ECE697AA – Computer Networks

Fall 2008 – Lab 1

Prof. Wolf

Please answer the following questions and submit your lab report electronically on SPARK by October 31, 2007 11:59 p.m. Grading will be based on the rubric posted on the course website.

Pre-Lab

- Visit the Open Network Laboratory web site at: http://onl.wustl.edu/
- Watch the ONL video to see some of the features in action: http://onl.arl.wustl.edu/avi/onlVideo.avi
  (Don't worry if you don't understand it all – we'll do much simpler exercises.)
- Use your username (available on SPARK as an entry in your grade book) and the password provided to log in to ONL (side-bar on the left). Change your password after logging in.
- After logging in, click on "Getting Started" and follow the instructions.
- Make sure to set up the SSH tunnel: http://onl.arl.wustl.edu/restricted/ssh-tunneling-rli.html
- If you have any problems, please email me.

Lab Assignment

The lab assignment is divided into three parts: the first part can be done "offline" without a reservation on ONL; the second and third parts require a reservation (a one-hour slot should suffice in most cases). Only the third part is required for the lab report. Only four people can use ONL at the same time, so plan accordingly. Please do not reserve resources unless you are going to actually use them.

Part 1: Offline Preparation

- Get the configuration file following configuration file from the course web page: http://www.ecs.umass.edu/ece/wolf/courses/ECE697AA/labs/lab1-1.exp
  Store it on the host where you plan to run the RLI. It is recommended that you put it into the same directory where your RLI.jar file is stored.
- Start the RLI, open the *lab1-1.exp* configuration file, and explore the following questions by viewing the appropriate RLI menus. You can determine parameters values by using the left or right mouse buttons and selecting appropriate icons in the RLI. Note that you do not need to provide an answer in your lab report. This is solely for you to learn more about ONL. Consider a packet P that enters port 2 with a destination IP address of D where D is specified below:
  1. Which route entry will be used at port 2 if D = 192.168.1.33?
  2. Which route entry will be used at port 2 if D = 192.168.1.64?
  3. For D = 192.168.1.33, indicate the path (i.e., sequence of ingress ports, egress ports and host interfaces) taken through the router once P enters ingress port 2.
  4. What changes to the routing table at port 2 would be needed to forward packets to port 0 when D = 192.168.1.X where X is between 118 and 121 inclusive.
  5. What is the capacity (Mbps) of the egress link at port 3? Port 4? Hint: See "queue tables" in port menu.
- Exit RLI, and start it again, but do not open a configuration file. Begin by adding a cluster ("add cluster" in "topology" menu). At this point, all settings have default values, and all ports

are identically configured. This means that you can determine the settings of all ports by examining any single port (e.g., port 2).

6. What are the default values of the following parameters:
    - Switch Rate
    - Link Rate
    - Thresholds and rates of VOQs
    - Thresholds and rates of Datagram Queues
7. What is the content of the routing tables on ports 1–7?

- Setup route tables using only 32-bit netmasks such that the host(s) n1p1a, n1p1b, n1p1c, n1p2 and n1p3 can communicate with each other across the router. [Note that the given file (*lab1-1.exp*) from the previous exercise uses route table entries that potentially match 16 consecutive IP addresses; e.g., 192.168.1.48/28. This is not what you should do here. You should use 32-bit netmasks instead.]

8. What is the content of the routing tables at ports 1-3?

- Save your configuration as *lab1-2.exp* in your directory.
- Modify your configuration such that any packet coming from the host(s) attached to ports 1, 2 or 3 first go to port 7, out from port 7 onto a link attached to port 6, and then to the port attached to the destination host. For example, a packet from host n1p1a destined for n1p2 should go through the GigE switch, into port 1, out port 7 onto the link to port 6, then to port 2, and finally to n1p2. This requires that you add a link from port 7 to port 6.

9. What is the content of the routing tables at ports 1-3 and 6-7?

- Add a monitoring panel labeled *Ports 2 and 3* that will display four bandwidth plots: bandwidth coming into ports 2 and 3 and bandwidth going out of ports 2 and 3. Add a second monitoring panel called *Ports 7 and 6* that will display two bandwidth plots: bandwidth going out of port 7 and into port 6.
- Save your configuration as *lab1-3.exp* in your directory.

Part 2: Online Preparation

For this part of the assignment you need a reservation on the ONL testbed. On the ONL web site, log in, and click “Make a Reservation” in the sidebar on the left. On the reservation form, request one (1) cluster and zero (0) additional hosts for sixty (60) minutes. As for part 1, you do not need to report on the results from this part of the exercise in your lab report.

- Once your reserved time comes around, connect the SSH tunnel, and run the RLI.
- Open *lab1-1.exp* and click on “commit” in the “file” menu. It may take several minutes to complete the setup (you can follow the progress on the bar that reads “committing”). Once the configuration is set up, right-click on host *n1p2* and determine which physical machine has been assigned to act as this host (should be *onlXX.arl.wustl.edu*). From *onl.arl.wustl.edu* SSH to *onlXX* and answer the following questions [Note 1: When outside of the ONL testbed, you can only SSH into *onl.arl.wustl.edu*. This means that you will need to SSH first into *onl.arl.wustl.edu* and then into your desired host. Note 2: You should SSH into the control interface, not the data one; i.e., the interface will NOT be *n1p2*. You will be SSHing into something like *onl02*, *onl19*, or *onl15*.]:

1. What host is *n1p2* in your setup?
2. Run the following command:

    ```
    netstat -i
    ```

    The output of the *netstat* command should show the number of packets transmitted (TX-OK) and the number of packets received (RX-OK) for all interfaces. Determine which interface is the data interface and which one is the control interface. Repeated

calls to the command shows that the number of packets on the control interface increases. Assume `ethX` is the data interface.

Run the following commands:

```
/sbin/ifconfig ethX
netstat –I=ethX
ping n1p3 -c 10
netstat -I=ethX
```

The output of the *netstat* command should show the number of packets transmitted (TX-OK) and the number of packets received (RX-OK) for the `ethX` interface. Explain why the changes in the TX-OK and RX-OK columns for the `ethX` interface make sense. Note that each host runs ARP to determine the binding of IP-to-MAC addresses.

There are six plots on your traffic graph. Explain why the plots make sense given that you just ran the ping command. Pass your mouse over each of the six labels (e.g., IPPBW 2) to highlight the corresponding line.

- Open your *lab1-2.exp* configuration and commit. Design an ideally minimal set of experiments using any tool you like (e.g., *ping*) that can verify that your routing tables are correct. Explore the following questions:
    3. List the set commands that you run in your experiment. Specify on which machine (e.g., n1p2) you run each command and what output you expect. It may be a good idea to copy and paste from the SSH terminal.
    4. How does your experiment show that your routing tables work correctly?
- Open your *lab1-3.exp* configuration and commit. Ping *n1p2* from *n1p3*.
    5. Why do the traffic displays demonstrate that your routing tables are correct?
- Modify the routing table(s) so that the returning ping packet (ICMP echo reply) goes directly from *n1p2* to *n1p3* instead of going through port 7.
    6. What change(s) did you make to route tables?

Part 3: Assignment

For this part of the assignment, you should answer the following questions by designing simple ONL experiments, performing measurements, and reporting your results. There is no single right way to solving the problems. For each question, discuss in your lab report how you set up the experiment (feel free to add screen shot) and show the measurement results. Explain what these results mean.

1. What is the maximum throughput (e.g., using *iperf*) that you can achieve between two hosts?
2. What is the maximum aggregate bandwidth that the ONL router can forward?
3. What is the maximum number of hops that you can configure between two hosts (assuming single ONL cluster and no plugins)? What is the end-to-end delay for that configuration?

Lab Report

The lab report that you submit should contain:

- Answers to Questions 1. – 3. from Part 3 (nothing from Parts 1 and 2). Provide (concise!) explanations and show supporting data (e.g., screenshots, terminal output, tables, graphs, etc.) for your lab report.

Help!

The ONL web site has a simple tutorial with a step-by-step explanation of a simple example. Click “Tutorial” on the left side-bar, then “Examples, then “The Remote Laboratory Interface”. If you need any other help, email me.