CS 421: COMPUTER NETWORKS **FALL 2006**

FINAL
January 5, 2007
150 minutes

Name: _____

Student No: _____

Q1	
Q2	
Q3	
TOT	

1)

a) (6 pts) Given the following parameters for a datagram packet switching network:

N: number of hops between two given stations;
L: total number of bits to be Xmitted;
B: common data rate, in bits/second, on all links;
H: number of overhead bits per packet;
P: packet size, in bits (excluding overhead bits);
D: propagation delay per hop, in seconds.

Derive a general expression for end-to-end delay between the two stations. Assume L is a multiple of P, and that the processing and queueing delays in each node are negligible.

b) (6 pts) Suppose that we would like to communicate over a connection where the packet loss rate is high and the round trip delay is large. Which of the following protocols is more suitable: Go-Back-N or Selective Repeat? Fully justify your answer.

c) Two transport layer entities communicate across a reliable network. Let the normalized time to transmit a segment be unity. Assume that the one-way end-to-end propagation delay is three units and it takes unit time to process the data in a received segment. The sender is initially granted a credit of seven segments and the receiver uses a flow control method that permits an update of the sender's credit allocation immediately. That is, the sender's window size is seven, and upon receiving and processing a segment the receiver immediately sends back an acknowledgement as usual.

i. (5 pts) What is the maximum achievable throughput?

ii. (5 pts) What is the maximum available throughput if the end-to-end propagation delay is zero?

d) (6 pts) Assume that the bandwidth of a connection is 1 Mbps ($1x10^6$ bits/sec) and the round-trip propagation delay for the connection is 10 msec. Assume that each data packet is 125 Bytes long and the ACK packets are 25 Bytes long. Assuming that no packets are lost, what should be the minimum window size (in packets) in order to achieve full bandwidth utilization when Selective Repeat protocol is used? What is the minimum number of bits necessary to represent the sequence numbers for proper operation using this window size?

e) (6 pts) Suppose that the TCP congestion window, CongWin, at a TCP sender is currently 8 KB and the slow start threshold, ssthresh, 10 KB (assume that 1KB=1000 Bytes). Assume that the maximum segment size, MSS, is 1000 Bytes. After the sender sends 6 segments for a total of 6 KB of data and receives all the ACKs for the data transmitted, what will be the value of CongWin and ssthresh in units of KB?

2)

a) (10 pts) Four subnets are defined by the following IP prefixes:

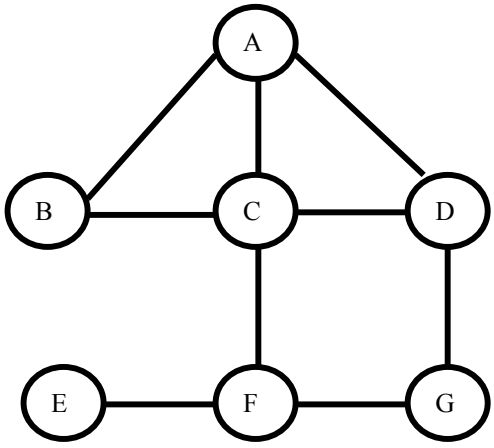
Subnet	Subnet address
1	139.179.0.0/16
2	139.183.0.0/16
3	140.183.14.0/23
4	140.183.192.0/18

In the following table indicate which subnets the following hosts with given IP addresses belong. If there are some hosts that do not belong to any of the subnets, mark them with a "-``.

Host	IP Address	Subnet
A	139.179.12.118	
B	139.183.12.16	
C	140.183.12.115	
D	140.183.190.55	
E	140.183.224.88	

b) (6 pts) The largest IP router can hold 200,000 entries in its forwarding table while the largest Ethernet switch can hold 1,000,000 entries in its forwarding table. However, a large IP network can support many more hosts than a large Ethernet network. Why?

c) Consider the following network topology. Suppose that the routers are running RIP without poisoned reverse, and they are all turned on simultaneously. Recall that in RIP, the weight assigned to each link is one.



i. (4 pts) Fill in the following table to show the initial routing table at node A:

Destination	Distance	Next hop
B		
C		
D		
E		
F		
G		

ii. (4 pts) Fill in the following table to show the routing table at node A after iteration 1:

Destination	Distance	Next hop
B		
C		
D		
E		
F		
G		

iii. (4 pts) Fill in the following table to show the routing table at node A after iteration 2:

Destination	Distance	Next hop
B		
C		
D		
E		
F		
G		

3)

a) (8 pts) Suppose the data bit sequence 010111010 is to be transmitted using the generator sequence 100000111. Compute the CRC bits and the transmitted bit sequence. If all three least significant bits in the received sequence contain bit errors, determine whether this error can be detected by the receiver by implementing the receiver's algorithm.

b) Suppose that nodes A, B and C are connected to the same Ethernet. Assume that each of these three nodes is trying to retransmit a frame. These frames have already experienced 2 and 3 and 4 collisions, respectively, i.e., collision counters are 2, 3 and 4 for nodes A, B and C. Assume further that all other nodes on the Ethernet are inactive.

   i. (6 pts) Assume that all three nodes detected the last collision simultaneously. Node C chooses 5 as the random number according to the exponential backoff algorithm. What is the probability that A will be the first node initiating a retransmission attempt?

   ii. (6 pts) Consider part i. if node C chooses 2 as the random number (instead of 5). What is the probability that B will be the first node initiating a retransmission attempt?

c) (6 pts) Consider a 100 Mb/s 100BaseT Ethernet network with a star topology composed of 5 nodes where each node has a point-to-point connection with a hub in the middle. The distances from the 5 nodes to the hub are given by 100m, 200m, 500m, 900m and 1000 m, respectively. Calculate the minimum frame size that this LAN can support so that the CSMA/CD protocol will function correctly. Assume that the speed of propagation is $2x10^5$ m/s.

d) (6 pts) A transport layer segment consisting of 500 data bits and 160 bits of header is sent to the internet layer which appends another 160 bits of header. This packet is then transmitted through two Ethernet networks, each of which has a maximum transfer unit of 1,500 bits. Recall that a MAC address is 6 bytes, and the Ethernet frame has a two bytes Type field and a 4 Bytes CRC field. What is the length of the frame in bits that is received by the link layer at the destination?

e) (6 pts) What is the hidden terminal problem in wireless networks? How does the CSMA/CA mechanism used in IEEE802.11 standard solve this problem? You may use a drawing to explain your answer.