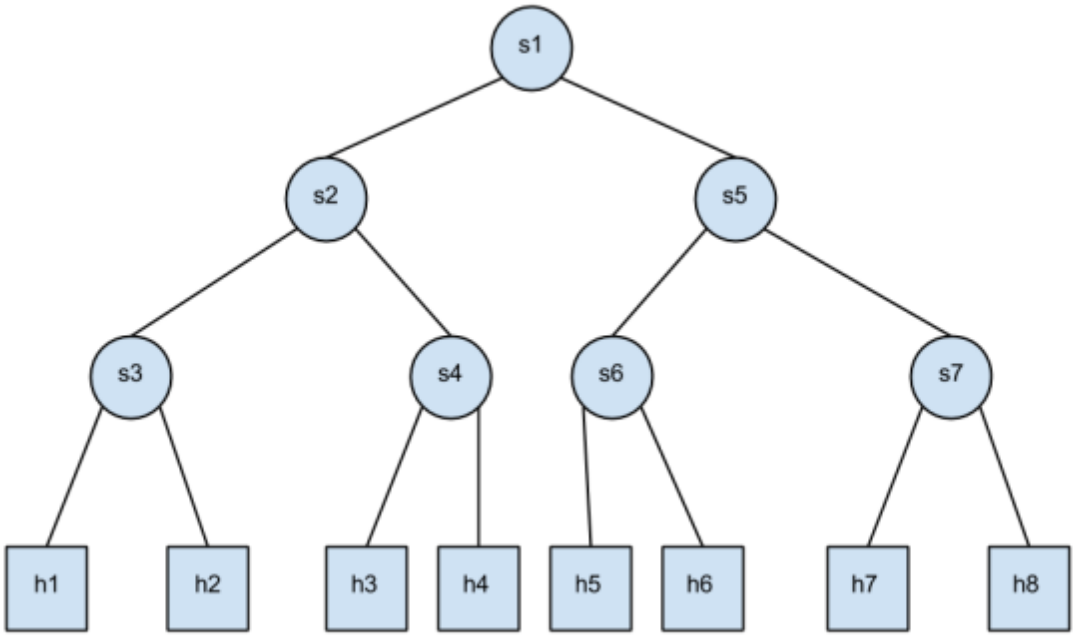
COEN 241
Cloud Computing
HOMEWORK-3
MININET AND OPENFLOW
REPORT

Piyush Kulkarni
ID: 1629006

—

Task 1 - Defining custom topologies



1. What is the output of “nodes” and “net”
Answer:
mininet> nodes gives all the nodes in the current topology

```
mininet> nodes
available nodes are:
c0 h1 h2 h3 h4 h5 h6 h7 h8 s1 s2 s3 s4 s5 s6 s7
mininet>
```

mininet> net displays all the links in the current topology.

```
mininet> net
h1 h1-eth0:s3-eth2
h2 h2-eth0:s3-eth3
h3 h3-eth0:s4-eth2
h4 h4-eth0:s4-eth3
h5 h5-eth0:s6-eth2
h6 h6-eth0:s6-eth3
h7 h7-eth0:s7-eth2
h8 h8-eth0:s7-eth3
s1 lo:  s1-eth1:s2-eth1 s1-eth2:s5-eth1
s2 lo:  s2-eth1:s1-eth1 s2-eth2:s3-eth1 s2-eth3:s4-eth1
s3 lo:  s3-eth1:s2-eth2 s3-eth2:h1-eth0 s3-eth3:h2-eth0
s4 lo:  s4-eth1:s2-eth3 s4-eth2:h3-eth0 s4-eth3:h4-eth0
s5 lo:  s5-eth1:s1-eth2 s5-eth2:s6-eth1 s5-eth3:s7-eth1
s6 lo:  s6-eth1:s5-eth2 s6-eth2:h5-eth0 s6-eth3:h6-eth0
s7 lo:  s7-eth1:s5-eth3 s7-eth2:h7-eth0 s7-eth3:h8-eth0
c0
mininet>
```

It is observed that the interface eth0 of the host h1 is connected to eth2 of switch s3 and the interface eth0 of host h2 is connected to eth3 of switch s3, and so on.

2. What is the output of “h7 ifconfig”

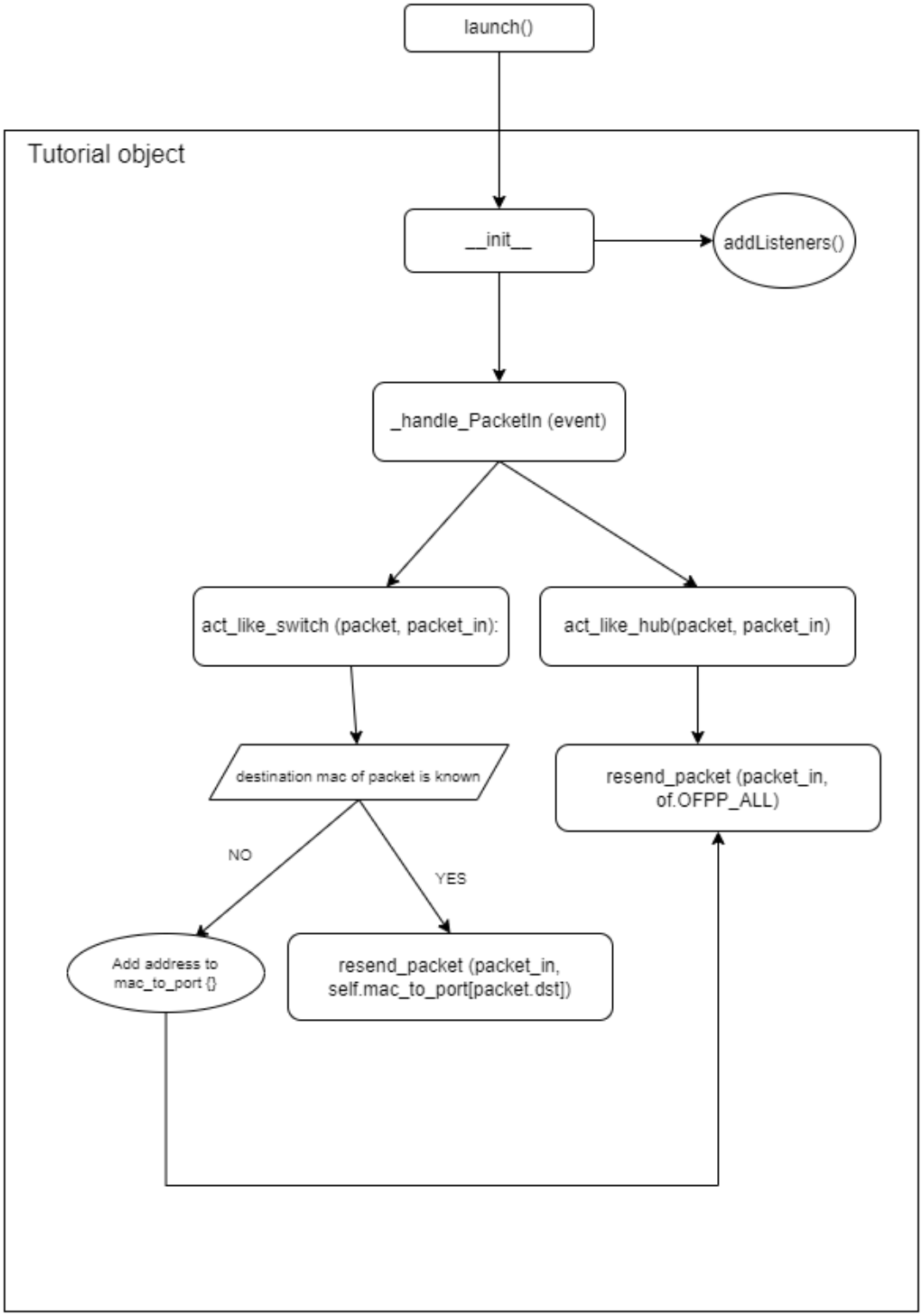
Answer: This command displays the IP address, broadcast address and MAC address of the host h7.

```
mininet> h7 ifconfig
h7-eth0: flags=4163<UP,BROADCAST,RUNNING,MULTICAST>  mtu 1500
        inet 10.0.0.7  netmask 255.0.0.0  broadcast 10.255.255.255
        inet6 fe80::dcc1:57ff:fea9:e875  prefixlen 64  scopeid 0x20<link>
        ether de:c1:57:a9:e8:75  txqueuelen 1000  (Ethernet)
        RX packets 29  bytes 2002 (2.0 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
```

Task 2 - Analyze the “of_tutorial’ controller

1. Draw the function call graph of this controller. For example, once a packet comes to the controller, which function is the first to be called, which one is the second, and so forth?



2. Have h1 ping h2, and h1 ping h8 for 100 times (e.g., h1 ping -c100 p2).

h1 ping h2

```
100 packets transmitted, 100 received, 0% packet loss, time 99367ms
rtt min/avg/max/mdev = 0.778/7.060/194.161/20.207 ms
```

h1 ping h8

```
100 packets transmitted, 100 received, 0% packet loss, time 99251ms
rtt min/avg/max/mdev = 9.007/28.943/312.170/43.574 ms
```

a. How long does it take (on average) to ping for each case?

h1 ping h2 : 7.060 ms
h1 ping h8 : 28.943

b. What is the minimum and maximum ping you have observed?

h1 ping h2:
- minimum -> 0.778
- maximum -> 194.161

h1 ping h8:
- minimum -> 9.007
- maximum -> 312.170

c. What is the difference, and why?

It is observed that the ping observed for h1 ping h8 is significantly higher than h1 ping h8. The main reason for this could be the multiple number of switches that a packet must be transmitted through, from h1 to h8, as compared to just one switch between h1 and h8.

3. Run “iperf h1 h2” and “iperf h1 h8”

```
mininet> iperf h1 h2
*** Iperf: testing TCP bandwidth between h1 and h2
.*** Results: ['8.00 Mbits/sec', '9.06 Mbits/sec']
mininet> iperf h1 h8
*** Iperf: testing TCP bandwidth between h1 and h8
*** Results: ['3.46 Mbits/sec', '3.94 Mbits/sec']
mininet>
```

a. What is “iperf” used for?

iperf does performance evaluation of the network. It runs regression tests between the specified nodes. Returns two-element array of [server, client] speeds.

b. What is the throughput for each case?

h2 h2:

Server - 8.00 Mbits/sec
Client - 9.06 Mbits/sec

h1 h8:

Server - 3.46 Mbits/sec
Client - 3.94 Mbits/sec

c. What is the difference, and explain the reasons for the difference.
It is observed that the throughput observed for h1 ping h8 is less than half of that observed for h1 ping h8. It takes more time for a packet to pass through multiple switches, as a switch has to broadcast every incoming packet to every other node.
Whereas h1 and h2 have just one switch between them, resulting in a faster packet transfer rate.

4. Which of the switches observe traffic?
All switches observe traffic.

Task 3: MAC Learning Controller

1. Describe how the above code works, such as how the "MAC to Port" map is established. You could use a 'ping' example to describe the establishment process (e.g., h1 ping h2).
Considering operation h1 ping h2, the packet has to be transmitted through switch 's3'. Here, when the packet p arrives from h1 on one of its input ports, mac_to_port{} is checked for the occurrence of packet.src as key, and value as the input port. This indicates that the port can be used every time a packet is to be transmitted to the host specified in the key.
If the pair is present, the packet is sent to the specified port.
If not, the switch learns by adding the key,value pair to mac_to_port{}, and the packet is sent out to every port other than the input port.

2. Have h1 ping h2, and h1 ping h8 for 100 times (e.g., h1 ping -c100 p2).

h1 ping h2

```
100 packets transmitted, 100 received, 0% packet loss, time 99342ms
rtt min/avg/max/mdev = 1.171/11.274/102.988/18.678 ms
```

h1 ping h8

```
100 packets transmitted, 100 received, 0% packet loss, time 99357ms
rtt min/avg/max/mdev = 12.062/35.437/230.000/28.790 ms
```

a. How long did it take (on average) to ping for each case?

h1 ping h2 : 11.274 ms
h1 ping h8 : 35.437 ms

b. What is the minimum and maximum ping you have observed?

h1 ping h2:
    minimum -> 1.171 ms
    maximum -> 102.988 ms
h1 ping h8:
    minimum -> 12.062 ms
    maximum -> 230.0 ms

c. Any difference from Task 2 and why do you think there is a change if there is?
Although the average ping is slightly higher than that of Task2, the minimum and maximum values of ping are quite lower than those observed in task2. This is because the switch now has a better understanding of the network, through storing known mac addresses, and reducing the need of broadcasting an incoming packet to every other switch. Now it has to make a transfer to one known address, which reduces the time spent in overall transmission, and thus the ping.

3. Run "iperf h1 h2" and "iperf h1 h8".

```
mininet> iperf h1 h2
*** Iperf: testing TCP bandwidth between h1 and h2
*** Results: ['646 Kbits/sec', '824 Kbits/sec']
mininet> iperf h1 h8
*** Iperf: testing TCP bandwidth between h1 and h8
*** Results: ['148 Kbits/sec', '332 Kbits/sec']
```

a. What is the throughput for each case?
h2 h2:
    Server - 646 Kbits/sec
    Client - 824 Kbits/sec

h1 h8:
    Server - 148 Kbits/sec
    Client - 332 Kbits/sec