L50 - Lab 1, Basic Measurements

Dr Noa Zilberman

Michaelmas, 2018/19

The goals of this lab are to:

- Introduce you to our experimental environment.
- Gain experience using basic measurement tools.
- Gain understanding of differences between measurement methods.
- Build intuitions about different measurement effects.

All the measurement tools used in this lab are basic tools, available to every user. It is expected that you have used some of them before. Through using these tools you can experience some of the complexities in measurements, without having to focus on setup and usage know-hows.

Note: Lab1 is longer than other labs. It is possible that you will not be able to complete the entire lab within two hours. You can complete the lab on your own or in the next practical session. We recommend that you focus your attention on the measurements rather than on the scripting of plots.

1 Background

The lab will focus on three tools learned during lecture 2:

- Ping, as a mean to measure round trip time (RTT).
- Traceroute, as a mean to measure a route (topology).
- iperf, as a mean to measure effective bandwidth.

Please refer to the lecture slides for detailed information on the tools.

2 Jupyter Notebook

The Jupyter Notebook is a web application that allows you to create and share documents that contain live code, equations, visualisations and explanatory text. Uses include: data cleaning and transformation, numerical simulation, statistical modelling, machine learning and much more. (jupyter.org)

The L50 laboratory work requires students to bring together a diverse range of skills and knowledge: from shell commands and scripting languages to knowledge of measurement and system features and statistical analysis.
The courses aim is to focus on the intrinsic complexity of the subject matter and not the extrinsic complexity resulting from integrating disparate tools and platforms.
Jupyter Notebooks support this goal by providing a unified environment for:

- Executing measurements.
- Collecting measurement results.
- Post-processing collected measurements.
- Plotting processed measurements results.

Further information about the Jupyter Notebook environment can be found at the projects website (jupyter.org), as well as in the introduction handout.

Template All labs have a pre-prepared Jupyter templates, used for the experiments. The templates are built to ease the completion of the laboratory, with a focus on measurements collection. The notebooks include a description of the setup, a walk through of the command lines and the infrastructure for capturing and processing the results. The plots included in the templates are mostly intended as "sanity checks", providing a rough representation of the results so you can easily detect problems in the measurement apparatus. In Lab1, all the plots, except for the last experiment, were already prepared for you.

3 Setup

In this experiment you will use two machines, A and B, connected directly using a single fiber. The fiber is connected between two standard network interface cards (NICs). Further details of the equipment and the setup are provided in the introduction handout and the Jupyter notebook.
To get started, on Machine A (replace <host> with machine A IP address or hostname, <crsid> with your crsid):

```
ssh -X root@<host>
mkdir /root/<crsid>
cd /root/<crsid>
```

```
git clone http://github.com/cucl-srg/L50
cd L50
jupyter notebook --allow-root
```

4 Usage

The following details only the options that will be used as part of the lab. See the command manual for the full list of options.

Ping:
`ping <address> [Optional: -c <count>] [Optional: -i <interval>] [Optional: -f]`
-i (interval) - gap between pings in seconds, default=1.
-f (flood) - flooding. If interval is not given, it sets interval to zero and outputs packets as fast as they come back or one hundred times per second, whichever is more.
-c (count) - number of ping measurements. If unspecified, ping runs until killed.

Traceroute:
`traceroute <address> [Optional: -I]`
-I (ICMP) - use ICMP Echo Request packets. If unspecified, use UDP packets.

iperf (Server):
`iperf -s -B <server address> [Optional: -u]`
-u (UDP) - use UDP rather than TCP.

iperf (Client):
TCP:
`iperf -c <server address> [Opt: -i <interval>] [Opt: -t <time>] [Opt: -f <format>] [Opt: -d] [Opt: -w <TCP window size>]`
-i (interval) - how often to report bandwidth, in seconds.
-t (time) - length of test, in seconds. Default value is 10.
-f (format) - 'k' for Kbits/sec, 'm' for Mbits/sec, 'g' for Gbits/sec. Default is adaptive.
-d (dual test) - Do a bidirectional test simultaneously.
-w (TCP window size) - TCP window size (socket buffer size), eg. -w 20KB.

UDP:
`iperf -c <server address> [Opt: -i <interval>] [Opt: -t <time>] [Opt: -f <format>] [Opt: -d] [Opt: -b <bandwidth>]`
-i (interval) - how often to report bandwidth, in seconds.
-t (time) - length of test, in seconds. Default value is 10.
-f (format) - 'k' for Kbits/sec, 'm' for Mbits/sec, 'g' for Gbits/sec. Default is adaptive.
-d (dual test) - Do a bidirectional test simultaneously.

-b (bandwidth) - bandwidth to send at in bits/sec, e.g. -b 20m (Mbits/sec).
Note: By default, iperf restricts bandwidth for UDP clients to a maximum of 1 Mbit/sec. There is no restriction for TCP clients.

iperf3 (Server):
TCP/UDP:
`iperf3 -s -B <server address>`

iperf3 (Client):
TCP:
`iperf3 -c <server address> [Opt: -i <interval>] [Opt: -t <time>] [Opt: -f <format>] [Opt: -w <window size>]`
UDP:
`iperf3 -c <server address> [Opt: -i <interval>] [Opt: -t <time>] [Opt: -f <format>] [Opt: -b <bandwidth>]`

5 Saving Your Experiments

Make sure to back up your experiments, including (but not limited to) Jupyter notebooks, dump files and scripts. Remember that multiple teams may use the same test machines, so be careful when handling data.
All the measurements are saved under your crsid folder, so backing up the entire folder is a good idea. To copy a remote directory onto your local machine:
`sftp root@<hostname>.nf.cl.cam.ac.uk` and `get -r <directory>`.
There are also other ways to copy a remote directory, you are welcome to use those as well. You may wish to compress results files in order to save space.
Exporting a Notebook as `.tex` will save graphs as separate files, which you can then include in your lab report.

Please do not push any changes, data or results directly to L50 repository. You can fork the repository to your own user and push changes there. If you would like to suggest a correction or an enhancement to a notebook or a script, please use pull-requests.

6 Understanding Your Measurements

A single lab report will be required for the first three labs. Instructions for the lab report will be provided separately.
The following items are intended to help you understand your results, and may provide supporting evidence for your report. However, they are just suggestions - feel free to approach the data differently!

- Explain how the use of different vantage points affects the results.
- Discuss the similarities and differences in results when using different tools for the same goal.
- Consider the effect of different configurations on ping measurements, and try to explain why certain configurations alter the results.
- Compare and contrast the use of UDP and TCP for bandwidth measurements.
- Discuss the limitations of ping, traceroute and iperf, as they manifest in your results.

You should always look for odd or surprising results, and try to explain them. Note that sometimes exceptional results indicate a problem in your setup or scripts.