Mininet Basics - for Mac

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(Note this setup assumes you are using a mac, should be OK on windows & linux as well as long as you can get a VM running.)

Mininet is a network virtualiation tool. You can use it to simlate a network. The topology and nodes in the network can be specified programmatically with the mininet API for python, or via command line args.

- Download virtual box

https://www.virtualbox.org

- Verify the SHA256 https://www.virtualbox.org/download/hashes/6.1.30/SHA256SUMS
- OR MD5 checksums https://www.virtualbox.org/download/hashes/6.1.30/MD5SUMS

```
$ shasum -a 256 download
$ md5 download
```

Download an Ubuntu iso from the ubuntu website:
http://releases.ubuntu.com/focal/
Again, verify the checksum. I used SHA256
http://releases.ubuntu.com/focal/SHA256SUMS

- Open virtual box
- Click “New”
- Set up the VM. Name it “Ubuntu”. I recommend at least 2.5 GB RAM.
- All other settings can be default.
- Now to load the iso…
- Go to Settings->Storage.
- Click on the little disc on the left, then click on the disc on the right next to “Optical Drive”. From there select your iso.

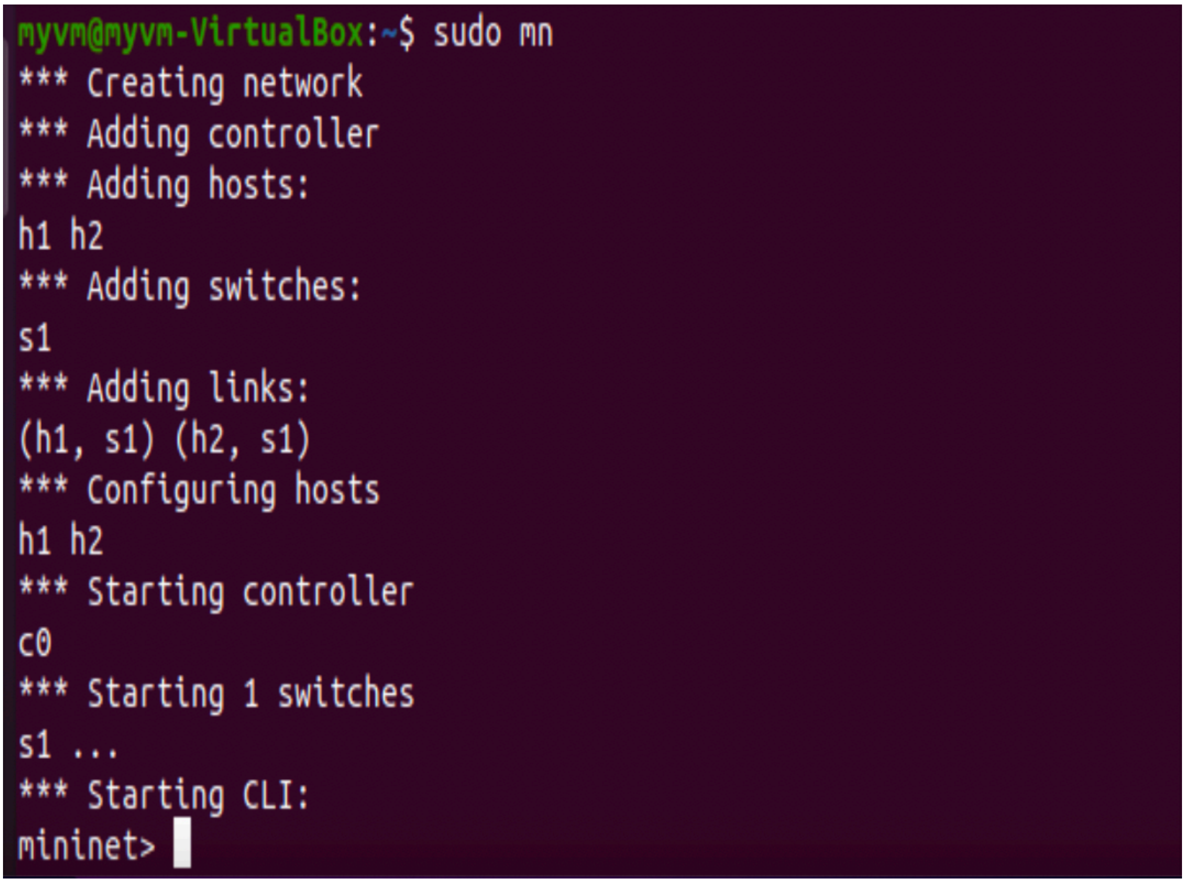
Boot up ubuntu!

Follow the Mininet tutorial to learn Mininet basics..

http://mininet.org/walkthrough/

Launch Mininet: initialises the “*minimal*” configuration: a simple network topology of 2 hosts, a switch, and a network controller.

```
$ sudo mn
```

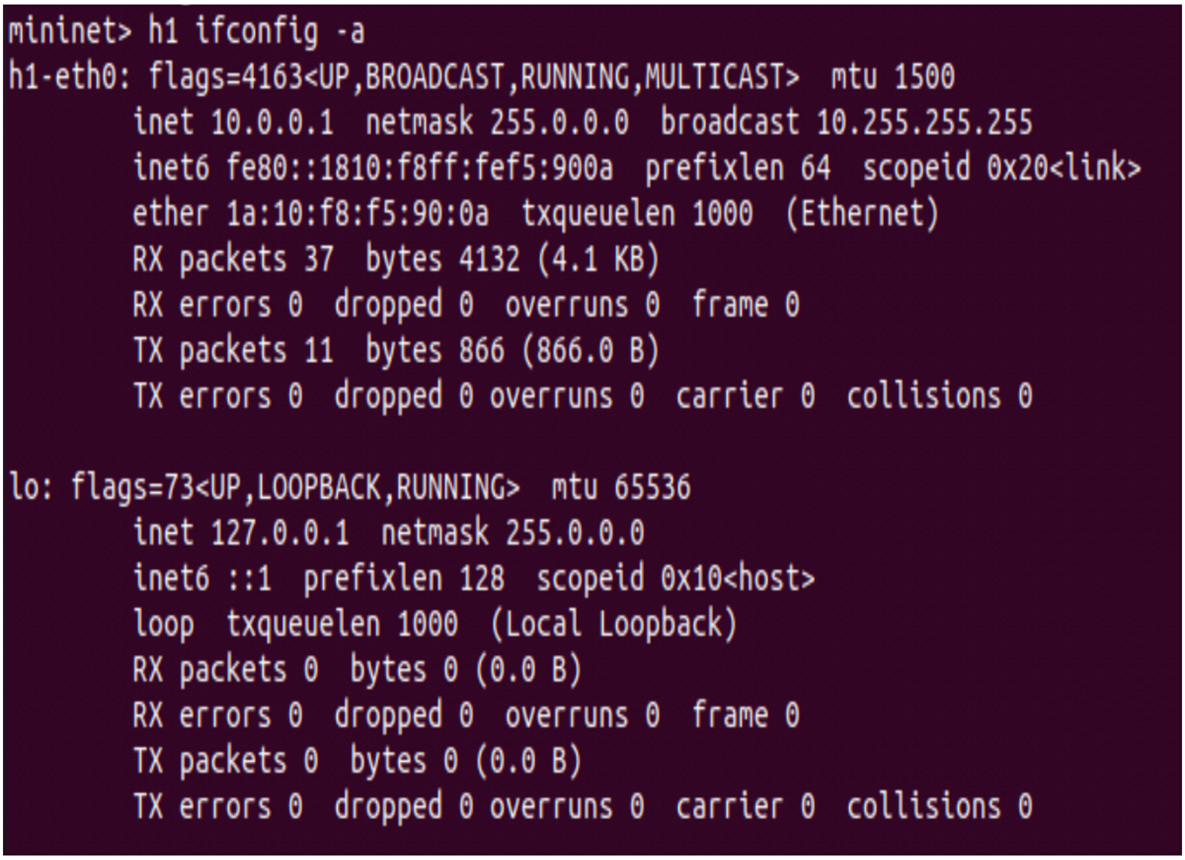


```
myvm@myvm-VirtualBox:~$ sudo mn
*** Creating network
*** Adding controller
*** Adding hosts:
h1 h2
*** Adding switches:
s1
*** Adding links:
(h1, s1) (h2, s1)
*** Configuring hosts
h1 h2
*** Starting controller
c0
*** Starting 1 switches
s1 ...
*** Starting CLI:
mininet>
```

We can prepend a command with a host name to run the command on that host.
For example:

```
$ h1 ifconfig -a
```

Runs the ifconfig command on the first host h1.

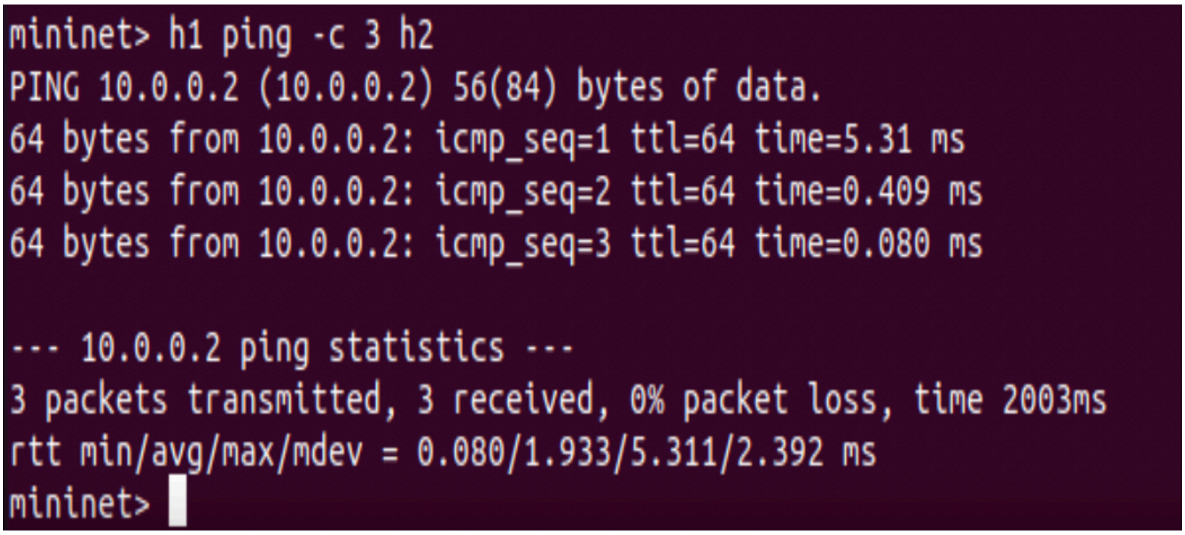


```
mininet> h1 ifconfig -a
h1-eth0: flags=4163<UP,BROADCAST,RUNNING,MULTICAST>  mtu 1500
        inet 10.0.0.1  netmask 255.0.0.0  broadcast 10.255.255.255
        inet6 fe80::1810:f8ff:fef5:900a  prefixlen 64  scopeid 0x20<link>
        ether 1a:10:f8:f5:90:0a  txqueuelen 1000  (Ethernet)
        RX packets 37  bytes 4132 (4.1 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
```

We can see the loopback address as well as the outward link going into the switch, eth0. We don’t see any other links because the host runs in its own space defined by Mininet. However only the network is virtualised, each host can see the same processes.

Pinging one host from another:

```
$ h1 ping –c 3 h2
```



```
mininet> h1 ping -c 3 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=5.31 ms
64 bytes from 10.0.0.2: icmp_seq=2 ttl=64 time=0.409 ms
64 bytes from 10.0.0.2: icmp_seq=3 ttl=64 time=0.080 ms

--- 10.0.0.2 ping statistics ---
3 packets transmitted, 3 received, 0% packet loss, time 2003ms
rtt min/avg/max/mdev = 0.080/1.933/5.311/2.392 ms
mininet> 
```

You can also run other processes on hosts, like a simple web server.

I run a simple web server on h1:

```
$ h1 python3 -m http.server 80 &
```

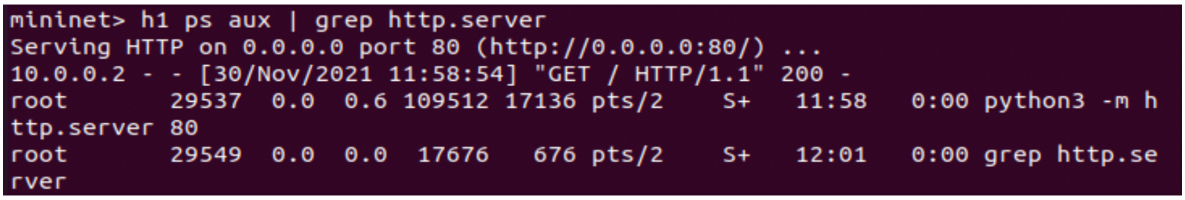
And grab it from h2:

```
$ h2 wget -O - h1
```

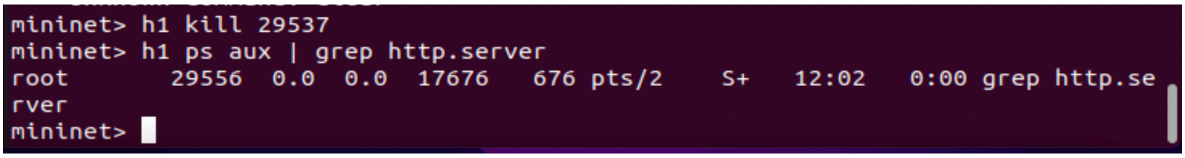
After this is done you can kill the process on h1

$ h1 ps aux | grep http.server

$ kill (process id)



```
mininet> h1 ps aux | grep http.server
Serving HTTP on 0.0.0.0 port 80 (http://0.0.0.0:80/) ...
10.0.0.2 - - [30/Nov/2021 11:58:54] "GET / HTTP/1.1" 200 -
root       29537  0.0  0.6 109512 17136 pts/2    S+   11:58   0:00 python3 -m h
ttp.server 80
root       29549  0.0  0.0  17676   676 pts/2    S+   12:01   0:00 grep http.se
rver
```



```
mininet> h1 kill 29537
mininet> h1 ps aux | grep http.server
root       29556  0.0  0.0  17676   676 pts/2    S+   12:02   0:00 grep http.se
rver
mininet> 
```

You can also do this quickly in an automated way:

```
$ sudo mn --test pingpair
```

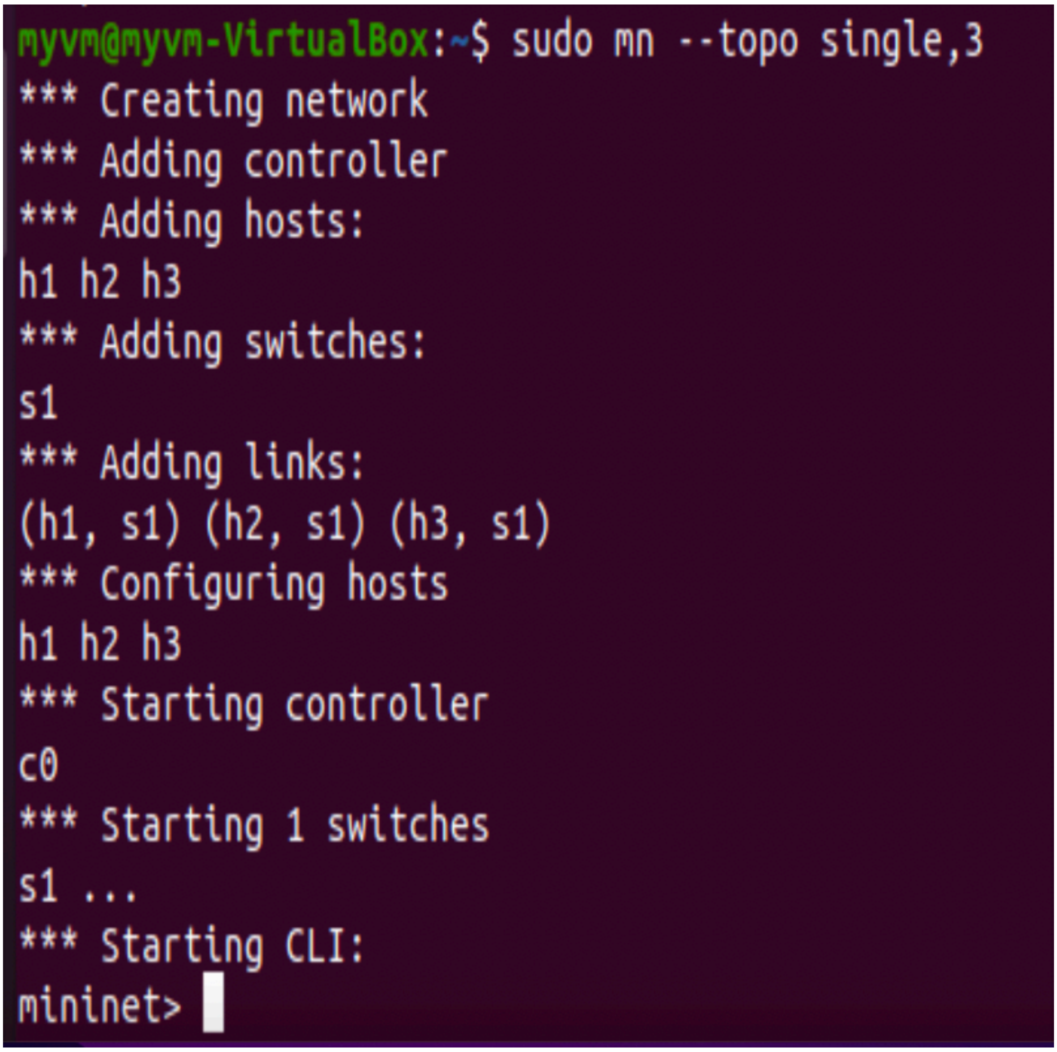
You can also parametrically test & define different network topologies.

For example, if you wanted to test a network with a switch with 3 hosts instead of two:

```
$ sudo mn --test pingall --topo single,3
```

To just initialise it, you would just use --topo

```
$ sudo mn —topo single,3
```



```
myvm@myvm-VirtualBox:~$ sudo mn --topo single,3
*** Creating network
*** Adding controller
*** Adding hosts:
h1 h2 h3
*** Adding switches:
s1
*** Adding links:
(h1, s1) (h2, s1) (h3, s1)
*** Configuring hosts
h1 h2 h3
*** Starting controller
c0
*** Starting 1 switches
s1 ...
*** Starting CLI:
mininet>
```

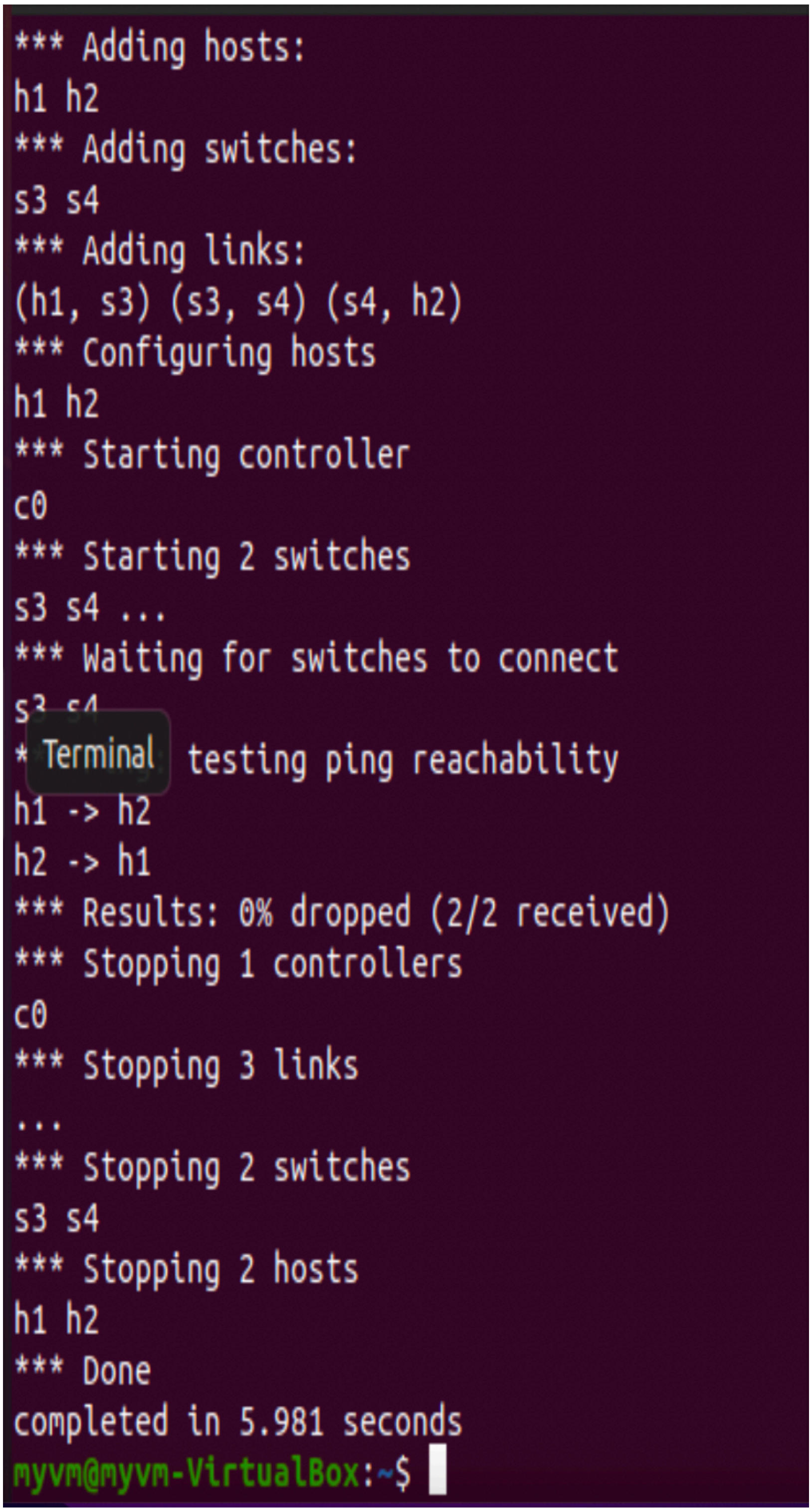
The mininet website says “Parametrized topologies are one of Mininet’s most useful and powerful features.”

Custom topology: You can use the mininet API to define a custom topology in a python script, and then you can load this in with mininet.

```
#topo-2sw-2host.py
#implements a custom topo with 2 switches, 2 hosts.

from mininet.topo import Topo

class MyTopo( Topo ):
    “Simple topology example”

    def build( self ):
        “Create custom network topography”

        #add hosts and switches
        leftHost = self.addHost( ‘h1’ )
        rightHost = self.addHost( ‘h2’ )
        leftSwitch = self.addSwitch( ’s3’ )
        rightSwitch = self.addSwitch( ’s4’ )

        #add links between nodes
        self.addLink( leftHost, leftSwitch)
        self.addLink( rightHost, rightSwitch)
        self.addLink( rightSwitch, rightHost)

topos = { ‘mytopo’ : (lambda: MyTopo() ) }
```

Running the following command to invoke the custom topology:

```
$ sudo mn —custom ./topo—2sw—2host.py —topo mytopo —test
pingall
```



```
*** Adding hosts:
h1 h2
*** Adding switches:
s3 s4
*** Adding links:
(h1, s3) (s3, s4) (s4, h2)
*** Configuring hosts
h1 h2
*** Starting controller
c0
*** Starting 2 switches
s3 s4 ...
*** Waiting for switches to connect
s3 s4
*** Ping: testing ping reachability
h1 -> h2
h2 -> h1
*** Results: 0% dropped (2/2 received)
*** Stopping 1 controllers
c0
*** Stopping 3 links
...
*** Stopping 2 switches
s3 s4
*** Stopping 2 hosts
h1 h2
*** Done
completed in 5.981 seconds
myvm@myvm-VirtualBox:~$
```

You can also add an option to make the MAC addressing of hosts more logical, and follow a 1,2,3,… pattern instead of being random. (i.e h1's MAC is 00:00:00:00:00:01, h2's MAC is 00:00:00:00:00:02, etc..)

Makes it easier to interpret wireshark traffic, ifconfig output, etc.

Before:

```
$ sudo mn
```

```
...
mininet> h1 ifconfig
h1-eth0  Link encap:Ethernet  HWaddr f6:9d:5a:7f:41:42
          inet addr:10.0.0.1  Bcast:10.255.255.255
Mask:255.0.0.0
          UP BROADCAST RUNNING MULTICAST  MTU:1500
Metric:1
          RX packets:6 errors:0 dropped:0 overruns:0
frame:0
          TX packets:6 errors:0 dropped:0 overruns:0
carrier:0
          collisions:0 txqueuelen:1000
          RX bytes:392 (392.0 B)  TX bytes:392 (392.0 B)
mininet> exit
```

After (notice HWaddr is much simpler.)

```
$ sudo mn --mac
...
mininet> h1 ifconfig
h1-eth0  Link encap:Ethernet  HWaddr 00:00:00:00:00:01
          inet addr:10.0.0.1  Bcast:10.255.255.255
Mask:255.0.0.0
          UP BROADCAST RUNNING MULTICAST  MTU:1500
Metric:1
          RX packets:0 errors:0 dropped:0 overruns:0
frame:0
          TX packets:0 errors:0 dropped:0 overruns:0
carrier:0
          collisions:0 txqueuelen:1000
          RX bytes:0 (0.0 B)  TX bytes:0 (0.0 B)
mininet> exit
```

We can also use a different switch types, here's an example using the Open vSwitch (OVS), which is preinstalled on mininet VM.

```
$ sudo mn --switch ovsk --test iperf
```

Introduction to programming Mininet networks with Python

Following the tutorial specified at https://github.com/mininet/mininet/wiki/Introduction-to-Mininet

Now we do **everything** programatically in python, no mininet command line tool.

A basic switch connected to N hosts, implemented purely in Python:

```
#!/usr/bin/python

from mininet.topo import Topo
from mininet.net import Mininet
from mininet.util import dumpNodeConnections
from mininet.log import setLogLevel

class SingleSwitchTopo(Topo):
    "Single switch connected to n hosts."
    def build(self, n=2):
        switch = self.addSwitch('s1')
        # Python's range(N) generates 0..N-1
        for h in range(n):
            host = self.addHost('h%s' % (h + 1))
            self.addLink(host, switch)

def simpleTest():
    "Create and test a simple network"
    topo = SingleSwitchTopo(n=4)
    net = Mininet(topo)
    net.start()
    print( "Dumping host connections" )
    dumpNodeConnections(net.hosts)
    print( "Testing network connectivity" )
    net.pingAll()
    net.stop()

if __name__ == '__main__':
    # Tell mininet to print useful information
    setLogLevel('info')
    simpleTest()
```

Explaining this:

“Topo” is the base class for Mininet topologies

“build():” is the method you override when you want to define a custom topology. Constructor parameters will be passed automatically by Topo.__init__().

This method creates a template for the network that consists of:

- A graph of node names
- A database of configuration information

Mininet uses this to create the network.

“addSwitch()” adds a switch to the topology and returns its name.

“addHost()” similarly adds a host.

“addLink()” creates a link between two nodes

“Mininet”: main class to create and manage a network

“start()”: starts your network

“stop()”: stops your network

“pingAll()”: Makes all nodes ping eachother. Useful for testing connectivity

“net.hosts”: all hosts in the network

“dumpNodeConnections()”: dumps connections to / from a set of nodes.