CS 421: Computer Networks **FALL 2014**

MIDTERM
November 20, 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) (8 pts) Suppose you are driving from Ankara to İstanbul over the toll highway O-4. For each of the network delays listed below, find an analogous delay in the driving example.

Network Delay	**Analogous driving delay**
Propagation delay	
Transmission delay	
Processing delay	
Queueing delay	

b) (5 pts) Suppose that a Go-Back-N based sender is sending segments to a Selective Repeat based receiver. Is it possible to achieve reliable communication between the sender and the receiver? Fully justify your answer.

c) (5 pts) Suppose that a Selective Repeat based sender is sending segments to a Go-Back-N based receiver. Is it possible to achieve reliable communication between the sender and the receiver? Fully justify your answer.

d) (6 pts) Give an advantage and disadvantage of implementing the congestion control algorithm at the transport layer instead of the network layer.

e) Suppose you are developing a video streaming application.

i) (5 pts) Which of the following five architectures will you prefer? Why?

- A single TCP connection, similar to HTTP
- A single UDP connection, similar to DNS
- Two TCP connections, similar to FTP
- Two UDP connections
- One TCP and one UDP connection

ii) (5 pts) For your preferred architecture, describe how you map video data and control information into the connection(s). Justify your mapping.

2)

a) (2 pts) Consider a connection where the distance between the sender and the receiver is 500 km. Assume that the delay for the connection is dominated by the propagation delay. Calculate the round-trip delay for this connection using a speed of propagation of $2x10^5$ km/s.

b) (5 pts) We use the above connection to transfer a file of size 10^4 Bytes. Assume that each packet has a maximum size of 1250 Bytes including a 40 Byte header. Calculate the minimum number of segments necessary to transfer this file and the transmission times of each segment assuming that the connection has a transmission rate of 10 Mbps.

c) (12 pts) Consider the above file transfer. Assume that the communication between the sender and receiver is full duplex, i.e., sender can send data segments while receiving an ACK segment. We use the **Selective Repeat** protocol for the file transfer with a window size of **N = 6** segments. Assume that all data segments are received correctly while the **first transmissions** of the **data segment** with sequence numbers **5,** and **ACK segment** with acknowledgment numbers **3** are errored, whereas **all other data** and **ACK segments are fully reliable**. The timeout for each data segment is set to **10 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) (12 pts) Calculate the transfer time for the above file transfer when **Go-Back-N** protocol is used with a window size of **N = 6** segments. Each window of the sender has a timeout of **10 msec starting from the time when the window is set by the sender**.

3)

a) (6 pts) Consider the TCP round-trip time and timeout estimation algorithm:

$$\text{EstimatedRTT} = (0.875 \times \text{EstimatedRTT}) + (0.125 \times \text{SampleRTT})$$

$$\text{DevRTT} = (0.75 \times \text{DevRTT}) + (0.25 \times |\text{SampleRTT} - \text{EstimatedRTT}|)$$

$$\text{Timeout} = \text{EstimatedRTT} + 4 \times \text{DevRTT}$$

Suppose that a TCP connection currently has the values of EstimatedRTT = 32 ms and DevRTT = 4 ms. The next segment transmitted over the TCP connection experiences a timeout and the acknowledgment for that segment arrives 40 ms after the retransmission. The SampleRTT for the segment transmitted next over the TCP connection is measured as 16 ms. Calculate the last value of the Timeout obtained for this TCP connection.

b) At time *t*, a TCP connection has CongWin=10000 Bytes, ssthresh=5000 Bytes and no unacknowledged segments. The sender sends three more segments between *t* and *s* ($s > t$) each containing 1000 Bytes (with sequence numbers 2000, 3000, and 4000). TCP sender receives two ACK segments between *t* and *s* with acknowledgement numbers 3000 and 3000. Assume that the maximum segment size (MSS) for the connection is 1000 Bytes.

   i) (6 pts) Assume that the last ACK segment contains a Receive Window of 2000 Bytes. How many more bytes can the TCP sender send at time *s*?

   ii) (6 pts) Assume that the last ACK segment that the sender received contains a Receive Window of 12000 Bytes. How many more bytes can the TCP sender send at time *s*?

c) (5 pts) Three TCP connections are sharing a link with capacity of 60 Mbps. Assume that the bandwidth bottleneck for all three connections is this shared link. The roundtrip times for the connections are 10 ms, 15 ms and 30 ms, respectively. Calculate the maximum throughputs achieved by each connection.

d) (6 pts) Suppose that you want to download an extremely large file, e.g., in the order of TBytes, from a remote server to your host using FTP. You would like to download the file with the minimum possible delay. You have access to the source codes of the TCP implementation at your host and you are free to make any changes in TCP algorithms and parameters at your host. However, **you need to guarantee that TCP remains fully reliable after your modifications and also make sure that your modified TCP implementation can flawlessly communicate with the standard TCP implementation at the server**. Propose a modification to TCP in order to decrease the download time for this huge file.

e) (6 pts) Now assume that you want to upload an extremely huge file to a remote server. Propose a modification to TCP in order to decrease the upload time for this huge file subject to the constraints as highlighted above.