CS 421: Computer Networks **SPRING 2010**

MIDTERM
March 30, 2010
120 minutes

Name: _____

Student No: _____

Show all your work very clearly. Partial credits will only be given if you carefully state your answer with a reasonable justification.

Q1	
Q2	
Q3	
TOT	

1)

a) (6 pts) Make an estimate of the time it will take to send a 1MB file from Van to Istanbul over a 800Mbps microwave link for the first half of the distance, through a router in Amasya, and then the rest of the journey over a 10Gbps fiber optic link. (Note: be sure to list any assumptions you make in solving this problem.)

b) (6 pts) Consider distributing a file of 10 Gbits to 100 peers. The server has an upload rate of 20Mbps, and each peer has upload rate of 200Kbps and download rate of 1Mbps. How long will it take to distribute the file using client-server distribution? How long using P2P distribution?

c) (6 pts) If an HTTP client wants to get a Web page, but knows only the URL of the HTTP server, what application-layer and transport-layer protocols are needed to download the page?

d) (6 pts) Why does an application have more control of what data is sent in a segment using UDP than it does when using TCP? Why does an application have more control of when the segment in sent when using UDP than it does when using TCP?

e) (6 pts) Assume that a TCP sender sends a large amount of data and then goes idle at time t_1 (because it has no more data to send), and that it remains idle for a relatively long period of time. At time t_2, it has more data to send and begins sending again. What are the advantages and disadvantages of using the CongWin and ssthresh values from t_1, when it begins sending data at t_2?

2)

a) (10 pts) Consider a 1 Mbits/sec connection with a 14 msec one-way propagation delay, i.e., 28 msec roundtrip propagation delay. We want to transfer a file of size 9000 bytes. Each segment has a total size of 625 bytes including the 25-bytes header. When there is data to be transmitted, each segment contains the maximum number of bytes. Assume that ACK segments have a size of 125 bytes and there is a processing delay of 1 msec after a segment is fully received at the receiver until the transmission of the corresponding ACK is started. Assume that the processing delay at the sender after an ACK is received is negligible. **Go-Back-N** protocol is used with a window size of N = 8 segments. Assume that **data packets are not corrupted or lost, but every 6th ACK message crossing the reverse channel is lost**. The timeout for each window is set to 40 msec starting from the beginning of the sender's window. How much time is required to complete the transfer of the whole file and receive the final ACK at the sender?

b) (10 pts) Redo Question 2.a for the **Selective Repeat** protocol. Assume that the timeout for each segment is set to 40 msec starting from the end of the transmission of the segment.

c) You have developed a new reliable data transport protocol called **Go-Bilkent-Go**. This protocol sends 5 segments in a row and then waits to receive a single ACK for all five segments. If one of the five segments is received in error (assume no segments are lost), the receiver discards all other segments and sends a NAK. When the sender receives a NAK, it has to retransmit all five segments. In this problem, you can ignore the processing times of segments and ACKs/NAKs at the hosts, but you need to take into account all other sources of delay. We have the following notation:

- T = one-way end-to-end delay in seconds (including propagation, queuing, store-and-forward and processing delays inside the network)
- N_A = number of bits in an ACK or NAK segment
- N_D = number of bits in a data segment (including header)
- N_H = number of header bits in a data segment
- p = probability that a data segment is received with errors (assume that ACK/NAKs are perfectly reliable)
- R = transmission rate in bps between the sender and receiver

i) (8 pts) Calculate the average duration for sending five segments and receiving the corresponding ACK. *Hint:* Recall that $\sum_{k=1}^{\infty} k(1-q)^{k-1} = \frac{1}{q^2}$.

ii) (5 pts) Calculate the net (excluding retransmissions and overhead) average rate of data transfer between the sender and the receiver.

3)

a) (8 pts) A TCP sender is transmitting 1250-byte segments over a 100 Mbps ($100x10^6$ bits/sec) connection which has a 10 msec one-way delay. TCP receiver sends back 125-byte ACK packets. Assume further that a very large amount of data is transferred and no packets are lost or experience errors. The sender utilization (U_{sender}) is defined as the percentage of time the sender is busy transmitting bits (same as defined in the textbook). Remember that the receive window field in the TCP header is 2-bytes long. What is the maximum value of U_{sender} possible for this connection assuming that window scaling is not used?

b) (9 pts) Suppose a TCP connection experiences round-trip times (RTT) of 10 msec for 50% of its packets, 20 msec for 45% of its packets, 100 msec for 5% of its packets and no packets are lost. Assume that the timeout is equal to the estimated mean (EstimatedRTT) plus 4 times the estimated deviation (DevRTT), i.e., TimeOut = EstimatedRTT+4xDevRTT. TCP calculates the Estimated RTT and DevRTT such that they are equal to their true (ensemble) averages, i.e., EstimatedRTT = E[SampleRTT] and DevRTT = E[|SampleRTT-EstimatedRTT|]. Will there be any premature timeouts? If yes, what fraction of the packets will be assumed lost by the TCP sender (although there are actually no lost packets)?

c) Assume that hosts A and B are directly connected over a 1 Gbps link. There is a TCP connection between two processes, one running at Host A and the other at Host B, in order to transfer a very large file from Host A to Host B. The application running at Host A can write data to its TCP send buffer at 100 Mbps, whereas the application running at Host B can read data from its TCP receive buffer at 50 Mbps.

   i) (5 pts) What is the average rate of data transfer from the application at Host A to the application at Host B? Justify your answer.

   ii) (5 pts) Describe the effect of TCP flow control on this file transfer.

d) (10 pts) Assume that the congestion window of a TCP flow was 18 segments long when a timeout occurred. Assume that there are no segments or acknowledgments of this flow that were in transit when the timeout occurred. The round trip delay for the flow is fixed and is equal to 50 msec and the transmission time for a segment is 5 msec. The receive window is fixed at 100 segments for the entire duration of the connection. What is the minimum time the flow will spend in the Slow Start phase after the timeout before reaching the Congestion Avoidance phase?