# CS 485/ECE 440/CS 585 Lab 1

Part 1 is due by 11:59pm on Wednesday, 3 September 2012. Part 2 is due by 11:59pm on Thursday, 18 October 2012. Part 3 is due by 11:59pm on Friday, 26 October 2012. Make sure that you're in class on 18 October, that's the “D-day” when we'll be collecting all of our data together. All submissions should be sent as an e-mail attachment to the instructor (jedcrandall@gmail.com). Please send only PDF and/or gzipped tar files. Note that all parts are individual assignments, you need your groupmate to complete the assignment but you'll each turn in individual assignments separately.

The purpose of Lab 1 is to learn about TCP congestion control, sockets, and experimental methodology (including some basic statistical analysis).

**Part 1** is worth 15 points. You should set up a small network with one router and two endhosts. All three of your machines should be able to get to the Internet (including DNS), and all of your machines should be able to route packets to each other and any of your groupmate's machines. The router should have 4 NICs: two to connect to the endhosts, one to connect out to the Internet via NAT, and one to connect to the router of your groupmate. Each endpoint should have only one interface: directly to the router. Each endpoint should get its Internet through the router, not through a NAT NIC of its own.

For part 1, you should submit a gzipped tar ball with the following *.txt files (with *.txt extensions):

- A tcptraceroute from one of your endhosts to your other endhost
- A tcptraceroute from one of your endhosts to your groupmate's first endhost
- A tcptraceroute from one of your endhosts to your groupmate's other endhost
- A tcptraceroute from one of your endhosts to google.com
- The output of “sudo route -n” on your router

Just dump the tcptraceroute or route dump output into a text file, and name the file clearly so I can tell which of the above it is. Make sure you send me a gzipped tarball, not a ZIP file. The extension on the file you send me should be “.tar.gz”, and you should only send me one file. Check the traceroutes and make sure they're routing the way they're supposed to be. For local routing between virtual machines, packets should go through your router (and maybe also your groupmates' router) only, never through VirtualBox's NAT (only Internet traffic should go through the NAT).

**Part 2** is worth 25 points. You should get your network hooked up to the class internetwork via BGP as per the instructions that are forthcoming from the TAs and I. You should use tc rules on both interfaces of both Ethernet connections of your endhosts (*i.e.*, four tc rules total for the subnets you don't share with your groupmate). From each endhost to the router the bandwidth should be limited to 50 kilobits per second. From the router to each endhost you should add a constant delay, where the

number of milliseconds of the delay is the last digit of your LoboID multiplied by 5. You should add the same delay for outgoing traffic from your router to the router of your groupmate (*i.e.*, add a fifth tc rule).

You should configure your two endpoints according to a simple rule: one endpoint should use the "cubic" TCP algorithm and its IP address should end with ".66", the other endpoint should use the "reno" TCP algorithm and its IP address should end with ".77". We'll develop a server/client protocol for testing TCP in class, you should implement this protocol using sockets (in the language of your choice) and run this on your endhosts. For part 2 you'll submit some tcpdumps that we'll create together in class on Thursday, 18 October. The tcpdumps should demonstrate that your virtual machines are routable on the class internetwork (*i.e.*, BGP is working) and that your client and server implement the protocol correctly, so the implementations of these things need to be completed and up and running before class starts on 18 October. All tcpdumps submitted will be made available to the whole class for part 3 of the lab. Further instructions about how to collect the tcpdumps and how to submit them will are forthcoming.

**Part 3** is worth 60 points. We'll make all the tcpdumps collected by all students on 18 October available to the entire class, and then you should analyze this data with respect to finding the major differences in TCP performance between "cubic" and "reno". Note that our class internetwork will probably be "long and skinny," (*i.e.*, high latency and low-bandwidth), so you won't necessarily be concluding that cubic performs better. Each student will individually submit a 3-page writeup (about 1 page of text and 2 pages of figures), explaining their findings.

5 of the 60 points will be a paragraph at the end of your writeup where you should describe a societal impact issue related to TCP congestion control and give your informed opinion about the issue. Some issues you might think about are BitTorrent traffic throttling, optimistic TCP acknowledgements, and the challenges of filtering large-bandwidth national backbones. Email me for papers about these topics or other topics that interest you. Your paragraph should draw from what you've learned about TCP in this lab. Don't just summarize an issue, tell me something I don't know based on your understanding of TCP congestion control.

For some background research for this lab, you should read up on: design of experiments, *t*-tests, Mann-Whitney *U* tests, TCP cubic, TCP reno, BGP, quagga, IP tunnels.