Cairo University
Faculty of Engineering

ELC 3080 Spring 2024

Computer Networks Project

Virtual Networks Lab using Linux and the CORE Network Emulator

1 Rules

1- Two students per project (max).

2- Final delivery: May 16

3- Hard copy should be submitted to the TA and softcopy uploaded on the class room.

4- Softcopy file should be named Networks2024_Project_Sec_BN.docx where Sec and BN are section and BN of one of the submitting students.

5- Projects will be checked for duplication/copies. Copiers will be given a -4 grade in the overall final grade.

6- Project cover page should contain names of students, section, and bench number ordered by section and BN.

7- The maximum number of pages is 12 pages without cover page using Times-Roman 12pt font size and single spacing including all figures and tables needed in the answer. Students exceeding length will be penalized by 2% for each additional page.

8- Each of the following sections describes an experiment based on the provided **Project_OSPF_TCP.imn** file (not the file used in the demo). In your report, divide the answers to correspond to one of these sections in exactly the same sequence and same name, for example use Question 2.i, Question 3.ii and so on.

9- The tutorial file CUVirtualNetLab.pdf explained/introduced most of the needed tools like iperf3, vtysh, wireshark, etc. If you have not gone through it, do not start working on the assignment below.

10- It is better to start the network emulation once and run wireshark captures. You can reset wireshark captures from experiment to another.

2 Effect of TCP Window Size

1- Set wireshark filter to display TCP packets only.
2- Start an iperf3 server on node n11.
3- Start an iperf3 client on node n7 connecting to server on node n11 for a duration of 40 seconds and reporting interval of 10. **Note that in iperf, the client is the node sending the traffic and the server simply receives and sends an ACK**.

Questions

i. Vary iperf3 window size from 1Kbytes to 6 Kbytes in increments of 1 Kbyte, then set it to 12, 16, 24, 32 Kbytes. Plot the avg throughput and the avg number of retransmissions as function of window size. Comment on the results and explain the zigzag behaviour noticed for larger window sizes. Note that number of retransmissions is the 5th column in iperf3 default output.
ii. Click on any of the TCP a data segment whose source is node n7, dissect the segment by following different protocol layer headers from TCP->IP->Ethernet identifying how many header bytes are added by each layer, identify the TCP options used.
iii. Repeat for an ACK packet sent from node n11.

3 TCP short versus long paths

1- Run an iperf3 server on node n8.
2- Start an iperf3 client on node n7 connecting to server on node n8 for a duration of 40 seconds and reporting interval of 10 with window size 4K.

Questions

i. Compare the result of throughput with the case when connection was made to node n11. Why throughput drops when connecting to n8 although capacities on the two paths are the same.

4 Higher Link Capacity with Drops versus Reliable Lower Capacity

1- This part will be based on the path between n7 and n11.
2- For each case of the following, run iperf3 client from n7 to n11 with window size 4K.
    a. Select link between n4 and n5, configure it to have capacity of 10 Mbps with zero loss in both directions.
    b. Select link between n4 and n5, configure it to have capacity of 3 Mbps with zero loss in both directions.
    c. Select link between n4 and n5, configure it to have capacity of 10 Mbps with 5% loss in both directions.
    d. Select link between n4 and n5, configure it to have capacity of 100 Mbps with 10% loss in both directions.
    e. Select link between n4 and n5, configure it to have capacity of 10 Mbps with 1% loss in direction from n4 to n5 and 0% loss in the other direction.
    f. Select link between n4 and n5, configure it to have capacity of 10 Mbps with 0% loss in direction from n4 to n5 and 1% loss in the other direction.

Questions

i. Compare throughputs in cases a, b, c. Why b is better than c?
ii. Compare throughputs in cases b, c and d. Which is better? Why?
iii. Compare throughputs in cases e and f? Which is better? Why?

5 OSPF Link Cost Changes

1- Stop any running iperf3 clients.
2- Set all links to have zero loss in the two directions with 100 Mbps speed.
3- Run iperf3 between n7 and n11 for a duration of 500 seconds or longer. Identify the path between n7 and n11.
4- Open vtysh on node n5 by opening a bash terminal and typing vtysh. Now we can configure router and link costs.
5- Type the following in vtysh:
`show ip ospf interface eth1`
This displays information about interface eth1. Note its ospf cost.
6- Type the following
`configure terminal`
`interface eth1` (the interface for the link between n5 and n4)
`ospf cost 40` (set cost to 40)

Questions

i. Check what happens to the path between n7 and n11 (as seen after steps 3 and 6)? Explain what happens.
ii. Set the cost of eth1 at node n5 back to 10. Establish two iperf3 connections: one from n7 to n11 and the second from n11 to n7 both for duration of 500 seconds. Now go to node n4 and set interface cost for interface connecting n4 with n5 to 40.
What happens in the paths of the two connections? Explain what happens. What do you conclude?

6 OSPF Database Updates

1- Start wireshark and have its filter to capture only OSPF related packets.
2- Go to another router say router n2, open vtysh and issue the commands:
```
config terminal
show ip ospf database
show ip ospf route
```
3- On router n4, set link cost of eth1 to 20. Capture the link state packets advertised in wireshark.
4- Go to router n4, go out of vtysh, or open new bash terminal and issue the following commands to disconnect router n4 from the network:
```
ifconfig eth0 down
ifconfig eth1 down
ifconfig eth2 down
```

Questions

i. Capture and explain the outputs due to execution of step 2. Why some destinations have more than route in the routing tables?
ii. After executing step 3, determine how long it took the network to exchange link state packets and adjust routing tables. **(Hint: you can calculate the required time by observing the time of first OSPF update message and the last ACK from Wireshark).**
iii. After execution of step 4, identify the new routing table and router database at router n2. Explain the updates in the new routing table and the new database.