# EECS 563
# Homework 10

1. Perform the bit stuffing procedure for the following binary sequence:
110001111111101111111101001

2. Perform bit de-stuffing for the following sequence: 11101111101111100111110.

3. Consider the various combinations of communication channels with bit rates of 10 Mbps and 10 Gbps over links that have roundtrip times of 0.1 msec and 10 msec.

a. Find the delay-bandwidth product (in Mbits) for each of the combinations of speed and distance.

b . A protocol uses a 16-bit sequence numbers (n=16) to count individual transmitted bytes. How long does it take for the sequence numbers to wrap around?

c. Suppose 16-bit sequence numbers (n=16) are used to transmit blocks of 1250 bytes over the above channels. How long does it take for the sequence numbers to wrap around, that is, to go from 0 up to $2^n$?

4. Three possible strategies for sending ACK frames in a Go-Back-N setting are as follows: send an ACK frame immediately after each frame is received, send an ACK frame after every other frame is received, and send an ACK frame when the next piggyback opportunity arises. Which of these strategies are appropriate for the following situations?

a. An interactive application produces a packet to send each keystroke from the client; the server echoes each keystroke that it receives from the client.

b. A bulk data transfer application where a server sends a large file that is segmented in a number of full-size packets that are to be transferred to the client.

5. Consider a 1 Mb/s link and with a one-way propagation delay of 5 ms.

a. What is the efficiency for Stop-and-Wait ARQ if the frame size is 1250 Bytes and 6250 Bytes.

b. Repeat part a) for a 50 ms one-way propagation delay.

c. Use Stop-Wait-Efficiency-Trade-offs to check your answers.

6. Consider a 2.5 Mb/s link and with

a. For a a one-way propagation delay of 2 ms find the efficiency of a sliding window Go-Back-N ARQ if 3-bit sequence numbering is used with frame sizes of 100 Bytes bits, 200 Bytes and 525 Bytes .

b. Repeat part a. for a 4 ms one-way propagation delay.

c. Repeat part a. for a 8 ms one-way propagation delay.

d. Use Sliding Window Efficiency Trade-offs to check your answers. Your answers can also be verified using the simulation of a Sliding Window Data link Control Protocol .

7. A sliding window Go-Back-N ARQ protocol is used for a 2.5 Mb/s link with a one-way propagation delay of 5 ms. The frame size is 250 bytes.

a. How many bits are needed in the sequence number to achieve 100% efficiency?

b. What window sizes will limit the senders rate to about 1.25 Mb/s and 625 kb/s?

c. Use Sliding Window Efficiency Trade-offs to check your answers. Your answers can also be verified using the simulation of a Sliding Window Data link Control Protocol .

8. Explain the role of all of the protocol fields in an HDLC frame.

9. Constant length packets of length 2000 bits are input to a token bucket. The token arrival rate is 200 tokens/sec and the token buffer can hold 10 tokens. Packets not conforming to the average rate and maximum burst size are dropped. The link rate is 1 Mb/s.

a. What is the average rate in b/s leaving the token bucket?

b. What is the maximum burst size in bits for traffic leaving the token bucket?

10. What is a disadvantage of using a selective repeat ARQ?