15-441: Computer Networks
Homework 1

Assigned: Sep 2, 2011
Due: ~~Sep 15, 2011~~ Sept 20, 2011 1:30 PM in class
Lead TAs:
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Units	
1 Byte	8 bits
1 KByte	2^{10} bytes
1 Mbps	10^6 bits per second
1 GHz	10^9 Hz

1. [Sec 1.5] Calculate the total time required to transfer a 1500 KByte file in the following cases, assuming a RTT of 10ms, a packet size of 1500 bytes, and an initial 3 RTT of handshaking before the actual data is sent.
   (a) The bandwidth is 10 Mbps and data packets can be sent continuously.
   (b) The bandwidth is 10 Mbps, but after we finish sending each data packet we must wait one RTT before sending the next
   (c) The bandwidth is infinite, i.e., the transmit time is zero, but only up to 25 packets can be sent per RTT

2. [Sec 2.6.2] This problem illustrates possible danger of incorporating randomization in design.

   Let A and B be two stations attempting to transmit on an ethernet. Each has a steady queue of frames ready to send; A's frames will be numbered A_1, A_2 and so on, and B's similarly. Let T = 51.2 μs be the exponential backoff base unit. Suppose A and B simultaneously attempt to send frame 1, collide, and happen to choose backoff times of 0 x T and 1 x T, respectively. As a result, A transmits A_1 while B waits. At the end of this transmission, B will attempt to retransmit B_1 while A will attempt to transmit A_2. These first attempts will collide, but now A backs off for either 0 x T or 1 x T, while B backs off for time equal to one of 0 x T, ..., 3 X T.
   (a) Give the probability that A wins this second backoff race immediately after its first collision.
   (b) Suppose A wins the second backoff race. A transmits A_2 and, when it is finished, A and B collide again as A tries to transmit A_3 while B tries once more to transmit B_1. Give the probability that A wins this third backoff race immediately after the first collision.
   (c) Give a reasonable lower bound for the probability that A wins all the remaining backoff races.
   (d) What then happens to the frame B_1?

   This scenario is known as the ethernet capture effect.

3. [Sec 1.5] Consider a network with a ring topology, link bandwidths of 1000 Mbps, and propagation speed 2×10^8 m/s.

(a) What would the circumference of the loop need to be to exactly contain one 1500 byte packet, assuming nodes do not introduce delay?

(b) What would the circumference of the loop need to be to contain at least one 1500 byte packet, if there was a node every 250 m, and each node introduced 32 bits of delay (bit time cost in queue)?

4. [Sec 2.2] Chuck, an ex-441 student, is given the task of building a new network link technology. Unfortunately, many of his beta-testers complain that their packets get corrupted when using his technology! He tracks the problem down to time synchronization problems between the sender and receiver on the link. Perhaps you can help Chuck solve his problems by telling him a little about different encoding methods:

   For each of these sub-parts, identify whether the encoding can have problems with:

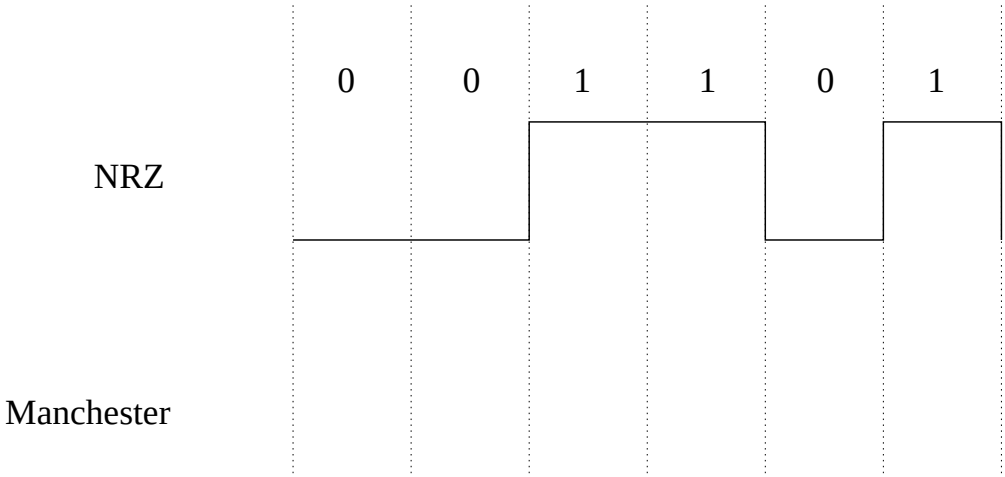
   A. Long strings of 0s
   B. Long strings of 1s
   C. Both long strings of 1s or long strings of 0s
   D. None of the above

   (a) Manchester encoding

   (b) NRZ encoding

   (c) NRZI encoding

   (d) Draw the digital waveform corresponding to the Manchester encoded version of this sequence of 0s and 1s. We've given you the NRZ version as a reference.



5. [Sec 2.2] For this problem, assume that the ethernet network uses Manchester encoding. Assume that the hosts on this ethernet network do not have synchronized clocks. Why does this allow collisions to be detected soon after they occur, without waiting for the CRC at the end of the packet?

6. [Sec 2.1]

   (a) For an ideal channel of 2.4 GHz bandwidth, what is the maximum channel capacity in bits per second?

   (b) For a noisy channel of 2.4 GHz bandwidth and signal-to-noise ratio $\left(\frac{S}{N}\right)$ of 1000, what is the maximum channel capacity in bits per second?