College of Computer and Information Science Fall 2011
Northeastern University
CS4700 & CS5700: Fundamentals of Computer Networks

Problem Set 7 (due December 7, 2011 @ 11:59pm).
[80 points]

Important Notes:

1. Late submissions will result in a 10% penalty per day (e.g., 2.5 days late result in 25% penalty).
2. You can use the Internet to get some help, but you should use your own words, examples, and code when answering the questions.
3. No teamwork allowed.

Problem 1 [80 points]: Weighted Fair Queuing

Suppose a router has three input flows and one output. It receives the packets listed in the table below all at about the same time, in the order listed, during a period in which the output port is busy but all queues are otherwise empty.

Packet	Size	Flow
1	100	1
2	200	1
3	50	1
4	120	2
5	190	2
6	200	2
7	160	3
8	50	3

Give the order in which the packets are transmitted, assuming:

(a) Fair queuing

(b) Weighted fair queuing, with flow 3 having weight 2, and the other two with weight 1

Problem 2 [20 points]: TCP Congestion Control

(a) Consider a simple congestion-control algorithm that uses linear increase and multiplicative decrease but not slow start, that works in units of packets rather than bytes, and starts each connection with a congestion window equal to one packet. Assume the delay is only due to latency, and that when a group of packets is sent, only a single ACK is returned. Plot the congestion window as a function of the round-trip times for the situation in which the following packets are lost: 9, 25, 30, 38, and 50. For simplicity, assume a perfect timeout mechanism that detects a lost packet exactly 1 RTT after it is transmitted.

(b) For the situation given in the previous problem, compute the effective throughput achieved by this connection. Assume that each packet holds 1 KB of data and that the RTT = 100ms.

Problem 3 [20 points]: Distributed Hash Tables

Consider a P2P network constituted of nodes:

0245, 0466
1021, 1041, 1042, 1043, 1126, 1326, 1664
2013, 2165, 2245, 2567
3617, 3621, 3631
4136, 4536
5023, 5123, 5345, 5678, 5520, 5543, 5525, 5673
6602, 6712,
7523, 7612

1. Show *RouteTab* at node 1041 and *RouteTab* at 5543. Assume that each digit takes values in {0, …, 7}.
2. How would a node (*nodeid* 1041) locate a file with *objectid* 5524? (ignore the LeafSet).

Problem 4 [20 points]: Reliable Multicast using Polynomial Interpolation

Consider a multicast communication using Polynomial Interpolation to provide efficient reliability. This is the scheme presented in class. Assume that all computation is done in GF(7), which means that addition and multiplication are modulus 7 (and therefore inverses also).

(1) In this specific example, assume that the sender groups packets in groups of 3 (e.g., M_2, M_1, M_0) and builds a polynomial: $P(X) = M_2X^2 + M_1X + M_0$. The sender sends P(0), P(1), P(2). However, one receiver did not receive one packet, and another receiver did not get two packets. The sender sent additional packets: P(3), and P(4).

How does a receiver who received packets P(0)=1, P(2)=0, P(3)=2, recover M_2, M_1, M_0? What are M_2, M_1, M_0? Show the details of the computation (Lagrange Interpolation) to determine the values of M_2, M_1, M_0.

(2) In this specific example, assume that the sender groups packets in groups of 4 (e.g., M_3, M_2, M_1, M_0) and builds a polynomial: $P(X) = M_3X^3 + M_2X^2 + M_1X + M_0$. The sender sends P(0), P(1), P(2), P(3). However, one receiver did not receive one packet, and another receiver did not get two packets. The sender sent additional packets: P(4), and P(5).

How does a receiver who got packets P(0)=1, P(2)=0, P(3)=0, P(4)=2, recover M_3, M_2, M_1, M_0? What are M_3, M_2, M_1, M_0? Show the details of the computation.