# ECE697AA – Computer Networks

## *Fall 2008 – Lab 2*

### Prof. Wolf

Please answer the following questions and submit your lab report electronically on SPARK by November 17, 2007 11:59 p.m. Grading will be based on the rubric posted on the course website.

## *Lab Assignment*

In this lab you will design your own experiment to compare stochastic queuing in a real network with our queuing theory results from class. The ultimate goal of this part of the assignment is to create a graph with load (i.e., ρ) on the x-axis and delay on the y-axis. The graph should show the theoretical result from class and the experimental result that you derived.

When designing your experiment, you should consider the guidelines by Jain. Please do not follow them step-by-step as some of the rules may not be applicable to this experiment. Just make sure you consider all important aspects of your experiment.

You are given a tool called `tg` that can generate traffic that has an (approximately) exponential distribution. An extensive manual to `tg` is available at `http://www.postel.org/tg/tg2002.pdf` (Sections 2.4.4 and 2.5 may be or particular interest). The binaries are installed on ONL in the `/usr/local/bin/tg` directory and an example is available at `~onl/export/Examples/tg/` (see `README.local`). The tool can generate exponential traffic in two ways:

1) It can generate traffic with an exponential distribution.
2) It can use a two-state on-off source model discussed in class to generate traffic. That is, it has a transmit state and a silent state. Based on the parameters you provide, the generator remains in the current state or switches. Thus, transmit and silence periods have a geometric distribution. This can be considered an arrival process with exponential distribution.

Note: if you use UDP traffic, you do not need to use the server side of the tool.
Hint: As a starting point, consider a tg "action" of `arrival exponential 0.005 length exponential 576 60 1500` which generates exponentially distributed traffic with a mean rate of 200 packets per second that are exponentially distributed in size ranging from 60 to 1500 bytes (average 576 bytes). If you set the outgoing link bandwidth to 1Mbps, you should see queuing effects.

To measure the delay, use the `ping` command with the `-i 0.2` option to send 5 pings per second. You can collect the delays observed by `ping` while you generate traffic with `tg` and then compute the average delay.

- Describe your experimental setup. Make sure to address the following issues (plus whatever else you deem important):
  - What is your network configuration (topology, link speeds, etc.)?
  - What is your traffic model? What parameters do you change in order to generate a different load on the network? How do these parameter values relate to the theoretical queuing model?
  - How do you determine the observed delay? How long do you run the traffic generator for each data point?

    - How many different data points do you generate?
- Show the graph that compares your experimental results and the theoretical model.
- Explain differences that you observe between your measurements and the theoretical model.

Note: Please be aware that depending on the traffic model, link speeds, etc. you choose you may or may not get close to the theoretical results. The goal of this assignment is not to get a perfect match between theory and your experiment. If you get results that differ, that is ok – just try to explain why they are different.

## Hints

- You may want to run the experiments at low data rates (e.g., order of a few Mbps) to keep things simple and avoid effects that appear at very high data rates. You can set the output port data rate on the switch to the desired rate for that link.
- If you want to monitor the length of a router queue, do the following. Set up a new queue and direct traffic into it. On the port, click on Queue Tables and select "add egress queue" under edit. Give this new queue the queue id 300. Again click on the port and choose Egress Filters. Add a general match filter choose its protocol to be "*" (i.e., overwrite the tcp field with "*") and the qid 300. This will direct all traffic into our new queue. Finally, add a monitoring panel that monitors queue 300 on that port (Egress / QLength / QID 300).

## Lab Report

The lab report that you submit should contain a detailed description of your setup (traffic parameters, queue lengths, etc.). The most important aspect is the figure that shows the comparison between theory and practice and the explanation of any differences you may observe.

## 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.