CS 421: COMPUTER NETWORKS **SPRING 2013**

FINAL
May 16, 2013
150 minutes

Name: _____

Student No: _____

Show all your work very clearly. Partial credits will only be given if you carefully state your answer with a reasonable justification.

Q1	
Q2	
Q3	
TOT	

1)

a) (4 pts) Why does DNS use UDP as the transport layer protocol instead of TCP?

b) Suppose that an application running at host A is using a TCP socket to transfer data to another application running at a remote host. Suppose that the application running at host A writes 5 times to the buffer of the TCP socket (the application writes 500 Bytes in each write operation).

i) (3 pts) Is it possible that the underlying network layer at host A transmits more than 5 IP packets without counting retransmissions? Why or why not?

ii) (3 pts) Is it possible that the underlying network layer at host A transmits less than 5 IP packets? Why or why not?

c) (5 pts) Assume that there is a TCP connection with a roundtrip time of 50 ms. What is the maximum possible data transfer rate, in bps, for this connection assuming that TCP Options are not used? *Hint:* Recall that the Receive Window field in the TCP header is 2 Bytes long.

d) (7 pts) Suppose that a file composed of 31 segments, each with a size of 1000Bytes, will be transferred over a TCP connection with a round-trip delay of 100ms and bandwidth of 100Mbps, i.e., $100x10^6$ bits/second. Assume that no loss event occurs during the entire file transfer. Further assume that the slow start threshold (ssthresh) at the beginning of the TCP connection is infinitely large. Ignore all processing and queueing delays. How long does it take to transmit the entire file and receive the final ACK?

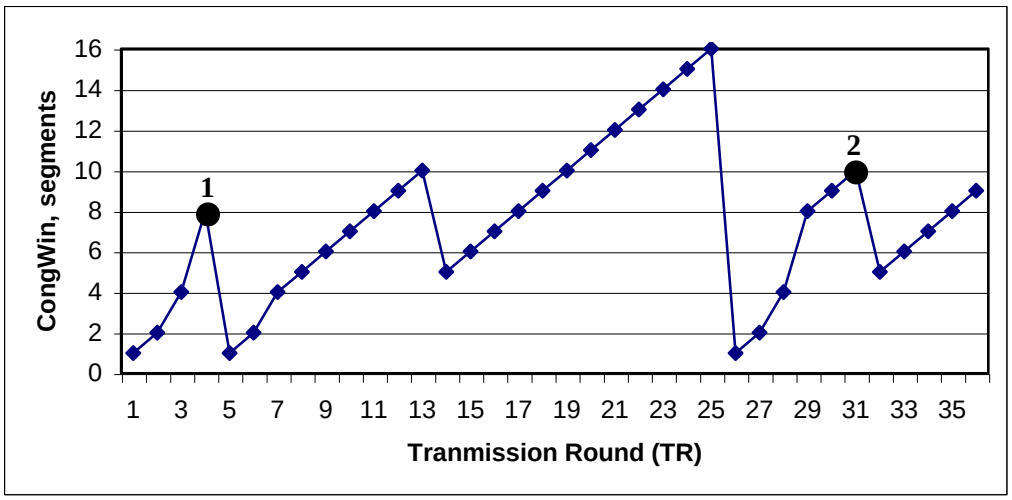
e) The following figure shows the evolution of the Congestion Window for a TCP connection as a function of time.

i) (2 pts) What is the event that occurred at "1" resulting in a decrease in the congestion window?

ii) (2 pts) What is the event that occurred at "2" resulting in a decrease in the congestion window?

iii) (2 pts) Among the events that occurred at "1" and "2", which one is an indication of a more severely congested network?

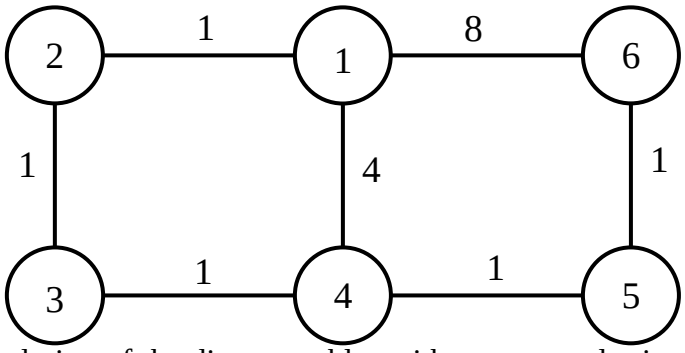
iv) (2 pts) Does the event at "2" necessarily mean that a packet is lost in the network? Why or why not?



2)

a) The network below uses the distance-vector routing algorithm. Assume the following:

- Links have the same cost in both directions.
- Nodes exchange their routing info once every second, in perfect synchrony and with negligible transmission delays. Specifically, at every t = i, i = 0, 1, 2, 3,..., each node sends and receives routing info instantaneously, and updates its routing table; the update is completed by time t=i+0.1.
- At time t = 0, the link costs are as shown below and the routing tables have been stabilized. At time t = 0.5, the cost of the link (5,6) becomes 7. There are no further link cost changes.
- Route advertisements are **only exchanged periodically**, i.e., there are no immediate route advertisements after a link cost change. Hence the first route advertisement after the link cost change at t = 0.5 sec occurs at t = 1.0 sec. *Note:* However, whenever a link cost change occurs, the two nodes at the endpoints of this link immediately make corresponding changes in their distance tables.
- Assume that the distance vector algorithm **does not use poisoned reverse**.



i) (12 pts) Give the evolution of the distance tables with respect to destination 6. Specifically, give the distance table entries for destination 6 at nodes 1-5, for t = 0.1, 0.5, 1.1, 2.1, ..., **until** all distance vectors stabilize. Present your final answer in the table given below where $D^i(j)$ is the distance vector element denoting the distance from *i* to *j*.

Time, t	$D^1(6)$ via			$D^2(6)$ via		$D^3(6)$ via		$D^4(6)$ via			$D^5(6)$ via	
	2	4	6	1	3	2	4	1	3	5	4	6
0.1												
0.5												
1.1												
2.1												
3.1												
4.1												
5.1												
6.1												
7.1												
8.1												
9.1												
10.1												
11.1												

ii) (5 pts) Consider the above network topology after the link cost change for link (5,6) occurred. Suppose link (1,6) is overloaded with traffic. Identify a single link cost change (on **just one link**) for a **link other than (1,6)** that will change the shortest path from node 2 to node 6 away from link (1,6) **without affecting the shortest path between any other source-destination pair**. You need to avoid any situation where routers need to choose between multiple equal-cost shortest paths.

b) (5 pts) You are given the assignment of setting subnet addresses for 5 campuses of your company. The number of Internet connected PCs in each campus is given in the following table. Assume that the 139.179.128.0/18 address block is given to you for this purpose. Use the following table to show the addresses of the five subnets that you created.

Campus	# of PCs	Subnet address (CIDR format)
1	8000	
2	3500	
3	1200	
4	1000	
5	700	

c) (5 pts) When a packet is going from a home network into the public Internet, which transport and network layer header fields will be changed by a Network Address Translation (NAT) enabled router?

d) (5 pts) Why are checksum and fragmentation eliminated from the IPv6 header? Discuss any negative implications of this elimination.

3)

a) (7 pts) Suppose the data sequence 11100010 is transmitted using the generator sequence 110011011. Compute the CRC bits and the transmitted bit sequence. If the 2^{nd}, 5^{th} and 6^{th} bits starting from the highest order (leftmost) bit in the received sequence are errored, determine whether this error can be detected by the receiver.

b) (5 pts) Consider an Ethernet LAN using CSMA/CD running at 100 Mbits/sec. The propagation speed for the signal over the cable is $2x10^8$ m/sec. The distances between the nodes in this Ethernet are given in the following table. Compute the minimum frame size in bytes so that the CSMA/CD algorithm will work properly.

Distance (m)	A	B	C	D
A	-	500	300	400
B	500	-	500	500
C	300	500	-	600
D	400	500	600	-

c) (4 pts) Suppose that every host in the Internet is part of an Ethernet based LAN and each host has a globally-unique Ethernet address. Is it a good idea to eliminate IP completely and make the whole Internet one large Ethernet interconnected by Ethernet switches? Why or why not (give at least two reasons to justify your answer)?

d) Assume that there are four nodes A, B, C and D on a 100 Mbits/sec Ethernet. Suppose these four nodes are involved in a collision which is the first collision for A's frame, third collision for B's frame, second collision for C's frame and fourth collision for D's frame. After the collision is detected (we assume that all nodes detect the collision exactly at the same time), nodes calculate their backoff times according to the binary exponential backoff algorithm.

i. (5 pts) What is the probability that the first transmission after the above collision will be a successful retransmission by A?

ii. (5 pts) What is the probability that the first transmission after the above collision will be a successful retransmission by D?

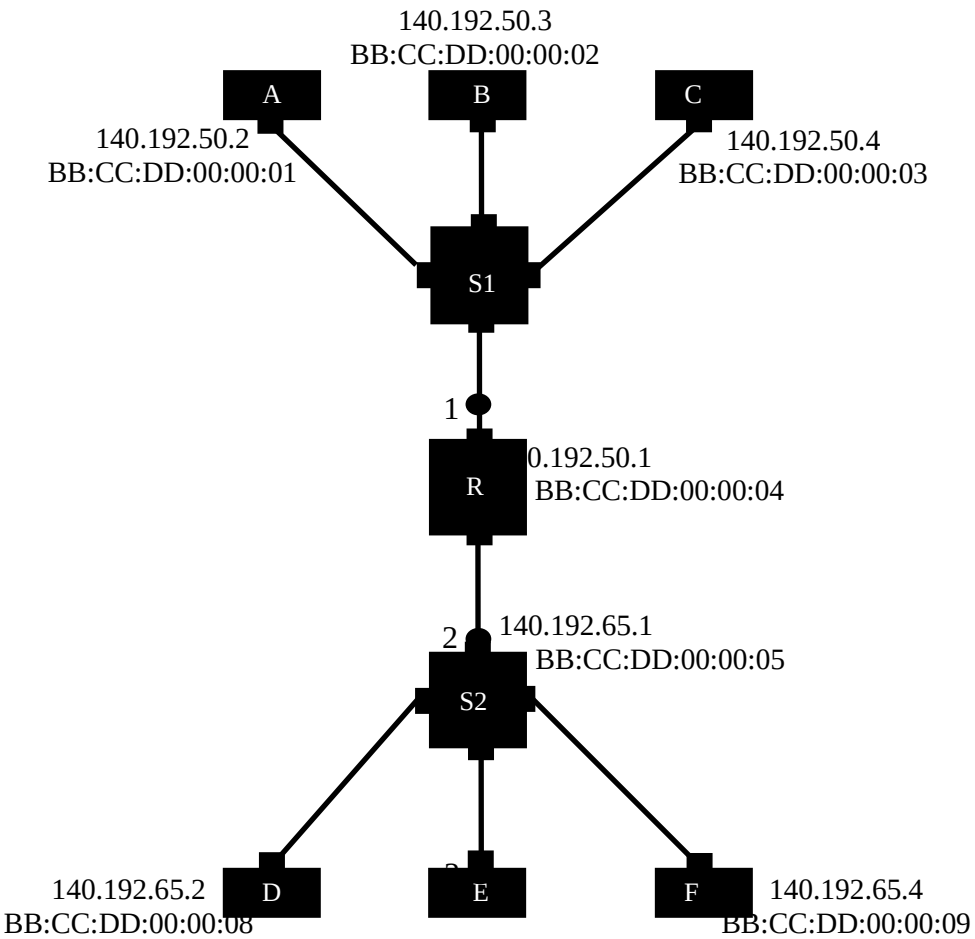
e) Consider the network below with 6 hosts (A, B, C, D, E, F), 2 switches (S1 and S2) and 1 router (R). For each host and router interface, the figure shows the corresponding IP address and MAC address. Assume that the routers and hosts are correctly configured with correct routing information, i.e., their forwarding tables are correctly configured. Assume further that **ARP tables of the router and all hosts are fully populated** with the IP-MAC address mappings of all network interfaces in the LAN. On the other hand, the **switch tables of both switches are initially empty**. Assume that host A is sending a single IP datagram to host E, and host A knows host E's IP address.

i. (6 pts) Use the following table to write down the Ethernet source and destination addresses and IP source and destination addresses of the IP datagram encapsulated within the Ethernet frame at points 1, 2, and 3 in the following figure for the datagram going from A to E.

Point	Source Ethernet address	Destination Ethernet address	Source IP address	Destination IP address
1				
2				
3				

ii. (3 pts) How many of the 6 hosts in the network will receive the frame containing the datagram sent by A to E? Justify your answer.

iii. (3 pts) Suppose that shortly after A sends the datagram to E, D sends a datagram to A. How many of the 6 hosts in the network will receive the frame containing the datagram sent by D to A? Justify your answer.



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