SIMON FRASER UNIVERSITY
SCHOOL OF ENGINEERING SCIENCE

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

Midterm No. 2
Thursday, April 4, 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 4 The Network Layer: Data Plane (30 points)**:

   (a) Recall that both routers and link-layer switches are called packet switches. What is the fundamental difference between a router and link-layer switch? (5 points)

   (b) We noted that network layer functionality can be broadly divided into data plane functionality and control plane functionality. What are the main functions of the data plane and the control plane? (4 points)

   (c) We made a distinction between the forwarding function and the routing function performed in the network layer. What are the key differences between routing and forwarding? (5 points)

   (d) What is HOL blocking? Does it occur in input ports or output ports? (4 points)

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

   (f) Suppose that datagrams are limited to 1,500 bytes (including header) between source Host A and destination Host B. Assuming a 20-byte IP header, how many datagrams would be required to send an MP3 consisting of 5 million bytes? Explain how you computed your answer. (8 points)

2. **Chapter 5 The Network Layer: Control Plane (35 points)**:

   Consider the two families of routing algorithms.

   (a) Explain the Dijkstra's and Bellman-Ford algorithms and show notation, equations, and iteration steps for each algorithm. (10 points)

(b) Consider the network shown in Figure 1(a). With the indicated link costs, use the Dijkstra's algorithm to compute the shortest path from node A to all other nodes:

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

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

(c) Consider the network shown in Figure 1(b). Assume that each node initially knows the costs to each of its neighbours. Use the Bellman-Ford algorithm and show the routing table entries at node A. (10 points)

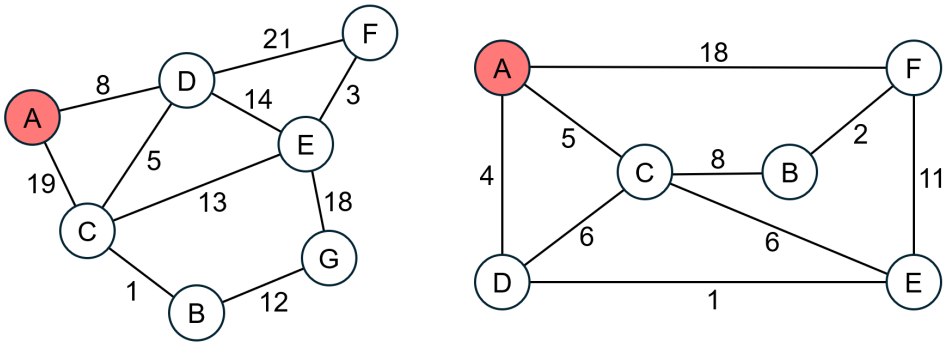

Figure 1: Apply the Dijkstra's algorithm to find the shortest path from node A in Figure 1(a) and the Bellman-Ford algorithm to show the routing table entries at node A in Figure 1(b).

3. **Chapter 6 The Link Layer and LANs (20 points)**:

(a) In CSMA/CD, after the fifth collision, what is the probability that a node chooses K = 4? The result K = 4 corresponds to a delay of how many seconds on a 10 Mbps Ethernet? (10 points)

(b) For K = 100, how long does the adapter wait after a collision for 100 Mbps and 1 Gbps broadcast channels? (10 points)

4. **Case Study: Implementation of BGP in a Network Simulator (15 points)**:

Consider the case study dealing with implementation of the Border Gateway Protocol (BGP) in a network simulator.

(a) What is an Autonomous System (AS)? (1 point)

(b) List four types of BGP messages. (2 points)

(c) What are BGP weaknesses? (2 points)

(d) Show a network of routers used in the simulation scenario. You do not need to use the same example as in the study but your network should include all types of BGP nodes. (3 points)

(e) How was the implementation of BGP in the network simulator validated? (5 points)

(f) List BGP properties considered in the scalability analysis. (2 points)