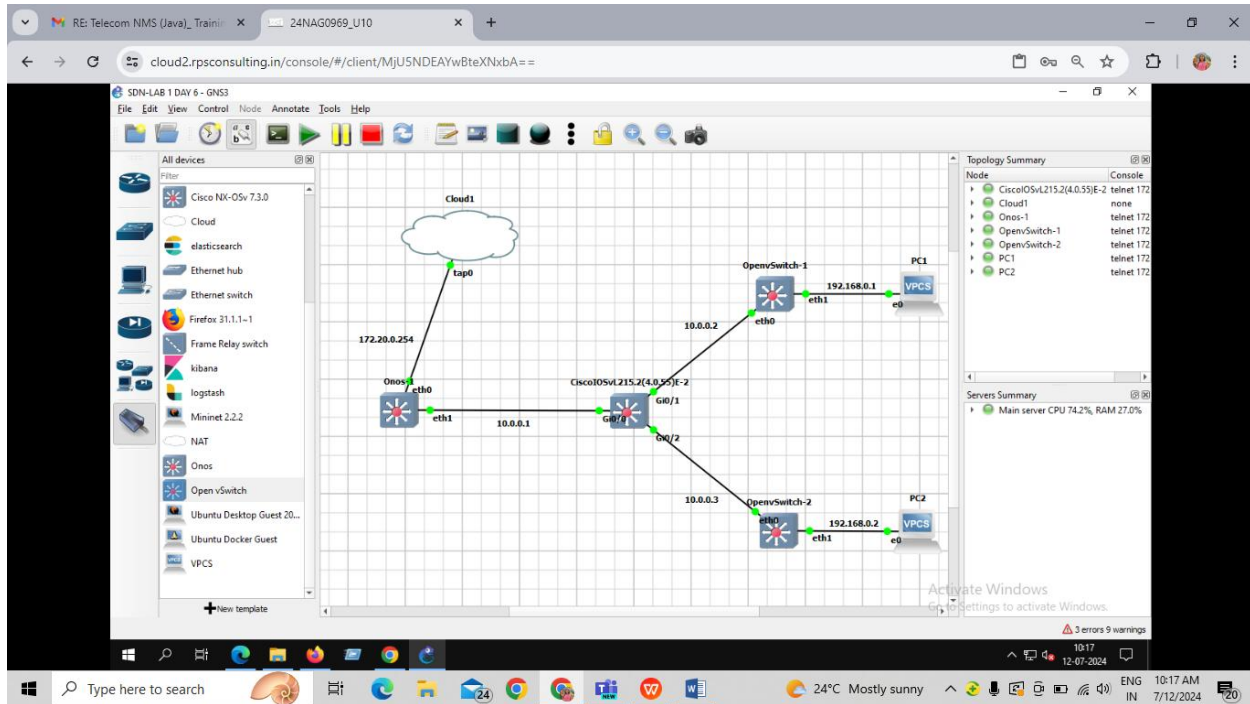
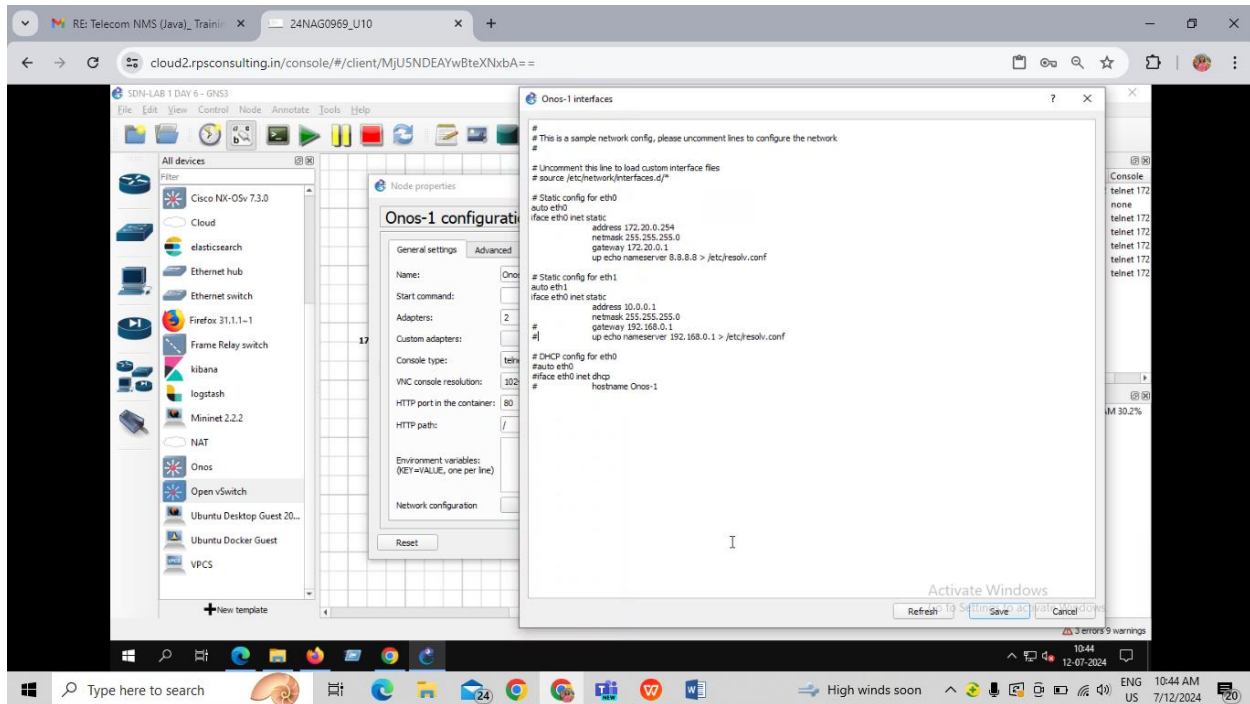


# SDN-LAB

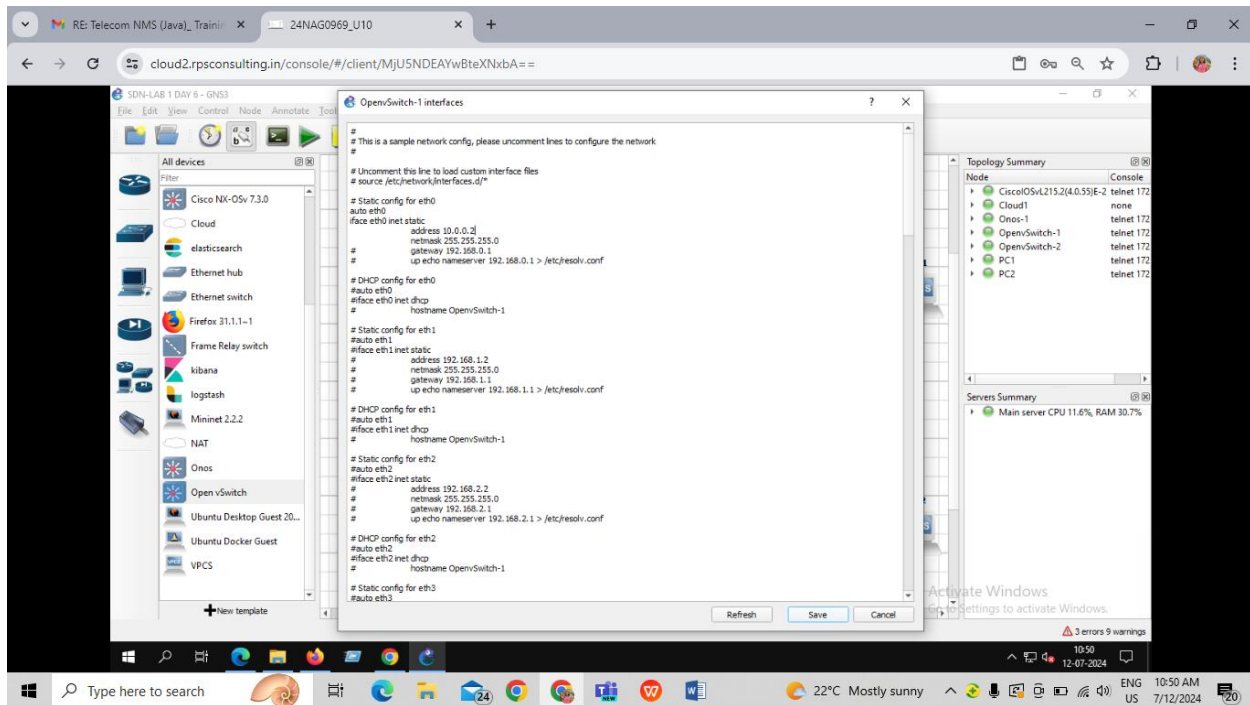
## Topology:



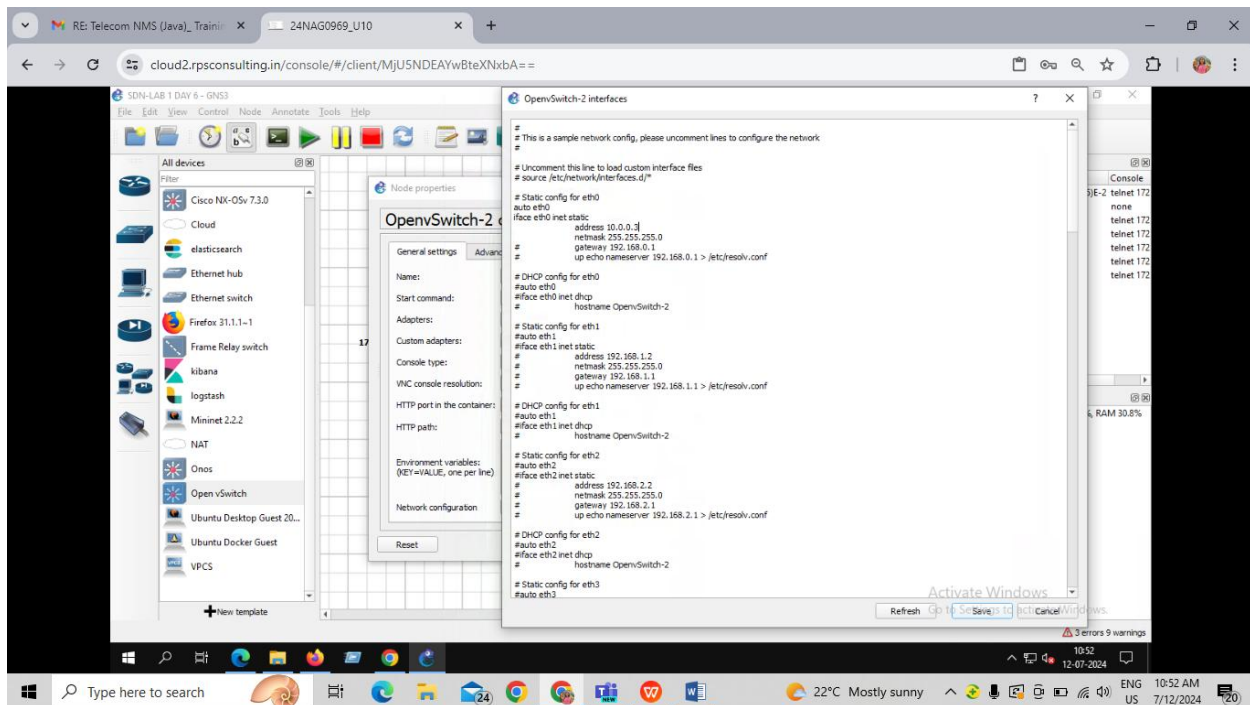
## Step 2: Configure the ONOS Controller eth0 and eth1 IP address



### Step 3: Assign the static IP address on eth0 port of Open Switch -1



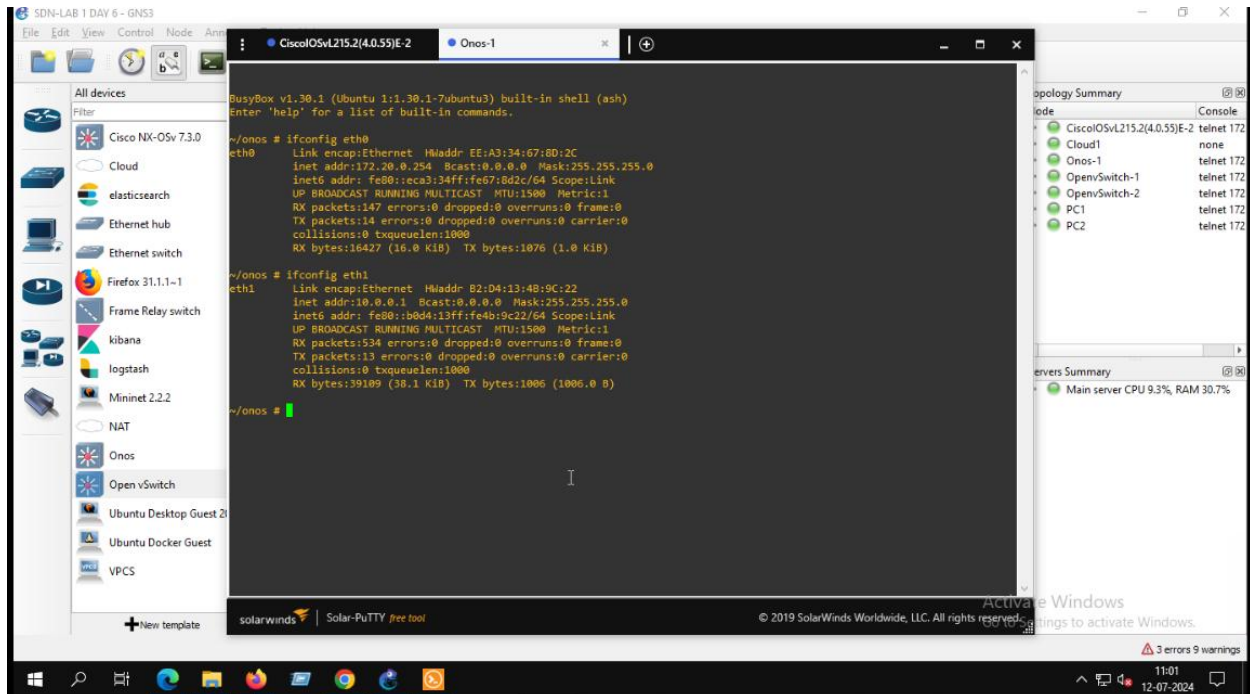
### Step 4: Assign the static IP address on eth0 port of Open Switch -2



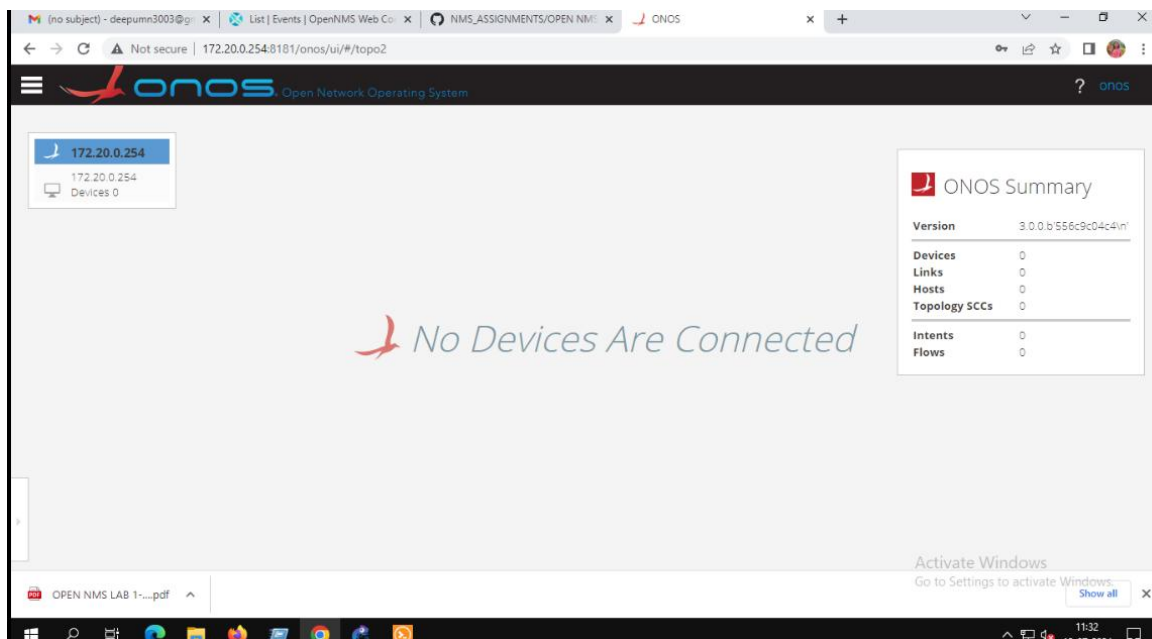
**Step 5: Start the Cisco Switch first and wait till it come up.**

**Step 6: Start the ONOS Controller once SW come up**

**Step 7: Post ONOS come up, run the command `ifconfig eth 0` and `ifconfig eth1` and verify the IP**



**Step 8: Go to browser and open the URL `172.20.0.254:8181/onos/ui`**



Step 9: Start both the open switch

Step 10: check the IP in both the switch via ifconfig eth0 command

The screenshot displays the GNS3 interface for SDN-LAB 1 DAY 6 - GNS3. The left sidebar shows a list of devices including Cisco NX-OSv 7.3.0, Cloud, elasticsearch, Ethernet hub, Ethernet switch, Firefox 31.1.1-1, Frame Relay switch, kibana, logstash, Mininet 2.2.2, NAT, Onos, Open vSwitch, Ubuntu Desktop Guest 2, Ubuntu Docker Guest, and VPCS. The main window shows a terminal window with the following output:

```
2024-07-12T05:21:46Z|00053|bridge|INFO|bridge br0: added interface eth2 on port 14
2024-07-12T05:21:46Z|00054|bridge|INFO|bridge br0: added interface eth14 on port 15
2024-07-12T05:21:46Z|00055|bridge|INFO|bridge br0: added interface eth15 on port 16
2024-07-12T05:21:46Z|00056|bridge|INFO|bridge br1: added interface br1 on port 6
2024-07-12T05:21:46Z|00057|bridge|INFO|bridge br3: using datapath ID 000092b5eB3
2024-07-12T05:21:46Z|00058|connmgr|INFO|br3: added service controller "punix:/va
r/run/openswitch/br3.mgmt"
2024-07-12T05:21:46Z|00059|bridge|INFO|bridge br2: using datapath ID 000022618a3
2024-07-12T05:21:46Z|00060|connmgr|INFO|br2: added service controller "punix:/va
r/run/openswitch/br2.mgmt"
2024-07-12T05:21:46Z|00061|bridge|INFO|bridge br0: using datapath ID 000082d3182
2024-07-12T05:21:46Z|00062|connmgr|INFO|br0: added service controller "punix:/va
r/run/openswitch/br0.mgmt"
2024-07-12T05:21:46Z|00063|bridge|INFO|bridge br1: using datapath ID 000046ac408
2024-07-12T05:21:46Z|00064|connmgr|INFO|br1: added service controller "punix:/va
r/run/openswitch/br1.mgmt"
2024-07-12T05:21:46Z|00065|ofproto_dpif_xlate|INFO|/proc/sys/net/core/netdev_max
 backlog: open failed (No such file or directory)
/ #
/ # ifconfig eth0
eth0      Link encap:Ethernet  Hwaddr D6:84:17:50:7A:AE
          inet addr:10.0.0.2  Bcast:0.0.0.0  Mask:255.255.255.0
          inet6 addr: fe80::d484:17ff:fe50:7aae/64 Scope:Link
          UP BROADCAST RUNNING PROMISC MULTICAST  MTU:1500  Metric:1
          RX packets:2057 errors:0 dropped:0 overruns:0 frame:0
          TX packets:30 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:1000
          RX bytes:150317 (146.7 KiB)  TX bytes:2292 (2.2 KiB)
/ #
```

The right sidebar shows a topology summary table:

Node	Console
CiscoOSvL215.2(4.0.55)E-2	telnet 172
Cloud1	none
Onos-1	telnet 172
OpenvSwitch-1	telnet 172
OpenvSwitch-2	telnet 172
PC1	telnet 172
PC2	telnet 172

The bottom status bar shows the system is running on Solar-PuTTY, with 3 errors and 9 warnings. The system time is 11:50 on 12-07-2024.

The screenshot displays the GNS3 interface for SDN-LAB 1 DAY 6 - GNS3. The left sidebar shows a list of devices including Cisco NX-OSv 7.3.0, Cloud, elasticsearch, Ethernet hub, Ethernet switch, Firefox 31.1.1-1, Frame Relay switch, kibana, logstash, Mininet 2.2.2, NAT, Onos, Open vSwitch, Ubuntu Desktop Guest 2, Ubuntu Docker Guest, and VPCS. The main window shows a terminal window with the following output:

```
2024-07-12T05:23:20Z|00052|bridge|INFO|bridge br0: added interface br0 on port 6
2024-07-12T05:23:20Z|00053|bridge|INFO|bridge br0: added interface eth14 on port 14
2024-07-12T05:23:20Z|00054|bridge|INFO|bridge br0: added interface eth2 on port 15
2024-07-12T05:23:20Z|00055|bridge|INFO|bridge br0: added interface eth15 on port 16
2024-07-12T05:23:20Z|00056|bridge|INFO|bridge br1: added interface br1 on port 6
2024-07-12T05:23:20Z|00057|bridge|INFO|bridge br3: using datapath ID 00006330d5
2024-07-12T05:23:20Z|00058|connmgr|INFO|br3: added service controller "punix:/va
r/run/openswitch/br3.mgmt"
2024-07-12T05:23:20Z|00059|bridge|INFO|bridge br2: using datapath ID 00006239f11
2024-07-12T05:23:20Z|00060|connmgr|INFO|br2: added service controller "punix:/va
r/run/openswitch/br2.mgmt"
2024-07-12T05:23:20Z|00061|bridge|INFO|bridge br0: using datapath ID 00000e41548
2024-07-12T05:23:20Z|00062|connmgr|INFO|br0: added service controller "punix:/va
r/run/openswitch/br0.mgmt"
2024-07-12T05:23:20Z|00063|bridge|INFO|bridge br1: using datapath ID 0000bad3e47
2024-07-12T05:23:20Z|00064|connmgr|INFO|br1: added service controller "punix:/va
r/run/openswitch/br1.mgmt"
/ #
/ # ifconfig eth0
eth0      Link encap:Ethernet  Hwaddr 4A:C8:1B:50:89:69
          inet addr:10.0.0.3  Bcast:0.0.0.0  Mask:255.255.255.0
          inet6 addr: fe80::14c8:18ff:fe50:8969/64 Scope:Link
          UP BROADCAST RUNNING PROMISC MULTICAST  MTU:1500  Metric:1
          RX packets:2024 errors:0 dropped:1 overruns:0 frame:0
          TX packets:30 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:1000
          RX bytes:147865 (144.3 KiB)  TX bytes:2292 (2.2 KiB)
/ #
```

The right sidebar shows a topology summary table:

Node	Console
CiscoOSvL215.2(4.0.55)E-2	telnet 172
Cloud1	none
Onos-1	telnet 172
OpenvSwitch-1	telnet 172
OpenvSwitch-2	telnet 172
PC1	telnet 172
PC2	telnet 172

The bottom status bar shows the system is running on Solar-PuTTY, with 3 errors and 9 warnings. The system time is 11:51 on 12-07-2024.



## Step 11: Ping the controller IP 10.0.0.1 from both the SW

The screenshot shows the GNS3 interface with a terminal window open for the CiscoOSvL215.2(4.0.55) node. The terminal displays the following commands and output:

```
2024-07-12T05:21:46Z[00060]connmgr[INFO]br2: added service controller "punix:/va
r/run/openswitch/br2.mgmt"
2024-07-12T05:21:46Z[00061]bridge[INFO]bridge br0: using datapath ID 000002d3182
e2e40
2024-07-12T05:21:46Z[00062]connmgr[INFO]br0: added service controller "punix:/va
r/run/openswitch/br0.mgmt"
2024-07-12T05:21:46Z[00063]bridge[INFO]bridge br1: using datapath ID 000046ac408
ba043
2024-07-12T05:21:46Z[00064]connmgr[INFO]br1: added service controller "punix:/va
r/run/openswitch/br1.mgmt"
2024-07-12T05:21:46Z[00065]ofproto_dpif_vl[INFO]/proc/sys/net/core/netdev_max
 backlog: open failed (No such file or directory)
/ #
/ # ifconfig eth0
eth0      Link encap:Ethernet  HWaddr D6:84:17:50:7A:AE
          inet addr:10.0.0.2  Bcast:0.0.0.0  Mask:255.255.255.0
          inet6 addr: fe80::d484:17ff:fe50:7aae/64 Scope:Link
          UP BROADCAST RUNNING PROMISC MULTICAST  MTU:1500  Metric:1
          RX packets:2087 errors:0 dropped:0 overruns:0 frame:0
          TX packets:190 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:1000
          RX bytes:150317 (146.7 KiB)  TX bytes:2292 (2.2 KiB)

/ #
/ # ping 10.0.0.1
PING 10.0.0.1 (10.0.0.1): 56 data bytes
64 bytes from 10.0.0.1: seq=0 ttl=64 time=37.827 ms
64 bytes from 10.0.0.1: seq=1 ttl=64 time=16.841 ms
64 bytes from 10.0.0.1: seq=2 ttl=64 time=13.126 ms
64 bytes from 10.0.0.1: seq=3 ttl=64 time=18.356 ms
64 bytes from 10.0.0.1: seq=4 ttl=64 time=17.818 ms
64 bytes from 10.0.0.1: seq=5 ttl=64 time=17.350 ms
64 bytes from 10.0.0.1: seq=6 ttl=64 time=17.704 ms
64 bytes from 10.0.0.1: seq=7 ttl=64 time=13.710 ms
64 bytes from 10.0.0.1: seq=8 ttl=64 time=14.503 ms
^Z[1]+  Stopped                  ping 10.0.0.1
/ #
```

The terminal window also shows a topology summary on the right side, listing the nodes and their connections:

Node	Console
CiscoOSvL215.2(4.0.55)E-2	telnet 172
Cloud1	none
Onos-1	telnet 172
OpenvSwitch-1	telnet 172
OpenvSwitch-2	telnet 172
PC1	telnet 172
PC2	telnet 172

The screenshot shows the GNS3 interface with a terminal window open for the CiscoOSvL215.2(4.0.55) node. The terminal displays the following commands and output:

```
2024-07-12T05:23:20Z[00059]bridge[INFO]bridge br2: using datapath ID 0000b239f11
e2446
2024-07-12T05:23:20Z[00060]connmgr[INFO]br2: added service controller "punix:/va
r/run/openswitch/br2.mgmt"
2024-07-12T05:23:20Z[00061]bridge[INFO]bridge br0: using datapath ID 00000e41548
64448
2024-07-12T05:23:20Z[00062]connmgr[INFO]br0: added service controller "punix:/va
r/run/openswitch/br0.mgmt"
2024-07-12T05:23:20Z[00063]bridge[INFO]bridge br1: using datapath ID 0000bad3e47
60442
2024-07-12T05:23:20Z[00064]connmgr[INFO]br1: added service controller "punix:/va
r/run/openswitch/br1.mgmt"
/ #
/ # ifconfig eth0
eth0      Link encap:Ethernet  HWaddr 4A:CB:10:50:89:09
          inet addr:10.0.0.3  Bcast:0.0.0.0  Mask:255.255.255.0
          inet6 addr: fe80::40b:10ff:fe50:8909/64 Scope:Link
          UP BROADCAST RUNNING PROMISC MULTICAST  MTU:1500  Metric:1
          RX packets:2024 errors:0 dropped:1 overruns:0 frame:0
          TX packets:30 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:1000
          RX bytes:147865 (144.3 KiB)  TX bytes:2292 (2.2 KiB)

/ #
/ # ping 10.0.0.1
PING 10.0.0.1 (10.0.0.1): 56 data bytes
64 bytes from 10.0.0.1: seq=0 ttl=64 time=45.479 ms
64 bytes from 10.0.0.1: seq=1 ttl=64 time=16.822 ms
64 bytes from 10.0.0.1: seq=2 ttl=64 time=20.481 ms
64 bytes from 10.0.0.1: seq=3 ttl=64 time=19.201 ms
64 bytes from 10.0.0.1: seq=4 ttl=64 time=14.487 ms
64 bytes from 10.0.0.1: seq=5 ttl=64 time=22.414 ms
64 bytes from 10.0.0.1: seq=6 ttl=64 time=10.651 ms
64 bytes from 10.0.0.1: seq=7 ttl=64 time=14.145 ms
64 bytes from 10.0.0.1: seq=8 ttl=64 time=17.417 ms
64 bytes from 10.0.0.1: seq=9 ttl=64 time=17.827 ms
^Z[1]+  Stopped                  ping 10.0.0.1
/ #
```

The terminal window also shows a topology summary on the right side, listing the nodes and their connections:

Node	Console
CiscoOSvL215.2(4.0.55)E-2	telnet 172
Cloud1	none
Onos-1	telnet 172
OpenvSwitch-1	telnet 172
OpenvSwitch-2	telnet 172
PC1	telnet 172
PC2	telnet 172

## Step 12: Configure the SW with controller information

Setup protocol: `ovs-vsctl set bridge br0 protocols=OpenFlow13`

Setup controller: `ovs-vsctl set-controller br0 tcp:10.0.0.1:6633`

The screenshot shows the GNS3 interface with the 'Open vSwitch-1' console window active. The console output includes the following commands and their results:

```
//run/openvswitch/br0.mgmt
2024-07-12T05:21:46Z[00063]|bridge|INFO|bridge br1: using datapath ID 000046ac488
2024-07-12T05:21:46Z[00064]|connmgr|INFO|br1: added service controller "punix:/va
//run/openvswitch/br1.mgmt
2024-07-12T05:21:46Z[00065]|ofproto_dpif_xlate|INFO|/proc/sys/net/core/netdev_max
_backlog: open failed (No such file or directory)
# # ifconfig eth0
eth0      Link encap:Ethernet  HWaddr D6:B4:17:50:7A:AE
          inet addr:10.0.0.2  Bcast:0.0.0.0  Mask:255.255.255.0
          inet6 addr: fe80::d484:17ff:fe50:7aae/64 Scope:Link
          UP BROADCAST RUNNING PROMISC MULTICAST  MTU:1500  Metric:1
          RX packets:2057 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:1000
          RX bytes:150317 (146.7 KiB)  TX bytes:2292 (2.2 KiB)

# # ping 10.0.0.1
PING 10.0.0.1 (10.0.0.1): 56 data bytes
64 bytes from 10.0.0.1: seq=0 ttl=64 time=37.827 ms
64 bytes from 10.0.0.1: seq=1 ttl=64 time=16.841 ms
64 bytes from 10.0.0.1: seq=2 ttl=64 time=13.126 ms
64 bytes from 10.0.0.1: seq=3 ttl=64 time=18.356 ms
64 bytes from 10.0.0.1: seq=4 ttl=64 time=17.818 ms
64 bytes from 10.0.0.1: seq=5 ttl=64 time=17.350 ms
64 bytes from 10.0.0.1: seq=6 ttl=64 time=17.704 ms
64 bytes from 10.0.0.1: seq=7 ttl=64 time=12.710 ms
64 bytes from 10.0.0.1: seq=8 ttl=64 time=14.503 ms
^C[1] Stopped      ping 10.0.0.1

# #
# ovs-vsctl set bridge br0 protocols=OpenFlow13
# ovs-vsctl set-controller br0 tcp:10.0.0.1:6633
```

The topology summary on the right shows the following nodes and their connections:

Node	Console
Cisco OSvL215.2(4.0.55)E-2	telnet 172
Cloud1	none
Onos-1	telnet 172
Open vSwitch-1	telnet 172
Open vSwitch-2	telnet 172
PC1	telnet 172
PC2	telnet 172

The screenshot shows the GNS3 interface with the 'Open vSwitch-1' console window active. The console output includes the following commands and their results:

```
2024-07-12T05:23:20Z[00062]|connmgr|INFO|br0: added service controller "punix:/va
//run/openvswitch/br0.mgmt
2024-07-12T05:23:20Z[00063]|bridge|INFO|bridge br1: using datapath ID 0000bad3e47
2024-07-12T05:23:20Z[00064]|connmgr|INFO|br1: added service controller "punix:/va
//run/openvswitch/br1.mgmt
# # ifconfig eth0
eth0      Link encap:Ethernet  HWaddr 4A:C8:1B:50:89:69
          inet addr:10.0.0.3  Bcast:0.0.0.0  Mask:255.255.255.0
          inet6 addr: fe80::48c8:18ff:fe50:8969/64 Scope:Link
          UP BROADCAST RUNNING PROMISC MULTICAST  MTU:1500  Metric:1
          RX packets:2024 errors:0 dropped:1 overruns:0 frame:0
          TX packets:30 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:1000
          RX bytes:147865 (144.3 KiB)  TX bytes:2292 (2.2 KiB)

# # ping 10.0.0.1
PING 10.0.0.1 (10.0.0.1): 56 data bytes
64 bytes from 10.0.0.1: seq=0 ttl=64 time=45.479 ms
64 bytes from 10.0.0.1: seq=1 ttl=64 time=16.822 ms
64 bytes from 10.0.0.1: seq=2 ttl=64 time=20.481 ms
64 bytes from 10.0.0.1: seq=3 ttl=64 time=19.201 ms
64 bytes from 10.0.0.1: seq=4 ttl=64 time=14.487 ms
64 bytes from 10.0.0.1: seq=5 ttl=64 time=22.414 ms
64 bytes from 10.0.0.1: seq=6 ttl=64 time=10.651 ms
64 bytes from 10.0.0.1: seq=7 ttl=64 time=14.145 ms
64 bytes from 10.0.0.1: seq=8 ttl=64 time=17.417 ms
64 bytes from 10.0.0.1: seq=9 ttl=64 time=17.827 ms
^C[1] Stopped      ping 10.0.0.1

# #
# ovs-vsctl set bridge br0 protocols=OpenFlow13
# ovs-vsctl set-controller br0 tcp:10.0.0.1:6633
```

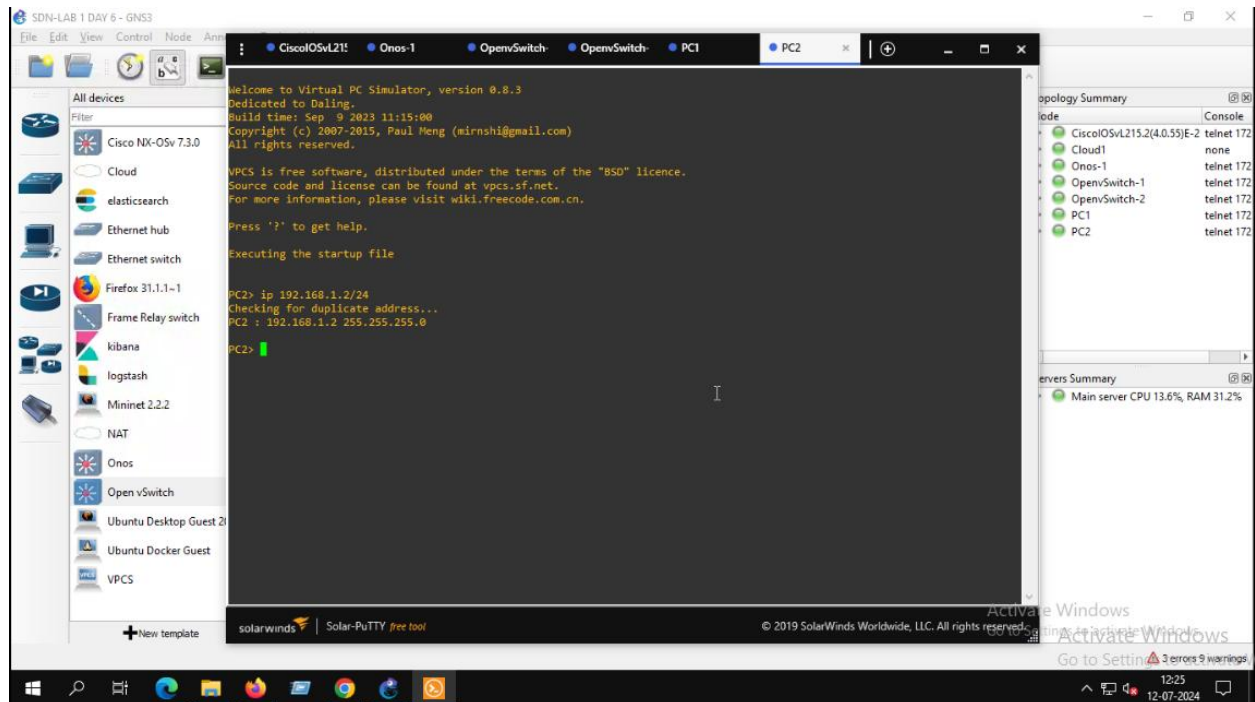
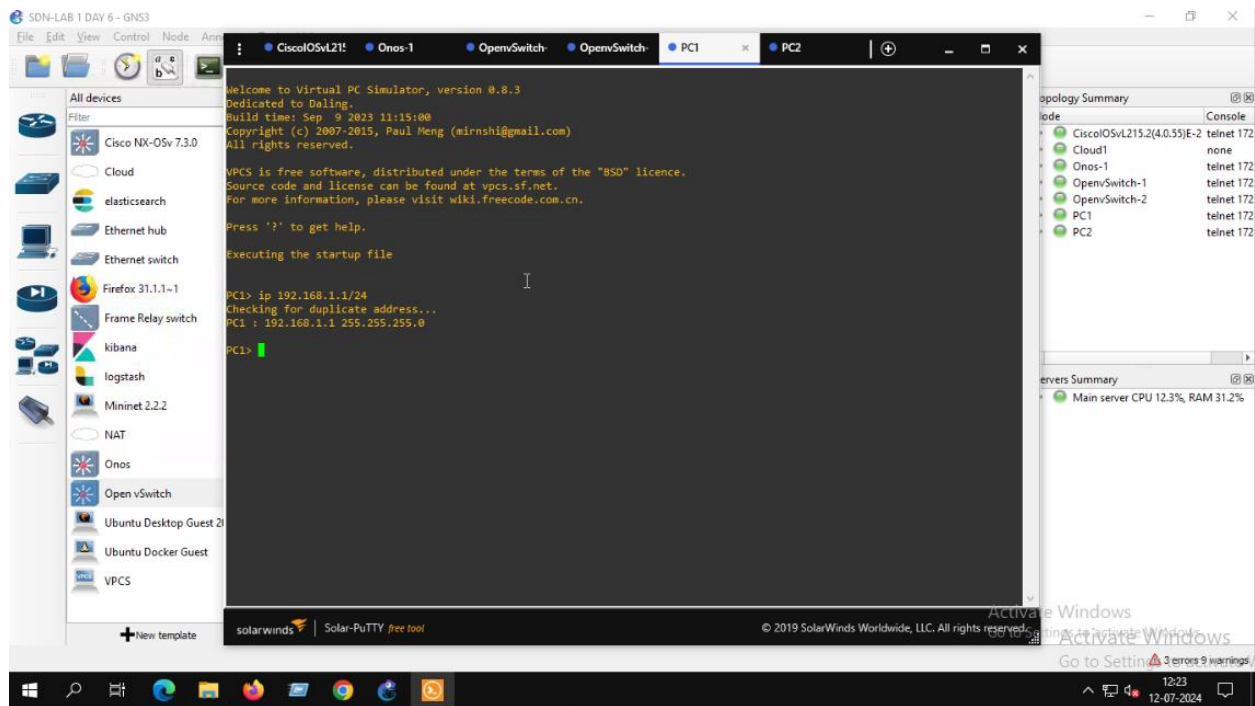
The topology summary on the right shows the following nodes and their connections:

Node	Console
Cisco OSvL215.2(4.0.55)E-2	telnet 172
Cloud1	none
Onos-1	telnet 172
Open vSwitch-1	telnet 172
Open vSwitch-2	telnet 172
PC1	telnet 172
PC2	telnet 172

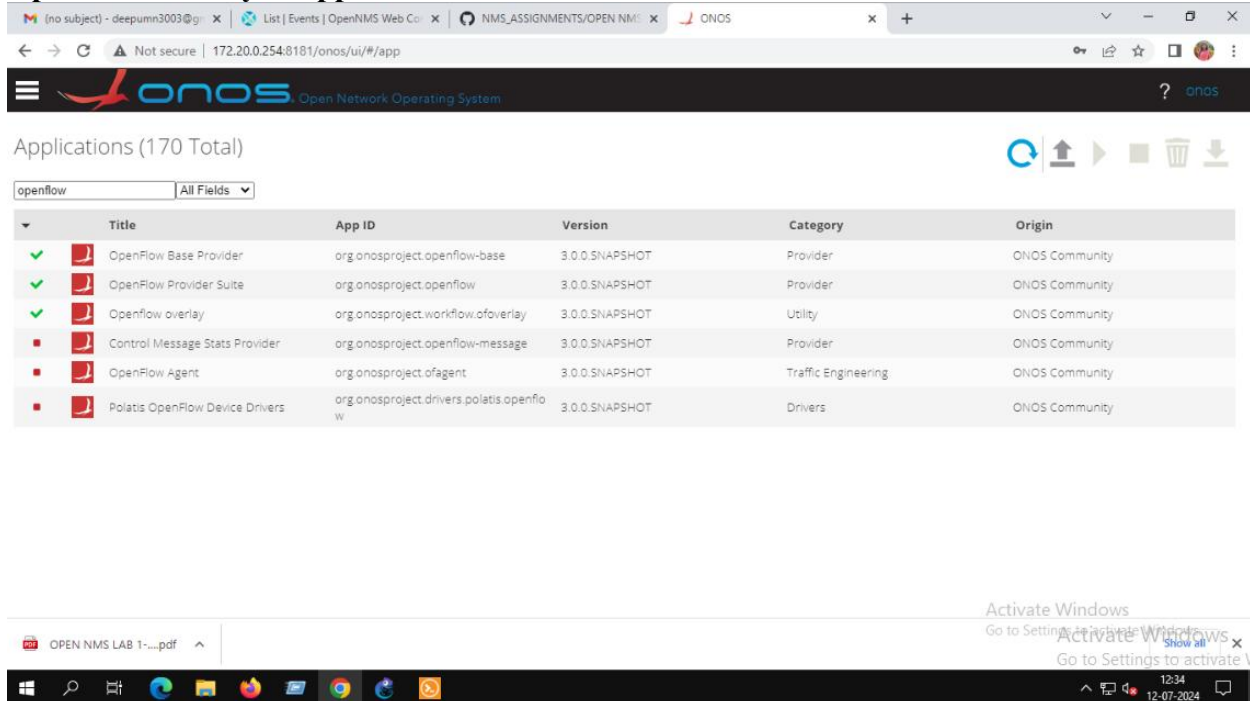
## Step 13: Set the IP on both the PC and PING – It will be successful

PC1: IP 192.168.1.1/24

PC2: ip 192.168.1.2/24

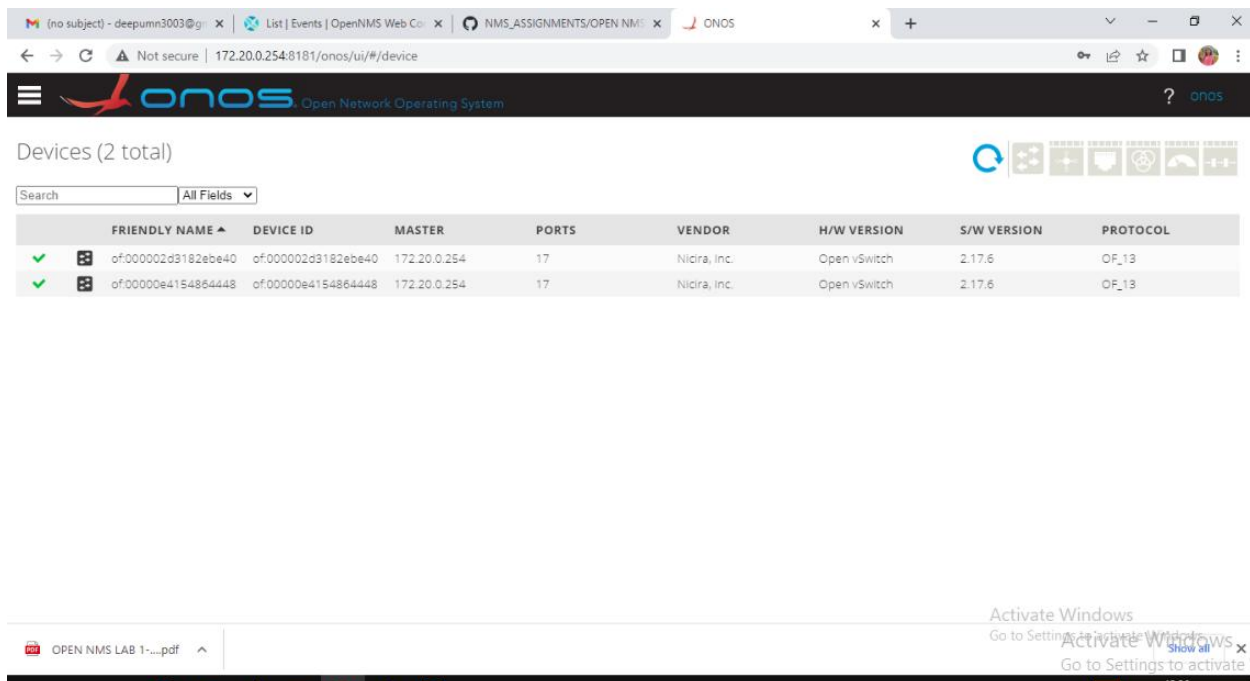


## Step 14: Go to ONOS GUI and enable the OpenFlow base application, provider suite and OpenFlow overlay in application TAB



The screenshot shows the ONOS GUI with the 'Applications' tab selected. The page title is 'Applications (170 Total)'. A search bar contains 'openflow' and a dropdown menu shows 'All Fields'. Below the search bar is a table listing applications. The table has columns: Title, App ID, Version, Category, and Origin. The first three rows are highlighted with green checkmarks, indicating they are enabled: 'OpenFlow Base Provider', 'OpenFlow Provider Suite', and 'OpenFlow overlay'. The remaining three rows are not highlighted, indicating they are disabled: 'Control Message Stats Provider', 'OpenFlow Agent', and 'Polaris OpenFlow Device Drivers'.

Title	App ID	Version	Category	Origin
OpenFlow Base Provider	org.onosproject.openflow-base	3.0.0.SNAPSHOT	Provider	ONOS Community
OpenFlow Provider Suite	org.onosproject.openflow	3.0.0.SNAPSHOT	Provider	ONOS Community
OpenFlow overlay	org.onosproject.workflow.ofoverlay	3.0.0.SNAPSHOT	Utility	ONOS Community
Control Message Stats Provider	org.onosproject.openflow-message	3.0.0.SNAPSHOT	Provider	ONOS Community
OpenFlow Agent	org.onosproject.ofagent	3.0.0.SNAPSHOT	Traffic Engineering	ONOS Community
Polaris OpenFlow Device Drivers	org.onosproject.drivers.polaris.openflow	3.0.0.SNAPSHOT	Drivers	ONOS Community



The screenshot shows the ONOS GUI with the 'Devices' tab selected. The page title is 'Devices (2 total)'. A search bar is empty and a dropdown menu shows 'All Fields'. Below the search bar is a table listing devices. The table has columns: Friendly Name, Device ID, Master, Ports, Vendor, H/W Version, S/W Version, and Protocol. There are two rows, both highlighted with green checkmarks, indicating they are enabled. Both devices are 'Open vSwitch' from 'Nicira, Inc.' with version '2.17.6' and protocol 'OF\_13'.

FRIENDLY NAME	DEVICE ID	MASTER	PORTS	VENDOR	H/W VERSION	S/W VERSION	PROTOCOL
of:000002d3182ebe40	of:000002d3182ebe40	172.20.0.254	17	Nicira, Inc.	Open vSwitch	2.17.6	OF_13
of:00000e4154864448	of:00000e4154864448	172.20.0.254	17	Nicira, Inc.	Open vSwitch	2.17.6	OF_13



## Step 15: Check in Open switch , controller in connected mode and Ping from PC1 to PC2 fail ovs-vsctl show

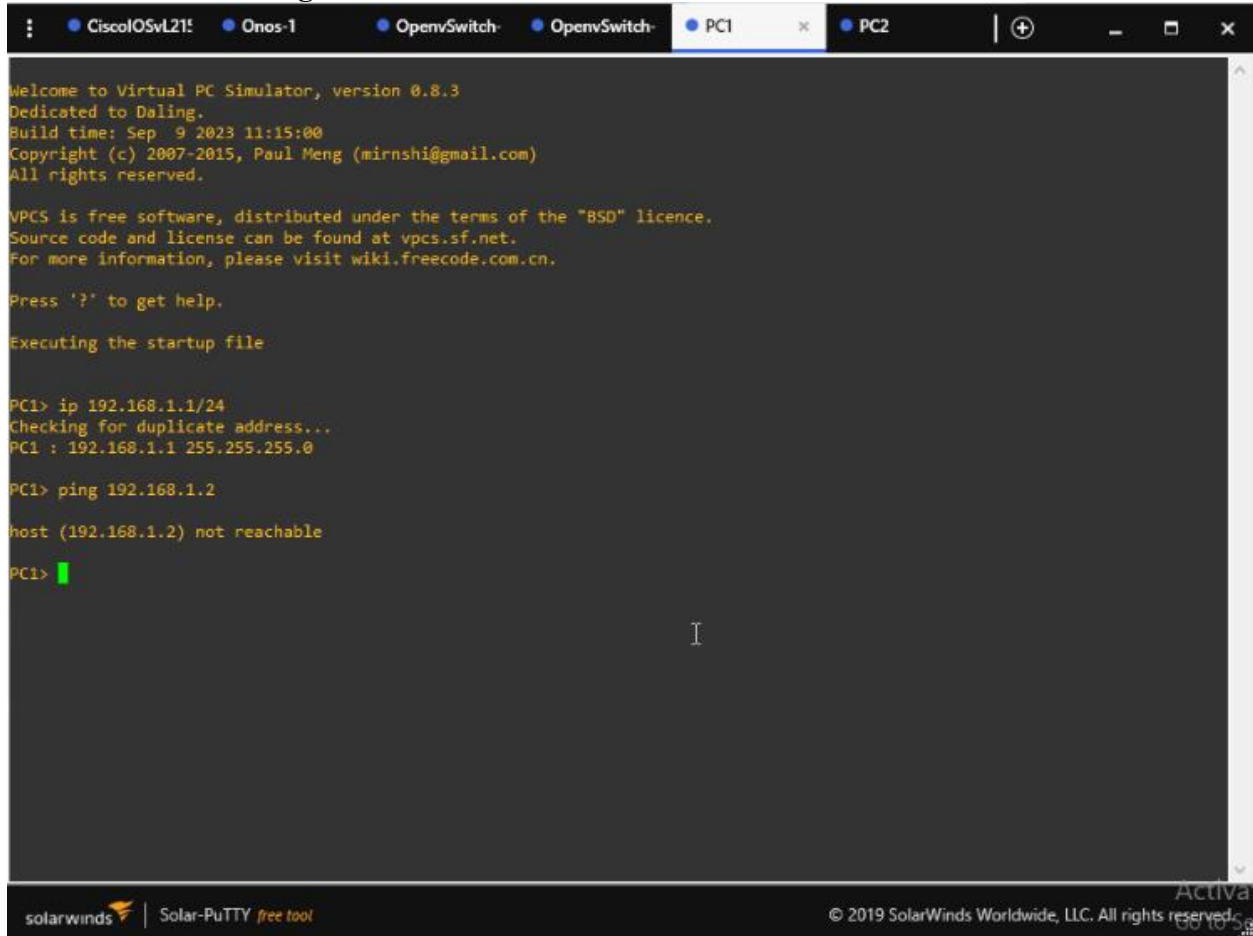
The screenshot shows the OpenNMS web interface with the 'OpenSwitch' tab selected. The 'ovs-vsctl show' command output is displayed in the terminal window. The output shows Bridge br0 with a controller connected to 'tcp:10.0.0.1:6633'. The bridge has 16 ports (eth1 to eth16) and is connected to a network device.

```
# ovs-vsctl show
a1796677-a09e-40d7-9842-53a3800fc67b
Bridge br0
  Controller "tcp:10.0.0.1:6633"
    is_connected: true
  datapath_type: netdev
  Port eth7
    Interface eth7
  Port eth8
    Interface eth8
  Port eth9
    Interface eth9
  Port eth11
    Interface eth11
  Port eth13
    Interface eth13
  Port eth4
    Interface eth4
  Port eth3
    Interface eth3
  Port eth10
    Interface eth10
  Port eth5
    Interface eth5
  Port eth2
    Interface eth2
  Port eth14
    Interface eth14
  Port eth0
    Interface eth0
  Port eth12
    Interface eth12
  Port eth6
    Interface eth6
  Port eth15
    Interface eth15
  Port eth1
    Interface eth1
```

The screenshot shows the OpenNMS web interface with the 'OpenSwitch' tab selected. The 'ovs-vsctl show' command output is displayed in the terminal window. The output shows four bridges: br2, br3, br1, and br0. Bridge br0 is connected to a controller at 'tcp:10.0.0.1:6633'. The bridges have various ports and interfaces configured.

```
# ovs-vsctl show
d73dd8ff-72e0-434d-833b-356b1e90c6a2
Bridge br2
  datapath_type: netdev
  Port br2
    Interface br2
      type: internal
Bridge br3
  datapath_type: netdev
  Port br3
    Interface br3
      type: internal
Bridge br1
  datapath_type: netdev
  Port br1
    Interface br1
      type: internal
Bridge br0
  Controller "tcp:10.0.0.1:6633"
    is_connected: true
  datapath_type: netdev
  Port eth8
    Interface eth8
  Port eth5
    Interface eth5
  Port eth14
    Interface eth14
  Port eth3
    Interface eth3
  Port eth6
    Interface eth6
  Port eth1
    Interface eth1
  Port eth0
    Interface eth0
  Port eth10
    Interface eth10
```

Step 16: Ping PC1 to PC2 – **Ping Fail** as Open V switch is connected with ONOS Controller and all the forwarding decision is not moved to ONOS Controller.



The screenshot shows a Solar-PuTTY terminal window with a tab for PC1. The terminal output is as follows:

```
Welcome to Virtual PC Simulator, version 0.8.3
Dedicated to Daling.
Build time: Sep  9 2023 11:15:00
Copyright (c) 2007-2015, Paul Meng (mirnshi@gmail.com)
All rights reserved.

VPCS is free software, distributed under the terms of the "BSD" licence.
Source code and license can be found at vpcs.sf.net.
For more information, please visit wiki.freecode.com.cn.

Press '?' to get help.

Executing the startup file

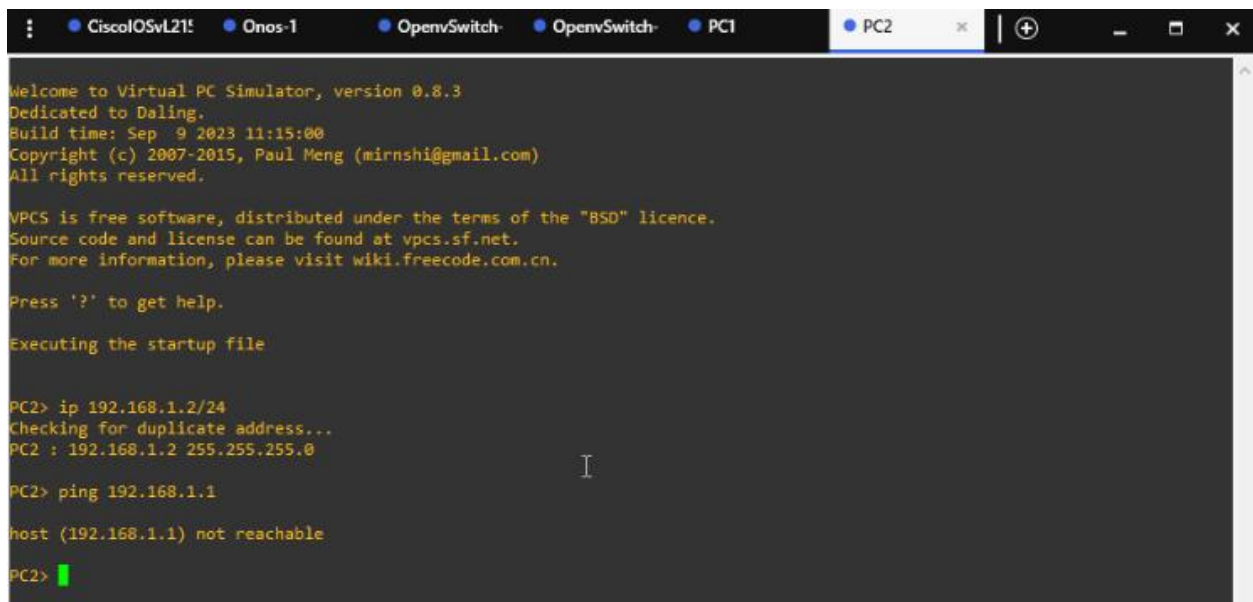
PC1> ip 192.168.1.1/24
Checking for duplicate address...
PC1 : 192.168.1.1 255.255.255.0

PC1> ping 192.168.1.2

host (192.168.1.2) not reachable

PC1>
```

The bottom of the window shows the SolarWinds logo and the text "Solar-PuTTY free tool" and "© 2019 SolarWinds Worldwide, LLC. All rights reserved."



The screenshot shows a Solar-PuTTY terminal window with a tab for PC2. The terminal output is as follows:

```
Welcome to Virtual PC Simulator, version 0.8.3
Dedicated to Daling.
Build time: Sep  9 2023 11:15:00
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All rights reserved.

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Source code and license can be found at vpcs.sf.net.
For more information, please visit wiki.freecode.com.cn.

Press '?' to get help.

Executing the startup file

PC2> ip 192.168.1.2/24
Checking for duplicate address...
PC2 : 192.168.1.2 255.255.255.0

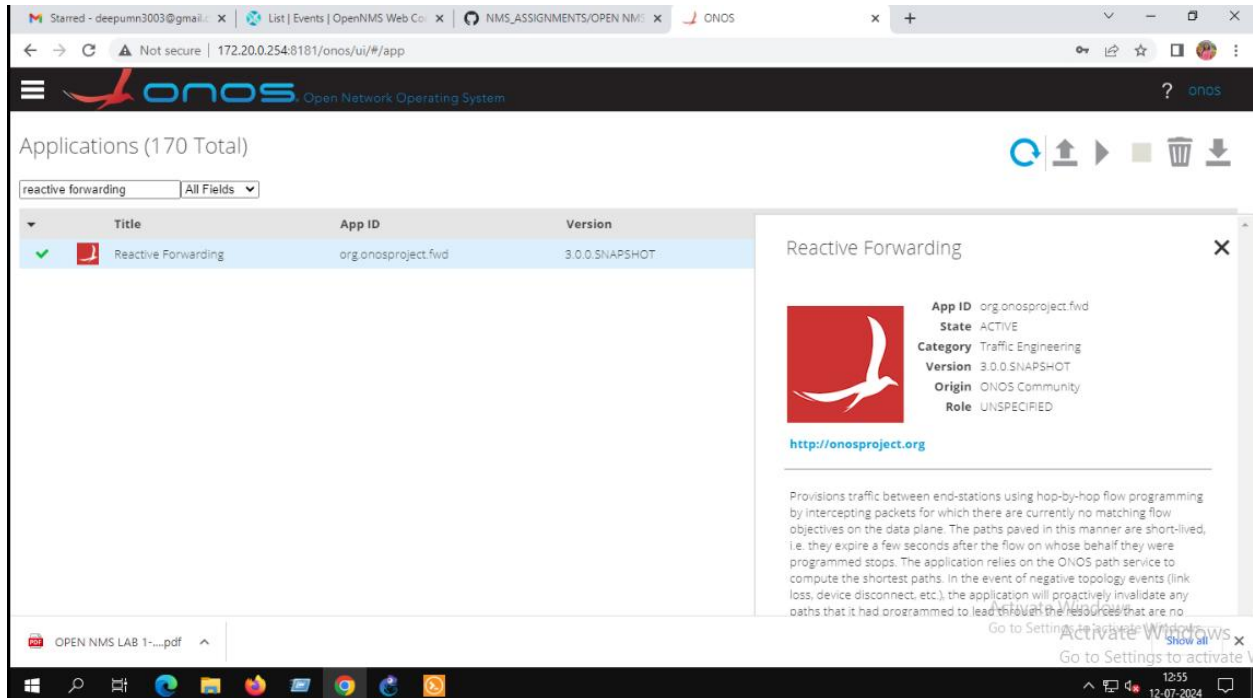
PC2> ping 192.168.1.1

host (192.168.1.1) not reachable

PC2>
```

The bottom of the window shows the SolarWinds logo and the text "Solar-PuTTY free tool" and "© 2019 SolarWinds Worldwide, LLC. All rights reserved."

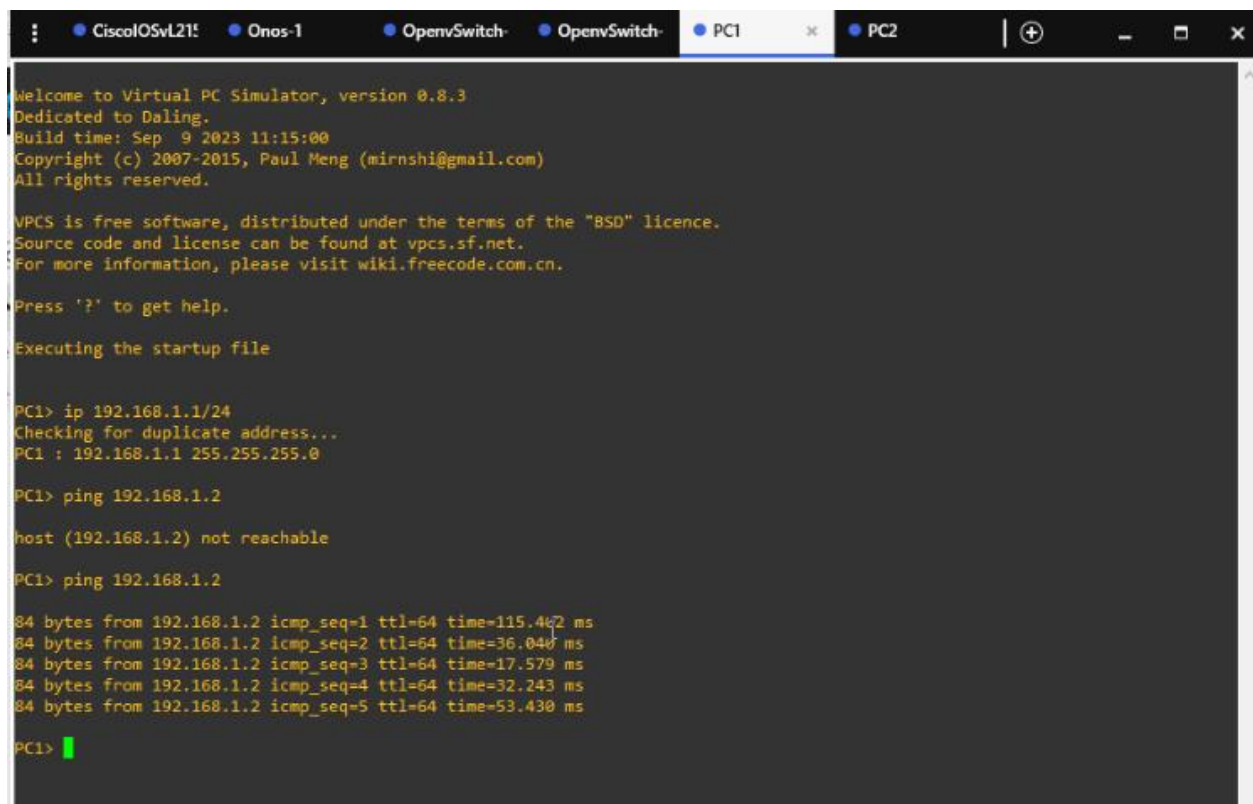
**Step 17: Enable reactive forwarding in application and check, PC1 to PC2 ping should be successful.**



The screenshot shows the ONOS (Open Network Operating System) web interface. The main heading is "Applications (170 Total)". A search filter "reactive forwarding" is applied, and a dropdown menu shows "All Fields". A table lists the application:

Title	App ID	Version
Reactive Forwarding	org.onosproject.fwd	3.0.0.SNAPSHOT

A detailed view of the "Reactive Forwarding" application is shown on the right. It includes the ONOS logo, the App ID "org.onosproject.fwd", State "ACTIVE", Category "Traffic Engineering", Version "3.0.0.SNAPSHOT", Origin "ONOS Community", and Role "UNSPECIFIED". A description states: "Provisions traffic between end-stations using hop-by-hop flow programming by intercepting packets for which there are currently no matching flow objectives on the data plane. The paths paved in this manner are short-lived, i.e. they expire a few seconds after the flow on whose behalf they were programmed stops. The application relies on the ONOS path service to compute the shortest paths. In the event of negative topology events (link loss, device disconnect, etc.), the application will proactively invalidate any paths that it had programmed to lead through the resources that are no longer available."



The screenshot shows a terminal window titled "Virtual PC Simulator, version 0.8.3". The terminal output is as follows:

```
Welcome to Virtual PC Simulator, version 0.8.3
Dedicated to Daling.
Build time: Sep  9 2023 11:15:00
Copyright (c) 2007-2015, Paul Meng (mirnshi@gmail.com)
All rights reserved.

VPCS is free software, distributed under the terms of the "BSD" licence.
Source code and license can be found at vpcs.sf.net.
For more information, please visit wiki.freecode.com.cn.

Press '?' to get help.

Executing the startup file

PC1> ip 192.168.1.1/24
Checking for duplicate address...
PC1 : 192.168.1.1 255.255.255.0

PC1> ping 192.168.1.2
host (192.168.1.2) not reachable

PC1> ping 192.168.1.2
84 bytes from 192.168.1.2 icmp_seq=1 ttl=64 time=115.462 ms
84 bytes from 192.168.1.2 icmp_seq=2 ttl=64 time=36.040 ms
84 bytes from 192.168.1.2 icmp_seq=3 ttl=64 time=17.579 ms
84 bytes from 192.168.1.2 icmp_seq=4 ttl=64 time=32.243 ms
84 bytes from 192.168.1.2 icmp_seq=5 ttl=64 time=53.430 ms

PC1>
```

```

Welcome to Virtual PC Simulator, version 0.8.3
Dedicated to Daling.
Build time: Sep  9 2023 11:15:00
Copyright (c) 2007-2015, Paul Meng (mirnshi@gmail.com)
All rights reserved.

VPCS is free software, distributed under the terms of the "BSD" licence.
Source code and license can be found at vpcs.sf.net.
For more information, please visit wiki.freecode.com.cn.

Press '?' to get help.

Executing the startup file

PC2> ip 192.168.1.2/24
Checking for duplicate address...
PC2 : 192.168.1.2 255.255.255.0

PC2> ping 192.168.1.1
host (192.168.1.1) not reachable

PC2> ping 192.168.1.1
84 bytes from 192.168.1.1 icmp_seq=1 ttl=64 time=27.666 ms
84 bytes from 192.168.1.1 icmp_seq=2 ttl=64 time=31.826 ms
84 bytes from 192.168.1.1 icmp_seq=3 ttl=64 time=32.556 ms
84 bytes from 192.168.1.1 icmp_seq=4 ttl=64 time=24.843 ms
84 bytes from 192.168.1.1 icmp_seq=5 ttl=64 time=30.486 ms
PC2>

```

## Step 18: Check the Devices , Topology on ONOS GUI

Stared - deepunn3003@gmail... x List | Events | OpenNMS Web Co... x NMS\_ASSIGNMENTS/OPEN NM... x ONOS

← → ↻ Not secure | 172.20.0.254:8181/onos/ui/#/device

**onos** Open Network Operating System ? onos

Devices (2 total)

Search  All Fields ▾

	FRIENDLY NAME ▲	DEVICE ID	MASTER	PORTS	VENDOR	H/W VERSION	S/W VERSION	PROTOCOL
✓	of:000002d3182ebe40	of:000002d3182ebe40	172.20.0.254	17	Nicira, Inc.	Open vSwitch	2.17.6	OF_13
✓	of:00000e4154864448	of:00000e4154864448	172.20.0.254	17	Nicira, Inc.	Open vSwitch	2.17.6	OF_13

## Step 19: Connect to Postman

<http://172.20.0.254:8181/onos/v1/devices>

<http://172.20.0.254:8181/onos/v1/flows>

<http://172.20.0.254:8181/onos/v1/links>

<http://172.20.0.254:8181/onos/v1/topology>



## <http://172.20.0.254:8181/onos/v1/devices>

The screenshot shows the Postman application interface. The left sidebar displays a history of requests, including several PUT requests to /restconf/data/ietf-interfaces and GET requests to /restconf/data/ietf-interfaces and /restconf/data/Cisco-IOS-XE-r. The main panel shows a GET request to `http://172.20.0.254:8181/onos/v1/devices` with Basic Authentication (Username: onos, Password: rocks). The response is a JSON array of device information, including details like id, type, role, mfr, ha, sn, serial, driver, and chassisId.

```
1 {
2   "devices": [
3     {
4       "id": "of:09000e4184864448",
5       "type": "SWITCH",
6       "available": true,
7       "role": "MASTER",
8       "mfr": "Nicira, Inc.",
9       "ha": "Open vSwitch",
10      "sn": "2.17.0",
11      "serial": "None",
12      "driver": "ovs",
13      "chassisId": "e4184864448",

```

## <http://172.20.0.254:8181/onos/v1/flows>

The screenshot shows the Postman application interface. The left sidebar displays a history of requests, including several PUT requests to /restconf/data/ietf-interfaces and GET requests to /restconf/data/ietf-interfaces and /restconf/data/Cisco-IOS-XE-r. The main panel shows a GET request to `http://172.20.0.254:8181/onos/v1/flows` with Basic Authentication (Username: onos, Password: rocks). The response is a JSON array of flow information, including details like groupId, state, life, liveType, lastSeen, packets, bytes, id, appId, and priority.

```
1 {
2   "flows": [
3     {
4       "groupId": 0,
5       "state": "ADDED",
6       "life": 1912,
7       "liveType": "UNKNOWN",
8       "lastSeen": 1720769721257,
9       "packets": 0,
10      "bytes": 0,
11      "id": "281477468454793",
12      "appId": "org.onosproject.core",
13      "priority": 40000,

```

<http://172.20.0.254:8181/onos/v1/links>

The screenshot shows the Postman application interface. The left sidebar displays a history of requests, including several GET requests to the /onos/v1/links endpoint and PUT requests to /restconf/data/ietf-interfaces. The main workspace shows a GET request to `http://172.20.0.254:8181/onos/v1/links` with a Basic Authorization header (Username: onos, Password: rocks). The response is a JSON object with a "links" array containing two entries, each with "src", "port", and "device" fields. The status is 200 OK, and the response is displayed in the Pretty view.

```
{  "links": [    {      "src": {        "port": "7",        "device": "of:000002c3182ebe40"      },      "dst": {        "port": "7",        "device": "of:00000e4154864448"      },      "type": "INDIRECT",      "state": "ACTIVE"    }  ]}
```

<http://172.20.0.254:8181/onos/v1/topology>

The screenshot shows the Postman application interface. The left sidebar displays a history of requests, including several GET requests to the /onos/v1/topology endpoint and PUT requests to /restconf/data/ietf-interfaces. The main workspace shows a GET request to `http://172.20.0.254:8181/onos/v1/topology` with a Basic Authorization header (Username: onos, Password: rocks). The response is a JSON object with "time", "devices", "links", and "clusters" fields. The status is 200 OK, and the response is displayed in the Pretty view.

```
{  "time": 6052015438939999,  "devices": 2,  "links": 2,  "clusters": 2}
```