ACN

Gateway can work at any layer

router only works on the network layer

Net Neutrality → [Insta whatsapp | pack] all are diff.

↓

whatever I do my net provides should not charges ~~tree~~ me differently.

Internet more priority is → real time traffic

100 mbps → Best effort packet delivery service

→ one person (router) saying something should not be imp. majority wins.

→

Pakistan ISP took down youtube

what was the breaker to move from LAN to MAN or WAN (network to network)

HTTP

Host to Host : Network Layer

A/4 & A/4 :

ACN

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what was the breaker to move from LAN to MAN or WAN (network to network)
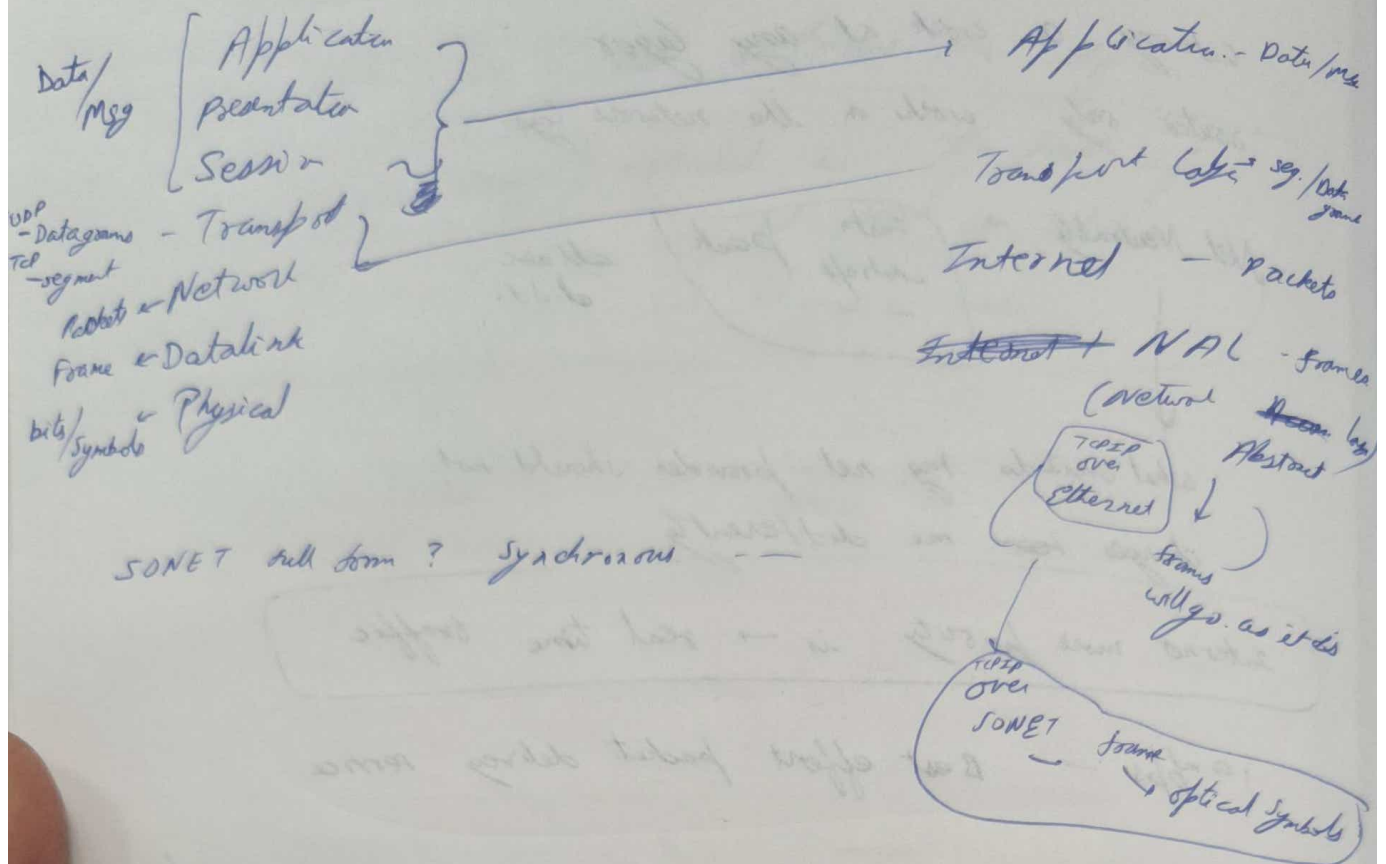
HTTP

Host to Host : Network layer

App to App :

OSI Model   TCRIP suit

Data/Msg
[Application ──────────────→ Application - Data/msg
  Pscentation
  Session } ─────────────── Transport Laye seg./Data
UDP   gram
─Datagrams ─ Transpod }
TCP   Internet ── Packets
─segment
     Packets ← Network   Internet + NAL ─ frames
   Frame ← Datalink   (Network   Abstract
bits/Symbols ← Physical   ┌─────┐
                                         │TCRIP│)
                                         │over │ ↓
                                         │Etheret│
                                         └─────┘ frames
SONET full form ? Synchronous ──   will go as it is

                                    ┌─────┐
                                    │TCRIP│
                                    │over │
                                    │SONET│ frame
                                    └─────┘
                                       → optical Symbols

Interenal naming convention for diff. Tabs is Port.

This net was working from STSR
                                  (single Thread single Resurce)

URI → URL + URN
      ↓
   ~~schema~~
   ~~Schma~~ Syntax → see which are optional ?

Subdomain used to org. the website.

with

when we have domain name what is use of
↳ aadhar.com

sub domain
(www)

F Q D N
Fully Fullyfied Domain Name

ims · iit . ac . in
sub   Domain name
domain

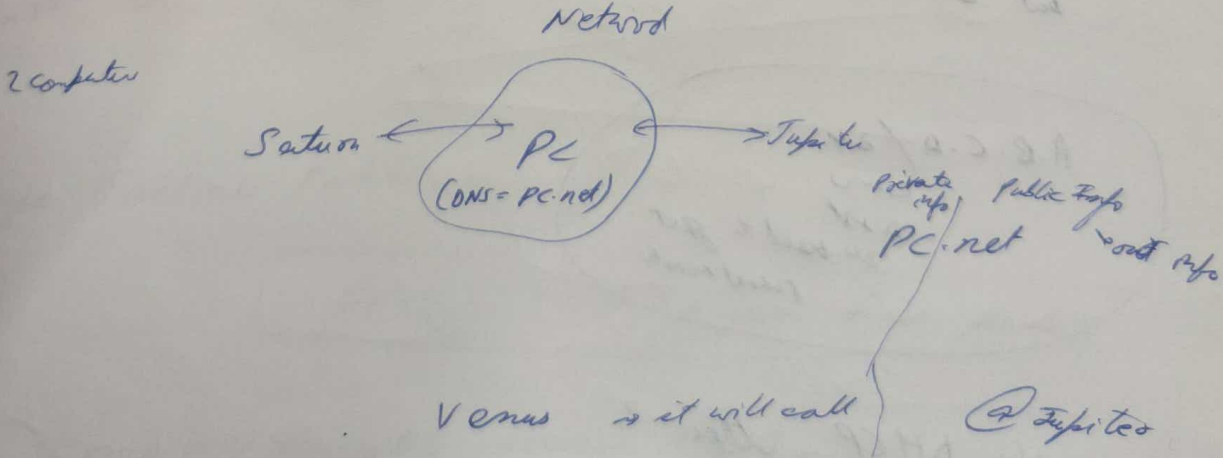if add·ress purchased → adjoint to Domain name
of Dynamic IP → No Business → no monetization

Definition
Just a file / folder & can't be host machine

In reality it is diff.
↳ Wikipedia . org
SLD   TLD
it does not have subdomain (it is have root /

Network

2 computer

Saturn ←   → PC ←   → Jupiter
         (DNS = PC. net)
                                        Private   Public Info
                                          info   ↳ out info
                                        PC. net

Venus → it will call   @ Jupiter

if Jupiter & Saturn for out side. the I
must use Saturn. PC.net   F Q D N

Now System is becoming Sub Domain

sub domain
domain → it is a file & folder

reality (" " " which can point out to
a machine in our local area)

for example network for a sensitive data
to a seperate machine

Host having a domain
Domain " " Host
as long as it is assigned to a machine
not to a file

```
→ it must have IP → registered out → PC.net    internal machine is
         IP           DNS                         Saturn
```

host having IP + DNS is registered the it is sub domain

sub Domain having a machine assigned not a file the it is Host

(198.168.0.1) same IP on internal or each world router

but 2 Net can't have same IP.

A.B.C.D/24
first
24 used to get
subnet mask

No DHCP then ?

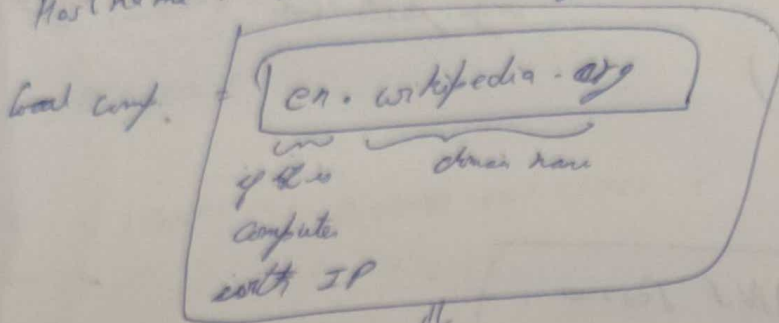3 comp. not having DHCP server.

The you APIPA is being used.

Specific Range

ACN

folder

www.   abc. com   ciaca. github. com

subdomain   Domain Name.   folder   online Computer

→ logical folder
→ organise system.

It is a
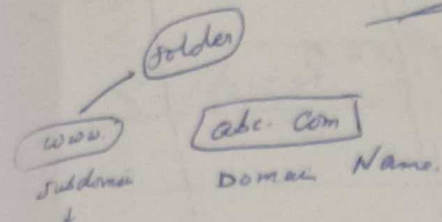
Hostname : Domain Identifier of host with a IP

local conf.
en. wikipedia . org

if it is   domain name
compute
with IP

Hostname
(This is this if Requirement).

host → domain → DNS (organised here)

DOMAIN → HOST → IP

CS   cs. ucla . edu   fc15. cs. ucla . edu

Hostname.   Hostnam

How does Internet work.?
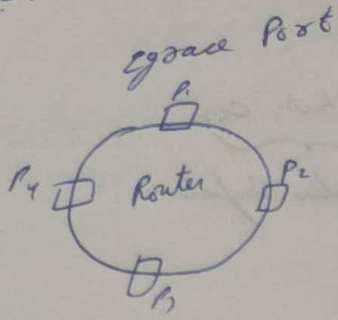
Yellow Socket → LAN ⎤ Router
Blue   "   → WAN ⎦

IP
Lan change with diff. Compute

LAN Route → 4 port → 1 IP
It should be

mostly all port is unique IP

so soft running — 1 IP → & all port connected
of diff IP

Fabric

Egrace Port

P₄ Router P₂
        P₃

P₁ connecting to P₂

P₁   P₁ to P₄

P₂   P₁ to P₃

P₃

P₄
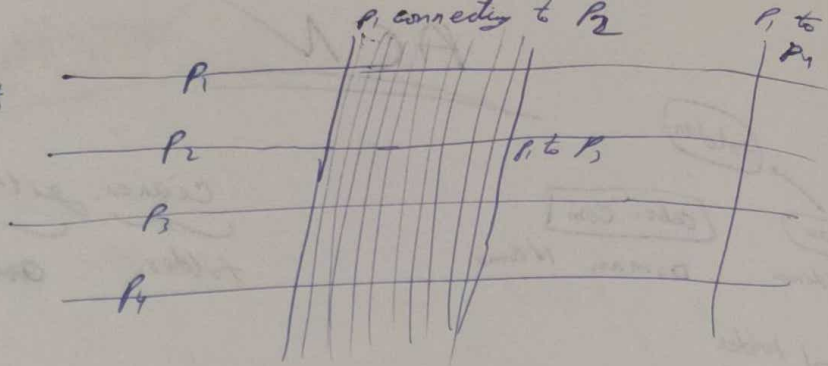
Mess inside Router
every port can talk to every port.

3 nanometer chips
(are seperated t other)
     by 3 nnm

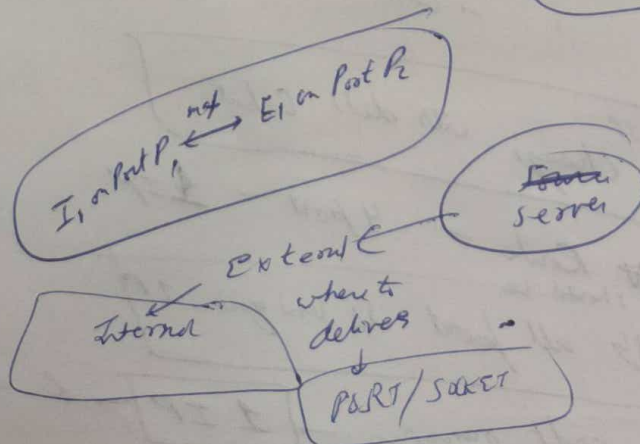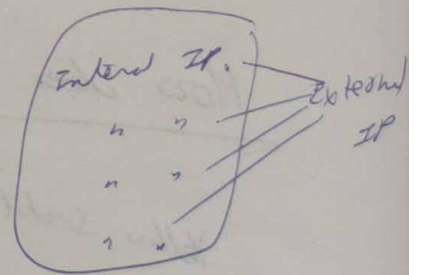Destination IP — DNS Server

Dest MAC : FF : FF ——— :FF   Brodcast.
                    6

NAT

                    internal mapping external
                      IP   IP

Q X.Y.Z.1
   X.Y.Z.2
      |
   X.Y.Z.n

Conf
on
LAN
node

WAN IP

Internal IP.
   "   "   External IP
   "   "
   "   "

I₁ on Port P₁ nat E₁ on Port P₂

                    server

            External
Internal   where to
            delivers
                ↓
            PORT / SOCKET
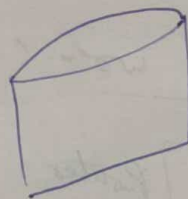
any Endpoint is spoofed

Software Defined Networks.

Traditional network consists of

> Data plane
? Control plane (logic)

> Management "

> SDN - DUMB SWITCHES + SMART CONTROLLER

—

OPENFlow upgrade not possible as [Southbound API]

not supported

This is must.

(SDN context is assumed to be on same network)

(switch = LAN)
↓
don't have power to decide
where to ~~switch~~ send it.

Controller
↑↓

$H_1 \longrightarrow$ Switch $\longrightarrow H_2$

So, it will send partial packet to Controller.
(Header)

& Controller decide where & set it.

? First time switch ask to control
> for ~~remaining~~ packet for same ~~up~~ same switch will
logic (H_1 to H_2)
make decision

> H_2 to H_1 again both steps as this is new logic.

Controller

send forwarding rule

M_1 → → switch 1 → → switch 2 → →
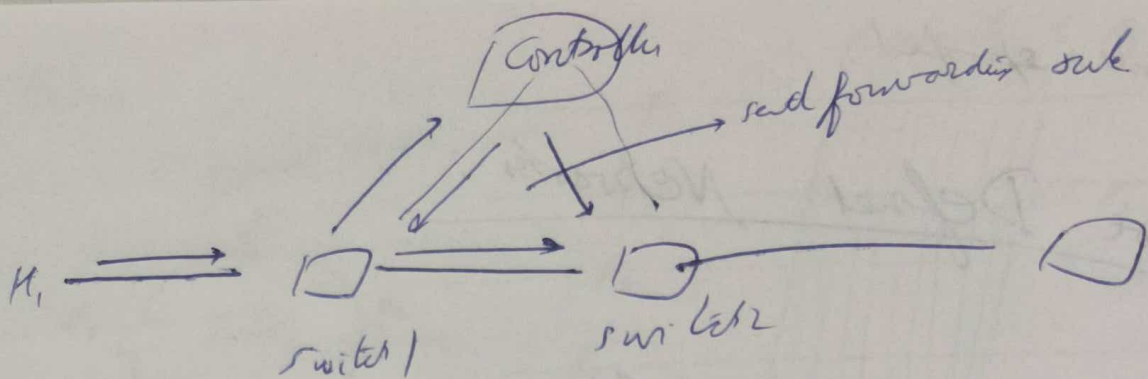
switch 1

switch 2

$M1$ → switch 1 → Controller → switch 2 → Controller → the

Next the Controller will not be called for switch 2

Software Defined Network:

OPEN - FLOW Protocol:

→ Layer 2 - Protocol.
(all device communicate with out IP)

all are in local Network.

→ Allows ⌐ direct Access
            ⌐ manipulation
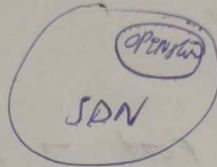
OPEN Flow ≠ SDN

Protocol Mess
↓

① Controlled to Switch   ② Asynchronous   ③ Symmetric

    Handshake.   Packet In   Hello
    Modify state   Flow Removed   Echo Req.
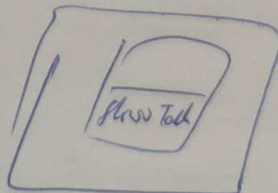   Role Req.   Port Status   Reply
        | Error

Component of OpenFlow.

M_1 M_2 M_1

Controller
→ Defines forwarding policies

→ Centralized vs distributed

nw-dst   single Controller → Multiple switch

1   "   →   /   "

1

Performance Control
├ Throughput   : How many rate
└ Latency   : deg. based processing.

Handling Control failure
- backup controller
- hybrid switches

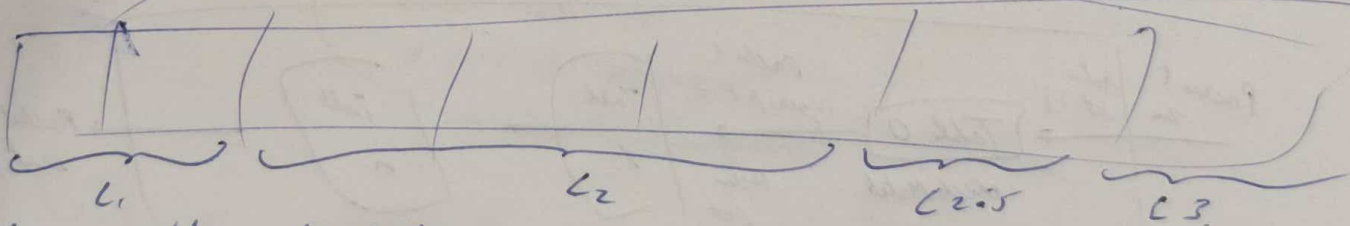Secure Channel

Flow Table

• a flow Table Entry.

| Packet Counter + Byte Counter | 1 forward packet to port
2 Encapsulate
3 Drop packet
4 send to normal |

| matching Rules | Statistics | Instruction |

L₁   L₂   C₂·₅   C₃.

* → wild card Entry
(only youtube IP is more impt.

          Rules.

dl-Type → LLDP   we can have
                        multiple
dl-vlan   flow
                        Table.
nw-src
nw-dst
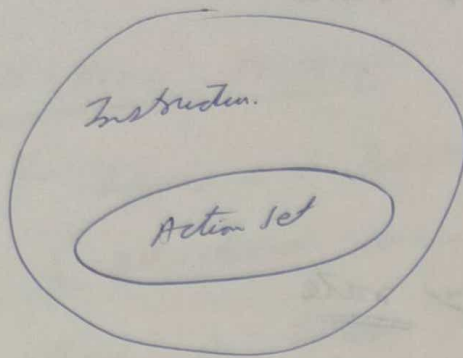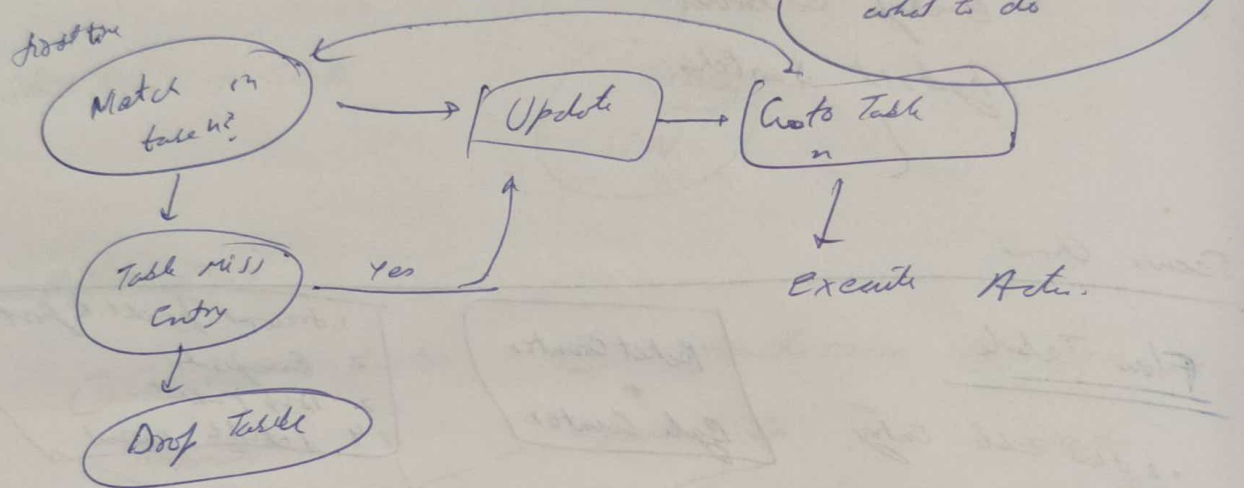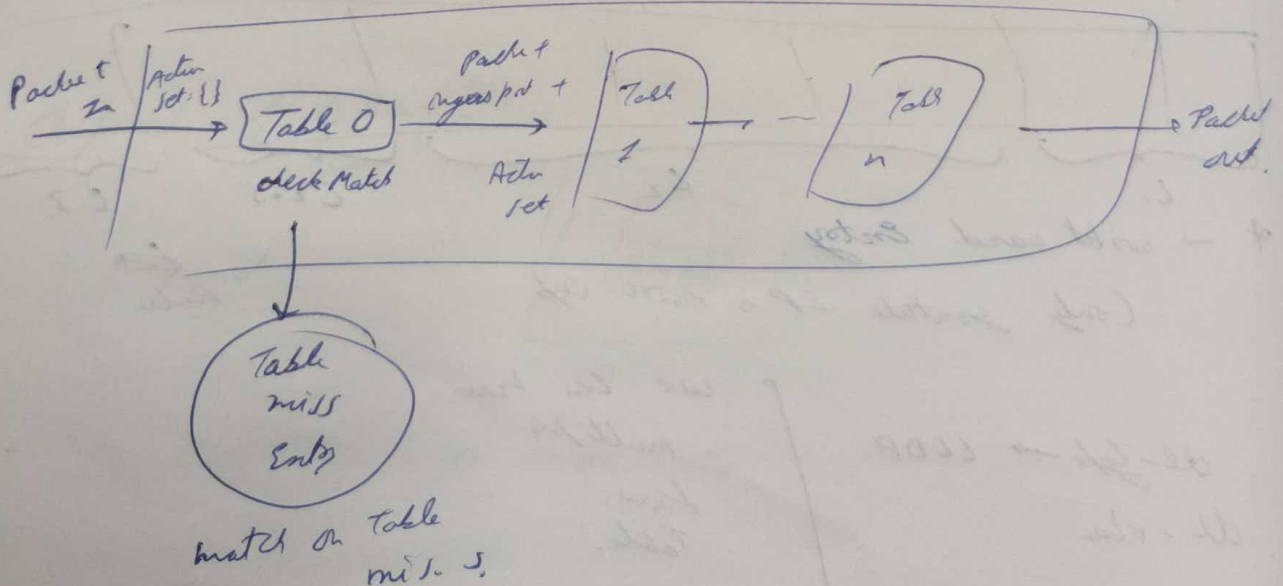
> Instructions : move it to another pipeline. (Process
                                                it move
                                              or action set
                                              is performed)
→ Action Set :

Instruction.
  (Action Set)

Instruct
 - Apply Actor
 - " Clear "
 - Write Action
 - " Metadata
 - Goto - Table

> If you do not find a match (Controller tell
                                what to do)

first tom

Match in
table n? ──→ Update ──→ Goto Table
                              n

Table Miss ─── Yes   Execute Action
Entry

Droof Table

→ ① Matching ───────

Pipeline processing.

Packet | Action   Packet
In | set: {}   →   ongoes port +   Table   Table
              Table 0   1   n   → Packet
              check Match   Action   out.
                    | Set
                    ↓
                Table
                miss
                Entry

              match on Table
                    miss.

Table Miss Entry Must be Configured?

— multiple match → do priority check

Lowest Priority

65575

rows	IP	MAL	VLAN	#c
	X	Y	3	TCP

② Port = 4

rows 2				TCP
	X	Y	J	TCP

② higher
precedence

2 Port

switch will decide on Precidence
+
TCAM ← How Router Works
match in million Entry

Binary Trie

```
1    0    1    1
|    |    |    |
[X]  [1]  [X]  [X]
[X]  [0]  [X]  [X]
```

Linear Search
↓
Hash → ⊗ Same Info
↓
Resolve hash
Job   & Provide IP
of switch

X — don't Care

match on this
route the use
1 or 2 accordingly

other routes not seq.

① Per Table packet processor → Data Structure?

Table miss → ① lowest priority Entry if nothing else happen.

Table Miss Entry Must be Configured?

→ multiple match → do priority check

Lowest Priority

(65535)

srul IP	MAC	VLAN	4c
X	Y	3	TCP

② Port = 4

srul2			
X	Y	3	TCP

② higher precedence

2 Port

switch will decide on Precedence

TCAM ← How Router Works — match on million Entry

Binary Trie

Linear Search
↓
Hash → ∅ → (Same Info)
↓
X resolve hash & Prooride IP

Job of switch करता है

1   0   1   1

| X | | 1 | | X | | X |
| X | | 0 | | X | | X |

x → don't care

→ match on this route the use 1 or 2 accordingly

other routes not sel.

→ ② Per Table Packet process → (Data structure?)

Table Miss → ① Lowest priority Entry if nothing else happen.

Flow removal ' Idle—Timeout → Idle for some time → Expir
  hard-time out → Currently Used the
→ Controller can
  also remove it   also remove it after
  critical situation.   Expir

              ↓
         Precedence   should not
                            be same
      or, hard-time out
          idle — "".   or idle should be lesser

    > faster removal is best. ←

Diff switches (software)	CONTROLLER	
Open vSwitch.	POX (cool)	Lang
Pantou / Open WRT	NOX	
	Floodlight (-)	

· Issues in SDN

Performance issues

        → CPU Power   ⎤ selling point
        → Flow Table size ⎦
        → Packet buffer size
          (discard payload over time)

        → Bandwidth b/w switch & Controller
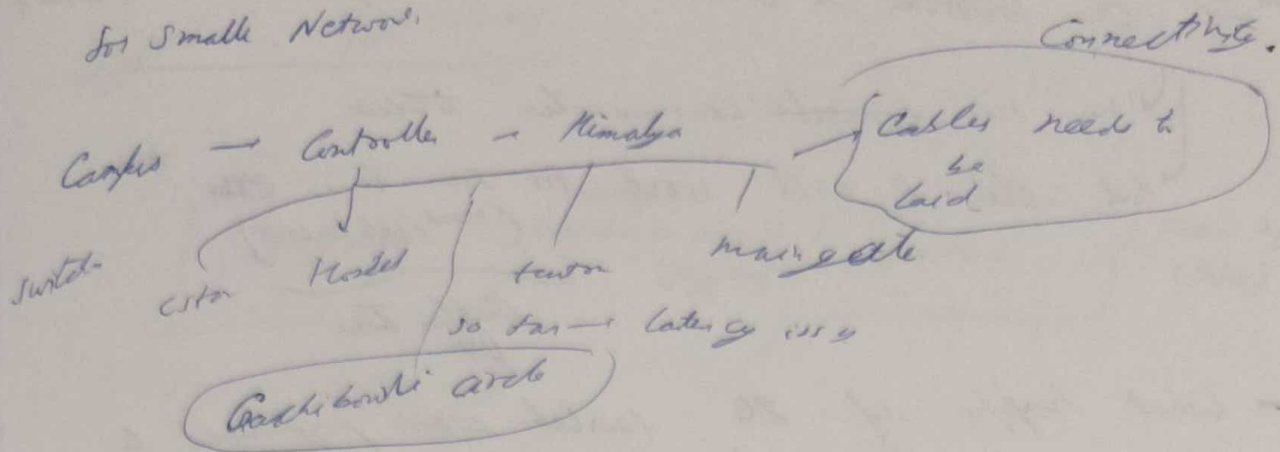   (DDOS attack)

> Looke procedu
    ① Hash table
    ② Linear Table.
> Ordering switch.

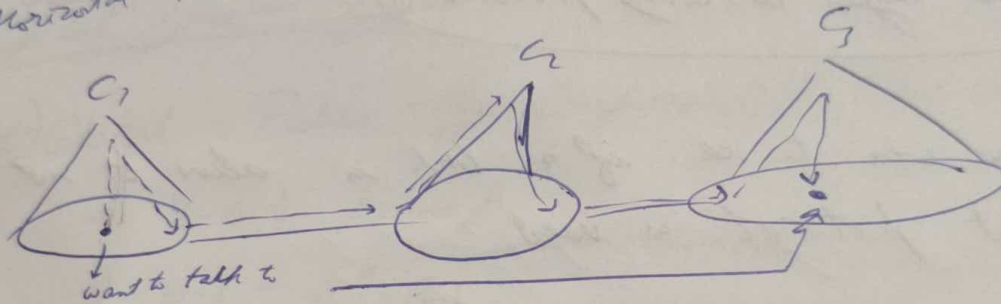# Management Issues (How to define scope of a controller)

For Small Network.

$$Connectivity.$$

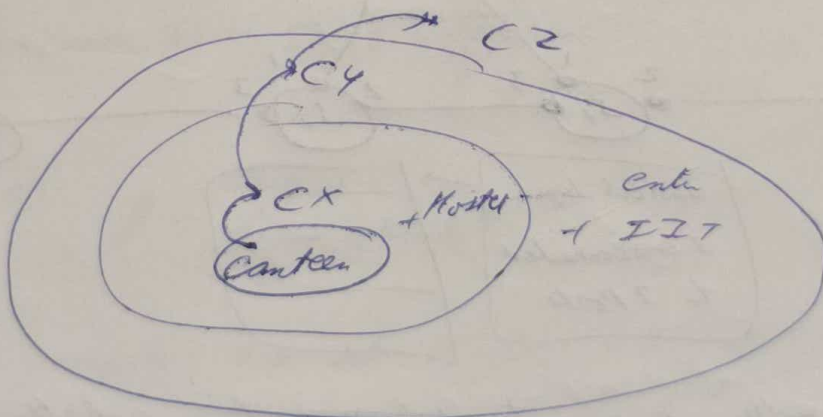Campus → Controller → Himalya   {Cables need to be laid}

Switch

Cisco   Model   team   manageable

so far → Latency issue

(Grachibowli circle)

Controller

C_1 → IIT.

C_2 → Grachibowli.

C_3 → stadium.

Horizontal Partitioning

C_1 C_2 C_3

want to talk to

Vertical Partition (Global View Required)

C2

C4

CX   + Hostel   Centre

Canteen   ← IIT

{ C_1 can control 1 area only

can optimize ~~local~~ path only.

Can't Optimize Globally }

Security Issues

- If the Controller is down what will happen to network

  ↳ no new ~~connect~~ Communication occur

  but old will work for some time ~~this~~ ~~then~~
  (hard/idle timeout)

  ___
  Buffer Time.

- What happen if the switch was programed to linked to a link & that is broke

  ↳ Controller will keep on ~~for~~ pinging switch
  which other are alive.

  (Linked Layer discovery protocol) to find available links

- if you were to see if a link is alive or not what protocol is used?
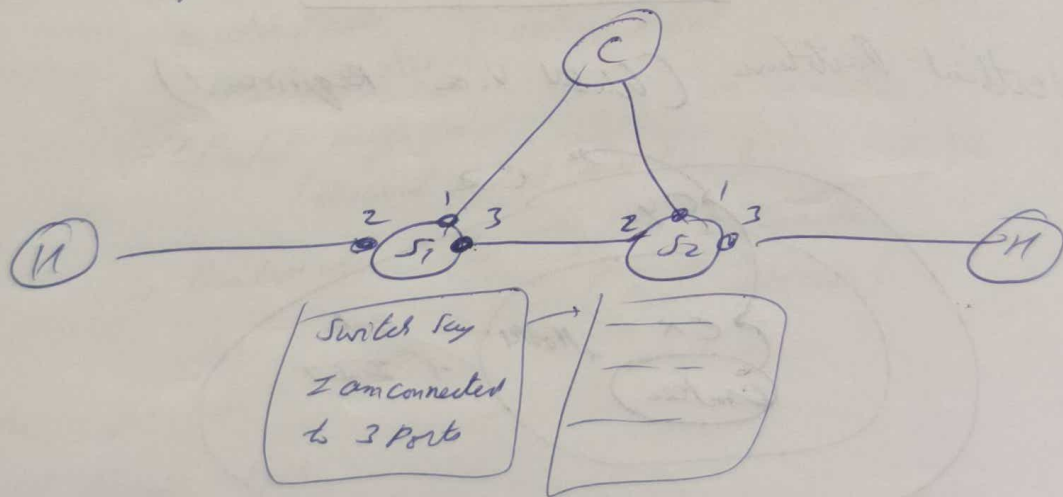
How Controller know to ~~which port~~ whether S_1 & S_2 are connected.

- ~~to~~ Controller will create to a packet
  & it can send it to @ switch

  & ~~& to~~ say them to 'Expend them to all live
  ~~send~~ Port & those switch will through
  it back to controller

Link Layer :

host
HTTP

what is a link ? → link = Medium + Adapters

Communication Medium.

Network adapter.   depending on a the redium.

Broadcast link : shared bus media

Adaptors Communicating

On
Addresses

MAC
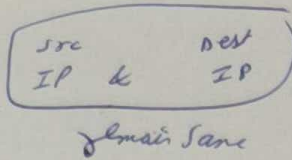: is point to point connection.   No address reg.
: many people on network

MAC Address
00 - 15 - C5 - 41 - 04 - A9
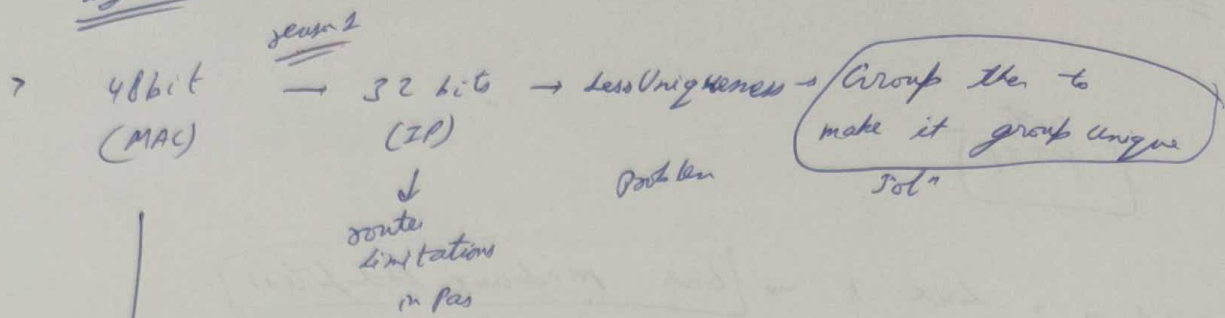vendor   Adapters assigned by vendor
Blocks.

Global
uniqueness

IPV4 → 32

Router : $\boxed{\text{src IP \& Dest IP}}$ IP $\boxed{\text{MAC Address}}$ of Dest

remain same   → will be changing.
                          from HOP TO HOP.

why IP

reason 1

→   48 bit   reason 2   32 bits → Less Uniqueness → $\boxed{\text{Group them to make it group unique}}$
    (MAC)   (IP)   Sol^n

                   ↓   Problem

                 route
                 limitations
                 in Pas

reason 2

↓

if groupism is reg-;ch $\boxed{IP}$ first & can be made common.
to make it a group but for **MAC** we need to
store whon 48 bits for each used as

$\underline{X-Y-Z} - \underline{A-B-C}$ No groupism IP.
   vendor   Adapter

as   MAC   Address   is   Predefined.

       when MAC is said   IP can be fetched.

lessons

1 > To bootstrap a IP network. we need to associate
each IP with identifier for each machine So, MAC is req.

2 > ~~No~~ All grow networks not use IP so, only IP network
         is not sufficient.

why can't we have Processor more th 1GHz

Hardware   1GHz → 10^9 operation.

Software → I have give you more operation.

closer chipset → 7 nm → 1.5 GHz → more open

more operation can be dine

Cat & Mouse

harder → 3 GHz → so Many operati.

software → Still more operati.

Okay let's stop it to such it an interesting

we will not increase power

1 core → 2 core

multi process Or

↓ Final Step

Parallel Core   So, all task perform Parallelly.

Multi Tasking   challeng accepted

Promiscuous Mode

> Normal adopter receives frames sent to

  > local MAC
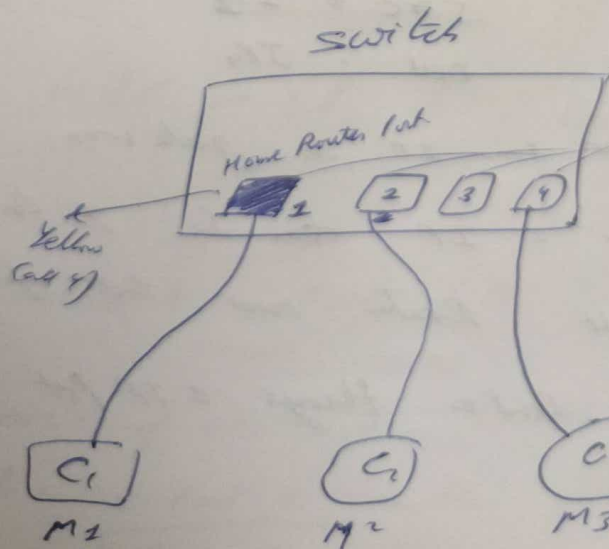 > Broadcast address.

                              who am I ?

Acquiring an IP addres → [DHCP server]   MAC
                                             to
                                             IP

           who Are You → (ARP)

                IP to MAC

Q

                    switch

                              4 ports Q) MAC Address
Home Router 1st   of each Port. Is
                                       it same ? NO

Yellow
Cat 5)   None of Port have
                                       MAC Address

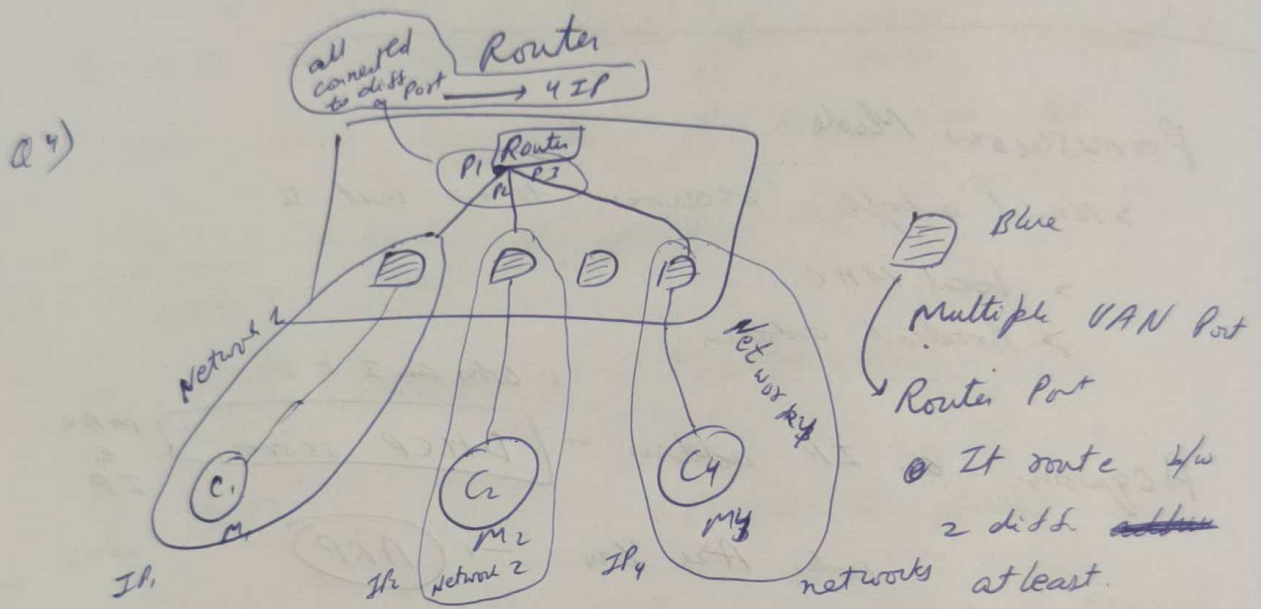   actually MAC don't have

C1   C2   C4   at

M1   M2   M3

Q2) why switch don't have MAC address for Port?

class → 48 bit Namespace → Limited.

So, No MAC to any switch or Router

Q3) $^{1mth}_{IP?}$ Port 1 → Have MAC Address of <u>the Computer</u>
    it is <u>connected to</u> i.e. M1.
                                    → if connected.

Q' To Read from C_1 to C_4 switch Ports are
   i.e. m_1 to M_4 internally Connected in the
                                        switch.

Q4)

all red
connected
to diff port   Router
               → 4 IP

P1 [Router] P2

Network 1   Network 4

C_1 C_2 $C4$

M_1 M_2 $M4$

IP_1 IP_2 Network 2 IP_4

Blue

(Multiple VAN Port
└→ Router Port
  ⊙ It route b/w
      2 diff ~~add~~
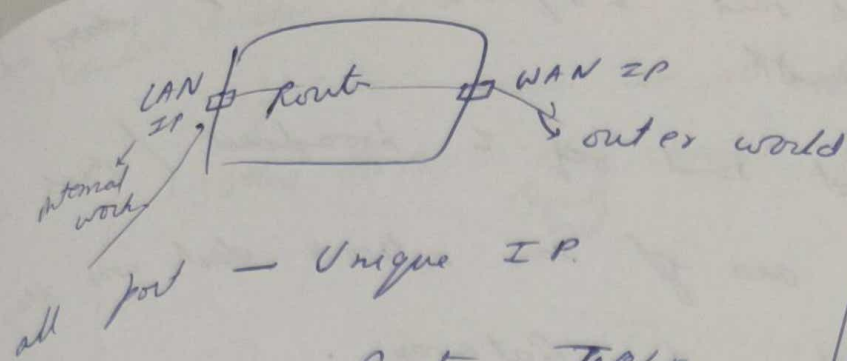   networks at least.

Q5 ~~for~~ How to send Info from C_1 to C_4

$$Sorc = IP_1 -$$
$$Dest = IP_4$$

phone address Have same IP as gate way,

Router Must Have a IP. ~~for~~ So, To Connect from

Sor to Dest Router must Intercept.

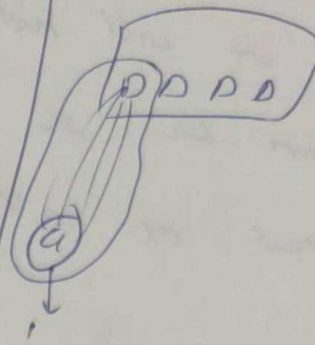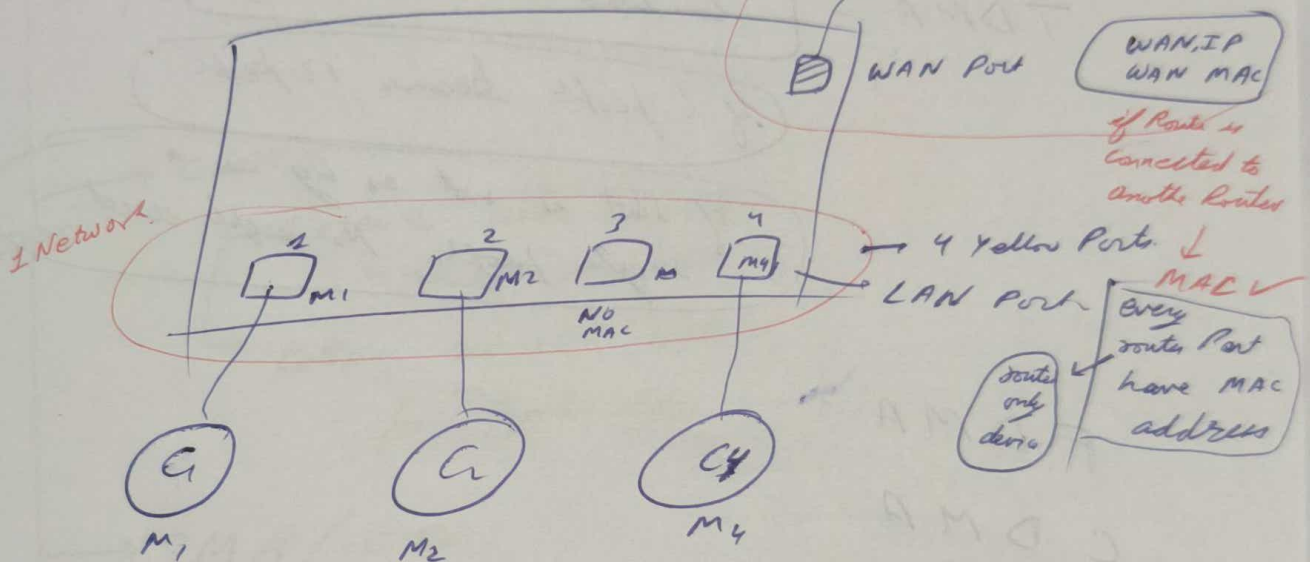req will go to Router. through 1 IP Port

LAN [Router] WAN IP
IP, ↳ outer world
internal
work

In Router only
scenario

all port — Unique IP.

Route → Routing TABLE

IP	→	Port
1.4.2/24	→	1

Home Router.

Blue Port (Router 2)
→ Network 2

WAN Port   WAN,IP
           WAN MAC

if Router is
connected to
another Router

1 Network.

1	2	3	4
M1	M2	NO MAC	M4

→ 4 Yellow Ports. ↓
→ LAN Port   MAC ✓

Every
router Port
have MAC
address

router
only
device

C₁   C₁   C4
M₁   M₂   M4

So, 2 Network —

1 LAN side IP
1 WAN side IP

Why MAC is req. for WAN Port
                    Network Layer Port
                    (Layer 3)

Connect to Router (Layer 3) then why MAC req?

→ even if we are talking about Packet transfer

from 1 Port to another we are transferring data

(HOP to HOP) so MAC req.

> if we need to send a seq. to another IP address obu.
not in same network.
So, we will not send seq to broadcast (which would
have been the case if same network dest. was there)
instead seq. will go to **Gateway**.

> Collision

> Medium SHARING

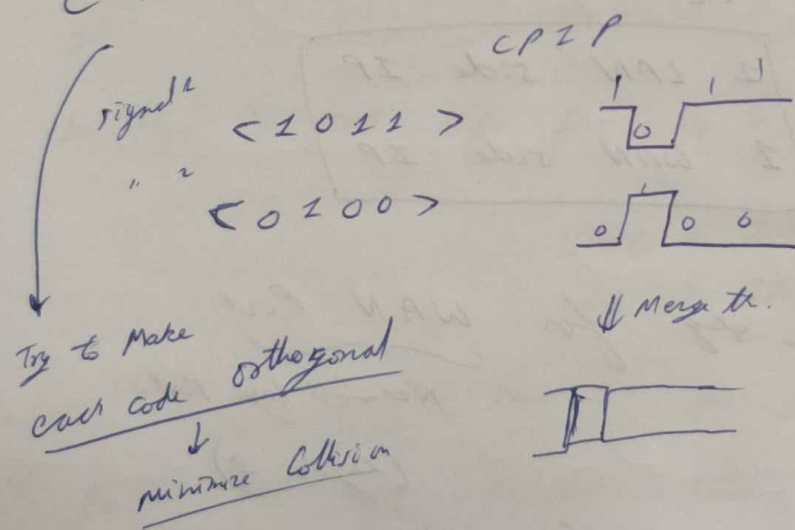Static Channel Partitioning.   Problem ?

TDMA → (low load → Unused Info)
       (if 6 people becomes 12 people)
       (if slot is not as big as a
         single people   No people used)

FDMA :

CDMA

(signal 1   < 1 0 1 1 >
  " 2   < 0 1 0 0 >)

CPIP

if data to
transfer
1 1 1 1

Try to Make
cach code orthogonal
      ↓
minimize Collision

if Merge th.

minimize collision
as orthogonal signal.

IMEI → MAC → Phone
IMSI → SIM → IP (change)

Random Access Protocol:
- if collision occur we will resolve it
- slotted Aloha → slot creates first
    (equal size)

start at beginning of slot
- Pure (unslotted) ~~[scribbled]~~ ALOHA !

→ CSMA
    - Listen to other senders
        ↳ Transmit your data
    - Collision can still occur
        ↳ Propagation delay

↳ CSMA / CD
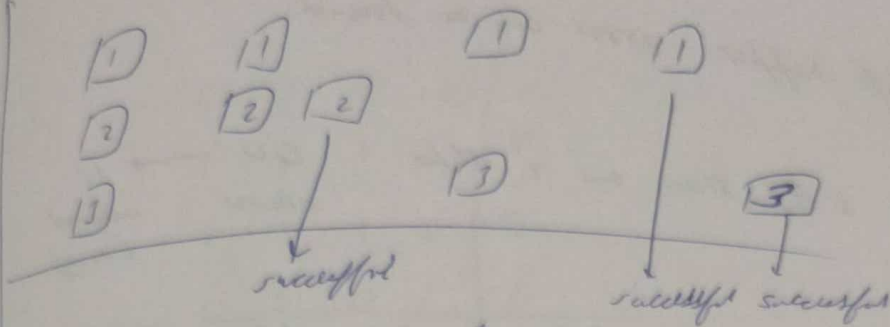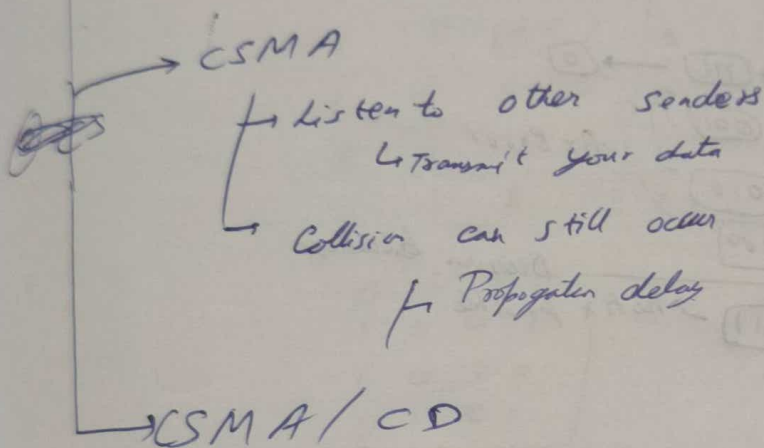
Dynamic Channel partitioning ("take turns")

Error Detection & Correction in Link Layer

How To detect
- "Can I say if received msg is correct or not?"
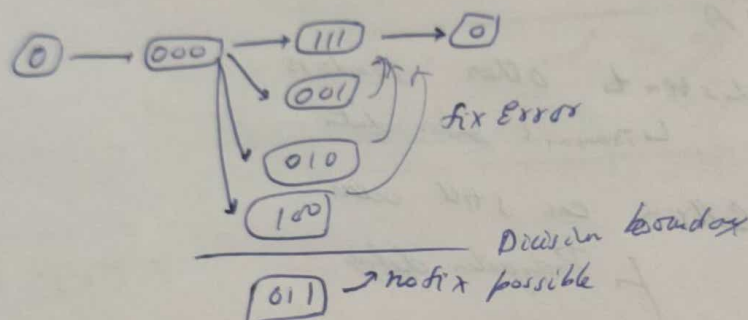
? Codewords are required

simple sender

msg   repeat msg   received

$0 \rightarrow$ 00 $\longrightarrow$ 0

              01 x $\longrightarrow$ ② ? $\rightarrow$ error Detected

              10 x $\longrightarrow$ 10

$1 \rightarrow$ 11 $\longrightarrow$ 1
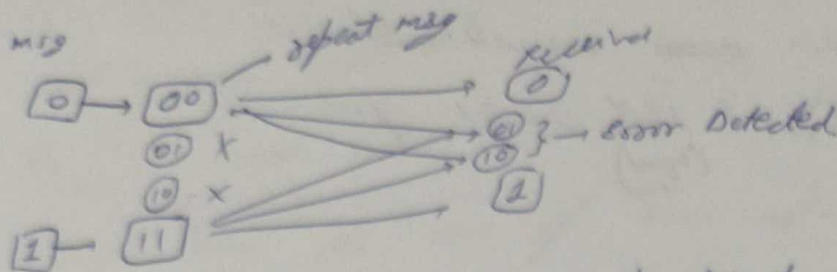
if bit flip happen error can be found.

if insted of 1 flip there are 2 flips   00 $\longrightarrow$ 11
                                          allowed   allowed
                                                     (error)

<u>Hamming distance</u> : flips to convert 1 to another.

$d_{min} = n \longrightarrow (n-1)$ bit flips allowed.

$0 \longrightarrow$ 000 $\longrightarrow$ 111 $\longrightarrow$ 0

                    001

                    010   fix Error

                    100
_____ Decision boundary
         011 $\rightarrow$ nofix possible

$d_{min} = 3$
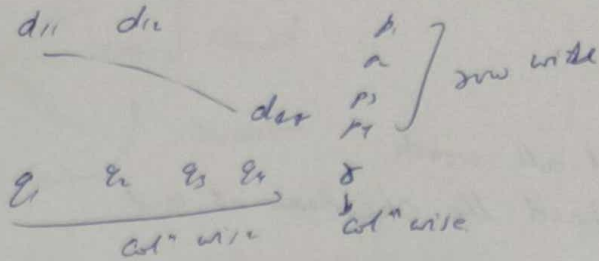error can be found $= d_{min} - 1 = 3 - 1 = 2$
& error can be corrected $= \lfloor \frac{d_{min}}{2} \rfloor = 1$

<u>Parity Bits</u>
         odd
even   Parity

even parity : Only Odd error can be found.
        /All   bit

No mechanism to correct it

→ 2-D parity

d_{11} d_{12} ... $\begin{array}{c} p_1 \\ p_2 \\ p_3 \\ p_4 \end{array}$ ⎤ row wise

... d_{44}

$\underline{e_1 \quad e_2 \quad e_3 \quad e_4 \qquad \delta}$
col^n wise   col^n wise

Actual
Msg

$$\begin{array}{cccc|c}
0 & 0 & 0 & 0 & 0 \\
1 & 1 & 1 & 1 & 0 \\
1 & 0 & 1 & 0 & 0 \\
0 & 1 & 0 & 1 & 0 \\
\hline
0 & 0 & 0 & 0 & 0
\end{array}$$

1 flip → 3 bit change

$$\begin{array}{cccc|c}
0 & 0 & 0 & 0 & \\
1 & 1 & ⓪ & 1 & 1 \\
1 & 0 & 1 & 0 & \\
0 & 1 & 0 & 1 & \\
\hline
& & 1 & & 1
\end{array}$$

$\boxed{d_{min} = 4}$

error can be detected = ③

$$\begin{array}{cccc|c}
0 & 0 & 0 & 0 & \\
1 & 0 & 0 & 1 & \\
1 & 0 & 1 & 0 & \\
0 & 1 & 0 & 1 & \\
\hline
1 & 1 & & &
\end{array}$$

same row/col^n
→ 2 flips ⇒ ≥ 2 parity bit change.

$$\begin{array}{cccc|c}
1 & 0 & 0 & 0 & \boxed{1} \\
1 & 1 & 1 & 1 & 0 \\
1 & 0 & 0 & 0 & \boxed{1} \\
0 & 1 & 0 & 1 & 0 \\
\hline
\boxed{1} & 0 & \boxed{1} & 0 & 0
\end{array}$$

flip 3 bit change
> 3 bit change.

Correct upto $\boxed{1 \text{ bit error}}$

detect upto 4 bit change.

CheckSUM :

sender
- all all words
- Append the checksum at end.

```
   $001    1101   0010   1101
 +  1100   0011   1101   0101
 _____
 ① 0110  0001  0000  0010    sum
```

                                    + 1

```
   0110    0001    0000    0011  → Final sum.
```
                                 flip
                                        1100

+ 0111 + 1111 + 1111 + 1100

                           1111

```
 | 1001 | 1110 | 1111 | 1100 |   Internet check sum
                                 (inverter of Final sun)
```

+ 1001   1110   1111   1100
_____
   1111   1111   1111   1111

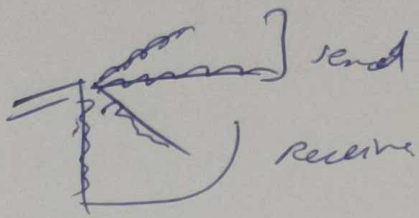(All circuit get Avoided)

Ethernet Uses CSMA/CD

Latency : Amount of time my @message take from -inception to Completion

→ (message)

↓

delay : Amount of time it takes to transfer 1 bit from A to B
(Propagation delay)

→ (bit)

↓

jitter : If I send 2 msg of the same variation in latency is jitter.

→ All thing Connectionless.

] Send

) Receive

CSMA/CD → not needed → full duplex

Why are ~~we~~ ~~do~~ still worry about CSMA/CD

NL → Devices → Routes.
Physical → Bridges, switch
Datalink ter → Repeaters.

Because other devices might not be full duplex.

D → (Hub)
may
not be full
duplex