CS 421: Computer Networks **SPRING 2004**

MIDTERM I
April 7, 2004
120 minutes

Name: ______________________________

Student No: ___________________________

1)

a) Consider a 1 Mbits/sec channel with a 10 msec one-way propagation delay. We want to transfer a file of size 8000 Bytes. Each packet carries a header of 40 Bytes long and the maximum number of data bytes in a packet is 960 Bytes. When there is data to be transmitted, each packet contains the maximum number of bytes. Assume that ACK packets are of 125 Bytes long and there is a processing delay of 1 msec after a packet is fully received until the transmission of the corresponding ACK is started. Selective Repeat protocol is used with a window size of N = 5 packets.

   i. (5 pts) Assume there are no transmission errors and no lost packets or ACKs. How much time is required to complete the transfer of the whole file and receive the final ACK?

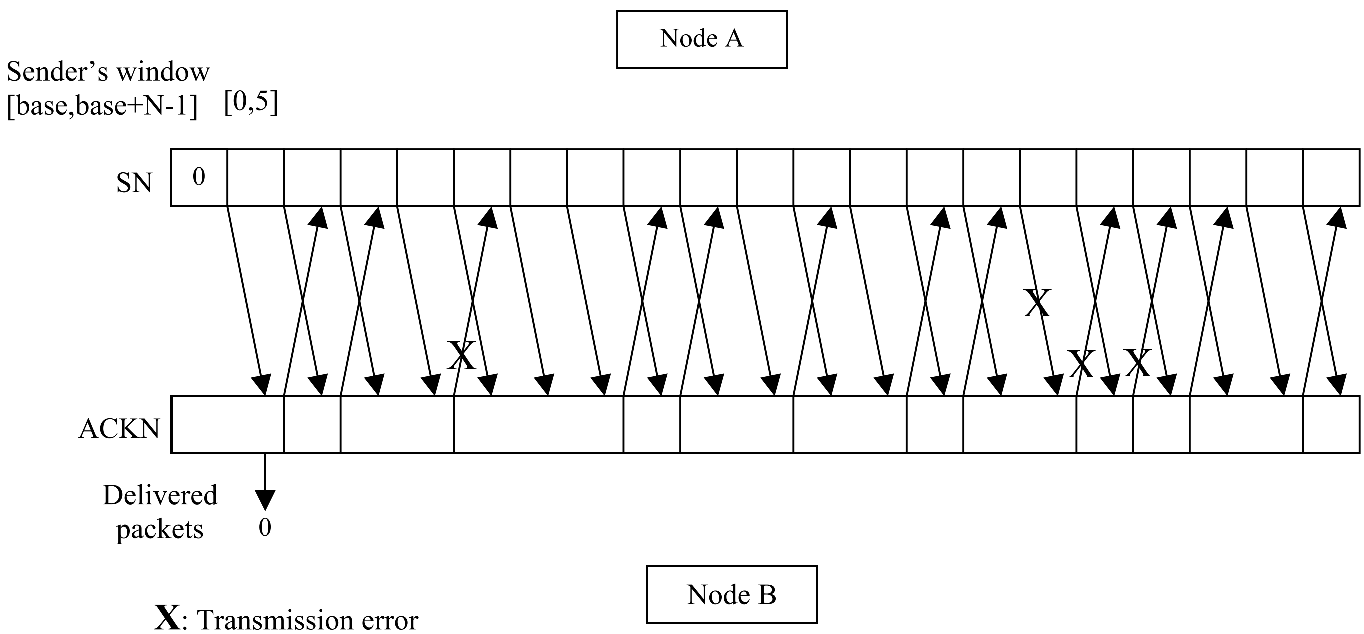
   ii. (10 pts) Now assume every 8^{th} packet crossing the forward channel is lost while ACKs are not lost or corrupted. How much time is required to complete the transfer of the whole file and receive the final ACK?

b) (10 pts) Compare and contrast HTTP and SMTP in **<u>at most five sentences</u>**.

2)

a) (10 pts) Suppose that segments each with a transmission time of 1 msec are sent using the Stop-and-Wait protocol. Assume that one-third of the time, a feedback is returned 3 msec after the end of transmission. This received feedback is an ACK with probability ¾, and it is a NAK with probability ¼. One-third of the time, the feedback is returned 5 msec after the end of transmission. Similar to the above case, this received feedback is an ACK with probability ¾, and it is a NAK with probability ¼.The other one-third of the time, the packet is lost, and after a timeout of 6 msec (from the end of the transmission) the packet is retransmitted. We assume that the reverse channel, i.e., the channel from the receiver to the sender, is perfectly reliable. Assume that each time an ACK is received, a new segment is sent. Find the average time from the start of a segment transmission until the acknowledgment that the segment is received successfully arrives at the transmitting node. Also find the average rate of successful segment transmissions/second.

b) (15 pts) Consider the use of Go-Back-6 protocol for communication from Node A to Node B. Assume that when the sender reaches at the end of the window, i.e., all packets in the window are sent but not ACK'd, the sender goes to the beginning of the window and retransmits all packets in the window, as if the timeout occurred. In the following figure, indicate the sequence number (SN) for packets sent from A to B, the ACK number (ACKN) for packets sent from B to A, the times and SN of the packets at B delivered to the application layer, and the window kept at A. **Note that packets received during the transmission of another packet will be immediately processed, but the corresponding action, e.g., update of SN/ACKN, will take effect with the start of transmission of the next packet.**



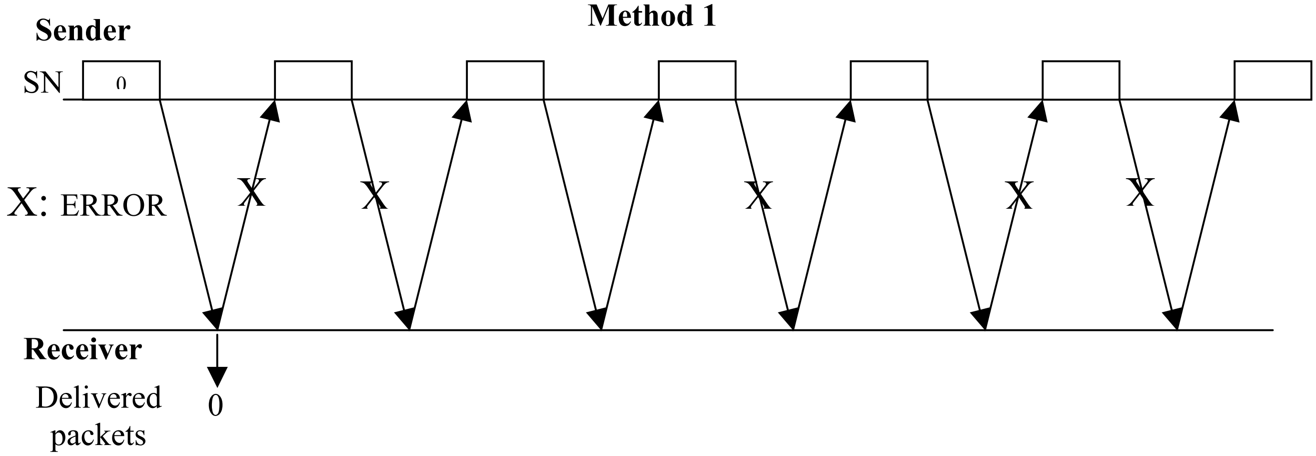
3) Consider the Stop-and-Wait protocol over a link where there are **no** lost segments, but transmission errors can occur. Suppose that we can use the following two methods for generating the feedback information.

Method 1: After each reception the receiver sends an ACK or NAK message informing the sender whether the last received segment contains any detected errors (**no numbering** is used for ACKs and NAKs).

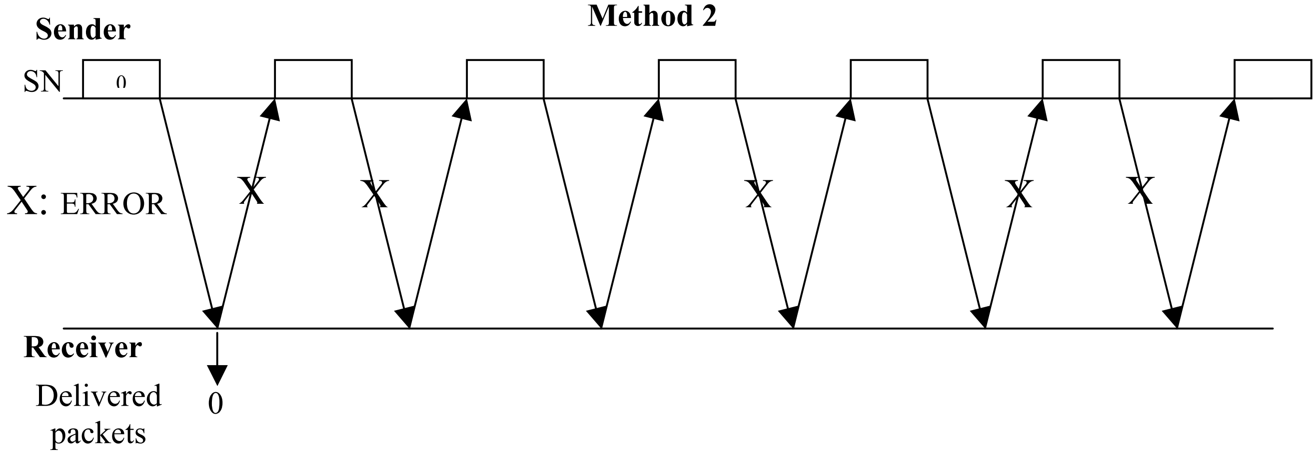
Method 2: The receiver sends the sequence number of the next awaited segment (request number) after each segment is received.

a) (7 pts) Suppose a sequence of transmissions between the sender and receiver is given by the following illustration. For both methods, indicate the sequence number (SN) for segments sent from the sender to the receiver, type of the feedback, i.e., ACK or NAK (for Method 1), or request number (for Method 2) for segments sent from the receiver to the transmitter, the times and SNs of the packets at the receiver delivered to the application layer.

Method 1



Method 2



b) (13 pts) In this part, we will show that Method 2 is more efficient than Method 1. Let p_1 be the probability that segments sent from the sender to the receiver will be received with errors, and let p_2 be the probability that segments sent from the receiver to the sender will be received with errors. Let N_i be the average number of transmissions starting from the first transmission of a segment until the segment is successfully received for Method i, $i = 1,2$. Compute N_1 and N_2, and show that $N_2 \le N_1$.

4)

a) (15 pts) Suppose that the sequence number is represented by k bits. We showed in the class that the window size, N, with the Selective Repeat protocol needs to satisfy $2^k \geq 2N$ so that no dilemma will occur at the receiver. Obtain the analogous relation between k and N for the Go-Back-N protocol, and prove that the receiver will not have any problems if this relation is satisfied.

b) (7 pts) There are two loss events in TCP: three duplicate acknowledgements and timeout. Which one of these events is an indication of a more severe congestion? Justify your answer in **at most three sentences**.

c) (8 pts) Suppose upon receiving a segment containing N Bytes of data, the TCP receiver divides the received data into M parts, where $M \leq N$, and sends M separate acknowledgements each covering one of the M distinct pieces of the received data sequence instead of sending a single acknowledgement. Explain what sort of problems may arise due to this TCP receiver behavior. **Use at most three sentences.**