



TKN SS18 Lab: SDN Applications

Lab report

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Chapters

- ▶ 1. Initial setup
- ▶ 2. Some commands
- ▶ 3. Executing a topology with 3 hosts, each connected to each of the 3 switches (STP enabled), and iperf readings.
- ▶ 4. Ryu Topology Viewer
- ▶ 5. Executing a topology with 3 hosts, each connected to the 2 of the 3 switches with link aggregation, and iperf readings

Chapter 1. Initial setup

- ▶ Download and install the latest version of Oracle VM.
- ▶ Download and import Mininet 2.2.2 image 64 bit in a VM.
- ▶ In network settings, enable the second adapter and choose Host-only adapter.
- ▶ Perform **'sudo apt-get update'** and **'sudo apt-upgrade'**, post first start of mininet.
- ▶ Enable DHCP client for eth1 interface.
- ▶ A GUI version of mininet environment can be downloaded for working on multiple sessions. To do that use the following command:
'sudo apt-get update && sudo apt-get install xinit lxde virtualbox-guest-dkms'

Mininet GUI environment



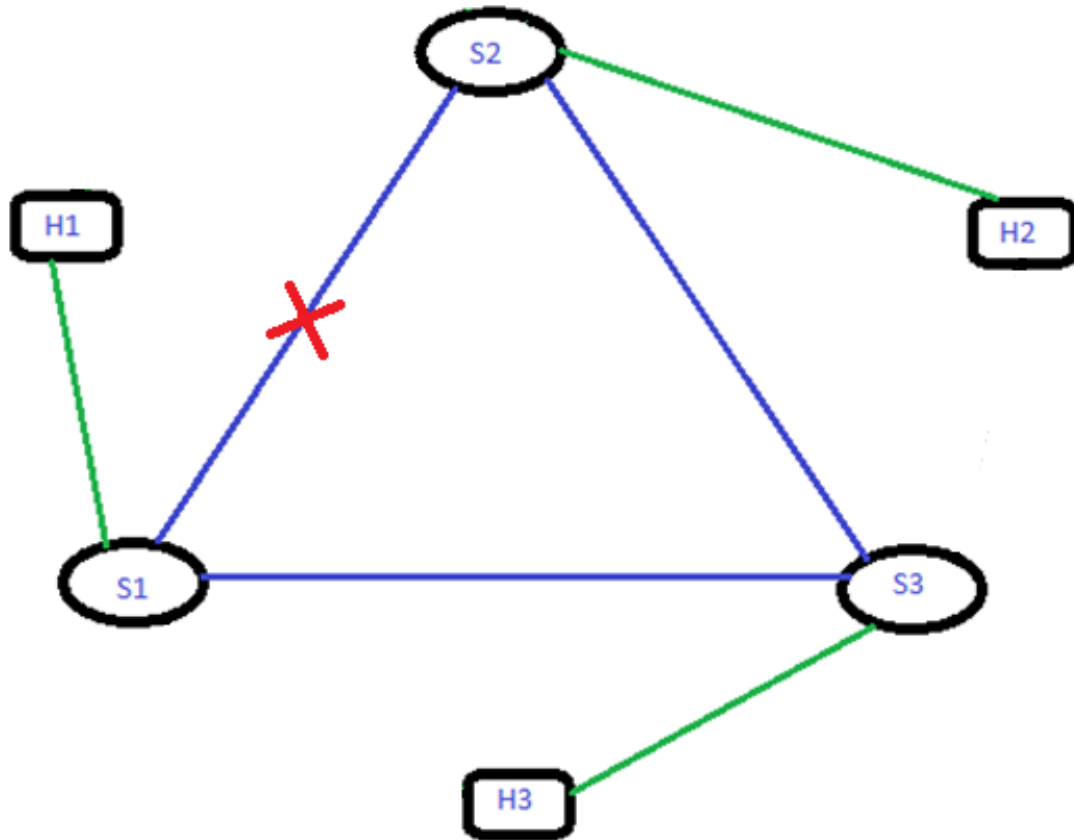
Chapter 2. Some commands

- ▶ To initiate mininet with a topology:
`'sudo mn --controller=remote --custom <filename> --topo <topo name>'`
- ▶ To specify OpenFlow protocol version:
`'sudo ovs-vsctl set bridge <switch_name> protocols=OpenFlow13'`
- ▶ To enable STP: `'ovs-vsctl set bridge <switch_name> stp-enable=true'`
- ▶ To run a switch: `'PYTHONPATH=. ./bin/ryu-manager ryu/app/<filename>.py'`
- ▶ IPERF measurement –

Opening a TCP connection: `'iperf -s'`

Running an iperf – `'iperf -c <destination IP> -t <t in secs> (optional)'`

Chapter 3



Executing a topology with 3 hosts, each connected to each of the 3 switches, and iperf readings.

Setting up and running the topology

- ▶ Make sure eth1 and eth0 interfaces have IP addresses.
- ▶ Execute the .py topology file from mininet/custom directory with the following command: `'sudo mn --controller=remote --custom <filename> --topo <topo name>'`
- ▶ The topology can be designed in the following way in a python file.

Add hosts and switches

```
Host1 = self.addHost( 'h1' )  
Host2 = self.addHost( 'h2' )  
Host3 = self.addHost( 'h3' )  
Switch1 = self.addSwitch( 's1' )  
Switch2 = self.addSwitch( 's2' )  
Switch3 = self.addSwitch( 's3' )
```

Add links

```
self.addLink( Host1, Switch1 )  
self.addLink( Host2, Switch2 )  
self.addLink( Host3, Switch3 )  
  
self.addLink( Switch1, Switch2 )  
self.addLink( Switch2, Switch3 )  
self.addLink( Switch3, Switch1 )
```

- ▶ When the topology gets live, run a controller that is simple_switch_13.py using the following command:
`PYTHONPATH=. ./bin/ryu-manager ryu/app/<filename>.py`

Iperf readings

taken after the topology was running with a controller

The screenshot displays six terminal windows arranged in a 2x3 grid, showing Iperf test results on three nodes: h1, h2, and h3. Each window shows the command executed, the connection details, and the test results for a 50-second interval.

Node	Local IP	Remote IP	Transfer (GB)	Bandwidth (Gbps)
h1	10.0.0.1	10.0.0.2	16.8	2.89
h2	10.0.0.2	10.0.0.1	16.3	2.80
h3	10.0.0.3	10.0.0.1	12.9	2.21
h1	10.0.0.1	10.0.0.3	13.8	2.36
h2	10.0.0.2	10.0.0.3	12.9	2.22
h3	10.0.0.3	10.0.0.2	13.1	2.24

Each terminal window shows the following output:

```
root@mininet-vm:~/mininet/custom# iperf -c 10.0.0.2 -t 50
Client connecting to 10.0.0.2, TCP port 5001
TCP window size: 85.3 KByte (default)
-----
[ 19] local 10.0.0.1 port 47818 connected with 10.0.0.2 port 5001
[ ID] Interval      Transfer    Bandwidth
[ 19] 0.0-50.0 sec  16.8 GBytes  2.89 Gbits/sec
root@mininet-vm:~/mininet/custom#
```


Iperf readings (50 secs) in a tabular format

Destination Source	H1	H2	H3
H1	-	2.89 Gbps	2.36 Gbps
H2	2.80 Gbps	-	2.22 Gbps
H3	2.21 Gbps	2.24 Gbps	-

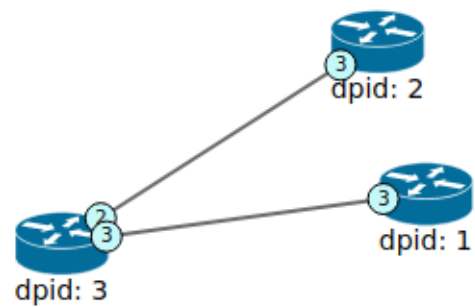
Chapter 4. Ryu Topology Viewer

Ryu topology viewer helps to visualize the topology that is already running.

- ▶ Run mininet with any desired topology.
- ▶ In another console, navigate to the directory where python files for running switches are located and execute the following command in another window:
`'ryu run gui_topology/gui_topology.py' <filename>.py --observe-links'`
- ▶ Make sure there are no errors present post execution.
- ▶ Go to a browser and type in the eth0 IP address of mininet followed by colon and the port number 8080.
- ▶ E.g. 192.168.1.1:8080

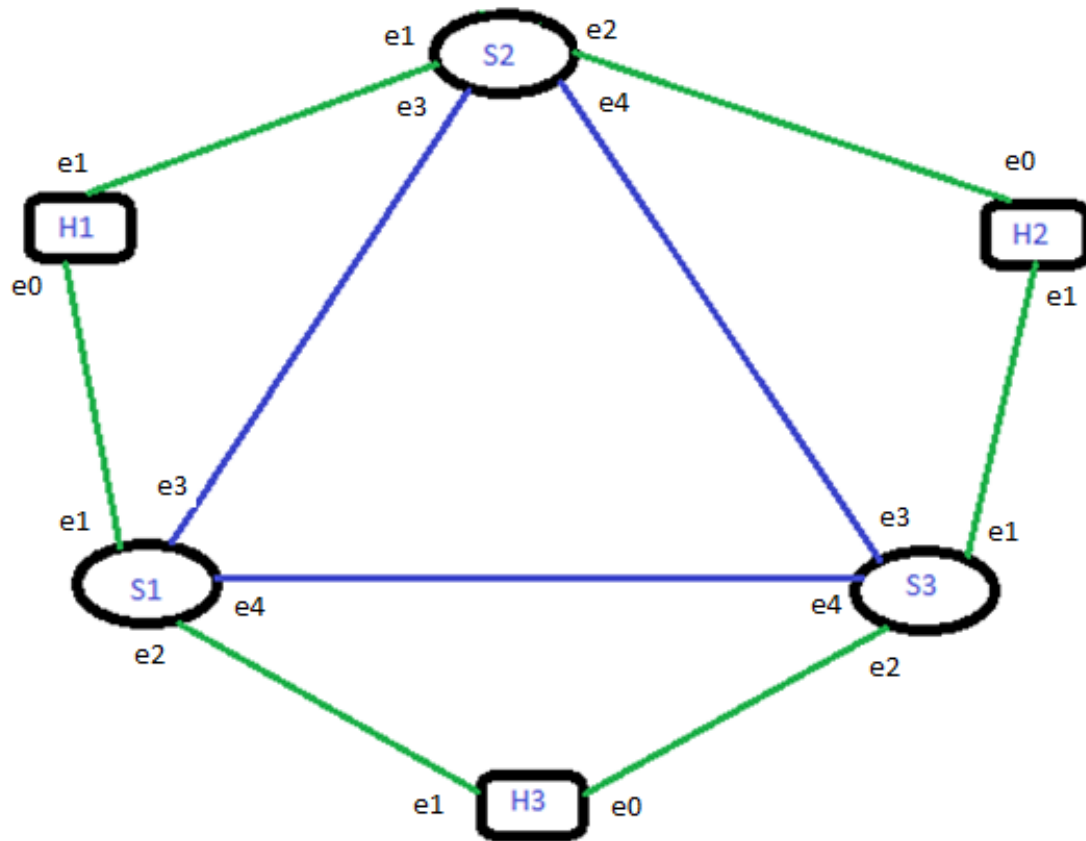
← → ↻ ⓘ 192.168.137.219:8080

Ryu Topology Viewer



mininet@mi... [mininet@mi... [emacs24@... ["Node: h1"] ["Node: h3"] ["Node: h2"]

Chapter 5



Executing a topology with 3 hosts, each connected to 2 of the 3 switches.

Requirements:

- To have equal throughput across all the links.
- To use all the links.
- As much as it gets.

Setting up and running the topology

- ▶ Follow the initial steps from the 3rd chapter.
- ▶ The topology can be designed in the following way in a python file which will create 3 switches and 3 hosts, each host connected to 2 switches

Add hosts and switches

```
Host1 = self.addHost( 'h1' )  
Host2 = self.addHost( 'h2' )  
Host3 = self.addHost( 'h3' )  
Switch1 = self.addSwitch( 's1' )  
Switch2 = self.addSwitch( 's2' )  
Switch3 = self.addSwitch( 's3' )
```

Add links

```
self.addLink( Host1, Switch1 )  
self.addLink( Host1, Switch2 )  
self.addLink( Host2, Switch2 )  
self.addLink( Host2, Switch3 )  
self.addLink( Host3, Switch3 )  
self.addLink( Host3, Switch1 )  
self.addLink( Switch1, Switch2 )  
self.addLink( Switch2, Switch3 )  
self.addLink( Switch3, Switch1 )
```

Accomplishing the requirements.

- ▶ Here, the idea is to divide the topology in 3 different network.
- ▶ When the network goes live after executing the topology and starting up the controller (**simple_switch_13.py**), the following things need to be configured on each host.
- ▶ The directly connected destination host's interface must be in the same network of the source host's interface. So, in the topology H1's 'e1' interface is connected to H2's 'e0' interface via switch.

Likewise,

Connections	Network
H1 e0 <-> H3 e1	10.0.0.0/29
H1 e1 <-> H2 e0	10.0.1.0/29
H2 e1 <-> H3 e0	10.0.2.0/29

- ▶ This way all the links will be used with equal throughput and every host will be reachable from every other host.
- ▶ Configuration on each host:

H1	H2	H3
Ip addr add 10.0.0.1 dev h1-eth0	Ip addr add 10.0.1.2 dev h1-eth0	Ip addr add 10.0.2.2 dev h1-eth0
Ip addr add 10.0.1.1 dev h1-eth1	Ip addr add 10.0.2.1 dev h1-eth1	Ip addr add 10.0.0.2 dev h1-eth1

Iperf readings 20 secs

```
"Node: h1"
root@mininet-vm:~/mininet/custom# iperf -c 10.0.1.2 -t 20
-----
Client connecting to 10.0.1.2, TCP port 5001
TCP window size: 85,3 KByte (default)
-----
[ 19] local 10.0.1.1 port 54074 connected with 10.0.1.2 port 5001
[ ID] Interval      Transfer    Bandwidth
[ 19] 0.0-20.0 sec  4.01 GBytes  1.72 Gbits/sec
root@mininet-vm:~/mininet/custom#

"Node: h2"
root@mininet-vm:~/mininet/custom# iperf -c 10.0.1.1 -t 20
-----
Client connecting to 10.0.1.1, TCP port 5001
TCP window size: 85,3 KByte (default)
-----
[ 19] local 10.0.1.2 port 55802 connected with 10.0.1.1 port 5001
[ ID] Interval      Transfer    Bandwidth
[ 19] 0.0-20.0 sec  3.04 GBytes  1.30 Gbits/sec
root@mininet-vm:~/mininet/custom#

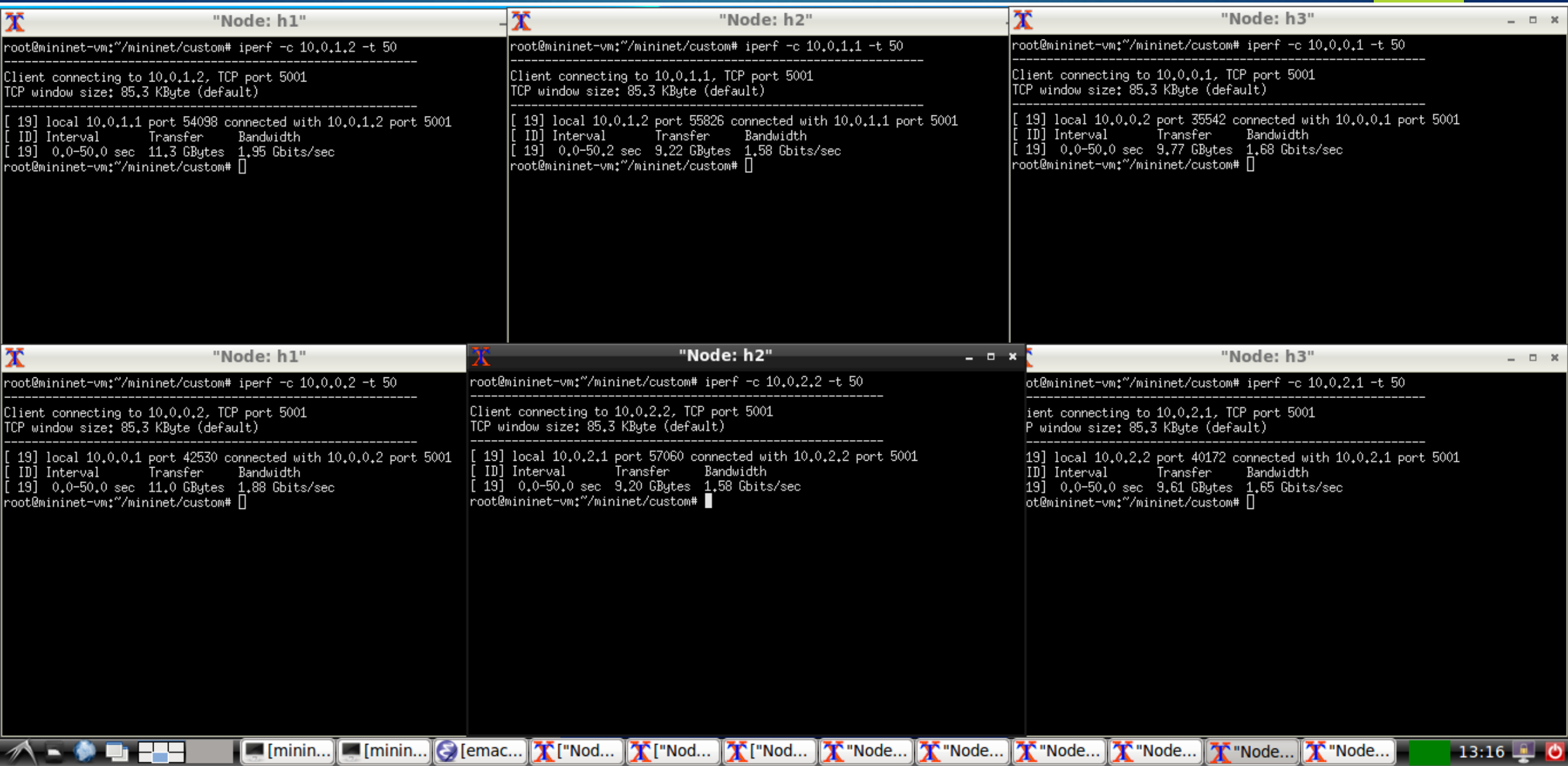
"Node: h3"
root@mininet-vm:~/mininet/custom# iperf -c 10.0.0.1 -t 20
-----
Client connecting to 10.0.0.1, TCP port 5001
TCP window size: 85,3 KByte (default)
-----
[ 19] local 10.0.0.2 port 35516 connected with 10.0.0.1 port 5001
[ ID] Interval      Transfer    Bandwidth
[ 19] 0.0-20.0 sec  3.17 GBytes  1.36 Gbits/sec
root@mininet-vm:~/mininet/custom#

"Node: h1"
root@mininet-vm:~/mininet/custom# iperf -c 10.0.0.2 -t 20
-----
Client connecting to 10.0.0.2, TCP port 5001
TCP window size: 85,3 KByte (default)
-----
[ 19] local 10.0.0.1 port 42506 connected with 10.0.0.2 port 5001
[ ID] Interval      Transfer    Bandwidth
[ 19] 0.0-20.0 sec  3.83 GBytes  1.64 Gbits/sec
root@mininet-vm:~/mininet/custom#

"Node: h2"
root@mininet-vm:~/mininet/custom# iperf -c 10.0.2.2 -t 20
-----
Client connecting to 10.0.2.2, TCP port 5001
TCP window size: 85,3 KByte (default)
-----
[ 19] local 10.0.2.1 port 57036 connected with 10.0.2.2 port 5001
[ ID] Interval      Transfer    Bandwidth
[ 19] 0.0-20.0 sec  3.02 GBytes  1.30 Gbits/sec
root@mininet-vm:~/mininet/custom#

"Node: h3"
ot@mininet-vm:~/mininet/custom# iperf -c 10.0.2.1 -t 20
-----
ient connecting to 10.0.2.1, TCP port 5001
P window size: 85,3 KByte (default)
-----
19] local 10.0.2.2 port 40150 connected with 10.0.2.1 port 5001
ID] Interval      Transfer    Bandwidth
19] 0.0-20.0 sec  3.35 GBytes  1.44 Gbits/sec
ot@mininet-vm:~/mininet/custom#
```

Iperf readings 50 secs



```
root@mininet-vm:~/mininet/custom# iperf -c 10.0.1.2 -t 50
-----
Client connecting to 10.0.1.2, TCP port 5001
TCP window size: 85.3 KByte (default)
-----
[ 19] local 10.0.1.1 port 54098 connected with 10.0.1.2 port 5001
[ ID] Interval      Transfer    Bandwidth
[ 19] 0.0-50.0 sec  11.3 GBytes  1.95 Gbits/sec
root@mininet-vm:~/mininet/custom#
```

```
root@mininet-vm:~/mininet/custom# iperf -c 10.0.1.1 -t 50
-----
Client connecting to 10.0.1.1, TCP port 5001
TCP window size: 85.3 KByte (default)
-----
[ 19] local 10.0.1.2 port 55826 connected with 10.0.1.1 port 5001
[ ID] Interval      Transfer    Bandwidth
[ 19] 0.0-50.2 sec   9.22 GBytes  1.58 Gbits/sec
root@mininet-vm:~/mininet/custom#
```

```
root@mininet-vm:~/mininet/custom# iperf -c 10.0.0.1 -t 50
-----
Client connecting to 10.0.0.1, TCP port 5001
TCP window size: 85.3 KByte (default)
-----
[ 19] local 10.0.0.2 port 35542 connected with 10.0.0.1 port 5001
[ ID] Interval      Transfer    Bandwidth
[ 19] 0.0-50.0 sec   9.77 GBytes  1.68 Gbits/sec
root@mininet-vm:~/mininet/custom#
```

```
root@mininet-vm:~/mininet/custom# iperf -c 10.0.0.2 -t 50
-----
Client connecting to 10.0.0.2, TCP port 5001
TCP window size: 85.3 KByte (default)
-----
[ 19] local 10.0.0.1 port 42530 connected with 10.0.0.2 port 5001
[ ID] Interval      Transfer    Bandwidth
[ 19] 0.0-50.0 sec  11.0 GBytes  1.88 Gbits/sec
root@mininet-vm:~/mininet/custom#
```

```
root@mininet-vm:~/mininet/custom# iperf -c 10.0.2.2 -t 50
-----
Client connecting to 10.0.2.2, TCP port 5001
TCP window size: 85.3 KByte (default)
-----
[ 19] local 10.0.2.1 port 57060 connected with 10.0.2.2 port 5001
[ ID] Interval      Transfer    Bandwidth
[ 19] 0.0-50.0 sec   9.20 GBytes  1.58 Gbits/sec
root@mininet-vm:~/mininet/custom#
```

```
ot@mininet-vm:~/mininet/custom# iperf -c 10.0.2.1 -t 50
-----
ient connecting to 10.0.2.1, TCP port 5001
P window size: 85.3 KByte (default)
-----
[ 19] local 10.0.2.2 port 40172 connected with 10.0.2.1 port 5001
[ ID] Interval      Transfer    Bandwidth
[ 19] 0.0-50.0 sec   9.61 GBytes  1.65 Gbits/sec
ot@mininet-vm:~/mininet/custom#
```

Iperf readings in a tabular format

Destination Source		H1		H2		H3	
		20 secs	50 secs	20 secs	50 secs	20 secs	50 secs
H1	Bandwidth			1.72 Gbps	1.95 Gbps	1.64 Gbps	1.88 Gbps
	Transfer			4.01 GBs	11.3 GBs	3.83 GBs	11.0 GBs
H2	Bandwidth	1.30 Gbps	1.58 Gbps			1.30 Gbps	1.58 Gbps
	Transfer	3.04 GBs	9.22 GBs			3.02 GBs	9.20 GBs
H3	Bandwidth	1.36 Gbps	1.68 Gbps	1.44 Gbps	1.65 Gbps		
	Transfer	3.17 GBs	9.77 GBs	3.35 GBs	9.61 GBs		

Ifconfig for all 3 hosts

Each host can be seen utilizing its both the links

"Node: h1"	"Node: h2"	"Node: h3"
<pre>root@mininet-vm:~/mininet/custom# ifconfig h1-eth0 Link encap:Ethernet HWaddr e2:15:55:2c:bc:ea inet addr:10.0.0.1 Bcast:0.0.0.0 Mask:255.255.255.248 UP BROADCAST RUNNING MULTICAST MTU:1500 Metric:1 RX packets:531282 errors:0 dropped:0 overruns:0 frame:0 TX packets:451604 errors:0 dropped:0 overruns:0 carrier:0 collisions:0 txqueuelen:1000 RX bytes:9380896388 (9.3 GB) TX bytes:10873406176 (10.8 GB) h1-eth1 Link encap:Ethernet HWaddr 8e:7a:d3:45:ef:fa inet addr:10.0.1.1 Bcast:0.0.0.0 Mask:255.255.255.248 UP BROADCAST RUNNING MULTICAST MTU:1500 Metric:1 RX packets:651315 errors:0 dropped:0 overruns:0 frame:0 TX packets:642632 errors:0 dropped:0 overruns:0 carrier:0 collisions:0 txqueuelen:1000 RX bytes:8713070838 (8.7 GB) TX bytes:14806145216 (14.8 GB) lo Link encap:Local Loopback inet addr:127.0.0.1 Mask:255.0.0.0 UP LOOPBACK RUNNING MTU:65536 Metric:1 RX packets:3 errors:0 dropped:0 overruns:0 frame:0 TX packets:3 errors:0 dropped:0 overruns:0 carrier:0 collisions:0 txqueuelen:0 RX bytes:336 (336.0 B) TX bytes:336 (336.0 B) root@mininet-vm:~/mininet/custom#</pre>	<pre>root@mininet-vm:~/mininet/custom# ifconfig h2-eth0 Link encap:Ethernet HWaddr 02:5f:6d:00:20:df inet addr:10.0.1.2 Bcast:0.0.0.0 Mask:255.255.255.248 UP BROADCAST RUNNING MULTICAST MTU:1500 Metric:1 RX packets:786715 errors:0 dropped:0 overruns:0 frame:0 TX packets:513421 errors:0 dropped:0 overruns:0 carrier:0 collisions:0 txqueuelen:1000 RX bytes:14812196702 (14.8 GB) TX bytes:8707279346 (8.7 GB) h2-eth1 Link encap:Ethernet HWaddr 02:c6:7f:bb:4b:78 inet addr:10.0.2.1 Bcast:0.0.0.0 Mask:255.255.255.248 UP BROADCAST RUNNING MULTICAST MTU:1500 Metric:1 RX packets:715988 errors:0 dropped:0 overruns:0 frame:0 TX packets:596081 errors:0 dropped:0 overruns:0 carrier:0 collisions:0 txqueuelen:1000 RX bytes:8981072520 (8.9 GB) TX bytes:9090992402 (9.0 GB) lo Link encap:Local Loopback inet addr:127.0.0.1 Mask:255.0.0.0 UP LOOPBACK RUNNING MTU:65536 Metric:1 RX packets:1 errors:0 dropped:0 overruns:0 frame:0 TX packets:1 errors:0 dropped:0 overruns:0 carrier:0 collisions:0 txqueuelen:0 RX bytes:112 (112.0 B) TX bytes:112 (112.0 B) root@mininet-vm:~/mininet/custom#</pre>	<pre>root@mininet-vm:~/mininet/custom# ifconfig h3-eth0 Link encap:Ethernet HWaddr 92:7f:d3:a7:da:13 inet addr:10.0.2.2 Bcast:0.0.0.0 Mask:255.255.255.248 UP BROADCAST RUNNING MULTICAST MTU:1500 Metric:1 RX packets:741290 errors:0 dropped:0 overruns:0 frame:0 TX packets:578614 errors:0 dropped:0 overruns:0 carrier:0 collisions:0 txqueuelen:1000 RX bytes:9097091180 (9.0 GB) TX bytes:8975302924 (8.9 GB) h3-eth1 Link encap:Ethernet HWaddr aa:81:b4:2c:58:80 inet addr:10.0.0.2 Bcast:0.0.0.0 Mask:255.255.255.248 UP BROADCAST RUNNING MULTICAST MTU:1500 Metric:1 RX packets:596640 errors:0 dropped:0 overruns:0 frame:0 TX packets:388878 errors:0 dropped:0 overruns:0 carrier:0 collisions:0 txqueuelen:1000 RX bytes:10879497688 (10.8 GB) TX bytes:9374915420 (9.3 GB) lo Link encap:Local Loopback inet addr:127.0.0.1 Mask:255.0.0.0 UP LOOPBACK RUNNING MTU:65536 Metric:1 RX packets:2 errors:0 dropped:0 overruns:0 frame:0 TX packets:2 errors:0 dropped:0 overruns:0 carrier:0 collisions:0 txqueuelen:0 RX bytes:168 (168.0 B) TX bytes:168 (168.0 B) root@mininet-vm:~/mininet/custom#</pre>

The end

