

# CS 640: Introduction to Computer Networks

## Midterm – II

12/14/2006

**Allotted time: 11:00AM to 12:40 PM (100 minutes)**

**Name:** \_\_\_\_\_

**UW -ID Number:** \_\_\_\_\_

1. There are 7 questions in this mid-term. All 7 must be answered for full credit. The exam is lengthy: you may want to answer the “easy” questions first ( $\leq 4$  points).
2. Partial credit will be given for partially correct answers.
3. Print your answers legibly.
4. If a question seems ambiguous, clearly state all assumptions you have made in answering it.
5. This is a **closed-book** exam. However, you are allowed to refer to a cheat-sheet.

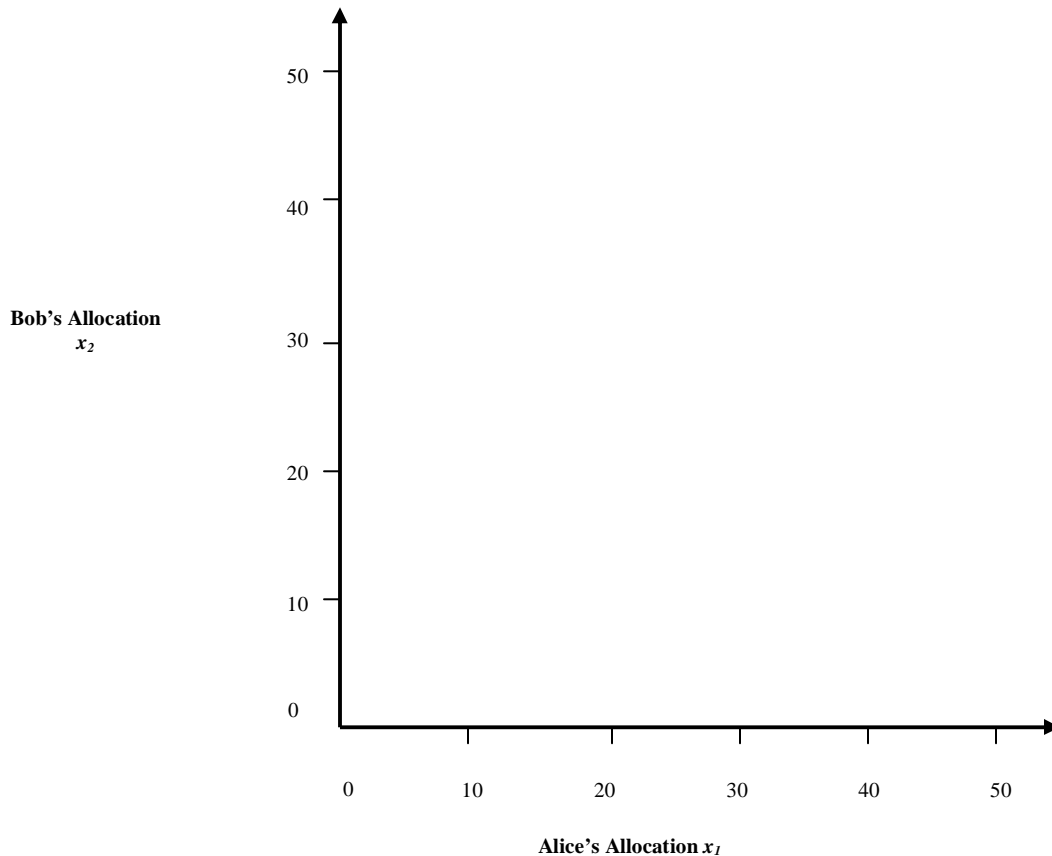
Question	Max points	Your score
1	15	
2	17	
3	15	
4	15	
5	13	
6	15	
7	10	
<b>Total</b>	<b>100</b>	

## 1. Congestion Control and Resource Allocation

Alice and Bob are the only users in a network. Alice and Bob wish to share the network's total capacity using a TCP-style, reliable, congestion controlled transport protocol. Assume that their congestion control algorithms and parameters are identical. . The total capacity of the network is 40 units.

The figure below is an incomplete “phase plot”. As we saw in class, such plots can be used to track how the relative capacity allocations of Alice and Bob evolve for a given choice of congestion control algorithm. Assume that linear congestion control algorithm is used. That is,

For increase:  $W \leftarrow A_I + B_I W$ , and  
For decrease:  $W \leftarrow A_D + B_D W$ ,  
 $A_I \geq 0, B_I \geq 1$  and  $A_D \leq 0, B_D \leq 1$ .



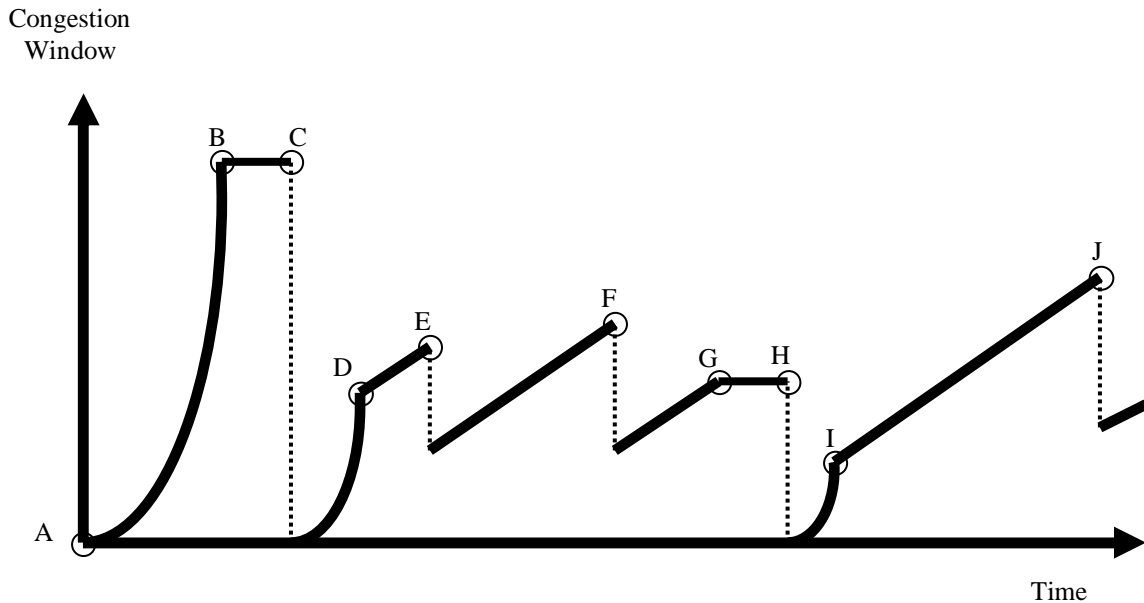
1. Say the current capacity allocations are Alice=20, Bob=10 units, respectively. Assume that both users employ Purely-Multiplicative Increase, Purely-Additive Decrease (MIAD) based congestion control. Will Alice and Bob receive a fair share of the network resources eventually? Will Alice end up with more, or less, than twice Bob's share? Use the phase plot to explain your answer. **[5 points]**

2. What linear congestion control algorithm does the current TCP implementation use? What are the default increase and decrease parameters? If Alice and Bob stuck with the current TCP implementation, what average allocations will they achieve in the long-term? **[3 points]**

3. TCP's current congestion control implementation (i.e. the algorithm and its parameters) could lead to highly inefficient use of network resources in two situations: (a) when the available network capacity is on the order of several Gbps; and (b) when TCP is being run across a satellite link. Explain why. Can you outline a simple fix to this problem (without affecting fairness)? **[7 points]**

## 2. TCP Behavior

The picture below shows the evolution of the congestion window of a regular TCP flow across time. The circled spots on the graph are “time instances of interest”. Answer the questions below.



1. What purpose does TCP's slow start phase serve? Identify all time intervals when the TCP flow is undergoing slow start. [3 points]

2. Say the size of the congestion window at time B is 60 packets. What is the value of the “ssthresh” variable of the TCP flow at time E? [2 points]

3. Are there situations (in the picture above) where fast retransmit is unable to help the TCP flow avoid a time-out? Why does this happen? [4 points]

4. The above TCP flow is running across a path with a total capacity of 8Mbps. The *one-way* delay of the path is 20ms. The TCP flow sends 1000B packets and there is no other cross traffic. Say the size of the congestion window at E and F are 40 and 50 packets respectively (just before loss occurred). What is the average sending rate in Mbps of the TCP flow for the E-F time interval?

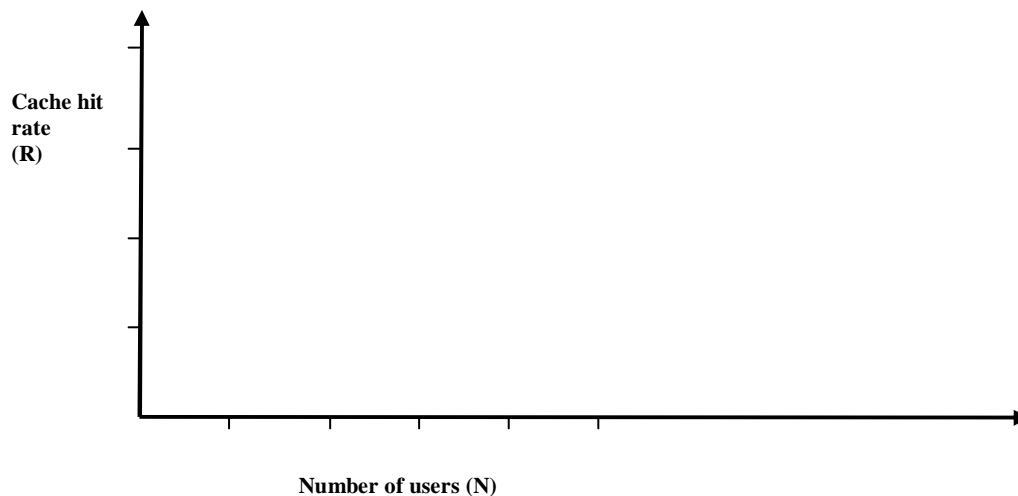
Assume that the flow is using the default congestion control parameters of current TCP implementations. Assume that there are no receiver-side buffer limitations. **[8 points]**

### 3. DNS and the Web

1. Circle correct statements. [2 points for all correct answers. -1 for each wrong answer]

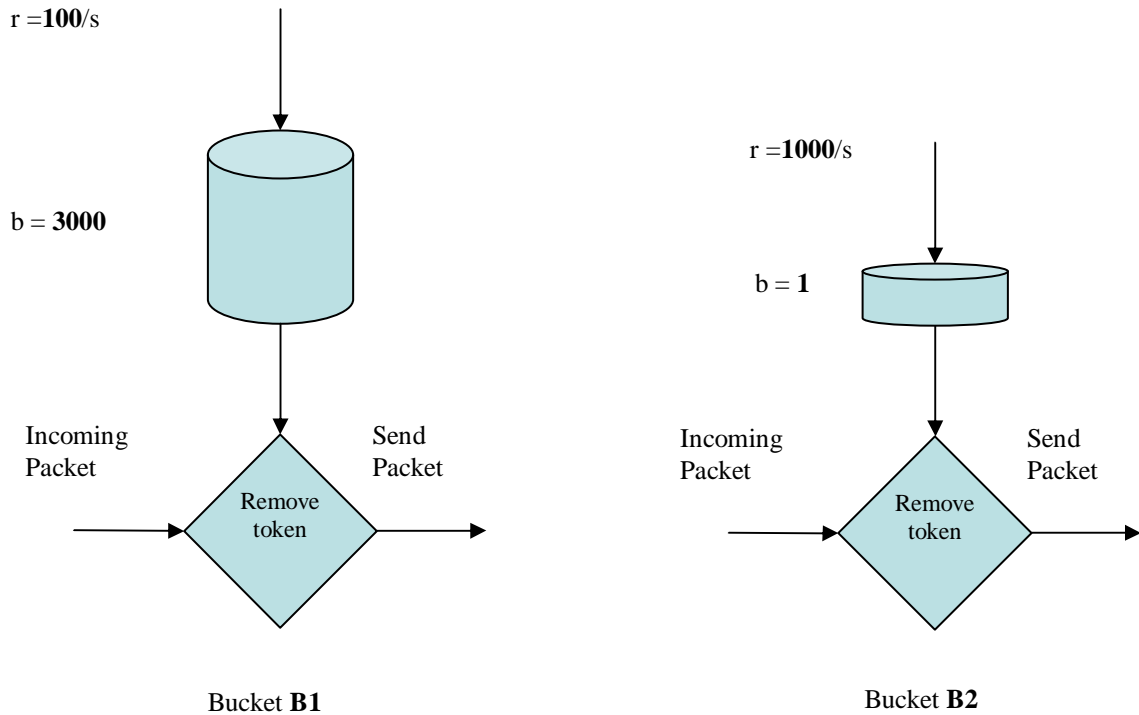
- Local DNS name servers typically perform recursive DNS queries, while remote name servers perform iterative DNS queries.
- DNS runs over TCP because reliable delivery of DNS responses is key to the overall functioning of Web-based transactions.
- Every DNS name resolution request is first directed toward one of the root name servers.
- In DNS, multiple unrelated domain names (e.g. `www.bobsserver.com` and `www.onlinecasino.com`) can map to the same IP address.

3. Pepsico has decided to deploy a Web proxy cache to improve the Web (HTTP) access response times of its employees. Let  $R$  denote the Web object hit rate ( $R$ ) at the Pepsico proxy cache and  $N$  the number of employees sharing the cache. Assume a fixed, finite cache size. As  $N$  varies from 1 to a very large value (e.g., 1,000,000,000), plot how  $R$  would evolve as a function of  $N$ . Now assume that the cache size is infinite. How would this impact the shape of the curve? Briefly explain your answers. [5 points]

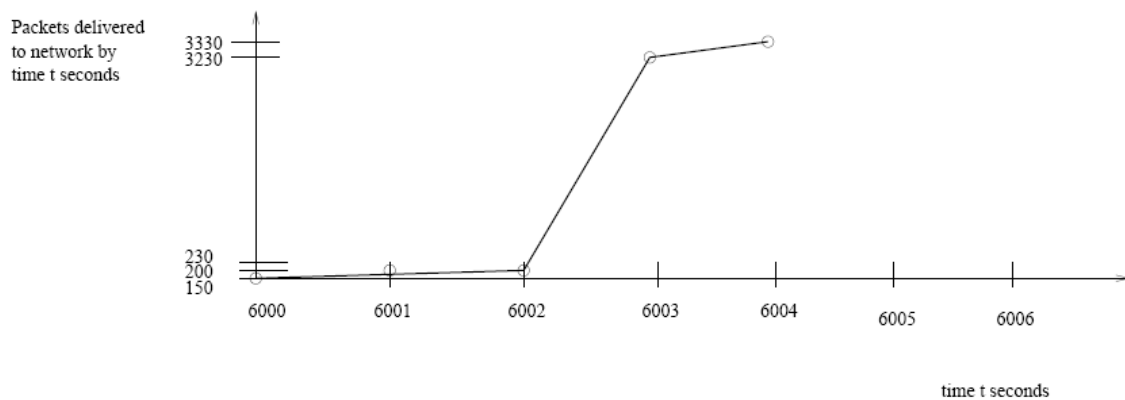


4. Jared, the SubWay guy, has decided to run for the President in 2008. He launched a website, <http://www.jaredforpres.org>, to increase the general public awareness of his illustrious past. You are a UW-Madison CS Major, a genius hacker, and you hate Jared. You want to attack Jared's site so that each time users from UW-Madison try to visit [www.jareddforpres.org](http://www.jareddforpres.org), they end up visiting [www.jaredsux.org](http://www.jaredsux.org). Based on your knowledge of DNS from the class, briefly sketch how you can pull this attack off. It is quite likely that your attack may not work for all UW users. Clearly state when your attack will or will not work. **[8 points]**

#### 4. Leaky Buckets and Queuing



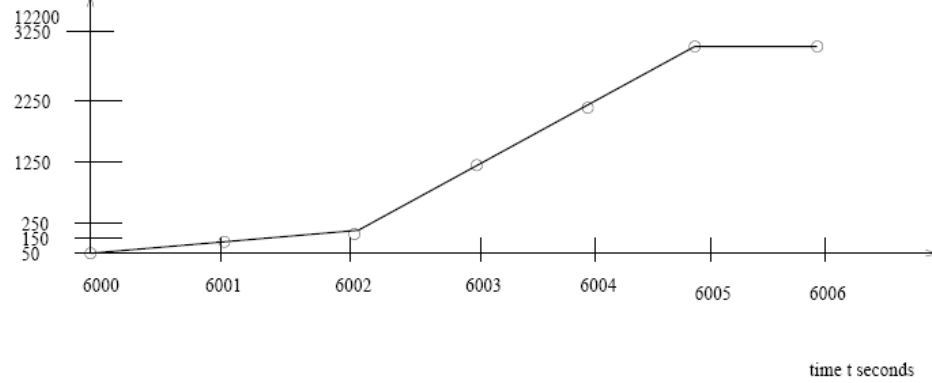
1. Consider the above figure showing two separate leaky buckets. Below, you are shown four flow behaviors. For each flow behavior, identify whether it could have been generated if the flow passed through: (1) bucket B1 alone; (2) first through bucket B1 and then through bucket B2. Circle the right answers. If the flow behavior is impossible in either case, circle “Neither”. [6 points]



**Behavior1:**    **B1?**                      **B1 → B2?**                      **Neither?**

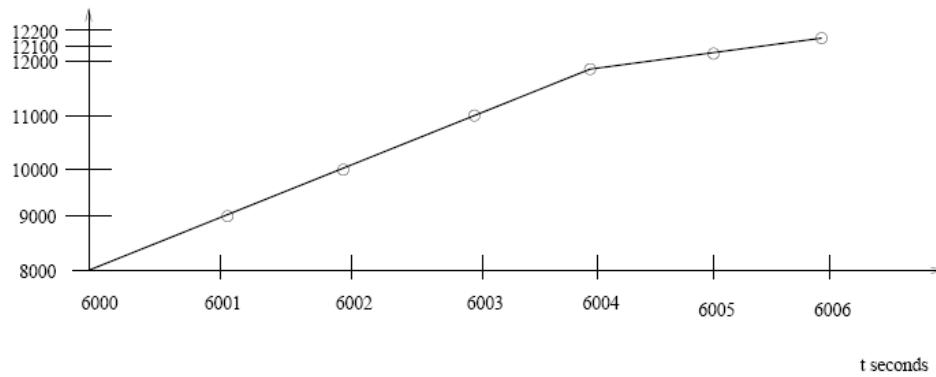


Packet delivered  
to network by time  
t seconds



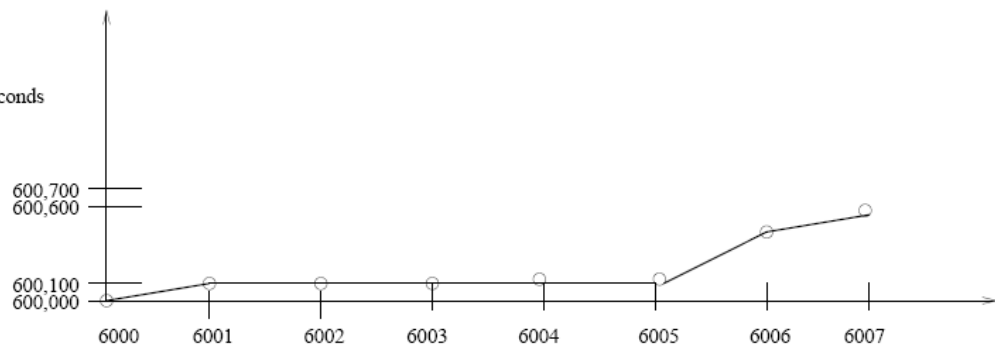
**Behavior 2:**    **B1?**                      **B1 → B2?**                      **Neither?**

Packets delivered  
to network  
by time t seconds



**Behavior 3:**    **B1?**                      **B1 → B2?**                      **Neither?**

Packets  
delivered  
to network  
by time t seconds



**Behavior 4:**    **B1?**                      **B1 → B2?**                      **Neither?**

2. Explain how RED solves the lock-out and full-queues problem. Although RED is effective at solving these issues, a TCP flow may actually observe lower net throughput in a network of RED routers compared to a network of FIFO routers. Why? **[5 points]**

3. Two users, one using Telnet and one sending files with FTP, both send their traffic out via a router R. The outbound link from R is slow enough that both users keep packets in R's queue at all times. Discuss the relative performance seen by the two users if R's queuing policy for these flows is:

- Equal weight Fair Queuing, where we count the cost of only data bytes and not IP or TCP headers; and,
- Priority Queuing (PQ) where FTP traffic gets higher priority than Telnet.

**[4 points]**

## 5. Wireless and Mobile IP

1. RTS/CTS control messages are not needed in networks where the DATA and ACK packet sizes are small (almost the same size as RTS/CTS packets). Why? **[3 points]**

2. Most wireless network administrators (e.g. UW wireless network) turn off the RTS/CTS mechanism in all wireless cards and access points by default (even though the DATA packets are not that small). Why is that OK? **[4 points]**

3. Ronald McDonald wants to do a VoIP call with Mr. Burger King. Ron places the VoIP call while at McDonalds. Ron uses his WiFi enabled laptop for the call. His call runs over the McDonalds wireless network, which is also his home network. A minute into the call, Ron decides to take his laptop to the Starbucks next door (they have better coffee there). Assume Ron uses Mobile-IP. What is the effect on the performance of Ron's call:

(a) During the transition from McDonald's to Starbucks?

(b) After Ron has settled down at Starbucks?

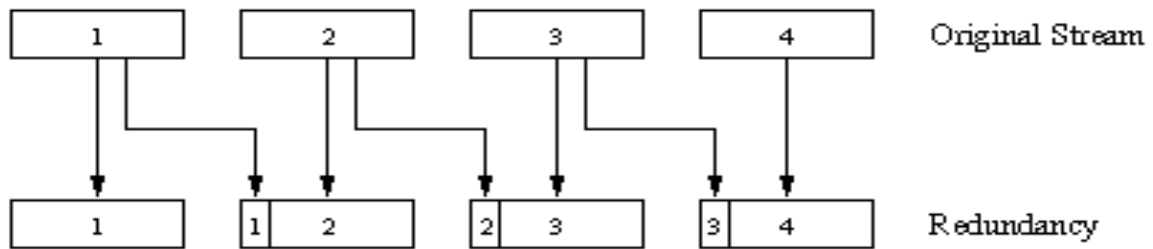
Suggest simple fixes to salvage the performance in either case. **[6 points]**

## 6. Multimedia and QoS

1. Consider the following two FEC schemes:

Scheme 1: Send a redundant chunk after every  $n$  data chunks. The redundant chunk is an XOR of the original  $n$  data chunks.

Scheme 2: Piggyback a lower resolution stream as redundant information, as shown below.



Suppose that the transmission rate of the lower bit rate encoding in Scheme 2 is 25% of the transmission rate of the actual stream. And, for Scheme 1, assume  $n = 4$ .

Assume that the first packet in every group of  $L$  packets is lost. In the table below, identify which of the two schemes would have better playback delay and better audio quality for  $L=5$  and  $L=2$ . Provide brief explanations in each box. **[8 points]**

	Playback Delay	Audio Quality
<b>L=5</b>		
<b>L=2</b>		

2. Briefly explain why admission control is *not* necessary in a network where a majority of flows are elastic in nature. **[3 points]**

3. Although traffic conditioning and policing are a must in DiffServ, the aggregate amount of state maintained across routers in a DiffServ network is much lower than the state in an IntServ network. Give two reasons for this. **[4 points]**

## 7. Peer-to-Peer

A major problem with current P2P file sharing systems is that users of the system do not have as much incentive to let others upload their data as they have to download data from others. As a result, a large fraction of users in most p2p systems are “free-loaders”. Your goal is to modify the KaZaa P2P protocol to address the free-loading problem.

1. The “tit-for-tat” approach of Bit-torrent *cannot* be directly applied to improve the freeloading situation in KaZaa. Why? **[4 points]**

2. Suggest a simple modification to the KaZaa protocol that can address the freeloading problem. Outline the potential drawbacks of your approach. **[6 points]**