HW #3 Solutions

Problem 1

Since the wireless link is collision and error-free, the following cycle of transmissions is repeated:

DATA|SIFS|ACK|DIFS|BO|…

Maximum user throughput = user payload/Total transmission time for payload

Time for SIFS, DIFS, and BO are given as 10μs, 50 μs, and 310 μs.

Time for ACK transmission = ((Ack header =14 bytes)+ (PLCP header = 24 bytes))@(1Mbps)

= 304μs

Problem 1

i) UDP payload of 100 bytes

UDP header of 28 bytes

MAC header of 42 bytes

Total Data: 170 bytes

DATA transmission time:

170 bytes @11 Mbps and (PLCP header = 24 bytes) @ 1 Mbps

= 123.636µs + 192µs = 315.636µs.

Total transmission time = Time for DATA+SIFS+ACK+DIFS+BO

= 315.636µs + 10µs + 304µs + 50 µs+310 µs

= 989.636µs

Maximum user throughput = 100*8/989.636µs = 0.81Mbps

Problem 1

ii) UDP payload of 500 bytes

Total Data: 570 bytes

DATA transmission time:

570 bytes @11 Mbps and (PLCP header = 24 bytes) @ 1 Mbps

= 414.545µs + 192µs = 606.545µs

Total transmission time = 1280.545µs

Maximum user throughput = 500*8/1280.545µs = 3.12Mbps

Problem 1

iii) UDP payload of 1500 bytes

Total Data: 1570 bytes

DATA transmission time:

1570 bytes @11 Mbps and (PLCP header = 24 bytes) @ 1 Mbps

= 1141.818μs + 192μs = 1333.818μs

Total transmission time = 2007.818μs

Maximum user throughput = 1500*8/2007.818μs = 5.98Mbps

Problem 2

ρ= 150 users/sq.mile

FA region = 10 sq.miles

***v* = 10 miles/hour**

Binding lifetime = 2 min

Perimeter = L = $4\sqrt{10}$ = 12.65 miles

Boundary Crossing Rate = ρ vL/π = 300*10*12.65/3.14 = 3.36 crossings/sec

→ # Registration due to mobility = 3.36 registrations/second

 # users per FA region = 300*10 = 3000 users

→ # Registration due to Time-out = 3000/(5*60)= 10 registrations/second

Therefore, the percentage of registration due to mobility is 3.36/(10+3.36) = 25.15%

Problem 3

PCM Voice at 64Kbps using RTP/UDP/IP

10Mbps Ethernet loaded up to 80% = 8Mbps

1a) Packetization interval 20ms → 50 packets / second

Each packet contains 218 bytes including:

- **Voice payload: 64K*20ms = 160 bytes**
- **RTP/UDP/IP header = 40 bytes**
- **Ethernet header = 18 bytes**

Bandwidth requirement for one stream is 218bytes*50*8 = 87.2Kbps

Therefore, number of streams accommodated: 8M/87.2K = 91

Problem 3

1b) Packetization interval 10ms → 100 packets / second

Each packet contains 138 bytes including:

- **Voice payload: 64K*10ms = 80 bytes**
- **RTP/UDP/IP header = 40 bytes**
- **Ethernet header = 18 bytes**

Bandwidth requirement for one stream is 138bytes*100*8 = 110.4Kbps

Therefore, number of streams accommodated: 8M/110.4K = 72

Problem 3

Consider 10ms packetization

2a) IP in IP encapsulation

Packet size becomes 138 + 20 = 158 bytes

Bandwidth per stream 158bytes * 100 * 8 = 126.4Kbps

Number of streams accommodated: 8M/126.4K = 63

Problem 3

2b.) Minimal encapsulation

Depending on whether the entry-point is also the source of the original packet, overhead introduced by Minimal encapsulation is either 8 or 12 bytes.

In the former case, number of streams accommodated = 8M/(146*100*8) =68

In the latter case, number of streams accommodated = 8M/(150*100*8) =66

2c.) GRE encapsulation

Note that GRE uses GRE header and IP encapsulation.

The minimum length of a GRE header is 4 bytes, so we have 24 bytes extra,

Number of streams accommodated = 8M/(162*100*8)=61