# CT420 Assignment 1

# NTP Benchmarking

**Overview:**

Time synchronisation protocols like NTP are widely used to synchronize the clocks of computers and other devices over a network, thereby addressing the insufficiencies of ordinary real-time clocks (RTC), i.e., quartz-controlled clocks, you find in a computer or mobile phone.
However, the accuracy of this synchronisation depends on a variety of parameters, like the network load, the distance to NTP servers, etc.

Therfore, you are asked to do a time series / performance analysis of remote NTP servers that are based in different geographical areas.
It requires you to install / configure / use a NTP daemon and an NTP console (i.e., ntpq) on your own computer. Note that all standard Linux distros support NTP out-of-the box.
There are various options to get NTP working on non-Linux computers:

1. Run a Linux VM on your computer, for example using Oracle VirtualBox. Any common Linux Distribution would do. Please note that a Linux system will be used for the second assignment as well.
2. Alternatively, you can install Docker and run a Linux container (of your choice). Again, this setup can be used for assignment 2.
3. Windows users may alternatively use Meinberg's NTP tools (https://www.meinbergglobal.com/english/sw/ntp.htm#ntp_stable). Please note that the latter also requires Microsoft's Visual Studio Redistributable package as highlighted on Meinberg's website.

**PLEASE NOTE:** NTP time synchronisation does NOT work on NUIG's internal (Ethernet or Wi-Fi) network because of firewall issues. Please use your private Internet connection (e.g., your mobile phone configured as a hotspot) for this experiment.

**Technical Support:**

Online or F2F "Drop-in" labs will be organised on demand. Please use the Canvas Discussion Forum to post your questions, and to arrange 1:1 sessions with the lab tutors if needed.

**PTO**

**Assignment Instructions:**

1. Install NTP on your computer, and verify the NTP daemon (via ntpq, see Figure 1). Create a user account entailing your full name (i.e., in your subsequent videos an open shell must show your name in the directory path).

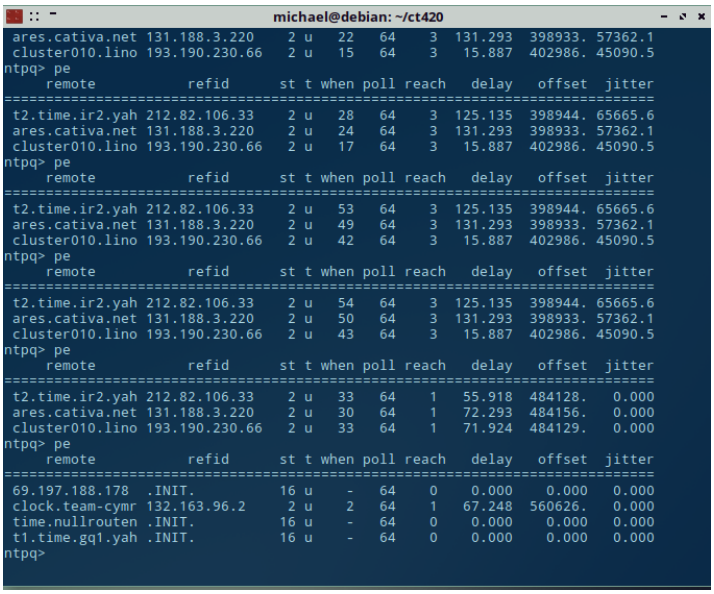


**Figure 1: ntpq screenshot**

2. Configure your NTP client so that it pings one NTP server (or your choice) based in each of the following areas (i.e., 6 servers in total):
   - Ireland
   - UK
   - Mainland Europe
   - US
   - Australia
   - Asia

   Use a geotag service to map your servers and estimate their geographical distance. Add the google maps images to your report. Also, determine the average number of packet hops to reach each of these servers (using *ping* or *traceroute*).

3. Collect NTP offset, delay and jitter data (using ntpq) concurrently for all chosen time servers every 20 minutes over an 8 - 12 hours period[1]. While it is preferable to run the experiment in one go (e.g. overnight), you can – if needed – break it down into a series of shorter runs.
   For each server determine maximum, minimum, mean and standard deviation of the collected data and argue if there is any correlation to geographical (NTP server) distance, number of packet hops, or time of day.

[1] Note that delay represents the average time an NTP packet requires to be routed from the server to your computer, offset is the perceived difference in time between both end points, while jitter shows the variation in the delay of received NTP packets.

Visually present and contrast your data by plotting delay and jitter readings in separate diagrams (using a suitable diagram form). The x-axis must be calibrated to UTC time.
Using the above diagram determine if there are any temporal variations of delay / jitter readings over time.

**Deliverables:**

A. A report summarising your experiments and findings, including maps and diagrams.

B. A short (5-10 minutes) video (where you introduce yourself with name and student id) that shows "NTP at work" on your computer. In this video, please provide a summary of your NTP configuration (including remote NTP servers), show / explain some live ntpq outputs, and summarise / comment on your findings, thereby highlighting the best performing and the worst performing setup (in terms of delay and jitter).
The video must be limited in size (i.e., 250 MByte) and can be submitted via Dropbox or OneDrive link.

**Hints:**

- www.ip-adress.com/ip-address-distance provides you with longitude and latitude estimates, which can be further visualised using Google maps as described in https://support.google.com/maps/answer/18539?hl=en&co=GENIE.Platform%3DDesktop. Distance measurements can be done via https://www.nhc.noaa.gov/gccalc.shtml
Note that the geographic location of Galway is 53.2707° N, 9.0568° W.
- NTP servers can be found in https://www.ntppool.org/en/; the website defines pools of NTP servers (like for example shown in https://www.pool.ntp.org/zone/ie), which can be added in your ntp.conf file (e.g. "server 0.ie.pool.ntp.org" or "server 0.europe.pool.ntp.org"). The pool server(s) are subsequently shown in ntpq, similar to Figure 1.
Please note that these pools can change over time, therefore you should replace the pool name with the server's name in your configuration file, before you start your experiments.
- In Linux, a crontab scheduler can be used to schedule queries in 15-20 minute intervals to the NTP servers.
To set up a crontab scheduler, the 'crontab -e' command is used.
For example, *"* / 30 * * * * ntpq – p >> ntplog.txt*" will invoke a query every 30 minutes and add the results to ntplog.txt.
- Ntplog.txt can be further processed by a spreadsheet software, e.g., Microsoft Excel. This may include the following steps:
    - The data is transferred from the Linux client to a Windows machine as a text file.
    - This file is edited to replace all spaces with commas and imported into Excel as a CSV file.
    - The filter function in Excel is used to filter data by IP address and all logs relating to a specific NTP server is exported to a new Excel sheet.
    - The maximum, minimum, mean and standard deviation for delay and jitter for each NTP server can be calculated using excel functions.
    - Finally, Excel is used to plot the data.

**Marking Scheme:**

1. The normal plagiarism guidelines apply.
2. The report accounts for 10 marks:
    a. 2 mark for geotagging including images.
    b. 2 marks for determining maximum, minimum, mean and standard deviation of the collected data.
    c. 2 marks for discussing correlations between measurements and geographical (NTP server) distance / network packet hops.
    d. 3 marks for visually presenting and contrasting data by plotting delay and jitter readings. Marks are deducted for poor plots with for example missing labels.
    e. 1 mark for an analysis of temporal variations of delay / jitter readings over time.
3. The video accounts for 10 marks:
    a. 1 mark for your introduction (your name / student id) and showing NTP working.
    b. 2 mark for a summary of your NTP configuration (including remote NTP servers).
    c. 3 marks for showcasing and explaining some live ntpq outputs.
    d. 4 marks for summarising / commenting some of your findings as listed in your report.
4. Generally, marks are deducted for sloppy work, or if less than 6 NTP server locations are used.