Department of Computer Science and Information Systems, BITS Pilani (RAJASTHAN)
Second Semester 2021-2022
COMPUTER NETWORKS (CS F303)
MID SEMESTER TEST (CLOSED BOOK)

Duration: 90 Mints (2:00 PM to 03:30 PM) **Date: 14-03-2022** **MM: 50**

Instructions: All questions are compulsory. Please attempt subparts of a question in sequence. Show the computing steps required to arrive final/intermediate answer wherever applicable.

Q.1 Consider a client and an HTTP server connected through a bidirectional link (20 meters of length) that can transmit at a rate of 150 bits/sec. The propagation speed of the link is 2 x 10^8 meters/sec. The data packets transferred over the link are of size 200 Kbits, and the control packets (e.g., ACK, handshaking) is of size 100 bits. The web page to be downloaded from the server contains 10 referenced objects on the same server. Each referenced object and the webpage object are of size 200 Kbits. **[4+4+2=10M]**
Compute the time required to download the complete webpage (including referenced objects) for (a) and (b). (You can omit the time required for DNS query and response in your calculations.)

a) The client uses non-persistent HTTP with parallel connections. (You can assume that each connection gets 1/N of the link bandwidth for N parallel connections. There is no restriction on the server for the opening number of parallel connections.)

b) The client uses a persistent HTTP connection.

c) Do you see a significant benefit of persistent HTTP over non-persistent HTTP? Justify and explain your answer.

Q.2 A TCP Tahoe connection begins data transmission by the slow-start algorithm and uses segment sequence numbering in place of byte sequence numbering. The segment sequence numbering starts with 0, and all the segments received successfully (including ACK segments) except the segment with sequence number 5, which is lost during transmission. The initial value of *ssthresh* is 10 segments. Assume that the congestion window is updated on receipt of every ACK segment. You can also assume that the timeout period is sufficiently large so that, when a timeout occurs, all the acknowledgments sent by the receiver are received by the sender if they are not lost. **[3+2+2=7M]**
Draw the packet transmission timeline diagram for the TCP connection and answer the following questions. Your answers must be in coherence with the diagram to get the credit.

i) How many duplicate ACKs are received by the sender before the timeout event for the segment with sequence number 5?

ii) What is the value of *ssthresh* right after the timeout event?

iii) Once the retransmitted segment is successfully received by the receiver and the sender receives its ACK, which sequence number segments does the sender transmits?

Q.3 In the standard Selective Repeat (SR) protocol discussed in the class, the sender transmits a packet as soon as it is available, provided that it lies in the current window. Consider a modified SR protocol that sends two packets at a time. That is, the sender will transmit a pair of packets and will transmit the next pair of packets only when it knows that both packets in the first pair have been received correctly by the receiver. **[9+3=12M]**

a) Design an error-control protocol for the unidirectional reliable transfer of packets and provide an FSM description of the sender and receiver. You can assume that the channel may lose, corrupt, and reorder the packets.

b) Give an example using a timeline trace of sender and receiver and show how your designed protocol recovers from a lost packet.

Q.4 Consider a modified TCP's AIMD algorithm in which the congestion window size is measured in the number of segments, not in bytes. The additive increase and multiplicative decrease factors are the same as the standard TCP. If the result of multiplicative decrease is not an integer, then round down to the nearest integer. Suppose that two TCP connections, T1 and T2, share a bottleneck link of speed 30 segments/sec. Assume that both T1 and T2 always remain in the congestion avoidance phase. The RTT of T1 is 50 milli sec, and the RTT of T2 is 100 milli sec. When the data rate in the link exceeds the link's speed, i.e., 30 segments/sec, both TCP connections experience data segment loss. **[9+2=11M]**

a) If both T1 and T2 at time t_0 have a congestion window of 10 segments, what are their congestion window sizes after 1000 milli sec? Show your calculation steps in a tabular form for better clarity.

b) Will these two connections get an equal share of the bottleneck link bandwidth in the long run? Justify and explain your answer.

Q.5 Answer the following questions. **[4+3+3=10]**

a) Consider a DHT-based Peer to Peer Chord network (discussed in the class) with a 4bit identifier space. The active peers' identifiers are 2, 7, 10, 12, and 15. The keys present in the network are with identifiers 0, 1, 2, 8, and 15.
   i) Determine which peer is responsible for each key?
   ii) Suppose the peer with identifier 2 receives a request to locate the key with identifier 1. Show how the request will be forwarded to locate the requested key value in the network with and without the finger table option?

b) Consider the TCP connection-close mechanism discussed in the class. What consequences can occur if the client closes the connection immediately after receiving the FIN packet from the server? Explain.

c) Consider a router with three output interfaces, i.e., A, B, and C, connected to the subnetworks 10.0.0.0/8, 10.1.0.0/16, and 10.1.3.0/24, respectively. Suppose three datagrams arrive at input interface D of the router with destination IP addresses 10.1.2.5, 10.2.3.8, and 12.1.3.1. Which output interfaces would the router forward these datagrams? Provide an appropriate justification for your answer.

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