CS 421: Computer Networks **SPRING 2011**

MIDTERM
April 7, 2011
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) (5 pts) Consider a modification in SMTP such that the sender's user agent directly contacts with the receiver's mail server instead of using his/her own mail server as the intermediate server. What might be a possible problem with this modified SMTP?

b) (5 pts) Suppose you are developing an application which can tolerate some loss, but which is very sensitive to delay. Which of the two transport layer services, namely TCP and UDP, will you prefer? Fully justify your reasonings by discussing the advantages and disadvantages of using the two alternatives.

c) (5 pts) Although UDP header contains a checksum for error detection and errored segments are discarded, why is UDP still considered as an unreliable protocol?

d) (5 pts) Give an advantage of using cumulative acknowledgements compared with selective acknowledgements.

e) (5 pts) Give a disadvantage of using cumulative acknowledgements compared with selective acknowledgements.

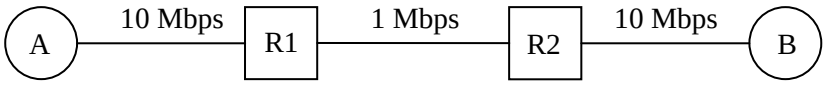
f) (5 pts) In earlier versions of TCP, the retransmission timeout was set to 2 x EstimatedRTT. It was changed later to the currently used method. What was the problem with the timeout calculation method in earlier versions of TCP?

2)

a) Assume that there are 3 links on a path connecting hosts A and B passing through routers R1 and R2 as shown in the following figure. Each link has a distance of 400 km and the transmission rate of each link is shown in the figure. We are transmitting a file composed of **five packets** from node A to node B using datagram packet switching. Each packet has a length of 1000 Bytes including all headers. Assume that the processing and queuing delays in each intermediate node are negligible and the propagation speed is $2x10^5$ km/s.

i. (7 pts) Calculate the total delay incurred in transferring the file from node A to node B.

ii. (3 pts) What is the average rate of data transfer, in bps, in the above file transfer assuming that each packet contains a 40 Byte header?



b) (7 pts) Suppose you use the Go-Back-N protocol for reliable data delivery over a connection with an end-to-end delay of 20 msec. The data is transferred using segments each with a size of 1000 Bytes and ACK packets have a size of 40 Bytes. The connection is perfectly reliable with a transmission rate of 10 Mbps. What should be the minimum window size, in segments, so that the sender achieves full utilization for this connection?

c) (10 pts) Consider a connection with a 5 msec one-way propagation delay, i.e., 10 msec roundtrip propagation delay. We want to transfer a file composed of 20 segments (with sequence numbers from 1 to 20), where each segment has a transmission time of 1 msec. Assume that ACK segments have negligibly small size and there is no processing delay at the receiver. Assume also that the processing delay at the sender after an ACK is received is negligible. We assume that the communication between the sender and receiver is fully duplex, i.e., sender can send data segments while receiving an ACK segment. **Selective Repeat** protocol is used with a window size of N = 8 segments. Assume that the **first transmissions** of the segments with sequence numbers **7, 13 and 19** are errored, whereas no other data segments are errored/lost and **all retransmissions and all ACK packets are fully reliable**. The timeout for each data segment is set to 20 msec starting from the end of the transmission of the segment. How much time is required to complete the transfer of the whole file and receive the final ACK at the sender?

d) (10 pts) Answer c) when **Go-Back-N** protocol is used with a window size of N = 8 segments and with a window timeout of 20 msec starting from the end of transmission of the first segment in the window.

3)

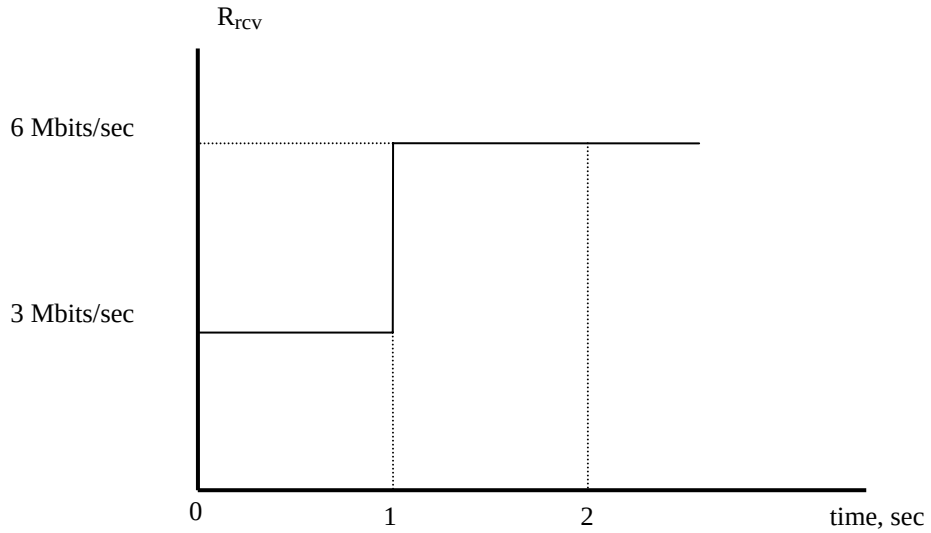
a) (7 pts) Consider the RTT estimation algorithm for setting the retransmission TimeOut used by TCP as we discussed in the class:

$$\text{EstimatedRTT}(k+1) \leftarrow (1 - \alpha)\,\text{EstimatedRTT}(k) + \alpha\,\text{SampleRTT}(k+1)$$

for k = 1,2,…, where EstimatedRTT(1) = SampleRTT(1). Assume that α is unknown. Assume that a TCP sender A first measures the sample round trip time as 16 msec for the first packet, and A thus sets EstimatedRTT(1) to 16 msec. The next sample round trip time that A measures is 48 ms. In response, A sets EstimeatedRTT(2) to 24 msec. The next sample round trip time that A measures is 20 msec. What is EstimatedRTT(3) computed by A?

b) (8 pts) Suppose we have a web server and a web client connected by a link of rate R bits/sec. Let RTT be the round-trip delay of the link. Let S denote the maximum segment size of TCP. Suppose the client would like to retrieve a file of size F, F = 10*S, from the server using the HTTP protocol. Assume that the SYN segment, SYNACK segment, HTTP request message and TCP ACK segment all have negligibly small sizes, i.e., their transmission times can be taken as 0. All data segments, i.e., segments containing file content, on the other hand have sizes equal to S. Ignore the sizes of all the protocols headers. Assume that the server and the client can send/receive an ACK while receiving/sending data. Let T be the period from the time at which the client initiates the TCP connection to the server until the time at which the client has completely downloaded the file. Calculate T in terms of S/R when RTT = 4*(S/R). Assume that the slow-start threshold, ssthresh, is infinitely large and there are no segment losses so that the TCP connection will be in the slow-start phase during the whole transmission of the file.

c) (6 pts) Suppose that R_{rcv}, the rate at which bits are arriving to a TCP receive buffer, is given in the following figure as a function of time. The application process at the receiver can remove bits from the receive buffer at the maximum rate of 5 Mbits/sec ($5x10^6$ bits/sec). Assume that the receive buffer is initially empty and it has a fixed size of 150,000 Bytes. What is the value of the Receive Window advertised by the receiver at t = 2 sec?



d) (6 pts) Assume that the congestion window of a TCP flow was 24 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, i.e., the time from the completion of a segment transmission until the corresponding ACK is full received is equal to 10 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?

e) (6 pts) Suppose that there are two TCP connections sharing a bottleneck link which has a bandwidth of 10 Mbps, i.e., all other links that these two connections pass through have bandwidths significantly larger than 10 Mbps. The first connection has a round-trip delay of 10 msec, whereas the second connection has a round-trip delay of 15 msec. Calculate the average throughputs achieved by each connection.