SIMON FRASER UNIVERSITY
SCHOOL OF ENGINEERING SCIENCE

Spring 2021
ENSC 427: COMMUNICATION NETWORKS

Final Examination
Tuesday, April 27, 2021

Duration: 180 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 3 Transport Layer (30 points)**:
   (a) List the mechanisms employed by reliable data transfer (rdt) to deal with:
      i. Channel with bit errors: How to recover from errors? (2 points)
      ii. Duplicate packets: How to handle duplicates? (2 points)
      iii. Channel with errors and loss: What is the sender's approach? (2 points)

   (b) Show the states and main fine state machine (FSM) specifications for rdt protocols:
      i. rdt1.0: over a reliable channel (8 points)
      ii. rdt2.2: over channels with bit errors (8 points)
      iii. rdt3.0: over channels with bit errors and loss (8 points)

2. **Chapter 3 Transport Layer (25 points)**:

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

(a) What are the main phases of the TCP congestion control algorithm? (3 points)

(b) Identify and label various intervals. (7 points)

(c) What happens at the 5th, 13th, 27th, 35th, and 39th time unit. (5 points)

(d) Identify the intervals of time at which the value of *ssthresh* changes and give the new value of *ssthresh*. (7 points)

(e) Why TCP Reno does not employ the slow start phase when a triple duplicate ACK is received? (3 points)

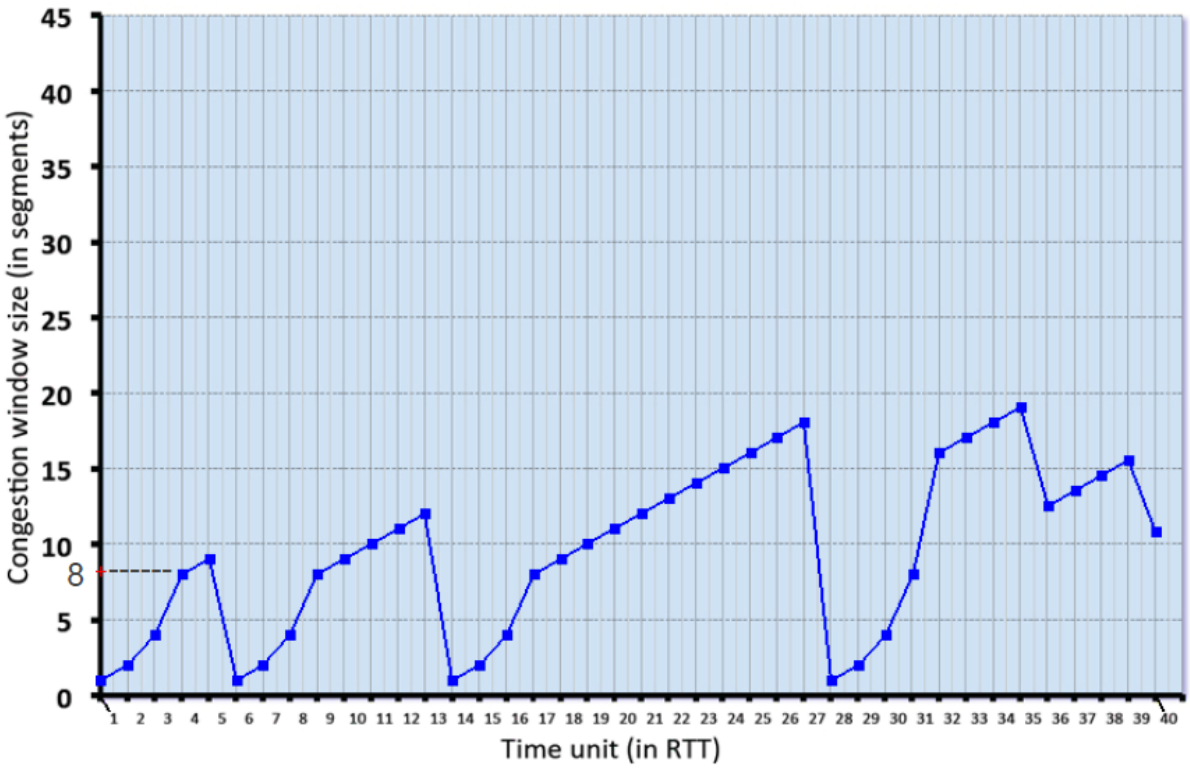

Figure 1: TCP window size as a function of time.

3. **Chapter 5 The Network Layer: Control Plane (25 points)**:

   (a) Consider the network shown in Figure 2. With the indicated link costs, use Dijkstra's algorithm to compute the shortest path from z to all network nodes.

      i. Show how the algorithm works by computing an appropriate table. (10 points)

      ii. Draw the shortest path tree found by the algorithm. (5 points)

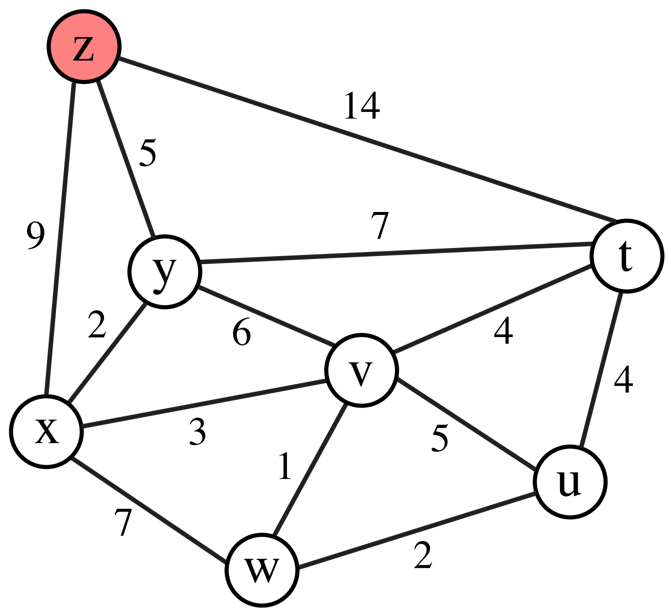

Figure 2: Apply Dijkstra's algorithm to find the shortest path from node z.

   (b) Consider the network shown in Figure 3. Assume that each node initially knows the costs to each of its neighbors.

      i. Use Bellman-Ford algorithm and show the routing table entries at node z. (10 points)

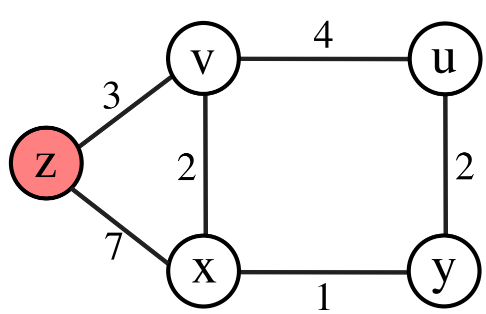

Figure 3: Apply Bellman-Ford algorithm to show the routing table entries at node z.

4. **Chapter 7: Wireless and Mobile Networks (20 points)**:

   (a) Show elements of mobile network architecture for a 4G/5G cellular network. Include elements of the home and visited networks. (5 points)

   (b) Consider a case when the corespondent wants to send a datagram to a mobile device. Illustrate the steps to a mobile device for:

      i. Indirect routing (5 points)

      ii. Direct routing (5 points)

   (c) What is the difference between direct and indirect routing of datagrams to/from a roaming mobile host? (3 points)

   (d) What does “triangle routing” mean? (2 points)