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Friday, April 28, 2023
Computer Networks

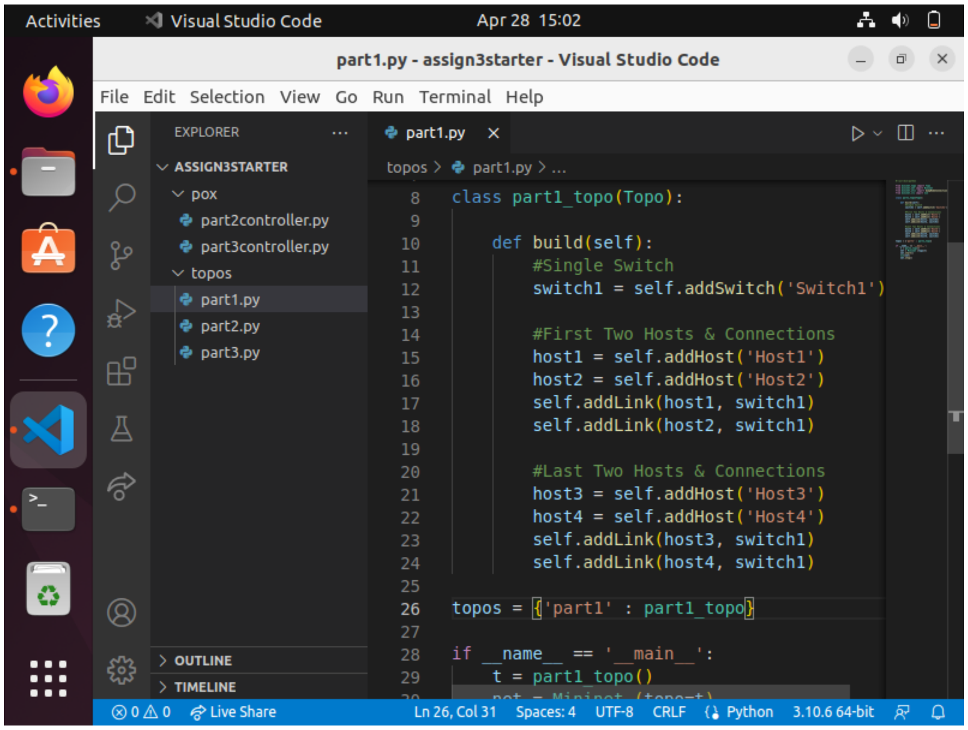
Programming Assignment 3 Report

This document contains the Report for my Programming Assignment 3

Project Synopsis

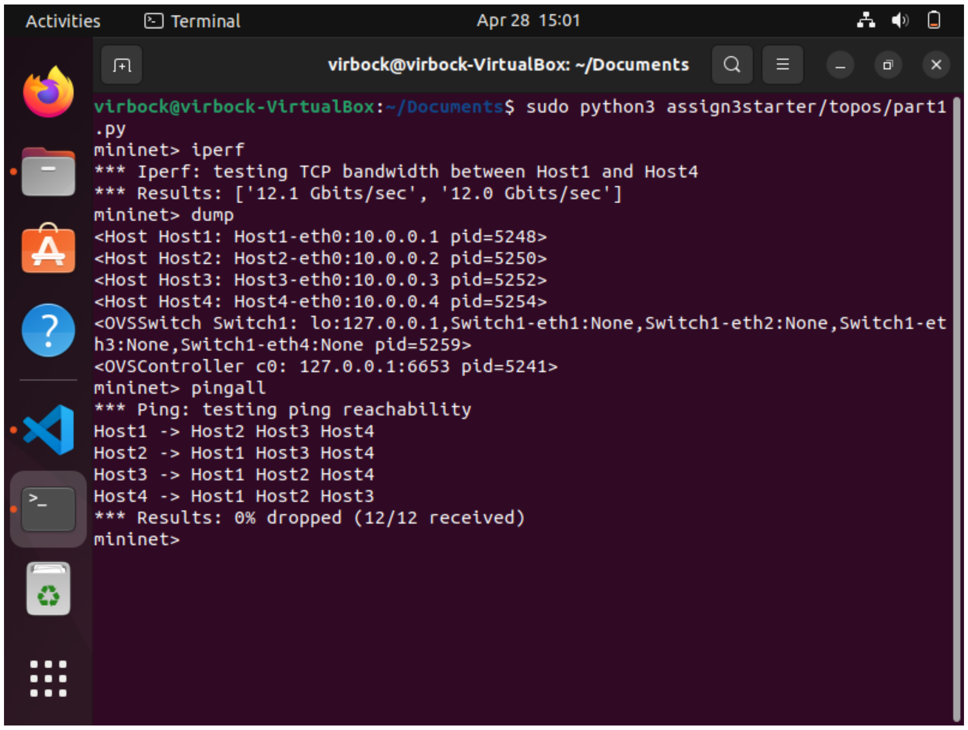
For this project, I was tasked to experiment with Mininet and use its functionality to gain a better understanding of Software Defined Networking. Skipping over the semantics of Software Defined Networking, I was tasked with 3 objectives. I was tasked to create a Network Topology that I would use with Mininet, then I was tasked to create a POX Controller extension file that would act as a Firewall for an existing Network Topology that was used with Mininet. Finally, I was tasked to create a POX Controller extension file that would have specific Firewalls for specific switches/subsystems/hosts intercommunications. Overall, the assignment gave me a very comprehensive list of objectives!

Execution Samples / Testing Scenarios



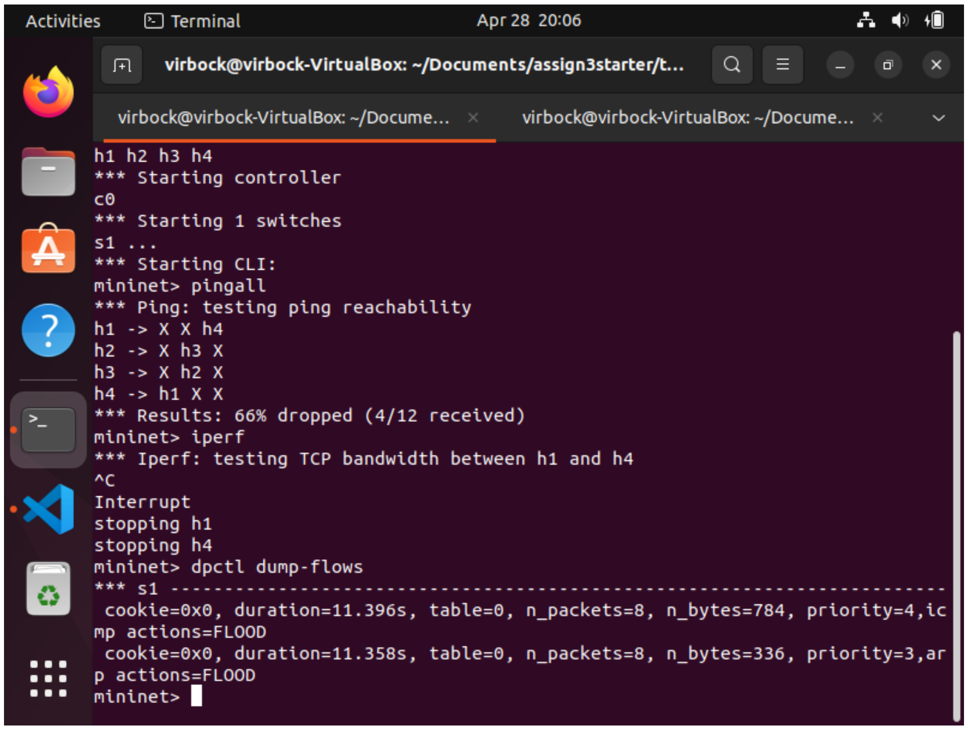
```
class part1_topo(Topo):

    def build(self):
        #Single Switch
        switch1 = self.addSwitch('Switch1')

        #First Two Hosts & Connections
        host1 = self.addHost('Host1')
        host2 = self.addHost('Host2')
        self.addLink(host1, switch1)
        self.addLink(host2, switch1)

        #Last Two Hosts & Connections
        host3 = self.addHost('Host3')
        host4 = self.addHost('Host4')
        self.addLink(host3, switch1)
        self.addLink(host4, switch1)

topos = {'part1' : part1_topo}

if __name__ == '__main__':
    t = part1_topo()
```

The figure above represents the network topology that I created for Task 1, a rather simple layout!



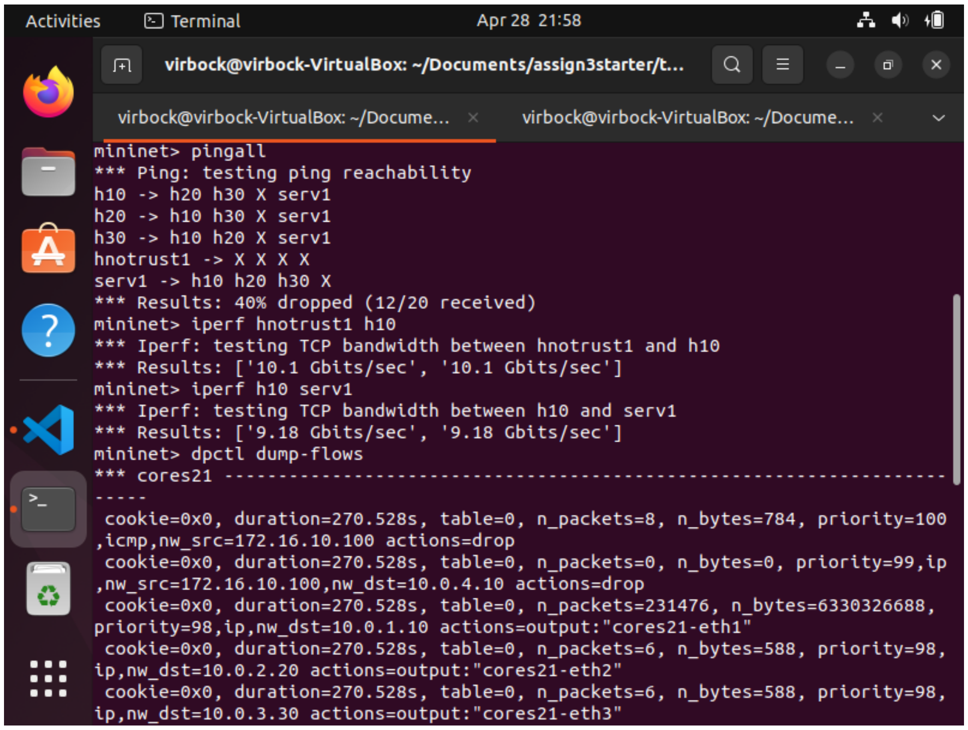
```
virbock@virbock-VirtualBox:~/Documents$ sudo python3 assign3starter/topos/part1
.py
mininet> iperf
*** Iperf: testing TCP bandwidth between Host1 and Host4
*** Results: ['12.1 Gbits/sec', '12.0 Gbits/sec']
mininet> dump
<Host Host1: Host1-eth0:10.0.0.1 pid=5248>
<Host Host2: Host2-eth0:10.0.0.2 pid=5250>
<Host Host3: Host3-eth0:10.0.0.3 pid=5252>
<Host Host4: Host4-eth0:10.0.0.4 pid=5254>
<OVSSwitch Switch1: lo:127.0.0.1,Switch1-eth1:None,Switch1-eth2:None,Switch1-et
h3:None,Switch1-eth4:None pid=5259>
<OVSController c0: 127.0.0.1:6653 pid=5241>
mininet> pingall
*** Ping: testing ping reachability
Host1 -> Host2 Host3 Host4
Host2 -> Host1 Host3 Host4
Host3 -> Host1 Host2 Host4
Host4 -> Host1 Host2 Host3
*** Results: 0% dropped (12/12 received)
mininet>
```

The figure above shows the executions of iperf, dump, and pingall in Mininet for the network topology that I was tasked to create earlier

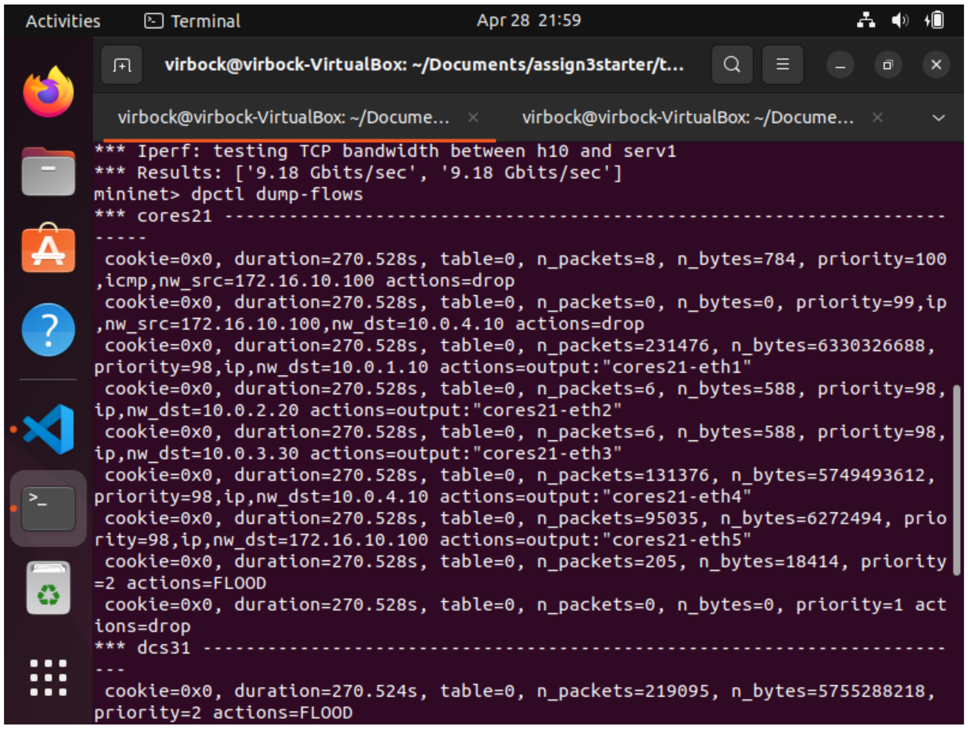

Activities
Terminal
Apr 28 20:06
virbock@virbock-VirtualBox: ~/Documents/assign3starter/t...
virbock@virbock-VirtualBox: ~/Docume...
virbock@virbock-VirtualBox: ~/Docume...

```
h1 h2 h3 h4
*** Starting controller
c0
*** Starting 1 switches
s1 ...
*** Starting CLI:
mininet> pingall
*** Ping: testing ping reachability
h1 -> X X h4
h2 -> X h3 X
h3 -> X h2 X
h4 -> h1 X X
*** Results: 66% dropped (4/12 received)
mininet> iperf
*** Iperf: testing TCP bandwidth between h1 and h4
^C
Interrupt
stopping h1
stopping h4
mininet> dpctl dump-flows
*** s1 ------------------------------------------------------------------------
 cookie=0x0, duration=11.396s, table=0, n_packets=8, n_bytes=784, priority=4,ic
mp actions=FLOOD
 cookie=0x0, duration=11.358s, table=0, n_packets=8, n_bytes=336, priority=3,ar
p actions=FLOOD
mininet> 
```

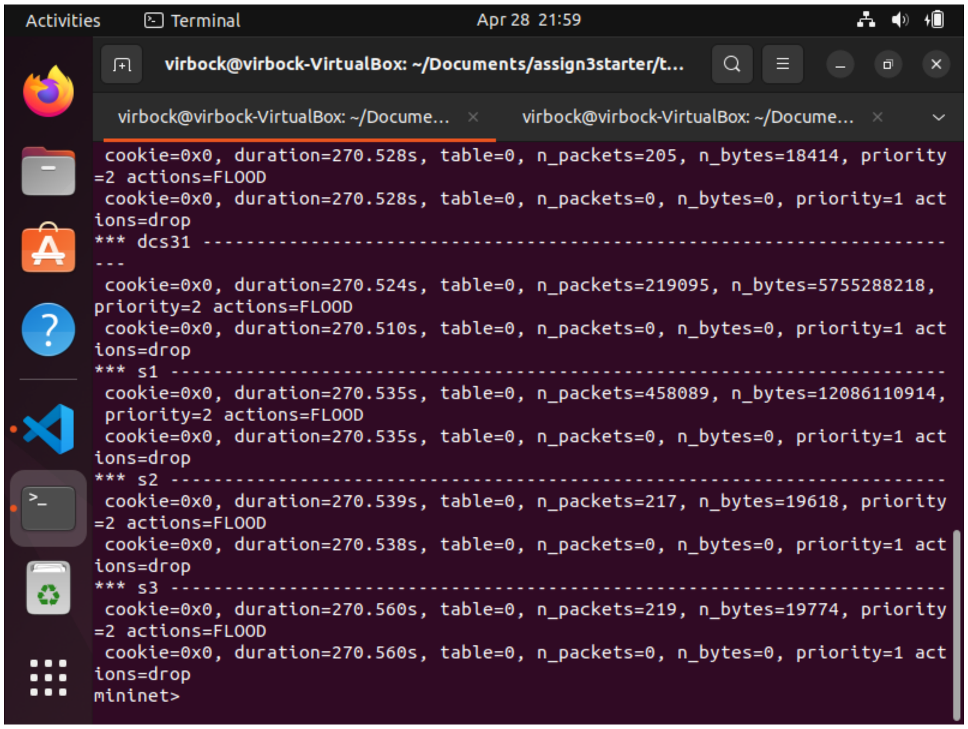
The figure above shows the executions of pingall, iperf, and dpctl dump-flows for the Network Topology and POX Controller I was tasked to work on for task 2


Activities
Terminal
Apr 28 21:58
virbock@virbock-VirtualBox: ~/Documents/assign3starter/t...
virbock@virbock-VirtualBox: ~/Docume...
virbock@virbock-VirtualBox: ~/Docume...

```
mininet> pingall
*** Ping: testing ping reachability
h10 -> h20 h30 X serv1
h20 -> h10 h30 X serv1
h30 -> h10 h20 X serv1
hnotrust1 -> X X X X
serv1 -> h10 h20 h30 X
*** Results: 40% dropped (12/20 received)
mininet> iperf hnotrust1 h10
*** Iperf: testing TCP bandwidth between hnotrust1 and h10
*** Results: ['10.1 Gbits/sec', '10.1 Gbits/sec']
mininet> iperf h10 serv1
*** Iperf: testing TCP bandwidth between h10 and serv1
*** Results: ['9.18 Gbits/sec', '9.18 Gbits/sec']
mininet> dpctl dump-flows
*** cores21 -------------------------------------------------------------------
-----
 cookie=0x0, duration=270.528s, table=0, n_packets=8, n_bytes=784, priority=100
,icmp,nw_src=172.16.10.100 actions=drop
 cookie=0x0, duration=270.528s, table=0, n_packets=0, n_bytes=0, priority=99,ip
,nw_src=172.16.10.100,nw_dst=10.0.4.10 actions=drop
 cookie=0x0, duration=270.528s, table=0, n_packets=231476, n_bytes=6330326688,
priority=98,ip,nw_dst=10.0.1.10 actions=output:"cores21-eth1"
 cookie=0x0, duration=270.528s, table=0, n_packets=6, n_bytes=588, priority=98,
ip,nw_dst=10.0.2.20 actions=output:"cores21-eth2"
 cookie=0x0, duration=270.528s, table=0, n_packets=6, n_bytes=588, priority=98,
ip,nw_dst=10.0.3.30 actions=output:"cores21-eth3"
```

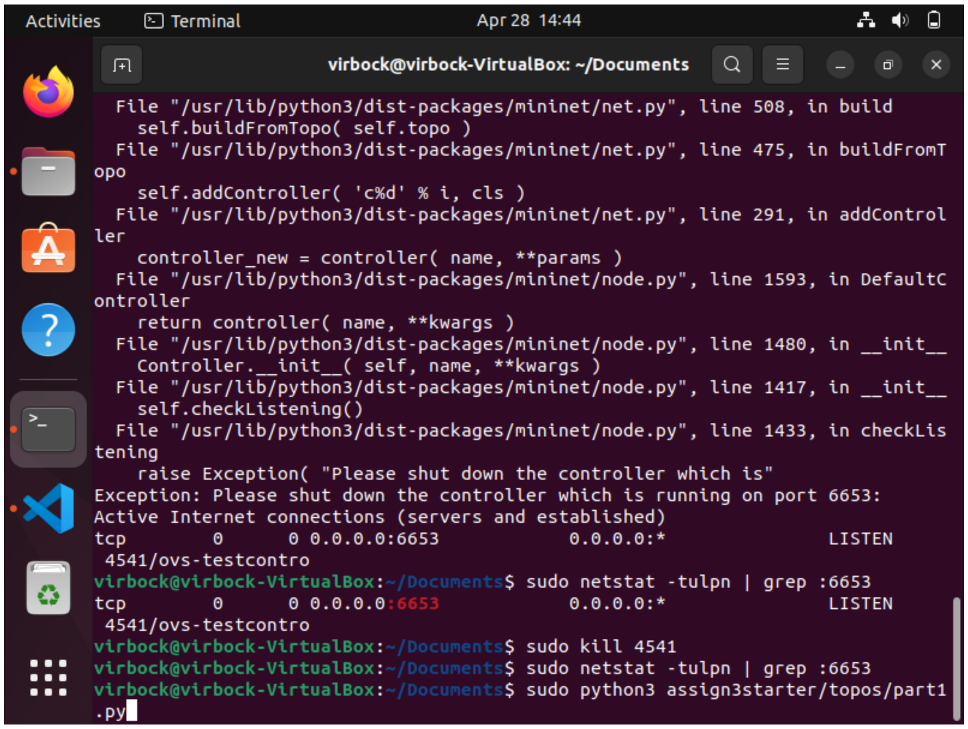

Activities
Terminal
Apr 28 21:59
virbock@virbock-VirtualBox: ~/Documents/assign3starter/t...
virbock@virbock-VirtualBox: ~/Docume...
virbock@virbock-VirtualBox: ~/Docume...

```
*** Iperf: testing TCP bandwidth between h10 and serv1
*** Results: ['9.18 Gbits/sec', '9.18 Gbits/sec']
mininet> dpctl dump-flows
*** cores21 ------------------------------------------------------------------
-----
 cookie=0x0, duration=270.528s, table=0, n_packets=8, n_bytes=784, priority=100
,icmp,nw_src=172.16.10.100 actions=drop
 cookie=0x0, duration=270.528s, table=0, n_packets=0, n_bytes=0, priority=99,ip
,nw_src=172.16.10.100,nw_dst=10.0.4.10 actions=drop
 cookie=0x0, duration=270.528s, table=0, n_packets=231476, n_bytes=6330326688,
priority=98,ip,nw_dst=10.0.1.10 actions=output:"cores21-eth1"
 cookie=0x0, duration=270.528s, table=0, n_packets=6, n_bytes=588, priority=98,
ip,nw_dst=10.0.2.20 actions=output:"cores21-eth2"
 cookie=0x0, duration=270.528s, table=0, n_packets=6, n_bytes=588, priority=98,
ip,nw_dst=10.0.3.30 actions=output:"cores21-eth3"
 cookie=0x0, duration=270.528s, table=0, n_packets=131376, n_bytes=5749493612,
priority=98,ip,nw_dst=10.0.4.10 actions=output:"cores21-eth4"
 cookie=0x0, duration=270.528s, table=0, n_packets=95035, n_bytes=6272494, prio
rity=98,ip,nw_dst=172.16.10.100 actions=output:"cores21-eth5"
 cookie=0x0, duration=270.528s, table=0, n_packets=205, n_bytes=18414, priority
=2 actions=FLOOD
 cookie=0x0, duration=270.528s, table=0, n_packets=0, n_bytes=0, priority=1 act
ions=drop
*** dcs31 --------------------------------------------------------------------
---
 cookie=0x0, duration=270.524s, table=0, n_packets=219095, n_bytes=5755288218,
priority=2 actions=FLOOD
```


Activities
Terminal
Apr 28 21:59
virbock@virbock-VirtualBox: ~/Documents/assign3starter/t...
virbock@virbock-VirtualBox: ~/Docume...
virbock@virbock-VirtualBox: ~/Docume...

```
 cookie=0x0, duration=270.528s, table=0, n_packets=205, n_bytes=18414, priority
=2 actions=FLOOD
 cookie=0x0, duration=270.528s, table=0, n_packets=0, n_bytes=0, priority=1 act
ions=drop
*** dcs31 --------------------------------------------------------------------
---
 cookie=0x0, duration=270.524s, table=0, n_packets=219095, n_bytes=5755288218,
priority=2 actions=FLOOD
 cookie=0x0, duration=270.510s, table=0, n_packets=0, n_bytes=0, priority=1 act
ions=drop
*** s1 -----------------------------------------------------------------------
 cookie=0x0, duration=270.535s, table=0, n_packets=458089, n_bytes=12086110914,
 priority=2 actions=FLOOD
 cookie=0x0, duration=270.535s, table=0, n_packets=0, n_bytes=0, priority=1 act
ions=drop
*** s2 -----------------------------------------------------------------------
 cookie=0x0, duration=270.539s, table=0, n_packets=217, n_bytes=19618, priority
=2 actions=FLOOD
 cookie=0x0, duration=270.538s, table=0, n_packets=0, n_bytes=0, priority=1 act
ions=drop
*** s3 -----------------------------------------------------------------------
 cookie=0x0, duration=270.560s, table=0, n_packets=219, n_bytes=19774, priority
=2 actions=FLOOD
 cookie=0x0, duration=270.560s, table=0, n_packets=0, n_bytes=0, priority=1 act
ions=drop
mininet>
```

The 3 figures above all show the execution samples for the Network Topology and POX Controller tasks I was assigned for task 3 – pingall, iperf, and dpctl dump-flows



```
  File "/usr/lib/python3/dist-packages/mininet/net.py", line 508, in build
    self.buildFromTopo( self.topo )
  File "/usr/lib/python3/dist-packages/mininet/net.py", line 475, in buildFromT
opo
    self.addController( 'c%d' % i, cls )
  File "/usr/lib/python3/dist-packages/mininet/net.py", line 291, in addControl
ler
    controller_new = controller( name, **params )
  File "/usr/lib/python3/dist-packages/mininet/node.py", line 1593, in DefaultC
ontroller
    return controller( name, **kwargs )
  File "/usr/lib/python3/dist-packages/mininet/node.py", line 1480, in __init__
    Controller.__init__( self, name, **kwargs )
  File "/usr/lib/python3/dist-packages/mininet/node.py", line 1417, in __init__
    self.checkListening()
  File "/usr/lib/python3/dist-packages/mininet/node.py", line 1433, in checkLis
tening
    raise Exception( "Please shut down the controller which is"
Exception: Please shut down the controller which is running on port 6653:
Active Internet connections (servers and established)
tcp        0      0 0.0.0.0:6653            0.0.0.0:*               LISTEN
 4541/ovs-testcontro
virbock@virbock-VirtualBox:~/Documents$ sudo netstat -tulpn | grep :6653
tcp        0      0 0.0.0.0:6653            0.0.0.0:*               LISTEN
 4541/ovs-testcontro
virbock@virbock-VirtualBox:~/Documents$ sudo kill 4541
virbock@virbock-VirtualBox:~/Documents$ sudo netstat -tulpn | grep :6653
virbock@virbock-VirtualBox:~/Documents$ sudo python3 assign3starter/topos/part1
.py
```

The figure above shows an example of one of the EXHAUSTING issues I was running into, where I had previously active controllers taking up ports I was supposed to use!

Instructions for Running the Program

1. Install all the required dependencies and programs needed for this project, it's all in the project synopsis
2. Unzip my "Loi_Gregorio_PA3.zip" file
3. Navigate into the main directory, where "pox", "assign3starter", and "README" is located
4. When you're in this directory, it's best to have 2 terminals open
    a. In your first terminal, navigate to the "assign3starter" directory, then into the "topos" directory
    b. In your second terminal, navigate to the "pox" directory

5. Now that you have both terminals configured, it’s time to launch testing campaigns as needed
6. If you need to test task1
    a. In your first terminal, run “sudo python part1.py”
    b. Once completed, your Mininet CLI should pop up, have fun!
7. If you need to test task2
    a. In your second terminal, start your POX Controller by running “./pox.py part2controller”
    b. Then, in your first terminal, start your Mininet Network Topology by running

    sudo mn —custom PATH/part2.py —topo part2 —controller remote,port=6633

    c. Replace PATH with the file path to part2.py, which is located under the “topos” directory of “assign3starter”
    d. You’re all set to interact with your Mininet CLI!
8. If you need to test task3
    a. In your second terminal, start your POX Controller by running “./pox.py part3controller”
    b. Then, in your first terminal, start your Mininet Network Topology by running
    c. *sudo mn —custom PATH/part3.py —topo part3 —controller remote,port=6633*
    d. Replace PATH with the file path to part3.py, which is located under the “topos” directory of “assign3starter”
    e. You’re all set to interact with your Mininet CLI!
9. Once finished, you can exit Mininet by typing “quit” and simply do CTRL+C to exit from the POX Controller environment

References Used

- Project Synopsis PDF
- w3schools.com for python language documentation checks
- https://www.javatpoint.com/icmp-protocol
- https://www.ipxo.com/blog/address-resolution-protocol/
- https://github.com/mininet/openflow-tutorial/wiki
- https://noxrepo.github.io/pox-doc/html/
- http://mininet.org/walkthrough/
- https://docs.openvswitch.org/en/latest/
- https://docs.pica8.com/display/PICOS2111cg/PicOS+OpenFlow+Tutorials
- As well as the DEMO VIDEO uploaded to the Course's Home Page on Blackboard
    - This was very useful, thank you so much Dr. Tosh 😊

Work Distribution

I had some scheduling issues – Although I planned to work in a team, I ended up having to work by myself to save my partner from suffering due to my scheduling conflicts!

Conclusion

This project was a big insight into the many different types of software applications there are in the field. This was my first time interacting with a project of this nature, where a separate environment is linked to another purely by 3rd party libraries such as the POX Controller. As advanced and stressful as this project was, I gained a lot from it and will use this applicable network knowledge in future endeavors. The command line interaction with Mininet also gave me some very useful network scoping tactics that I hope to use in the future – I am very inexperienced when it comes to using commands to interact with networks (Especially Software Defined Networks). In conclusion, I found this project to be very difficult but very rewarding – I was able to grab the big picture and practicality of SDN's.

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