1. **Ans**

table0_flow1.json

```
{
    "dpid": 1,
    "table_id": 0,
    "idle_timeout": 0,
    "hard_timeout": 0,
    "priority": 0,
    "match":{
    },
    "actions":[
        {
            "type":"GOTO_TABLE",
            "table_id": 10
        }
    ]
}
```

โดยการทำงานของ code ตัวนี้คืออันดับแรกเราจะตั้ง table_id ให้เป็น เลข 0 ตามโจทย์ที่ต้องการและทำการสั่ง actions ให้กับ table ว่าจะต้องการให้ทำงานอย่างไร ผมเลยทำการตั้งเป็น type GOTO_TABLE เพื่อสั่งการให้ย้ายไป table หมายเลข 1

table10_flow1.json

```
{
    "dpid": 1,
    "table_id": 10,
    "idle_timeout": 0,
    "hard_timeout": 0,
    "priority": 100,
    "match": {
        "ip_proto": 6
    },
    "actions": [
        {
            "type": "DROP"
        }
    ]
}
```

table10_flow2.json

```
{
    "dpid": 1,
    "table_id": 10,
    "idle_timeout": 0,
    "hard_timeout": 0,
    "priority": 100,
    "match":{
    },
    "actions":[
        {
            "type":"GOTO_TABLE",
            "table_id": 20
        }
    ]
}
```

ทำการตั้ง table_id เป็นหมายเลข 10 โดย table นี้จะมีการทำ 2 อย่างคือ DROP TCP และสั่ง GOTO_TABLE ไปยัง table หมายเลข 20

Table30_drop.json

```
{
    "dpid": 1,
    "table_id": 20,
    "idle_timeout": 0,
    "hard_timeout": 0,
    "priority": 100,
    "match":{
        "eth_type": 2048,
        "ipv4_dst": "10.1.1.2",
        "ip_proto": 6
    },
    "actions":[        {
        "type": "DROP"
    }
    ]
}
```

table20_flow1.json

```
{
    "dpid": 1,
    "table_id": 20,
    "idle_timeout": 0,
    "hard_timeout": 0,
    "priority": 100,
    "match": {
        "ip_proto": 1
    },
    "actions": [
        {
            "type": "DROP"
        }
    ]
}
```

table20_flow2.json

```
{
    "dpid": 1,
    "table_id": 20,
    "idle_timeout": 0,
    "hard_timeout": 0,
    "priority": 100,
    "match":{
    },
    "actions":[
        {
            "type":"GOTO_TABLE",
            "table_id": 30
        }
    ]
}
```

โค้ดนี้ก็จะมีการทำงานคล้ายๆกับ table เมื่อกี้โดยจะเปลี่ยนตรง ip_proto เป็น 1 เพื่อทำการ DROP ICMP และทำการ DROP ตรง h2 block TCP

table30_drop.json

```
{
    "dpid": 1,
    "table_id": 30,
    "idle_timeout": 0,
    "hard_timeout": 0,
    "priority": 100,
    "match": {
        "eth_type": 2048,
        "ipv4_dst": "10.1.1.5",
        "ip_proto": 1
    },
    "actions": [
        {
            "type": "DROP"
        }
    ]
}
```

table30_flow1.json

```
{
    "dpid": 1,
    "table_id": 30,
    "idle_timeout": 0,
    "hard_timeout": 0,
    "priority": 0,
    "match":{
    "dl_dst": "00:00:00:00:00:01"
    },
    "actions":[
        {
            "type":"OUTPUT",
            "port": 1
        }
    ]
}
```

table30_flow2.json

```
{
    "dpid": 1,
    "table_id": 30,
    "idle_timeout": 0,
    "hard_timeout": 0,
    "priority": 0,
    "match":{
    "dl_dst": "00:00:00:00:00:02"
    },
    "actions":[
        {
            "type":"OUTPUT",
            "port": 2
        }
    ]
}
```

table30_flow3.json

```
{
    "dpid": 1,
    "table_id": 30,
    "idle_timeout": 0,
    "hard_timeout": 0,
    "priority": 0,
    "match":{
    "dl_dst": "00:00:00:00:00:03"
    },
    "actions":[
        {
            "type":"OUTPUT",
            "port": 3
        }
    ]
}
```

table30_flow4.json

```
{
    "dpid": 1,
    "table_id": 30,
    "idle_timeout": 0,
    "hard_timeout": 0,
    "priority": 0,
    "match":{
    "dl_dst": "00:00:00:00:00:04"
    },
    "actions":[
        {
            "type":"OUTPUT",
            "port": 4
        }
    ]
}
```

table30_flow5.json

```
{
    "dpid": 1,
    "table_id": 30,
    "idle_timeout": 0,
    "hard_timeout": 0,
    "priority": 0,
    "match":{
    "dl_dst": "00:00:00:00:00:05"
    },
    "actions":[
        {
            "type":"OUTPUT",
            "port": 5
        }
    ]
}
```

table30_flow6.json

```
{
    "dpid": 1,
    "table_id": 30,
    "idle_timeout": 0,
    "hard_timeout": 0,
    "priority": 0,
    "match":{
    "dl_dst": "00:00:00:00:00:06"
    },
    "actions":[
        {
            "type":"OUTPUT",
            "port": 6
        }
    ]
}
```

โค๊ดนี้จะเป็นการส่งการทำงาน Forwarding ไปยัง port แต่ละ port และทำการบล็อก ICMP h5 ที่ table 30

a. ทำการ run ryu manager

```
test@test:~/Desktop/SDN_Network/HomeWork$ ryu-manager ryu.app.ofctl_rest
```

b. สร้าง topology ตามโจทย์

```
test@test:~/Desktop/SDN_Network/HomeWork$ sudo mn --controller=remote,ip=127.0.0.1 --mac -i 10.1.1.0/24 --switch=ovs
k,protocols=OpenFlow13 --topo=single,6
```

c. Add flow

curl -X POST http://localhost:8080/stats/flowentry/add -d '@table0_flow1.json'

curl -X POST http://localhost:8080/stats/flowentry/add -d '@table10_flow1.json'

curl -X POST http://localhost:8080/stats/flowentry/add -d '@table10_flow2.json'

curl -X POST http://localhost:8080/stats/flowentry/add -d ‘@table20_drop.json

curl -X POST http://localhost:8080/stats/flowentry/add -d '@table20_flow1.json'

curl -X POST http://localhost:8080/stats/flowentry/add -d '@table20_flow2.json'

curl -X POST http://localhost:8080/stats/flowentry/add -d ‘@table30_drop.json

curl -X POST http://localhost:8080/stats/flowentry/add -d ‘@table30_flow1.json

curl -X POST http://localhost:8080/stats/flowentry/add -d ‘@table30_flow2.json

curl -X POST http://localhost:8080/stats/flowentry/add -d ‘@table30_flow3.json

curl -X POST http://localhost:8080/stats/flowentry/add -d ‘@table30_flow4.json

curl -X POST http://localhost:8080/stats/flowentry/add -d ‘@table30_flow5.json

curl -X POST http://localhost:8080/stats/flowentry/add -d '@table30_flow6.json

```
test@test:~/Desktop/SDN_Network/HomeWork/Multitable/Json_Mulititable$ curl -X POST http://localhost:8080/stats/flowentry/add -d '@table0_flow1.json'
test@test:~/Desktop/SDN_Network/HomeWork/Multitable/Json_Mulititable$ curl -X POST http://localhost:8080/stats/flowentry/add -d '@table10_flow1.json'
test@test:~/Desktop/SDN_Network/HomeWork/Multitable/Json_Mulititable$ curl -X POST http://localhost:8080/stats/flowentry/add -d '@table20_flow1.json'
test@test:~/Desktop/SDN_Network/HomeWork/Multitable/Json_Mulititable$ curl -X POST http://localhost:8080/stats/flowentry/add -d '@table20_drop.json'
test@test:~/Desktop/SDN_Network/HomeWork/Multitable/Json_Mulititable$ curl -X POST http://localhost:8080/stats/flowentry/add -d '@table20_flow2.json'
test@test:~/Desktop/SDN_Network/HomeWork/Multitable/Json_Mulititable$ curl -X POST http://localhost:8080/stats/flowentry/add -d '@table30_drop.json'
test@test:~/Desktop/SDN_Network/HomeWork/Multitable/Json_Mulititable$ curl -X POST http://localhost:8080/stats/flowentry/add -d '@table30_flow1.json'
test@test:~/Desktop/SDN_Network/HomeWork/Multitable/Json_Mulititable$ curl -X POST http://localhost:8080/stats/flowentry/add -d '@table30_flow2.json'
test@test:~/Desktop/SDN_Network/HomeWork/Multitable/Json_Mulititable$ curl -X POST http://localhost:8080/stats/flowentry/add -d '@table30_flow3.json'
test@test:~/Desktop/SDN_Network/HomeWork/Multitable/Json_Mulititable$ curl -X POST http://localhost:8080/stats/flowentry/add -d '@table30_flow4.json'
test@test:~/Desktop/SDN_Network/HomeWork/Multitable/Json_Mulititable$ curl -X POST http://localhost:8080/stats/flowentry/add -d '@table30_flow5.json'
test@test:~/Desktop/SDN_Network/HomeWork/Multitable/Json_Mulititable$ curl -X POST http://localhost:8080/stats/flowentry/add -d '@table30_flow6.json'
```

Verify flow

```
test@test:~/Desktop/SDN_Network/HomeWork/Multitable/Json_Mulititable$ sudo ovs-ofctl -O OpenFlow13 dump-flows s1
[sudo] password for test:
test@test:~/Desktop/SDN_Network/HomeWork/Multitable/Json_Mulititable$
[sudo] password for test:
 cookie=0x0, duration=96.575s, table=0, n_packets=11, n_bytes=770, priority=100 actions=goto_table:10
 cookie=0x0, duration=74.453s, table=20, n_packets=0, n_bytes=0, priority=100,tcp,nw_dst=10.1.1.2 actions=drop
 cookie=0x0, duration=66.582s, table=20, n_packets=0, n_bytes=0, priority=100 actions=goto_table:30
 cookie=0x0, duration=57.253s, table=30, n_packets=0, n_bytes=0, priority=100,icmp,nw_dst=10.1.1.5 actions=drop
 cookie=0x0, duration=49.580s, table=30, n_packets=0, n_bytes=0, priority=0,dl_dst=00:00:00:00:00:01 actions=output:"s1-eth1"
 cookie=0x0, duration=47.606s, table=30, n_packets=0, n_bytes=0, priority=0,dl_dst=00:00:00:00:00:02 actions=output:"s1-eth2"
 cookie=0x0, duration=45.118s, table=30, n_packets=0, n_bytes=0, priority=0,dl_dst=00:00:00:00:00:03 actions=output:"s1-eth3"
 cookie=0x0, duration=42.198s, table=30, n_packets=0, n_bytes=0, priority=0,dl_dst=00:00:00:00:00:04 actions=output:"s1-eth4"
 cookie=0x0, duration=39.990s, table=30, n_packets=0, n_bytes=0, priority=0,dl_dst=00:00:00:00:00:05 actions=output:"s1-eth5"
 cookie=0x0, duration=37.494s, table=30, n_packets=0, n_bytes=0, priority=0,dl_dst=00:00:00:00:00:06 actions=output:"s1-eth6"
```

2. **Ans** Network_Topo.py

Network_Topo.py 5

HomeWork > Network_Topo.py > SingleSwitchTopo > build

```python
#!/usr/bin/python


from mininet.topo import Topo
from mininet.net import Mininet
from mininet.log import setLogLevel
from mininet.cli import CLI
from mininet.node import OVSSwitch, Controller, RemoteController

class SingleSwitchTopo(Topo):
    def build(self):
        s1 = self.addSwitch('s1')
        s2 = self.addSwitch('s2')
        s3 = self.addSwitch('s3')
        s4 = self.addSwitch('s4')
        h1 = self.addHost('h1', mac="00:00:00:00:00:01", ip="192.168.1.1/24")
        h2 = self.addHost('h2', mac="00:00:00:00:00:02", ip="192.168.1.2/24")
        h3 = self.addHost('h3', mac="00:00:00:00:00:03", ip="192.168.1.3/24")
        h4 = self.addHost('h4', mac="00:00:00:00:00:04", ip="192.168.1.4/24")
        h5 = self.addHost('h5', mac="00:00:00:00:00:05", ip="192.168.1.5/24")
        h6 = self.addHost('h6', mac="00:00:00:00:00:06", ip="192.168.1.6/24")
        h7 = self.addHost('h7', mac="00:00:00:00:00:07", ip="192.168.1.7/24")
        h8 = self.addHost('h8', mac="00:00:00:00:00:08", ip="192.168.1.8/24")
        h9 = self.addHost('h9', mac="00:00:00:00:00:09", ip="192.168.1.9/24")


        self.addLink(h1, s2)    # h1 ต่อกับ s2
        self.addLink(h2, s2)
        self.addLink(h3, s2)
        self.addLink(h4, s3)
        self.addLink(h5, s3)
        self.addLink(h6, s3)
        self.addLink(h7, s4)
        self.addLink(h8, s4)
        self.addLink(h9, s4)

        self.addLink(s1, s2)
        self.addLink(s1, s3)
        self.addLink(s1, s4)
        self.addLink(s2, s3)
        self.addLink(s3, s4)


if __name__ == '__main__':
    setLogLevel('info')
    topo = SingleSwitchTopo()
    c1 = RemoteController('c1', ip='127.0.0.1')
    net = Mininet(topo=topo, controller=c1)
    net.start()
    net.pingAll()
    CLI(net)
    net.stop()

```

```
test@test:~/Desktop/SDN_Network/HomeWork$ sudo python3 Network_Topo.py
Unable to contact the remote controller at 127.0.0.1:6653
Unable to contact the remote controller at 127.0.0.1:6633
Setting remote controller to 127.0.0.1:6653
*** Creating network
*** Adding controller
*** Adding hosts:
h1 h2 h3 h4 h5 h6 h7 h8 h9
*** Adding switches:
s1 s2 s3 s4
*** Adding links:
(h1, s2) (h2, s2) (h3, s2) (h4, s3) (h5, s3) (h6, s3) (h7, s4) (h8, s4) (h9, s4) (s1, s2) (s1
, s3) (s1, s4) (s2, s3) (s3, s4)
*** Configuring hosts
h1 h2 h3 h4 h5 h6 h7 h8 h9
*** Starting controller
c1
*** Starting 4 switches
s1 s2 s3 s4 ...
*** Ping: testing ping reachability
```

```
mininet> links
h1-eth0<->s2-eth1 (OK OK)
h2-eth0<->s2-eth2 (OK OK)
h3-eth0<->s2-eth3 (OK OK)
h4-eth0<->s3-eth1 (OK OK)
h5-eth0<->s3-eth2 (OK OK)
h6-eth0<->s3-eth3 (OK OK)
h7-eth0<->s4-eth1 (OK OK)
h8-eth0<->s4-eth2 (OK OK)
h9-eth0<->s4-eth3 (OK OK)
s1-eth1<->s2-eth4 (OK OK)
s1-eth2<->s3-eth4 (OK OK)
s1-eth3<->s4-eth4 (OK OK)
s2-eth5<->s3-eth5 (OK OK)
s3-eth6<->s4-eth5 (OK OK)
mininet>
```

```
mininet> nodes
available nodes are:
c1 h1 h2 h3 h4 h5 h6 h7 h8 h9 s1 s2 s3 s4
mininet>
```

```
mininet> net
h1 h1-eth0:s2-eth1
h2 h2-eth0:s2-eth2
h3 h3-eth0:s2-eth3
h4 h4-eth0:s3-eth1
h5 h5-eth0:s3-eth2
h6 h6-eth0:s3-eth3
h7 h7-eth0:s4-eth1
h8 h8-eth0:s4-eth2
h9 h9-eth0:s4-eth3
s1 lo:  s1-eth1:s2-eth4 s1-eth2:s3-eth4 s1-eth3:s4-eth4
s2 lo:  s2-eth1:h1-eth0 s2-eth2:h2-eth0 s2-eth3:h3-eth0 s2-eth4:s1-eth1 s2-eth5:s3-eth5
s3 lo:  s3-eth1:h4-eth0 s3-eth2:h5-eth0 s3-eth3:h6-eth0 s3-eth4:s1-eth2 s3-eth5:s2-eth5 s3-et
h6:s4-eth5
s4 lo:  s4-eth1:h7-eth0 s4-eth2:h8-eth0 s4-eth3:h9-eth0 s4-eth4:s1-eth3 s4-eth5:s3-eth6
c1
mininet>
```