University of St Andrews School of Computer Science

CS2003 — Internet and the Web — 2020/21

Exercise 11: Measurement
Date: 2020-11-26

As with all lab exercises, this exercise is not directly assessed. It is intended to complement the material presented in lectures and may turn up in the exam. This week we have a shorter exercise class with just two tools to try out. This is because I have set a number of readings for the tutorial this week and I would like you to spend some time on those. So if you find that this week's exercises do not take as long, then please get started on the reading.
Please split off into your Tutorial Group Teams channels and start a meeting at the beginning of the class. While you are not explicitly asked to collaborate this week, you can use the meeting for discussion during the class. I will rotate around the class and pop in on meetings.
You will need to do this week's class on a *lab machine* — the tools will not work correctly on a host server.

1 Delay and throughput estimation of end-to-end paths

1. Use `ping` to work out the network delay from a Linux workstation in the Lab to `www.caida.org`.

   For instance, from a CS lab machine, I can use:

   ```
   $ ping -A -n -c 30 www.caida.org
   ```

   This makes 30 measurements, with the final line of output of the format:

   ```
   rtt min/avg/max/mdev = WWWW/XXXX/YYYY/ZZZZ ms
   ```

   The times reported are round-trip-times (RTTs), so the one-way delay is half of that. Note these times, as well as the number of bytes transmitted for each measurement. Use the `avg` time (this is the arithmetic mean) to make your calculations.

   We looked at CAIDA in a previous class - you can find out more about CAIDA at https://www.caida.org/home/about/faq.xml

2. Now run:

```
ping -A -n -c 30 -s 1256 www.caida.org
```

Note these times, as well as the number of bytes transmitted for each measurement.

3. By examining the data you have collected above, estimate the throughput (data rate) for the end-to-end path between your workstation and `www.caida.org`. To do this, we note that the only difference between your two measurements is the size of the packet that is sent. We also remember that the transmission delay is related to the number of bits to be transmitted ($T_x = b/r$).

   If we call the first measurement t' and the second t'', then the difference between the two round trip times (t_{rtt})) is due to the additional packet size, d = 1200 bytes (look at `man ping` for the `-s` argument to see why this is true). So then we have:

$$t_{rtt} = t'' - t'$$

$$t_d = t_{rtt}/2$$

$$r = d/t_d$$

   Remember your units (t will be in milliseconds, d in bytes).

   Using the above, I estimate the throughput from a lab machine to `www.caida.org` to be approximately 94.44Mbps. Your results may differ. What assumptions does this calculation make?

2 Routing measurement

1. Run:

```
ping -c 5 www.caida.org
```

   The output from ping shows '`ttl=49`'. What is the TTL? (Look this up – it is a field in the IPv4 packet header)

2. Now run:

```
ping -c 5 -t 9 www.caida.org
```

   What is reported in the `ping` output?

   Look at https://www.geant.org/About to find out what GEANT is.

3. Run `traceroute` to `www.caida.org`:

   ```
   traceroute www.caida.org
   ```

   Examine the network path that is displayed. What more can you say about the last ping measurement that you ran?

4. Examine again the output of the traceroute to `www.caida.org`. What do you think is happening between hop 9 and hop 10?

   Note: This should be a large delay – as shown below. There is a possibility that the route has changed since I ran `traceroute`; the hop count might have changed, or the delay might occur at a different point in the path. I see:

   ```
    9  janet.mx1.lon.uk.geant.net (62.40.124.197)  12.208 ms  11.334 ms  11.290 ms
   10  internet2-gw.mx1.lon.uk.geant.net (62.40.124.45)  86.071 ms  85.918 ms  85.913 ms
   ```

   Hint: look up https://map.geant.org

Tristan Henderson, with thanks to Saleem Bhatti