Assignment-02 CS 433 Computer Networks (2023-24)

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a) The code is attached with this repository. A mininet includes three inter-connected subnets each with a router and two hosts.

Here's a brief explanation of the key components and implementation:

1. Custom Router Class (LinuxRouter):

- Inherits from the Mininet Node class.
- Overrides the config method to enable IP forwarding on the router.
- o Overrides the terminate method to disable IP forwarding when terminating.

2. Topology Class (NetworkTopo):

- Inherits from the Mininet Topo class.
- Defines the network topology, including routers, switches, and links between them.
- Configures IP addresses for router interfaces.

3. Topology Building (build method in NetworkTopo):

- Adds three routers (r1, r2, r3) with specific IP addresses.
- o Adds three switches (s1, s2, s3).
- Establishes links between routers and switches.
- Configures point-to-point links between routers (r1-eth2 to r2-eth2, r2-eth3 to r3-eth2, r3-eth3 to r1-eth3).
- Adds hosts (h1 to h6) and connects them to switches with assigned IP addresses and default routes.

4. Mininet Initialization and Startup (run function):

- Creates an instance of the NetworkTopo topology.
- Initializes Mininet with the specified topology.
- Starts the Mininet network.

5. Packet Capture and Static Routes (run function):

- Enables packet capture on specific interfaces of r1.
- o Configures static routes on routers to ensure proper routing between subnets.

6. CLI Interaction (CLI(net) in run` function):

Opens the Mininet Command Line Interface (CLI) for user interaction.

7. Routing Table Display and Modification (run function):

- Displays the initial routing tables for routers (r1, r2, r3).
- Modifies default routes for specific traffic.
- Displays the updated routing tables.

8. Packet Capture Cleanup (run function):

Stops the packet capture on r1 before exiting.

9. Mininet Cleanup (run function):

Stops the Mininet network.

10. Script Execution Check ('if name == 'main':):

Ensures that the script is executed when run directly and not when imported as a

module.

```
127.0.0.134040 127.0.0.13553 wboxuser@Ubuntu:~$ sudo /bin/python3 /home/vboxuser/Desktop/Q1.py
*** Creating network
     *** Adding controller
*** Adding hosts:
h1 h2 h3 h4 h5 h6 r1 r2 r3
*** Adding switches:
      *** Adding links:

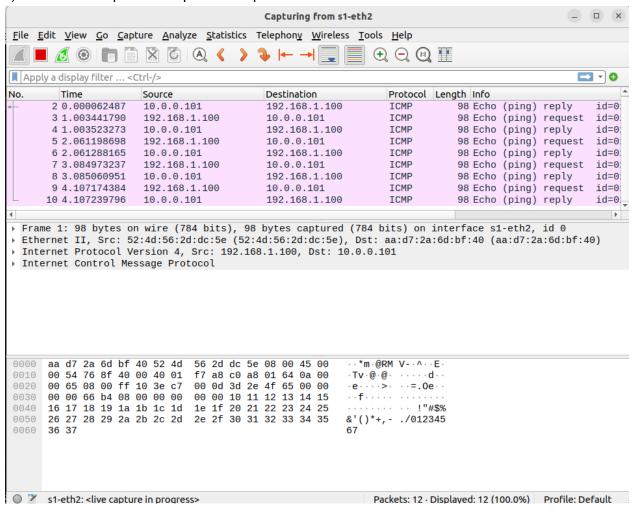
(h1, s1) (h2, s1) (h3, s2) (h4, s2) (h5, s3) (h6, s3) (r1, r2) (r2, r3) (r3, r1) (s1, r1) (s2, r2) (s3, r3)

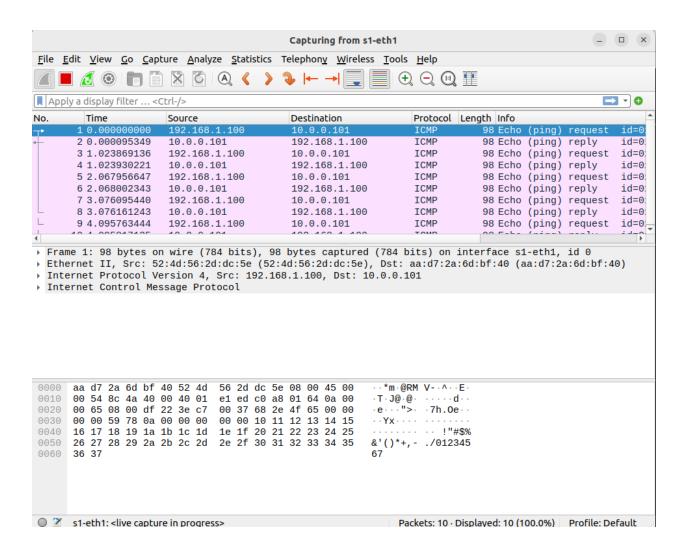
*** Configuring hosts

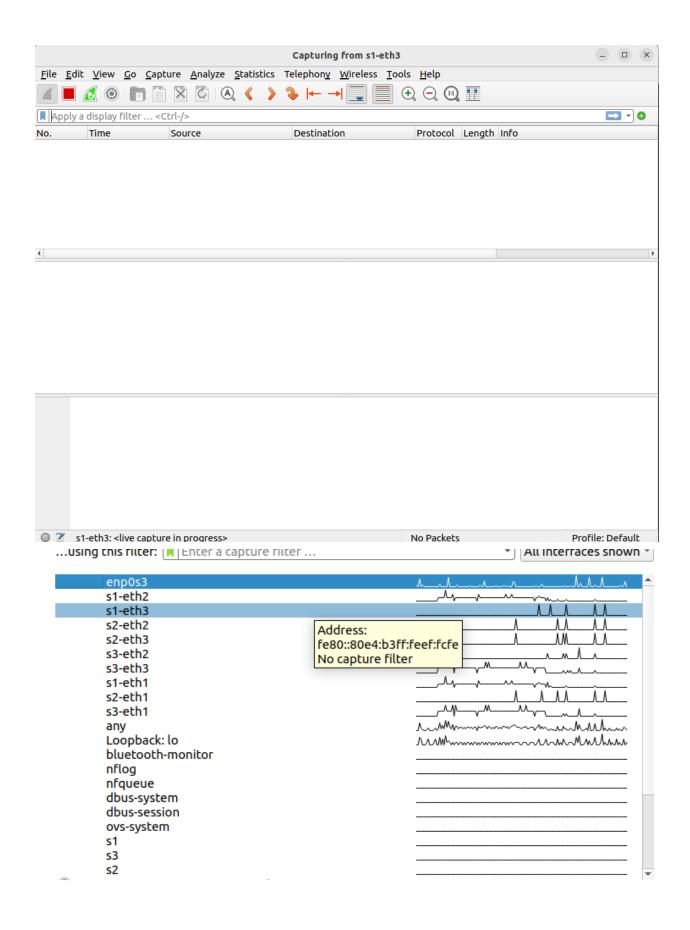
h1 h2 h3 h4 h5 h6 r1 r2 r3

*** Starting controller
      s1 s2 s3
*** Waiting for switches to coms sl s2 s3
* Routing Table for Router r1:
Kernel IP routing table
Destination Gateway
10.0.0.0 192.168.6.1
172.16.0.0 192.168.4.2
192.168.1.0 0.0.0.0
192.168.4.0 0.0.0.0
192.168.6.0 0.0.0.0
**Routing Table for Router r2:
Kernel IP routing table
Destination Gateway
10.0.0.0 192.168.5.2
172.16.0.0 0.0.0.0
                   Waiting for switches to connect
                                                                                                                             Genmask Fl
255.0.0.0 UG
255.240.0.0 UG
255.255.255.25 U
255.255.255.252 U
                                                                                                                                                                                                                                                                    Use Iface
0 r1-eth3
0 r1-eth2
0 r1-eth1
                                                                                                                                                                                          Flags Metric Ref
                                                                                                                                                                                                                                                                            0 r1-eth2
0 r1-eth3
   Kernel IP routing table
Destination Gateway
10.0.0.0 192.168.5.2
172.16.0.0 0.0.0.0
192.168.1.0 192.168.4.1
192.168.4.0 0.0.0.0
192.168.5.0 0.0.0.0
* Routing Table for Router r3:
Kernel IP routing table
Destination Gateway
10.0.0.0 0.0.0.0
                                                                                                                             Genmask Fl
255.0.0.0 UG
255.240.0.0 U
255.255.255.25 UG
255.255.255.252 U
                                                                                                                                                                                        Flags Metric Ref
UG 0 0
U 0 0
UG 0 0
                                                                                                                                                                                                                                                                    Use Iface
0 r2-eth3
0 r2-eth1
0 r2-eth2
                                                                                                                                                                                                                                                                            0 r2-eth2
0 r2-eth3
                                                                                                                              Genmask
255.0.0.0
                                                                                                                                                                                          Flags Metric Ref
                                                                                                                                                                                                                                                                   Use Iface
    mininet> hl ping -c 3 h6
PING 10.0.0.101 (10.0.0.101) 56(84) bytes of data.
64 bytes from 10.0.0.101: icmp_seq=1 ttl=62 time=5.03 ms
64 bytes from 10.0.0.101: icmp_seq=2 ttl=62 time=0.602 ms
64 bytes from 10.0.0.101: icmp_seq=3 ttl=62 time=0.218 ms
    --- 10.0.0.101 ping statistics --- 3 packets transmitted, 3 received, 0% packet loss, time 2030ms rtt min/avg/max/mdev = 0.218/1.951/5.033/2.184 ms mininet> h1 ping -c h4 ping: invalid argument: '172.16.0.101' mininet> h1 ping -c 3 h4 PING 172.16.0.101 (172.16.0.101) 56(84) bytes of data. 64 bytes from 172.16.0.101: icmp_seq=1 ttl=62 time=3.73 ms 64 bytes from 172.16.0.101: icmp_seq=2 ttl=62 time=0.954 ms 64 bytes from 172.16.0.101: icmp_seq=3 ttl=62 time=0.098 ms
    --- 172.16.0.101 ping statistics ---
3 packets transmitted, 3 received, 0% packet loss, time 2090ms
rtt min/avg/max/mdev = 0.098/1.594/3.732/1.551 ms
mininet> h1 ping - c 3 h2
PING 192.168.1.101 (192.168.1.101) 56(84) bytes of data.
64 bytes from 192.168.1.101: icmp_seq=1 ttl=64 time=3.05 ms
64 bytes from 192.168.1.101: icmp_seq=2 ttl=64 time=0.425 ms
64 bytes from 192.168.1.101: icmp_seq=3 ttl=64 time=0.086 ms
    --- 192.168.1.101 ping statistics --- 3 packets transmitted, 3 received, 0% packet loss, time 2153ms rtt min/avg/max/mdev = 0.086/1.185/3.046/1.322 ms mininet>
```

b) WireShark output for the packets captured on router 1:







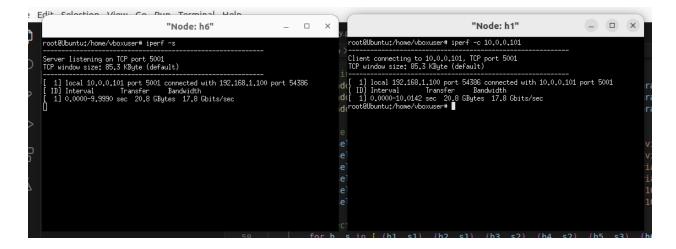
```
# Vary the default route for h1 to h6 traffic via different routers
net['r1'].cmd('ip route del 10.0.0.0/8 via 192.168.6.1')
net['r1'].cmd('ip route add 10.0.0.0/8 via 192.168.4.2')
net['r3'].cmd('ip route del 192.168.1.0/24 via 192.168.6.2')
net['r3'].cmd('ip route add 192.168.1.0/24 via 192.168.5.1')
```

Code snippet for varying the default route

```
* Updated Routing Table for Router r1:
Kernel IP routing table
Destination
                Gateway
                                 Genmask
                                                 Flags Metric Ref
                                                                      Use Iface
10.0.0.0
                192.168.4.2
                                 255.0.0.0
                                                 UG
                                                       0
                                                               0
                                                                        0 r1-eth2
172.16.0.0
                192.168.4.2
                                 255.240.0.0
                                                 UG
                                                       0
                                                               0
                                                                        0 r1-eth2
192.168.1.0
                0.0.0.0
                                 255.255.255.0
                                                 U
                                                       0
                                                               0
                                                                        0 r1-eth1
192.168.4.0
                0.0.0.0
                                 255.255.255.252 U
                                                        0
                                                               0
                                                                        0 r1-eth2
192.168.6.0
                0.0.0.0
                                 255.255.255.252 U
                                                       0
                                                               0
                                                                        0 r1-eth3
* Updated Routing Table for Router r2:
Kernel IP routing table
                Gateway
                                                 Flags Metric Ref
Destination
                                 Genmask
                                                                      Use Iface
10.0.0.0
                192.168.5.2
                                 255.0.0.0
                                                 UG
                                                       0
                                                               0
                                                                        0 r2-eth3
                0.0.0.0
                                 255.240.0.0
                                                 U
                                                       0
                                                               0
                                                                        0 r2-eth1
172.16.0.0
                                 255.255.255.0
                                                 UG
                                                       0
                                                               0
                                                                        0 r2-eth2
192.168.1.0
                192.168.4.1
192.168.4.0
                0.0.0.0
                                 255.255.255.252 U
                                                        0
                                                               0
                                                                        0 r2-eth2
192.168.5.0
                0.0.0.0
                                 255.255.255.252 U
                                                        0
                                                               0
                                                                        0 r2-eth3
* Updated Routing Table for Router r3:
Kernel IP routing table
                                 Genmask
                                                 Flags Metric Ref
                                                                      Use Iface
Destination
                Gateway
10.0.0.0
                0.0.0.0
                                 255.0.0.0
                                                                        0 r3-eth1
                                                 U
                                                       0
                                                               0
172.16.0.0
                192.168.5.1
                                 255.240.0.0
                                                 UG
                                                        0
                                                               0
                                                                        0 r3-eth2
192.168.1.0
                192.168.5.1
                                 255.255.255.0
                                                 UG
                                                        0
                                                               0
                                                                        0 r3-eth2
                                 255.255.255.252 U
192.168.5.0
                0.0.0.0
                                                        0
                                                               0
                                                                        0 r3-eth2
192.168.6.0
                0.0.0.0
                                 255.255.255.252 U
                                                        0
                                                               0
                                                                        0 r3-eth3
*** Starting CLI:
```

```
mininet> h1 ping -c 3 h6
PING 10.0.0.101 (10.0.0.101) 56(84) bytes of data.
64 bytes from 10.0.0.101: icmp_seq=1 ttl=61 time=4.50 ms
64 bytes from 10.0.0.101: icmp_seq=2 ttl=61 time=1.42 ms
64 bytes from 10.0.0.101: icmp_seq=3 ttl=61 time=0.108 ms

--- 10.0.0.101 ping statistics ---
3 packets transmitted, 3 received, 0% packet loss, time 2008ms
rtt_min/avg/max/mdev = 0.108/2.008/4.501/1.841 ms
```



d)

	u)										
	* Updated Routing Table for Router r1:										
	Kernel IP routin										
	Destination	Gateway	Genmask	_	Metric	Ref		Iface			
				UG	0	0	0	r1-eth2			
	172.16.0.0	192.168.4.2	255.240.0.0	UG	0	0	0	r1-eth2			
١	192.168.1.0	0.0.0.0	255.255.255.0	U	0	0	0	r1-eth1			
١	192.168.4.0	0.0.0.0	255.255.255.252	U	0	0	0	r1-eth2			
١	192.168.6.0	0.0.0.0	255.255.255.252	U	0	0	0	r1-eth3			
١	* Updated Routin	ng Table for Rout	ter r2:								
	Kernel IP routing table										
١	Destination	Gateway		Flags	Metric	Ref	Use	Iface			
١	10.0.0.0	192.168.5.2	255.0.0.0	UG	0	0	0	r2-eth3			
١	172.16.0.0	0.0.0.0	255.240.0.0	U	0	0	0	r2-eth1			
١	192.168.1.0	192.168.4.1	255.255.255.0	UG	0	0	0	r2-eth2			
١	192.168.4.0	0.0.0.0	255.255.255.252	U	0	0	0	r2-eth2			
	192.168.5.0	0.0.0.0	255.255.255.252	U	0	0	0	r2-eth3			
	* Updated Routing Table for Router r3:										
	Kernel IP routing table										
١	Destination	Gateway	Genmask	Flags	Metric	Ref	Use	Iface			
١	10.0.0.0	0.0.0.0	255.0.0.0	U	0	0	0	r3-eth1			
	172.16.0.0	192.168.5.1	255.240.0.0	UG	0	0	0	r3-eth2			
	192.168.1.0	192.168.5.1	255.255.255.0	UG	0	0	0	r3-eth2			
	192.168.5.0	0.0.0.0	255.255.255.252	U	0	0	0	r3-eth2			
	192.168.6.0	0.0.0.0	255.255.255.252	U	0	0	0	r3-eth3			
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* Routing Table	for Router r1:									
	Kernel IP routing table									
Destination		Genmask	Flags	Metric	Ref	Use	Iface			
10.0.0.0	192.168.6.1	255.0.0.0	UG	0	0	0	r1-eth3			
172.16.0.0	192.168.4.2	255.240.0.0	UG	0	0	0	r1-eth2			
192.168.1.0	0.0.0.0	255.255.255.0	U	0	0	0	r1-eth1			
192.168.4.0	0.0.0.0	255.255.255.252	U	0	0		r1-eth2			
192.168.6.0	0.0.0.0	255.255.255.252	U	0	0	0	r1-eth3			
* Routing Table										
Kernel IP routin	ng table									
Destination	,		Flags	Metric	Ref	Use	Iface			
	192.168.5.2	255.0.0.0	UG	0	0	0	r2-eth3			
172.16.0.0		255.240.0.0	U	0	0	0	r2-eth1			
192.168.1.0	192.168.4.1	255.255.255.0	UG	0	0	0	r2-eth2			
192.168.4.0	0.0.0.0	255.255.255.252	U	0	0	0	r2-eth2			
192.168.5.0		255.255.255.252	U	0	0	0	r2-eth3			
* Routing Table										
Kernel IP routing table										
Destination	Gateway			Metric			Iface			
10.0.0.0	0.0.0.0	255.0.0.0	U	0	0		r3-eth1			
	192.168.5.1		UG	0	0		r3-eth2			
	192.168.6.2		UG	0	0		r3-eth3			
	0.0.0.0	255.255.255.252		0	0		r3-eth2			
192.168.6.0	0.0.0.0	255.255.255.252	U	0	0	0	r3-eth3			