Carnegie Mellon
Computer Science Department.

15-744 Spring 2007 Tools Problem Set 2

This problem set has 2 questions with many sub-parts. Answer them as clearly and concisely as possible. You may discuss ideas with others in the class, but your code, solutions and writeup must be your own. If you do discuss at length with others, please mention in your solution for the problem who you collaborated with. Do not look at anyone else's solutions or copy them from anywhere.

This assignment is due by **5:00pm, Wednesday, April 18th** either in class or to the course secretary in Wean Hall 8018.

Glossary

ICMP: The Internet Control Message Protocol. The protocol that ping uses.
Ruby: A cool scripting language. You'll be modifying an existing ruby script for this assignment.
RTT: Round-Tip Time.
CDF: Cumulative Distribution Function.

1. Scriptroute is a network measurement tool that makes it easy to write network measurement scripts and to perform distributed measurment by running those scripts on remote servers.

   First, take a peek at the Scriptroute page:

   `http://www.scriptroute.org/`

   Grab the source:

   `http://www.scriptroute.org/source/scriptroute-0.3.18.tar.gz`

   configure:

   ```
   ./configure --prefix=/YOUR/HOME/DIR/scriptroute
   make
   make install
   ```

   Then, try running a ping from the CMU RON node:

   ```
   cd /YOUR/HOME/DIR/scriptroute/bin/
   edit sr-remotely.rb
   and add
     $LOAD_PATH << ‘‘/YOUR/HOME/DIR/scriptroute/lib/ruby/1.6’’
     $LOAD_PATH << ‘‘/YOUR/HOME/DIR/scriptroute/lib/ruby/1.8’’
   at the top.  (You only need one, depending on the version of ruby on
   your system.  The CS public linux servers need 1.6)

   Then, run

   ./sr-remotely.rb cmu.ron.lcs.mit.edu sr-ping www.cs.cmu.edu
   ```

   Executing sr-ping will take about 10 seconds, so be patient. At the end, you should see the ping output. (Note that you don't have to do this testing through sr-remotely; if you have your own machine on which you can install the scriptroute program as root, go ahead and do all these things locally.)

(a) Modify the `sr-ping` script so that it takes two new arguments: The second should specify an integer number of packets to send, and the third should specify the amount of time to wait in-between packet transmissions. The script should default to 10 and 1, respectively.

(Not that the "delay =" line isn't actually listened to - the `Scriptroute::send_train` line recomputes its own delay. This seems like a bug.)

(b) Modify the `sr-ping` script so that it also prints out the IP ID of the ICMP echoreply. For example:

```
> ./sr-remotely.rb cmu.ron.lcs.mit.edu sr-ping www.cs.cmu.edu 3
host: cmu.ron.lcs.mit.edu
file: sr-ping
args: www.cs.cmu.edu 3
warning: no credentials (~/.srcookie) file found.
1 128.2.203.164 (128.2.203.164) 0.227 ms [id=16109]
2 128.2.203.164 (128.2.203.164) 0.349 ms [id=16110]
3 128.2.203.164 (128.2.203.164) 0.169 ms [id=16111]
```

(c) Execute `sr-ping www.cs.cmu.edu 3 5`. This will send an ICMP echo request every five seconds. Include the output of this program. How is the IP ID field being incremented? (Hint: This might be easiest if you run this experiment at night or during off-hours.)

Now, repeat the above command but *also* run a normal ping simultaneously to the same machine. Include the output. What's different? Why is the output different?

(d) Modify sr-ping to take a third (and final, we promise) argument, `-tcp`. If this argument is specified, sr-ping should send probes using TCP SYN packets to port 8000 of the specified machine. (hint: see the `sr-tcptraceroute` file...)

(e) Find a server that responds to both ICMP and TCP pings. Record the ping times for 600 pings using both ICMP and TCP. Send pings no more than two per second (delay of 0.5). Note that if you're executing scriptroute remotely, you'll have to use multiple executions of the script—it doesn't want to run for more than 30 seconds. We suggest 10 executions of 60 pings each at 0.5 seconds delay.

Analyze this script to show the min/max/average RTT and the stddev of the RTTs. (If this sounds painful, you might steal Dave's analysis scripts from

```
http://www.cs.cmu.edu/~dga/dga-util.tar.gz
```

Then plot the CDF of round-trip times for both the TCP ping and the ICMP ping.

What conclusions can you draw from this data? Note that the effects we're looking for may not happen on all paths. If your data is inconclusive, what differencs might you expect to see and why?

(f) Try pinging `www.ebay.com` with normal ping. What happens?

(g) Now try the same experiment, but send 5 pings spaced 1 second apart with your `-tcp` flag in `sr-ping`. What's happening?

(h) Based upon the above, give two reasons why TCP-based probing might be better than ICMP-based probing.

2. Extend your ping program to "round-rbin" through a series of comma-separated IP addresses, like

```
sr-ping www.cs.cmu.edu,www.cmu.edu,www.yahoo.com 3 1
```

First, try executing this command:

```
sr-ping 128.2.255.169,128.2.255.204 4 0.5
```

What appears to be going on with the IP IDs?

Now, try sending TCP probes instead:

```
  sr-ping 128.2.255.169,128.2.255.204 4 0.5 tcp
```

What's going on with the IP IDs this time? What is a possible explanation for this relationship? Can you think of a useful application for this behavior? (Hint: One of the programs included with scriptroute makes use of this feature.) Why might the router be giving different answers with ICMP and TCP probes? (hint: think fast path vs. slow path processing.)[1]

[1] Interestingly, this behavior appears to be new—I (dga) had never seen it before now. Older routers would respond the same to both ICMP and TCP probes.