SIMON FRASER UNIVERSITY
SCHOOL OF ENGINEERING SCIENCE

Spring 2026
ENSC 427: COMMUNICATION NETWORKS

Midterm No. 1
Wednesday, February 25, 2026

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 (20 points)**:

   Consider sending a packet from a source host to a destination host over a fixed route.

   (a) List the delay components in the end-to-end delay. (3 points)

   (b) Briefly describe each component and include their typical order of magnitude. (3 points)

   (c) Which of these delays are constant and which are variable? (3 points)

   (d) How long does it take a packet of length L to **propagate** over a link of distance d, propagation speed s, and transmission rate R bps? (3 points)

   (e) 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)

   (f) What is the end-to-end delay in a network with $N - 1$ routers. Assume that the network is uncongested. (3 points)

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

   Consider the Internet Application Layer:

   (a) TCP can be enhanced with TLS to provide process-to-process security services, including encryption. Does TLS operate at the transport layer or the application layer? (4 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)

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

Assume that TCP Reno is the protocol experiencing the behavior shown in Fig. 1. The initial value of *cwnd* (congestion window) is 1 and the initial value of *ssthresh* (slow start threshold) is 8. In all cases, provide a brief discussion justifying your answer.

(a) What are the main phases of the TCP congestion control algorithm? (5 points)

(b) List TCP mechanisms used to detect packet loss. How does TCP react to each type of detected packet loss? (6 points)

(c) Identify the intervals of time when each phase operates. (6 points)

(d) What happens after the 4th, 10th, 13th, 25th, 29th, and 36th time unit. (6 points)

(e) Identify the intervals of time at which the value of *ssthresh* changes and give the new value of *ssthresh*. (5 points)

(f) Why TCP Reno does not employ the slow start phase when a triple duplicate ACK is received? (2 points)

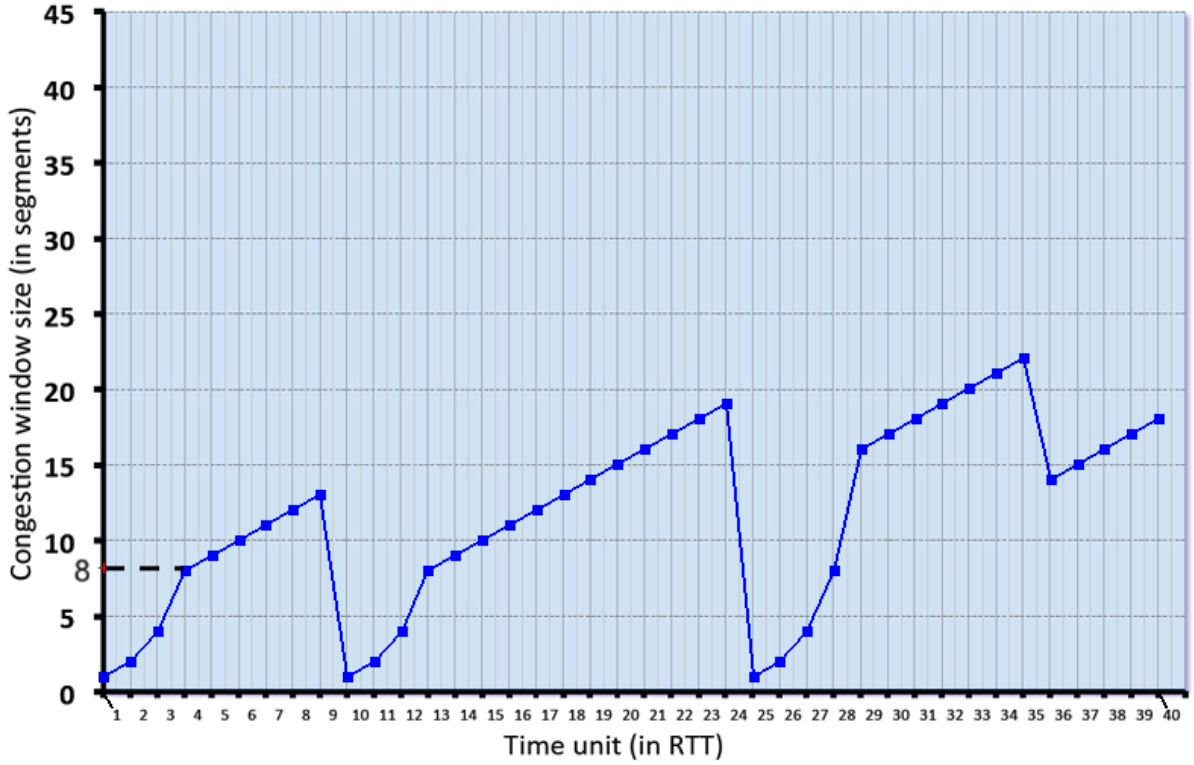

Figure 1: TCP window size as a function of time.

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4. **Chapter 4: The Network Layer: Data Plane (25 points)**:

   (a) What guarantees are made by the Internets service model regarding the host-to-host delivery of datagrams? (2 points)

   (b) What are the main functions of the data plane and the control plane? (2 points)

   (c) What are the key differences between routing and forwarding? (4 points)

   (d) What is the role of the forwarding table within a router? (4 points)

   (e) What is a non-blocking switching fabric? (2 points)

   (f) Do routers have IP addresses? If so, how many? (4 points)

   (g) What are main differences between IPv4 and IPv6? (5 points)

   (h) Describe the mechanism used to transition from IPv4 to IPv6 (2 points)

5. **Case Study: Mapping the Internet (5 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? (1 point)

   (b) Name the utility used to map the Internet. (1 point)

   (c) Which protocol generates echo messages? When are the echo messages generated? (1 point)

   (d) Describe the experiment setup. (1 point)

   (e) What are the results and conclusions of the experiments? (1 point)

6. **Case Study: Distributed Denial of Service Attacks (5 points)**:

   Recall the case study dealing with denial of service attacks:

   (a) What are distributed denial of service (DDoS) attacks? (1 point)

   (b) List four elements of a DDoS attack and steps during a DDoS attack. (1 point)

   (c) What was the goal of the simulation study? (1 point)

   (d) List at least two queuing algorithms used in simulation scenarios. (1 point)

   (e) Summarize the main findings based on simulation results. (1 point)