There are 3 problems in computer networks

1. communication problem
2. identification problem
3. connection problem

(1) communication problem

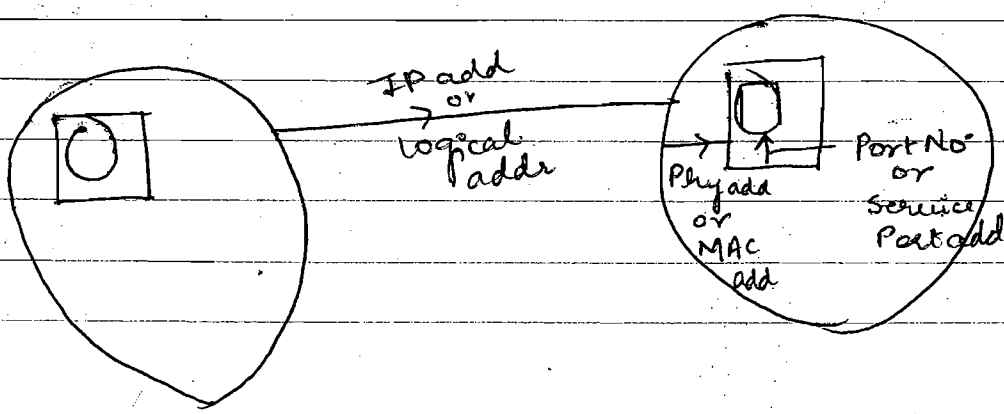
* solved using protocols
* protocols are the language of computers

protocols talks about syntax & scemantics

Syntax — How (format)
— when (timing)

Scemantics → what

(2) Identification problem :-



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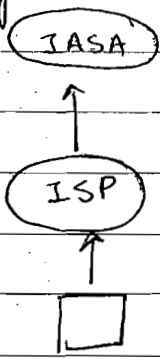
IP address or logical address :-

IPV4



Classification of telephone no

* each telephone no contains 11 digits
* It contains 2 parts
  - STD
  - Device ID
* all the nos are unique
* hidden meaning in dividing
  (a) 3, 8 (cities)
  10^3, 10^8
  cities devices
  (b) 4, 7 (Town)
  10^4, 10^7
  (c) 5, 6 (villages)
  10^5, 10^6

IPv
the
(1) ea
(2)
(3)
clas

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IPV4 are logical addrs directly adopted the above conventions:

(1) each IP addr contains 32 bits

(2) contains 2 parts — N/w ID
— Host ID

(3) All IP are unique (INternet)
(WWW)

IP addr are not permanent
MAC addrs are permanent

hidden meaning

IP addrs are classified into 5 classes
Class A,
— B
— C
— D
— E

Class A

In class A N/w ID is of 8 bits and HID is of 24 bits

Theoritical
2^8 N/w
2^{24} Host

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practically

N/w	H
0 ----	----

$2^7 \times 2^{24}$

$2^{31} \Rightarrow \frac{2^{32}}{2}$ half of the addr are class A addr

all 0 & all 1 are not used

$(2^7 - 2)$ N/w and $(2^{24} - 2)$ host ID.

Class B :-

16 N/w	16 host
10-- ----	---- ----

2^{14} N/w $(2^{16} - 2)$ host

Class

Then

Class

It is assig

Class

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Class C

Theory :- 2^{24} N/w 2^{8} H/w Total IP = 2^{32}

110- ---- ---- / ----

2^{21} N/w $2^{8}-2$ Host

Class D

every class D addr starts with 1110

It is use for multi casting, class D addr is not assigned to any host

Class E

starts with 1111

reserved for future used

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Ranges and Numbers.

class A

0 1 1 1 1 1 1 1 | ___ ___ ___

1 to 126

126 N/w.

$2^{24} - 2 \cong$ 16 million

class B.

10 ------ | ------ | ___ ___

128 to 191

$2^{16} - 2 = 64k$

0.000000 ⇒ 128

10 111111

26. 63

128 + 63 = 191

class C

110 ----- | ___ ___ | ___

0 ---- 128 + 64 = 192

0 1 1 1 1 1 223

2^{21} | $(2^8 - 2)$ Host

class

Class

The

The

1) CI

2) NAT

CIDR

CIDR

(1) Su

(2) Su

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Class D :- 224 - 239
Class E :- 240 - 255

The disadvantage of IPV4 is IPV4 exaustion

The solution for above problem are
1) CIDR
classless interdomain Routing

2) NAT
Network address translation

CIDR classless interdomain Routing
CIDR can be implemented in two ways

(1) Subnetting -> dividing a n/w into small part
(2) supernetting -> combing 2 n/w to get a bigger n/w

194.1.1.2 class C 24 n/w
if 22 n/w then supern
if 26 subnetting

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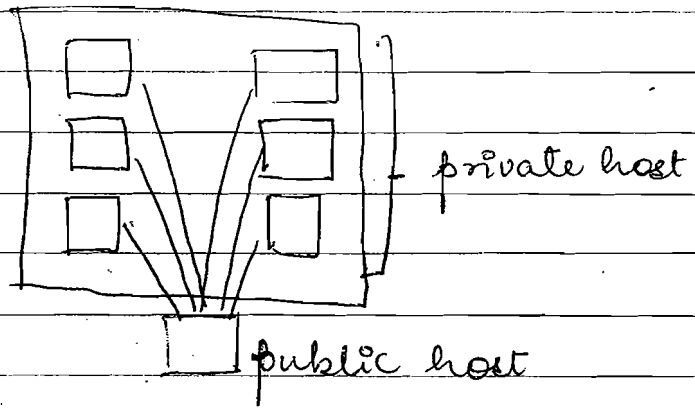
NAT Network address translation



Internet Cafe

Range of the IP address and set aside for private host

10.0.0.0 - 10.255.255.254 - 1 Class A
172.16.0.0 - 172.31.0.0 - 16 Class B
192.168.0.0 - 192.168.255.255 - 255 Class C

Note IPV4 addr are exausted

Spe
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have
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use

If u
net
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ap

Use

→ Tes
→ 1
san

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Special IP addr 127

If there is a problem with NIC then we have to send a packet from host to same host but it is not possible acc to IP then we use 127 address.

i.e. destination addr is

127.—.—.—

127.0.0.0 X

127.255.255.255 X

If we use 127 as destination add the packet will be sent by the sender and received by the receiver but it will never be appeared on the n/w

Uses of loop back addressing

→ Test NIC

→ Used for interprocess communication in the same host for testing client server apps

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Com

Physical Addressing System

→ physical address is 48 bit
→ It is used in data link layer
→ used by ARP and it is H/w addr printed on NIC which is permanent
→ physical address is unique
→ No hierarchy in physical address
→ No grouping possible in physical addr.
→ ~~connection problem~~.

Port Number or Service Point Addressing

→ It is 16 bit no°
→ used in TCP layer
→ It is s/w generated no°
→ fixed for a particular process
→ Port Number are permanent

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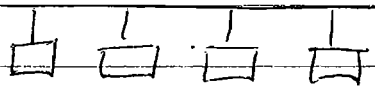
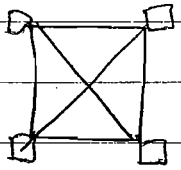
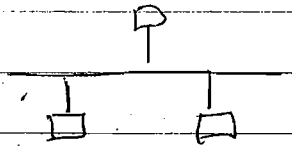
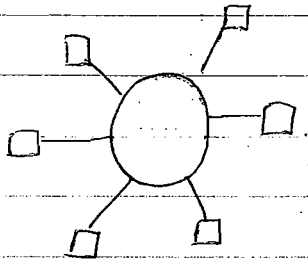
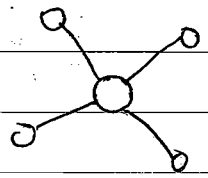
Connection Problem :-

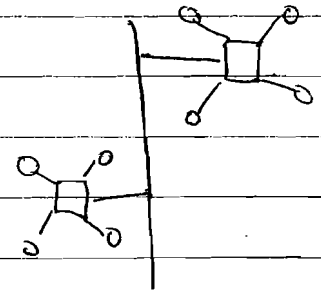

broadcast link


point-point link


Bus topology


Ring topology


star topology



Tree topology

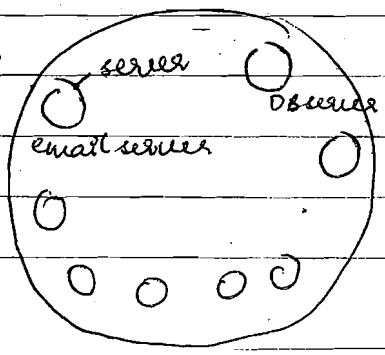
Objects in C-N environment

1) work station and server
2) HUB
   SWITCH
   Bridge
   Router
   Brouter
   Gateway

LAN devices

WAN devices

workstation and servers:-
The difference b/w workstation and server is only in terms of S/W, but not in terms of H/W.



HUB:
all
(i)
(ii)
ass
(iii)
pack
(iv)
Swi
and
Cacti
help
lab

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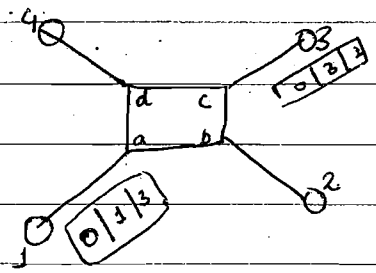
HUB: central connecting device connecting all workstations and servers.

(i) It is a pure electronic device
(ii) Hub is a passive device, i.e. it is not an intelligent device and not associated with any s/w
(iii) It is a broadcasting device, i.e. incoming packet is broadcasted to all outgoing links
(iv) N/w traffic is high in hub/N/w and so it is slow.

Switch :-

It is also used to connect workstations and servers but switch is an intelligent device (active) associated with s/w and with help of the s/w, it will construct a lookup table.



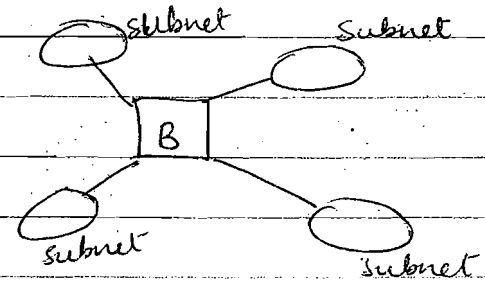
lookup table

sys No	Interface
1	a
2	b
3	c
4	d

cost of switch is high, approximately 2 to 3 times of hub its operation is not simple.

Bridge:-

Bridge is used to connect multiple subnet or LAN's. It is an intelligent device (active). It will construct look up tables with the help of software to keep track of different lans. Its design criteria is filtering and forwarding. The diff b/w switch and Bridge is only in terms of interfaces. Switch has more interfaces than bridges.



Router

simil

sophi

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rout

and

Gatew

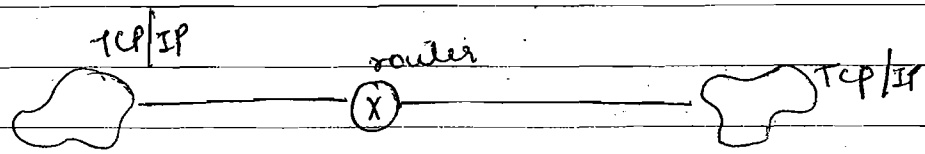
desi

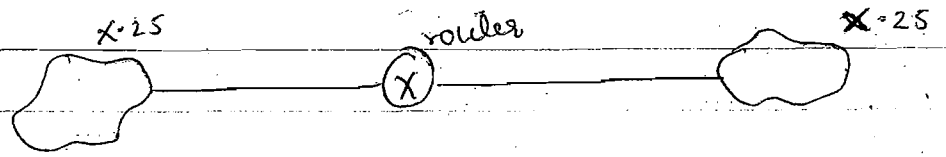
Router :- It is used to connect two different similar network.

It is active device associated with sophisticated software

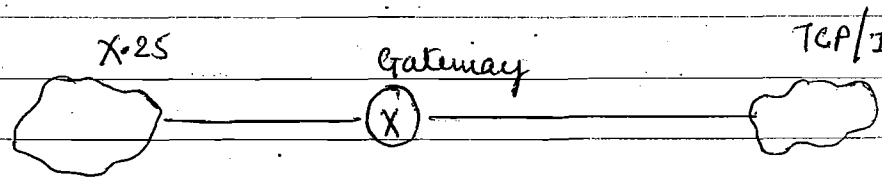
Its design criteria is routing hence it can have many routing algos. The cost of router is very high.

Their operation is very complicated and requires manual configuration also





Gateway :- It is used to connect two diff dissimilar n/w. It is also called protocol converter



Brouter :- It is two in one device. It has the capability of bridge as well as router.

Functions in Computer Network:-

- mandatory
- optional

mandatory	optional
error control	compression
flow control	Encryption
Seg & reassembly	routing
muxng & demuxng	Encoding
	Name resolution

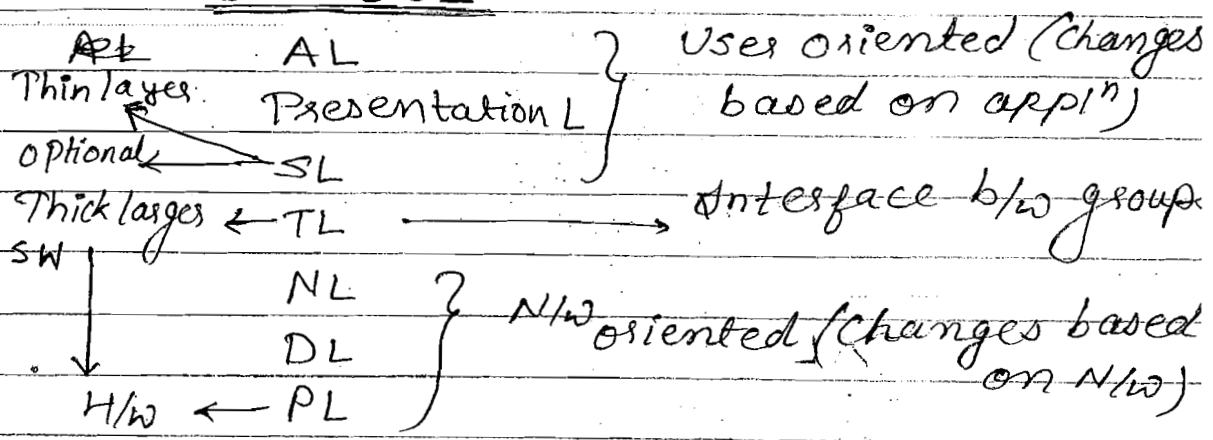
There are nearly 70 functions in computer networks and several reference model discussed about these functionality.

OSI → fundamental
TCP/IP → practical.
X.25
ATM
ISDN
F relay
IEEE 802

There are nearly 70 functions in computer n/w & several reference models discussed about this functionality

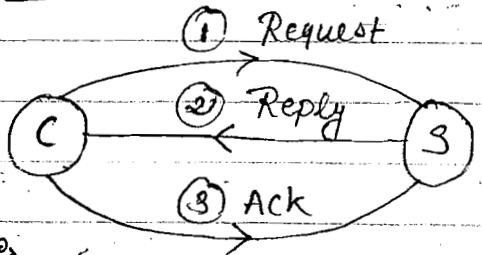
i) OSI or ISO ii) TCP/IP iii) X.25 iv) ATM
v) ISDN vi) Frelay vii) IEEE 802

ISO-OSI

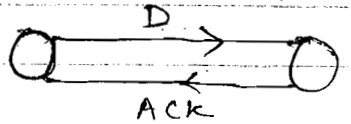


Communications are of 2 types:-
i) Connecn oriented commn
ii) Connecn less commn

Connection Oriented Commn



a) Connecn Establishment
b) Data transfer



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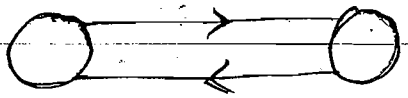
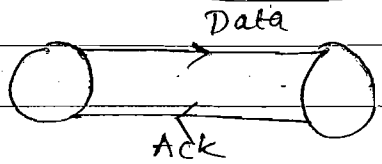
Data Termination:-

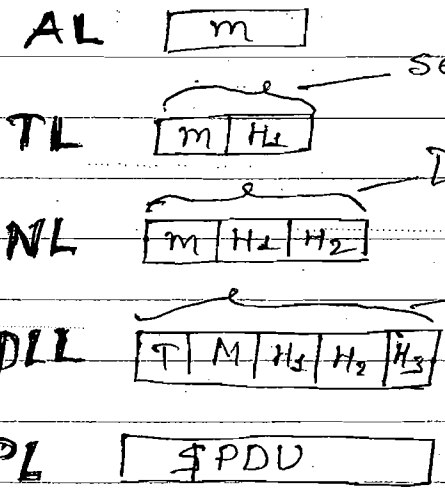


CONNECTIONLESS COMM^N:-



* Connection less is fast but connection oriented is reliable.

TCP/IP



Responsibility:-

It deals with electrical, mechanical, functional & procedural characteristics of interfaces & medium.

a) Representation of bits:-

Copper cable - Electrical signal

F
b) Synch
c) Link C
d) trans.
Respons
a) Erro
If we a
to corre
b) Flow
what a
flow cor
window
c) Acces
CSMA/CI

Fibes ~~Light~~ optic — light
Wireless — Electromagnetic

b) Synchsonization of bits:-

c) Link configuration

Broadcast Link — point to point link

d) transmission modes

i) simplex
ii) half duplese
iii) full duplex

nection

Responsibility of DLL:-

a) Errors Control:-

i) Errors detection

ii)
a) CRC
b) LRC
c) VRC
d) Checksum

ii) Errors Correction

a) Hamming codes

If we detect an errors but not able to correct it then it is ask for retransmissi

b) Flow Control:-

A sendes should not send what a receives can receive. Generally flow control is taken care by sliding window protocol.

mechanical, istics

c) Access Control:-

Protocols like CSMA/CD, CSMA/CA, Token passing.

signal

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1) Framing :- The max. size of a packet in internet environment is 64kB. If we have to send a data more than 64kB then f go for framing.

2) Physical Addressing :- It is also c/d Ethernet address or MAN address & it is used to identify host in a n/w.

Responsibilities of N/w Layes :-
a) Routing
b) Congestion Control
c) Logical addressing
d) Feedback messaging

Responsibilities of Transpost layes :-
a) Error Control
b) Flow Control
c) Segmentation & reassembly
d) Multiplexing & Demultiplexing
e) service point addressing

* There are some well known post no. reserved by IANA & it is from 0 — 1024 to identify the destination server's post no.

* We can get IP address of the destination server by DNS.

(WLS)
B, b

A
TL
NL
DLL
PL

Differe
1) It takes
to end
2) Its co
is on pa
errors.
3) less p
sum me

Sess
a) Dia

Sends
Server

a packet
4 kB. If
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c/d Ether-
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yes:-

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post
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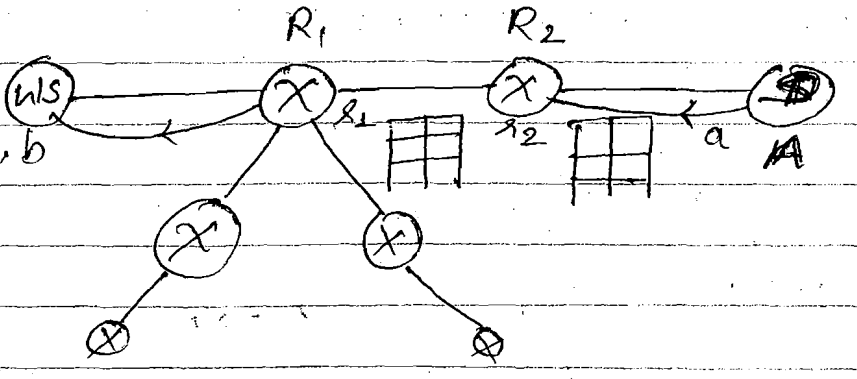
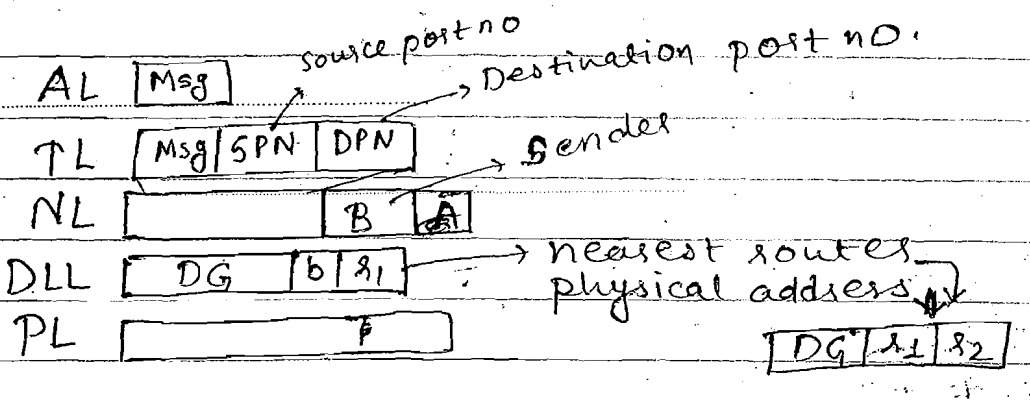
destination





Difference b/w DLL & TL:-

TL	DLL
1) It takes care of end-to end comm^n.	Link (node) to Link
2) Its concentration is on packet level errors.	on bit level errors
3) less powered check-sum method	uses more powered CRC method.

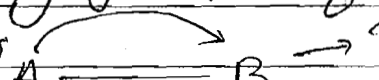
Session Layer:-

a) Dialogue control or discipline:-

Session layer sends some dummy pckts to the server to keep the connec^n alive.

b) Maintaining Synchronization or check points :-

c) Maintaining groups of Opesation



→ Transfering money from A to B.

A = A-50
B = B+50

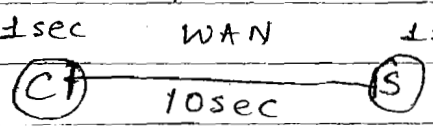
} It groups it into one logical group so both can performed or nothing can be performed.

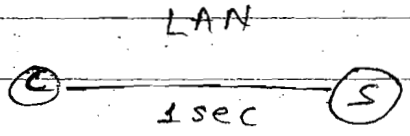
Presentation Layer :-

a) Encoding

b) compression :-

In LAN's generally we not compress the data but in WAN we compress the data





c) Encryption

Application Layer

The majority of protocols available in application layer

The de
uses ir

Protoc
AL-
TL-
NL-
DLL-
PL-

Work

Sn
B
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B
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PL & D
NL & T
AL

★PL & DLL
other l
generall

- The design criteria of appl^n layer is user interface (convenience of user)

- Protocols at various Layers :-

AL - SMTP, Telnet, FTP, TFTP, HTTP, HTTPS, P

TL - TCP, UDP

NL - IP, IGMP, ICP, OSPF, BGP, RIP (Routing algo protocol)

DLL - HDLC, CSMA/CD, CSMA/CA

PL - RS-232

Work station & server - 7 layer

Hub	- 1 (PL)
Switch	- 2 (PL, DLL)
Bridge	- 2 (PL, DLL)
Routes	- 3 (PL, DLL, NL)
Broutes	- 3 (PL, DLL, NL)
Gateway	- 7

PL & DLL —— NIC

NL & TL ⟶ OS Kernel of NIC

AL ⟶ program (designed as user program)

★ PL & DLL is present in NIC only but other layers can present anywhere generally they are in OS;

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Diff b/w OSI & TCP/IP :-

OSI	TCP/IP
i) OSI :- It has 7 layers.	5 layers
ii) There is no definition for multicasting in OSI.	There is definition for multicasting in TCP/IP
iii) There is no flexibility in OSI	Highly flexible

Advantages of Layering :-

i) It uses divide & conquer principle, so it is easy to implement.

ii) It has uses object oriented principles like encapsulation & abstractions.

Disadvantages :-

i) Duplication of the functionality
Eg :- TL & DLL

ii) Interdependency among the layering system. TL & NL are integrated.

Types of Casting

i) Unicasting :- Sending data from single source to single destination

ii) Broadcasting :- Sending data from one node to all node

a) Directed

b) Limited broadcast

Sending a msg from a node to all the host in some other n/w.

12.6

12

130

198

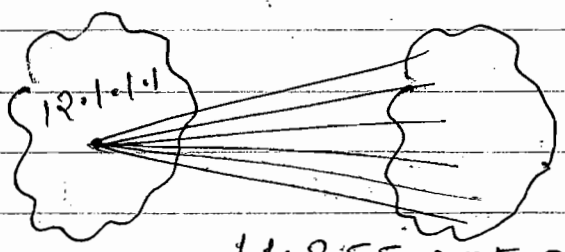
Limite

& data
havin
i.e. wi

Then
can't
this it
send fr
255.25
Broadca

Multica

12.0.0.0 11.0.0.0



11.255.255.255

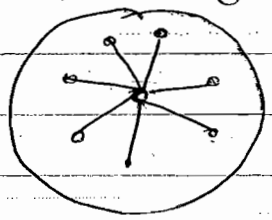
↳ Used as direct broadcast address

130.1.2.3 ⟶ 130.1.255.255

198.1.2.3 ⟷ 198.1.2.255

Limited Broadcast:-

Sending the node data from one node to all nodes having same n/w as sending node i.e. within the n/w.



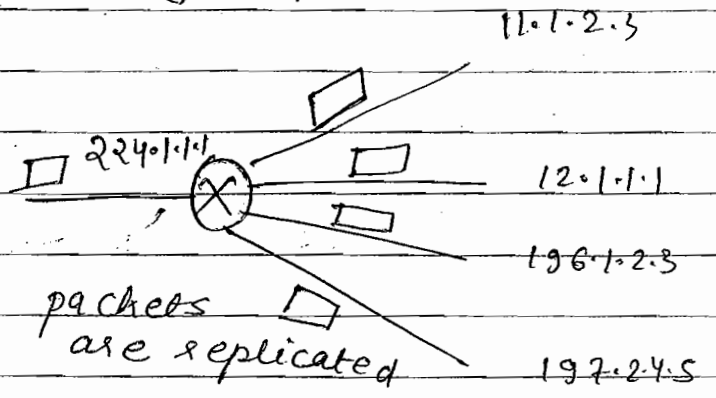
Then limited broadcast address can't be 11.255.255.255 b'coz for this it have to go routes + then send from routes. Therefore 255.255.255.255 is used as limited broadcast address.

Multicasting:-

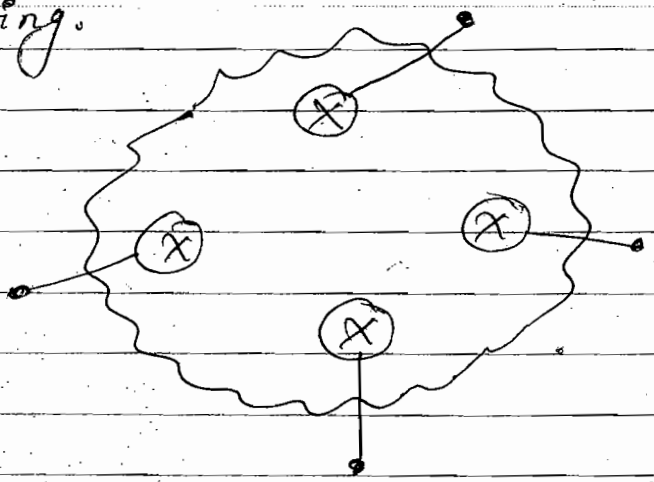
On multicasting class D

address is used as groupID.

224.1.1.1
11.1.2.3
12.1.1.1
196.1.2.3
197.2.4.5



ANY CAST:- It is used in mobile phone routing.



all the routers are valid and it chose ~~closes~~ closest routes.

Delays in Computes Networks:-

i) Queueing Delay:-
ii) Processing Delay
iii) Transmission Delay
iv) Propagation Delay

Queueing Delay:- The amount of time packet waits in the queue before being

taken
queueing
Factor
i) Buff
ii) Route

Process
taken b
packet
extract
routing
Factors
i) Route
ii) Routi

Transmis
time tak
the pac
smission

Propagat
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tion Dela

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taken up for processing. Range of queueing delay is 0–∞.

Factors affecting queueing delay:–

i) Buffer size

ii) Router speed

Processing Delay:– The amount of time taken by a routers to process the packet. Processing is identifying DIP, extracting N/w id, searching the routing table, deciding the next hop.

Factors affecting processing delay:–

i) Router speed

ii) Routing table size

Transmission Delay:– The amount of time taken by a routers to transfer the packet to outgoing link is c/d transmission delay.

$$TD = \frac{L}{B}$$

$L \rightarrow$ Length of packet

$B \rightarrow$ Bandwidth of link

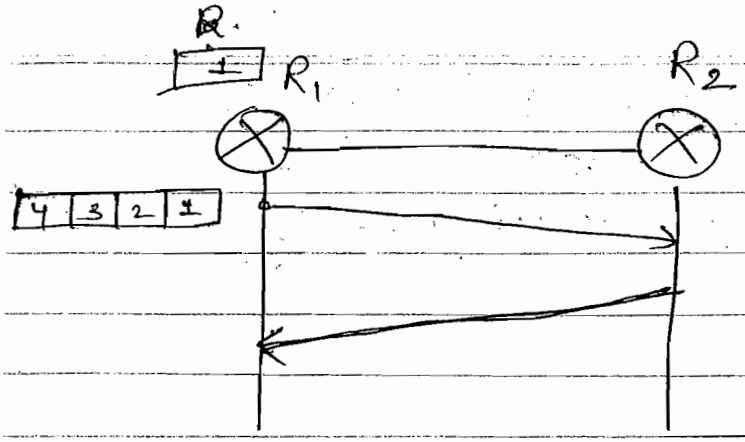
Propagation Delay:– The amount of time taken by a bit to make a physical journey from 1 point to other is propagation delay.

$$PD = \frac{D}{V}$$

$D \rightarrow$ Distance

$V \rightarrow$ velocity of link

Round trip time = 2 × propagn delay



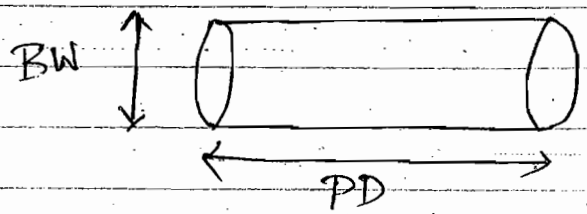
Pd (Data $R_1 \rightarrow R_2$)
+
Qd (at R_2) $\cong 0$
+
Processing delay $\cong 0$ (at R_2)
+
Pd (ack at R_2) $\cong 0$
+
Pd (ack from $R_2 \rightarrow R_1$)

$RTT = 2 \times Pd$

Timeout = $2 \times RTT$

If timeout is too small then retransmission of the pckt ↑.
If timeout is too large then pckts hold the buffers for large time & processing is slow.

CAPACITY OF A LINK :-



Capacity of link = BW × PD

If BW × PD is high then it is c/d thick pipe, & if it is low c/d as thin pipe.
~~A~~ High in WAN b'coz PD is high

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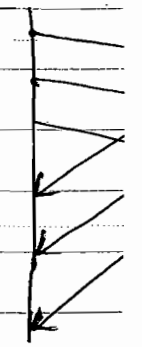
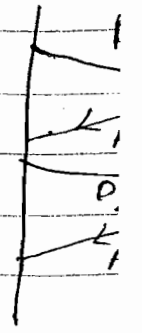


iii) Posit



SLIDING WINDOW PROTOCOL :-

Characteristics :-

i) It is used in connec^n oriented comm^n only.

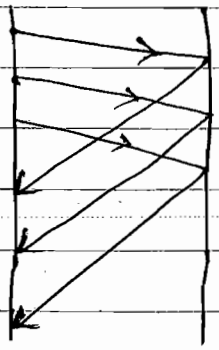
ii) Sliding window protocol connec^n are full duplex comm^n.

iii) Sliding window protocol is theoretical concept & practically implemented in terms of Go Back N & Selective Repeat protocol.

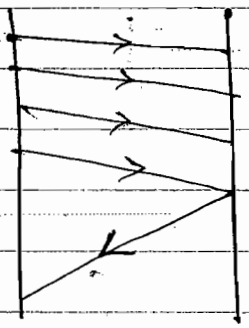
iv) It is used to ctrl flow as well as errors (it is pckt level errors)

Different types of Ack :-

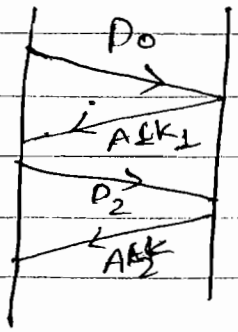
i) Independent Ack



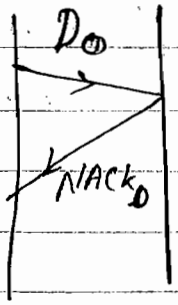
ii) Cumulated Ack



iii) Positive Ack



iv) Negative Ack



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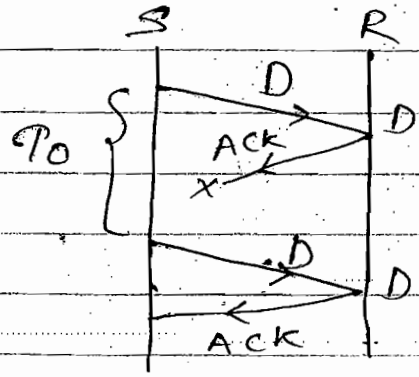
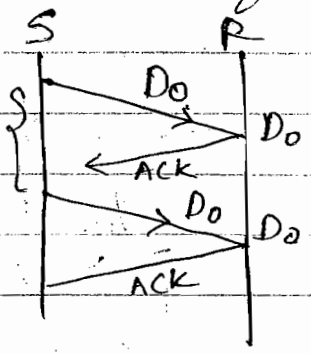
STOP & WAIT PROTOCOL

Xmit a packt.
Stop & wait for ACK.
There is problem of deadlock ∴ we use timeout.

Duplicate PCKT Problem



∴ Sequence no. for data pckts



Delay

Add seq

No of seq

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half dupl
ii) Through

iii) If BWX
is very th
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iv) Stop & w
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v) Stop & wa
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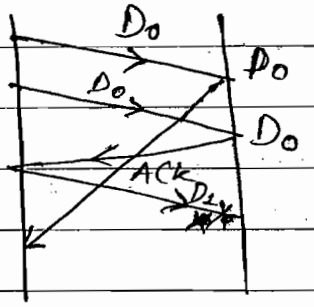
Delay ACK :—



Add sequence no. of to ACK

No of sequence no. seqd :—

Two ~~A~~ sequence & ∴ 1 bi

Characteristics of stop & wait :—

i) It uses the link b/w client & server as half duplex.

ii) Throughput is, 1 data pckt per RTT

iii) If BW×PD product is very high i.e. line is very thick then stop & wait is not usefu

ts

iv) so stop & wait is useless in WAN & usefu in only LAN.

iv) stop & wait protocol is an eg of closed loop protocol.

v) Stop & wait is a special category of sliding window protocol where sender & receiver window size is 1.

If the BW of line is 4·5 Mbps, RTT is 45ms and pkt size is 1KB, then find

the link utilization in stop & wait.

$$\frac{1KB}{45ms} \times 1.5Mbps$$

$$\frac{10^3 \times 2^3}{45} = \frac{1 \times 1024 \times 8}{45 \times 10^{-3}} = 182Kbps$$

$$\text{efficiency} = \frac{\text{Throughput}}{BW} = \frac{182kbps}{1.5Mbps}$$

$$= 12.1\%$$

★ In the above problem we have seen that link utilization is very less in WAN's.

What is the throughput achievable in stop & wait protocol by a max. pkt size of 1kB & network spans

a) 10km b) 5000km

Assume that speed of light in cable is 70% that of speed of light in vaccum

$$t = \frac{D}{s} \quad t = \frac{10 \times 10^3}{3 \times 10^8 \times 0.7} = 47.6\mu s$$

$$= \frac{1 \times 10^3}{10 \times 10^{-6} + 3 \times 10^4 \times 0.7}$$

$$\text{Throughput} = \frac{1 \times 10^3}{95.2}$$

$$= 84 Mbps$$

b) WA

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If the delay is is 0. time & stop & Total t

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82kbps

5Mbps

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pkt

cable

in bdccm

=47.6μs

b) WAN

$$Pd = \frac{5000 \times 10^3}{0.7 \times 3 \times 10^8}$$

$$= 5000 \times 47.6 \mu sec$$

$$RTT = 23800 \mu sec$$

$$= 23800 \times 2 = 47600 \mu sec$$

$$TP = 0.168 \text{ Mbps}$$

If the pkt size is 1kB & propagation delay is 25msec. The channel capacity is 10^9 bps then find the xmission time & utilization of the sendes in stop & wait protocol.

Total time = Td + Pd + Pd = 50.008ms

$$Td = \frac{L}{B} = \frac{1024 \times 8}{10^9} \cong 0.008ms$$

$$\text{Sendes utilization} = \frac{0.008}{50.008} = 0.00015$$

From the above 3 problems we have seen that the link utilization & sendes utilization is very less in stop & wait & ∴ it is not applicable for WAN's

So to resolve this problem we need an alternative mechanism & it is c/d pipelining technique.

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Advantages of pipelining:-
* sender utilization is high.
* Line utilization is very high.
* It can be applicable for WAN.

Limitations of pipelining:-
* It requires large buffer size
* More sequence no. are needed.

Status of the packet ~~send~~ at sender side:-
i) pckts to the L.H.S. of senders window W_S are xmitted & acknowledged.
ii) pckts within W_S are xmitted and waiting for the ACK.
iii) pckts to the RHS of W_S are waiting for xmission.

Status of the packet at received side:-
i) Pckts to the L.H.S. of W_R are received, pushed to the upper layers & acknowledged.
ii) Sequence no.'s within W_R indicate the pckts that are expected.

The sizes of W_S & W_R dependson on the efficiency reqd.

Dependi
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i) Go ba

GO BACK
Chara
i) GBN
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ii) Its nd
ack. i.e.
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Validatior
i) The seq
ii) Duplica

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& more
W_S

Depending upon the error correction sliding window protocols are implemented as

i) Go back-N ii) Selective Repeat

GO BACK N :-

Characteristics

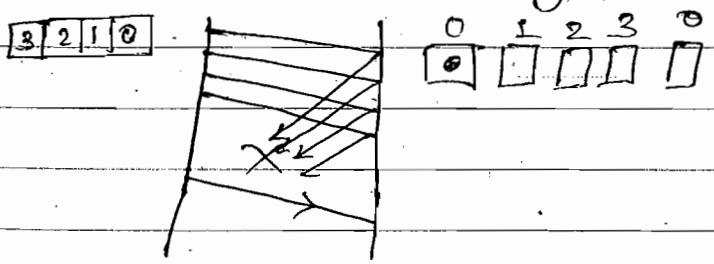
i) GBN never receive in order & never going to receive out of order & having receives window size is 1.

ii) Its natural choice is cumulative ack. i.e. accumulate some of data & give ack to some of the pckts). If possible we may use piggybacking ack.

Validation of window sizes in GBN:-

i) The receives window size is always 1.

ii) Duplicates pckts may get accepted.



$W_S = 4$

sequence no. = 4

This problem can be avoided by using 1 more sequence no. i.e.

$W_S = 4$ then sequence no = 5

sequence no = $W_S + 1$

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Q) Assume 'N' is defined as max available sequence numbers, then

$W_S = N-1 \qquad W_R = 1$

7654 3

Q) Assume 'N' is defined as max available sequence numbers, then

$W_S = N \qquad W_R = 1$

Q) If 'k' is defined as no. of bits in sequence no. field

$W_S = 2^k - 1 \qquad W_R = 1$

Selective Repeat

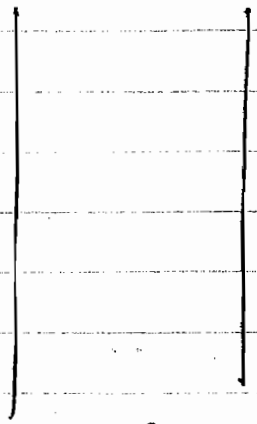
* SR receives receives out of order packets then receives W_R is more

$W_S \geq W_R$

then 1.

* Its natural choice is independent acknowledgement.
* If possible it also uses piggybacking.

$W_S = 4 \qquad W_R = 4$



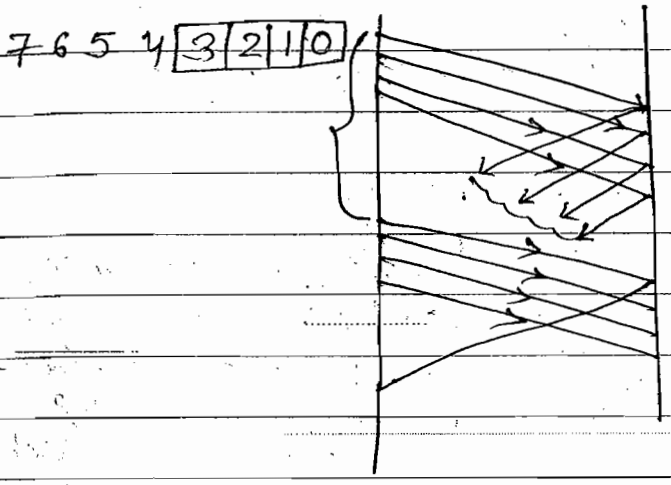
otherwise

Q) Assu

Q) N is

Q) k

$W_S + W_R \leq$ Sequence No



No. of sequence no = 8

W_S	W_R	
4	4	(optimal)
5	3	(allowed)
6	2	(— 11 —)
7	1	(GBN)

others

Q) Assume N is max available sequence no's

$$W_S = \frac{N}{2} \quad W_R = \frac{N}{2}$$

Q) N is max available sequence no.

$$W_S = \frac{N+1}{2} \quad W_R = \frac{N+1}{2}$$

Q) k no. of bits in sequence no. field

$$W_S = \frac{2^k}{2} = 2^{k-1} \quad W_R = 2^{k-1}$$

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Comparision b/w GBN & SR & stop & wait

i) ~~implementation of~~

Stop & wait	GBN	SR
1) Implementation is simple	Moderate	Complex
2) Response time is very fast	Moderate	very slow bcoz if error comes sender have to resend the packet & at there to apply sorting at receiver & searching at sender. Binary search is applied b'coz ~~no~~ sequence no. are in sorted orders
3) Buffer reqd is less in stop & wait	Moderate	Very Large
4) Reqd of sequence no. are very less (always 2) ~~It is slig~~	~~Moderate~~ slightly less than SR if window size is same $\|W_S\|=4$ $\|W_R\|=4$ 5 sequence no. reqd	slightly higher then SR if WS. is same. $\|W_S\|=4$ $\|W_R\|=4$ 4 + 2 = 6 seq. no. reqd min 2

5) efficier very

6) Bandwidt very pc

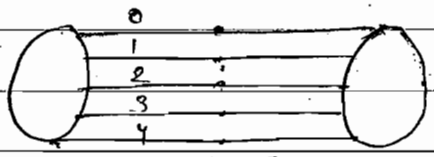
Assur simul and e & wait overall

overal

A chann propagat range gives ast

5) Efficiency	very less	Moderate b'coz more no. of repetation than SR	high
6) Bandwidth Utilizn	very poor	Moderate	high

Assume that we run 'n' channels simultaneously b/w client & sesves and each one is operated with stop & wait protocol then what is the overall affect of commn.



overall affect is equivalent to SR.

A channel has a bit rate of 4kbps and a propagation delay of 20msec. For what range of frame size, does stop & wait gives an efficiency of atleast 50%?

$$\frac{1}{2} = \frac{\text{trans. time}(tt)}{tt + Rtt}$$

$$\frac{1}{2} = \frac{1}{1 + \frac{Rtt}{tt}} \quad \therefore \quad \frac{Rtt}{tt} = 1$$

$$Rtt = tt$$

$$tt = \frac{L}{B}$$

$$L = 20ms \times 4kbps = 160 \text{ bits}$$

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More than 50%

RTT > TT

Consides a MAN with average source & destination distance of 20 km & one way delay of 100 μsec. At what data rate does RTT equals Xmission delay for 1 KB pckt.

RTT = 2 × 100 = 200 μsec

Xmission delay TT = 200 μsec

$$200\,\mu sec = \frac{1 \times 10^3 \text{ Bytes}}{B}$$

$$B = \frac{1 \times 1024 \times 8}{200 \times 10^{-9}}$$

$B =$

Q) Suppo
window
to the
of 1.25 s
carries -
of 5 bits
field of

Data size =

No. of
Data

No

Calc
i) Calc
ii) No.
one R
iii) Find
iv) Send
v) No. of

vi) Let us

Q) Suppose you are designing a ~~stop~~ sliding window protocol for a 1 Mbps point to point to the moon, which has one-way latency of 1.25 sec. Assuming that each frame carries 1 KB of data, what is the min. no. of bits we need for the sequence no. field of in headers.

source & one way rate for

$$RTT = 2.5 \text{ sec}$$

$$BW = 1 \text{ Mbps}$$

4 sec

$$\text{Data size} = RTT \times BW = 2.5 \times 1 \text{ Mbps}$$

$$= 2.5 \text{ Mb}$$

$$\text{No. of pkts} = \frac{\text{Data size}}{} = \frac{2.5 \text{ Mb}}{1 \times 10^3 \times 8} = 305 \text{ packets}$$

→ No. of sequence no.

$$\text{No. of pkts} = \frac{2.5 \text{ Mb}}{10^3 \times 8}$$

bits reqd

$$\text{No. of sequence} = \lceil \log_2 305 \rceil$$

$$\cong 9$$

Calculate

i) Calculate RTT

ii) No. of bits that can be xmitted in one RTT, using formula data size = RTT X BW

iii) Find no. of pkts by data size / pkt size

iv) Senders window size W_S = no. of pkts

v) No. of sequence no. reqd = Senders window size

vi) Let us say no. of sequence no. k, then no

no of bits seqd. $\lceil \log_2 k \rceil$.

Note:-

A 3000km long trunk operates at 1.536Mbps is used to xmit 53 byte frame & uses SWP(sliding). If propagation speed is 6 μsec/km, how many bits should the sequence no. field be?

$$RTT = 2 \times 3000\,km \times 6\,\frac{\mu sec}{km}$$

$$= 36000\,\mu sec$$

$$\text{Data size} = RTT \times BW$$

$$= 36000 \times 1.536$$

$$= 93 \times 10^3 \text{ bits}$$

$$\text{No. of pckts} = \frac{\text{Data size}}{\text{packt size}} = \frac{93 \times 10^3}{53 \times 8} = 219$$

Compute the fraction of BW that is wasted on overhead (headers & retransmission) on a heavily loaded 50kbps satellite channel with data frames consisting of 40 headers and 3960 data

bits. Ack frames never occur, NAK frames are 40 bits. The error rate for data frames is 1 percent and error rate for NAK frame is negligible

Let us assume that we are sending 100 frame

Total bits xmitted = 100 X 4000 bits

Total header bits = 40 X 100 = 4000 bits

Retransmission bits = 4000 bits

NAK bits = 40

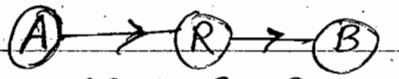
Total overhead = 4000 + 4000 + 40

= 8040

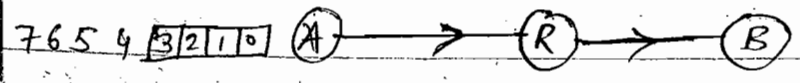
$$\text{Wastage} = \frac{8040}{4000 \times 100 + 4000 + 40}$$

BW wastage = wastage X BW

Suppose 'A' is connected to 'B' via an intermediate routes 'R'.



The A-R link is instantaneous, but the R-B link xmits only one packet each second, one at a time. Assume A sends to B using SWP with $W_S = 4$. For the time T = 2, state what pckts arrive at 'R' and in queue



At time t = 0, pckts 0, 1, 2, 3 are

released by A & they are immediately available at R.

At time t=0, the pckt 0 starts journey from R. ∴ pckts 1,2,3 are in queue at R.

At time t=1 pckt 0 is received by B & ACK for pckt 0 starts from B and pckt 1 leaves from R. Now pckts 2,3 are in queue at R.

At time t=2, ack for pckt 0 arrives at R & then immediately at A. Now window slides at pckt 4. and pckt 4 is immediately available at R. then pckt 2 leaves R ∴ pckts 3 & 4 are in queue at R. At time t=a, a+1, a+2 are waiting in queue.

Gate 2003 Host A sending data to host B over a full duplex mode. A & B are using SWP for flow ctrl. W_S & W_R are 5 pckts each. Data pckts (sent from A to B) are all 100 bytes long & xmission time for such a pckt is 50 μs. ACK pckts (send from B to A) are very small & require negligible xmission time. The propagation delay over the link is 200 μs. What is the max. achievable throughput in this comm^n.

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SR prot
i) Min(
ii) Max(
iii) M+N
iv) MN

2004
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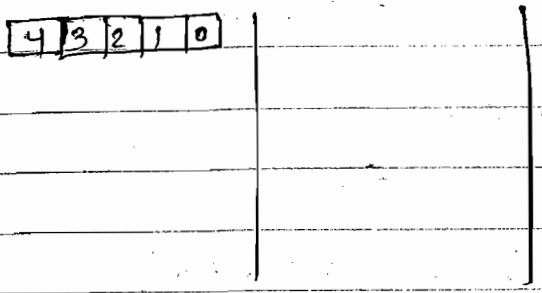

xmission time for 1st pckt is 50 μsec & then 1 round trip time we are sending packets 1, 2, 3 & 4 ∴ Total time taken to send 5 pckts = 2×200 + 50
= 450 μs

$$\text{throughput} = \frac{\text{Data size}}{\text{time to xmit 1 ws}} = \frac{500 \text{ byte}}{450 \times 10^{-6}}$$

2004
In a SWP the Ws is 'N' & Wr is 'M'. The min no. of distinct sequence no. reqd. to ensure the correct oper^n of SR protocol are.
i) Min (M, N)
ii) Max (M, N)
iii) M+N
iv) MN

2004
A 20 Mbps satellite link has a propagation delay of 400 ms. The xmitter employs GBN & set N set to 10. Assuming that each frame is 100 bytes what is the max data rate possible?

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Throughput = Window/RTT

$= \frac{10 \times 100 \times 8}{800 \times 10^6}$

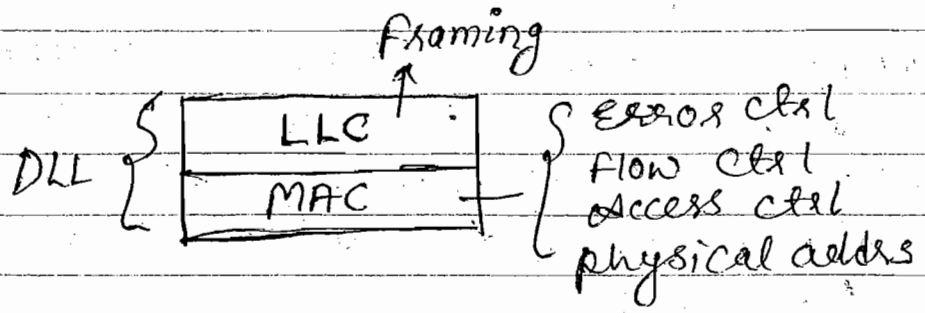
$= 10^7 = 10$ Mbps

LAN TECHNOLOGIES :-

NIC (N/w interface card) :- Physical layer & DLL layers are available in NIC. And 48 bit physical address is also present.

IEEE 802 :-

IEEE 802.1
- .2
- .3 — Ethernet
- .4 — Token Bus
- .5 — Token Ring
- .11 — Wireless
- .17 —



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ii) It s
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Ethernet :—

i) It uses bus topology.
ii) Its access ctrl method is CSMA/CD
iii) No errors ctrl & flow ctrl in Ethernet (pckt level)
iv) No acknowledgement
v) It implements connection less comm^n.
vi) Ethernet not useful for Real time application, interactive appl^n & priority based appl^n.

Real time appl^n :- b'coz it is not sure that no collision occurs.

* In ethernet there is restriction on max size of data b'coz otherwise starvation takes place.
* Also restriction on min size of data b'coz otherwise to detect the collision

To detect the collision

$$T_d \geq RTT$$

$$\frac{L}{B} = 2 \times \frac{d}{v}$$

$$\boxed{L \geq 2 \times \frac{Bd}{v}}$$

onsider building a CSMA/CD N/w running t 1Gbps over a 1km cable with no peaters. The signal speed is 2,00,000km/sec. hat is min pakt size?

$d = 1km$

$BW = 1Gbps$

$v = 2,00,000\ km/sec$

$$L = 2 \times \frac{1 \times 10^9 \times 1km}{2 \times 10^5\ km/sec}$$

$$= 2 \times \frac{1 \times 10^9 \times 1}{2 \times 10^5}$$

$$= 10000\ bits$$

$$L = \frac{10000}{8} = 1250\ bytes$$

Q003

A 2km long broadcast LAN has 10^7 b/s BW & uses CSMA/CD. The signal travel along the wire at 2×10^8 m/s. What is the min pakt size that can be used on this n/w.

$d = 2km$

$BW = 10^7\ b/s$

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

$$L = 2 \times \frac{2 \times 10^3 \times 10^7}{2 \times 10^8}$$

$L = 200\ bits = 25\ bytes$

BACKOFF

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where
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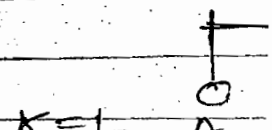
After 1st



$n = [0, 1]$

P(col

P(A

P(

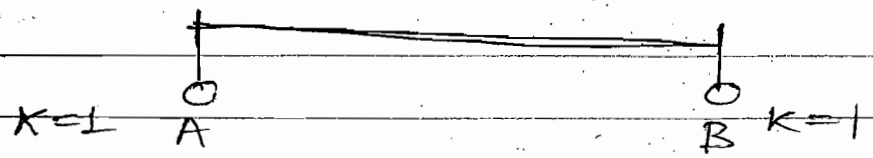
Let us
then A

BACKOFF ALGORITHM:- Whenever there is a collision this algo will give waiting times for the stations involved in collision for xemission by the following formula

waiting time = $n \times 51.2$ usec

where 'n' is randomely chosen from $0 - 2^{k-1}$ where k is collision no

After 1st collision:-



n=[0,1] n=[0,1]

A	B	
0	0	→ collision
0	1	→ A wins
1	0	→ B wins
1	1	→ collision

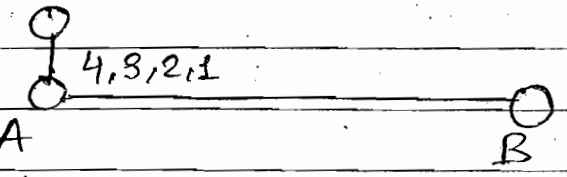
$P(\text{collision}) = \frac{2}{4} = \frac{1}{2}$

$P(A \text{ wins}) = \frac{1}{4}$

$P(B \text{ wins}) = \frac{1}{4}$

Let us assume that A wins the race then A has ximitted its 1st pckt. So

A is ready with 2nd pckt & B is ready with 1st pckt only. Again there is collision.



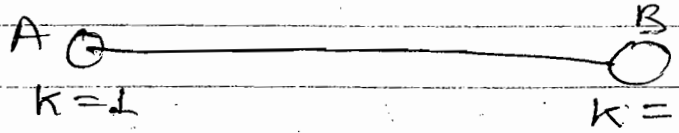
A: $k=1$ $[0,1]$

B: $k=2$ $[0, 2^2-1]$ $[0,1,2,3]$

A	B	
0	0	→ Collision
0	1	→ A
0	2	→ A
0	3	→ A
1	0	→ B
1	1	→ Collision
1	2	→ A
1	3	→ A

$P(\text{collision}) = \frac{2}{8} = \frac{1}{4}$ $P(A) = \frac{5}{8}$ $P(B) = \frac{1}{8}$

Let us assume that ag A again won the backoff algorith & it has xmitted 2nd pckt ~~& wkiti~~ ready with 3rd pckt & B is ready with 1st pckt only. Again there is collision



A: $k=1$ $[0,1]$

B: $k=3$ $[0,1,2,\ldots,7]$

P(A

P(B

P(C

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A and T
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attempt
A wins
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What is
the 2nd
i) 0.5

Specif
* Bit fi

$$P(A) = \frac{13}{16}$$

$$P(B) = \frac{1}{16}$$

$$P(\text{collision}) = \frac{2}{16}$$

From the above 3 cases we find that probability for successive collision is reduces by 1/2.

CAPTURE EFFECT :-

If a station wins a first collision then the probability for it to win the successive collision is ↑.

A and B are 2 stations on an ethernet, each has a steady queue of frames to send. Both A & B attempt to xmit a frame, collide & A wins the 1st backoff race. At the end of the successful xmission by A both A & B attempt to xmit & collide What is the probability that A wins the 2nd backoff race.

i) 0.5 ii) 0.625 iii) 0.75 iv) 1-i

Specifications of Ethernet :-

* Bit time :- Time reqd. to xmit bit.

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Date :

Conversion of bit time into seconds

$$= \frac{\text{bit time}}{BW}$$

Specification of Ethernate:—

i) Data Rate → 10 mbps
→ 100 mbps
→ 1 Gbps

ii) Signaling:— We used Manchester encoding

Baud rate = 2x bit rate.

iii) Addressing:— MAC or Physical address

IEEE 802.3 Frame Format

7	1	6	6	2	46-1500	4
Preamble	SFD	SA	DA	Length of Data	Data	CRC

← Header → ← T →

Preamble is a sequence of 0 & 1 to recognize the pckt & c/d pattern also. These is pattern matches implemented on NIC to match the pattern.

SFD is start of the frame delimiter.

Preamble:—

It is used to alert the

static
frame
SFD:-
is 10101
where
starts.
Note:-
combin

SA & DA
Length
seqd.
max si
avoid
& used

CRC
errors.
forma
tailer
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to xfe

Imple

stations about starting of the frame.

SFD :- It has 1 byte infosm^n & it is 10101011. It is used to indicate where 1st byte of the pckt actually starts.

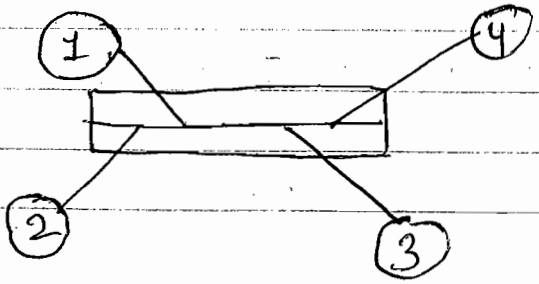
Note :-
In Ethernet 2^n frame format SFD is combined with preamble.

SA & DA :- Both are physical address.

Length of Data :- This field is reqd. to know the end of data. max size is 1500 bytes & is used to avoid monopolization. Min size is 46 byte & used to detect collision :-

CRC :- CRC is used to detect the errors. CRC is at the end of the format as why CRC is part of a tailer. If it is part of headers then NIC takes 2 xmission delay to xfer the data pckt to the N/w

Implementation of 802.3 :-



Logical – Bus
Physical – Hub

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Date :

Efficiency calculations of Ethernet:-

Ethernet opesn are following 3 pesiods.

i) Xmission Pesiod (T.P.) at Σ link is utilized in xmitting data pckt.

ii) Collision Pesiod (C.P.) is where or when the link is utiliged in dealing with collision.

iii) Nothing is happening on the link. Ideal Pesiod (IP).

$$\eta_E = \frac{TP}{TP+CP+IP}$$

Assume that there are 'n' no. of station, the probability for a station to xmit the data pckt is P_s so the probability for not to send data pckt is $1-P_s$. For a successful xmission only 1 station should xmit the data the probability for it is

$$^nC_1 \times P_s \times (1-P_s)^{n-1}$$

Let $A = {}^nC_1 \times P_s \times (1-P_s)^{n-1}$

T_{prop} = propagation delay

No. of collision = $\frac{1}{A}$

$\lim_{n \to \infty} \frac{1}{A} = e$

Max. duration for 1 collision period or contention slot is TP.

Time taken for collision period = No. of collision × collision period

= $T_{prop} \times e$ (Theoretically)

= $T_{prop} \times 2e$ (Practically)

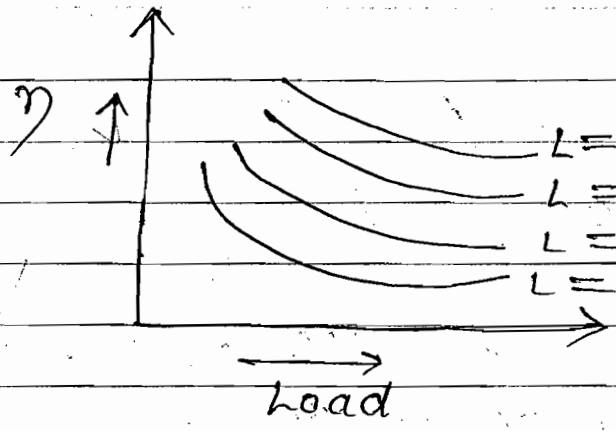
Use practical value not theoretical

$$\eta_E = \frac{TP}{TP + 2e * T_{prop}}$$

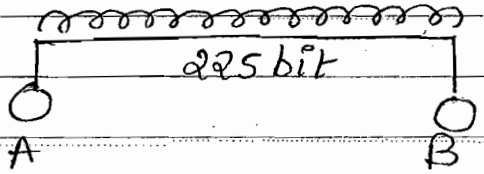
$$= \frac{1}{1 + 2e * \frac{T_{prop}}{TP}} \quad \text{Let } \frac{T_{prop}}{TP} = a$$

$$= \frac{1}{1 + 2ae} \quad \text{where } a = \frac{T_{prop}}{TP}$$

$$= \frac{1}{1 + 5.4a} = \frac{1}{1 + 5.4 \times \frac{T_{prop} * B}{L}}$$



Q) Suppose Node A & B are on the same 10Mbps ethernet segment & propagation delay b/w the 2 nodes is 225 bit times. Suppose A & B send frame at t=0 the frames collided then at what time A or B finishes xmitting a jam signal. Assume that jam signal is 48 bit.



$t = 0$

$t = \frac{225}{2}$ → collision occurs

$t = \frac{225}{2} + \frac{225}{2}$ → A & B detects a collision

$t = 225 + 48$ → A & B will stop xmitting the jam signal

Suppose
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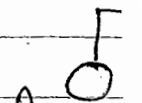
link is
1000 bit



t

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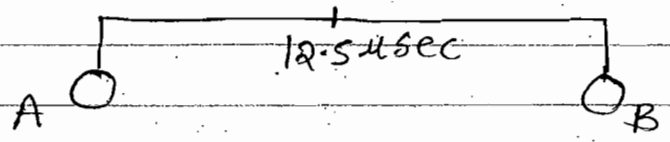
Suppose two nodes A & B are attached to the opposite nodes of a cable with propagation delay of 12.5 μs. Both nodes attempt to xmit at t=0, frames collide & after first collision A draws 0 in backoff algo & B draws 1. Ignore the jam signal At what time (in sec) A's pckt completely delivered to B. If BW of the link is 10Mbps and packet size is 1000 bits.



$t = 0$ start

$t = \frac{12.5}{2}$ → collision occurs

$t = \frac{12.5}{2} + \frac{12.5}{2}$ → A & B comes to known abt collision

$t = 12.5 + 12.5$

$t = 25$ μs A starts xmitting

Consides 10 Mbps ethernet LAN that has station attached to 2.5 km LAN, given that xmission speed is 2.3×10^8 m/s If the pckt size is 128 bytes. Find the

efficiency of ethernet?

$$\frac{1}{1+5.4a} = \frac{1}{1+5.4\times\frac{T_{prop}}{T_p}}$$

$$T_P = \frac{L}{B} = \frac{2.5\times10^3}{2.3\times10^8} = 1.0\times10^{-5}$$

$$T_{prop} = \frac{d}{v}$$

Advantages of Ethernet:-

i) Cost of ethernet is less.
ii) Maintanance & administsation are very simple.
iii) Ethernet cables are Robust to noise.

Disadvantages of Ethernet:-

i) If load ↑, no. of collisions ↑ & η ↓ (comes down) ∴ for a high load n/w we can't use ethernet.
ii) Ethernet offers non-deterministic service. ∴ it is not applicable for real time appln.
iii) There are no priorities in Ethern

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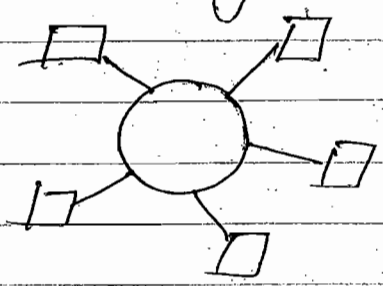
and not applicable for client server application.

iv) There is restriction on min. size of packt. So it is not applicable for interactive appln where data size is 1 or 2 bytes.

IEEE 802.5 is the soln for all the above problem.

Token Ring (802.5)



Chasactesistics:-

i) It uses token passing as access method.

ii) It uses ring topology.

iii) There are no collisions in token ring & it offers unidirectional opdn (so no limit on min. pckt size). ∴ applicable for interactive appln.

iv) There are no collision ∴ it is deterministic & applicable for Real time applications.

v) There are priorities in Token ring ∴ so applicable for client server applns.

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Date :

Problems in Token Ring:-

a) Token Problem:-

i) Vanished tokens to corrupted tokens

ii) Source problem → Due to this there is Orphan pckt (no parent)

2) Stray pckt

3) Monopolization of source

iii) Destination problem

1) Busy

2) Crashed

iv) Ring problem:-

For all the above problems we have 2 soln:- (Tht)

i) Token holding time:- It is the max. amount of time that a station can hold a token. So it is going to solve monopolization problem.

ii) Monitor station.

For all the remaining problem soln is Monitor station which is going to be act as leader.

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Vanished token:-

Min. token return time = propagation delay in the ring + No. of ~~stations~~ stations * delay by 1 station

Max. token return time = propagation delay in the ring + Token holding time * no of station

If u don't get back the token in the above range, monitor will understand that token is vanished and generate other token.

Corrupted token:- In this case, correct the token & send it.

Orphan pckt:- Put a stamp on the pckt & absorb it if u see it for the 2nd time.

Stray pckt:- Monitor is going to remove it.

~~Availab~~ Destination Problem:-

Available (A)	Copied (C)	
1	1	→ A & C
1	0	→ Busy
0	0	→ Crash
0	1	→ invalid

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Date :

For any sexmissions clear the stamp & sexmit.

Ring problem:- Continuously if the token being lost, then a beacon frame is produced which will be reflected back from the cut & we can check it manually.

* Monitor introduces some more problem

i) Monitor get crashed → A pckt c/d **AMP** (Active Monitor Packet) at equal intervals of time using that station will understand that monitor is active.

ii) Malfunctioning of Monitor:- It releases AMP packts but it does not perform any other task. There is no sol^n to malfunctioning of monitors.

Specifications of Token Ring:-

a) Data Rate:-
- 4 Mbps
- 16 Mbps
- 100 Mbps (IBM token ring)

b) Signaling:- Differential Manchester encoding (DME)

c) Add

Toke

SD

1.

SD-
AC -
FC -
SA -
DA -
CRC -
ED -
FS -

SD &
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AC:-

Priori
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Token

c) Addressing :- Physical or MAC

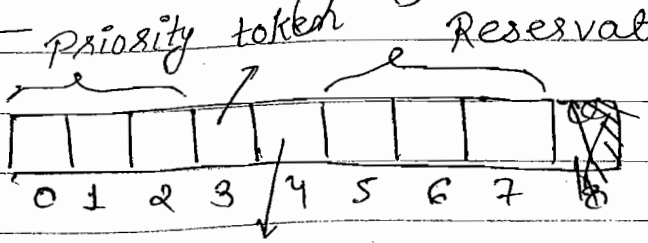
Token Ring Frame Format

SD	AC	FC	SA	DA	Data	CRC	ED	FS
1	1	1	6	6		4	1	1

SD - Start delimites
AC → Access ctrl
FC → Frame ctrl
SA → Source address → Physical addresses
DA → Destination address → Physical addresses
CRC →
ED → End delimites
FS → Frame status

SD & ED :- They are used to identify the 2 extreme ends of the frames & they are using invalid differential machester encoding signals.

AC :-



Priority :- 0 to 7 priority levels are available

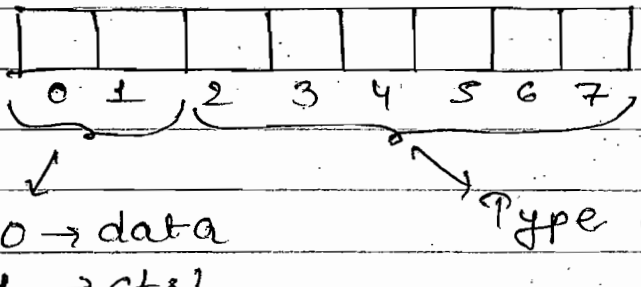
Token :- Token bit = 1 (Token frame)

=0 (not token frame)

Monitor bit =1 (stamped)
=0 (not stamped)

Reservation :- It is used to reserve

Frame control :-



Type of ctrl frames :-

i) Client Token :- It is used in the process of election

ii) AMP (Active monitor pckt) :-

iii) Beacon Packet :-
It is used to identify the major cuts in the ring.

iv) Purge frame :- It is used to clear the ring from unwanted bits.

v) SMP
is use
this a
Every 1
is don

vi) Frame

A
0

A
0
0
1
1

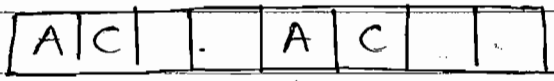
Q- Why
bits
Since
we nee

Why F
CRC is
but src
destn

v) SMP (Standby monitor present):- It is used to identify neighbours & this will take place every 10ms. Every 10ms neighbours identification is done.

vi) Frame status:-

It is 1 byte information



A	C
0	0
0	1 invalid
1	0
1	1

Q: Why FS is having 2 sets of A & C bits?

Since FS is not included in CRC we need 2 sets.

Why FS is not included in CRC?

CRC is calculated by the source but frame status is calculated by destination.

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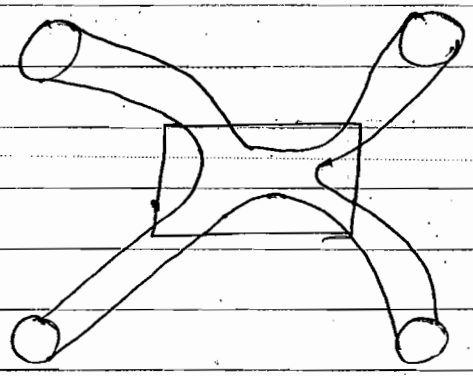
Token Format

SD	AC	ED
1	1	1

$\Rightarrow$ 3 byte = 24 bits

Implementation of Token Ring :—



Logical – Ring
Physical – Star

Types of Modes
i) Transmission Mode
ii) Receiving mode
iii) Listening mode
iv) Bypass mode

Consides a token ring having 50 Mbps BW & token holding time of 5ms, find the min. & max. data sizes.

Max size of the frame that we can send is B.W. X THT

$= 50 \times 5 = 250$ k bits

Calcul

Ring :—

if BW c
the tot
the si
min. to

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Note :—
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P

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Calculation of minimum size of token ring :-

=24 bits

if BW of a ring is 4Mbps & length of the token is 24 bits & velocity of the signal is 1.8×10^8 m/s then calculate min. token ring size.

$$\text{Capacity of ring} = P.d \times BW$$
$$24 = P.d \times 4\text{Mbps}$$

For min token ring, capacity of ring is equal to 24.

$$\frac{d}{v} * BW = 24$$

$$\frac{d}{1.8 \times 10^8} * 4 \times 10^6 = 24$$

$$d = 1.06 \text{ km}$$

Note :-

(wire)
The condition for min size of token ring is

Propagation delay = xmission delay

that implies $\frac{d}{v} = \frac{L}{BW}$

50Mbps
5ms, find
at we
k bits

$$\frac{T_{prop}}{T_{trans}} = 1$$

If it is greater than 1 then it is good enough.

If it is less than 1 then collision may taken place.

If BW of a link is 16 Mbps and $v = 1.8 \times 10^8$ m/s. $L = 24$ then find the min. token ring size

$$\frac{d}{v} * BW = L$$

$$\frac{d}{1.8 * 10^8} * 16 \times 10^6 = 24.$$

$$d = \frac{24 \times 1.8 \times 100}{16} = \frac{90}{2}$$

$$d = 270 \text{ m}$$

But cost ↑ b'coz BW is high.

Calculation of Ring Latency:- Let us assume that there are n stations in the ring & each station introduces a delay of b bits then, ring latency equals to $p \cdot d + n * b$

Ring latency $= p \cdot d + n * b$

$= \frac{d}{v} + n \times b$

$= \frac{d}{v}(BW) + n \times b \longrightarrow$ in bits

OR

$= \frac{d}{v} + \frac{n \times b}{BW} \longrightarrow$ in seconds

Min. Token Return Time:-

Min. token return time = Ring Laten

Max. token return time:-

Max. token return time = Ring Latency +
n x Token hold
time

Token Reinsertion Strategy:-

Delay token reinsertion	Early token reinsertion
⇒ Token is reinserted after getting entire data packet	Token is reinserted as soon as data xmission is over.
⇒ Efficiency is low.	Efficiency is high.
⇒ Reliability is high	Reliability is low.
⇒ It is used under low load condition.	Used under high load condition.

a = data xmission time
b = Ring latency
c = Token xmission time
d = propagation delay b/w successive stations.

⇒ Cycle time = a+b+c+d i.e. more time reqd. to send a pckt	cycle time = a+c+d less time reqd
⇒ Throughput is ~~more~~ less	~~less~~ More

Suppose a group of 32 station is reqd. by a token ring LAN. For 1000 bit pckt, 10Mbps speed, 2.5 bit latency per adapter & 50 meters b/w

the station. Calculate the time taken to xfer a pckt in (a) early token reinsertion
b) Delay token reinsertion strategy

a) Early token reinsertion

$L = 1000 bit$

$BW = 10 Mbps$

$a = \frac{L}{BW} = \frac{1000}{10 \times 10^6} = 10^{-4} = 100 \mu s$

~~$b = 32 \times 2.5 = \frac{32 \times 5}{2}$~~

Length of ring $= 50 \times 32$
$= 1600$

~~Ring Latency~~ $= 1600$

$p.d = \frac{1600}{2 \times 10^8} = 8 \mu sec$

Total delay introduced $= 2.5 \times 32$
$= 80 bits$

$= \frac{80}{10 \times 10^6} = 8 \mu s$

$b = 16 \mu s$

$c = \frac{24}{10 \times 10^6} = 2.4 \mu sec$

$d = \frac{50}{2\times10^8} = 0.25\,\mu sec$

Early token cycle time $= a + c + d$

$= 100 + 2.4 + 0.25$

$= 102.65\,\mu s$

Delay token cycle time $= a + b + c + d$

$= 100 + 16 + 2.4 + 0.25$

$= 118.65\,\mu s$

Find the ring latency of a ring where the data rate of ring is 4 Mbps & no. of stations are 20 separated by 100 meters & bit delay in each station is 2.5 bits. Recalculate the problem for 16 Mbps data rate of the link with 80 stations.

~~Pd~~ Length of ring $= 20\times100$
$= 2000$

$P.d = \frac{2000}{2\times10^8} = 10^{-5}\,s = 10\,\mu s$

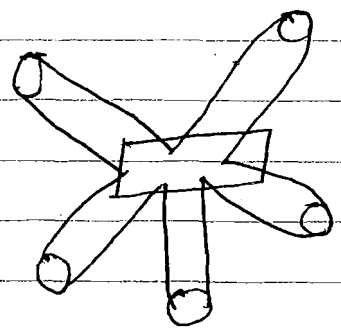
~~Total de~~ $=$ ~~40 us~~ 40 bits

~~To~~ Delay introduced $= 20\times2.5$
$= 50$ bits

Total Ring latency = 90 bits

p.d = 10 μs

A token ring LAN n/w interconnects M stations using star topology in the following way, all the i/p & o/p lines of the token ring stations are interfaces are connected to a cabinet where the actual ring is placed. Suppose the distance from each station to a cabinet is 100 meters & ring latency per station is 8 bit (processing delay). Assume the pckts are 1250 bytes and rings speed is 25Mbps find the ring latency normalized to pckt xmission time. in terms of 'M'.



Size of Ring = 200 * M

meters

token

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

At a propagation speed of 200 meters/μs. What is the effective length added to a ring by 1 bit delay at each repeater or station for

a) 1 Mbps line b) 40 Mbps line

a) $\frac{1 \text{ bit}}{1 \times 10^6} \times 200 \times 10^8$

$= 200$

b) $\frac{1 \text{ bit}}{40 \times 10^6} \times 2 \times 10^8$

$= 5$ meters

At a xmission rate of 5 Mbps & propagation speed of 200 m/μsec, to how many

meters of cable is the 1 bit delay in token sing interface equivalent?

BW = 200m/μsec = 2×10^8 m/s

Xmission rate = 5 Mbps

$\rightarrow v = 2 \times 10^8$ m/s

200 meters/μs

i added

ach

line

& propagation

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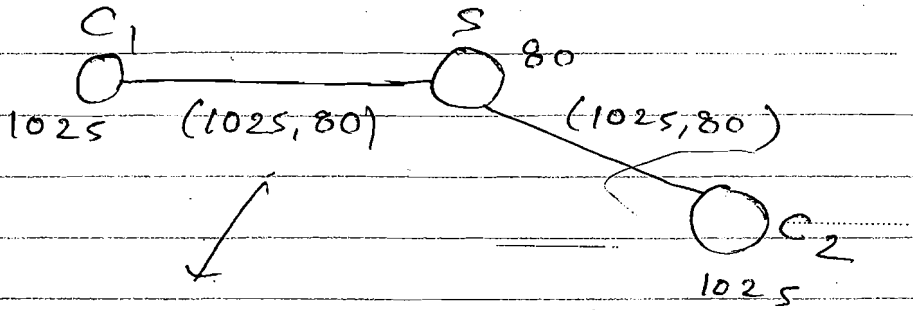
TCP/IP

Sockets are going to identify the connection.



∴ post no. are not sufficient to identify the connection uniquely ∴ we use socket no.

Socket no. = App IP Address + post no.

TCP Characteristics:-

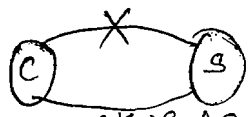
It is realiable byte stream oriented post to post transpost layer protocol.

Note:- i) TCP is using Selective Repeat protocol & having -tive ACK.

ii) TCP is using cumulative ack principal.

iii) TCP connections are full duplex connec^n.

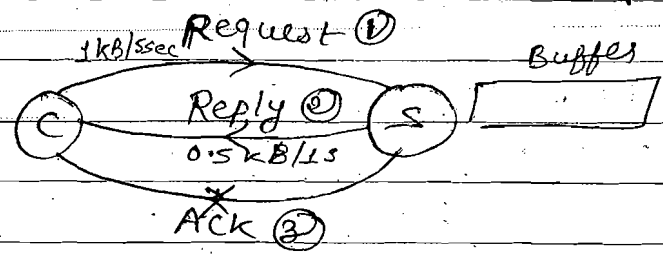
Symmetric connec^n:- If any one party terminate then whole connec^n get terminate.



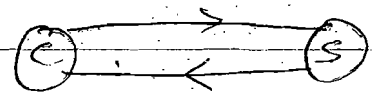
alive Asymmetric connec^n

Assymetric connec^n :- If one party terminate only that particular connec^n closed not whole connec^n termination

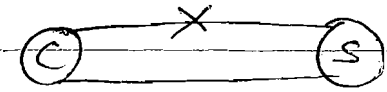
* TCP uses assymetric connec^n.
* TCP uses sliding window protocols.
* TCP connec^n are having 3 phases :-
  i) Connec^n establishment phase
  ii)



  ii) Data Xfes



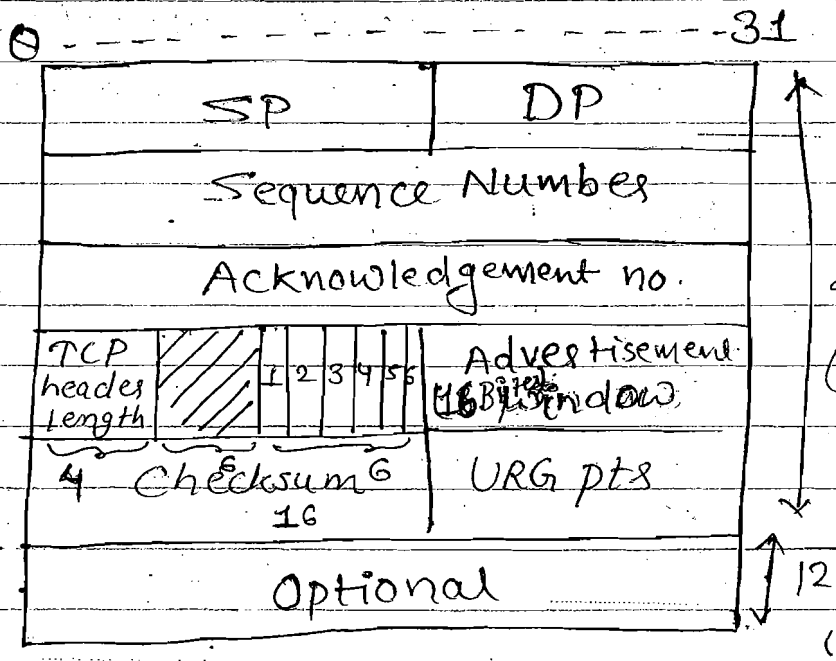
  iii) Connec^n Termination



Data from C → S X
Data from S → C ✓
Ack from C → S ✓
Ack from S → C X

* It doesnot support broadcast or multicasting. b'coz it is connection oriented.

TCP Header :—



SP & DP → source & destination port.

6 Flags :—

i) SYN Flag ii) ACK Flag iii) FIN flag
iv) URG flag v) PSH flag vi) RST flag

SYN flag :— synchronization flag used for connec'n establishment.

ACK flag :— It indicates if ACK is 1 then it contain data & ACK

means
invali
request
reply
purely
data
FIN fla
the co
RST fla
the co
URG flag
is set
layes i
PSH fla
with t
it mu
withou
TCP h
field
If T

means piggybacking & ACK=0 means invalid.

	SYN	ACK	
request ←	1	0	
reply ←	1	1	
	0	1	→ Data & ACK (piggybacki OR ACK
purely data ←	0	0	

FIN Flag:- (Finish) used to terminate the connection.

RST Flag:- (Reset) It is used to refresh the connection.

URG flag:- (Urgent) If urgent flag (URG flag) is set at transport layer then n/w layer will increase the priority no.

PSH flag:- (Push) As & when, a pckt with PSH=1 is available at TCP, it must push it to the upper layers without waiting for 50ms.

TCP header length:- Each no. in header field represent 5 bytes of TCP header.

If TCP header length is 6
then 6 X 5 = 30

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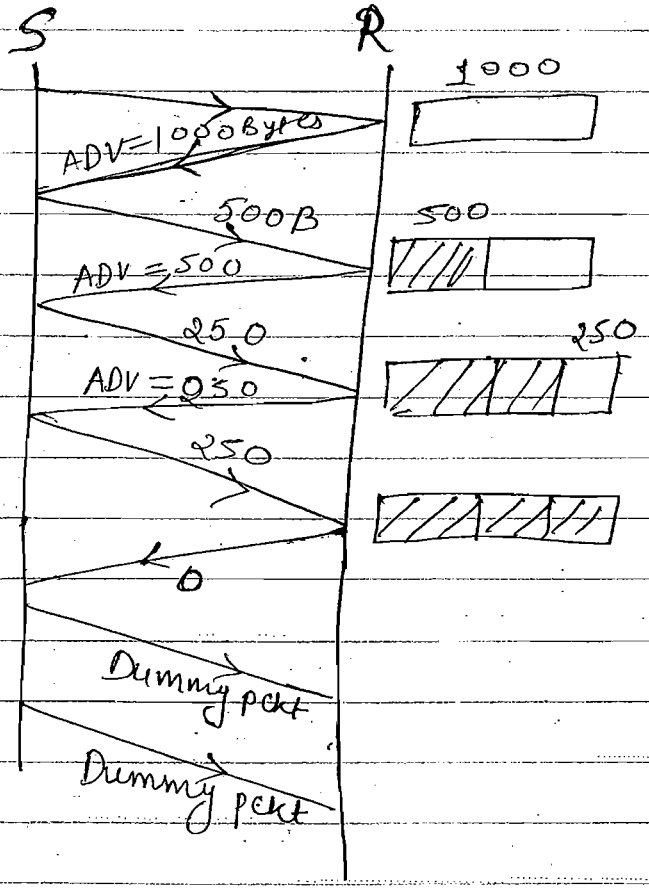
Advertisement Window :-

It is used to take care of flow control.



Silly Window Syndrom

~~Reason for Wil~~

Whenever there is 1 byte of data is exchanged b/w sender & receiver then it is silly window syndrom. During silly window syndrom efficiency is zero.

Reason for silly Window Syndrom :-

i) Whenever receiver announces its

window

ii) Wher

iii) Wher

at a ti

We ca

in adv

so we a

options

so we

So n to

the co

Checksu

window size as zero.
ii) When sendes generates 1 Byte
iii) When receiver consumes 1 byte at a time.

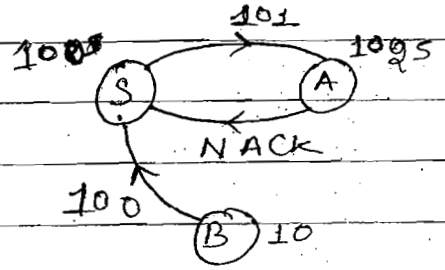
We can send a max-size of 64kB in advertisement window of 16 bits, so we append ~~40 &~~ 14 bits to it from options field & make it 30 bits & so we can go for 1GB.

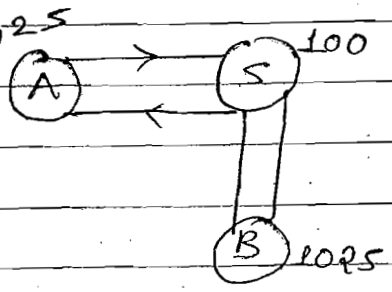
Soln to silly window syndrom:- To reset the connecn using RST flag.

Checksum:-

TCP uses random initial ~~transiti~~ sequence no. b'coz to stop segments from previously closed session to be accepted as valid segment for this session.

Even if B claims that it is A but then also it cannot ~~o~~ come into sole b'coz sequence no. is different.





Case-1

WRAP Around:— Whenever we start with the sequence no., the time taken to reach the same sequence no. is c/d Wrap around time.

Consides the lined BW is 40 Mbps & sequence no. field consist of 32 bits. Find the wrap around time for sequence no.s.

Possible sequence no = 2^{32}

Converting BW into Byte/s

4

1 seg

5M

4G

So wr

Conside

of 50 se

in sequ

situati

BW =

Time p

Byte g

Sequenc

No. of s

Note

Min. seq

no prob

40 Mbps = 5 MBps

1 sec ⟶ 5 MB ⟶ 5M sequence number

5M sequence no ⟶ 1 sec

4 G seq. no. ⟶ $\frac{4XG}{5XM} = \frac{4000}{5} = 800$ sec

∴ wrap around time is 800 sec.

Consider a BW of 40 Mbps & life period of 50 sec. Find the suitable no. of bits in sequence no. field to handle the situation.

BW = 40 Mbps = 5 MBps

Time period = 50 sec

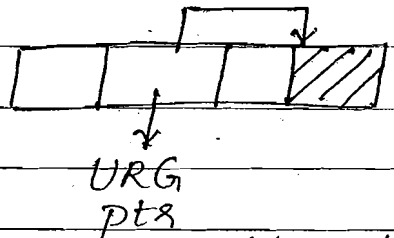
Byte generated in
50 sec = 50 x 5 MB
= 250 M Byte

Sequence no. seq = 250 M

No. of sequence no. field = $\log\lceil 250M \rceil$
= 8 + 20 = 28 bit

Note
Min. seqd 28 bit & it can be large no problem.

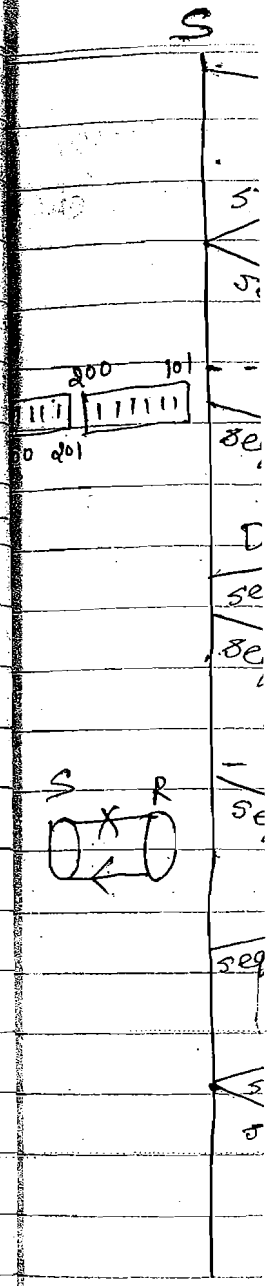
URG Pointer:- It is used to indicate how much data in the packet is urgent.



It is applicable when URG flag = 1 otherwise it should be ignored.

TCP connection management:-

Syn pckt eats up 1 sequence no.
FIN pckt eats up 1 sequence no.
ACK pck not eats up any sequence no.



TCP c

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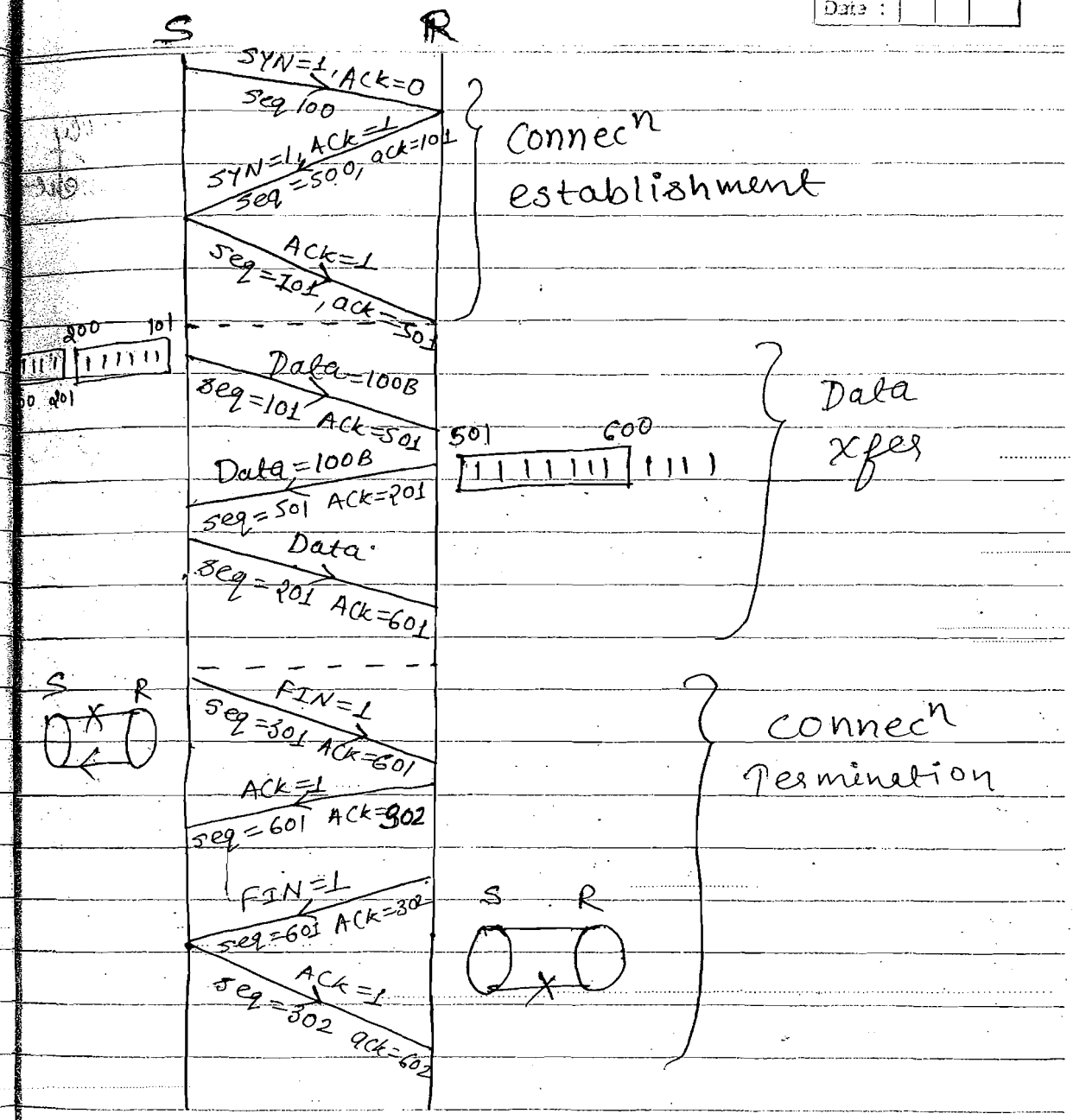
no.
no.
uence no.



TCP congestion control:-

TCP Senders is having 2 windows, 1 is sender window W_s & 2nd is congestion window W_c. W_s will give u receives capacity & W_c will give u underlying n/w capadity. so u should xmit min (W_s, W_c).

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Estimation of ~~Ws~~ sender window size :-

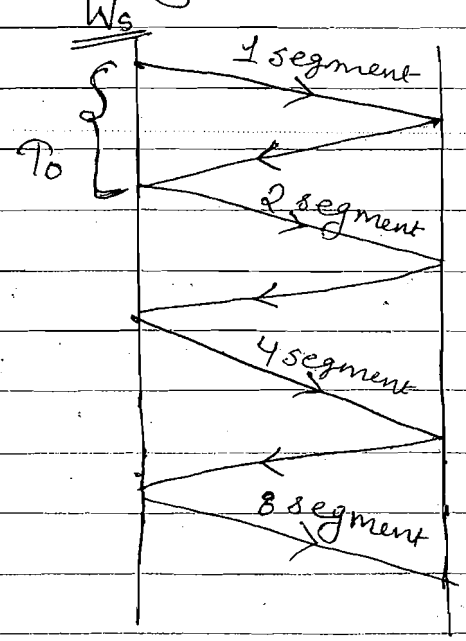
It cannot be statically determined & so we use advertisement window dynamically.

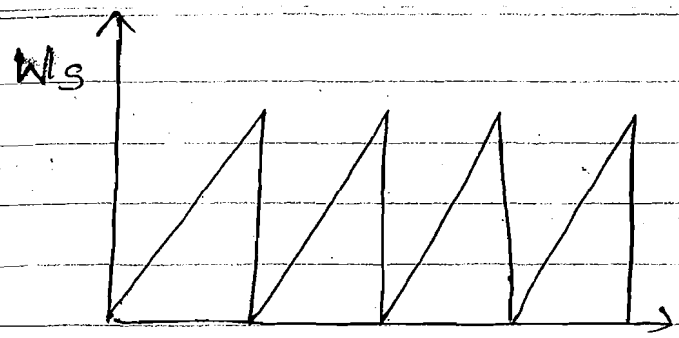
Estimation of congestion window size :-

These are no static methods which means we go for AIMD (Aditive increase & multiple decrease) or slow start algorithm.

AIMD :-

First W_c capacity is 1 if it we receive the ack in time then send 2 segments, next 4, 8, 16 so on. If there is any time out then restart from 1.





$$\text{Throughput} = \frac{W_S \times MSS \text{ (Max. segment size)}}{R.T.T.}$$ → Theoretically

$$\text{Throughput} = \frac{W_S \times MSS \times 0.75}{R.T.T.}$$ → Practically

Of AIMD algo with congestion ctrl

TCP Times Management :-

TCP uses 4 times for its open^n

i) ACK times
ii) Keep alive times
iii) Persistance times
iv) Timed & wait times

Keep alive times :-

It is used to keep track of idle TCP connection. If there is no comm^n for a predefined period of time the connec^n will be closed automatically.

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Persistance times :-

It is used in silly window syndrom to xfes silly packets in equal intervals of time & this is decided by persistance times.

(ACK times :-

We can't detesmine Round trip time statically as we did in DLL.

So we need dynamic methods.

BASIC ALGORITHM :-

Lets assume initial

Q/ Round trip time = 50 sec

Smoothing factor = 0.9

New R.T.T = 70 sec

Find the estimated R.T.T.

$ERTT = \alpha * IRTT + (1-\alpha) NRTT$

$= 0.9 * 50 + 0.1 \times 70$

$= 45 + 7$

$ERTT = 52$ sec

$T.O = 2 \times 52$

$= 104$

$IRTT = 52$ sec

$NRTT = 80$ sec → (given value)

$= 0.9 * 52 + 0.1 * 80$

$= 46.8 + 8$

$ERTT = 54.8$

(Timeout) $T_o = 2 \times RTT$

$= 2 \times 54.8$

$= 109.6$

The default of basic algorithm is using 2 as the scaling factor in Timeout

JACOBSON'S ALGO:-

Algo says that instead of multiplying RTT with 2; you take standard deviation to calculate the time out.

$$\text{standard deviation } D_N = |IRTT - NRTT|$$

Q) $IRTT = 50 \text{ sec}$ $NRTT = 70 \text{ sec}$, $\alpha = 0.9$

$ERTT = 0.9 * 50 + 0.1 * 70$

$= 52 \text{ sec}$

D_i (initial deviation) $= 5 \text{ sec}$ (given)

$D_N = |50 - 70| = 20 \text{ sec}$

$$D_E = \alpha D_i + (1 - \alpha) D_N$$

$= 0.9 \times 5 + 0.1 \times 20$

$= 4.5 + 2$

$= 6.5$

$$T_o = ERTT + 4 \times DE = 52 + 6.5 \times 4$$

$= 52 + 26 = 78 \text{ sec}$

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KARN'S ALGO:- If timeout occuss b'coz of delayed ACK, the data pckt is sexmitted, then there is a possibility of 2 ACK (delayed ACK for 1st pckt, ACK for sexmitted pckt) then it causes ambiguity that which ACK must be taken into account for the next xmission. This ambiguity is resolved by Karn's algorithm. This algo says that don't update R.T.T. for any segment that is sexmitted, but just double the amount for the each failure until segment gets through.

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UDP

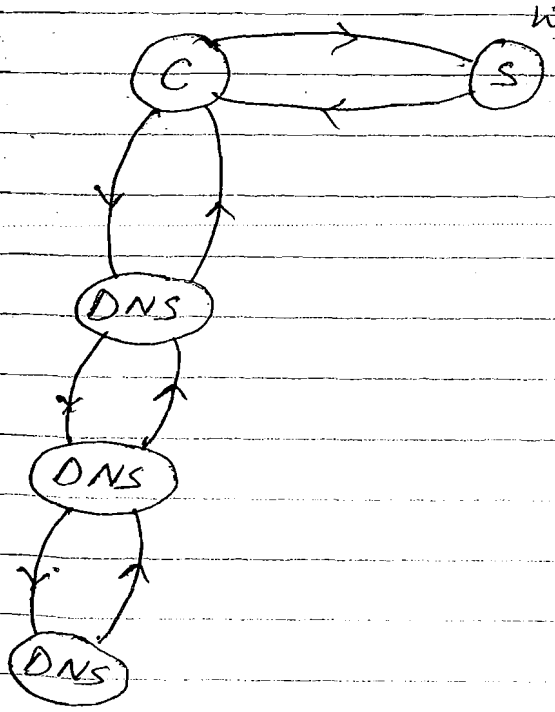
- It is connectionless protocol.

Need for UDP:—

* It is used for multicasting & broadcasting application.
* TCP for real time application TCP is not applicable. bcoz of congestion window. ∴ UDP is used & it doesn't have congestion window.
* For multimedia appln TCP is not used b'coz of congestion window
* Some appln require fastness rather than reliability so TCP can't be used

Eg:— DNS

so DNS uses UDP protocol.



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UDP header :-

SP	DP
checksum	length

TCP	UDP
i) Connection oriented, reliable, slow	Connecⁿ less, not reliable, fast
ii) Overhead is high (header & connecⁿ)	low
iii) HTTP, FTP, Telnet, Remote login, SMTP, HTTPS.	DNS, RIP, SNMP, RTP & all multimedia protocols.
iv) Web applicⁿ, mail, file xfes, remote system administration etc use TCP	Name translation, realtime, multimedia, broadcasting, multicasting, n/w mgmt.

IP
IG
ICM
ARP
RAR

IP :-
IP

Specia

Directe

valid

ii) Limite

Al

iii) This

N

All

When a
time g

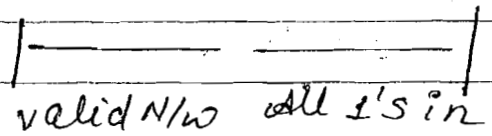
IP

IP	Class Addressing
IGMP	
ICMP	Feedback msg
ARP	IP → MAC
RARP	MAC → IP

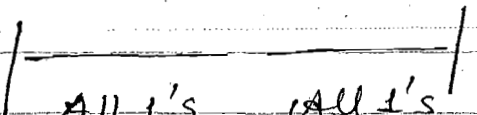
IP :-
IP addresses are logical addresses

Special IP Addresses :-

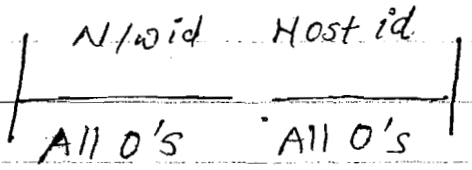
Directed Broadcast Address :-



ii) Limited broadcast address :-



iii) This host address :-



When a host connected to n/w 1st time we can specify ip addresses

in 3 ways.

i) Static

ii) Dynamic (DHCP)

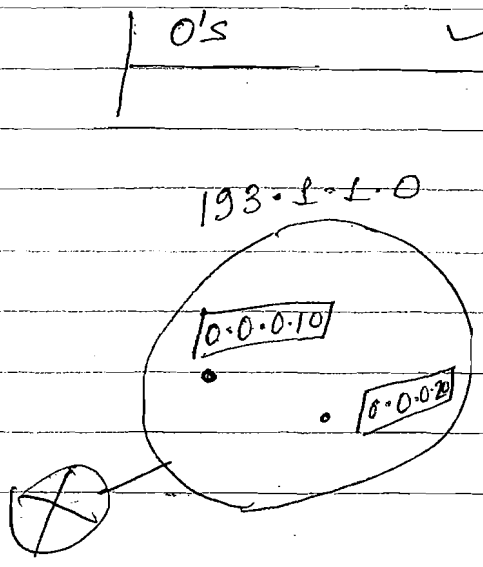
iii) Auto

Static:- In this statically allocate the ip address to the host system.

Dynamic:- In dynamic we use DHCP, & DHCP have a pool of IP addresse & howeves wants an IP address should send a request to DHCP server with source ip address as 0.0.0.0. It says that "I don't have IP & give me1 plz".

Auto:- Os will assign some ip addresse during boot time

iv) Host within a N/w:-



It is within same

Loop

Which a des
i) 25
ii) 10
iii) 0.
iv) 0.

Which
i) 0.0
ii) 10
iii) 1.
iv) 0.

It is used to send a packt from host within a n/w to a host within the same n/w.

Loop Back Address:—

~~127.0~~

Which of the following cannot be a destination IP address.

i) 255.255.255.255 (Limited broadcast)

ii) 10.1.1.1 (Valid IP address)

iii) 0.0.0.100 (within same n/w class)

iv) 0.0.0.0 b'coz it is source i/p addres

Which only has a source IP address

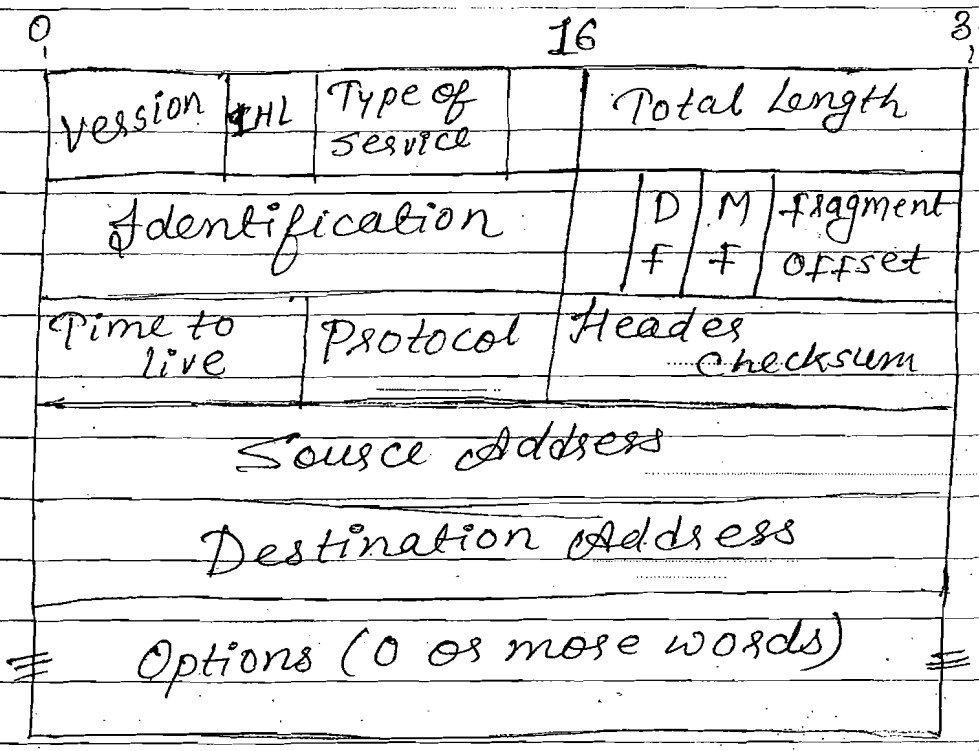
i) 0.0.100.1 (Both source & destination IP,

ii) 10.1.1.200 (Both source & destination IP

iii) 1.2.3.4 ——— 11 ———

iv) 0.0.0.0 (only as source)

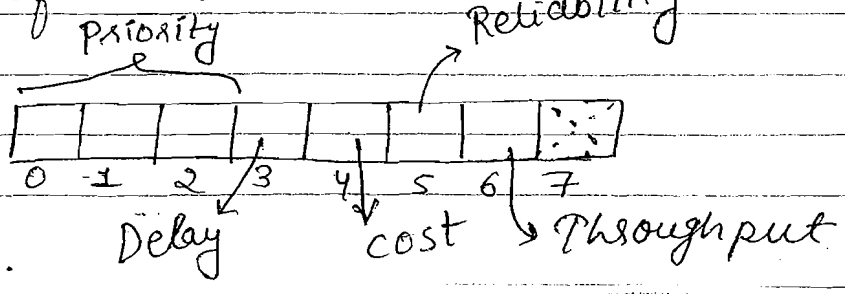
IP HEADER



Version:- It will tell us it is which version IPV1 — IPV6

Header length:- It is used to know the length of header. It is 4 bit. Each no. in header length indicates 4 Byte word in the header. If Header length = 5 then actual length header length = 5 x 4 = 20

Type of Service:-



The no. of connec b/w two port is only 1 but no. of connecⁿ b/w two sockets can be more than 1.

If Delay bit = 1 that means the route the pckt such a way that delay is less.
If cost bit = 1 choose that route for pckt which gives less cost
If throughput = 1 send from route where how throughput high.
Same for reliability.

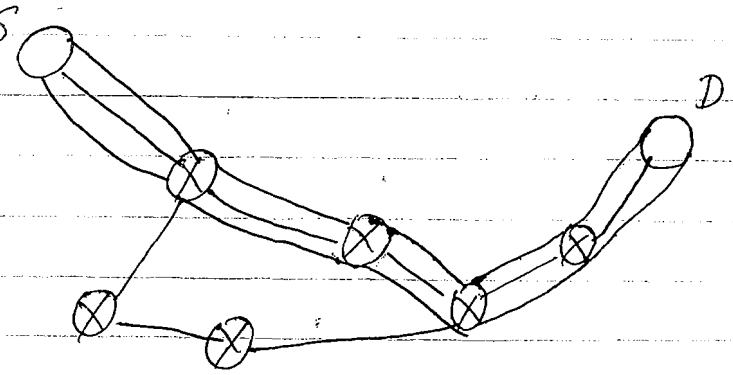
Total Length :- Total length is 16 bit field with which we can represent $2^{16} = 64kB$.

payload	TCP headers	IP headers

Identification no:—
Each & every datagram will use a identification no. starting from 0 to 64k.

OFFSET :- This field is used to know how many byt data bytes are ahead of this fragment in a particular pckt.

NOTE :- In N/w layer comm^{n} can be connec^{n} oriented or connec^{n} less.
Eg. for connec^{n} oriented is virtual ckts.



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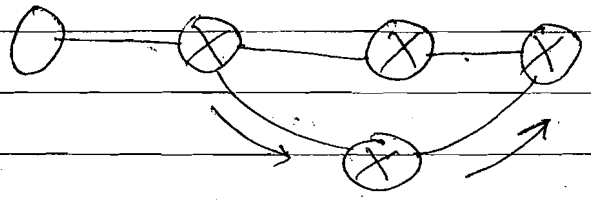
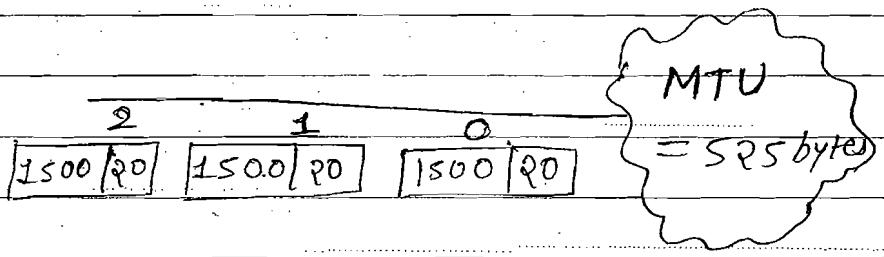
Eg. for connecⁿless is datagram commⁿ:



Virtual ckt	Datagram ckt
i) Reliable	less Reliable
ii) Static	Dynamic
iii) Less Overhead	Overhead.



	20 505	20 505	20 490
ID	0	0	0
Offset	0	505	1010
MF	1	1	0

	504	504	492
ID	0	0	0
Offset	0	63	126
MF	1	1	0

504
504
1008
505
63
2

504
496
496
16

Mose Fra
fragme
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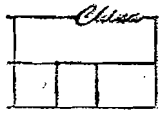
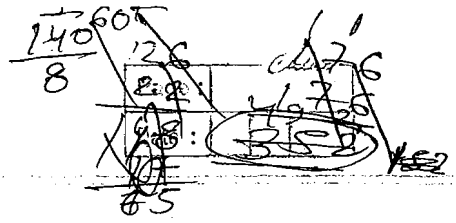
20 17

ID 0
Offset 126
MF 1

20 17

IP 0
Offset 6
MF 1





1. comm^{n}:

• More fragment (MF):— This bit says if more fragments are following the current fragment or not.

↑ clk able = d.

	20 | 492		
	126		
	20 | 176	20 | 176	20 | 140
ID	0	0	0
Offset	126	148	170
MF	1	1	0

	20 | 504		
	20 | 176	20 | 176	20 | 152
IP	0	0	0
Offset	63	85	107
MF	1	1	1

Don't Fragment (DF):—

Whenever a pkt with DF=1, reaches at routers, it should not fragment it.

Reassembly Algorithm used at destination:—

i) Classify the fragments based on the identification no.

ii) Identify the fragment with offset=0 & designate it as 1st fragment.

iii) Identify the fragment with MF=0 & designate it as last fragment.

iv) Identify the data bytes in the 1st fragment & divide it by 8 & search for a fragment with the same offset & designate it as 2nd fragment

v) Repeat the previous step till completion.

* We cannot sort them according to offset b'coz if a pkt bet of fragment being lost then we can't get right sequence by sorting.

Reason.

1) All th
same

2) Every
Cmax.

Time

O

S

loop

Dia.
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Check
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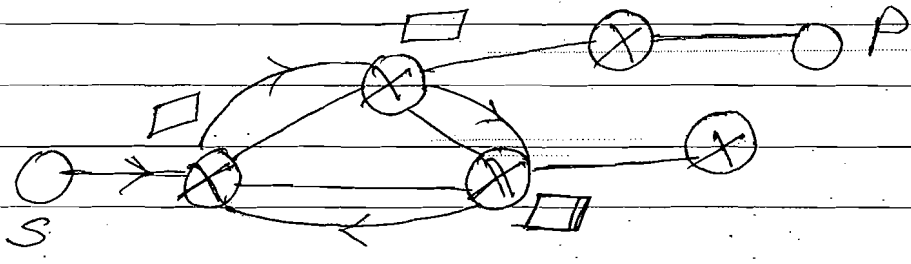
change
towards
Offs

Reasons for applying Reassembly at

1) All the fragments will not follow same path
2) Every n/w will have its own MTU (max. transmittable unit)

Time to live (or TTL):—



It is used to avoid infinite looping.

Diameter in CN:— Max. no. of hops b/w senders & Receivers.

Protocol field:— It is used to identify to whom it the IP is offering the service.

Checksum:— At each & every routers checksum have to be computed b'coz some of the fields in IP headers may change as the pckt makes a journey towards destination like MF, TTL, Offset, 16-bit datagram length &

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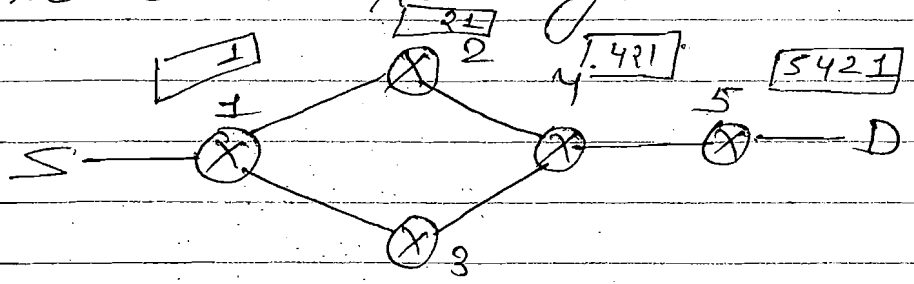
Options.

Options:—
i) Strict source Routing
ii) Lose source Routing
iii) Time stamp value
iv) Record route routing

Strict source Routing:—



1 2 4 5 Strict source routing

1 4 5 Lose source routing

Note:— Every pt All the datagrams should contain the source routing information.

Time Stamp Value:— Every routes has to put arrival time & departure time.

Only 1st pckt need to have this information.

Record Route:— Routes taken by pckt are recorded.

Su

Subne
many

(Adva
ii) Re
possibl
iii) Mai
very si
iv)

Disadv
i) Ader
steps
a) Hr
b) De
c) Hos
d) Pso

Note:—
some

193.

Subnetting & Supesnetting (CIDR)

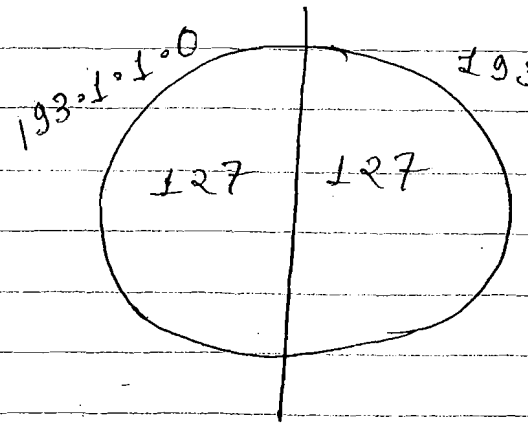
Subnetting:— Dividing a single n/w into many smaller n/w is subnetting.

Advantages:— i) It improves security
ii) Restructuring of internal network is possible without affecting other n/w.
iii) Maintanance & administration is very simple.
iv)

Disadvantages:—
i) Identification problem contains 4 steps
a) ~~Hr~~ Determine n/w
b) Determine subnet
c) Host
d) Process

Note:— In subnetting we borrow some bit from host part.

193.1.1.00000010



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Subnet Mask :-

It is a 32-bit system & it is used to find out no. of bits borrowed from the host part & these exact position based on the following rules.

Rule no. 1 :- No. of 1's in a subnet mask indicates n/w id part & borrowed bits part.

Rule no. 2 :- No. of 0's indicate host id part.

i/p Address 192.192.192.200
subnet mask 255.255.255.~~16~~

i) Find no. of bits borrowed
ii) Subnet id's
iii) Find no. of host per subnet.
iv) Find no. of subnets

i) 1
iv) 2
ii) [192.192.192.16 / 192.192.192.0]
iii) ~~2^8 = 32~~ $2^7 - 2 = 128 - 2 = 126$ Hosts are possible

128 / 64 / 19^2

8
11001000
1

From a
broadc
19
⇒ 19
1
19:
⇒ 192
ip Ad
a) No
b) Su
c) 2^8
192.19

64 8
01001000

From above ques^n what is directed broadcast address from the subnet

192.192.192.0

⇒ 192.192.192.239

192.192.192.0

00001000

11110111 → 239

192.192.192.16

⇒ 192.192.192.255

ip Address 192.192.192.200

255.255.255.72

a) No. of subnets = 4

b) Subnet ip's

11001000 200

01001000

c) $2^6 - 2 = 62$ hosts/subnet

$2^6 - 2$ 255 8

64 − 2 = 62

192.192.192.8

⇒ 192.192.192.191

255
164 0
191
8
183

150.100.100.100
255.255.255.0

01100100.01100100

24 = 16 + BP
24 = 16 + BP
BP = 8 bits

No. of 0's = 8

No. of subnet = 256 = 2^8
Hosts/subnet = $2^8 - 2$

150.100.100.100
255.255.128.128
8 8 1 1 ⟶ 15

18 = 16 + BP
BP = 2 bits

No. of subnet = $2^2 = 4$
Host/subnet = $2^{14} - 2$
No. of 0's = 14

Default subnet masks :-
Class A → 255.0.0.0
Class B → 255.255.0.0
Class C → 255.255.255.0

192.55.12.120

subnet mask 255.255.255.240

8 8 8 4

28 = ~~16~~ + 24 + BP

BP = 4 bits

No. of subnets = $2^4 = 16$

Hosts/subnet $= 2^4 - 2$

$= 14$

255.255.255.72

8 8 8 2

26 = 24 + BP

BP = 2 bits

No. of subnet = 4

Host/subnet $= 2^6 - 2 = 62$

128.12.34.71

255.255.255.0

24 = 16 + BW

BW = 8

No of subnets = 2^8

Hosts/subnet $= 2^8 - 2$

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In an organization that uses class C n/w requires 14 subnets with each with 10 systems then propose a suitable subnetting for the n/w.
192.192.192.0.

14 → 4 bits bits selected for subnets

255.255.255.[1111]0000 → bits for host

255.255.255.240

Propose a subnet mask for the class 129.1.0.0 so that we get 240 subnets and 240 hosts per subnet

255.255.11110000.00000000

240 → 8 bit

~~255.255.255.0~~

We can choose any 8 bit from 16 bits of Host id ∴ Total no. of subnet mask possible are

$= {}^{16}C_8$

es class
theach..
ose a
n/w.

selected
3 subnets

bits for
host

he class
240
ubnet

000

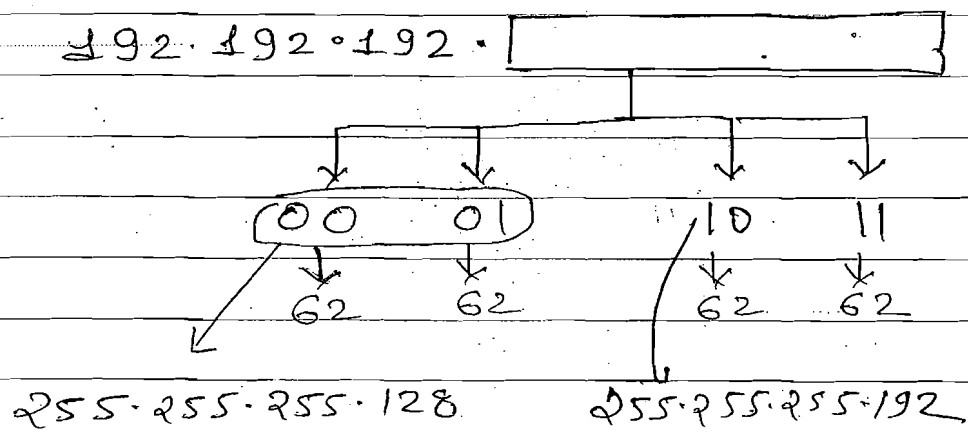
rom
no. of

An organization uses class C, it requires 3 subnet each with ~~16 & 128 systems~~ 60, 60 & ~~128~~ 124 system totally. propose subnet mask.

60 + 60 + 128 = 248

~~255.25~~

192.192.192.0 (given)



If we borrow 2 bit from host id part we get 4 subnet with 62 host in each subnet - so it is not possible to go with fixed length subnet masking, so we go with variable length masking

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192.192.192.00000000

0 | 1

SID- 192.192.192.0

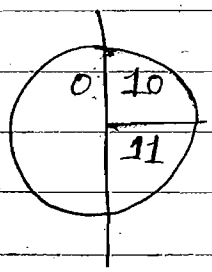
SM 255.255.255.128

Host $2^7 - 2 = 126$

1 → 10 | 11

10 → 192.192.192.128, 255.255.255.192, 62 hosts

11 → 192.192.192.192, 255.255.255.192, 62 host



32
1 6
4 1

A pckt with IP address 155.100.12.55 arrives at a routes. Explain how the pckt is delivered to the appropriate host using the following routing table

N/W ID	Mask	Link	
10.0.0.0	255.0.0.0	1	
192.192.192.0	255.255.255.0	3	
155.100.0.0	255.255.0.0	2	
200.100.200.0	255.255.255.0	4	
0.0.0.0	0.0.0.0	3	Default routes
0.0.0.0	0.0.0.0	5	

If not the de

It is u

The n/w is supern

Restrict

i) All the class

ii) The in seq

Advan

i) We ca

ii) Size

iii)

Supe

It is addre on the Rule 1 Part

If nothing matches then we go to the default route.

* It uses 1st match.

Supernetting

The process of aggregating 2 or more n/w's to generate a single n/w is supernetting.

Restrictions in supernetting:-

i) All the n/w must belong to the same class

ii) The N/w id's of this n/w's must be in sequential orders.

Advantages of supernetting:-

i) We can save some ip addresses

ii) Size of routing table decreases

iii)

Supernet Mask

It is used to generate single IP address to a group of n/w's based on the 2 rules.

Rule 1:- No. of 1's indicate fixed part & no. of 0's indicate variable part.

192.8

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192.192.192.10

255.255.240.0 → supernet mask

24 > 20

255.255.255.240 → subnet mask

24 < 28

Perform CIDR aggregation on the following IP addresses & generate a single IP address for it.

205.100.0.0

205.100.1.0

205.100.2.0

205.100.3.0

11001101.01100100.00000000.00000000

11001101.01100100.00000000.00000000

11001101.01100100.00000000.00000000

11001101.01100100.00000000.00000000

SM. 255.255.252.0

SID. 205.100.0.0

Perform CIDR aggregation & find supernetmask & supernet id

200.96.86.0

200.96.87.0

200.96.88.0

200.96.89.0

S.M. 25

S.ID 20

If 20

find

aggre

For the

find t

It is

Find t

aggrega

class C 12

class B 12

class A 12

12

we c

S.M. 255.255.240.0

S.I.D 200.96.80.0

If 200.96 supernet mask is 255.255.128.0 find the no. of class C n/w's aggregated

255.255.128.0

24 = 17 + 7 changing

2^7 = 128 class C n/w are aggregated

For the supernet mask is 255.255.192.0 find the no. of NID bits, host bits

24 bits, 8 bits

It is class C.

Find the supernet id for the following aggregation.

class B { 128.56.24.0
128.56.25.0

class A { 125.56.26.0
125.56.27.0

We cannot aggregate class A & class B.

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Gate 2008

In a class B n/w the subnet mask is 255.255.248.0 then find the max no. of host possible

$2^{11} - 2 = 2046$ hosts/N/w

$2^{11} - 2$ host/N/w

$2048 - 2 = 2046$

Gate 2003

Subnet mask for a n/w is 255.255.31.0 which of the following pair of i/p addresses could belong to the same n/w.

a) 172.57.88.62 & 172.56.87.233

~~b) 172.56.87.233~~

b) 10.35.28.2 & 10.35.29.4

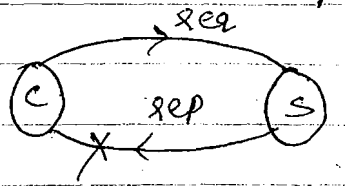
c) 192.203.31.87 & 191.234.31.88

d) 128.8.129.43 & 128.8.161.55

285

Imagine that a two-way handshake rather than a 3-way handshake were used to set up connection. In otherwords, the third msg was not reqd. Are deadlocks now possible? Give an example.

Eg

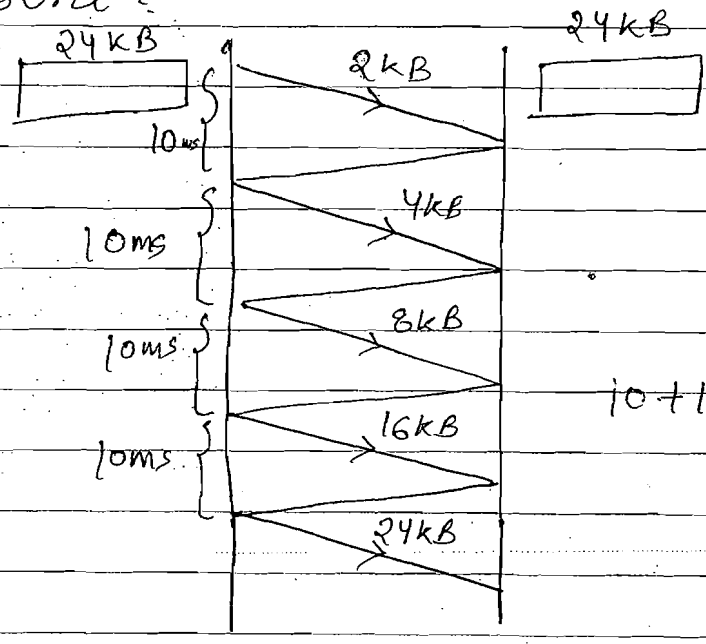


reply is lost

The payload of TCP segment is ~~6 Byte~~ 65515 Bytes why such a ~~s~~ strange no. is choosen?

B'coz 65515 + 20 = 64K

Consides the effecting of using slow stast on a line with 10ms RTT & no congestion. The receives window size is 24kB & the max. segment size is 2kB. How long does it take before the 1st full window can be sent?



10+10+10+10 = 40

Suppose the TCP congestion window is 18kB & then tibe out occurs then how big will the window be if the next 4 xmission bussts.

Assume that the max. segment size is 1kB.

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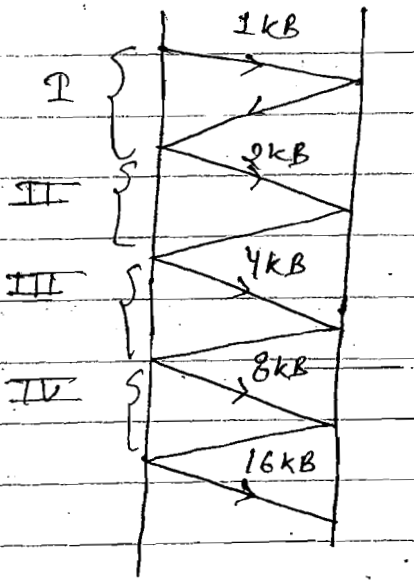
Whenever time out occurs window size drop to 1.



If the TCP RTT is currently 30ms & the following ACK comes in after 26, 32 & 24 ms respectively. What is the new RTT estimate. Use $\beta = 0.9$.

$IRTT = 30ms$

$NRTT = 26$

$ERTT = 30 \times 0.9 + 0.1 \times 26$

$= 30 \times \frac{9}{10} + \frac{1}{10} \times 26$

$= 27 + 2.6$

$ERTT = 29.6 \text{ sec}$

$NRTT = 32$

$ERTT = 29.6 \times 0.9 + 32 \times 0.1$

$= 296 \times \frac{9}{10} + 32 \times \frac{1}{10}$

$= 266.4 + 3.2 = 269.6 \text{ms}$

$\frac{26.64}{3.2}$
29.84

85
296×9
2664
$\frac{3.2}{269.6}$

=q

RT:

Note
Gener

A TCP m/c
bytes o
1 way c
Through
line eff

Th

Lin

size

$= 29.84$

$\overline{RTT} = 29.84$

$= 29.84 \times 0.9 + 24 \times 0.1$

$= 29.84 \times \frac{9}{10} + 2.4$

$= 26.95 + 2.4$

$= 29.096$

Note: Generally the smoothing factor is $\frac{3}{4}$.

A TCP m/c is sending windows of 65535 bytes over 1 GBPS channel that has 1 way delay of 10ms. What is the max. throughput achievable. What is the line efficiency?

$64KB = 2^{16} B$

Channel capacity $= 1GBps = 2^{30} Bps$

$\text{Throughput} = \frac{64KB}{20} = \frac{64 \times 8 \times 1K}{20 \times 10^{-3}}$

$= 25.6 Mbps$

$\text{Link utilization} = \frac{25.6 \times 10^6}{10^9}$

$= 25.6 \times 10^{-3}$

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Which of the following statement are false about internet protocol (IP)?

a) It is possible for a computes to have multiple IP address.

b) IP pckts from the same source to same destination can take different route

c) IP insures that a pckt is not forwarded to destination

d) The pckt source cannot set the route of an outgoing pckt (source routing)

Which of the following functionality must be implement by Xpost protocol over & above the n/w protocol.

a) Recovery from packet losses

b) Detection of duplicate pckt

c) Pckt delivery in correct orders

d) End to end connectivity

Matching

P: Data Link Layer → 1. Ensures reliable Xpost of data over a physical point to point

Q: N/w Layer → 2. Encodes/decodes data for physical xmission

R: Xpost layer → 3) Allow end to end comm^n two processes

→ 4) Routes data from one n/w node to the next

Which of with sk

i) Both forwa

ii) A bi use M

The shown

Destin

128.75.43

128.75.4

192.12.17

Default

On whi routes destinat

Packets through

a) Th

b) TCP

c) UDP

d) Neit

Which of the following is not true with respect to bridge & routes.

i) Both bridge & routes selectively forward data pckts.

ii) A bridge uses IP addresses & route use MAC address

iii) The routing table of a router is shown below

Destination	Subnet Mask	Interface
128.75.43.0	255.255.255.0	Eth 0
128.75.43.0	255.255.255.128	Eth 1
192.12.17.5	255.255.255.255	Eth 2
Default	—	Eth 3

On which of the interfaces will the routes forward pckts address it to destinations 128.75.43.16 & 192.12.17.0

128.75.43.16 → Eth 0

192.12.17.0 → Eth 3 or default.

Packets of same session can be routed through different path

a) In TCP but not UDP

b) TCP & UDP

c) UDP but not TCP

d) Neither TCP & UDP

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ARP is used for

a) finding ip address from DNS

b) finding ip address of the default gateway (it is in routing table)

c) finding ip address that correspond to MAC

d) Finding MAC address that correspond to IP address

The max. window size of for data xmission using n bit seq frame sequence no. is

Ans → 2^n & receiver window size 2^n

An organization has class B n/w & wishes to form subnets for 64 departments The subnet mask could be

a) 255.255.0.0

b) 255.255.64.0

c) 255.255.128.0

d) 255.255.255.0

Find for which of the following reason does internet protocol (IP) use TTL (time to live)

a) Ensures that pckts reach the destination within that time

b) Discard pckts that reach later then that size time

c) Preve
nately

d) Limit
queued

Two co
as foll
203.19
128.0.
& subr
which
these
i) C_1
are or
ii) C_2 a
but C
n/w.
iii) C_1
C_2 as
iv) C_1 &
differe

c) Prevent pckts from looping indefinately

d) Limit the time for which a pckt queued in intermediate routers.

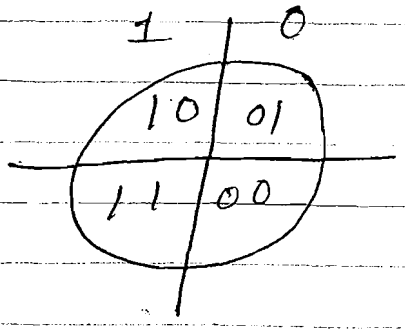
Two computers C_1 & C_2 are configured as follows. C_1 has IP address of 203.197.2.53 & subnet mask of 255.255.128.0. C_2 has IP address of 203.197.75.201 & subnet mask of 255.255.192.0. Which of the following statement is true

i) C_1 & C_2 both assume that they are on the same n/w.

ii) C_2 assumes C_1 is on same n/w but C_1 assumes C_2 is on different n/w.

iii) C_1 assume C_2 is on same n/w but C_2 assumes C_1 is on different n/w.

iv) C_1 & C_2 both assume they are on different n/w.



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In ethernet when manchester encoding is used bit rate is

a) Half the baud rate
b) Twice the baud rate
c) same as baud rate
d) None

Which of the following uses UDP as Xport protocol

a) HTTP
b) Telnet
c) DNS
d)

These are n stations in a slotted LAN each station attempts to xmit with a probability P in each time slot what is the probability that only one station xmits in a given time slot.

$$^{n}C_{1}\, P(1-P)^{n-1}$$

In a token ring n/w the xmission speed is 10Mbits per sec & the propagation speed is 200 m/μs 1 bit delay in the n/w is equivalent to

~~1 obps~~ → 2×10^{8} m/s = p.d.

10^{7} bps = ~~xmission speed~~

No.

The ac
split in
no. whe
4 max

Max. v

Match
P) S
Q)
R)
S)

PPP is
used
the p
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What
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Encoding

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1 bit delay = $\frac{1}{200 \times 10^6}$

The address of a class B host is split into subnets with a 6-bit subnet no. What is the max. no. of subnets & max. no. of hosts in the subnet.

2^6 subnets

Max. no. of hosts = $2^{10} - 2$ hosts/subnet

Match the following

P) SMTP → 1) AL
Q) BGP → 2) TL
R) TCP → 3) DLL
S) PPP → 4) NL
5) PL

PPP is a point to point protocol used at data link layer all the pckts from us home computer will be send to the closest routes using PPP.

What is the max. size of data that applicatn layer can pass

on to the TCP layer below it.

Ans → Any size

AL → Any size
TL → 64 KB or 1500 Byte
NL → It depends on LAN topology
DLL

With slow start phase of TCP congestion ctrl algo the size of window

i) doesn't ↑
ii) Increases linearly
iii) ↑ quadratically
iv) ↑ exponentially

If a class B n/w on the internet has a subnet mask of 255.255.248.0 what is the max. no. of hosts per subnet.

$2^{11} - 2 = 2048 - 2 = 2046$ host/subnet

Routin
subd
the so

the s/w
O/p line
be xm

Sta
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downloade
when n/w

Single
1) Single
shortest
algorith
shortes
also kno
Dijkastr
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as edge
Dijkastr
at eve
& info

Routing Algosithms

Routing :-

subnet :- It is a collection of all the routers.

The routing algosithm is the s/w responsible for deciding which o/p line an incoming pckt should be xmitted on.

Routing

Static (Non Adaptive)	Dynamic (Adaptive)
(Computed offline, downloaded to routers when n/w is booted)	(are based on traffic & topology)
Single source shortest path :-	
1) Single source shortest path algosithm. It is shortest path algo also known as Dijkastra's algo. Here routers are considered as nodes & links are considered as edges. Then Dijkastra algo run at every node & infosmn is	downloaded to that routers.

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FLOODING:— It is static Routing.

Advantages:— Every pckt is kept on
1) Shortest route every g outgoing link
2) Deli accept the 1 it assive on.

Advantages:—
i) Shortest path is ~~tato~~ taken by 1st pckt always.
ii) Delivery is gusanteed
iii)

DisAdvantages:—
i) N/w traffic is very high
ii) Vast no. of duplicate pckts

Soln:—
i) Hop Count
ii) Damming → If a pckt is seen for the 2nd time then discard it.
iii) Sel

Selective FLOODING:— Send the pckt to appximate right direction.

Distance Vectos Routing:—

A
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of fos

Metric
of pck

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with

i) He
ii) Ech
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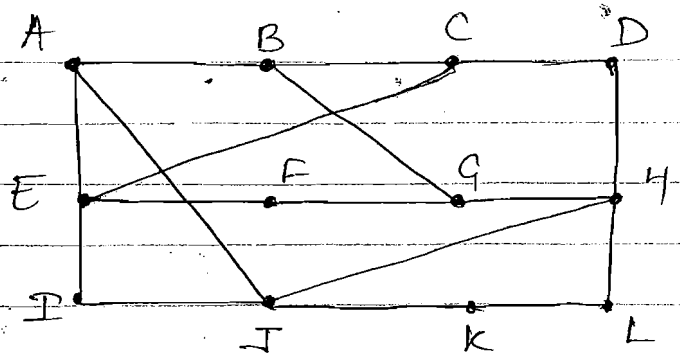


It is also know as Bellman ford or Ford Fleakeson algo.

Metrics → HOP / Time delay / Total no. of pckts queued along the path.

For this algo assume that we go with delay.

i) Hello pckt :- To know neighbours

ii) Echo pckt :- It is used to calculate propagation delay

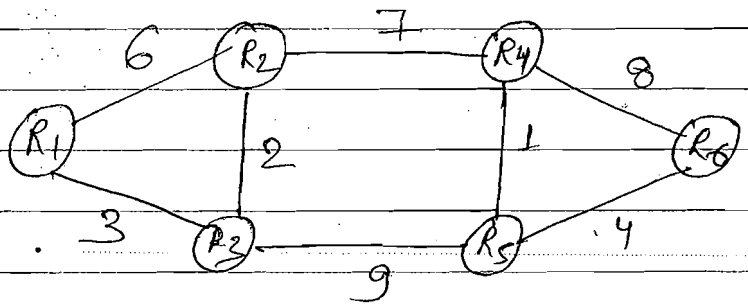
	A	I	H	k	New estimate from I	
A	0	24	20	21	8	A
B	12	36	31	28	20	A
C	25	18	19	36	28	I
D	40	27	8	24	20	H
E	14	7	30	22	~~17~~	I
F	23	20	19	40	30	I
G	18	31	6	31	18	H
H	17	20	0	19	12	H
I	21	0	14	22	10	I
J	9	11	7	10	0	—
k	24	22	22	0	6	k
L	29	33	9	9	15	k

$JA=8$ $JI=10$ $JH=12$ $Jk=6$

Model

	A
1	0
2	5
3	3
4	13
5	12
6	∞

A



R1

0	1
6	2
3	3
∞	—
∞	—
∞	—

R2

6	1
0	—
~~∞~~ 2	3
7	4
∞	—
∞	—

R3

3	1
2	2
0	—
∞	—
9	5
∞	—

New estimate from J

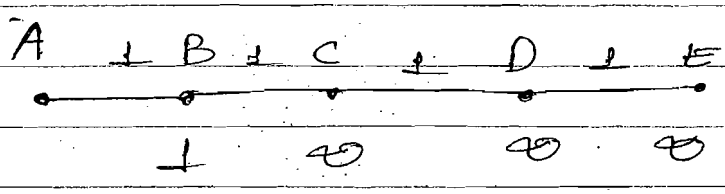
26	A
20	A
28	I
20	H
~~17~~	I
30	I
18	H
12	H
10	I
0	—
6	K
15	K

3	1
2	2
0	—
∞	—
9	5
∞	—

Modified table

R_1

1	0	—
2	5	3
3	3	5
4	13	2
5	12	3
6	∞	—



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Count to infinity :-

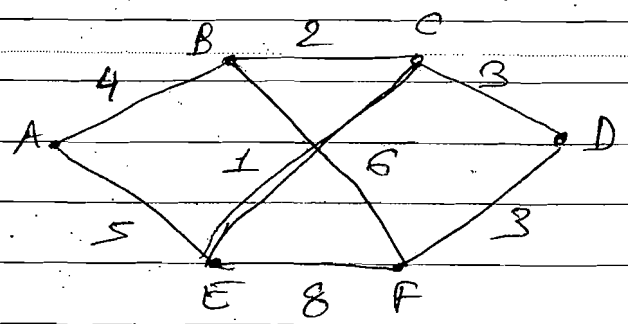
Good news spread fast while, bad news spred slow.

Disadvantage :-

1) It is too slow to converge (to reach a stable state).

2)

Link State Routing :-



i) Identify neighbours "Hello" pckt

ii) Identify delay "Echo" pkt

iii) Build LSR pckt

iv) Construct the graph & apply DA.

Sequence no. preserves the freshness

Cryptography

Fermats

~~Fermat's~~ theorem:—

If 'p' is a prime & 'a' is a positive integes not devisible by 'p' then

$$a^{p-1} \equiv 1 \pmod{p}$$

$$a^{p} \equiv a \pmod{p}$$ } Condition is that $a \nmid p$

Eules's toilent functions:—

$\phi(n)$

$\phi(n)$ = no. of +tive integers less than 'n' and relatively psime to 'n'.

$$\phi(5) = \{1, 2, 3, 4, 5\}$$
$$= 4$$

$\phi(p) = (p-1)$ 'p is psime

$\phi(23) = 22$

$\phi(35) = \{1, 2, 3, 4, 6, 8, 9, 11, 12, 13, 16, 17, 18, 19, 22, 23, 24, 26, 27, 29, 31, 32, 33, 34\}$

$= 24$

$\phi(35) = \phi(7 * 5) = \phi(7) * \phi(5)$

$= 6 * 4 = 24$

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Eules's Theosem:-

It states that for every 'a' & 'n' that are relatively prime

$$a^{\phi(n)} \cong 1 \pmod{n}$$

Eg: $a=3; n=10 \quad \phi(n)=4$

$$a^{4} \cong 1 \pmod{10}$$

$$3^{4} \cong 1 \pmod{10}$$

$$81 \cong 1$$

Chinese Remainder Theosem:-

It states that it is possible to reconstruct integers in a certain range from residues modulo a set of pairwise relatively prime moduli.

$$Z_{10} = \{0 \text{ ---- } 9\}$$

	modulo 2	modulo 5
	mod 2	mod 5
0	0	0
1	1	1
2	0	2
3	1	3
4	0	4
5	1	0
6	0	1

	mod 2	mod 5
7	1	2
8	0	3
9	1	4
10	0	0

Discrete Logarithm:-

If 'a' & 'n' are relatively prime, then there is atleast 1 integer 'm' that satisfies

$$a^m \equiv 1 \pmod{n} \qquad m = \phi(n)$$

namely

The least positive exponents 'm' for which $a^m \equiv 1 \pmod{n}$ is referred to as

i) The orders (or period) of $a \pmod n$

ii) The exponent to which a belongs to mod n.

iii) It is also cld length of period generated by a.

Find the orders of $7 \pmod{19}$

$$7^1 \equiv 7 \bmod 19 = 7$$
$$7^2 = 7^2 \bmod 19 = 11$$
$$7^3 = 7^3 \bmod 19 = 1$$

Orders = 3

generated sequence = 7, 11, 1

$7^4 = 7^4 \bmod 19 = 7$

$7^5 = 7^5 \bmod 19 = 11$

$7^6 = 7^6 \bmod 19 = 1$

Length of sequence = 3

If we get a sequence for n mod 3 then a is c/d primitive root of n.

Q:- Check if 3 is a primitive root of 7 or not.

$3 \bmod 7 = 3$

$3^2 \bmod 7 = 2$

$3^3 \bmod 7 = 6$

$3^4 \bmod 7 = 4$

$3^5 \bmod 7 = 5$

$3^6 \bmod 7 = 1$

length of sequence is 6 i.e. 7 − 1

∴ 3 is a primitive root of 7.

Discrete logarithm of '2' base 3 mod 7 is

$3^2 \bmod 7 = 2$

is = 2

'6' base DL of '6' base 3 mod 7

$3^3 \bmod 7 = 6$ is = 3

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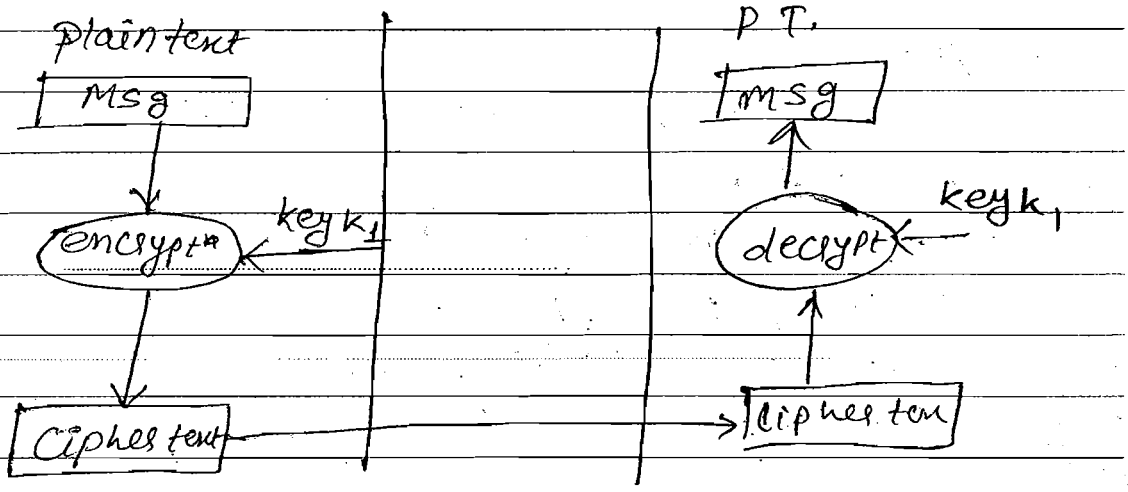
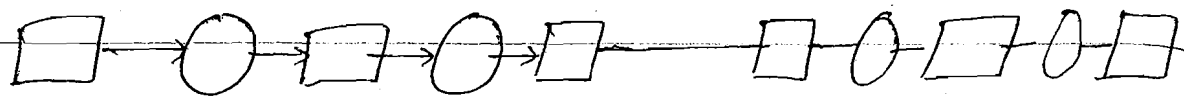
Symmetric Encryption :-



If same key & same algo are used at both senders & receiver side then it is c/d symmetric key encryption.

Public key or Assymetric key encryption :-



RSA :-

1) Select 2 prime no's 'p' & 'q' such that $p \neq q$

2) Calculate $n = p \times q$

3) $\phi(n) = (p-1)(q-1)$

4) Select integes 'e' such that gcd of $\phi(n)$ is equal to 1

$$\gcd(\phi(n), e) = 1$$

& ~~1 less~~ $1 < e < \phi(n)$

5) Calculate d such that

$$d \cong e^{-1} \pmod{\phi(n)}$$

or

$$d \times e \cong 1 \pmod{\phi(n)}$$

6 Public key $P_U = \{e, n\}$

Private key $P_R = \{d, n\}$

Diffie Hellmann key Exchange :-

If 'A' & 'B' wants to exchange a key then

i) They will be 2 publicly known no's which are a prime no. q & an integes α i.e. primitive route of q.

ii) A &
& com

iii) B &
& com

iv) Each
privite
availab

v) Uses
$(Y_B)^X$
key a

ii) A selects a random integer $X_A < q$ & computes $Y_A = \alpha^{X_A} \bmod q$

iii) B selects a random integer $X_B < q$ & computes

$$Y_B = \alpha^{X_B} \bmod q$$

iv) Each side keeps the X value as private & makes Y value publically available

v) User A compute the key as $(Y_B)^{X_A} \bmod q$ & user B compute the key as $(Y_A)^{X_B} \bmod q$.