Model Questions for CS656-004 Final Exam.

March 11th, 1999

Forward. The final exam is comprehensive. You should review all materials, starting from the very beginning of the semester. It is well advisable that you study the midterm review and the midterm itself and that you also review all homework problems before and after the midterm.

Disclaimer. Use the following questions as a help after having familiarized yourself with all course materials. Those questions are not comprehensive, meaning that some exam questions will not be like any of them — I guarantee it. Also there are questions in this document that go beyond merely memorizing and understanding course materials and that require some thinking; such questions are marked “(Challenging).”

Network Layer and Switching Technologies.

1. What are the differences between connection-oriented and connectionless network layer services?

2. Circle one or more of the following combinations that is feasible (not necessarily popular in the real world):

   - unreliable, connection-oriented transport service above an unreliable connectionless network layer
   - reliable, connection-oriented transport service above an unreliable connectionless network layer
   - reliable, connection-oriented transport service above a reliable connectionless network layer
• unreliable, connectionless transport service above a reliable, connection-oriented layer

3. Compare and contract circuit switching with virtual circuit switching. (hint: you should be able to answer this type of questions for any two switching technologies.)

4. (Challenging) Based on what we described in class regarding ATM virtual circuit establishment, what is most likely routing method used by ATM networks (distance vector, link state, path vector)? Explain your answer.

5. Define the following terms: PNNI, CBR, interated networks, and VCI.

Network Routing.

1. Circle the routing protocol(s) that is/are used by the Internet.
   
   OSPF
   PNNI
   RIP
   BGP

2. Circle the routing method(s) that uses broadcast for the exchange of information among routers.
   
   distance vector
   link state
   path vector

3. Circle the routing protocol(s) that uses link-state routing:

   OSPF
   PNNI
   RIP
   BGP
   IS-IS

4. Consider the network topology shown on page 12 of IP Multicast slides (but discard the routing tables shown on the same page). Starting with an initial distance vector
that contains exactly one entry which describes how to reach itself with cost 0, show
the contents of distance vectors at all routers after $B$, $C$, and $D$ in that order sending
their vectors.

5. Give two disadvantages of distance vector routing.

6. Give two advantages of link state routing.
   (General hint: you should be able compare and contrast any two routing methods.)

7. Explain the reason why path vector routing can avoid routing loop problems, which
   haunt distance vector routing.

8. Use one sentence to define each of the the following terms: LSA, flooding, and IS-IS.

**Internet Protocol.**

1. The OSI model has 7 layers. The Internet uses a different number of layers. List those
   layers, top to bottom.

2. Circle the hostid part of each of the following IP addresses:
   200.14.80.9
   10.192.8.20
   155.12.60.42

3. Name three most important network and transport layer protocols of the Internet and
   briefly describe their purposes.

4. What is fragmentation? Which fields in the IP header are involved in fragmentation?

5. IP datagram headers include a 16-bit checksum which, somewhat surprisingly, is not a
   CRC code. How is the checksum generated? Also give the the reason(s) why we use
   this method.

6. What is the purpose of ARP? Describe in 3 sentences how it works.

7. Define the following terms: AS, CIDR, RIP, DNS, and ARPANET.
Queueing Theory

1. Generalize the results of the T1-line example to show that, when \( N \) users share a communication link, packet switching is \( N \) times more efficient than circuit switching.

2. Do problem #1 of HW# 3.

3. Consider the configuration shown below. Inter packet arrival times are exponentially distributed (mean rates shown in the figure). Packet lengths are exponentially distributed with average 250 bits per packet. We assume that the queue associated with port 0 has infinite capacity. Compute the average number of messages in the router, including the one that is currently under transmission.

4. In the real world, what will happen to a packet that, when it arrives at at a router, the router runs out of buffer space?

Transport Layer and TCP

1. Give four functions of the transport layer.

2. What item is found in a UDP datagram and a TCP segment, but is not found in the IP header?

3. Why does every byte in a TCP segment have a unique sequence number associated with it?
4. How is the initial sequence number of a TCP connection selected?

5. Describe how an outgoing TCP flow is limited by the network capacity (that is, slowed down if the network cannot sustain the current flow rate).

6. (Challenging) This problem is designed to help you gain further insight into the additive recovery mechanism of the TCP, which increases the size of the sliding window by 1 each time an ACK is received.

Consider a TCP connection between two machines $X$ and $Y$. The round-trip time between the two machines is $T$. Assume that at time $t_0$, $X$’s window size is 1 and $X$ sends the first segment (here we use the DLL convention that the size of a window is the number of packets it can hold). Answer the following questions.

(a) Determine the size of the window at time $t_0 + T$, the moment when the acknowledgment of the first segment arrives at $X$.

(b) Let $W_1$, be your answer in the previous questions. $X$ sends at time $t_0 + T W_1$ segments. Assume that the time for $X$ to transmit segments is negligible compared to the round-trip time $T$ and thus that all the acknowledgments of these $W_1$ segments will return to $X$ by time $t_0 + 2T$. Determine the size of the window at that moment.

(c) Repeat the previous question for $t_0 + 3T$ and so forth, and find a general solution for $t_0 + n \times T$.

7. (Challenging) Machine $A$ uses a TCP connection to send a query to database server $S$ via a TCP connection. Both the query message and the server’s reply can be contained in one TCP segment. Determine the minimum number of TCP segments to the transaction. (Hint: you should try to include in connection establishment segments the request and the reply.)

8. Define the following terms: multiplicative decrease, additive recovery, SYN, PSH, Nagle’s algorithm

Security
1. Point out the reason(s) why (35, 100) and (17,100) is not a pair of legitimate RSA public/private keys.

2. Describe how Triple DES works.

3. Discuss the problem(s) when block ciphers, such as DES and IDEA, are used in true block cipher mode (that is, electronic code book mode).

4. RSA algorithms are said to be much slower than traditional ciphers (such as DES and IDEA). With robust traditional ciphers at our disposal, what are RSA algorithms used for?

5. What is the application of one-way hash functions, such as MD5, which cannot prevent a message from being read by the enemy?

6. Circle correct description(s) about RSA encryption.
   - You pick two keys randomly, make one of the keys available to your friends, and keep the other to yourself.
   - One way to enable your friend, upon receiving a message from you, to perform authentication is to encrypt the message with your private key.
   - Another way to enable authentication is to encrypt only the digest of the message with your public key.
   - To have both secrecy and authentication, you encrypt the message with both your private key and your public key.

**IP Multicast**

1. Give two applications of multicast communications.

2. Which of the following multicast protocols involve the broadcast of group membership information: DVMRP, MOSPF, CBT?

3. What is IGMP? Briefly describe its purpose.
4. Using the network topology and routing tables shown on page 12 of IP multicast slides, answer the following questions.

   (a) Show the broadcast tree produced by the RPF algorithm when C is the source.
   (b) Let M be the first multicast datagram from C. Count the number of times M is forwarded by routers, including the ones that are discarded by the receiver router.

5. (Challenging) Compare and contrast the two broadcast methods we discussed in the course: RPF and flooding. (Hint: which one uses more bandwidth? which one depends on routing tables? which one has to remember the past, that is, to keep track of which broadcast has been received, and so forth)

6. Circle the multicast protocol(s) that involves Dijkstra’s shortest path computation algorithm:
   DVMRP
   CBT
   MOSPF

7. Discuss the advantages and disadvantages of the source-rooted trees and shared tree.

8. Argue against the following hypothesis: the core node of a CBT multicast tree with N members must have processed at least N JOIN-REQUEST messages (there could be more because some previous members may have quit).