SIMON FRASER UNIVERSITY
SCHOOL OF ENGINEERING SCIENCE

Spring 2024
ENSC 427: COMMUNICATION NETWORKS
ENSC 894: SPECIAL TOPICS II COMMUNICATION NETWORKS

Midterm No. 1
Thursday, February 15, 2024

Duration: 110 minutes. Attempt all problems. Questions are not equally weighted. Please provide detailed answers and include diagrams, graphs, and tables, as needed. Expand all acronyms. Closed book and closed notes. Simple calculators (with no graphing/programming functions) are permitted. PDAs, laptops, and wireless phones are not permitted. Please write legibly. Illegible text will not be graded. Please use a pen (no pencils, please).

1. **Chapter 1 Computer Networks and the Internet (35 points)**:

   (a) What are the five layers in the Internet protocol stack? (5 points)

   (b) What are the principal responsibilities of each of these layers? (5 points)

   (c) Consider two hosts, A and B, connected by a single link of rate R bps. Suppose that the two hosts are separated by m meters, and suppose the propagation speed along the link is s meters/sec. Host A is to send a packet of size L bits to Host B. (20 points)

   i. Express the propagation delay, d_{prop}, in terms of m and s. (2 points)

   ii. Determine the transmission time of the packet, d_{trans}, in terms of L and R. (2 points)

   iii. Ignoring processing and queuing delays, obtain an expression for the end-to-end delay. (3 points)

   iv. Suppose Host A begins to transmit the packet at time $t = 0$. At time $t = d_{trans}$, where is the last bit of the packet? (2 points)

   v. Suppose d_{prop} is greater than d_{trans}. At time $t = d_{trans}$, where is the first bit of the packet? (3 points)

   vi. Suppose d_{prop} is less than d_{trans}. At time $t = d_{trans}$, where is the first bit of the packet? (3 points)

   vii. Suppose $s = 2.5 \times 10^8$, $L = 1,500$ bytes, and $R = 10$ Mbps. Find the distance m so that d_{prop} equals d_{trans}. (5 points)

   (d) Metcalfe's law states the value of a computer network is proportional to the square of the number of connected users of the system. Let n denote the number of users in a computer network. Assuming each user sends one message to each of the other users, how many messages will be sent? Does your answer support Metcalfe's law? (5 points)

2. **Chapter 2 Application Layer (20 points)**:

   (a) HTTP:

      i. What is the HOL blocking issue in HTTP/1.1? (2 points)

      ii. How does HTTP/2 attempt to solve it? (2 points)

   (b) What is an overlay network? Does it include routers? What are the edges in the overlay network? (6 points)

   (c) Consider an HTTP client that wants to retrieve a Web document at a given URL. The IP address of the HTTP server is initially unknown. What transport and application-layer protocols besides HTTP are needed in this scenario? (5 points)

   (d) Consider an overlay network with N active peers, with each pair of peers having an active TCP connection. Additionally, suppose that the TCP connections pass through a total of M routers. How many nodes and edges are there in the corresponding overlay network? (5 points)

3. **Chapter 3 Transport Layer (30 points)**:

   (a) Consider the *rdt*3.0 protocol:

      i. Why did we need to introduce sequence numbers? (5 points)

      ii. Why did we need to introduce timers? (5 points)

      iii. Draw a diagram showing that if the network connection between the sender and receiver can reorder messages (that is, that two messages propagating in the medium between the sender and receiver can be reordered), then the alternating-bit protocol will not work correctly (make sure you clearly identify the sense in which it will not work correctly). Your diagram should have the sender on the left and the receiver on the right, with the time axis running down the page, showing data (D) and acknowledgment (A) message exchange. Make sure you indicate the sequence number associated with any data or acknowledgment segment. (5 points)

   (b) Computation of round trip time:

      i. What is round trip time and how is it estimated? (2 points)

      ii. What is timeout? How is its value set in TCP? (6 points)

      iii. What are typical values of the parameters used? (2 points)

      iv. Suppose that TCP's current estimated values for the round trip time and deviation in the RTT are 200 ms and 20 ms, respectively. Suppose that the next three measured values of the RTT are 400 ms, 300 ms, and 500 ms. Compute TCP's new value of the round trip time, deviation in the RTT, and timeout after each of these three measured RTT values is obtained. (5 points)

4. **Case Study: Mapping the Internet (15 points)**:

   Recall the case study dealing with discovering the Internet graph:

   (a) What field in the IP header is used to infer the Internet topology? Name the utility used to map the Internet. (2 points)

(b) Which protocol generates echo messages? When are the echo messages generated? (2 points)

(c) Provide a high-level description (pseudocode) of the algorithm. (3 points)

(d) Describe the experiment setup. (4 points)

(e) What are the results and conclusions of the experiments? (4 points)