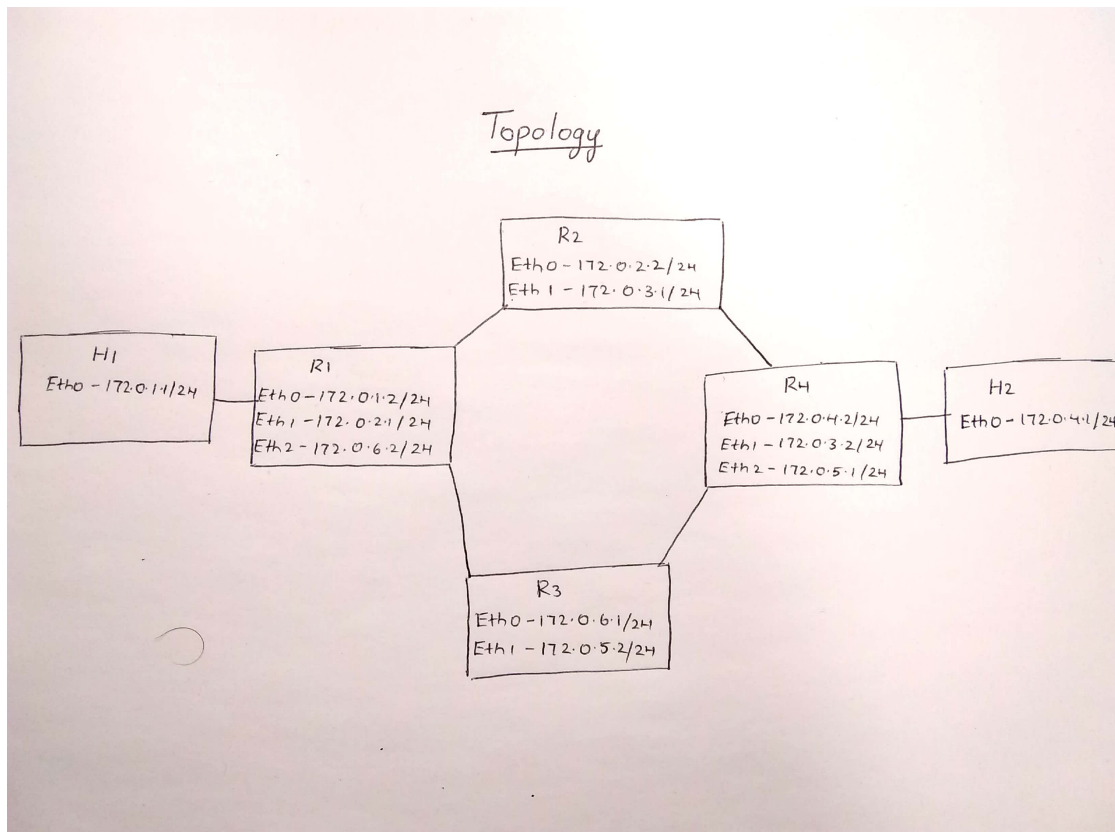


## Part A

### A1. Create your own topology as below.

(a) please find the attached topo.py file in Part A folder

(b) below is the topology figure which is used in setting up static routes



### A2. Create static routes

(a) Configuration setup : After running the start.py, run the below commands in mininetx.

1) First enable ip forwarding for the nodes, using the below command:

```
H1 echo 1 > /proc/sys/net/ipv4/ip_forward
H2 echo 1 > /proc/sys/net/ipv4/ip_forward
R1 echo 1 > /proc/sys/net/ipv4/ip_forward
R2 echo 1 > /proc/sys/net/ipv4/ip_forward
R3 echo 1 > /proc/sys/net/ipv4/ip_forward
R4 echo 1 > /proc/sys/net/ipv4/ip_forward
```

```

mininext> H1 echo 1 > /proc/sys/net/ipv4/ip_forward
mininext> H2 echo 1 > /proc/sys/net/ipv4/ip_forward
mininext> R1 echo 1 > /proc/sys/net/ipv4/ip_forward
mininext> R2 echo 1 > /proc/sys/net/ipv4/ip_forward
mininext> R3 echo 1 > /proc/sys/net/ipv4/ip_forward
mininext> R4 echo 1 > /proc/sys/net/ipv4/ip_forward
mininext> █

```

2) Set the interface ip's for the topology ( as required ), using the below command:

```

R1 ip addr add 172.0.2.1/24 dev R1-eth1
R1 ip addr add 172.0.6.2/24 dev R1-eth2
R2 ip addr add 172.0.3.1/24 dev R2-eth1
R4 ip addr add 172.0.3.2/24 dev R4-eth1
R4 ip addr add 172.0.5.1/24 dev R4-eth2
R3 ip addr add 172.0.5.2/24 dev R3-eth1

```

```

mininext> R1 ip addr add 172.0.2.1/24 dev R1-eth1
mininext> R1 ip addr add 172.0.6.2/24 dev R1-eth2
mininext> R2 ip addr add 172.0.3.1/24 dev R2-eth1
mininext> R4 ip addr add 172.0.3.2/24 dev R4-eth1
mininext> R4 ip addr add 172.0.5.1/24 dev R4-eth2
mininext> R3 ip addr add 172.0.5.2/24 dev R3-eth1
mininext> █

```

3) Set the static routes ( as required ), using the below command:

```

H1 ip route add default via 172.0.1.2 dev H1-eth0
R1 ip route add 172.0.3.0 via 172.0.2.2 dev R1-eth1
R1 ip route add 172.0.4.0/24 via 172.0.2.2 dev R1-eth1
R2 ip route add 172.0.4.0/24 via 172.0.3.2 dev R2-eth1

```

```

mininext>
mininext> H1 ip route add default via 172.0.1.2 dev H1-eth0
mininext> R1 ip route add 172.0.3.0 via 172.0.2.2 dev R1-eth1
mininext> R1 ip route add 172.0.4.0/24 via 172.0.2.2 dev R1-eth1
mininext> R2 ip route add 172.0.4.0/24 via 172.0.3.2 dev R2-eth1
mininext> █

```

4) Allow natting for R1, R2, R4 routers, using the below command:

```

R1 iptables -t nat -A POSTROUTING -o R1-eth1 -j MASQUERADE
R1 iptables -A FORWARD -i R1-eth1 -o R1-eth0 -m state --

```

```

state RELATED,ESTABLISHED -j ACCEPT
    R1 iptables -A FORWARD -i R1-eth0 -o R1-eth1 -j ACCEPT

    R2 iptables -t nat -A POSTROUTING -o R2-eth1 -j MASQUERADE
    R2 iptables -A FORWARD -i R2-eth1 -o R2-eth0 -m state --
state RELATED,ESTABLISHED -j ACCEPT
    R2 iptables -A FORWARD -i R2-eth0 -o R2-eth1 -j ACCEPT

    R4 iptables -t nat -A POSTROUTING -o R4-eth0 -j MASQUERADE
    R4 iptables -A FORWARD -i R4-eth0 -o R4-eth1 -m state --
state RELATED,ESTABLISHED -j ACCEPT
    R4 iptables -A FORWARD -i R4-eth1 -o R4-eth0 -j ACCEPT

```

```

mininext>
mininext> R1 iptables -t nat -A POSTROUTING -o R1-eth1 -j MASQUERADE
mininext> R1 iptables -A FORWARD -i R1-eth1 -o R1-eth0 -m state --state RELATED,ESTABLISHED -j ACCEPT
mininext> R1 iptables -A FORWARD -i R1-eth0 -o R1-eth1 -j ACCEPT
mininext>
mininext> R2 iptables -t nat -A POSTROUTING -o R2-eth1 -j MASQUERADE
mininext> R2 iptables -A FORWARD -i R2-eth1 -o R2-eth0 -m state --state RELATED,ESTABLISHED -j ACCEPT
mininext> R2 iptables -A FORWARD -i R2-eth0 -o R2-eth1 -j ACCEPT
mininext>
mininext> R4 iptables -t nat -A POSTROUTING -o R4-eth0 -j MASQUERADE
mininext> R4 iptables -A FORWARD -i R4-eth0 -o R4-eth1 -m state --state RELATED,ESTABLISHED -j ACCEPT
mininext> R4 iptables -A FORWARD -i R4-eth1 -o R4-eth0 -j ACCEPT
mininext> █

```

**Routing tables at all nodes (screenshot) :**

```

mininext> H1 route -n
Kernel IP routing table
Destination      Gateway          Genmask          Flags Metric Ref    Use Iface
0.0.0.0          172.0.1.2       0.0.0.0          UG        0      0      0 H1-eth0
172.0.1.0        0.0.0.0         255.255.255.0    U          0      0      0 H1-eth0
172.0.2.0        172.0.1.2       255.255.255.0    UG         2      0      0 H1-eth0
172.0.3.0        172.0.1.2       255.255.255.0    UG         3      0      0 H1-eth0
172.0.5.0        172.0.1.2       255.255.255.0    UG         4      0      0 H1-eth0
172.0.6.0        172.0.1.2       255.255.255.0    UG         2      0      0 H1-eth0
mininext>
mininext>
mininext> H2 route -n
Kernel IP routing table
Destination      Gateway          Genmask          Flags Metric Ref    Use Iface
172.0.1.0        172.0.4.2       255.255.255.0    UG         4      0      0 H2-eth0
172.0.2.0        172.0.4.2       255.255.255.0    UG         3      0      0 H2-eth0
172.0.3.0        172.0.4.2       255.255.255.0    UG         2      0      0 H2-eth0
172.0.4.0        0.0.0.0         255.255.255.0    U          0      0      0 H2-eth0
172.0.5.0        172.0.4.2       255.255.255.0    UG         2      0      0 H2-eth0
172.0.6.0        172.0.4.2       255.255.255.0    UG         4      0      0 H2-eth0
mininext>
mininext>
mininext> R1 route -n
Kernel IP routing table
Destination      Gateway          Genmask          Flags Metric Ref    Use Iface
172.0.1.0        0.0.0.0         255.255.255.0    U          0      0      0 R1-eth0
172.0.2.0        0.0.0.0         255.255.255.0    U          0      0      0 R1-eth1
172.0.3.0        172.0.2.2       255.255.255.255  UGH         0      0      0 R1-eth1
172.0.3.0        172.0.2.2       255.255.255.0    UG         2      0      0 R1-eth1
172.0.4.0        172.0.2.2       255.255.255.252  UG         3      0      0 R1-eth1
172.0.4.0        172.0.2.2       255.255.255.0    UG         0      0      0 R1-eth1
172.0.5.0        172.0.2.2       255.255.255.0    UG         3      0      0 R1-eth1
172.0.6.0        0.0.0.0         255.255.255.0    U          0      0      0 R1-eth2
mininext>
mininext>
mininext> R2 route -n
Kernel IP routing table
Destination      Gateway          Genmask          Flags Metric Ref    Use Iface
172.0.1.0        172.0.2.1       255.255.255.0    UG         2      0      0 R2-eth0
172.0.2.0        0.0.0.0         255.255.255.0    U          0      0      0 R2-eth0
172.0.3.0        0.0.0.0         255.255.255.0    U          0      0      0 R2-eth1
172.0.4.0        172.0.3.2       255.255.255.252  UG         2      0      0 R2-eth1
172.0.4.0        172.0.3.2       255.255.255.0    UG         0      0      0 R2-eth1
172.0.5.0        172.0.3.2       255.255.255.0    UG         2      0      0 R2-eth1
172.0.6.0        172.0.2.1       255.255.255.0    UG         2      0      0 R2-eth0
mininext>
mininext>
mininext> R3 route -n
Kernel IP routing table
Destination      Gateway          Genmask          Flags Metric Ref    Use Iface
172.0.5.0        0.0.0.0         255.255.255.0    U          0      0      0 R3-eth0
172.0.5.0        0.0.0.0         255.255.255.0    U          0      0      0 R3-eth1
mininext>
mininext>
mininext> R4 route -n
Kernel IP routing table
Destination      Gateway          Genmask          Flags Metric Ref    Use Iface
172.0.1.0        172.0.3.1       255.255.255.0    UG         3      0      0 R4-eth1
172.0.2.0        172.0.3.1       255.255.255.0    UG         2      0      0 R4-eth1
172.0.3.0        0.0.0.0         255.255.255.0    U          0      0      0 R4-eth1
172.0.4.0        0.0.0.0         255.255.255.252  U          0      0      0 R4-eth0
172.0.5.0        0.0.0.0         255.255.255.0    U          0      0      0 R4-eth2
172.0.6.0        172.0.3.1       255.255.255.0    UG         3      0      0 R4-eth1

```

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

```
[mininext>
[mininext> H1 traceroute H2
traceroute to 172.0.4.1 (172.0.4.1), 30 hops max, 60 byte packets
 1  172.0.1.2 (172.0.1.2)  0.033 ms  0.006 ms  0.004 ms
 2  172.0.2.2 (172.0.2.2)  0.019 ms  0.009 ms  0.008 ms
 3  172.0.3.2 (172.0.3.2)  0.019 ms  0.012 ms  0.010 ms
 4  172.0.4.1 (172.0.4.1)  0.022 ms  0.015 ms  0.015 ms
mininext>
```

```
[mininext> H1 ping H2
[PING 172.0.4.1 (172.0.4.1) 56(84) bytes of data.
64 bytes from 172.0.4.1: icmp_seq=1 ttl=61 time=0.062 ms
64 bytes from 172.0.4.1: icmp_seq=2 ttl=61 time=0.091 ms
64 bytes from 172.0.4.1: icmp_seq=3 ttl=61 time=0.095 ms
64 bytes from 172.0.4.1: icmp_seq=4 ttl=61 time=0.094 ms
64 bytes from 172.0.4.1: icmp_seq=5 ttl=61 time=0.080 ms
64 bytes from 172.0.4.1: icmp_seq=6 ttl=61 time=0.061 ms
64 bytes from 172.0.4.1: icmp_seq=7 ttl=61 time=0.094 ms
64 bytes from 172.0.4.1: icmp_seq=8 ttl=61 time=0.079 ms
64 bytes from 172.0.4.1: icmp_seq=9 ttl=61 time=0.096 ms
64 bytes from 172.0.4.1: icmp_seq=10 ttl=61 time=0.079 ms
64 bytes from 172.0.4.1: icmp_seq=11 ttl=61 time=0.097 ms
64 bytes from 172.0.4.1: icmp_seq=12 ttl=61 time=0.079 ms
64 bytes from 172.0.4.1: icmp_seq=13 ttl=61 time=0.094 ms
64 bytes from 172.0.4.1: icmp_seq=14 ttl=61 time=0.078 ms
64 bytes from 172.0.4.1: icmp_seq=15 ttl=61 time=0.097 ms
64 bytes from 172.0.4.1: icmp_seq=16 ttl=61 time=0.097 ms
64 bytes from 172.0.4.1: icmp_seq=17 ttl=61 time=0.080 ms
64 bytes from 172.0.4.1: icmp_seq=18 ttl=61 time=0.078 ms
64 bytes from 172.0.4.1: icmp_seq=19 ttl=61 time=0.077 ms
64 bytes from 172.0.4.1: icmp_seq=20 ttl=61 time=0.095 ms
64 bytes from 172.0.4.1: icmp_seq=21 ttl=61 time=0.097 ms
64 bytes from 172.0.4.1: icmp_seq=22 ttl=61 time=0.078 ms
64 bytes from 172.0.4.1: icmp_seq=23 ttl=61 time=0.077 ms
64 bytes from 172.0.4.1: icmp_seq=24 ttl=61 time=0.078 ms
64 bytes from 172.0.4.1: icmp_seq=25 ttl=61 time=0.080 ms
64 bytes from 172.0.4.1: icmp_seq=26 ttl=61 time=0.079 ms
```

