Q6. d. node F goes down

A

D	N	M
D	E	3~
D	S	5

C

D	N	M
D	E	3~
D	B	J

E

D	N	M
D	G	2~
D	A	4
D	C	4

F

D	~~N~~	M

Q1. a) $P_S = 1000 mW$

in dBm $= 10\log_{10} \frac{P_S}{1}$

$= 10\log_{10} \frac{1000}{1}$

$= 30$ dBm

b. $P_{TN} = -100$ dBm

$\Rightarrow -100 = 10\log_{10} \frac{P_{TN}}{1}$

$\Rightarrow P_{TN} = 10^{-10}$ mW

$\Rightarrow P_{TN} = 10^{-13}$ watt.

c. $SNR = 10\log_{10} \frac{P_S}{P_{TN}} = 10\log_{10} \frac{1}{10^{-13}}$

$= 130$ dB

Path loss = 120 dB, thus, resultant SNR =

130 − 120 = 10 dB

d. Shannon's capacity

$$C = B \times \log_2 \left(1 + \frac{P_S}{P_N}\right)$$

Our SNR $\Rightarrow 10 = 10 \log_{10} \frac{P_S}{P_N}$

$$\Rightarrow \frac{P_S}{P_N} = 10$$

$$C = 80 \times \log_2 (1+10) = 276 \text{Mbps}$$

e. An efficient MCS scheme should try to obtain a throughput close to shannon's capacity.

Now, let us compute bitrate for each MCS scheme & see which one will be close to shannon capacity.

256 Subcarriers → 234 data

Let us compute OFDM symbol duration

80M timesamples → 1 sec

$$256 \rightarrow \frac{256}{80} = 3.2 \mu s$$

Guard interval $= 0.4 \mu s$

Symbol duration = 3.6 μs

I'm starting from the end

9, 256 QAM 5/6 $\Rightarrow$ $234 \times 8 \times \frac{5}{6}$

= 1560 bits

data rate = $\frac{1560}{3.6 \mu s}$ = 433 Mbps > Shannon's capacity

8, $234 \times 8 \times \frac{3}{4}$ = 1404

data rate = 390 Mbps > Shannon's capacity

7, $234 \times 6 \times \frac{5}{6}$ = 1170

data rate = 325 >

6, $234 \times 6 \times \frac{3}{4}$ = 1053

= 292.5 > Shanno's

5, $234 \times 6 \times \frac{2}{3}$ = 936

= 260 Mbps < Shanno's

We should use MCS scheme of 5 here

g. If coherence BW = 200 KHz,

Delay spread = $\frac{1}{200\,KHz}$

$= 5\,\mu s$

as symbol duration < Delay spread, there will be ISI.

Q2.

a. 190.15.16.19, for indirect routing the correspondent remains unaware of Mobile's location

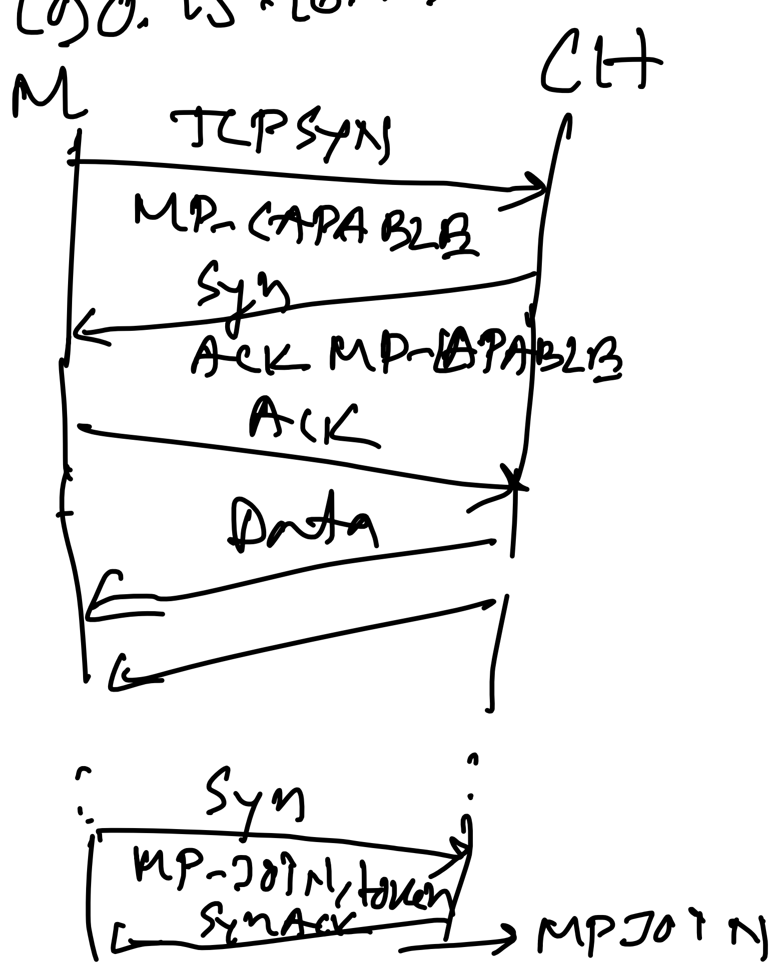
b. 190.15.16.19, the mobile node directly replies back to the sender using the permanent addr.

Q3.

a. In this case, the mobile can no longer directly send packet to the CH as ingress filtering would not allow packets to flow. Thus, here better to use direct routing. In that case, the

CH will contact the homeagent to get the ~~ad~~ current addr. of the mobile & then directly connect at the foreign network. In this, a new TCP connection also needs to be initiated between CH & 220.120.100.90.

b. If the mobility is handled at the transport layer, the MPTCP can take care of this, where the mobile will create another subflow from the new address & join it with conn. initiated from 190.15.16.19. For the same



Q4.

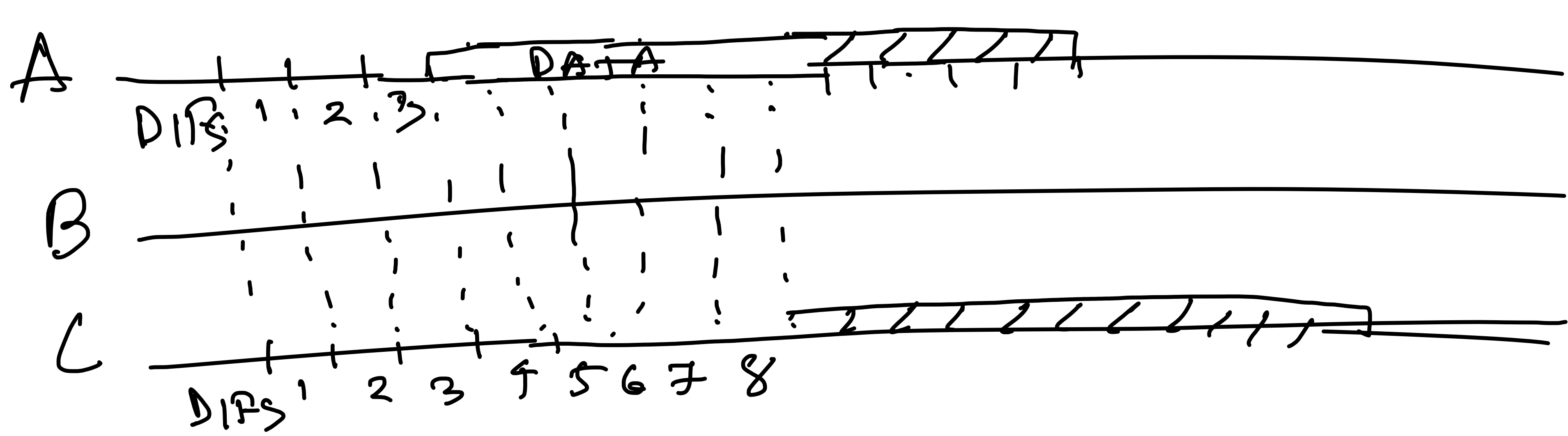
a. Since the IoT nodes would want to maximize their power savings, they should sleep for more time & wake up or receive for lesser time. If the nodes receive this info one-by-one each node need to wake up, see the TIM map, send a PS-poll & receive. Here, multicast could be used to save airtime. Since the data is common multicast is more efficient choice. Where all the nodes will wake up for beacon & get the info about buffered packets from TIM. Then they can send PS-poll frame, the AP would then transmit the data in multicast fashion

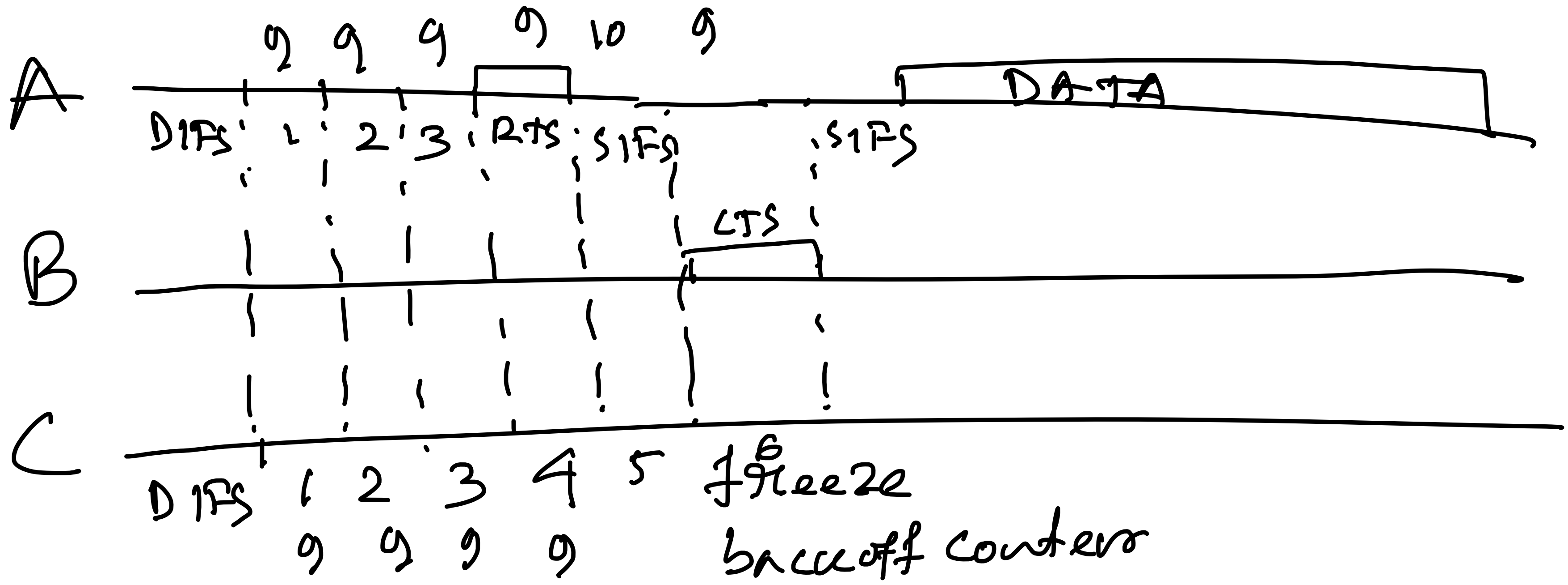
b. The uplink data is different. Here, multicast can not be used. Instead uplink OFDMA can be used to save airtime. In this case the AP will send a Trigger frame to inform the clients about RU allocation & then client can transmit in parallel using OFDMA.

Q5. A B C

Yes, there will be a collision here as A, C are hidden from each others. when they both transmit i.e., initially A, C will sense the channel to be free for DIFS, the start backoff counters. A's backoff counter will reach 0 first & will start transmission. However, C cannot sense this transmission & will keep reducing backoff counter. Once it is expired, C will also start transmissin and collide.

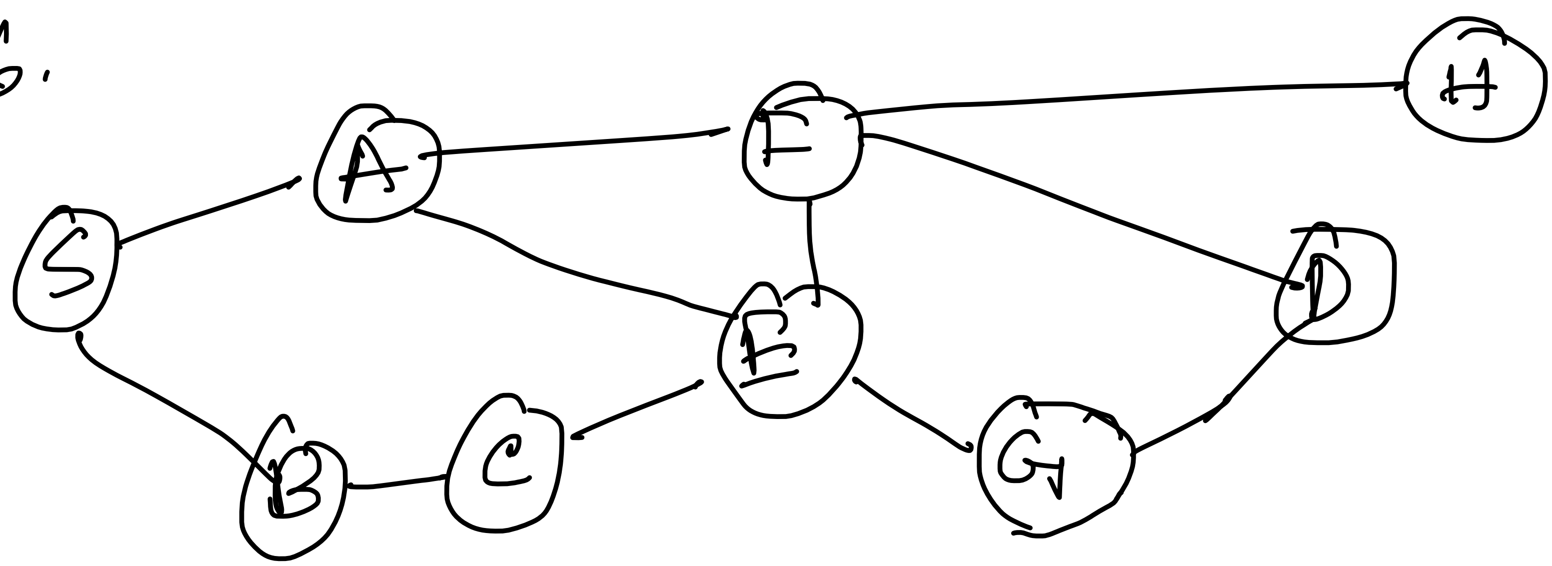
To allow efficient comm, RTS, CTS should be enabled here





Using RTS & CTS help avoiding collision as when CTS is transmitted by B, C can hear it & stops its backoff counters.

Q6.



a. A

Dest	Next hop	Metric
D	F	2*
D	S	4
D	E	3

C

Dest	Nexthop	Metric
D	E	3 *
D	B	5

E

Dest	Nexthop	Metric
D	G	2 *
D	F	2 *
D	C	4
D	A	3

F

Dest	Nexthop	Metric
D	D	1 *
D	H	3
D	E	3
D	A	3

b. A-F, B-F go down

A

Dest	Nexthop	Metric
D	E	3*
D	S	5

C

D	N	M
D	E	3*
D	B	5

E

D	N	M
D	G	2*
D	A	4
D	C	4

F

D	N	M
D	D	1*
D	H	3

c. F, G down

A

D	N	M
D	F	2*
D	S	4

C

D	N	M
D	B	5*

E

X

F

D	N	M
D	D	1*
D	A	3
D	H	3

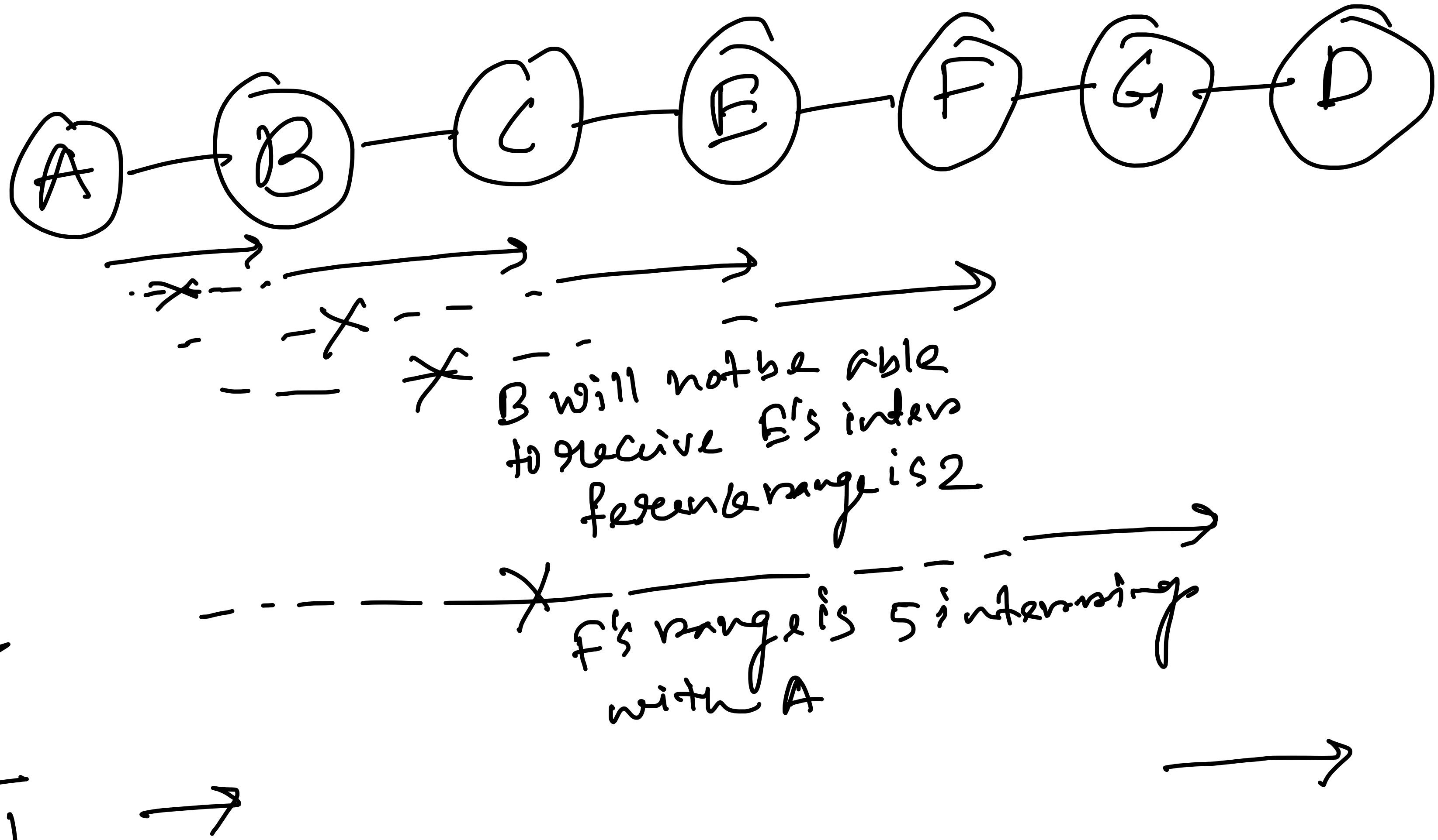
d. node F go down

A

D	N	M

Q7.

a.



A → 2
B → 2
C → 3
E → 2
F → 5
G → 2
D → 1

Thus rate $= \frac{R}{5}$

b. With PIP, there are 3 orthogonal channels.

Slot 1	Slot 2
A → B (Ch1)	B → C (Ch1)
C → E (Ch2)	E → F (Ch2)
F → G (Ch3)	G → D (Ch1)

Thus rate $R = \frac{R}{2}$

Q8.

C1 → WiFi 5 $CW_{min} = 32$, $CW_{max} = 1024$

C2 → WiFi 6 $CW_{min} = 16$, $CW_{max} = 512$

$WiFi_5 = 10\mu s$ $WiFi_6 = 9\mu s$, $SIFS = 10\mu s$

Note that the random value is chosen between $[0, CW]$ if the initial cw is higher for C1, it will likely select a higher random numbers compared to C1. Further, $DIFS = SIFS + 2 \times$ Slot time

for WiFi 5, it is $DIFS = 10 + 2 \times 10$
$= 30\mu s$

for WiFi 6, it is $= 10 + 2 \times 9$
$= 28\mu s$

Thus, when they both wait for DIFS duration for the channel to be free, C2 will find it free earlier & will also pick a smaller random number. Thus, will have an overall better performance compared to C1.