Computer Comm & Networks - ITCS 8166 (Assignment – 3)

Abdullah Al Raqibul Islam (UNCC ID# **801151189**)

Software Details

1. Host Operating System and version: macOS (Version: 10.15.7)
2. Virtualization tool name and version: VirtualBox (Version: 6.1.16)

Milestones

1. Your application should learn the switches, links and hosts by observing the Packet_In event. To generate Packet_In event, use the mininet pingall function.

Answer:

Code attached:

- Topology definition: code/aislam6_topo.py
- RYU Controller: code/aislam6_ryu.py

2. Print the network topology to show links, hosts and switches. ()

Answer:

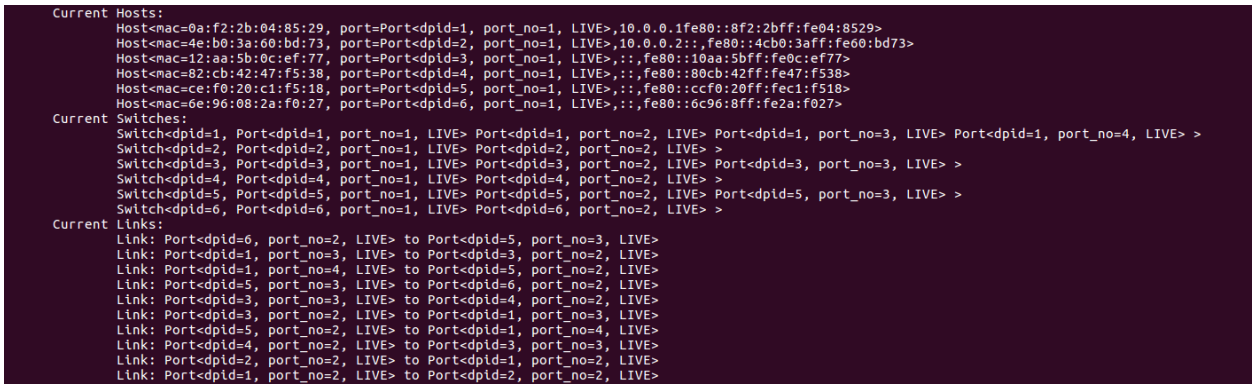
Code attached:

- Topology definition: code/aislam6_topo.py
- RYU Controller: code/aislam6_ryu.py

Reproduce: Run the attached codes using the following commands:

```
> sudo ryu-manager aislam6_ryu.py --observe-links
> sudo python aislam6_topo.py
```

Verification and required information/output: Screenshot attached below



Screenshot: Printing network topology

3. Now, you have the network topology. Using iperf, measure the bandwidth(bw) between hosts and include the resulting bw as cost of the link. Since the link from host to switch is unconstrained, the bw you measure between two adjacent hosts will be bandwidth of links connecting two adjacent switches of the hosts.

Answer:

Code attached:

- Topology definition: code/aislam6_topo.py
- RYU Controller: code/aislam6_ryu.py

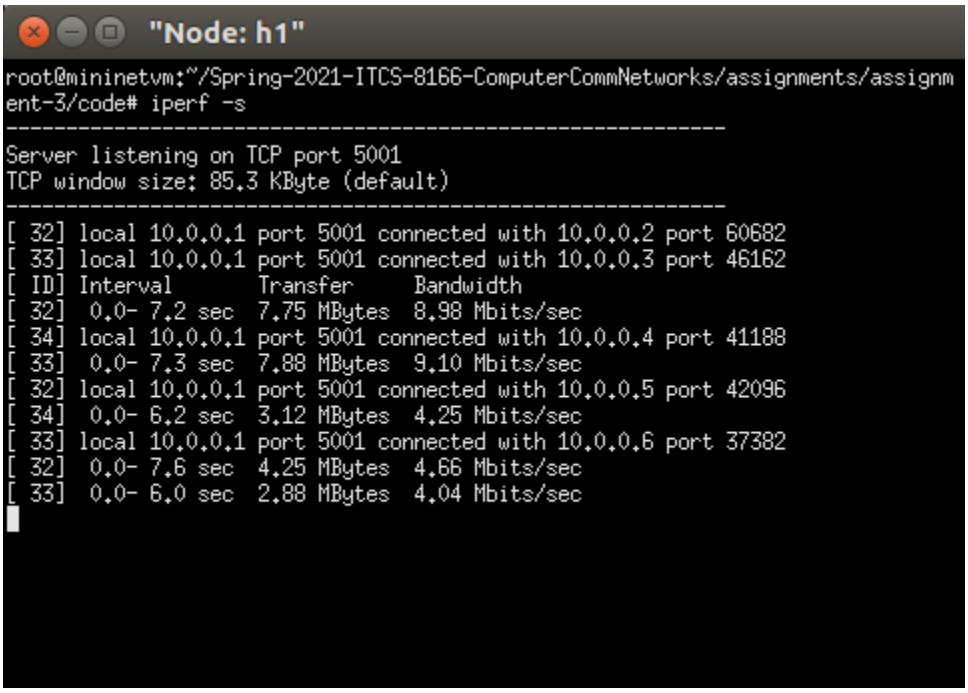
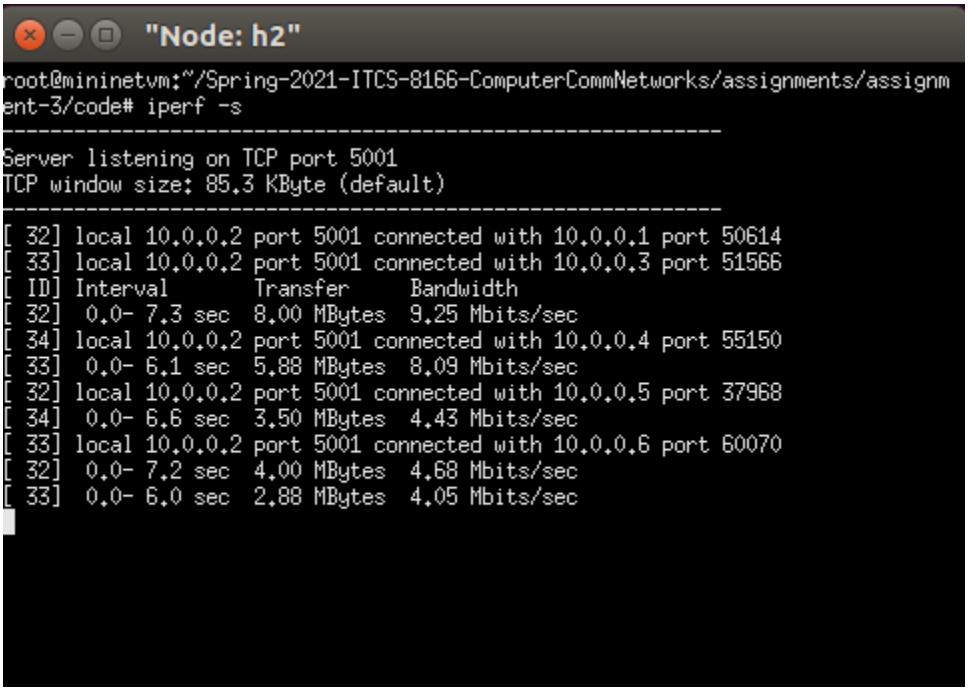
Process:

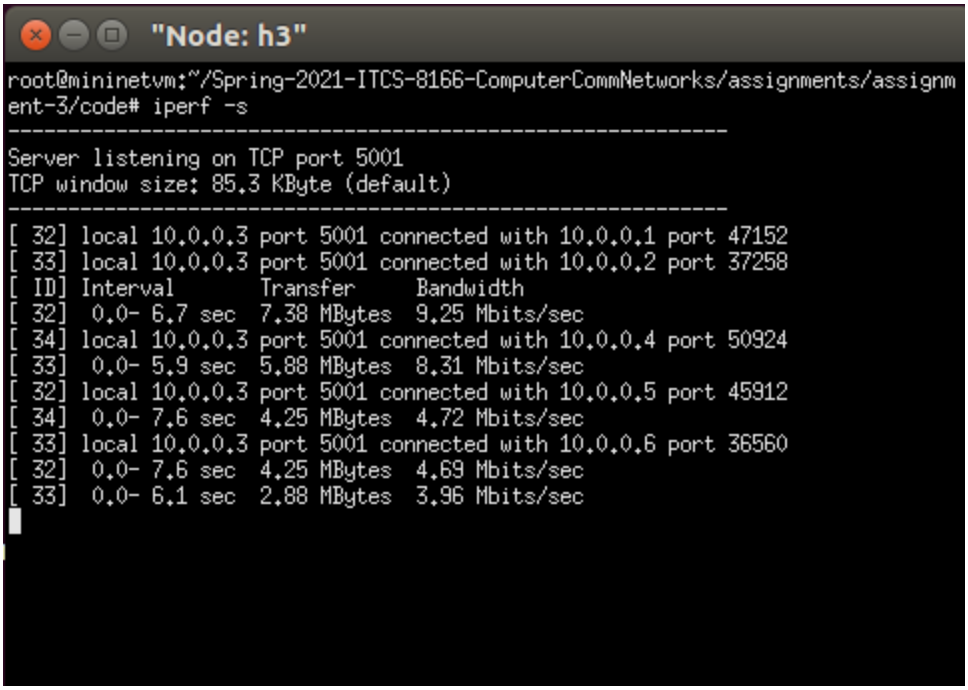
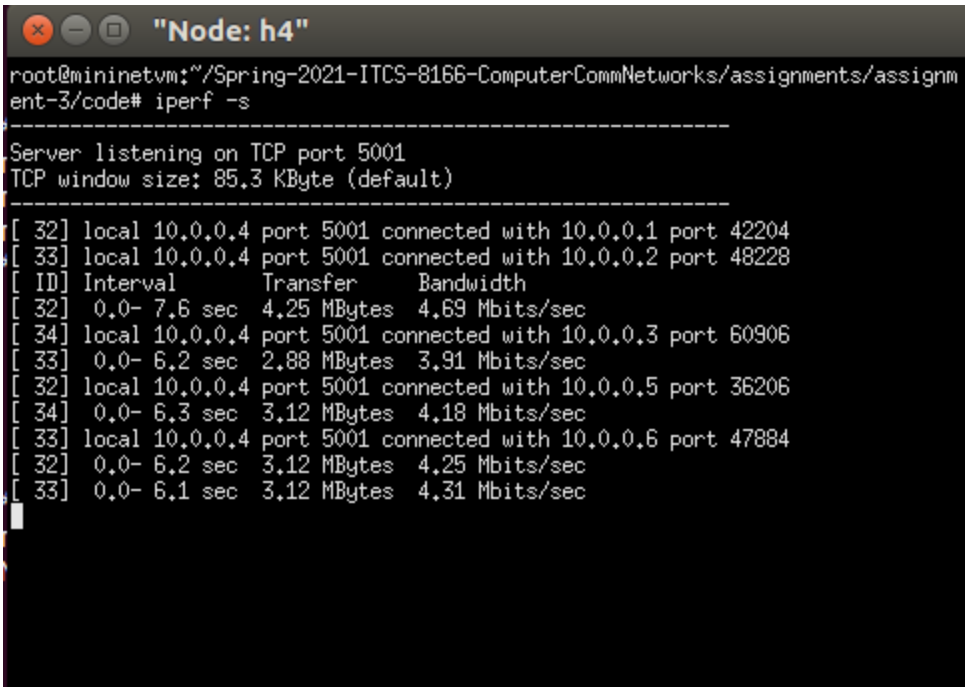
- Run iperf server on all the hosts
- The ryu-controller runs the iperf client to measure the bandwidth between the hosts

Reproduce: Run the attached codes using the following commands:

```
> sudo ryu-manager aislam6_ryu.py --observe-links
> sudo python aislam6_topo.py

# After running the topology, mininet CLI will launch. Now run
the following command to start terminal for all the hosts

mininet> xterm h1 h2 h3 h4 h5 h6

# Now start a iperf server in each of the 6 terminals (for 6
hosts)
> iperf -s

# Now in the mininet terminal, run the “pingall” command to
initiate the link-cost measuring process
```

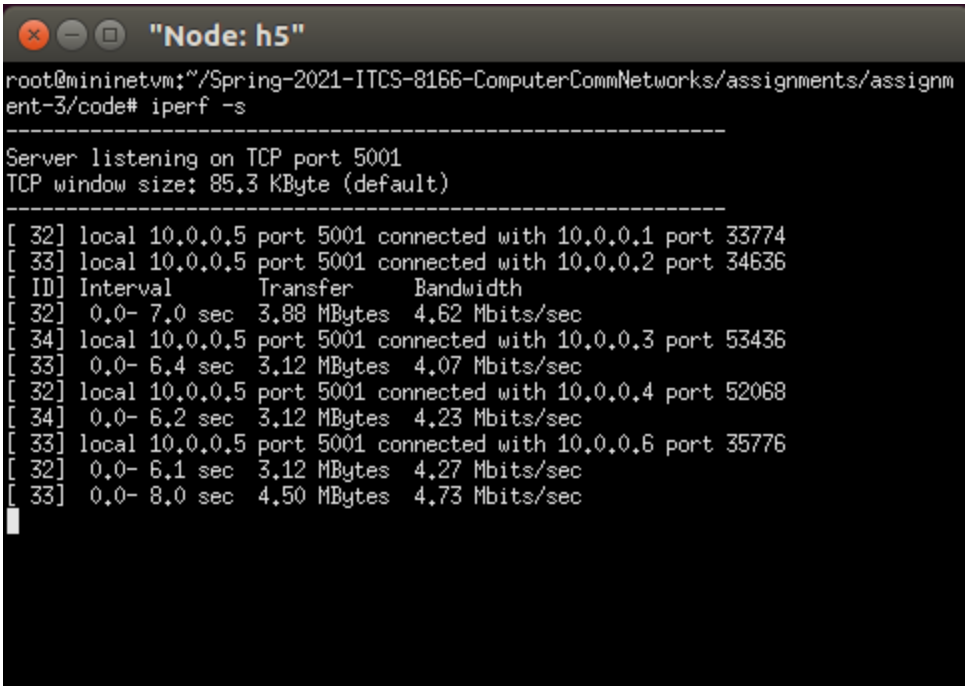
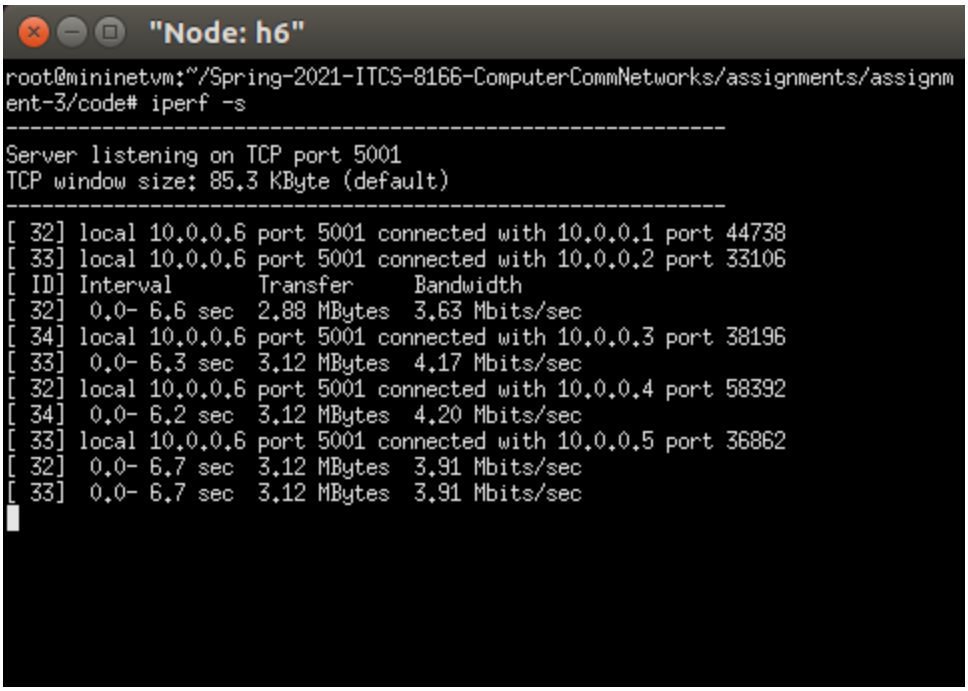
Verification and required information/output: Screenshot of iperf servers attached below

Host-1	
Host-2	

Host-3	
Host-4	

"Node: h3"
root@mininetvm:~/Spring-2021-ITCS-8166-ComputerCommNetworks/assignments/assignment-3/code# iperf -s
Server listening on TCP port 5001
TCP window size: 85.3 KByte (default)
[32] local 10.0.0.3 port 5001 connected with 10.0.0.1 port 47152
[33] local 10.0.0.3 port 5001 connected with 10.0.0.2 port 37258
[ID] Interval Transfer Bandwidth
[32] 0.0- 6.7 sec 7.38 MBytes 9.25 Mbits/sec
[34] local 10.0.0.3 port 5001 connected with 10.0.0.4 port 50924
[33] 0.0- 5.9 sec 5.88 MBytes 8.31 Mbits/sec
[32] local 10.0.0.3 port 5001 connected with 10.0.0.5 port 45912
[34] 0.0- 7.6 sec 4.25 MBytes 4.72 Mbits/sec
[33] local 10.0.0.3 port 5001 connected with 10.0.0.6 port 36560
[32] 0.0- 7.6 sec 4.25 MBytes 4.69 Mbits/sec
[33] 0.0- 6.1 sec 2.88 MBytes 3.96 Mbits/sec

"Node: h4"
root@mininetvm:~/Spring-2021-ITCS-8166-ComputerCommNetworks/assignments/assignment-3/code# iperf -s
Server listening on TCP port 5001
TCP window size: 85.3 KByte (default)
[32] local 10.0.0.4 port 5001 connected with 10.0.0.1 port 42204
[33] local 10.0.0.4 port 5001 connected with 10.0.0.2 port 48228
[ID] Interval Transfer Bandwidth
[32] 0.0- 7.6 sec 4.25 MBytes 4.69 Mbits/sec
[34] local 10.0.0.4 port 5001 connected with 10.0.0.3 port 60906
[33] 0.0- 6.2 sec 2.88 MBytes 3.91 Mbits/sec
[32] local 10.0.0.4 port 5001 connected with 10.0.0.5 port 36206
[34] 0.0- 6.3 sec 3.12 MBytes 4.18 Mbits/sec
[33] local 10.0.0.4 port 5001 connected with 10.0.0.6 port 47884
[32] 0.0- 6.2 sec 3.12 MBytes 4.25 Mbits/sec
[33] 0.0- 6.1 sec 3.12 MBytes 4.31 Mbits/sec

Host-5	
Host-6	

4. Print the network topology along with list costs.

Answer:

Verification and required information/output: Screenshot attached below

```
        Current Hosts:
                Host<mac=1a:20:be:02:bf:5d, port=Port<dpid=1, port_no=1, LIVE>,10.0.0.1fe80::1820:beff:fe02:bf5d>
                Host<mac=0a:e7:a4:9e:19:35, port=Port<dpid=2, port_no=1, LIVE>,10.0.0.2fe80::8e7:a4ff:fe9e:1935>
                Host<mac=66:3b:7d:93:b0:64, port=Port<dpid=3, port_no=1, LIVE>,10.0.0.3>
                Host<mac=82:bf:71:6b:d9:3d, port=Port<dpid=4, port_no=1, LIVE>,10.0.0.4>
                Host<mac=3e:ca:3a:55:48:35, port=Port<dpid=5, port_no=1, LIVE>,10.0.0.5>
                Host<mac=d2:7f:46:4a:9e:e6, port=Port<dpid=6, port_no=1, LIVE>,10.0.0.6>
        Current Switches:
                Switch<dpid=1, Port<dpid=1, port_no=1, LIVE> Port<dpid=1, port_no=2, LIVE> Port<dpid=1, port_no=3, LIVE> Port<dpid=1, port_no=4, LIVE> >
                Switch<dpid=2, Port<dpid=2, port_no=1, LIVE> Port<dpid=2, port_no=2, LIVE> >
                Switch<dpid=3, Port<dpid=3, port_no=1, LIVE> Port<dpid=3, port_no=2, LIVE> Port<dpid=3, port_no=3, LIVE> >
                Switch<dpid=4, Port<dpid=4, port_no=1, LIVE> Port<dpid=4, port_no=2, LIVE> >
                Switch<dpid=5, Port<dpid=5, port_no=1, LIVE> Port<dpid=5, port_no=2, LIVE> Port<dpid=5, port_no=3, LIVE> >
                Switch<dpid=6, Port<dpid=6, port_no=1, LIVE> Port<dpid=6, port_no=2, LIVE> >
        Current Links:
                Link: Port<dpid=6, port_no=2, LIVE> to Port<dpid=5, port_no=3, LIVE>
                Link: Port<dpid=1, port_no=3, LIVE> to Port<dpid=3, port_no=2, LIVE>
                Link: Port<dpid=1, port_no=4, LIVE> to Port<dpid=5, port_no=2, LIVE>
                Link: Port<dpid=5, port_no=3, LIVE> to Port<dpid=6, port_no=2, LIVE>
                Link: Port<dpid=3, port_no=3, LIVE> to Port<dpid=4, port_no=2, LIVE>
                Link: Port<dpid=2, port_no=2, LIVE> to Port<dpid=1, port_no=2, LIVE>
                Link: Port<dpid=5, port_no=2, LIVE> to Port<dpid=1, port_no=4, LIVE>
                Link: Port<dpid=4, port_no=2, LIVE> to Port<dpid=3, port_no=3, LIVE>
                Link: Port<dpid=3, port_no=2, LIVE> to Port<dpid=1, port_no=3, LIVE>
                Link: Port<dpid=1, port_no=2, LIVE> to Port<dpid=2, port_no=2, LIVE>
***Measuring Bandwidth***
iperf --server on h1 with ip 10.0.0.1 and iperf --client in h2
iperf --server on h1 with ip 10.0.0.1 and iperf --client in h3
iperf --server on h1 with ip 10.0.0.1 and iperf --client in h4
iperf --server on h1 with ip 10.0.0.1 and iperf --client in h5
iperf --server on h1 with ip 10.0.0.1 and iperf --client in h6
iperf --server on h2 with ip 10.0.0.2 and iperf --client in h1
iperf --server on h2 with ip 10.0.0.2 and iperf --client in h3
iperf --server on h2 with ip 10.0.0.2 and iperf --client in h4
iperf --server on h2 with ip 10.0.0.2 and iperf --client in h5
iperf --server on h2 with ip 10.0.0.2 and iperf --client in h6
iperf --server on h3 with ip 10.0.0.3 and iperf --client in h1
iperf --server on h3 with ip 10.0.0.3 and iperf --client in h2
```

Screenshot: Network topology while measuring link-cost (not able to capture both of them in a single screen)

```
***Measuring Bandwidth***
iperf --server on h1 with ip 10.0.0.1 and iperf --client in h2
iperf --server on h1 with ip 10.0.0.1 and iperf --client in h3
iperf --server on h1 with ip 10.0.0.1 and iperf --client in h4
iperf --server on h1 with ip 10.0.0.1 and iperf --client in h5
iperf --server on h1 with ip 10.0.0.1 and iperf --client in h6
iperf --server on h2 with ip 10.0.0.2 and iperf --client in h1
iperf --server on h2 with ip 10.0.0.2 and iperf --client in h3
iperf --server on h2 with ip 10.0.0.2 and iperf --client in h4
iperf --server on h2 with ip 10.0.0.2 and iperf --client in h5
iperf --server on h2 with ip 10.0.0.2 and iperf --client in h6
iperf --server on h3 with ip 10.0.0.3 and iperf --client in h1
iperf --server on h3 with ip 10.0.0.3 and iperf --client in h2
iperf --server on h3 with ip 10.0.0.3 and iperf --client in h4
iperf --server on h3 with ip 10.0.0.3 and iperf --client in h5
iperf --server on h3 with ip 10.0.0.3 and iperf --client in h6
iperf --server on h4 with ip 10.0.0.4 and iperf --client in h1
iperf --server on h4 with ip 10.0.0.4 and iperf --client in h2
iperf --server on h4 with ip 10.0.0.4 and iperf --client in h3
iperf --server on h4 with ip 10.0.0.4 and iperf --client in h5
iperf --server on h4 with ip 10.0.0.4 and iperf --client in h6
iperf --server on h5 with ip 10.0.0.5 and iperf --client in h1
iperf --server on h5 with ip 10.0.0.5 and iperf --client in h2
iperf --server on h5 with ip 10.0.0.5 and iperf --client in h3
iperf --server on h5 with ip 10.0.0.5 and iperf --client in h4
iperf --server on h5 with ip 10.0.0.5 and iperf --client in h6
iperf --server on h6 with ip 10.0.0.6 and iperf --client in h1
iperf --server on h6 with ip 10.0.0.6 and iperf --client in h2
iperf --server on h6 with ip 10.0.0.6 and iperf --client in h3
iperf --server on h6 with ip 10.0.0.6 and iperf --client in h4
iperf --server on h6 with ip 10.0.0.6 and iperf --client in h5
Link Costs: {('h3', 'h2'): 9.18, ('h2', 'h3'): 9.44, ('h5', 'h2'): 6.33, ('h1', 'h4'): 6.42, ('h4', 'h3'): 6.44, ('h6', 'h3'): 4.68, ('h5', 'h6'): 4.81, ('h2', 'h4'): 4.65, ('h3', 'h5'): 5.08,
('h5', 'h1'): 6.38, ('h3', 'h1'): 12.2, ('h2', 'h5'): 4.82, ('h3', 'h4'): 5.04, ('h6', 'h4'): 5.11, ('h2', 'h1'): 12.1, ('h1', 'h3'): 12.0, ('h4', 'h5'): 5.06, ('h6', 'h1'): 4.65, ('h5', 'h4'):
 5.1, ('h1', 'h6'): 4.67, ('h4', 'h1'): 4.89, ('h6', 'h5'): 6.48, ('h2', 'h6'): 5.03, ('h1', 'h2'): 12.2, ('h4', 'h6'): 5.06, ('h5', 'h3'): 6.43, ('h1', 'h5'): 6.18, ('h4', 'h2'): 5.38, ('h3',
'h6'): 5.05, ('h6', 'h2'): 4.75}
```

Screenshot: Measuring link-costs and list of link-costs