

(a) the routing tables at all nodes (as a screen capture) and explain what you did to configure them correctly.

Steps to configure each node:

1. Create each host, set an IP address for each host.
2. Create a routing node and set the forwarding variable to 1 through "self.cmd('sysctl net.ipv4.ip_forward=1')" of 'LinuxRouter', which will enable forwarding of node routing.
3. Add the link in the appropriate order.
4. Through "net.get("R1").cmd("ifconfig R1-eth1 171.0.0.1")", assign ip (171.0.0.1) to R1-eth1 subnet, and then assign ip to all other subnet nodes.
5. Assign a gateway to the host through "net.get("H1").cmd("route add default gw 170.0.0.2")".
6. Set a static routing path for each routing node through "net.get("R1").cmd("ip route add 173.0.0.0/16 via 171.0.0.2")", the subnet ip (173.0.0.0/16) to get the packet through the forwarding of the subnet ip (171.0.0.2).

```
*** Adding hosts:
H1 H2 R1 R2 R3 R4
*** Adding switches:

*** Adding links:
(H1, R1) (R1, R2) (R1, R3) (R2, R4) (R3, R4) (R4, H2)
*** Configuring hosts
H1 H2 R1 R2 R3 R4
*** Starting controller
c0
*** Starting 0 switches

*** Starting CLI:
mininet> net
H1 H1-eth0:R1-eth0
H2 H2-eth0:R4-eth0
R1 R1-eth0:H1-eth0 R1-eth1:R2-eth1 R1-eth2:R3-eth1
R2 R2-eth0:R4-eth1 R2-eth1:R1-eth1
R3 R3-eth0:R4-eth2 R3-eth1:R1-eth2
R4 R4-eth0:H2-eth0 R4-eth1:R2-eth0 R4-eth2:R3-eth0
c0
mininet> pingall
*** Ping: testing ping reachability
H1 -> H2 R1 R2 R3 R4
H2 -> H1 R1 R2 R3 R4
R1 -> H1 H2 R2 R3 R4
R2 -> H1 H2 R1 R3 R4
R3 -> H1 H2 R1 R2 R4
R4 -> H1 H2 R1 R2 R3
*** Results: 0% dropped (30/30 received)
```

```
mininet> H1 route
Kernel IP routing table
Destination      Gateway         Genmask         Flags Metric Ref    Use Iface
default          170.0.0.2      0.0.0.0         UG        0      0      0 H1-eth0
170.0.0.0        0.0.0.0        255.255.0.0     U         0      0      0 H1-eth0
mininet> R1 route
Kernel IP routing table
Destination      Gateway         Genmask         Flags Metric Ref    Use Iface
170.0.0.0        0.0.0.0        255.255.0.0     U         0      0      0 R1-eth0
171.0.0.0        0.0.0.0        255.255.0.0     U         0      0      0 R1-eth1
172.0.0.0        0.0.0.0        255.255.0.0     U         0      0      0 R1-eth2
173.0.0.0        171.0.0.2      255.255.0.0     UG        0      0      0 R1-eth1
174.0.0.0        172.0.0.2      255.255.0.0     UG        0      0      0 R1-eth2
175.0.0.0        172.0.0.2      255.255.0.0     UG        0      0      0 R1-eth2
mininet> R2 route
Kernel IP routing table
Destination      Gateway         Genmask         Flags Metric Ref    Use Iface
170.0.0.0        171.0.0.1      255.255.0.0     UG        0      0      0 R2-eth1
171.0.0.0        0.0.0.0        255.255.0.0     U         0      0      0 R2-eth1
172.0.0.0        171.0.0.1      255.255.0.0     UG        0      0      0 R2-eth1
173.0.0.0        0.0.0.0        255.255.0.0     U         0      0      0 R2-eth0
174.0.0.0        173.0.0.2      255.255.0.0     UG        0      0      0 R2-eth0
175.0.0.0        173.0.0.2      255.255.0.0     UG        0      0      0 R2-eth0
```

```
mininet> R3 route
Kernel IP routing table
Destination      Gateway         Genmask         Flags Metric Ref    Use Iface
170.0.0.0        172.0.0.1      255.255.0.0     UG        0      0      0 R3-eth1
171.0.0.0        172.0.0.1      255.255.0.0     UG        0      0      0 R3-eth1
172.0.0.0        0.0.0.0        255.255.0.0     U         0      0      0 R3-eth1
173.0.0.0        174.0.0.2      255.255.0.0     UG        0      0      0 R3-eth0
174.0.0.0        0.0.0.0        255.255.0.0     U         0      0      0 R3-eth0
175.0.0.0        174.0.0.2      255.255.0.0     UG        0      0      0 R3-eth0
mininet> R4 route
Kernel IP routing table
Destination      Gateway         Genmask         Flags Metric Ref    Use Iface
170.0.0.0        173.0.0.1      255.255.0.0     UG        0      0      0 R4-eth1
171.0.0.0        173.0.0.1      255.255.0.0     UG        0      0      0 R4-eth1
172.0.0.0        174.0.0.1      255.255.0.0     UG        0      0      0 R4-eth2
173.0.0.0        0.0.0.0        255.255.0.0     U         0      0      0 R4-eth1
174.0.0.0        0.0.0.0        255.255.0.0     U         0      0      0 R4-eth2
175.0.0.0        0.0.0.0        255.255.0.0     U         0      0      0 R4-eth0
mininet> H2 route
Kernel IP routing table
Destination      Gateway         Genmask         Flags Metric Ref    Use Iface
default          175.0.0.2      0.0.0.0         UG        0      0      0 H2-eth0
175.0.0.0        0.0.0.0        255.255.0.0     U         0      0      0 H2-eth0
```

(b) provide the trace route output that gives the path between nodes H1 & H2.

```
mininet> H1 traceroute H2
traceroute to 175.0.0.1 (175.0.0.1), 30 hops max, 60 byte packets
 1  170.0.0.2 (170.0.0.2)  0.461 ms  0.402 ms  0.384 ms
 2  172.0.0.2 (172.0.0.2)  0.370 ms  0.342 ms  0.323 ms
 3  173.0.0.2 (173.0.0.2)  0.305 ms  0.269 ms  0.246 ms
 4  175.0.0.1 (175.0.0.1)  0.225 ms  0.194 ms  0.169 ms
mininet> H2 traceroute H1
traceroute to 170.0.0.1 (170.0.0.1), 30 hops max, 60 byte packets
 1  175.0.0.2 (175.0.0.2)  0.469 ms  0.434 ms  0.423 ms
 2  173.0.0.1 (173.0.0.1)  0.413 ms  0.394 ms  0.384 ms
 3  172.0.0.1 (172.0.0.1)  0.372 ms  0.349 ms  0.335 ms
 4  170.0.0.1 (170.0.0.1)  0.322 ms  0.299 ms  0.283 ms
```

H1 traceroute H2:

H1 -> R1 -> R3 -> R4 -> H2

H2 traceroute H1:

H2 -> R4 -> R2 -> R1 -> H1