Introduction to Computer Networks (Midterm Exam, S15)

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(1) Closed-book exam, and total: 100 points.
(2) Please put down your name and student ID on the answer sheet.
(3) Please turn in your problem set and answer sheet when you finish the test.
(4) Good Luck!

1. (5%) Please list the seven layers in the ISO OSI reference model. Please simply describe what flow control and congestion control do.
2. (5%) Suppose there is a 1Gbps microwave link between geostationary satellite and its base station to Earth. Every minute the satellite takes a digital photo and sends it to the base station. Assume a propagation speed of 2.4×10^8 meters/sec. Let x denote the size of the photo. What is the minimum value of x for the microwave link to be continuously transmitting?
3. (20%, 10 points each) Consider sending a large file of F bits from Host A to Host B in the network shown in Fig. 1.
   a) There are three links (and two switches) between Hosts A and B, and the links are uncongested (i.e., no queueing delays). Host A segments the file into segments of S bits each and adds 10 bytes of header to each segment, forming packets of $L = 80 + S$ bits. Each link has a transmission rate of R bps. Suppose that the propagation delay of each link is t sec. Find the value of S that minimizes the delay of moving the file from Host A to Host B.
   b) Now, you replace the two switches in between A and B in Fig. 1 with two circuit switching ones. What is the minimum allowable circuit setup time it takes so that the time it takes to send the file of F bits from A to B is less than that with the approach in Problem 3-a)?

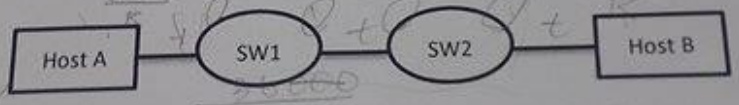

Fig. 1. The network topology

4. (10%) Please choose from the list below for those services provided by each of TCP and UDP:
   connection service, connectionless service, routing, admission control, flow control, congestion control, throughput guarantee, error correction, reliable

delivery, timely delivery, secure delivery, multiplexing and demultiplexing, layer 4 authentication

5. (30%, 10 points each) Compare GBN, SR, and TCP (with no delayed ACK).
   a) Assume that the numbers of sequence numbers of all the three protocols are of 32 bits. Consider GBN and SR. What is the largest allowable sender window size that will avoid the occurrence of the dilemma problems encountered by the receiver with too large windows for each of the protocols? As for TCP (no delayed ACK), what is the maximum allowable sender window size at any time?
   b) Further assume that the timeout values for the three protocols are sufficiently long such that 5 consecutive data segments and their corresponding ACKs can be received (if not lost in the channel) by the receiving host (Host B) and the sending host (Host A), respectively. Suppose Host A sends 5 data segments back-to-back to Host B and the first transmission of the 2nd segment (sent from Host A) is lost. In the end, all 5 data segments have been correctly received by Host B.
   How many segments has Host A sent in total and how many ACKs has Host B sent in total? What are their sequence numbers? Please answer this question for all three protocols. You can simply index the data segments by numbers 0, 1, 2, 3, and 4.
   c) Following Problem 5-b). If the timeout values for all three protocols are much longer than 5 RTT, then which protocol successfully delivers all five data segments in shortest time interval?
6. (30%, 10 points each) Consider that only a single TCP (Reno) connection uses one 20Mbps link which does not buffer any data. Suppose that this link is the only congested link between the sending and receiving hosts. Assume that the TCP sender has a huge file to send to the receiver, and the receiver's receive buffer is much larger than the congestion window. We also make the following assumptions: each TCP segment size is 500 bytes; the two-way propagation delay of this connection is 120 msec; and this TCP connection is always in congestion avoidance state, that is, ignore slow start.
   a) What is the maximum window size (in segments) that this TCP connection can achieve?
   b) What is the average window size (in segments) and the average throughput (in bps) of this TCP connection?
   c) How long would it take for this TCP connection to reach its maximum window again and recovering from a packet loss?