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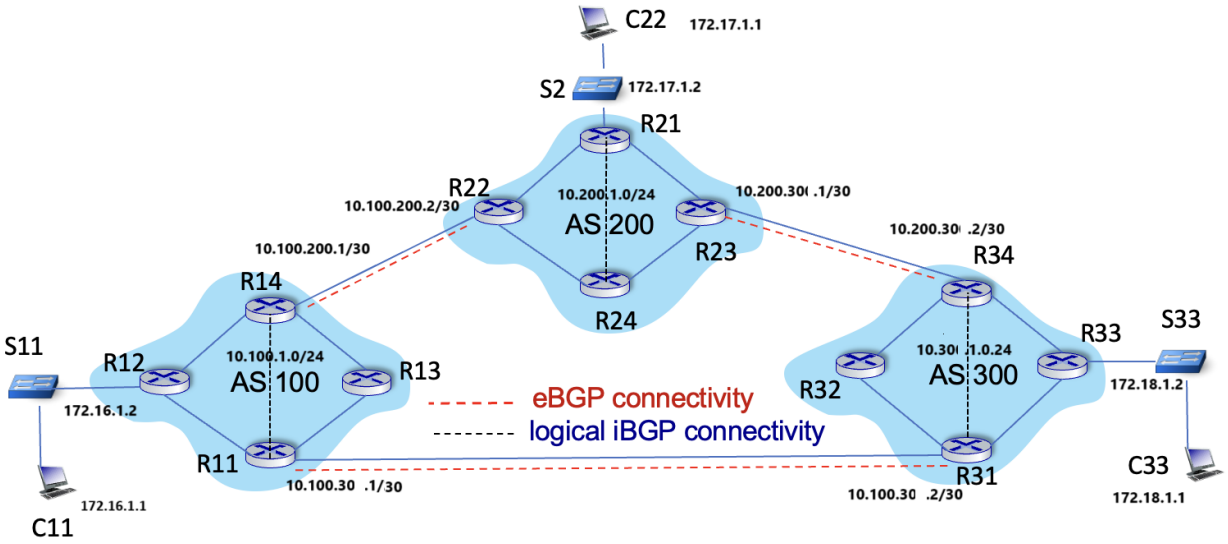
TUGAS 4 JARKOMLAN : iBGP dan eBGP



Topologi yang harus diwujudkan terlebih dahulu dalam lingkungan Mininet adalah dengan topologi pada gambar berikut dengan pendefinisian routing sebagai berikut:

e-BGP antara R14 - R22, R23 - R34, sedangkan router lainnya pada masing-masing AS menggunakan iBGP dan OSPF. Pendefinisian AS adalah sebagai berikut:

AS 100
- R11, R12, R13, R14

AS 200
- R21, R22, R23, R24

AS 300

- R31, R32, R33, R34

Kode program yang sudah ada yaitu ospf-lab.py dimodifikasi untuk mengikuti topologi yang diberikan . Modifikasinya adalah sebagai berikut:

frr.conf

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```
                C11 = self.addHost('C11', ip="172.16.1.2/24", defaultRoute="via 172.16.1.1")
                C21 = self.addHost('C21', ip="172.17.1.2/24", defaultRoute="via 172.17.1.1")
                C31 = self.addHost('C31', ip="172.18.1.2/24", defaultRoute="via 172.18.1.1")

                S11 = self.addSwitch("S11", inNamespace=True)
                S21 = self.addSwitch("S21", inNamespace=True)
                S31 = self.addSwitch("S31", inNamespace=True)

                R11  =  self.addNode("R11",  cls=LinuxRouter,  ip=None,  privateDirs=privateDirs,
inNamespace=True)
                R12  =  self.addNode("R12",  cls=LinuxRouter,  ip=None,  privateDirs=privateDirs,
inNamespace=True)
                R13  =  self.addNode("R13",  cls=LinuxRouter,  ip=None,  privateDirs=privateDirs,
inNamespace=True)
                R14  =  self.addNode("R14",  cls=LinuxRouter,  ip=None,  privateDirs=privateDirs,
inNamespace=True)

                R21  =  self.addNode("R21",  cls=LinuxRouter,  ip=None,  privateDirs=privateDirs,
inNamespace=True)
                R22  =  self.addNode("R22",  cls=LinuxRouter,  ip=None,  privateDirs=privateDirs,
inNamespace=True)
                R23  =  self.addNode("R23",  cls=LinuxRouter,  ip=None,  privateDirs=privateDirs,
inNamespace=True)
                R24  =  self.addNode("R24",  cls=LinuxRouter,  ip=None,  privateDirs=privateDirs,
inNamespace=True)

                R31  =  self.addNode("R31",  cls=LinuxRouter,  ip=None,  privateDirs=privateDirs,
inNamespace=True)
                R32  =  self.addNode("R32",  cls=LinuxRouter,  ip=None,  privateDirs=privateDirs,
inNamespace=True)
                R33  =  self.addNode("R33",  cls=LinuxRouter,  ip=None,  privateDirs=privateDirs,
inNamespace=True)
                R34  =  self.addNode("R34",  cls=LinuxRouter,  ip=None,  privateDirs=privateDirs,
inNamespace=True)

                # Subnet 1
                self.addLink(S11, C11)
                self.addLink(S11,  R12, intfName2=”eth0”
                self.addLink(R12, R11, intfName1="eth1", intfName2="eth1")
                self.addLink(R12, R14, intfName1="eth2", intfName2="eth1")
                self.addLink(R13, R14, intfName1="eth0", intfName2="eth2")
                self.addLink(R13, R11, intfName1="eth1", intfName2="eth2")

                # Subnet 2
                self.addLink(S22, C22)
                self.addLink(S22, R21, intfName2=”eth0”)
                self.addLink(R22, R21, intfName1="eth1", intfName2="eth1")
                self.addLink(R22, R24, intfName1="eth2", intfName2="eth1")
                self.addLink(R23, R24, intfName1="eth1", intfName2="eth2")
                self.addLink(R23, R21, intfName1="eth2", intfName2="eth2")

                # Subnet 3
                self.addLink(S33, C33)
                self.addLink(S33, R33, intfName2=”eth0”)
                self.addLink(R32, R31, intfName1="eth1", intfName2="eth1")
                self.addLink(R32, R34, intfName1="eth2", intfName2="eth1")
                self.addLink(R33, R34, intfName1="eth1", intfName2="eth2")
                self.addLink(R33, R31, intfName1="eth2", intfName2="eth2")

                # Backbone routers (inter-subnet links)
                self.addLink(R14, R22, intfName1="eth0", intfName2="eth0")
                self.addLink(R23, R34, intfName1="eth0", intfName2="eth0")
                self.addLink(R11, R31, intfName1="eth0", intfName2="eth0")
```

Setelah dilakukan modifikasi program dijalankan dengan perintah sudo python3 ospf-lab.py
Jika berhasil maka akan ada tampilan seperti Berikut.

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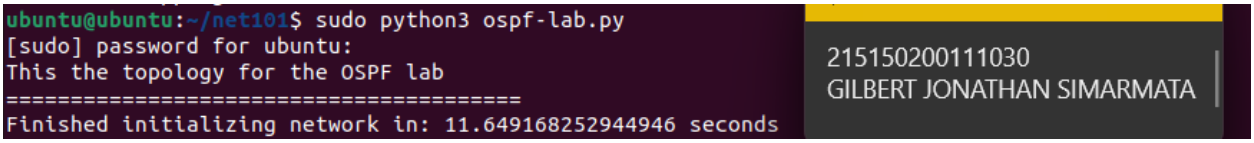

Untuk memasuki Privilege exec mode tiap router dapat menjalankan script
“./connect.sh <router name> vtysh”

Untuk merealisasikan topologi iBGP dan eBGP maka kita akan melakukan konfigurasi terlebih dahulu untuk iBGP dan OSPF didalam as-as yang ada
Berikut Adalah konfigurasi ibgp dan ospf untuk tiap router dan juga ebg untuk menghubungkan antar AS

AS100 :

Router R11

frr.conf

```
frr version 8.5.6
frr defaults traditional
hostname R11
service integrated-vtysh-config
!
interface eth0
 ip address 10.100.30.1/30
exit
!
interface eth1
 ip address 10.100.1.1/24
exit
!
interface eth2
 ip address 10.100.3.1/24
exit
!
interface lo
 ip address 128.100.0.11/32
exit
!
router bgp 100
 bgp router-id 1.1.1.1
 no bgp hard-administrative-reset
 no bgp graceful-restart notification
 neighbor 10.100.1.2 remote-as 100
```

```
 neighbor 10.100.1.2 update-source lo
 neighbor 10.100.3.2 remote-as 100
 neighbor 10.100.3.2 update-source lo
 neighbor 10.100.30.2 remote-as 300
 neighbor 10.100.30.2 update-source lo
 !
 address-family ipv4 unicast
  network 128.100.0.11/32
 exit-address-family
exit
!
router ospf
 ospf router-id 1.1.1.1
 network 10.100.1.0/24 area 1
 network 10.100.3.0/24 area 1
exit
!
```

Router R12

frr.conf

```
frr version 8.5.6
frr defaults traditional
hostname R12
service integrated-vtysh-config
!
ip route 172.16.1.0/24 Null0
!
interface eth0
 ip address 172.16.1.1/24
exit
!
interface eth1
 ip address 10.100.1.2/24
exit
!
interface eth2
 ip address 10.100.2.1/24
exit
!
interface lo
 ip address 128.100.0.12/32
exit
!
router bgp 100
 bgp router-id 1.1.1.2
```

```
 no bgp hard-administrative-reset
 no bgp graceful-restart notification
 neighbor 10.100.1.1 remote-as 100
 neighbor 10.100.1.1 update-source lo
 neighbor 10.100.2.2 remote-as 100
 neighbor 10.100.2.2 update-source lo
 !
 address-family ipv4 unicast
  network 128.100.0.12/32
  network 172.16.1.0/24
 exit-address-family
exit
!
router ospf
 ospf router-id 1.1.1.2
 network 10.100.1.0/24 area 1
 network 10.100.2.0/24 area 1
 network 172.16.1.0/24 area 1
exit
!
```

Router R13

frr.conf

```
frr version 8.5.6
frr defaults traditional
hostname R13
service integrated-vtysh-config
!
ip route 172.16.1.0/24 10.100.3.1
!
interface eth0
 ip address 10.100.4.1/24
exit
!
interface eth1
 ip address 10.100.3.2/24
exit
!
interface lo
 ip address 128.100.0.13/32
exit
!
router bgp 100
 bgp router-id 1.1.1.3
 no bgp ebgp-requires-policy
 no bgp hard-administrative-reset
```

```
 no bgp graceful-restart notification
 neighbor 10.100.3.1 remote-as 100
 neighbor 10.100.3.1 update-source lo
 neighbor 10.100.4.2 remote-as 100
 neighbor 10.100.4.2 update-source lo
 !
 address-family ipv4 unicast
  network 128.100.0.13/32
 exit-address-family
exit
!
router ospf
 ospf router-id 1.1.1.3
 network 10.100.3.0/24 area 1
 network 10.100.4.0/24 area 1
exit
!
```

Router R14

frr.conf

```
frr version 8.5.6
frr defaults traditional
hostname ubuntu
hostname R14
service integrated-vtysh-config
!
ip route 172.16.1.0/24 Null0
!
interface eth0
 ip address 10.100.200.1/30
exit
!
interface eth1
 ip address 10.100.2.2/24
exit
!
interface eth2
 ip address 10.100.4.2/24
exit
!
interface lo
 ip address 128.100.0.14/32
exit
!
router bgp 100
 bgp router-id 1.1.1.1
```

```
 no bgp ebgp-requires-policy
 no bgp hard-administrative-reset
 no bgp graceful-restart notification
 neighbor 10.100.2.1 remote-as 100
 neighbor 10.100.2.1 update-source lo
 neighbor 10.100.4.1 remote-as 100
 neighbor 10.100.4.1 update-source lo
 neighbor 10.100.200.2 remote-as 200
 neighbor 10.100.200.2 update-source lo
 !
 address-family ipv4 unicast
  network 10.100.200.0/30
  network 128.100.0.14/32
  network 172.16.1.0/24
  neighbor 10.100.200.2 next-hop-self
 exit-address-family
exit
!
router ospf
 ospf router-id 1.1.1.4
 network 10.100.1.0/24 area 1
 network 10.100.4.0/24 area 1
 network 128.100.0.14/32 area 1
exit
!
```

AS 200

Router R21

frr.conf

```
frr version 8.5.6
frr defaults traditional
hostname ubuntu
hostname R21
service integrated-vtysh-config
!
interface eth0
 ip address 172.17.1.1/24
exit
!
interface eth1
 ip address 10.200.1.1/24
exit
!
interface eth2
 ip address 10.200.3.1/24
```

```
exit
!
interface lo
 ip address 128.200.0.21/32
exit
!
router bgp 200
 bgp router-id 2.2.2.1
 no bgp ebgp-requires-policy
 no bgp hard-administrative-reset
 no bgp graceful-restart notification
 neighbor 10.200.1.2 remote-as 200
 neighbor 10.200.1.2 update-source lo
 neighbor 10.200.3.2 remote-as 200
 neighbor 10.200.3.2 update-source lo
 !
 address-family ipv4 unicast
  network 128.200.0.21/32
  network 172.17.1.0/24
 exit-address-family
exit
!
router ospf
 ospf router-id 2.2.2.1
 network 10.200.1.0/24 area 2
 network 10.200.3.0/24 area 2
 network 128.200.0.21/32 area 2
 network 172.17.1.0/24 area 2
exit
!
```

Router R22

frr.conf

```
frr version 8.5.6
frr defaults traditional
hostname ubuntu
hostname R22
service integrated-vtysh-config
!
ip route 172.17.1.0/24 Null0
!
interface eth0
 ip address 10.100.200.2/30
exit
!
```

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```
interface eth1
 ip address 10.200.1.2/24
exit
!
interface eth2
 ip address 10.200.2.1/24
exit
!
interface lo
 ip address 128.200.0.22/32
exit
!
router bgp 200
 bgp router-id 2.2.2.2
 no bgp hard-administrative-reset
 no bgp graceful-restart notification
 neighbor 10.100.200.1 remote-as 100
 neighbor 10.100.200.1 update-source lo
 neighbor 10.200.1.1 remote-as 200
 neighbor 10.200.1.1 update-source lo
 neighbor 10.200.2.2 remote-as 200
 neighbor 10.200.2.2 update-source lo
 !
 address-family ipv4 unicast
  network 10.100.200.0/30
  network 128.200.0.22/32
  network 172.17.1.0/24
  neighbor 10.100.200.1 next-hop-self
 exit-address-family
exit
!
router ospf
 ospf router-id 2.2.2.2
 network 10.200.1.0/24 area 2
 network 10.200.2.0/24 area 2
 network 128.200.0.22/32 area 2
exit
!
```

Router R23

frr.conf

```
frr version 8.5.6
frr defaults traditional
hostname ubuntu
hostname R23
service integrated-vtysh-config
```

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```
!
interface eth0
 ip address 10.200.30.1/30
exit
!
interface eth1
 ip address 10.200.4.1/24
exit
!
interface eth2
 ip address 10.200.3.2/24
exit
!
interface lo
 ip address 128.200.0.23/32
exit
!
router bgp 200
 bgp router-id 2.2.2.3
 no bgp ebgp-requires-policy
 no bgp hard-administrative-reset
 no bgp graceful-restart notification
 neighbor 10.200.3.1 remote-as 200
 neighbor 10.200.3.1 update-source lo
 neighbor 10.200.4.2 remote-as 200
 neighbor 10.200.4.2 update-source lo
 neighbor 10.200.30.2 remote-as 300
 neighbor 10.200.30.2 update-source lo
 !
 address-family ipv4 unicast
  network 128.200.0.23/32
 exit-address-family
exit
!
router ospf
 ospf router-id 2.2.2.3
 network 10.200.3.0/24 area 2
 network 10.200.4.0/24 area 2
 network 128.200.0.23/32 area 2
exit
!
```

Router R24

frr.conf

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```
frr version 8.5.6
frr defaults traditional
hostname ubuntu
hostname R24
service integrated-vtysh-config
!
interface eth1
 ip address 10.200.2.2/24
exit
!
interface eth2
 ip address 10.200.4.2/24
exit
!
interface lo
 ip address 128.100.0.24/32
exit
!
router bgp 200
 bgp router-id 2.2.2.4
 no bgp ebgp-requires-policy
 no bgp hard-administrative-reset
 no bgp graceful-restart notification
 neighbor 10.200.2.1 remote-as 200
 neighbor 10.200.2.1 update-source lo
 neighbor 10.200.4.1 remote-as 200
 neighbor 10.200.4.1 update-source lo
 !
 address-family ipv4 unicast
  network 128.200.0.24/32
 exit-address-family
exit
!
router ospf
 ospf router-id 2.2.2.4
 network 10.200.2.0/24 area 2
 network 10.200.4.0/24 area 2
exit
!
```

AS 300

Router R31

frr.conf

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```
frr version 8.5.6
frr defaults traditional
hostname ubuntu
hostname R31
service integrated-vtysh-config
!
interface eth0
 ip address 10.100.30.2/30
exit
!
interface eth1
 ip address 10.30.1.1/24
exit
!
interface eth2
 ip address 10.30.3.1/24
exit
!
interface lo
 ip address 128.30.0.31/32
exit
!
router bgp 300
 bgp router-id 3.3.3.1
 no bgp hard-administrative-reset
 no bgp graceful-restart notification
 neighbor 10.30.1.2 remote-as 300
 neighbor 10.30.1.2 update-source lo
 neighbor 10.30.3.2 remote-as 300
 neighbor 10.30.3.2 update-source lo
 neighbor 10.100.30.1 remote-as 100
 neighbor 10.100.30.1 update-source lo
 !
 address-family ipv4 unicast
  network 128.30.0.31/32
 exit-address-family
exit
!
router ospf
 ospf router-id 3.3.3.1
 network 10.30.1.0/24 area 3
 network 10.30.3.0/24 area 3
exit
!
```

Router R32

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frr.conf

```
frr version 8.5.6
frr defaults traditional
hostname ubuntu
hostname R32
service integrated-vtysh-config
!
interface eth1
 ip address 10.30.1.2/24
exit
!
interface eth2
 ip address 10.30.2.1/24
exit
!
interface lo
 ip address 128.20.0.32/32
exit
!
router bgp 300
 bgp router-id 3.3.3.2
 no bgp hard-administrative-reset
 no bgp graceful-restart notification
 neighbor 10.30.1.1 remote-as 300
 neighbor 10.30.1.1 update-source lo
 !
 address-family ipv4 unicast
  network 128.200.0.32/32
 exit-address-family
exit
!
router ospf
 ospf router-id 3.3.3.2
 network 10.30.1.0/24 area 3
 network 10.30.2.0/24 area 3
exit
!
```

Router R33

frr.conf

```
frr version 8.5.6
frr defaults traditional
hostname ubuntu
hostname R33
```

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```
service integrated-vtysh-config
!
interface eth0
 ip address 172.18.1.1/24
exit
!
interface eth1
 ip address 10.30.4.1/24
exit
!
interface eth2
 ip address 10.30.3.2/24
exit
!
interface lo
 ip address 128.30.0.33/32
exit
!
router bgp 300
 bgp router-id 3.3.3.3
 no bgp hard-administrative-reset
 no bgp graceful-restart notification
 neighbor 10.30.3.1 remote-as 300
 neighbor 10.30.3.1 update-source lo
 neighbor 10.30.4.2 remote-as 300
 neighbor 10.30.4.2 update-source lo
 !
 address-family ipv4 unicast
  network 128.30.0.33/32
 exit-address-family
exit
!
router ospf
 ospf router-id 3.3.3.3
 network 10.30.3.0/24 area 3
 network 10.30.4.0/24 area 3
 network 172.18.1.0/24 area 3
exit
!
```

Router R34

frr.conf

```
frr version 8.5.6
frr defaults traditional
hostname ubuntu
```

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```
hostname R34
service integrated-vtysh-config
!
interface eth0
 ip address 10.200.30.2/30
exit
!
interface eth1
 ip address 10.30.2.2/24
exit
!
interface eth2
 ip address 10.30.4.2/24
exit
!
interface lo
 ip address 128.30.0.34/32
exit
!
router bgp 300
 bgp router-id 3.3.3.4
 no bgp hard-administrative-reset
 no bgp graceful-restart notification
 neighbor 10.30.2.1 remote-as 300
 neighbor 10.30.2.1 update-source lo
 neighbor 10.30.4.1 remote-as 300
 neighbor 10.30.4.1 update-source lo
 neighbor 10.200.30.1 remote-as 100
 neighbor 10.200.30.1 update-source lo
 !
 address-family ipv4 unicast
  network 128.30.0.34/32
 exit-address-family
exit
!
router ospf
 ospf router-id 3.3.3.4
 network 10.30.2.0/24 area 3
 network 10.30.4.0/24 area 3
exit
!
```

Setelah konfigurasi dilakukan, selanjutnya melakukan tes koneksi antar router dalam AS untuk melakukan tes konektivitas pada iBGP

C11 > R11

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```
mininet> C11 ping R11
PING 10.100.1.1 (10.100.1.1) 56(84) bytes of data.
64 bytes from 10.100.1.1: icmp_seq=1 ttl=63 time=0.049 ms
64 bytes from 10.100.1.1: icmp_seq=2 ttl=63 time=0.255 ms
64 bytes from 10.100.1.1: icmp_seq=3 ttl=63 time=0.045 ms
64 bytes from 10.100.1.1: icmp_seq=4 ttl=63 time=0.046 ms
64 bytes from 10.100.1.1: icmp_seq=5 ttl=63 time=0.043 ms
^C
--- 10.100.1.1 ping statistics ---
5 packets transmitted, 5 received, 0% packet loss, time 4135ms
rtt min/avg/max/mdev = 0.043/0.087/0.255/0.083 ms
```

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C11 > R12

```
mininet> C11 ping R12 -c 5
PING 172.16.1.1 (172.16.1.1) 56(84) bytes of data.
64 bytes from 172.16.1.1: icmp_seq=1 ttl=64 time=0.449 ms
64 bytes from 172.16.1.1: icmp_seq=2 ttl=64 time=0.028 ms
64 bytes from 172.16.1.1: icmp_seq=3 ttl=64 time=0.040 ms
64 bytes from 172.16.1.1: icmp_seq=4 ttl=64 time=0.035 ms
64 bytes from 172.16.1.1: icmp_seq=5 ttl=64 time=0.039 ms

--- 172.16.1.1 ping statistics ---
5 packets transmitted, 5 received, 0% packet loss, time 4083ms
rtt min/avg/max/mdev = 0.028/0.118/0.449/0.165 ms
```

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R13 > C13

```
mininet> R13 ping C11 -c 5
PING 172.16.1.2 (172.16.1.2) 56(84) bytes of data.
64 bytes from 172.16.1.2: icmp_seq=1 ttl=62 time=0.099 ms
64 bytes from 172.16.1.2: icmp_seq=2 ttl=62 time=0.057 ms
64 bytes from 172.16.1.2: icmp_seq=3 ttl=62 time=0.072 ms
64 bytes from 172.16.1.2: icmp_seq=4 ttl=62 time=0.050 ms
64 bytes from 172.16.1.2: icmp_seq=5 ttl=62 time=0.050 ms

--- 172.16.1.2 ping statistics ---
5 packets transmitted, 5 received, 0% packet loss, time 4103ms
rtt min/avg/max/mdev = 0.050/0.065/0.099/0.018 ms
```

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R14 > R11

```
mininet> R14 ping R11 -c 5
PING 10.100.1.1 (10.100.1.1) 56(84) bytes of data.
64 bytes from 10.100.1.1: icmp_seq=1 ttl=63 time=0.061 ms
64 bytes from 10.100.1.1: icmp_seq=2 ttl=63 time=0.039 ms
64 bytes from 10.100.1.1: icmp_seq=3 ttl=63 time=0.042 ms
64 bytes from 10.100.1.1: icmp_seq=4 ttl=63 time=0.041 ms
64 bytes from 10.100.1.1: icmp_seq=5 ttl=63 time=0.040 ms

--- 10.100.1.1 ping statistics ---
5 packets transmitted, 5 received, 0% packet loss, time 4086ms
rtt min/avg/max/mdev = 0.039/0.044/0.061/0.008 ms
```

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C21 > R21

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```
mininet> C21 ping R21 -c 5
PING 172.17.1.1 (172.17.1.1) 56(84) bytes of data.
64 bytes from 172.17.1.1: icmp_seq=1 ttl=64 time=0.223 ms
64 bytes from 172.17.1.1: icmp_seq=2 ttl=64 time=0.038 ms
64 bytes from 172.17.1.1: icmp_seq=3 ttl=64 time=0.035 ms
64 bytes from 172.17.1.1: icmp_seq=4 ttl=64 time=0.036 ms
64 bytes from 172.17.1.1: icmp_seq=5 ttl=64 time=0.038 ms
```

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C21 > R23

```
mininet> C21 ping R23 -c 5
PING 10.200.4.1 (10.200.4.1) 56(84) bytes of data.
64 bytes from 10.200.4.1: icmp_seq=1 ttl=63 time=0.051 ms
64 bytes from 10.200.4.1: icmp_seq=2 ttl=63 time=0.063 ms
64 bytes from 10.200.4.1: icmp_seq=3 ttl=63 time=0.044 ms
64 bytes from 10.200.4.1: icmp_seq=4 ttl=63 time=0.045 ms
64 bytes from 10.200.4.1: icmp_seq=5 ttl=63 time=0.184 ms

--- 10.200.4.1 ping statistics ---
5 packets transmitted, 5 received, 0% packet loss, time 4129ms
rtt min/avg/max/mdev = 0.044/0.077/0.184/0.053 ms
```

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R23 > C21

```
mininet> R23 ping C21 -c 5
PING 172.17.1.2 (172.17.1.2) 56(84) bytes of data.
64 bytes from 172.17.1.2: icmp_seq=1 ttl=63 time=0.048 ms
64 bytes from 172.17.1.2: icmp_seq=2 ttl=63 time=0.042 ms
64 bytes from 172.17.1.2: icmp_seq=3 ttl=63 time=0.208 ms
64 bytes from 172.17.1.2: icmp_seq=4 ttl=63 time=0.045 ms
64 bytes from 172.17.1.2: icmp_seq=5 ttl=63 time=0.044 ms

--- 172.17.1.2 ping statistics ---
5 packets transmitted, 5 received, 0% packet loss, time 4084ms
rtt min/avg/max/mdev = 0.042/0.077/0.208/0.065 ms
```

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R23 > R21

```
mininet> R23 ping R21 -c 5
PING 172.17.1.1 (172.17.1.1) 56(84) bytes of data.
64 bytes from 172.17.1.1: icmp_seq=1 ttl=64 time=0.052 ms
64 bytes from 172.17.1.1: icmp_seq=2 ttl=64 time=0.031 ms
64 bytes from 172.17.1.1: icmp_seq=3 ttl=64 time=0.022 ms
64 bytes from 172.17.1.1: icmp_seq=4 ttl=64 time=0.030 ms
64 bytes from 172.17.1.1: icmp_seq=5 ttl=64 time=0.034 ms

--- 172.17.1.1 ping statistics ---
5 packets transmitted, 5 received, 0% packet loss, time 4122ms
rtt min/avg/max/mdev = 0.022/0.033/0.052/0.009 ms
```

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C31 > R31

```
mininet> C31 ping R31 -c 5
PING 10.30.1.1 (10.30.1.1) 56(84) bytes of data.
64 bytes from 10.30.1.1: icmp_seq=1 ttl=63 time=0.049 ms
64 bytes from 10.30.1.1: icmp_seq=2 ttl=63 time=0.039 ms
64 bytes from 10.30.1.1: icmp_seq=3 ttl=63 time=0.048 ms
64 bytes from 10.30.1.1: icmp_seq=4 ttl=63 time=0.046 ms
64 bytes from 10.30.1.1: icmp_seq=5 ttl=63 time=0.054 ms

--- 10.30.1.1 ping statistics ---
5 packets transmitted, 5 received, 0% packet loss, time 4130ms
rtt min/avg/max/mdev = 0.039/0.047/0.054/0.004 ms
```

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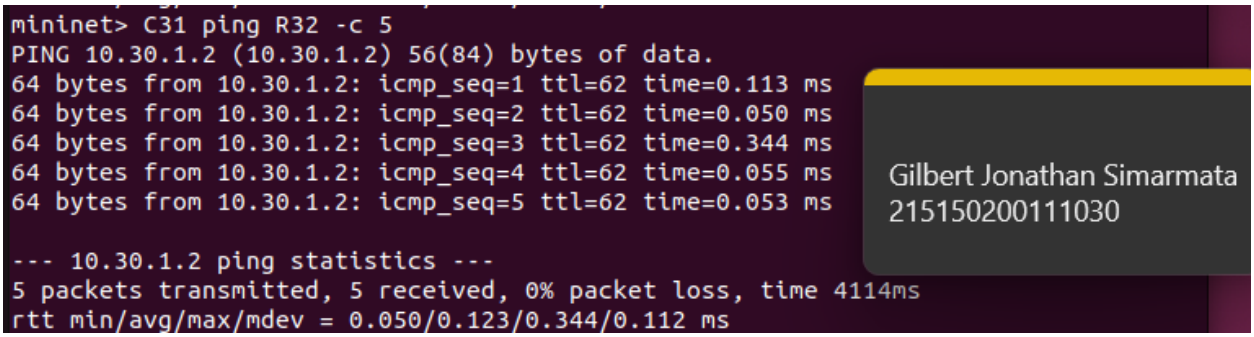
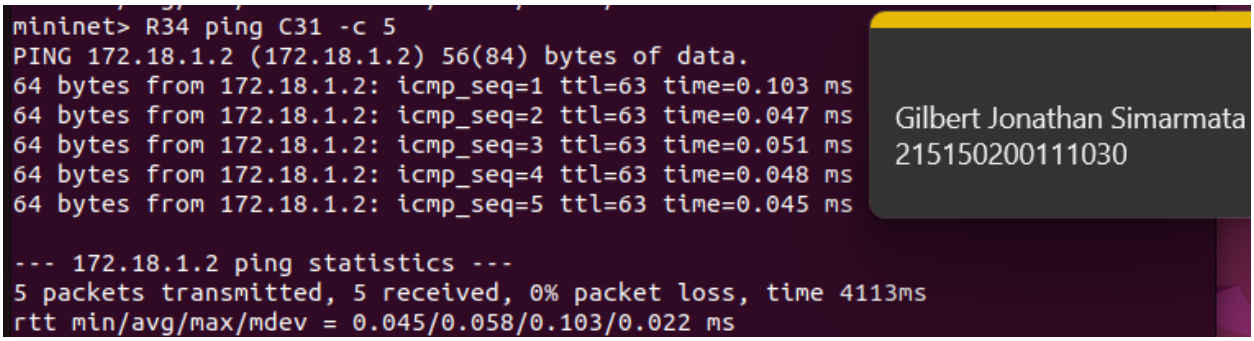
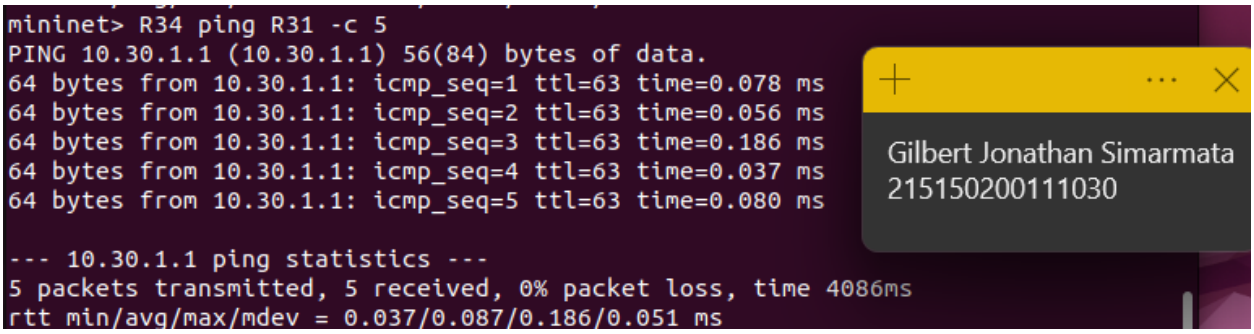
C31 > R32



R34 > C31



R34 > R31



Setelah itu melakukan tes koneksi antar AS dengan melakukan tes konektivitas untuk eBGP

C11 > C21
C21 > R11
R11 > C31
R21 > R31

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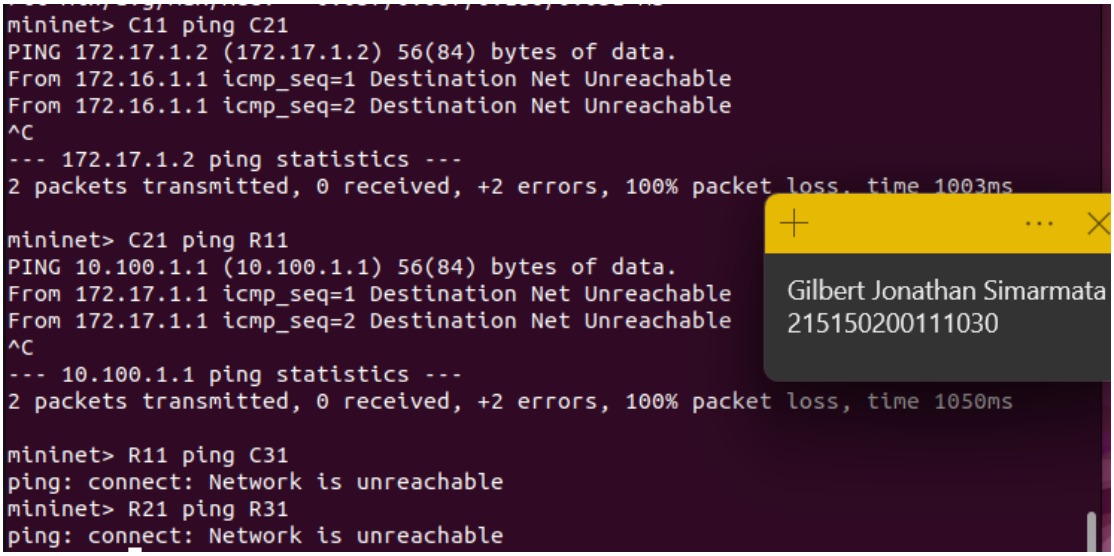
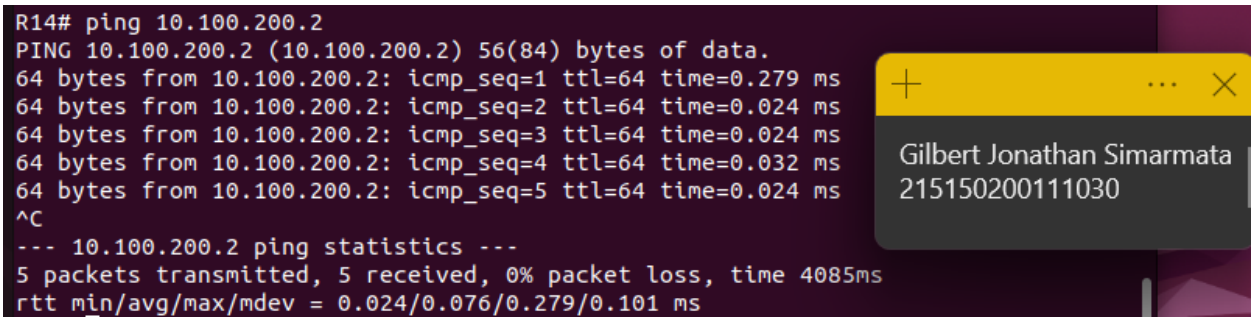


R14 > R22



Ping dapat dilakukan tetapi tidak dapat melalui CLI mininet

Kesimpulan dari tugas ini adalah untuk membangun topologi jaringan yang melibatkan implementasi **iBGP (Internal BGP)** dan **eBGP (External BGP)** pada beberapa router yang terhubung dalam jaringan dengan menggunakan **Mininet**. Topologi ini terdiri dari tiga Autonomous Systems (AS): AS 100, AS 200, dan AS 300, dengan beberapa router yang saling berinteraksi melalui BGP dan OSPF.
Berikut adalah poin-poin penting yang bisa disimpulkan:

1. **Topologi Jaringan**: Tugas ini mengharuskan pembuatan topologi dengan 3 AS yang saling terhubung. AS 100, AS 200, dan AS 300 memiliki router-router yang saling berhubungan menggunakan iBGP dalam satu AS dan eBGP untuk menghubungkan antar AS.
2. **Konfigurasi BGP**:
    - **iBGP** digunakan untuk komunikasi antar router dalam satu AS. Setiap router di dalam AS yang sama saling terkoneksi menggunakan BGP.
    - **eBGP** digunakan untuk komunikasi antar AS yang berbeda. Router yang berada di border AS, seperti R14 dan R22 (antar AS 100 dan AS 200), R23 dan R34 (antar AS 200 dan AS 300), seharusnya saling berkomunikasi menggunakan eBGP.

- Namun, routing **eBGP tidak dapat dijalankan secara penuh dalam simulasi ini karena terdapat kesalahan konfigurasi**. Meski demikian, prinsip dasar dan konfigurasi eBGP tetap relevan untuk pengembangan jaringan lintas-AS.

3. **OSPF**: Setiap router di dalam AS menggunakan **OSPF** (Open Shortest Path First) untuk menentukan rute terbaik ke jaringan yang berada dalam area yang sama.
4. **Modifikasi Program**: Pada tugas ini, modifikasi dilakukan pada skrip Mininet (ospf-lab.py) untuk menciptakan topologi sesuai dengan gambar yang diberikan. Router-router ditambahkan dengan interface yang sesuai dan dihubungkan dengan menggunakan **BGP** dan **OSPF** untuk memastikan komunikasi antar router berjalan dengan baik.
5. **Konfigurasi Router**:
   - Setiap router dalam AS dikonfigurasi dengan IP address dan BGP settings sesuai dengan skema jaringan yang diberikan.
   - Router yang terhubung dengan antar AS menggunakan eBGP, sedangkan router di dalam AS menggunakan iBGP.
   - Konfigurasi OSPF digunakan untuk menghubungkan jaringan dalam area yang sama.
6. **Pelaksanaan dan Uji Coba**: Setelah melakukan modifikasi pada konfigurasi router dan topologi jaringan, pengguna diminta untuk menjalankan skrip Mininet dan memverifikasi koneksi antar router dengan menggunakan command vtysh untuk masuk ke privilege exec mode dan melakukan pengecekan konfigurasi BGP dan OSPF. Namun, komunikasi eBGP tidak berhasil dijalankan sepenuhnya karena ada kesalahan dalam konfigurasi.

Secara keseluruhan, tugas ini bertujuan untuk memahami dan mengimplementasikan BGP, baik itu iBGP maupun eBGP, serta OSPF dalam topologi jaringan yang terdiri dari beberapa AS. Penggunaan Mininet untuk simulasi jaringan dan FRR (Free Range Routing) sebagai perangkat lunak routing sangat membantu dalam memahami cara kerja protokol-protokol tersebut dalam skala yang lebih besar, meskipun implementasi eBGP perlu diperbaiki untuk mencapai hasil yang diinginkan.