ECE158a Assignment 1

September 22, 2022

Due date: October 7

1 Introduction

1.1 Testing reachability with *ping*:

Ping is a network utility that uses the Internet Control Message Protocol (ICMP) to test the reachability of a given host on the Internet. For example: Try the following commands

$ ping www.google.com or $ ping 8.8.8.8

Its operation is as simple as sending an ICMP Echo Request packet and waiting for an ICMP Echo Reply. This allows us to check if the given destination is reachable. You could also use ping to measure the round trip time (RTT) between the hosts. Look up the manual entry of ping for more details.

1.2 Measuring bandwidth with *iperf*:

Iperf is a network utility to measure the bandwidth of a network link (through TCP or UDP). In order to measure the bandwidth between two hosts, one host should be set as the *iperf* server and the other as client. Client then setup a TCP session (or send through UDP if specified so) with the server and measures the bandwidth. In particular, the server side runs *iperf* and listens on the default (or specified) port:

$ iperf -s

while the client runs *iperf* and connects to the server (with IP address, say 10.1.1.1):

$ iperf -c 10.1.1.1

1.3 Wireshark

Wireshark is a free and open source network analyzer that could monitor the packets being transmitted on the specified network interfaces. Wireshark supports wide variety of protocols that could help you analyze the captured packets. You could download Wireshark and learn the basic operations from the official site.

2 Questions

2.1

In your own machine, try to ping at least 5 different destinations. For example, different websites, your other computer, or your smartphone. Report the measured RTT and the time-to-live (TTL) field from the ping reply. Explain in your own words what these two numbers represent, and explain if you find any relation between them.

2.2

Visit a website that uses HTTP protocol (e.g. http://mininet.org) and use Wireshark to capture your traffic. Save the packets in the packet capture file type with name "*http.pcap*", and upload with your report.

2.3

Use the *iperf* commands to measure the bandwidth between your pc and the website you used for previous question and report your results.

2.4

Consider a simple network containing two hosts as illustrated in the figure 1 on the left side. Hosts A and B are 30000km away form each other, and are connected by a single-direct link with capacity $C = 100Mbps$. Assume the propagation speed is $2 \times 10^8 m/s$.

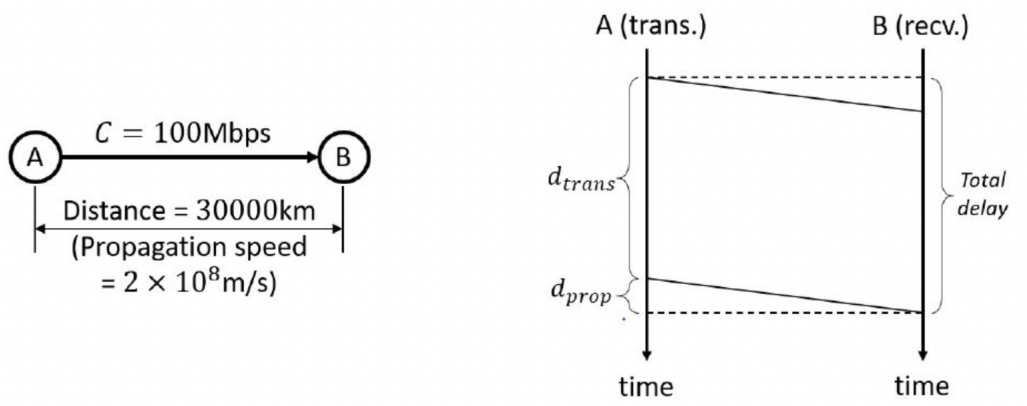

Figure 1: A simple network

1. The "Bandwidth-delay product" of a link is defined as $C \times d_{prop}$ and calculate the bandwidth-delay product for this link.
2. What is the maximum number of bits on the link (sent but not yet received) at any given time?
3. Imagine that A sends a 3GB file to B, determine the total delay (the time elapses since A starts sending until B finishes reception).

3 Optional

In this part we are going to introduce a useful tool called *MiniNet*, all the questions in this part don't weight any points but they will be a great help and a good practice for enthusiastic students.

3.1 Network emulation with Mininet

- **Set up the Mininet virtual machine (VM):**
  In this part, we will set up a Mininet virtual machine which provides an environment for network emulation. Before we get started, first check that you have the required software as specified in the prerequisites section, and then download a Mininet VM image(Mininet 2.2.2) from Mininet official website.
  The following instructions assume that you work with VirtualBox (if you are a mac user you can use 30days free trial of VMware Fusion, you also may work with other VM managers, which should follow the similar process, and you may find this setup note helpful).

  1. Unzip the downloaded file and import the .ovf file in VirtualBox.
  2. In "VirtualBox > Preferences", select the "Network" tab. Select "host-only net-work" tab, and check if there is a host-only network exists. If there is not, add one host-only network and check its configuration to make sure it has "DHCP server" enabled. This allows you to add a host-only adapter to the Mininet VM in the next step.

3. In the "settings" of the VM, go to the "network" tab and add a network interface with "host-only adapter" type. (This step creates a network interface connecting your machine and the VM which would be used later).
4. Now turn on the VM and log in with the username/password: mininet/mininet.
5. You may now use this VM through this VirtualBox console.

- **Secure shell (SSH) communication through X terminals:**
With the *xterm* command, you may open X terminals for specified devices (hosts or switches). This works as performing an SSH and log into the device. You may then run any application or command through this X terminal as you would do on your computer. The following steps walk you through setting up a SSH connection into your VM through the Terminal of "your own machine" (the one that is actually running the VM).

  1. We are now going to configure the Mininet VM with the additional "host-only adapter" interface. In the VM console, execute
  $ sudo dhclient eth1
  This assigns an IP address for the VM's additional network interface. Now execute
  $ ifconfig
  This shows you a list of the network interfaces of the Mininet VM. Find a network interface that has IP address starting with 192 and write the address down, this would be the IP address that you would use to SSH from your Terminal.
  2. Now you are ready to remotely login into the VM. Open up a Terminal window from your machine, and execute
  $ ssh -X mininet@ < the IP address from the previous step >
  and then enter the password (mininet).
  3. You have now SSH into the VM with the X window forwarding enabled. The X window forwarding is useful when running applications that has graphical interface. For example, you may try
  $ sudo wireshark &
  You should see a window popped up, which is the Wireshark program running in this VM.
  Note: The Mininet VM comes with Wireshark installed. (You don't need to download and install it yourself.)

- **Simple network topology:**
The command mn is used to setup an emulation scenario and enter into the Mininet command line interface (CLI). Since Mininet must run as root, try the following command in your VM to start Mininet:
$ sudo mn
This generates a simple topology where two hosts connected to one switch, as shown in figure 2 (A).
Various parameters could be set to specify the network setup for the emulation. For example , - *-topo* could be used to specify the network topology, and *–link* could be used to customize the links.

3.2 Optional questions

1. Now ping from your machine to the Mininet VM. Specify the parameter to send 5 consecutive ping packets to the VM. At the same time, use Wireshark to capture/monitor the ping requests and replies. (You may either run Wireshark directly from your machine or from the VM). Remember to apply filters to show only the ping requests and replies, and explain the filters you have chosen. Save the packets in the Wireshark default packet capture file type (.pcap or .pcapng), with file name "ping.pcap", and upload with your report.

2. In Mininet, how do you generate the topologies in Figure 2 with the –topo parameters? Write down the single line command you would use to generate scenarios with these topologies. Also, for each scenario, you could use the command net in the Mininet CLI to verify your topology. Include the list of connections after each command.

3. Consider the topology (A) in Figure 2. Use the iperf command to measure the bandwidth between host 1 and host 2. At the same time, use the Wireshark to capture/monitor these packets between the two hosts and take a screenshot to show the captured packets. Report as much information of these packets as you could from Wireshark.

4. Consider again the topology (A) in Figure 2, but now generate scenarios with different link parameters (e.g. bandwidth, delay). In particular, first fix the bandwidth and vary the delay with at least 10 different values; then fix the delay and vary the bandwidth with at least 10 different values. For each scenario you generated, use ping and iperf to measure the RTT and the bandwidth between the two hosts under different link parameters. Show the measured results and explain the relation between the RTT, the bandwidth, and the link parameters.

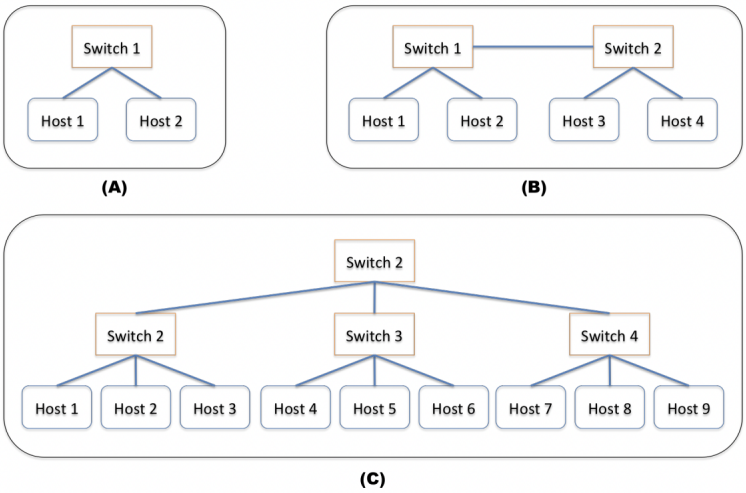

Figure 2: Example network topologies.