CNT5106C Computer Networks, Fall 2009
Instructor: Prof. Ahmed Helmy
Homework #2
On Queuing, Transport Layer, Congestion Control and TCP
[Date Assigned: Oct 11th, 2009. Due Date: October 19th, 2009 in class or to the TAs]
Full grade points: 80, Total Points: 95, Extra points: 15 points.

Q1. (4 points) Describe why an application developer might choose to run an application over UDP rather than TCP. Give examples of such applications.

Q2. (4 points) Why is it that voice and video traffic is often sent over TCP rather than UDP in today's Internet? (Hint: not because of TCP's congestion-control mechanism)

Q3. (4 points) Is it possible for an application to enjoy reliable data transfer even when the application runs over UDP? If so, how?

- ***Queuing Theory***

Note: You may want to make use of the following equations:

- M/D/1: queuing delay $Tq = \frac{Ts(2-\rho)}{2.(1-\rho)}$; Ts is service time & ρ is link utilization
- M/D/1: average queue length or buffer occupancy $q = \lambda.Tq = \rho + \frac{\rho^2}{2.(1-\rho)}$
- M/M/1: queuing delay $Tq = \frac{Ts}{(1-\rho)}$, buffer occupancy: $q = \frac{\rho}{(1-\rho)}$

Q4. (8 points) Consider two queuing systems, serving packets with lengths that have exponential distribution, and the packet arrival process is Poisson. The first queuing system (system I) has a single queue and a single server, and hence the packet arrival rate is X, and the server speed is Y. The second queuing system (system II) has two queues and two servers, and hence the packet arrival rate is X/2, and the server speed is Y/2. Derive a relation between the delays in each of these systems. What conclusion can you make?

Q5. *i-* (4 points) What is meant by implicit congestion signaling and explicit congestion signaling? Give examples of congestion control protocols that use each type of signaling.
ii- (6 points) Discuss the advantages and disadvantages of each of the above schemes.

Q6. (8 points) In one type of congestion control protocols the congested router sends a message (e.g., source quench) to the end points to alleviate the extent of congestion. Discuss the problems faced by such a scheme, providing potential solutions.

Q7. (10 points) Based on your understanding of how congestion occurs in the network and the phases of congestion, discuss how TCP is attempting to control network congestion. (Use a graph to illustrate)

Q8. *i.* (6 points) In TCP slow start mechanism, what is the equation used to increase CongWin and how does the window grow according to this equation? How does the equation change for the congestion avoidance phase and how does the window grow then?
ii. (8 points) In the details of the fast retransmit-fast recovery mechanism the window grows according to the equation used in slow start (before the cumulative ACK is received). Does that mean that TCP can send as many segments as it would have in slow start (for the same window size)? Why or why not?

Q9. *i.* (4 points) Why do we say that TCP uses an AIMD mechanism?
ii. (4 points) Why does TCP use AIMD?
iii. (4 points) What happens if TCP uses MIMD?

Q10. (6 points) If you use TCP to transfer a big file, you are likely to get a fair share of the network bandwidth (i.e., similar to that given to other long TCP connections). Describe a way in which you can get more than your fair share. Reason about how much more bandwidth you can get.

Q11. (6 points) In ATM ABR congestion control the equation to increase the rate is given by:

$Rate_{new}=Rate_{old}-Rate_{old}*RDF$, where *RDF* is the rate decrease factor,

a. discuss how fast/slow does the sender respond to congestion for the various value of *RDF*.
b. If the equation was changed to $Rate_{new}=Rate_{old}*alpha$, do you think the response will be better or worse and why.

Q12. (9 points) Argue for or against this statement (reason using examples as necessary): "Packets are lost only when network failures occur (e.g., a link goes down). But when the network heals (e.g., the failed link comes back up again), packets do not get lost."