CS 421: COMPUTER NETWORKS **FALL 2007**

FINAL
January 9, 2008
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) (5 pts) An application process on host A is assigned port p, and an application process on host B is assigned port q. Is it possible to have two or more TCP connections between these two ports concurrently? Justify your answer.

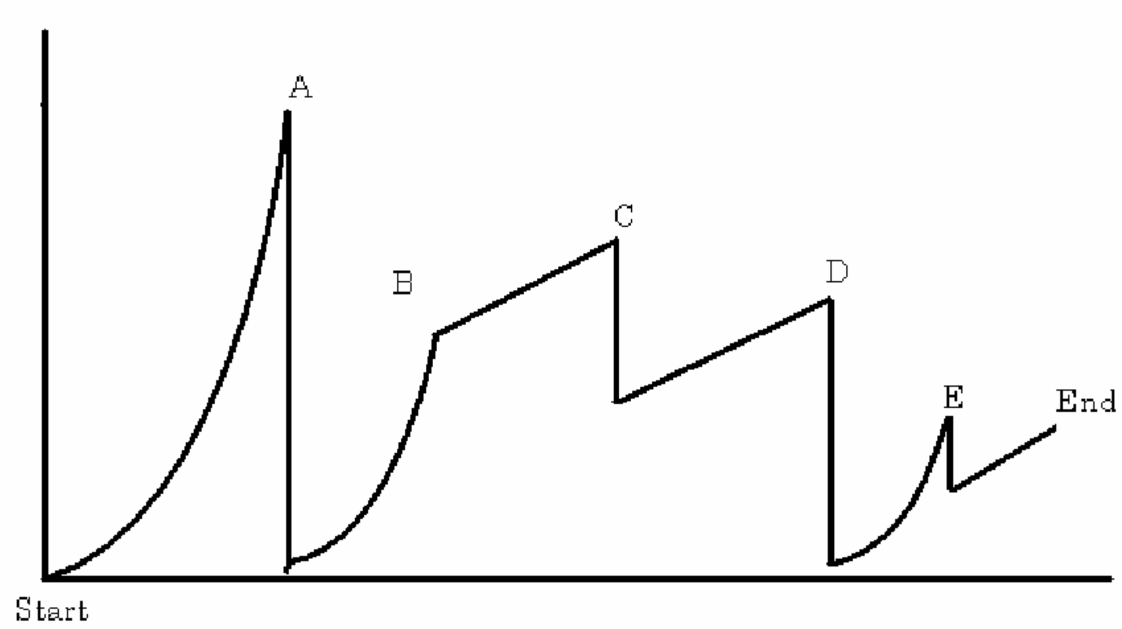
b) (6 pts) A TCP sender is transmitting over a 1 Gbps (1×10^9 bits/sec) channel which has a 10 msec **one-way** delay. What is the maximum sender utilization (U_{sender}) possible? (Sender utilization is the percentage of time the sender is busy transmitting bits). *Hint*: The receive window field in the TCP header is 2 Bytes long and assume that no options are used.

c) Consider the following TCP congestion window plot as a function of time.

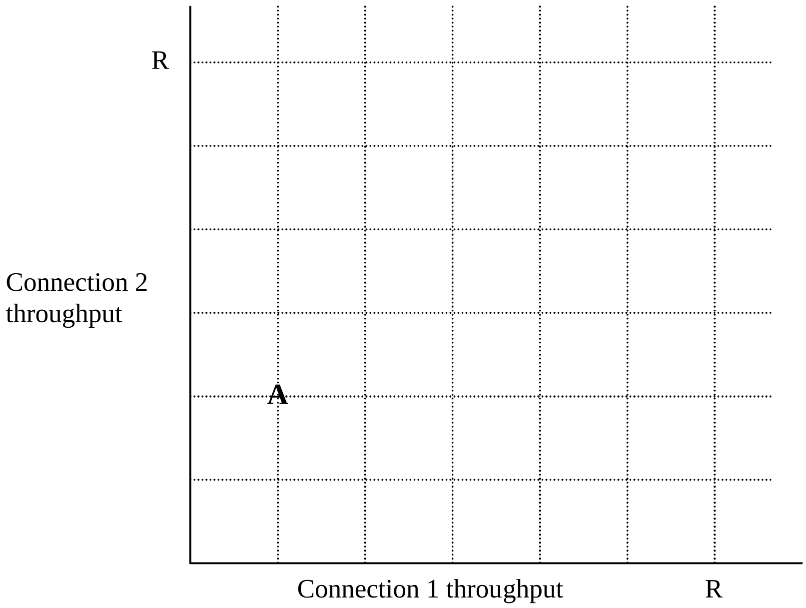
   i. (4 pts) At what regions in the plot is the TCP connection in the slow start phase? Mark regions as "X $\rightarrow$ Y".

   ii. (4 pts) At what regions in the plot is TCP in the congestion avoidance phase?

   iii. (4 pts) List all the TCP loss events in the plot (give the point at which each event occur and the type of each loss event.)



d) (8 pts) Assume a congestion feedback model for a system composed of two flows sharing a bottleneck link with bandwidth R bits/sec where both connections have the same RTT. Each flow gets binary synchronous feedback in discrete time steps of one RTT. If the aggregate consumption of the two flows is above the bottleneck bandwidth, both senders receive a congestion notification signal (**CN**), otherwise they receive no CN. The flows use a simple congestion control scheme: When no CN is received in a time step, each sender increases its window to βW, where W is the current window size and $\beta > 1$. On the other hand, for each congested time step, i.e., when senders receive CN, each sender decreases its window to αW, where $0 < \alpha < 1$ (typical values can be: $\alpha = 0.5$, $\beta = 1.01$). We can call this algorithm as *Multiplicative Increase-Multiplicative Decrease* (**MIMD**). **Prove or disprove** that MIMD achieves a fair allocation of bandwidth between the flows, i.e., each flow getting R/2, by using graphical arguments similar to the one we made in class in showing that TCP's AIMD algorithm is fair.



2)

a) (6 pts) Compare link state routing and distance vector routing algorithms in terms of:

   i) Speed of convergence

   ii) Communication overhead

b) (5 pts) How does BGP prevent routing loops, i.e., reject paths passing through the same AS multiple times?

c) (8 pts) An ISP wants to advertise the following IP address blocks (* can be any number in the range 0-255):

188.90.58.*
188.90.59.*
188.90.60.*
188.90.61.*
188.90.62.*
188.90.63.*

Since the sizes of the Internet routing tables have grown to huge proportions, ISP wants to announce the **fewest number of CIDR prefixes** to exactly cover all the above IP addresses. Give the IP address block(s) that I need to use for advertising all addresses listed above, but no other addresses (use address/prefix format of CIDR).

c) (8 pts) Suppose host A transmits a 1900 byte IP packet over a 2-hop path to host B. The MTU of the first link (A to router) is 900 bytes, and the MTU of the second link (router to B) is 500 bytes. Assuming that IP header does not contain any options, indicate the length (in bytes), more flag, and offset field values **(specify the offset values in units of 8 bytes)** of the fragment(s) transmitted over each link in the tables below.

First link

Fragment	Length	Offset	Flag
1			
2			
3			
4			
5			
6			

Second link

Fragment	Length	Offset	Flag
1			
2			
3			
4			
5			
6			

d) (4 pts) Choose an appropriate header (A-D) for each protocol below so that the headers in the packet shown below will be in the correct order.

A	B	C	D	Application data	CRC

   i) HTTP header __________

   ii) IP header __________

   iii) Ethernet header __________

   iv) TCP header __________

3)

a) (8 pts) Suppose the data sequence 101110 is transmitted using the generator sequence 1001. Compute the CRC bits and the transmitted bit sequence. If the 1st and 6th 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) Suppose that nodes A, B and C are connected to the same Ethernet. Assume that nodes A, B and C are involved in a collision, which is the 1st, 2nd and 3rd collisions for nodes A, B and C, respectively.

   i. (5 pts) What is the probability that the next transmission after this collision will made by node A and this will be a successful transmission?

   ii. (5 pts) What is the probability that the next transmission after this collision will made by node C and this will be a successful transmission?

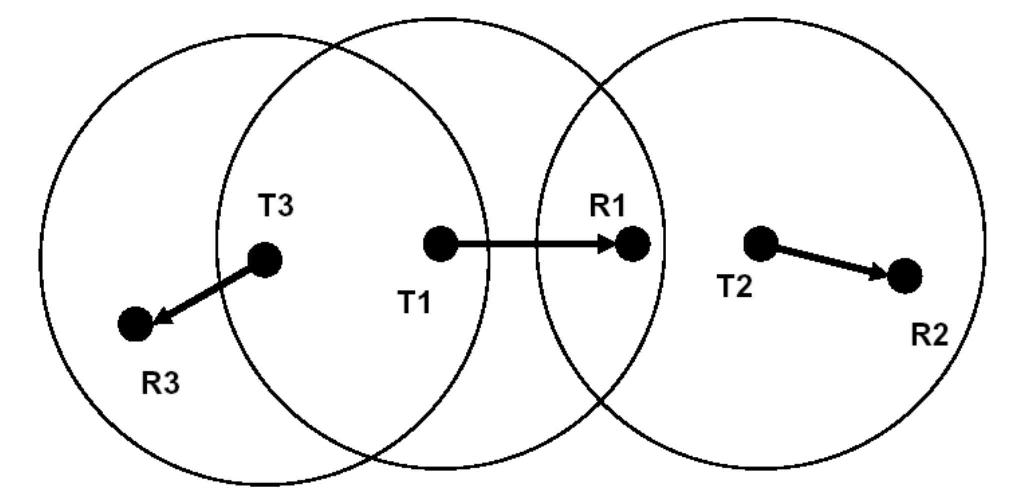
c) Consider a network element which has four Ethernet cables plugged into four different ports. Suppose that this network element can be either a **router**, a **switch**, or a **hub**. Answer the following questions separately for each network element.

   i. (3 pts) How many MAC addresses are necessary for each network element?

   ii. (3 pts) How many IP addresses are necessary for each network element?

   iii. (3 pts) For each network element, which field(s) inside which header(s) must it look up to decide how to forward a packet?

d) The picture below shows three pairs of nodes in an IEEE 802.11 WLAN where transmitters are marked with Ti and receivers with Ri. For each transmitter, the circle indicates the transmission range, which is also equal to the interference range, i.e., the range that will trigger the carrier sensing mechanism.



   i) (6 pts) Identify a potential hidden terminal situation and indicate the transmitter(s) and receiver(s) involved.

   ii) (5 pts) Is there a common solution for the hidden node problem?