College of Computer and Information Science
Northeastern University
CS4700 & CS5700: Fundamentals of Computer Networks

Fall 2011

Problem Set 3 (due October 14, 2011).

Important Notes:

1. Problem 1 and Problem 3 can be done in teams.
2. Late submissions will result in a 10% penalty per day (e.g., 2.5 days late result in 25% penalty).
3. You can use the Internet to get some help, but you should use your own words, examples, and code when answering the questions. Reference Internet materiel when appropriate.

Problems 1-3 are for both CS4700 & CS5700 students.

Problem 1 [50 points, team]: Implementation of Sliding Window ARQ

1. Extend your PS2, Problem 5 implementation of the Stop and Wait ARQ mechanism to support arbitrary window sizes (SWS and RWS).
2. Run your server and client on login.ccs.neu.edu.
    a. What are the average packet delay, throughput, and packet loss rate that you are experiencing?
    b. Find good values for the SWS and RWS that maximize the system throughput. In your report, describe how you determined these values (e.g., by first estimating the round trip time). What is the best throughput that you could achieve? Discuss.
3. Run your server on login.ccs.neu.edu and your client on a machine outside the college.
    a. What are the average packet delay, throughput, and packet loss rate that you are experiencing?
    b. Find good values for the SWS and RWS that maximize the system throughput. In your report, describe how you determined these values (e.g., by first estimating the round trip time). What is the best throughput that you could achieve? Discuss.

Problem 2 [10 points, individual]: IEEE802.11

1. What is the meaning of the hidden-terminal problem?
2. How does IEEE802.11 limit the hidden terminal problem effects?
3. How does IEEE802.11 prioritize control messages such as ACKs?
4. What is the purpose of fragmentation?
5. Explain in your own words what is happening in slide 43 of lecture 3 "802.11 - competing stations - simple version".

Problem 3 [40 points, team]: M/M/1 Performance/Statistical Multiplexing

The goal of this problem is to simulate a queuing system with 8 queues and one server.

1. **(10 points)** Write a program that generates a Poisson distribution with rate λ. Write a program that generates an exponential distribution with mean $1/\mu$. There are many resources on the Internet to help you simulating random processes e.g.,

you can check http://www.ds.unifi.it/VL/VL_EN/poisson/poisson8.html. You can use C/C++, Java, or matlab (matlab is probably the easiest).

2. **(30 points)** Let a system consist of:
   - Two computers connected using a 64Mbps line.
   - 8 parallel sessions, each with packet arrival rate λ=2000pkts/s.
   - Packets length is exponentially distributed with mean 2000bits.

Simulate and compute the average delay of packets for the following two strategies:

a. Each has a dedicated share of the 64Mbps link. In other words, each session has 8Mbps.
b. All sessions share the 64Mbps.

Additional Required Problem for graduate students (CS5700).

Problem 4 [20 points, individual]: Ethernet Performance
Consider slide 35 "Ethernet Performance" of set "Direct Link Networks". The goal of this exercise is to re-derive the formulas of the slide.

Assume that retransmissions occur with probability *p,* and there are *k* stations ready to transmit.

1. Why is the probability that a station acquires the channel $A=kp(1-p)^{k-1}$. Show how to find the value of p that maximizes A. What is the limit of A when k ->∞?
2. Why is the probability that a contention interval has exactly j slots is $A(1-A)^{j-1}$? Show how to compute the average number of slots per contention.
3. If a slot duration: $2t$ = 51.2ms, the channel efficiency is $P/(P+2t/A)$. Plot the channel efficiency for several packet sizes and number of stations.