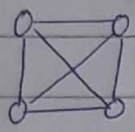
Tenen Baun

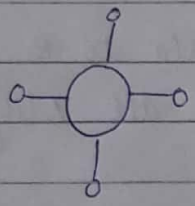
Whenever 2 or more autonomous systems are connected together - network

how the systems are connected - topology

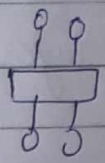
ex: Mesh Topology  high reliability in case of failure of any link but more cost

Bus Topology

all systems are connected using single link

Ring topology 

Star topology

 entire communication depends on central switch if it fails, the entire system fails.

Methods to classify network

→ wired or wireless network
→ Infrastructure or
→ Based on channel - like bluetooth
→ Based on various parameters

Here we discuss based on channel

2 Models to define network

- ISO-OSI model
- TCP-IP model

In transfering data, we perform several operations of similar type in single layer known as layered model.
↳ open system interaction

ISO-OSI layered model has 7 layers

1. Application layer
2. Presentation
3. Session
4. Transport
5. Network
6. Data ~~link~~ link
7. Physical layer - Digital & analog communication

A ——— B

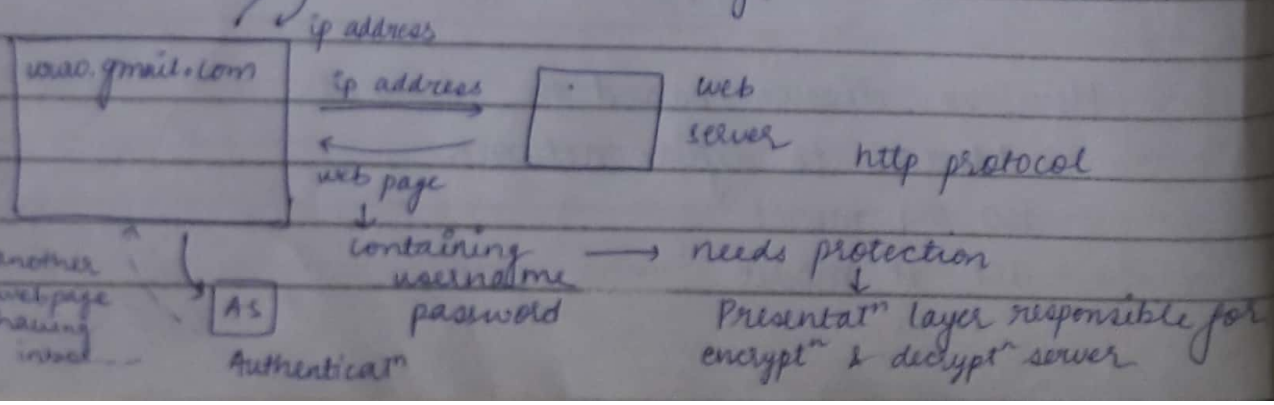
A has to transmit data to B
Both machines have all 7 layers.

→ Lower layer is responsible to provide service to its upper layer. User connected to application layer.

A has to send mail to B
abc@gmail.com xyz@gmail.com

A first switches on computer and press (types) www.gmail.com
↳ calling applicat^n

A table contains data which contains domain & ip address
we have a server (centralised entity)

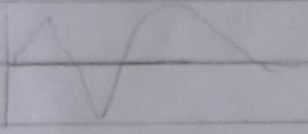


Presentation layer is also responsible for data conversion so that unicode is obtained.

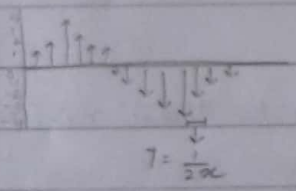
15/1/18 Conversion

- Analog to Digital
  analog → sample → quantizat^n → binarification

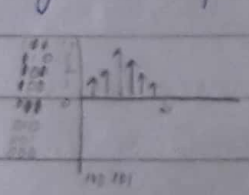
sampling : measuring the amplitude at equal interval of time

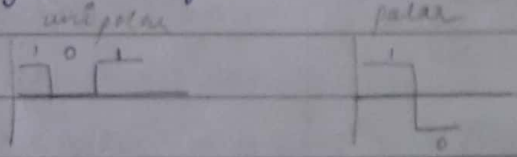


convert this signal from time domain to frequency domain using fourier series.



quantization - it is a method of assigning integral values in a specific range to sampled instances. According to to ensure the accurate reproduction of original signal using pulse modulat^n the sampling rate must be ~~atte~~ atleast twice the highest freq of original signal.

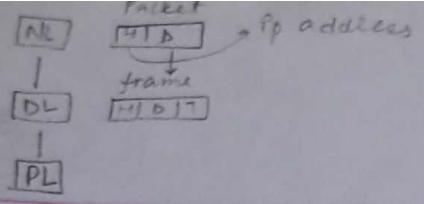




Digital to Analog

If you want to differentiate b/w 1 and 0 using phase than it is PSK

" " " using amplitude - ASK
frequency - FSK



for analog to analog : AM, PM, FM
unipolar, polar

} 1st assignment

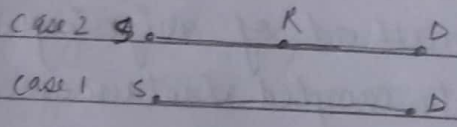
Data link Layer (Logic link control)

F bits = H + Data + T
= H + Data

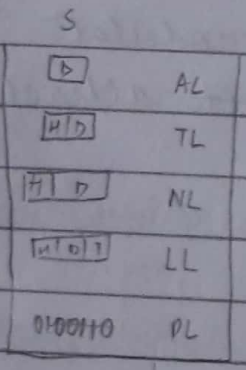
3 types of functionality
- flow control
-
-

Flow control

If the no. of intermediate router is K, then no. of link is K+1

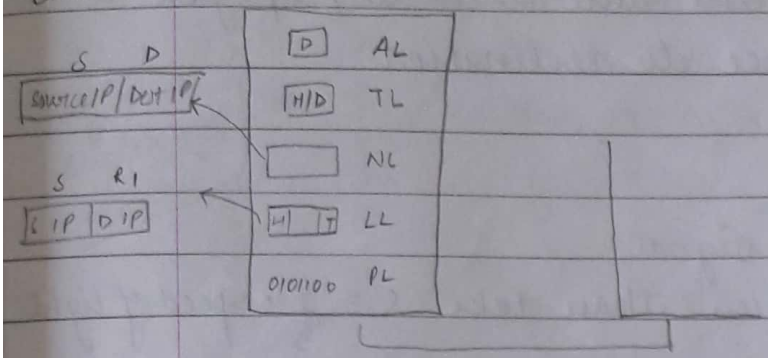


case 1



S uses all the layer

case 2



R uses only 3 layers

The communication b/w S and R1 is point to point
S and D is end to end.

S — R — D 4 times Data link layer is

Flow control (stop and wait protocol)

~~fast~~ flow control means how much amount of data that can be transmitted by the ~~trans~~ transmitter without receiving any acknowledgement. Data is transfered in the form of frame which contains overhead and data. [H | Data | T]

F bits = H + Data ← size of frame

S D

at time t = 0 S starts transmission ← A bits size of acknowledgement

I - propogation delay

C bit/sec - channel capacity

eg C = 100 mbps, it means you can transmit 100×10^6 bits per sec

time taken to transmit one bit = $\frac{1}{C} = \frac{1}{100}$ μsec

time taken to transmit f bits or frame = $\frac{f}{c}$

all the communicat^{n}s are serial mode

propogation delay = $(\frac{2}{3} \times \text{speed of light})^{-1} \times \text{distance}$

17/1/18

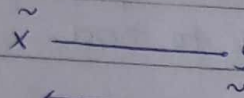
Propogation delay is the time taken to propogate a signal from source to destination

$$I = \frac{\text{distance}}{\text{speed of signal}}$$

if speed is not given than take $s = \frac{2}{3} \times$ speed of light

B - bit length of line

ex: x is 5 bit away from y



$C = 1 * 10^6$ bits/sec

time taken to transmit 1 bit = 1 μsec $\frac{1}{C}$

speed of signal = 2×10^8 m/sec s

distance covered by signal in 1 μsec = 200 m $\frac{s}{C}$

or

1 bit

no. of bits b/w x and y = $\frac{2 \times 10^3}{200}$ $\frac{d \times C}{s}$

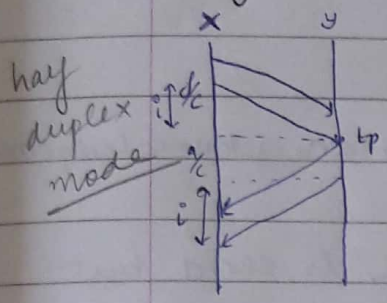
$= 10$ B. $I \times C$

$$\boxed{B = C * I}$$

Flow control means how much amount of data that can be transmitted by the transmitter without receiving any to acknowledgement.

- stop and wait → one frame
- sliding window → more than one frame

Performance of stop and wait protocol without error



at time $t = 0$, X starts transmission

" $t = \frac{1}{c}$, X transmits First bit

" $t = \frac{2}{c}$, " second bit

" $t = \frac{f}{c}$, " last bit

" $t = \frac{f}{c} + i$, Y receives last bit of data frame

tp is the time taken to process the frame and tp is negligible

at time $t = \frac{f}{c} + i + \frac{1}{c}$, Y transmit first bit of ACK

" $t = \frac{f}{c} + i + \frac{A}{c}$, " last bit "

" $t = \frac{f}{c} + i + \frac{A}{c} + i$, X receives last bit of ACK

in terms of bits

$$\text{efficiency of } X = \frac{f/c}{\frac{f}{c} + 2i + \frac{A}{c}} = \frac{F}{F + 2CI + A}$$

in terms of time

$$= \frac{1}{1 + \frac{2CI + A}{F}}$$

larger the waiting time, lesser the efficiency

If we are considering header also then

$$\eta = \frac{D/c}{\frac{F}{c} + 2I + \frac{A}{c}} = \frac{D}{F + 2CI + A}$$

$$= \left(\frac{D}{D+H}\right)\left(\frac{1}{1 + \frac{2CI + A}{F}}\right)$$

header

waiting time

Loss of efficiency is bcz of header and waiting time.

expected.

$N = R + 1$

$N = \frac{1+9}{2} = 5$

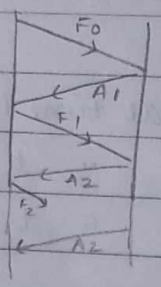
DATE 8
PAGE

18/1/18

Performance of stop and wait protocol with error.

3 mechanims of acknowledgement

- ack - whenever you get a frame send an acknowledgement otherwise do nothing
- nack - when you get a frame no ack. is send but when frame is lost then ack is send. It is used when system is reliable
- - when you get a frame, you send what you are expecting next.



Retransmission happens bcz of the following 3 reason.

1. frame is lost so no acknowledgment is received.
2. frame is send but acknowledgment is lost.
3. acknowledgment is received after $^{F}/_{c} + 2I + {}^{A}/_{c}$

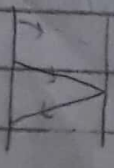
Let us assume that P_0 is the prob of data frame being lost.

P_1 is the prob. of ack. frame being lost.

$(1-P_1)$ is the prob of getting the ack. frame.

prob of success $s = (1-P_0)(1-P_1)$

" failure $l = 1 - s$



$$\eta = \frac{D/c}{\left(\frac{F}{c} + 2I + \frac{A}{c}\right) + \left(\frac{F}{c} + 2I + \frac{A}{c}\right)}$$

$$\eta = \frac{D/C}{\left(\frac{F}{C} + 2I + \frac{A}{C}\right)} * \frac{1}{N}$$

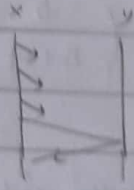
where N is the expected no. of retransmission attempts

$$N = \sum_{K=1}^{\infty} K P_K$$

where P_K is the prob that exactly k attempts are needed for successfully transmitting a frame.

$$P_4 = l_1 l_2 l_3 (1-L)$$

$$P_k = l^{k-1}(1-l)$$



$$N = \sum_{K=1}^{\infty} K L^{K-1}(1-L) = (1-L)\sum_{K=1}^{\infty} K L^{K-1}$$

$$N = (1-L)\left[1.L^0 + 2.L^1 + 3.L^2 + \ldots \infty\right] \quad -①$$

$$NL = (1-L)\left[1.L^1 + 2.L^2 + 3L^3 + \ldots \infty\right] \quad -②$$

① - ②

$$N - NL = (1-L)\left[1.L^0 + 1.L^1 + L^2 + \ldots \infty\right]$$

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

$$\boxed{N = \frac{1}{1-L} = \frac{1}{S}}$$

$$\eta = \frac{D/C}{F/C + 2I + A/C} * \frac{1}{N} \quad (R+1)$$

$$\eta = \left(\frac{D}{D+H}\right) * \frac{1}{1 + \frac{2CI + A}{F}} * \left(\frac{1}{1-L}\right)^{-1}$$

$$\eta = \left(\frac{D}{D+H}\right) * \left(\frac{1}{1 + \frac{2CI+A}{F}}\right) * (1-P_0)(1-P_1)$$

Bit error rate

Let E be the bit lost rate.

x → y

1 → 0 (1-E)

00 → 00 (1-E)(1-E)

$(1-P_0) = (1-E)^F$

$(1-P_1) = (1-E)^A$

$$\eta = \left(\frac{D}{D+H}\right) * \left(\frac{1}{1+\frac{2CI+A}{F}}\right) * (1-E)^{F} (1-E)^{A}$$

($F = H+D$)

D↑ bit error rate ↑

D↓ H↑

diff. both side with respect to D

$$\frac{d\eta}{dD} = 0$$

$$D = \sqrt{\frac{H+CT}{E}} \quad \text{where } T = 2I + \frac{A}{C}$$

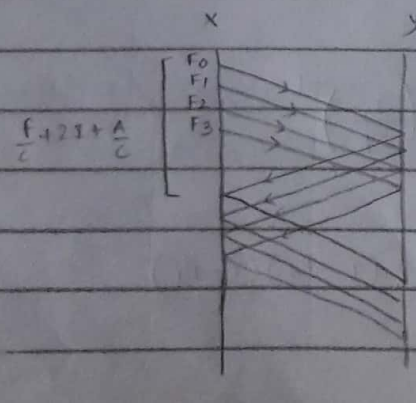
$F_{opt} = D_{opt} + H.$

Sliding Window Protocol

→ to minimise the waiting time

→ more than one frame in send.

→ full duplex mode of ~~communication~~ communication.



$W = 4$

$$\eta = \left(\frac{D}{D+H}\right) * \left(\frac{W}{1+\frac{2CI+A}{F}}\right) * (1-E)^{H+D}(1-E)^{A}$$

waiting time = 0

when $W.\frac{f}{C} \geq \frac{f}{C} + 2I + \frac{A}{C}$

$$W \geq 1 + \frac{2CI+A}{F}$$

when W is large

$$\eta = \left(\frac{D}{D+H}\right)(1-P_0)(1-P_1)$$

when $W\frac{f}{C} < \frac{f}{C} + 2I + \frac{A}{C}$

then waiting time > 0

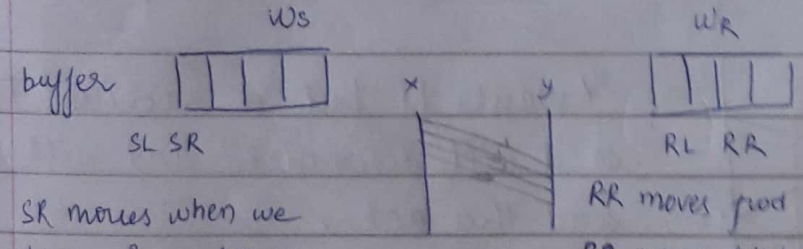
i.e when W is small

$$\eta = \left(\frac{D}{D+H}\right)\left(\frac{W}{1+\frac{2CI+A}{F}}\right)(1-P_0)(1-P_1)$$

$\frac{f}{C} = 1$, $\frac{A}{C} = 1$ $I = 4$ $W = 15$

$$W.\frac{f}{C} > 1 + 8 + 1$$

$15 > 10$ ⇒ waiting time = 0



SR moves when we transmit a frame

SL moves when we recieve an ack frame.

RR moves fwd when we recieve a frame.

RR moves bkd if there is any errors in frame

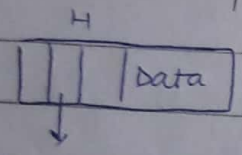
RL moves fwd when we send ack frame

max. difference b/w SL and SR is window size.
The left side of the window contains those frame which are transmitted as well as acknowledged.
Within window we have frames which are waiting for acknowledgment.

Error Recovery in Flow Control

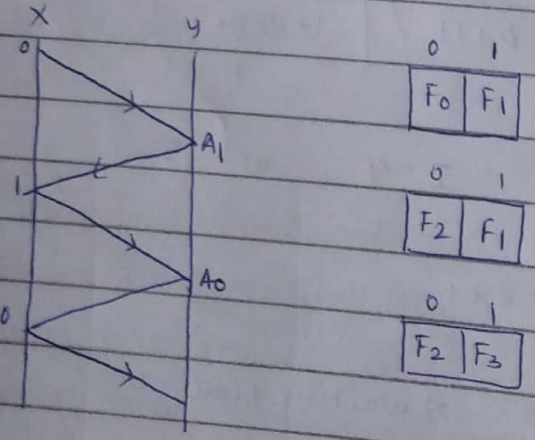
- Go back N ARQ
- Selective Repeat ARQ

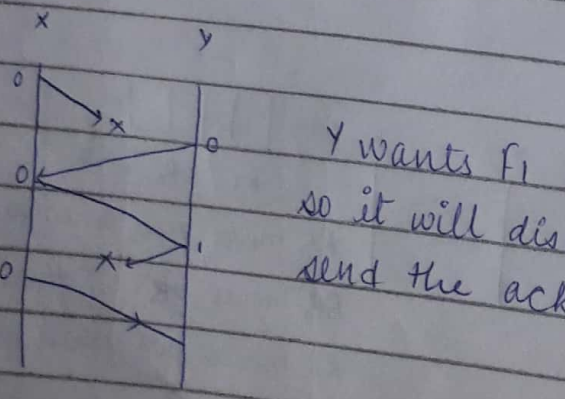
Flow control protocol specification and verification



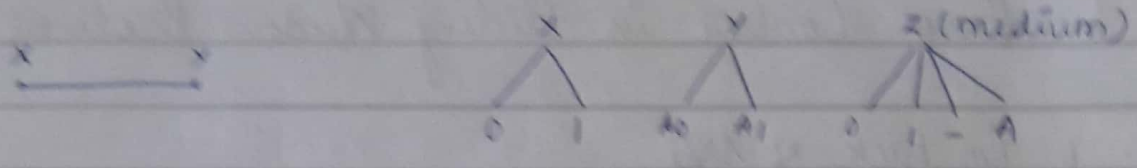
larger the sequence no. larger the header.

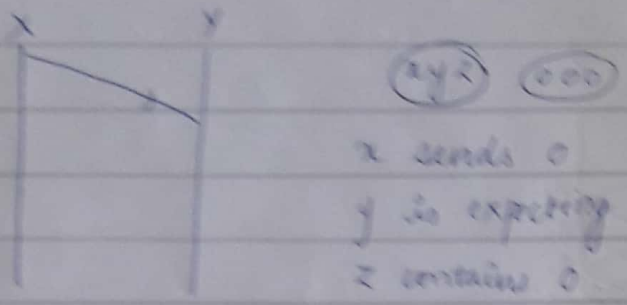
$F_0, F_1, F_2, F_3, F_4, F_5, F_6, F_7$
F_8, F_9



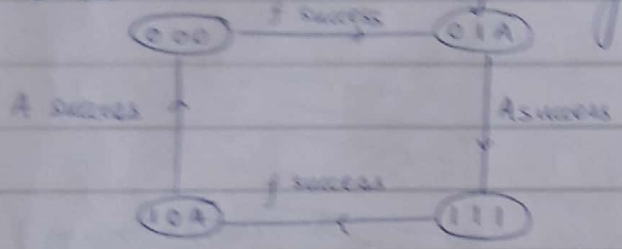


Y wants F_1 but it receives F_0 so it will discard F_0 and will again send the ack.

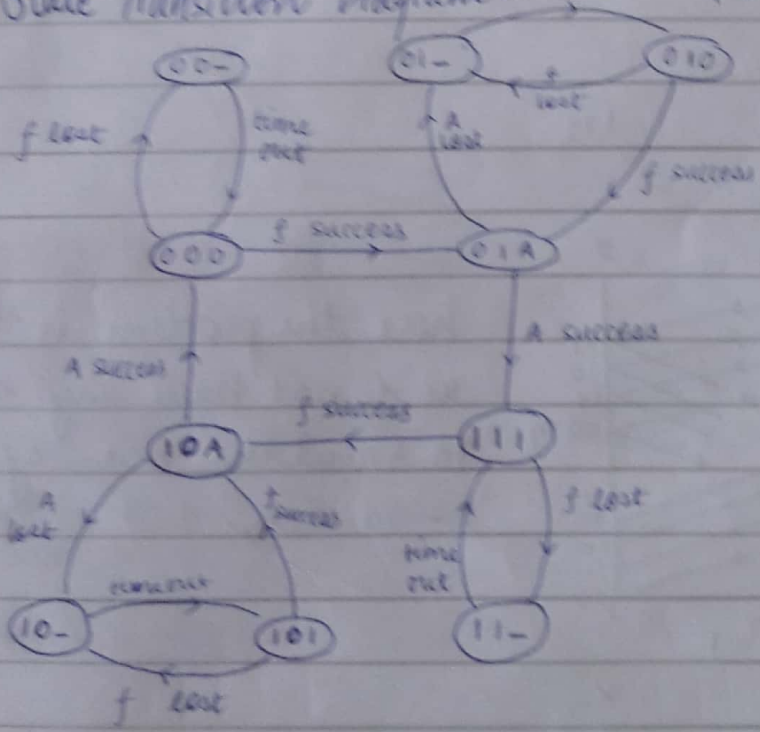




State Transition Diagram for 1 bit sliding window protocol

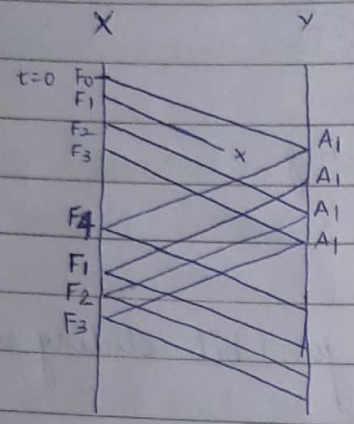


State Transition Diagram time out (in case of error)



Error Control in Sliding Window Protocol

1. Go back N ARQ

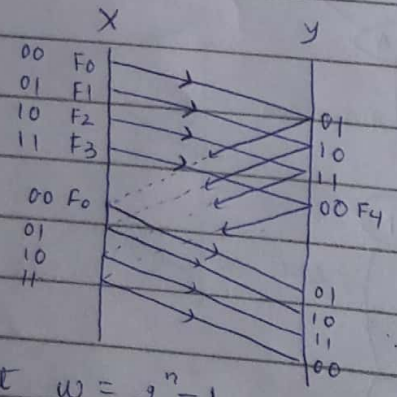


without error

$n = 2$.
↓
no. of bits

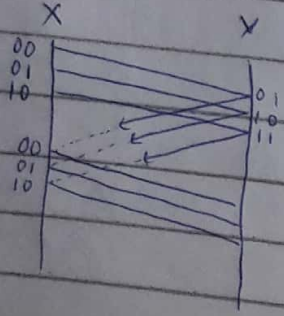
$w = 2^n$ (maximum)
↓
window size

00 01 10 11 00 . . .
F_0 F_1 F_2 F_3 F_4 . . . F_{99}



here the problem is that we do not have any mechanism to know the ack. of the send ack.

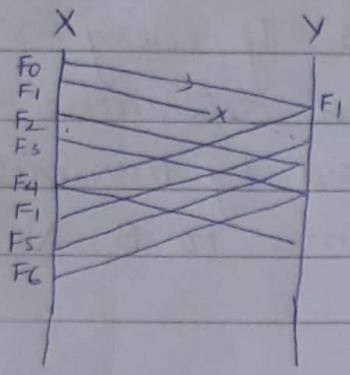
Now let $w = 2^n - 1$



here the problem is solved

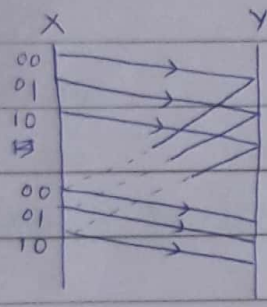
max. size of receiver window = 1

2. Selective Repeat ARQ



size of receiver window should be more

$n = 2$ $\quad W = 2^n - 1$

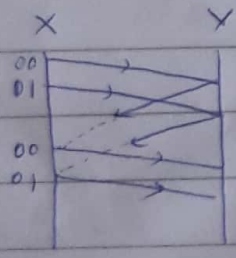


Three frames expected by Y

F0	F1	F2
00	01	10

F3	F4	F5
11	00	01
	✓	✓

Let $W = 2^{n-1}$

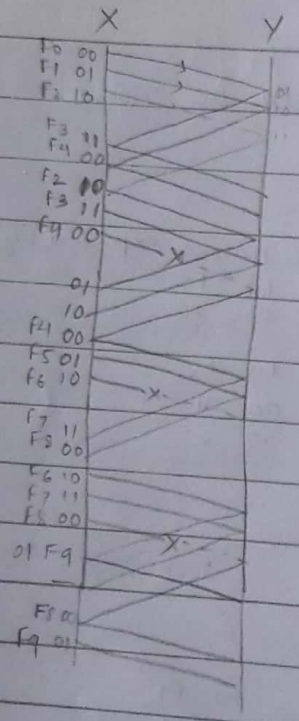


F0	F1
00	01

F2	F3
10	11

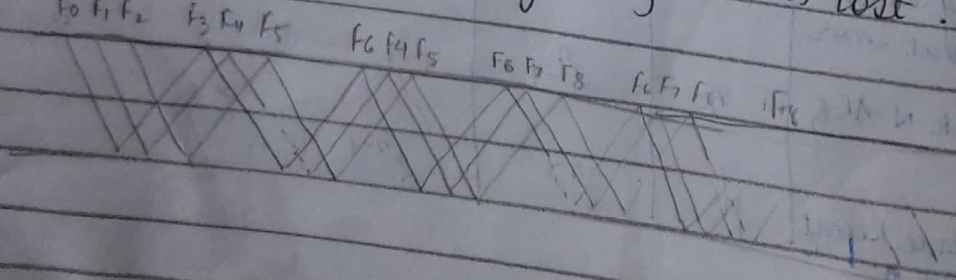
	Seq No. field	W_{max} S	W_{max} R
Sliding window without error	n	2^n	1
Goback N ARQ	n	$2^n - 1$	1
Selective Repeat ARQ	n	2^{n-1}	2^{n-1}

Q. A and B are two station, both station uses go back N sliding window protocol with $w = 3$. A wish to transmit 9 frames to B. If every 3rd frame that A transmit get lost then determine the total no. of frames transmitted by transmitter in order to deliever entire 9 frames to B. No ack. frame ever get lost.



Ans = 21

Q. Repeat above ques if every 5th frame is lost.



Q.1 A 25kbps satellite link has a propogat~ delay of 400ms. The transmitter implied go back ARQ protocal which n set to 10. Assuming that each frame is 100B long. What is the max data rate possible

Q.2 Suppose user A uses 32B packet to transfer msg to station B using sliding window protocol. The round trip delay b/w A & B is 80 ms. and the bandwidth of the line is 128 kbps. What is the optimal window size used by station A. 3.

Ans 1

$C = 25$ kbps

$I = 400$ ms.

$f = 100B = 800$ bits

$n = 10$.

$w = 2^{10} - 1 = 1023$

$$\eta = \left(\frac{D}{D+H}\right) * \left(\frac{w}{1 + \frac{2CI+A}{F}}\right) * (1-P_0)(1-P_1)$$

header size is not given so we will assume its size to be negligible

no error given

$\eta = \frac{A}{C}$ is also negligible

time taken to transmit one frame $= \frac{800}{25 \times 10^3}$

$= 0.032$ sec

$$w * \frac{f}{C} \;?\; \frac{f}{C} + 2I + \frac{A}{C}$$

$$1023 * 0.032 \;?\; 0.032 + 2 * 400 \times 10^{-3}$$

$32.736 \geq 0.83$

so there is no loss bcz of waiting time.

Ans 2 $F = 32B = 32 \times 8$ bits

$= 256$ bits

$2I = 80ms$

$I = 40ms$

$c = 128kbps.$

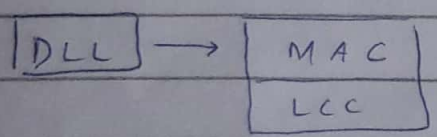
$$w * \frac{f}{c} = \frac{f}{c} + 2I + \frac{A}{c}$$

$$w * \frac{256}{128 \times 10^3} = \frac{256}{128 \times 10^3} + 80 \times 10^{-3}$$

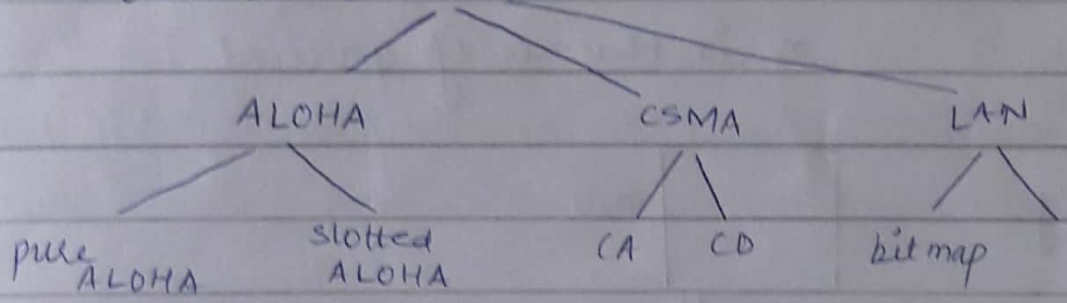
$$w = \frac{82 \times 10^{-3}}{2 \times 10^{-3}}$$

$w = 41$

$n = 6.$



Dynamic Channel Allocation



Standards → another protocol of MAC

IEEE 802.3	IEEE 802.4	IEEE 802.5
(bus topology)	token (bus)	(Ring)

Pure ALOHA

Assumption - Infinite no. of users are there in the zone of a satellite. Each user wish to transmit a fixed size frame. The time taken to transmit such a frame is called 1 frame time i.e f/c

- when more than one user transmit the frame then there exist a collision. In case of collision user wait for random period of time and again trying to transmit

the frame.

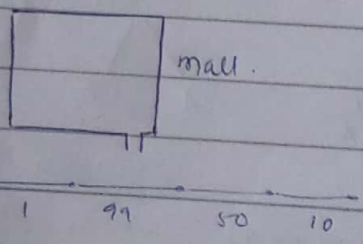
- Data is transmitted successfully if and only if one user transmits the frame.

According to Poission dist. prob of n arrivals during time t is

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

where λ is the mean arrival rate
t is the time durat^n
n is the no. of arrival

eg.



λ = 40 customer/hr

$P_0(1)$ = prob that no customer arrive in next one hour.

Now in pure ALOHA.

Let us assume that G is the mean no of frames generated by all the users per frame time.
S is the mean no. of success per frame time.

$0 \leq S \leq 1$ $\quad$ $0 \leq G < \infty$

relation b/w G & S

$G = \lambda$ when $t = 1$

$$\boxed{S = P_0 G}$$

$$S = e^{-Gt} \cdot G$$

where t is the vulnerable time
P_0 is the prob that no one accesses in time t.

In pure ALOHA protocol users can start transmitting the frame at any time without waiting for an event.

1 sec = 1000ms
1 bit = 1ms.

vulnerable period = 2 frame time

$$\boxed{S = e^{-2G} \cdot G}$$

$$\frac{dS}{dG} = 0$$

$$-2e^{-2G} \cdot G + e^{-2G} = 0.$$

$$e^{-2G}(1 - 2G) = 0.$$

$e^{-2G} = 0$ and $1 - 2G = 0$.

$G = \infty$ $\qquad$ $G = 1/2 \rightarrow$ max success

↓

min success

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

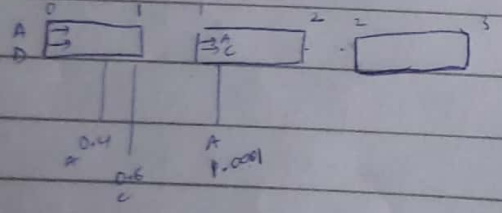
$$S_{max} = \frac{1}{2e}$$

$$= 18.4\%$$

Slotted ALOHA Protocol.

1 slot = 1 frame time

In * case of slotted ALOHA protocol user can start transmitting the frame only during the beginning of slot.



Vulnerable time = 1 sec.

$$P_0 = \frac{e^{-\lambda t} (\lambda t)^0}{0!}$$

$$P_0 = e^{-G}$$

$\lambda = G$
$t = 1$

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

$$\frac{dS}{dG} = 0$$

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

$$e^{-G} (1 - G) = 0$$

$e^{-G} = 0$, $1 - G = 0$

$G = \infty$ $G = 1$

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

$= 36.8\%$

Pure ALOHA	Slotted ALOHA
1. Users can start transmitting the frame at any time without waiting for an event.	Users can only transmit the frame at the beginning of the slot.
2. vulnerable time = 2 frame time	vulnerable period = 1 frame time
3. $P_0 = e^{-2G}$	$P_0 = e^{-G}$
4. When $G = \frac{1}{2}$ then S is S_{max}	When $G = 1$ then S is S_{max}.
5. $S_{max} = 18.4\%$	$S_{max} = 36.8\%$

Finite population slotted ALOHA protocol

Let us assume that G_i is the mean no. of frames generated by user i per frame time.

S_i is the mean no. of success of user i per frame time

or

G_i is the prob. that user i transmits the frame

S_i is the prob. of success

G is the mean no. of frames generated by all the users per frame time. S is the mean no. of success of all the users per frame time.

$G_A = \frac{04}{10}$

$S_A = \frac{2}{10}$

Q. 4 users are trying to acquire a medium using finite populat^n slotted aloha protocol (A, B, C, D) The prob that a user tranomit the frame per frame time is as follow:

$G_A = 0.4$ 0.2016 $G_C = 0.2$ 0.0756

$G_B = 0.3$ 0.1296 $G_D = 0.1$ 0.0336

Determine the prob of success of individual user. Also determine the total success.

$S_A = G_A (1-G_B)(1-G_C)(1-G_D)$

$= 0.4 \times 0.7 \times 0.8 \times 0.9 = 0.2016$

$S_B = G_B (1-G_A)(1-G_C)(1-G_D)$

$= 0.3 \times 0.6 \times 0.8 \times 0.9 = 0.1296$

$S_C = 0.2 \times 0.6 \times 0.7 \times 0.9$

$= 0.0756$

$S_D = 0.0336$

3. Let us assume that the mean no. of frames generated by all the user is same.

i.e $G_A = G_B = G_C = G_D = 0.25$

$S_A = G_A(1-G_A)^3$

$= 0.25(1-0.25)^3$

Finite populat^{n} slotted ALOHA protocol.

n users are there. Each user generate same no. of frame

$G_1 = G_2 = G_3 \ldots = G_N$

$G = G_1 + G_2 + \ldots G_N$

$NG_i = G$

$G_i = \frac{G}{N}$

$S = S_1 + S_2 + S_3 \ldots S_N$

$NS_i = S$

$S_i = \frac{S}{N}$

$S_i = G_i(1-G_j)^{N-1}$ where $i \neq j$

$1 \leq j \leq N$ except i

if $G_i = G_j$

$S_i = G_i(1-G_i)^{N-1}$

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

When $N \to \infty$

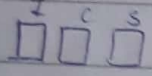
$$\lim_{N \to \infty} \left(1 + \frac{-G}{N}\right)^{N-1} = e^{-G}$$

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

Q. Measurement of an infinite user slotted ALOHA channel shows that 10% of slots are ideal. What is total channel load i.e G.

(b) What is the throughput i.e S.

(c) Is the channel overloaded & underloaded.



P_0 = prob that no one will arrive

$0.1 = e^{-G}$

$\log(0.1) = -G$

$G = 2.3$

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

$= 0.1 \times 2.3$

$= 0.23$

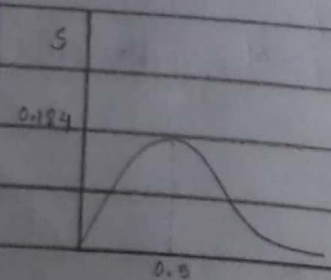
(c) $G > 1$ so overloaded.

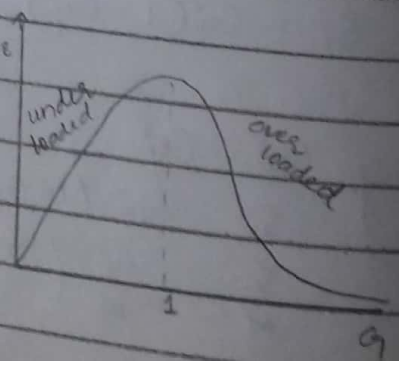
Pure ALOHA

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

Slotted ALOHA

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





Q.1 10,000 airline reservation stations are competing for the use of a single slotted ALOHA channel. The avg station makes 18 request per hour. A slot is of 125 μsec. What is the approx. channel load i.e G.

~~1 hour~~ → 18 req

Q2 A large populat^{n} of ALOHA user manages to generate 50 request per second including both original and retransmission Time is slotted in units of 40 msec.
(a) What is the change of success on the first attempt
(b) What is the prob of exactly k collision and then success.
(c) What is the expected no. of retransmission.

Q3 A group of n stations share a 56 kbps pure ALOHA channel. Each station output a 1000 bits frame on an avg. of once every 100 sec. What is the max value of n.

Ans1

$$1 \text{ hour} \longrightarrow 18 \text{ req.}$$

$$1 \text{ sec} \longrightarrow \frac{18}{60\times60} \text{ req.}$$

$$1\,\mu\text{sec} \longrightarrow \frac{18\times10^{-6}}{60\times60} \text{ req.}$$

$$1 \text{ slot} \longrightarrow \frac{18\times125\times10^{-6}}{60\times60} \text{ req.}$$

$$G_1 = \text{mean req of all the user}$$

$$= \frac{18\times125\times10^{-6}}{60\times60}\times10^{4}$$

$$= 6.25\times10^{-3}$$

$$n * \frac{1000}{100} = 56\times10^{3}\times0.1$$

Ans 2. 1 sec ⟶ 50 req.

40 msec ⟶ $50 \times 40 \times 10^{-3}$ req

$G = 2$

(i) prob of success in 1st attempt $= e^{-G} \times G$

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

(ii) prob of exactly k collision & then success

$= (1 - e^{-G})^k e^{-G} \times G$

(iii) expected no. of retransmission $= \sum_{k=1}^{\infty} k P_k$

$= 1 \cdot e^{-2} + 2 \cdot (1 - e^{-2}) e^{-2} + 3 \cdot (1 - e^{-2})^2 e^{-2} + \ldots$

$= e^2$

Ans 3 $\frac{n^* 1000}{100} = 56 \times 10^3 \times 0.18$

$n = 1008$

C.S.M.A

Before transmitting the frame, first sense the medium

If medium is busy then wait.

→ Non persistant CSMA

→ persistant CSMA → 1 persistant

→ P persistant

In this user sense the medium after discrete interval of time i.e non continuous sensing of medium.

In this user sense the medium continuously.

In 1 persistant CSMA user continuously sense the medium and whenever user get medium is idle then transmit the frame with the probability of 1.

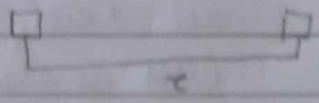
In case of P persistant CSMA user transmit the frame with the probability of p.

→ Determine the min. size of the frame to detect the collision in CSMA protocol or Determine how long a user can transmit the frame to detect the collision.

Let us assume that τ is the end to end delay b/w two furthest station.

cable length = d m.

$$\tau = \frac{d}{s}$$



at $t = 0$ A and B sense the medium

at $t = \tau$ A & B will detect the collision.

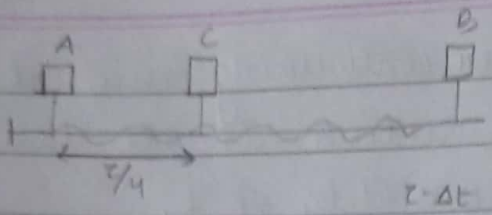
If $\frac{f}{c} < \tau$, then A will go to waiting state. Now if A gets to know about collision, it can't do anything. It has to wait till time out.

If $\frac{f}{c} > \tau$, then A will stop the transmission at τ and wait for some time.

Whenever there is a collision user will stop the transmission and will send a jam signal.

time taken to detect a collision $= 2\tau + \frac{fi}{c}$

if upto this time no jam signal is received then the channel is allocated.



$$\frac{F}{c} \geq 2\tau + \frac{F_j}{c}$$

$$\frac{F_{min}}{c} = 2\tau + \frac{F_j}{c}$$

$$F_{min} = 2\tau c + F_j$$

if F_j is negligible, then time taken to detect a collision is 2τ.

Let 1 slot = 2τ

CSMA is also called 1 slot LAN protocol.

Performance of IEEE 802.3 under the condition of constant and heavy load.

K stations suddenly become ready for transmission. Instead of taking binary back off exponential algo use constant retransmission prob in each slot.

Let p is the prob that a user transmit the frame
A is the prob of success. (1-A) is the prob that no channel is allocated.

$$A = {}^{k}C_1 \cdot p(1-p)^{k-1}$$

$$\frac{dA}{dp} = 0.$$

$$p = \frac{1}{k}$$

$A_{max} = k \cdot \frac{1}{k}\left(1-\frac{1}{k}\right)^{k-1}$

$A_{max} = \left(1-\frac{1}{k}\right)^{k-1}$

if k is very large

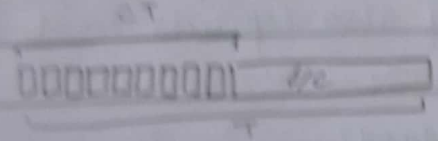
$A = e^{-1}$

$= 0.368$

$\eta = \frac{\text{useful time}}{\text{total time}}$

There are three types of slot

1) collision slot 2) Ideal slot 3) successful slot.



CT: contension time

$CT = 2T \times N$

N: expected no. of con slot

$\eta = \frac{T_c}{CT + T_c}$

$N = \sum_{j=1}^{\infty} j P_j$

P_j: prob that contension interval requires exactly j slot

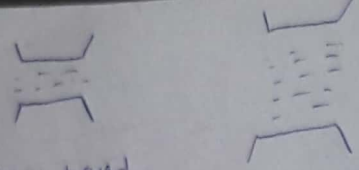
$P_j = (1-A)^{j-1} A$

$N = \sum_{j=1}^{\infty} j(1-A)^{j-1} A$

$1 - A = L$

$N = \sum_{j=1}^{\infty} j(L)^{j-1}(1-L)$

$N = \frac{1}{1-L} = \frac{1}{A}$



base band broad band

$$\eta = \frac{f/c}{2\tau \cdot \frac{1}{A} + f/c} = \frac{1}{1 + 2\tau \frac{c}{f} \cdot \frac{1}{A}}$$

$$\eta = \frac{1}{1 + 2\frac{L}{s}\frac{c}{f}\frac{1}{A}} \qquad \tau = \frac{L}{s}$$

When A is Amax.

$$\eta = \frac{1}{1 + 5.4\frac{L}{s}\frac{c}{f}}$$

s and c are constant

so η of LAN depends on L and f.

min frame size = 2τ

so min size of frame also depends on length of cable

so we can say that η also depends on L.

There are some standard

1. Cable standard

(i) 10 Base 2 → length
↳ data rate → technology — 10 Mbps, 200m

(ii) 10 Base 5

(iii) 100 Base T — twisted pair — standard length = 100m, length upto 2km

(iv) 100 Base F — fibre

there are 2 types of fibre

(i) single mode: used for long range

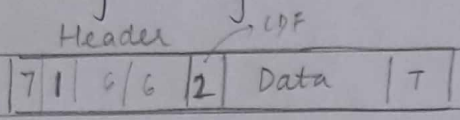
(ii) multi mode: used for short range

(v) 10 Broad 36 — length = 3600 m

logical address - IP
physical " - MAC

	Basic ethernet	fast ethernet	Gigabit ethernet
data rate	10Mbps	100Mbps	1Gbps
cable length	2500 m	250 m	250 m
min size of packet	72 Byte	72 B	72 B

IEEE 802.3 frame format



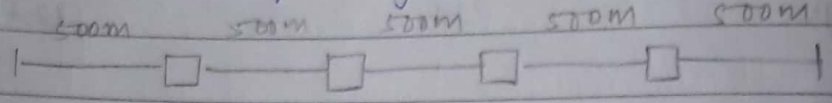
header contains first seven byte of preamble
delimeter is of 1B.
Source address is of 6B
Destination " " 6B
Length of data field is 46B (min) and 1500B (max)
tail is of 4B, contains CRC

preamble is used for synchronization purpose. It transmit alternate 0,1 upto 7B.
There are two mode of transmission
- Synchronous
- Asynchronous

In asynchronous mode we add start and stop bit.
SFD is responsible for this.

48 bit MAC address i.e source address.
LDF - indicate actual length of data frame.

Consider 10 Base 5 technology. After every 500m a repeater is required. Repeater is used to regenerate the same signal after strengthing it.



$$\frac{F}{C} = 2\tau$$

$$F/C = 2 (\text{pro. delay} + 4 * \text{processing delay at repeater})$$

$$\frac{F_{min}}{10 \times 10^6} = 57.6\ \mu sec$$

$$F_{min} = 576\ bit$$

$$= 72\ B.$$

Binary backoff exponential algorithm.
This algo gives waiting time for the stations that are involved in collision.

waiting time = $K * \underbrace{51.2\ \mu sec}_{2\tau}$ { assuming min frame size ignoring 72 preamble and 1 byte

where K is randomly vary from 0 to $2^n - 1$

n: collision no.

A and B are two station and both want to send a frame. They both sense the medium and it is ideal so both of them start transmission.

$n = 0$

$k = 0$ i.e both will not wait

prob of transmission = 1

prob of collision = 1

Now $n = 1$ so $k = 0$ to 1

prob of transmission of A $= \frac{1}{2}$.

prob of success of A $= 1/4$.

prob of collision $= 1/2$.

A and B are only two users over an ethernet. A's frame no. will be $A_1, A_2 \ldots$ B's frame no. will be $B_1, B_2 \ldots$ A and B transmits the frame and collision happens. After the 1st collision A select $k=0$ and transmits A_1 while B wait for their turn. Now A wish to transmit A_2 and B wish to transmit B_1. Now determine what

i) what is the prob that A gets 2nd back off race

ii) What is the prob that B wins the 2nd back off race.

A_2 & B_1 will collide

A_2	B_1
$n = 1$	$n = 2$
$k = 0, 1$	$k = 0, 1, 2, 3$

	A	B
P	1/2	1/2
P	1/2	1/2
P	1	1/2
P	1/2	1/4

A/B			
A	B		
A		B	
A			B
B	A		
	A/B		
	A	B	
	A		B

(i) $P(A) = \frac{5}{8}$

(ii) $P(B) = \frac{1}{8}$

Token Ring

It uses ring topology

Important properties of token ring

1. It offers connectionless communication.
2. Priority can be assigned whereas in the case of CSMA priorities cannot be assigned.
3. No restriction on minimum and max. size of packet whereas in ethernet there is restriction on size
4. It offers deterministic services i.e it is suitable for real time application whereas ethernet is not suitable for real time app.

Token Reinsertion Strategies

There are two type of token reinsertion

Early Token release	Token is transmitted after receiving the last bit of the data frame i.e after getting entire data packet back token is released.
1. Token is transmitted immediately after transmitting the last bit of data frame i.e as soon as data is transmitted token is released.	
2. Reliability is low	Reliability is high
3. Efficiency is high	Efficiency is comparatively low.
4. used when system is heavily loaded.	used when system is lightly loaded.
5. Cycle time = a+c+d a = F/C b = I (propagation delay in ring)	Cycle time = a+b+c+d $c = \frac{F_T}{C}$ $d = I_{AB}$

6. $\eta = \frac{a}{a+c+d}$ | $\eta = \frac{a}{a+b+c+d}$

Problem related to token ring

1. Problem related to token
   (i) lost token problem or damaged/corrupted token problem

2. Problem related to source
   (i) monopoly problem
   (ii) orphan packet problem
   (iii) Stray Packet

Once a packet is produced by the source if source is down before packet is received then such generated packet is known as orphan packet. Hence it is circulating around the ring upto its circulating time.

While producing the packet if source is down then partial packet is released to the ring and nobody understand the packet. Hence it is circulating around the ring.

3 Problem related to destination
destination may present in one of the following 3 mode
(i) busy destination
(ii) down/crash destination
(iii) safe operation

4. Problem related to ring
(i) major cut in the ring or unhealthy part in the ring

In order to solve the above problems either we can deploy a monitor station who is monitoring the ring (or act as a ring admin) or use various types of timer like token holding timer value, ring token rotation timer value, token holder timer value.

Types of frames in token ring
1. Data frame
2. Token frame
3. Abort frame

1. | SD | AC | FC | SA | DA | 6-Max | CRC | ED | FS |
THT

Starting delimeter

AC: access control FC: frame control
ED: ending delimeter FS: frame status

2. | SD | AC | ED | size of token = 24 bit (default size)

3. | SD | ED |

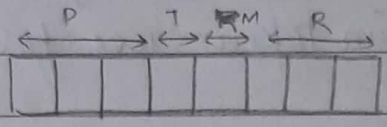
SD: it contains 1 0 J K 1 0 J K
ED: it contain 1 1 J K 1 1 I E

I: informat^n bit
E: error bit

SD and ED are used to indicate starting and ending of frames. They are using invalid differential manchester

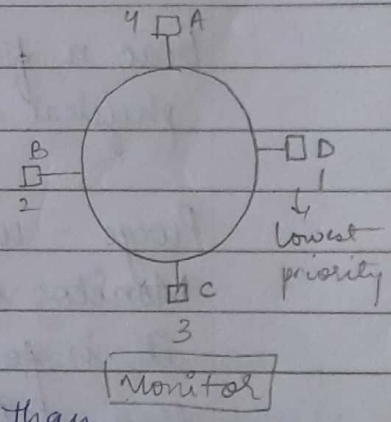
encoding signal. JK positions are used as bits in such a way to violate DME principles.

AC: In this first 3 bit is for priority, next one bit for token, next one bit for monitor and remaining 3 bit for reservation.



if T=0 means it is data frame
T=1 " " token "

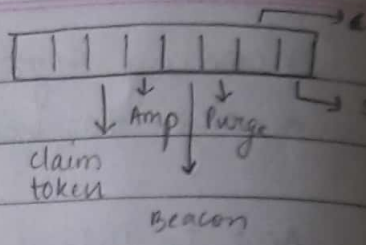
M=0 before crossing monitor station
M=1 after " " "



A transmit the data frame and it reaches B. If B also wants to transmit the data it will set the P and R bits to 2. Now the data frame reaches C. C also wants to transmit the data its priority is higher than 2 so it will overwrite P and R bit to 3. Frame will reach D and it will forward it to A. Now A will see the P and R bit and will send the token to C. Now C will start transmission.

No meaning of priority field for data frame, only reservation can be done whereas token frame have priority field as well as reservation field. User can get the token when the priority of the user is equal to the priority of the token. This mech is called access control mech or token passing mech.

with the help of virtualizat^{n} duplicate address (MAC) can be created.



FC

If the value of 1st two bit is -

00 : data frame

11 : control frame

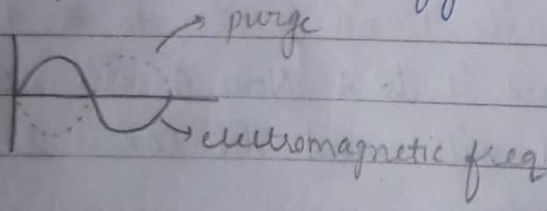
If it is a control frame then only the other 6 bits are used

claim token - use for election purpose of monitor

AMP (active monitor present) - it is released by monitor station in equal interval of time to indicate that monitor is available for service.

Beac n frame - This frame is use to identify the physical cut in the ring.

Purge - use to remove unwanted bits from the ring. Monitor station measures the freq. of the signal. If it is found to be invalid then it produce opposite freq pattern and nullify the invalid freq.



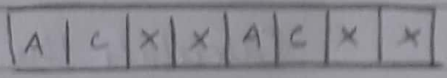
DAT (duplicate address test) - when new station wants to enter and join the network then it sends a DAT frame indicating its address. If any other ~~addr~~ station is having the same physical address then it sends a refusal packet to the new station then new station changes its address and again sends DAT frame.

CRC khud pado

SMP (Standby monitor present) - This bit is used to get knowledge about upstream neighbour. Every station have upstream and downstream station. It is necessary to have knowledge of upstream station.

→ Data size depend on token timer value.

FS (frame status)
It contain 2 important field.

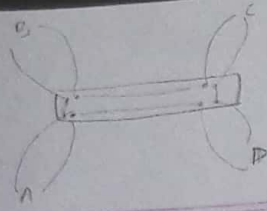


A : available
C : copy

if initially A = 0	then C = 0
success 1	1
busy 1	0
invalid 0	1

Q.1 Why FS is not included in CRC.
Ans CRC is calculated by the source station whereas FS is field by destination station. Therefore while calculating CRC it is not possible for source ✗ to predict FS value.

Q2 Why FS is having two set of A,C field.
Ans Since FS is not included in CRC calculation, to have its own error calculation it uses two sets of AC bits. If both sets are same then it is assumed to be correct. otherwise it is treated as error.

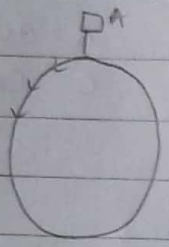


Implementation of Token Ring

There are 4 modes of operation for token ring

1. Transmission mode
2. Receiving mode
3. Listening mode (waiting for either data or token)
4. Bypass mode (in this mode station is disconnected from the ring for maintenance purpose)

Calculate the min size of token ring.



$C = 1 * 10^6$ bits/sec

speed $= 2 \times 10^8$ m/s

distance covered by 1 bit $= \frac{2 \times 10^8}{10^6}$

$= 200$ m

token frame $= 24$ bit

min size of ring $= 24 * 200$

$= 4800$ m

length of ring > 4800 m $\rightarrow$ no overlapping

$T_p > T_x$

if propogation delay is greater than transmission time of token frame then there is no overlapping

If length of ring is less than min size then there are 2 soln

- add more cable length not good
- add artifical delay in the ring. Artifical delay is needed only when total time of propogatn is less than transmission time. This causes overlapping. Therefore to avoid overlapping in the ring artifical

delay is introduced.
1 bit delay = 200m
9 bit delay = 1800m (stopping bit for 9 μs)
so a 3000m ring size should have 9 bit delay to avoid overlapping.

Token Rotation Timer Value (TRT)
TRT = propagation delay of ring + no of active stations x delay at each station

Min TRT - time taken to rotate the token when no station is using the token.
Max TRT - time taken to receive token back when every station is using the token.

Switching
Deciding the path - routing for transferring the data using the path - switching

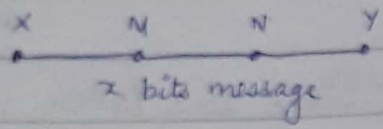
Routing Table
↓
Routing Mechanism
↓
Routing Principles

Deciding path at run time → adaptive or dynamic routing algo (on bases of current network traffic)

Before transferring data deciding the path
→ static or non-adaptive routing algo

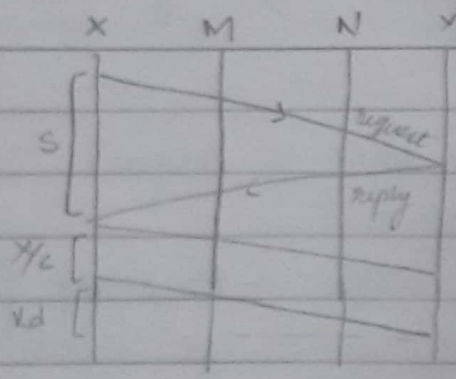
Switching types
- circuit switching
- message "
- packet "

Assumption
x bits is the size of the message
C is the channel capacity in bits/second



K is the hop path length
No. of intermediate stations = k-1
d is per hop path delay

(i) Circuit Switch Network



X sends request for a connect
X gets a reply

S → circuit set up time
(time taken to create connection)

Once connection is created path is dedicated to X & Y
Intermediate stations do not perform any operation over this path.

does not retransmit frame
does not do error correction.

Q Determine total delay experienced by circuit switch network.

$T_{CSN} = S + \frac{X}{C} + kd + tp$ "error detect"

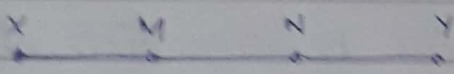
$\frac{X}{C}$ ↓ total delay

↓ transmit the last bit

↓ negligible

(ii) Message Switch Network

also known as store & forward switching

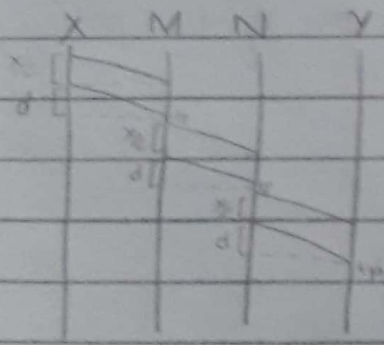


X→M (entire msg delivered to M)

no error ~~msg~~ in msg so it transmits message to N.

Intermediate station performs errors detection & transmission process.

Q. Determine total delay experienced by message switch network?



$T_{MSN} = \frac{X}{C} + d + tp$ ↑ negligible (no errors)

$+ \frac{X}{C} + d + tp$

$+ \frac{X}{C} + d + tp$

$T_{MSN} = \frac{X}{C} + (k-1)\frac{X}{C} + (k-1)tp + kd + tp$

↓ time taken to retransmit entire message by (k-1) intermediate stations

$$T_{MSN} = \frac{X}{C} + (k-1)\frac{X}{C} + kd$$

In CSN, there is an overhead of creating connection. But in MSN, message retransmission is required for intermediate stations.

Q. Compare the delay of message switch network & CSN under what cond^n, MSN offers lower delay?

CSN → connection creation

MSN → retransmission by intermediate stations

$$T_{MSN} < T_{CSN}$$

$$\frac{X}{C} + (k-1)\frac{X}{C} + kd < s + \frac{X}{C} + kd$$

$$(k-1)\frac{X}{C} < s$$

then MSN offers lower delay.

This is also a routing policy.
No intermediate stations may be one of the policy for selecting routing mechanism.

(iii) Packet Switch Network

Packets is created from message

Assumption

P is size of packet

$P = h + p$

h → header

P → pay load or data portion of message

eg size of msg = 4500 bytes

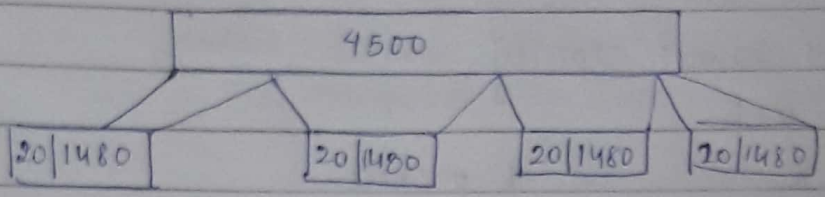
& IP packet size = 1500 bytes.

Determine the no of packets required?

IP packet header = 20 bytes

no of packets required = 4

P = 20 + 1480 bytes.



Thus 4 packets required.

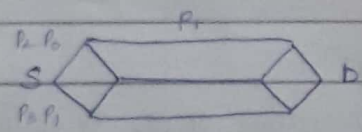
There are 2 types of packet switching

(i) Data gram packet switching

(ii) Virtual circuit " "

DGPS → connection less

VCPS → virtual connection oriented PS



→ DGPS

(you do don't know the path)

- DGPS

In data gram packet switching each & every packet rotate independently. It means each & every packet contain entire routing information.

- Virtual Circuit Packet Switching

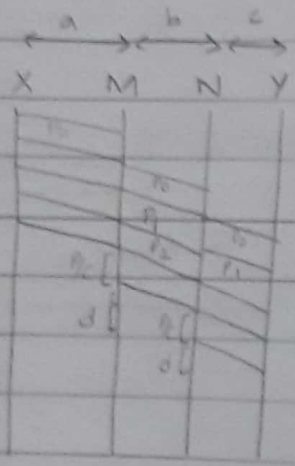
Every packet follow the path of the first packet. First packet contain entire path information.

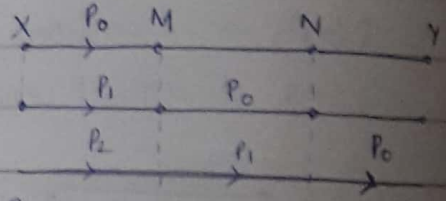
DGPS is used when system is heavily loaded
VGPS " lightly "

Q. Determine the delay experienced by lightly loaded packet switch network?

X is size of message
C → channel capacity
P = p+h
$n = \frac{x}{P}$ no. of packets
↳ pay load (not packet size)

Data transmitted is in form of packet





Assumpt°:
At time when X is transmitting last bit of P, M is transmitting last bit of P_0

Assumption:
Time taken to propagate P_0 packet from M to N
= time taken to propagate P_1 from X to M.

time taken to transmit last bit of P_2 = $\frac{P}{C}$
by X

" " " " " of P_1 by M = $\frac{P}{C}$

But these are performed parallelly.
Even processing is done parallelly.

$$T_{PSN} = \frac{x}{p} + \frac{p+h}{c} + (k-1)t_p + t_p + kd$$

(total delay)

- $\frac{x}{p}$ → no. of packets
- $\frac{p+h}{c}$ → time to transmit one packet
- $(k-1)t_p$ → (k-1) users retransmitting the last packet
- t_p → destination is processing the last packet
- kd

only p is variable

Q. What should be the optimum size of the data portion of the packet in lightly loaded PSN.
Optⁿ size is obtained when delay is minⁿ.

$$\frac{dT}{dp} = 0$$

$$p = \sqrt{\frac{hx}{(k-1)}}$$ → optimum size of data portion of packet.

$$P_{opt} = p_{opt} + h$$

let us assume $t_p \cong$ neg & $h \cong$ neg

$$T_{PSN} = \frac{x}{c} + (k-1)\frac{p}{c} + kd$$

Q. Compare the delay of lightly loaded PSN & CSN? Under what condⁿ PSN offers lower delay.

$$T_{PSN} < T_{CSN}$$

$$\frac{x}{c} + (k-1)\frac{p}{c} + kd < s + \frac{x}{c} + kd$$

$$(k-1)\frac{p}{c} < s$$

If time taken to transmit last packet by all intermediate stations is less than connection establishment time, then PSN is better than CSN.

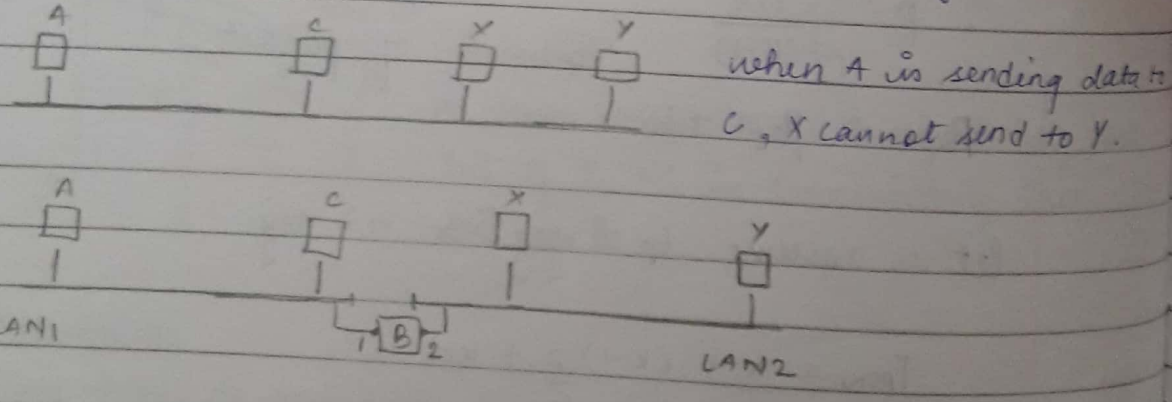
In MSN, whole message was transmitted & in PSN, only a packet is transmitted. Thus, PSN is better than MSN.

Q. In sliding window protocol, can the sender receive acknowledgment for a packet that falls outside its current window. If so specify scenario under which this will occur.

19/3/18

BRIDGE

It is a device ~~not to~~ connected at data link layer.



Bridge maintains a table known as forwarding table.

Bridge perform 3 basic fn
(i) Forward data from one LAN to another LAN
(ii) Identify where stations are connected in LAN.
(iii) Prevent loop in the LAN.

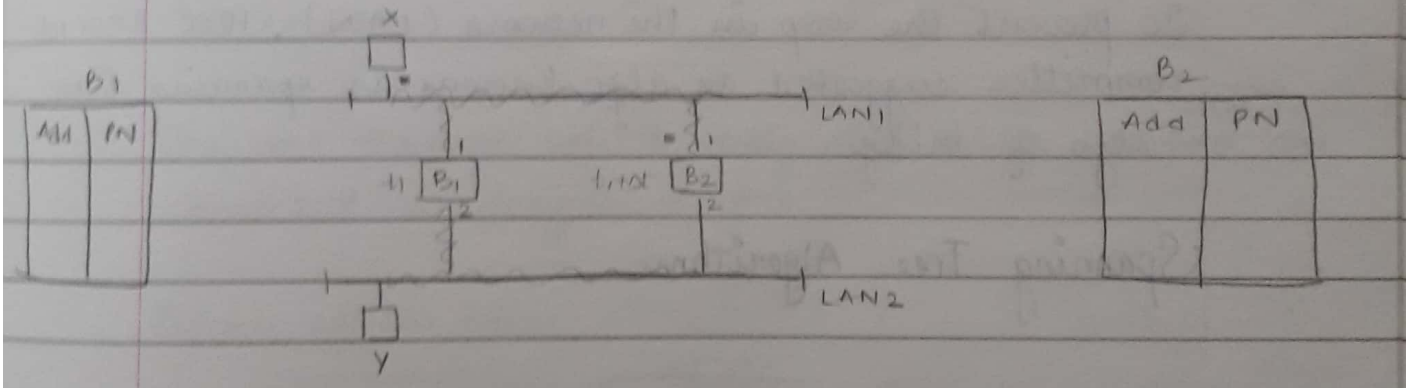
Forwarding table contains two fields i.e address field and port no. field.

Bridge first checks the source address of frame in forwarding table. If there is an entry then it will update it and if there is no entry then it will insert one.

Now bridge check destination address of frame. If it is present then it will send it. If not then it will forward the frame to all ports.

Add	Port No
A	1
C	1
X	2
Y	2

Problem



At time t1 B1 receives the data and it checks the entry in FT so it will insert the entry and it will check destination address entry. Since there is no entry it will transmit the data to all the ports.

Same with B2.

B1

Add	PN
X	1

B2

Add	PN
X	1

B_2 receives one more frame which is forwarded by B_1. It will check the entry corresponding to source address. Since there is entry corresponding to X then it will update it.

B_2

Addr	Port
X	2

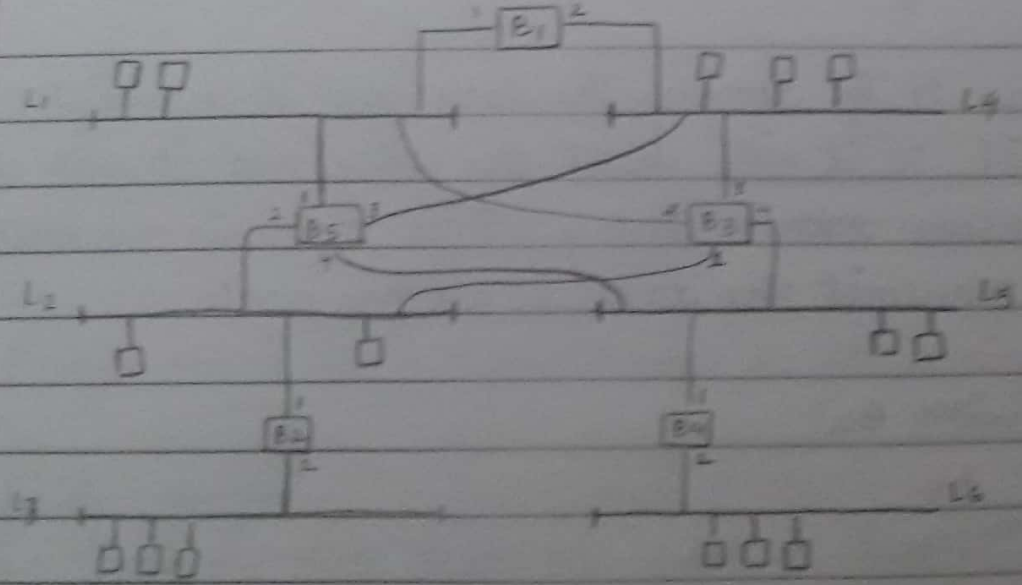
B_1

Addr	Port
X	2

Now when Y will send data, bridge B_1 will check the entry and will insert one entry corresponding to Y then it will check the entry corresponding to destination address. Since the entry is present and port no. is 2 it will store the data.

To prevent the loop in the network (LAN), IEEE 802.1d committee suggested an algo known as spanning tree algo of bridge.

Spanning Tree Algorithm



Cost b/w bridge and LAN in hop path length.

Root bridge

Assume root bridge is a bridge having lowest bridge ID.

Root port

All the ports of root bridge are root port. A root port is a port which will offer least cost path from a bridge to the root bridge. In case of tie, the root port is a port having lowest port id.

Designated bridge is a bridge which offers low cost path from LAN to root bridge. In case of tie, lower ID bridge is selected.

The port through which designated bridge and LAN ~~port~~ are connected is designated port.

Remove all the other

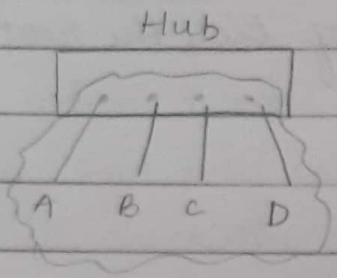
1. Identify the root bridge among all the bridges.
2. Identify root port of all the bridges except root bridge.
3. Identify the designated bridge of each LAN.
4. Only root ports and designated ports are allowed to forward frames. They are only ports that forward the frame and other ports are in blocking state.

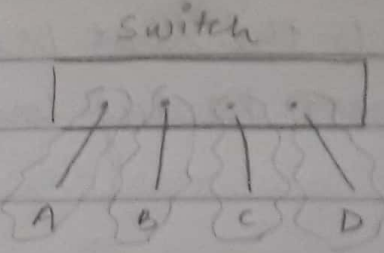
HUB

Hub is a physical layer broadcast device. It uses one collision domain.

↓

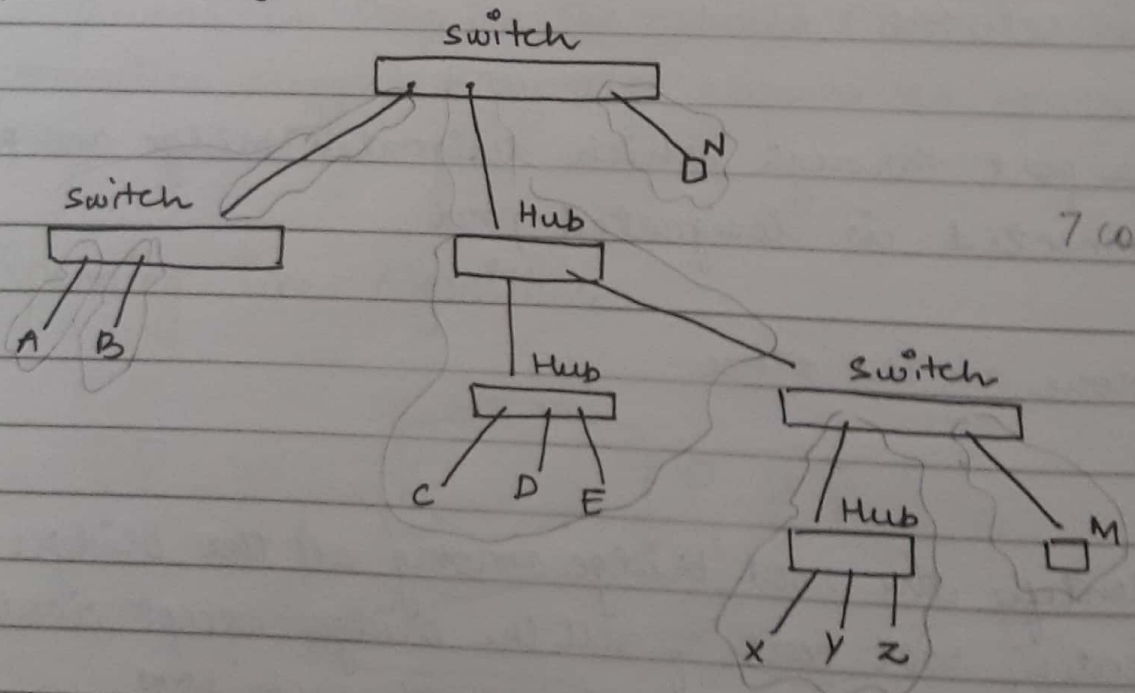
all computers trying to acquire medium at a time then they are all in one collision domain.





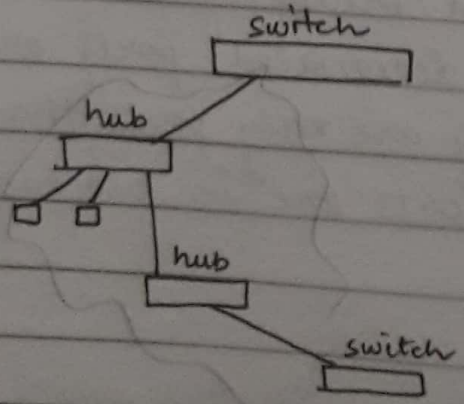
4 collision domain

Identify the no. of collision domain available in the following graph.



7 collision domain

Q2



1 collision domain

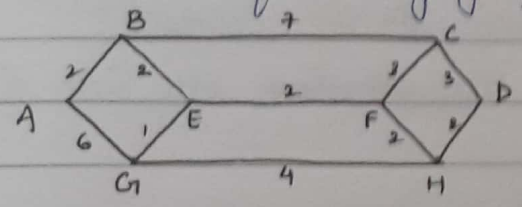
Q. Difference b/w Hub and Switch.

Router

Selecting the path from source to destination

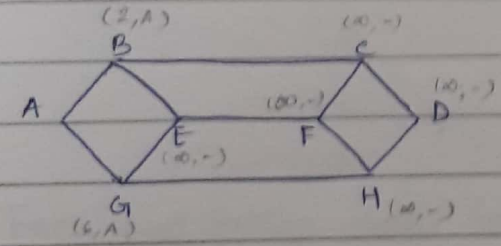
Static Routing – Dijkstra or single source shortest path algo

Consider the following graph

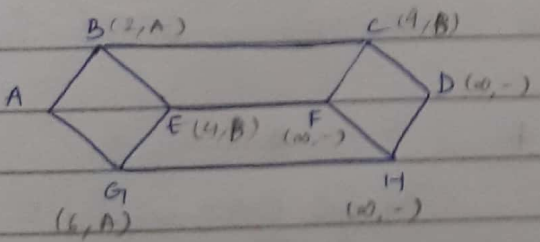


Find shortest path from A.

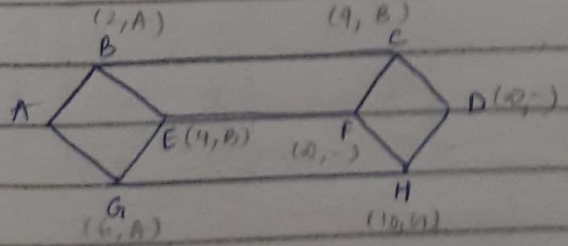
A	B	G



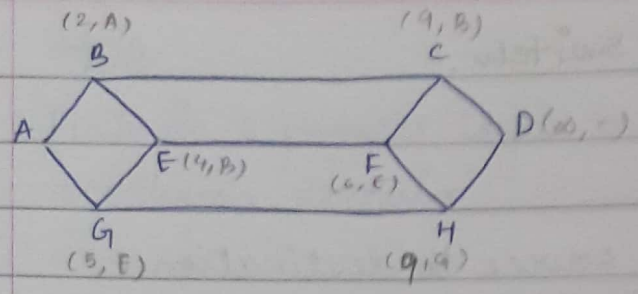
A	B	G	C	E

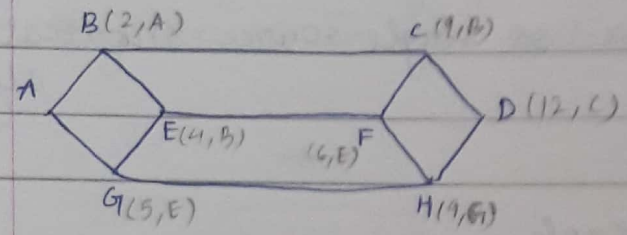


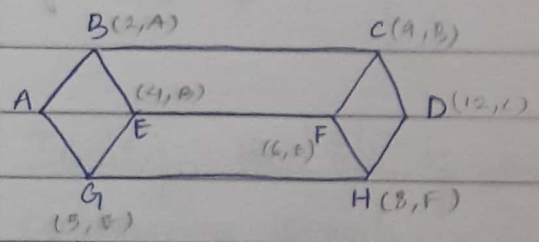
A	B	G	C	E	H

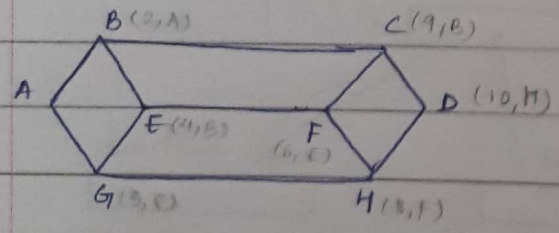


A	B	G	C	E	H	F

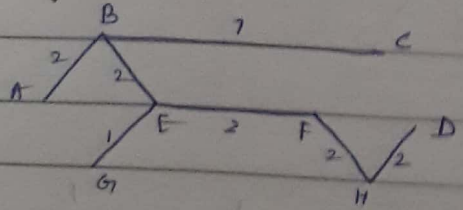








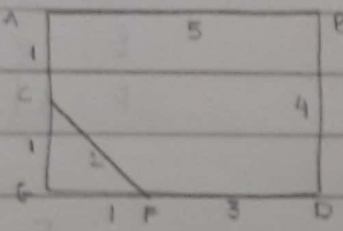
No. of lines not used 4



graph for A only

It states that, let us assume that there exist an optimal path from node I to node J and node K belongs to that path then the optimal path from node K to node J also falls along the same path. The routing table constructed by applying optimality principle is called optimality principle routing table.

Dynamic Routing Algorithm
↳ Distance Vector Routing Algo
In this algo, ~~initially~~ path is adaptive



Each and every node have a routing table and initially it contains info about its neighbour only.

A		B		C		D		E		F	
A	0	A	5	A	1	A	-	A	-	A	-
B	5	B	0	B	-	B	4	B	-	B	-
C	1	C	-	C	0	C	-	C	1	C	2
D	-	D	4	D	-	D	0	D	-	D	3
E	-	E	-	E	1	E	-	E	0	E	1
F	-	F	-	F	2	F	3	F	1	F	0

After every regular interval of time, each router

A

A	0	0	0
B	5	5	5
C	1	1	1
D	-	9	6
E	-	2	2
F	-	3	3

B

A	5	5	5
B	0	0	0
C	-	6	6
D	4	4	4
E	-	-	7
F	-	7	7

C

A	1	1	1
B	-	6	6
C	0	0	0
D	-	5	5
E	1	1	1
F	2	2	2

D

A	-	9	6
B	4	4	4
C	-	5	5
D	0	0	0
E	-	4	4
F	3	3	3

E

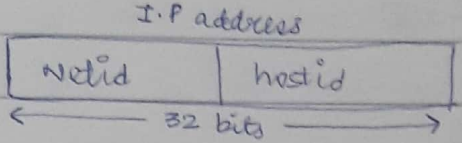
A	-	2	2
B	-	-	7
C	1	1	1
D	-	4	4
E	0	0	0
F	1	1	1

F

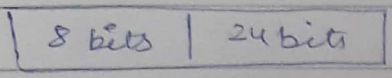
A	-	3	3
B	-	7	7
C	2	2	2
D	3	3	3
E	1	1	1
F	0	0	0

Q. After how many rounds the routing table is stablized.
3

The link from C to E is down.
provide the routing table of A
want to problem



Note 1. All zeroes in hostid field is reserved for network address
2. All ones in hostid field is reserved for broadcast address



N_1 0000 0000 00000000 00000000 00000000

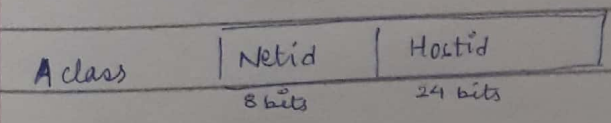
$h_1 N_1$ 0000 0001 00000000 00000000 00000001

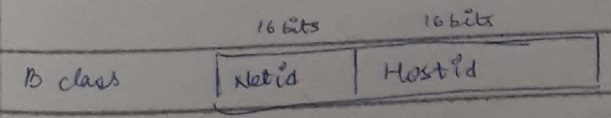
Host N_1 0000 0001 11111111 11111111 11111110

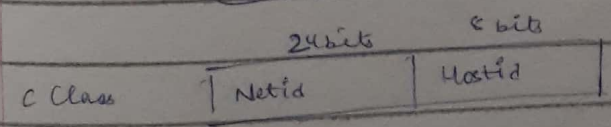
Sol

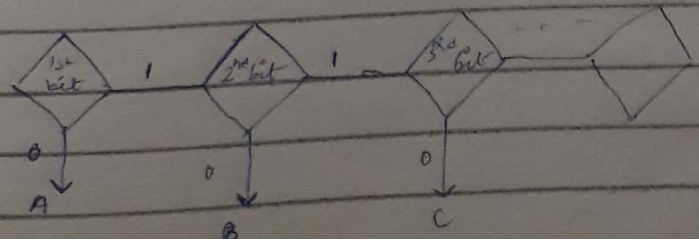
1.

2.









	max no. of network	max no of host in each network
A class	2^7	$2^{24} - 2$
B class	2^{16-2}	$2^{16} - 2$
C class	2^{24-3}	$2^8 - 2$

e.g 192.168.10.230

1100 0000 . 1010 0000 . 0000 1010 . 1110 0110

↓ C class

net id = 24 bits

Network address = 192.168.10.0

Masking

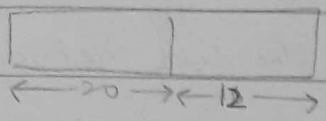
It is the concept of identifying the network address of a given host address. In masking IP address is bits wise anded with mask address to determine the network address.

In mask address no. of ~~bits~~ zeroes ~~in host id field~~ indicates no. of bits in host id field. and no. of ones indicate no. of bits in network id.

Q. Determine the max. no. of host possible in a network having mask address 255.255.240.0

11111111 1111 1111 1111 0000 0000 0000 0000

host id



$2^{12} - 2$

Q. Determine the network address of a host having 150.100.150.25 IP address and 255.255.224.0 mask address.

10010110 01100100 00110010 00011001

\+ 11111111 11111111 11100000 00000000

150 . 100 . 32 . 0

Q. Determine the network address.

A class 0 to 127

B class 128 to 191

C class 192 to 223

(a) 100.200.100.50 A class 100.0.0.0

(b) 150.250.100.75 B class 150.250.0.0

(c) 200.100.10.20 C class 200.100.10.0

(d) 100.50.10.20 100.0.0.0

Q4

(a) 100.200.100.50 100.200.96.0

255.255.224.0

11100000

0110 0100

(b) 150.150.150.150 10010110 150.150.150.148

255.255.255.252 11111100

A IP 192.168.10.230 11100110 192.168.10.224

mask 255.255.255.224 11100000

B 192.168.10.180 10110100 192.168.10.176

255.255.255.240 11110000

10110000

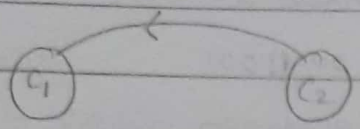
C_1 and C_2 computers have above IP and mask address resp. Which of the following statement is true.

(i) C_1 assumes that C_2 belongs to the same network but C_2 assumes that C_1 belongs to the diff network.

(ii) C_1 assumes that C_2 belongs to the diff network but C_2 assumes that C_1 belongs to same network.

(iii) C_1 and C_2 both assumes that they belong to same network

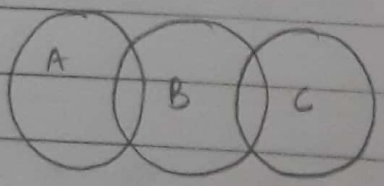
(iv) C_1 and C_2 both assumes that they belong to different network.



C_2 IP	192.168.10.180	1011 0100
C_1 Mask	255.255.255.224	1110 0000
	192.168.10.160	1010 0000

C_1 IP	192.168.10.230	1110 0110
C_2 Mask	255.255.255.240	1111 0000
	192.168.10.224	1110 0000

Adhoc Network



Radio range

Mobile adhoc
Sensor
VANET

adhoc network works on battery
Dynamic Topology
Security - less

Q IP address of host1 of S1

192.168.20.33

IP address of ~~host~~ last host of S1

192.168.20.62

Subnet mask of S_1 - 255.255.255.224

subnet mask of S_2 - 255.255.255.224

first host of S_2 - 192.168.20.65

last host of S_2 - 192.168.20.94

broadcast add. of S_2 - 192.168.20.95

Fixed length subnet id - when we have same no. of bits in host id field.

✓

Consider an organisation is having C class network address. Organisation wish to form 5 no. of subnets with following no. of host

S_1 - 60

S_2 - 60

S_3 - 30

S_4 - 30

S_5 - 10

Design the network

192.168.20.xxxx xxxx

to identify 60 hosts we need 6 bits.

192.168.20. [--] xxxxxx

↓

4 groups possible.

00

✓01

✓10

11

S_1 : 192.168.20.0100 0000

h_1 of S_1 → 192.168.20.65

broadcast address of S_1 - 192.168.20.127

subnet mask of S_1 - 255.255.255.192

S_2 : 192.168.20.1000 0000

h_1 of S_1

broadcast address of S_2 : 192.168.20.191

subnet mask of S_2 - 255.255.255.192.

192.168.20.00xx xxxx } remaining groups

192.168.20.11xx xxxx }

192.168.20.000x xxxx } 2 group for 30 hosts

✓ 001x xxxx }

S_3 : 192.168.20.~~59~~32.

h_1 of S_3 : 192.168.20.33

broadcast address of S_3 : 192.168.20.63

subnet mask of S_3 : 255.255.255.224

192.168.20.110xxxxx ✓

1xxxxx '110

S_4 : 192.168.20.192

h_1 of S_4 : 192.168.20.193

broadcast address of S_4 : 192.168.20.207

subnet mask : 255.255.255.224

S_5 : 192.168.20.224.

h_1 of S_5 : 192.168.20.225

broadcast address of S_5 : 192.168.20.239

Subnet mask : 255.255.255.240