CSCI-3171 Network Computing
Lab 1 – Winter 2026

Submission Instructions:

Submit **one PDF file** for your lab report on Brightspace under the Lab 1 portal. Include the following:

1. Summary Report: Provide a summary of your observations for the given questions.
2. Graphs and Numerical Values: Include any relevant graphs and numerical values derived from your experiments.
3. Screenshots: If necessary, include screenshots. However, note that command responses can be easily copy-pasted into the report without the need for heavy screenshots.
4. References and Citations: Clearly list all external sources or documentation used. Cite them properly within the report using a consistent citation format and include a references section at the end.
5. Identification: Ensure your **full name and banner ID** are clearly mentioned in the report.

Late submission: Refer to the syllabus on Brightspace for a complete description of the late submission policy.

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1. Abstract

This lab aims to deepen your understanding of the Internet by introducing you to essential tools such as ping, traceroute, and iPerf. The goal is to gain insights into the performance of Internet communications, focusing on aspects like delay and throughput.

2. Note on Analyzing Results in Labs

When instructed to **analyze** something in a lab (either the current lab or any future lab), there are typically two methods to approach the task. First, you may use quantitative analysis which involves examining measurable, numerical data. For example:

- If you analyze packet round-trip times, you might examine statistics such as the minimum, maximum, average, and standard deviation of these times.
- If analyzing throughput (e.g., using IPerf3), you might determine whether throughput increases, decreases, or remains stable over time. You could also investigate if certain routers report zero throughput.
- If comparing multiple servers, identify the fastest and slowest servers, and quantify the differences between them.

Second, you may proceed with qualitative analysis, which involves interpreting your observations:

- Identify servers with the best and worst throughput and discuss the differences observed.
- Propose possible explanations for these differences based on factors discussed in class, such as network congestion, infrastructure issues, or other problems packets may encounter on their way to the server.
- You do not need definitive proof. This step involves hypothesizing reasons for your findings. In academic or research contexts, these qualitative observations are valuable for identifying areas that may warrant future investigation.

3. Measuring Delays with Ping

Ping is a network utility tool used to test host reachability. It measures the round-trip time for data packets to travel from source to destination and back.

On your computer, start a ping command with the destination www.example.com. The steps to executing a ping network test depend upon the operating system you are using the result may also vary.

- For Windows, go to Search in the taskbar and type **`cmd`** to bring up the Command Prompt.
- For Mac and Linux, open the Terminal utility.

You can find below typical extracts from Windows and Mac OSes.

```
PS C:\Users\user> ping -n 5 www.example.com

Pinging www.example.com [93.184.216.34] with 32 bytes of data:
Reply from 93.184.216.34: bytes=32 time=22ms TTL=57
Reply from 93.184.216.34: bytes=32 time=23ms TTL=57
Reply from 93.184.216.34: bytes=32 time=26ms TTL=57
Reply from 93.184.216.34: bytes=32 time=23ms TTL=57
Reply from 93.184.216.34: bytes=32 time=27ms TTL=57

Ping statistics for 93.184.216.34:
    Packets: Sent = 5, Received = 5, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 22ms, Maximum = 27ms, Average = 24ms
```

```
% ping -c5 www.example.com
PING www.example.com (93.184.216.34): 56 data bytes
64 bytes from 93.184.216.34: icmp_seq=0 ttl=57 time=49.546 ms
64 bytes from 93.184.216.34: icmp_seq=1 ttl=57 time=22.621 ms
64 bytes from 93.184.216.34: icmp_seq=2 ttl=57 time=22.193 ms
64 bytes from 93.184.216.34: icmp_seq=3 ttl=57 time=25.184 ms
64 bytes from 93.184.216.34: icmp_seq=4 ttl=57 time=26.247 ms

--- www.example.com ping statistics ---
5 packets transmitted, 5 packets received, 0.0% packet loss
round-trip min/avg/max/stddev = 22.193/29.158/49.546/10.307 ms
```

Answer the following questions and provide a summary of your observations for each question.

Q1.	Change the previous commands to send 10 packets to the destination. Give the command and a text extract of the result. (2 points)
Q2.	How many bytes are sent in each packet? (1 point)
Q3.	What is the IP address of the destination? (1 point)
Q4.	How many packets are lost? (1 point)
Q5.	How is the round-trip time for each packet computed? (1 point)
Q6.	Analyze the statistics for the 10 packets in terms of min/avg/max round trip times. (1 point)

Now, let us ping different destinations:

Destination	Host	Country
fr-bes-as2200-client.anchors.atlas.ripe.net	IMT Atlantique University	France
in-nda-as132420.anchors.atlas.ripe.net	E2E Networks	India
ca-mtr-as852.anchors.atlas.ripe.net	TELUS	Canada
www.auth.gr	Aristotle University	Greece
en.sjtu.edu.cn	Shanghai University	China
www.unisa.edu.au	University of South Australia	Australia

Note: Targets ending with atlas.ripe.net are part of RIPE Atlas. RIPE Atlas is a global network of probes that measure Internet connectivity and reachability, providing an understanding of the state of the Internet in real time. If you encounter any problem in reaching any of these targets you can replace it with one selected from this map: https://atlas.ripe.net/anchors/map. You have just to make sure that you are replacing a target with another one in the same country.

Q7.	Give the command and a text extract of the result. (2 points)
Q8.	Notice the RTT reported by ping for each target. Do you see a pattern? Which targets tend to have longer RTTs? Provide an explanation. (3 points)

4. Tracing the Route with Traceroute

Traceroute is a network diagnostic tool used to trace the route that data packets take from a source to a destination across the Internet. It provides information about the various routers that route the packets towards the destination. The tool is available on most operating systems, with commands such as **`traceroute`** on Unix-like systems (including Linux and macOS) and **`tracert`** on Windows.

This is an extract of a traceroute between a computer on Dal FCS network and the website server of University of Calgary.

```
lahoud@timberlea:~$ traceroute www.ucalgary.ca
traceroute to www.ucalgary.ca (136.159.96.125), 30 hops max, 60 byte packets
 1  GW81AD1600.Backbone.Dal.Ca (129.173.22.1)  0.550 ms  0.519 ms  0.505 ms
 2  192.75.138.17 (192.75.138.17)  0.728 ms  0.943 ms  0.689 ms
 3  192.75.96.137 (192.75.96.137)  1.205 ms  0.732 ms  1.005 ms
 4  hlfx1rtr1.network.canarie.ca (205.189.32.233)  1.413 ms  1.160 ms  1.394 ms
 5  mtrl3rtr1.network.canarie.ca (205.189.32.48)  14.844 ms  14.833 ms  15.015 ms
 6  mtrl2rtr1.network.canarie.ca (205.189.32.200)  14.809 ms  14.929 ms  15.274 ms
 7  toro1rtr1.network.canarie.ca (205.189.32.192)  21.598 ms  21.364 ms  21.552 ms
 8  toro3rtr1.network.canarie.ca (205.189.32.118)  21.860 ms  22.149 ms  22.138 ms
 9  wnpg2rtr3.network.canarie.ca (205.189.32.211)  42.928 ms  43.076 ms  43.211 ms
```

```
10  clgr2rtr3.network.canarie.ca (205.189.32.176)  57.403 ms  57.357 ms  57.701 ms
11  205.189.32.213 (205.189.32.213)  57.258 ms  57.030 ms  57.418 ms
12  h98.gpvpn.ucalgary.ca (136.159.199.98)  57.466 ms  57.113 ms  57.554 ms
13  h77.gpvpn.ucalgary.ca (136.159.199.77)  56.982 ms  57.088 ms  57.092 ms
14  ucalgary.ca (136.159.96.125)  57.404 ms  57.605 ms  57.291 ms
```

As you can see in the previous extract, the packets go through 13 routers before reaching the destination. Each router is uniquely identified by its IP address and Fully Qualified Domain Name (FQDN). For instance, the fifth router is denoted by the IP address 205.189.32.48 and the name mtrl3rtr1.network.canarie.ca.

The routers belong to different entities and are located in various cities. To obtain detailed information about these routers, you can use the service provided by ipinfo. Simply enter the following URL format into your browser's address bar: https://ipinfo.io/<IP_ADDRESS>, replacing <IP_ADDRESS> with the IP address you are investigating. For example, to check the IP address 192.75.96.137, you would enter https://ipinfo.io/192.75.96.137. This will provide useful details such as the owning entity (e.g., Dalhousie University, as shown in the "Summary" section) and the city location (e.g., Halifax, indicated in the "IP Geolocation" section).

However, IP location services have limitations, and precisely determining the location of IP addresses can be challenging in practice. Another useful strategy is to examine the FQDN. For instance, the FQDN mtrl3rtr1.network.canarie.ca offers clues about its ownership and geographic location: "canarie.ca" indicates it is operated by CANARIE, Canada's advanced research and education network; "mtrl" suggests it is likely located in Montreal; and "rtr" denotes that it is a router. Thus, this FQDN strongly implies that the device belongs to CANARIE and is physically located in Montreal.

Q9.	Using the information provided by ipinfo.io, identify the entities responsible for the different routers between the source and the destination. (1 point)
Q10.	Can you try to guess the location of the different routers from the FQDN? Compare to the result provided by ipinfo. Do you spot any differences? (3 points)
Q11.	Referring to www.canarie.ca, identify the mission of the CANARIE network. (1 point)
Q12.	Using the map in figure 1, can you map the results of the traceroute command? You can either copy the map and draw on it or create a list of the cities (with arrows between). (1 point)

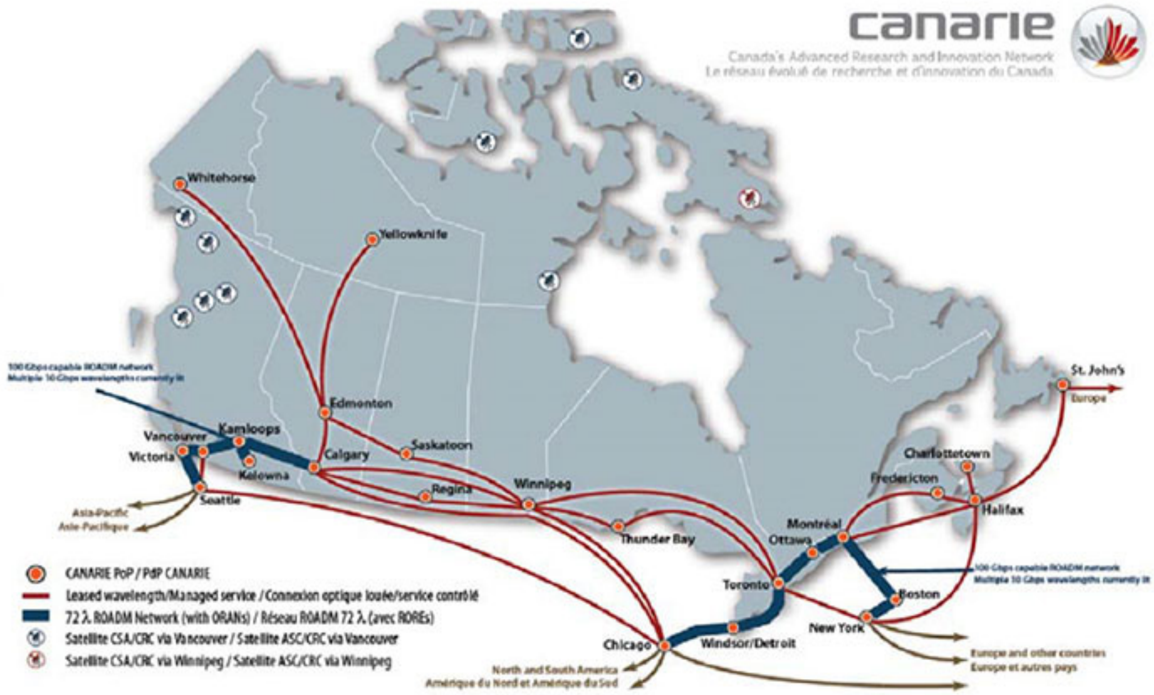

Figure 1 - CANARIE network map

Let us now run a traceroute to **stanford.edu** (without any preceding www). It is possible to execute the traceroute command directly from your laptop. However, we will leverage the server waverley.cs.dal.ca within the FCS network for enhanced consistency in results. If Waverley is not working try timberlea.cs.dal.ca.

Access this server by logging in with your CSID and password via SSH. Execute the command **`ssh CSID@waverley.cs.dal.ca`** (or CSID@timberlea.cs.dal.ca) on the command line (replace CSID with your specific CSID; if not yet created, visit https://csid.cs.dal.ca). Launch the traceroute to stanford.edu and answer the following questions.

Q13.	Give the traceroute command and a text extract of the result. (2 points)
Q14.	Do you spot any common routers with the previous result? Provide an explanation. (1 points)
Q15.	Using the information provided by ipinfo.io, identify the entities responsible for the different routers between the source and the destination. (1 point)
Q16.	Can you locate the different routers? (1 point)
Q17.	In the traceroute output, one line displays incomplete results as indicated by (* * *). Explain what happened. (1 point)

Now, run a traceroute towards fr-bes-as2200-client.anchors.atlas.ripe.net.

Q18.	Give the traceroute command and a text extract of the result. (2 points)
Q19.	Using the information provided by ipinfo.io, identify the entities responsible for the different routers between the source and the destination. (1 point)
Q20.	Can you locate the different routers? (1 point)

Q21.	Can you identify when the packets crossed the ocean using round trip times? How did you proceed? (1 point)

5. Measuring the Throughput with iPerf3

iPerf3 is a tool for network performance measurement. It is a cross-platform tool that can produce standardized performance measurements for any network. It supports tuning of various parameters related to timing, buffers, and protocols (TCP, UDP, SCTP with IPv4 and IPv6). iPerf3 has client and server functionality and can create data streams to measure the throughput between the two ends in one or both directions. Typical iPerf3 output contains a time-stamped report of the amount of data transferred and the throughput measured. The user documentation is available for your reference.

In this lab, you will perform measurements between your computer (iPerf3 client) and public iPerf3 servers. Start by downloading and installing iPerf3 on your computer (homebrew may be required for installation on some Mac computers). Now, launch an iPerf3 connection towards a public server in Montreal. You need to navigate to the directory where the download is located, and launch it from a terminal using the following command on Unix-like systems:

`./iperf3 -c speedtest-west.eastlink.ca `

Or on Windows: **`iperf3.exe -c speedtest-west.eastlink.ca `**

Q22.	Copy the obtained result (interval - transfer - bitrate columns). (1 point)
Q23.	Analyze the time-stamped results (successive time intervals). Note that for your analysis, you may need to refer to the note in Section 2 of the current document (Note on analyzing results in labs). (2 point)
Q24.	Analyze the final average results (receiver line at the end of the output). (1 point)

Now, select one public iPerf3 server form each continent from the list available on https://github.com/R0GGER/public-iperf3-servers. You can find the IP addresses of the servers by scrolling down on the GitHub page.

Q25.	Copy the obtained result (interval - transfer - bitrate columns). (6 points)
Q26.	Analyze and compare the final average results. (5 points)
Q27.	What are the parameters influencing the throughput results you measured? (1 point)