CS 421: Computer Networks **SPRING 2014**

MIDTERM
April 3, 2014
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) Which switching paradigm can support more users: circuit or packet switching? Justify your answer.

b) (5 pts) A modification is proposed for DNS so that local name servers will also cache negative results, i.e., names or domains that could not be resolved, in order to reduce the query traffic to root servers. Will this modification be more effective if the erroneous queries for non-existent domains are generated mostly by users typing wrong URLs into their browsers by mistake, or if they are generated by malicious programs repeatedly trying to resolve a non-existent domain name?

c) Suppose that we want to design a reliable data transfer protocol that only uses negative acknowledgments (NAK). The sender operates in a selective repeat fashion with an extremely large window. The sender only retransmits a segment when it receives a NAK from the receiver. The network between the sender and receiver may lose or corrupt messages, and the delays are variable and unknown.

   i) (5 pts) Would sequence numbers be necessary in this protocol? Why?

   ii) (6 pts) Would a timer be necessary in this protocol? Why? If so, would it be preferable to have the timer at the sender or receiver? Why?

   iii) (5 pts) Give an advantage of this NAK-based protocol compared with the selective repeat protocol we have discussed in class..

d) (6 pts) Assume that Go-Back-N protocol is used for reliable delivery over a network with no out-of-order packets. Is it possible for the sender to receive an ACK for a packet that falls outside of the current sender’s window? If yes, give a scenario where this situation happens. If no, explain why it cannot occur.

2)

a) (12 pts) Consider a connection with a 1**0msec** roundtrip, delay (including all delays incurred within the network, but excluding the packet transmission time of the sender). We want to transfer a file composed of **16 segments** (with sequence numbers from 1 to 16), where each segment has a transmission time of **1msec**. 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 full 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 all data segments are received correctly while the **first transmissions** of the **data segments** with sequence numbers **6 and 11,** and **ACK segments** with acknowledgment numbers **12 and 15** are errored, whereas **all other data** and **ACK segments are fully reliable**. The timeout for each data segment is set to **15msec 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?

b) (12 pts) Answer the above Question b) when **Go-Back-N** protocol is used with a window size of **N = 8** segments. Each window of the sender has a timeout of **15msec starting from the time when the window is set by the sender**.

c) (8 pts) Suppose that you are given the task of building a reliable acoustic communication link between two underwater terminals, where TCP is going to be used as the transport layer protocol. Assume that layers 1 and 2 (the physical and link layers) have already been designed so you do not need to worry about how to physically get a packet between the terminals. Assume that the underwater link has a capacity of 100Kbps and a distance of 6km. Note that acoustic signals propagate at a speed of 1500m/s under the water. In this task, you have the flexibility of changing any part of TCP. Propose **two modifications** to TCP so that you can obtain a higher throughput over this underwater link. You need to justify each proposal. Make sure that your proposals do not harm the reliability of TCP.

3)

a) At time *t*, a TCP connection has CongWin=5000Bytes, ssthresh=9000Bytes and no unacknowledged segments. The sender sends five more segments between *t* and *s* ($s > t$) each containing 1000Bytes (with sequence numbers 7500, 8500, 9500, 10500 and 11500). TCP sender receives three ACK segments between *t* and *s* with acknowledgement numbers 8500, 9500 and 10500.

   i) (7 pts) Assume that the last ACK segment contains a Receive Window of 3000Bytes. How many more bytes can the TCP sender send at time *s*?

   ii) (7 pts) Assume that the last ACK segment that the sender received contains a Receive Window of 12000Bytes. How many more bytes can the TCP sender send at time *s*?

b) A TCP connection passes through a 10Mbps link which does not buffer any packets. Suppose that there are no other connections using this link and this link is the only congested link for the given connection, i.e., all other links along the connection have much larger available capacity. Assume that the TCP sender has a huge file to send. The receive buffer at the TCP receiver can be assumed infinitely large. The round-trip delay for this connection is 10ms.

   i) (7 pts) Calculate the maximum window size, in bytes, that this TCP connection can achieve.

   ii) (7 pts) Now assume that the link has a capacity of 100Mbps. Calculate the maximum window size, in bytes, that this TCP connection can achieve.

c) (8 pts) Three TCP connections are sharing a link with capacity of 100Mbps (100×10^6bps). Assume that the bandwidth bottleneck for all three connections is this shared link. The roundtrip times for the connections are 5ms, 10ms and 30ms, respectively. Calculate the maximum throughputs achieved by each connection.