SIMON FRASER UNIVERSITY
SCHOOL OF ENGINEERING SCIENCE

Spring 2024
ENSC 427: COMMUNICATION NETWORKS
ENSC 894 G300: SPECIAL TOPICS II COMMUNICATION NETWORKS

Final Examination
Wednesday, April 24, 2024

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 (35 points)**:

    Use flow diagrams with a sender and a receiver side to illustrate your answers.

    (a) Consider Stop-and-Wait protocol:

        i. Illustrate its operation with no loss. (2 points)

        ii. Illustrate its operation with lost packet. (2 points)

        iii. Illustrate its operation with lost ACK. (2 points)

        iv. Illustrate its operation with premature time-out. (2 points)

        v. Calculate its utilization. (2.5 points)

    (b) Consider Stop-and-Wait protocol with pipeline:

        i. Describe the protocol. (2 points)

        ii. Calculate its utilization. (2.5 points)

    (c) Consider Go-Back-N protocol:

        i. Illustrate its operation with a lost packet. (5 points)

    (d) Consider Selective Repeat protocol:

        i. Illustrate its operation with a lost packet. (5 points)

        ii. Illustrate the Selective Repeat receiver dilemma with too-large windows: a new packet or a retransmission? (Hint: Consider the cases when all ACK packets are lost.) (5 points)

        iii. Suppose the sequence number space is of size k. What is the largest allowable sender window that will avoid the occurrence of such problems? Justify your answer. (5 points)

2. **Chapter 4 The Network Layer: Data Plane (20 points)**:

Consider the router and the two attached subnets (A and B) shown in Figure 1. The number of hosts is also shown. The subnets share the 23 high-order bits of the address space: 25.126.246.0/23.

Assign subnet addresses to each of the subnets (A and B) so that the amount of address space assigned is minimal, and at the same time leaving the largest possible contiguous address space available for assignment if a new subnet were to be added.

  (a) How many hosts can there be in this address space? (4 points)

  (b) What is the subnet address of subnet A? (CIDR notation) (4 points)

  (c) What is the broadcast address of subnet A? (2 points)

  (d) What is the starting address of subnet A? (1 point)

  (e) What is the ending address of subnet A? (1 point)

  (f) What is the subnet address of subnet B? (CIDR notation) (4 points)

  (g) What is the broadcast address of subnet B? (2 points)

  (h) What is the starting address of subnet B? (1 point)

  (i) What is the ending address of subnet B? (1 point)
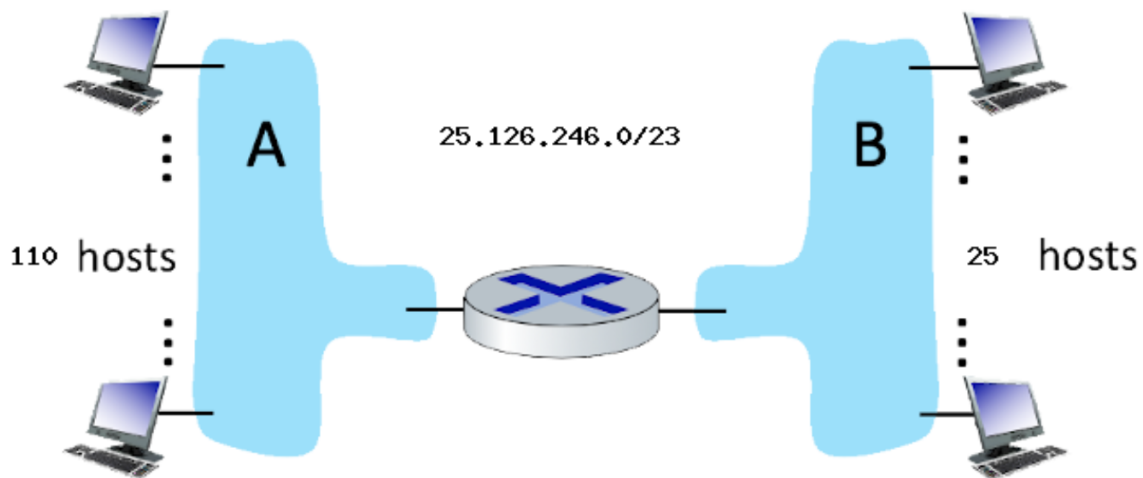

Figure 1: Network with a router and two attached subnets (A and B).

3. **Chapter 6 The Link Layer and LANs (30 points)**:

Consider a network with N active nodes. Assume that nodes have many frames to send, each transmitting with probability p.

(a) Consider slotted ALOHA:

    i. Derive the expression for its efficiency. (5 points)

    ii. Find the value of p that maximizes this expression. (5 points)

    iii. Using the value of p found in ii., find the efficiency of slotted ALOHA by letting N approach infinity. (5 points)

(b) Consider pure ALOHA:

    i. Derive the expression for its efficiency. (5 points)

    ii. Find the value of p that maximizes this expression. (5 points)

    iii. Using the value of p found in ii., find the efficiency of pure ALOHA by letting N approach infinity. (5 points)

4. **Chapter 7 Wireless and Mobile Networks (15 points)**:

(a) What are the differences between the following types of wireless channel impairments: path loss, multipath propagation, interference from other sources? (3 points)

(b) What is meant by a "visited network" and a "home network" in 4G/5G cellular architecture? (3 points)

(c) What is meant by "hand over" of a network device? (3 points)

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

(e) What does "triangle routing" mean? (3 points)