not use these techniques.   ↳ Multiplexing ~~How~~ bandwidth is used

All WAN are point to point topology
each section is possessed by / owned by by 2 points only
Channel is full duplex.



Phone will DLL & PL in both this but they are different from router to router

CRC & Error detection codes

Host & Router dist^n तक

Routers & Routers रहता dist^n ⟶ Prob. of errors रहता

↳ Protocols in this is PPP (Point to Point Protocol)
(House & ISP)

↳ Complex rules are required.

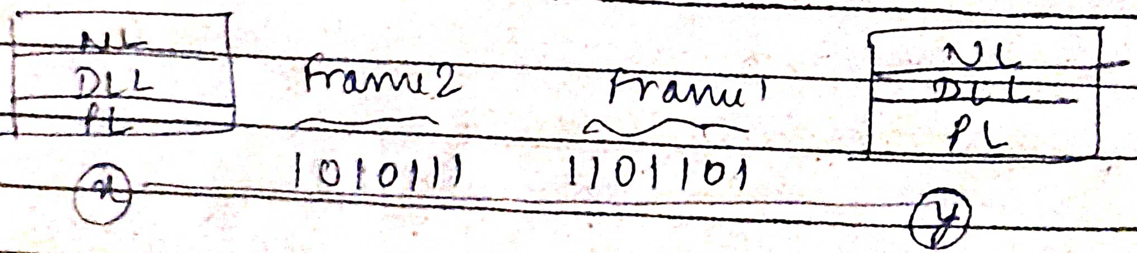
TPDUs पर Routing decision & then adding header is called Packet & is passed to NL from TL

• E2 Section मे DLL काम करेगा Error Control & Flow Control.

पूरे N/W मे DLL ~~दो~~ Pts ~~अ~~ के बीच मे होती है। ∴ Different rules.

Data Link Layer :-

① **Framing:**



Framing: Sender & Receiver will be able to do something else / identify the boundaries of frames. wait ~~that they~~
(to check CRC & parity bit)
to get the header.

↗ Not a practical approach.

~~Character~~ Counter → counting no. of bits as frame is of fixed size.

But it is not void.

Reason:

1) Max. Frame size = Decided (upper bound) every frame not possible.
2) Few bits can be lost in a noisy channel उसके आगे सबमें error हो सके

Method

Start bits	Frame	Stop bits
$\boxed{\ }$ 0111110	$\boxed{\qquad\qquad}$	$\boxed{\ }$ 0111110

Start & Stop is agreed by both. * Agreement

How can be ensure that these pattern is not in data?

Same problem as Token.

BIT STUFFING To make sure start & stop bit (~token) should not repeat in data.

Data: 0111011110111110111110

Start $\boxed{0111110}$ $\boxed{0}$ $\boxed{0}$ $\boxed{0}$ Stop $\boxed{0111110}$

हर चार one के बाद एक zero डालेगा ही।

Receiver हर चार one के बाद वाला zero Remove करेगा ही।

16, 10, 2023 Monday.

modular 2 division

Date: Page:

Bigger Start & Bigger stop then no. of stuffed bits are less

& vice versa for opposite.

There is a tradeoff betn Start & Stop bits & no. of bits stuffed.

In betn 6 bit 1 01111110

If I am sending sparse data means only zero then send 0 1110 → type less no. of bit stuffing

& also size of start & stop bits pattern less.

& Just opp. if I am sending 1's then make start & stop as 100001 type less bit stuffed.

Error control (CRC).

Flow Control

∴ We need to make sender fast.

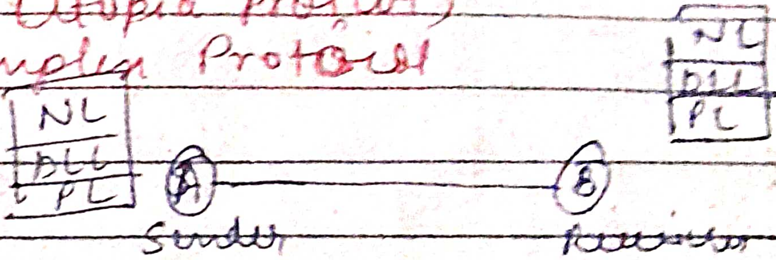
Protocols No. रटे याद 2 रखनी)

→ Same in Transport Layer

Error & Flow Control Protocols :-

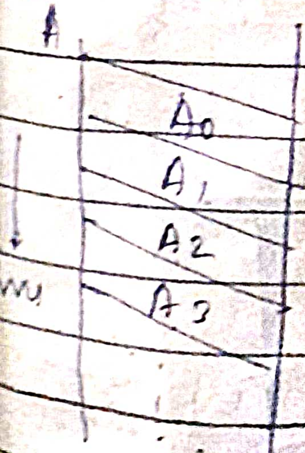
Not real ← (Utopia protocol)

Protocol #1 : Unrestricted Simplex Protocol



Assumption / condition
- Data Traffic is simplex
- Channel is noise free
- Both sender & receiver have infinite (large) no. of buffer
- Receiver has infinite (very high) processing speed.

No protocols for error control (channel is noise free)
No protocols for flow control (Infinite buffers)
[Unrealistic ~~can~~ situation]



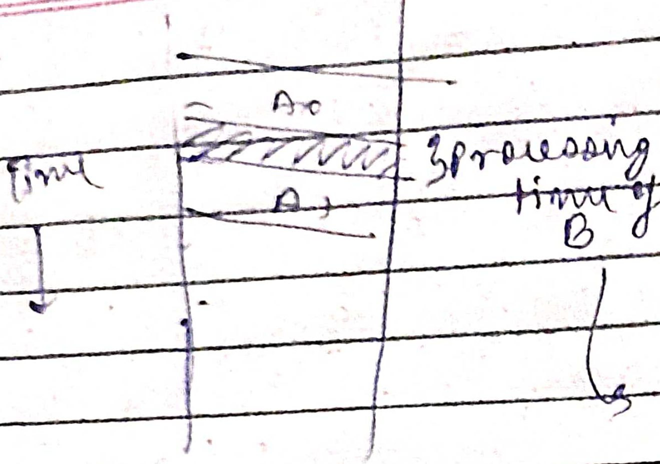
A के A0 भेजने के बाद A नहीं सोचेगा
की ना रुकेगा
कोई check ही नहीं है।

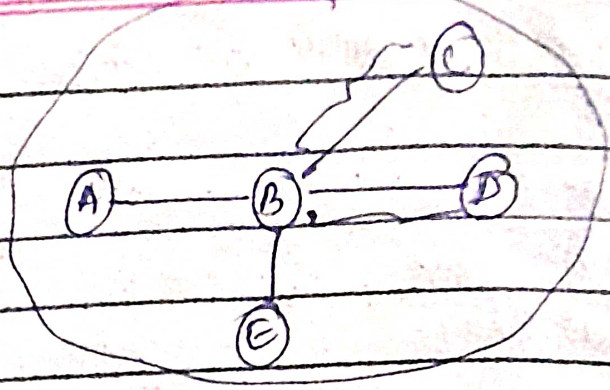
Protocol #2 : Stop & Wait Protocol → Only Data from A to B, Ack from B to A

Assumption (channel is ~~half~~ duplex)
- Data Traffic is simplex
- Channel is noise free → No error control mechanism required.
- Both sender & receiver ~~has~~ has 1 Buffer each
- Receiver has finite & limited processing speed.

③ & ④ ⇒ There can be overflow
∴ Flow Control Mechanism

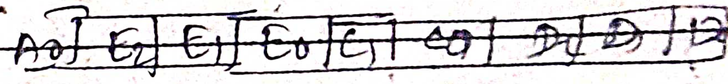
Overflow
- Either overwrite the frame
- Or discard the incoming frame

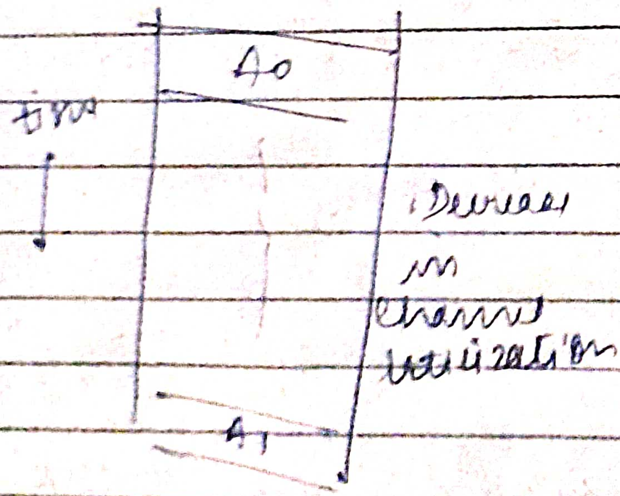


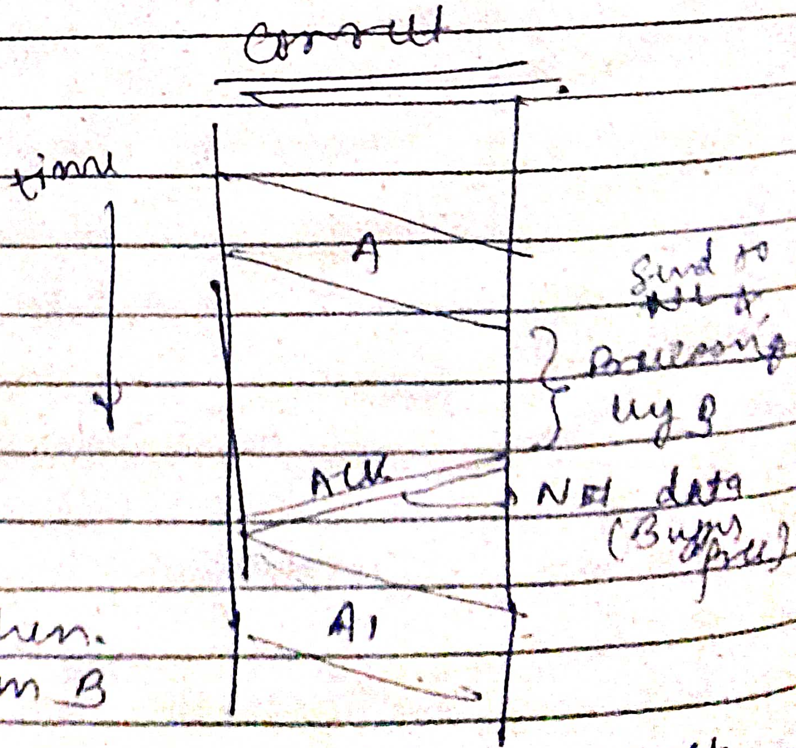


But this can't be calculated since we don't know processing time

Even if we know this time (Although we can't know) then channel utilization would decrease.







A will send frame & then wait for Ack from B

i.e. Stop & wait

Better than worst case at each time

Traffic is simpler because we are only sending data from A to B and rather

"Ack" from B to A which is not "data"

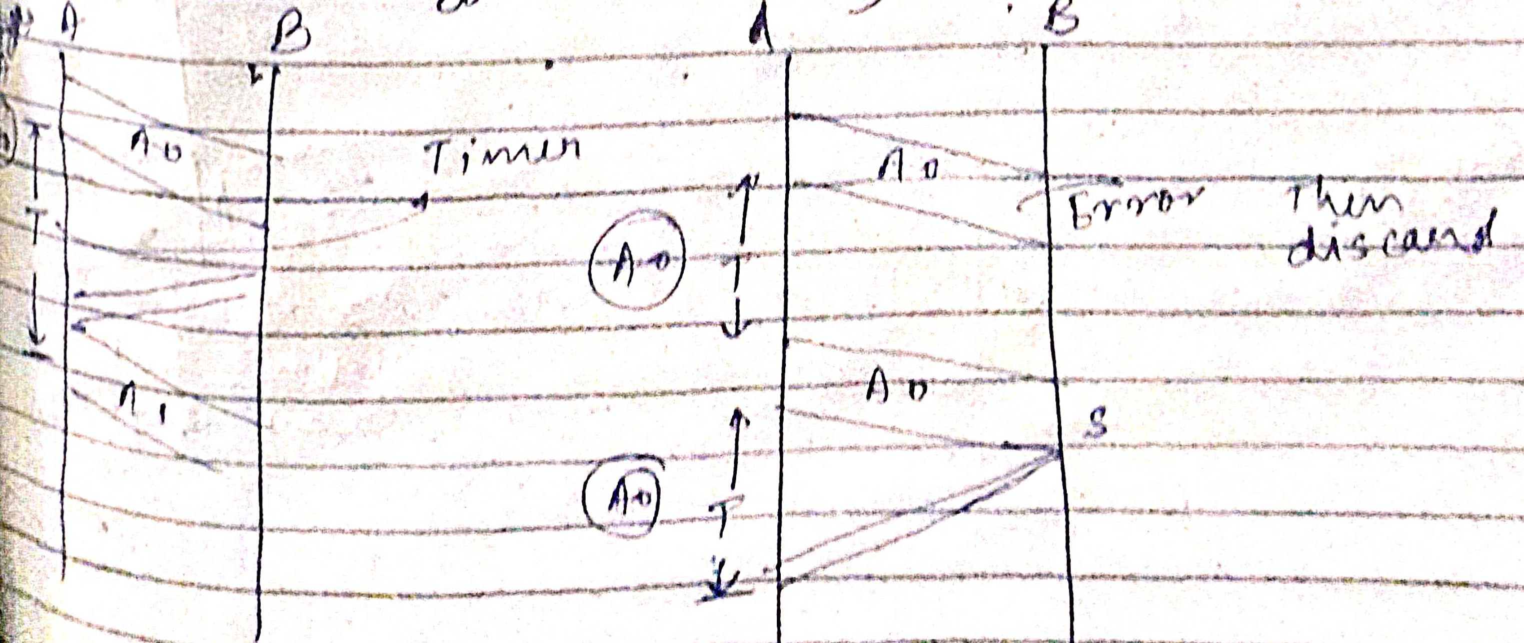
Protocol #3 : Stop & Wait Protocol (Noisy channel)

Assumption :-

1. Data Traffic is simplex.
2. Channel is noisy. } error control
3. Both sender & receiver have 1 buffer each } flow
4. Receiver has limited processing speed. } control

error can be identified easily using "CRC method"

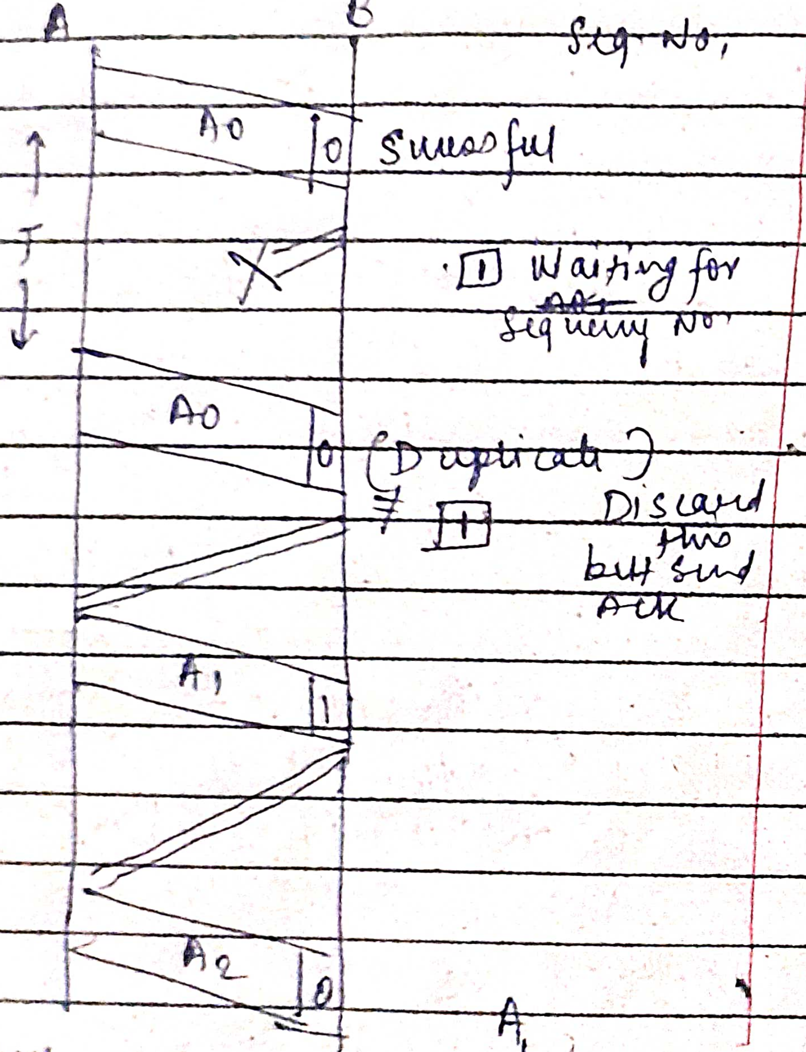
After receiving a frame by receiver,
Receiver will send "Ack" after checking 2 cond:
(i) Frame error free. (ii) Process it to NL & buffer
(A का तक Buffer में रहेगा)



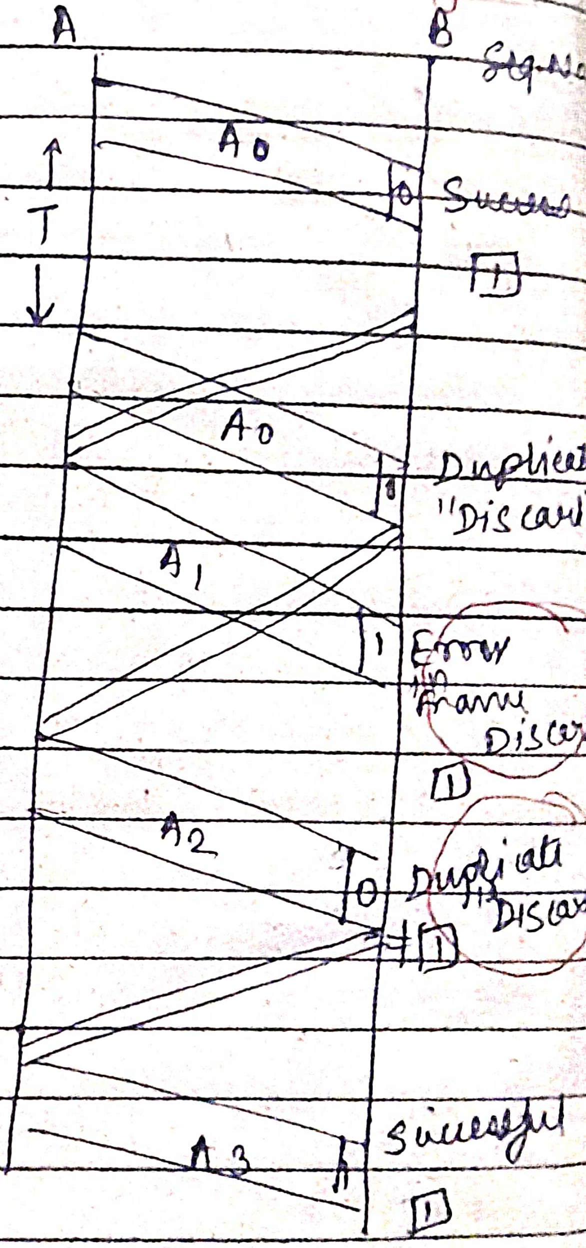
T: Time out interval

Sequence No. { Alternate 0 & 1

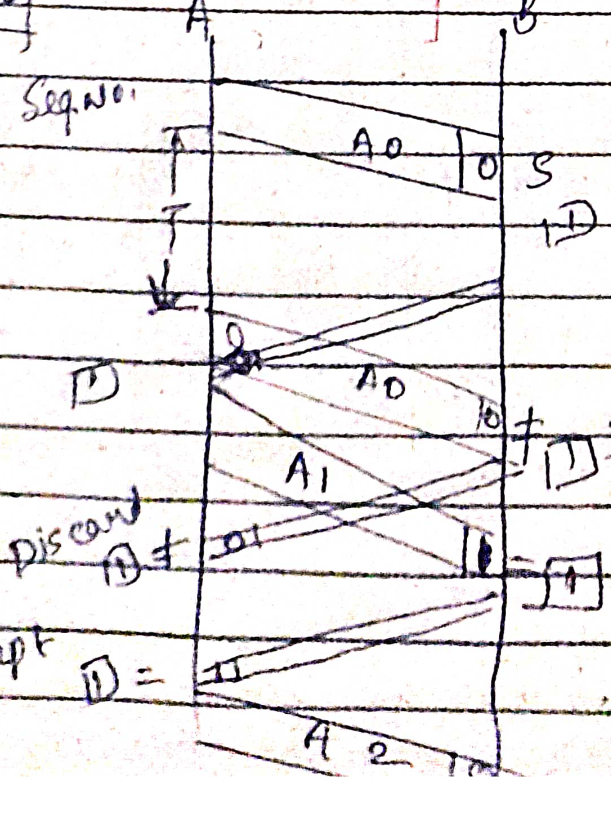
Case 1: Ack is lost



Case 2: Ack is Delayed



Same for frame has error



A1 & A2 are lost

Solution: put same sequence No in Acknowledgement

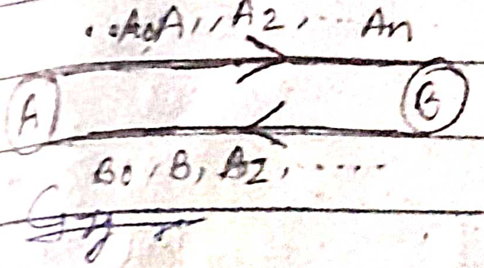
Problem Solved

2023
Wednesday

Sliding window protocols

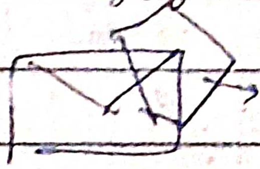
...ing window Protocols [Protocol #4, #5 & #6]

[Data Traffic is Duplex]



A0, A1, A2 ...
B0, B1, B2 ...
} replaced by Ack in any one then Prot. #3

"Piggybacking"

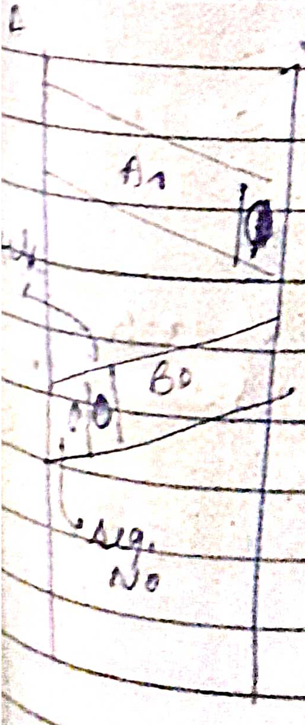


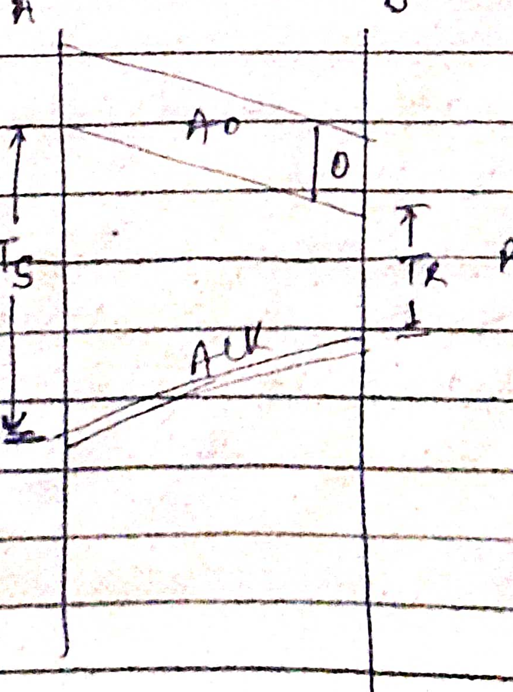
→ Acknowledgement card.

→ Acknowledgement is a part of data frame. [possible, when traffic is duplex]

Overheads of sending "Ack" individually is prevented by 'Piggybacking' - Improving efficiency of protocol.
Store & Forward time, Src & Dest-add^r of Ack.

Ack is merely a "Sequence Number"





Receiver wait कर रहा है for Data पर नहीं पहुँचा तो ...

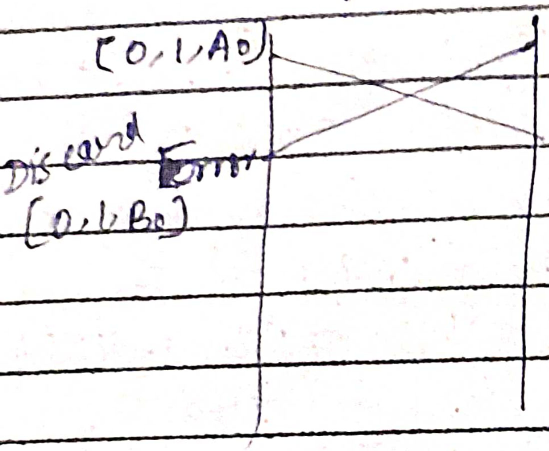
In this approach Ts ↑es ~~from # 3~~
since it need to incorporate TR

Seq. No. "Ack"

Q) First Frame से "Ack" क्या? [0, 1, A0]

Sol: ↳ Reverse of the sequence No. you want to send

Within Frame, Double CRC लगता है | Header Data



[0, 1, B0]

Discard

Error [0,1,A0]

Header अलग check होता है

Data bits अलग होता है } CRC

0 As First Ack, will fail here

Protocol #4: "One bit sliding window protocol.

Assumptions:-

① Data Traffic is duplex, hence concept of piggybacking is used.

② Channel is noisy. (errors can be here)

③ Both sender & receiver has one buffer each.

Here both A & B have 2 buffers each (one for sending & one for receiving)

④ Receiver has finite & limited processing speed.