CS/ECE 438: Communication Networks — Fall 2006

Problem Set 3 — Solutions

1. (a) No. It takes 200 bit durations for the signal to propagate to B, and another 200 for B's transmission to make it back, so A will have sent 400 bits at the time.

   (b) A stops after 400 bits and sends 32 bits of jamming signal, so it finishes sending the jamming signal at $t = 432$ bits or 43.2μs after it starts transmission. B starts sending after 200 bit durations. It detects a collision with A but finishes its preamble and then sends 32 bits of jamming, for a total finish time of $t = 200 + 64 + 32 = 29.6\mu$s.

   (c) B's jamming signal finishes arriving at A at $t = 296 + 200 = 496$ bits, or 49.6 μs. A's jamming signal finishes arriving at B at $t = 432 + 200 = 632$ bits or 63.2μs.

   (d) A transmits at $t = 49.6\mu$s, and its transmission reaches B at $t = 69.6\mu$s. B itself transmits at $t = 63.2\mu$s, so it's had enough time to send the preamble and it just jams for 32 bits, finishing at time $t = 72.8\mu$s. A hears the collision at $t = 83.2\mu$s and jams until $t = 86.4\mu$s. So A hears the channel become idle at $t = 72.8 + 20 = 92.8\mu$s, and B hears it idle at $t = 86.4 + 20 = 106.4\mu$s.

   (e) If B starts transmitting at $t = 106.4\mu$s, its signal will reach A at $t = 126.4\mu$s. A will still be waiting for its 512 bit durations, since $92.8 + 51.2 = 144.0\mu$s, so at that point A will stay silent and let B finish its transmission.

2. (a)

$$q_i = \frac{1}{2^{i-1}}$$

   (b)

$$p_i = \left(\prod_{j=1}^{i-1} q_j\right) \cdot (1 - q_i)$$

$$\begin{aligned} p_1 &= 0 \\ p_2 &= 0.5 \\ p_3 &= 0.375 \\ p_4 &= 0.109 \\ p_5 &= 0.015 \end{aligned}$$

   (c) If A picks 0 (with probability 1/2), it wins if B does not pick 0, which happens with probability 3/4. If A picks 1, it wins if B picks 2 or 3, which happens with probability 1/2. So A wins with probability $1/2 * 3/4 + 1/2 * 1/2 = 5/8$.

(d) In general, we can see that A wins after i collisions with probability:

$$w_i = \frac{2^i - 1 + 2^i - 2}{2^{i+1}}$$

The chance of winning all 10 frames is surprisingly high:

$$\prod_{i=2}^{11} w_i \approx 0.419$$

3. (a) i. The node sends for THT seconds and then waits for RingLatency for the token to rotate around the network before sending again. So the fraction of useful time is THT/(THT + RingLatency).

   ii. THT should be infinite; i.e. the station should send continuously without releasing the token.

   iii. TRT $\leq$ RingLatency + THT*N

   (b) i. After the host transmits its 1024 bit packet (taking 102.4μs), it needs to wait for one RingLatency for the end of the packet to arrive so it can release the token, and another RingLatency for the token to rotate around the ring. So it takes a total of 102.4+150*2 = 402.4 μs to send 1024 bits, giving a throughput of 2.54 Mbps.

   ii. The total token rotation time is going to be N*(150+500)+150, since each host will need to wait for RingLatency before releasing the token.

   iii. With immediate release, the TRT is N*500+150, as in (a).iii. Out of this time, N*500 is spent on useful transmissions, so the throughput is:

$$10\text{Mbps} * \frac{N * 500}{N * 500 + 150}$$

4. (a) The following edges will be left out: (B6,F), (B6,D), (B7,I)

   (b) This part of the problem will not be graded because of some confusion about the functionality of bridges. Bridges will be reviewed in class on October 11th.

   (c) (B6,D) and (B7,I) are not used in the new tree.