CMPT 371 Summer 2019: Homework Assignment 1
Available: May 14, 2019
Due Date: May 21, 2019

Q1. **End-to-end Delay.** Assume we are sending one packet of length L bits along a path of N links between source and destination. Each of the links has transmission rate of R bits/sec. What would be the end-to-end delay? (1 point). Why? (2 points)
Generalize the formula for sending P packets back-to-back over the N links. (2 points)

Q2. Packet-switched & Circuit-switched. Suppose we have users that generate data at a rate of 100kbps when they are busy. However, these users are busy generating data only 10% of the time. Suppose we have a 1 Gbps link between source and destination.
What is the maximum number of users that can be supported simultaneously if we use circuit switching? (2 points)
Now consider packet switching and a user population of M users. What will be the formula for the probability that more than N users are sending data? (3 points)

Q3. Queueing Delay. Suppose N packers arrive simultaneously to a link at which no packets are currently being transmitted or queued. Each packet is of length L and the link has transmission rate R. What is the average queueing delay for the N packets? (5 points)

Q4. Traceroute. Perform traceroute to www.utoronto.ca at three different hours of the day. Display the outputs (copy and paste the results from your terminal). (1 point) Find the average and standard deviation of the round-trip delays at each of the three hours. (2 points)
Find the number of routers in the path at each of the three hours. Did the paths change during any of the hours? (1 point)
Try to identify the number of ISP networks in the path. (1 point)
Where the largest delays happen? Can you think why? (1 point)
You can learn more about traceroute here: https://linux.die.net/man/8/traceroute
You can alternatively use tracert in cmd of windows systems: https://ss64.com/nt/tracert.html

Q5. Wireshark Setup. Go to https://www.wireshark.org/. Download and install Wireshark. Browse the website and find some more about Wireshark. Start capturing packets on your connected port. Please paste a screenshot of your first packet capture here. (1 point)
List three different protocols that you see in your first packet capture. (2 points)
Explain in your own words what did you understand about Wireshark from your first packet capture experiment. (2 points)

Please submit your answers in pdf format, before the midnight on May 21, 2019 on the canvas system HW1 activity.