WN

Midsem

1. B = 80MHz

1024 Sub-carriers, 996 data Sub-carriers

Modulation = 256 QAM

Coding rate = 5/6

Guard band = 400ns

a. 80MHz BW means

80M time samples can be sent in 1 sec

∴ 1024 time " $\frac{1024}{80M}$

$= 12.8\mu s$

Guard band = 400 ns

Symbol duration = 12.8 + 0.4

$= 13.2\mu s$

Out of 1024, 996 are data Sub-carriers

Thus data sent in 13.2 μs

$= 996 \times 8 \times \frac{5}{6}$

Thus, 996×5 bits 13.2 μs

Thus bitrate $\Rightarrow \frac{996 \times 8 \times \frac{5}{6}}{13.2} \times 10^6$

$= 503$ Mbps

b. the channel is divided into 4*242 tones, bitrate?

for each users

$242 \times 8 \times \frac{5}{6}$ bits in 13.2 μs

Thus, bitrate $= \frac{242 \times 8 \times \frac{5}{6}}{13.2} \times 10^6$

$\therefore = 122.22$ Mbps

2. one 1500B packet = 8 OFDMA symbols

block ACK = 4 "

normal ACK = 1

CWmin = 15, DIFS = 28, SIFS = 10,

Slot time = 9

b. for OFDMA transmission of data

First DIFS + backoff + Data + SIFS + Block ACK

$= 28 + \frac{15}{2} \times 9 + 10 \times 8 \times 13.2 + 10 + 4 \times 13.2$

$= 1214.3 \mu s$

Out of this effective data duration

$= 1008 \times 13.2 = 1056$

Thus, efficiency $= \frac{1056}{1214.3} \times 100$

$= 86.96\%$

a. for OFDMA data and normal ack through OFDMA

$= DIFS + backoff + Data + SIFS + ACK_1$

$+ SIFS + ACK_2 + SIFS$

$+ ACK_3 + SIFS + ACK_4$

$\cdots + SIFS + ACK_{10}$

$= 28 + \frac{15}{2} \times 9 + 10 \times 8 + (10 \times 10) + (10+1) \times 13.2$

$= 1383.5 \mu s$

Data = 80, efficiency = $\frac{80 \times 13.2}{285.5} \times 100$

$= 76\%$.

* Note that here both data and ACK are sent in OFDMA, thus data & ACK for 4 users will be sent in parallel, however the ACK is normal ACK, thus need to send 10 separate ACKs for 10 aggregate packets.

C. OFDMA for data but ACKs in OFDM fashion but block-ACK thus ACK for each user will be sent one-by-one fashion

$= DIFS + backoff + data + SIFS + ACK_{user1}$
$+ SIFS + ACK_{user2} + SIFS + ACK_{user3}$
$+ SIFS + ACK_{user3}$

$= 28 + \frac{15}{2} \times 9 + \underset{\times 13.2}{10 \times 8} + (4 \times 10) + \underset{\times 13.2}{(4 \times 4)}$

$= 1402.7$

$$\text{efficiency} = \frac{\text{data}}{\text{total}} = \frac{80 \times 13.2}{1402.7} \times 100$$

$$= 75.28\% .$$

3. User A = 1 1 1 0 1 0 0 0

B = 1 0 1 1 1 0 1 1

A. User A → 1 0 is encoded as −1

B → 0

User A sends (1 1 1 −1 1 −1 −1 −1) × 1

= 1 1 1 −1 1 −1 −1 −1

User B Sends (1 −1 1 1 1 −1 1 1) × (−1)

= −1 1 −1 −1 −1 1 −1 −1

in the channel, we get combination of user A & B' signal, thus, we get

$$1 \quad 1 \quad 1 \quad -1 \quad 1 \quad -1 \quad -1 \quad -1$$
$$-1 \quad 1 \quad -1 \quad -1 \quad -1 \quad 1 \quad -1 \quad -1$$

$$0 \quad 2 \quad 0 \quad -2 \quad 0 \quad 0 \quad -2 \quad -2$$

Now the receive to receive user A's data, it correlates with user A's code

$$0 \quad 2 \quad 0 \quad -2 \quad 0 \quad 0 \quad -2 \quad -2$$
$$1 \quad 1 \quad 1 \quad -1 \quad -1 \quad -1 \quad -1 \quad -1$$

$$0 \quad +2 \quad 0 \quad +2 \quad 0 \quad 0 \quad +2 \quad +2$$

$$= +8$$

Thus easily recovers 1 Sent by A

For user B

0 2 0 -2 0 0 -2 -2

1 -1 1 1 1 -1 1 1

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0 -2 0 -2 0 0 -2 -2

$= -8$

Receiver can easily recover -1, i.e, 0 sent by user B

b. User B uses 5 times more power than A

Thus, user A sends

1 1 1 -1 1 -1 -1 -1

User B send

-5 5 -5 -5 -5 5 -5 -5

combined, we get 1 1 1 -1 1 -1 -1 -1

-5 5 -5 -5 -5 5 -5 -5

-4 6 -4 -6 -4 4 -6 -6

Receiver for receiving user A's code

$$-4\ 6 \quad -4\ -6 \quad -4\ 4\ -6\ -6$$
$$1\ 1 \quad 1\ -1 \quad 1\ -1\ -1\ -1$$

$$-4\ 6 \quad -4\ +6 \quad -4\ -4\ +6\ +6$$

$= +6$

For user B

$$-4\ 6 \quad -4\ -6 \quad -4\ 4\ -6\ -6$$
$$1\ -1 \quad 1\ 1 \quad 1\ -1\ 1\ 1$$

$$-4\ -6 \quad -4\ -6 \quad -4\ -4\ -6\ -6$$

$= -40$

Thus receiver, receives user B's data with higher power than user A & thus won't be able to decode user A's data effectively

4. SampleRate – Samples 10th pkt at a rate with lower lossless Tx time

SampleRateDiff – ↑ / ↓ rate higher than current

a. Dest A. Samplerate starts with 54 → 3761, Samples at 48 as lower lossless tx & moves as well as avg is also lower

at 48, does not Sample at 36 Samples at 54 and don't move

SampleRateDiff

54 → Samples at 48?
NO as ① ✓
② Rate 48 < 54

Thus stays at 54 only and don't Sample at 48

b. for Test B

Sample Rate

54 → no Sampling at 48

Sample Rate diff

54 → no Sampling at 46.

5.

a. $AP_1 - C_2 = 36$

$AP_2 - C_2 = 24$

$AP_2 - C_5 = 12$

$AP_3 - C_5 = 24$

$AP_3 - C_{11} = 6$

Suppose, a total of D packets need to Sent thus, if association is not changed i.e, $AP_1 - C_1$

$AP_2 - C_3$

$AP_3 - C_7 - C_{11}$

1

total airtime by multicast packets

$$= \frac{D}{36} + \frac{D}{12} + \frac{D}{6}$$

(1) if C_2 moves to AP_2

$$\frac{D}{12} + \frac{D}{6}$$

(2) if C_5 moves to AP_3 & C_2 at AP_1 only

$$\frac{D}{36} + \frac{D}{6}$$

(3) if C_5 moves to AP_3 & C_2 at AP_2

$$\frac{D}{24} + \frac{D}{6}$$

thus Dinesh will choose (3)

i.e., $C_2 - AP_1$

$C_5, C_7 - C_{11} - AP_3$

b. C_{11} turns off its WiFi interface, thus the frames destined to C_{11} will face 100% losses, thus AP will stop sending frames (in one case multicast) to C_{11} thus others clients will face 100% multicast paced losses, will report this to Discast. Server who will inturn will pick a new target client.

Now, the target client will be the one with poorest channel cw either C_9, C_{10}

0.05, 0.3
0.08 0.13

Now, interms of association,

① $C_2 - AP_1$

$C_5 - AP_2$

$C_7 - C_{10} \rightarrow AP_3$

$$\frac{1}{36} + \frac{1}{12} + \frac{1}{36}$$

$$= 0.133 \times D$$

② $C_2 - AP_2$

$C_5 - AP_2$

$C_7 - C_{10} - AP_3$

$$\frac{1}{12} + \frac{1}{36}$$

$$= 0.06D + 0.027$$

$= 0.107D$

③ $C_2 - AP_2$

$C_5 - AP_3$

$C_7 - C_{10} - AP_3$

$\frac{D}{24} + \frac{D}{24}$

$= 0.04D \times 2$

$= 0.08D$

④ $C_2 - AP_1$

$C_5 - AP_3$

$C_7 - C_{10} - AP_3$

$\frac{D}{36} + \frac{D}{24}$

$= 0.02D + .04D$

$= 0.06D$

④ is least

thus Dircast will choose

$C_2 - AP_1$

$C_5, C_7 - C_0 - AP_3$

C. C_{11} goes to power save mode, then AP will buffer frames destinate to C_{11}. Thus, other Dircast client will face 100% losses & will report to the

Dincast Servers & Servers will in-turn select a new target