13/20 → ALOHA

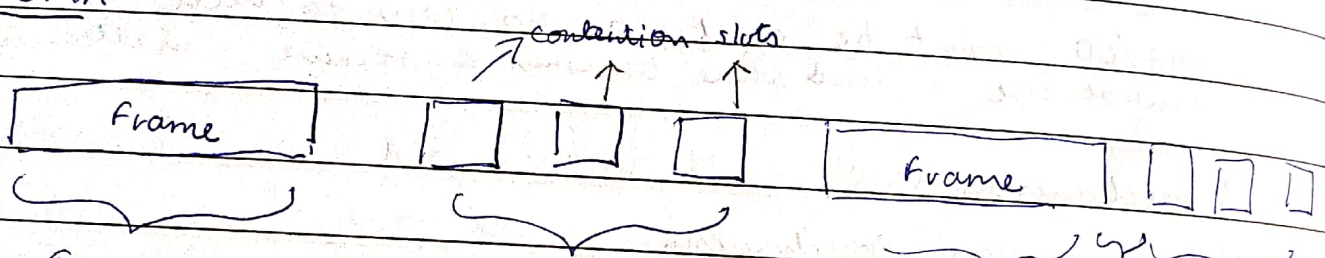
→ CSMA < CSMA/CD – wired Network
CSMA/CA – wireless network

→ Contention free protocols

→ Limited Contention Protocols

→ Wavelength Division Multiplexing.

CSMA



Frame Transmission period

contention period

can have idle time

Binary Exponential back off algo.

0, 1, 2, 3

0 . . . 7

0 . . . 15

↑

Max 10 attempts

0 — 1023

If can't transmit within this, gives up transmission.

~~ALOHA – no probability in time slots~~ CSMA – probability time slots waiting time is random

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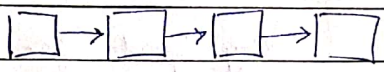
Contention Free Protocols

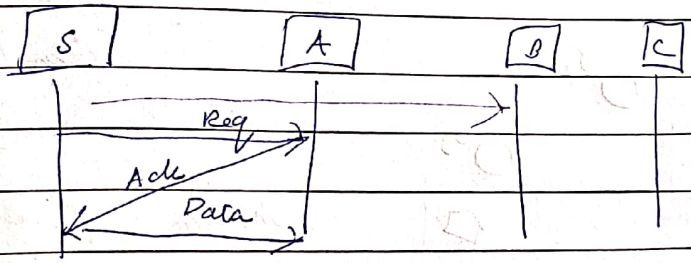
Polling

Polling Method
Select Method.

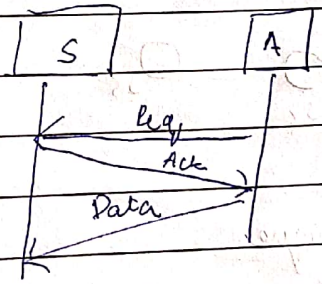
Signals are connected in daisy channel 

server wants to send to client (selecting a client to send to) - Select method.
Client wants to sent to server, server must select client - Polling Method

Select Method:

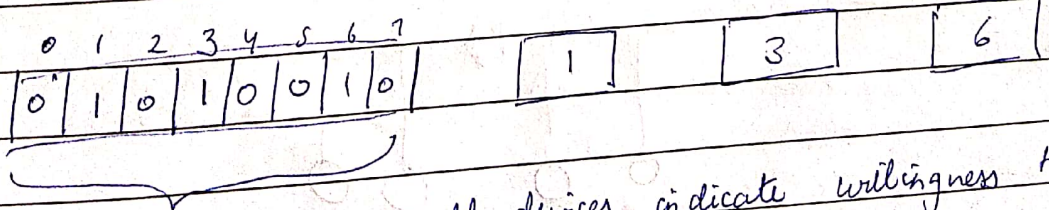


Polling Method :



Bit Map Method

eg.



Contention slot - all devices indicate willingness to transmit by changing 0 → 1

works on reservation

8 devices, all initially have 0.

To indicate that a particular dev. wants to transmit

Transmit in Round-Robin Fashion

Other dev. have to wait for 3 frame slot time.

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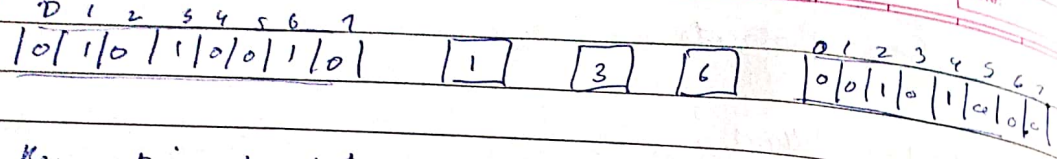


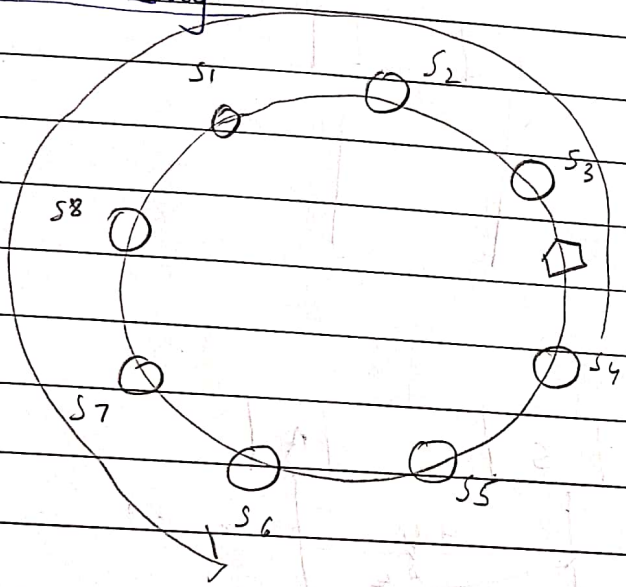
Reservation of slots is done by Bit Map

Very good for heavy load as starvation does not occur.
Not good for light load

Also commonly called Reservation Method.

Token Passing

- Token Ring
- Token Bus

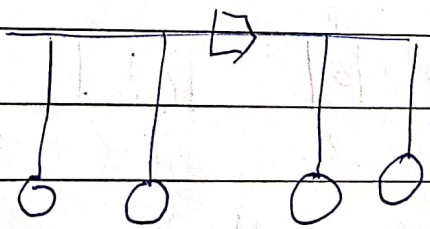


whoever capture token/data can transmit.

Token Ring Technique

Disadv: Starvation might occur as the same might capture token each time.

Token Bus Technique



Whoever wants to transmit, captures the token.

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If want delay ↓ .. — ALOHA
throughput Max — Contention free

Binary Countdown

4 stations — Bit time 0 1 2 3

∵ 4 bits Addr 0 - 15 ∴ Max 16 stations

2	0010	0 — — — (not matching ∴ eliminated)
4	0100	0 — — —
10	1010	① 0 1 0
09	1001	① 0 0 —

~~OR~~ OR

① 0 1 0 ← address can transmit i.e. station 10

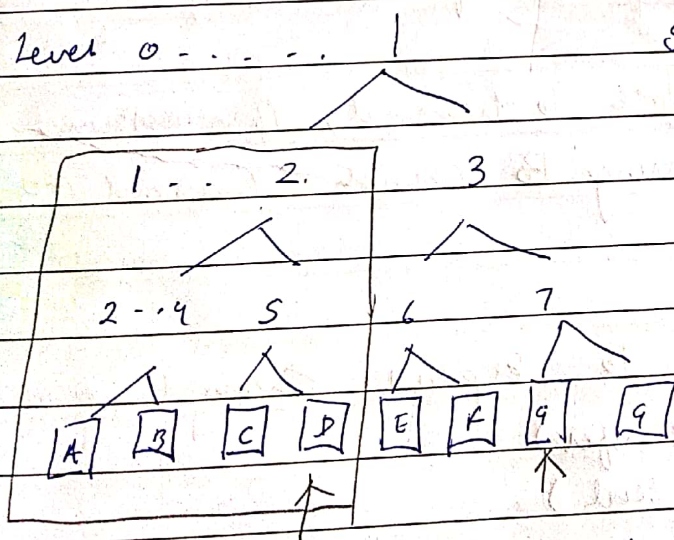
∴ Priority based ∵ largest always given.

Limited Contention

Combines best features of Contention free & Contention based

Adaptive Tree Walking Protocol — Divide & Conquer

Systems are connected / arranged in a hierarchy.



If D & G want to transmit → collision
For next time slot only [ ] can compete ∴ only D is there → go through

Light load situation — At time slot 0 everyone can transmit
If only 1, ~~not~~ no collision → go through
If collision, they can compete for next time slot.

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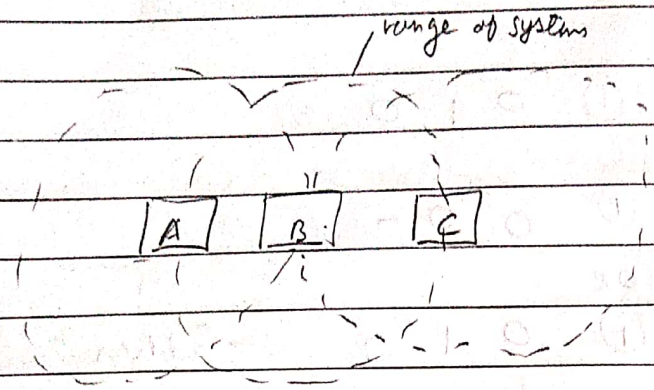
Contention Based Protocols Of Wireless Network.

CSMA/CD cannot transmit & receive at same time as at time of transmitting your own signals are strong near you, receiving signals from far will be weak.

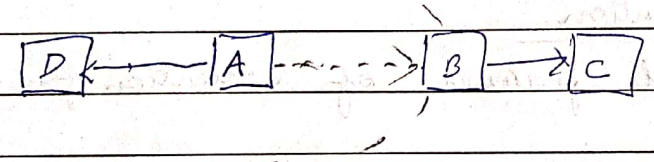
CSMA/CA used instead

MACAW is commonly used



Hidden Station Problem:
both may transmit at same time as they cannot sense each other resulting in collision at B.

Exposed Terminal Problem



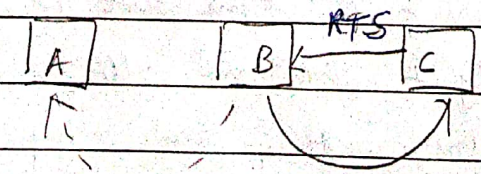
B is in the range of A, whatever A is transmitting to D, it reaches B also bc of broadcasting

Even though B was free to transmit, B assumes that transmission is occurring. B cannot transmit to C
∵ CSMA/CA

MACA Protocol soln to Exposed Terminal Prob.

RTS (Request to transfer)

CTS (Clear to Send)



CTS reaches A too ∵ in range

If B is ready to transmit it gives back CTS

A cannot transfer to B

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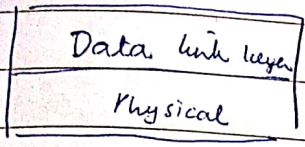
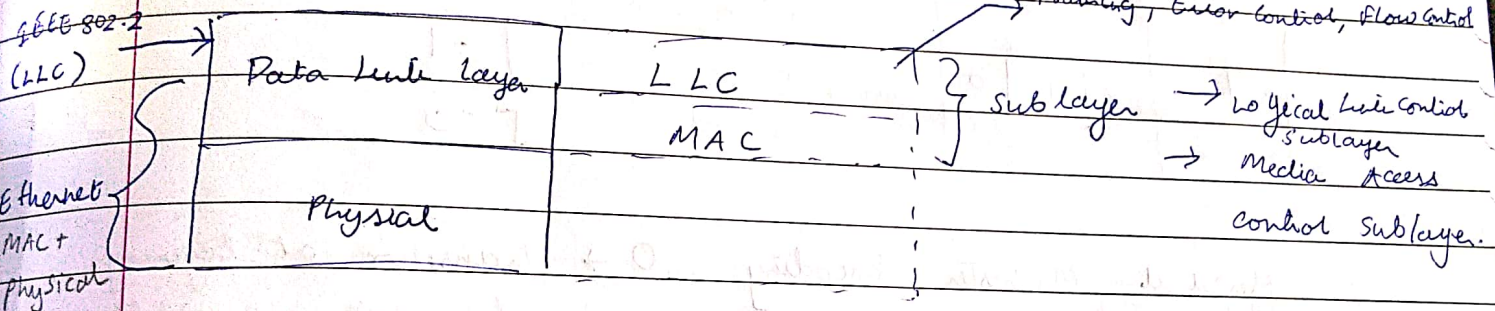
5/3/20

ETHERNET (LAN)

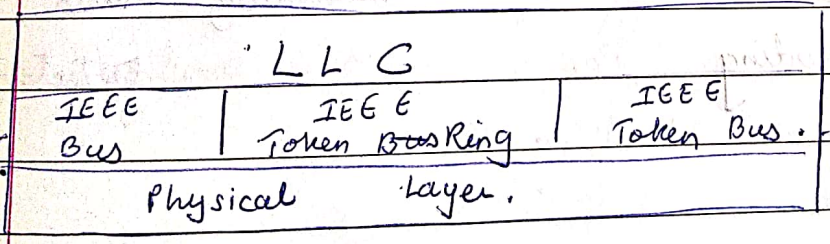
Layered Architecture



These 2 layers are sufficient for local network communicat^{n} betn 1 device to another device.



Ethernet follows IGEE std → IEEE 802.3 ref to combinat^{n} of physical layer + part of DLL → MAC



→ Topology.

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Sublayer of Physical layer.

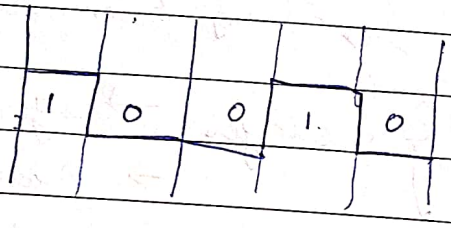
↓

Data encoding

(Manchester encoding) & Differential Mc-

If ethernet is working at speed = 10Mb

∴ Baud rate = $2x^{\uparrow} = 20$



⌊ = 1

⌈ = 0

Differential Machester Encoding : 0 → transition at begining

1 → transition in middle.

Preamble generator

Data → binary + phased encoding

Receiving/ Transmitting

Channel collision sensing

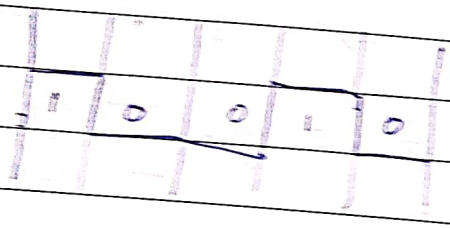
Channel Detection

Channel

Scanned with CamScanner

Sublayer of Physical layer.

- Data encoding
  (Manchester encoding) & Differential Mc
- If ethernet is working at speed = 10Mb
  ∴ Baud rate = $2 \times 10^7 = 20$



⌊ = 1

⌈ = 0

Differential Manchester Encoding : 0 → transition at beginning
1 → transition in middle.

- Preamble
  Generator
- Data → binary → phased encoding
- Receiving / transmitting
- Channel Hand
- Collision sensing
- Detection

Ethernet diff
- Length of segment
- Length of frame
- Topology

10Mb standard ← works on speed of
802.3
802.3i
802.3a
802.3j
802.3ae → 200 Gbps | 400 Gbps Optical Fibre Cable (2017)

10 Base-F
10 Base-5
10 Base-2
10 Base-T

Design specifications

10 Base 5 — 100 stations can be connect
- 10 → Bandwidth in Mbps
- Base → Baseband
- 5 → 500mt Max length of segment.

(Base Band: transmitting to only 1 freq ∵ local area)

Co-axial cables are used — commonly called Thick co-axial cables ∴ Thick Internet.

Restrictions: no of stations that can be connected
: length of tap
: dist b/t 2 stations.

10 Base 2 - Bus topology
- Thin co-axial cable
- 10 Mbps
- 185 mts
- 30 systems can be connected (max).

Scanned with CamScanner

Ethernet diff
- length of segment
- length of frame
- Topology

10Mb standard ← works on speed of
802.3
802.3i
802.3a
802.3j
802.3bs all → 200 Gbps | 400 Gbps Optical Fibre Cable (2017)

10 Base-F
10 Base-5
10 Base-2
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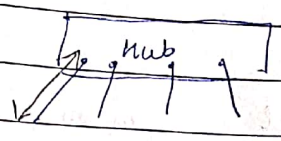
10 Base 2 — Bus topology
Thin co-axial cable
- 10 Mbps
- 185 mts
- systems can be connected (max).

Scanned with CamScanner

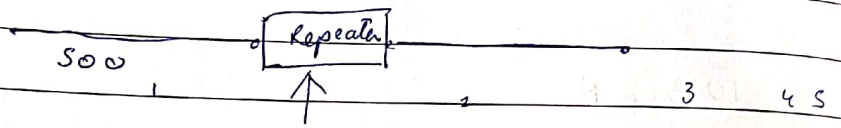
10 Base T - 10 Mbps Base band signal Twisted pair cable
- Bus or star topology
- Hub is used (passive device used to connected devices)
- 100m



Taking from 1 port to all ports - Broadcasting

10 Base 5 - 5-4-3 Rule

To connect 500m cable



can use upto 4 repeaters to connect 5 links & only 3 links should be populated

- 300 systems can be connected.
- 2.5 kms

10 Base F - Star topology / Bus topology
- Fibre Optic Cable
- Dist upto 2000m
- 1024 systems

Standard Ethernet - 10 Mbps
fast ethernet - 100 mbps
10 G / Ethernet - 10 Gbps
1 G

Bus is obsolete, either star or ring is usually used

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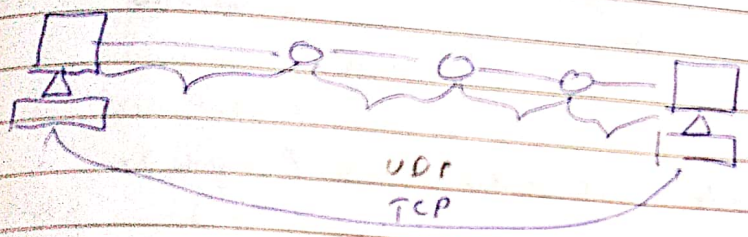
Properties of Ethernet :-

(a) Connectionless, unreliable



Connection is only possible betn end systems.

(b) It creates a frame, & the frame has some format

frame format

7	1	6	6	2	46 - 1500	4 bytes
Preamble	SFD	DA	SA	length/type	Data	CRC
7 bytes	Start Flag	Dest addr	Src Addr	2 bytes	46 - 1500 bytes	4 bytes

Delimiter

created by Physical layer

DLL layer

min size 64B
Ip packet, 12B

Initial std given by Robert Metcalf

std taken by DIX (Digital Intel Xerox)

↓

modified to IEEE

Preamble

7 byte info sent from src to dest

Alternating 0s & 1s

SFD

Alternating 0s & 1s

start & end of

indicates start of data

DA

48 bits

MAC address - divided into 2 parts - manufacturer
- unicode

47:5B:- - - - 4 octets.

↑ L → R

but within each sent in rev i.e 7 before 4.

if all bits 1 → Broadcast

if all octets end w/o 0 → Minicast address.

odd - multicast
even - unicast

burned on NIC card.

CRC

CRC 32 ~~fixed pol~~

for error control.

Max size of frame = 1580

Length/Type — which protocol
length of data

6/3/20

max length of LAN = 2500

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6/3/20

Cabling w.r.t. Ethernet (standard)

- 10 Base 5
- 10 Base 2
- 10 Base T
- 10 Base F

} Physical characteristics – length of cable, – length of frame, – encoding

max length of LAN = 2500m

MAC sublayer Ethernet (CSMA/CD)

Fast Ethernet – 100 Mbps

Gigabit ethernet – 1000 Mbps – 1 Gbps

10 " " – 10000 Mbps – 10 Gbps

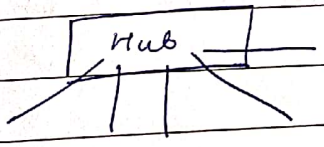
2017 ⇒ IEEE 802.3bs → 200 Gbps / 400 Gbps → OFC

Bus

Ring } most commonly used.

Star

Star



MAC Sublayer Ethernet (CSMA/CD)

Packet arrived from N/W layer

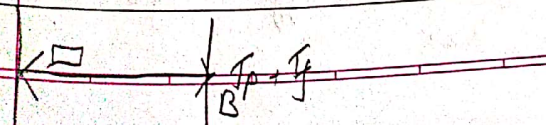
Data encapsulation

Framing Addressing CRC generate CSMA/CD

Link Control

Channel Allocation

Collision Resolution BEDA



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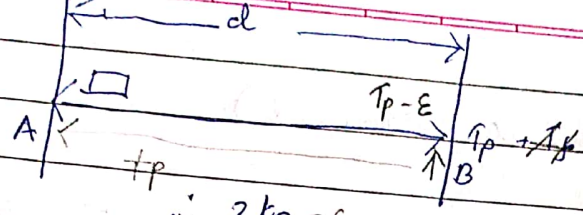
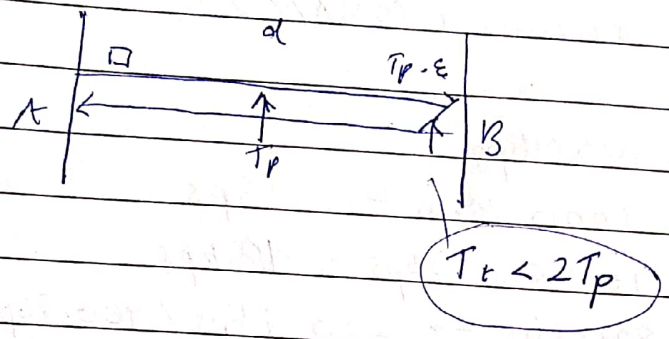


$T_p = \frac{d}{s}$

$\therefore 2t_p - \varepsilon$

$T_t = \frac{\text{Size}}{B}$

restriction: $T_t \Rightarrow 2T_p$ to recognize collision



$2t_p - \varepsilon$

min frame size $= 2T_p$

If 100 Base, dist ↓ by 10

MAC = 48 bits (address)
(6 bytes)

Last bit of 1st byte = 0 Unicast
= 1 Broadcast

FF : FF : FF : FF : FF : FF - indicates broadcast.

Ethernet makes use of 1-persistent CSMA.

If collision, it uses
BEBA - Binomial Exponential Back off Algo

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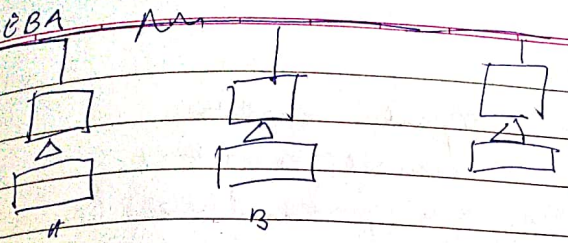
BEBA



$2^k = \{0, 1\}$ — wait for slot time

dont wait, transmit immediately after finding channel free

00 } collision
11 }

01 } No collision
10 }

∴ Probability (collision) = 50 %

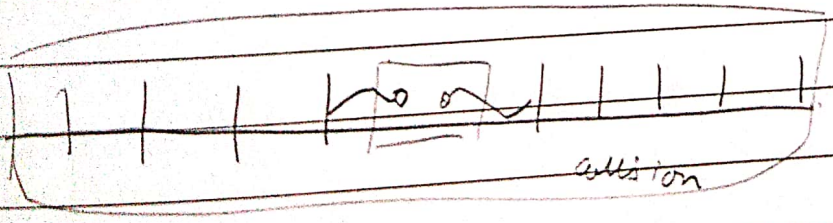
k = 0 . . . 7 — 00, 11

∴ Prob (collision) = $\left(\frac{2}{8}\right)$

k = 5

0 . . . 31

Bridged Ethernet & Switched Ethernet



Bridge

2 - 4 ports max.

collision domain reduced due to bridge

No. of collisions ↓

Same no. of broadcast domain ↑

No. of domains ↑ but belong to same N/W

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Switch multipost switch
Communicat^{n} is 1 to -1
For every port, there is a buffer.

Initially works as hub, when it has more info works 1 to 1
Initially no map table.

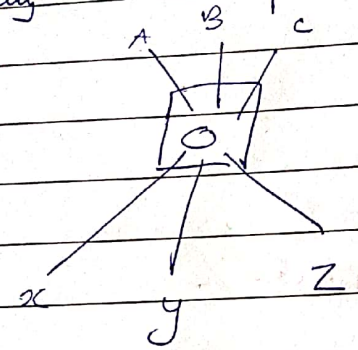
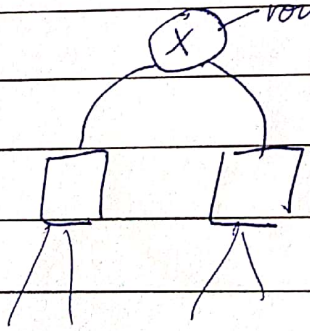


Table is constructed by learning mechanism.



reduces broadcast domain.
2 collision domains
2 broadcast domains

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Fast Ethernet

100 Base T_x - Twisted Cable UTP or TCP → Cat-5 ∴ 2 pairs for R/T

100 Base F_x - 150 m

100 Base T_4 - Twisted pair - 4 cables each supports upto 25 Mbps ⇒ 100 Mbps

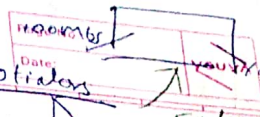
Encoding scheme : 4B/5B & MLT-3

Switch - Full duplex

2 pairs of fibre cable - 1000 Base LX
" - 1000 Base SX
UTP/STP - 1000 Base CX
1000 Base T4

} Baseband signal - whatever created by device is sent

Autonegotiation



Token card by

encoding scheme : 8B/10T + NRZ-I

IEEE ~~802.3~~ 65 ~~65~~ 200/400

IEEE 802.1
802.2 LLC
802.3 Token Bus
802.4 - Token Bus
802.5 Token Ring
802.6 (MAN)
802.7
.
.
.
802.11 Wifi
802.15 - Bluetooth
802.16 - sensor nodes

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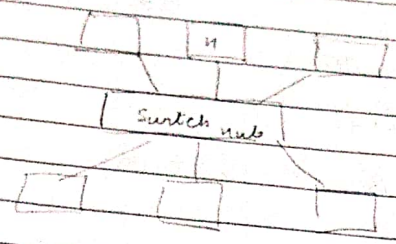
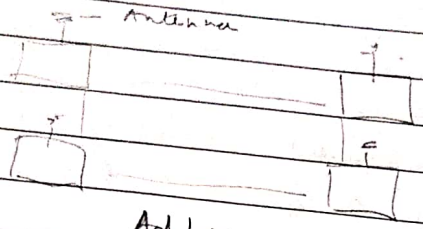
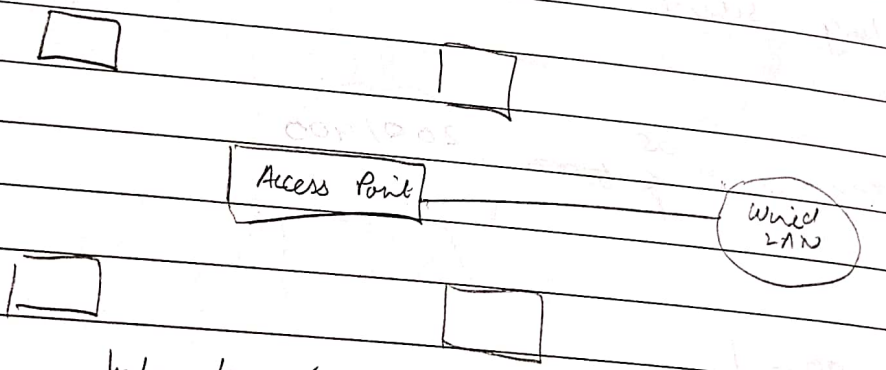
9/3/20

Wireless LAN (802.11)





Adhoc - devices communicate w/o infrastructure.

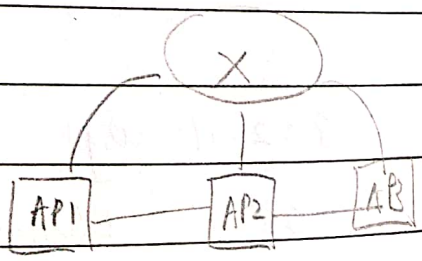


Infrastructure Based Local N/W

Architecture

BSS → Basic Service Set

ESS → Extended Service set.



Switch, Acess Point - DLL

Access Point - Does conversion as wireless LAN uses diff protocol from wired LAN.

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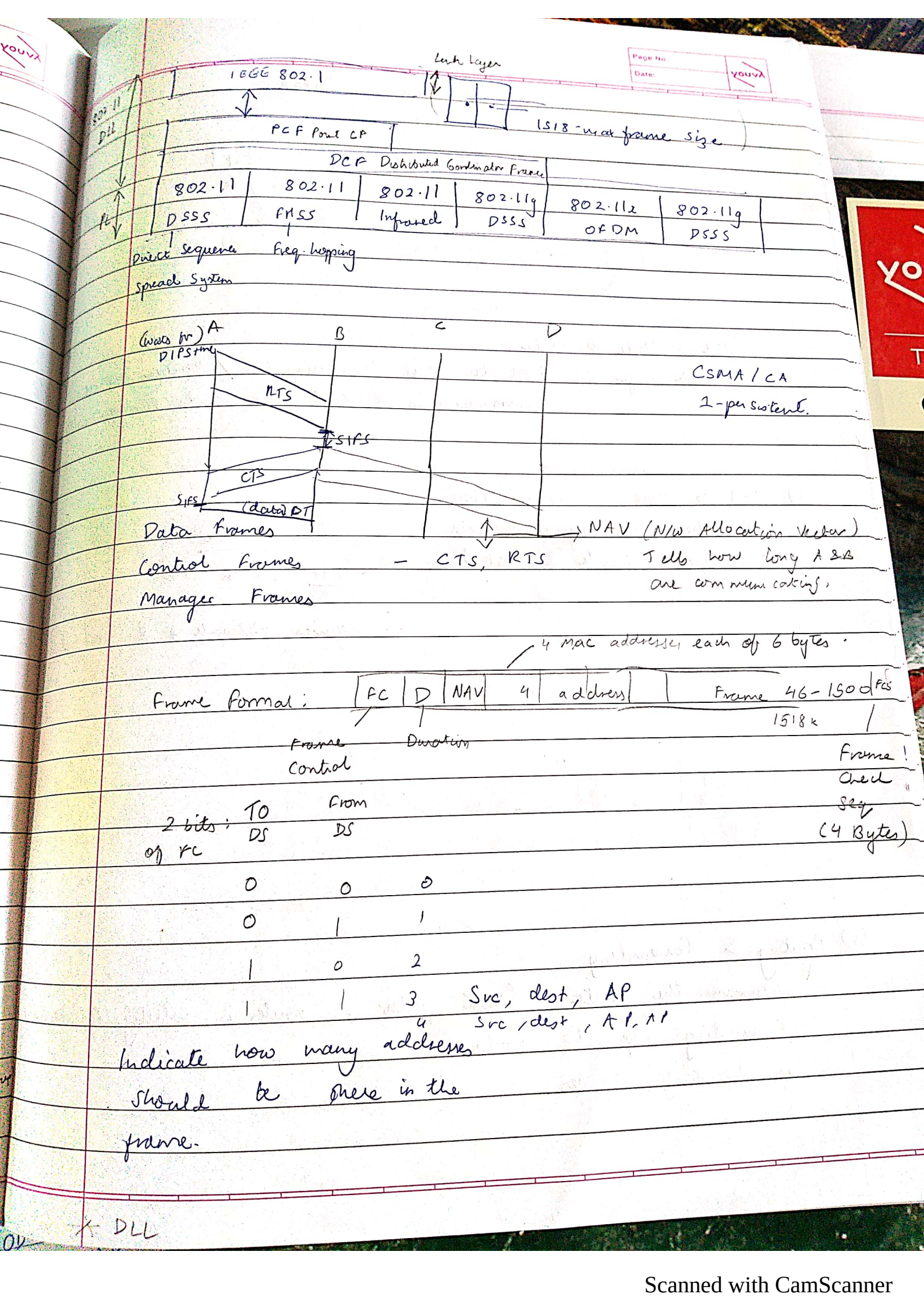

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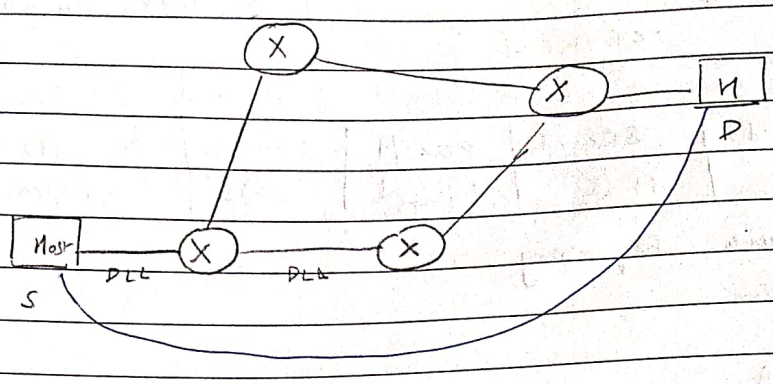
Page No.:
Date:

NETWORK LAYER



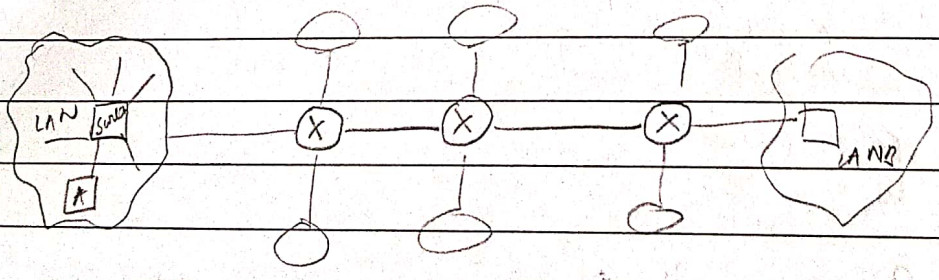
DLL : Node to Node

Network Layer : Host to Host Communication / Machine to Machine Communication / end to end Communication.

(1) Host to Host communication.

(2) IP address or Logical Address. (identifies network & host) ie < which network to go to / Host within n/w

∴ requires Network id & Host id.



(3) Routing & Forwarding

Determine the route. (best path ∴ router is intelligent device)

Forwarding info to route.

- uses routing tables.

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eg.

Path A	Port
A	1
B	2
C	3
D	4

OSTF- Open Shortest Path Follow.
BGBGP

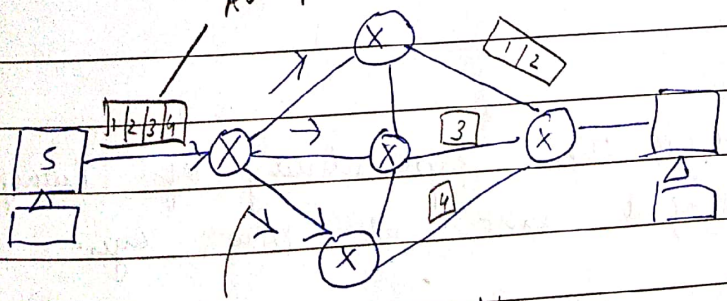
Router works in Layer 3 It contains S/W

(4) Providing services to transport layer.
Connectionless service → IP
Connection-oriented → ATM (Virtual circuit switching)
Transport layer does sequencing.

(5) Fragmentation.
∴ Buffer capacity might not be there.
∴ Handshaking is req to find buffer size.

(6) Congestion Control.

20 Services:
data gram service or Packet switching (connectionless)
Virtual circuit (VC) - connection oriented.
All packets do not follow same path



determining the path is responsibility of Network Layer.

Read!
Dijkstra's Algo
Bellman Ford Algo

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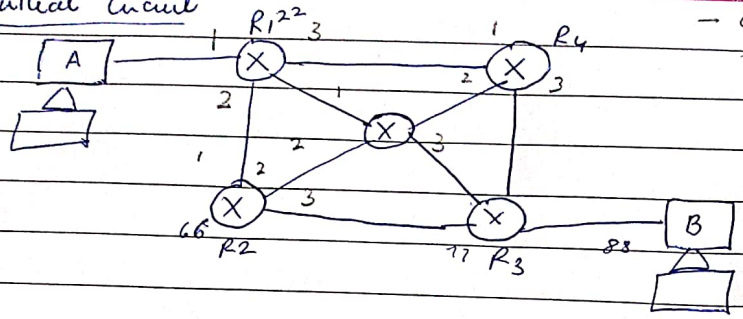
Virtual Circuit



– est connection ckt first then communicates

Input port		Output Port	
label	Port	Label	Port
22	1	?	2

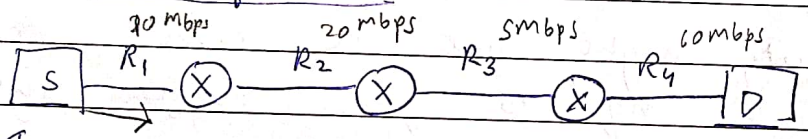
eg.

↖ unknown during setup phase ∴ 66

VCI – Virtual Ckt Identifiers

Only 1st communicat" req IP address of A & B, all others req VCI

Network Performance



T_t

T_p

T_{proc}

T_{que}

∵ transmission from S, R1, R2, R3

$(n+1)(T_p + T_t + T_{proc}) + n(T_{que})$

Throughput = min (bandwidth) (R_1, R_2, R_3, R_4)

Congestion Control is the responsibility of Transport Layer. Some functionalities of it exist at N/w layer.

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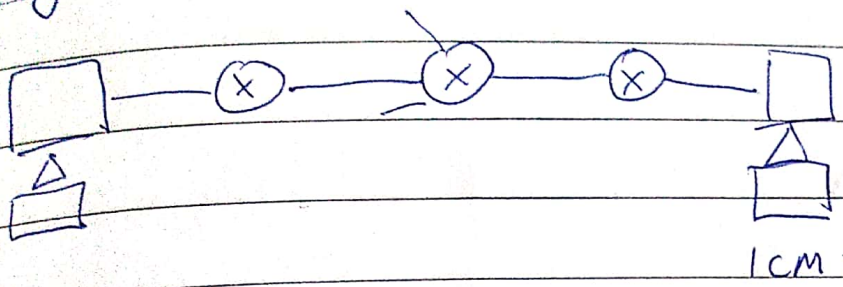
Congestion Control



Chalk packets →

← Back

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Network Layer in Detail :

(IP → Internet Protocol

App^n layer — Data

↓

Transport layer — Segment

↓

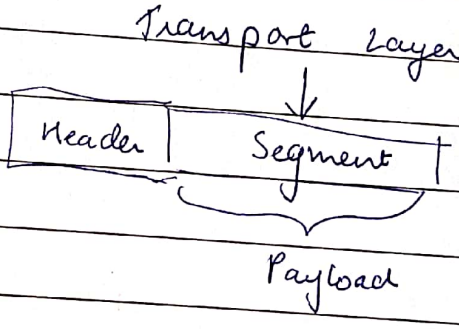
N/w layer — Data gram

↓

DLL — Frame)

Packetisation

Packet



Size of header : 20 - 60 Bytes.

IP version — 0110 or 0100 — packet < Header Packet — 0000 ... 1111

Header length

| ver 4bits | HLEN 4 | Type of Service 8 | Total length 16 |

← IPv4 (Total = 32bit)

Header length is scaled to get 20 - 60B.

↑ Scale factor of 4

eg. If HLEN = 5

= 5 x 4 = 20

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In n/w layer, when packets are sent, based on type of service priority can be given.

Type of service | P | P | P | D | T | R | C | 4 |

- P P P — Priority of packet, 3 bits → X mostly taken care of transport layer
- D — Delay parameter (try to transmit w/ delay as small as possible)
- T — Throughput – try to make max high
- R — reliability
- last bit — not used

Not reliable – ∵ IP is connectionless protocol.

Total Length of packet : 2^{16} B = 65535

Max Payload possible – ~~8~~20, 60

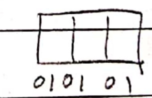
Max of DLL : 46 – 1500 (Payload)

Ver	HLEN	Type of service	Total Length
Identification 16	Flag 3	Fragmentation ~~set~~ offset (13)	
TTL			

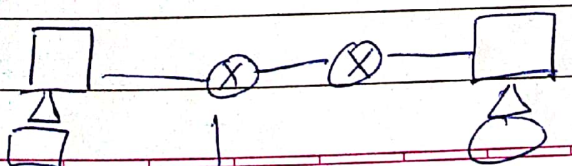
Fragmentation offset → To indicate no. of bytes preceding the packet.
if 10 = 10 × 8 = 80 bytes
∵ given as octets.

TTL — Time packet remains in the n/w. How no. of routers it can passed so as to reduce traffic in n/w

eg. DLL supports : 1500 B
Transport layer gives | 3000 B | segment
Then N/w layer does fragmentation based on max size of payload. — dividing of payload into packets dep^n of



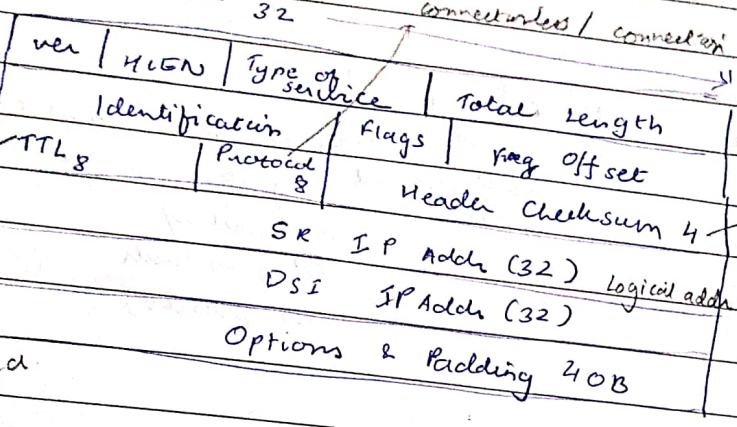
So Each fragment has same fragment id, on receiving, n/w layer puts them together based on fragment id.



fragment may happen at each station dep on max size

IP - Internet Protocol

connectionless / connection-oriented



As it moves from one hop to another it drops 1 (i hops)

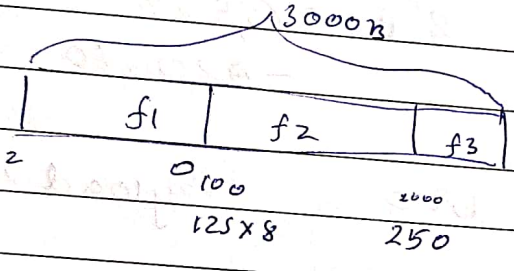
0 - 255

Max life of any packet = 120s then it is dropped

It is calculated for every as TTL changes on every router.

Minimum Header Size = 20

Max " " = 60



$\frac{1000}{8} = 125$

1000B 1000B 1000B

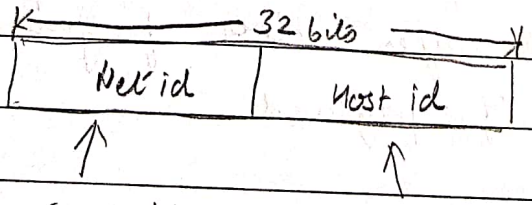
Offset is addr of 1st fragment

offset of next is size of prev + offset.

Multiples of 8 should be fragmentation no.

IPv4 = 32 bits

IPv6 = 128 bits



To identify n/w no of bits used depends on type of addr

In that network, host is identified w/

$8 \times 4 = 32$

1

∴ octet

0 - 255

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represented in decimal

min :— 0.0.0.0

0.0.0.1

⋮

0.0.0.255

0.0.1.0

0.0.1.255

⋮

255.255.255.255

112.68.38.22 — Valid

112.68.360.22 — Not valid.

2 Representations of IP addr :- classful

- classless (CIDR)

classless Inter Domain Representation

5 different classes of IP addresses :-

class A	1 – 126	eg. 88.36.26.24 (88 represents class ∴ A class)
B	128 – 191	
C	192 – 223	
D	224 – 239 → multicasting	for group (like broadcasting but 61 is for class is represented by every1)
E	240 – 214	1st Octet

E is only for testing experimental purpose, reserved, not given to any comp.

127 - used for special purpose (testing purpose / diagnostic purpose)

- Loop back addr. 127.0.0.1

0 - To represent your own System 0.0.0.0

IANA - Authority that gives the IP addresses

255.255.255.... - for broadcasting.

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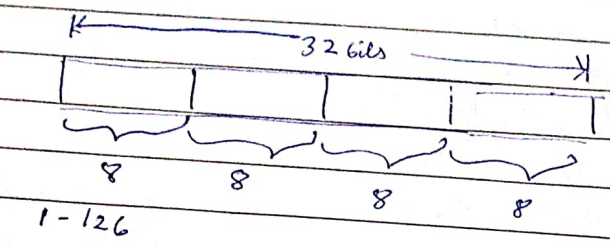
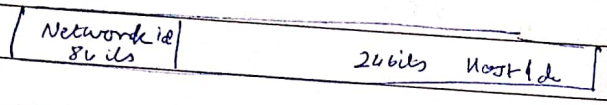
A - class





If first bit = 0, it belongs to class A.

0 - - - - - - -

all 0s & 1s — not possible

0 0 0 0 0 0 0 1

0 1 1 1 1 1 1 1

N/w id indicates no of n/w possible.

No of n/w possible = 126

'A' : No. of IP addres ~~not~~ used $\approx 2^{31}$ — ∵ 1 is fixed

126 n/w ids are possible.

2^{24} IP addresses computers are possible

0 0 0

0 0 1

0 0 2

⋮

255 255 255 ~~255~~

$2^{24} - 2$ — IP addr is possible.

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1.0.0.0 } - n/w id
: } These 2 are not possible
1.255.255.255 } ← directed broadcast addr. i.e. ping

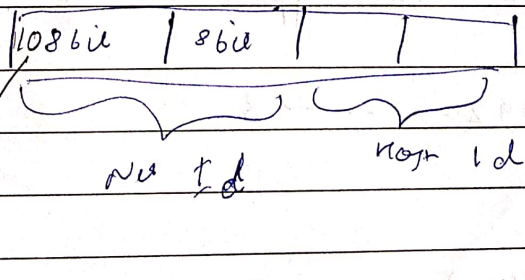
56.0.0.0 - n/w id
56.0.0.0
:
56.255.255.255 - broadcast id.

Dividing big network into many small subnetworks
→ subnets.

Subnet / Default masks 255.0.0.0
A mask used to identify the n/w idea of a given network

56.26.36.72
255.0.0.0
56 0 0 0

B Class
128-191



first 2 bits are always 1,0

14 bits are variable —
∴ 2^{14} possible networks.
Supports $(2^{16}-2)$ hosts.

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132.166.0.0

132.0.0.1

132.0 255.254 ∵ network portion next id.

∵ 255 - broadcasting.

Default mask 255.255.0.0.

IP address 168.38.22.48

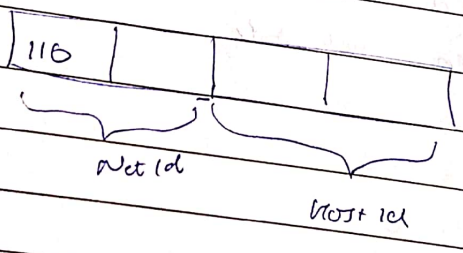
168.38.0.0

⋮

166.38.255.254.

168.38.255.255

C class



prefix : 110

2^{21} possible networks available

each h/w supports $2^8 - 2 = 254$ systems.

192 223

D class

Prefix : 1110

2^{20}

Class E: prefix : 1111

used / private or public

within organisation can be duplicated in an orgn eg. 10.0.0.0 10.0.0.0

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10.255.255.255 - A class private addr

172.16.0.0 - B "

↓

172.31.00

192.168.0.0 - C "

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