CS3543 Lab Assignment for Feb 19th (Deadline: 23:59 on February 25th (TUE), 2020)

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General Information

1. This assignment is a pair assignment. The same mark will be offered to the pair of students regardless of individual contributions.
2. The assignment is customized for Ubuntu + KVM environment. It is highly recommended for non-Ubuntu users to enable dual boot on your laptop computer and install Ubuntu. If you would like to work on another operating system and virtualization platform, you need to interpret the Ubuntu/KVM terminology to another environment's terminology.
3. Each pair can create a locally copy of this question file, give the answer to the local copy, and submit in a form of PDF file.
4. Only one submission is good enough as far as the student name and ID are properly mentioned.
5. Do not send any private comment to separately mention the buddy.

Question 1.

Install Mininet as a VM and SDN Controller of your choice. Form a custom network topology using Mininet Hosts and Open vSwitch (OVS) given in Figure 1. Manually configure IP address to each Mininet Host. It is highly recommended to give IP addresses in the same prefix to avoid routing in the network. Activate OVSes as stand-alone learning switches without SDN Controller. Launch Mininet using "-x" options so that you will get terminal access to Mininet Hosts and Open vSwitches.

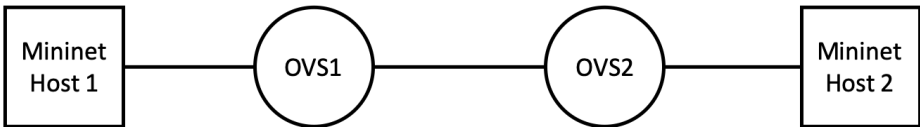


Figure 1.

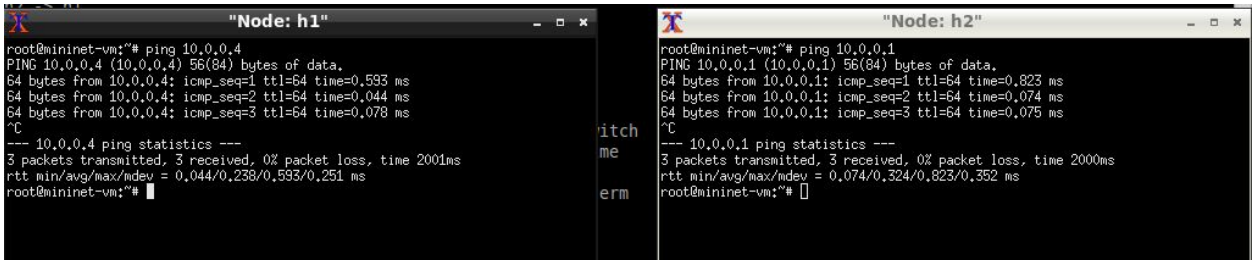
1.1. Give the screen capture of Mininet Configuration for the custom topology creation.

```
mininet@mininet-vm:~$ sudo mn --custom ~/mininet/custom/topo-2sw-2host.py --topo mytopo -x --controller=none
*** Creating network
*** Adding controller
*** Adding hosts:
h1 h2
*** Adding switches:
s3 s4
*** Adding links:
(h1, s3) (s3, s4) (s4, h2)
*** Configuring hosts
h1 h2
*** Running terms on :0
*** Starting controller

*** Starting 2 switches
s3 s4 ...
*** Starting CLI:
mininet> pingall
*** Ping: testing ping reachability
h1 -> h2
h2 -> h1
*** Results: 0% dropped (2/2 received)
mininet>
```

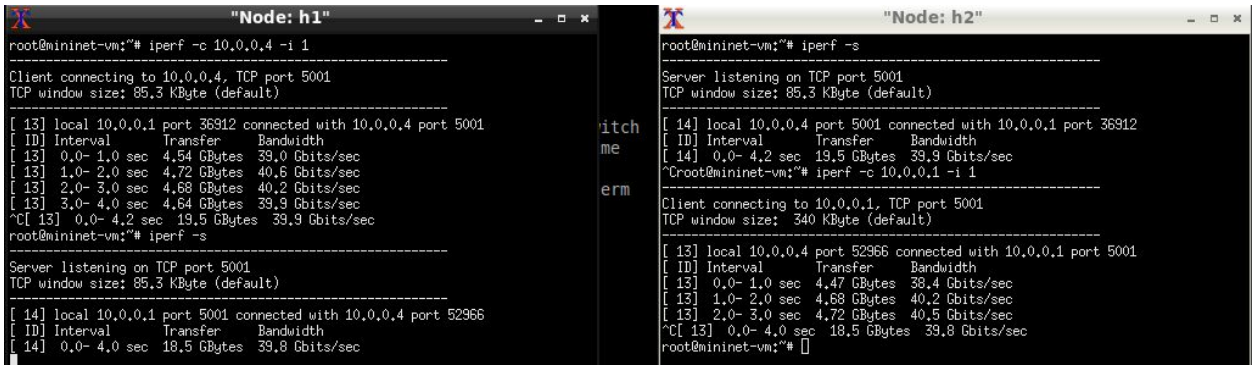
```python
from mininet.topo import Topo

class MyTopo( Topo ):
    "Simple topology example."

    def __init__( self ):
        "Create custom topo."

        # Initialize topology
        Topo.__init__( self )

        # Add hosts and switches
        leftHost = self.addHost( 'h1', ip='10.0.0.1/24' )
        rightHost = self.addHost( 'h2', ip='10.0.0.4/24' )
        leftSwitch = self.addSwitch( 's3' , failMode='standalone')
        rightSwitch = self.addSwitch( 's4', failMode='standalone' )

        # Add links
        self.addLink( leftHost, leftSwitch )
        self.addLink( leftSwitch, rightSwitch )
        self.addLink( rightSwitch, rightHost )


topos = { 'mytopo': ( lambda: MyTopo() ) }
```

1.2. Run ping and iperf between Mininet Hosts, and insert the screen captures of the results.

ping



iperf



Question 2.

Form a custom network topology using Mininet Hosts, Open vSwitch (OVS) and SDN controller of your choice given in Figure 2. Activate OVSes as SDN Switches that need instruction by SDN Controller. Activate SDN controller using the standard Learning Switch code, which is available as a sample code bundled with most SDN Controllers. Refer to the tutorials of Mininet and each SDN Controller if needed.

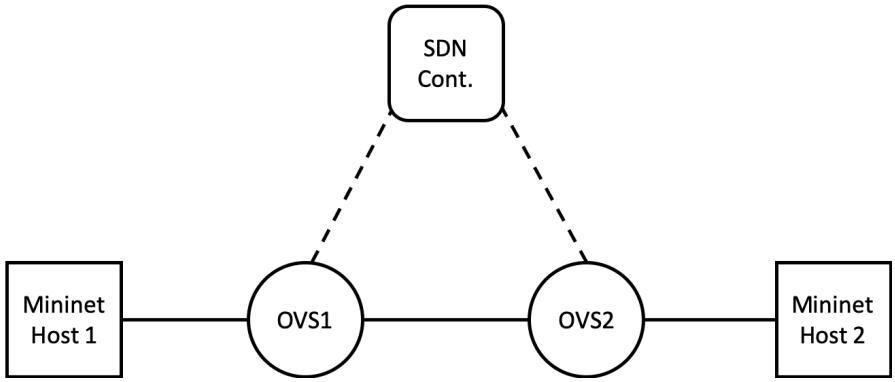
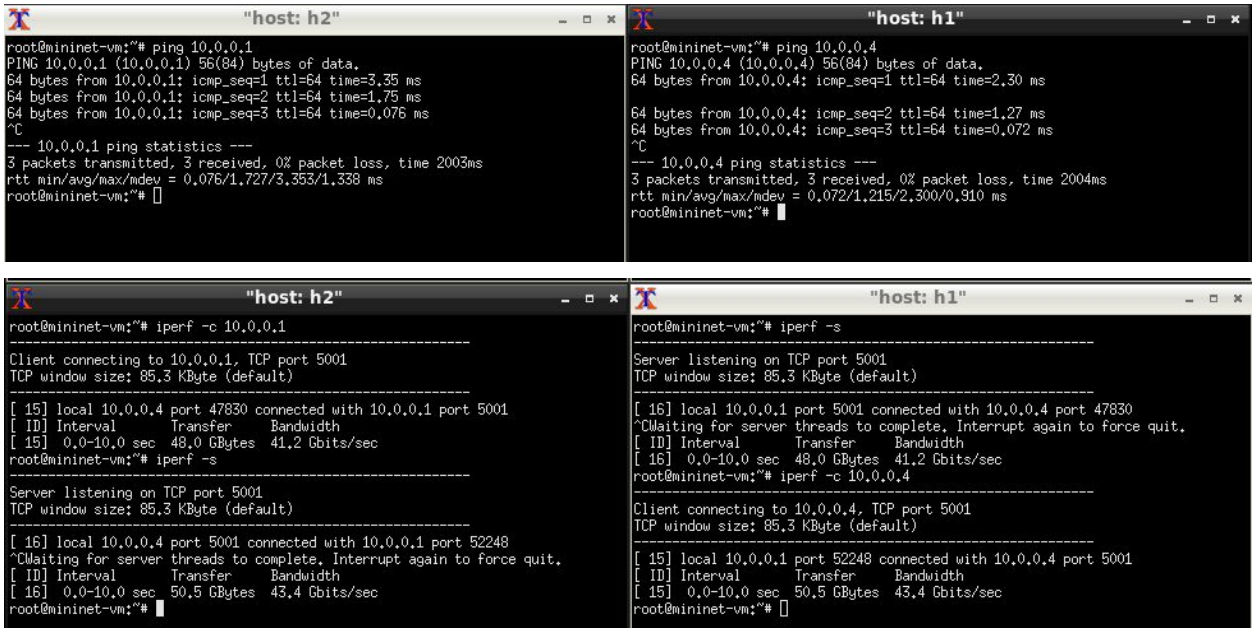


Figure 2.

2.1. Which SDN controller did you use? Give its name and version.

ryu 4.34

2.2. Run ping and iperf between Mininet Hosts, and insert the screen captures of the results.



2.2. Execute the command to dump the flow table of OVS1 to CLI and insert the screenshot.

```
mininet> dpctl dump-flows
*** s3 ------------------------------------------------------------------------
NXST_FLOW reply (xid=0x4):
 cookie=0x0, duration=18.927s, table=0, n_packets=2, n_bytes=140, idle_age=13, in_port=1,dl_src=92:23:92:98:ed:7b,dl_dst=8a:4
e:2f:e5:33:1e actions=output:2
 cookie=0x0, duration=18.928s, table=0, n_packets=3, n_bytes=238, idle_age=13, in_port=2,dl_src=8a:4e:2f:e5:33:1e,dl_dst=92:2
3:92:98:ed:7b actions=output:1
*** s4 ------------------------------------------------------------------------
NXST_FLOW reply (xid=0x4):
 cookie=0x0, duration=18.939s, table=0, n_packets=2, n_bytes=140, idle_age=13, in_port=1,dl_src=92:23:92:98:ed:7b,dl_dst=8a:4
e:2f:e5:33:1e actions=output:2
 cookie=0x0, duration=18.94s, table=0, n_packets=3, n_bytes=238, idle_age=13, in_port=2,dl_src=8a:4e:2f:e5:33:1e,dl_dst=92:23
:92:98:ed:7b actions=output:1
mininet>
```

2.3. Explain the flow rule about the communication between Mininet Hosts 1 and 2. Give the human understandable interpretation of these flow rules.

When h1 ping h2 and vice versa, first the sqitch receives the packet. Since, the switch doesn't know what to do it with(forward to where) it asks the sdn controller for the details.The SDN controller then tells where to forward the packet and that entry is stored into the flow table of the switch. The flow table has two such rules for forwarding packets to either direction. Each rule has details such as Cookie(*an opaque data value that is set by the controller*
, acts as an identifier to flow entry whcih can map back to internal state associated with it, need not be unique), duration(time since, it has been added), table(table id where it is stored), n_packets(num of packets sent), n_bytes(number of byted sent), idle_age(seconds not in use), in_port(port number), dl_src(source), dl_dst(destination), actions(action to be taken that is usually the place to forward when such input packet is received).

Question 3.

Form a custom network topology using Mininet Hosts, Open vSwitch (OVS) and SDN controller of your choice given in Figure 3. Activate OVSes as SDN Switches that need instruction by SDN Controller. Activate SDN controller using the standard Learning Switch code, which is available as a sample code bundled with most SDN Controllers. Refer to the tutorials of Mininet and each SDN Controller if needed.

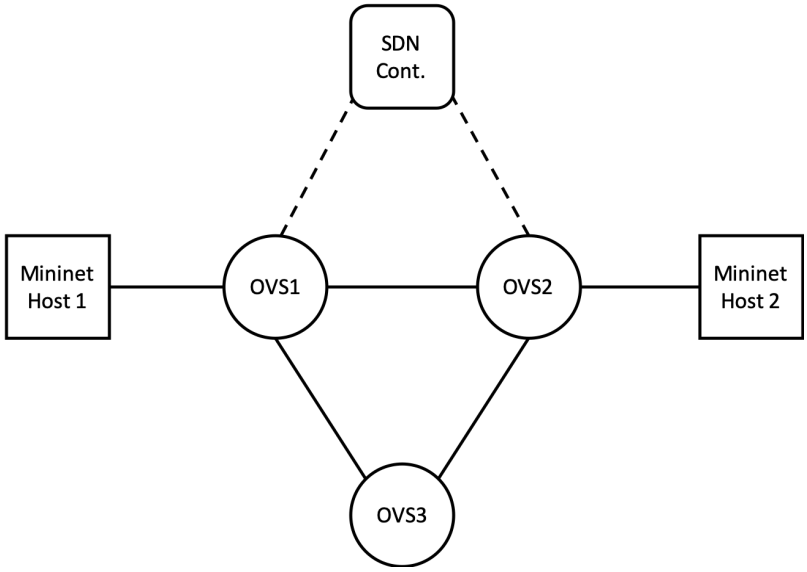
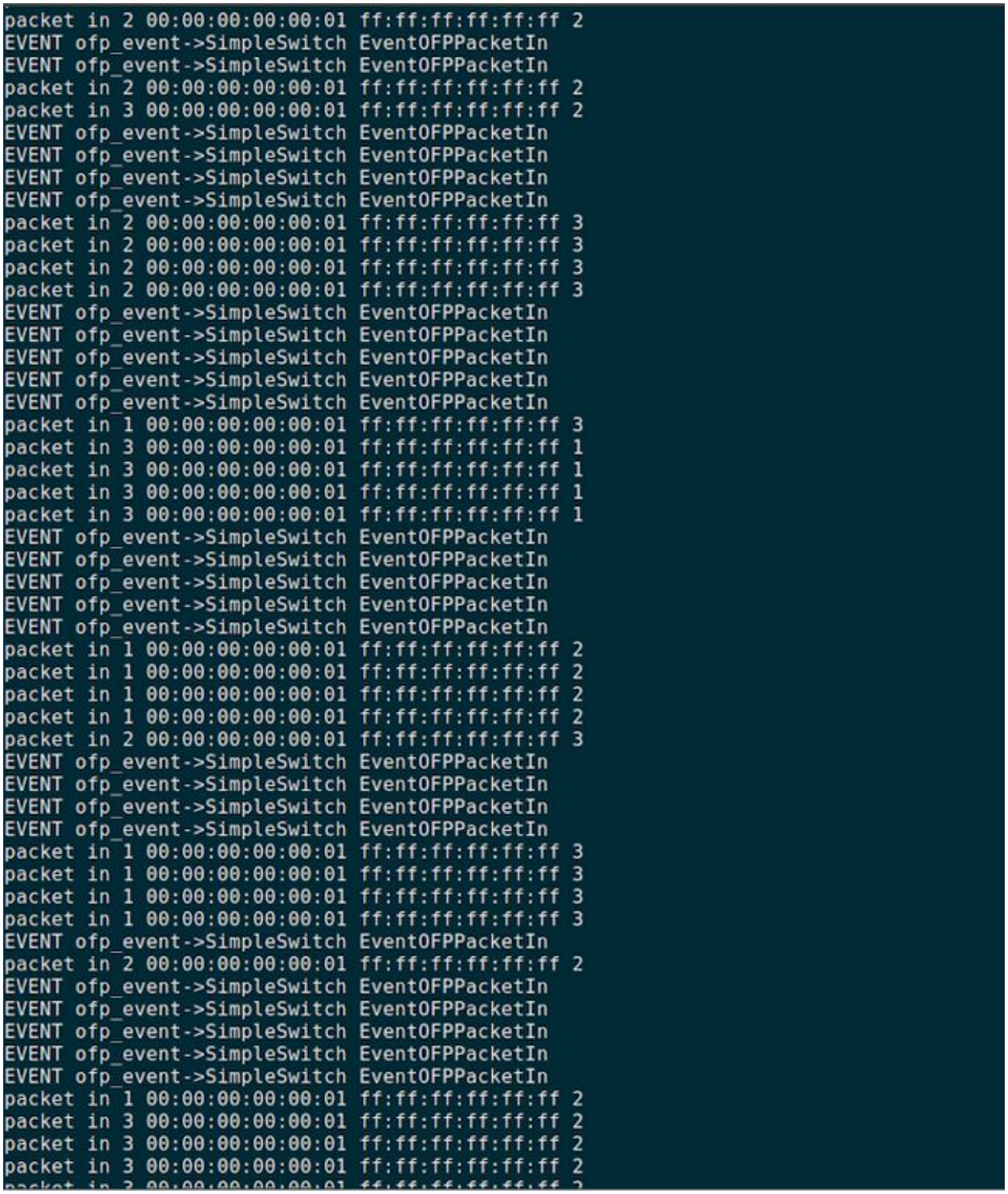
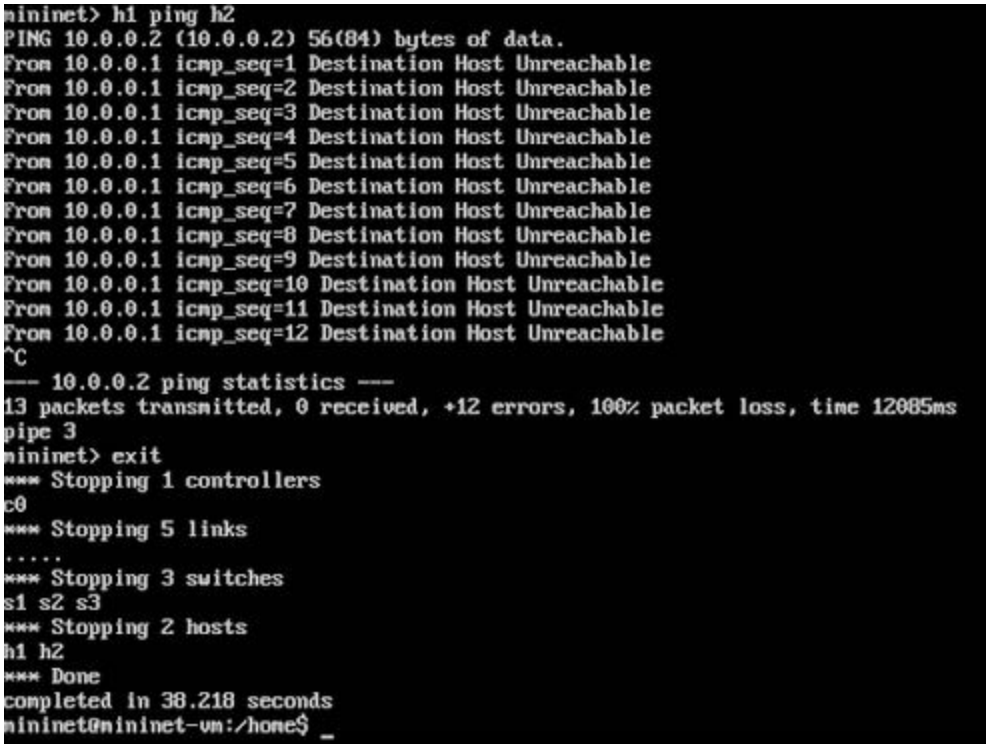


Figure 3.

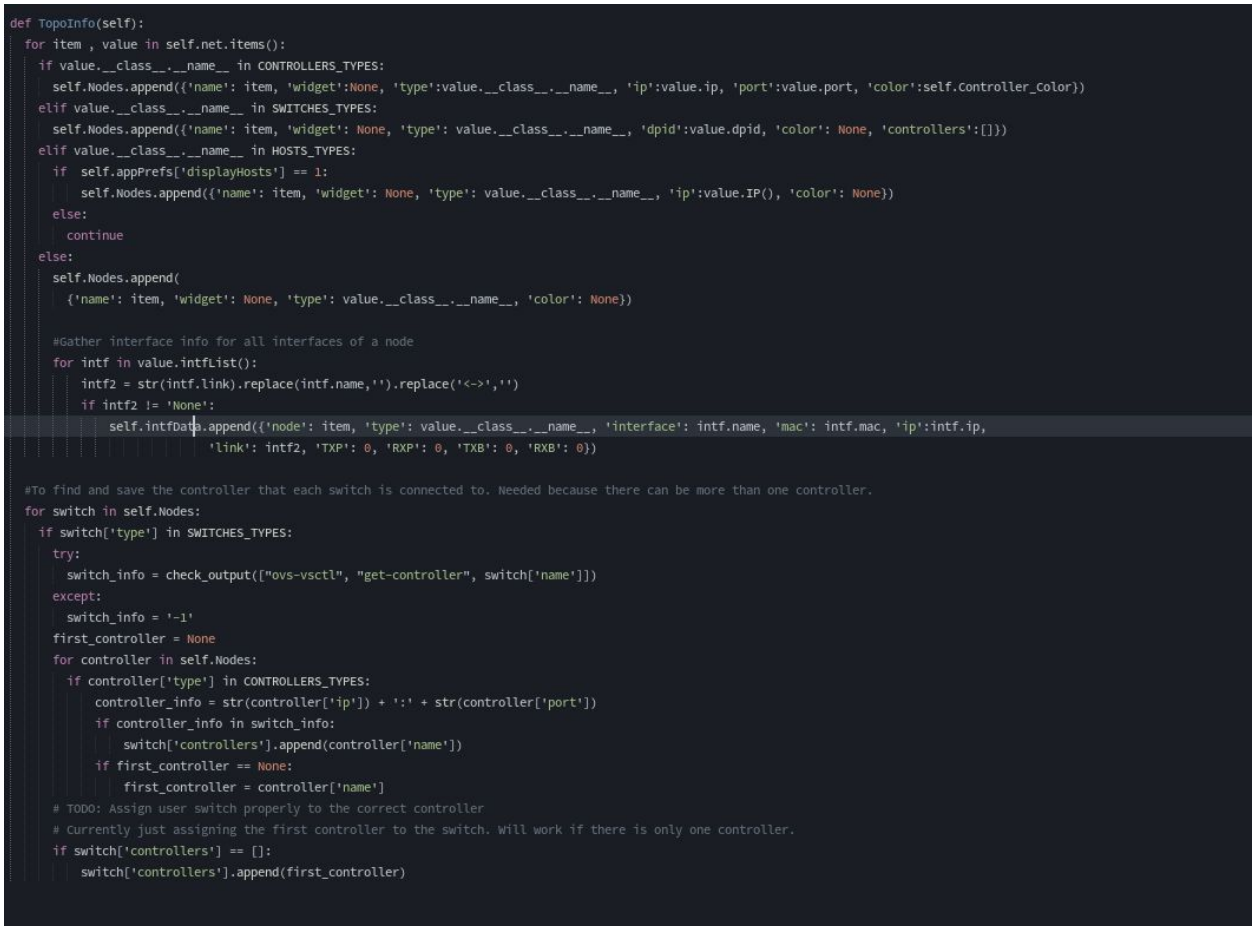
3.1. When you enable the SDN controller and let Mininet Hosts 1 and 2 communicate, you will see the phenomenon called Broadcast Storm. Insert the screen capture of the console of SDN Controller or OVS that indicate Broadcast Storm.





3.2. Implement “My STP (Spanning Tree Protocol)” so that you can avoid Broadcast Storm in the network. Demonstrate “My STP” is working properly to TAs.

3.3. As part of My STP implementation, you need to get the network topology information. Insert the screen capture of the code where you get the topology information using the API of SDN controller. You must not import the configuration of Custom Topology as part of the implementation.



```
def TopoInfo(self):
  for item , value in self.net.items():
    if value.__class__.__name__ in CONTROLLERS_TYPES:
      self.Nodes.append({'name': item, 'widget':None, 'type':value.__class__.__name__, 'ip':value.ip, 'port':value.port, 'color':self.Controller_Color})
    elif value.__class__.__name__ in SWITCHES_TYPES:
      self.Nodes.append({'name': item, 'widget': None, 'type': value.__class__.__name__, 'dpid':value.dpid, 'color': None, 'controllers':[]})
    elif value.__class__.__name__ in HOSTS_TYPES:
      if  self.appPrefs['displayHosts'] == 1:
          self.Nodes.append({'name': item, 'widget': None, 'type': value.__class__.__name__, 'ip':value.IP(), 'color': None})
      else:
        continue
    else:
      self.Nodes.append(
        {'name': item, 'widget': None, 'type': value.__class__.__name__, 'color': None})

      #Gather interface info for all interfaces of a node
      for intf in value.intfList():
          intf2 = str(intf.link).replace(intf.name,'').replace('<->','')
          if intf2 != 'None':
              self.intfData.append({'node': item, 'type': value.__class__.__name__, 'interface': intf.name, 'mac': intf.mac, 'ip':intf.ip,
                                    'link': intf2, 'TXP': 0, 'RXP': 0, 'TXB': 0, 'RXB': 0})

  #To find and save the controller that each switch is connected to. Needed because there can be more than one controller.
  for switch in self.Nodes:
    if switch['type'] in SWITCHES_TYPES:
      try:
        switch_info = check_output(["ovs-vsctl", "get-controller", switch['name']])
      except:
        switch_info = '-1'
      first_controller = None
      for controller in self.Nodes:
        if controller['type'] in CONTROLLERS_TYPES:
            controller_info = str(controller['ip']) + ':' + str(controller['port'])
            if controller_info in switch_info:
                switch['controllers'].append(controller['name'])
            if first_controller == None:
                first_controller = controller['name']
      # TODO: Assign user switch properly to the correct controller
      # Currently just assigning the first controller to the switch. Will work if there is only one controller.
      if switch['controllers'] == []:
          switch['controllers'].append(first_controller)
```

source: https://github.com/fabiobento/stp-mininet-ryu-tutorial/blob/master/MiniNAM.py
This code was used from the source for obtaining the topology information, the STP implementation was also inspired from here.

Additional Instructions

1. STP must not be enabled on Open vSwitches

Done!!