Date - 08/01/2025

• Wireless & Mobile Networks

→ Terminologies : → Wireless Hosts, nodes
→ wireless link → Base station
→ Infrastructure mode → No infrastructure — Ad-Hoc Network
→ Hand-off → single hop, infrastructure Based.
→ Multi-hop, infrastructure based.
→ single hop, infrastructure less → Multihop, infra.. less.

• Last hop is generally wireless. ge
(End-host : Mostly client)

• Link : → signal detoriation
• Transmission speed • coverage Area.
(30-70 m generally)

SNR
Signal to Noise Ratio.

BER ↓, SNR ↑
(Bit Error Rate)

Transmission power ↑, SNR ↑, BER ↓

After a certain threshold, transmission power increases but SNR gain will increase in slow manner.

Another problem is battery, TP ↑ battery consumption ↑.

Base station

wifi → AP (Axis Access point)
3G/4G → Base station (connects wires b/w service stations & provide wireless link to cellphones)

Access point connects wired & wireless connection on different sides..

Infrastructure mode : wireless node using a base station is infrastructure - mode.

No - infrastructure : No connection with extra device to forward packet.

single hop → No. of hops b/w wireless station and base station.
ex- wifi, 3a/4a/5a.
↳ (They are now IP based)
cellular Network

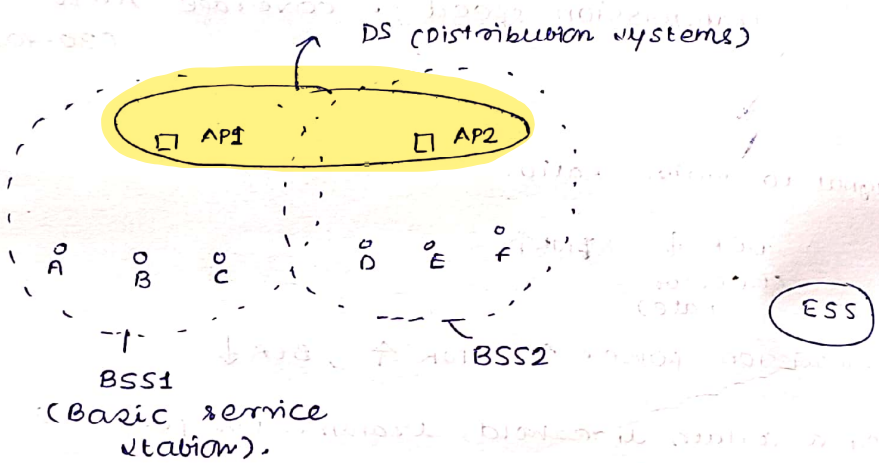
In beginning of Internet, telephone infra was used to transmit packets.

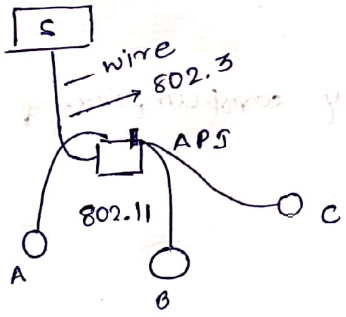
Multi-Hop: Mesh network, some sensor Network

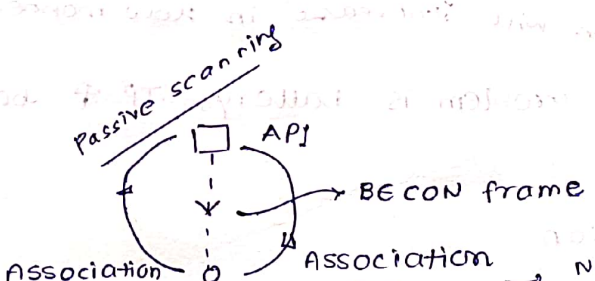
single Hop, infra less: Bluetooth

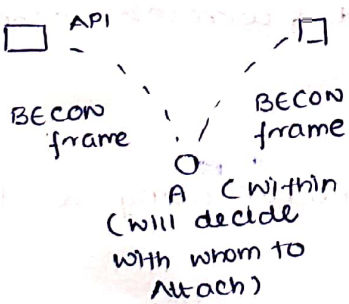
Multi-Hop, infra less: MANET, VANET.

WI-FI (802.11)



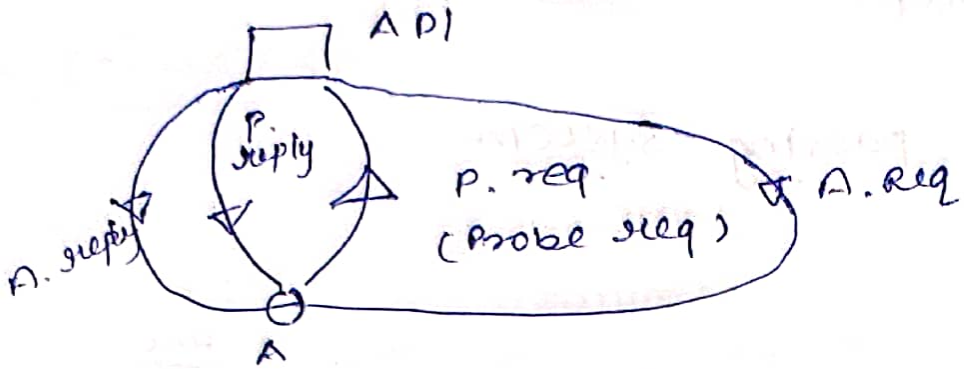






MAC (Medium Access control)
[shared Medium]
Wifi → CSMA/CA

Active scanning



Handoff : change of base station

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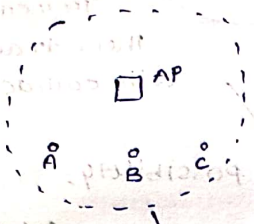
Wireless and Mobile Networks

802.11 (CSMA/CA)



(shared medium)

MAC - CSMA/CA

wifi → No collision Detection. (signal fading)

AP - Access Point

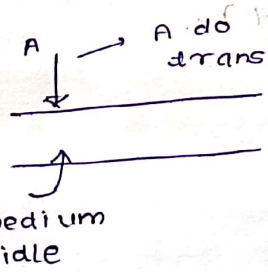
A, B, C - wireless stations/ nodes in range of AP.

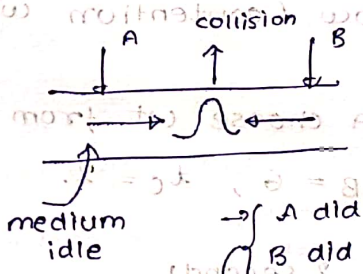
(Hidden Node Problem)

(Detection is not possible mostly due to property of medium) (cost of trans+ receipt)

- In CSMA/CA, probability of collision is lower than CSMA/CD.
- In CSMA/CA, a station continuously checks if the channel is busy. In case it finds a free channel, instead of transmission, every station goes to exp. backoff with an initial window of (0, 7) to avoid the possibility of collision. (same rule for AP and stations).

(1)

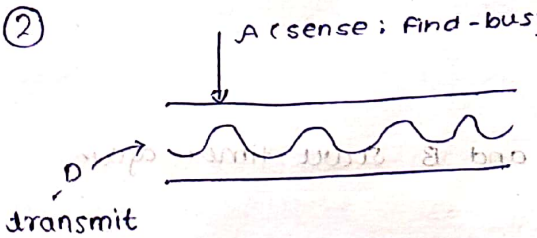


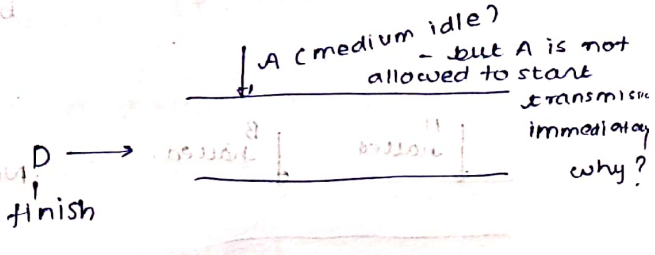


(2) * Signal fading: No node is able to get collided signal.
* (Hidden node problem)

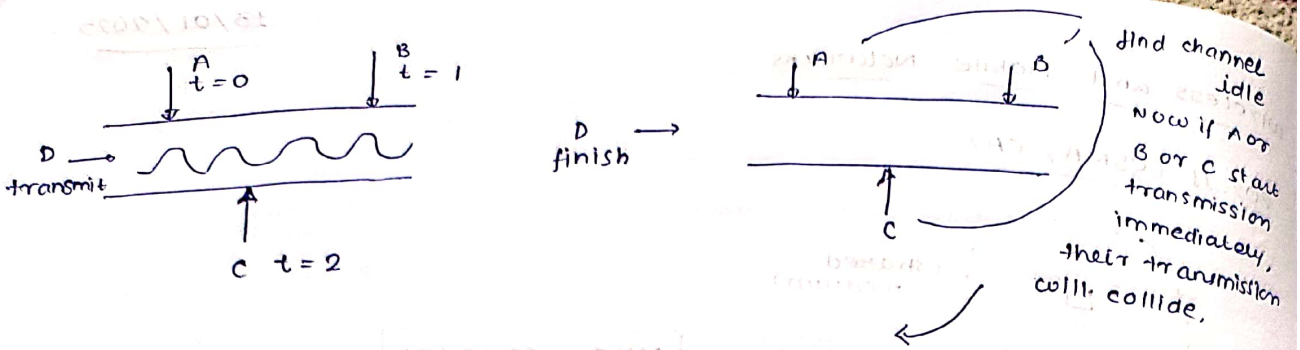
- wifi - Data frame + Acknowledgement Frame
(If in between collision happens, it will not reach).

(2)





PTU



CSMA/CA tries to avoid this possibility,

- Less efficient - Because in case of a single node also it will not transmit.

Cellular Network - Freq. Division multiplexing
(NO collision: channel divided into multiple parts, each using one for simultaneous transmission).

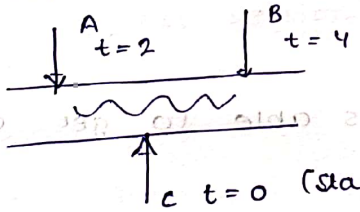
Time Division multiplexing
(NO collision: Allot time interval to multiple parts).

- Now A, B, C go to exponential backoff. with initial window (contention window → 0 to 7).

Let, A choose wt from 0 to 7. ($t_A = 2$).

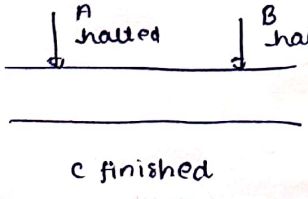
$t_B = 6$, $t_C = 2$.

After 2 seconds,



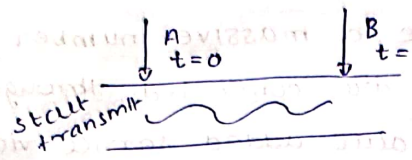
C starts transmission. (A will halt at wt = 2).
(B will halt at wt = 4).

As medium became busy.



Now A and B start timer again.

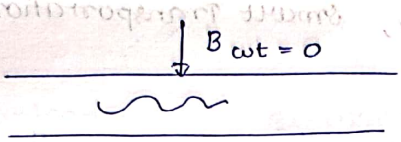
After 2 more seconds, (Resume clock)



→ will halt at wt = 2.

A finished, B_wt = 2.

After 2 more seconds,



(start transmit)

Q. In 802.11, suppose A, B & C make their first carrier sense as part of an attempt to transmit, while a fourth station D is transmitting,

Draw a timeline showing one possible sequence of transmissions & exponential backoff choices. your timeline should meet the criteria that initial transmission attempts should be in order A, B & C but successful transmission should be in order C, B & A.

→ D is transmitting. (t = 0)

A, B, C sense channel is busy hence they wait.

D finished transmission. (t = 8) (A arrived at t=2, B at t=4, C at t = 6),

A, B, C sense medium is free. (t = 8)

They go to exponential backoff. {0, 7}.

Let, A choose → 6,
B choose → 4
C choose → 2.

After 2 seconds, C transmit and A, B halt.

C finished, (A → 4, B → 2) (t = 10 → 14)

After 2 more seconds, B transmit and A halt.

B finished (A → 2). (t = 16 - 20)

After 2 more seconds, A transmit.

A finished. (t = 22 - 26).

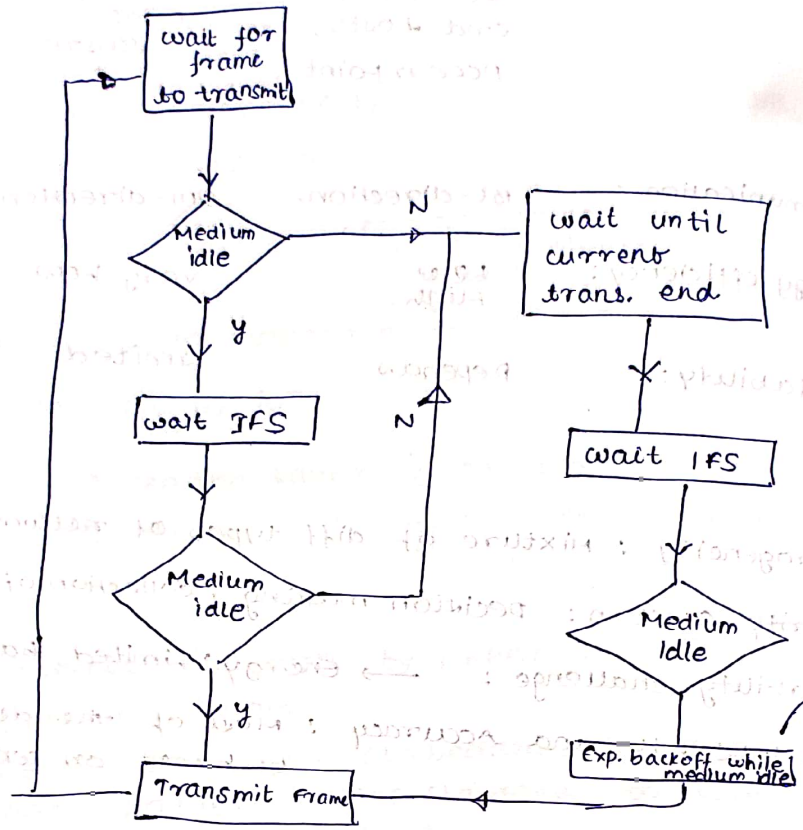
∴ Transmission → C, B, A.

15/1/2025

Wireless and Mobile Networks

DCF – Distributed co-ordination function – uses CSMA/CA

Flow chart :

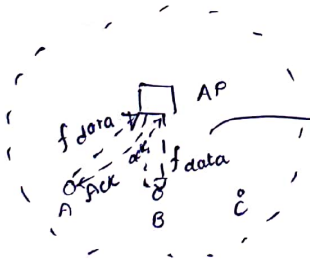


SIFS – Short IFS — 28 μs - FHSS, 10 μs - DSSS

PIFS – Point Coordination Function IFS – SIFS + 1 slot time

DIFS – Distributed Coordination function IFS – SIFS + 2 slot time

IFS – Inter Frame Space.



→ Infrastructure based wireless network.

- Data frame
- Acknowledgement frame (More priority)

- Hidden Node Problem

A & B in range
C & B in range
A & C not in range of each other

In 802.11, assumption is if A is in range of B, then B is also in range of A.

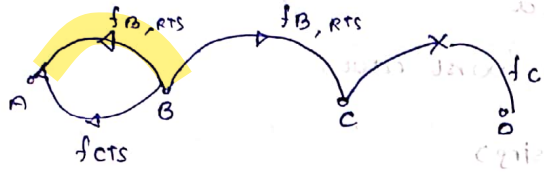
A & C transfer frame f_A & f_C at same time to B → f_A & f_C collide at B.

A & C → Hidden to each other.

B will not send any acknowledgement.

(A will not know when C will transmit), ↓ (Because not in range)

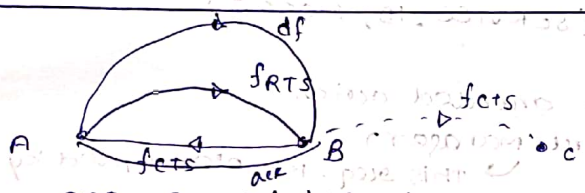
Expose Node problem



soln: C get RTS but not CTS.

C is exposed node.

C doesn't transmit to D because B is transmitting to D.



RTS – Request to send.

→ time period – Data frame + Ack.

CTS – clear to send

→ time period – Data frame + Ack.

C – get f_{CTS} frame but not f_{RTS}.

- Do not use RTS, CTS if not mentioned in question (It is optional)

Problem: RTS of both A and C can collide (Hidden Node Prob.) (If they send data at same time)

$f_D > f_{RTS}$ → RTS frame is quite smaller as compared to data frame.

Because of small size, possibility of collision in RTS is less.

Frame size: 0-2312 bytes

100 bits – 10 sec

910 bits – 1 sec → Less collision chance

$f_D <$ threshold – Do not use RTS/CTS, th – max. of Data frame. (No RTS, CTS required)

$f_D >$ threshold – Use RTS & CTS.

20/1/2025

- wireless

Bit Error Rate (BER)
↳ voice transmission
↳ Data transmission.

wired & wireless
↳ channel characteristics.

time invariant
(do not change w.r.t time)

SNR (Signal to Noise RATIO) is constant, except Atterevation.
(Atterevation → power of signal gets detoriated w.r.t time)

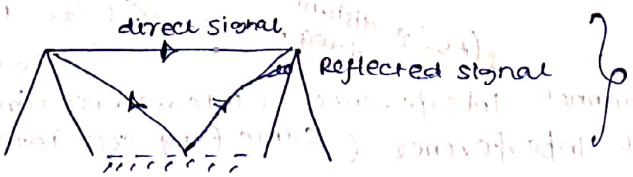
Error

* FEC (Forward error correction)
↳ Error Detection & correction takes place at the receiver end.
• Linear Block codes, convolutional codes.

* Retransmission
↳ Error Detection takes place at receiver end but tells the sender to re-transmit the whole frame together again.

wireless

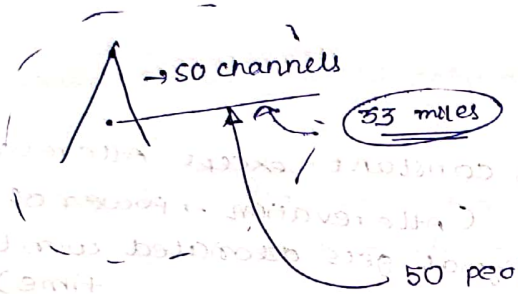
→ Time variant
→ SNR is variable (Not so good channel).
↳ Measured in dB.
→ Multipath propagation. (Antenna).
→ First thing to place at both sender & receiver side is an Antenna. (Omnidirectional).
→ If there is no obstacle b/w receiving and transmitting Antenna, it is called LOS (Line of sight) Antenna.



→ In ab Non-LOS (obstacle) path, the signal power may increase if in phase or may decrease if in opposite phase. (constructive & destructive ?).

→ SNR varying, BER varying, bad channel, no sufficient control over reliability of channel.

- Tower - Base station (Many Antennas)



- when moving from one base station to another base station, it is called handoff (channel changes)

(MSC → coverage area, may cover many base station).
↓
[Mobile switching centre].
↳ If we go outside coverage area, it will show us roaming.

→ cellular communication.

→ overcame the challenges of Traditional cellphones.

- Basic principle
  ↳ Frequency Reuse.
- convert bigger geographical regions into smaller ones.
  (Smaller Antennas of smaller radius)

  Give 50 channel to each small Region (Let's say 3 miles)
  [Low power Transmitter]
  [No interference b/w regions].
  we can use same 50 channels in all small regions.
  (Spacial Frequency...)

  More no. of users can be accomodated.

N = cluster size
Freq. reuse factor = $\frac{1}{N}$.

↑ (Assign distant freq.) // (see PPT) for more concepts

- Adjacent-channel Interference (Interference among adj. cells)
- Co-channel Interference (same freq cell interference)

$N = i^2 + j^2 + ij, \quad i \geq 0, j \geq 0$

If $N = 3$, reduced, Ratio ↑, co-channel interference also increases.

// co-channel reuse ratio = $\frac{D}{R}$ (D = Distance b/w co-channel cell

R = Radius of each cell).

Assumption, $R \rightarrow$ constant.

If $N = 3$, D ↓ (Repetitions will increase).

co-channel reuse ↓.

co-channel interference ↑

// opposite for $N = 9$.

- S = Duplex channels available

K = Group of channels allocated for each cell.

N = Number of cells in each cluster.

So, $S = K * N$.

N = cluster size

M = No. of times cluster is repeated to cover given geographical region.

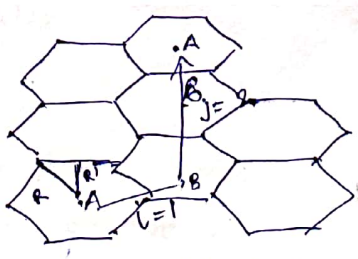
capacity = $M.KN = MS$

Typical cluster size → 4, 7 or 12.

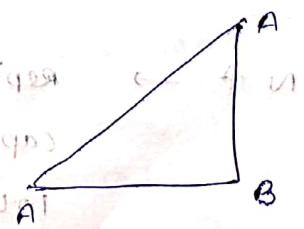
(If cluster size is small, the capacity of channels is more.)

For hexagonal geometry,

$$\mathcal{D} = \frac{D}{R} = \sqrt{3N}$$



$N = 7$, $i = 1, j = 2$

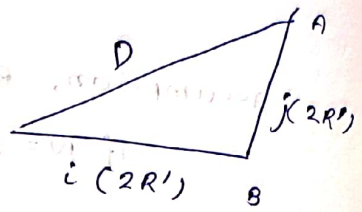


Nearest - co-channel cell

For $N = i^2 + j^2 + ij$,

(i) Move i cells along any chain of hexagons & then (ii) turn 60° counter-clockwise and move j cells.

$$\boxed{R' = \frac{\sqrt{3}}{2} R}$$



using cosine Rule,

$$D^2 = [i(2R')]^2 + [j(2R')]^2 - 2\,i(2R').\,j(2R').\cos 120^\circ$$

where, $R' = \frac{\sqrt{3}}{2} R$.

$$\therefore D = \sqrt{3i^2R^2 + 3j^2R^2 + ij\,3R^2}$$

$$= \sqrt{3N}.R$$

But $i=1, j=2$.

Hence, $$\boxed{\varnothing = \frac{D}{R} = \sqrt{3N}.}$$

$$\left\{ \begin{array}{l} \text{If } N=3, \ \varnothing = 3 \\ N=7, \ \varnothing = 4.58 \\ N=12, \ \varnothing = 6 \\ N=13, \ \varnothing = 6.24 \end{array} \right\}.$$

Decreasing the value of N,

If $N \downarrow$ ⟶ Repitition will increase.
capacity
Interference

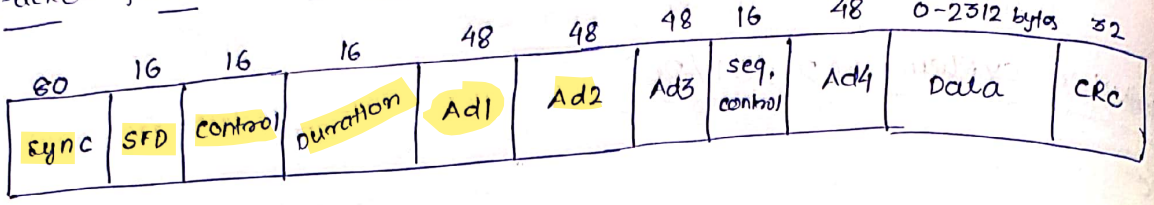
$N \uparrow$ ⟶ Repitition
capacity
Interference

(H/W what is cell splitting? without changing D/R ratio, how we can minimize cell size).

22/1/2025

• Wireless and Mobile Networks

Packet format of 802.11 (Wi-Fi)



Sync - Receiver synchronize with the sender, (seq. of Bits)

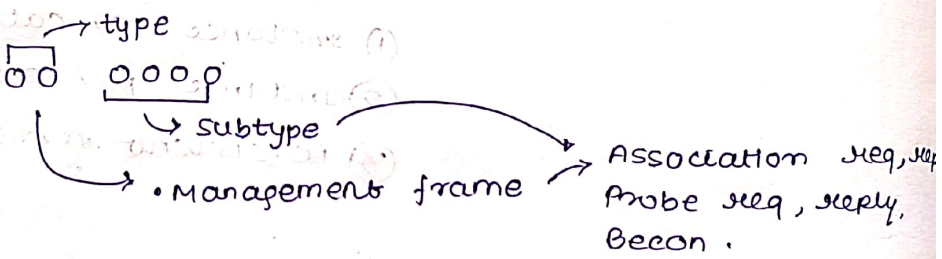
SFD - start Frame Delimiter
(Bit pattern - Frame start point)

Duration - for specifying certain time period in RTS and CTS
(send + Acknowledge).

sequence control - If acknowledgement is not received, data frame retransmitted.
(Receiver end - To identify duplicate packet (sequence no) if ack lost).

CRC - Error control (cyclic Redundancy check).

control -



01 • control frame — RTS, CTS, Ack.

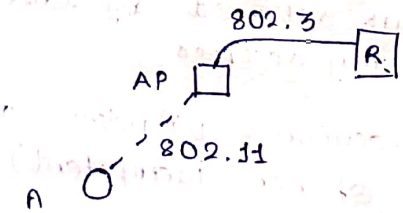
10 : Data frame

11 : Reserved.

(Sometimes)
Ad3 - BSSID

Ad1 : Receiver Add Ad2 : sender Add.

Packet transfer from wireless node to Router through access point and vice versa

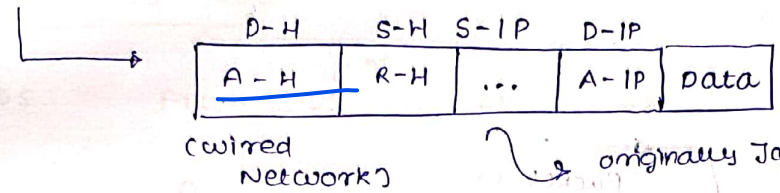


R-A

- AP knows Hardware Address of A and vice versa. (Becon frame Advertisement).

R's ARP table & A's ARP table are populated. (Assume IP addresses are known)

R ⟶ AP ⟶ A



(wired Network)

↳ originally Jana se packet ayaa hai,

// In case of wired network, AP is transparent.

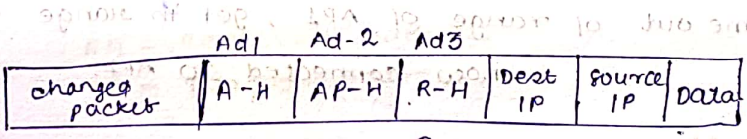
↓ Transferred

Reaches to AP.

AP converts 802.3 packet to 802.11 packet.

(AP has accepted the packet despite not-matching hardware address) ⟶ Because A is attached with AP.

Interface card - Promiscus mode (Accept every packet).



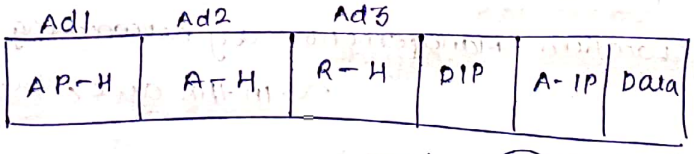
↳ original address

↓ DIFS and DCF

Packet reached A.

Return from A-R

A ⟶ AP ⟶ R

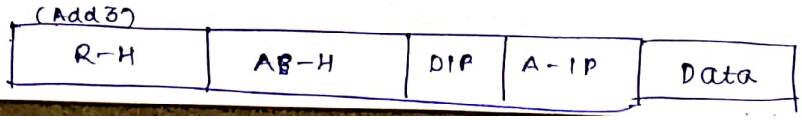


↓ DIFS & DCF

Data for 802.11 packet

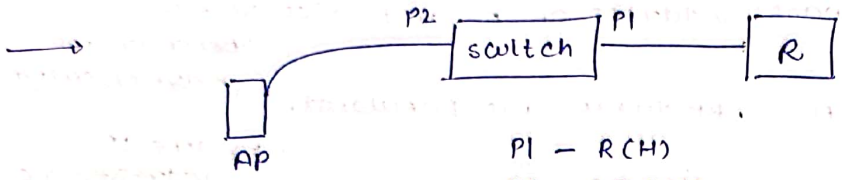
Reaches to AP.

Converts 802.11 to 802.3



Reaches to Router R. (over wired link)

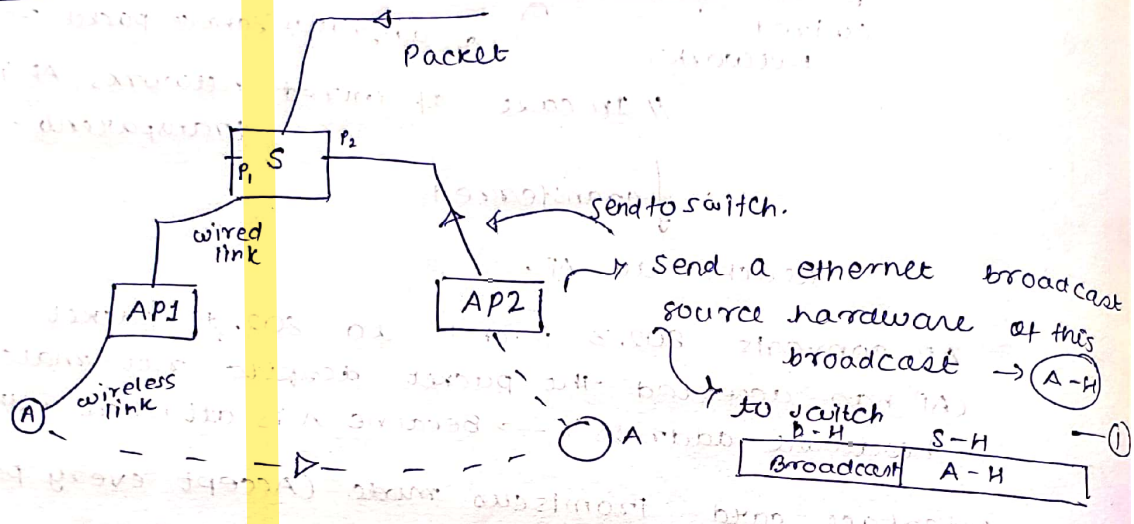
what if switch is connected b/w R and AP?



P1 – R(H)
P2 – AP(H)

Baki वही same रहेगा।

Mobility



A came out of range of AP1, got in range of AP2 and now connected to AP2.

Destination hardware → A–H.

Packet reaches to switch S.

S will transfer through P1 and to AP1.

But, A has attached itself to AP2. ——(1)

switch came to know A–H is attached with port P2.

Deletes previous entry & updates it.

Now, new packet will be forwardded to AP2.

(Location Management by networking device
↳ In this case, by switch).

// (This is case of same subnet)

↳ In diff. subnet, Mobile IP is used to deal with the situation.

27/1/2025

- **Wireless and Mobile Networks**

To DS — 0 1

From DS — 1 0

DS – Distribution system

BSSid – MAC address of AP.

AP :- (2 MAC Address)

MAC Address table

To DS	From DS (AP)	A1	A2	A3	A4
0	0	DA	SA	Bssid	–
0	1	DA	Bssid	SA	–
1	0	Bssid	SA	DA	–
1	1	RA	TA	DA	SA

- sometimes RA and TA may not be source and destination addresses.

RA – Receiver Address

TA – Target Address.

- sometimes, Receiver may not be destination like (AP) – DA is that which process packet at Network Layer – like router or wireless node.

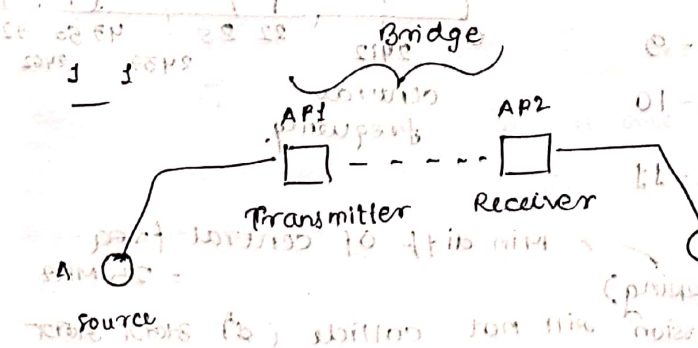
→ wi-fi (Router) : Access point working as router.

Ad1 – Receiver, Ad2 → Transmitter,

0 0 → Adhoc Network. (AP is not needed)

(All belong to same BSSid, they are in the range of each other)

1 1



Physical specification of 802.11

FHSS, DSSS, HR-DSSS, OFDM - Modulation techniques.
(FHSS, DSSS — 1 MBPS; HR-DSSS — Wi-Fi)

802.11 - 1 MBPS, 2 Mbps,
- b — 11 mbps
- a, g — 54 mbps
- n — 600 mbps
- ac — 1.3 gbps — 3.47 gbps
- ax — 14 gbps

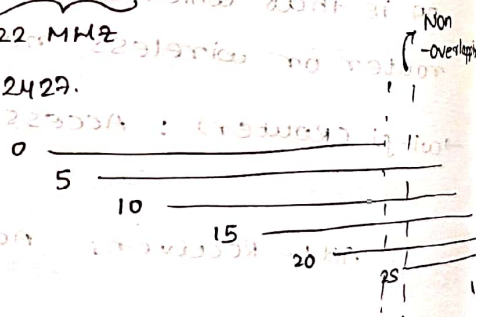
Frequency band — 2.4 GHz — (2400 - 2483 MHz)
a : 5.1 GHz — 5.8 GHz
except ax, ac

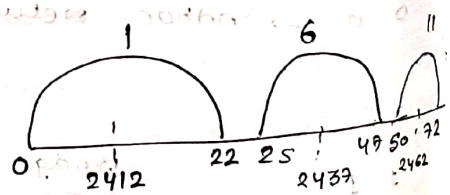
Max Distance — (30 - 70 m)

- 11 channels - Diff b/w 2 channel is 5 MHz.
If 25 MHz, they are called non-overlapping.

2400 — 2422

00 - 22 : ch - 1 (22 MHz)
05 - 27 : ch - 2 → 2427
10 - 32 : ch - 3
15 - 37 : ch - 4
20 - 42 : ch - 5
25 - 47 : ch - 6
30 - 52 : ch - 7
35 - 57 : ch - 8
40 - 62 : ch - 9
45 - 67 : ch - 10
50 - 72 : ch - 11

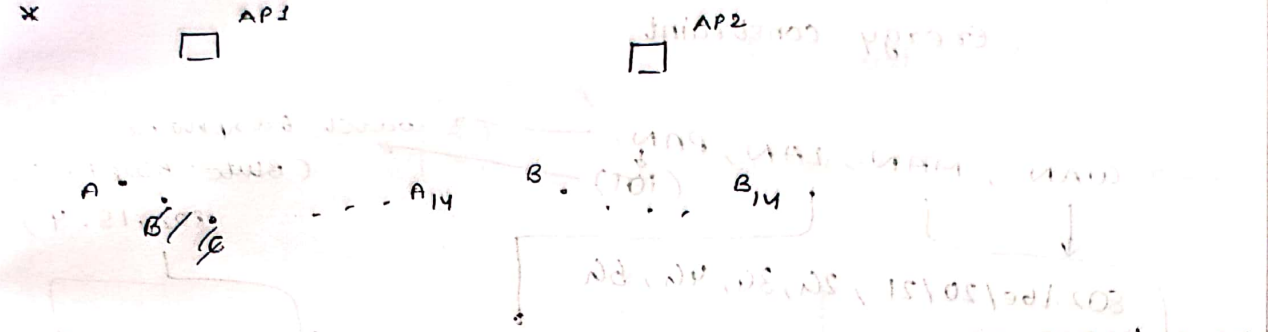




central frequency.

Maximum (3 channel are non-overlapping). → Min diff of central freq = 25 MHz.
↳ Transmission will not collide (एक साथ होगा wire p transmission)

- If AP is on channel 6, all stations attached to the access point should be tuning themselves to channel 6.



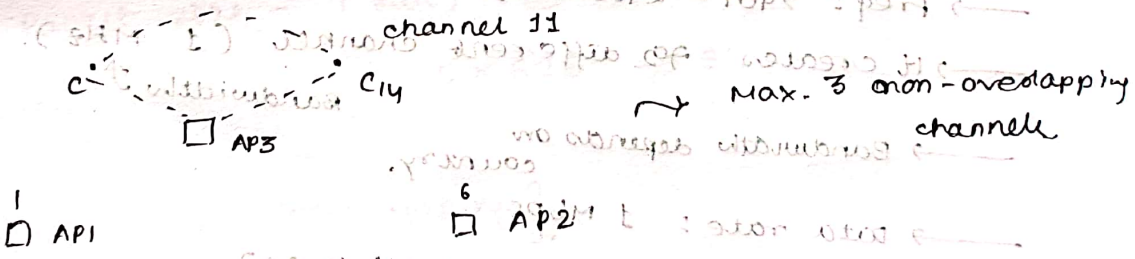
- AP1 & AP2 : set on the same channel → no effective gain

So, even if we increase the no. of access points, still only 15 nodes can be accomodated.

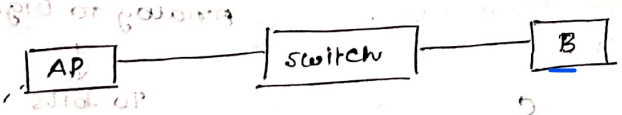
In this case, we use non-overlapping channels.

AP1 – channel 1, AP2 – channel 6,

30 stations can be supported;
(No collision b/w A and B stations).



Q.



Packet transfer from A to B.

A & B are in same subnet.

→ with a harmful copy.

05/02/2025

Power management (802.11)

Sleep and awake

- Put node in sleeping mode ⟶ POWER SAVING.

Transmit :- If node does not have any frame to transmit, remain in SLEEP Mode.

Receive :- Does not know when to awake?

AP - Buffer data frame for sleeping stations.

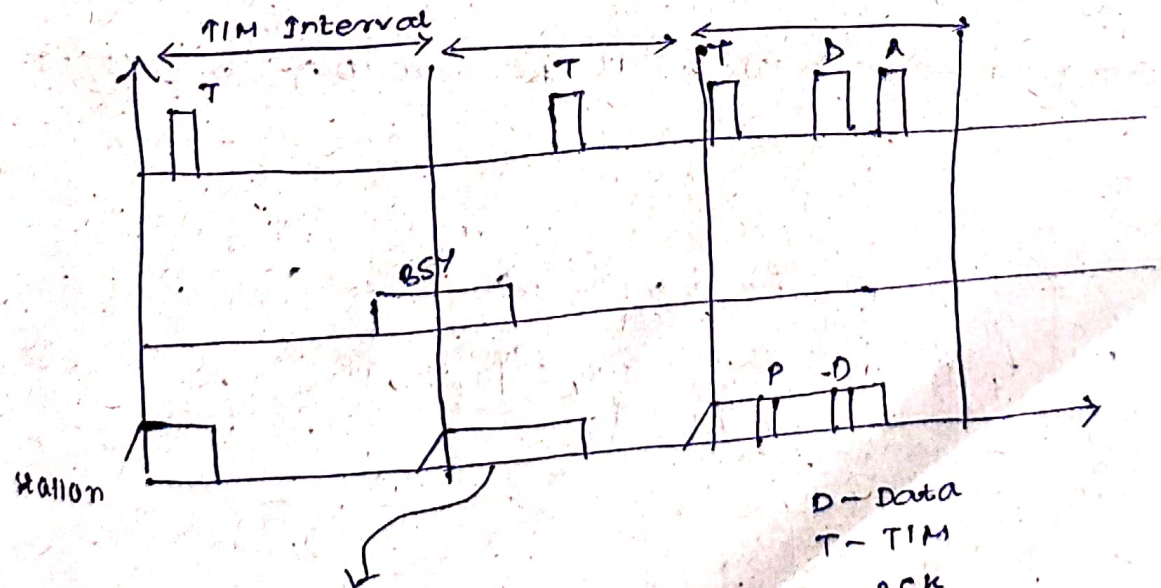
AP prepares - TIM (Traffic indication map).

TIM - contain list of stations for which unicast frame buffered.

→ Of whom? - For those stations which goes to power saving mode.

- Station inform to AP, using PS (mode 1) that it is going to sleep.

PS (mode 2) : station have a TIM & frame at AP, so it awake itself and inform to AP.



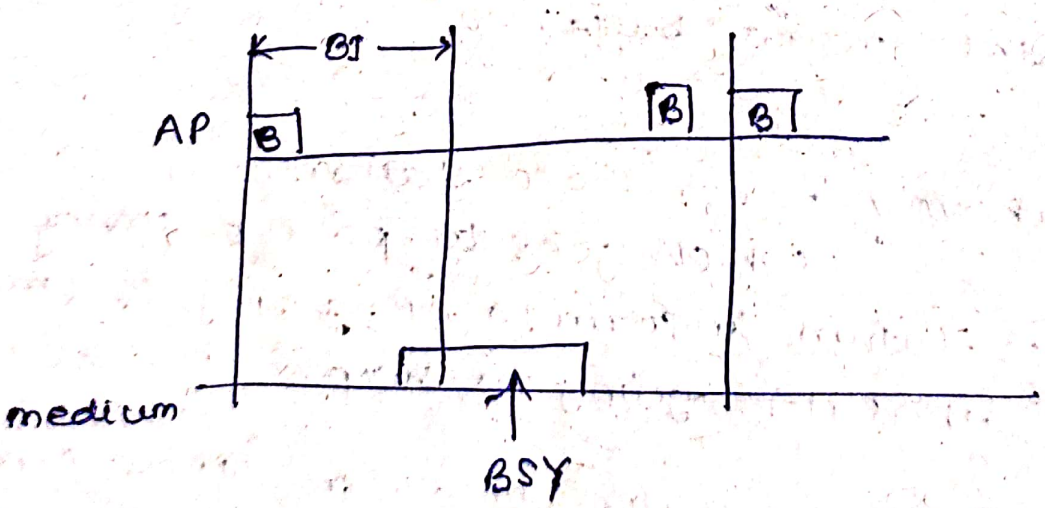
Medium was busy so station remain awake till it get TIM.

D - Data
T - TIM
A - ACK
P - Power save
BSY - Busy station

- Station awake at start of TIM Interval.
- When station get TIM it finds AP has some buffered frame for it?
- Station send PS (mode 2) & stay on.
- AP on receiving PS send data & get ack.

- Clock of AP & clock of station should be synchronized at the beginning, (Time synchronization function).

→ Becon frame is used. [Sent after every becon interval]



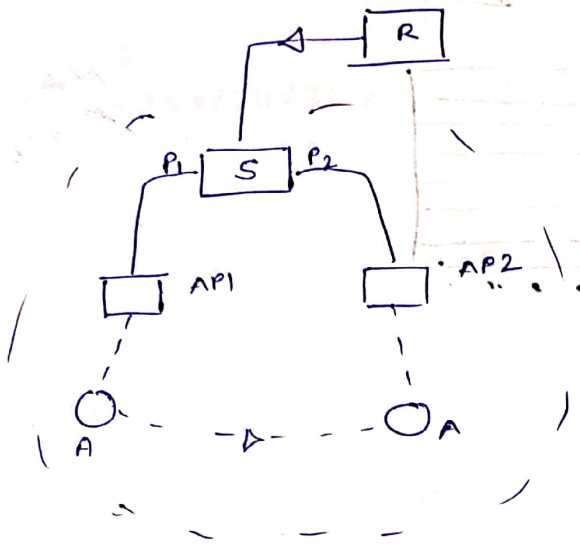
Inside Becon frame, AP puts a time stamp, to synchronize with the station.

(2 questions - send in whatsapp group) → 5/2/25

* Last class ...

wireless and Mobile Networks (An assignment was sent in group today).

Mobile IP



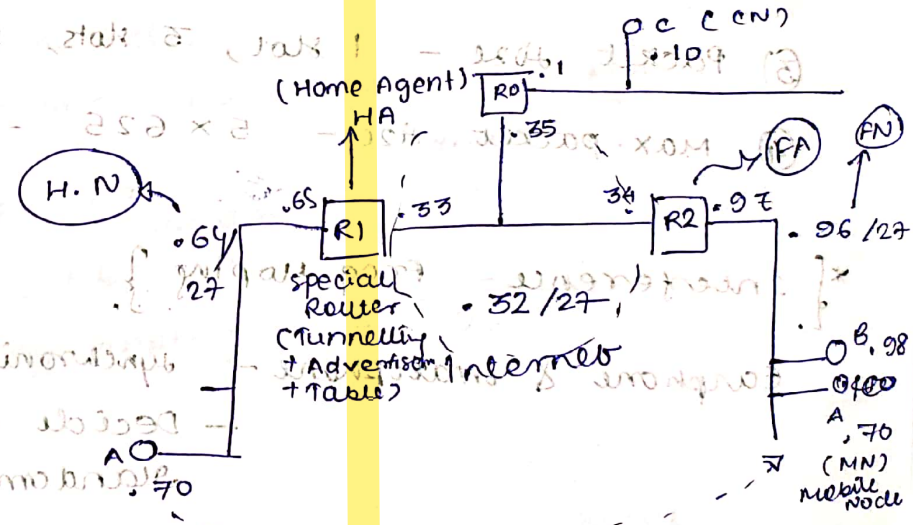
→ No change in Routing table, change in node is dealt by the Link layer.

Mobility at Network layer → change of subnet.

(EX) 202.141.55.0/24 → 8 subnets

↓

.0/27
.32/27
.64/27
.96/27
.128/27



Initially, A → moved to .96 network

Now, C → A

.10	.70

C → R_0 R_0 → R_1 (.33)

R_1 → A

After movement,

C → A

| .10 | .70 |

C → R_0 → R_1 → ? Failed to deliver

How to deliver?

→ Method 1

R_0	Mask	N. H
.70	/27 → /32	.34 (Node Address)

R_2	N. H	int	Flag
.70	/27 → /32	.97	0

⟹ change entries in Routing Table of R_0 & R_2.

Method 2

change IP address of node.

C → A

| .10 | .100 |

A → .100

Not .70 ✗

(IP layer – change IP address of node).

TCP connection

→ source port
→ source IP
→ Dest port
→ Dest IP

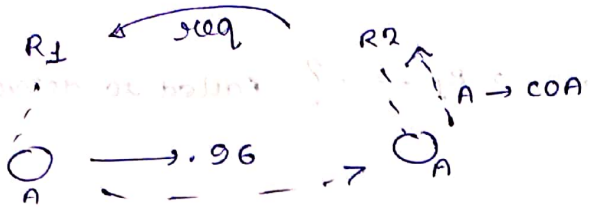
change IP address → we cannot hold the ongoing TCP connection.

TCP says – Do not change IP } of contradiction
IP Layer says – change IP }

Soln :– Keep both IP addresses.

पुराना को use करेंगे TCP के साथ
नया को use करेंगे IP के साथ } Mobile IP.

(COA – care of Address). → New IP address.



Router Advertisement
(Additional capability added to support mobility).

Generally, COA → IP address of R2. (.97)

// R2 → .70 — MAC of .70 (Registered) Node

Forwards Req to R1 : .70 मेरे पास है (R2)

// R1 → .70 — .97

Now, C → A

.10	.70

→ R0 → R1

.10	.70

Now, R1 checks the table.

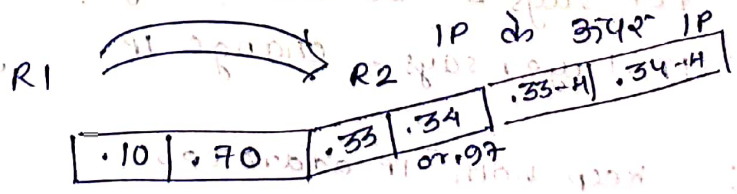
It finds .70 is with .97

↓

R2 (But not as a normal packet)

Mobility - Tunneling वहुत use होती है। (Similar to IPV6).

Puts a tunnel.

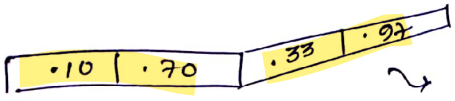


R1 sends packet to R_2 using its Routing Table.

NH → .34.

R2 receives it.

At R2/



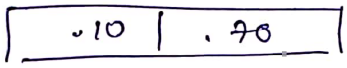
↳ Tunnelled packet

A bit inside the IP header is set to determine a tunnelled packet.

R2 checks ~~with~~ whether is it a tunelled packet or normal packet.

It Removes the tunnelled IP part.

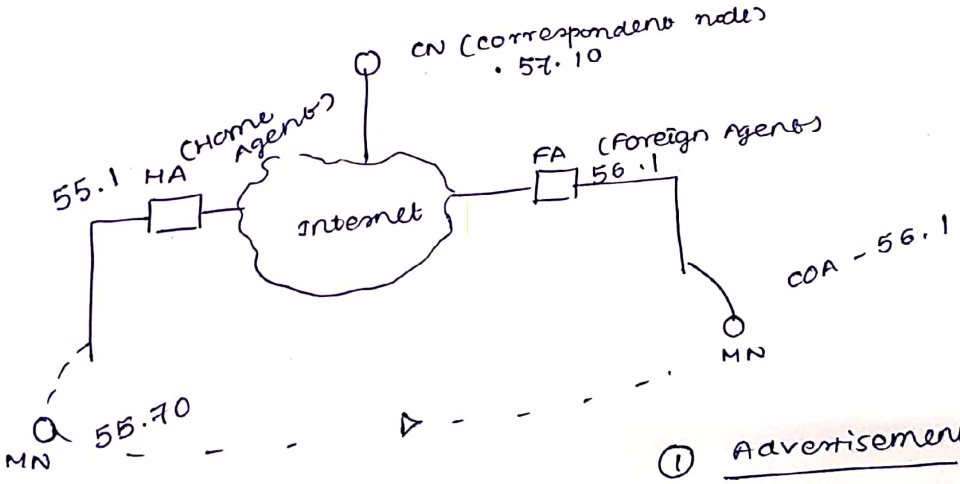
It does de-tunnelling.



Now, instead of using normal routing table, it checks the registered node table & checks whether there is any entry.

.70 ⟶ .70 - MAC

Transfer the packet.

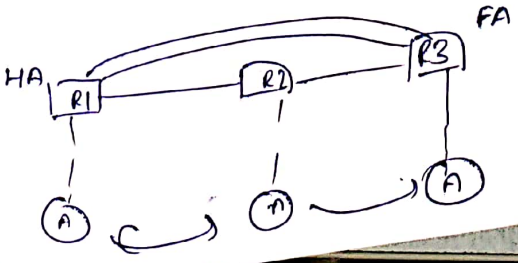


HN - 202.141.55.0/24
FN - 202.141.56.0/24
CN - 202.141.57.0/24.

① Advertisement
↳ HA, FA

② Registration
MN - reg with HA.

③ Tunnel
HA ⟷ FA
IP in IP encapsulation

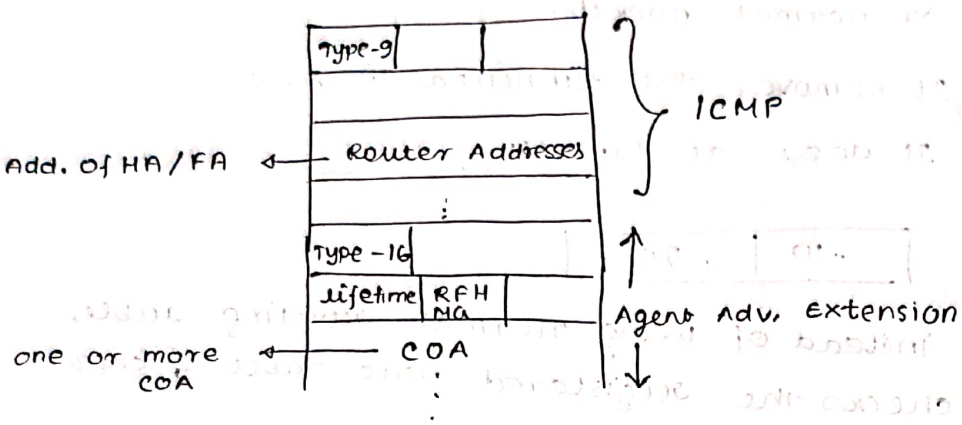


17/02/2025

Wireless and Mobile Networks (Assignment-2 given today). ↳(except 3rd Q.)

Advertisement

Advertisement can always have a TTL = 1 on a particular link/subnet. ⟶ ICMP packet Type-9 { Router Advertisement }



H → Home Agent

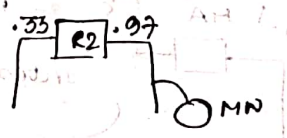
F → Foreign Agent → Mobile Node

R → Registration Bit – MN should register with FA

MA → Registration Bit other than IP-in-IP encapsulation

Private IP cannot be used as dest. add

So, CoA → @ .33 ⟶ Towards Internet will be given to Mobile node. (Public).



// If not private (.97), can also be given.

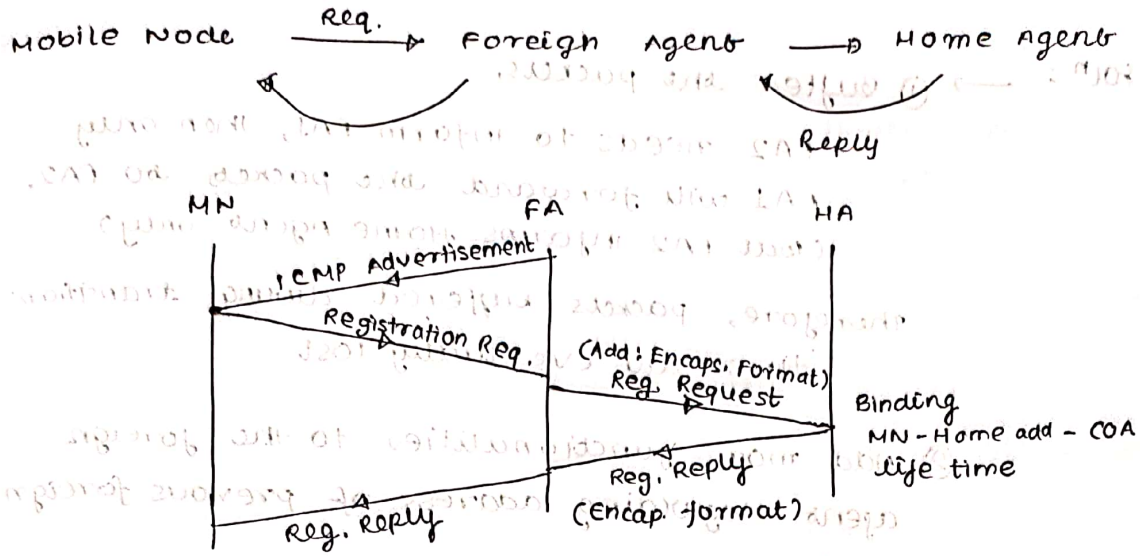
- Multiple mobile nodes can be using the same CoA.

// Mobile Node can decide by seeing the Router Addresses whether it is in range of HA or FA.

- In Mobile & wireless networks, the number of packets to be sent (unnecessary) should be minimized as it will flood the network.

If advertisement not received, the mobile node can send solicitation message to know where it is.

Registration



Reg. Req. → Source / Dest Address

→ Mobile Node - Home add.

→ HA - address

→ COA

→ Lifetime

→ Id

UDP packet
(Port : 434)

Reg. Reply

→ MN - Home Address

→ HA - address

→ Id

→ Lifetime,

Q. MN - 55.10
COA - 56.1
FA - 56.1
HA - 55.1

202.141. . . ./24

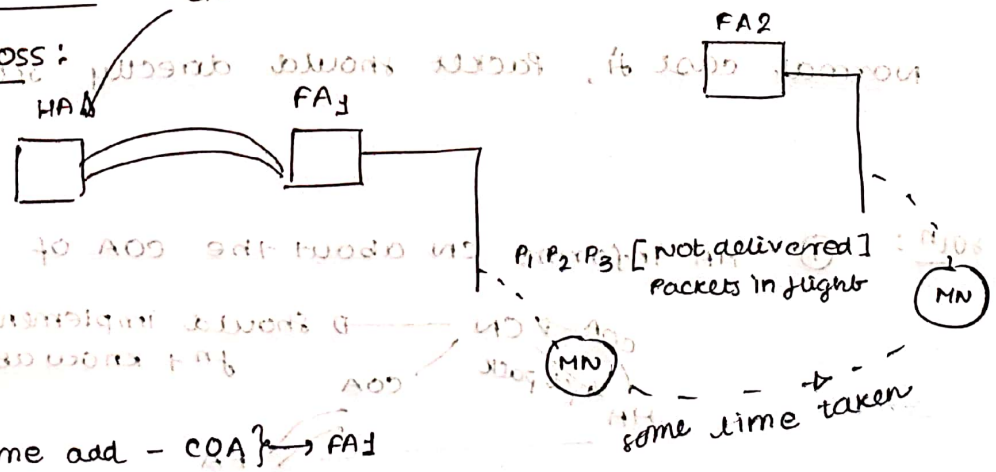
Do the above process using these values,

// Tunnelling

Mobile IP Issues

CN

① Packet Loss:
(change of subnet)



HA → { MN - home add - COA } → FA1

changed to

MN home add - COA (FA2)

[Binding change]

// Mobile Node has moved but still not registered with home agent → Packet loss.

Soln : → ① Buffer the packets.

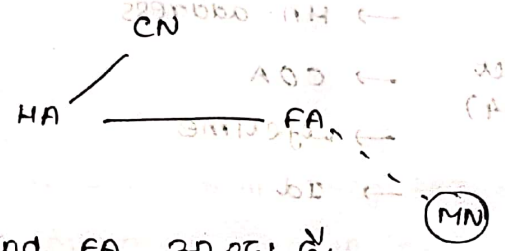
FA2 needs to inform FA1, then only FA1 will forward the packets to FA2.
(But FA2 informs Home Agent only).

Therefore, packets buffered during transition time are eventually lost.

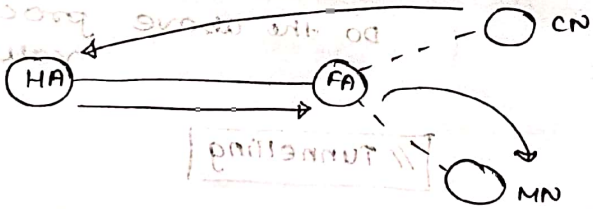
② Add more functionalities to the foreign agent regarding address of previous foreign agent.

③ Give responsibility to upper layers.

② Triangular Routing : CN → HA → FA → MN.



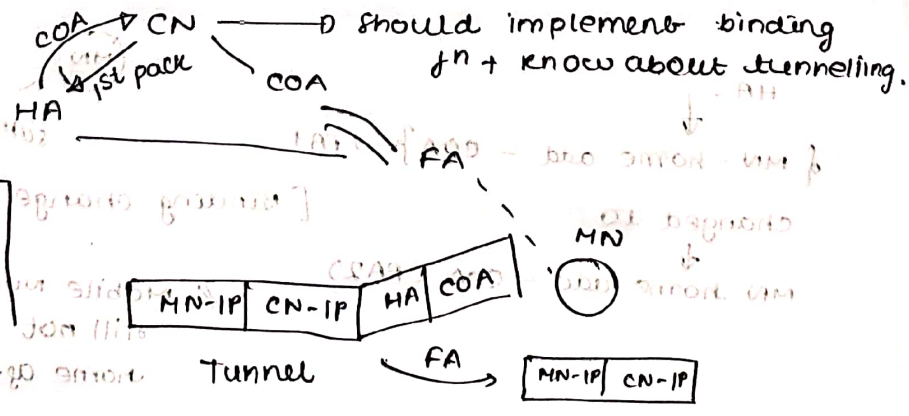
Bich मे HA and FA आ रहा है,
Direct CN → MN नही होगा,
इसलिए इसे Triangular Routing कहते है,



(worst case of Triangular Routing → same subnet)

Normal case मे, Packet should directly reach the MN,

Soln : ① HA informs CN about the COA of MN,



→ Additional functionality (Not feasible).

② Now MN moved to FA2.

FAJ → Anchor Foreign Agent
↳ (Start working as Home Agent)

Feb-19

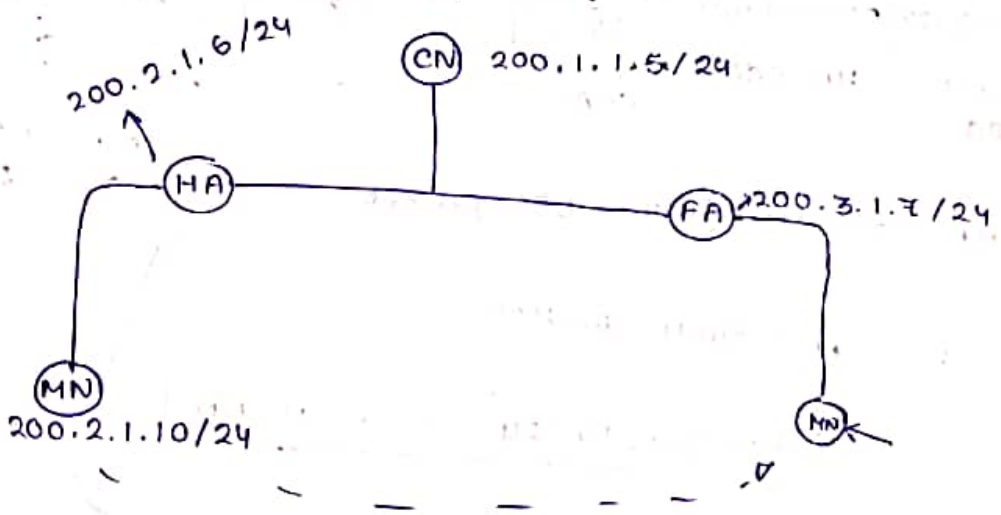
(Assgn-2, Q.2)

. changes :

do - Registration

tables HA, FA

Transfer packet.

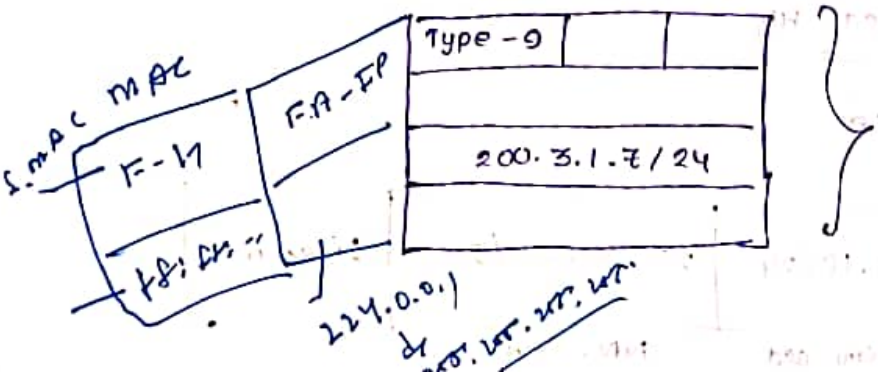


Advertisement

FA will advertise 200.3.1.7/24 as COA.

MN will accept this COA.

ICMP packet



Registration

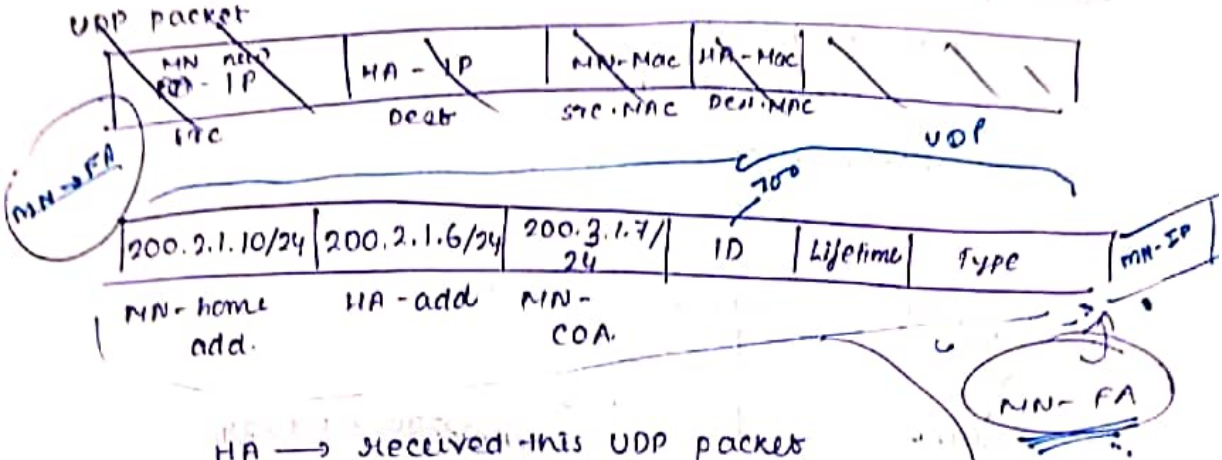
MN ⟶ FA : Registration Request

FA

Table

200.2.1.10/24	H - MN

Forward request to HA

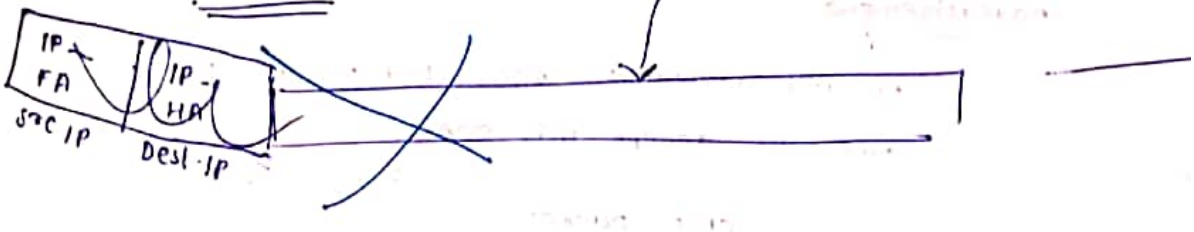


HA ⟶ received this UDP packet

FA : Table updation

200.2.1.10/24 ⟶	H-MN

Encapsulate

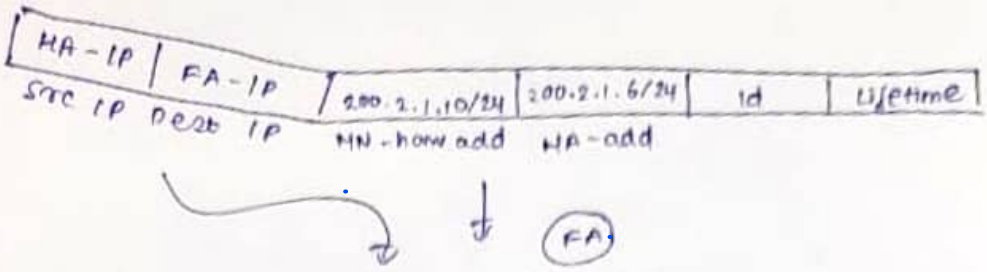


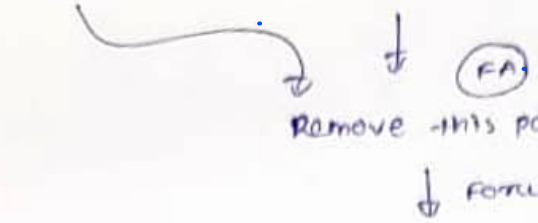
Reached HA

HA-table

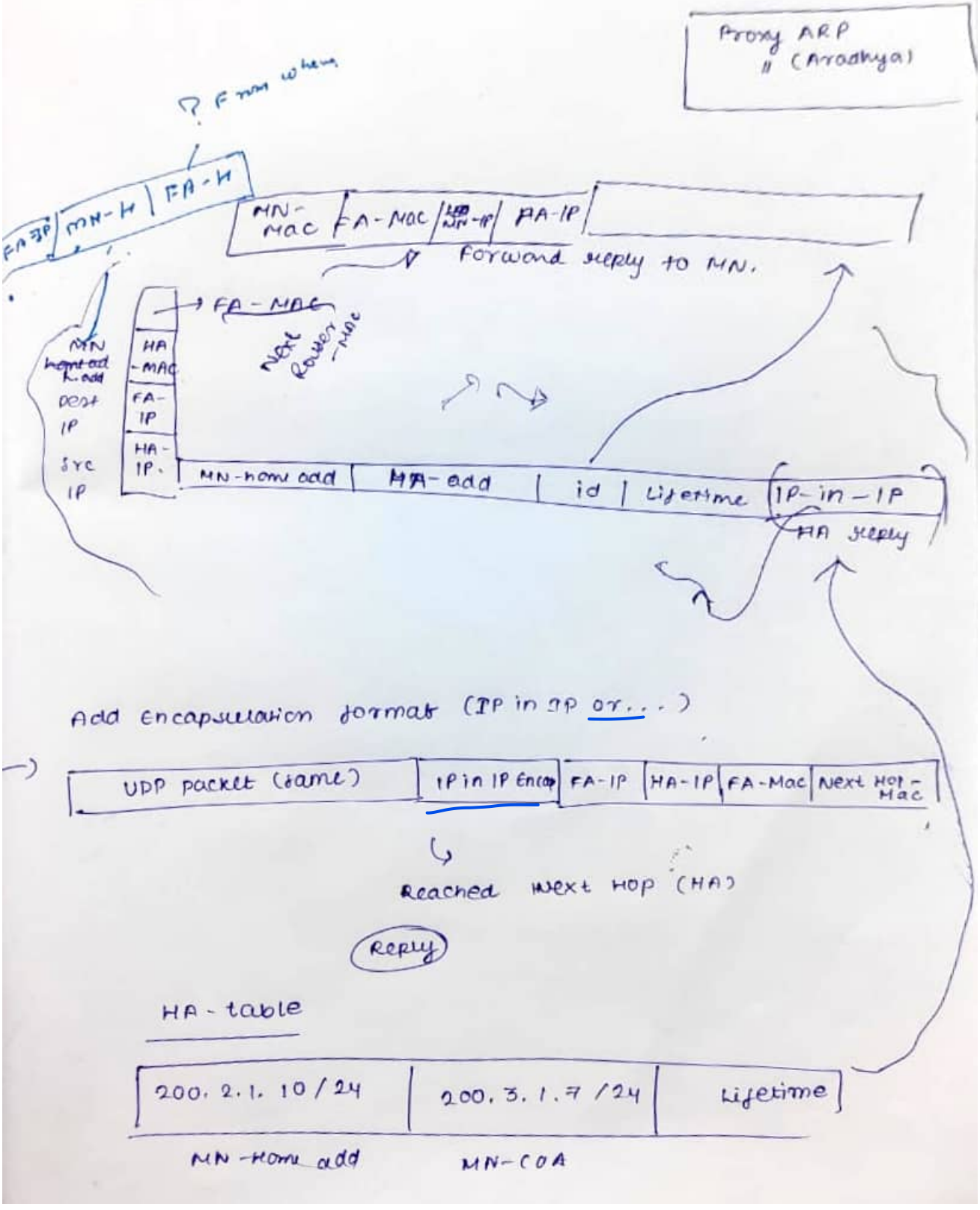
200.2.1.10/24	200.3.1.7/24	Lifetime
MN Home add	MN-COA	

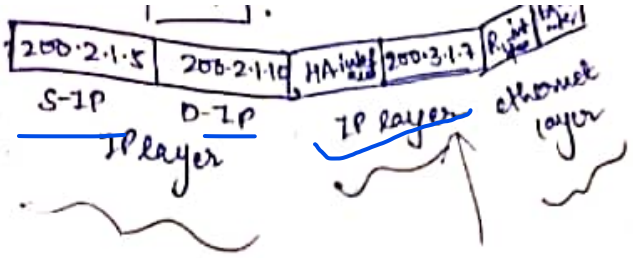
Reg Reply

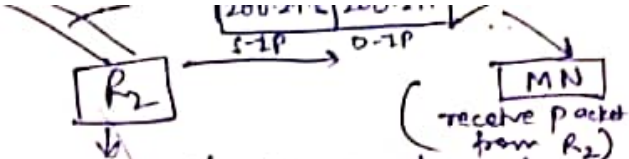




Proxy ARP
" (Arradhya)







→ Tunneling is done to redirect packet destined for a MN to its current-location (COA) on a FN. and FA on the FN receives the tunneled packet and delivers them to MN, acting local gateway for MN

debunelling the packet and check the D-IP and check its table which is prepared before and it knows the MAC of MN so, it forward the packet to MN

→ if :- CN - · · 2.1.0/24

(P → CN to MN.

↓

before movement

↑

after movement)

ARP req

CN ⇄ MN (same subnet)

ARP reply ⟹ (same Routing)

↙

→ Default gateway is not going to use.

- FA checking protocol field to check either it is encapsulated packet or not that's why do detunneling before doing any preprocessing

* from where Hardware address of MN to FA)

→ Sends ARP req to MN

← MN reply with MAC of MN to CN.

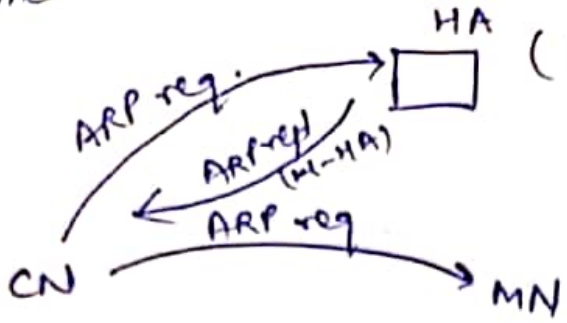
Now

CN-IP	MN-IP	CN-MAC	MN-MAC

⟶ MN

Now when MN is moved to FN

now when CN sends ARP req is doesn't get ARP reply



(After registration HA knows that MN is out of network and receive ARP req of MN. Now here HA act as proxy and sends its own MAC to CN and this act as proxy ARP.

Now at CN

CN-IP	MN-IP	CN-H	HA-H
S-IP	D-IP	S-MAC	D-MAC

now HA checks its table and sends this packet to destinated COA) by

Ques-1

Wireless & mobile Network Assignment-2

1: An institute campus has a hostel. The hostel has 4 wings (w1, w2, w3, w4). Each wing has 8 rooms. Room numbers are r1, r2 ... r32. Each room needs one Wi-Fi connection. Single AP can connect maximum 8 stations and has routing capabilities. All AP's are connected to a layer 3 switch (rs1). The switch rs1 is placed between wing w2 and wing w3. The rs1 switch is connected to another layer three switch rs2 placed in the campus at a distance of approximately 1 Km. Switch rs2 is connected to a gateway router (rg) which is connected to rest of the Internet through ISP router. IP address block assigned for the Institute is 202.141.80.0/24.

i) Design a campus wide Wi-Fi solution so that the hostel rooms can be connected to rest of the Internet. Specify topology, AP'S, channels of AP'S and connected nodes, cables type, switchs ports type, routing table entries of layer three switches & ISP router. Each wing requires separate subnet. You should tell how many maximum IP addresses are sufficient for each wing, with subnet IP addresses with netmask. Give IP address of rooms.

ii) A node (CN) having IP 202.141.64.10/24 connect to a mobile node (MN) having IP 202.141.96.10/24 with HA address as 202.141.96.1/24. MN has moved to room number r1 of wing w1 of the hostel while connected to the CN. Show the changes inside the network and delivery of the packet p1 from CN to MN and of packet p2 from MN to CN use mobile IP (MIP).

MN moves to room number r25 situated in wing w4. Show the changes inside the network and delivery of packet p3 from CN to MN and packet p4 from MN to CN use MIP. State any assumption taken.

iii) Design a solution for above campus using CISCO CAPWAP

2: show delivery of an IP packet (P) to a mobile node (MN) from a corresponding node (CN). Assume mobile node is in foreign network and registered.
Consider IP addresses as:
CN---200.1.1.5/24,
HA---200.2.1.6/24,
FA---200.3.1.7/24,
MN old IP 200.2.1.10/24 and
MN gets care of address 200.3.1.7/24. Hardware address of FA = H-FA, HA = H-HA and of MN = H-MN. You are also required to show table entries done at HA and at FA during the registration process when MN moved from the home network to the foreign network. If CN is in 200.2.1.0/24 network with an address 200.2.1.100/24 how packet P will be send to MN from CN. → before movement & after movement of MN.

3: If H.A address is 205.50.40.3 and F.A address is 208.80.70.4 show how IP-in-IP encapsulation/de-capsulation will take place for a packet with S.A 196.6.5.3 and D.A as 205.50.40.6.

4: How route is optimized for problem no.2 and show delivery of the packet on this optimized route.

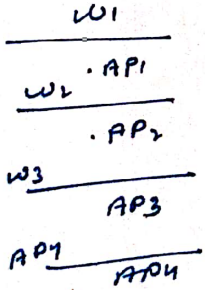
5: How two mobile nodes can use the same COA in mobile IP?

6: In what conditions home agent intercepts the ARP packet destined for mobile host. Explain proxy ARP in mobile IP.

7: "IP address change required by network layer during mobility creates problem for TCP" Discuss.

→ Assume APs of serving adjacent wings are interfearing each other but APs of alternate wings are out of range of each other. not interfearing

i.e APs of w_1 & w_2 are in range
& APs of w_1 & w_3 are out of range



Assignment-1 (Wireless and Mobile Networks)

1. Consider the scenario given in Figure.1. Node A and B are in transmission range of AP1 whereas node C is in range of AP3. All three APs and Router R are connected via a layer-2 switch supporting IEEE 802.3. Assume that ARP caches at all the devices (Node A, B, C, APs, and router R) are flushed. In this question, you have to explain the packet transfer process in different cases asked. Special attention should be given to the values of ToDS and FromDS fields and discovery of address1, address2, address3 and address4 in all the cases.

(a) Packet transfer from Node A to B.

(b) Packet transfer from Node A to C.

(c) Packet transfer from Node A to B when node B has moved from transmission range of AP1 to transmission range of AP2.

(d) HTTP request from node B (when it is under AP1) and reply from a server on Internet (when node B is under AP2). Will the movement of node B make any effect? Explain.

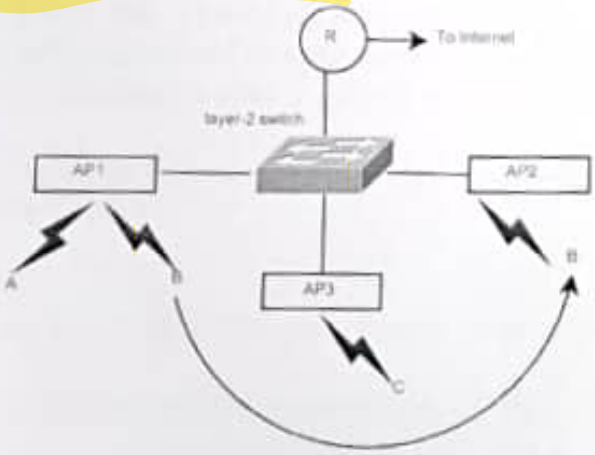
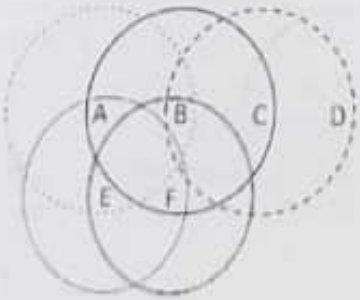


Figure 1: Figure for Question 1

2. Consider the wireless topology of 6 nodes given in Figure below. Circles around each node illustrate their transmission range. Assume that the transmissions of two nodes collide if and only if they transmit at the same time in overlapping transmission areas. Further, assume that losses occur only due to collisions.



(a) When node A transmits to node B, list the potential hidden and exposed terminals.

(b) What about when node B transmits to node C?

(c) Taking help from above cases, explain how (RTS/CTS) can solve the problem of hidden and exposed terminals.

(d) RTS/CTS is more like time-division multiplexing or frequency-division multiplexing? Comment.

3. Explain DCF in 802.11. State the relationship among SIFS, PIFS and DIFS. If contention window (CW) size is large for lighter load, how would it effect bandwidth utilization? Consider number of nodes to be three and contention window (CW) size to be sixty three to explain your answer.

4. In 802.11 suppose A, B, and C all makes their first carrier sense, as part of an attempt to transmit, while a fourth station D is transmitting. Draw a timeline showing one possible sequence of transmissions and exponential back off choices. Your timeline should also meet the criteria that initial transmission attempts should be in the order A, B, and C but successful transmission should be in the order C, B, and A. consider following:

i) Station A,B and C sense channel at t=0,1,2 respectively and channel was busy. At t=3 D finishes transmission. CW = 7 initially. If C do transmission for 7 unit time, B do transmission for 8 unit time and A do for 10 unit time. State at what time C, B and A will finish transmission.

ii) In i) if E comes when B is transmitting, and E do transmission for 10 unit time, is it possible that E can start transmission before A? if yes explain when E will finish and when A will finish transmission, if no why?

iii) In i) if E comes when B has just finished transmission, is it possible that E can start transmission before A? Give reason for your answer.

5. Consider figure:

A----AP1----S----AP2

Node A has moved from AP1 to AP2. Show how table of switch can be updated to support mobility at link layer.

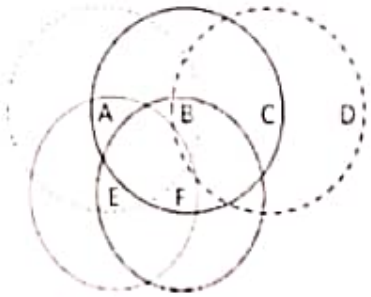
6. Show flow of packet (P1) from A to B and back packet (P2) B to A in following figure:

A----AP1----R----AP2------B

where A and B are wireless nodes connected to router R through AP1 and AP2 respectively. Show ARP req/rply packets from A to R.

7. Router R connects to switch S and switch S connects to access point AP1 and AP2. A mobile wireless node N1 moves from AP1 to AP2. Node N2 is connected to router R. Consider IP address of N2 is 202.141.55.35/27 and of N1 is 202.141.55.67/27. Show delivery of a packet P1 from N2 to N1 and back another packet P2 in response from N1 to N2, before the movement and after the movement. Consider hardware address of N1 as H-N1, of N2 as H-N2, of AP1 as H-AP1, of AP2 as H-AP2, of router R one interface as H-.33(N2 side) and for another interface as H-.66 (N1 side). Consider IP address for H-.33 interface as 202.141.55.33/27 and for interface H-.66 as 202.141.55.66/27. Assume ARP tables are populated so no arp req/reply required.

1. Consider the wireless topology of 6 nodes given in Figure below. Circles around each node illustrate their transmission range. Assume that the transmissions of two nodes collide if and only if they transmit at the same time in overlapping transmission areas. Further, assume that losses occur only due to collisions.



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