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Lab Report

Department of Information and Communication Technology

Report No: 04

Report Name: SDN Controllers and Mininet.

Course Title: Network Planning and designing Lab.

Course Code: ICT-3208

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Objectives : The main objectives of the lab how to install and use traffic generators as powerful tools for testing network performance , Install and configure SDN Controller , Install and understand how the mininet simulator works , Implement and run basic examples for understanding the role of the controller and how it interact with mininet.

Theory :

Traffic Generator:

iPerf : iPerf is a tool for active measurements of the maximum achievable bandwidth on IP networks. It supports tuning of various parameters related to timing, buffers and protocols.

Software Defined Networking: Software Defined Networking that by separating control of network functions from hardware devices, administrators acquire more power to route and direct traffic in response to changing requirements.

Controller: Controller is suitable for initial testing of OpenFlow networks. OVS-testcontroller is a simple OpenFlow controller that manages any number of switches over the OpenFlow protocol, causing them to function as L2 MAC-learning switches or hubs.

Mininet : Mininet creates a realistic virtual network, running real kernel, switch and application code, on a single machine .

Methodology :

Install iperf :

```
File  Edit  View  Search  Terminal  Help
zafrul_hasan_nasim@zafrul-hasan-nasim-VirtualBox:~$ sudo apt-get install iperf
[sudo] password for zafrul_hasan_nasim:
Reading package lists... Done
Building dependency tree
Reading state information... Done
iperf is already the newest version (2.0.10+dfsg1-1ubuntu0.18.04.2).
iperf set to manually installed.
The following packages were automatically installed and are no longer required:
  efibootmgr gir1.2-geocodeglib-1.0 libegl1-mesa libfwup1 libllvm8
  libwayland-egl1-mesa ubuntu-web-launchers
Use 'sudo apt autoremove' to remove them.
0 upgraded, 0 newly installed, 0 to remove and 134 not upgraded.
```

Install Mininet:

```
zafrul_hasan_nasim@zafrul-hasan-nasim-VirtualBox:~$ sudo apt-get install minine
t
Reading package lists... Done
Building dependency tree
Reading state information... Done
mininet is already the newest version (2.2.2-2ubuntu1).
The following packages were automatically installed and are no longer required:
  efibootmgr gir1.2-geocodeglib-1.0 libegl1-mesa libfwup1 libllvm8
  libwayland-egl1-mesa ubuntu-web-launchers
Use 'sudo apt autoremove' to remove them.
0 upgraded, 0 newly installed, 0 to remove and 134 not upgraded.
```

Exercises:

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

```
zafrul_hasan_nasim@zafrul-hasan-nasim-VirtualBox:~$ iperf --help
Usage: iperf [-s|-c host] [options]
       iperf [-h|--help] [-v|--version]

Client/Server:
  -b, --bandwidth #[kmgKMG | pps]  bandwidth to send at in bits/sec or packets
per second
  -e, --enhancedreports    use enhanced reporting giving more tcp/udp and traff
ic information
  -f, --format    [kmgKMG]   format to report: Kbits, Mbits, KBytes, MBytes
  -i, --interval  #        seconds between periodic bandwidth reports
  -l, --len       #[kmKM]    length of buffer in bytes to read or write (Defaul
ts: TCP=128K, v4 UDP=1470, v6 UDP=1450)
  -m, --print_mss          print TCP maximum segment size (MTU - TCP/IP header)
  -o, --output    <filename> output the report or error message to this specifi
ed file
  -p, --port      #        server port to listen on/connect to
  -u, --udp                use UDP rather than TCP
      --udp-counters-64bit use 64 bit sequence numbers with UDP
  -w, --window    #[KM]    TCP window size (socket buffer size)
  -z, --realtime           request realtime scheduler
  -B, --bind      <host>   bind to <host>, an interface or multicast address
  -C, --compatibility      for use with older versions does not sent extra msgs
  -M, --mss       #        set TCP maximum segment size (MTU - 40 bytes)
  -N, --nodelay            set TCP no delay, disabling Nagle's Algorithm
  -S, --tos       #        set the socket's IP_TOS (byte) field

Server specific:
```

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).

Terminal -1 :

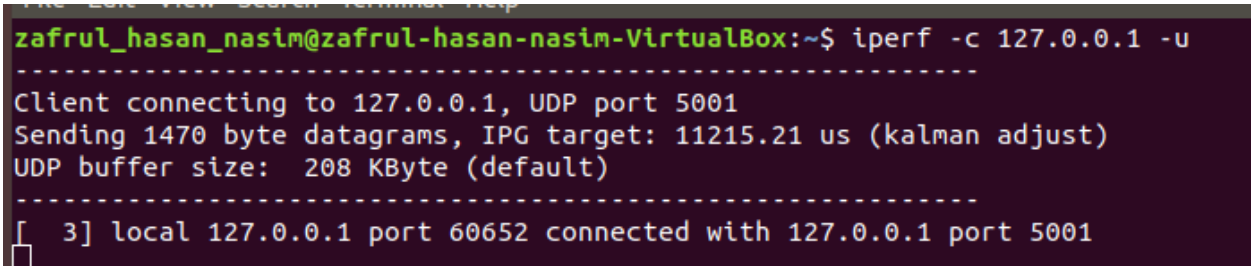
```
zafrul_hasan_nasim@zafrul-hasan-nasim-VirtualBox:~$ iperf -s
------------------------------------------------------------
Server listening on TCP port 5001
TCP window size:  128 KByte (default)
------------------------------------------------------------
```

Terminal -2:

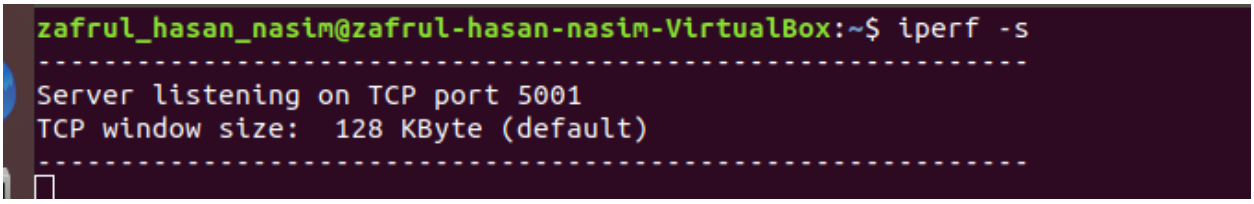
```
zafrul_hasan_nasim@zafrul-hasan-nasim-VirtualBox:~$ iperf -c 127.0.0.1 -u
------------------------------------------------------------
Client connecting to 127.0.0.1, UDP port 5001
Sending 1470 byte datagrams, IPG target: 11215.21 us (kalman adjust)
UDP buffer size:  208 KByte (default)
------------------------------------------------------------
[  3] local 127.0.0.1 port 60652 connected with 127.0.0.1 port 5001
```

Exercise 4.1.3: Open two Linux terminals, and configure terminal-1 as client and terminal-2 as server for exchanging UDP traffic.

Terminal -1 as client :



Terminal-2 as server :



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

The Command lines are :

Terminal-1 :

```
zafrul_hasan_nasim@zafrul-hasan-nasim-VirtualBox:~$ iperf -c 127.0.0.1 -u -l 10
0 -t 20 -b 1 -p 9900
------------------------------------------------------------
Client connecting to 127.0.0.1, UDP port 9900
Sending 100 byte datagrams, IPG target: 800000000.00 us (kalman adjust)
UDP buffer size:  208 KByte (default)
------------------------------------------------------------
WARNING: delay too large, reducing from 800.0 to 1.0 seconds.
[  3] local 127.0.0.1 port 42068 connected with 127.0.0.1 port 9900
[ ID] Interval       Transfer     Bandwidth
[  3]  0.0-20.0 sec   100 Bytes  40.0 bits/sec
[  3] Sent 1 datagrams
read failed: Connection refused
[  3] WARNING: did not receive ack of last datagram after 2 tries.
```

Terminal-2 :

```
File  Edit  View  Search  Terminal  Help
zafrul_hasan_nasim@zafrul-hasan-nasim-VirtualBox:~$ iperf -s -u -p 9900
------------------------------------------------------------
Server listening on UDP port 9900
Receiving 1470 byte datagrams
UDP buffer size:  208 KByte (default)
------------------------------------------------------------
```

Using Mininet:

Exercise 4.2.1: Open two Linux terminals, and execute the command line ifconfig in terminal-1.

Interfaces are :

```
zafrul_hasan_nasim@zafrul-hasan-nasim-VirtualBox:~$ ifconfig
enp0s3: flags=4163<UP,BROADCAST,RUNNING,MULTICAST>  mtu 1500
        inet 10.0.2.15  netmask 255.255.255.0  broadcast 10.0.2.255
        inet6 fe80::153b:cca1:e7bc:dd1c  prefixlen 64  scopeid 0x20<link>
        ether 08:00:27:44:19:2e  txqueuelen 1000  (Ethernet)
        RX packets 26  bytes 3918 (3.9 KB)
        RX errors 0  dropped 0  overruns 0  frame 0
        TX packets 166  bytes 16811 (16.8 KB)
        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 2814  bytes 1929590 (1.9 MB)
        RX errors 0  dropped 0  overruns 0  frame 0
        TX packets 2814  bytes 1929590 (1.9 MB)
        TX errors 0  dropped 0 overruns 0  carrier 0  collisions 0
```

In terminal-2, execute the command line sudo mn:

```
zafrul_hasan_nasim@zafrul-hasan-nasim-VirtualBox:~$ sudo mn
*** 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 , then real and virtual interfaces are :

```
zafrul_hasan_nasim@zafrul-hasan-nasim-VirtualBox:~$ ifconfig
enp0s3: flags=4163<UP,BROADCAST,RUNNING,MULTICAST>  mtu 1500
        inet 10.0.2.15  netmask 255.255.255.0  broadcast 10.0.2.255
        inet6 fe80::153b:cca1:e7bc:dd1c  prefixlen 64  scopeid 0x20<link>
        ether 08:00:27:44:19:2e  txqueuelen 1000  (Ethernet)
        RX packets 26  bytes 3918 (3.9 KB)
        RX errors 0  dropped 0  overruns 0  frame 0
        TX packets 166  bytes 16811 (16.8 KB)
        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 2814  bytes 1929590 (1.9 MB)
        RX errors 0  dropped 0  overruns 0  frame 0
        TX packets 2814  bytes 1929590 (1.9 MB)
        TX errors 0  dropped 0 overruns 0  carrier 0  collisions 0
```

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

 # mininet> help

```
File  Edit  View  Search  Terminal  Help
*** Starting CLI:
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> nodes

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

 # mininet> net

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

 # mininet> dump

```
mininet> dump
<Host h1: h1-eth0:10.0.0.1 pid=1844>
<Host h2: h2-eth0:10.0.0.2 pid=1846>
<OVSBridge s1: lo:127.0.0.1,s1-eth1:None,s1-eth2:None pid=1851>
```

 # mininet> h1 ifconfig –a

```
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::9859:faff:fe6d:116a  prefixlen 64  scopeid 0x20<link>
        ether 9a:59:fa:6d:11:6a  txqueuelen 1000  (Ethernet)
        RX packets 34  bytes 3825 (3.8 KB)
        RX errors 0  dropped 0  overruns 0  frame 0
        TX packets 10  bytes 796 (796.0 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> s1 ifconfig –a

```
mininet> s1 ifconfig -a
enp0s3: flags=4163<UP,BROADCAST,RUNNING,MULTICAST>  mtu 1500
        inet 10.0.2.15  netmask 255.255.255.0  broadcast 10.0.2.255
        inet6 fe80::153b:cca1:e7bc:dd1c  prefixlen 64  scopeid 0x20<link>
        ether 08:00:27:44:19:2e  txqueuelen 1000  (Ethernet)
        RX packets 29  bytes 4098 (4.0 KB)
        RX errors 0  dropped 0  overruns 0  frame 0
        TX packets 199  bytes 19639 (19.6 KB)
        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 2831  bytes 1930995 (1.9 MB)
        RX errors 0  dropped 0  overruns 0  frame 0
        TX packets 2831  bytes 1930995 (1.9 MB)
        TX errors 0  dropped 0 overruns 0  carrier 0  collisions 0

ovs-system: flags=4098<BROADCAST,MULTICAST>  mtu 1500
        ether 72:ed:ca:5b:82:24  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 ea:43:f2:ec:b4:4c  txqueuelen 1000  (Ethernet)
        RX packets 0  bytes 0 (0.0 B)
```

 # mininet> h1 ping -c 5 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=0.456 ms
64 bytes from 10.0.0.2: icmp_seq=2 ttl=64 time=0.104 ms
64 bytes from 10.0.0.2: icmp_seq=3 ttl=64 time=0.105 ms
64 bytes from 10.0.0.2: icmp_seq=4 ttl=64 time=0.180 ms
64 bytes from 10.0.0.2: icmp_seq=5 ttl=64 time=0.161 ms

--- 10.0.0.2 ping statistics ---
5 packets transmitted, 5 received, 0% packet loss, time 4071ms
rtt min/avg/max/mdev = 0.104/0.201/0.456/0.131 ms
```

Exercise 4.2.3: In terminal-2, display the following command line:

 # sudo mn --link tc,bw=10,delay=500ms

```
zafrul_hasan_nasim@zafrul-hasan-nasim-VirtualBox:~$ sudo mn --link tc,bw=10,del
ay=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:
(10.00Mbit 500ms delay) (10.00Mbit 500ms delay) (h1, s1) (10.00Mbit 500ms delay
) (10.00Mbit 500ms delay) (h2, s1)
*** Configuring hosts
h1 h2
*** Starting controller

*** Starting 1 switches
s1 ...(10.00Mbit 500ms delay) (10.00Mbit 500ms delay)
*** Starting CLI:
```

 # mininet> h1 ping -c 5 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=4003 ms
64 bytes from 10.0.0.2: icmp_seq=2 ttl=64 time=2999 ms
64 bytes from 10.0.0.2: icmp_seq=3 ttl=64 time=2001 ms
64 bytes from 10.0.0.2: icmp_seq=4 ttl=64 time=2000 ms
64 bytes from 10.0.0.2: icmp_seq=5 ttl=64 time=2000 ms

--- 10.0.0.2 ping statistics ---
5 packets transmitted, 5 received, 0% packet loss, time 4051ms
rtt min/avg/max/mdev = 2000.415/2601.245/4003.890/800.874 ms, pipe 4
```

Conclusion : From this lab , I have known that how to Install and configure SDN Controller , Install and understand how the mininet simulator works and also install and use traffic generators as powerful tools for testing network performance. I have understood that how to use mininet as teaching, development and research. . I also learnt how to Implement and to run basic examples for understanding the role of the controller and how it interact with mininet.