Rajat Sethi – ECE 4380 – Exam 1

1.1)

A → R: 8,000 bits / 10,000,000 bps + 3.36 ms = 4.16 ms

R → B: 8,000 bits / 2,000,000 bps + 14 ms = 18 ms

B → C: 8,000 bits / 4,000,000 bps + 3.9 ms = 5.9 ms

C → B (ACK): 800 bits / 4,000,000 bps + 3.9 ms = 4.1 ms

B → R (ACK): 800 bits / 2,000,000 bps + 14 ms = 14.4 ms

R → A (ACK): 800 bits / 10,000,000 bps + 3.36 ms = 3.44 ms

RTT = 50 ms

1.2)

10,000,000 bps * 0.050 s (RTT) = 500,000 bits sent before first ACK returns = 62,500 bytes = 7.8125 frames.

By rounding up, the sliding window count should be **8 frames** to maximize throughput.

1.3)

RTT for B → C = (B → C) + (C → B (ACK)) = 5.9 ms + 4.1 ms = 10 ms

8,000 bits / 0.01 s = **800,000 bps or 0.8 Mbps** throughput.

1.4) A must send at a throughput of 2 Mbps to avoid buffer overflow, which allows for 5 channels.

2.1)

C starts sending at t=0

at t=4, B detects a collision with A's last packet.

B sends a jamming signal to A and C, which takes (9.6 microseconds Tx + 4 microseconds delay) and reaches C at t=17.6

C sends a 32-bit jamming sequence back to B, which takes (3.2 microseconds Tx + 4 microseconds delay) and reaches B at t=24.8

B is finally idle at **24.8 microseconds**.

2.2)

Host C is idle again when it finishes sending its own jamming sequence at **20.8 microseconds.**

2.3)

Host A finishes receiving B's signal at 17.6 microseconds. It sends its packet immediately and collides with B, 4 microseconds later. Another 4 microseconds later, it gets B's jamming sequence, which takes 9.6 microseconds. A is idle again at 35.2 microseconds.

2.4)

There is a 25% chance that A succeeds. If either Host B and C select slot 0 too, then the transmission will collide again. If Host B and C select slot 1, then A's transmission won't collide.

3.1)

t=0, A sends Frames 1, 2, and 3 to R. R sends Frame 1 to B

t=1, Frame 1 reaches B, ACK 1 fails to send back to R. R sends Frame 2 to B.

t=2, Frame 2 reaches B, ACK 2 starts to go back to R. R sends Frame 3 to B.

t=3, Frame 2 ACK reaches R and A, Frame 3 reaches B, ACK 3 starts to go back to R.

t=4, Frame 1 Time-outs, retransmits to R and B. Frame 3 ACK reaches R and A.

t=5, Frame 1 reaches B, ACK 1 goes back to R.

t=6, Frame 1 ACK reaches R and A, sliding window moves forward. Frames 4, 5, and 6 get transmitted to R, where Frame 4 gets sent to B.

t=7, Frame 4 reaches B, ACK 4 starts to go back to R. R sends Frame 5 to B.

t=8, Frame 5 reaches B, ACK 5 starts to go back to R. Frame 4 ACK reaches R and A, A sends Frame 7 to R. R sends Frame 6 to B.

t=9, Frame 6 reaches B, ACK 6 starts to go back to R. Frame 5 ACK reaches R and A, A sends Frame 8 to R. R sends Frame 7 to B.

t=10, Frame 7 reaches B, ACK 7 starts to go back to R. Frame 6 ACK reaches R and A, A sends Frame 9 to R. R sends Frame 8 to B.

The 6th Frame's Acknowledgement comes back at t=10

3.2)

t=0, A sends Frame 1, 2, 3. Frame 1 is sent to B, Frame 2 is queued, Frame 3 is dropped.

t=1, Frame 1 reaches B, returns ACK 1 (which is lost). R sends Frame 2 to B.

t=2, Frame 2 reaches B, returns ACK 2

t=3, Frame 2 ACK reaches R and A.

t=4, Frames 1 and 3 do not send back ACKs and are retransmitted. Frame 1 goes to B, while Frame 3 waits in the queue.

t=5, Frame 1 reaches B, returns ACK 1. R sends Frame 3 to B.

t=6, Frame 1 ACK reaches R and A, A sends Frame 4 and 5 to R. Frame 4 is sent to B, while Frame 5 waits in the queue. Frame 3 reaches B, returns ACK 3.

t=7, Frame 3 ACK reaches R and A, A sends Frame 6 to R. Frame 5 is sent to B, while Frame 6 waits in the queue. Frame 4 reaches B, returns ACK 4.

t=8, Frame 4 ACK reaches R and A, A sends Frame 7 to R. Frame 6 is sent to B, while Frame 7 waits in the queue. Frame 5 reaches B, returns ACK 5.

t=9, Frame 5 ACK reaches R and A, A sends Frame 8 to R. Frame 7 is sent to B, while Frame 8 waits in the queue. Frame 6 reaches B, returns ACK 6.

t=10, Frame 6 ACK reaches R and A, A sends Frame 9 to R. Frame 8 is sent to B, while Frame 9 waits in the queue. Frame 7 reaches B, returns ACK 7.

The 6th Frame's Acknowledgement comes back at t=10

4.1) The Data Link Layer

4.4) An ACK must be sent each time a frame received, even if it's a duplicate.

4.5) Yes, the error can be detected. E(x) = C(x) * P(x). Since E(x) has an x^8, and C(x) has an x^4, then P(x) must have an x^4 as well to remain undetected. However, since C(x) also has an x term, E(x) should also have an x^5 term (since x^4 * x = x^5) for the error to go undetected. Since E(x) does not have a term for x^5, the error can be detected.

4.6) 9.6 microseconds is enough time for a 64-bit preamble and 32-bit jamming signal to come through (assuming a 10 Mbps bandwidth). This helps prevent collisions from happening immediately when a new frame is transmitted.

4.9) 5-bits allows for more encodings, enough encodings to remove any consecutive 0s.

4.10) Channels 1, 6, and 11 do not have overlapping frequencies.