

LAB 2
CONSTRUCT A SIMPLE NETWORK



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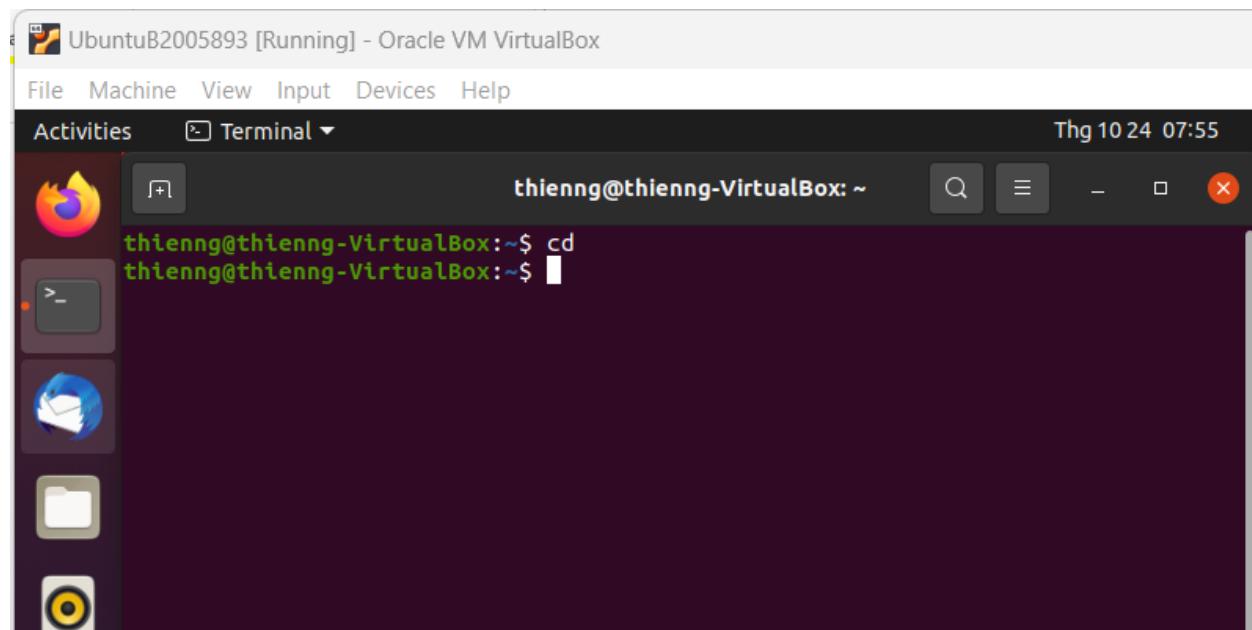
ID: B2005893

Group: M01

*Submission: an **ID_NAME_Lab02.pdf** file describes clearly how did you solve the problem*

Exercise 0: change the directory to your home directory

Answer: \$cd



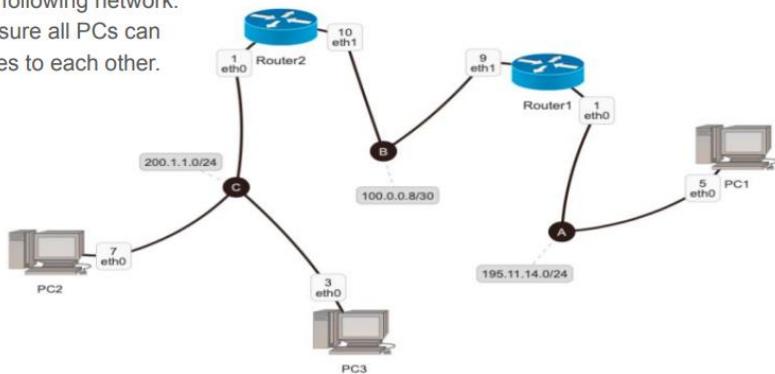
```
thienng@thienng-VirtualBox:~$ cd
```

Exercise 6: Construct the following network. Please make sure all PCs can send messages to each other.

Exercise 6

Construct the following network.

Please make sure all PCs can send messages to each other.



Answer:

1. Create folders and files for exercise 6

Here is the lab configurations:

```
$ tree
```

```
$ cat lab.conf
```

```
UbuntuB2005893 [Running] - Oracle VM VirtualBox
File Machine View Input Devices Help
Activities Terminal Thg 10 19 14:48
thienng@thienng-VirtualBox:~/LAB2/EX6$ tree
.
├── lab.conf
├── pc1
├── pc1.startup
├── pc2
├── pc2.startup
├── pc3
├── pc3.startup
└── r1
    ├── r1.startup
    └── r2
        └── r2.startup
5 directories, 6 files
thienng@thienng-VirtualBox:~/LAB2/EX6$ cat lab.conf
pc1[0]=A
pc2[0]=C
pc3[0]=C
r1[0]=A
r1[1]=B
r2[0]=C
r2[1]=B
thienng@thienng-VirtualBox:~/LAB2/EX6$
```

```
$ cat pc1.startup  
$ cat pc2.startup  
$ cat pc3.startup  
$ cat pc4.startup  
$ cat sw.startup
```

UbuntuB2005893 [Running] - Oracle VM VirtualBox

File Machine View Input Devices Help

Activities Terminal

thienng@thienng-VirtualBox: ~/LAB2/EX8\$ cat lab.conf

```
pc1[0]=A
pc2[0]=B
pc3[0]=C
pc4[0]=D
sw[0]=A
sw[1]=B
sw[2]=C
sw[3]=D
```

thienng@thienng-VirtualBox: ~/LAB2/EX8\$ cat pc1.startup

```
ifconfig eth0 10.0.0.10/24 up
ifconfig eth0 hw ether 00:00:00:00:00:10
```

thienng@thienng-VirtualBox: ~/LAB2/EX8\$ cat pc2.startup

```
ifconfig eth0 10.0.0.20/24 up
ifconfig eth0 hw ether 00:00:00:00:00:20
```

thienng@thienng-VirtualBox: ~/LAB2/EX8\$ cat pc3.startup

```
ifconfig eth0 10.0.0.30/24 up
ifconfig eth0 hw ether 00:00:00:00:00:30
```

thienng@thienng-VirtualBox: ~/LAB2/EX8\$ cat pc4.startup

```
ifconfig eth0 10.0.0.40/24 up
ifconfig eth0 hw ether 00:00:00:00:00:40
```

thienng@thienng-VirtualBox: ~/LAB2/EX8\$ cat sw.startup

```
ifconfig eth0 up
ifconfig eth0 hw ether 00:00:00:00:10:10
ifconfig eth1 up
ifconfig eth1 hw ether 00:00:00:00:20:20
ifconfig eth2 up
ifconfig eth2 hw ether 00:00:00:00:30:30
ifconfig eth3 up
ifconfig eth3 hw ether 00:00:00:00:40:40
brctl addbr br0
brctl addif br0 eth0
brctl addif br0 eth1
brctl addif br0 eth2
brctl addif br0 eth3
brctl stp br0 on
ifconfig br0 up
```

thienng@thienng-VirtualBox: ~/LAB2/EX8\$

2. Start kathara

```
$ sudo kathara lstart
```

The screenshot shows a desktop environment with several open windows. In the foreground, there are four terminal windows (XTerm) stacked vertically. The top window is titled 'root@pc2: /' and displays a log of network interface configuration commands. The other three windows are labeled 'root@pc1: /', 'root@pc3: /', and 'root@pc4: /', each showing a similar log. To the left of the terminals is a dock containing icons for a browser, file manager, terminal, and system tools. A file manager window is visible in the background, showing a directory structure. The desktop has a purple and black theme.

```
thienng@thienng-VirtualBox: ~/LAB2/EX8
thienng@pc2: ~
[sudo] password:
INFO --- Start ---+
Deplo++ ifco
Deplo++ ifco
INFO --- Start ---+
thienng--- End ++ ifco
root@pc2++ ifco --- Start ---+
--- End ++ ifco
root@pc2++ ifco --- Start ---+
--- End ++ ifco
root@pc2++ ifco --- Start ---+
--- End ++ ifco
root@pc2++ ifco --- Startup Commands Log
--- End ++ ifconfig eth0 up
root@pc2++ ifconfig eth0 hw ether 00:00:00:00:00:10
++ ifconfig eth1 hw ether 00:00:00:00:00:20
++ ifconfig eth2 hw ether 00:00:00:00:00:30
++ ifconfig eth3 hw ether 00:00:00:00:00:40
++ brctl addbr br0
++ brctl addif br0 eth0
++ brctl addif br0 eth1
++ brctl addif br0 eth2
++ brctl addif br0 eth3
++ brctl stp br0 on
++ ifconfig br0 up
--- End Startup Commands Log
root@pc2: #
```

3. Ping on pc1 to pc2 and pc3

From pc1:

```
# ping 200.1.1.7
```

```
# ping 200.1.1.3
```

```
root@pc1: /  
--- Startup Commands Log  
++ ifconfig eth0 195.11.14.5/24 up  
++ route add default gw 195.11.14.1  
--- End Startup Commands Log  
  
root@pc1:/# ping 200.1.1.7  
PING 200.1.1.7 (200.1.1.7) 56(84) bytes of data.  
64 bytes from 200.1.1.7: icmp_seq=1 ttl=62 time=0.134 ms  
64 bytes from 200.1.1.7: icmp_seq=2 ttl=62 time=0.075 ms  
^C  
--- 200.1.1.7 ping statistics ---  
2 packets transmitted, 2 received, 0% packet loss, time 14ms  
rtt min/avg/max/mdev = 0.075/0.104/0.134/0.031 ms  
root@pc1:/# ping 200.1.1.3  
PING 200.1.1.3 (200.1.1.3) 56(84) bytes of data.  
64 bytes from 200.1.1.3: icmp_seq=1 ttl=62 time=0.104 ms  
64 bytes from 200.1.1.3: icmp_seq=2 ttl=62 time=0.084 ms  
^C  
--- 200.1.1.3 ping statistics ---  
2 packets transmitted, 2 received, 0% packet loss, time 20ms  
rtt min/avg/max/mdev = 0.084/0.094/0.104/0.010 ms  
root@pc1:/#
```

4. Route on r1 and r2

From r1:

```
# route -n
```

```
root@r1: /  
--- Startup Commands Log  
++ ifconfig eth0 195.11.14.1/24 up  
++ ifconfig eth1 100.0.0.9/24 up  
++ route add -net 200.1.1.0/24 gw 100.0.0.10  
--- End Startup Commands Log  
  
root@r1:/# route -n  
Kernel IP routing table  
Destination      Gateway      Genmask      Flags Metric Ref    Use Iface  
100.0.0.0        0.0.0.0      255.255.255.0 U     0      0        0 eth1  
195.11.14.0      0.0.0.0      255.255.255.0 U     0      0        0 eth0  
200.1.1.0        100.0.0.10   255.255.255.0 UG    0      0        0 eth1  
root@r1:/#
```

From r2:

```
# route -n
```

```
root@r2: ~
--- Startup Commands Log ---
++ ifconfig eth0 200.1.1.1/24 up
++ ifconfig eth1 100.0.0.10/24 up
++ route add -net 195.11.14.0/24 gw 100.0.0.9

--- End Startup Commands Log

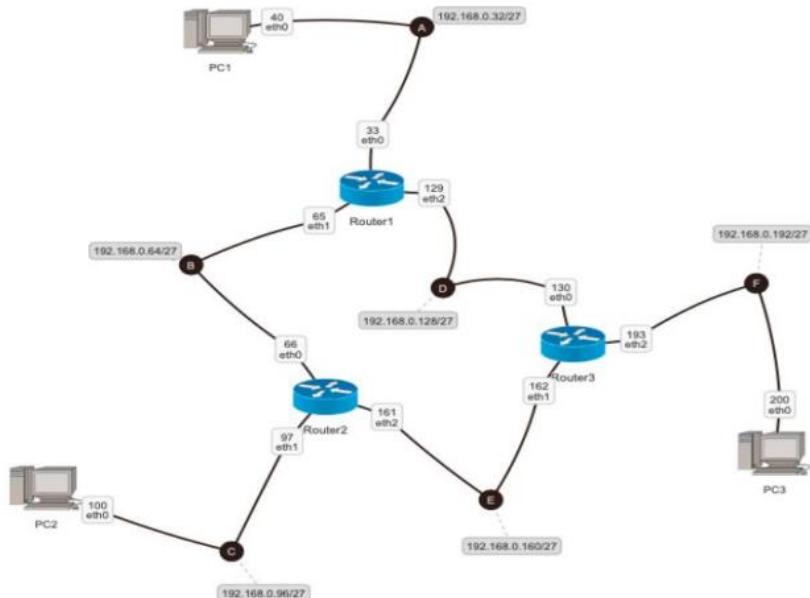
root@r2: # route -n
Kernel IP routing table
Destination     Gateway      Genmask      Flags Metric Ref    Use Iface
100.0.0.0        0.0.0.0    255.255.255.0 U     0      0        0 eth1
195.11.14.0      100.0.0.9  255.255.255.0 UG    0      0        0 eth1
200.1.1.0        0.0.0.0    255.255.255.0 U     0      0        0 eth0
root@r2: #
```

5. Delete VMs

```
$sudo kathara wipe
```

```
thienng@thienng-VirtualBox: ~/LAB2/EX6$ sudo kathara wipe
[sudo] password for thienng:
Sorry, try again.
[sudo] password for thienng:
Are you sure to wipe Kathara? (y/n) y
```

Exercise 7: Construct the following network.



1. Lab configuration

```
$ tree
```

```
thiennng@thienng-VirtualBox:~/LAB2/EX7$ tree
.
├── lab.conf
├── pc1
├── pc1.startup
├── pc2
├── pc2.startup
├── pc3
├── pc3.startup
├── r1
├── r1.startup
├── r2
├── r2.startup
└── r3
    └── r3.startup

6 directories, 7 files
thiennng@thienng-VirtualBox:~/LAB2/EX7$
```

```
$ cat lab.conf
```

```
UbuntuB2005893 [Running] - Oracle VM VirtualBox
File Machine View Input Devices Help
Activities Terminal ▾ Thg 10 19 23:07
thienng@thienng-VirtualBox: ~/LAB2/EX7$ cat lab.conf
pc1[0]=A
pc2[0]=C
pc3[0]=F

r1[0]=A
r1[1]=B
r1[2]=D

r2[0]=B
r2[1]=C
r2[2]=E

r3[0]=D
r3[1]=E
r3[2]=F
thienng@thienng-VirtualBox:~/LAB2/EX7$
```

```
$ cat pc1.startup
```

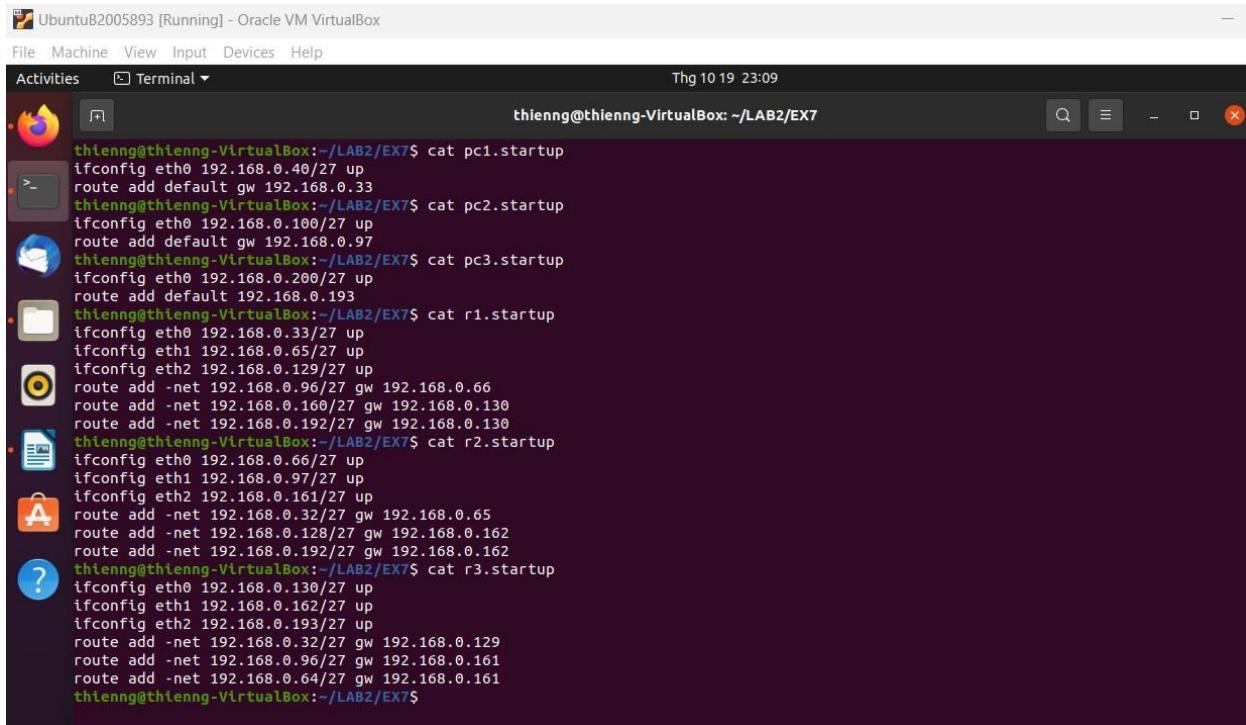
```
$ cat pc2.startup
```

```
$ cat pc3. Startup
```

```
$ cat r1.startup
```

```
$ cat r2.startup
```

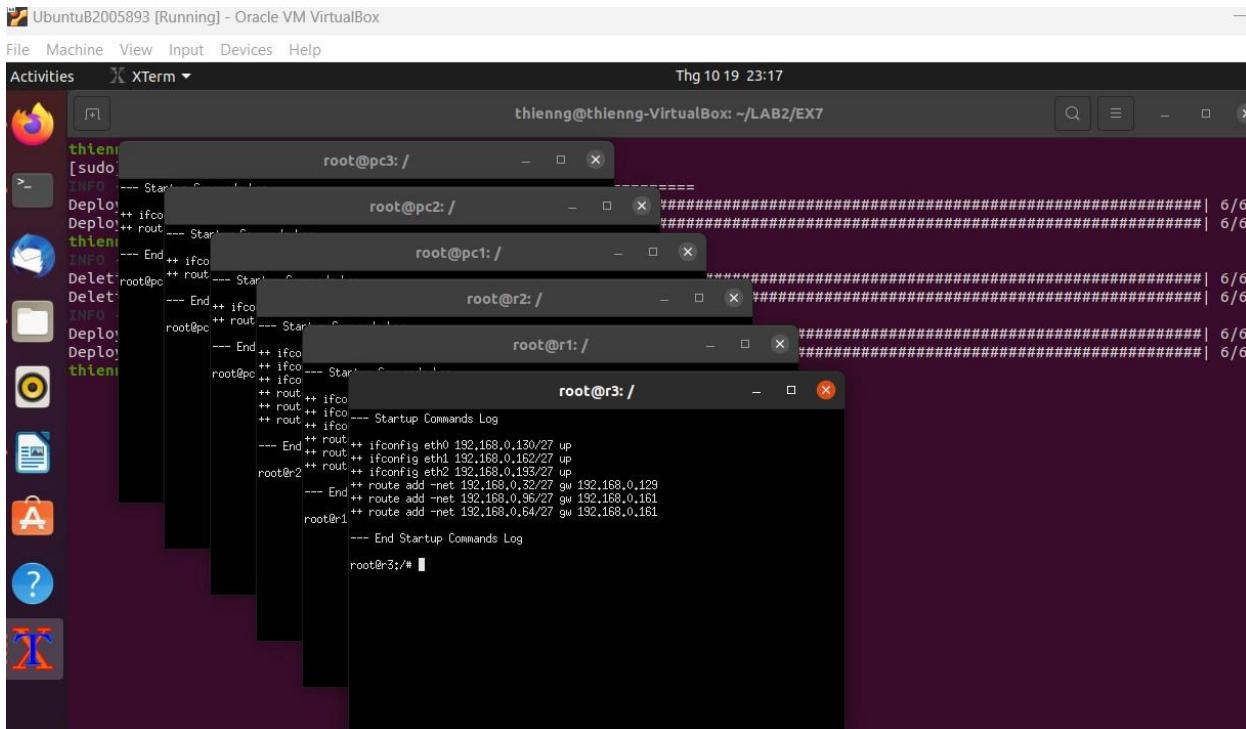
```
$ cat r3.startup
```



```
thienng@thienng-VirtualBox:~/LAB2/EX7$ cat pc1.startup
ifconfig eth0 192.168.0.40/27 up
route add default gw 192.168.0.33
thienng@thienng-VirtualBox:~/LAB2/EX7$ cat pc2.startup
ifconfig eth0 192.168.0.100/27 up
route add default gw 192.168.0.97
thienng@thienng-VirtualBox:~/LAB2/EX7$ cat pc3.startup
ifconfig eth0 192.168.0.200/27 up
route add default 192.168.0.193
thienng@thienng-VirtualBox:~/LAB2/EX7$ cat r1.startup
ifconfig eth0 192.168.0.33/27 up
ifconfig eth1 192.168.0.65/27 up
ifconfig eth2 192.168.0.129/27 up
route add -net 192.168.0.96/27 gw 192.168.0.66
route add -net 192.168.0.160/27 gw 192.168.0.130
route add -net 192.168.0.192/27 gw 192.168.0.130
thienng@thienng-VirtualBox:~/LAB2/EX7$ cat r2.startup
ifconfig eth0 192.168.0.66/27 up
ifconfig eth1 192.168.0.97/27 up
ifconfig eth2 192.168.0.161/27 up
route add -net 192.168.0.32/27 gw 192.168.0.65
route add -net 192.168.0.128/27 gw 192.168.0.162
route add -net 192.168.0.192/27 gw 192.168.0.162
thienng@thienng-VirtualBox:~/LAB2/EX7$ cat r3.startup
ifconfig eth0 192.168.0.130/27 up
ifconfig eth1 192.168.0.162/27 up
ifconfig eth2 192.168.0.193/27 up
route add -net 192.168.0.32/27 gw 192.168.0.129
route add -net 192.168.0.96/27 gw 192.168.0.161
route add -net 192.168.0.64/27 gw 192.168.0.161
thienng@thienng-VirtualBox:~/LAB2/EX7$
```

2. Start kathara

```
$ sudo kathara lstart
```



```
[sudo] password for thienng:
[thienng@pc3: ~]$ root@pc3: / 
INFO --- Start Commands Log
Deploy:++ ifco
Deploy:++ rout --- Start Commands Log
thienng@pc3: ~$ root@pc2: / 
INFO --- End ++ ifco
Delete:root@pc2: ~$ root@pc2: ~$ 
Delete:root@pc2: ~$ 
thienng@pc2: ~$ root@pc1: / 
INFO --- End ++ ifco
Delete:root@pc1: ~$ root@pc1: ~$ 
Delete:root@pc1: ~$ 
thienng@pc1: ~$ root@r1: / 
INFO --- End ++ ifco
Delete:root@r1: ~$ root@r1: ~$ 
Delete:root@r1: ~$ 
thienng@r1: ~$ root@r2: / 
INFO --- End ++ ifco
Delete:root@r2: ~$ root@r2: ~$ 
Delete:root@r2: ~$ 
thienng@r2: ~$ root@r3: / 
INFO --- End ++ ifco
Delete:root@r3: ~$ root@r3: ~$ 
Delete:root@r3: ~$ 
thienng@r3: ~$
```

3. Check if all pcs can send messages to each others

From pc1, ping to pc2 and pc3:

```
# ping 192.168.0.100
```

```
# ping 192.168.0.200
```

```

UbuntuB2005893 [Running] - Oracle VM VirtualBox
File Machine View Input Devices Help
Activities XTerm ▾ Thg 10 19 23:18
root@pc1: /
--- Startup Commands Log
++ ifconfig eth0 192.168.0.40/27 up
++ route add default gw 192.168.0.33
--- End Startup Commands Log

root@pc1:/# ping 192.168.0.100
PING 192.168.0.100 (192.168.0.100) 56(84) bytes of data.
64 bytes from 192.168.0.100: icmp_seq=1 ttl=62 time=0.111 ms
64 bytes from 192.168.0.100: icmp_seq=2 ttl=62 time=0.066 ms
^C
--- 192.168.0.100 ping statistics ---
2 packets transmitted, 2 received, 0% packet loss, time 11ms
rtt min/avg/max/mdev = 0.066/0.088/0.111/0.024 ms
root@pc1:/# ping 192.168.0.200
PING 192.168.0.200 (192.168.0.200) 56(84) bytes of data.
64 bytes from 192.168.0.200: icmp_seq=1 ttl=62 time=0.116 ms
64 bytes from 192.168.0.200: icmp_seq=2 ttl=62 time=0.061 ms
^C
--- 192.168.0.200 ping statistics ---
2 packets transmitted, 2 received, 0% packet loss, time 20ms
rtt min/avg/max/mdev = 0.061/0.088/0.116/0.029 ms
root@pc1:/#

```

4. Route on r1, r2 and r3

From r1:

```
# route -n
```

```

UbuntuB2005893 [Running] - Oracle VM VirtualBox
File Machine View Input Devices Help
Activities XTerm ▾ Thg 10 19 23:19
root@r1: /
--- Startup Commands Log
++ ifconfig eth0 192.168.0.33/27 up
++ ifconfig eth1 192.168.0.65/27 up
++ ifconfig eth2 192.168.0.129/27 up
++ route add -net 192.168.0.96/27 gw 192.168.0.66
++ route add -net 192.168.0.160/27 gw 192.168.0.130
++ route add -net 192.168.0.192/27 gw 192.168.0.130
--- End Startup Commands Log

root@r1:/# route -n
Kernel IP routing table
Destination     Gateway         Genmask        Flags Metric Ref    Use Iface
192.168.0.32   0.0.0.0        255.255.255.224 U      0      0      0 eth0
192.168.0.64   0.0.0.0        255.255.255.224 U      0      0      0 eth1
192.168.0.96   192.168.0.66   255.255.255.224 UG     0      0      0 eth1
192.168.0.128  0.0.0.0        255.255.255.224 U      0      0      0 eth2
192.168.0.160  192.168.0.130  255.255.255.224 UG     0      0      0 eth2
192.168.0.192  192.168.0.130  255.255.255.224 UG     0      0      0 eth2
root@r1:/#

```

From r2:

```
# route -n
```

```
UbuntuB2005893 [Running] - Oracle VM VirtualBox
File Machine View Input Devices Help
Activities XTerm ▾ Thg 10 19 23:19
root@r2: /
--- Startup Commands Log
++ ifconfig eth0 192.168.0.66/27 up
++ ifconfig eth1 192.168.0.97/27 up
++ ifconfig eth2 192.168.0.161/27 up
++ route add -net 192.168.0.32/27 gw 192.168.0.65
++ route add -net 192.168.0.128/27 gw 192.168.0.162
++ route add -net 192.168.0.192/27 gw 192.168.0.162
--- End Startup Commands Log
root@r2: # route -n
Kernel IP routing table
Destination Gateway Genmask Flags Metric Ref Use Iface
192.168.0.32 192.168.0.65 255.255.255.224 UG 0 0 0 eth0
192.168.0.64 0.0.0.0 255.255.255.224 U 0 0 0 eth0
192.168.0.96 0.0.0.0 255.255.255.224 U 0 0 0 eth1
192.168.0.128 192.168.0.162 255.255.255.224 UG 0 0 0 eth2
192.168.0.160 0.0.0.0 255.255.255.224 U 0 0 0 eth2
192.168.0.192 192.168.0.162 255.255.255.224 UG 0 0 0 eth2
root@r2: #
```

From r3:

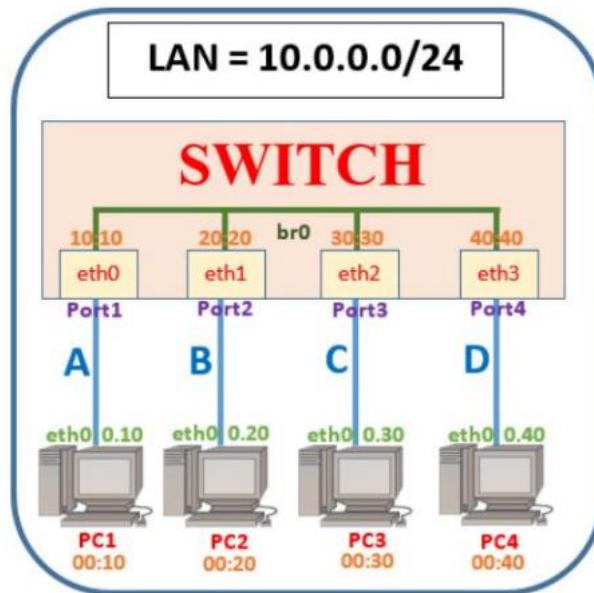
```
# route -n
```

```
UbuntuB2005893 [Running] - Oracle VM VirtualBox
File Machine View Input Devices Help
Activities XTerm ▾ Thg 10 19 23:20
root@r3: /
--- Startup Commands Log
++ ifconfig eth0 192.168.0.130/27 up
++ ifconfig eth1 192.168.0.162/27 up
++ ifconfig eth2 192.168.0.193/27 up
++ route add -net 192.168.0.32/27 gw 192.168.0.129
++ route add -net 192.168.0.96/27 gw 192.168.0.161
++ route add -net 192.168.0.64/27 gw 192.168.0.161
--- End Startup Commands Log
root@r3: # route -n
Kernel IP routing table
Destination Gateway Genmask Flags Metric Ref Use Iface
192.168.0.32 192.168.0.129 255.255.255.224 UG 0 0 0 eth0
192.168.0.64 192.168.0.161 255.255.255.224 UG 0 0 0 eth1
192.168.0.96 192.168.0.161 255.255.255.224 UG 0 0 0 eth1
192.168.0.128 0.0.0.0 255.255.255.224 U 0 0 0 eth0
192.168.0.160 0.0.0.0 255.255.255.224 U 0 0 0 eth1
192.168.0.192 0.0.0.0 255.255.255.224 U 0 0 0 eth2
root@r3: #
```

5. Delete all VMs

```
$ sudo kathara wipe
```

```
UbuntuB2005893 [Running] - Oracle VM VirtualBox
File Machine View Input Devices Help
Activities Terminal ▾ Thg 10 19 23:21
thienng@thienng-VirtualBox: ~/LAB2/EX7$ sudo kathara wipe
Are you sure to wipe Kathara? (y/n) y
thienng@thienng-VirtualBox: ~/LAB2/EX7$
```

Exercise 8: Construct a LAN using a switch

- Lab Configuration:

```
$ tree  
$ cat lab.conf  
$ cat pc1.startup  
$ cat pc2.startup  
$ cat pc3.startup  
$ cat pc4.startup  
$ cat sw.startup
```

A screenshot of a Linux desktop environment showing a terminal window. The terminal title is "UbuntuB2005893 [Running] - Oracle VM VirtualBox". The terminal window shows the command \$ tree being run, displaying the directory structure:

```
thienng@thienng-VirtualBox:~/LAB2/EX8$ tree  
.  
├── lab.conf  
├── pc1  
├── pc1.startup  
├── pc2  
├── pc2.startup  
├── pc3  
├── pc3.startup  
├── pc4  
├── pc4.startup  
└── sw  
    └── sw.startup  
5 directories, 6 files
```

The terminal window also shows the current user is "thienng" and the date and time are "Thg 10 20 16:09".

CT106H – Computer Network

UbuntuB2005893 [Running] - Oracle VM VirtualBox

File Machine View Input Devices Help

Activities Terminal Thg 10 22 18:42

thienng@thienng-VirtualBox: ~/LAB2/EX8\$ cat lab.conf

```
pc1[0]=A
pc2[0]=B
pc3[0]=C
pc4[0]=D
sw[0]=A
sw[1]=B
sw[2]=C
sw[3]=D
```

thienng@thienng-VirtualBox: ~/LAB2/EX8\$ cat pci.startup

```
ifconfig eth0 10.0.0.10/24 up
ifconfig eth0 hw ether 00:00:00:00:00:10
```

thienng@thienng-VirtualBox: ~/LAB2/EX8\$ cat pc2.startup

```
ifconfig eth0 10.0.0.20/24 up
ifconfig eth0 hw ether 00:00:00:00:00:20
```

thienng@thienng-VirtualBox: ~/LAB2/EX8\$ cat pc3.startup

```
ifconfig eth0 10.0.0.30/24 up
ifconfig eth0 hw ether 00:00:00:00:00:30
```

thienng@thienng-VirtualBox: ~/LAB2/EX8\$ cat pc4.startup

```
ifconfig eth0 10.0.0.40/24 up
ifconfig eth0 hw ether 00:00:00:00:00:40
```

thienng@thienng-VirtualBox: ~/LAB2/EX8\$ cat sw.startup

```
ifconfig eth0 up
ifconfig eth0 hw ether 00:00:00:00:10:10
ifconfig eth1 up
ifconfig eth1 hw ether 00:00:00:00:20:20
ifconfig eth2 up
ifconfig eth2 hw ether 00:00:00:00:30:30
ifconfig eth3 up
ifconfig eth3 hw ether 00:00:00:00:40:40
brctl addbr br0
brctl addif br0 eth0
brctl addif br0 eth1
brctl addif br0 eth2
brctl addif br0 eth3
brctl stp br0 on
ifconfig br0 up
```

thienng@thienng-VirtualBox: ~/LAB2/EX8\$

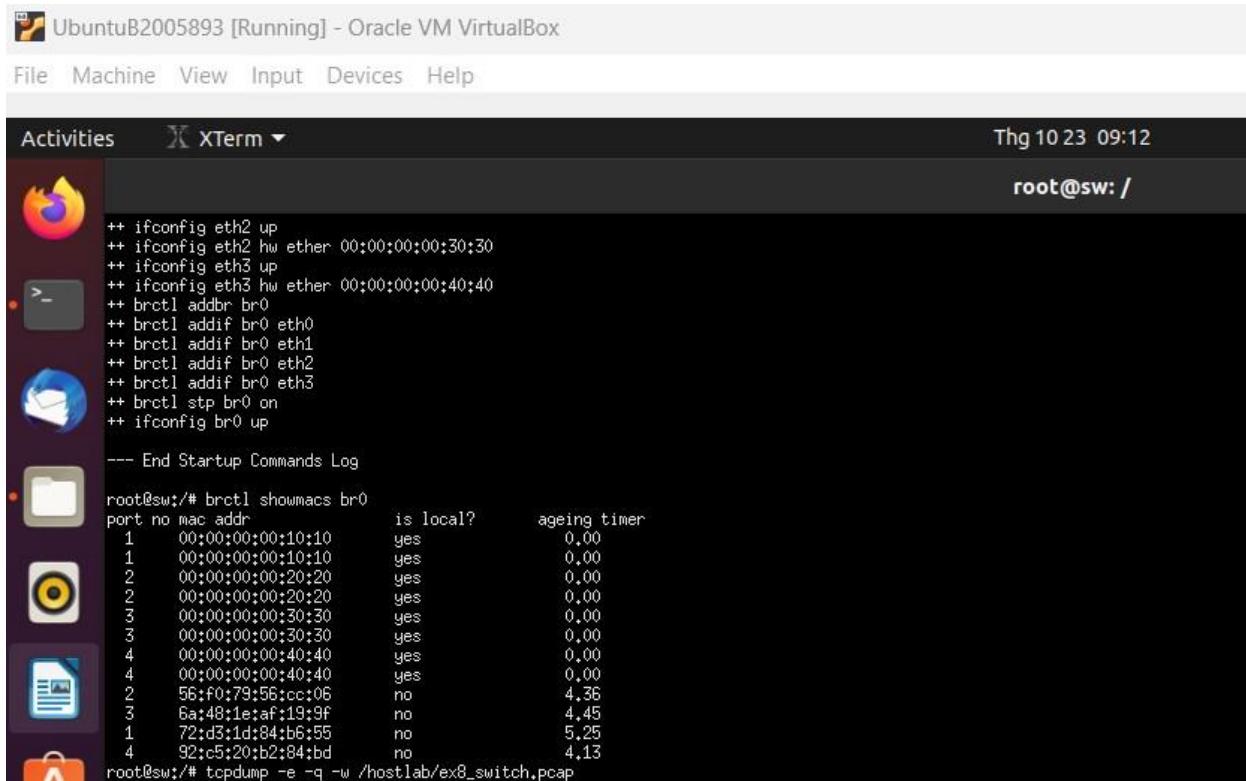
- Start Kathara
\$ sudo kathara lstart

The screenshot shows a Linux desktop environment with several open windows:

- A terminal window titled "root@pc2: /" showing a log of startup commands.
- A terminal window titled "root@pc1: /" showing a log of startup commands.
- A terminal window titled "root@pc3: /" showing a log of startup commands.
- A terminal window titled "root@pc4: /" showing a log of startup commands.
- A terminal window titled "root@sw: /" showing a log of startup commands.
- A file manager window titled "thien" showing a list of files and folders.

The desktop has a dark theme with icons for various applications like a browser, email, and file manager.

- \$ brctl showmacs br0



The screenshot shows a terminal window titled "XTerm" running on an Ubuntu desktop environment. The terminal displays the output of the command \$ brctl showmacs br0. The output shows the configuration of bridge br0, including the addition of interfaces eth0, eth1, eth2, and eth3, and the activation of the Spanning Tree Protocol (STP) on br0.

```
++ ifconfig eth2 up
++ ifconfig eth2 hw ether 00:00:00:00:30:30
++ ifconfig eth3 up
++ ifconfig eth3 hw ether 00:00:00:00:40:40
++ brctl addbr br0
++ brctl addif br0 eth0
++ brctl addif br0 eth1
++ brctl addif br0 eth2
++ brctl addif br0 eth3
++ brctl stp br0 on
++ ifconfig br0 up

--- End Startup Commands Log

root@sw:/# brctl showmacs br0
port no mac addr      is local?    ageing timer
  1  00:00:00:00:10:10  yes          0.00
  1  00:00:00:00:10:10  yes          0.00
  2  00:00:00:00:20:20  yes          0.00
  2  00:00:00:00:20:20  yes          0.00
  3  00:00:00:00:30:30  yes          0.00
  3  00:00:00:00:30:30  yes          0.00
  4  00:00:00:00:40:40  yes          0.00
  4  00:00:00:00:40:40  yes          0.00
  2  56:f0:79:56:cc:06  no           4.36
  3  6a:48:1e:a1:19:9f  no           4.45
  1  72:d3:1d:84:b6:55  no           5.25
  4  92:c5:20:b2:84:bd  no           4.13
```

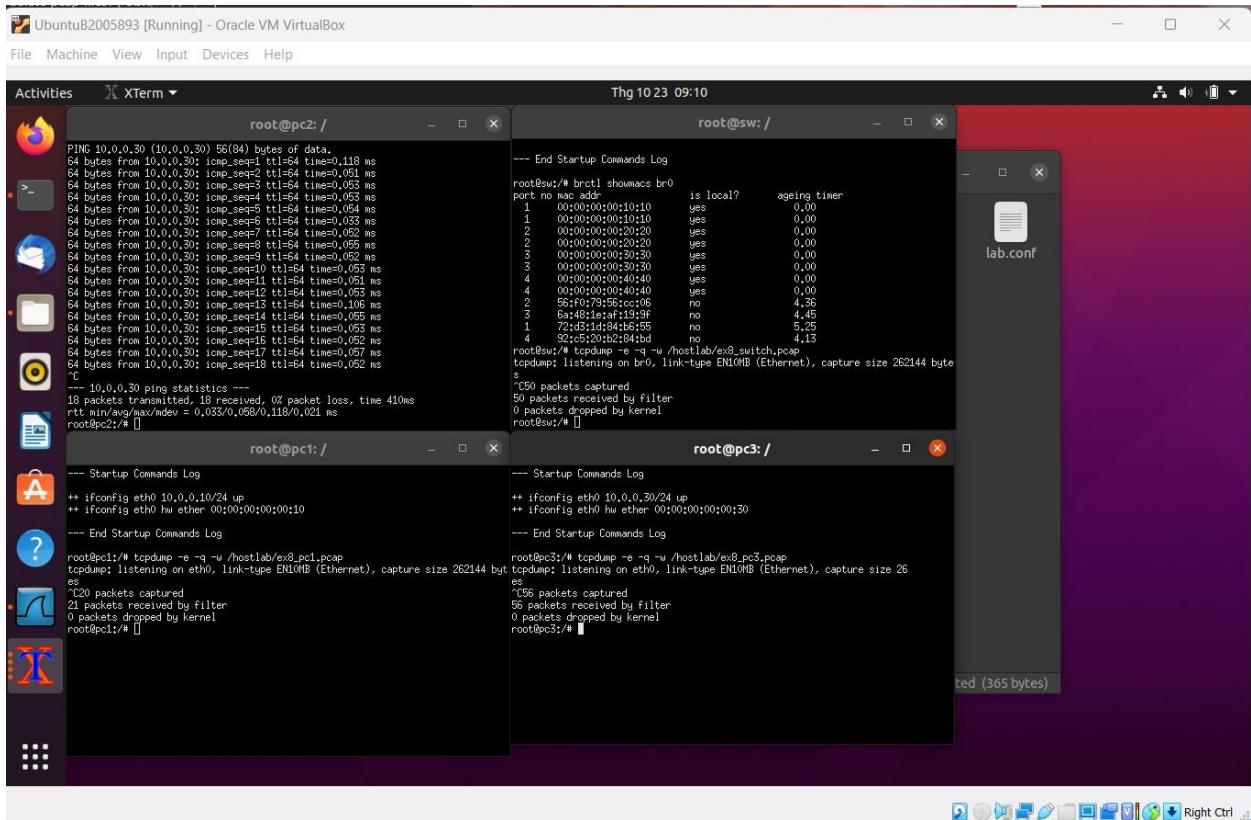
root@sw:/# tcpdump -e -q -w /hostlab/ex8_switch.pcap

1. sniff switch, pc1, pc3. On pc2, send message to pc3

```
$ tcpdump -e -q -w /hostlab/ex8_switch.pcap
$ tcpdump -e -q -w /hostlab/ex8_pc1.pcap
$ tcpdump -e -q -w /hostlab/ex8_pc3.pcap

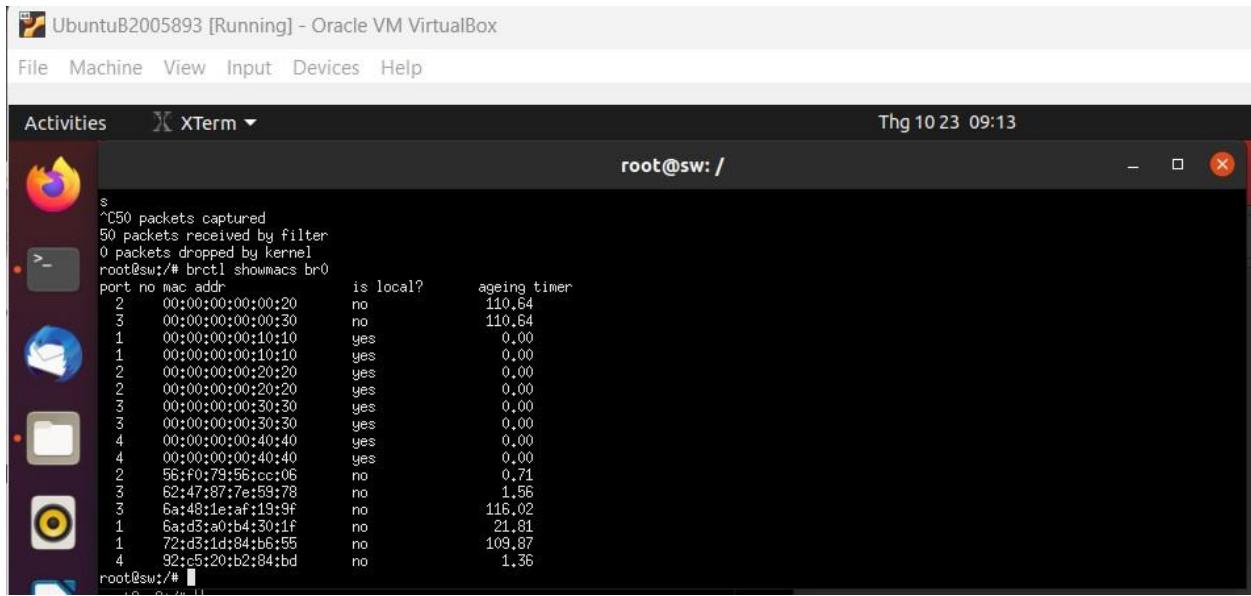
On pc2:
# ping 10.0.0.30
```

2.



3. On the switch check the contain of the Mac Lookup Table again

brctl showmacs br0



→ Answer: Compared to the previous MAC table, we can see that the interfaces can connected on the network. Besides, static entries are manually added to the table by a switch administrator

4. Use Wireshark to open ex8_switch.pcap, open the frame using ARP protocol with the source MAC address of 00:00:00:00:00:20

Frame 4: 42 bytes on wire (336 bits), 42 bytes captured (336 bits)

Encapsulation type: Ethernet (1)
Arrival Time: Oct 23, 2022 09:10:13.513953000 +07
[Time shift for this packet: 0.000000000 seconds]
Epoch Time: 1666491013.513953000 seconds
[Time delta from previous captured frame: 0.680925000 seconds]
[Time delta from previous displayed frame: 0.000000000 seconds]
[Time since reference or first frame: 1.522875000 seconds]

Frame Number: 4
Frame Length: 42 bytes (336 bits)
Capture Length: 42 bytes (336 bits)
[Frame is marked: False]
[Frame is ignored: False]
[Protocols in frame: eth:ethertype:arp]
[Coloring Rule Name: ARP]
[Coloring Rule String: arp]

Ethernet II, Src: 00:00:00:00:00:20 (00:00:00:00:00:20), Dst: Broadcast (ff:ff:ff:ff:ff:ff)

Destination: Broadcast (ff:ff:ff:ff:ff:ff)
Address: Broadcast (ff:ff:ff:ff:ff:ff)
....1.... = LG bit: Locally administered address (this is NOT the factory default)
....1.... = IG bit: Group address (multicast/broadcast)

No.	Time	Source	Destination	Protocol	Length	Info
4	1.522875	00:00:00:00:00:20	Broadcast	ARP	42	Who has 10.0.0.30? Tell 10.0.0.20
5	1.522907	00:00:00:00:00:30	00:00:00:00:00:20	ARP	42	10.0.0.30 is at 00:00:00:00:00:30
16	6.628527	00:00:00:00:00:30	00:00:00:00:00:20	ARP	42	Who has 10.0.0.20? Tell 10.0.0.30
17	6.628538	00:00:00:00:00:20	00:00:00:00:00:30	ARP	42	10.0.0.20 is at 00:00:00:00:00:20

0000 ff ff ff ff ff 00 00 00 00 00 00 20 08 06 00 01
0010 08 00 06 04 00 01 00 00 00 00 20 0a 00 00 14
0020 00 00 00 00 00 00 0a 00 00 1e

[Coloring Rule String: arp]

Ethernet II, Src: 00:00:00:00:00:20 (00:00:00:00:00:20), Dst: Broadcast (ff:ff:ff:ff:ff:ff)

Destination: Broadcast (ff:ff:ff:ff:ff:ff)
Address: Broadcast (ff:ff:ff:ff:ff:ff)
....1.... = LG bit: Locally administered address (this is NOT the factory default)
....1.... = IG bit: Group address (multicast/broadcast)

Source: 00:00:00:00:00:20 (00:00:00:00:00:20)
Address: 00:00:00:00:00:20 (00:00:00:00:00:20)
....0.... = LG bit: Globally unique address (factory default)
....0.... = IG bit: Individual address (unicast)

Type: ARP (0x0806)

Address Resolution Protocol (request)

Hardware type: Ethernet (1)
Protocol type: IPv4 (0x0800)
Hardware size: 6
Protocol size: 4
Opcode: request (1)
Sender MAC address: 00:00:00:00:00:20 (00:00:00:00:00:20)
Sender IP address: 10.0.0.20
Target MAC address: 00:00:00:00:00:00 (00:00:00:00:00:00)
Target IP address: 10.0.0.30

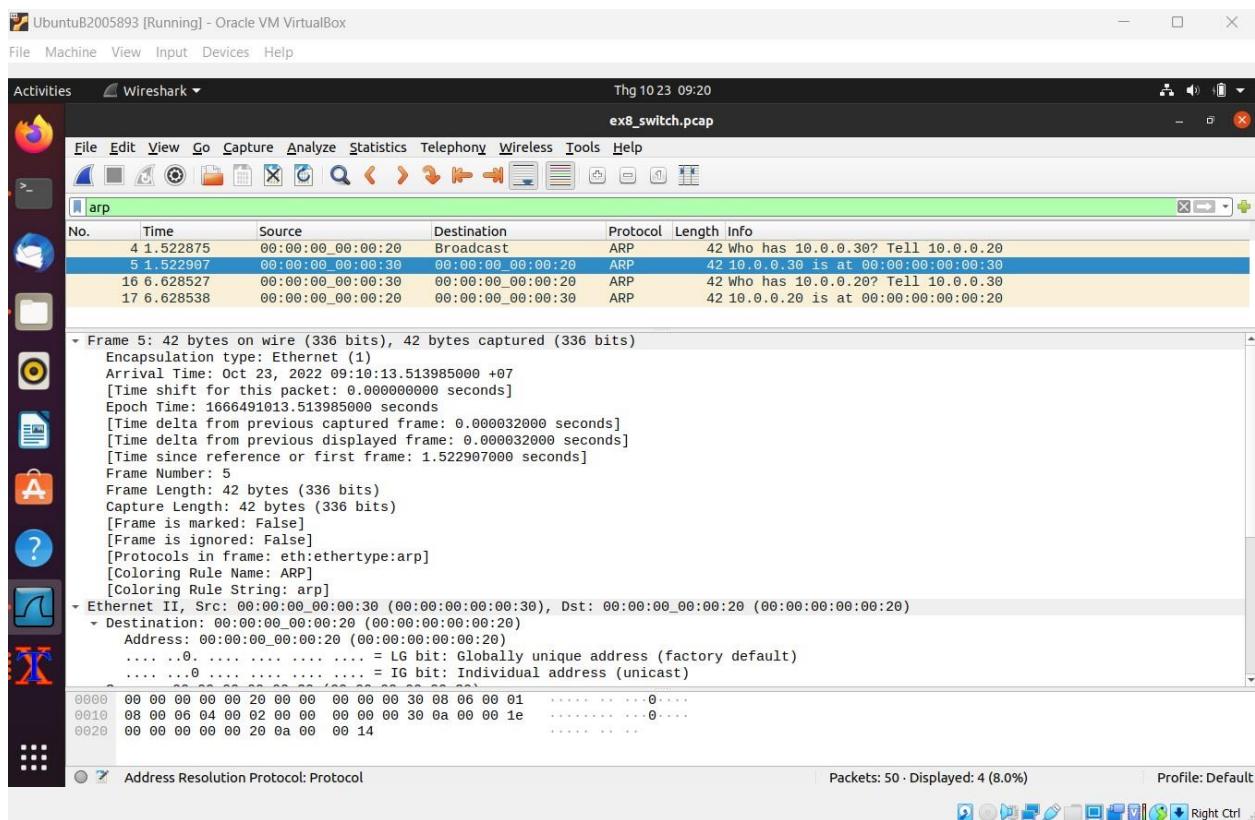
No.	Time	Source	Destination	Protocol	Length	Info
4	1.522875	00:00:00:00:00:20	Broadcast	ARP	42	Who has 10.0.0.30? Tell 10.0.0.20
5	1.522907	00:00:00:00:00:30	00:00:00:00:00:20	ARP	42	10.0.0.30 is at 00:00:00:00:00:30
16	6.628527	00:00:00:00:00:30	00:00:00:00:00:20	ARP	42	Who has 10.0.0.20? Tell 10.0.0.30
17	6.628538	00:00:00:00:00:20	00:00:00:00:00:30	ARP	42	10.0.0.20 is at 00:00:00:00:00:20

0000 ff ff ff ff ff 00 00 00 00 00 00 20 08 06 00 01
0010 08 00 06 04 00 01 00 00 00 00 20 0a 00 00 14
0020 00 00 00 00 00 00 0a 00 00 1e

→ Answer: The frame contain:

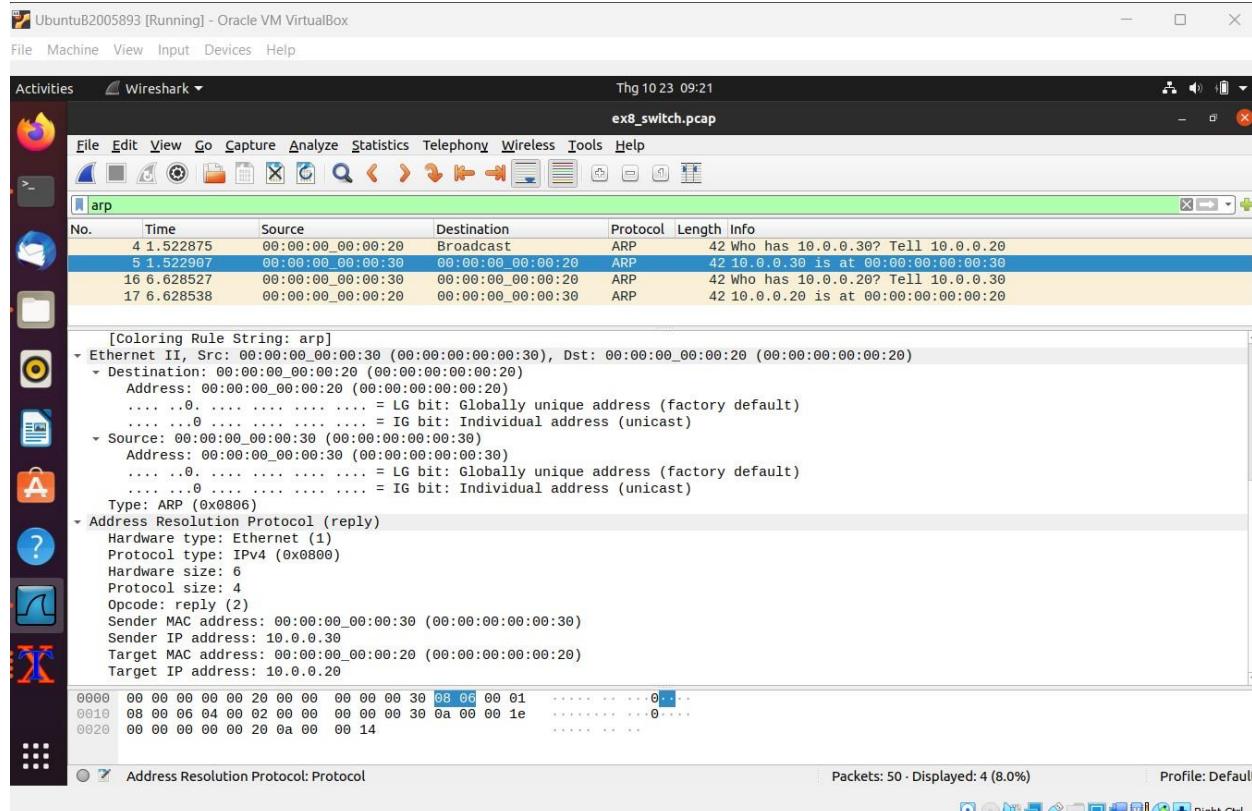
- The source address `00:00:00:00:00:20`
- The hex value for the destination address is `ff:ff:ff:ff:ff:ff`, the broadcast address
- The hex value for the Ethernet Frame Type is `0x0806`, for ARP
- The ARP message containing the IP address (`10.0.0.20`) for the sender and it wants to send this data to (`10.0.0.30`), but it doesn't know the MAC address to send it to, so it has sent an Address Resolution Protocol (ARP) request to find out that information. We can also see that in the field “Target MAC address” is set to `00:00:00:00:00:00` to question the machine whose corresponding IP address (`10.0.0.30`) is being queried

5. Use Wireshark to open `ex8_switch.pcap`, open the frame using ARP protocol with the source MAC address of `00:00:00:00:00:30`

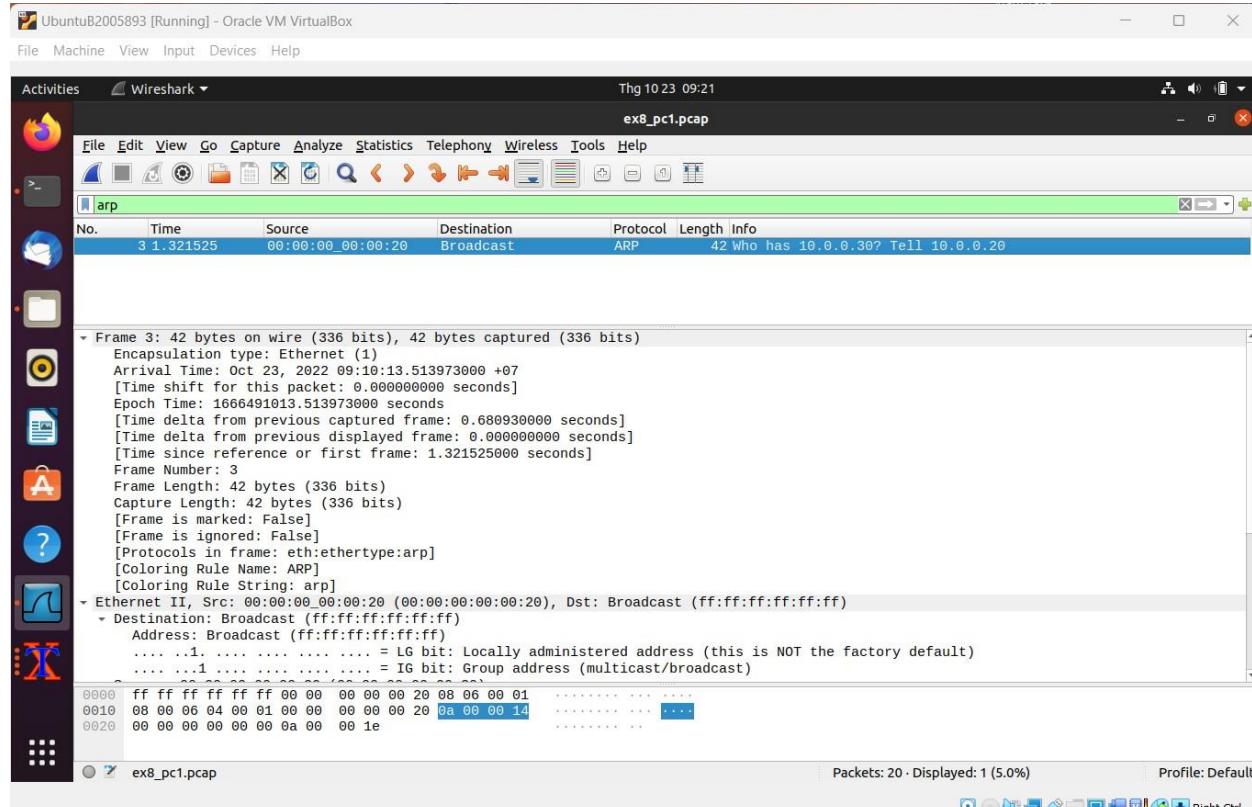


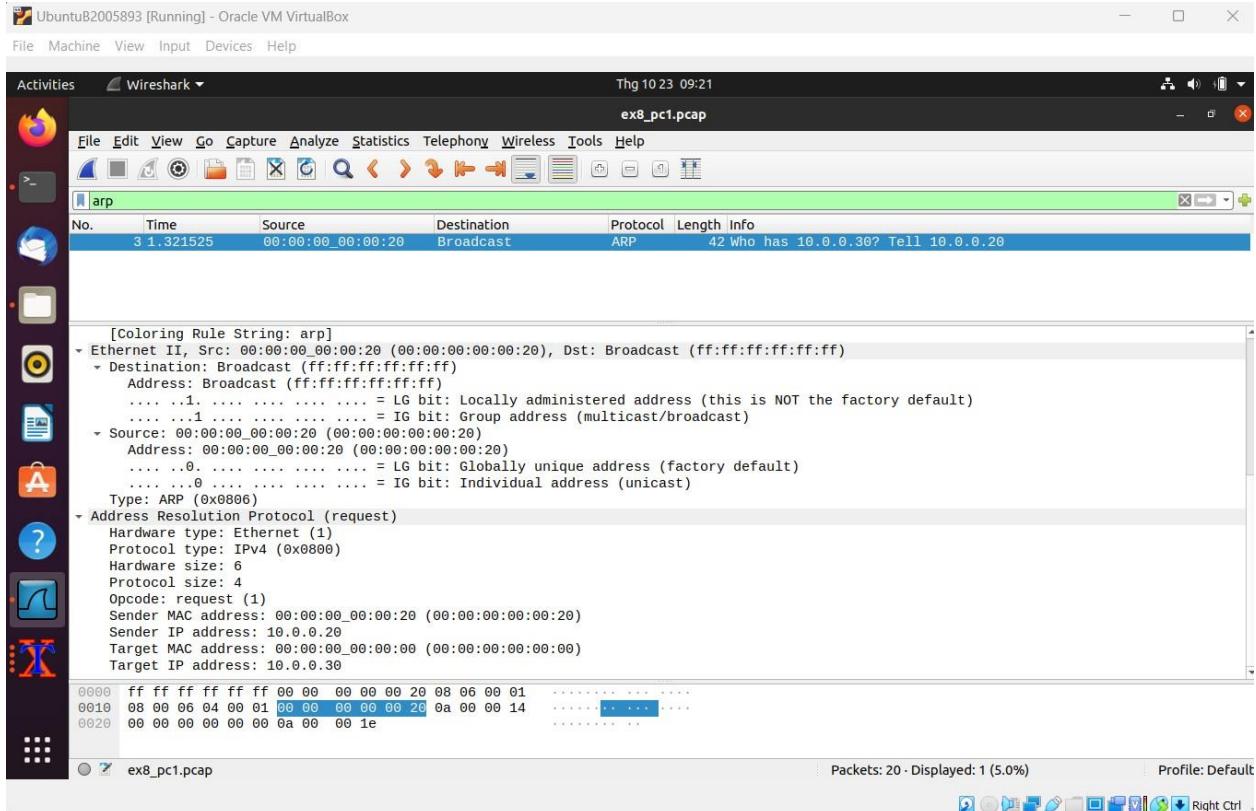
→ Answer: The frame contain:

- The source address `00:00:00:00:00:30`
- The destination address `00:00:00:00:00:20`
- The hex value for opcode field within the ARP-payload of the request is 2, for reply
- The ARP message containing the answer to the earlier ARP request appears in the “Sender MAC address” field, which contains the Ethernet address `00:00:00:00:30` for the sender with IP address `10.0.0.30`



6. Use Wireshark to open ex8_switch.pcap, open the frame using ARP protocol with the source MAC address of 00:00:00:00:00:30





→ Answer: The frame contain:

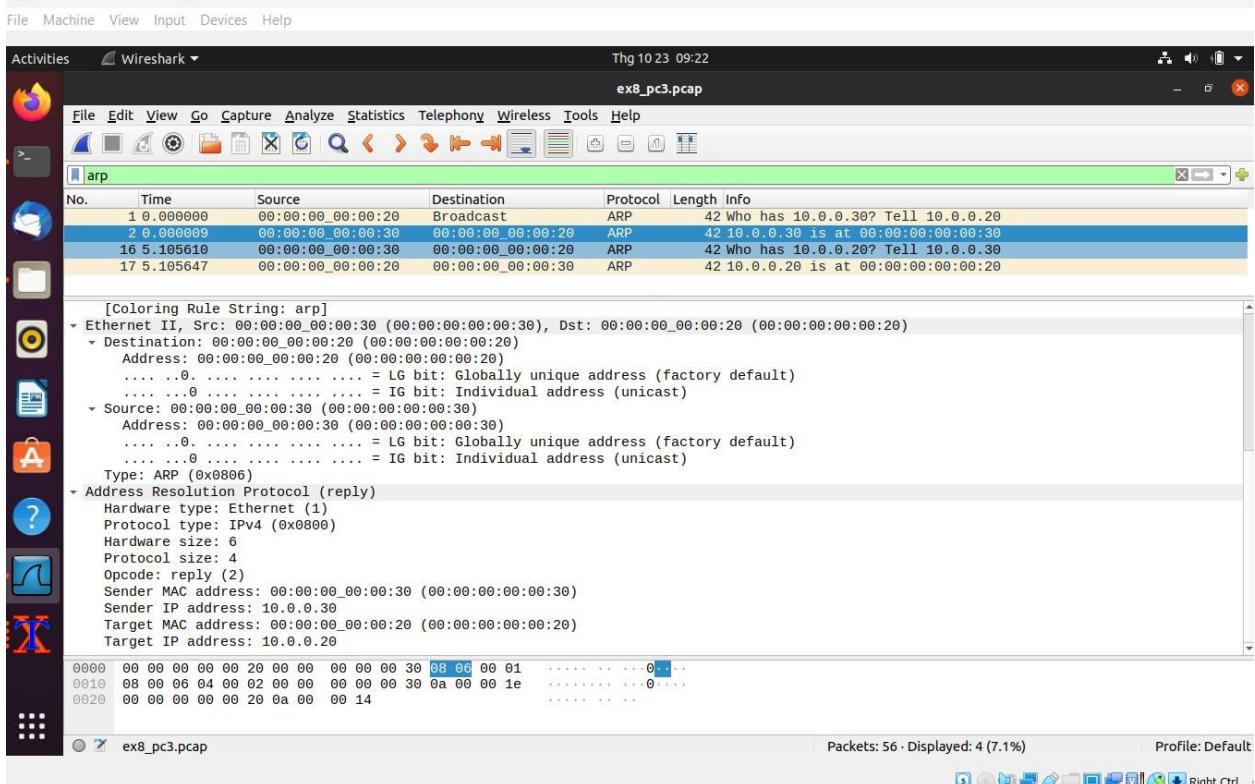
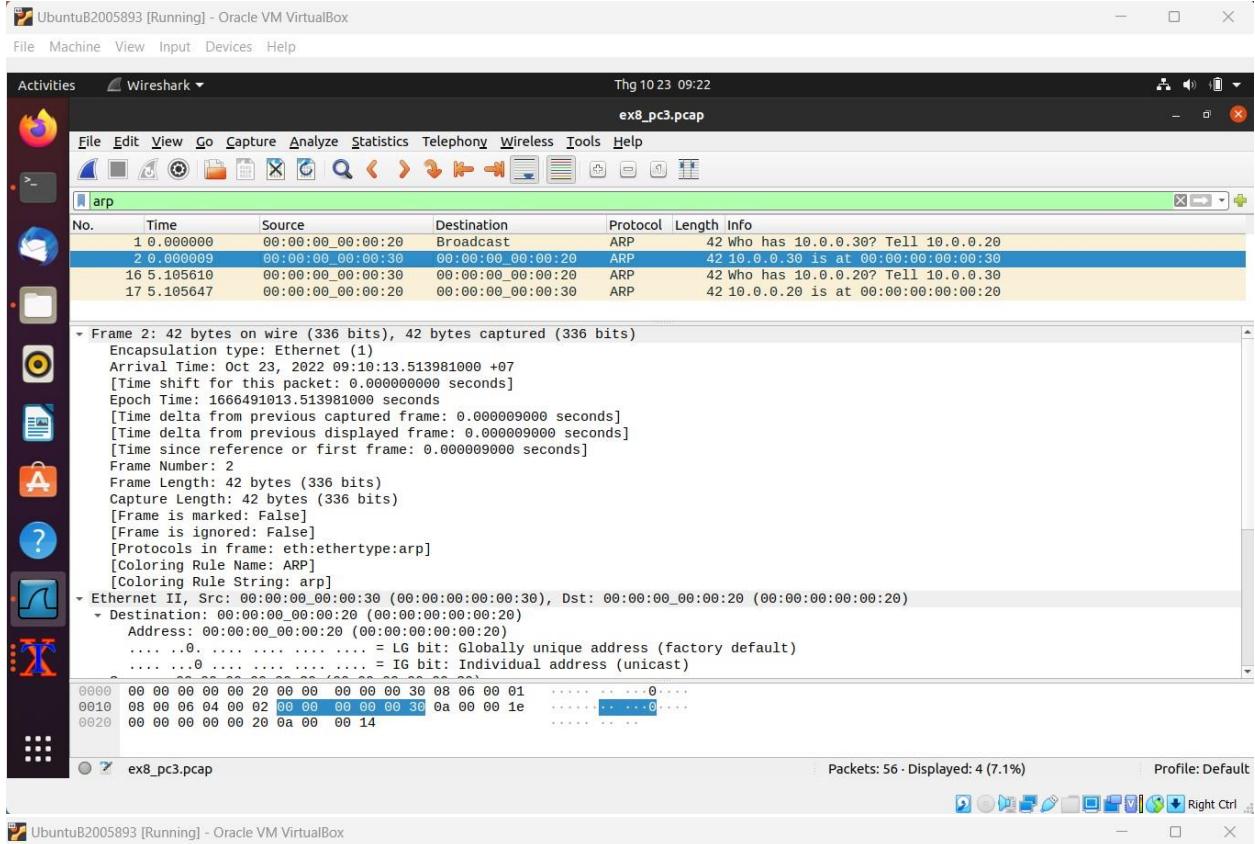
- The source address *00:00:00:00:00:20*
- The hex value for the destination address is *ff:ff:ff:ff:ff:ff*, the broadcast address
- The hex value for the Ethernet Frame Type is *0x0806*, for ARP
- The ARP message containing the IP address (*10.0.0.20*) for the sender and it wants to send this data to (*10.0.0.30*), but it doesn't know the MAC address to send it to, so it has sent an Address Resolution Protocol (ARP) request to find out that information. We can also see that in the field “Target MAC address” is set to *00:00:00:00:00:00* to question the machine whose corresponding IP address (*10.0.0.30*) is being queried

7. Use Wireshark to open pc3_switch.pcap, open the frame using ARP protocol with the source MAC address of *00:00:00:00:00:30*

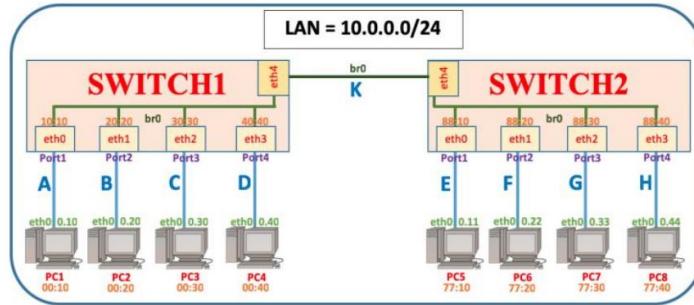
→ Answer: The frame contain:

- The source address *00:00:00:00:00:30*
- The destination address *00:00:00:00:00:20*
- The hex value for opcode field withing the ARP-payload of the request is 2, for reply
- The ARP message containing the answer to the earlier ARP request appears in the “Sender MAC address” field, which contains the Ethernet address *00:00:00:00:30* for the sender with IP address *10.0.0.30*

CT106H – Computer Network



Exercise 9: Construct the following network



1. Lab configuration

\$ tree

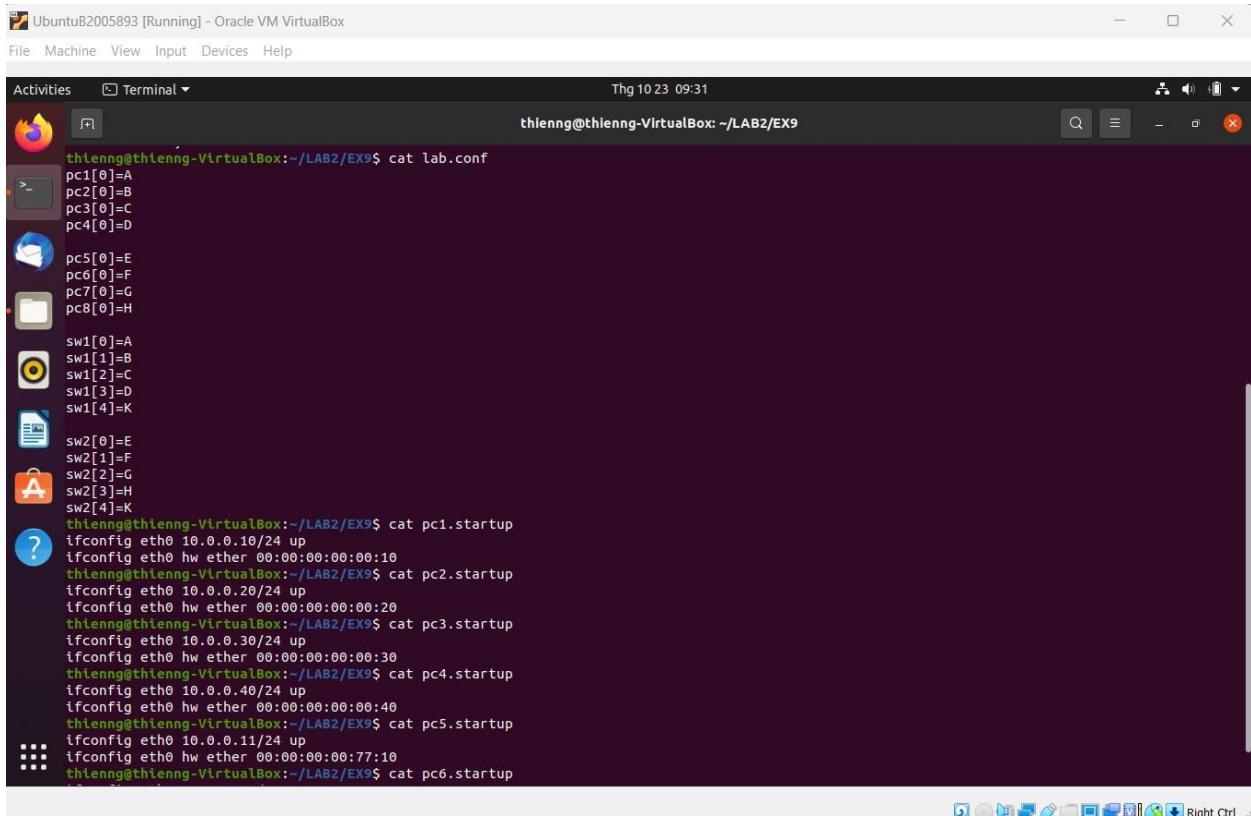
```
thienng@thienng-VirtualBox:~/LAB2/EX9$ tree
.
├── lab.conf
├── pc1
│   └── pc1.startup
├── pc2
│   └── pc2.startup
├── pc3
│   └── pc3.startup
├── pc4
│   └── pc4.startup
├── pc5
│   └── pc5.startup
├── pc6
│   └── pc6.startup
├── pc7
│   └── pc7.startup
├── pc8
│   └── pc8.startup
└── shared
    ├── sw1.startup
    └── sw2.startup

9 directories, 11 files
```

\$ cat lab.conf

```
$ lab pc1.startup
$ lab pc2.startup
$ lab pc3.startup
$ lab pc4.startup
$ lab pc5.startup
$ lab pc6.startup
$ lab pc7.startup
$ lab pc8.startup
$ lab sw1.startup
$ lab sw2.startup
```

CT106H – Computer Network



UbuntuB2005893 [Running] - Oracle VM VirtualBox

File Machine View Input Devices Help

Activities Terminal Thg 10 23 09:31

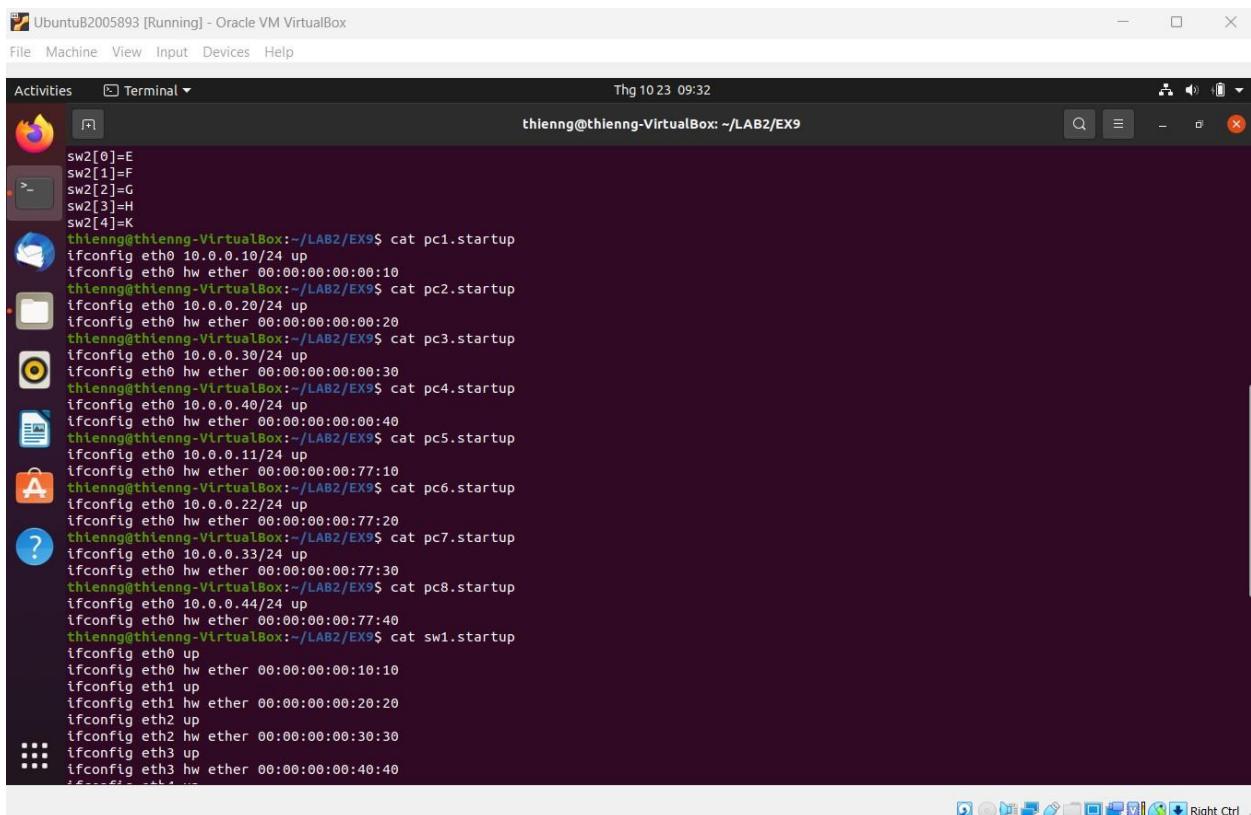
```
thienng@thienng-VirtualBox:~/LAB2/EX9$ cat lab.conf
pc1[0]=A
pc2[0]=B
pc3[0]=C
pc4[0]=D
pc5[0]=E
pc6[0]=F
pc7[0]=G
pc8[0]=H

sw1[0]=A
sw1[1]=B
sw1[2]=C
sw1[3]=D
sw1[4]=K

sw2[0]=E
sw2[1]=F
sw2[2]=G
sw2[3]=H
sw2[4]=K

thienng@thienng-VirtualBox:~/LAB2/EX9$ cat pc1.startup
ifconfig eth0 10.0.0.10/24 up
ifconfig eth0 hw ether 00:00:00:00:00:10
thienng@thienng-VirtualBox:~/LAB2/EX9$ cat pc2.startup
ifconfig eth0 10.0.0.20/24 up
ifconfig eth0 hw ether 00:00:00:00:00:20
thienng@thienng-VirtualBox:~/LAB2/EX9$ cat pc3.startup
ifconfig eth0 10.0.0.30/24 up
ifconfig eth0 hw ether 00:00:00:00:00:30
thienng@thienng-VirtualBox:~/LAB2/EX9$ cat pc4.startup
ifconfig eth0 10.0.0.40/24 up
ifconfig eth0 hw ether 00:00:00:00:00:40
thienng@thienng-VirtualBox:~/LAB2/EX9$ cat pc5.startup
ifconfig eth0 10.0.0.11/24 up
ifconfig eth0 hw ether 00:00:00:00:77:10
thienng@thienng-VirtualBox:~/LAB2/EX9$ cat pc6.startup
```

Right Ctrl



UbuntuB2005893 [Running] - Oracle VM VirtualBox

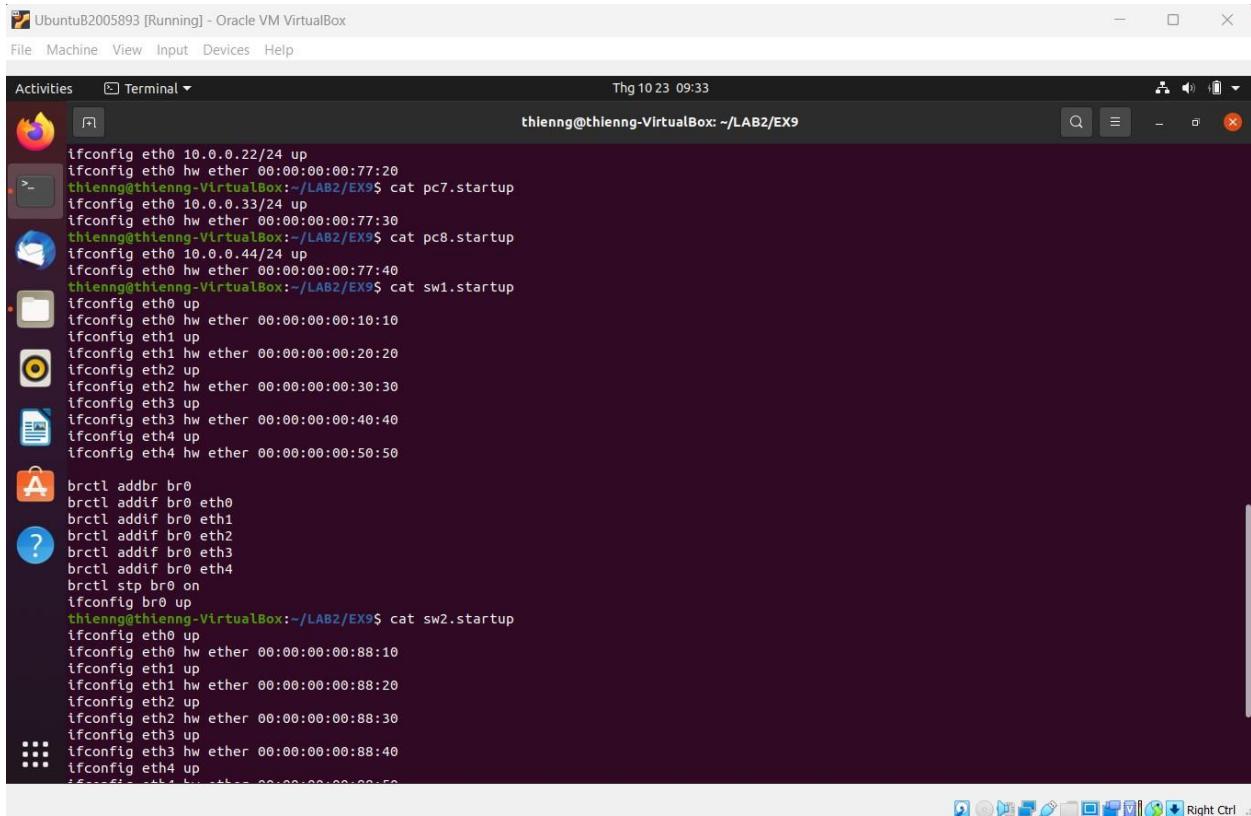
File Machine View Input Devices Help

Activities Terminal Thg 10 23 09:32

```
thienng@thienng-VirtualBox:~/LAB2/EX9$ cat pc1.startup
ifconfig eth0 10.0.0.10/24 up
ifconfig eth0 hw ether 00:00:00:00:00:10
thienng@thienng-VirtualBox:~/LAB2/EX9$ cat pc2.startup
ifconfig eth0 10.0.0.20/24 up
ifconfig eth0 hw ether 00:00:00:00:00:20
thienng@thienng-VirtualBox:~/LAB2/EX9$ cat pc3.startup
ifconfig eth0 10.0.0.30/24 up
ifconfig eth0 hw ether 00:00:00:00:00:30
thienng@thienng-VirtualBox:~/LAB2/EX9$ cat pc4.startup
ifconfig eth0 10.0.0.40/24 up
ifconfig eth0 hw ether 00:00:00:00:00:40
thienng@thienng-VirtualBox:~/LAB2/EX9$ cat pc5.startup
ifconfig eth0 10.0.0.11/24 up
ifconfig eth0 hw ether 00:00:00:00:77:10
thienng@thienng-VirtualBox:~/LAB2/EX9$ cat pc6.startup
ifconfig eth0 10.0.0.22/24 up
ifconfig eth0 hw ether 00:00:00:00:77:20
thienng@thienng-VirtualBox:~/LAB2/EX9$ cat pc7.startup
ifconfig eth0 10.0.0.33/24 up
ifconfig eth0 hw ether 00:00:00:00:77:30
thienng@thienng-VirtualBox:~/LAB2/EX9$ cat pc8.startup
ifconfig eth0 10.0.0.44/24 up
ifconfig eth0 hw ether 00:00:00:00:77:40
thienng@thienng-VirtualBox:~/LAB2/EX9$ cat sw1.startup
ifconfig eth0 up
ifconfig eth0 hw ether 00:00:00:00:10:10
ifconfig eth1 up
ifconfig eth1 hw ether 00:00:00:00:20:20
ifconfig eth2 up
ifconfig eth2 hw ether 00:00:00:00:30:30
ifconfig eth3 up
ifconfig eth3 hw ether 00:00:00:00:40:40
```

Right Ctrl

CT106H – Computer Network



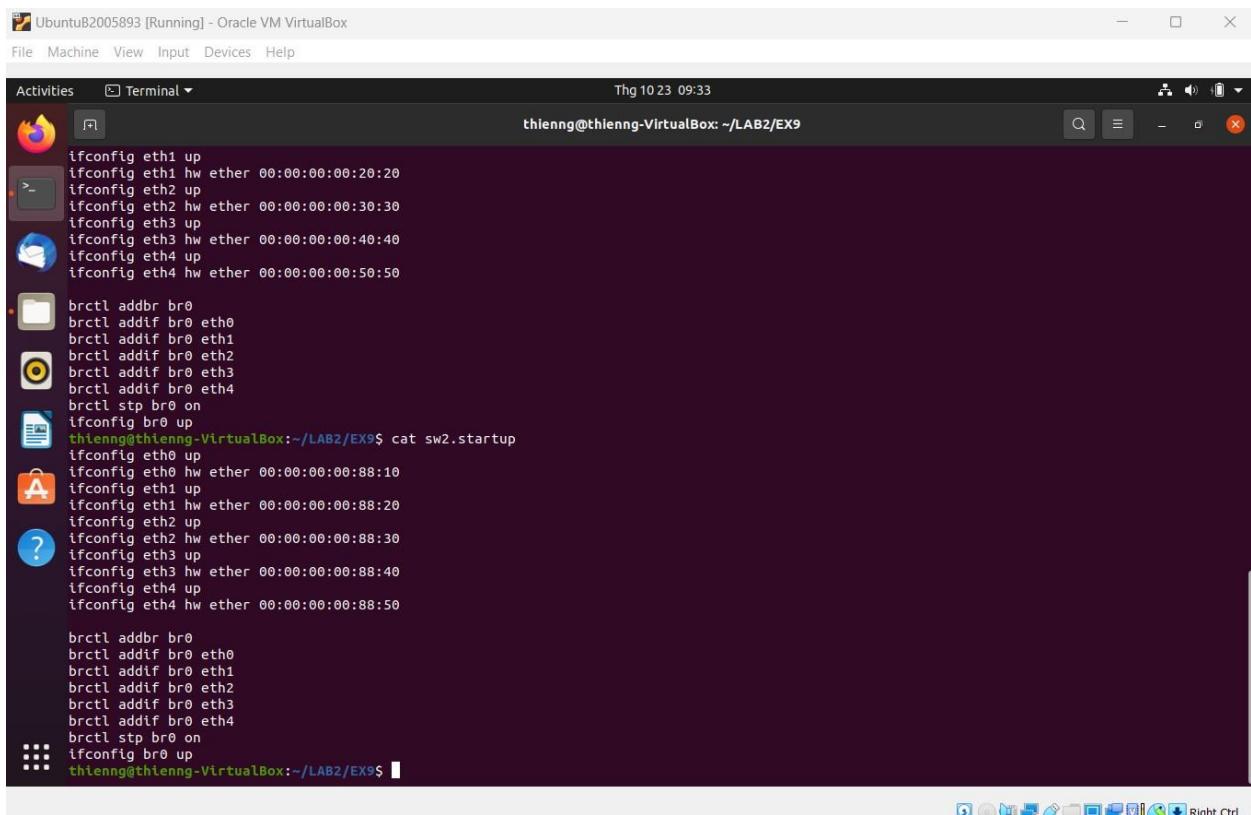
UbuntuB2005893 [Running] - Oracle VM VirtualBox

File Machine View Input Devices Help

Activities Terminal Thg 10 23 09:33

```
thienng@thienng-VirtualBox: ~/LAB2/EX9$ ifconfig eth0 10.0.0.22/24 up
ifconfig eth0 hw ether 00:00:00:00:77:20
thienng@thienng-VirtualBox: ~/LAB2/EX9$ cat pc7.startup
ifconfig eth0 10.0.0.33/24 up
ifconfig eth0 hw ether 00:00:00:00:77:30
thienng@thienng-VirtualBox: ~/LAB2/EX9$ cat pc8.startup
ifconfig eth0 10.0.0.44/24 up
ifconfig eth0 hw ether 00:00:00:00:77:40
thienng@thienng-VirtualBox: ~/LAB2/EX9$ cat sw1.startup
ifconfig eth0 up
ifconfig eth0 hw ether 00:00:00:00:10:10
ifconfig eth1 up
ifconfig eth1 hw ether 00:00:00:00:20:20
ifconfig eth2 up
ifconfig eth2 hw ether 00:00:00:00:30:30
ifconfig eth3 up
ifconfig eth3 hw ether 00:00:00:00:40:40
ifconfig eth4 up
ifconfig eth4 hw ether 00:00:00:00:50:50

brctl addbr br0
brctl addif br0 eth0
brctl addif br0 eth1
brctl addif br0 eth2
brctl addif br0 eth3
brctl addif br0 eth4
brctl stp br0 on
ifconfig br0 up
thienng@thienng-VirtualBox: ~/LAB2/EX9$ cat sw2.startup
ifconfig eth0 up
ifconfig eth0 hw ether 00:00:00:00:88:10
ifconfig eth1 up
ifconfig eth1 hw ether 00:00:00:00:88:20
ifconfig eth2 up
ifconfig eth2 hw ether 00:00:00:00:88:30
ifconfig eth3 up
ifconfig eth3 hw ether 00:00:00:00:88:40
ifconfig eth4 up
ifconfig eth4 hw ether 00:00:00:00:88:50
```



UbuntuB2005893 [Running] - Oracle VM VirtualBox

File Machine View Input Devices Help

Activities Terminal Thg 10 23 09:33

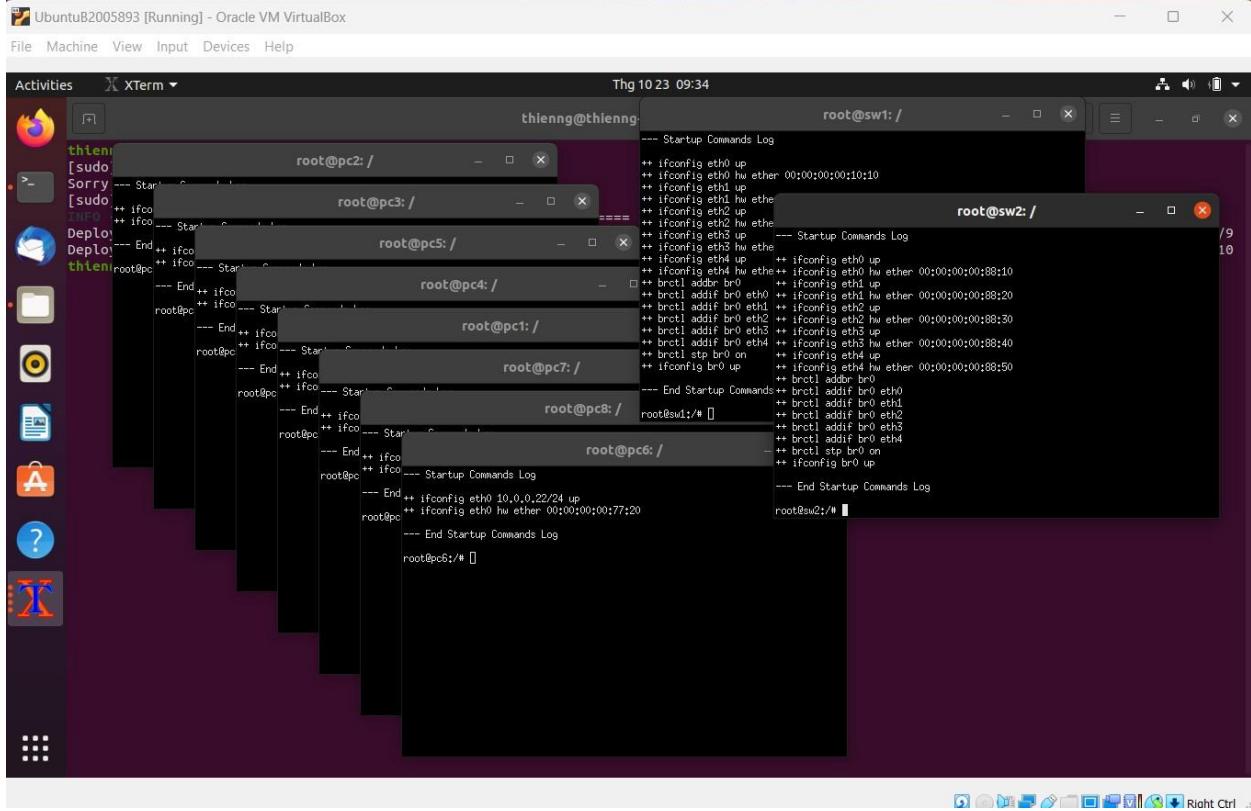
```
thienng@thienng-VirtualBox: ~/LAB2/EX9$ ifconfig eth1 up
ifconfig eth1 hw ether 00:00:00:00:20:20
ifconfig eth2 up
ifconfig eth2 hw ether 00:00:00:00:30:30
ifconfig eth3 up
ifconfig eth3 hw ether 00:00:00:00:40:40
ifconfig eth4 up
ifconfig eth4 hw ether 00:00:00:00:50:50

brctl addbr br0
brctl addif br0 eth0
brctl addif br0 eth1
brctl addif br0 eth2
brctl addif br0 eth3
brctl addif br0 eth4
brctl stp br0 on
ifconfig br0 up
thienng@thienng-VirtualBox: ~/LAB2/EX9$ cat sw2.startup
ifconfig eth0 up
ifconfig eth0 hw ether 00:00:00:00:88:10
ifconfig eth1 up
ifconfig eth1 hw ether 00:00:00:00:88:20
ifconfig eth2 up
ifconfig eth2 hw ether 00:00:00:00:88:30
ifconfig eth3 up
ifconfig eth3 hw ether 00:00:00:00:88:40
ifconfig eth4 up
ifconfig eth4 hw ether 00:00:00:00:88:50

brctl addbr br0
brctl addif br0 eth0
brctl addif br0 eth1
brctl addif br0 eth2
brctl addif br0 eth3
brctl addif br0 eth4
brctl stp br0 on
ifconfig br0 up
thienng@thienng-VirtualBox: ~/LAB2/EX9$
```

2. Start kathara

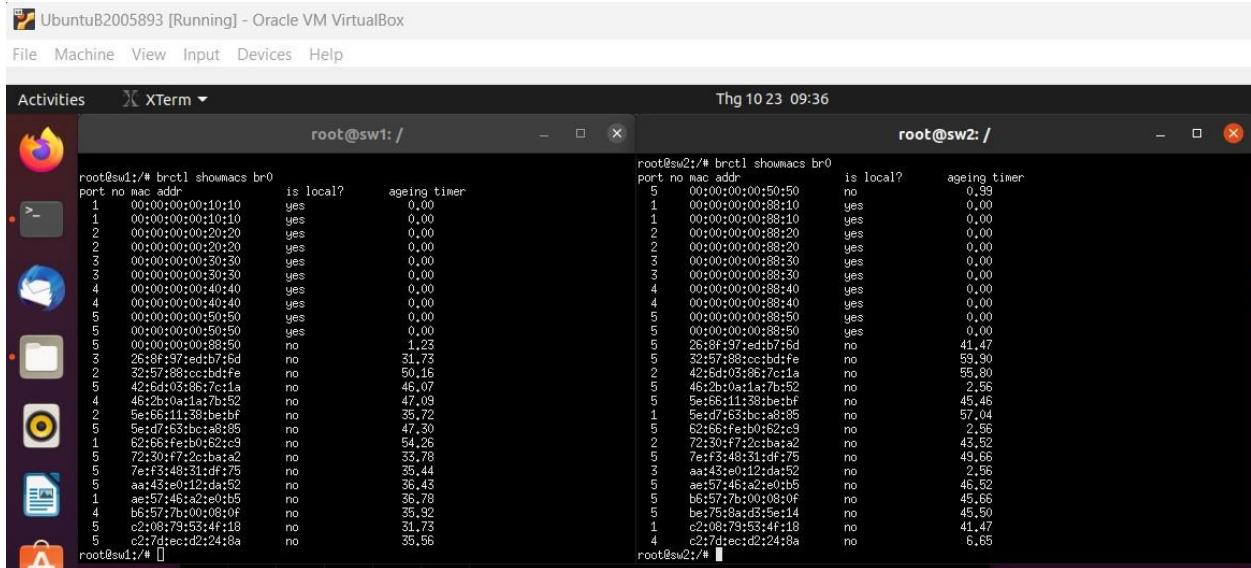
```
$ sudo kathara lstart
```



3. Mac Lookup Table

On sw1 and sw2:

```
# brctl showmacs br0
```



4. Test connectivity

A. Send frame between 2 pcs of the same switch

On pc1, ping to pc4 while sniffing on sw1 and sw2, and then show the mac lookup table on switch 1 and switch 2

```
# ping 10.0.0.40
```

```
# brctl showmacs br0
```

```
root@sw1:/# tcpdump -e -q -w /hosthome/ex9_switch1_A.pcap
tcpdump: listening on br0, link-type EN10MB (Ethernet), capture size 262144 bytes
^C88 packets captured
38 packets received by filter
0 packets dropped by kernel
root@sw1:# 

root@sw2:/# tcpdump -e -q -w /hosthome/ex9_switch2_A.pcap
tcpdump: listening on br0, link-type EN10MB (Ethernet), capture size 262144 bytes
^C1 packet captured
1 packet received by filter
0 packets dropped by kernel
root@sw2:# 

root@pc1:/#
64 bytes from 10.0.0.40: icmp_seq=1 ttl=64 time=0.168 ms
64 bytes from 10.0.0.40: icmp_seq=2 ttl=64 time=0.048 ms
64 bytes from 10.0.0.40: icmp_seq=3 ttl=64 time=0.056 ms
64 bytes from 10.0.0.40: icmp_seq=4 ttl=64 time=0.046 ms
64 bytes from 10.0.0.40: icmp_seq=5 ttl=64 time=0.052 ms
64 bytes from 10.0.0.40: icmp_seq=6 ttl=64 time=0.047 ms
64 bytes from 10.0.0.40: icmp_seq=7 ttl=64 time=0.054 ms
64 bytes from 10.0.0.40: icmp_seq=8 ttl=64 time=0.052 ms
64 bytes from 10.0.0.40: icmp_seq=9 ttl=64 time=0.054 ms
64 bytes from 10.0.0.40: icmp_seq=10 ttl=64 time=0.051 ms
64 bytes from 10.0.0.40: icmp_seq=11 ttl=64 time=0.050 ms
64 bytes from 10.0.0.40: icmp_seq=12 ttl=64 time=0.067 ms
64 bytes from 10.0.0.40: icmp_seq=13 ttl=64 time=0.050 ms
64 bytes from 10.0.0.40: icmp_seq=14 ttl=64 time=0.051 ms
64 bytes from 10.0.0.40: icmp_seq=15 ttl=64 time=0.047 ms
64 bytes from 10.0.0.40: icmp_seq=16 ttl=64 time=0.074 ms
64 bytes from 10.0.0.40: icmp_seq=17 ttl=64 time=0.075 ms
64 bytes from 10.0.0.40: icmp_seq=18 ttl=64 time=0.048 ms
^C
-- 10.0.0.40 ping statistics --
18 packets transmitted, 18 received, 0% packet loss, time 416ms
rtt min/avg/max/mdev = 0.046/0.060/0.168/0.028 ms
root@pc1:# 
```

We can see that switch 2 does not receive any frame because pc1 and pc4 are on switch 1

```
root@sw1:/# brctl showmacs br0
port no mac addr          is local?      ageing timer
1   00:00:00:00:00:10    no            78.24
4   00:00:00:00:00:40    no            78.24
1   00:00:00:00:10:10   yes           0.00
1   00:00:00:00:10:10   yes           0.00
2   00:00:00:00:20:20   yes           0.00
2   00:00:00:00:20:20   yes           0.00
3   00:00:00:00:30:30   yes           0.00
3   00:00:00:00:30:30   yes           0.00
4   00:00:00:00:40:40   yes           0.00
4   00:00:00:00:40:40   yes           0.00
5   00:00:00:00:50:50   yes           0.00
5   00:00:00:00:50:50   yes           0.00
5   00:00:00:00:50:50   yes           0.00
5   00:00:00:00:50:50   no            1.50
root@sw1:# 

root@sw2:/# brctl showmacs br0
port no mac addr          is local?      ageing timer
5   00:00:00:00:00:10    no            99.57
5   00:00:00:00:50:50   no            1.43
1   00:00:00:00:88:10   yes           0.00
1   00:00:00:00:88:10   yes           0.00
2   00:00:00:00:88:20   yes           0.00
2   00:00:00:00:88:20   yes           0.00
3   00:00:00:00:88:30   yes           0.00
3   00:00:00:00:88:30   yes           0.00
4   00:00:00:00:88:40   yes           0.00
4   00:00:00:00:88:40   yes           0.00
5   00:00:00:00:88:50   yes           0.00
5   00:00:00:00:88:50   yes           0.00
root@sw2:# 
```

B. Send frame between 2 pcs on both switch

On pc1, ping to pc7 while sniffing on sw1 and sw2, and then show the mac lookup table on switch 1 and switch 2

The screenshot shows two terminal windows side-by-side. The left window is titled 'root@sw1:' and shows the command 'tcpdump -e -q -w /hosthome/ex3_switch1_B.pcap' running, capturing 36 packets. The right window is titled 'root@sw2:' and shows the same command running, also capturing 36 packets. Below these, another terminal window titled 'root@pc2:' shows a ping session from 10.0.0.33 to 10.0.0.33, sending 17 packets and receiving 17 packets with 0% loss.

```

root@sw1:~# tcpdump -e -q -w /hosthome/ex3_switch1_B.pcap
tcpdump: listening on br0, link-type EN10MB (Ethernet), capture size 262144 bytes
36 packets captured
36 packets received by filter
0 packets dropped by kernel
root@sw1:~# 

root@sw2:~# tcpdump -e -q -w /hosthome/ex3_switch2_B.pcap
tcpdump: listening on br0, link-type EN10MB (Ethernet), capture size 262144 bytes
36 packets captured
36 packets received by filter
0 packets dropped by kernel
root@sw2:~# 

root@pc2:~# ping 10.0.0.33
PING 10.0.0.33 (10.0.0.33) 56(34) bytes of data.
64 bytes from 10.0.0.33: icmp_seq=1 ttl=64 time=0.204 ms
64 bytes from 10.0.0.33: icmp_seq=2 ttl=64 time=0.063 ms
64 bytes from 10.0.0.33: icmp_seq=3 ttl=64 time=0.069 ms
64 bytes from 10.0.0.33: icmp_seq=4 ttl=64 time=0.064 ms
64 bytes from 10.0.0.33: icmp_seq=5 ttl=64 time=0.101 ms
64 bytes from 10.0.0.33: icmp_seq=6 ttl=64 time=0.073 ms
64 bytes from 10.0.0.33: icmp_seq=7 ttl=64 time=0.063 ms
64 bytes from 10.0.0.33: icmp_seq=8 ttl=64 time=0.063 ms
64 bytes from 10.0.0.33: icmp_seq=9 ttl=64 time=0.063 ms
64 bytes from 10.0.0.33: icmp_seq=10 ttl=64 time=0.065 ms
64 bytes from 10.0.0.33: icmp_seq=11 ttl=64 time=0.063 ms
64 bytes from 10.0.0.33: icmp_seq=12 ttl=64 time=0.063 ms
64 bytes from 10.0.0.33: icmp_seq=13 ttl=64 time=0.078 ms
64 bytes from 10.0.0.33: icmp_seq=14 ttl=64 time=0.065 ms
64 bytes from 10.0.0.33: icmp_seq=15 ttl=64 time=0.064 ms
64 bytes from 10.0.0.33: icmp_seq=16 ttl=64 time=0.119 ms
64 bytes from 10.0.0.33: icmp_seq=17 ttl=64 time=0.058 ms
...
-- 10.0.0.33 ping statistics --
17 packets transmitted, 17 received, 0% packet loss, time 389ms
rtt min/avg/max/mdev = 0.058/0.073/0.204/0.035 ms
root@pc2:~# 

```

We can see now that switch had received frame because pc7 is of switch 2

The screenshot shows two terminal windows side-by-side. The left window is titled 'root@sw1:' and shows the command 'brctl showmacs br0' running, displaying a table of MAC addresses on port 0. The right window is titled 'root@sw2:' and shows the same command running, displaying a similar table. Both tables show entries for various MAC addresses and their corresponding ports and aging timers.

```

root@sw1:~# tcpdump -e -q -w /hosthome/ex3_switch1_B.pcap
tcpdump: listening on br0, link-type EN10MB (Ethernet), capture size 262144 bytes
36 packets captured
36 packets received by filter
0 packets dropped by kernel
root@sw1:~# brctl showmacs br0
port no mac addr      is local?    ageing timer
  2  00:00:00:00:00:20  no          43,62
  1  00:00:00:00:10:10 yes          0,00
  1  00:00:00:00:10:10 yes          0,00
  2  00:00:00:00:20:20 yes          0,00
  2  00:00:00:00:20:20 yes          0,00
  3  00:00:00:00:30:30 yes          0,00
  3  00:00:00:00:30:30 yes          0,00
  4  00:00:00:00:40:40 yes          0,00
  4  00:00:00:00:40:40 yes          0,00
  5  00:00:00:00:50:50 yes          0,00
  5  00:00:00:00:50:50 yes          0,00
  5  00:00:00:00:77:30 no           43,62
  5  00:00:00:00:88:50 no           1,47
root@sw1:~# 

root@sw2:~# tcpdump -e -q -w /hosthome/ex3_switch2_B.pcap
tcpdump: listening on br0, link-type EN10MB (Ethernet), capture size 262144 bytes
36 packets captured
36 packets received by filter
0 packets dropped by kernel
root@sw2:~# brctl showmacs br0
port no mac addr      is local?    ageing timer
  5  00:00:00:00:00:20  no          44,01
  5  00:00:00:00:50:50  no          1,86
  3  00:00:00:00:77:30  no          44,01
  1  00:00:00:00:88:10  yes          0,00
  1  00:00:00:00:88:10  yes          0,00
  2  00:00:00:00:88:20  yes          0,00
  2  00:00:00:00:88:20  yes          0,00
  3  00:00:00:00:88:30  yes          0,00
  3  00:00:00:00:88:30  yes          0,00
  4  00:00:00:00:88:40  yes          0,00
  4  00:00:00:00:88:40  yes          0,00
  5  00:00:00:00:88:50  yes          0,00
  5  00:00:00:00:88:50  yes          0,00
root@sw2:~# 

```

5. Delete all VMs

\$ sudo kathara wipe

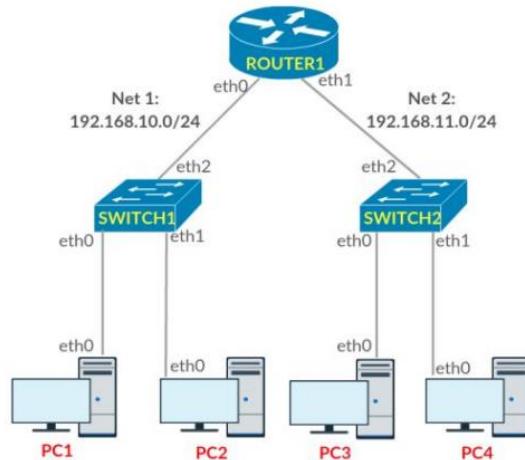
The screenshot shows a terminal window titled 'thienng@thienng-VirtualBox: ~/LAB2/EX9\$'. The user runs the command 'sudo kathara wipe', which prompts 'Are you sure to wipe Kathara? (y/n)'. The user responds with 'y'.

```

thienng@thienng-VirtualBox:~/LAB2/EX9$ sudo kathara wipe
Are you sure to wipe Kathara? (y/n) y
thienng@thienng-VirtualBox:~/LAB2/EX9$ 

```

Exercise 10: Construct the following network



1. Lab configuration

```

$ tree
$ cat lab.conf
$ cat pc1.startup
$ cat pc2.startup
$ cat pc3.startup
$ cat pc4.startup
$ cat r1.startup
$ cat sw1.startup
$ cat sw2.startup
  
```

```

Ubuntu2005893 [Running] - Oracle VM VirtualBox
File Machine View Input Devices Help
Activities Terminal Thg 10 23 12:16
thienng@thienng-VirtualBox:~/LAB2/EX10$ mkdir pc1 pc2 pc3 pc4 r1 sw1 sw2
thienng@thienng-VirtualBox:~/LAB2/EX10$ touch lab.conf pc1.startup pc2.startup pc3.startup pc4.startup r1.startup sw1.startup sw2.startup
thienng@thienng-VirtualBox:~/LAB2/EX10$ tree
.
├── lab.conf
├── pc1
│   └── pc1.startup
├── pc2
│   └── pc2.startup
├── pc3
│   └── pc3.startup
├── pc4
│   └── pc4.startup
└── r1
    └── r1.startup

    ├── sw1
    │   └── sw1.startup
    └── sw2
        └── sw2.startup

7 directories, 8 files
thienng@thienng-VirtualBox:~/LAB2/EX10$ 
  
```

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UbuntuB2005893 [Running] - Oracle VM VirtualBox

File Machine View Input Devices Help

Activities Terminal

Thg 10 23 12:19

thienng@thienng-VirtualBox:~/LAB2/EX10\$ cat lab.conf

```
pc1[0]=A
pc2[0]=B
pc3[0]=C
pc4[0]=D

sw1[0]=A
sw1[1]=B
sw1[2]=E

sw2[0]=C
sw2[1]=D
sw2[2]=F

r1[0]=E
r1[1]=F
```

thienng@thienng-VirtualBox:~/LAB2/EX10\$ cat pc1.startup

```
ifconfig eth0 192.168.10.10/24
ifconfig eth0 hw ether 00:00:00:00:10:10
route add default gw 192.168.10.1
```

thienng@thienng-VirtualBox:~/LAB2/EX10\$ cat pc2.startup

```
ifconfig eth0 192.168.10.11/24
ifconfig eth0 hw ether 00:00:00:00:10:11
route add default gw 192.168.10.1
```

thienng@thienng-VirtualBox:~/LAB2/EX10\$ cat pc3.startup

```
ifconfig eth0 192.168.11.10/24
ifconfig eth0 hw ether 00:00:00:00:11:10
route add default gw 192.168.11.1
```

thienng@thienng-VirtualBox:~/LAB2/EX10\$ cat pc4.startup

```
ifconfig eth0 192.168.11.11/24
ifconfig eth0 hw ether 00:00:00:00:11:11
route add default gw 192.168.11.1
```

thienng@thienng-VirtualBox:~/LAB2/EX10\$

Right Ctrl

UbuntuB2005893 [Running] - Oracle VM VirtualBox

File Machine View Input Devices Help

Activities Terminal

Thg 10 24 14:35

thienng@thienng-VirtualBox:~/LAB2/EX10\$ cat r1.startup

```
ifconfig eth0 192.168.10.1/24 up
ifconfig eth0 hw ether 00:00:00:50:10:10
ifconfig eth1 192.168.11.1/24 up
ifconfig eth1 hw ether 00:00:00:50:11:10
```

thienng@thienng-VirtualBox:~/LAB2/EX10\$ cat sw1.startup

```
ifconfig eth0 up
ifconfig eth0 hw ether 00:00:00:10:10:10
ifconfig eth1 up
ifconfig eth1 hw ether 00:00:00:10:10:11
ifconfig eth2 up
ifconfig eth2 hw ether 00:00:00:10:10:12
```

brctl addbr br0
brctl addif br0 eth0
brctl addif br0 eth1
brctl addif br0 eth2
brctl stp br0 on
ifconfig br0 up

thienng@thienng-VirtualBox:~/LAB2/EX10\$ cat sw2.startup

```
ifconfig eth0 up
ifconfig eth0 hw ether 00:00:00:20:11:10
ifconfig eth1 up
ifconfig eth1 hw ether 00:00:00:20:11:11
ifconfig eth2 up
ifconfig eth2 hw ether 00:00:00:20:11:12
```

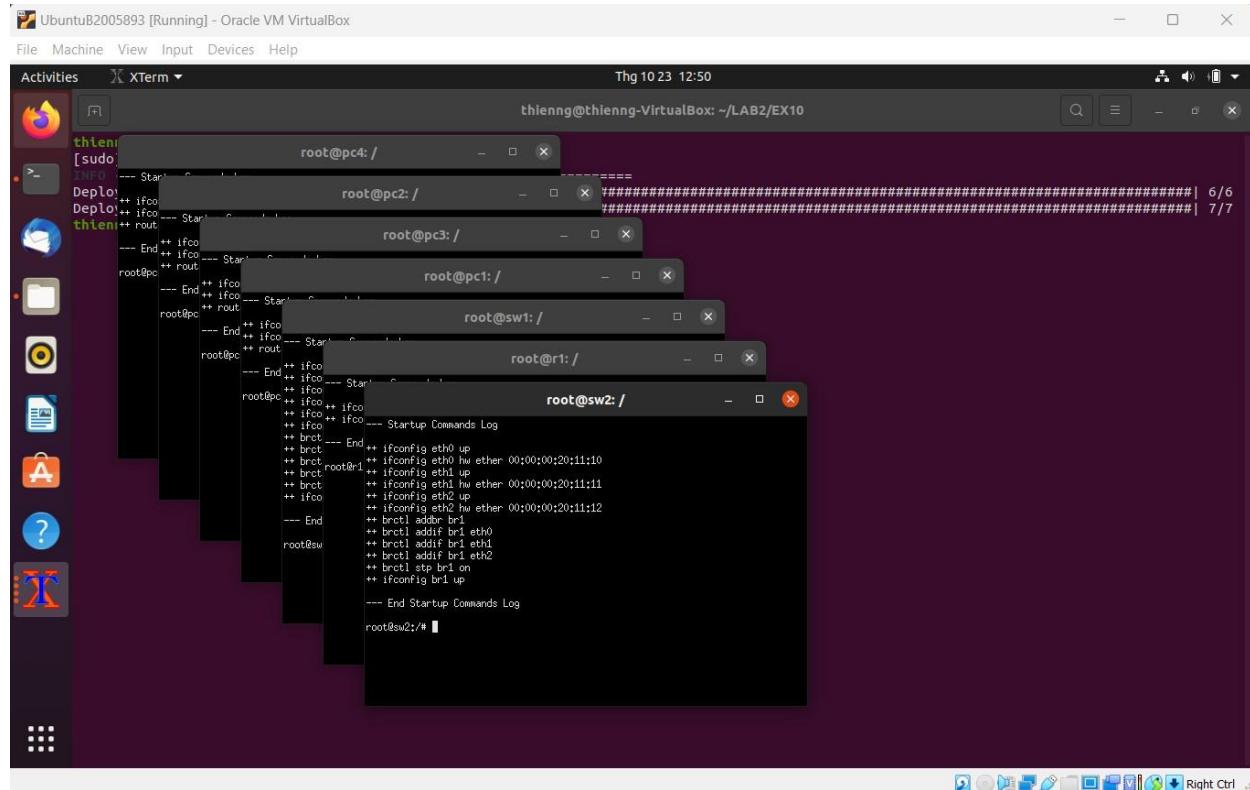
brctl addbr br1
brctl addif br1 eth0
brctl addif br1 eth1
brctl addif br1 eth2
brctl stp br1 on
ifconfig br1 up

thienng@thienng-VirtualBox:~/LAB2/EX10\$

Right Ctrl

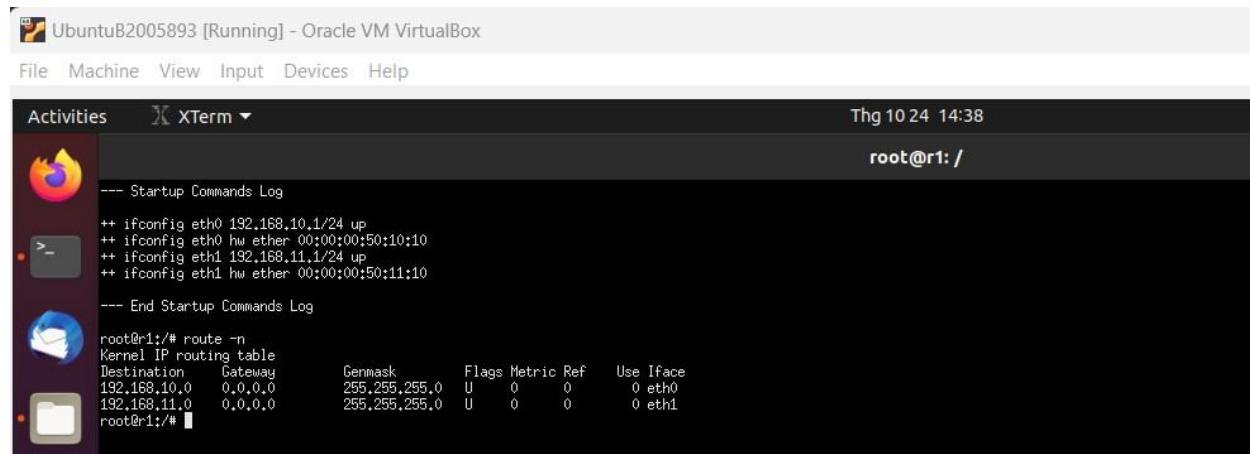
2. Start kathara

```
$ sudo kathara lstart
```

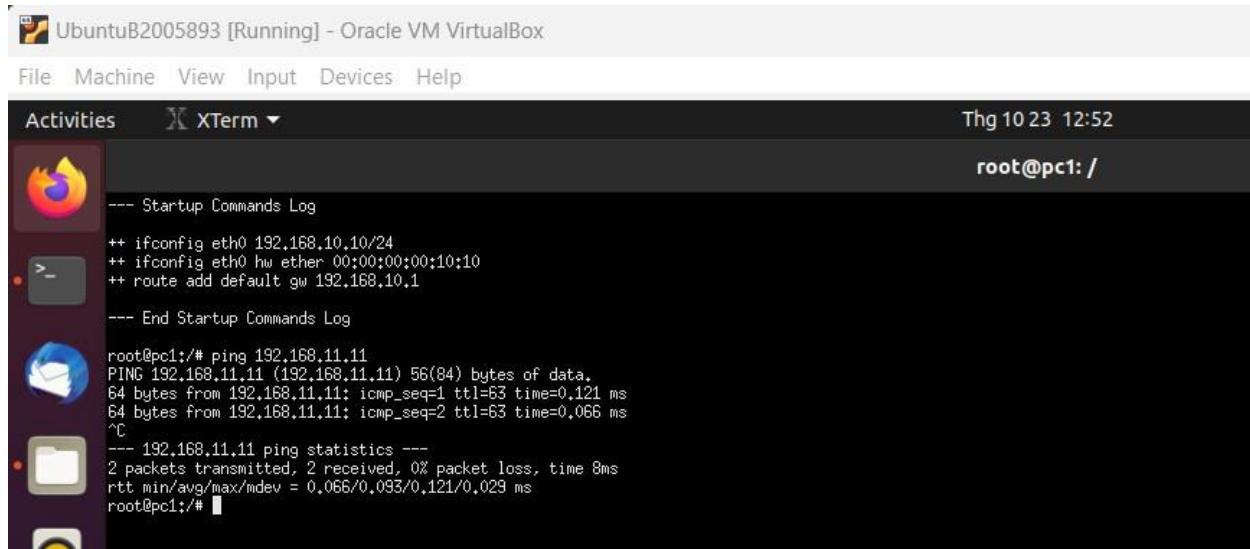


3. Routing table on r1

```
# route -n
```



4. Ping from pc1 to pc4
ping 192.168.11.11



```
UbuntuB2005893 [Running] - Oracle VM VirtualBox
File Machine View Input Devices Help
Activities XTerm ▾ Thg 10 23 12:52
root@pc1: /  

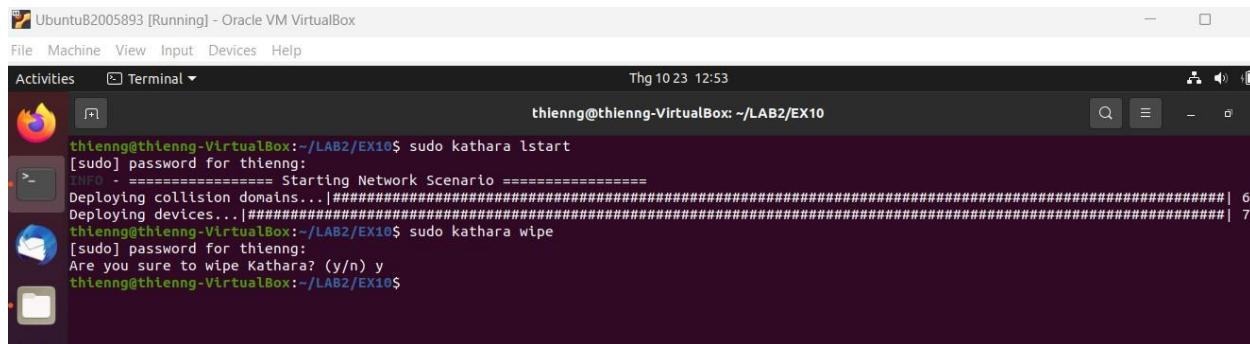
--- Startup Commands Log  

++ ifconfig eth0 192.168.10.10/24
++ ifconfig eth0 hw ether 00:00:00:00:10:10
++ route add default gw 192.168.10.1  

--- End Startup Commands Log  

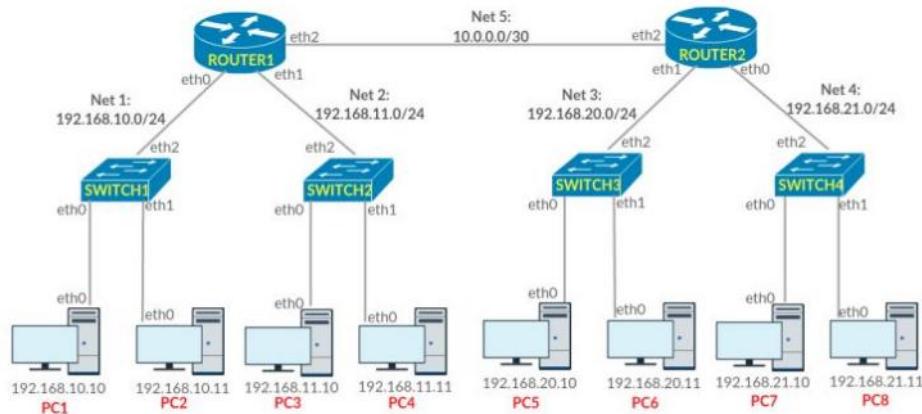
root@pc1:/# ping 192.168.11.11
PING 192.168.11.11 (192.168.11.11) 56(84) bytes of data.
64 bytes from 192.168.11.11: icmp_seq=1 ttl=63 time=0.121 ms
64 bytes from 192.168.11.11: icmp_seq=2 ttl=63 time=0.066 ms
^C
--- 192.168.11.11 ping statistics ---
2 packets transmitted, 2 received, 0% packet loss, time 8ms
rtt min/avg/max/mdev = 0.066/0.093/0.121/0.029 ms
root@pc1:/#
```

5. Delete all VMs
\$ sudo kathara wipe



```
UbuntuB2005893 [Running] - Oracle VM VirtualBox
File Machine View Input Devices Help
Activities Terminal ▾ Thg 10 23 12:53
thienng@thienng-VirtualBox: ~/LAB2/EX10
[sudo] password for thienng:
INFO - ===== Starting Network Scenario =====
Deploying collision domains...|#####
Deploying devices...|#####
thienng@thienng-VirtualBox: ~/LAB2/EX10$ sudo kathara wipe
[sudo] password for thienng:
Are you sure to wipe Kathara? (y/n) y
thienng@thienng-VirtualBox: ~/LAB2/EX10$
```

Exercise 11: Construct the following network



1. Lab configuration

\$ tree

```
Ubuntu2005893 [Running] - Oracle VM VirtualBox
File Machine View Input Devices Help
Activities Terminal Thg 10 23 12:58
thienng@thienng-VirtualBox:~/LAB2/EX11
thienng@thienng-VirtualBox:~/LAB2/EX11$ mkdir pc5 pc6 pc7 pc8 r2 sw3 sw4
thienng@thienng-VirtualBox:~/LAB2/EX11$ touch pc5.startup
thienng@thienng-VirtualBox:~/LAB2/EX11$ touch pc6.startup pc7.startup pc8.startup r2.startup sw3.startup sw4.startup
thienng@thienng-VirtualBox:~/LAB2/EX11$ tree
.
├── lab.conf
├── pc1
│   └── pc1.startup
├── pc2
│   └── pc2.startup
├── pc3
│   └── pc3.startup
├── pc4
│   └── pc4.startup
├── pc5
│   └── pc5.startup
├── pc6
│   └── pc6.startup
├── pc7
│   └── pc7.startup
├── pc8
│   └── pc8.startup
└── r1
    ├── r1
    └── r2
        ├── r2.startup
        └── sw1
            ├── sw1
            └── sw1.startup
        ├── sw2
        └── sw2.startup
        ├── sw3
        └── sw3.startup
        ├── sw4
        └── sw4.startup

14 directories, 15 files
thienng@thienng-VirtualBox:~/LAB2/EX11$
```

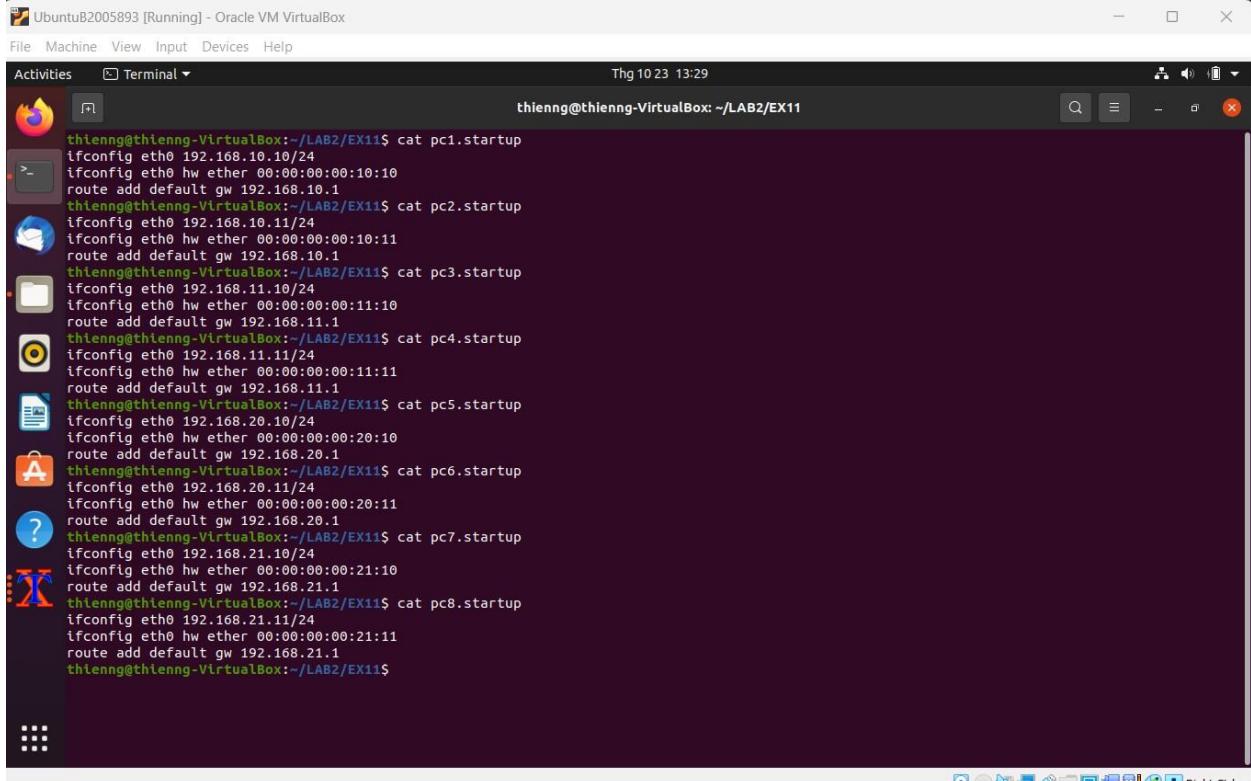
```
$ cat lab.conf
```

The screenshot shows a terminal window titled "UbuntuB2005893 [Running] - Oracle VM VirtualBox". The terminal window has a dark background and contains the following text:

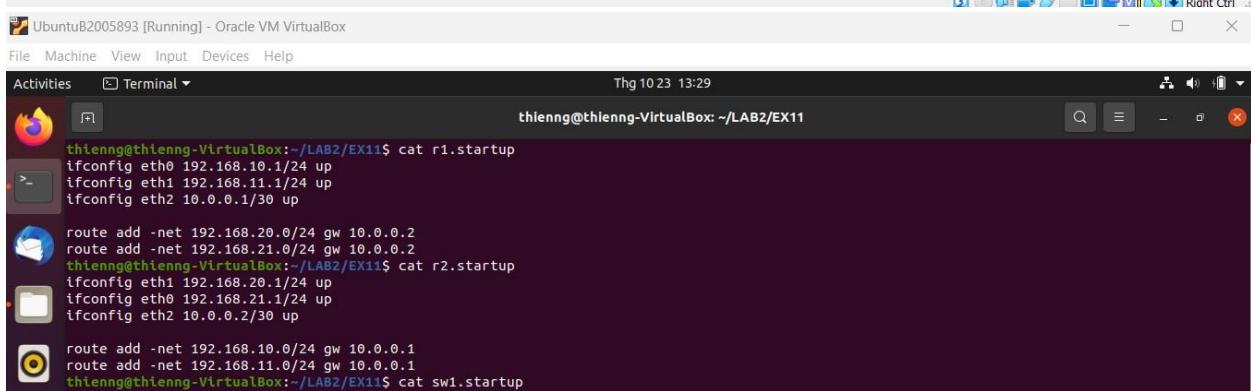
```
thienng@thienng-VirtualBox:~/LAB2/EX1$ cat lab.conf
pc1[0]=A
pc2[0]=B
pc3[0]=C
pc4[0]=D
pc5[0]=E
pc6[0]=F
pc7[0]=G
pc8[0]=H
sw1[0]=A
sw1[1]=B
sw1[2]=net1
sw2[0]=C
sw2[1]=D
sw2[2]=net2
sw3[0]=E
sw3[1]=F
sw3[2]=net3
sw4[0]=G
sw4[1]=H
sw4[2]=net4
r1[0]=net1
r1[1]=net2
r1[2]=net5
r2[1]=net3
r2[0]=net4
r2[2]=net5
thienng@thienng-VirtualBox:~/LAB2/EX1$
```

```
$ cat pc1.startup
$ cat pc2.startup
$ cat pc3.startup
$ cat pc4.startup
$ cat pc5.startup
$ cat pc6.startup
$ cat pc7.startup
$ cat pc8.startup
$ cat r1.startup
$ cat r2.startup
$ cat sw1.startup
$ cat sw2.startup
$ cat sw3.startup
$ cat sw4.startup
```

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```
UbuntuB2005893 [Running] - Oracle VM VirtualBox
File Machine View Input Devices Help
Activities Terminal Thg 10 23 13:29
thienng@thienng-VirtualBox:~/LAB2/EX11$ cat pc1.startup
ifconfig eth0 192.168.10.10/24
ifconfig eth0 hw ether 00:00:00:00:10:10
route add default gw 192.168.10.1
thienng@thienng-VirtualBox:~/LAB2/EX11$ cat pc2.startup
ifconfig eth0 192.168.10.11/24
ifconfig eth0 hw ether 00:00:00:00:10:11
route add default gw 192.168.10.1
thienng@thienng-VirtualBox:~/LAB2/EX11$ cat pc3.startup
ifconfig eth0 192.168.11.10/24
ifconfig eth0 hw ether 00:00:00:00:11:10
route add default gw 192.168.11.1
thienng@thienng-VirtualBox:~/LAB2/EX11$ cat pc4.startup
ifconfig eth0 192.168.11.11/24
ifconfig eth0 hw ether 00:00:00:00:11:11
route add default gw 192.168.11.1
thienng@thienng-VirtualBox:~/LAB2/EX11$ cat pc5.startup
ifconfig eth0 192.168.20.10/24
ifconfig eth0 hw ether 00:00:00:00:20:10
route add default gw 192.168.20.1
thienng@thienng-VirtualBox:~/LAB2/EX11$ cat pc6.startup
ifconfig eth0 192.168.20.11/24
ifconfig eth0 hw ether 00:00:00:00:20:11
route add default gw 192.168.20.1
thienng@thienng-VirtualBox:~/LAB2/EX11$ cat pc7.startup
ifconfig eth0 192.168.21.10/24
ifconfig eth0 hw ether 00:00:00:00:21:10
route add default gw 192.168.21.1
thienng@thienng-VirtualBox:~/LAB2/EX11$ cat pc8.startup
ifconfig eth0 192.168.21.11/24
ifconfig eth0 hw ether 00:00:00:00:21:11
route add default gw 192.168.21.1
thienng@thienng-VirtualBox:~/LAB2/EX11$
```



```
UbuntuB2005893 [Running] - Oracle VM VirtualBox
File Machine View Input Devices Help
Activities Terminal Thg 10 23 13:29
thienng@thienng-VirtualBox:~/LAB2/EX11$ cat r1.startup
ifconfig eth0 192.168.10.1/24 up
ifconfig eth1 192.168.11.1/24 up
ifconfig eth2 10.0.0.1/30 up

route add -net 192.168.20.0/24 gw 10.0.0.2
route add -net 192.168.21.0/24 gw 10.0.0.2
thienng@thienng-VirtualBox:~/LAB2/EX11$ cat r2.startup
ifconfig eth1 192.168.20.1/24 up
ifconfig eth0 192.168.21.1/24 up
ifconfig eth2 10.0.0.2/30 up

route add -net 192.168.10.0/24 gw 10.0.0.1
route add -net 192.168.11.0/24 gw 10.0.0.1
thienng@thienng-VirtualBox:~/LAB2/EX11$ cat sw1.startup
```

```
UbuntuB2005893 [Running] - Oracle VM VirtualBox
File Machine View Input Devices Help
Activities Terminal ▾
thienng@thienng-VirtualBox:~/LAB2/EX11$ cat sw1.startup
ifconfig eth0 up
ifconfig eth0 hw ether 00:00:00:10:10:10
ifconfig eth1 up
ifconfig eth1 hw ether 00:00:00:10:10:11
ifconfig eth2 up
ifconfig eth2 hw ether 00:00:00:10:10:12

brctl addbr br0
brctl addif br0 eth0
brctl addif br0 eth1
brctl addif br0 eth2
brctl stp br0 on
ifconfig br0 up
thienng@thienng-VirtualBox:~/LAB2/EX11$ cat sw2.startup
ifconfig eth0 up
ifconfig eth0 hw ether 00:00:00:20:11:10
ifconfig eth1 up
ifconfig eth1 hw ether 00:00:00:20:11:11
ifconfig eth2 up
ifconfig eth2 hw ether 00:00:00:20:11:12

brctl addbr br1
brctl addif br1 eth0
brctl addif br1 eth1
brctl addif br1 eth2
brctl stp br1 on
ifconfig br1 up
thienng@thienng-VirtualBox:~/LAB2/EX11$ cat sw3.startup
```

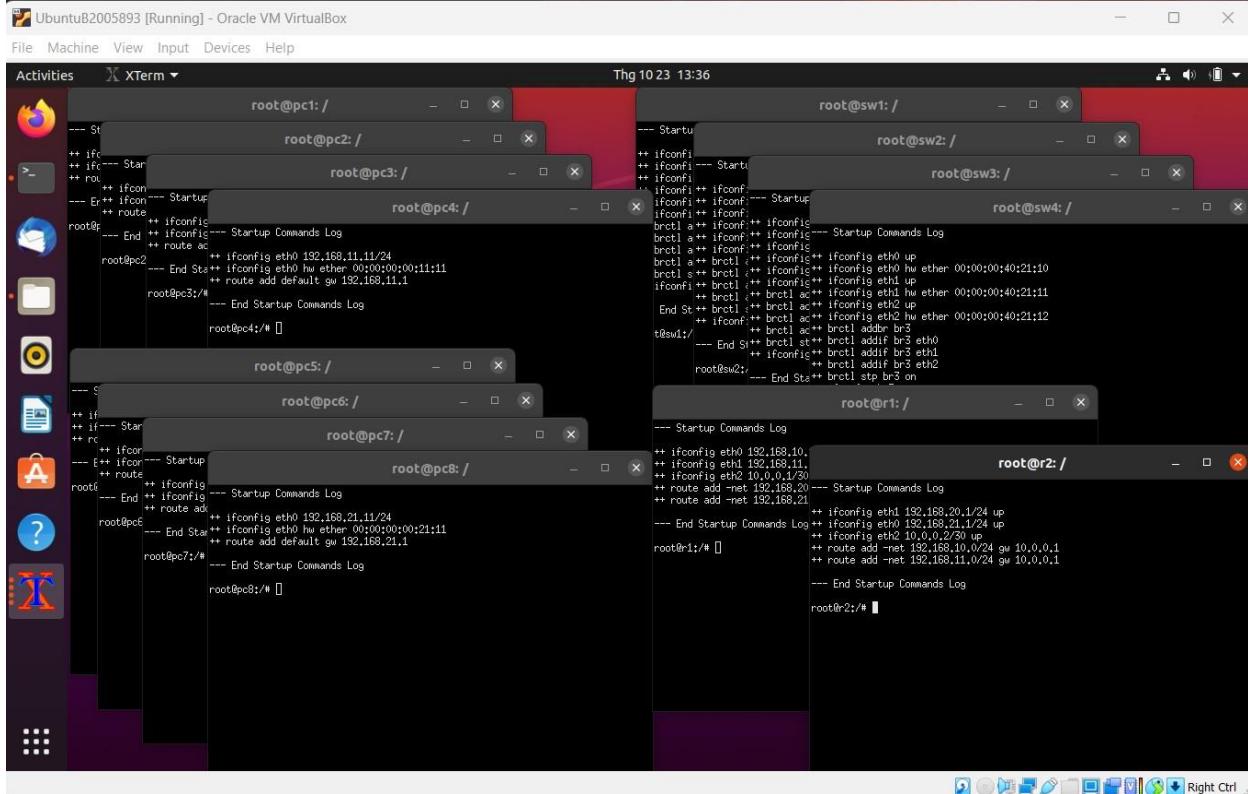
```
UbuntuB2005893 [Running] - Oracle VM VirtualBox
File Machine View Input Devices Help
Activities Terminal ▾
thienng@thienng-VirtualBox:~/LAB2/EX11$ cat sw3.startup
ifconfig eth0 up
ifconfig eth0 hw ether 00:00:00:30:20:10
ifconfig eth1 up
ifconfig eth1 hw ether 00:00:00:30:20:11
ifconfig eth2 up
ifconfig eth2 hw ether 00:00:00:30:20:12

brctl addbr br2
brctl addif br2 eth0
brctl addif br2 eth1
brctl addif br2 eth2
brctl stp br2 on
ifconfig br2 up
thienng@thienng-VirtualBox:~/LAB2/EX11$ cat sw4.startup
ifconfig eth0 up
ifconfig eth0 hw ether 00:00:00:40:21:10
ifconfig eth1 up
ifconfig eth1 hw ether 00:00:00:40:21:11
ifconfig eth2 up
ifconfig eth2 hw ether 00:00:00:40:21:12

brctl addbr br3
brctl addif br3 eth0
brctl addif br3 eth1
brctl addif br3 eth2
brctl stp br3 on
ifconfig br3 up
thienng@thienng-VirtualBox:~/LAB2/EX11$
```

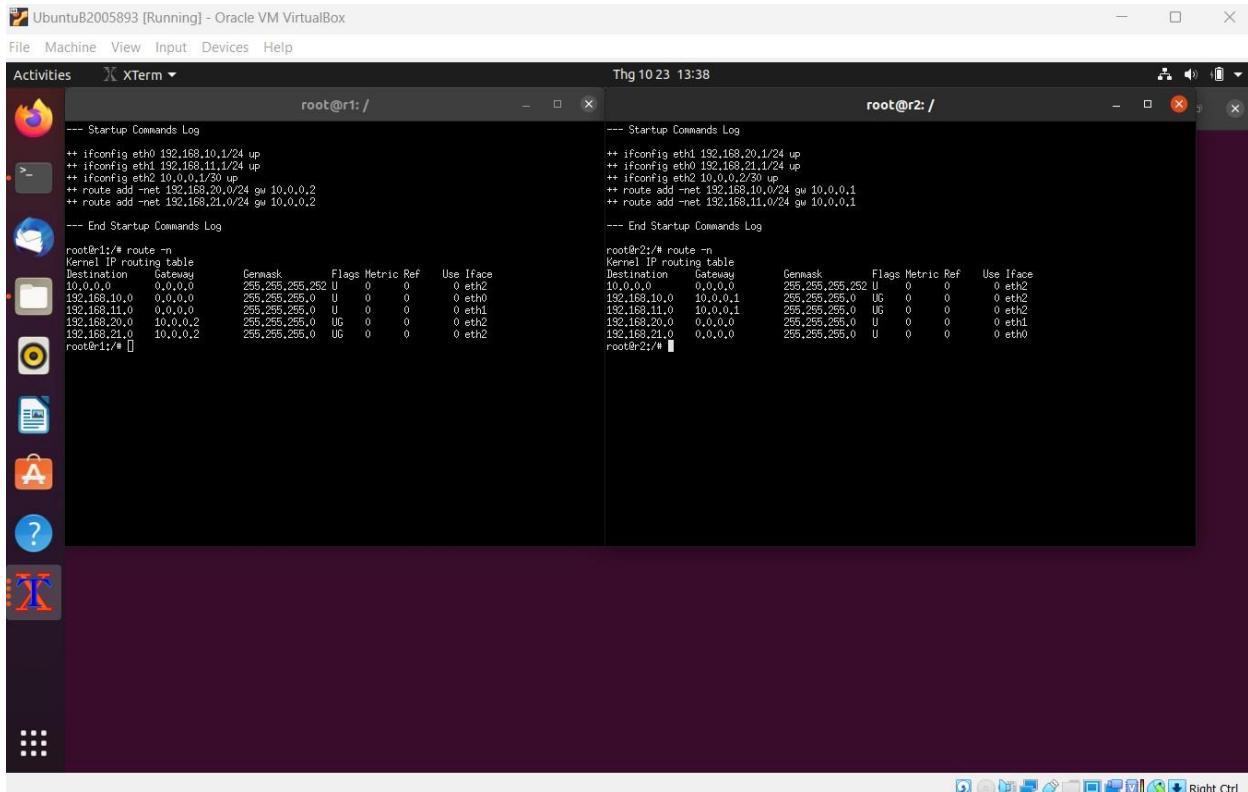
2. Start kathara

\$ sudo kathara lstart



3. Routing tables of 2 routers

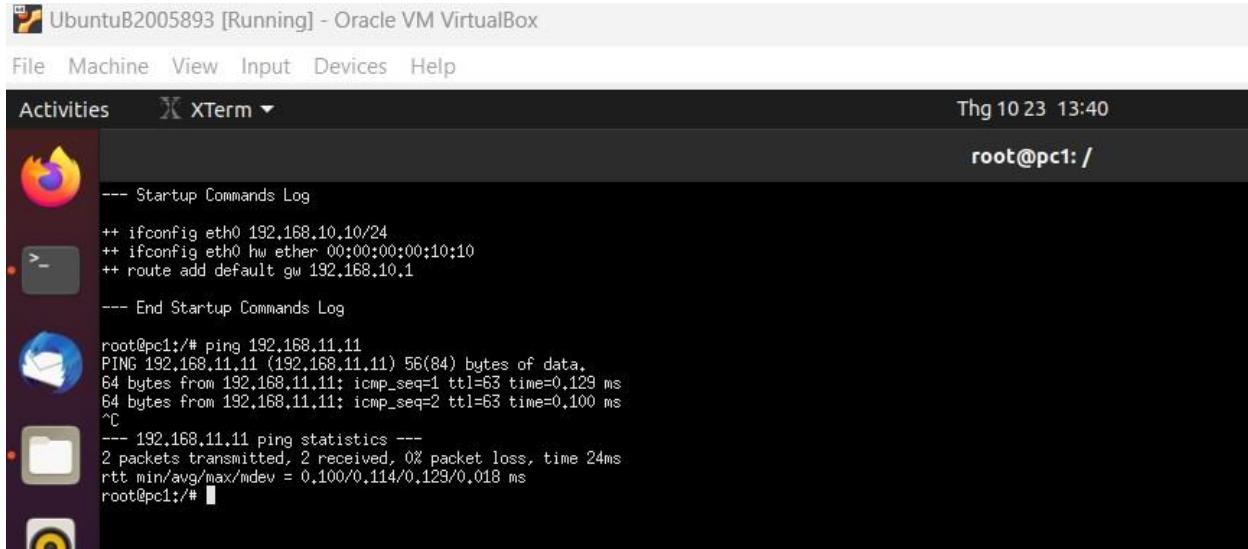
On both routers: # route -n



4. Test connectivity

A. Ping from pc1 to pc4 of switch 2

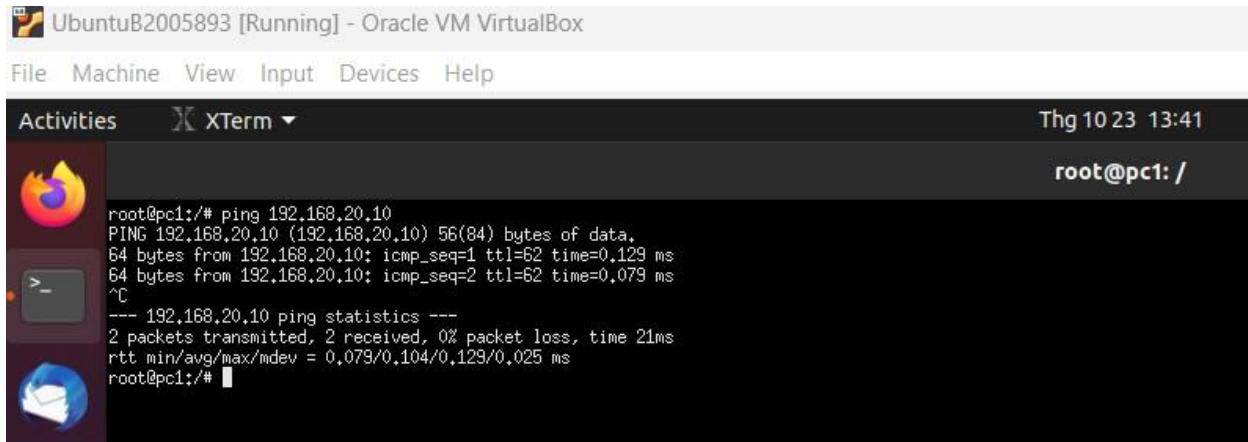
On pc1: # ping 192.168.11.11



```
UbuntuB2005893 [Running] - Oracle VM VirtualBox
File Machine View Input Devices Help
Activities XTerm ▾ Thg 10 23 13:40
root@pc1: / --- Startup Commands Log
++ ifconfig eth0 192.168.10.10/24
++ ifconfig eth0 hw ether 00:00:00:00:10:10
++ route add default gw 192.168.10.1
--- End Startup Commands Log
root@pc1:/# ping 192.168.11.11
PING 192.168.11.11 (192.168.11.11) 56(84) bytes of data,
64 bytes from 192.168.11.11: icmp_seq=1 ttl=63 time=0.129 ms
64 bytes from 192.168.11.11: icmp_seq=2 ttl=63 time=0.100 ms
^C
--- 192.168.11.11 ping statistics ---
2 packets transmitted, 2 received, 0% packet loss, time 24ms
rtt min/avg/max/mdev = 0.100/0.114/0.129/0.018 ms
root@pc1:/#
```

B. Ping from pc1 to pc5 of switch 3

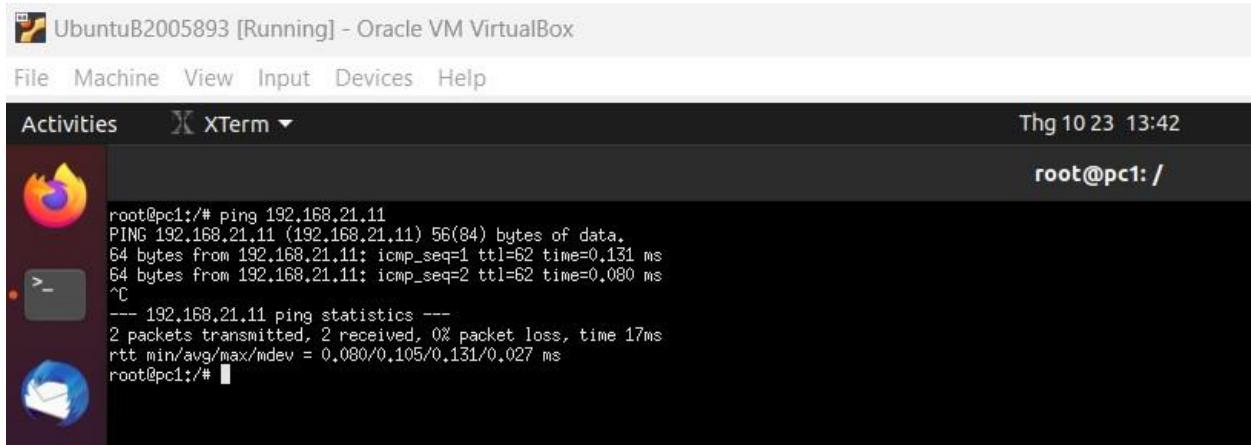
On pc1: ping 192.168.20.10



```
UbuntuB2005893 [Running] - Oracle VM VirtualBox
File Machine View Input Devices Help
Activities XTerm ▾ Thg 10 23 13:41
root@pc1: / --- 192.168.20.10 ping statistics ---
2 packets transmitted, 2 received, 0% packet loss, time 21ms
rtt min/avg/max/mdev = 0.079/0.104/0.129/0.025 ms
root@pc1:/#
```

C. Ping from pc1 to pc8 of switch 4

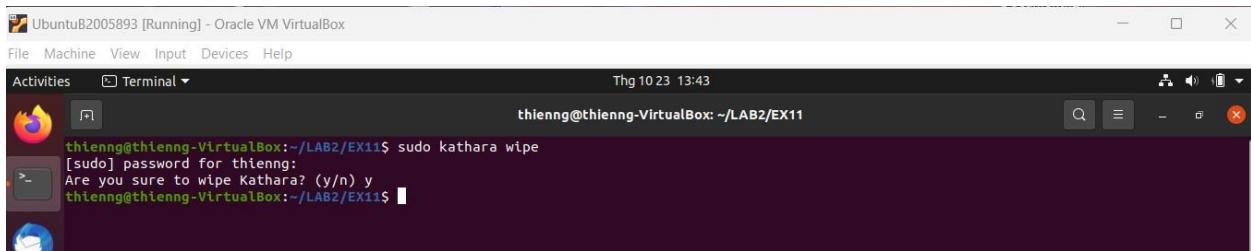
On pc1: ping 192.168.21.11



```
root@pc1:/# ping 192.168.21.11
PING 192.168.21.11 (192.168.21.11) 56(84) bytes of data.
64 bytes from 192.168.21.11: icmp_seq=1 ttl=62 time=0.131 ms
64 bytes from 192.168.21.11: icmp_seq=2 ttl=62 time=0.080 ms
^C
--- 192.168.21.11 ping statistics ---
2 packets transmitted, 2 received, 0% packet loss, time 17ms
rtt min/avg/max/mdev = 0.080/0.105/0.131/0.027 ms
root@pc1:/#
```

5. Delete all VMs

\$ sudo kathara wipe



```
thienng@thienng-VirtualBox:~/LAB2/EX11$ sudo kathara wipe
[sudo] password for thienng:
Are you sure to wipe Kathara? (y/n) y
thienng@thienng-VirtualBox:~/LAB2/EX11$
```