EECS 122: Introduction to Communication Networks

Homework 8

(12 points)

Due: 1999-Nov-01-Mon (in class, or 467 Cory by 2pm)

Problem 1. (2 points) In homework 7 problem 2 we calculated the throughput and efficiency (in the absence of transmission errors) of the alternating bit protocol using 440 byte data packets and 60 byte ack packets over a link with a 5 ms propagation delay in each direction. We found alternating bit to be very inefficient over links with very high data rates—at 1 Gbps, the throughput was 99.96 packets per second, which implies an efficiency of only 0.035%. Let's try replacing the alternating bit protocol by a sliding window protocol. At 1 Gbps, what would the throughput and efficiency if the window size were 10 packets? 100? 1000? 10,000?

Note For problems 2–5, you will need to refer to the notes from the Oct-20 lecture.

Problem 2.

a) (food-for-thought) Show that two-dimensional parity can detect all 3-bit errors.

b) (1 point) Give an example of a 4-bit error that it cannot detect.

c) (food-for-thought) Show that it can correct all 1-bit errors.

d) (food-for-thought) Show that it cannot correct any 2-bit errors.

Problem 3.

a) (1 point) Suppose the message 1100100100101010 is transmitted using CRC-8. What is the transmitted codeword? (Reminder: The CRC calculation is a division of polynomials, not a division of integers, so there is no carrying. Also, it's modulo 2, so $2x^i = 0$ and $-x^i = x^i$. Although it uses more ink, it may be easier to understand the calculation in its polynomial form than in its bit-string form.)

b) (1 point) Suppose the third, fourth, and fifth most significant bits of the codeword are inverted. What is the result of the receiver's CRC check?

c) (1 point) How does the receiver know an error has occurred?

Problem 4. Consider the convolutional code using the automaton presented in the slides (it's the same automaton as in figure 6.18 of the textbook).

a) (1 point) To send the message 101001, what is transmitted by the encoder?

b) (1 point) Suppose the channel inverts the second and third bits. What message does the decoder output?

c) (food-for-thought) For the same message, find a 1-bit error for which the receiver might not reconstruct the original message.

Problem 5. TCP Tahoe uses two algorithms to adjust the congestion window: *congestion avoidance* (increase the window by one packet per round-trip time until a loss occurs, then reset it to one), and *slow start* (double the window once per round-trip time, but switch to congestion avoidance when doubling the window would exceed half the number of packets that were unacknowledged when the last loss occurred). Suppose a channel has a constant round-trip time RTT and is able to carry 32 packets per RTT (so if more than 32 are sent, only the first 32 arrive).

a) (1 point) If only the congestion avoidance algorithm is used, what is the throughput in packets per RTT? What is the efficiency of the protocol? Assume no transmission errors, but of course packets must be lost when the channel is congested. Assume no other traffic uses the channel. You can use a simple analysis in which you divide time into slots of one RTT each, and count the number of packets delivered in each slot. You may assume that the sender reacts to a loss in the very next slot (in real life it would take a little longer).

b) (1 point) As the rate of the channel increases (it is able to carry more packets per round trip), the efficiency approaches what?

c) (1 point) Going back to the link that can carry at most 32 packets per RTT, if the protocol uses both congestion avoidance and slow start, what are the throughput and efficiency?

d) (1 point) As the rate of the channel increases, the efficiency approaches what?