SIMON FRASER UNIVERSITY
SCHOOL OF ENGINEERING SCIENCE

Spring 2023
ENSC 427: COMMUNICATION NETWORKS
ENSC 894: SPECIAL TOPICS II COMMUNICATION NETWORKS

Midterm No. 1
Thursday, February 16, 2023

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 (25 points)**:

   (a) Which layers in the Internet protocol stack does a router process? Which layers does a link-layer switch process? Which layers does a host process? (5 points)

   (b) Consider a simple network consisting of two end systems connected by a single router utilizing store-and-forward transmission. What is the end-to-end delay in case of sending one packet of length L from source to destination over a path consisting of N links each of rate R. Generalize the formula for sending P such packets back-to-back over the N links. (5 points)

   (c) Consider a packet of length L that begins at end system A and travels over three links to a destination end system. These three links are connected by two packet switches. Let d_i, s_i, and R_i denote the length, propagation speed, and the transmission rate of link i, for $i = 1, 2, 3$. The packet switch delays each packet by d_{proc}. Assuming no queuing delays, in terms of d_i, s_i, R_i, $(i = 1, 2, 3)$, and L, what is the total end-to-end delay for the packet? (10 points)

   (d) Consider the throughput example corresponding to Figure 1. Suppose that there are M client-server pairs rather than 10. Denote R_s, R_c, and R for the rates of the server links, client links, and network link. Assume all other links have abundant capacity and that there is no other traffic in the network besides the traffic generated by the M client-server pairs. Derive a general expression for throughput in terms of R_s, R_c, R, and M. (5 points)

2. **Chapter 2 Application Layer (15 points)**:

   (a) What is meant by a handshaking protocol? (5 points)

   (b) Describe how Web caching can reduce the delay in receiving a requested object. Will Web caching reduce the delay for all objects requested by a user or for only some of the objects? Why? (10 points)

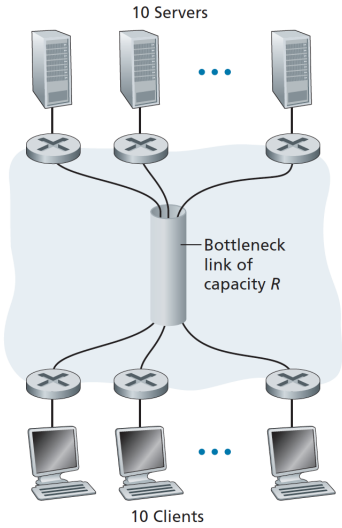

Figure 1: Network with 10 client-server pairs.

3. **Chapter 3 Transport Layer (45 points)**:

   (a) Suppose that the roundtrip delay between sender and receiver is constant and known to the sender. Would a timer still be necessary in protocol *rdt* 3.0, assuming that packets can be lost? Explain. (10 points)

   (b) Give diagrams of the operation of protocol *rdt* 3.0 (no FSM need to be included) when data packets and when acknowledgment packets are garbled. (15 points)

   (c) Consider transferring an enormous file of L bytes from *Host A* to *Host B*. Assume an MSS of 536 bytes.

      i. What is the maximum value of L such that TCP sequence numbers are not exhausted? Recall that the TCP sequence number field has 4 bytes. (10 points)

      ii. For the L you obtain in (i), find how long it takes to transmit the file. Assume that a total of 66 bytes of transport, network, and data-link header are added to each segment before the resulting packet is sent out over a 155 Mbps link. Ignore flow control and congestion control so A can pump out the segments back to back and continuously. (10 points)

4. **Case Study: Distributed Denial of Service Attacks (15 points)**:

   (a) What was the goal of the simulation study? (2 points)

   (b) What are distributed denial of service (DDoS) attacks? (2 points)

   (c) List four elements of a DDoS attack and steps during a DDoS attack. (2 points)

   (d) List at least three defenses against such attacks. (2 points)

   (e) Describe simulation topologies. (2 points)

   (f) List at least three queuing algorithms used in simulation scenarios. (3 points)

   (g) Summarize the main findings based on simulation results. (2 points)