CS 447-003 Networks and Data Communications
Midterm Exam (PARTIAL SOLUTIONS)
Fall, 2023

2:00 - 3:15 pm
October 17, 2023

This exam is a closed-book and closed note exam. There are 5 questions in this exam. You have 75 minutes to finish the questions. Please write your answers on separated piece of papers. To avoid grading problems, please staple your papers in the ascending order in the question number. Calculator can be used during this exam, but you cannot share a calculator with anyone else.

Your last 3 digits: ___________________

QUESTION #1 (4 points for each, 15 minutes)

#1: Why don’t network applications perform actual network data transmissions (instead, “protocol stack” does the work)? Mention at least two different reasons.

- By separating applications and network protocols, it is easy to replace a network protocol by another one without recompiling applications.
- By separating applications and network protocols, it is easy for standard protocols (especially those developed under open software) to be used by any network applications. This will let some network protocols to be used as universal standards, without dependent on proprietary protocols.

#2: What are the primary advantages (two different advantages) and disadvantages (two different disadvantages) in “datagram packet-switching networks”?

Advantages:

1. Cheap ways to transmit data (since resource is shared)
2. No path setup delay (we can transmit data anytime)

Disadvantages:

1. Best-effort service (packets can be dropped, no guaranteed transmission speed)
2. Slow transmission (each router on a path performs routing for every packet) – packets take longer time before they reach their destinations

#3: What is the difference between “firewalls” and “(security) proxies”?

The following difference is what we discussed in the classroom:

Firewalls: “transparent” from either senders or receivers

Proxies: “visible” to both senders and receivers
#4: Why is it difficult to determine “the optimum window size” for network connections through the Internet? Mention two most significant reasons (if you provided more than two solutions, only the first two will be graded).

1. The distance to each destination varies (if the destination has never been connected before)
2. The network traffic in the Internet backbone dynamically fluctuates in such ways that predicting the end-to-end delay to each destination (the delay added at each intermediate router is hard to predict).

Grading criteria: the two should be one about the Internet backbone and the other about destination host computer. Two point for each.

#5: What is the primary advantage of “1-persistent algorithm”? What is the primary disadvantage of “1-persistent algorithm”?

**Advantage**: 1-persistent algorithm is efficient for not-busy networks. It is because a host computer, which is waiting for its transmission opportunity, is allowed to start its transmission as soon as a currently-transmitting host computer finishes its transmission (and it will succeed, if it is the only waiting host).

**Disadvantage**: 1-persistent algorithm is not efficient for busy networks. It is because if more than one host computer are waiting for its transmission opportunity, is a packet collision will happen if more than one host computer start their transmission as soon as a currently-transmitting host computer finishes its transmission.
**QUESTION #2 (20 points, 15 minutes)**

Using the following given Message (M) and Key (K), mathematically demonstrate (show the procedures) how CRC error detection can end up with an undetectable error using a complete example ("complete" means that you need to show the procedure at both sender and receiver).

- Message (M) = “1 0 1 0 1 0 0” (7 bits)
- Key (K) = “1 1 0 1” (4 bits)

with the following three assumptions (three requirements):

(a) bit-errors occur in following ways: the error bits must be over at most six bits (e.g., “bcbcbcb” where b = a bad (error) bit and c = a good (no error) bit).
(b) the number of the bits in bit errors should be less than six bits
(c) bit errors did not occur either at the beginning or the end of the transferred bit sequence

Show all your work.

**QUESTION #3 (20 points, 15 minutes)**

For a network system that consists of four rings and two bridges as shown below, find the probability that any two stations, selected at random, will be unable to communicate.

For this question, you do not have to complete your calculation. Establish a formula to calculate the probability with all necessary numbers in it.

- Each ring consists of 81 tapping repeaters and 81 links (for 80 host computers and 1 connection to a bridge).
- The mean failure rate for a tapping repeater is \( P_R \) (0 < \( P_R \) < 1)
- The mean failure rate for a link is \( P_L \) (0 < \( P_L \) < 1)
- The mean failure rate for a bridge is \( P_B \) (0 < \( P_B \) < 1)
- Wires between a tapping repeater and a bridge will never fail
- Wires between a tapping repeater and a host computer will never fail
- Host computers will never fail
QUESTION #4 (20 points, 15 minutes)

One of the weaknesses in CSMA/CD is that, if a collision is not detected, CSMA/CD does not take advantage of “CD”. How large the minimum packet size (in bytes), if any collision will be detected?

- Transmission rate = 5 Gbps (G = 10^9)
- Segment length of a LAN: 255 meters
- Signal propagation speed: 185 m/μs

Show all your work for full credit.

QUESTION #5 (20 points, 15 minutes)

A network link has a data rate of 2.5 Gbps (1G = 10^9) and a propagation speed of 200m/μs. The distance between the sending and receiving hosts is 2,000 kilometers (1Km = 1,000m). The two hosts exchange fixed-size frames (packets) of 40 bytes using the sliding-window flow control. If the sliding-window flow-control is used, the receiver needs to uniquely notify each packet it receives to its sender using the (packet) sequence number. As we discussed in the classroom, the packet sequence number is placed in the packet header (e.g., “the TCP packet sequence number” is in “the TCP packet header”). Find the minimum space size (in bits) in the packet header for the packet sequence number to fully utilize the link capacity (i.e., U = 100%). Assume that ACKs (ACK messages) are negligible in size and the processing each ACK message at each host is instantaneous.