EE 706: Communication Networks

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Endsemester Exam: **30 points** (180 min) April 28, 2012

Each of the following questions is worth 2 points.

1. Suppose the Mini Slotted Alternating Priority (MSAP) protocol is in operation for a system with $M = 10$ nodes. Suppose the nodes have priorities from 0 to 9. Let the minislot duration be τ which is greater than the maximum propagation delay in the system and the data transmission duration be T_f. Suppose node 4 just finished transmitting a frame of duration T_f. Suppose nodes 2 and 6 each have two frames of duration T_f to send (total of four frames). What is the order in which the four frames will be transmitted under each of the following priority schemes?
   (i) Round-Robin
   (ii) Alternating Priorities
2. In the following scenarios, devise a CSMA protocol which is optimal and give reasons for your design. Assume all nodes are in the transmission range of each other.
   (i) The network has only two transmitting nodes which both want to communicate to a single destination on the same frequency band. The destination sends acknowledgements on a different frequency band.
   (ii) The network has only three nodes which want to communicate with each other on the same frequency band.
3. If an Ethernet system has data rate D and maximum propagation delay τ, the minimum packet length in bits is N. What is the minimum packet length in the following scenarios? Explain your answer briefly (just the final answer is not sufficient).
   (i) Data rate $2D$ and maximum propagation delay 2τ.
   (ii) Data rate $\frac{D}{2}$ and maximum propagation delay 2τ.
4. Suppose a bridge participating in the spanning tree algorithm has N ports $1, 2, \ldots, N$ on which it receives configuration messages $C_1, C_2, \ldots, C_N$ respectively. Answer the following questions.
   (i) When does the bridge declare itself to be the root?
   (ii) If the bridge does not declare itself to be the root, which port is designated the root port?
   (iii) If the bridge does not declare itself to be the root, for which ports does it decide to be the designated bridge?
   (iv) If the bridge does not declare itself to be the root, which ports are put in blocking state?
5. The spanning tree algorithm ensures that there no loops when Ethernet LANs are connected by bridges. Give an example illustrating what might go wrong if there are loops when LANs are connected by bridges.
6. Suppose a 1420 byte IPv4 datagram which has 1400 bytes of data and 20 bytes of IPv4 header arrives at a router and needs to be sent over a network which has an MTU of 550 bytes. Describe the fragmentation process and specify the size of each fragment. Also specify the values of those fields in each fragment header which differ from the values of the corresponding fields in the original datagram header.
7. Suppose a NAT server running port-based NAT acts as an interface between a LAN employing private IP addresses and the Internet. Suppose the NAT server has a single class C public IP address block at its disposal and 100 port numbers which are not assigned to any application to use in the port-based NAT protocol. If each node in the LAN can generate TCP packets from upto 5 different applications (each application will have a different TCP source port), what is the maximum number of nodes in the LAN which the NAT server can support?

8. Suppose there are three nodes A, B, C in an Ethernet LAN with IP addresses 10.107.1.1, 10.107.1.2 and 10.107.1.3 respectively. Their MAC addresses are 01:02:03:04:05:0A, 01:02:03:04:05:0B and 01:02:03:04:05:0C respectively. Their ARP caches are initially empty. What ARP related events occur in response to each item in the following scenario? Show the status of the ARP cache for each of the nodes after these events. Assume the ARP timeout value is 60 seconds and that ARP cache update takes negligible amount of time.

   (i) At $t = 0s$, A wants to send a packet to IP address 10.107.1.3.

   (ii) At $t = 10s$, A wants to send a packet to IP address 10.107.1.2.

   (iii) At $t = 65s$, C wants to send a packet to IP address 10.107.1.1.

   (iv) At $t = 70s$, B wants to send a packet to IP address 10.107.1.3.

9. In the six-node communication network shown in Figure 1, suppose node A has received link state packets from all the other nodes in the network. Detail the steps of Dijkstra's algorithm which runs at A to compute the minimum delay paths to all the nodes in the network.

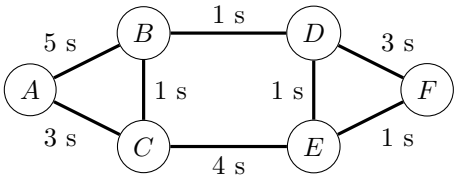

Figure 1

10. Explain how explicit congestion notification works. Your explanation should describe the role of the different participating nodes and the fields in the packet header which are modified to signal congestion.

11. A source wants to send 3000 bytes to a destination using TCP. Draw the timing diagram of the complete TCP communication including the TCP connection setup, data transfer and TCP connection termination. Assume that the maximum segment size is 1000 bytes (this is only TCP payload and does not include header). Assume that the source chooses an initial sequence number of x and the destination chooses an initial sequence number of y. Indicate the flags which are set and the sequence numbers for each segment.

12. Give an example illustrating the silly window syndrome (SWS) of TCP when the SWS avoidance algorithms are not present.

13. Describe the TCP round trip time (RTT) estimation algorithm which takes the variation of the RTT into account.

14. What happens in TCP congestion control after each of the following events?

   (i) The source is in slow start phase with a congestion window of 6 MSS and a slow start threshold of 10 MSS. A cumulative acknowledgement for 2 MSS worth of data arrives.

   (ii) The source is in slow start phase with a congestion window of 6 MSS and a slow start threshold of 10 MSS. A timeout occurs.

   (iii) The source is in congestion avoidance phase with a congestion window of 16 MSS. A timeout occurs.

   (iv) The source is in congestion avoidance phase with a congestion window of 16 MSS. Three duplicate ACKs arrive.

15. Briefly describe the structure of an ns-3 script which simulates a single packet exchange between a node having a `UdpEchoClient` and a node having a `UdpEchoServer` connected by a point-to-point link. Mention the names of the objects created and the sequence in which they are created. Describe the role of an object if you don't remember the exact name.