Lab Assignment 3

(Due on 03/23/2011)

**Objective.** This lab assignment is designed to develop a deeper understanding on the reliable data transfer and congestion control mechanisms, and the TCP performance.

**Team.** You can work in a team of no more than 3 students in this lab assignment. A description of each team member’s task in this lab assignment is required with your submission.

**Submission.** Electronic submission is accepted via email to yuan.xue@vanderbilt.edu and xujie.si@vanderbilt.edu. The submission package should include the following components: 1) document that describe your design choices; 2) the source code; 3) team task assignment.

1. (25 pts) Measure the TCP/UDP performance using DETERlab. First create a network of four end nodes (nodeA, nodeB, nodeC, nodeD) and two routers. nodeA, nodeB and router1 form a local area network of 100Mbps and 0ms delay. nodeC, nodeD and router2 form another local area network of 100Mbps and 0ms delay. router1 and router2 are connected using a duplex link with 10Mbps and 10msec delay.

   **Experiment I.** Design the code and experiment to measure the throughput of a TCP connection between nodeA and nodeC. (Hint: transfer a large file using TCP and measure the transfer time.) (2 pts)

   **Experiment II.** Change the bandwidth of the duplex link to 50Mbps and 100Mbps. Perform the measurement again. what are the new TCP throughput? Do you think TCP fully exploit the expanded link capacity? Now change the delay of the link to 50msec and 500msec. Perform the measurement again, what are the new TCP throughput? (Consider to present your measurement results in a table or visualized it using a figure) Do you think TCP fully exploit the expanded link capacity? What is the impact of link delay on the TCP performance? Could you please explain your observation? (8 pts)

   **Experiment III.** Change the link between router1 and router2 with loss rate 0.05 and 0.1. Perform the measurement again, what are the new TCP throughput? Could you please explain your observation? (3 pts)

   **Experiment IV.** Now setup two simultaneous TCP connections between nodeA and nodeC, the other between nodeB and nodeD (the two connections transfer at the same time). Now measure the throughput of each TCP connection, respectively. Compare their throughput. (2 pts)

   **Experiment V.** Now setup a network with the following topology. Setup two simultaneous TCP connections between nodeA and nodeC, the other between nodeB and nodeD (the two connections transfer at the same time). Now measure the throughput of each TCP connection, respectively. Compare their throughput. (2 pts)
Experiment VI. Now setup one TCP connection between nodeA and nodeC and one UDP flow sent from nodeB to nodeD. The two connections transfer at the same time. Change the UDP traffic rate to the following values: 100Kbps, 500Kbps, 5Mbps, 10Mbps. Measure the throughput of TCP connection in each scenario. Compare the throughput of TCP and UDP (UDP’s throughput may be different from its sending rate, as packets may get lost). (8 pts)

2. (55 pts + 30 pts extra) Write a program to perform reliable data transfer (uni-directional) using UDP socket. You have the flexibility to choose the programming language and the operating system, though C/C++ over Linux platform is preferred.

- Describe the reliable data transfer mechanism you’ve used in your code. For example, what is the acknowledgement method (cumulative acknowledgement, delayed acknowledgement, selective acknowledgement, and/or negative acknowledgement)? What events trigger the retransmission? What do you decide the (congestion/receive) window size? (15 pts)

- Run your code on the same topology as in Experiment I. Measure the throughput of your reliable data delivery protocol. (40 pts)

- Compare it with the TCP throughput you measured in Experiment I. If it is higher than TCP, Congratulations! You will get extra credit (15 pts) (Assuming that your measurement in Experiment I is accurate).
- Run Experiment VI again with your reliable data transfer protocol and the UDP protocol. Compare the throughput of your protocol with the TCP throughput you measured in Experiment VI. If it is higher than TCP, Congratulations, again! You will get extra credit (15 pts) (Assuming that your measurement in Experiment VI is accurate).