

EE450

Mininet Lab Report

Yuhang Xiao

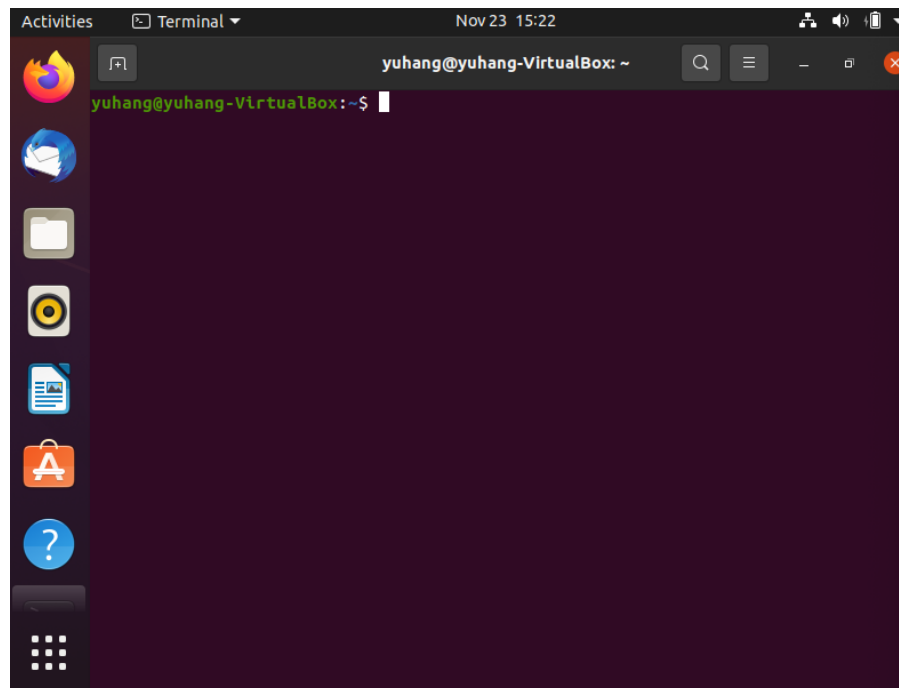
Abstract

This report investigated Mininet and iPerf3, which are virtual tools to design and test networks. The first lab explored the Mininet, which invoked Mininet from the command-line interface (CLI) utility. Then Miniedit, which is a graphical user interface (GUI) of Mininet, is used to construct, emulate and save a network topology. The second lab demonstrated how to use iPerf3 to measure and test network throughput in the designed network topology coming from the first lab. It explored the functionality of different options from the command line utility. Through this report, Mininet and iPerf3 would be known well.

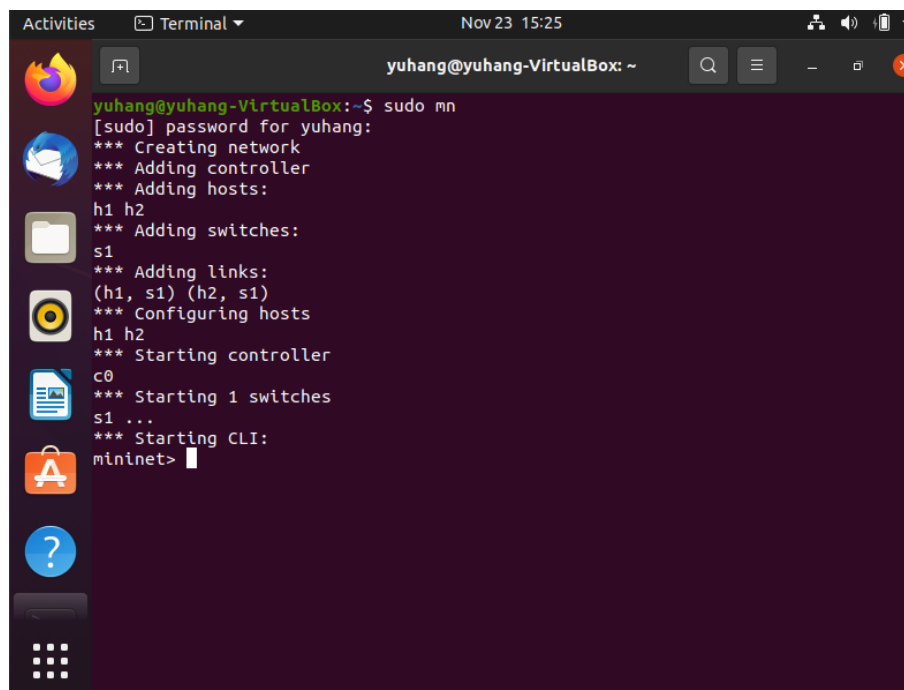
Lab 1

1.
Introduction, no screenshot.

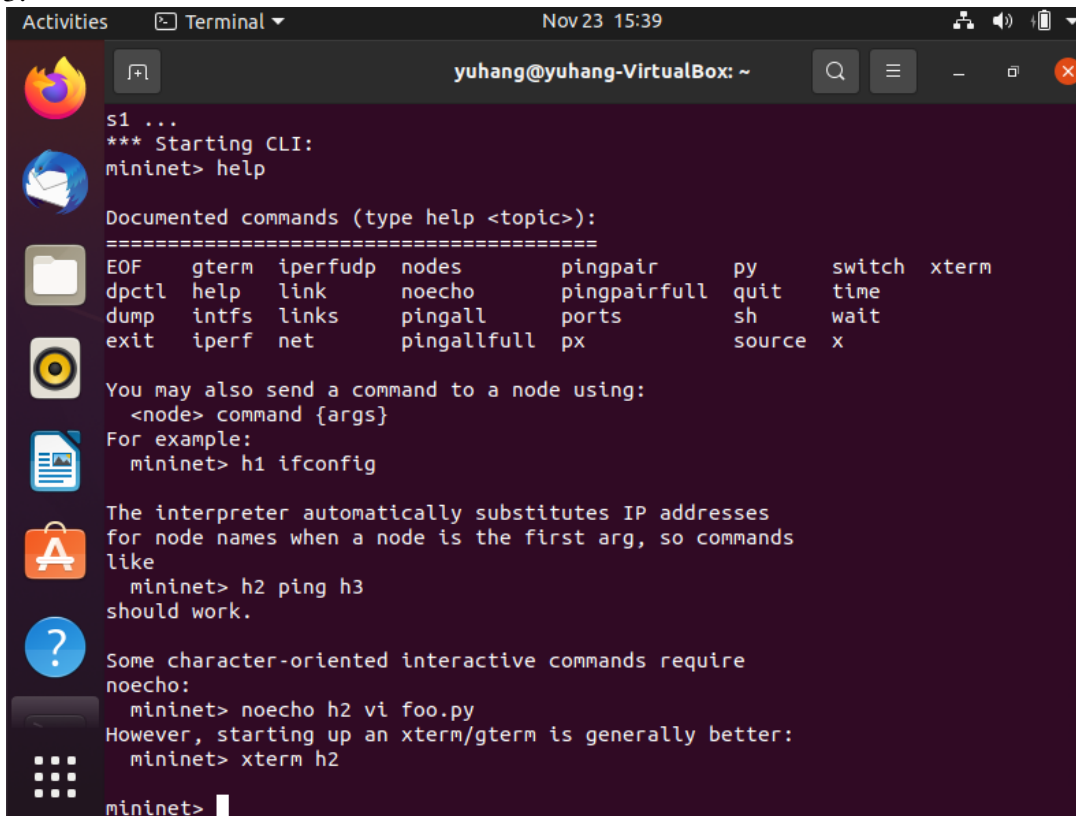
2.
2.1
Step 1.



Step 2.



Step 3.



A terminal window titled 'yuhang@yuhang-VirtualBox: ~' with a date and time of 'Nov 23 15:39'. The window shows the output of the 'mininet> help' command. The output includes a list of documented commands, instructions on how to send commands to nodes, and examples of using 'ifconfig', 'ping', and 'xterm'.

```
s1 ...
*** Starting CLI:
mininet> help

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

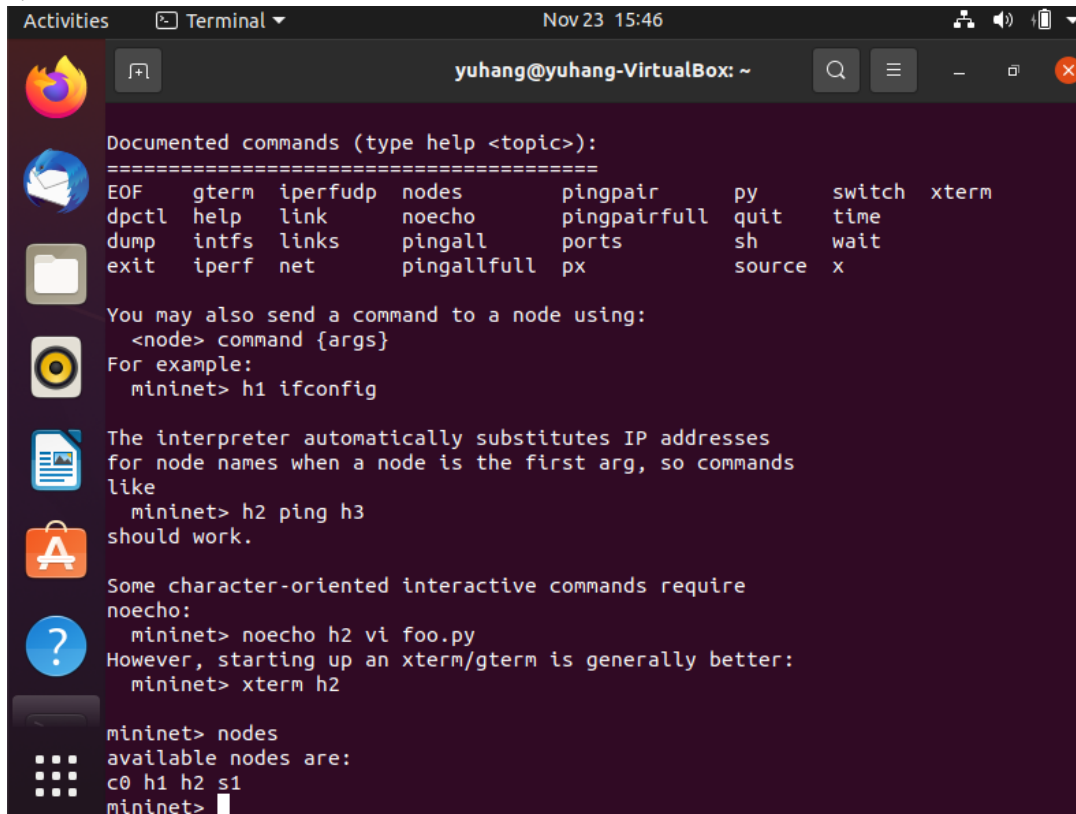
You may also send a command to a node using:
<node> command {args}
For example:
mininet> h1 ifconfig

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>
```

Step 4.



A terminal window titled 'yuhang@yuhang-VirtualBox: ~' with a date and time of 'Nov 23 15:46'. The window shows the output of the 'mininet> nodes' command, which lists the available nodes: c0, h1, h2, and s1.

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

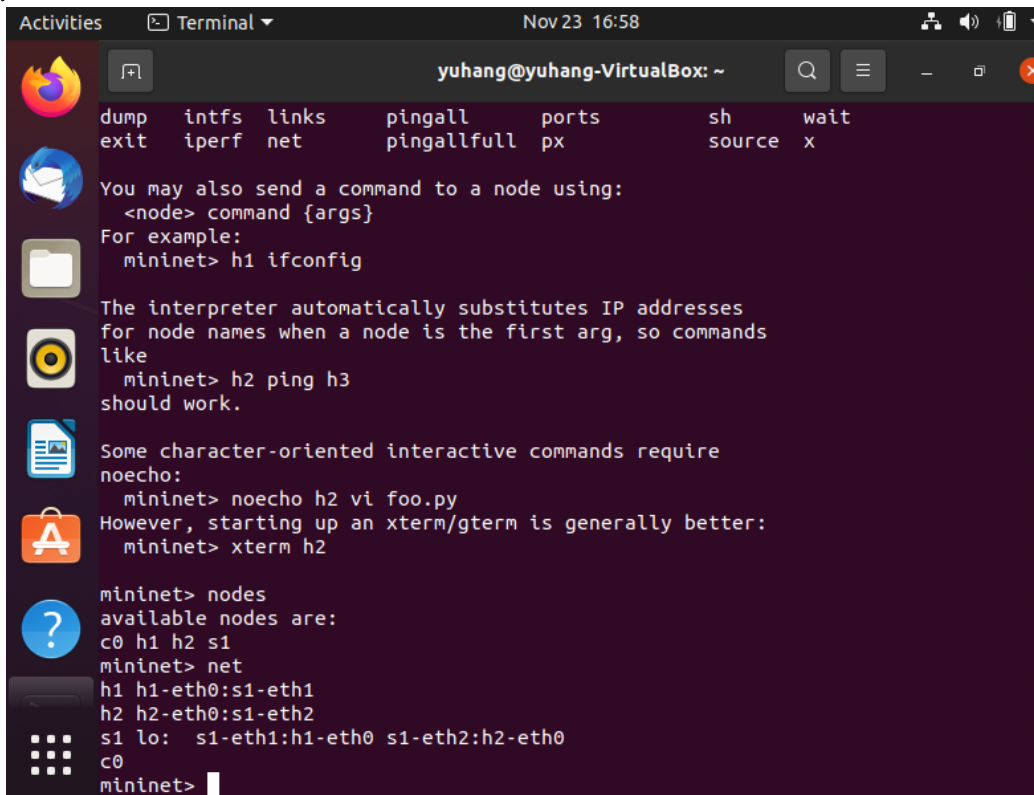
You may also send a command to a node using:
<node> command {args}
For example:
mininet> h1 ifconfig

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
available nodes are:
c0 h1 h2 s1
mininet>
```

Step 5.



Activities Terminal Nov 23 16:58 yuhang@yuhang-VirtualBox: ~

```
dump      intfs  links  pingall  ports  sh      wait
exit      iperf  net    pingallfull  px    source  x

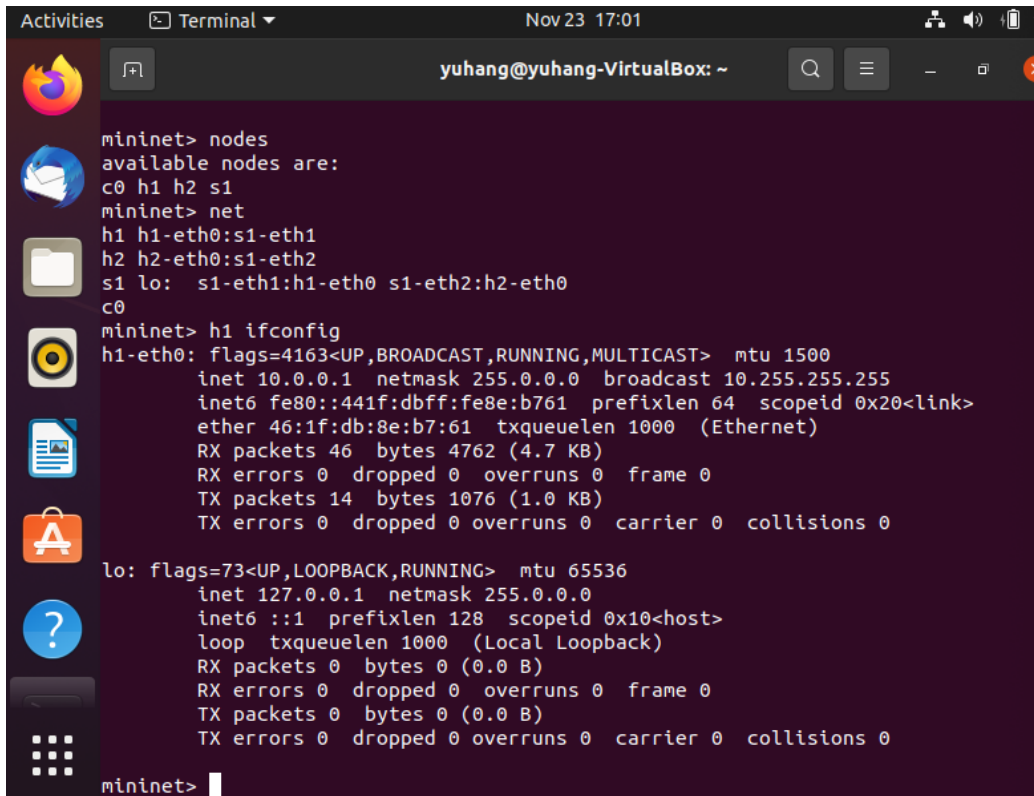
You may also send a command to a node using:
<node> command {args}
For example:
mininet> h1 ifconfig

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
available nodes are:
c0 h1 h2 s1
mininet> net
h1 h1-eth0:s1-eth1
h2 h2-eth0:s1-eth2
s1 lo: s1-eth1:h1-eth0 s1-eth2:h2-eth0
c0
mininet>
```

Step 6.



Activities Terminal Nov 23 17:01 yuhang@yuhang-VirtualBox: ~

```
mininet> nodes
available nodes are:
c0 h1 h2 s1
mininet> net
h1 h1-eth0:s1-eth1
h2 h2-eth0:s1-eth2
s1 lo: s1-eth1:h1-eth0 s1-eth2:h2-eth0
c0
mininet> h1 ifconfig
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::441f:dbff:fe8e:b761 prefixlen 64 scopeid 0x20<link>
ether 46:1f:db:8e:b7:61 txqueuelen 1000 (Ethernet)
RX packets 46 bytes 4762 (4.7 KB)
RX errors 0 dropped 0 overruns 0 frame 0
TX packets 14 bytes 1076 (1.0 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 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>
```

2.2

Step 1.

```
mininet> h1 ping 10.0.0.2
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=35.4 ms
64 bytes from 10.0.0.2: icmp_seq=2 ttl=64 time=0.367 ms
64 bytes from 10.0.0.2: icmp_seq=3 ttl=64 time=0.058 ms
64 bytes from 10.0.0.2: icmp_seq=4 ttl=64 time=0.224 ms
64 bytes from 10.0.0.2: icmp_seq=5 ttl=64 time=0.088 ms
64 bytes from 10.0.0.2: icmp_seq=6 ttl=64 time=0.074 ms
64 bytes from 10.0.0.2: icmp_seq=7 ttl=64 time=0.079 ms
64 bytes from 10.0.0.2: icmp_seq=8 ttl=64 time=0.066 ms
64 bytes from 10.0.0.2: icmp_seq=9 ttl=64 time=0.066 ms
^C
--- 10.0.0.2 ping statistics ---
9 packets transmitted, 9 received, 0% packet loss, time 8165ms
rtt min/avg/max/mdev = 0.058/4.041/35.352/11.070 ms
mininet>
```

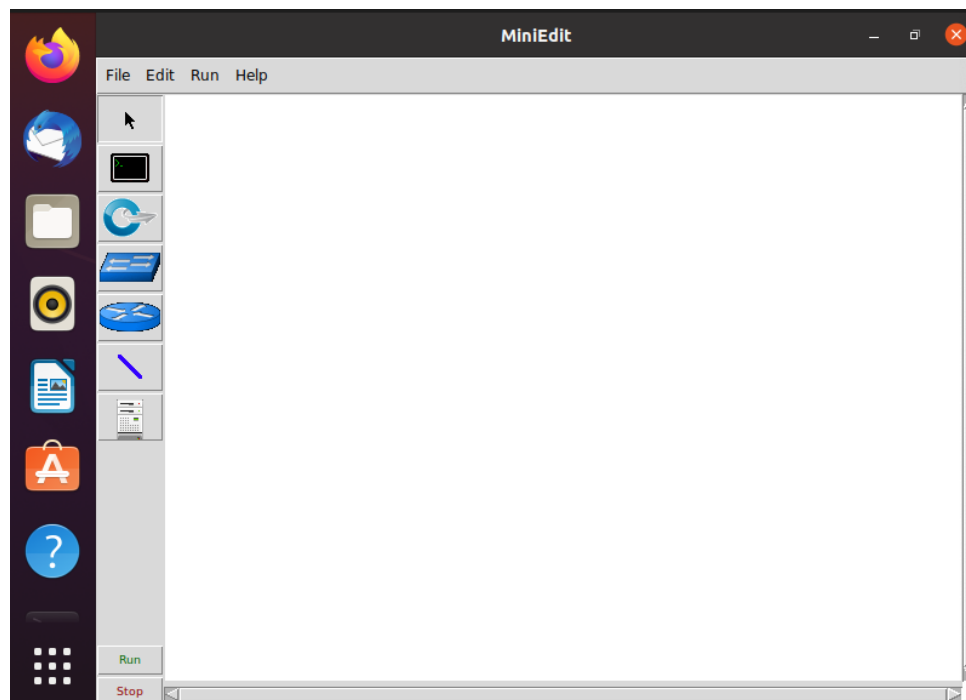
Step 2.

```
mininet> exit
*** Stopping 1 controllers
c0
*** Stopping 2 links
..
*** Stopping 1 switches
s1
*** Stopping 2 hosts
h1 h2
*** Done
completed in 6092.712 seconds
yuhang@yuhang-VirtualBox:~$
```

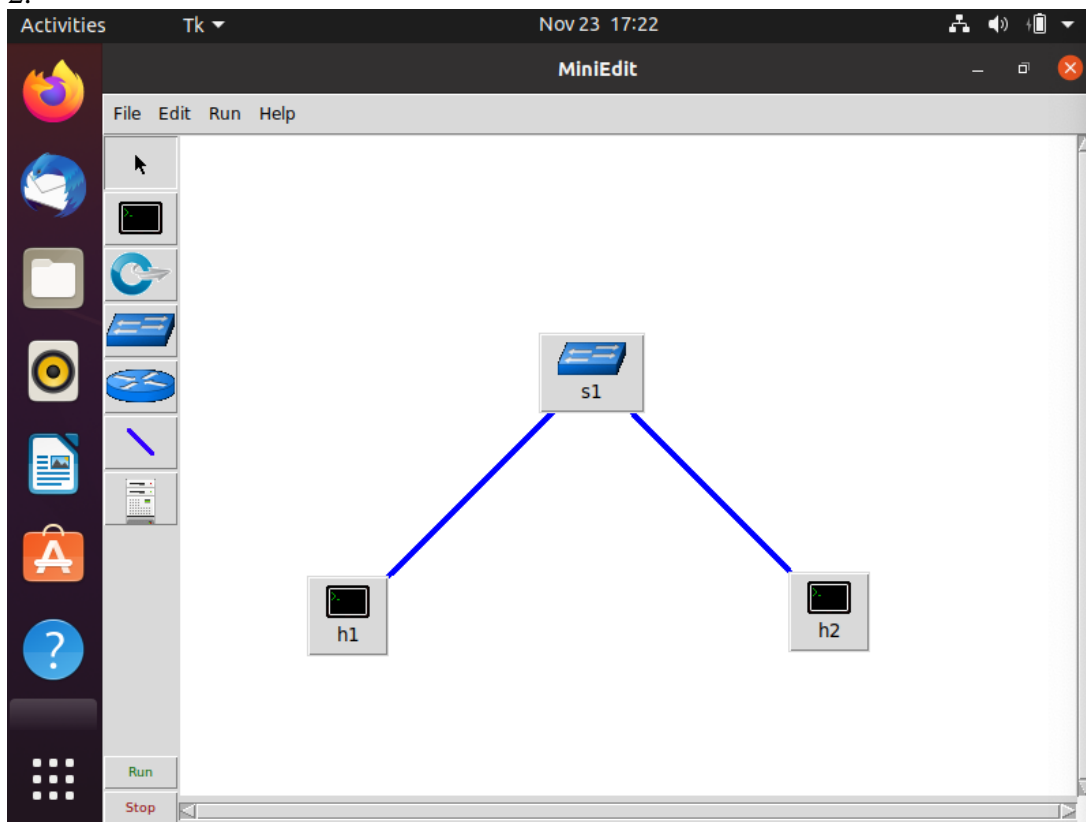
3.

3.1

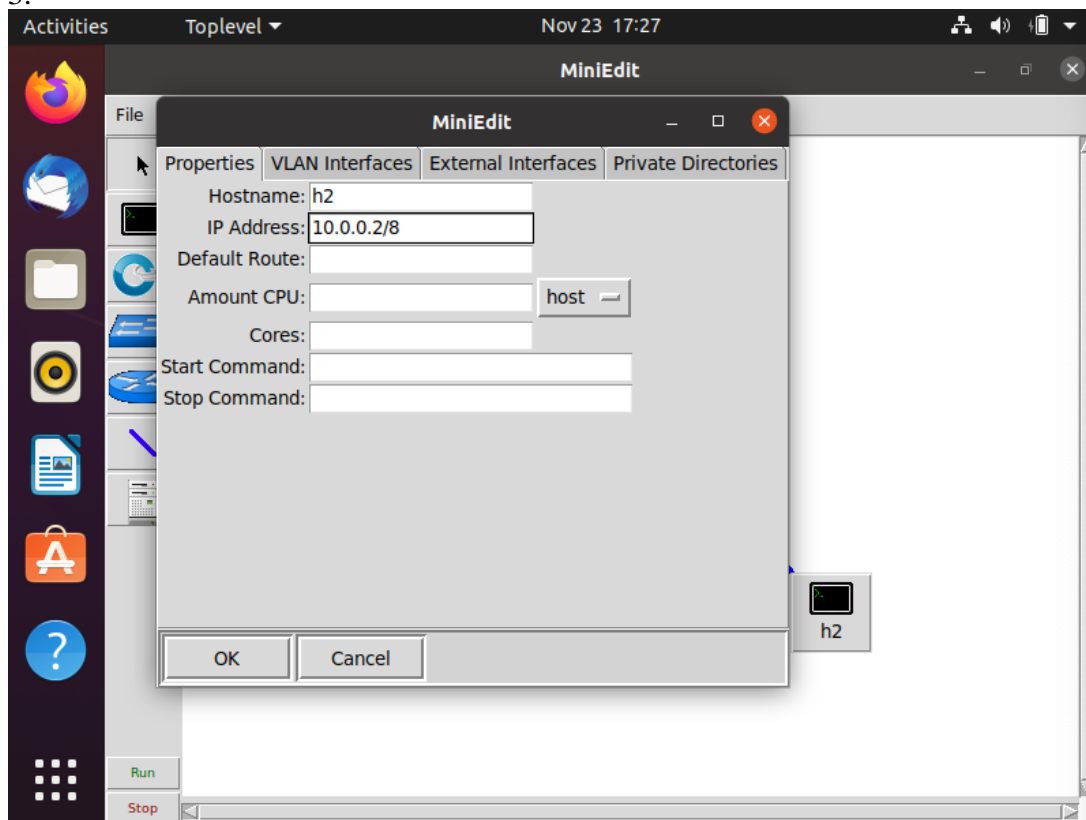
Step 1.



Step 2.

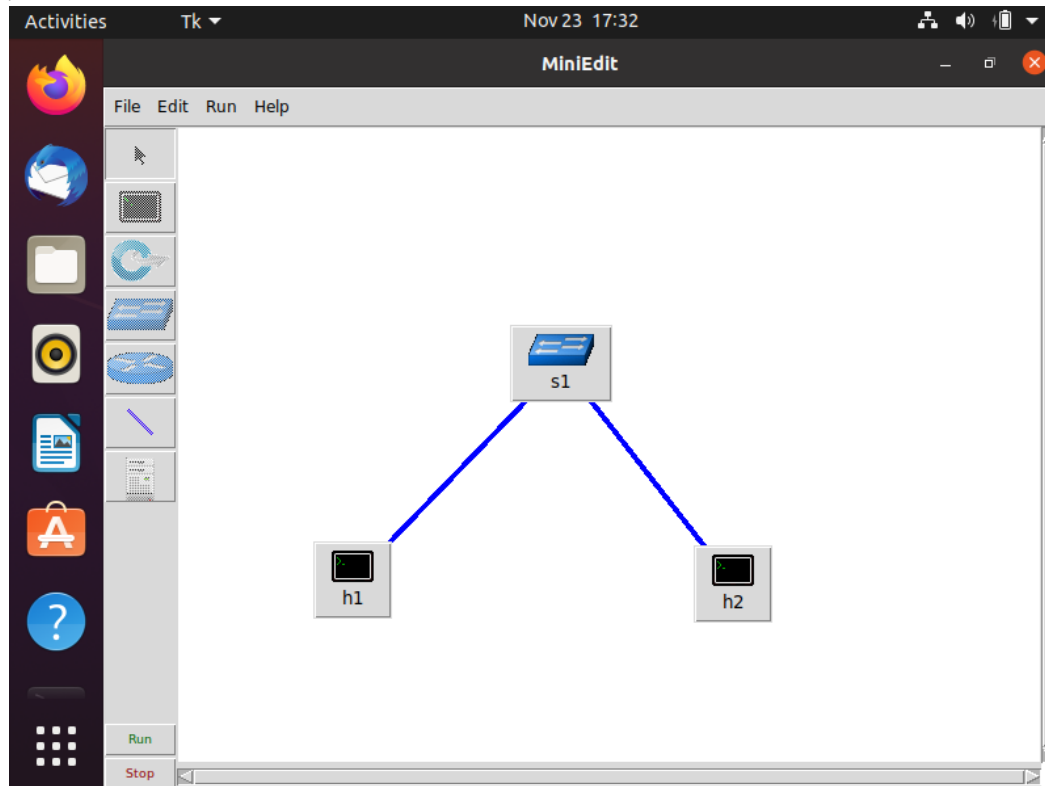


Step 3.

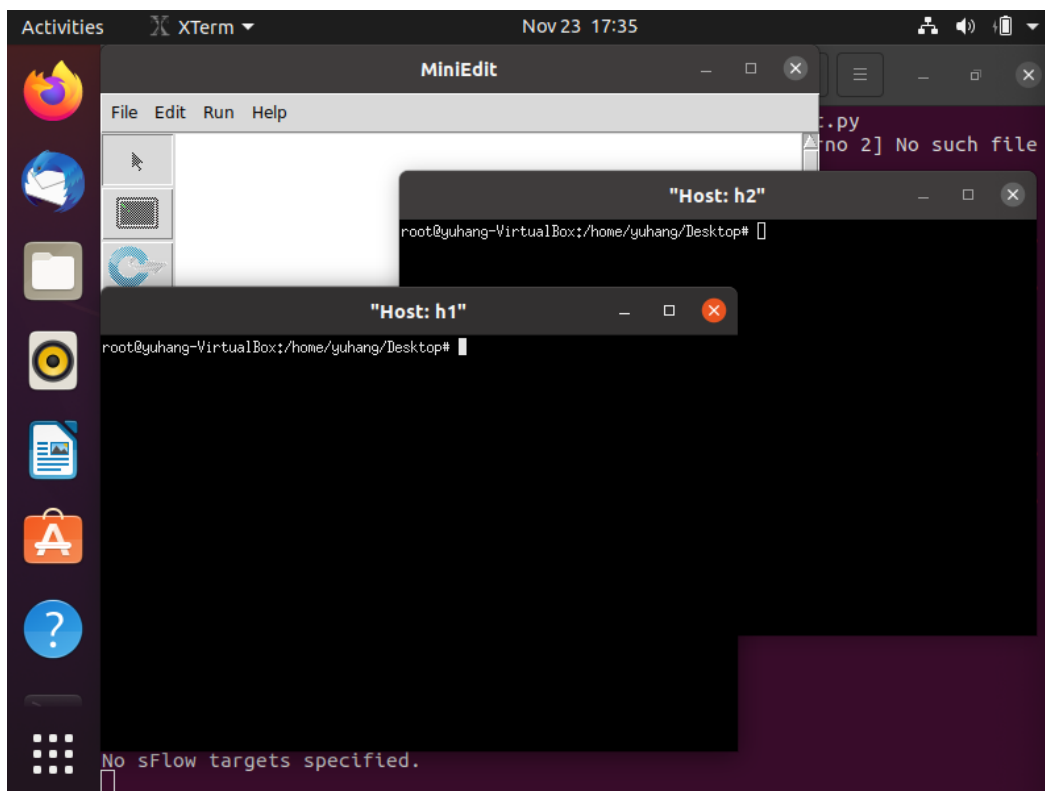


3.2

Step 1.



Step 2.



Step 3.

```
"Host: h1"
root@yuhang-VirtualBox:/home/yuhang/Desktop# ifconfig
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::f427:a6ff:fe50:605f prefixlen 64 scopeid 0x20<link>
    ether f6:27:a6:50:60:5f txqueuelen 1000 (Ethernet)
    RX packets 39 bytes 4157 (4.1 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

root@yuhang-VirtualBox:/home/yuhang/Desktop#
```

```
"Host: h2"
root@yuhang-VirtualBox:/home/yuhang/Desktop# ifconfig
h2-eth0: flags=4163<UP,BROADCAST,RUNNING,MULTICAST> mtu 1500
    inet 10.0.0.2 netmask 255.0.0.0 broadcast 10.255.255.255
    inet6 fe80::e441:e5ff:fe68:4aef prefixlen 64 scopeid 0x20<link>
    ether e6:41:e5:68:4a:ef txqueuelen 1000 (Ethernet)
    RX packets 40 bytes 4247 (4.2 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

root@yuhang-VirtualBox:/home/yuhang/Desktop#
```

Step 4.

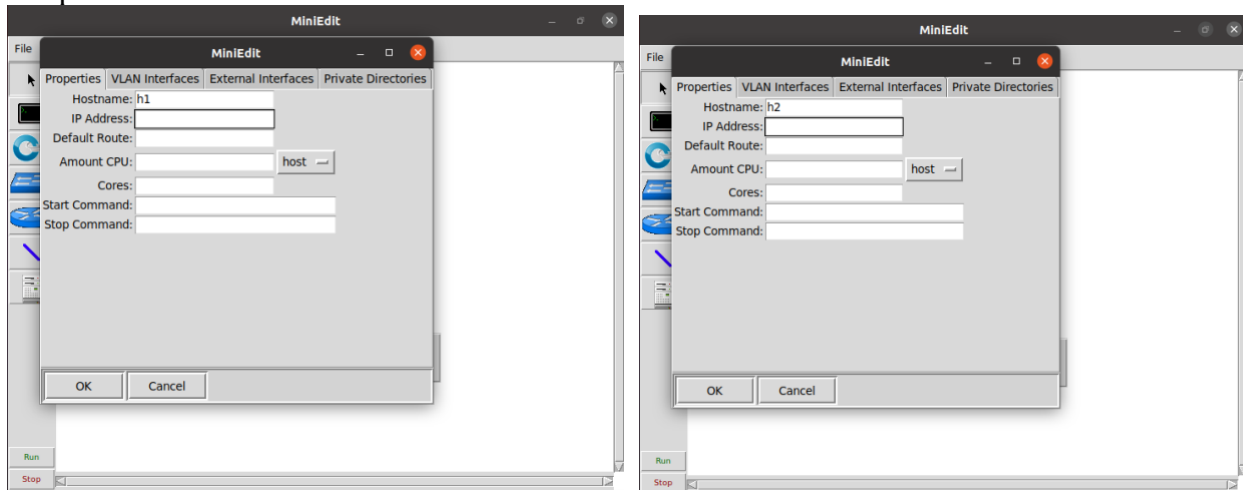
```
"Host: h1"
root@yuhang-VirtualBox:/home/yuhang/Desktop# ping 10.0.0.2
PING 10.0.0.2 (10.0.0.2) 56(84) bytes of data.
64 bytes from 10.0.0.2: icmp_seq=1 ttl=64 time=0.221 ms
64 bytes from 10.0.0.2: icmp_seq=2 ttl=64 time=0.066 ms
64 bytes from 10.0.0.2: icmp_seq=3 ttl=64 time=0.087 ms
64 bytes from 10.0.0.2: icmp_seq=4 ttl=64 time=0.065 ms
64 bytes from 10.0.0.2: icmp_seq=5 ttl=64 time=0.079 ms
64 bytes from 10.0.0.2: icmp_seq=6 ttl=64 time=0.065 ms
^C
--- 10.0.0.2 ping statistics ---
6 packets transmitted, 6 received, 0% packet loss, time 5097ms
rtt min/avg/max/mdev = 0.065/0.097/0.221/0.055 ms
root@yuhang-VirtualBox:/home/yuhang/Desktop#
```

Step 5.

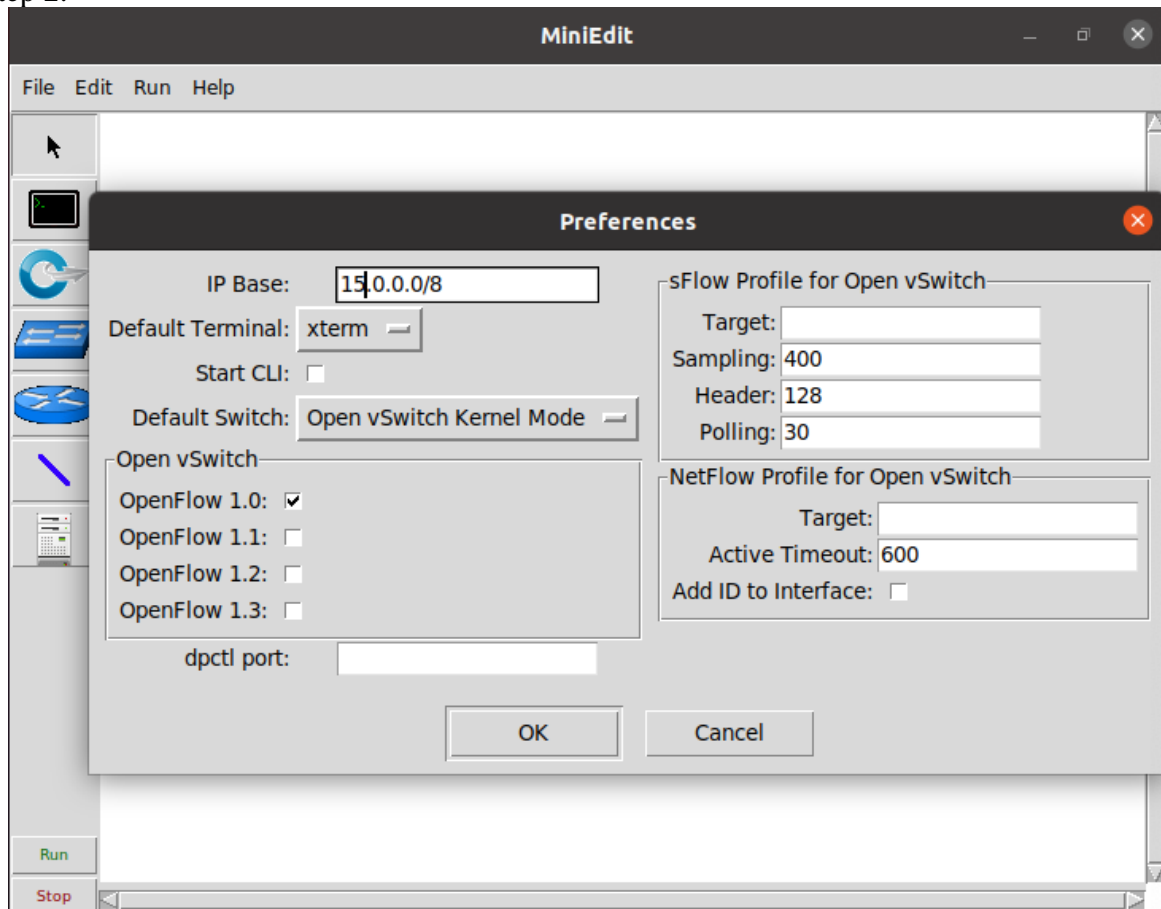
Stopped the emulation, no screenshot.

3.3

Step 1.



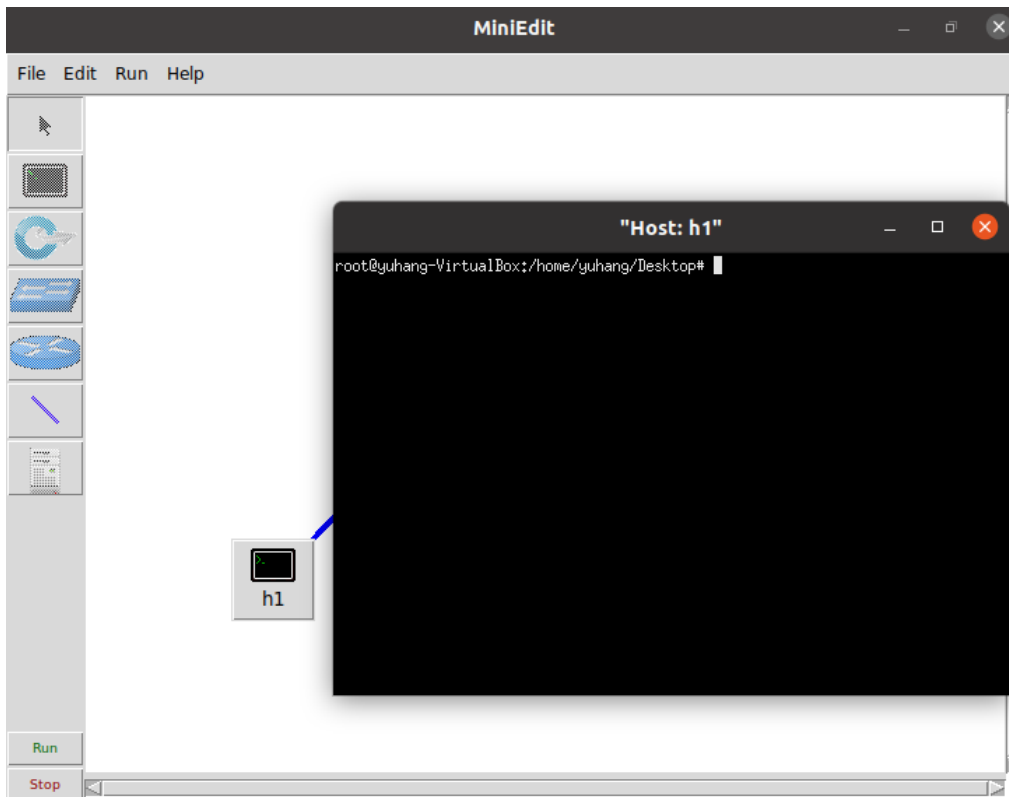
Step 2.



Step 3.

Run the emulation, no screenshot.

Step 4.



Step 5.

```
"Host: h1"
root@yuhang-VirtualBox:/home/yuhang/Desktop# ifconfig
h1-eth0: flags=4163<UP,BROADCAST,RUNNING,MULTICAST> mtu 1500
    inet 15.0.0.1 netmask 255.0.0.0 broadcast 15.255.255.255
    inet6 fe80::288d:69ff:fec4:dc8b prefixlen 64 scopeid 0x20<link>
    ether 2a:8d:69:c4:dc:8b txqueuelen 1000 (Ethernet)
    RX packets 37 bytes 4000 (4.0 KB)
    RX errors 0 dropped 0 overruns 0 frame 0
    TX packets 11 bytes 866 (866.0 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

root@yuhang-VirtualBox:/home/yuhang/Desktop#
```

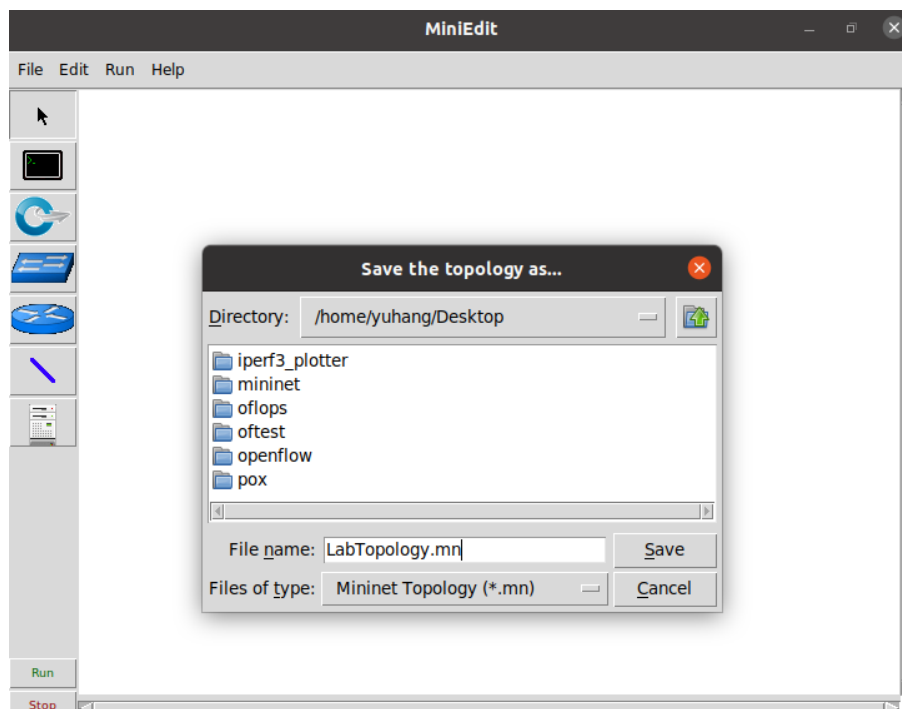
```
"Host: h2"
root@yuhang-VirtualBox:/home/yuhang/Desktop# ifconfig
h2-eth0: flags=4163<UP,BROADCAST,RUNNING,MULTICAST> mtu 1500
    inet 15.0.0.2 netmask 255.0.0.0 broadcast 15.255.255.255
    inet6 fe80::5473:d4ff:fe82:ddd2 prefixlen 64 scopeid 0x20<link>
    ether 56:73:d4:82:dd:d2 txqueuelen 1000 (Ethernet)
    RX packets 37 bytes 4000 (4.0 KB)
    RX errors 0 dropped 0 overruns 0 frame 0
    TX packets 11 bytes 866 (866.0 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

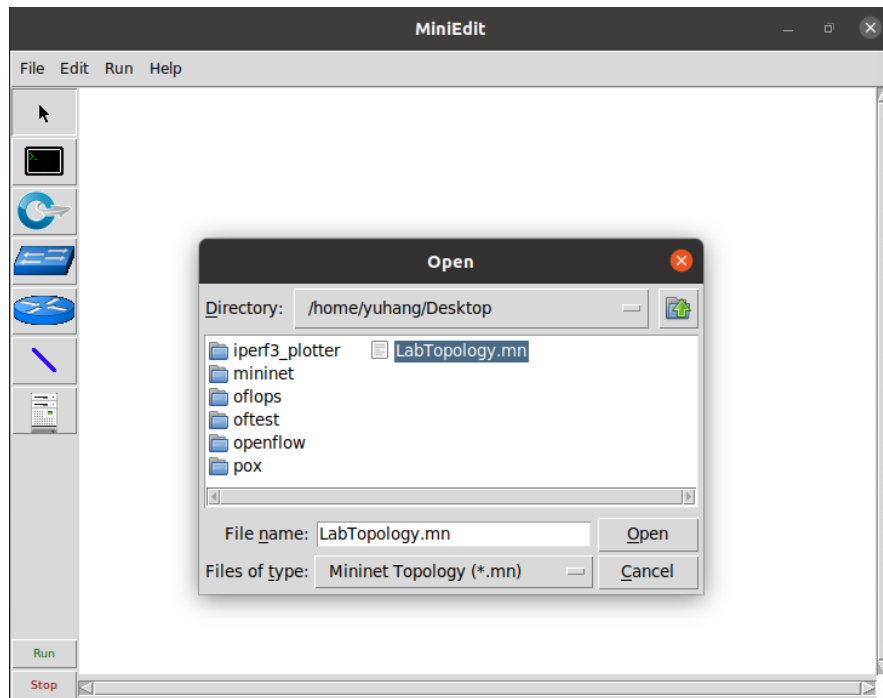
root@yuhang-VirtualBox:/home/yuhang/Desktop#
```

Step 6.
Stopped the emulation, no screenshot.

3.4
Step 1.



Step 2.

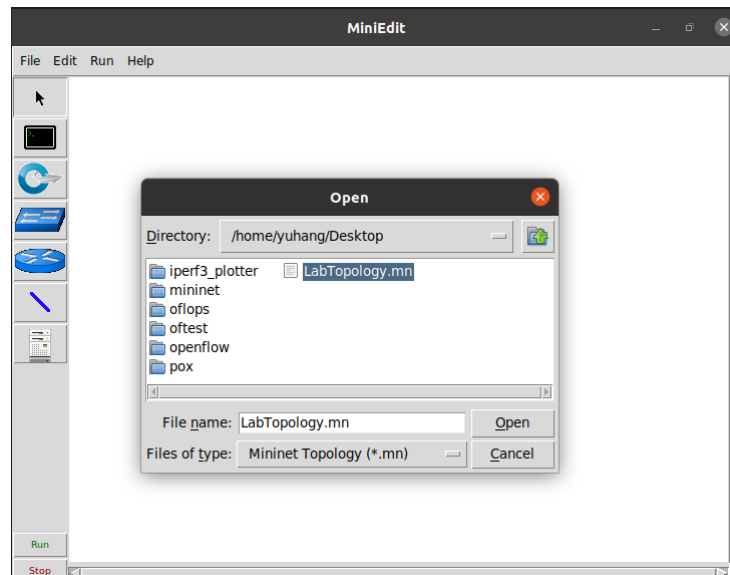


Lab 2

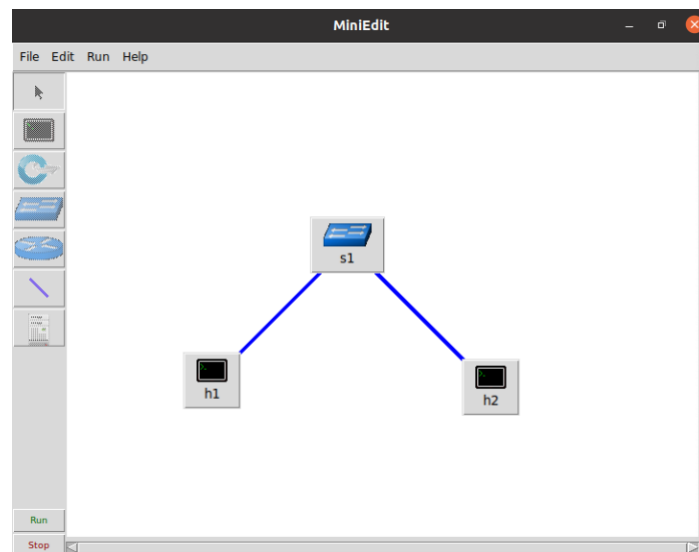
1.
Introduction, no screenshot.

2.
Step 1.
Start MiniEdit, no screenshot.

Step 2.

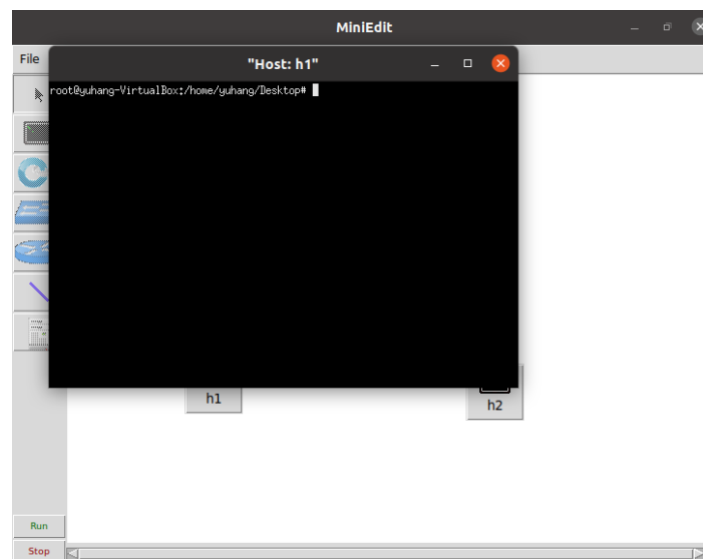


Step 3.



2.1

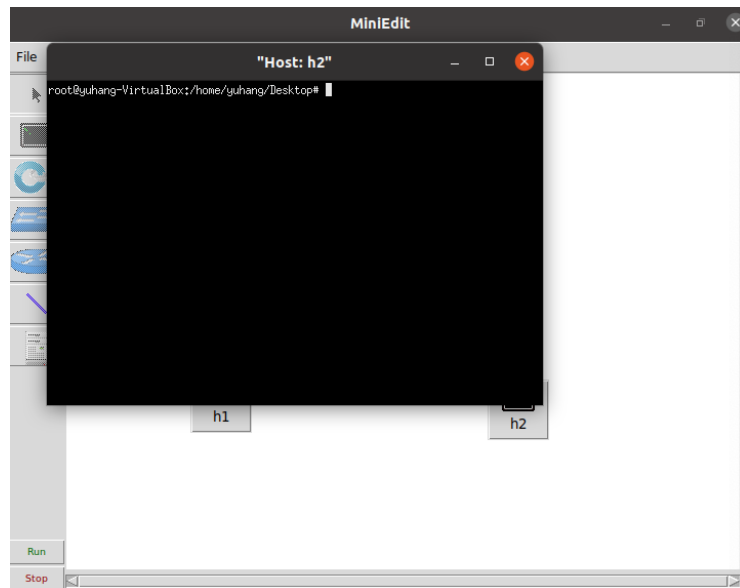
Step 1.



Step 2.

```
"Host: h1"
root@yuhang-VirtualBox:/home/yuhang/Desktop# ping 15.0.0.2
PING 15.0.0.2 (15.0.0.2) 56(84) bytes of data.
64 bytes from 15.0.0.2: icmp_seq=1 ttl=64 time=0.307 ms
64 bytes from 15.0.0.2: icmp_seq=2 ttl=64 time=0.248 ms
64 bytes from 15.0.0.2: icmp_seq=3 ttl=64 time=0.062 ms
64 bytes from 15.0.0.2: icmp_seq=4 ttl=64 time=0.067 ms
64 bytes from 15.0.0.2: icmp_seq=5 ttl=64 time=0.066 ms
64 bytes from 15.0.0.2: icmp_seq=6 ttl=64 time=0.070 ms
^C
--- 15.0.0.2 ping statistics ---
6 packets transmitted, 6 received, 0% packet loss, time 5115ms
rtt min/avg/max/mdev = 0.062/0.136/0.307/0.101 ms
root@yuhang-VirtualBox:/home/yuhang/Desktop#
```

3.
3.1
Step 1.



Step 2.

```
"Host: h2"
root@yuhang-VirtualBox:/home/yuhang/Desktop# iperf3 -s
-----
Server listening on 5201
-----
```

Step 3.

```
root@yuhang-VirtualBox:/home/yuhang/Desktop# iperf3 -c 15.0.0.2
Connecting to host 15.0.0.2, port 5201
[ 7] local 15.0.0.1 port 40560 connected to 15.0.0.2 port 5201
[ ID] Interval      Transfer    Bitrate    Retr  Cwnd
[ 7]  0.00-1.00    sec  1.45 GBytes 12.4 Gbits/sec  0  8.18 MBytes
[ 7]  1.00-2.01    sec   945 MBytes 7.88 Gbits/sec  0  8.18 MBytes
[ 7]  2.01-3.00    sec   285 MBytes 2.40 Gbits/sec  0  8.18 MBytes
[ 7]  3.00-4.00    sec   690 MBytes 5.79 Gbits/sec  0  8.18 MBytes
[ 7]  4.00-5.01    sec   675 MBytes 5.62 Gbits/sec  0  8.18 MBytes
[ 7]  5.01-6.00    sec   938 MBytes 7.93 Gbits/sec  0  8.18 MBytes
[ 7]  6.00-7.00    sec   578 MBytes 4.85 Gbits/sec  0  8.18 MBytes
[ 7]  7.00-8.00    sec   978 MBytes 8.18 Gbits/sec  0  8.18 MBytes
[ 7]  8.00-9.00    sec   1.01 GBytes 8.73 Gbits/sec  0  8.18 MBytes
[ 7]  9.00-10.00   sec   928 MBytes 7.79 Gbits/sec  0  8.18 MBytes
-----
[ ID] Interval      Transfer    Bitrate    Retr
[ 7]  0.00-10.00   sec  8.34 GBytes 7.16 Gbits/sec  0
[ 7]  0.00-10.04   sec  8.33 GBytes 7.13 Gbits/sec
iperf Done.
root@yuhang-VirtualBox:/home/yuhang/Desktop#
```

Step 4.

```
"Host: h2"
root@yuhang-VirtualBox:/home/yuhang/Desktop# iperf3 -s
-----
Server listening on 5201
-----
Accepted connection from 15.0.0.1, port 40558
[ 7] local 15.0.0.2 port 5201 connected to 15.0.0.1 port 40560
[ ID] Interval      Transfer    Bitrate
[ 7] 0.00-1.00  sec    1.40 GBytes 12.0 Gbits/sec
[ 7] 1.00-2.00  sec    987 MBytes  8.30 Gbits/sec
[ 7] 2.00-3.00  sec    278 MBytes  2.33 Gbits/sec
[ 7] 3.00-4.00  sec    685 MBytes  5.74 Gbits/sec
[ 7] 4.00-5.00  sec    658 MBytes  5.54 Gbits/sec
[ 7] 5.00-6.00  sec    949 MBytes  7.93 Gbits/sec
[ 7] 6.00-7.00  sec    590 MBytes  4.97 Gbits/sec
[ 7] 7.00-8.00  sec    969 MBytes  8.13 Gbits/sec
[ 7] 8.00-9.00  sec    1.00 GBytes  8.57 Gbits/sec
[ 7] 9.00-10.00 sec    904 MBytes  7.61 Gbits/sec
[ 7] 10.00-10.04 sec   49.4 MBytes  9.67 Gbits/sec
-----
[ ID] Interval      Transfer    Bitrate
[ 7] 0.00-10.04  sec    8.33 GBytes  7.13 Gbits/sec
-----
Server listening on 5201
-----
^Ciperf3: interrupt - the server has terminated
root@yuhang-VirtualBox:/home/yuhang/Desktop#
```

3.3

Step 1.

```
"Host: h2"
root@yuhang-VirtualBox:/home/yuhang/Desktop# iperf3 -s -i 2
-----
Server listening on 5201
-----
█
```

Step 2.

```
"Host: h1"
root@yuhang-VirtualBox:/home/yuhang/Desktop# iperf3 -c 15.0.0.2 -i 2
Connecting to host 15.0.0.2, port 5201
[ 7] local 15.0.0.1 port 34694 connected to 15.0.0.2 port 5201
[ ID] Interval      Transfer    Bitrate    Retr  Cwnd
[ 7] 0.00-2.00  sec    1.70 GBytes  7.30 Gbits/sec    0   8.15 MBytes
[ 7] 2.00-4.00  sec    3.55 GBytes 15.3 Gbits/sec    0   8.15 MBytes
[ 7] 4.00-6.00  sec    3.37 GBytes 14.5 Gbits/sec    0   8.15 MBytes
[ 7] 6.00-8.00  sec    1.36 GBytes  5.86 Gbits/sec    0   8.15 MBytes
[ 7] 8.00-10.00 sec    2.04 GBytes  8.78 Gbits/sec    0   8.15 MBytes
-----
[ ID] Interval      Transfer    Bitrate    Retr
[ 7] 0.00-10.00  sec    12.0 GBytes 10.3 Gbits/sec    0
[ 7] 0.00-10.04  sec    12.0 GBytes 10.3 Gbits/sec
-----
sender
receiver

iperf Done.
root@yuhang-VirtualBox:/home/yuhang/Desktop#
```


Step 3.

```
"Host: h2"
root@yuhang-VirtualBox:/home/yuhang/Desktop# iperf3 -s -i 2
-----
Server listening on 5201
-----
Accepted connection from 15.0.0.1, port 34680
[ 7] local 15.0.0.2 port 5201 connected to 15.0.0.1 port 34694
[ ID] Interval      Transfer    Bitrate
[ 7]  0.00-2.00  sec   1.64 GBytes  7.03 Gbits/sec
[ 7]  2.00-4.00  sec   3.50 GBytes 15.1 Gbits/sec
[ 7]  4.00-6.00  sec   3.42 GBytes 14.7 Gbits/sec
[ 7]  6.00-8.00  sec   1.36 GBytes  5.83 Gbits/sec
[ 7]  8.00-10.00 sec   2.09 GBytes  8.97 Gbits/sec
[ 7] 10.00-10.04 sec   14.2 MBytes  2.79 Gbits/sec
-----
[ ID] Interval      Transfer    Bitrate
[ 7]  0.00-10.04 sec  12.0 GBytes 10.3 Gbits/sec
-----
Server listening on 5201
-----
^Ciperf3: interrupt - the server has terminated
root@yuhang-VirtualBox:/home/yuhang/Desktop#
```

3.4

Step 1.

```
"Host: h2"
root@yuhang-VirtualBox:/home/yuhang/Desktop# iperf3 -s
-----
Server listening on 5201
-----
█
```

Step 2.

```
"Host: h1"
root@yuhang-VirtualBox:/home/yuhang/Desktop# iperf3 -c 15.0.0.2 -n 16G
Connecting to host 15.0.0.2, port 5201
[ 7] local 15.0.0.1 port 49126 connected to 15.0.0.2 port 5201
[ ID] Interval      Transfer    Bitrate    Retr  Cwnd
[ 7]  0.00-1.00  sec   1.15 GBytes  9.84 Gbits/sec    0   8.34 MBytes
[ 7]  1.00-2.00  sec   1.24 GBytes 10.6 Gbits/sec    0   8.34 MBytes
[ 7]  2.00-3.00  sec   1.04 GBytes  8.95 Gbits/sec    0   8.34 MBytes
[ 7]  3.00-4.00  sec   1.22 GBytes 10.5 Gbits/sec    0   8.34 MBytes
[ 7]  4.00-5.00  sec    984 MBytes  8.25 Gbits/sec    0   8.34 MBytes
[ 7]  5.00-6.00  sec   1.32 GBytes 11.3 Gbits/sec    0   8.34 MBytes
[ 7]  6.00-7.00  sec   1.44 GBytes 12.4 Gbits/sec    0   8.34 MBytes
[ 7]  7.00-8.00  sec   1.41 GBytes 12.1 Gbits/sec    0   8.34 MBytes
[ 7]  8.00-9.00  sec   1.43 GBytes 12.3 Gbits/sec    0   8.34 MBytes
[ 7]  9.00-10.00 sec   1.45 GBytes 12.5 Gbits/sec    0   8.34 MBytes
[ 7] 10.00-11.00 sec   1.43 GBytes 12.3 Gbits/sec    0   8.34 MBytes
[ 7] 11.00-12.00 sec   1.44 GBytes 12.4 Gbits/sec    0   8.34 MBytes
[ 7] 12.00-12.34 sec    482 MBytes 12.0 Gbits/sec    0   8.34 MBytes
-----
[ ID] Interval      Transfer    Bitrate    Retr
[ 7]  0.00-12.34 sec  16.0 GBytes 11.1 Gbits/sec    0
[ 7]  0.00-12.38 sec  16.0 GBytes 11.1 Gbits/sec    0
-----
iperf Done.
root@yuhang-VirtualBox:/home/yuhang/Desktop#
```

Step 3.

```
"Host: h2"

Server listening on 5201

Accepted connection from 15.0.0.1, port 49112
[ 7] local 15.0.0.2 port 5201 connected to 15.0.0.1 port 49126
[ ID] Interval      Transfer    Bitrate
[ 7]  0.00-1.00    sec  1.11 GBytes 9.52 Gbits/sec
[ 7]  1.00-2.00    sec  1.22 GBytes 10.5 Gbits/sec
[ 7]  2.00-3.00    sec  1.04 GBytes 8.94 Gbits/sec
[ 7]  3.00-4.00    sec  1.23 GBytes 10.6 Gbits/sec
[ 7]  4.00-5.00    sec  996 MBytes 8.37 Gbits/sec
[ 7]  5.00-6.00    sec  1.30 GBytes 11.1 Gbits/sec
[ 7]  6.00-7.00    sec  1.44 GBytes 12.4 Gbits/sec
[ 7]  7.00-8.00    sec  1.41 GBytes 12.1 Gbits/sec
[ 7]  8.00-9.00    sec  1.43 GBytes 12.3 Gbits/sec
[ 7]  9.00-10.00   sec  1.45 GBytes 12.5 Gbits/sec
[ 7] 10.00-11.00   sec  1.43 GBytes 12.3 Gbits/sec
[ 7] 11.00-12.00   sec  1.44 GBytes 12.4 Gbits/sec
[ 7] 12.00-12.38   sec   539 MBytes 12.0 Gbits/sec
-----
[ ID] Interval      Transfer    Bitrate
[ 7]  0.00-12.38   sec  16.0 GBytes 11.1 Gbits/sec
receiver

Server listening on 5201

^Ciperf3: interrupt - the server has terminated
root@yuhang-VirtualBox:/home/yuhang/Desktop#
```

3.5

Step 1.

```
"Host: h2"

root@yuhang-VirtualBox:/home/yuhang/Desktop# iperf3 -s

Server listening on 5201

█
```

Step 2.

```
"Host: h1"

root@yuhang-VirtualBox:/home/yuhang/Desktop# iperf3 -c 15.0.0.2 -u
Connecting to host 15.0.0.2, port 5201
[ 7] local 15.0.0.1 port 53909 connected to 15.0.0.2 port 5201
[ ID] Interval      Transfer    Bitrate      Total Datagrams
[ 7]  0.00-1.00    sec  129 KBytes  1.05 Mbits/sec  91
[ 7]  1.00-2.00    sec  127 KBytes  1.04 Mbits/sec  90
[ 7]  2.00-3.00    sec  129 KBytes  1.05 Mbits/sec  91
[ 7]  3.00-4.00    sec  129 KBytes  1.05 Mbits/sec  91
[ 7]  4.00-5.00    sec  127 KBytes  1.04 Mbits/sec  90
[ 7]  5.00-6.00    sec  129 KBytes  1.05 Mbits/sec  91
[ 7]  6.00-7.00    sec  127 KBytes  1.04 Mbits/sec  90
[ 7]  7.00-8.00    sec  129 KBytes  1.05 Mbits/sec  91
[ 7]  8.00-9.00    sec  127 KBytes  1.04 Mbits/sec  90
[ 7]  9.00-10.00   sec  129 KBytes  1.05 Mbits/sec  91
-----
[ ID] Interval      Transfer    Bitrate      Jitter    Lost/Total Datagrams
[ 7]  0.00-10.00   sec  1.25 MBytes  1.05 Mbits/sec  0.000 ms  0/906 (0%) sender
[ 7]  0.00-10.04   sec  1.25 MBytes  1.05 Mbits/sec  0.016 ms  0/906 (0%) receiver

iperf Done.
root@yuhang-VirtualBox:/home/yuhang/Desktop#
```

Step 3.

```
"Host: h2"
root@yuhang-VirtualBox:/home/yuhang/Desktop# iperf3 -s
Server listening on 5201
Accepted connection from 15.0.0.1, port 33246
[ 7] local 15.0.0.2 port 5201 connected to 15.0.0.1 port 53909
[ ID] Interval      Transfer    Bitrate      Jitter    Lost/Totl  Datagrams
[ 7] 0.00-1.00    sec      123 KBytes   1.01 Mbits/sec  0.013 ms   0/87 (0%)
[ 7] 1.00-2.00    sec      129 KBytes   1.05 Mbits/sec  0.012 ms   0/91 (0%)
[ 7] 2.00-3.00    sec      127 KBytes   1.04 Mbits/sec  0.014 ms   0/90 (0%)
[ 7] 3.00-4.00    sec      129 KBytes   1.05 Mbits/sec  0.013 ms   0/91 (0%)
[ 7] 4.00-5.00    sec      127 KBytes   1.04 Mbits/sec  0.008 ms   0/90 (0%)
[ 7] 5.00-6.00    sec      129 KBytes   1.05 Mbits/sec  0.005 ms   0/91 (0%)
[ 7] 6.00-7.00    sec      127 KBytes   1.04 Mbits/sec  0.035 ms   0/90 (0%)
[ 7] 7.00-8.00    sec      129 KBytes   1.05 Mbits/sec  0.015 ms   0/91 (0%)
[ 7] 8.00-9.00    sec      127 KBytes   1.04 Mbits/sec  0.036 ms   0/90 (0%)
[ 7] 9.00-10.00   sec      129 KBytes   1.05 Mbits/sec  0.015 ms   0/91 (0%)
[ 7] 10.00-10.04  sec       5.66 KBytes   1.10 Mbits/sec  0.016 ms   0/4 (0%)
[ ID] Interval      Transfer    Bitrate      Jitter    Lost/Totl  Datagrams
[ 7] 0.00-10.04   sec      1.25 MBytes   1.05 Mbits/sec  0.016 ms   0/906 (0%) receiver
Server listening on 5201
^Ciperf3: interrupt - the server has terminated
root@yuhang-VirtualBox:/home/yuhang/Desktop#
```

3.6
Step 1.

```
"Host: h2"
root@yuhang-VirtualBox:/home/yuhang/Desktop# iperf3 -s -p 3250
Server listening on 3250
█
```

Step 2.

```
"Host: h1"
root@yuhang-VirtualBox:/home/yuhang/Desktop# iperf3 -c 15.0.0.2 -p 3250
Connecting to host 15.0.0.2, port 3250
[ 7] local 15.0.0.1 port 37626 connected to 15.0.0.2 port 3250
[ ID] Interval      Transfer    Bitrate      Retr      Cwnd
[ 7] 0.00-1.00    sec      1.48 GBytes  12.7 Gbits/sec  0      8.01 MBytes
[ 7] 1.00-2.00    sec      1.35 GBytes  11.6 Gbits/sec  0      8.01 MBytes
[ 7] 2.00-3.00    sec      1.34 GBytes  11.5 Gbits/sec  0      8.01 MBytes
[ 7] 3.00-4.00    sec      1.26 GBytes  10.9 Gbits/sec  0      8.01 MBytes
[ 7] 4.00-5.00    sec      1.20 GBytes  10.2 Gbits/sec  0      8.01 MBytes
[ 7] 5.00-6.00    sec       790 MBytes  6.65 Gbits/sec  0      8.01 MBytes
[ 7] 6.00-7.00    sec       962 MBytes  8.07 Gbits/sec  0      8.01 MBytes
[ 7] 7.00-8.00    sec       654 MBytes  5.47 Gbits/sec  0      8.01 MBytes
[ 7] 8.00-9.00    sec      1.27 GBytes  11.0 Gbits/sec  0      8.01 MBytes
[ 7] 9.00-10.00   sec      1.28 GBytes  11.0 Gbits/sec  0      8.01 MBytes
[ ID] Interval      Transfer    Bitrate      Retr
[ 7] 0.00-10.00   sec      11.5 GBytes  9.90 Gbits/sec  0
[ 7] 0.00-10.05   sec      11.5 GBytes  9.85 Gbits/sec
iperf Done.
root@yuhang-VirtualBox:/home/yuhang/Desktop#
```

Step 3.

```
"Host: h2"
root@yuhang-VirtualBox:/home/yuhang/Desktop# iperf3 -s -p 3250
-----
Server listening on 3250
-----
Accepted connection from 15.0.0.1, port 37622
[ 7] local 15.0.0.2 port 3250 connected to 15.0.0.1 port 37626
[ ID] Interval      Transfer    Bitrate
[ 7] 0.00-1.00 sec  1.41 GBytes 12.1 Gbits/sec
[ 7] 1.00-2.00 sec  1.35 GBytes 11.6 Gbits/sec
[ 7] 2.00-3.00 sec  1.34 GBytes 11.5 Gbits/sec
[ 7] 3.00-4.00 sec  1.28 GBytes 11.0 Gbits/sec
[ 7] 4.00-5.00 sec  1.22 GBytes 10.5 Gbits/sec
[ 7] 5.00-6.00 sec   745 MBytes  6.25 Gbits/sec
[ 7] 6.00-7.00 sec  1015 MBytes  8.51 Gbits/sec
[ 7] 7.00-8.00 sec   607 MBytes  5.09 Gbits/sec
[ 7] 8.00-9.00 sec  1.27 GBytes 10.9 Gbits/sec
[ 7] 9.00-10.00 sec  1.28 GBytes 11.0 Gbits/sec
[ 7] 10.00-10.05 sec  60.9 MBytes 10.5 Gbits/sec
-----
[ ID] Interval      Transfer    Bitrate
[ 7] 0.00-10.05 sec 11.5 GBytes  9.85 Gbits/sec
-----
Server listening on 3250
-----
^Ciperf3: interrupt - the server has terminated
root@yuhang-VirtualBox:/home/yuhang/Desktop#
```

3.7

Step 1.

```
"Host: h2"
root@yuhang-VirtualBox:/home/yuhang/Desktop# iperf3 -s
-----
Server listening on 5201
-----
█
```

Step 2.

```
"Host: h1"
root@yuhang-VirtualBox:/home/yuhang/Desktop# iperf3 -c 15.0.0.2 -J > test_results.json
root@yuhang-VirtualBox:/home/yuhang/Desktop# █
```

Step 3.

```
"Host: h2"
root@yuhang-VirtualBox:/home/yuhang/Desktop# iperf3 -s
-----
Server listening on 5201
-----
Accepted connection from 15.0.0.1, port 59180
[ 7] local 15.0.0.2 port 5201 connected to 15.0.0.1 port 59190
[ ID] Interval      Transfer    Bitrate
[ 7] 0.00-1.00 sec  1.19 GBytes 10.2 Gbits/sec
[ 7] 1.00-2.00 sec  1002 MBytes  8.41 Gbits/sec
[ 7] 2.00-3.00 sec  1005 MBytes  8.43 Gbits/sec
[ 7] 3.00-4.00 sec  1.12 GBytes  9.60 Gbits/sec
[ 7] 4.00-5.00 sec  1.38 GBytes 11.9 Gbits/sec
[ 7] 5.00-6.00 sec   762 MBytes  6.39 Gbits/sec
[ 7] 6.00-7.00 sec   846 MBytes  7.10 Gbits/sec
[ 7] 7.00-8.00 sec   590 MBytes  4.95 Gbits/sec
[ 7] 8.00-9.00 sec   724 MBytes  6.08 Gbits/sec
[ 7] 9.00-10.00 sec  1.07 GBytes  9.16 Gbits/sec
[ 7] 10.00-10.05 sec  48.7 MBytes  8.93 Gbits/sec
-----
[ ID] Interval      Transfer    Bitrate
[ 7] 0.00-10.05 sec  9.62 GBytes  8.22 Gbits/sec
-----
Server listening on 5201
-----
^Ciperf3: interrupt - the server has terminated
root@yuhang-VirtualBox:/home/yuhang/Desktop#
```

3.8

Step 1.

```

"Host: h2"

root@yuhang-VirtualBox:/home/yuhang/Desktop# iperf3 -s -1
-----
Server listening on 5201
-----

```

Step 2.

```

"Host: h1"

root@yuhang-VirtualBox:/home/yuhang/Desktop# iperf3 -c 15.0.0.2
Connecting to host 15.0.0.2, port 5201
[ 7] local 15.0.0.1 port 34344 connected to 15.0.0.2 port 5201
[ ID] Interval           Transfer     Bitrate      Retr    Cwnd
[ 7]  0.00-1.00   sec    1.46 GBytes  12.5 Gbits/sec    0   8.06 MBytes
[ 7]  1.00-2.00   sec    1.40 GBytes  12.0 Gbits/sec    0   8.06 MBytes
[ 7]  2.00-3.00   sec    881 MBytes  7.39 Gbits/sec    0   8.06 MBytes
[ 7]  3.00-4.00   sec    686 MBytes  5.75 Gbits/sec    0   8.06 MBytes
[ 7]  4.00-5.00   sec    1.35 GBytes  11.6 Gbits/sec    0   8.06 MBytes
[ 7]  5.00-6.00   sec    1.32 GBytes  11.4 Gbits/sec    0   8.06 MBytes
[ 7]  6.00-7.00   sec    1.42 GBytes  12.1 Gbits/sec    0   8.06 MBytes
[ 7]  7.00-8.00   sec    1.37 GBytes  11.8 Gbits/sec    0   8.06 MBytes
[ 7]  8.00-9.00   sec    1.45 GBytes  12.5 Gbits/sec    0   8.06 MBytes
[ 7]  9.00-10.00  sec    1.43 GBytes  12.3 Gbits/sec    0   8.06 MBytes
-----
[ ID] Interval           Transfer     Bitrate      Retr
[ 7]  0.00-10.00  sec    12.7 GBytes  10.9 Gbits/sec    0
[ 7]  0.00-10.04  sec    12.7 GBytes  10.9 Gbits/sec    0
                                     sender
                                     receiver

iperf Done.
root@yuhang-VirtualBox:/home/yuhang/Desktop#

```

```

"Host: h2"

root@yuhang-VirtualBox:/home/yuhang/Desktop# iperf3 -s -1
-----
Server listening on 5201
-----
Accepted connection from 15.0.0.1, port 34328
[ 7] local 15.0.0.2 port 5201 connected to 15.0.0.1 port 34344
[ ID] Interval           Transfer     Bitrate
[ 7]  0.00-1.00   sec    1.40 GBytes  12.0 Gbits/sec
[ 7]  1.00-2.00   sec    1.40 GBytes  12.1 Gbits/sec
[ 7]  2.00-3.00   sec    916 MBytes  7.68 Gbits/sec
[ 7]  3.00-4.00   sec    696 MBytes  5.84 Gbits/sec
[ 7]  4.00-5.00   sec    1.31 GBytes  11.2 Gbits/sec
[ 7]  5.00-6.00   sec    1.33 GBytes  11.4 Gbits/sec
[ 7]  6.00-7.00   sec    1.41 GBytes  12.1 Gbits/sec
[ 7]  7.00-8.00   sec    1.37 GBytes  11.8 Gbits/sec
[ 7]  8.00-9.00   sec    1.45 GBytes  12.5 Gbits/sec
[ 7]  9.00-10.00  sec    1.43 GBytes  12.3 Gbits/sec
[ 7] 10.00-10.04  sec    60.0 MBytes  12.1 Gbits/sec
-----
[ ID] Interval           Transfer     Bitrate
[ 7]  0.00-10.04  sec    12.7 GBytes  10.9 Gbits/sec
                                     receiver

root@yuhang-VirtualBox:/home/yuhang/Desktop#

```

4.

Step 1.

```

"Host: h2"

root@yuhang-VirtualBox:/home/yuhang/Desktop# iperf3 -s
-----
Server listening on 5201
-----

```

Step 2.

```
"Host: h1"
root@yuhang-VirtualBox:/home/yuhang/Desktop# iperf3 -c 15.0.0.2 -J > test_results.json
root@yuhang-VirtualBox:/home/yuhang/Desktop#
```

Step 3.

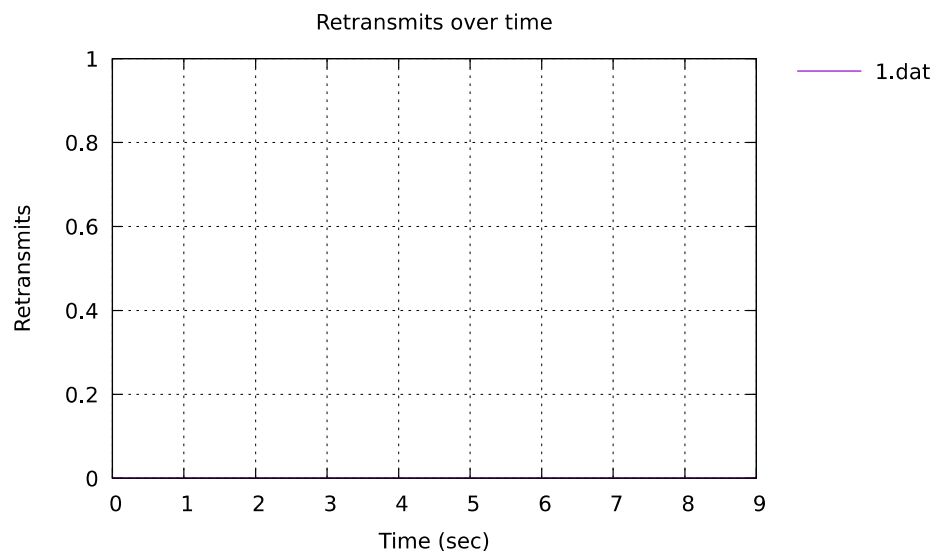
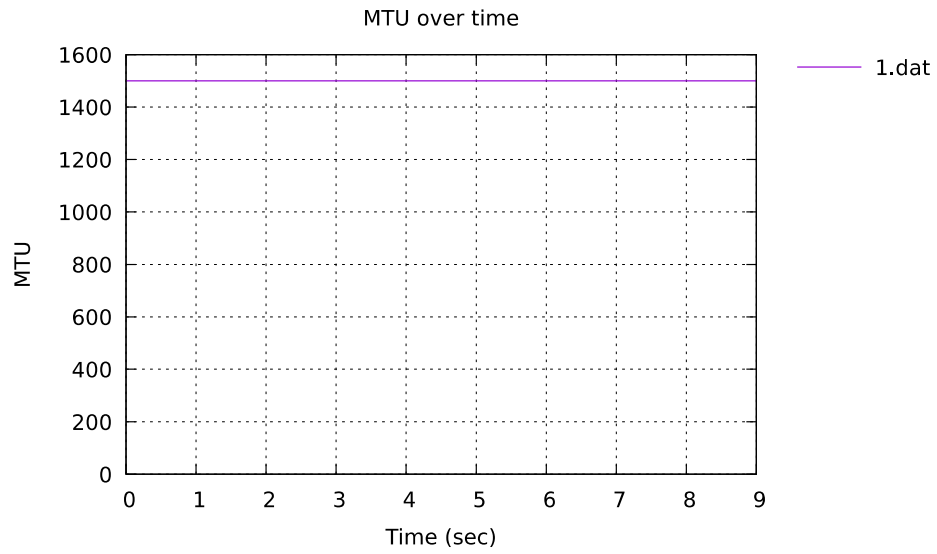
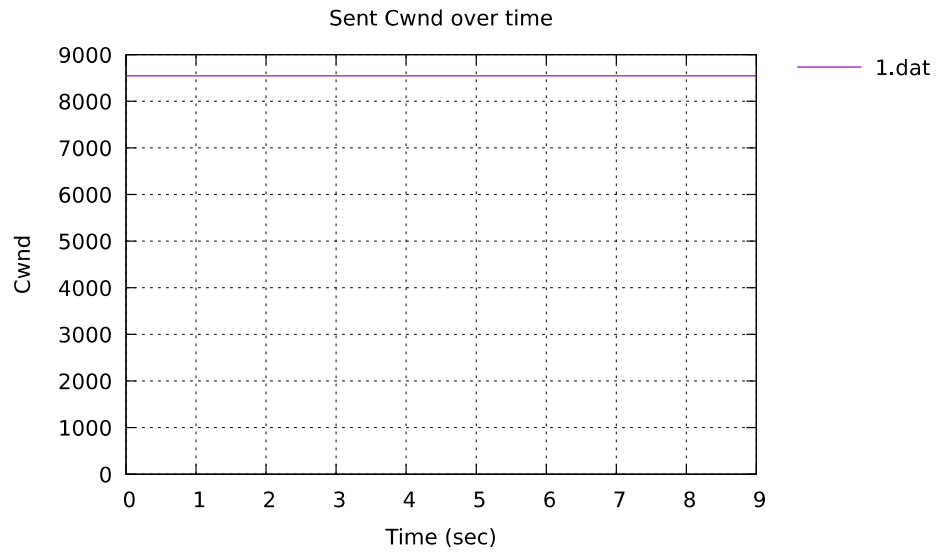
```
"Host: h1"
root@yuhang-VirtualBox:/home/yuhang/Desktop# iperf3 -c 15.0.0.2 -J > test_results.json
root@yuhang-VirtualBox:/home/yuhang/Desktop# plot_iperf.sh test_results.json
root@yuhang-VirtualBox:/home/yuhang/Desktop# ls
iperf3_plotter  LabTopology.mn  oflops  openflow  results
iperf.csv       mininet         oftest  pox       test_results.json
root@yuhang-VirtualBox:/home/yuhang/Desktop#
```

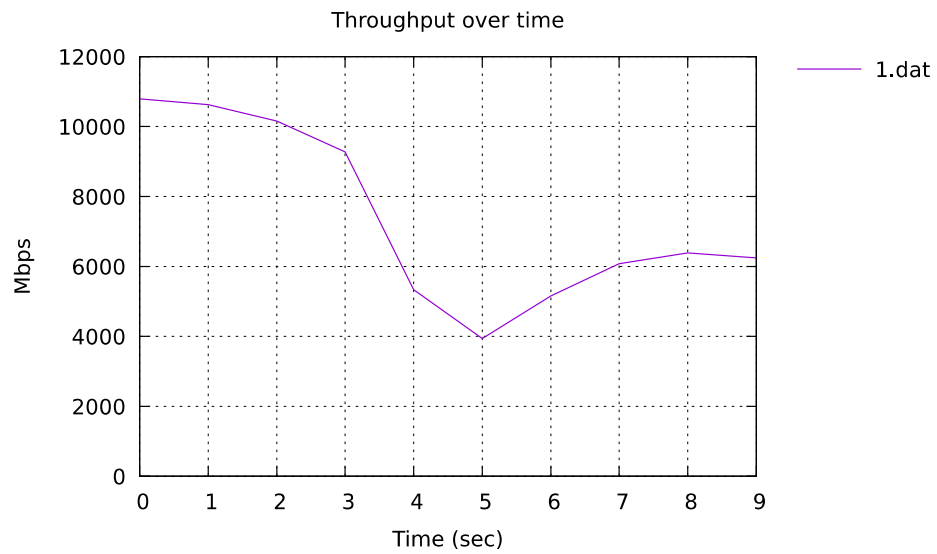
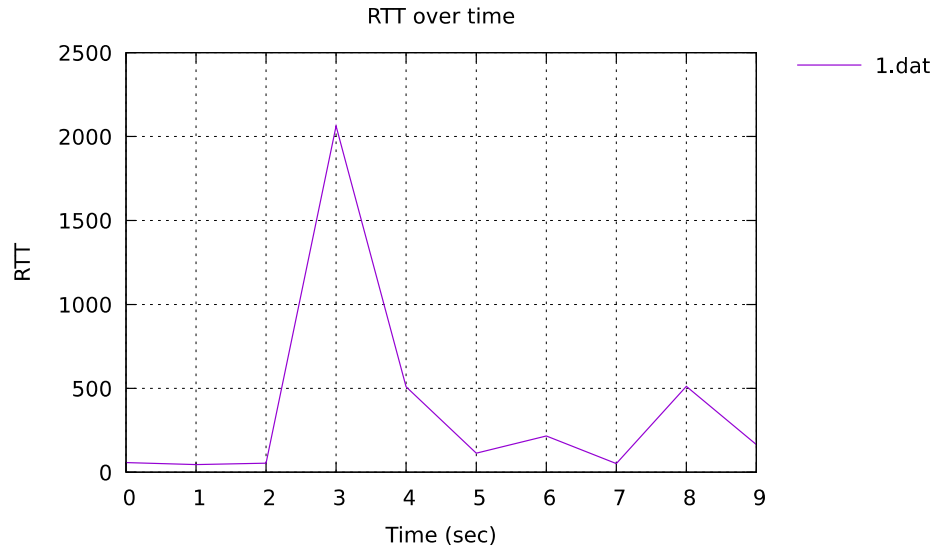
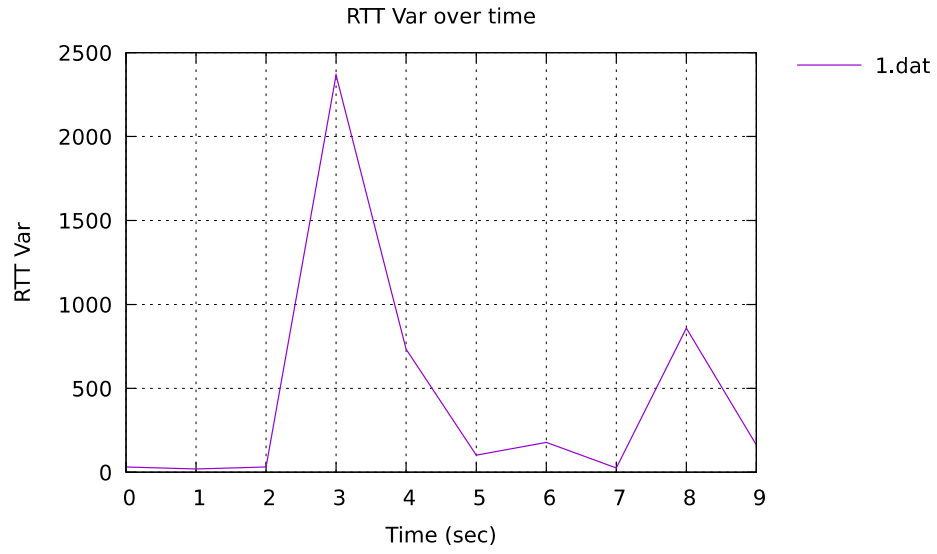
Step 4.

```
"Host: h1"
root@yuhang-VirtualBox:/home/yuhang/Desktop# iperf3 -c 15.0.0.2 -J > test_results.json
root@yuhang-VirtualBox:/home/yuhang/Desktop# plot_iperf.sh test_results.json
root@yuhang-VirtualBox:/home/yuhang/Desktop# ls
iperf3_plotter  LabTopology.mn  oflops  openflow  results
iperf.csv       mininet         oftest  pox       test_results.json
root@yuhang-VirtualBox:/home/yuhang/Desktop# cd results
root@yuhang-VirtualBox:/home/yuhang/Desktop/results#
```

Step 5.







Step 6.

```
"Host: h2"
Superscript
root@yuhang-VirtualBox:/home/yuhang/Desktop# iperf3 -s
-----
Server listening on 5201
-----
Accepted connection from 15.0.0.1, port 33624
[ 7] local 15.0.0.2 port 5201 connected to 15.0.0.1 port 33638
[ ID] Interval      Transfer    Bitrate
[ 7] 0.00-1.00    sec 1.27 GBytes 10.9 Gbits/sec
[ 7] 1.00-2.00    sec 1.31 GBytes 11.2 Gbits/sec
[ 7] 2.00-3.00    sec 1.21 GBytes 10.4 Gbits/sec
[ 7] 3.00-4.00    sec 1.19 GBytes 10.2 Gbits/sec
[ 7] 4.00-5.00    sec 668 MBytes 5.60 Gbits/sec
[ 7] 5.00-6.00    sec 481 MBytes 4.04 Gbits/sec
[ 7] 6.00-7.00    sec 646 MBytes 5.42 Gbits/sec
[ 7] 7.00-8.00    sec 712 MBytes 5.96 Gbits/sec
[ 7] 8.00-9.00    sec 856 MBytes 7.19 Gbits/sec
[ 7] 9.00-10.00   sec 771 MBytes 6.47 Gbits/sec
[ 7] 10.00-10.04  sec 14.7 MBytes 2.83 Gbits/sec
-----
[ ID] Interval      Transfer    Bitrate
[ 7] 0.00-10.04   sec 9.04 GBytes 7.73 Gbits/sec
-----
Server listening on 5201
-----
^Ciperf3: interrupt - the server has terminated
root@yuhang-VirtualBox:/home/yuhang/Desktop#
```

Conclusion

This report explored Mininet and iPerf3. Mininet is a virtual testbed used for testing network tools and protocols. The first lab invoked Mininet from the command-line interface (CLI) utility and used Miniedit to construct, emulate and save a self-defined network topology. It showed how powerful Mininet is to design your own network for testing. The second lab used iPerf3 to measure and test the designed network topology coming from the first lab. Different options from the command line utility are explored, such as intervals, port number, protocols and etc., to better understand its functionality. Through this report, Mininet and iPerf3 are well understood and hands-on experiences are acquired.