ECE 671 – Computer Networks
Fall 2011 – Lab 1

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Please answer the following questions and submit your lab report electronically on SPARK. Grading will be based on the rubric posted on the course website.

Lab Preparation

1. Visit the Open Network Laboratory web site at: http://onl.wustl.edu/
2. Use your ONL username and password (available on SPARK as an entry in your grade book) to log into ONL (side-bar on the left). Change your password after logging in.
3. After logging in, click on "Getting Started" and follow the instructions.
4. Make sure to set up the SSH tunnel: http://onl.arl.wustl.edu/restricted/ssh-tunneling-rli.html
5. For tutorial pages, see http://wiki.arl.wustl.edu/onl/index.php/Main_Page

Lab Goals

1. Through assigning the IP address and next hop in the route table to better understand the definition of subnet, prefix and mask of IP address.
2. Evaluate the performance of the TCP connection such as bandwidth and delay, and set the different amount of queue capacity to observe the TCP congestion avoidance mode.

ONL Setup

1. Familiarize yourself with the Remote Laboratory Interface (RLI) and iperf tool that is used to generate TCP traffic.
2. Download the base configuration file from the course web site into your personal direction, open it in the RLI. It will be show a network topology in the RLI. In this assignment, we use two "NPRs", seven PCs and two GigE switches. The other window is the bandwidth chart; the name showed in the right is the corresponding port in the router, such as "1.3", means the port 3 in the NPR.1
3. Make a reservation for an hour slot on ONL by clicking the "Make Reservation" in "File" menu in the RLI interface. Enter your ONL user name and password.
4. Once your reserved time shows success, click on "Commit" in "File" menu to complete the set-up. Please note that you cannot make a reservation without a topology and you cannot change the topology before or after commit. If there are any changes in topology after commit, please cancel the reservation and make a new reservation.

5. After the commit is done, the progress bar will show "Commit Completed" message. You can right-click on the end-system in the RLI window to find its IP address and hostname ("pc1coreXY", XY is the number, it could change after commit every time), and open an SSH terminal to log into this end-system.

Part 1: Set IP Address in the Routing Table

In the first part, you need to set the suitable prefix/mask in the Routing table for every port of NPR to ensure the successful connection between arbitrary PC hosts.

Click the connected port of the NPR, choose the Route Table in the Configuration menu, the pop window shows the "NPR*: port* Route Table" (Note: * is the number of port you choose). Then click "Add Route" in the "Operations" menu to add the route needed in the connection. You should set the "prefix/mask "and "next port" in the form and could ignore the "stas" choice. The Prefix/mask is a subnet address specified in Classless Inter-Domain Routing (CIDR) format, the Next hop indicates the output port associated with the table entry, the Stats is the statistics index associated with the table entry. Note: After edit the router table every time, you need to "Commit" the topology again. Run a ping command to check that if you have successfully connected to the two end-systems and also could read the round-trip delay of this connection.

In the report, provide a table showing the "prefix/mask" and "next port" of each port you set in the experiment (e.g., as shown).

NPR1						NPR2			
Port 1		Port 3		Port 4		Port 1		Port 3	
Prefix/ mask	Next port	Prefix/ mask	Next port	Prefix/ mask	Next port	Prefix/ mask	Next port	Prefix/ mask	Next port

Provide a brief explanation for your configuration choices. Also, include a screenshot of successful connectivity between hosts h1x2 to h4x2 using the ping command. Explain why the measured delay is within your expectations.

Part 2: TCP Congestion Control

In this part, you need to use the iperf command to establish the TCP connection between the client and server. You could read the round-trip time (measured with ping) and end-to-end throughput of TCP (measured by iperf) and change the link rate. Make sure to let iperf run long enough (tens of seconds) to get a stable throughput result.

First, you could choose one PC host in any subnet as the TCP sender and choose the host h4x2 as the server to observe the congestion control in the TCP connection by using iperf command.

To run an iperf measurement, you need to start the iperf program in server mode on the receiving end-system:

iperf -s -w 64kB

This command tells the iperf server to expect a transmission with window size of 64kB. (Depending on the operating system, iperf may allocate a buffer that's actually double the size specified in the command line.)

To send traffic, start the client on the transmitting end-system:

iperf -c x.x.x.x -w 64kB -t 30 –i 5

The IP address or name of the end-system with the iperf client needs to be specified in the place of x.x.x.x. This command transmits data for 30 seconds to the host and port specified using the stated window size. The transmission information will be showed in the screen in the 5secs internal. Both iperf programs report the throughput achieved.

Second, you need to change two parameters to observe the TCP connection, Delay and Link rate:

- **Delay:** The default delay is **50ms**, you should change the delay to observe the effect on bandwidth. Click on the center of the NPR.1 router, choose the "PluginTable" in the Configuration. In the windows pops up, select the plugin then choose the "PluginCommand" from the "Operations" menu. In the new window, enter the following in the message field: "**delay= 100**" (without quotes and with no space on the left of the equal sign and with one space on the right of the equal sign). Then press enter. In the RLI window select "Commit" from the "File" menu. In the experiment, you need to set two delays **50ms and 100ms** to observe the effect of delay in bandwidth.
- **Link rate:** Click the port of the router, choose the "QueueTable" in the Configuration, in the pops window, select the "SetPortRate" in the Operations menu, then enter the number of the bandwidth and press Enter. In the RLI window select "Commit" from the "File" menu. In this experiment, you need to set three link rate **5Mbps, 20Mbps and 1Gbps** to observe the changing of the bandwidth.

In your report, show a screenshot of the bandwidth variation in different delay and link rate. You could increase the observation time (using the "-t" option in the iperf command) and change the link rate continuously to observe the changes in the connection throughput. Observe if the bandwidth can reach the maximum link rate and explain the reason. Illustrate the effect of changes in the delay and link rate on the connection throughput.

Lab Report

Please prepare a brief lab report and submit it in PDF on SPARK.