

CS3543 Lab Assignment for Jan 18th (Deadline: 23:59 on January 22rd (WED), 2019)

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General Information

1. This assignment can be conducted and submitted by a per (up to 2) of students. 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 individual or 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.

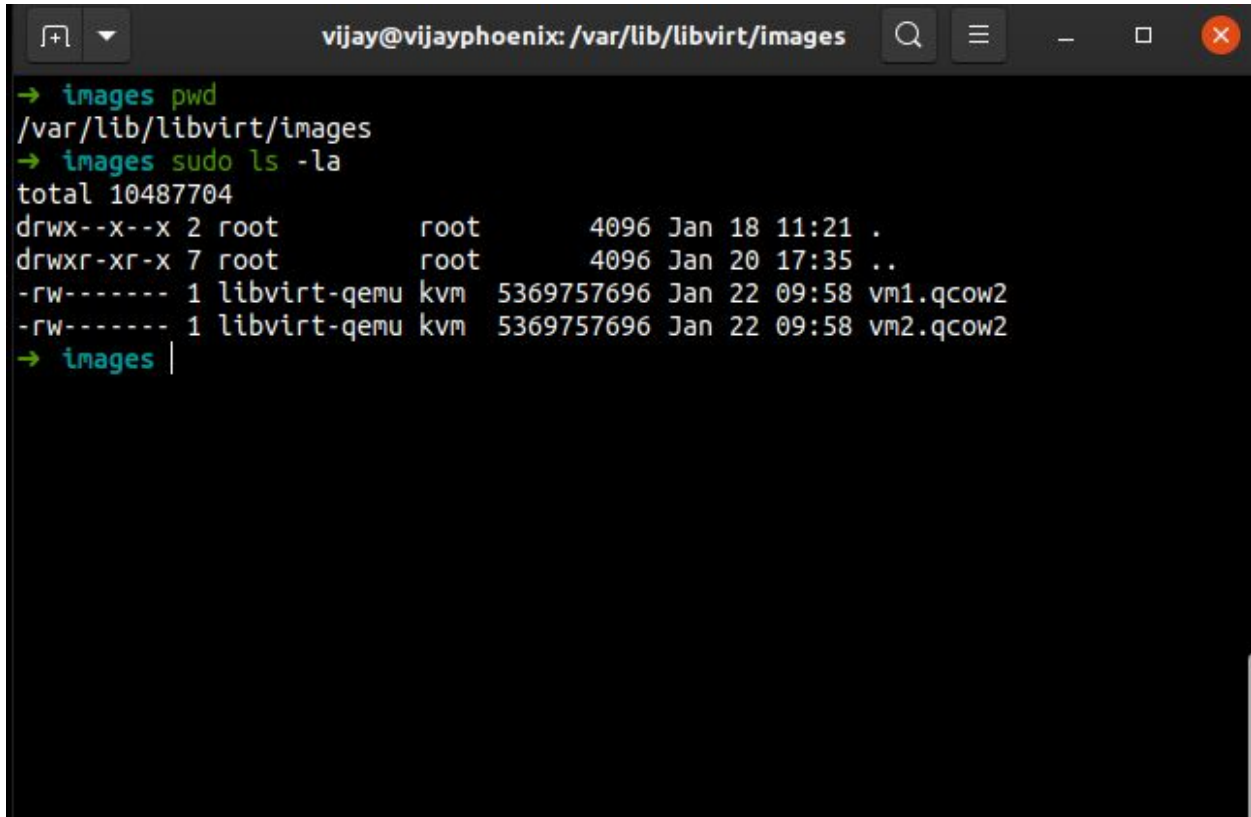
Question 1.

Fill the blanks in the following table in your VM environment. Be noted that yellow-marked blanks are to be filled as answer of Question 5.1.

| | VyOS1 | VyOS2 | VyOS3 |
|--|----------------------|----------------------|----------------------|
| IPv4 Address and Subnet Mask given to eth0 | 192.168.101.12/24 | 192.168.101.10/24 | 192.168.102.13/24 |
| IPv6 Address and Subnet Mask given to eth0 | 2013:abcd:101::12/64 | 2013:abcd:101::10/64 | 2013:abcd:102::13/64 |
| MAC Address of eth0 | 52:54:00:37:0a:4e | 52:54:00:f2:b4:5c | 52:54:00:3c:77:ce |
| Bridge I/F selected for connecting eth0 | bri0 | bri0 | bri1 |
| IPv4 Address and Subnet Mask given to eth1 | N/A | 192.168.102.10/24 | N/A |
| IPv6 Address and Subnet Mask given to eth1 | N/A | 2013:abcd:102::10/64 | N/A |
| MAC Address of eth1 | N/A | 52:54:00:e8:d1:89 | N/A |
| Bridge I/F selected for connecting eth1 | N/A | bri1 | N/A |

Question 2.

Show the file name and the full path to the disk image file (not ISO image) of VyOS1 in Host Ubuntu's file system. You may answer by pasting the screen capture of the result of "ls -al" command in the directly where the said image file is stored.

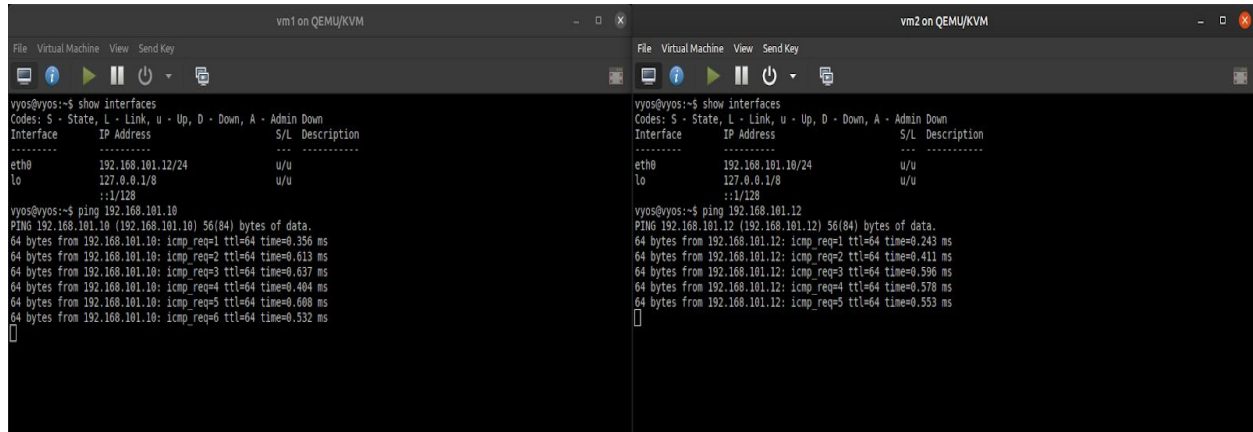


```
vijay@vijayphoenix: /var/lib/libvirt/images
→ images pwd
/var/lib/libvirt/images
→ images sudo ls -la
total 10487704
drwx--x--x 2 root      root      4096 Jan 18 11:21 .
drwxr-xr-x 7 root      root      4096 Jan 20 17:35 ..
-rw----- 1 libvirt-qemu kvm 5369757696 Jan 22 09:58 vm1.qcow2
-rw----- 1 libvirt-qemu kvm 5369757696 Jan 22 09:58 vm2.qcow2
→ images |
```

Question 3.

Show that both ping and ping6 are successful between VyOS1 and VyOS2. You may answer by pasting the screen capture of the result of both commands.

Ping :



The image shows two terminal windows side-by-side, both titled 'vm1 on QEMU/KVM' and 'vm2 on QEMU/KVM'. Each window displays the output of the 'show interfaces' and 'ping' commands. The 'show interfaces' command shows two interfaces: 'eth0' with IP address '192.168.101.12/24' and 'lo' with IP address '127.0.0.1/8'. The 'ping' command is executed from the 'eth0' interface to the other VM's IP address. The results show successful ping operations with various response times.

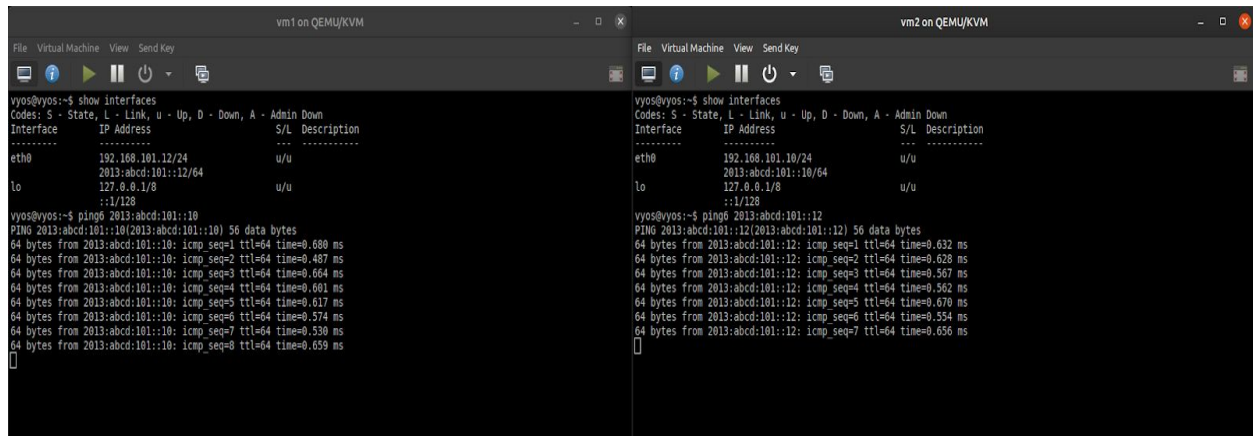
```
vyos@vyos:~$ show interfaces
Codes: S - State, L - Link, u - Up, D - Down, A - Admin Down
Interface    IP Address      S/L  Description
-----
eth0         192.168.101.12/24 u/u
lo           127.0.0.1/8      u/u
::1/128

vyos@vyos:~$ ping 192.168.101.10
PING 192.168.101.10 (192.168.101.10) 56(84) bytes of data:
64 bytes from 192.168.101.10: icmp req=1 ttl=64 time=0.356 ms
64 bytes from 192.168.101.10: icmp req=2 ttl=64 time=0.613 ms
64 bytes from 192.168.101.10: icmp req=3 ttl=64 time=0.637 ms
64 bytes from 192.168.101.10: icmp req=4 ttl=64 time=0.404 ms
64 bytes from 192.168.101.10: icmp req=5 ttl=64 time=0.608 ms
64 bytes from 192.168.101.10: icmp req=6 ttl=64 time=0.532 ms
^C
```

```
vyos@vyos:~$ show interfaces
Codes: S - State, L - Link, u - Up, D - Down, A - Admin Down
Interface    IP Address      S/L  Description
-----
eth0         192.168.101.10/24 u/u
lo           127.0.0.1/8      u/u
::1/128

vyos@vyos:~$ ping 192.168.101.12
PING 192.168.101.12 (192.168.101.12) 56(84) bytes of data:
64 bytes from 192.168.101.12: icmp req=1 ttl=64 time=0.243 ms
64 bytes from 192.168.101.12: icmp req=2 ttl=64 time=0.411 ms
64 bytes from 192.168.101.12: icmp req=3 ttl=64 time=0.596 ms
64 bytes from 192.168.101.12: icmp req=4 ttl=64 time=0.578 ms
64 bytes from 192.168.101.12: icmp req=5 ttl=64 time=0.553 ms
^C
```

Ping6:



The image shows two terminal windows side-by-side, both titled 'vm1 on QEMU/KVM' and 'vm2 on QEMU/KVM'. Each window displays the output of the 'show interfaces' and 'ping6' commands. The 'show interfaces' command shows two interfaces: 'eth0' with IP address '192.168.101.12/24' and 'lo' with IP address '127.0.0.1/8'. The 'ping6' command is executed from the 'eth0' interface to the other VM's IPv6 address. The results show successful ping6 operations with various response times.

```
vyos@vyos:~$ show interfaces
Codes: S - State, L - Link, u - Up, D - Down, A - Admin Down
Interface    IP Address      S/L  Description
-----
eth0         192.168.101.12/24 u/u
lo           127.0.0.1/8      u/u
::1/128

vyos@vyos:~$ ping6 2013:abcd:101::10
PING 2013:abcd:101::10(2013:abcd:101::10) 56 data bytes
64 bytes from 2013:abcd:101::10: icmp seq=1 ttl=64 time=0.680 ms
64 bytes from 2013:abcd:101::10: icmp seq=2 ttl=64 time=0.487 ms
64 bytes from 2013:abcd:101::10: icmp seq=3 ttl=64 time=0.664 ms
64 bytes from 2013:abcd:101::10: icmp seq=4 ttl=64 time=0.601 ms
64 bytes from 2013:abcd:101::10: icmp seq=5 ttl=64 time=0.617 ms
64 bytes from 2013:abcd:101::10: icmp seq=6 ttl=64 time=0.574 ms
64 bytes from 2013:abcd:101::10: icmp seq=7 ttl=64 time=0.530 ms
64 bytes from 2013:abcd:101::10: icmp seq=8 ttl=64 time=0.659 ms
^C
```

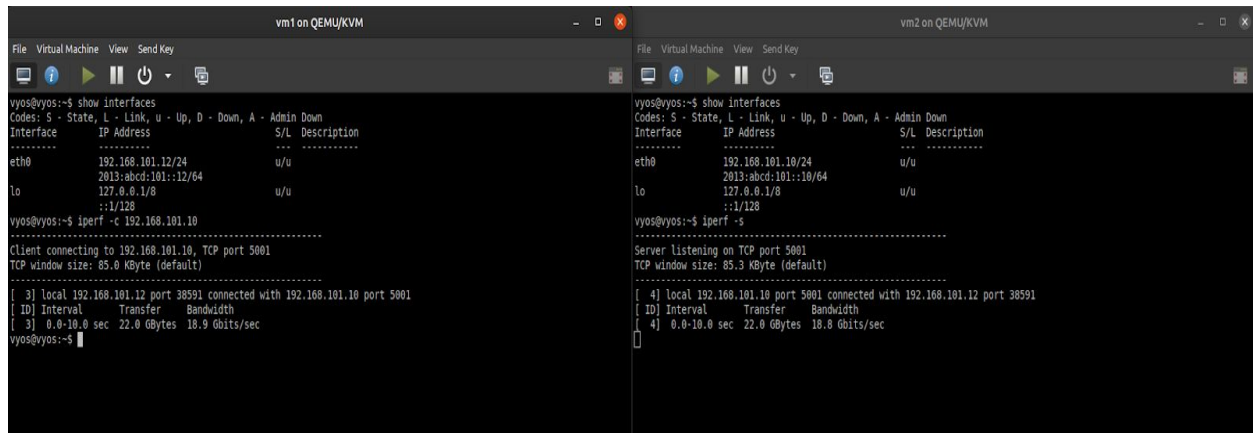
```
vyos@vyos:~$ show interfaces
Codes: S - State, L - Link, u - Up, D - Down, A - Admin Down
Interface    IP Address      S/L  Description
-----
eth0         192.168.101.10/24 u/u
lo           127.0.0.1/8      u/u
::1/128

vyos@vyos:~$ ping6 2013:abcd:101::12
PING 2013:abcd:101::12(2013:abcd:101::12) 56 data bytes
64 bytes from 2013:abcd:101::12: icmp seq=1 ttl=64 time=0.632 ms
64 bytes from 2013:abcd:101::12: icmp seq=2 ttl=64 time=0.628 ms
64 bytes from 2013:abcd:101::12: icmp seq=3 ttl=64 time=0.567 ms
64 bytes from 2013:abcd:101::12: icmp seq=4 ttl=64 time=0.562 ms
64 bytes from 2013:abcd:101::12: icmp seq=5 ttl=64 time=0.670 ms
64 bytes from 2013:abcd:101::12: icmp seq=6 ttl=64 time=0.554 ms
64 bytes from 2013:abcd:101::12: icmp seq=7 ttl=64 time=0.656 ms
^C
```

Question 4.

Show the result of iperf and check the TCP throughput from VyOS1 (client) to VyOS2 (server) using IPv4 and IPv6 respectively. You may answer by pasting the screen capture of the result of both commands.

IPv4:



The image shows two terminal windows side-by-side, both titled 'vm1 on QEMU/KVM' and 'vm2 on QEMU/KVM'. Both terminals show the output of the 'show interfaces' command, displaying the configuration for 'eth0' and 'lo' interfaces. The 'eth0' interface has IP address 192.168.101.12/24 and is connected to 2013:abcd:101::12/64. The 'lo' interface has IP address 127.0.0.1/8 and is connected to ::1/128. The 'vm1' terminal shows the output of the 'iperf -c 192.168.101.10' command, indicating a client connection to 192.168.101.10 on TCP port 5001. The output shows a transfer of 22.0 GBytes at 18.9 Gbits/sec. The 'vm2' terminal shows the output of the 'iperf -s' command, indicating a server listening on TCP port 5001. The output shows a transfer of 22.0 GBytes at 18.8 Gbits/sec.

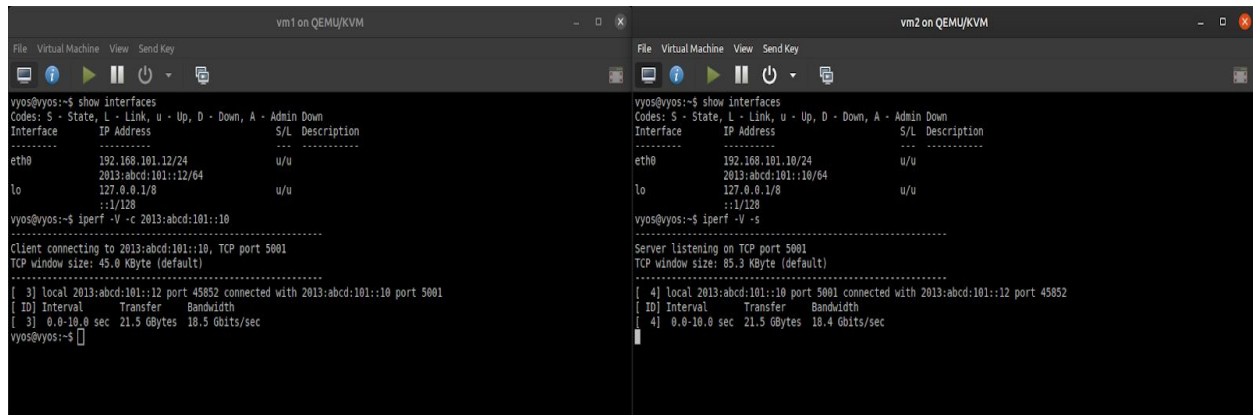
```
vm1 on QEMU/KVM
vyos@vyos:~$ show interfaces
Codes: S - State, L - Link, u - Up, D - Down, A - Admin Down
Interface IP Address S/L Description
-----
eth0      192.168.101.12/24 u/u
          2013:abcd:101::12/64
lo        127.0.0.1/8 u/u
          ::1/128

vyos@vyos:~$ iperf -c 192.168.101.10
Client connecting to 192.168.101.10, TCP port 5001
TCP window size: 65.0 KByte (default)
[ 3] local 192.168.101.12 port 38591 connected with 192.168.101.10 port 5001
[ ID] Interval Transfer Bandwidth
[ 3] 0.0-10.0 sec 22.0 GBytes 18.9 Gbits/sec
vyos@vyos:~$
```

```
vm2 on QEMU/KVM
vyos@vyos:~$ show interfaces
Codes: S - State, L - Link, u - Up, D - Down, A - Admin Down
Interface IP Address S/L Description
-----
eth0      192.168.101.10/24 u/u
          2013:abcd:101::10/64
lo        127.0.0.1/8 u/u
          ::1/128

vyos@vyos:~$ iperf -s
Server listening on TCP port 5001
TCP window size: 65.3 KByte (default)
[ 4] local 192.168.101.10 port 5001 connected with 192.168.101.12 port 38591
[ ID] Interval Transfer Bandwidth
[ 4] 0.0-10.0 sec 22.0 GBytes 18.8 Gbits/sec
vyos@vyos:~$
```

IPv6:



The image shows two terminal windows side-by-side, both titled 'vm1 on QEMU/KVM' and 'vm2 on QEMU/KVM'. Both terminals show the output of the 'show interfaces' command, displaying the configuration for 'eth0' and 'lo' interfaces. The 'eth0' interface has IP address 192.168.101.12/24 and is connected to 2013:abcd:101::12/64. The 'lo' interface has IP address 127.0.0.1/8 and is connected to ::1/128. The 'vm1' terminal shows the output of the 'iperf -v -c 2013:abcd:101::10' command, indicating a client connection to 2013:abcd:101::10 on TCP port 5001. The output shows a transfer of 21.5 GBytes at 18.5 Gbits/sec. The 'vm2' terminal shows the output of the 'iperf -v -s' command, indicating a server listening on TCP port 5001. The output shows a transfer of 21.5 GBytes at 18.4 Gbits/sec.

```
vm1 on QEMU/KVM
vyos@vyos:~$ show interfaces
Codes: S - State, L - Link, u - Up, D - Down, A - Admin Down
Interface IP Address S/L Description
-----
eth0      192.168.101.12/24 u/u
          2013:abcd:101::12/64
lo        127.0.0.1/8 u/u
          ::1/128

vyos@vyos:~$ iperf -v -c 2013:abcd:101::10
Client connecting to 2013:abcd:101::10, TCP port 5001
TCP window size: 45.0 KByte (default)
[ 3] local 2013:abcd:101::12 port 45852 connected with 2013:abcd:101::10 port 5001
[ ID] Interval Transfer Bandwidth
[ 3] 0.0-10.0 sec 21.5 GBytes 18.5 Gbits/sec
vyos@vyos:~$
```

```
vm2 on QEMU/KVM
vyos@vyos:~$ show interfaces
Codes: S - State, L - Link, u - Up, D - Down, A - Admin Down
Interface IP Address S/L Description
-----
eth0      192.168.101.10/24 u/u
          2013:abcd:101::10/64
lo        127.0.0.1/8 u/u
          ::1/128

vyos@vyos:~$ iperf -v -s
Server listening on TCP port 5001
TCP window size: 85.3 KByte (default)
[ 4] local 2013:abcd:101::10 port 5001 connected with 2013:abcd:101::12 port 45852
[ ID] Interval Transfer Bandwidth
[ 4] 0.0-10.0 sec 21.5 GBytes 18.4 Gbits/sec
vyos@vyos:~$
```

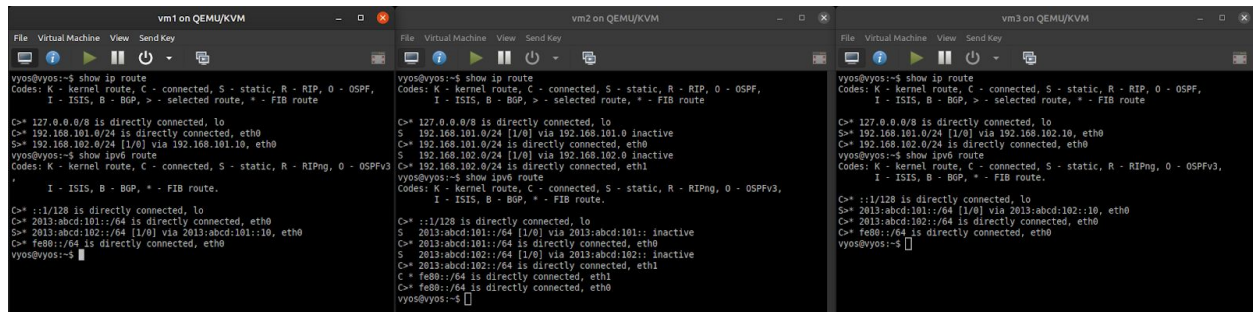
5. Install VyOS3 and connect to VyOS2 using a new bridge I/F referring the network diagram in the course material. The goal of this task is to allow VyOS1 and VyOS3 to successfully ping, ping6 and iperf (using both IPv4 and IPv6) with each other in the following network diagram.

Question 5.1.

Configure the network interface “eth1” of VyOS2 and “eth0” of VyOS3 and fill the blank in the table given in Question 1.

Question 5.2.

Configure the routing tables on VyOS1, VyOS2 and VyOS3 respectively, and paste the screen captures of respective routing tables.



The image displays three terminal windows side-by-side, each representing a VyOS virtual machine (vm1, vm2, and vm3). Each window shows the output of the 'show ip route' and 'show ipv6 route' commands. The output for each VM is as follows:

```
vm1 on QEMU/KVM
vyos@vyos:~$ show ip route
Codes: K - kernel route, C - connected, S - static, R - RIP, O - OSPF,
I - ISIS, B - BGP, > - selected route, * - FIB route
C>* 127.0.0.0/8 is directly connected, lo
C>* 192.168.101.0/24 is directly connected, eth0
S>* 192.168.102.0/24 [1/0] via 192.168.101.10, eth0
vyos@vyos:~$ show ipv6 route
Codes: K - kernel route, C - connected, S - static, R - RIPng, O - OSPFv3,
I - ISIS, B - BGP, * - FIB route.
C>* ::1/128 is directly connected, lo
C>* 2013:abcd:101::/64 is directly connected, eth0
S>* 2013:abcd:102::/64 [1/0] via 2013:abcd:101::10, eth0
C>* fe80::/64 is directly connected, eth0
vyos@vyos:~$

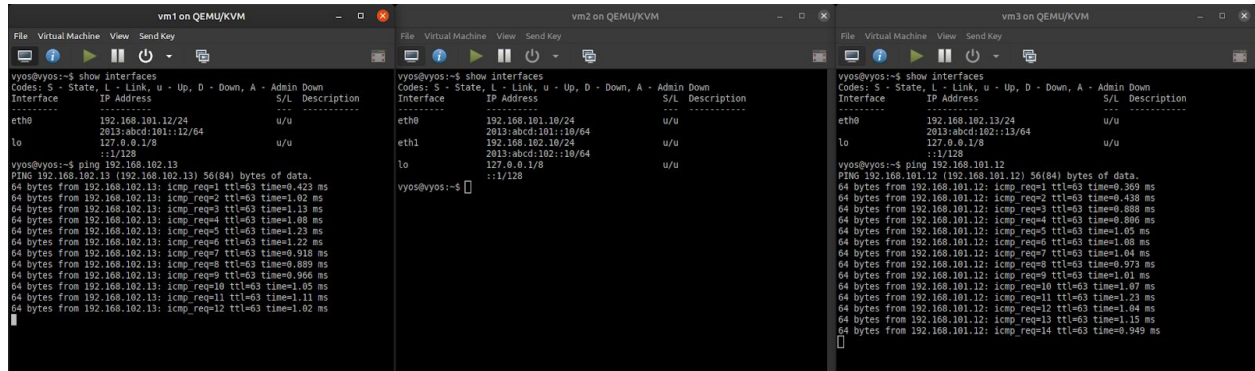
vm2 on QEMU/KVM
vyos@vyos:~$ show ip route
Codes: K - kernel route, C - connected, S - static, R - RIP, O - OSPF,
I - ISIS, B - BGP, > - selected route, * - FIB route
C>* 127.0.0.0/8 is directly connected, lo
S 192.168.101.0/24 [1/0] via 192.168.101.0 inactive
C>* 192.168.101.0/24 is directly connected, eth0
S 192.168.102.0/24 [1/0] via 192.168.102.0 inactive
C>* 192.168.102.0/24 is directly connected, eth1
vyos@vyos:~$ show ipv6 route
Codes: K - kernel route, C - connected, S - static, R - RIPng, O - OSPFv3,
I - ISIS, B - BGP, * - FIB route.
C>* ::1/128 is directly connected, lo
S 2013:abcd:101::/64 [1/0] via 2013:abcd:101:: inactive
C>* 2013:abcd:101::/64 is directly connected, eth0
S 2013:abcd:102::/64 [1/0] via 2013:abcd:102:: inactive
C>* 2013:abcd:102::/64 is directly connected, eth1
C>* fe80::/64 is directly connected, eth1
C>* fe80::/64 is directly connected, eth0
vyos@vyos:~$

vm3 on QEMU/KVM
vyos@vyos:~$ show ip route
Codes: K - kernel route, C - connected, S - static, R - RIP, O - OSPF,
I - ISIS, B - BGP, > - selected route, * - FIB route
C>* 127.0.0.0/8 is directly connected, lo
S>* 192.168.101.0/24 [1/0] via 192.168.102.10, eth0
C>* 192.168.102.0/24 is directly connected, eth0
vyos@vyos:~$ show ipv6 route
Codes: K - kernel route, C - connected, S - static, R - RIPng, O - OSPFv3,
I - ISIS, B - BGP, * - FIB route.
C>* ::1/128 is directly connected, lo
S>* 2013:abcd:101::/64 [1/0] via 2013:abcd:102::10, eth0
C>* 2013:abcd:102::/64 is directly connected, eth0
C>* fe80::/64 is directly connected, eth0
vyos@vyos:~$
```

Question 5.3.

Show that both ping and ping6 are successful between VyOS1 and VyOS3. You may answer by pasting the screen capture of the result of both commands.

ping:



The image shows three terminal windows for virtual machines vm1, vm2, and vm3. Each window displays the output of the 'show interfaces' and 'ping' commands. The 'show interfaces' command lists the interfaces and their IP addresses. The 'ping' command shows the results of a ping test between the VMs.

```
vm1 on QEMU/KVM
vyos@vyos:~$ show interfaces
Codes: S - State, L - Link, u - Up, D - Down, A - Admin Down
Interface IP Address S/L Description
-----
eth0 192.168.101.12/24 u/u
eth1 2013:abcd:101::12/64 u/u
lo 127.0.0.1/8 u/u

vyos@vyos:~$ ping 192.168.101.12
PING 192.168.101.12 (192.168.101.12) 56(84) bytes of data.
64 bytes from 192.168.101.12: icmp req=1 ttl=63 time=0.423 ms
64 bytes from 192.168.101.12: icmp req=2 ttl=63 time=0.438 ms
64 bytes from 192.168.101.12: icmp req=3 ttl=63 time=1.13 ms
64 bytes from 192.168.101.12: icmp req=4 ttl=63 time=1.08 ms
64 bytes from 192.168.101.12: icmp req=5 ttl=63 time=1.23 ms
64 bytes from 192.168.101.12: icmp req=6 ttl=63 time=1.22 ms
64 bytes from 192.168.101.12: icmp req=7 ttl=63 time=0.918 ms
64 bytes from 192.168.101.12: icmp req=8 ttl=63 time=0.889 ms
64 bytes from 192.168.101.12: icmp req=9 ttl=63 time=0.966 ms
64 bytes from 192.168.101.12: icmp req=10 ttl=63 time=1.05 ms
64 bytes from 192.168.101.12: icmp req=11 ttl=63 time=1.11 ms
64 bytes from 192.168.101.12: icmp req=12 ttl=63 time=1.62 ms
^C

```

```
vm2 on QEMU/KVM
vyos@vyos:~$ show interfaces
Codes: S - State, L - Link, u - Up, D - Down, A - Admin Down
Interface IP Address S/L Description
-----
eth0 192.168.101.10/24 u/u
eth1 2013:abcd:101::10/64 u/u
lo 127.0.0.1/8 u/u

vyos@vyos:~$

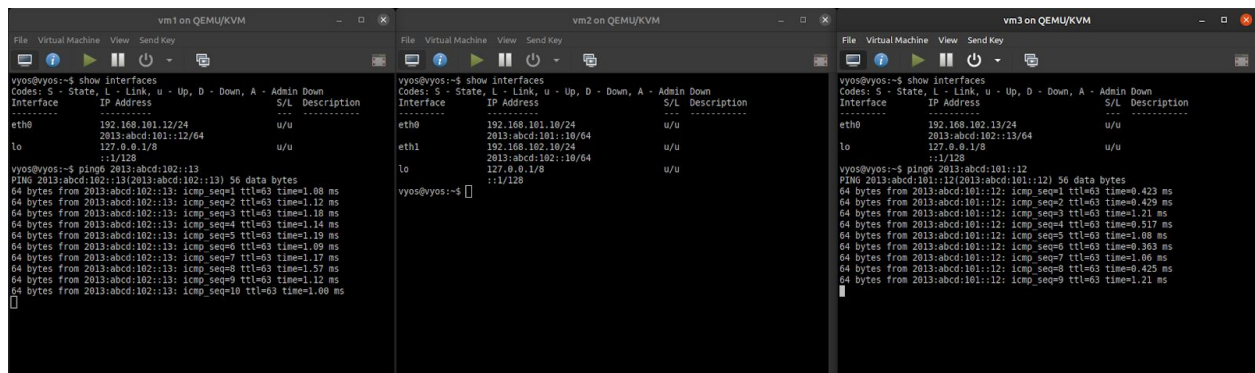
```

```
vm3 on QEMU/KVM
vyos@vyos:~$ show interfaces
Codes: S - State, L - Link, u - Up, D - Down, A - Admin Down
Interface IP Address S/L Description
-----
eth0 192.168.102.13/24 u/u
eth1 2013:abcd:102::13/64 u/u
lo 127.0.0.1/8 u/u

vyos@vyos:~$ ping 192.168.101.12
PING 192.168.101.12 (192.168.101.12) 56(84) bytes of data.
64 bytes from 192.168.101.12: icmp req=1 ttl=63 time=0.369 ms
64 bytes from 192.168.101.12: icmp req=2 ttl=63 time=0.438 ms
64 bytes from 192.168.101.12: icmp req=3 ttl=63 time=0.888 ms
64 bytes from 192.168.101.12: icmp req=4 ttl=63 time=0.886 ms
64 bytes from 192.168.101.12: icmp req=5 ttl=63 time=1.05 ms
64 bytes from 192.168.101.12: icmp req=6 ttl=63 time=1.08 ms
64 bytes from 192.168.101.12: icmp req=7 ttl=63 time=1.04 ms
64 bytes from 192.168.101.12: icmp req=8 ttl=63 time=0.973 ms
64 bytes from 192.168.101.12: icmp req=9 ttl=63 time=1.01 ms
64 bytes from 192.168.101.12: icmp req=10 ttl=63 time=1.07 ms
64 bytes from 192.168.101.12: icmp req=11 ttl=63 time=1.23 ms
64 bytes from 192.168.101.12: icmp req=12 ttl=63 time=1.64 ms
64 bytes from 192.168.101.12: icmp req=13 ttl=63 time=1.15 ms
64 bytes from 192.168.101.12: icmp req=14 ttl=63 time=0.949 ms
^C

```

ping6:



The image shows three terminal windows for virtual machines vm1, vm2, and vm3. Each window displays the output of the 'show interfaces' and 'ping6' commands. The 'show interfaces' command lists the interfaces and their IP addresses. The 'ping6' command shows the results of a ping6 test between the VMs.

```
vm1 on QEMU/KVM
vyos@vyos:~$ show interfaces
Codes: S - State, L - Link, u - Up, D - Down, A - Admin Down
Interface IP Address S/L Description
-----
eth0 192.168.101.12/24 u/u
eth1 2013:abcd:101::12/64 u/u
lo 127.0.0.1/8 u/u

vyos@vyos:~$ ping6 2013:abcd:102::13
PING 2013:abcd:102::13(2013:abcd:102::13) 56 data bytes
64 bytes from 2013:abcd:102::13: icmp seq=1 ttl=63 time=1.08 ms
64 bytes from 2013:abcd:102::13: icmp seq=2 ttl=63 time=1.12 ms
64 bytes from 2013:abcd:102::13: icmp seq=3 ttl=63 time=1.18 ms
64 bytes from 2013:abcd:102::13: icmp seq=4 ttl=63 time=1.14 ms
64 bytes from 2013:abcd:102::13: icmp seq=5 ttl=63 time=1.19 ms
64 bytes from 2013:abcd:102::13: icmp seq=6 ttl=63 time=1.09 ms
64 bytes from 2013:abcd:102::13: icmp seq=7 ttl=63 time=1.17 ms
64 bytes from 2013:abcd:102::13: icmp seq=8 ttl=63 time=1.57 ms
64 bytes from 2013:abcd:102::13: icmp seq=9 ttl=63 time=1.12 ms
64 bytes from 2013:abcd:102::13: icmp seq=10 ttl=63 time=1.60 ms
^C

```

```
vm2 on QEMU/KVM
vyos@vyos:~$ show interfaces
Codes: S - State, L - Link, u - Up, D - Down, A - Admin Down
Interface IP Address S/L Description
-----
eth0 192.168.101.10/24 u/u
eth1 192.168.102.10/24 u/u
lo 127.0.0.1/8 u/u

vyos@vyos:~$

```

```
vm3 on QEMU/KVM
vyos@vyos:~$ show interfaces
Codes: S - State, L - Link, u - Up, D - Down, A - Admin Down
Interface IP Address S/L Description
-----
eth0 192.168.102.13/24 u/u
eth1 2013:abcd:102::13/64 u/u
lo 127.0.0.1/8 u/u

vyos@vyos:~$ ping6 2013:abcd:101::12
PING 2013:abcd:101::12(2013:abcd:101::12) 56 data bytes
64 bytes from 2013:abcd:101::12: icmp seq=1 ttl=63 time=0.423 ms
64 bytes from 2013:abcd:101::12: icmp seq=2 ttl=63 time=0.429 ms
64 bytes from 2013:abcd:101::12: icmp seq=3 ttl=63 time=1.21 ms
64 bytes from 2013:abcd:101::12: icmp seq=4 ttl=63 time=0.517 ms
64 bytes from 2013:abcd:101::12: icmp seq=5 ttl=63 time=1.08 ms
64 bytes from 2013:abcd:101::12: icmp seq=6 ttl=63 time=0.363 ms
64 bytes from 2013:abcd:101::12: icmp seq=7 ttl=63 time=1.06 ms
64 bytes from 2013:abcd:101::12: icmp seq=8 ttl=63 time=0.425 ms
64 bytes from 2013:abcd:101::12: icmp seq=9 ttl=63 time=1.21 ms
^C

```

Question 5.4.

- a) Show the result of iperf and check the TCP throughput from VyOS1 (client) to VyOS3 (server) using IPv4 and IPv6 respectively. You may answer by pasting the screen capture of the result of both commands.

IPv4:

The image shows three terminal windows labeled vm1 on QEMU/KVM, vm2 on QEMU/KVM, and vm3 on QEMU/KVM. Each window displays the output of the 'show interfaces' command, showing the configuration for eth0, eth1, and lo interfaces. The IP addresses are 192.168.101.12/24 for eth0, 2013:abcd:101::12/64 for eth1, and 127.0.0.1/8 for lo. The output of the 'iperf' command is also shown, indicating a client connecting to 192.168.102.13 on TCP port 5001. The results show a transfer of 8.77 Gbytes at 7.53 Gbits/sec over a 0.0-10.0 second interval.

```
vm1 on QEMU/KVM
vyos@vyos:~$ show interfaces
Codes: S - State, L - Link, u - Up, D - Down, A - Admin Down
Interface IP Address S/L Description
-----
eth0 192.168.101.12/24 u/u
2013:abcd:101::12/64
lo 127.0.0.1/8 u/u
::1/128
vyos@vyos:~$ iperf -c 192.168.102.13
Client connecting to 192.168.102.13, TCP port 5001
TCP window size: 85.0 KByte (default)
[ 3] local 192.168.101.12 port 40862 connected with 192.168.102.13 port 5001
[ ID] Interval Transfer Bandwidth
[ 3] 0.0-10.0 sec 8.77 Gbytes 7.53 Gbits/sec
vyos@vyos:~$
```

```
vm2 on QEMU/KVM
vyos@vyos:~$ show interfaces
Codes: S - State, L - Link, u - Up, D - Down, A - Admin Down
Interface IP Address S/L Description
-----
eth0 192.168.101.10/24 u/u
2013:abcd:101::10/64
eth1 192.168.102.10/24 u/u
2013:abcd:102::10/64
lo 127.0.0.1/8 u/u
::1/128
vyos@vyos:~$
```

```
vm3 on QEMU/KVM
vyos@vyos:~$ show interfaces
Codes: S - State, L - Link, u - Up, D - Down, A - Admin Down
Interface IP Address S/L Description
-----
eth0 192.168.102.13/24 u/u
2013:abcd:102::13/64
lo 127.0.0.1/8 u/u
::1/128
vyos@vyos:~$ iperf -s
Server listening on TCP port 5001
TCP window size: 85.3 KByte (default)
[ 4] local 192.168.102.13 port 5001 connected with 192.168.101.12 port 40862
[ ID] Interval Transfer Bandwidth
[ 4] 0.0-10.0 sec 8.77 Gbytes 7.53 Gbits/sec
vyos@vyos:~$
```

IPv6:

The image shows three terminal windows labeled vm1 on QEMU/KVM, vm2 on QEMU/KVM, and vm3 on QEMU/KVM. Each window displays the output of the 'show interfaces' command, showing the configuration for eth0, eth1, and lo interfaces. The IP addresses are 192.168.101.12/24 for eth0, 2013:abcd:101::12/64 for eth1, and 127.0.0.1/8 for lo. The output of the 'iperf' command is also shown, indicating a client connecting to 2013:abcd:102::13 on TCP port 5001. The results show a transfer of 8.81 Gbytes at 7.57 Gbits/sec over a 0.0-10.0 second interval.

```
vm1 on QEMU/KVM
vyos@vyos:~$ show interfaces
Codes: S - State, L - Link, u - Up, D - Down, A - Admin Down
Interface IP Address S/L Description
-----
eth0 192.168.101.12/24 u/u
2013:abcd:101::12/64
lo 127.0.0.1/8 u/u
::1/128
vyos@vyos:~$ iperf -c 2013:abcd:102::13
Client connecting to 2013:abcd:102::13, TCP port 5001
TCP window size: 45.0 KByte (default)
[ 3] local 2013:abcd:101::12 port 55856 connected with 2013:abcd:102::13 port 5001
[ ID] Interval Transfer Bandwidth
[ 3] 0.0-10.0 sec 8.81 Gbytes 7.57 Gbits/sec
vyos@vyos:~$
```

```
vm2 on QEMU/KVM
vyos@vyos:~$ show interfaces
Codes: S - State, L - Link, u - Up, D - Down, A - Admin Down
Interface IP Address S/L Description
-----
eth0 192.168.101.10/24 u/u
2013:abcd:101::10/64
eth1 192.168.102.10/24 u/u
2013:abcd:102::10/64
lo 127.0.0.1/8 u/u
::1/128
vyos@vyos:~$
```

```
vm3 on QEMU/KVM
vyos@vyos:~$ show interfaces
Codes: S - State, L - Link, u - Up, D - Down, A - Admin Down
Interface IP Address S/L Description
-----
eth0 192.168.102.13/24 u/u
2013:abcd:102::13/64
lo 127.0.0.1/8 u/u
::1/128
vyos@vyos:~$ iperf -s
Server listening on TCP port 5001
TCP window size: 85.3 KByte (default)
[ 4] local 2013:abcd:102::13 port 5001 connected with 2013:abcd:101::12 port 55856
[ ID] Interval Transfer Bandwidth
[ 4] 0.0-10.0 sec 8.81 Gbytes 7.56 Gbits/sec
vyos@vyos:~$
```

- b) Compare the results between Question 4, and describe your thought (OPTIONAL: and appropriate reference or justification).