**CS 655: Computer Networks**

**Fall 2020**

**Sample Midterm Examination**

Please write clearly and neatly. Be precise in your answers – do not just re-iterate what you know about the topic. Clearly state any assumptions you make. The exam has 4questions over 5pages. Answer all questions.

**Problem 1 (Error Control)**

A 3000-km long, 1 Mbps link is used to transmit 1000-bitdata packets using the Selective Repeat protocol. If the speed of light in this link is 2 x105km/second, what is the minimum number of bits the sequence numbers should be? Assume no flow control, and negligible transmission and processing times for acknowledgments. Take 1M = 1000,000.

**Problem 2(Protocol Specification)**

Consider a scenario in which Host A and Host B want to send messages to Host C. A, B, and C are connected by a perfect broadcast channel (that is, any message sent will be received by the other two entities correctly; the channel will not corrupt, lose, or re-order packets).Also, assume that any message sent will be received by the other two entities at the same exact time. The transport layer at Host C should alternate in delivering messages from A and B to the layer above; that is, it should first deliver the data from a packet from A, then the data from a packet from B, and so on. Host A should first get data from the layer above before it sends a packet to C, then B gets data from the layer above before it sends a packet to C, and so on.

Draw an FSM specification for this protocol (one FSM for A, one for B, and one for C). (Hint: The FSM for B should be essentially the same as for A.) You should define and use events and actions, including:

• rdt\_send (data): call from above to send a data message.

• udt\_send (packet=<data, src=A, dest=C, ...>): your protocol sends a packet containing the data message, source A, destination C, and any other packet header fields that you may need for your protocol to work correctly.

• udt\_rcv (packet): your protocol receives a packet from the channel.

• extract (packet, data): function to extract data from the packet structure and deliver data to layer above your protocol.

Your protocol does not have to use ACK messages. Make sure you indicate the initial state for each entity’s FSM.

**Problem 3 (HTTP Performance)**

Consider the performance of persistent HTTP. Suppose a web client wants to download a base html page of size O= 100K bits from a web server. This base html page contains ten embedded objects (img01.jpg, img02.jpg, ..., img10.jpg) of the same size O= 100K bits each. All ten embedded objects reside on the same web server. The (minimum) round-trip propagation delay RTP=300 msec, and the channel rate R=100Mbps.

Assume the client uses persistent HTTP (HTTP 1.1) with pipelining to retrieve the ten embedded objects, how long is the response time—the time it takes to receive the base page and its ten embedded objects from the web server? In answering this question, assume error-free transmission. Be sure to consider TCP connection establishment (1 RTP) and the data transmission delay for the base file and the embedded objects. Ignore header / control bits. To support your answer, show all steps of your calculations along with associated expressions in terms of O, R, and RTP. Take 1M = 1,000,000.

Propagation delay = 300ms / 2 = 150ms

2 x RTP = 150ms + 150ms + 150ms + 150ms = 600ms to get the HTML file.

1 x RTP + O / R x 10 = 150ms + 150ms + (100 Kb / 100 Mbps) x 10 = 310ms to get the jpg files.

Response time = 2 x RTP + 1 x RTP + O / R x 10 = 3 x RTP + O / R x 10 = 910ms