Name: Md.Abdullah
ID : IT-17015

Lab report no: 08

Name of the report: SDN Controllers and Mininet

Objectives:

- ✔ Understanding SDN Controllers
- ✔ Learn how mininet work

Theory:

Explain how the traffic generators work?
Ans:
Traffic Generators

A traffic generators is used to put traffic onto a network for other machines to consume. Logically, a traffic generator has a physical layer address (and usually higher-level address), because it is supposed to look like a machine on the network to the target machines receiving the traffic

Question 5.3: Which is the main difference between configuring UDP and TCP traffic?
Ans:
UDP traffic if fully customized in terms of packet lengh and batwidth. Instead TCP only allow customize the amount of traffic.

Question 5.4: In your opinions which are the main advantages and disadvantages of working with mininet? Provide at least 3.
Ans:
Advantage:

1. free
2. easy to install
3. allow test scalability

Disadvantage:

1. It is not real devices
2. No real traffic can be injected
3. No INTERNET output.

Question 5.5: Explain the architecture of Software defined Networks?

Ans:
Controller role: Brain of the network
Switch role: Hands of the network
Host role: Clients

Question 5.6: What is the advantage of having a programmable Controller?
Ans:
Fully customize, program and controll your network.

Section 4.1: Using traffic Generators

Exercise 4.1.1: Open a Linux terminal, and execute the command line iperf --help. Provide four configuration options of iperf.

Ans:

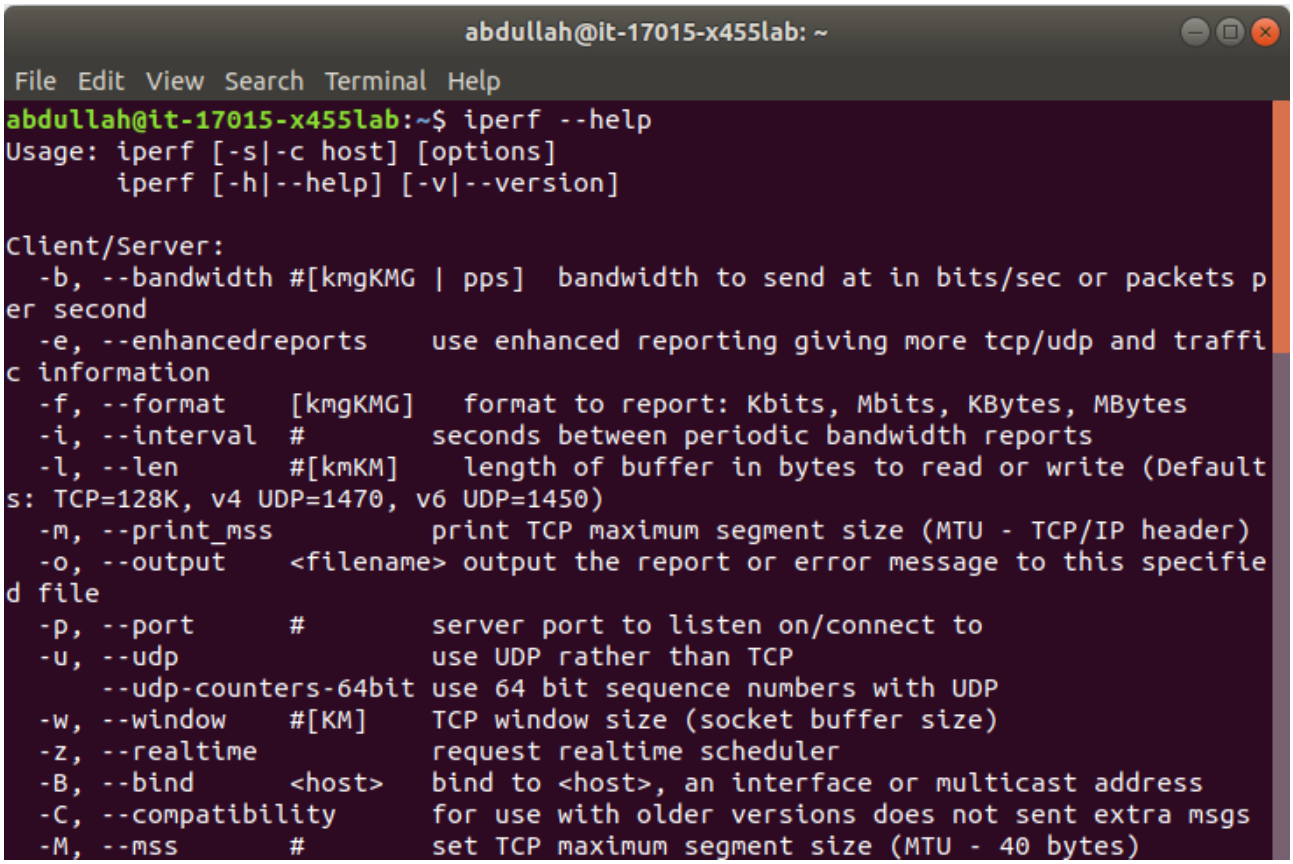
Client/Server:

-f, --format [kmKM] format to report: Kbits, Mbits, KBytes, MBytes

-i, --interval seconds between periodic bandwidth reports

-l, --len [KM] length of buffer to read or write (default 8 KB)

-m, --print_mss print TCP maximum segment size (MTU - TCP/IP header)



Exercise 4.1.2: Open two Linux terminals, and configure terminal-1 as client (iperf –c IPv4_server_address) and terminal-2 as server (iperf -s).Which are the statistics provided at the end of transmission?

Ans:

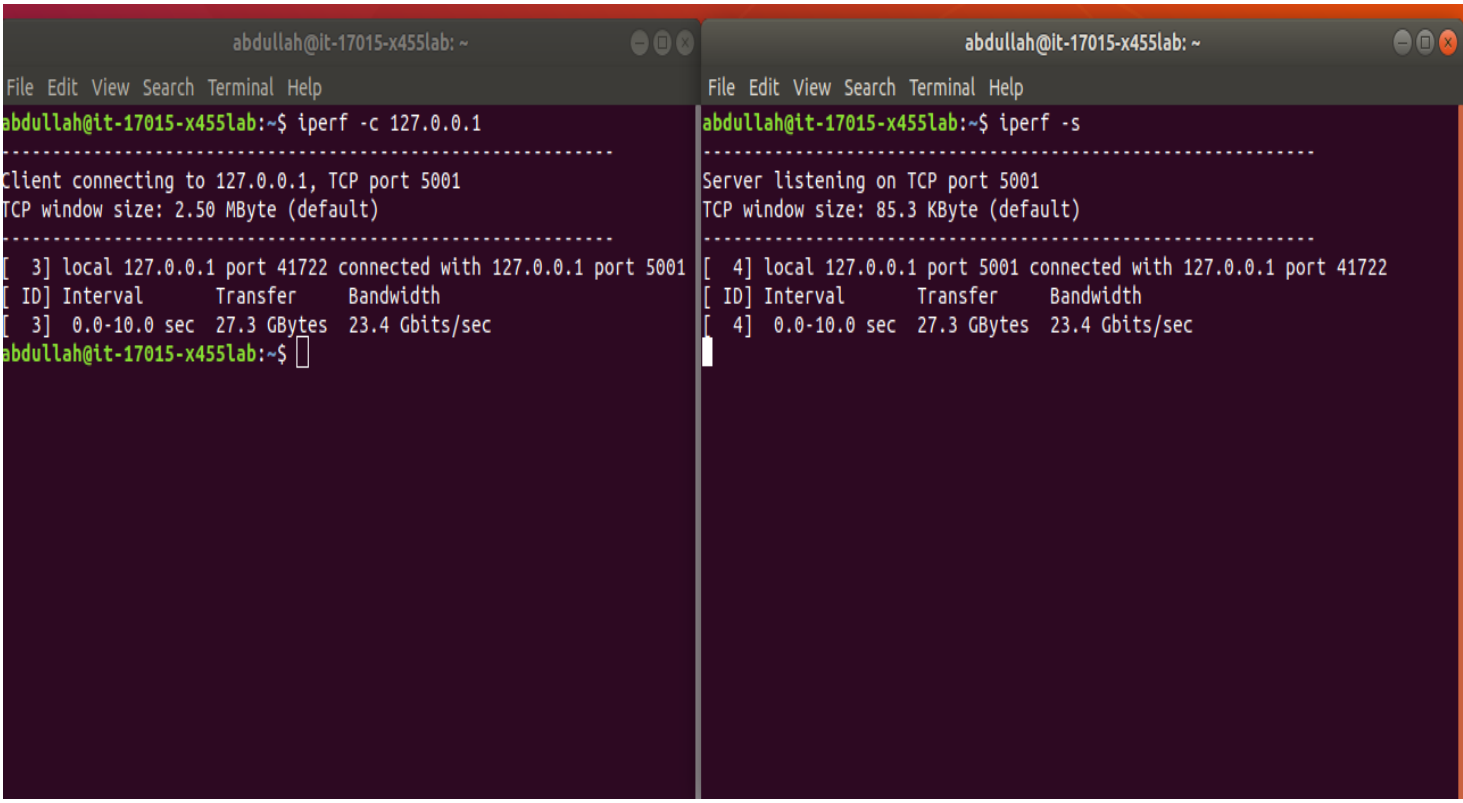
First we need to create a server by the following command:

$ iperf -s

Then we need to create a client by the following command:

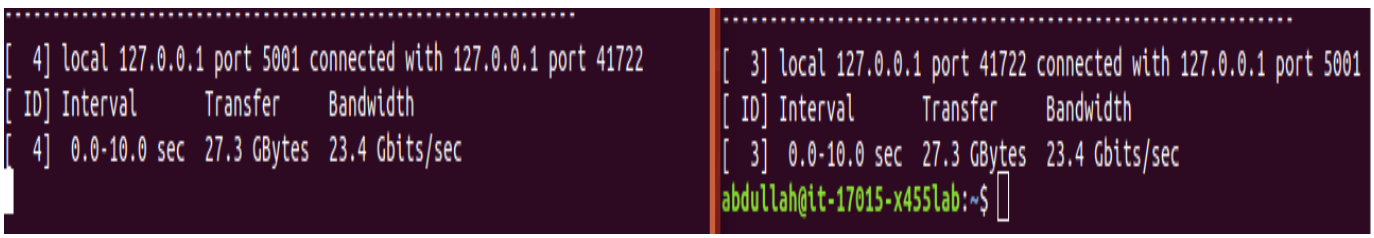
$ iperf -c 127.0.0.1

Here is the output:



The following statistics are provided at the end of the transmission:

The time interval, the amount of data transfer and the bandwidth.



Exercise 4.1.3: Open two Linux terminals, and configure terminal-1 as client and terminal-2 as server for exchanging UDP traffic, which are the command lines?

Ans:
First we need to create a server by the following command:

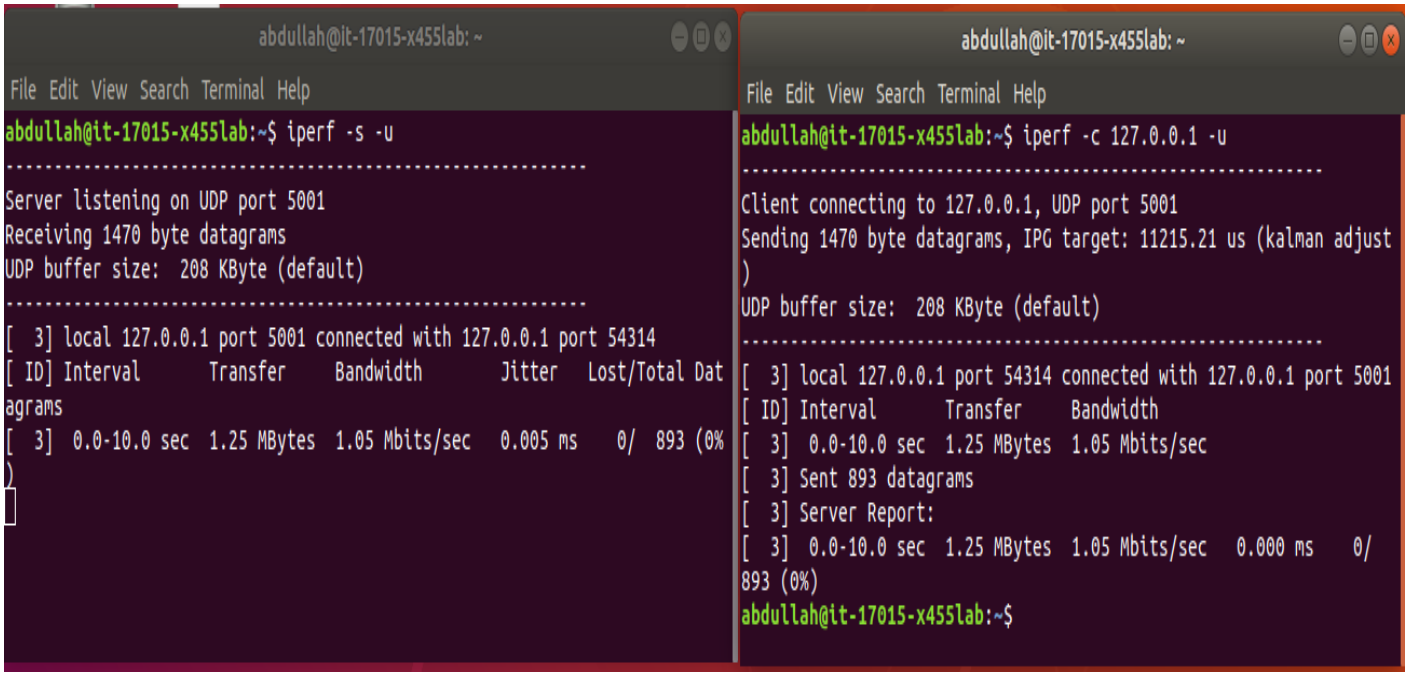
$ iperf -s -u

Here **u** for UDP trafic

Then we need to create a client by the following command:

$ iperf -c 127.0.0.1 -u

Here is the output of server and client:



Which are the statistics are provided at the end of transmission?

Ans: The time interval, the amount of data transfer, the bandwidth, the jitter and the datagram loss percentage.

```
[  3] local 127.0.0.1 port 5001 connected with 127.0.0.1 port 54314
[ ID] Interval       Transfer     Bandwidth        Jitter   Lost/Total Datagrams
[  3]  0.0-10.0 sec  1.25 MBytes  1.05 Mbits/sec   0.005 ms    0/  893 (0%)
```

What is different from the statistics provided in exercise 4.1.1.?
Ans:
The jitter and the datagram loss percentage, because TCP guaranties 0% packet loss.

Exercise 4.1.4: Open two Linux terminals, and configure terminal-1 as client and terminal-2 as server for exchanging UDP traffic, with:

- ✔ Packet length = 1000bytes
- ✔ Time = 20 seconds
- ✔ Bandwidth = 1Mbps
- ✔ Port = 9900

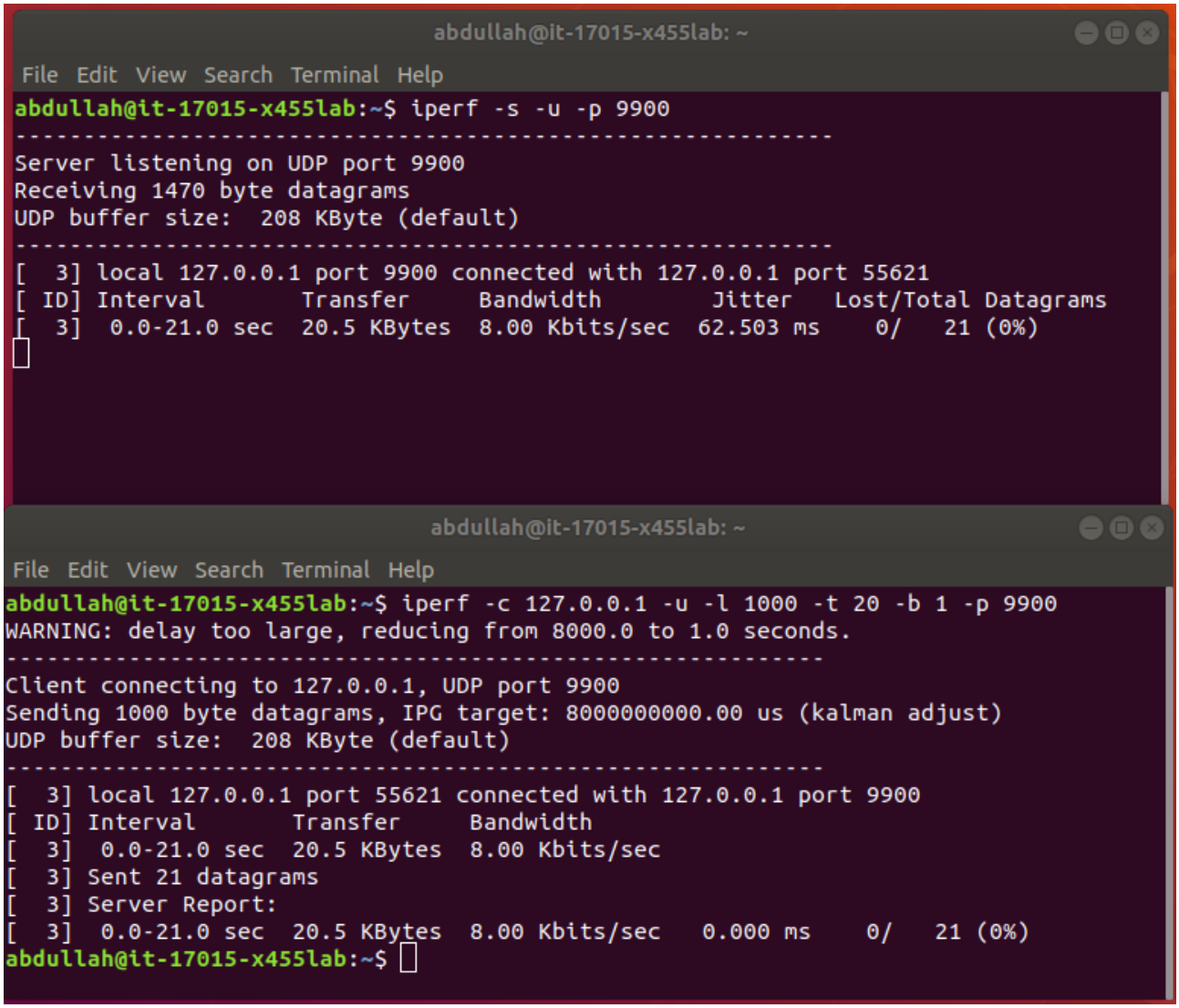
  Which are the command lines?

Ans:

The client command is:
iperf -c 127.0.0.1 -u -l 1000 -t 20 -b 1 -p 9900

The server command is:
iperf -s -u -p 9900

Output:



Sections 4.2: Using Mininet

Exercise 4.2.1: Open two Linux terminals, and execute the command line ifconfig in terminal-1. How many interfaces are present?

Ans:

```
File  Edit  View  Search  Terminal  Help
abdullah@it-17015-x455lab:~$ ifconfig
enp2s0: flags=4099<UP,BROADCAST,MULTICAST>  mtu 1500
        ether 38:d5:47:90:e1:e2  txqueuelen 1000  (Ethernet)
        RX packets 0  bytes 0 (0.0 B)
        RX errors 0  dropped 0  overruns 0  frame 0
        TX packets 0  bytes 0 (0.0 B)
        TX errors 0  dropped 0 overruns 0  carrier 0  collisions 0

lo: flags=73<UP,LOOPBACK,RUNNING>  mtu 65536
        inet 127.0.0.1  netmask 255.0.0.0
        inet6 ::1  prefixlen 128  scopeid 0x10<host>
        loop  txqueuelen 1000  (Local Loopback)
        RX packets 1037247  bytes 29322277112 (29.3 GB)
        RX errors 0  dropped 0  overruns 0  frame 0
        TX packets 1037247  bytes 29322277112 (29.3 GB)
        TX errors 0  dropped 0 overruns 0  carrier 0  collisions 0

wlp3s0: flags=4163<UP,BROADCAST,RUNNING,MULTICAST>  mtu 1500
        inet 192.168.43.29  netmask 255.255.255.0  broadcast 192.168.43.255
        inet6 fe80::fdb9:febb:db0f:44bd  prefixlen 64  scopeid 0x20<link>
        ether 74:c6:3b:d7:57:7d  txqueuelen 1000  (Ethernet)
        RX packets 93818  bytes 116676394 (116.6 MB)
        RX errors 0  dropped 0  overruns 0  frame 0
        TX packets 92333  bytes 11917582 (11.9 MB)
        TX errors 0  dropped 0 overruns 0  carrier 0  collisions 0

abdullah@it-17015-x455lab:~$
```

In terminal-2, execute the command line sudo mn, which is the output?

```
abdullah@it-17015-x455lab: ~
File  Edit  View  Search  Terminal  Help
abdullah@it-17015-x455lab:~$ sudo mn
[sudo] password for abdullah:
*** No default OpenFlow controller found for default switch!
*** Falling back to OVS Bridge
*** Creating network
*** Adding controller
*** Adding hosts:
h1 h2
*** Adding switches:
s1
*** Adding links:
(h1, s1) (h2, s1)
*** Configuring hosts
h1 h2
*** Starting controller

*** Starting 1 switches
s1 ...
*** Starting CLI:
mininet>
```

In terminal-1 execute the command line ifconfig. How many real and virtual interfaces are present now?

Ans:

```
abdullah@it-17015-x455lab:~$ ifconfig
enp2s0: flags=4099<UP,BROADCAST,MULTICAST>  mtu 1500
        ether 38:d5:47:90:e1:e2  txqueuelen 1000  (Ethernet)
        RX packets 0  bytes 0 (0.0 B)
        RX errors 0  dropped 0  overruns 0  frame 0
        TX packets 0  bytes 0 (0.0 B)
        TX errors 0  dropped 0 overruns 0  carrier 0  collisions 0

lo: flags=73<UP,LOOPBACK,RUNNING>  mtu 65536
        inet 127.0.0.1  netmask 255.0.0.0
        inet6 ::1  prefixlen 128  scopeid 0x10<host>
        loop  txqueuelen 1000  (Local Loopback)
        RX packets 1037369  bytes 29322287574 (29.3 GB)
        RX errors 0  dropped 0  overruns 0  frame 0
        TX packets 1037369  bytes 29322287574 (29.3 GB)
        TX errors 0  dropped 0 overruns 0  carrier 0  collisions 0

s1-eth1: flags=4163<UP,BROADCAST,RUNNING,MULTICAST>  mtu 1500
        inet6 fe80::c6e:2dff:fe9d:4028  prefixlen 64  scopeid 0x20<link>
        ether 0e:6e:2d:9d:40:28  txqueuelen 1000  (Ethernet)
        RX packets 7  bytes 586 (586.0 B)
        RX errors 0  dropped 0  overruns 0  frame 0
        TX packets 28  bytes 3620 (3.6 KB)
        TX errors 0  dropped 0 overruns 0  carrier 0  collisions 0

s1-eth2: flags=4163<UP,BROADCAST,RUNNING,MULTICAST>  mtu 1500
        inet6 fe80::dc37:aeff:fe0a:337b  prefixlen 64  scopeid 0x20<link>
        ether de:37:ae:0a:33:7b  txqueuelen 1000  (Ethernet)
        RX packets 8  bytes 656 (656.0 B)
        RX errors 0  dropped 0  overruns 0  frame 0
        TX packets 25  bytes 3390 (3.3 KB)
        TX errors 0  dropped 0 overruns 0  carrier 0  collisions 0

wlp3s0: flags=4163<UP,BROADCAST,RUNNING,MULTICAST>  mtu 1500
        inet 192.168.43.29  netmask 255.255.255.0  broadcast 192.168.43.255
```

Exercise 4.2.2: Interacting with mininet; in terminal-2, display the following command lines and explain what it does:

mininet> help
Ans:
Help for using mininet

```
mininet> help

Documented commands (type help <topic>):
========================================
EOF    gterm  iperfudp  nodes        pingpair      py      switch
dpctl  help   link      noecho       pingpairfull  quit    time
dump   intfs  links     pingall      ports         sh      x
exit   iperf  net       pingallfull  px            source  xterm

You may also send a command to a node using:
  <node> command {args}
For example:
  mininet> h1 ifconfig

The interpreter automatically substitutes IP addresses
for node names when a node is the first arg, so commands
like
  mininet> h2 ping h3
should work.

Some character-oriented interactive commands require
noecho:
  mininet> noecho h2 vi foo.py
However, starting up an xterm/gterm is generally better:
  mininet> xterm h2

mininet>
```

mininet> nodes
Ans:
Description of the nodes

```
mininet> nodes
available nodes are:
h1 h2 s1
mininet>
```

mininet> net
Ans:
Description of the network

```
mininet> net
h1 h1-eth0:s1-eth1
h2 h2-eth0:s1-eth2
s1 lo:  s1-eth1:h1-eth0 s1-eth2:h2-eth0
mininet>
```

mininet> dump
Ans:
Details of the network nodes IP address.

```
mininet> dump
<Host h1: h1-eth0:10.0.0.1 pid=13374>
<Host h2: h2-eth0:10.0.0.2 pid=13376>
<OVSBridge s1: lo:127.0.0.1,s1-eth1:None,s1-eth2:None pid=13381>
mininet>
```

mininet> h1 ifconfig –a
Ans:
Configuration of host 1

```
mininet> h1 ifconfig -a
h1-eth0: flags=4163<UP,BROADCAST,RUNNING,MULTICAST>  mtu 1500
        inet 10.0.0.1  netmask 255.0.0.0  broadcast 10.255.255.255
        inet6 fe80::305d:3fff:fe75:9f69  prefixlen 64  scopeid 0x20<link>
        ether 32:5d:3f:75:9f:69  txqueuelen 1000  (Ethernet)
        RX packets 44  bytes 5538 (5.5 KB)
        RX errors 0  dropped 0  overruns 0  frame 0
        TX packets 12  bytes 936 (936.0 B)
        TX errors 0  dropped 0 overruns 0  carrier 0  collisions 0

lo: flags=73<UP,LOOPBACK,RUNNING>  mtu 65536
        inet 127.0.0.1  netmask 255.0.0.0
        inet6 ::1  prefixlen 128  scopeid 0x10<host>
        loop  txqueuelen 1000  (Local Loopback)
        RX packets 0  bytes 0 (0.0 B)
        RX errors 0  dropped 0  overruns 0  frame 0
        TX packets 0  bytes 0 (0.0 B)
        TX errors 0  dropped 0 overruns 0  carrier 0  collisions 0

mininet>
```

mininet> s1 ifconfig –a

```
mininet> s1 ifconfig -a
enp2s0: flags=4099<UP,BROADCAST,MULTICAST>  mtu 1500
        ether 38:d5:47:90:e1:e2  txqueuelen 1000  (Ethernet)
        RX packets 0  bytes 0 (0.0 B)
        RX errors 0  dropped 0  overruns 0  frame 0
        TX packets 0  bytes 0 (0.0 B)
        TX errors 0  dropped 0 overruns 0  carrier 0  collisions 0

lo: flags=73<UP,LOOPBACK,RUNNING>  mtu 65536
        inet 127.0.0.1  netmask 255.0.0.0
        inet6 ::1  prefixlen 128  scopeid 0x10<host>
        loop  txqueuelen 1000  (Local Loopback)
        RX packets 1037373  bytes 29322287950 (29.3 GB)
        RX errors 0  dropped 0  overruns 0  frame 0
        TX packets 1037373  bytes 29322287950 (29.3 GB)
        TX errors 0  dropped 0 overruns 0  carrier 0  collisions 0

ovs-system: flags=4098<BROADCAST,MULTICAST>  mtu 1500
        ether 1e:e9:38:49:d8:77  txqueuelen 1000  (Ethernet)
        RX packets 0  bytes 0 (0.0 B)
        RX errors 0  dropped 0  overruns 0  frame 0
        TX packets 0  bytes 0 (0.0 B)
        TX errors 0  dropped 0 overruns 0  carrier 0  collisions 0

s1: flags=4098<BROADCAST,MULTICAST>  mtu 1500
        ether 32:97:00:da:37:41  txqueuelen 1000  (Ethernet)
        RX packets 0  bytes 0 (0.0 B)
        RX errors 0  dropped 45  overruns 0  frame 0
        TX packets 0  bytes 0 (0.0 B)
        TX errors 0  dropped 0 overruns 0  carrier 0  collisions 0

s1-eth1: flags=4163<UP,BROADCAST,RUNNING,MULTICAST>  mtu 1500
        inet6 fe80::c6e:2dff:fe9d:4028  prefixlen 64  scopeid 0x20<link>
        ether 0e:6e:2d:9d:40:28  txqueuelen 1000  (Ethernet)
        RX packets 13  bytes 1006 (1.0 KB)
        RX errors 0  dropped 0  overruns 0  frame 0
        TX packets 44  bytes 5538 (5.5 KB)
```

mininet> h1 ping -c 5 h2
Ans:
ping between h1 and h2

```
mininet> h1 ping -c 5 h2
PING 10.0.0.2 (10.0.0.2) 56(84) bytes of data.
64 bytes from 10.0.0.2: icmp_seq=1 ttl=64 time=0.532 ms
64 bytes from 10.0.0.2: icmp_seq=2 ttl=64 time=0.076 ms
64 bytes from 10.0.0.2: icmp_seq=3 ttl=64 time=0.075 ms
64 bytes from 10.0.0.2: icmp_seq=4 ttl=64 time=0.071 ms
64 bytes from 10.0.0.2: icmp_seq=5 ttl=64 time=0.074 ms

--- 10.0.0.2 ping statistics ---
5 packets transmitted, 5 received, 0% packet loss, time 4098ms
rtt min/avg/max/mdev = 0.071/0.165/0.532/0.183 ms
mininet>
```

Exercise 4.2.3: In terminal-2, display the following command line: sudo mn --link tc,bw=10,delay=500ms

Ans:

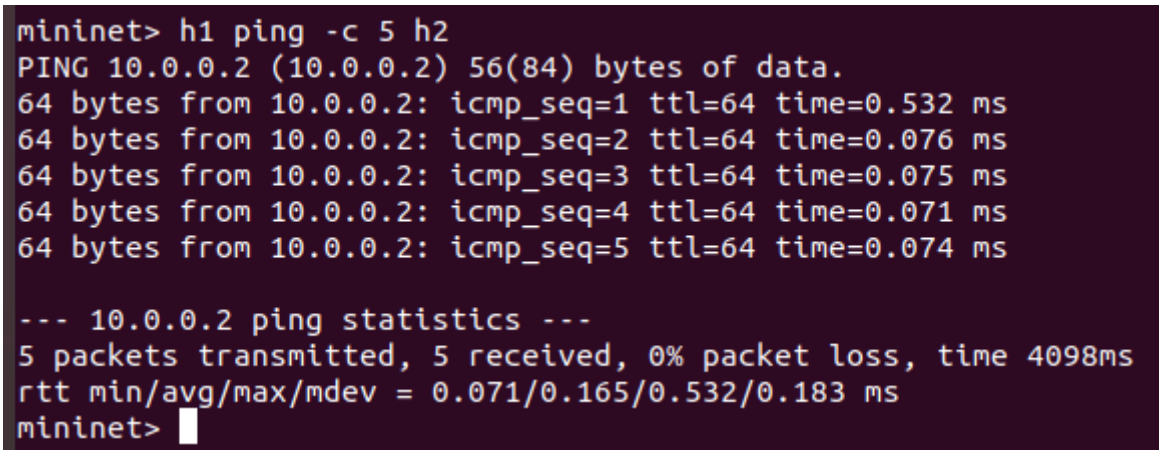
```
ovs-vsctl: missing command name (use --help for help)
abdullah@it-17015-x455lab:~$ sudo mn --link tc,bw=10,delay=500ms
*** No default OpenFlow controller found for default switch!
*** Falling back to OVS Bridge
*** Creating network
*** Adding controller
*** Adding hosts:
h1 h2
*** Adding switches:
s1
*** Adding links:
------------------------------------------------------------------------
Caught exception. Cleaning up...

Exception: Error creating interface pair (h1-eth0,s1-eth1): RTNETLINK answers: File exists

------------------------------------------------------------------------
*** Removing excess controllers/ofprotocols/ofdatapaths/pings/noxes
killall controller ofprotocol ofdatapath ping nox_core lt-nox_core ovs-openflowd ovs-controller udpbwtest mnexec ivs 2> /dev/null
killall -9 controller ofprotocol ofdatapath ping nox_core lt-nox_core ovs-openflowd ovs-controller udpbwtest mnexec ivs 2> /dev/null
pkill -9 -f "sudo mnexec"
*** Removing junk from /tmp
rm -f /tmp/vconn* /tmp/vlogs* /tmp/*.out /tmp/*.log
*** Removing old X11 tunnels
*** Removing excess kernel datapaths
ps ax | egrep -o 'dp[0-9]+' | sed 's/dp/nl:/'
***  Removing OVS datapaths
ovs-vsctl --timeout=1 list-br
ovs-vsctl --if-exists del-br s1
ovs-vsctl --timeout=1 list-br
*** Removing all links of the pattern foo-ethX
ip link show | egrep -o '([-_.[:alnum:]]+-eth[[:digit:]]+)'
( ip link del s1-eth1;ip link del s1-eth2 ) 2> /dev/null
ip link show
*** Killing stale mininet node processes
pkill -9 -f mininet:
*** Shutting down stale tunnels
pkill -9 -f Tunnel=Ethernet
```

mininet> h1 ping -c 5 h2, What happen with the link?

Ans:



Discussion:

I can successfully understand the all the things and can be able to execute with my ubuntu terminal. This lab helps me to understand the basic mininet, how mininet works, advanced mininet and SDN controllers.