# WORKSHOP FULL LAB

## CISCO SWITCHING & ROUTING

Untuk pemula yang ingin menjadi Network Engineer.

Penulis

**SUKMA WIJAYA**

# Kata Pengantar

**Alhamdulillah**, setelah sekian lama berlalu akhirnya Buku Panduan LAB CISCO – CPT ini dapat penulis selesaikan dengan baik. Buku Penulis buat dari rangkuman materi CCNA : Introduction to Nework(ITN), Switch Router Wireless(SRWE) dan Enterprise Networking, Security & Automation(ENSA) yang ada pada CISCO Networking Academy(netacad.com) di bantu juga dengan tools Open AI(ChatGPT).

Tujuan dari penulisan buku ini adalah untuk memudahkan rekan-rekan yang ingin belajar tentang jaringan computer dengan menggunakan perangkat CISCO dan ingin mengikuti ujian sertifikasi CCNA dari CISCO. Pada buku ini rekan-rekan akan mempelajari terkait Basic Configuration pada perangkat CISCO, Switching terdiri dari Spanning-tree Protocol(STP), Vlan, Trunking, VTP, dan Security Switch, serta Routing protocol(static route, dynamic route(RIPv2, EIGRP, OSPF, BGP), DHCP Server, HSRP(Host Standby Routing Protocol), NAT dan Access List. Di akhir Bab buku ini rekan-rekan bisa mencoba Lab Simulasi Jaringan Internet(Super_LAB).

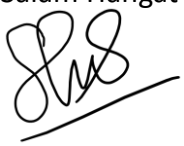
Buku ini Penulis persembahkan untuk ke Dua Orang Tua Penulis dan Istri(Bp. Ramli Rikin, Ibu Siti Iramani dan Bp. Hj. Tadi dan Ibu Hj. Wariah) untuk Istri dan Anak-anak Penulis(Sumroh, Usamah Alfatih, Sumayyah Az-Zahra, Muhammad Kholid Wijaya) atas dukungan nya. Semoga ini bisa jadi amal jariyah buat mereka semua. Aamiin.

Penulis ucapkan terima kasih banyak kepada para Mentor : Bang Ali Warman(Hendevane Training Partner)pertama kali mengajarkan saya terkait Cisco CCNA, Mas Agus Setiawan(Nixtrain Academy) yang selalu memotivasi dibalik layar, Om Wahyu M.Sun(CEO Smartnetindo.com) atas supportnya untuk selalu berkembang terus sampai di Global, Om Danu Wiyoto(BPN), Pak Dedi Gunawan(IDN), Pak Robi Kasamuddin, Pak Deny Julianto atas sharing dan motivasinya, serta untuk semua rekan-rekan yang tidak bisa Penulis sebutkan satu persatu terima kasih atas supportnya.

**Buku ini Free alias Gratis**, rekan-rekan bisa menyebarluaskan seluas luasnya, tetapi Penulis sangat melarang Buku ini di jual belikan tanpa seijin dari Penulis.

Demikian yang dapat Penulis sampaikan semoga bermanfaat, terima kasih.

Jum’at, 27 Juni 2025
Salam Hangat



Sukma Wijaya

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# Introduction

Cisco adalah sebuah perusahaan teknologi multinasional yang berpusat di San Jose, California, Amerika Serikat. Perusahaan ini bergerak di bidang jaringan, keamanan, kolaborasi, pusat data, dan Internet of Things. Cisco terkenal dengan produk dan layanannya yang mencakup router, switch, perangkat lunak jaringan, peralatan telekomunikasi, dan solusi keamanan. Cisco juga memiliki peran penting dalam pengembangan teknologi jaringan, terutama dalam bidang Internet Protocol (IP).

Beberapa produk CISCO diantaranya :

- Networking : Router, Switch, IP Phone dan Wireless
- Security : Firewall, ISE(Identity Service Engine), SSE(Secure Access), Cisco DUO, XDR, Umbrella, Secure Endpoint, Email Threat Defense, Hypershield, AI Defense.

Untuk belajar perangkat CISCO, CISCO menyediakan platform belajar yaitu : CISCO Networking Academy(netacad.com).

Cisco Networking Academy adalah program pendidikan global yang didirikan oleh Cisco untuk mengajarkan keterampilan jaringan komputer kepada siswa dan mahasiswa di seluruh dunia. Program ini bertujuan untuk mempersiapkan peserta dengan keterampilan yang dibutuhkan di bidang jaringan, termasuk merancang, membangun, dan memelihara jaringan, serta mempersiapkan mereka untuk sertifikasi industri dan peluang kerja.

Selain itu CISCO juga memiliki aplikasi Cisco Packet Tracer yang dimana aplikasi ini dapat memudahkan kita untuk melakukan simulasi jaringan dengan menggunakan perangkat CISCO baik itu router, switch, firewall, wireless, dan end device(PC, Laptop, Server, Printer, IP Phone).

Untuk mendapatkan aplikasi Cisco Packet Tracer, kalian bisa mendownloadnya di netacad.com (https://www.netacad.com/articles/news/download-cisco-packet-tracer) dengan cara register terlebih dahulu ke netacad.com jika belum ada akun disana.

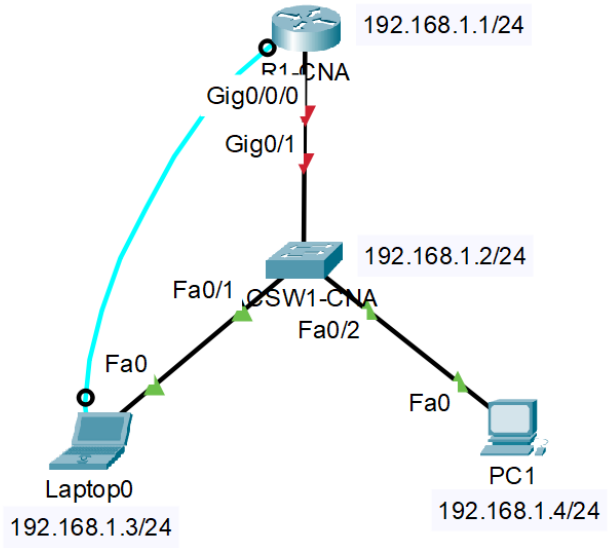

CISCO juga menyediakan program sertifikasi, dimana program ini bertujuan untuk melakukan validasi terkait kompetensi yang dimiliki oleh Network Engineer yang telah mempelajari perangkat CISCO.

Berikut ini Level Sertifikasi yang dikeluarkan oleh CISCO:

- **Entry Level** : CCST IT Support, CCST Networking, CCST Cybersecurity and CCT Field Technician.
- **Associate Level** : CCNA, CCNA Automation, CCNA CyberSecurity.
- **Profesional Level** : CCNP Enterprise, CCNP Service Provider, CCNP Data Center, CCNP Security, CCNP Collaboration, CCNP Automation, CCNP CyberSecurity.
- **Expert Level** : CCIE Enterprise Infrastructure, CCIE Enterprise Wirelless, CCIE Service Provider, CCIE Data Center, CCIE Security, CCIE Collaboration CCIE Automation and CCDE.

# 1. Basic Configuration

Pada Bab ini Kita akan mempelajari terkait cara konfiguarasi perangkat jaringan CISCO.




| Device | Hostname | Interface | IP Address | User/Password | Remote Access |
|---|---|---|---|---|---|
| Router | R1-CNA | Gi0/0/0 | 192.168.1.1/24 | admin/cisco123 | SSH/Telnet |
| Switch | ACSW1-CNA | Vlan 1 | 192.168.1.2/24 | admin/cisco123 | SSH/Telnet |
| Laptop | Laptop | Fa0 | 192.168.1.3/24 | | |
| PC | PC | Fa0 | 192.168.1.4/24 | | |

Dari topologi network diatas, Kita diminta untuk melakukan Basic Configuration pada perangkat Router dan Switch sesuai dengan informasi yang ada pada table terdiri dari Hostname, User Access, IP Address dan Remote Access.

**Router**

```
Router>enable
Router#configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#hostname R1-CNA
R1-CNA(config)#
R1-CNA(config)#enable secret cisco123
R1-CNA(config)#
R1-CNA(config)#username admin privilege 15 secret cisco123
R1-CNA(config)#
R1-CNA(config)#interface gi0/0/0
R1-CNA(config-if)#no shutdown
R1-CNA(config-if)#description To_ACSW1-CAN
R1-CNA(config-if)#ip address 192.168.1.1 255.255.255.0
R1-CNA(config-if)#exit
```

```
R1-CNA(config)#
R1-CNA(config)#ip domain-name cisco.com
R1-CNA(config)#
R1-CNA(config)#ip ssh version 2
Please create RSA keys (of at least 768 bits size) to enable SSH v2.
R1-CNA(config)#
R1-CNA(config)#crypto key generate rsa

The name for the keys will be: R1-CNA.cisco.com
Choose the size of the key modulus in the range of 360 to 4096 for your
General Purpose Keys. Choosing a key modulus greater than 512 may take
a few minutes.

How many bits in the modulus [512]: 1024
% Generating 1024 bit RSA keys, keys will be non-exportable...[OK]

R1-CNA(config)#
*Mar 1 0:23:23.775: %SSH-5-ENABLED: SSH 2 has been enabled
R1-CNA(config)#
R1-CNA(config)#line console 0
R1-CNA(config-line)#login local
R1-CNA(config-line)#exit
R1-CNA(config)#
R1-CNA(config)#line vty 0 4
R1-CNA(config-line)#login local
R1-CNA(config-line)#transport input all
R1-CNA(config-line)#exit
R1-CNA(config)#banner motd $ Authorized Access Only!!!
R1-CNA(config)#exit
R1-CNA#
R1-CNA#copy running-config startup-config

Destination filename [startup-config]?
Building configuration...
[OK]
R1-CNA#
```

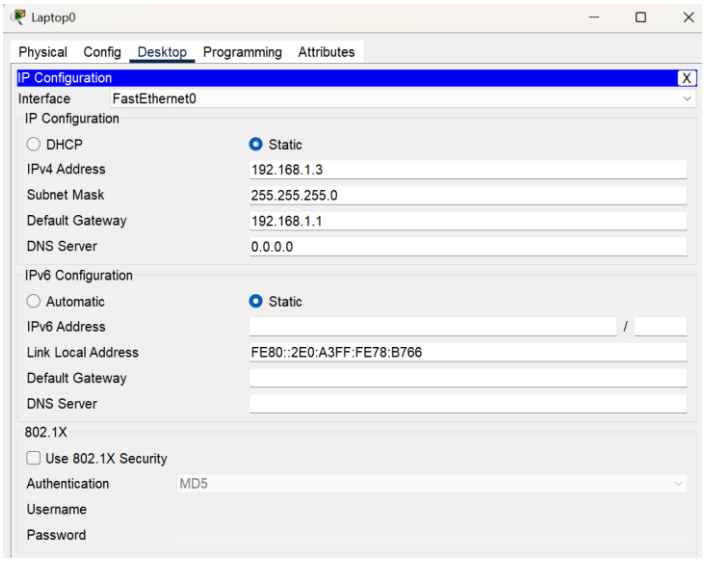
**Switch**

```
Switch>enable
Router#configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
Switch(config)#hostname ACSW1-CNA
ACSW1-CNA(config)#
ACSW1-CNA(config)#enable secret cisco123
ACSW1-CNA(config)#
ACSW1-CNA(config)#username admin privilege 15 secret cisco123
ACSW1-CNA(config)#
```

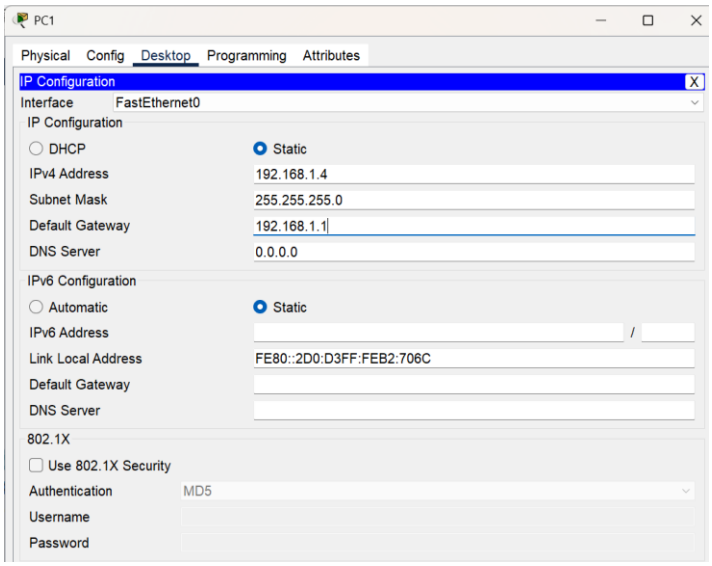
```
ACSW1-CNA(config)#interface vlan 1
ACSW1-CNA(config-if)#no shutdown
%LINK-5-CHANGED: Interface Vlan1, changed state to up
ACSW1-CNA(config-if)#description To_R1-CNA
ACSW1-CNA(config-if)#ip address 192.168.1.2 255.255.255.0
ACSW1-CNA(config-if)#exit
ACSW1-CNA(config)#
ACSW1-CNA(config)#ip domain-name cisco.com
ACSW1-CNA(config)#
ACSW1-CNA(config)#ip ssh version 2
Please create RSA keys (of at least 768 bits size) to enable SSH v2.
ACSW1-CNA(config)#
ACSW1-CNA(config)#crypto key generate rsa
The name for the keys will be: ACSW1-CNA.cisco.com
Choose the size of the key modulus in the range of 360 to 4096 for your
General Purpose Keys. Choosing a key modulus greater than 512 may take
a few minutes.

How many bits in the modulus [512]: 1024
% Generating 1024 bit RSA keys, keys will be non-exportable...[OK]

ACSW1-CNA(config)#
*Mar 1 0:23:23.775: %SSH-5-ENABLED: SSH 2 has been enabled
ACSW1-CNA(config)#
ACSW1-CNA(config)#line console 0
ACSW1-CNA(config-line)#login local
ACSW1-CNA(config-line)#exit
ACSW1-CNA(config)#
ACSW1-CNA(config)#line vty 0 4
ACSW1-CNA(config-line)#login local
ACSW1-CNA(config-line)#transport input all
ACSW1-CNA(config-line)#exit
ACSW1-CNA(config)#banner motd $ Authorized Access Only!!! $
ACSW1-CNA(config)#exit
ACSW1-CNA#
ACSW1-CNA#copy running-config startup-config
Destination filename [startup-config]?
Building configuration...
[OK]
ACSW1-CNA#
```

## Laptop & PC

### Laptop




### PC




## Verifikasi

### Ping Router to Switch and End Device

```
R1-CNA#ping 192.168.1.2

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.1.2, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 0/0/0 ms

R1-CNA#ping 192.168.1.3

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.1.3, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 0/0/1 ms

R1-CNA#
```

## Ping Switch to Router and End Device

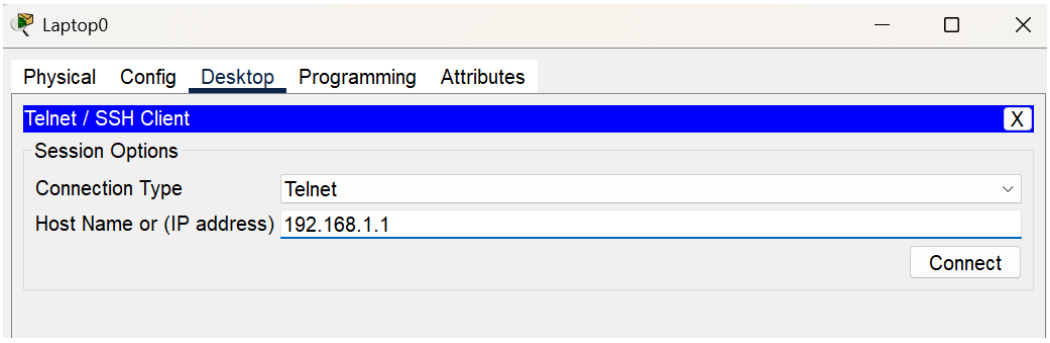
```
ACSW1-CNA#ping 192.168.1.1

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.1.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 0/0/0 ms

ACSW1-CNA#ping 192.168.1.4

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.1.4, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 0/0/0 ms

ACSW1-CNA#
```

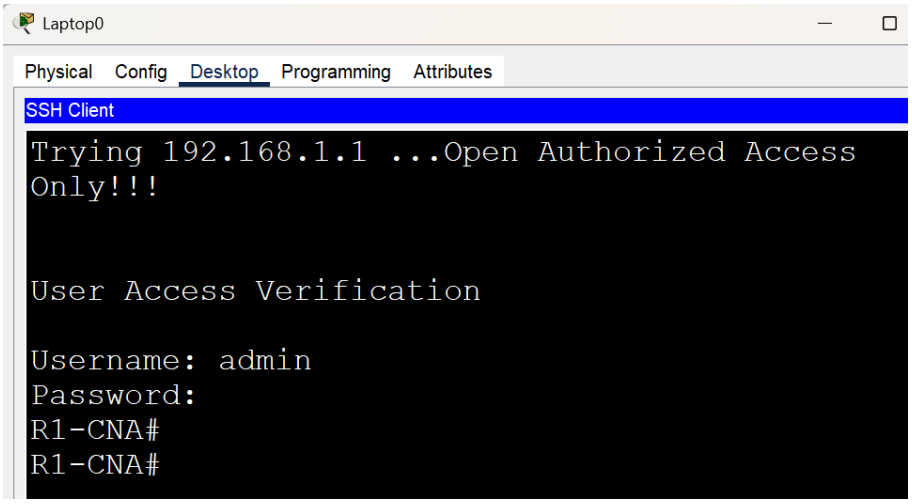
## Ping End Device(laptop/pc) to Router and Switch

```
C:\>ping 192.168.1.1

Pinging 192.168.1.1 with 32 bytes of data:

Reply from 192.168.1.1: bytes=32 time<1ms TTL=255
Reply from 192.168.1.1: bytes=32 time<1ms TTL=255
Reply from 192.168.1.1: bytes=32 time<1ms TTL=255
Reply from 192.168.1.1: bytes=32 time<1ms TTL=255

Ping statistics for 192.168.1.1:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 0ms, Maximum = 0ms, Average = 0ms

C:\>ping 192.168.1.2

Pinging 192.168.1.2 with 32 bytes of data:

Reply from 192.168.1.2: bytes=32 time<1ms TTL=255
Reply from 192.168.1.2: bytes=32 time=1ms TTL=255
Reply from 192.168.1.2: bytes=32 time<1ms TTL=255
Reply from 192.168.1.2: bytes=32 time<1ms TTL=255

Ping statistics for 192.168.1.2:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
```

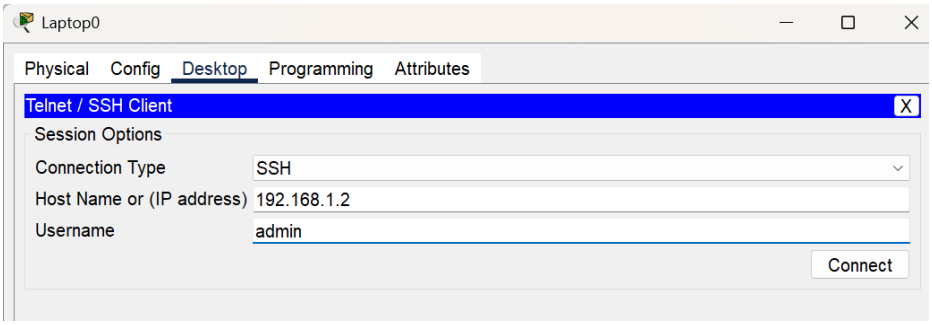
## Remote Access

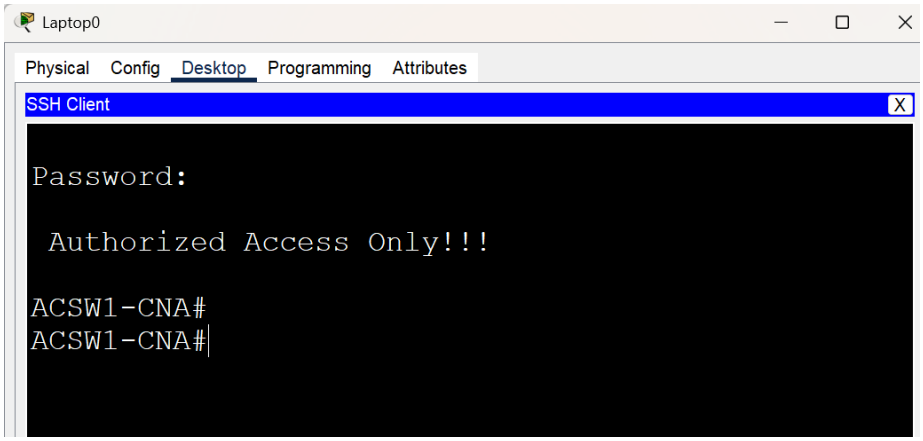
## Telnet End Device to Router/Switch






## SSH End Device to Router/Switch



# 2. Switching

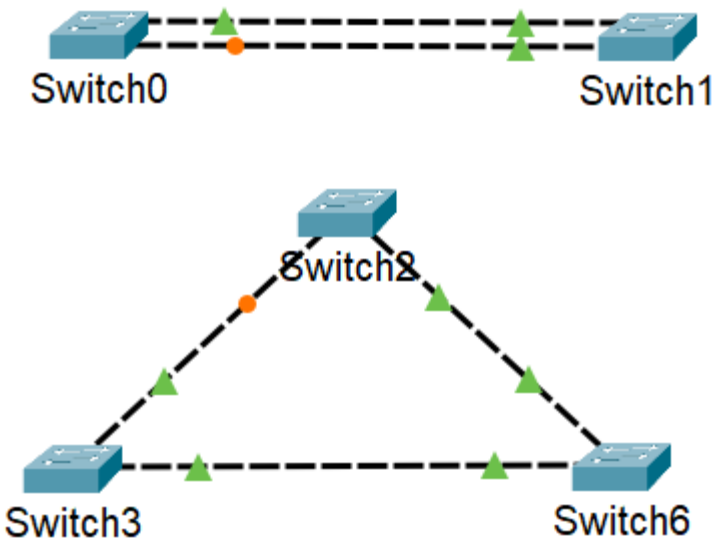
## STP (Spanning Tree Protocol)

**Spanning Tree Protocol (STP)** adalah protokol jaringan layer 2 (Data Link Layer) yang digunakan untuk **mencegah loop** dalam topologi jaringan **yang memiliki jalur redundan**, seperti di jaringan **LAN berbasis switch**..

Tanpa STP link jaringan redundansi akan mengalami loop atau pengulangan, dimana packet data akan berputar-putar pada diantara switch yang akan menyebabkan masalah gangguan pada jaringan.

**Fungsi STP :**

- Mencegah Looping : STP akan melakukan blocking pada salah satu link redundan, untuk mencegah terjadinya looping pada jaringan.
- Pemilihan Root Bridge : STP akan memilih salah satu switch sebagai Root Bridge, yang menjadi referensi utama untuk semua kalkulasi penentuan jalur dalam jaringan.
  STP memilih switch sebagai root bridge dengan cara melihat nilai id bridge priority pada masing-masing switch, nilai id bridge priority yang paling kecil pada switch akan dipilih sebagai root bridge.
  Jika nilai id bridge priority pada masing-masing switch sama, maka STP akan memilih dengan cara melihat nilai mac-address switch yang paling kecil akan di pilih sebagai root bridge.
- Penentuan Jalur Terpendek : STP akan menentukan jalur terdekat kearah switch root bridge.



Pada topologi diatas kita bisa melihat bahwa salah satu link statusnya di block oleh STP(ditandai warna orange). Jika link yang aktif bermasalah, maka dari sisi STP akan membuka link yang di blocking untuk mengalihkan traffic data.

**Verifikasi STP pada Switch 0 dan Switch 1**

```
Switch0#show spanning-tree
VLAN0001
  Spanning tree enabled protocol ieee
  Root ID     Priority    32769
              Address     0060.706A.5576
              Cost        4
              Port        25(GigabitEthernet0/1)
              Hello Time  2 sec  Max Age 20 sec  Forward Delay 15 sec

  Bridge ID   Priority    32769  (priority 32768 sys-id-ext 1)
              Address     00E0.A322.1B48
              Hello Time  2 sec  Max Age 20 sec  Forward Delay 15 sec
              Aging Time  20

Interface        Role Sts Cost      Prio.Nbr Type
---------------- ---- --- --------- -------- --------------------------------
Gi0/2            Altn BLK 4         128.26   P2p
Gi0/1            Root FWD 4         128.25   P2p

Switch0#
 Switch1#show spanning-tree
 VLAN0001
   Spanning tree enabled protocol ieee
   Root ID     Priority    32769
               Address     0060.706A.5576
               This bridge is the root
               Hello Time  2 sec  Max Age 20 sec  Forward Delay 15 sec

   Bridge ID   Priority    32769  (priority 32768 sys-id-ext 1)
               Address     0060.706A.5576
               Hello Time  2 sec  Max Age 20 sec  Forward Delay 15 sec
               Aging Time  20

 Interface        Role Sts Cost      Prio.Nbr Type
 ---------------- ---- --- --------- -------- --------------------------------
 Gi0/2            Desg FWD 4         128.26   P2p
 Gi0/1            Desg FWD 4         128.25   P2p

 Switch1#
```

Hasil verifikasi diatas Kita bisa melihat bahwa Switch 1 dipilih menjadi root bridge(*This bridge is the root*) oleh STP. STP memilih Switch 1 sebagai root bridge dikarenakan nilai mac-address pada Switch 1 lebih kecil dari pada Switch 0 walaupun nilai id bridge priority nya sama.

## Port Security Switch

Serangan Layer 2 Switching merupakan salah satu yang paling mudah dilakukan oleh peretas, tetapi ancaman ini dapat kita minimalisirkan dengan berbagai Solusi Layer 2 yang umum.

- Semua interface port pada switch harus diamankan terlebih dahulu, sebelum switch digunakan di operasional jaringan.
- Salah satu metode yang sangat mudah dilakukan adalah dengan cara menonaktifkan interface port pada switch yang belum terpakai. Di perangkat Switch Cisco Kita dapat menonaktifkan interface port yang belum terpakai

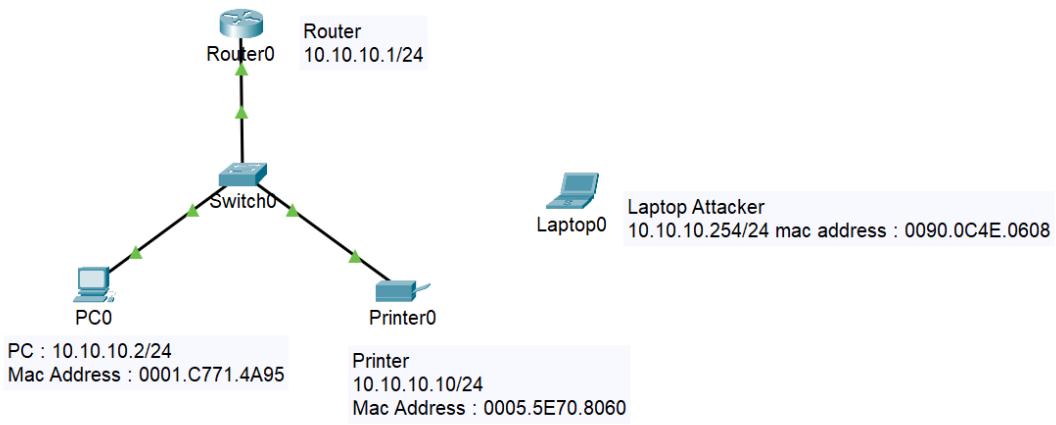
dengan command ***shutdown,*** jika ingin mengaktifkan interface port bisa dengan command ***no shutdown***.

Metode berikutnya yang dapat dilakukan untuk meminimalisirkan serangan pada Layer 2 Switch, Kita bisa lakukan Langkah berikut ini:

- Aktifkan port-security pada interface port switch yang terkoneksi langsung ke perangkat end device(Komputer, Printer, Laptop).
- Daftarkan alamat mac-address perangkat end device(Komputer, Printer, Laptop) di masing-masing interface port switch yang terkoneksi. Ada 2 cara yang pertama kita daftarkan mac-addressnya end device secara manual, dan kedua dari sisi interface port dapat mendaftarkan mac-address end device secara otomatis, ketika perangkat end device pertama kali konek ke switch.
- Tentukan mode violations ketika menerapkan port security pada interface port switch. Ada 3 mode violations yang dapat digunakan:

| Mode | Deskripsi |
|---|---|
| **shutdown** | Interface port akan non aktif(shutdown) jika perangkat end divice(Komputer, Printer, Laptop) yang konek ke switch mac-address nya tidak sesuai dengan yang sudah didaftarkan. Cara mengaktifkan kembali interface port tersebut dengan command *no shutdown*. |
| **restrict** | Interface port switch akan melakukan drop paket dari sumber alamat mac-address yang tidak diketahui(tidak terdaftar) ketika ada end divice yang konek ke switch. Dan akan menampilkan pesan syslog. |
| **protect** | Sama seperti restric, interface port switch akan melakukan drop paket dari sumber alamat mac-address yang tidak diketahui(tidak terdaftar), tetapi tidak akan menampilkan pesan. |

## Lab 1 Port Secutiy Switch

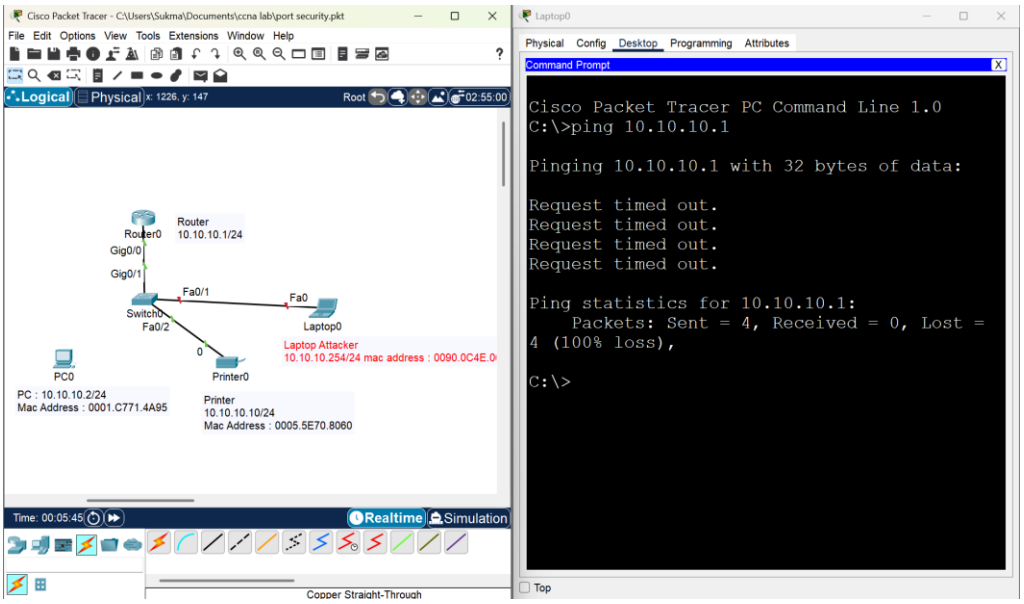



Sesuai ilustrasi di atas ada, Kita diminta untuk mengaktifkan fitur Port Security dan mendaftarkan mac-address end device ke interface port pada switch. Ada 2 mode violation yang akan kita terapkan yaitu mode violation shutdown pada interface port fa0/1 yang konek ke PC dan mode violation restric pada interface port fa0/2 yang konek ke printer.

**ACSW-CNA**

```
ACSW-CNA(config)#
ACSW-CNA(config)#interface fa0/1
ACSW-CNA(config-if)#switchport mode access
ACSW-CNA(config-if)#switchport access vlan 1
ACSW-CNA(config-if)#switchport port-security
ACSW-CNA(config-if)#switchport port-security mac-address 0001.C771.4A95
ACSW-CNA(config-if)#switchport port-security violation shutdown
ACSW-CNA(config-if)#description To_PC
ACSW-CNA(config-if)#exit
ACSW-CNA(config)#
ACSW-CNA(config)#interface Fa0/2
ACSW-CNA(config-if)#switchport mode access
ACSW-CNA(config-if)#switchport access vlan 1
ACSW-CNA(config-if)#switchport port-security
ACSW-CNA(config-if)#switchport port-security mac-address 0005.5E70.8060
ACSW-CNA(config-if)#switchport port-security violation restrict
ACSW-CNA(config-if)#description To_Printer
ACSW-CNA(config-if)#end
ACSW-CNA#
ACSW-CNA#
ACSW-CNA#wr
Building configuration...
[OK]
ACSW-CNA#
```

**Verifikasi :**

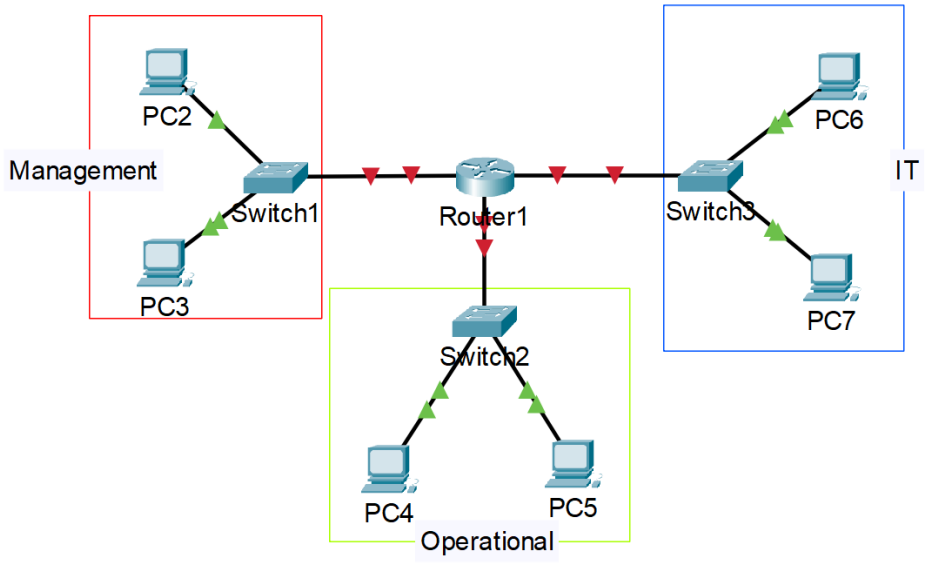



```
ACSW-CNA#
ACSW-CNA#
%LINK-5-CHANGED: Interface FastEthernet0/1, changed state to administratively down

%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/1, changed state to down

ACSW-CNA#show interface status
Port      Name               Status       Vlan       Duplex  Speed Type
Fa0/1     To_PC              err-disabled 1          auto    auto  10/100BaseTX
Fa0/2     To_Printer         connected    1          auto    auto  10/100BaseTX
Fa0/3                        notconnect   1          auto    auto  10/100BaseTX
Fa0/4                        notconnect   1          auto    auto  10/100BaseTX
Fa0/5                        notconnect   1          auto    auto  10/100BaseTX
```

Dari verifikasi ini kita bisa melihat bahwa ketika laptop attacker terkoneksi ke dalam jaringan melalui kabel utp di port fa0/1, maka dari sisi port fa0/1 pada switch akan melakukan ***shutdown*** dan status port fa0/1 menjadi ***err-disable***, karena mac address pada laptop attacker tidak terdaftar di port fa0/1 pada switch switch. Untuk mengembalikan status port fa0/1 ke awal bisa dilakukan dengan menggunakan command ***shutdown*** and ***no shutdown***.

## Vlan, Trunk & Inter-Vlan Routing

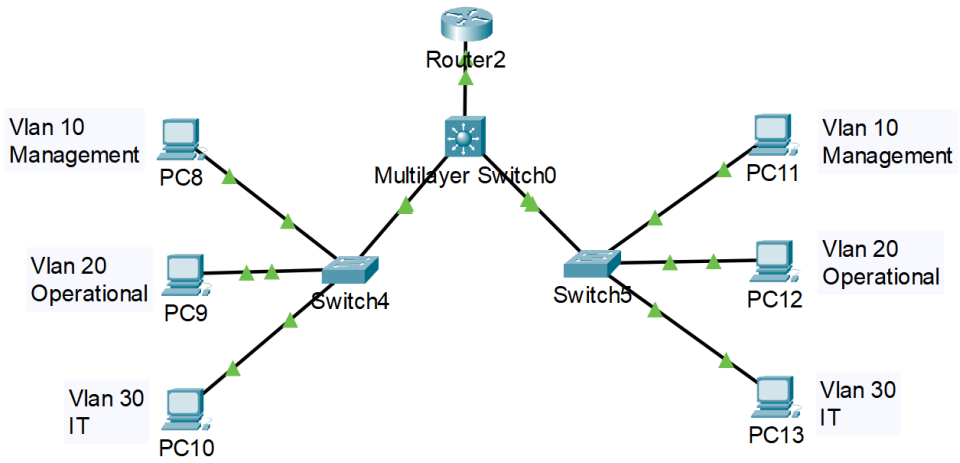
**Vlan**(Virtual LAN) adalah jaringan lan logic yang memungkinkan untuk membuat jaringan menjadi beberap segmen di dalam perangkat switch.




Sebelum menggunakan Vlan

Ilustrasi diatas menggambarkan, sebelum adanya Vlan, segmentasi jaringan dipisahkan berdasarkan perangkat fisik(switch), sehingga membutuhkan perangkat switch yang banyak sesuai dengan Departemen yang ada.

Dengan adanya Vlan Kita dapat menggabungkan berbagai macam segmentasi jaringan di dalam perangkat fisik(switch) yang sama, sehingga dapat menghemat cost karena tidak perlu lagi menyiapkan perangkat switch sesuai dengan departemen yang ada, dan dengan adanya vlan beban kinerja perangkat switch dapat berkurang dikarenakan traffic broadcast, unicast dan multicast hanya dilewatkan ke dalam segmentasi vlan yang sama.



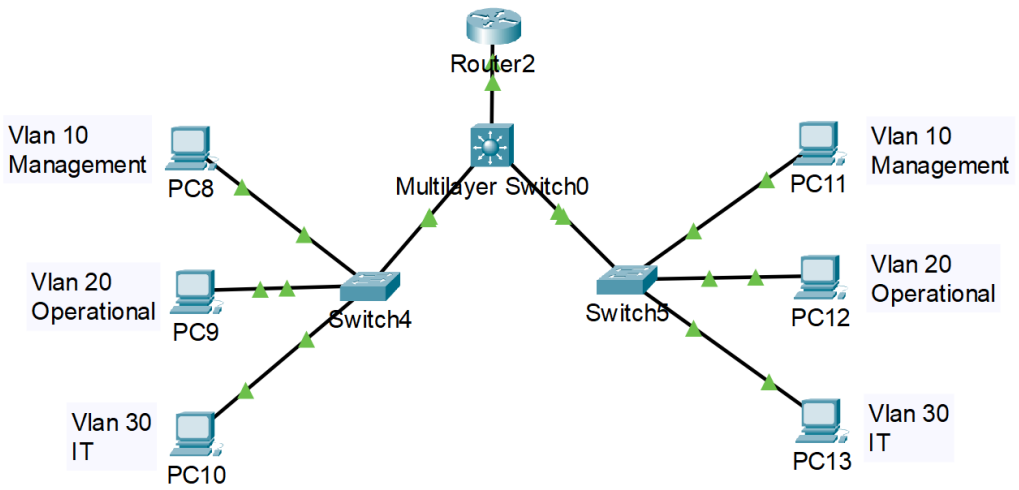

Sesudah Menggunakan Vlan

Pada saat melakukan konfigurasi vlan ada 2 mode switchport vlan yang harus kita tentukan pada interface port switch, terdiri dari:

- **Mode Access** : allow 1 vlan pada interface port switch yang connect ke end device.
- **Mode Trunk** : allow banyak vlan pada interface port switch yang conneck ke switch.

Supaya beda segmen vlan bisa berkomunikasi satu sama lain nya, konfigurasi yang harus dilakukan adalah InterVlan Routing pada perangkat Router.

## Lab 2 Vlan, Trunk & Inter-Vlan Routing




| Device | Hostname | Interface | Vlan | IP Address | Description |
|---|---|---|---|---|---|
| Router | R1-CNA | Gi0/0 | | | |
| | | Gi0/0.10 | 10 | 10.10.10.1/24 | Sub Interface 10 |
| | | Gi0/0.20 | 20 | 172.16.20.1/24 | Sub Interface 20 |
| | | Gi0/0.30 | 30 | 192.168.30.1/24 | Sub Interface 30 |
| Switch | CRSW-CNA | Gi1/0/1 | 10,20,30 | | Trunk Vlan |
| | | Gi1/0/2 | 10,20,30 | | Trunk Vlan |
| | | Gi1/0/3 | 10,20,30 | | Trunk Vlan |
| Switch | ACSW1-CNA | Gi0/1 | 10,20,30 | | Trunk Vlan |
| | | Fa0/1 | 10 | 10.10.10.2/24 | Access Vlan PC 10 |
| | | Fa0/2 | 20 | 172.16.20.2/24 | Access Vlan PC 20 |
| | | Fa0/3 | 30 | 192.168.30.2/24 | Access Vlan PC 30 |
| Switch | | Gi0/1 | 10,20,30 | | Trunk Vlan |

| | | | | | |
|---|---|---|---|---|---|
| | ACSW2-CNA | Fa0/1 | 10 | 10.10.10.3/24 | Access Vlan PC 10 |
| | | Fa0/2 | 20 | 172.16.20.3/24 | Access Vlan PC 20 |
| | | Fa0/3 | 30 | 192.168.30.3/24 | Access Vlan PC 30 |

Dari topologi network diatas, Kita diminta untuk konfigurasi segmen Vlan, Trunk dan InterVlan Routing, sesuai dengan informasi pada table.

**Create Vlan & Trunk Multilayer Switch(CRSW-CNA)**

**CRSW-CNA**

```
Switch>enable
Switch#
Switch#configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
Switch(config)#hostname CRSW-CNA
CRSW-CNA(config)#vlan 10
CRSW-CNA(config-vlan)#name Management
CRSW-CNA(config-vlan)#exit
CRSW-CNA(config)#vlan 20
CRSW-CNA(config-vlan)#name Operational
CRSW-CNA(config-vlan)#exit
CRSW-CNA(config)#vlan 30
CRSW-CNA(config-vlan)#name IT
CRSW-CNA(config-vlan)#exit
CRSW-CNA(config)#
CRSW-CNA(config)#interface gi1/0/1
CRSW-CNA(config-if)#switchport mode trunk
CRSW-CNA(config-if)#switchport trunk allowed vlan all
CRSW-CNA(config-if)#description To_R1-CNA
CRSW-CNA(config-if)#exit
CRSW-CNA(config)#
CRSW-CNA(config)#interface gi1/0/2
CRSW-CNA(config-if)#switchport mode trunk
CRSW-CNA(config-if)#switchport trunk allowed vlan 10,20,30
CRSW-CNA(config-if)#description To_ACSW1-CNA
CRSW-CNA(config-if)#exit
CRSW-CNA(config)#
CRSW-CNA(config)#interface gi1/0/3
CRSW-CNA(config-if)#switchport mode trunk
CRSW-CNA(config-if)#switchport trunk allowed vlan 10,20,30
CRSW-CNA(config-if)#description To_ACSW2-CNA
CRSW-CNA(config-if)#exit
CRSW-CNA(config)#end
CRSW-CNA#
```

```
CRSW-CNA#wr
Building configuration...
Compressed configuration from 7383 bytes to 3601 bytes[OK]
[OK]
CRSW-CNA#
```

**Verifikasi Vlan (*show vlan brief*)**

```
CRSW-CNA#show vlan brief

VLAN Name                             Status    Ports
---- -------------------------------- --------- -------------------------------
1    default                          active    Gig1/0/4, Gig1/0/5, Gig1/0/6, Gig1/0/7
                                                Gig1/0/8, Gig1/0/9, Gig1/0/10, Gig1/0/11
                                                Gig1/0/12, Gig1/0/13, Gig1/0/14, Gig1/0/15
                                                Gig1/0/16, Gig1/0/17, Gig1/0/18, Gig1/0/19
                                                Gig1/0/20, Gig1/0/21, Gig1/0/22, Gig1/0/23
                                                Gig1/0/24, Gig1/1/1, Gig1/1/2, Gig1/1/3
                                                Gig1/1/4
10   Management                       active
20   Operational                      active
30   IT                               active
1002 fddi-default                     active
1003 token-ring-default               active
1004 fddinet-default                  active
1005 trnet-default                    active
CRSW-CNA#
```

**Create Vlan & Trunk Switch(ACSW1-CNA & ACSW2-CNA)**

**ACSW1-CNA**

```
Switch>enable
Switch#configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
Switch(config)#hostname ACSW1-CNA
ACSW1-CNA(config)#
ACSW1-CNA(config)#vlan 10
ACSW1-CNA(config-vlan)#name Management
ACSW1-CNA(config-vlan)#exit
ACSW1-CNA(config)#vlan 20
ACSW1-CNA(config-vlan)#name Operational
ACSW1-CNA(config-vlan)#exit
ACSW1-CNA(config)#vlan 30
ACSW1-CNA(config-vlan)#name IT
ACSW1-CNA(config-vlan)#exit
ACSW1-CNA(config)#
ACSW1-CNA(config)#interface fa0/1
ACSW1-CNA(config-if)#switchport mode access
ACSW1-CNA(config-if)#switchport access vlan 10
ACSW1-CNA(config-if)#description To_PC_LAN_10
ACSW1-CNA(config-if)#exit
ACSW1-CNA(config)#
ACSW1-CNA(config)#interface fa0/2
ACSW1-CNA(config-if)#switchport mode access
ACSW1-CNA(config-if)#switchport access vlan 20
ACSW1-CNA(config-if)#description To_PC_LAN_20
ACSW1-CNA(config-if)#exit
ACSW1-CNA(config)#
```

```
ACSW1-CNA(config)#interface fa0/3
ACSW1-CNA(config-if)#switchport mode access
ACSW1-CNA(config-if)#switchport access vlan 30
ACSW1-CNA(config-if)#description To_PC_LAN_30
ACSW1-CNA(config-if)#exit
ACSW1-CNA(config)#
ACSW1-CNA(config)#interface gi0/1
ACSW1-CNA(config-if)#switchport mode trunk
ACSW1-CNA(config-if)#switchport trunk allowed vlan 10,20,30
ACSW1-CNA(config-if)#description To_CRSW-CNA
ACSW1-CNA(config-if)#end
ACSW1-CNA#
ACSW1-CNA#wr
Building configuration...
[OK]
```

**Verifikasi Vlan (*show vlan brief*)**

```
ACSW1-CNA#show vlan brief

VLAN Name                              Status    Ports
---- --------------------------------- --------- -------------------------------
1    default                           active    Fa0/4, Fa0/5, Fa0/6, Fa0/7
                                                 Fa0/8, Fa0/9, Fa0/10, Fa0/11
                                                 Fa0/12, Fa0/13, Fa0/14, Fa0/15
                                                 Fa0/16, Fa0/17, Fa0/18, Fa0/19
                                                 Fa0/20, Fa0/21, Fa0/22, Fa0/23
                                                 Fa0/24, Gig0/2
10   Management                        active    Fa0/1
20   Operational                       active    Fa0/2
30   IT                                active    Fa0/3
1002 fddi-default                      active
1003 token-ring-default                active
1004 fddinet-default                   active
1005 trnet-default                     active
ACSW1-CNA#
```

**ACSW2-CNA**

```
Switch>
Switch>enable
Switch#conf t
Enter configuration commands, one per line. End with CNTL/Z.
Switch(config)#hostname ACSW2-CNA
ACSW2-CNA(config)#
ACSW2-CNA(config)#vlan 10
ACSW2-CNA(config-vlan)#name Mangement
ACSW2-CNA(config-vlan)#exit
ACSW2-CNA(config)#vlan 20
ACSW2-CNA(config-vlan)#name Operational
ACSW2-CNA(config-vlan)#exit
ACSW2-CNA(config)#vlan 30
ACSW2-CNA(config-vlan)#name IT
ACSW2-CNA(config-vlan)#exit
ACSW2-CNA(config)#
ACSW2-CNA(config)#interface fa0/1
```

```
ACSW2-CNA(config-if)#switchport mode access
ACSW2-CNA(config-if)#switchport access vlan 10
ACSW2-CNA(config-if)#description To_PC_LAN_10
ACSW2-CNA(config-if)#exit
ACSW2-CNA(config)#
ACSW2-CNA(config)#interface fa0/2
ACSW2-CNA(config-if)#switchport mode access
ACSW2-CNA(config-if)#switchport access vlan 20
ACSW2-CNA(config-if)#description To_PC_LAN_20
ACSW2-CNA(config-if)#exit
ACSW2-CNA(config)#
ACSW2-CNA(config)#interface fa0/3
ACSW2-CNA(config-if)#switchport mode access
ACSW2-CNA(config-if)#switchport access vlan 30
ACSW2-CNA(config-if)#description To_PC_LAN_30
ACSW2-CNA(config-if)#exit
ACSW2-CNA(config)#
ACSW2-CNA(config)#interface gi0/1
ACSW2-CNA(config-if)#switchport mode trunk
ACSW2-CNA(config-if)#switchport trunk allowed vlan 10,20,30
ACSW2-CNA(config-if)#description To_CRSW-CNA
ACSW2-CNA(config-if)#exit
ACSW2-CNA(config)#end
ACSW2-CNA#
ACSW2-CNA#wr
Building configuration...
[OK]
 ACSW2-CNA#
```

### Verifikasi Vlan (*show vlan brief*)

```
ACSW2-CNA#show vlan brief

VLAN Name                              Status    Ports
---- --------------------------------- --------- -------------------------------
1    default                           active    Fa0/4, Fa0/5, Fa0/6, Fa0/7
                                                 Fa0/8, Fa0/9, Fa0/10, Fa0/11
                                                 Fa0/12, Fa0/13, Fa0/14, Fa0/15
                                                 Fa0/16, Fa0/17, Fa0/18, Fa0/19
                                                 Fa0/20, Fa0/21, Fa0/22, Fa0/23
                                                 Fa0/24, Gig0/2
10   Mangement                         active    Fa0/1
20   Operational                       active    Fa0/2
30   IT                                active    Fa0/3
1002 fddi-default                      active
1003 token-ring-default                active
1004 fddinet-default                   active
1005 trnet-default                     active
ACSW2-CNA#
```

**InterVlan Routing, Sub Interface Router(R1-CNA)**

**R1-CNA**

```
Router>enable
Router#configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#hostname R1-CNA
R1-CNA(config)#
R1-CNA(config)#interface gi0/0
R1-CNA(config-if)#no shutdown
R1-CNA(config-if)#description To_LAN
R1-CNA(config-if)#exit
R1-CNA(config)#
R1-CNA(config)#interface gi0/0.10
R1-CNA(config-subif)#encapsulation dot1Q 10
R1-CNA(config-subif)#ip address 10.10.10.1 255.255.255.0
R1-CNA(config-subif)#exit
R1-CNA(config)#
R1-CNA(config)#interface gi0/0.20
R1-CNA(config-subif)#encapsulation dot1Q 20
R1-CNA(config-subif)#ip address 172.16.20.1 255.255.255.0
R1-CNA(config-subif)#exit
R1-CNA(config)#
R1-CNA(config)#interface gi0/0.30
R1-CNA(config-subif)#encapsulation dot1Q 30
R1-CNA(config-subif)#ip address 192.168.30.1 255.255.255.0
R1-CNA(config-subif)#end
R1-CNA#
R1-CNA#wr
Building configuration...
[OK]
R1-CNA#
```

**Verifikasi Sub-Interface pada Router(R1-CNA) (*show ip interface brief*)**

```
R1-CNA#show ip interface brief
Interface              IP-Address      OK? Method Status                Protocol
GigabitEthernet0/0     unassigned      YES unset  up                    up
GigabitEthernet0/0.10  10.10.10.1      YES manual up                    up
GigabitEthernet0/0.20  172.16.20.1     YES manual up                    up
GigabitEthernet0/0.30  192.168.30.1    YES manual up                    up
GigabitEthernet0/1     unassigned      YES unset  administratively down down
Vlan1                  unassigned      YES unset  administratively down down
R1-CNA#
```

**Verifikasi Ping antar segment Vlan**

Ping Vlan IT dan Vlan Operasional dari PC Vlan Management

```
Ping statistics for 10.10.10.1:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 0ms, Maximum = 0ms, Average = 0ms

C:\>ping 172.16.20.3

Pinging 172.16.20.3 with 32 bytes of data:

Reply from 172.16.20.3: bytes=32 time<1ms TTL=127
Reply from 172.16.20.3: bytes=32 time<1ms TTL=127
Reply from 172.16.20.3: bytes=32 time<1ms TTL=127
Reply from 172.16.20.3: bytes=32 time<1ms TTL=127

Ping statistics for 172.16.20.3:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 0ms, Maximum = 0ms, Average = 0ms

C:\>ping 192.168.30.3

Pinging 192.168.30.3 with 32 bytes of data:

Reply from 192.168.30.3: bytes=32 time<1ms TTL=127
Reply from 192.168.30.3: bytes=32 time<1ms TTL=127
```

# 3. Routing

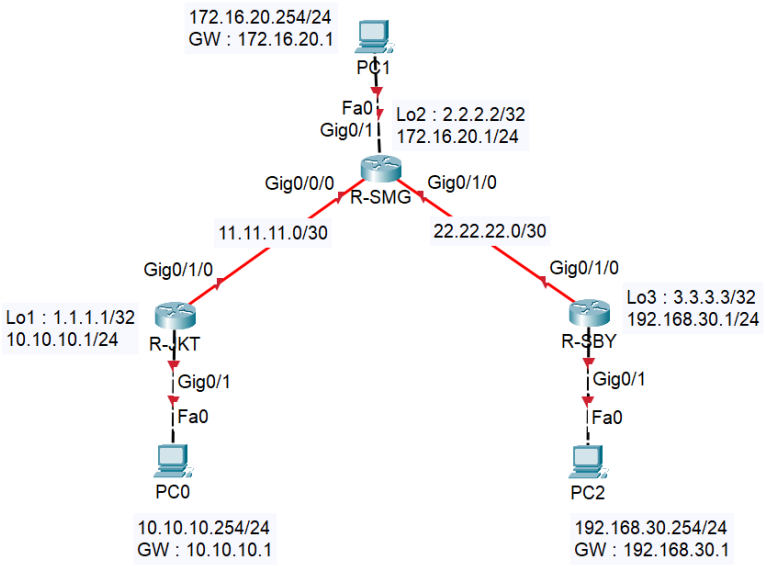
## Static Route

**Static Route** adalah metode pengiriman paket data melalui jaringan yang ditentukan jalurnya secara manual oleh Administrator Jaringan.

**Kelebihan dan kekurangan dari Static Route:**

- Keamanan yang lebih tinggi, karena administrator yang menentukan rute atau jalur pengiriman paket data pada jaringan.
- Penggunanaan bandwidth lebih sedikit, Static route tidak memerlukan komunikasi antar router terkait penentuan jalur/rutenya, karena jalur/rute sudah ditentukan secara manual, sehingga penggunaan bandwidth lebih kecil.
- Penggunaan sumber daya yang lebih rendah.
- Kekurangan static route tidak direkomendasikan untuk diterapkan di jaringan yang lebih kompleks, karena dari sisi administrator secara manual harus melakukan konfigurasi terkait rute/jalur di setiap router yang ada.
- Static route tidak dapat secara otomatis beradaptasi ketika ada update atau perubahan routing pada jaringan.

## Lab 3 Static Route



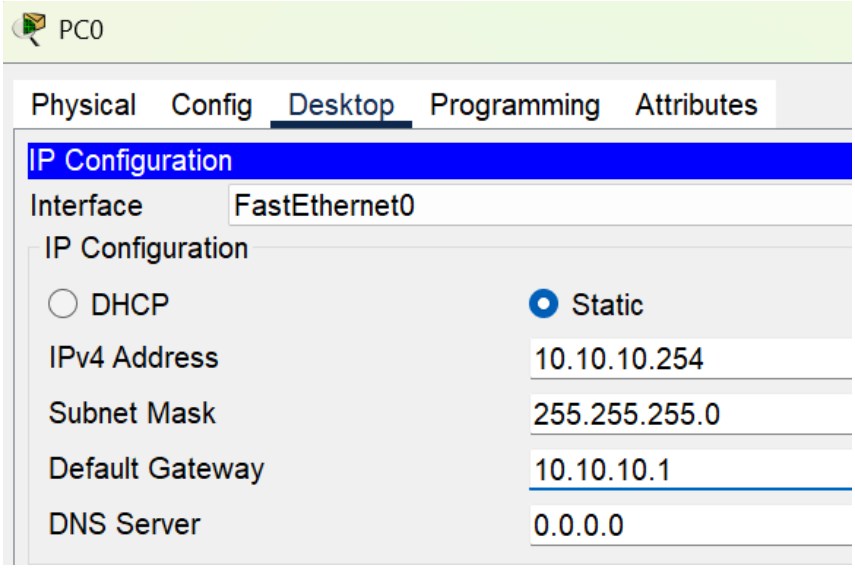
| Device | Interface | IP Address | Description |
|---|---|---|---|
| **R-JKT** | Gi0/1/0 | 11.11.11.1/30 | To_R-SMG |
| | Gi0/1 | 10.10.10.1/24 | To_LAN |
| | Loopback 1 | 1.1.1.1/32 | IP_Loopback |
| **R-SMG** | Gi0/0/0 | 11.11.11.2/30 | To_R-JKT |
| | Gi0/1/0 | 22.22.22.2/30 | To_R-SBY |
| | Gi0/1 | 172.16.20.1/24 | To_LAN |
| | Loopback 2 | 2.2.2.2/32 | IP_Loopback |
| **R-SBY** | Gi0/1/0 | 22.22.22.1/30 | To_R-SMG |
| | Gi0/1 | 192.168.30.1/24 | To_LAN |
| | Loopback 3 | 3.3.3.3/32 | IP_Loopback |

Pada topology diatas kita diminta untuk melakukan konfigurasi routing protocol static route, supaya LAN yang ada di R-JKT bisa berkomunikasi dengan LAN yang ada di R-SMG dan R-SBY.

**R-JKT**

```
Router>enable
Router#configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#hostname R-JKT
R-JKT(config)#
R-JKT(config)#interface loopback 1
R-JKT(config-if)#ip address 1.1.1.1 255.255.255.255
R-JKT(config-if)#exit
R-JKT(config)#
R-JKT(config)#int gi0/1/0
R-JKT(config-if)#no shutdown
R-JKT(config-if)#ip address 11.11.11.1 255.255.255.252
R-JKT(config-if)#description To_R-SMG
R-JKT(config-if)#exit
R-JKT(config)#
R-JKT(config)#int gi0/1
R-JKT(config-if)#no shutdown
R-JKT(config-if)#ip address 10.10.10.1 255.255.255.0
R-JKT(config-if)#description To_LAN
R-JKT(config-if)#exit
R-JKT(config)#
R-JKT(config)#ip route 2.2.2.2 255.255.255.255 11.11.11.2
R-JKT(config)#ip route 172.16.20.0 255.255.255.0 11.11.11.2
R-JKT(config)#ip route 3.3.3.3 255.255.255.255 11.11.11.2
R-JKT(config)#ip route 192.168.30.0 255.255.255.0 11.11.11.2
R-JKT(config)#end
R-JKT#wr
R-JKT#
```

**PC-JKT**

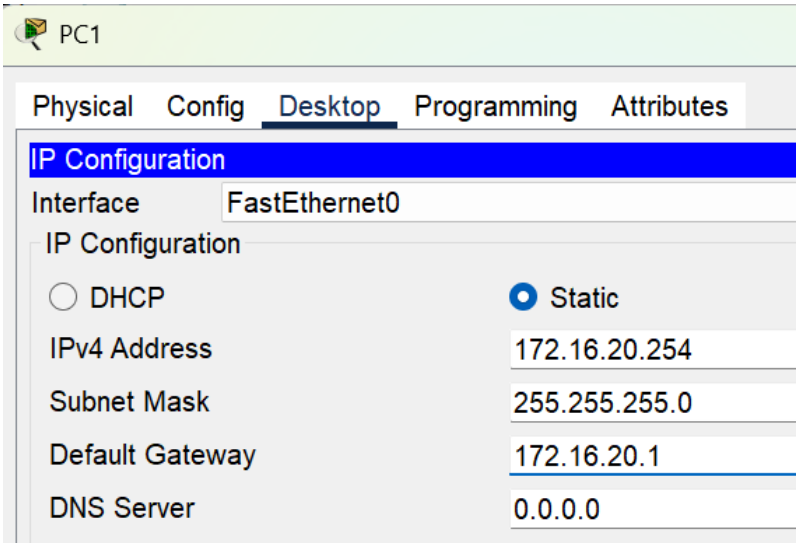



**R-SMG**

```
Router>enable
Router#configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#hostname R-SMG
R-SMG(config)#
R-SMG(config)#interface loopback 2
R-SMG(config-if)#ip address 2.2.2.2 255.255.255.255
R-SMG(config-if)#exit
R-SMG(config)#
R-SMG(config)#interface gi0/0/0
R-SMG(config-if)#no shutdown
R-SMG(config-if)#ip address 11.11.11.2 255.255.255.252
R-SMG(config-if)#description To_R-JKT
R-SMG(config-if)#exit
R-SMG(config)#
R-SMG(config)#interface gi0/1/0
R-SMG(config-if)#no shutdown
R-SMG(config-if)#ip address 22.22.22.2 255.255.255.252
R-SMG(config-if)#description To_R-SBY
R-SMG(config-if)#exit
R-SMG(config)#interface gi0/1
R-SMG(config-if)#no shutdown
R-SMG(config-if)#ip address 172.16.20.1 255.255.255.0
R-SMG(config-if)#description To_LAN
R-SMG(config-if)#exit
R-SMG(config)#
R-SMG(config)#ip route 1.1.1.1 255.255.255.255 11.11.11.1
R-SMG(config)#ip route 10.10.10.0 255.255.255.0 11.11.11.1
R-SMG(config)#ip route 3.3.3.3 255.255.255.255 22.22.22.1
```

```
R-SMG(config)#ip route 192.168.30.0 255.255.255.0 22.22.22.1
R-SMG(config)#exit
R-SMG#
%SYS-5-CONFIG_I: Configured from console by console
R-SMG#wr
Building configuration...
[OK]
 R-SMG#
```

**PC-SMG**

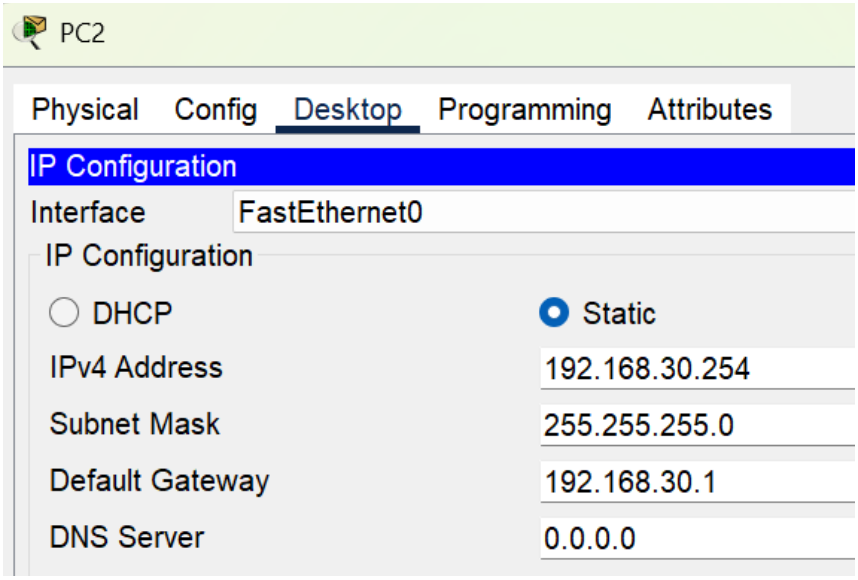



**R-SBY**

```
Router>enable
Router#configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#hostname R-SBY
R-SBY(config)#
R-SBY(config)#interface loopback 3
R-SBY(config-if)#ip address 3.3.3.3 255.255.255.255
R-SBY(config-if)#exit
R-SBY(config)#interface gi0/1/0
R-SBY(config-if)#no shutdown
R-SBY(config-if)#ip address 22.22.22.1 255.255.255.252
R-SBY(config-if)#description To_R-SMG
R-SBY(config-if)#exit
R-SBY(config)#
R-SBY(config)#interface gi0/1
R-SBY(config-if)#no shutdown
R-SBY(config-if)#ip address 192.168.30.1 255.255.255.0
R-SBY(config-if)#description To_LAN
R-SBY(config-if)#exit
R-SBY(config)#
R-SBY(config)#ip route 1.1.1.1 255.255.255.255 22.22.22.2
```

```
R-SBY(config)#ip route 2.2.2.2 255.255.255.255 22.22.22.2
R-SBY(config)#ip route 172.16.20.0 255.255.255.0 22.22.22.2
R-SBY(config)#ip route 10.10.10.0 255.255.255.0 22.22.22.2
R-SBY(config)#
R-SBY(config)#exit
R-SBY#
R-SBY#wr
Building configuration...
[OK]
 R-SBY#
```

**PC-SBY**




**Verifikasi :**

**R-JKT *show ip route.***

```
R-JKT#show ip route
Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2, E - EGP
       i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, ia - IS-IS inter area
       * - candidate default, U - per-user static route, o - ODR
       P - periodic downloaded static route

Gateway of last resort is not set

     1.0.0.0/32 is subnetted, 1 subnets
C       1.1.1.1/32 is directly connected, Loopback1
     2.0.0.0/32 is subnetted, 1 subnets
S       2.2.2.2/32 [1/0] via 11.11.11.2
     3.0.0.0/32 is subnetted, 1 subnets
S       3.3.3.3/32 [1/0] via 11.11.11.2
     10.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
C       10.10.10.0/24 is directly connected, GigabitEthernet0/1
L       10.10.10.1/32 is directly connected, GigabitEthernet0/1
     11.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
C       11.11.11.0/30 is directly connected, GigabitEthernet0/1/0
L       11.11.11.1/32 is directly connected, GigabitEthernet0/1/0
     172.16.0.0/24 is subnetted, 1 subnets
S       172.16.20.0/24 [1/0] via 11.11.11.2
S    192.168.30.0/24 [1/0] via 11.11.11.2

R-JKT#
```

**R-SMG *show ip route.***

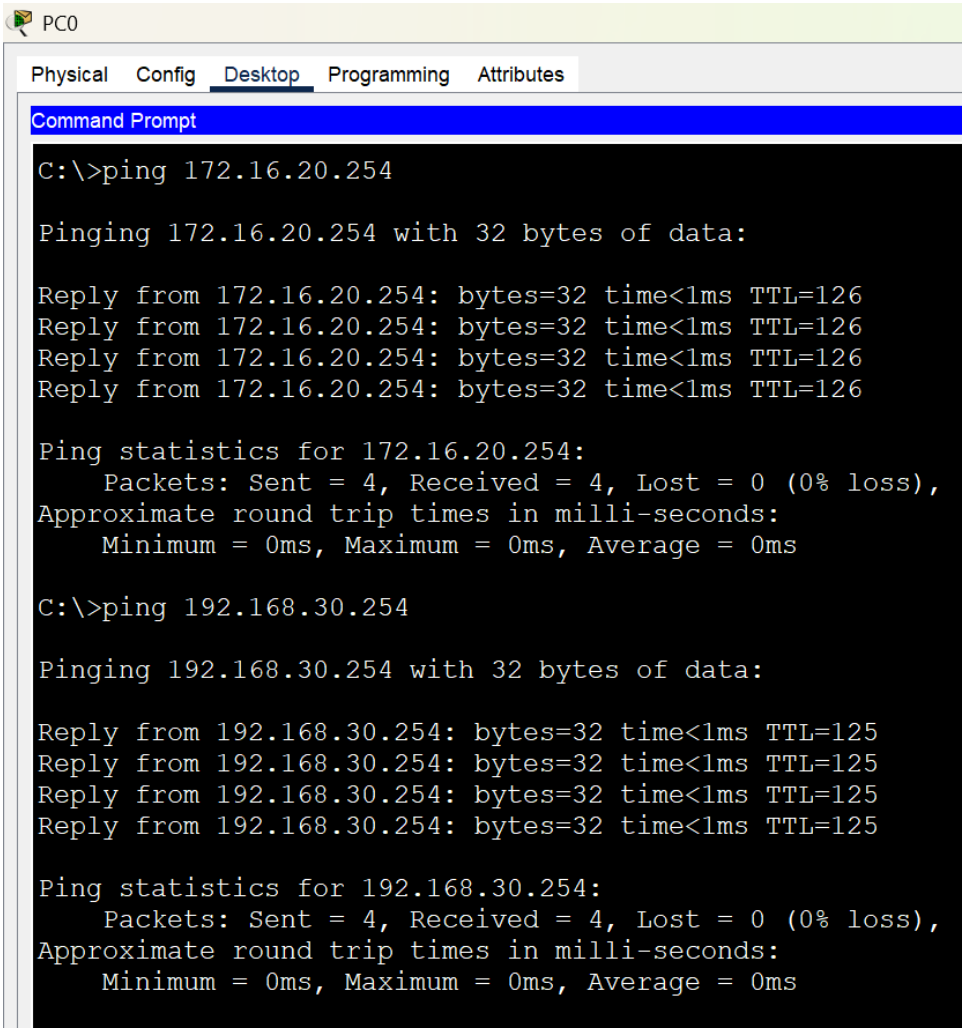
```
R-SMG#show ip route
Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2, E - EGP
       i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, ia - IS-IS inter area
       * - candidate default, U - per-user static route, o - ODR
       P - periodic downloaded static route

Gateway of last resort is not set

     1.0.0.0/32 is subnetted, 1 subnets
S       1.1.1.1/32 [1/0] via 11.11.11.1
     2.0.0.0/32 is subnetted, 1 subnets
C       2.2.2.2/32 is directly connected, Loopback2
     3.0.0.0/32 is subnetted, 1 subnets
S       3.3.3.3/32 [1/0] via 22.22.22.1
     10.0.0.0/24 is subnetted, 1 subnets
S       10.10.10.0/24 [1/0] via 11.11.11.1
     11.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
C       11.11.11.0/30 is directly connected, GigabitEthernet0/0/0
L       11.11.11.2/32 is directly connected, GigabitEthernet0/0/0
     22.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
C       22.22.22.0/30 is directly connected, GigabitEthernet0/1/0
L       22.22.22.2/32 is directly connected, GigabitEthernet0/1/0
     172.16.0.0/16 is variably subnetted, 2 subnets, 2 masks
C       172.16.20.0/24 is directly connected, GigabitEthernet0/1
L       172.16.20.1/32 is directly connected, GigabitEthernet0/1
S    192.168.30.0/24 [1/0] via 22.22.22.1

R-SMG#
```

**R-SBY *show ip route.***

```
R-SBY#show ip route
Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2, E - EGP
       i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, ia - IS-IS inter area
       * - candidate default, U - per-user static route, o - ODR
       P - periodic downloaded static route

Gateway of last resort is not set

     1.0.0.0/32 is subnetted, 1 subnets
S       1.1.1.1/32 [1/0] via 22.22.22.2
     2.0.0.0/32 is subnetted, 1 subnets
S       2.2.2.2/32 [1/0] via 22.22.22.2
     3.0.0.0/32 is subnetted, 1 subnets
C       3.3.3.3/32 is directly connected, Loopback3
     10.0.0.0/24 is subnetted, 1 subnets
S       10.10.10.0/24 [1/0] via 22.22.22.2
     22.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
C       22.22.22.0/30 is directly connected, GigabitEthernet0/1/0
L       22.22.22.1/32 is directly connected, GigabitEthernet0/1/0
     172.16.0.0/24 is subnetted, 1 subnets
S       172.16.20.0/24 [1/0] via 22.22.22.2
     192.168.30.0/24 is variably subnetted, 2 subnets, 2 masks
C       192.168.30.0/24 is directly connected, GigabitEthernet0/1
L       192.168.30.1/32 is directly connected, GigabitEthernet0/1

R-SBY#
```

Dari verifikasi konfigurasi routing protocol static route, kita bisa melihat bahwa static route sudah aktif di ketiga router dengan ditandai symbol **S**.

**Ping dari PC-JKT to PC-SMG dan PC-SBY**



## Dynamic Route

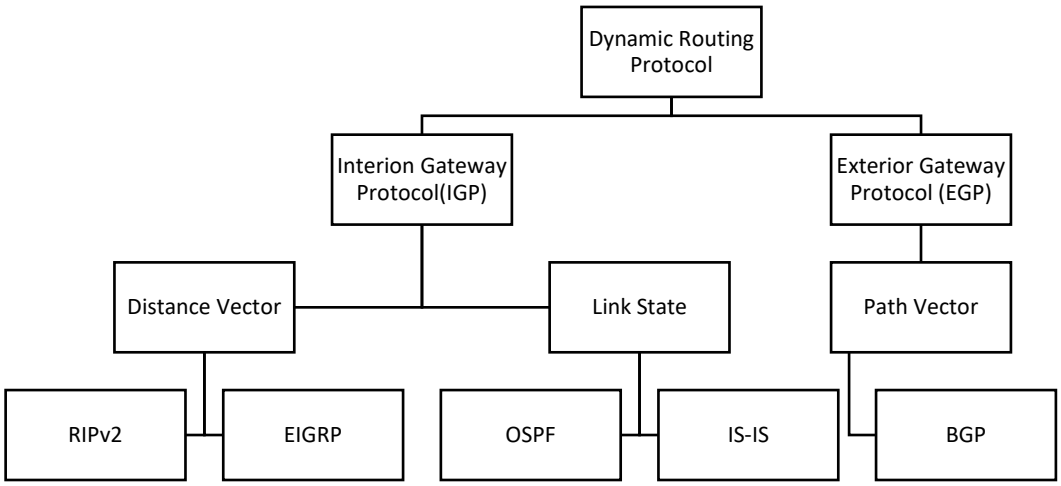
**Dynamic Route** adalah protocol jaringan yang digunakan dalam jaringan computer secara otomatis melakukan pertukaran informasi terkait perutean antar router. Protocol ini memungkinkan router untuk mempelajari rute terbaik dan memperbarui routing table nya, sehingga memungkinkan router dapat menyesuaikan secara dinamis terhadap perubahan topologi jaringan.

**Kelebihan dari Dynamic Route:**

- Update routing table secara otomatis : jika terjadi perubahan pada routing protocol salah satu router di dalam jaringan, maka routing table secara otomatis terupdate terkait perubahan tersebut.
- Pemilihan jalur secara dinamis : jika terjadi perubahan pada jaringan, router akan melakukan evaluasi ulang terkait jalur terbaik bagi paket data untuk mencapai tujuannya, dan memastikan peruteran secara efisien dan redundant.
- Scalability : dynamic route lebih stabil dari pada static route, karena dapat menangani jaringan yang lebih besar dan kompleks dengan banyak router.
- Efisien : dynamic route dapat menentukan jalur terbaik secara efisien, sehingga paket data dapat dikirim lebih cepat sampai tujuan.
- Adaptasi : dynamic route dapat beradaptasi lebih cepat ketika terjadi update atau perubahan pada jaringan.

**Ada 2 jenis protocol pada dynamic route :**

- Interior Gateway Protocol(IGP)
- Exterion Gateway Protocol(EGP)



**Jenis-Jenis Dynamic Route:**

- **Distance Vector** : Router melakukan update routing table dengan tetangganya secara berkala. Contoh RIPv2.
- **Link State** : Route saling bertukar informasi tentang link yang terhubung dengan nya, sehingga router dapat membuat peta secara keseluruhan. Contoh OSPF.
- **Path Vector** : Router saling bertukar informasi tentang jalur yang mereka gunakan untuk mencapai tujuan, bukan keseluruhan routing table. Contoh BGP.

**Administrative Distance**

Administrative Distance merupakan nilai dari setiap routing protocol yang dimana nilai paling kecil akan dipilih sebagai rute terbaik.

| Administrative Distance Route Source | Default Distance |
|---|---|
| Connected Interface | 0 |
| Static Route | 1 |
| Enhanced IGRP summary route | 5 |
| External BGP | 20 |
| Internal Enhanced IGRP | 90 |
| IGRP | 100 |
| OSPF | 110 |
| IS-IS | 115 |
| RIP | 120 |
| EIGRP | 170 |
| Internal BGP | 200 |
| Unknown | 255 |

## RIPv2

**Routing RIPv2** (Routing Information Protocol version 2) adalah salah satu protokol routing dinamis yang digunakan dalam jaringan komputer untuk menyebarkan informasi routing antar router dalam sebuah Autonomous System (AS). RIPv2 merupakan pengembangan dari RIPv1 dan memiliki beberapa fitur tambahan.

RIPv2 adalah **Distance Vector Routing Protocol** yang menggunakan **hop count** (jumlah lompatan antar router) sebagai metrik untuk menentukan jalur terbaik ke suatu tujuan dalam jaringan. Protokol ini termasuk dalam kategori **Interior Gateway Protocol (IGP)**, artinya digunakan dalam jaringan internal.

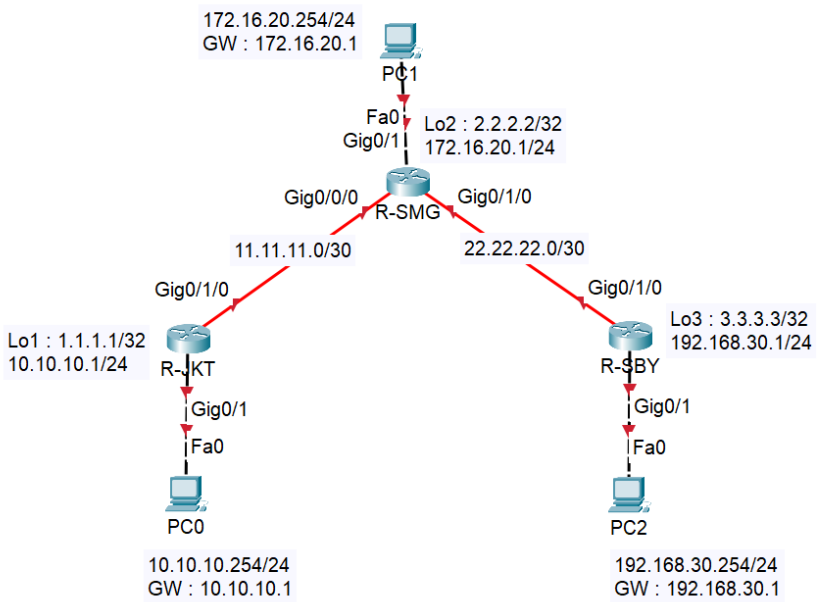
**Karakteristik RIPv2**

| Fitur | Deskripsi |
|---|---|
| Protokol | Distance Vector |
| Metrik | Houp count(maksismal 15 router, selebihnya = unreachable) |
| Update Routing | Setiap 30 detik |
| Routing Classless | Mendukung CIDR/subnetting |
| Autentikasi | Mendukung autentikasi(plaintext atau MD5) |
| Multicast | Mengirim update ke alamat multicast 224.0.0.9 |
| Versi IP | Hanya bekerja di IPv4 |

**Cara Kerja RIPv2**

1. Pertukaran Routing Table : setiap router secara berkala(default 30 detik) mengirimkan seluruh isi routing table-nya ke router tetangga menggunakan multicast.
2. Update dan Learning : router yang menerima update akan mengevaluasi apakah rute baru lebih baik(misal hop count lebih rendah), jika iya maka routing table-nya akan di perbarui.
3. Konvergensi : butuh waktu karena routing table dikirim secara periodic. Tidak secepat protocol link-state seperti OSPF.

## Lab 4 RIPv2




Sesuai dengan topologi sebelumnya, Kita akan melakukan konfigurasi routing protocol RIPv2 dengan menghapus terlebih dahulu konfigurasi static route.

**R-JKT**

```
R-JKT#
R-JKT#configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
R-JKT(config)#no ip route 2.2.2.2 255.255.255.255 11.11.11.2
R-JKT(config)#no ip route 172.16.20.0 255.255.255.0 11.11.11.2
R-JKT(config)#no ip route 3.3.3.3 255.255.255.255 11.11.11.2
R-JKT(config)#no ip route 192.168.30.0 255.255.255.0 11.11.11.2
R-JKT(config)#
R-JKT(config)#router rip
R-JKT(config-router)#version 2
R-JKT(config-router)#network 1.1.1.1
R-JKT(config-router)#network 10.10.10.0
R-JKT(config-router)#network 11.11.11.0
R-JKT(config-router)#end
R-JKT#
R-JKT#wr
Building configuration...
[OK]
 R-JKT#
```

**R-SMG**

```
R-SMG#
R-SMG#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R-SMG(config)#no ip route 1.1.1.1 255.255.255.255 11.11.11.1
R-SMG(config)#no ip route 10.10.10.0 255.255.255.0 11.11.11.1
R-SMG(config)#no ip route 3.3.3.3 255.255.255.255 22.22.22.1
R-SMG(config)#no ip route 192.168.30.0 255.255.255.0 22.22.22.1
R-SMG(config)#
R-SMG(config)#router rip
R-SMG(config-router)#version 2
R-SMG(config-router)#network 2.2.2.2
R-SMG(config-router)#network 172.16.20.0
R-SMG(config-router)#network 11.11.11.0
R-SMG(config-router)#network 22.22.22.0
R-SMG(config-router)#exit
R-SMG(config)#end
R-SMG#
R-SMG#wr
Building configuration...
[OK]
R-SMG#
```

**R-SBY**

```
R-SBY#
R-SBY#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R-SBY(config)#no ip route 1.1.1.1 255.255.255.255 22.22.22.2
R-SBY(config)#no ip route 2.2.2.2 255.255.255.255 22.22.22.2
R-SBY(config)#no ip route 10.10.10.0 255.255.255.0 22.22.22.2
R-SBY(config)#no ip route 172.16.20.0 255.255.255.0 22.22.22.2
R-SBY(config)#
R-SBY(config)#router rip
R-SBY(config-router)#version 2
R-SBY(config-router)#network 3.3.3.3
R-SBY(config-router)#network 192.168.30.0
R-SBY(config-router)#network 22.22.22.0
R-SBY(config-router)#end
R-SBY#
R-SBY#wr
Building configuration...
[OK]
 R-SBY#
```

**Verifikasi Routing Protocol RIPv2**

**R-JKT**

```
R-JKT>
R-JKT>show ip route
Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2, E - EGP
       i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, ia - IS-IS inter area
       * - candidate default, U - per-user static route, o - ODR
       P - periodic downloaded static route

Gateway of last resort is not set

     1.0.0.0/32 is subnetted, 1 subnets
C       1.1.1.1/32 is directly connected, Loopback1
R    2.0.0.0/8 [120/1] via 11.11.11.2, 00:00:17, GigabitEthernet0/1/0
R    3.0.0.0/8 [120/2] via 11.11.11.2, 00:00:17, GigabitEthernet0/1/0
     10.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
C       10.10.10.0/24 is directly connected, GigabitEthernet0/1
L       10.10.10.1/32 is directly connected, GigabitEthernet0/1
     11.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
C       11.11.11.0/30 is directly connected, GigabitEthernet0/1/0
L       11.11.11.1/32 is directly connected, GigabitEthernet0/1/0
R    22.0.0.0/8 [120/1] via 11.11.11.2, 00:00:17, GigabitEthernet0/1/0
R    172.16.0.0/16 [120/1] via 11.11.11.2, 00:00:17, GigabitEthernet0/1/0
R    192.168.30.0/24 [120/2] via 11.11.11.2, 00:00:17, GigabitEthernet0/1/0

R-JKT>
```

**R-SMG**

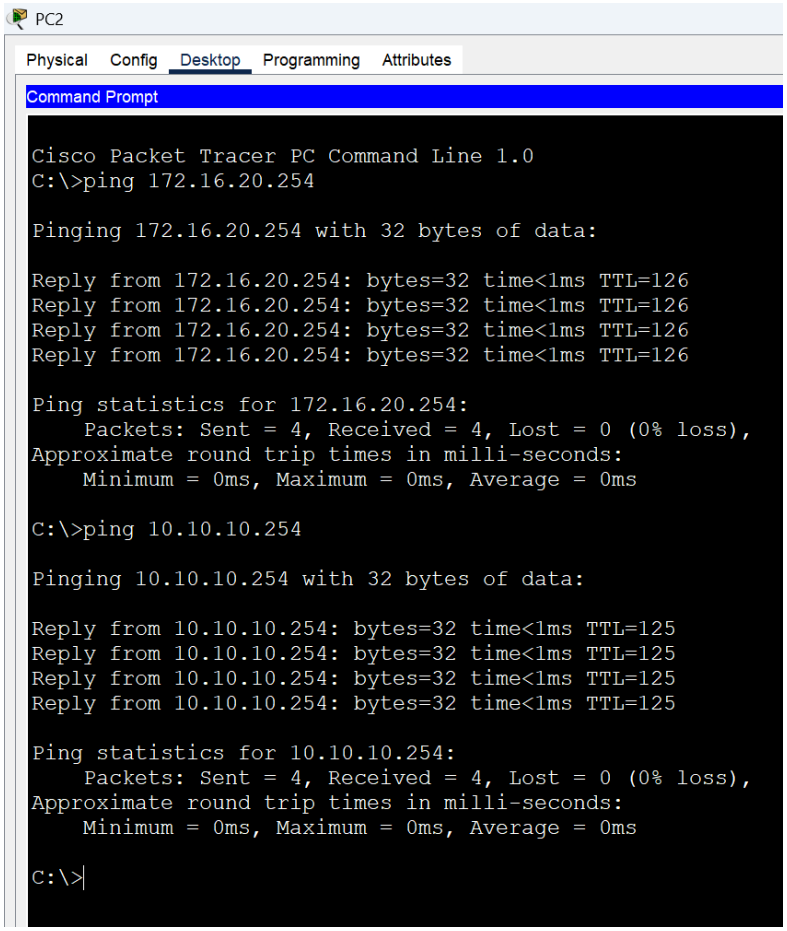
```
R-SMG>show ip route
Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2, E - EGP
       i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, ia - IS-IS inter area
       * - candidate default, U - per-user static route, o - ODR
       P - periodic downloaded static route

Gateway of last resort is not set

R    1.0.0.0/8 [120/1] via 11.11.11.1, 00:00:22, GigabitEthernet0/0/0
     2.0.0.0/32 is subnetted, 1 subnets
C       2.2.2.2/32 is directly connected, Loopback2
R    3.0.0.0/8 [120/1] via 22.22.22.1, 00:00:02, GigabitEthernet0/1/0
R    10.0.0.0/8 [120/1] via 11.11.11.1, 00:00:22, GigabitEthernet0/0/0
     11.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
C       11.11.11.0/30 is directly connected, GigabitEthernet0/0/0
L       11.11.11.2/32 is directly connected, GigabitEthernet0/0/0
     22.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
C       22.22.22.0/30 is directly connected, GigabitEthernet0/1/0
L       22.22.22.2/32 is directly connected, GigabitEthernet0/1/0
     172.16.0.0/16 is variably subnetted, 2 subnets, 2 masks
C       172.16.20.0/24 is directly connected, GigabitEthernet0/1
L       172.16.20.1/32 is directly connected, GigabitEthernet0/1
R    192.168.30.0/24 [120/1] via 22.22.22.1, 00:00:02, GigabitEthernet0/1/0

R-SMG>
```

**R-SBY**

```
R-SBY>
R-SBY>show ip route
Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2, E - EGP
       i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, ia - IS-IS inter area
       * - candidate default, U - per-user static route, o - ODR
       P - periodic downloaded static route

Gateway of last resort is not set

R    1.0.0.0/8 [120/2] via 22.22.22.2, 00:00:27, GigabitEthernet0/1/0
R    2.0.0.0/8 [120/1] via 22.22.22.2, 00:00:27, GigabitEthernet0/1/0
     3.0.0.0/32 is subnetted, 1 subnets
C       3.3.3.3/32 is directly connected, Loopback3
R    10.0.0.0/8 [120/2] via 22.22.22.2, 00:00:27, GigabitEthernet0/1/0
R    11.0.0.0/8 [120/1] via 22.22.22.2, 00:00:27, GigabitEthernet0/1/0
     22.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
C       22.22.22.0/30 is directly connected, GigabitEthernet0/1/0
L       22.22.22.1/32 is directly connected, GigabitEthernet0/1/0
R    172.16.0.0/16 [120/1] via 22.22.22.2, 00:00:27, GigabitEthernet0/1/0
     192.168.30.0/24 is variably subnetted, 2 subnets, 2 masks
C       192.168.30.0/24 is directly connected, GigabitEthernet0/1
L       192.168.30.1/32 is directly connected, GigabitEthernet0/1

R-SBY>
```

Dari hasil verifikasi ***show ip route*** Kita bisa melihat bahwa routing protocol RIPv2 sudah aktif, ditandai dengan symbol **R**.

**Ping PC-SBY to PC-SMG & PC-JKT**




## EIGRP

Routing **EIGRP (Enhanced Interior Gateway Routing Protocol)** adalah protokol routing dinamis yang dikembangkan oleh **Cisco Systems**. EIGRP adalah **protokol hybrid**, karena menggabungkan karakteristik dari **Distance Vector** dan **Link-State**, dan memberikan performa yang lebih baik dibandingkan protokol lama seperti RIP.

**EIGRP** digunakan untuk mendistribusikan dan mengelola informasi routing dalam satu **Autonomous System (AS)**. EIGRP hanya bekerja pada perangkat Cisco.

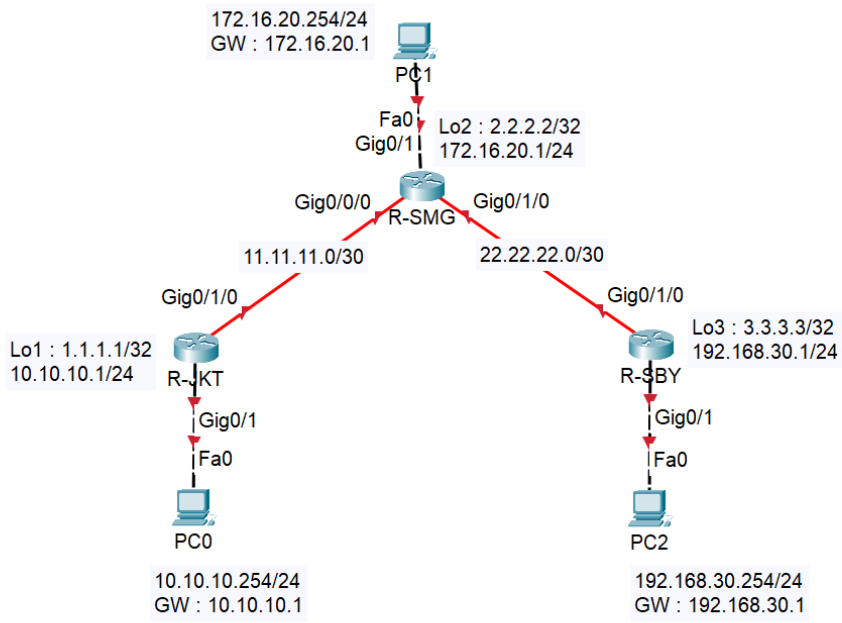
**Karakteristik EIGRP**

| Fitur | Deskripsi |
|---|---|
| Protokol | Hybrid (Distance Vector & Link-State) |
| Algoritma | DUAL (Diffusing Update Algorithm) |
| Metrik | Bandwidth, Delay(bisa juga: Load, Reliability) |
| Classless | Mendukung CIDR/VLSM |
| Autentikasi | Mendukung autentikasi MD5 |
| Multicast | Menggunakan 224.0.0.10 untuk pertukaran informasi |
| Routing Table | Menyimpan 3 table : Neighbor Table, Topology Table, Rotuing Table. |
| Versi IP | IPv4 & IPv6 |

**Cara Kerja EIGRP**

1. **Neighbor Discovery** : router mengirimkan hello packet untuk menemukan router EIGRP neighbor.
2. **DUAL Algorithm** : digunakan untuk menghitung jalur terbaik dan backup path tanpa loop. Menjamin fast convergence dan loop-free path.
3. **Topology Table** : menyimpan semua rute yang diterima dari tetangga, baik yang digunakan maupun tidak.
4. **Routing Table** : hanya rute terbaik(successor) yang dimasukkan ke routing table.

## Lab 5 EIGRP




Sesuai dengan topologi sebelumnya, Kita akan melakukan konfigurasi routing protocol EIGRP dengan menghapus terlebih dahulu konfigurasi RIPv2.

**R-JKT**

```
R-JKT#
R-JKT#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R-JKT(config)#no router rip
R-JKT(config)#router eigrp 10
R-JKT(config-router)#no auto-summary
R-JKT(config-router)#network 1.1.1.1 0.0.0.0
R-JKT(config-router)#network 10.10.10.0 0.0.0.255
R-JKT(config-router)#network 11.11.11.0 0.0.0.3
R-JKT(config-router)#
R-JKT(config-router)#end
```

```
R-JKT#
R-JKT#wr
Building configuration...
[OK]
 R-JKT#
```

**R-SMG**

```
R-SMG#
R-SMG#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R-SMG(config)#no router rip
R-SMG(config)#router eigrp 10
R-SMG(config-router)#no auto-summary
R-SMG(config-router)#network 2.2.2.2 0.0.0.0
R-SMG(config-router)#network 172.16.20.0 0.0.0.255
R-SMG(config-router)#network 22.22.22.0 0.0.0.3
R-SMG(config-router)#network 11.11.11.0 0.0.0.3
R-SMG(config-router)#end
R-SMG#
R-SMG#wr
Building configuration...
[OK]
R-SMG#
```

**R-SBY**

```
R-SBY#
R-SBY#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R-SBY(config)#no router rip
R-SBY(config)#router eigrp 10
R-SBY(config-router)#no auto-summary
R-SBY(config-router)#network 3.3.3.3 0.0.0.0
R-SBY(config-router)#network 192.168.30.0 0.0.0.255
R-SBY(config-router)#network 22.22.22.0 0.0.0.3
R-SBY(config-router)#end
R-SBY#
R-SBY#wr
Building configuration...
[OK]
 R-SBY#
```

## Verifikasi Routing Protocol RIPv2

### R-JKT

```
R-JKT#
R-JKT#show ip route
Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2, E - EGP
       i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, ia - IS-IS inter area
       * - candidate default, U - per-user static route, o - ODR
       P - periodic downloaded static route

Gateway of last resort is not set

     1.0.0.0/32 is subnetted, 1 subnets
C       1.1.1.1/32 is directly connected, Loopback1
     2.0.0.0/32 is subnetted, 1 subnets
D       2.2.2.2/32 [90/130816] via 11.11.11.2, 00:01:59, GigabitEthernet0/1/0
     3.0.0.0/32 is subnetted, 1 subnets
D       3.3.3.3/32 [90/131072] via 11.11.11.2, 00:01:59, GigabitEthernet0/1/0
     10.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
C       10.10.10.0/24 is directly connected, GigabitEthernet0/1
L       10.10.10.1/32 is directly connected, GigabitEthernet0/1
     11.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
C       11.11.11.0/30 is directly connected, GigabitEthernet0/1/0
L       11.11.11.1/32 is directly connected, GigabitEthernet0/1/0
     22.0.0.0/30 is subnetted, 1 subnets
D       22.22.22.0/30 [90/3072] via 11.11.11.2, 00:01:59, GigabitEthernet0/1/0
     172.16.0.0/24 is subnetted, 1 subnets
D       172.16.20.0/24 [90/5376] via 11.11.11.2, 00:01:59, GigabitEthernet0/1/0
D    192.168.30.0/24 [90/5632] via 11.11.11.2, 00:01:59, GigabitEthernet0/1/0

R-JKT#
```

### R-SMG

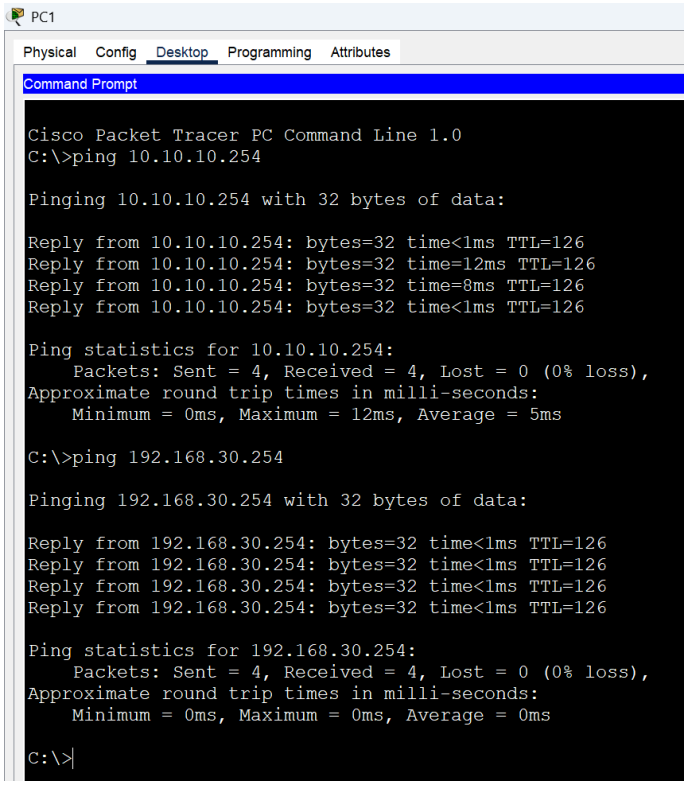
```
R-SMG#
R-SMG#show ip route
Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2, E - EGP
       i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, ia - IS-IS inter area
       * - candidate default, U - per-user static route, o - ODR
       P - periodic downloaded static route

Gateway of last resort is not set

     1.0.0.0/32 is subnetted, 1 subnets
D       1.1.1.1/32 [90/130816] via 11.11.11.1, 00:02:57, GigabitEthernet0/0/0
     2.0.0.0/32 is subnetted, 1 subnets
C       2.2.2.2/32 is directly connected, Loopback2
     3.0.0.0/32 is subnetted, 1 subnets
D       3.3.3.3/32 [90/130816] via 22.22.22.1, 00:09:32, GigabitEthernet0/1/0
     10.0.0.0/24 is subnetted, 1 subnets
D       10.10.10.0/24 [90/5376] via 11.11.11.1, 00:02:57, GigabitEthernet0/0/0
     11.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
C       11.11.11.0/30 is directly connected, GigabitEthernet0/0/0
L       11.11.11.2/32 is directly connected, GigabitEthernet0/0/0
     22.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
C       22.22.22.0/30 is directly connected, GigabitEthernet0/1/0
L       22.22.22.2/32 is directly connected, GigabitEthernet0/1/0
     172.16.0.0/16 is variably subnetted, 2 subnets, 2 masks
C       172.16.20.0/24 is directly connected, GigabitEthernet0/1
L       172.16.20.1/32 is directly connected, GigabitEthernet0/1
D    192.168.30.0/24 [90/5376] via 22.22.22.1, 00:09:32, GigabitEthernet0/1/0

R-SMG#
```

## R-SBY

```
R-SBY#
R-SBY#show ip route
Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2, E - EGP
       i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, ia - IS-IS inter area
       * - candidate default, U - per-user static route, o - ODR
       P - periodic downloaded static route

Gateway of last resort is not set

     1.0.0.0/32 is subnetted, 1 subnets
D       1.1.1.1/32 [90/131072] via 22.22.22.2, 00:03:45, GigabitEthernet0/1/0
     2.0.0.0/32 is subnetted, 1 subnets
D       2.2.2.2/32 [90/130816] via 22.22.22.2, 00:10:20, GigabitEthernet0/1/0
     3.0.0.0/32 is subnetted, 1 subnets
C       3.3.3.3/32 is directly connected, Loopback3
     10.0.0.0/24 is subnetted, 1 subnets
D       10.10.10.0/24 [90/5632] via 22.22.22.2, 00:03:45, GigabitEthernet0/1/0
     11.0.0.0/30 is subnetted, 1 subnets
D       11.11.11.0/30 [90/3072] via 22.22.22.2, 00:10:08, GigabitEthernet0/1/0
     22.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
C       22.22.22.0/30 is directly connected, GigabitEthernet0/1/0
L       22.22.22.1/32 is directly connected, GigabitEthernet0/1/0
     172.16.0.0/24 is subnetted, 1 subnets
D       172.16.20.0/24 [90/5376] via 22.22.22.2, 00:10:20, GigabitEthernet0/1/0
     192.168.30.0/24 is variably subnetted, 2 subnets, 2 masks
C       192.168.30.0/24 is directly connected, GigabitEthernet0/1
L       192.168.30.1/32 is directly connected, GigabitEthernet0/1

R-SBY#
```

Dari hasil verifikasi ***show ip route*** Kita bisa melihat bahwa routing protocol EIGRP sudah aktif, ditandai dengan symbol **D**.

## Ping PC-SMG to PC-SBY & PC-JKT



## OSPF

Routing **OSPF (Open Shortest Path First)** adalah salah satu protokol **routing dinamis** yang digunakan untuk mendistribusikan informasi routing dalam jaringan komputer, terutama dalam **jaringan besar dan kompleks**. OSPF adalah **Link-State Routing Protocol** yang mendukung standar terbuka (**open standard**), sehingga bisa digunakan di berbagai vendor perangkat jaringan (Cisco, MikroTik, Juniper, dll).

OSPF adalah **Interior Gateway Protocol (IGP)** yang bekerja di dalam **satu Autonomous System (AS)**. Protokol ini menggunakan **algoritma Dijkstra** untuk menghitung jalur terpendek ke tujuan berdasarkan **biaya (cost)**, bukan jumlah hop.

**Karakteristik OSPF**

| Fitur | Deskripsi |
|---|---|
| Protokol | Link-State |
| Algoritma | Dijkstra(Shortest Path First/SPF) |
| Metrik | Cost(berdasarkan bandwidth interface) |
| Classless | Mendukung CIDR/subnetting |
| Autentikasi | Mendukung autentikasi (planintext & MD5) |
| Multicast | Menggunakan 224.0.0.5(Hello) dan 224.0.0.6(update ke DR/BDR) |
| Konvergensi | Cepat, karena hanya perubahan yang dikirim |
| Versi IP | OSPFv2(IPv4) & OSPFv3(IPv6) |

**Struktur dan Konsep OSPF**

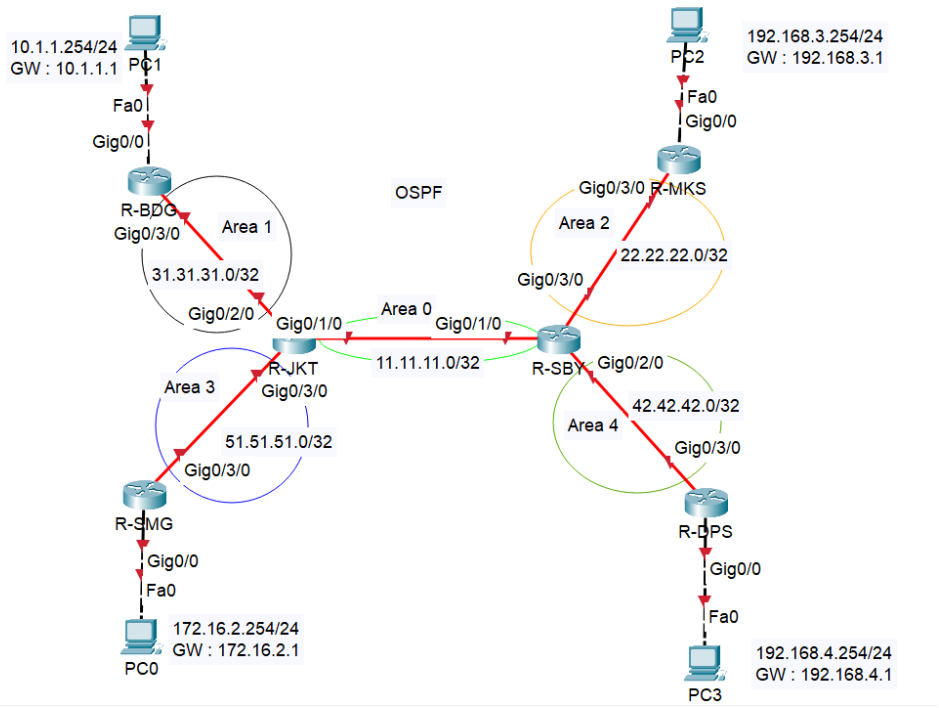
1. **Area** : OSPF membagi jaringan menjadi area untuk efisiensi
   - Area 0(Backbone Area) – wajib ada.
   - Area 1, 2 dst – Area non-Backbone.
2. **Router Types**:
   - Internal router : semua interface dalam 1 area.
   - Backbone router : salah satu area interface di area 0.
   - Area Border Router(ABR) : terhubung ke-dua atau lebih area.
3. Designated Router(**DR**) dan Backup Designated Router(**BDR**) : di jaringan broadcast(seperti Ethernet), DR & BDR dipilih untuk mengurangi overhead pertukaran informasi.
4. LSDB(Link-State Database) : semua router dalam area menyimpan Salinan basis data jaringan(topology map).

**Cara Kerja OSPF :**

1. **Neighbor Discovery** : router mengirim hello packet ke 224.0.0.5 untuk menemukan OSPF neighbor.
2. **Exchange Database** : setelah hubungan terbentuk, router akan melakukan pertukaran Link State Advertisement(LSA).
3. **SPF Calculation** : menggunakan algoritma Dijkstra untuk membangun jalur terpendek ke semua tujuan.

4. **Routing table update** : hanya perubahan(increment update) yang dikirim, lebih efisien.

## Lab 6 OSPF




| Device | Interface | IP Address | OSPF | Description |
|---|---|---|---|---|
| R-JKT | Gi0/1/0 | 11.11.11.1/30 | Area 0 | To_R-SBY |
| | Gi0/2/0 | 31.31.31.1/30 | Area 1 | To_R-BDG |
| | Gi0/3/0 | 51.51.51.1/30 | Area 3 | To_R-SMG |
| | Loopback 1 | 1.1.1.1/32 | Area 0 | IP_Loopback |
| R-SBY | Gi0/1/0 | 11.11.11.2/30 | Area 0 | To_R-JKT |
| | Gi0/2/0 | 42.42.42.1/30 | Area 4 | To_R-MKS |
| | Gi0/3/0 | 22.22.22.1/30 | Area 2 | To_R-DPS |
| | Loopback 2 | 2.2.2.2/32 | Area 0 | IP_Loopback |
| R-BDG | Gi0/3/0 | 31.31.31.2/30 | Area 1 | To_R-JKT |
| | Gi0/0 | 10.1.1.1/30 | Area 1 | To_LAN |
| | Loopback 3 | 3.3.3.3/32 | Area 1 | IP_Loopback |
| R-SMG | Gi0/3/0 | 51.51.51.2/30 | Area 3 | To_R-JKT |
| | Gi0/0 | 172.16.2.1/24 | Area 3 | To_LAN |
| | Loopback 4 | 4.4.4.4/32 | Area 3 | IP_Loopback |
| R-MKS | Gi0/3/0 | 22.22.22.2/30 | Area 2 | To_R-SBY |
| | Gi0/0 | 192.168.3.1/30 | Area 2 | To_LAN |
| | Loopback 5 | 5.5.5.5/32 | Area 2 | IP_Loopback |
| R-SMG | Gi0/3/0 | 42.42.42.2/30 | Area 4 | To_R-SBY |
| | Gi0/0 | 192.168.4.1/24 | Area 4 | To_LAN |
| | Loopback 6 | 6.6.6.6/32 | Area 4 | IP_Loopback |

Pada topologi diatas Kita diminta untuk melakukan konfigurasi routing protocol OSPF. Ada 5 area OSPF yang harus Kita konfigurasi terdiri dari A Backbone Area(Area 0) dan non-Backbone Area(Area1, Area2, Area3 & Area4).

**R-JKT**

```
Router>enable
Router#conf t
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#
Router(config)#hostname R-JKT
R-JKT(config)#
R-JKT(config)#interface loopback 1
R-JKT(config-if)#ip address 1.1.1.1 255.255.255.255
R-JKT(config-if)#exit
R-JKT(config)#
R-JKT(config)#interface gi0/1/0
R-JKT(config-if)#no shutdown
R-JKT(config-if)#description To_R-SBY
R-JKT(config-if)#ip address 11.11.11.1 255.255.255.252
R-JKT(config-if)#exit
R-JKT(config)#
R-JKT(config)#interface gi0/2/0
R-JKT(config-if)#no shutdown
R-JKT(config-if)#description To_R-BDG
R-JKT(config-if)#ip address 31.31.31.1 255.255.255.252
R-JKT(config-if)#exit
R-JKT(config)#
R-JKT(config)#interface gi0/3/0
R-JKT(config-if)#no shutdown
R-JKT(config-if)#description To_R-SMG
R-JKT(config-if)#ip address 51.51.51.1 255.255.255.252
R-JKT(config-if)#exit
R-JKT(config)#
R-JKT(config)#router ospf 1
R-JKT(config-router)#router-id 1.1.1.1
R-JKT(config-router)#network 1.1.1.1 0.0.0.0 area 0
R-JKT(config-router)#network 11.11.11.0 0.0.0.3 area 0
R-JKT(config-router)#network 31.31.31.0 0.0.0.3 area 1
R-JKT(config-router)#network 51.51.51.0 0.0.0.3 area 3
R-JKT(config-router)#exit
R-JKT(config)#
R-JKT(config)#interface gi0/1/0
R-JKT(config-if)#ip ospf network point-to-point
R-JKT(config-if)#exit
R-JKT(config)#
R-JKT(config)#interface gi0/2/0
R-JKT(config-if)#ip ospf network point-to-point
```

```
R-JKT(config-if)#exit
R-JKT(config)#interface gi0/3/0
R-JKT(config-if)#ip ospf network point-to-point
R-JKT(config-if)#exit
R-JKT(config)#end
R-JKT#
R-JKT#wr
Building configuration...
[OK]
R-JKT#
```

**R-SBY**

```
Router>enable
Router#conf t
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#hostname R-SBY
R-SBY(config)#
R-SBY(config)#interface loopback 2
R-SBY(config-if)#ip address 2.2.2.2 255.255.255.255
R-SBY(config-if)#exit
R-SBY(config)#
R-SBY(config)#interface gi0/1/0
R-SBY(config-if)#no shutdown
R-SBY(config-if)#description To_R-JKT
R-SBY(config-if)#ip address 11.11.11.2 255.255.255.252
R-SBY(config-if)#exit
R-SBY(config)#
R-SBY(config)#interface gi0/2/0
R-SBY(config-if)#no shutdown
R-SBY(config-if)#description To_R-DPS
R-SBY(config-if)#ip address 42.42.42.1 255.255.255.252
R-SBY(config-if)#exit
R-SBY(config)#
R-SBY(config)#interface gi0/3/0
R-SBY(config-if)#no shutdown
R-SBY(config-if)#description To_R-MKS
R-SBY(config-if)#ip address 22.22.22.1 255.255.255.252
R-SBY(config-if)#exit
R-SBY(config)#
R-SBY(config)#router ospf 2
R-SBY(config-router)#router-id 2.2.2.2
R-SBY(config-router)#network 2.2.2.2 0.0.0.0 area 0
R-SBY(config-router)#network 11.11.11.0 0.0.0.3 area 0
R-SBY(config-router)#network 22.22.22.0 0.0.0.3 area 2
R-SBY(config-router)#network 42.42.42.0 0.0.0.3 area 4
R-SBY(config-router)#exit
R-SBY(config)#interface gi0/1/0
```

```
R-SBY(config-if)#ip ospf network point-to-point
R-SBY(config-if)#exit
R-SBY(config)#
R-SBY(config)#interface gi0/2/0
R-SBY(config-if)#ip ospf network point-to-point
R-SBY(config-if)#exit
R-SBY(config)#
R-SBY(config)#interface gi0/3/0
R-SBY(config-if)#ip ospf network point-to-point
R-SBY(config-if)#exit
R-SBY(config)#end
R-SBY#
R-SBY#wr
Building configuration...
[OK]
R-SBY#
```

**R-BDG**

```
Router>enable
Router#conf t
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#hostname R-BDG
R-BDG(config)#interface loopback 3
R-BDG(config-if)#ip address 3.3.3.3 255.255.255.255
R-BDG(config-if)#exit
R-BDG(config)#
R-BDG(config)#interface gi0/3/0
R-BDG(config-if)#no shutdown
R-BDG(config-if)#description To_R-JKT
R-BDG(config-if)#ip address 31.31.31.2 255.255.255.252
R-BDG(config-if)#exit
R-BDG(config-if)#
R-BDG(config)#interface gi0/0
R-BDG(config-if)#no shutdown
R-BDG(config-if)#description To_LAN
R-BDG(config-if)#ip address 10.1.1.1 255.255.255.0
R-BDG(config-if)#exit
R-BDG(config)#
R-BDG(config)#router ospf 3
R-BDG(config-router)#router-id 3.3.3.3
R-BDG(config-router)#network 3.3.3.3 0.0.0.0 area 1
R-BDG(config-router)#network 31.31.31.0 0.0.0.3 area 1
R-BDG(config-router)#network 10.1.1.0 0.0.0.255 area 1
R-BDG(config-router)#exit
R-BDG(config)#
R-BDG(config)#interface gi0/3/0
R-BDG(config-if)#ip ospf network point-to-point
```

```
R-BDG(config-if)#end
R-BDG#
R-BDG#wr
Building configuration...
[OK]
R-BDG#
```

**R-SMG**

```
Router>enable
Router#conf t
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#hostname R-SMG
R-SMG(config)#interface loopback 4
R-SMG(config-if)#ip address 4.4.4.4 255.255.255.255
R-SMG(config-if)#exit
R-SMG(config)#
R-SMG(config)#interface gi0/3/0
R-SMG(config-if)#no shutdown
R-SMG(config-if)#description To_R-JKT
R-SMG(config-if)#ip address 51.51.51.2 255.255.255.252
R-SMG(config-if)#exit
R-SMG(config)#
R-SMG(config)#interface gi0/0
R-SMG(config-if)#no shutdown
R-SMG(config-if)#description To_LAN
R-SMG(config-if)#ip address 172.16.2.1 255.255.255.0
R-SMG(config-if)#exit
R-SMG(config)#
R-SMG(config)#router ospf 4
R-SMG(config-router)#router-id 4.4.4.4
R-SMG(config-router)#network 4.4.4.4 0.0.0.0 area 3
R-SMG(config-router)#network 51.51.51.0 0.0.0.3 area 3
R-SMG(config-router)#network 172.16.2.0 0.0.0.255 area 3
R-SMG(config-router)#exit
R-SMG(config)#
R-SMG(config)#interface gi0/3/0
R-SMG(config-if)#ip ospf network point-to-point
R-SMG(config-if)#end
R-SMG#
R-SMG#wr
Building configuration...
[OK]
R-SMG#
```

**R-MKS**

```
Router>enable
Router#conf t
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#hostname R-MKS
R-MKS(config)#interface loopback 5
R-MKS(config-if)#ip address 5.5.5.5 255.255.255.255
R-MKS(config-if)#exit
R-MKS(config)#
R-MKS(config)#interface gi0/3/0
R-MKS(config-if)#no shutdown
R-MKS(config-if)#description To_R-SBY
R-MKS(config-if)#ip address 22.22.22.2 255.255.255.252
R-MKS(config-if)#exit
R-MKS(config)#
R-MKS(config)#interface gi0/0
R-MKS(config-if)#no shutdown
R-MKS(config-if)#description To_LAN
R-MKS(config-if)#ip address 192.168.3.1 255.255.255.0
R-MKS(config-if)#exit
R-MKS(config)#
R-MKS(config)#router ospf 5
R-MKS(config-router)#router-id 5.5.5.5
R-MKS(config-router)#network 5.5.5.5 0.0.0.0 area 2
R-MKS(config-router)#network 22.22.22.0 0.0.0.3 area 2
R-MKS(config-router)#network 192.168.3.0 0.0.0.255 area 2
R-MKS(config-router)#exit
R-MKS(config)#
R-MKS(config)#interface gi0/3/0
R-MKS(config-if)#ip ospf network point-to-point
R-MKS(config-if)#end
R-MKS#
R-MKS#wr
Building configuration...
[OK]
R-MKS#
```

**R-DPS**

```
Router>enable
Router#conf t
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#hostname R-DPS
R-DPS(config)#interface loopback 6
R-DPS(config-if)#ip address 6.6.6.6 255.255.255.255
R-DPS(config-if)#exit
R-DPS(config)#interface gi0/3/0
R-DPS(config-if)#no shutdown
```

```
R-DPS(config-if)#description To_R-SBY
R-DPS(config-if)#ip address 42.42.42.2 255.255.255.252
R-DPS(config-if)#exit
R-DPS(config)#interface gi0/0
R-DPS(config-if)#no shutdown
R-DPS(config-if)#description To_LAN
R-DPS(config-if)#ip address 192.168.4.1 255.255.255.0
R-DPS(config-if)#exit
R-DPS(config)#
R-DPS(config)#router ospf 6
R-DPS(config-router)#router-id 6.6.6.6
R-DPS(config-router)#network 6.6.6.6 0.0.0.0 area 4
R-DPS(config-router)#network 42.42.42.0 0.0.0.3 area 4
R-DPS(config-router)#network 192.168.4.0 0.0.0.255 area 4
R-DPS(config-router)#exit
R-DPS(config)#
R-DPS(config)#interface gi0/3/0
R-DPS(config-if)#ip ospf network point-to-point
R-DPS(config-if)#end
R-DPS#
R-DPS#wr
Building configuration...
[OK]
R-DPS#
```

**Verifikasi**

**R-JKT**

```
R-JKT#show ip route ospf
     2.0.0.0/32 is subnetted, 1 subnets
O       2.2.2.2 [110/2] via 11.11.11.2, 00:52:16, GigabitEthernet0/1/0
     3.0.0.0/32 is subnetted, 1 subnets
O       3.3.3.3 [110/2] via 31.31.31.2, 00:42:11, GigabitEthernet0/2/0
     4.0.0.0/32 is subnetted, 1 subnets
O       4.4.4.4 [110/2] via 51.51.51.2, 00:30:32, GigabitEthernet0/3/0
     5.0.0.0/32 is subnetted, 1 subnets
O IA    5.5.5.5 [110/3] via 11.11.11.2, 00:21:35, GigabitEthernet0/1/0
     6.0.0.0/32 is subnetted, 1 subnets
O IA    6.6.6.6 [110/3] via 11.11.11.2, 00:15:04, GigabitEthernet0/1/0
     10.0.0.0/24 is subnetted, 1 subnets
O       10.1.1.0 [110/2] via 31.31.31.2, 00:42:11, GigabitEthernet0/2/0
     22.0.0.0/30 is subnetted, 1 subnets
O IA    22.22.22.0 [110/2] via 11.11.11.2, 00:23:56, GigabitEthernet0/1/0
     42.0.0.0/30 is subnetted, 1 subnets
O IA    42.42.42.0 [110/2] via 11.11.11.2, 00:17:14, GigabitEthernet0/1/0
     172.16.0.0/24 is subnetted, 1 subnets
O       172.16.2.0 [110/2] via 51.51.51.2, 00:30:32, GigabitEthernet0/3/0
O IA 192.168.3.0 [110/3] via 11.11.11.2, 00:21:35, GigabitEthernet0/1/0
O IA 192.168.4.0 [110/3] via 11.11.11.2, 00:15:04, GigabitEthernet0/1/0

R-JKT#show ip ospf neighbor


Neighbor ID     Pri   State           Dead Time   Address         Interface
2.2.2.2           0   FULL/  -        00:00:35    11.11.11.2      GigabitEthernet0/1/0
3.3.3.3           0   FULL/  -        00:00:30    31.31.31.2      GigabitEthernet0/2/0
4.4.4.4           0   FULL/  -        00:00:36    51.51.51.2      GigabitEthernet0/3/0
R-JKT#
```

## R-SBY

```
R-SBY#show ip route ospf
     1.0.0.0/32 is subnetted, 1 subnets
O       1.1.1.1 [110/2] via 11.11.11.1, 00:53:13, GigabitEthernet0/1/0
     3.0.0.0/32 is subnetted, 1 subnets
O IA    3.3.3.3 [110/3] via 11.11.11.1, 00:43:03, GigabitEthernet0/1/0
     4.0.0.0/32 is subnetted, 1 subnets
O IA    4.4.4.4 [110/3] via 11.11.11.1, 00:31:24, GigabitEthernet0/1/0
     5.0.0.0/32 is subnetted, 1 subnets
O       5.5.5.5 [110/2] via 22.22.22.2, 00:22:37, GigabitEthernet0/3/0
     6.0.0.0/32 is subnetted, 1 subnets
O       6.6.6.6 [110/2] via 42.42.42.2, 00:16:06, GigabitEthernet0/2/0
     10.0.0.0/24 is subnetted, 1 subnets
O IA    10.1.1.0 [110/3] via 11.11.11.1, 00:43:03, GigabitEthernet0/1/0
     31.0.0.0/30 is subnetted, 1 subnets
O IA    31.31.31.0 [110/2] via 11.11.11.1, 00:46:15, GigabitEthernet0/1/0
     51.0.0.0/30 is subnetted, 1 subnets
O IA    51.51.51.0 [110/2] via 11.11.11.1, 00:34:14, GigabitEthernet0/1/0
     172.16.0.0/24 is subnetted, 1 subnets
O IA    172.16.2.0 [110/3] via 11.11.11.1, 00:31:24, GigabitEthernet0/1/0
O    192.168.3.0 [110/2] via 22.22.22.2, 00:22:37, GigabitEthernet0/3/0
O    192.168.4.0 [110/2] via 42.42.42.2, 00:16:06, GigabitEthernet0/2/0

R-SBY#
R-SBY#show ip ospf nei
R-SBY#show ip ospf neighbor


Neighbor ID     Pri   State           Dead Time   Address         Interface
1.1.1.1           0   FULL/  -        00:00:32    11.11.11.1      GigabitEthernet0/1/0
5.5.5.5           0   FULL/  -        00:00:35    22.22.22.2      GigabitEthernet0/3/0
6.6.6.6           0   FULL/  -        00:00:37    42.42.42.2      GigabitEthernet0/2/0
R-SBY#
```

## R-BDG

```
R-BDG#show ip route ospf
     1.0.0.0/32 is subnetted, 1 subnets
O IA    1.1.1.1 [110/2] via 31.31.31.1, 00:45:07, GigabitEthernet0/3/0
     2.0.0.0/32 is subnetted, 1 subnets
O IA    2.2.2.2 [110/3] via 31.31.31.1, 00:45:07, GigabitEthernet0/3/0
     4.0.0.0/32 is subnetted, 1 subnets
O IA    4.4.4.4 [110/3] via 31.31.31.1, 00:33:23, GigabitEthernet0/3/0
     5.0.0.0/32 is subnetted, 1 subnets
O IA    5.5.5.5 [110/4] via 31.31.31.1, 00:24:27, GigabitEthernet0/3/0
     6.0.0.0/32 is subnetted, 1 subnets
O IA    6.6.6.6 [110/4] via 31.31.31.1, 00:17:56, GigabitEthernet0/3/0
     11.0.0.0/30 is subnetted, 1 subnets
O IA    11.11.11.0 [110/2] via 31.31.31.1, 00:45:07, GigabitEthernet0/3/0
     22.0.0.0/30 is subnetted, 1 subnets
O IA    22.22.22.0 [110/3] via 31.31.31.1, 00:26:47, GigabitEthernet0/3/0
     42.0.0.0/30 is subnetted, 1 subnets
O IA    42.42.42.0 [110/3] via 31.31.31.1, 00:20:06, GigabitEthernet0/3/0
     51.0.0.0/30 is subnetted, 1 subnets
O IA    51.51.51.0 [110/2] via 31.31.31.1, 00:36:13, GigabitEthernet0/3/0
     172.16.0.0/24 is subnetted, 1 subnets
O IA    172.16.2.0 [110/3] via 31.31.31.1, 00:33:23, GigabitEthernet0/3/0
O IA 192.168.3.0 [110/4] via 31.31.31.1, 00:24:27, GigabitEthernet0/3/0
O IA 192.168.4.0 [110/4] via 31.31.31.1, 00:17:56, GigabitEthernet0/3/0

R-BDG#show ip ospf neighbor


Neighbor ID     Pri   State           Dead Time   Address         Interface
1.1.1.1           0   FULL/  -        00:00:35    31.31.31.1      GigabitEthernet0/3/0
R-BDG#
```

## R-SMG

```
R-SMG#
R-SMG#show ip route ospf
     1.0.0.0/32 is subnetted, 1 subnets
O IA    1.1.1.1 [110/2] via 51.51.51.1, 00:36:05, GigabitEthernet0/3/0
     2.0.0.0/32 is subnetted, 1 subnets
O IA    2.2.2.2 [110/3] via 51.51.51.1, 00:36:05, GigabitEthernet0/3/0
     3.0.0.0/32 is subnetted, 1 subnets
O IA    3.3.3.3 [110/3] via 51.51.51.1, 00:36:05, GigabitEthernet0/3/0
     5.0.0.0/32 is subnetted, 1 subnets
O IA    5.5.5.5 [110/4] via 51.51.51.1, 00:27:04, GigabitEthernet0/3/0
     6.0.0.0/32 is subnetted, 1 subnets
O IA    6.6.6.6 [110/4] via 51.51.51.1, 00:20:30, GigabitEthernet0/3/0
     10.0.0.0/24 is subnetted, 1 subnets
O IA    10.1.1.0 [110/3] via 51.51.51.1, 00:36:05, GigabitEthernet0/3/0
     11.0.0.0/30 is subnetted, 1 subnets
O IA    11.11.11.0 [110/2] via 51.51.51.1, 00:36:05, GigabitEthernet0/3/0
     22.0.0.0/30 is subnetted, 1 subnets
O IA    22.22.22.0 [110/3] via 51.51.51.1, 00:29:24, GigabitEthernet0/3/0
     31.0.0.0/30 is subnetted, 1 subnets
O IA    31.31.31.0 [110/2] via 51.51.51.1, 00:36:05, GigabitEthernet0/3/0
     42.0.0.0/30 is subnetted, 1 subnets
O IA    42.42.42.0 [110/3] via 51.51.51.1, 00:22:43, GigabitEthernet0/3/0
O IA 192.168.3.0 [110/4] via 51.51.51.1, 00:27:04, GigabitEthernet0/3/0
O IA 192.168.4.0 [110/4] via 51.51.51.1, 00:20:30, GigabitEthernet0/3/0

R-SMG#show ip ospf neighbor


Neighbor ID     Pri   State           Dead Time   Address         Interface
1.1.1.1           0   FULL/  -        00:00:30    51.51.51.1      GigabitEthernet0/3/0
R-SMG#
R-SMG#
```

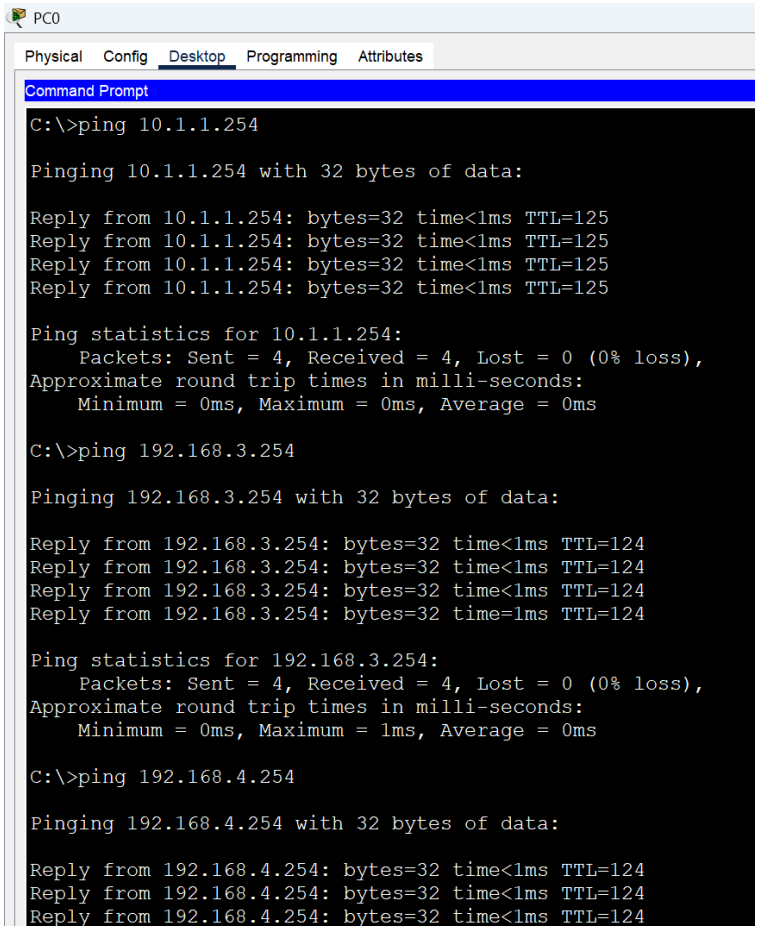
## R-MKS

```
R-MKS#show ip route ospf
     1.0.0.0/32 is subnetted, 1 subnets
O IA    1.1.1.1 [110/3] via 22.22.22.1, 00:30:32, GigabitEthernet0/3/0
     2.0.0.0/32 is subnetted, 1 subnets
O IA    2.2.2.2 [110/2] via 22.22.22.1, 00:30:32, GigabitEthernet0/3/0
     3.0.0.0/32 is subnetted, 1 subnets
O IA    3.3.3.3 [110/4] via 22.22.22.1, 00:30:32, GigabitEthernet0/3/0
     4.0.0.0/32 is subnetted, 1 subnets
O IA    4.4.4.4 [110/4] via 22.22.22.1, 00:30:32, GigabitEthernet0/3/0
     6.0.0.0/32 is subnetted, 1 subnets
O IA    6.6.6.6 [110/3] via 22.22.22.1, 00:23:53, GigabitEthernet0/3/0
     10.0.0.0/24 is subnetted, 1 subnets
O IA    10.1.1.0 [110/4] via 22.22.22.1, 00:30:32, GigabitEthernet0/3/0
     11.0.0.0/30 is subnetted, 1 subnets
O IA    11.11.11.0 [110/2] via 22.22.22.1, 00:30:32, GigabitEthernet0/3/0
     31.0.0.0/30 is subnetted, 1 subnets
O IA    31.31.31.0 [110/3] via 22.22.22.1, 00:30:32, GigabitEthernet0/3/0
     42.0.0.0/30 is subnetted, 1 subnets
O IA    42.42.42.0 [110/2] via 22.22.22.1, 00:26:06, GigabitEthernet0/3/0
     51.0.0.0/30 is subnetted, 1 subnets
O IA    51.51.51.0 [110/3] via 22.22.22.1, 00:30:32, GigabitEthernet0/3/0
     172.16.0.0/24 is subnetted, 1 subnets
O IA    172.16.2.0 [110/4] via 22.22.22.1, 00:30:32, GigabitEthernet0/3/0
O IA 192.168.4.0 [110/3] via 22.22.22.1, 00:23:53, GigabitEthernet0/3/0

R-MKS#
R-MKS#show ip ospf neighbor


Neighbor ID     Pri   State           Dead Time   Address         Interface
2.2.2.2           0   FULL/  -        00:00:36    22.22.22.1      GigabitEthernet0/3/0
R-MKS#
```

## R-DPS

```
R-DPS#show ip route ospf
     1.0.0.0/32 is subnetted, 1 subnets
O IA    1.1.1.1 [110/3] via 42.42.42.1, 00:24:53, GigabitEthernet0/3/0
     2.0.0.0/32 is subnetted, 1 subnets
O IA    2.2.2.2 [110/2] via 42.42.42.1, 00:24:53, GigabitEthernet0/3/0
     3.0.0.0/32 is subnetted, 1 subnets
O IA    3.3.3.3 [110/4] via 42.42.42.1, 00:24:53, GigabitEthernet0/3/0
     4.0.0.0/32 is subnetted, 1 subnets
O IA    4.4.4.4 [110/4] via 42.42.42.1, 00:24:53, GigabitEthernet0/3/0
     5.0.0.0/32 is subnetted, 1 subnets
O IA    5.5.5.5 [110/3] via 42.42.42.1, 00:24:53, GigabitEthernet0/3/0
     10.0.0.0/24 is subnetted, 1 subnets
O IA    10.1.1.0 [110/4] via 42.42.42.1, 00:24:53, GigabitEthernet0/3/0
     11.0.0.0/30 is subnetted, 1 subnets
O IA    11.11.11.0 [110/2] via 42.42.42.1, 00:24:53, GigabitEthernet0/3/0
     22.0.0.0/30 is subnetted, 1 subnets
O IA    22.22.22.0 [110/2] via 42.42.42.1, 00:24:53, GigabitEthernet0/3/0
     31.0.0.0/30 is subnetted, 1 subnets
O IA    31.31.31.0 [110/3] via 42.42.42.1, 00:24:53, GigabitEthernet0/3/0
     51.0.0.0/30 is subnetted, 1 subnets
O IA    51.51.51.0 [110/3] via 42.42.42.1, 00:24:53, GigabitEthernet0/3/0
     172.16.0.0/24 is subnetted, 1 subnets
O IA    172.16.2.0 [110/4] via 42.42.42.1, 00:24:53, GigabitEthernet0/3/0
O IA 192.168.3.0 [110/3] via 42.42.42.1, 00:24:53, GigabitEthernet0/3/0

R-DPS#
R-DPS#show ip ospf neighbor


Neighbor ID     Pri   State           Dead Time   Address         Interface
2.2.2.2           0   FULL/  -        00:00:32    42.42.42.1      GigabitEthernet0/3/0
R-DPS#
```

## Ping PC0-SMG to PC-BDG, PC-MKS, and PC-DPS



## BGP

**BGP (Border Gateway Protocol)** adalah **protokol routing antar domain** yang digunakan untuk mentransfer informasi routing antara jaringan-jaringan besar yang berbeda, atau biasa disebut **Autonomous System (AS)**. BGP adalah **protokol utama di internet**, karena bertanggung jawab mengatur bagaimana data ditransmisikan antar ISP, perusahaan besar, dan penyedia cloud.

**Fungsi Utama BGP**

1. Menyediakan routing antar Autonomous System(inter-domain).
2. Menentukan jalur terbaik berdasarkan kebijakan(policy), bukan hanya kecepatan atau jarak.
3. Mengelola ribuan hingga ratusan ribu rute secara efisien(skala besar).
4. Dasar dari internet global routing table.

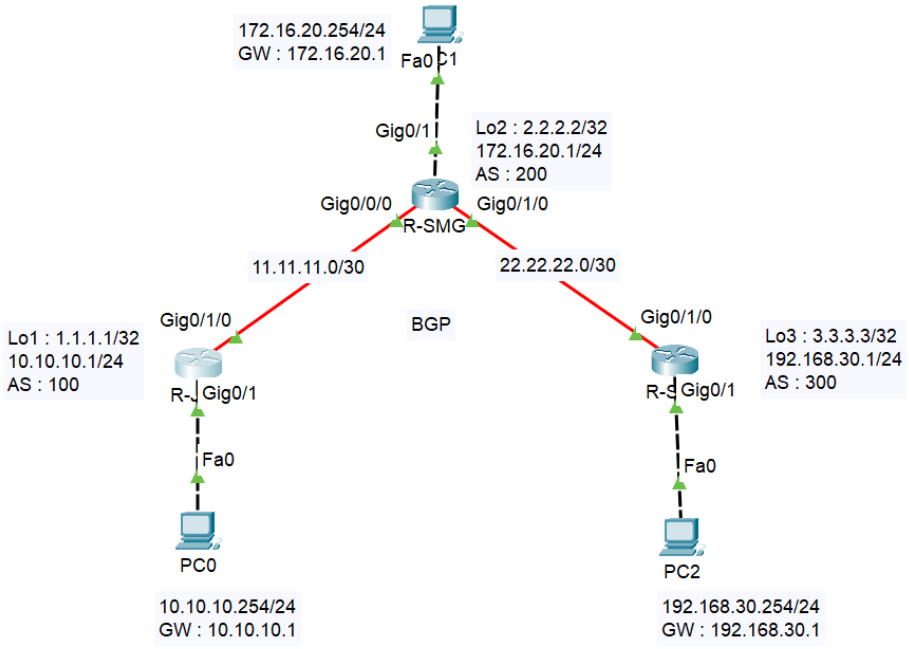
**Karakteristik BGP**

| Fitur | Deskripsi |
|---|---|
| Protokol | Path Vector |
| Layer | Layer 4(menggunakan TCP port 179) |
| Transport Protocol | TCP |
| Skalabilitas | Sangat tinggi(digunakan untuk internet global) |
| Konvergensi | Lebih lambat dibangding IGP(untuk stabilitas) |
| Routing Policy | Sangat fleksibel dengan atribut seperti AS-PATH, LOCAL_PREF, |
| Loop Prevention | Dengan pengecekan AS-PATH |
| Versi IP | IPv4 & IPv6 |

**Jenis BGP :**

1. **eBGP**(External BGP)
    - Digunakan antar AS yang berbeda, contoh : ISP dan Perusahaan.
2. **iBGP**(Internal BGP)
    - Digunakan di dalam satu AS
    - Semua router iBGP harus full-mesh secara logika, atau menggunakan Route Reflector.

## Lab 7 BGP




Sesuai dengan topologi diatas yang digunakan untuk konfigurasi RIPv2 dan EIGRP, Kita akan konfigurasi routing eBGP(Eksternal BGP) pada topologi tersebut dengan menghapus terlebih dahulu konfigurasi routing EIGRP nya. Pada Cisco Packet Tracer konfigurasi routing BGP hanya bisa dilakukan eBGP(eksternal BGP) saja, untuk iBGP(internal BGP) tidak di support.

**R-JKT**

```
R-JKT#
R-JKT#show run | sec route
router eigrp 10
network 1.1.1.1 0.0.0.0
network 10.10.10.0 0.0.0.255
network 11.11.11.0 0.0.0.3
R-JKT#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R-JKT(config)#no router eigrp 10
R-JKT(config)#router bgp 100
R-JKT(config-router)#neighbor 11.11.11.2 remote-as 200
R-JKT(config-router)#network 1.1.1.1 mask 255.255.255.255
R-JKT(config-router)#network 11.11.11.0 mask 255.255.255.252
R-JKT(config-router)#network 10.10.10.0 mask 255.255.255.0
R-JKT(config-router)#end
R-JKT#
R-JKT#wr
R-JKT#
```

**R-SMG**

```
R-SMG#
R-SMG#show run | sec route
router eigrp 10
network 2.2.2.2 0.0.0.0
network 172.16.20.0 0.0.0.255
network 22.22.22.0 0.0.0.3
network 11.11.11.0 0.0.0.3
R-SMG#
R-SMG#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R-SMG(config)#no router eigrp 10
R-SMG(config)#
R-SMG(config)#router bgp 200
R-SMG(config-router)#neighbor 11.11.11.1 remote-as 100
R-SMG(config-router)#neighbor 22.22.22.1 remote-as 300
R-SMG(config-router)#network 2.2.2.2 mask 255.255.255.255
R-SMG(config-router)#network 11.11.11.0 mask 255.255.255.252
R-SMG(config-router)#network 22.22.22.0 mask 255.255.255.252
R-SMG(config-router)#network 172.16.20.0 mask 255.255.255.0
R-SMG(config-router)#end
R-SMG#
R-SMG#wr
R-SMG#
```

**R-SBY**

```
R-SBY#
R-SBY#show run | sec route
router eigrp 10
network 3.3.3.3 0.0.0.0
network 192.168.30.0
network 22.22.22.0 0.0.0.3
R-SBY#
R-SBY#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R-SBY(config)#no router eigrp 10
R-SBY(config)#
R-SBY(config)#router bgp 300
R-SBY(config-router)#neighbor 22.22.22.2 remote-as 200
R-SBY(config-router)#network 3.3.3.3 mask 255.255.255.255
R-SBY(config-router)#network 22.22.22.0 mask 255.255.255.252
R-SBY(config-router)#network 192.168.30.0 mask 255.255.255.0
R-SBY(config-router)#end
R-SBY#
R-SBY#wr
R-SBY#
```

## Verifikasi

### R-JKT

```
R-JKT#show ip route bgp
B    2.2.2.2 [20/0] via 11.11.11.2, 00:00:00
B    3.3.3.3 [20/0] via 11.11.11.2, 00:00:00
B    22.22.22.0 [20/0] via 11.11.11.2, 00:00:00
B    172.16.20.0 [20/0] via 11.11.11.2, 00:00:00
B    192.168.30.0/24 [20/0] via 11.11.11.2, 00:00:00

R-JKT#show ip bgp
BGP table version is 10, local router ID is 1.1.1.1
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
              r RIB-failure, S Stale
Origin codes: i - IGP, e - EGP, ? - incomplete

   Network          Next Hop            Metric LocPrf Weight Path
*> 1.1.1.1/32       0.0.0.0                  0     0 32768 i
*> 2.2.2.2/32       11.11.11.2               0     0     0 200 i
*> 3.3.3.3/32       11.11.11.2               0     0     0 200 300 i
*> 10.10.10.0/24    0.0.0.0                  0     0 32768 i
*> 11.11.11.0/30    0.0.0.0                  0     0 32768 i
*                   11.11.11.2               0     0     0 200 i
*> 22.22.22.0/30    11.11.11.2               0     0     0 200 i
*> 172.16.20.0/24   11.11.11.2               0     0     0 200 i
*> 192.168.30.0/24  11.11.11.2               0     0     0 200 300 i

R-JKT#
```

### R-SMG

```
R-SMG#show ip route bgp
B    1.1.1.1 [20/0] via 11.11.11.1, 00:00:00
B    3.3.3.3 [20/0] via 22.22.22.1, 00:00:00
B    10.10.10.0 [20/0] via 11.11.11.1, 00:00:00
B    192.168.30.0/24 [20/0] via 22.22.22.1, 00:00:00

R-SMG#show ip bgp
BGP table version is 11, local router ID is 2.2.2.2
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
              r RIB-failure, S Stale
Origin codes: i - IGP, e - EGP, ? - incomplete

   Network          Next Hop            Metric LocPrf Weight Path
*> 1.1.1.1/32       11.11.11.1               0     0     0 100 i
*> 2.2.2.2/32       0.0.0.0                  0     0 32768 i
*> 3.3.3.3/32       22.22.22.1               0     0     0 300 i
*> 10.10.10.0/24    11.11.11.1               0     0     0 100 i
*  11.11.11.0/30    11.11.11.1               0     0     0 100 i
*>                  0.0.0.0                  0     0 32768 i
*> 22.22.22.0/30    0.0.0.0                  0     0 32768 i
*                   22.22.22.1               0     0     0 300 i
*> 172.16.20.0/24   0.0.0.0                  0     0 32768 i
*> 192.168.30.0/24  22.22.22.1               0     0     0 300 i

R-SMG#
```

**R-SBY**

```
R-SBY#
R-SBY#show ip route bgp
B    1.1.1.1 [20/0] via 22.22.22.2, 00:00:00
B    2.2.2.2 [20/0] via 22.22.22.2, 00:00:00
B    10.10.10.0 [20/0] via 22.22.22.2, 00:00:00
B    11.11.11.0 [20/0] via 22.22.22.2, 00:00:00
B    172.16.20.0 [20/0] via 22.22.22.2, 00:00:00

R-SBY#show ip bgp
BGP table version is 10, local router ID is 3.3.3.3
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
              r RIB-failure, S Stale
Origin codes: i - IGP, e - EGP, ? - incomplete

   Network          Next Hop            Metric LocPrf Weight Path
*> 1.1.1.1/32       22.22.22.2               0     0      0 200 100 i
*> 2.2.2.2/32       22.22.22.2               0     0      0 200 i
*> 3.3.3.3/32       0.0.0.0                  0     0 32768 i
*> 10.10.10.0/24    22.22.22.2               0     0      0 200 100 i
*> 11.11.11.0/30    22.22.22.2               0     0      0 200 i
*  22.22.22.0/30    22.22.22.2               0     0      0 200 i
*>                  0.0.0.0                  0     0 32768 i
*> 172.16.20.0/24   22.22.22.2               0     0      0 200 i
*> 192.168.30.0/24  0.0.0.0                  0     0 32768 i

R-SBY#
```

**Ping dari PC0-JKT to PC-SMG dan PC-SBY**

PC0

Physical | Config | Desktop | Programming | Attributes

Command Prompt

```
Cisco Packet Tracer PC Command Line 1.0
C:\>ping 172.16.20.254

Pinging 172.16.20.254 with 32 bytes of data:

Reply from 172.16.20.254: bytes=32 time<1ms TTL=126
Reply from 172.16.20.254: bytes=32 time<1ms TTL=126
Reply from 172.16.20.254: bytes=32 time=1ms TTL=126
Reply from 172.16.20.254: bytes=32 time<1ms TTL=126

Ping statistics for 172.16.20.254:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 0ms, Maximum = 1ms, Average = 0ms

C:\>ping 192.168.30.254

Pinging 192.168.30.254 with 32 bytes of data:

Reply from 192.168.30.254: bytes=32 time<1ms TTL=125
Reply from 192.168.30.254: bytes=32 time<1ms TTL=125
Reply from 192.168.30.254: bytes=32 time<1ms TTL=125
Reply from 192.168.30.254: bytes=32 time<1ms TTL=125

Ping statistics for 192.168.30.254:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 0ms, Maximum = 0ms, Average = 0ms

C:\>
```

## DHCP

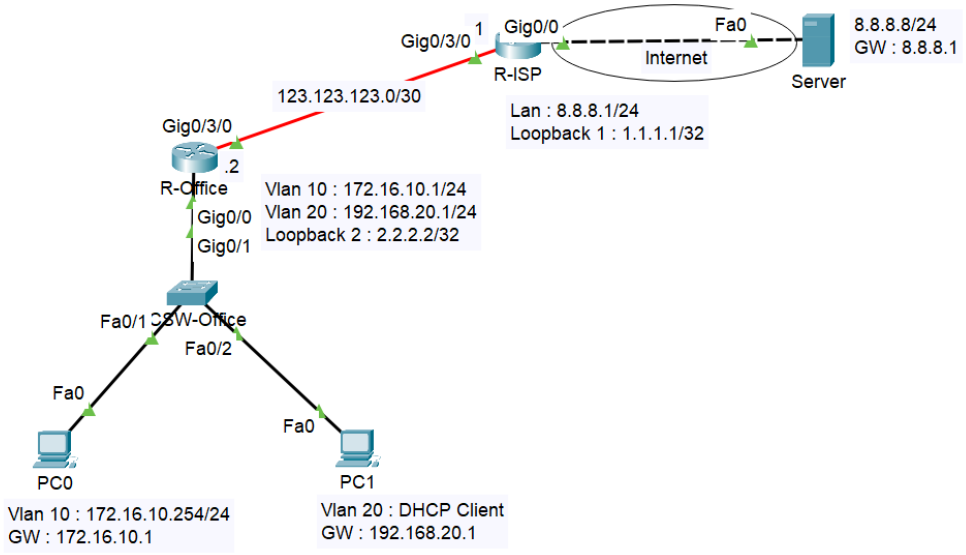
**DHCP** (Dynamic Host Configuration Protocol) adalah protokol jaringan yang secara otomatis memberikan **alamat IP** dan **konfigurasi jaringan lainnya** (seperti subnet mask, gateway, dan DNS server) ke perangkat-perangkat di jaringan, seperti komputer, printer, atau smartphone.

**Tujuan DHCP:**
Menghilangkan kebutuhan untuk mengatur IP secara manual pada setiap perangkat. Dengan DHCP, pengaturan menjadi lebih cepat, efisien, dan meminimalkan kesalahan konfigurasi.

**Cara Kerja DHCP (secara singkat):**

1. **DHCP Discover:** Perangkat (client) mengirim permintaan broadcast mencari server DHCP.
2. **DHCP Offer:** Server DHCP merespon dengan menawarkan alamat IP.
3. **DHCP Request:** Client memilih salah satu tawaran dan meminta alamat IP tersebut.
4. **DHCP Acknowledgement:** Server mengonfirmasi dan mengatur IP pada client.

## Lab 8 DHCP



| Device | Interface | Vlan | IP Address | Deskripsi |
|---|---|---|---|---|
| R-Office | Gi0/0.10 | 10 | 172.16.10.1/24 | Sub-interface Vlan 10 |
| | Gi0/0.20 | 20 | 192.168.20.1/24 | Sub-interface Vlan 20 |
| | Gi0/3/0 | | 123.123.123.2/30 | To_R-ISP |
| | Loopback 2 | | 2.2.2.2/32 | IP Loopback |
| Switch | Gi0/1 | 10,20 | | Trunk To_R-Office |
| | Fa0/1 | 10 | | Access To_PC |
| | Fa0/2 | 20 | | Access To_PC |
| PC0 | Fa0 | 10 | 172.16.10.254/24 | |
| PC1 | Fa0 | 20 | DHCP Client | |
| R-ISP | Gi0/3/0 | | 123.123.123.1/30 | To_R-Office |
| | Gi0/0 | | 8.8.8.1/24 | To_Server |
| | Loopback 1 | | 1.1.1.1/30 | IP Loopback |
| Server | Fa0 | | 8.8.8.8/24 | |

Sesuai dengan topologi diatas, Kita akan melakukan konfigurasi DHCP Server Vlan 20 pada Router R-Office dan DHCP Client pada PC1.

**R-Office**

```
Router>enable
Router#
Router#configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#hostname R-Office
R-Office(config)#interface loopback 2
R-Office(config-if)#ip address 2.2.2.2 255.255.255.255
R-Office(config-if)#exit
R-Office(config)#
R-Office(config)#interface gi0/3/0
R-Office(config-if)#no shutdown
R-Office(config-if)#description To_ISP
R-Office(config-if)#ip address 123.123.123.2 255.255.255.252
R-Office(config-if)#exit
R-Office(config)#
R-Office(config)#interface gi0/0
R-Office(config-if)#no shutdown
R-Office(config-if)#description To_ACSW-Office
R-Office(config-if)#exit
R-Office(config)#
```

```
R-Office(config)#interface gi0/0.10
R-Office(config-subif)#encapsulation dot1Q 10
R-Office(config-subif)#ip address 172.16.10.1 255.255.255.0
R-Office(config-subif)#exit
R-Office(config)#
R-Office(config)#interface gi0/0.20
R-Office(config-subif)#encapsulation dot1Q 20
R-Office(config-subif)#ip address 192.168.20.1 255.255.255.0
R-Office(config-subif)#exit
R-Office(config)#
R-Office(config)#ip dhcp pool LAN20
R-Office(dhcp-config)#network 192.168.20.0 255.255.255.0
R-Office(dhcp-config)#default-router 192.168.20.1
R-Office(dhcp-config)#domain-name cisco.com
R-Office(dhcp-config)#exit
R-Office(config)#
R-Office(config)#ip dhcp excluded-address 192.168.20.1 192.168.20.20
R-Office(config)#end
R-Office#
R-Office#wr
Building configuration...
[OK]
R-Office#
```

**ACSW-Office**

```
Switch>
Switch>enable
Switch#conf t
Enter configuration commands, one per line. End with CNTL/Z.
Switch(config)#hostname ACSW-Office
ACSW-Office(config)#
ACSW-Office(config)#vlan 10
ACSW-Office(config-vlan)#name LAN10
ACSW-Office(config-vlan)#exit
ACSW-Office(config)#vlan 20
ACSW-Office(config-vlan)#name LAN20
ACSW-Office(config-vlan)#exit
ACSW-Office(config)#
ACSW-Office(config)#interface gi0/1
ACSW-Office(config-if)#switchport mode trunk
ACSW-Office(config-if)#switchport trunk allowed vlan all
ACSW-Office(config-if)#description To_R-Office
ACSW-Office(config-if)#exit
ACSW-Office(config)#
ACSW-Office(config)#interface fa0/1
ACSW-Office(config-if)#switchport mode access
ACSW-Office(config-if)#switchport access vlan 10
```

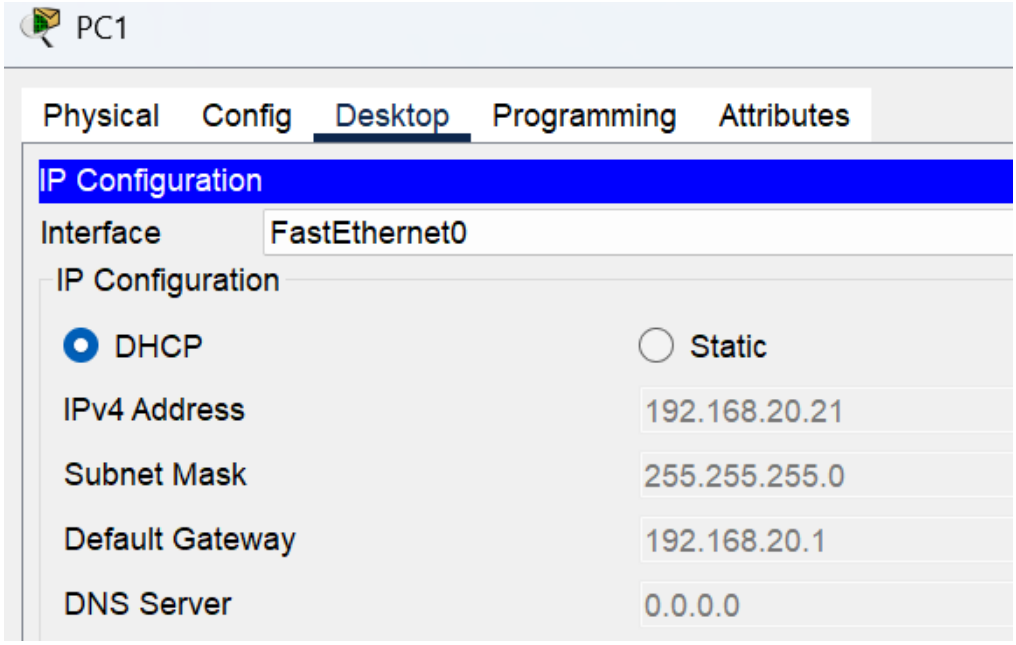
```
ACSW-Office(config-if)#description To_LAN10
ACSW-Office(config-if)#exit
ACSW-Office(config)#
ACSW-Office(config)#interface fa0/2
ACSW-Office(config-if)#switchport mode access
ACSW-Office(config-if)#switchport access vlan 20
ACSW-Office(config-if)#description To_LAN20
ACSW-Office(config-if)#end
ACSW-Office#
ACSW-Office#wr
Building configuration...
[OK]
 ACSW-Office#
```

Verifikasi DHPC

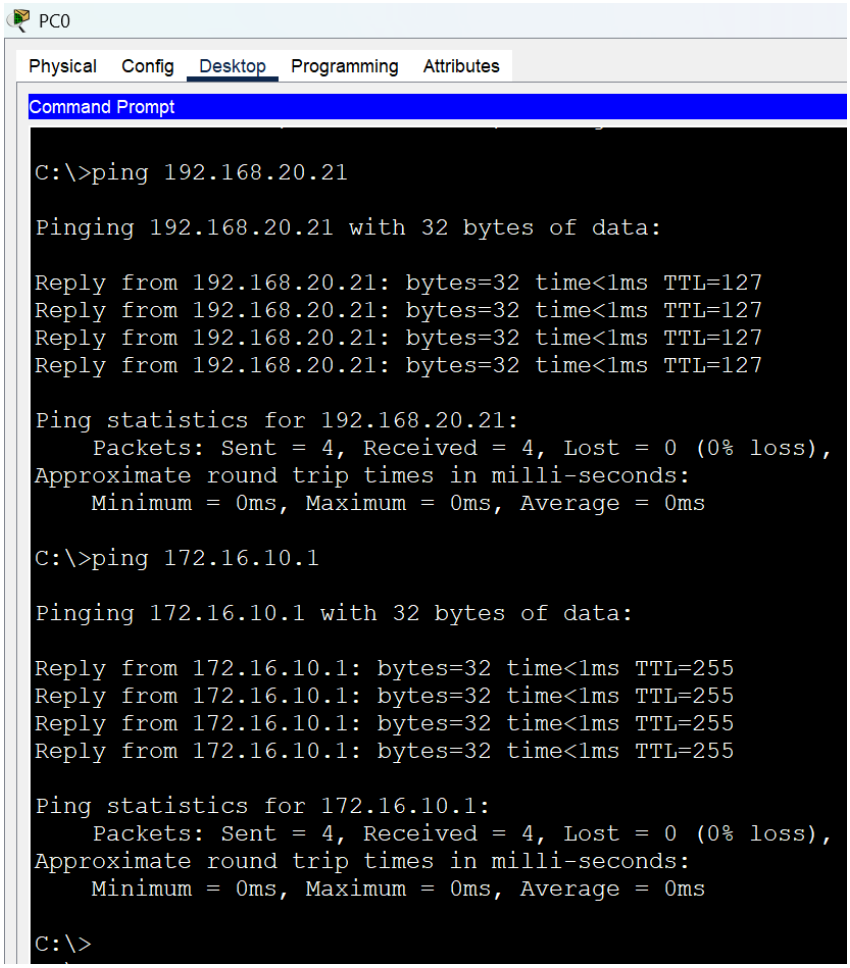
R-Office

```
R-Office#show ip dhcp pool

Pool LAN20 :
 Utilization mark (high/low)    : 100 / 0
 Subnet size (first/next)       : 0 / 0
 Total addresses                : 254
 Leased addresses               : 1
 Excluded addresses             : 1
 Pending event                  : none

 1 subnet is currently in the pool
 Current index        IP address range                    Leased/Excluded/Total
 192.168.20.1         192.168.20.1     - 192.168.20.254    1    / 1      / 254
R-Office#
R-Office#show ip dhcp binding
IP address       Client-ID/              Lease expiration        Type
                 Hardware address
192.168.20.21    0060.5C5C.8AEC           --                     Automatic
R-Office#
```

**PC1**



**Test PING PC0 to R-Office and PC1**




## Access List

**Access List (ACL)** adalah fitur di perangkat jaringan (seperti router dan switch) yang digunakan untuk **mengontrol lalu lintas jaringan** berdasarkan aturan tertentu. Dengan ACL, kamu bisa **mengizinkan** atau **menolak** paket data berdasarkan kriteria seperti:

- **Alamat IP sumber dan tujuan**
- **Port atau protokol (misalnya TCP, UDP, ICMP)**
- **Jenis layanan (seperti HTTP, FTP, dll)**

**Fungsi Utama Access List:**

1. **Keamanan:** Mencegah akses tidak sah ke bagian tertentu dari jaringan.
2. **Kontrol Lalu Lintas:** Memfilter trafik masuk/keluar dari interface router.
3. **Manajemen Bandwidth:** Bisa digunakan dalam kombinasi dengan QoS.
4. **Traffic Monitoring:** Digunakan untuk memantau jenis-jenis trafik tertentu.

**Format command ACL**

Router(config)#access-list *access-list number* {deny|permit|remark text} *source* [source-wilcard][log]

Penerapan ACL di interface
Router(config-if)#ip access-group {*access-list number*|*access-list name*} [in|out]

**Jenis-jenis ACL:**

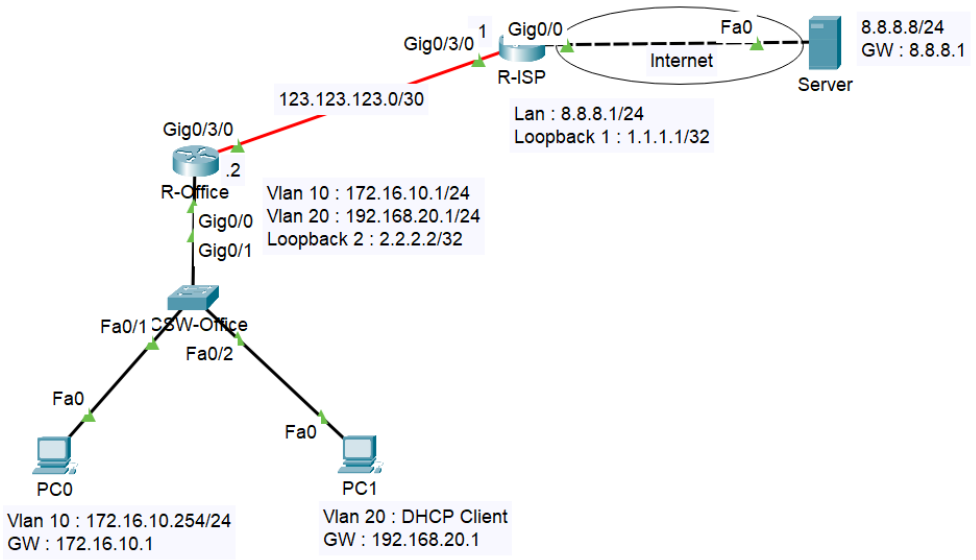
1. **Standard ACL**
   - Hanya memfilter berdasarkan alamat IP sumber.
   - Contoh: access-list 10 permit 192.168.1.0 0.0.0.255
2. **Extended ACL**
   - Lebih spesifik, bisa memfilter berdasarkan IP sumber & tujuan, protokol, dan port.
   - Contoh: access-list 100 permit tcp 192.168.1.0 0.0.0.255 any eq 80
3. **Named ACL**
   - ACL yang diberi nama agar lebih mudah dikelola daripada nomor.

**Cara Kerja (sederhana):**

ACL ditempatkan di interface router:

- **Inbound**: memfilter sebelum paket diproses oleh router.
- **Outbound**: memfilter setelah paket diproses dan akan keluar dari interface.

## Lab 9 Access List




Melanjutkan konfigurasi DHPC Server pada topologi sebelumnya, berikutnya Kita akan melakukan konfigurasi standard access-list pada R-Office. Permit traffic host 172.16.10.254 dan semua host pada segment ip 192.168.20.0/24 vlan 20 ke internet.

**R-Office**

```
R-Office>
R-Office>enable
R-Office#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R-Office(config)#
R-Office(config)#access-list 10 permit host 172.16.10.254
R-Office(config)# access-list 10 permit 192.168.20.0 0.0.0.255
R-Office(config-subif)#end
R-Office#
R-Office#wr
Building configuration...
[OK]
R-Office#
```

**Verifikasi ACL**

**R-Office**

```
R-Office#show access-lists
Standard IP access list 10
    10 permit host 172.16.10.254 (30 match(es))
    20 permit 192.168.20.0 0.0.0.255 (12 match(es))

R-Office#
```

## NAT

**NAT (Network Address Translation)** adalah mekanisme dalam jaringan yang digunakan untuk **mengubah alamat IP** di header paket data saat paket tersebut **melewati router**.

**Tujuan NAT:**

- **Menghemat alamat IP publik.**
- **Menyembunyikan jaringan internal dari luar.**
- **Memungkinkan banyak perangkat lokal berbagi satu alamat IP publik.**

**Jenis-jenis NAT**

| Jenis | Penjelasan |
|---|---|
| **Static NAT** | 1 alamat private = 1 alamat publik. Biasanya untuk server internal. |
| **Dynamic NAT** | Beberapa alamat private diterjemahkan ke beberapa alamat publik dari pool. |
| **PAT (Port Address Translation)** / NAT Overload | Banyak alamat private diterjemahkan ke satu IP publik, dibedakan lewat nomor port. Paling umum dipakai di rumah/kantor. |

**Ilustrasi PAT** (yang paling sering dipakai):

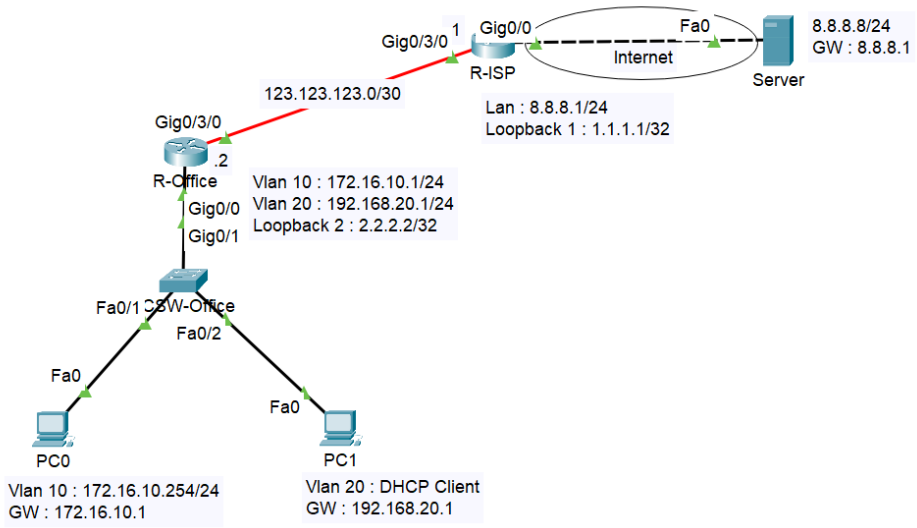
| Perangkat | IP Lokal | IP Publik (NAT) | Port |
|---|---|---|---|
| PC A | 192.168.1.2 | 203.0.113.5 | 1024 |
| PC B | 192.168.1.3 | 203.0.113.5 | 1025 |

Router akan mengganti IP dan port, jadi dua perangkat bisa memakai IP publik yang sama tanpa bentrok.

**Fungsi Utama NAT:**

- **Keamanan**: Menyembunyikan struktur internal jaringan.
- **Efisiensi IP**: Tidak perlu satu IP publik untuk setiap perangkat.
- **Konektivitas**: Mengizinkan perangkat dengan IP privat mengakses internet.

## Lab 10 NAT(PAT)




Masih dengan topology diatas, sebelumnya Kita sudah melakukan konfogurasi DHCP Server dan Access List. Berikutnya Kita akan melakukan konfigurasi Static Route dan NAT(PAT) pada R-Office supaya PC0(Vlan 10) dan PC1(Vlan 20) dapat berkomunikasi dengan Server.

**R-Office**

```
R-Office#
R-Office#conf t
Enter configuration commands, one per line. End with CNTL/Z.
R-Office(config)#
R-Office(config)#ip route 1.1.1.1 255.255.255.255 123.123.123.1
R-Office(config)#ip route 8.8.8.0 255.255.255.0 123.123.123.1
R-Office(config)#
```

```
R-Office(config)#ip nat inside source list 1 interface gi0/3/0 overload
R-Office(config)#interface gi0/3/0
R-Office(config-if)#ip nat outside
R-Office(config-if)#exit
R-Office(config)#interface gi0/0.10
R-Office(config-if)#ip nat inside
R-Office(config-if)#exit
R-Office(config)#interface gi0/0.20
R-Office(config-if)#ip nat inside
R-Office(config-if)#exit
R-Office(config)#end
R-Office#
R-Office#wr
Building configuration...
[OK]
R-Office#
```

**R-ISP**

```
Router>enable
Router#
Router#config terminal
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#hostname R-ISP
R-ISP(config)#interface loopback 1
R-ISP(config-if)#ip address 1.1.1.1 255.255.255.255
R-ISP(config-if)#exit
R-ISP(config)#
R-ISP(config)#interface gi0/3/0
R-ISP(config-if)#description To_R-Office
R-ISP(config-if)#ip address 123.123.123.1 255.255.255.252
R-ISP(config-if)#exit
R-ISP(config)#
R-ISP(config)#interface gi0/0
R-ISP(config-if)#no shutdown
R-ISP(config-if)#description To_SVR
R-ISP(config-if)#ip address 8.8.8.1 255.255.255.0
R-ISP(config-if)#exit
R-ISP(config)#
R-ISP(config)#ip route 2.2.2.2 255.255.255.255 123.123.123.2
R-ISP(config)#exit
R-ISP#
R-ISP#wr
Building configuration...
[OK]
R-ISP#
```

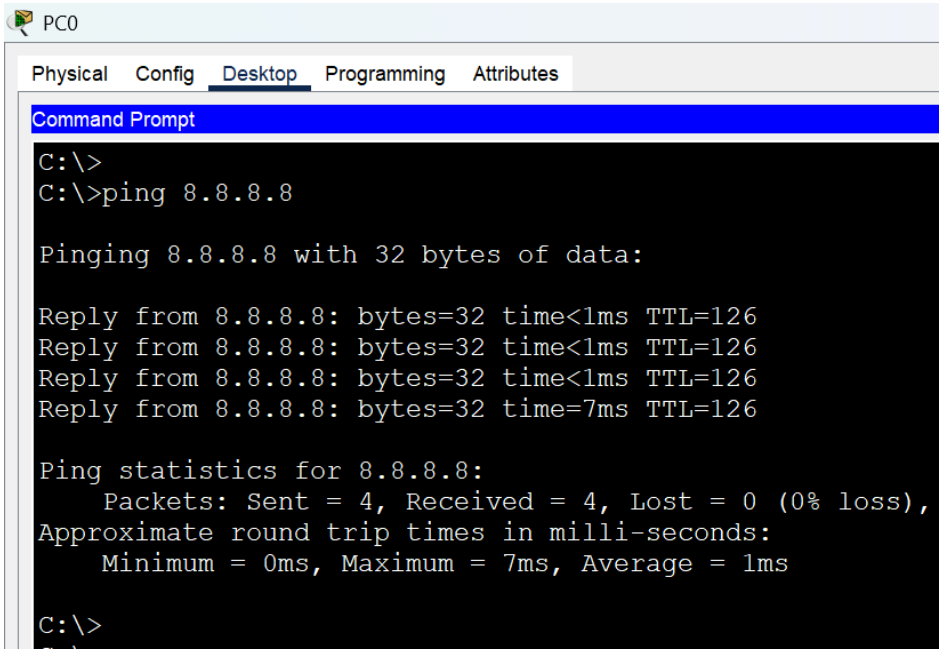
## Verifikasi NAT(PAT)

### R-Office

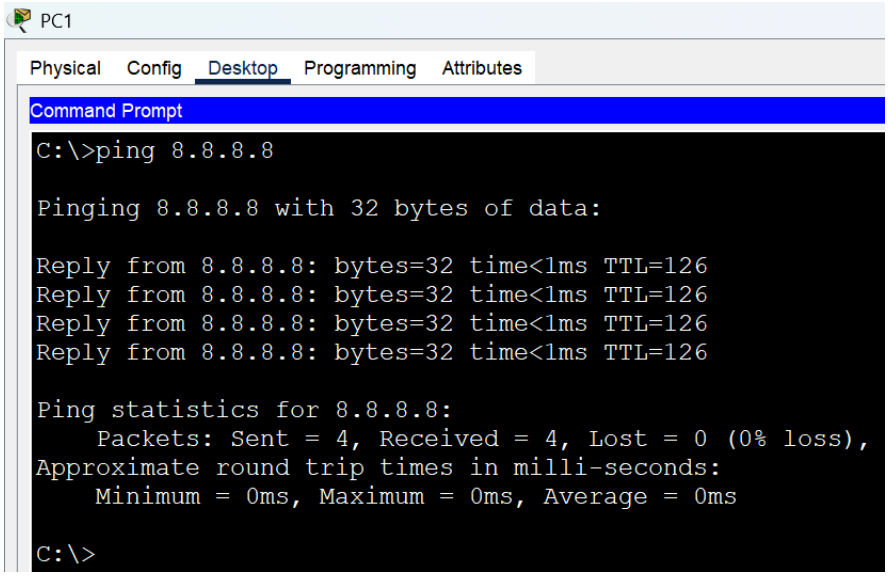
```
R-Office#show ip nat translations
Pro  Inside global     Inside local       Outside local      Outside global
icmp 123.123.123.2:23  172.16.10.254:23   8.8.8.8:23         8.8.8.8:23
icmp 123.123.123.2:24  172.16.10.254:24   8.8.8.8:24         8.8.8.8:24
icmp 123.123.123.2:25  172.16.10.254:25   8.8.8.8:25         8.8.8.8:25
icmp 123.123.123.2:26  172.16.10.254:26   8.8.8.8:26         8.8.8.8:26
icmp 123.123.123.2:3   192.168.20.21:3    8.8.8.8:3          8.8.8.8:3
icmp 123.123.123.2:4   192.168.20.21:4    8.8.8.8:4          8.8.8.8:4
icmp 123.123.123.2:5   192.168.20.21:5    8.8.8.8:5          8.8.8.8:5
icmp 123.123.123.2:6   192.168.20.21:6    8.8.8.8:6          8.8.8.8:6

R-Office#
```

### PC0 and PC1 ping to Server

### PC0




### PC1



## FHRP/HSRP

**FHRP (First Hop Redundancy Protocol)** adalah sekumpulan protokol yang digunakan untuk menyediakan **redundansi gateway default** di jaringan. Tujuannya adalah untuk memastikan **gateway tetap tersedia** jika satu router utama (first hop) gagal.

**Mengapa FHRP dibutuhkan?**
Kalau hanya ada satu router sebagai default gateway dan router itu mati, seluruh akses ke luar jaringan (seperti ke internet) akan terputus. Dengan FHRP, kalau satu router gagal, router cadangan akan otomatis menggantikannya **tanpa gangguan signifikan bagi pengguna.**

**Jenis-jenis FHRP:**

| Protokol | Vendor | Keterangan |
|---|---|---|
| **HSRP (Hot Standby Router Protocol)** | Cisco | Paling umum di perangkat Cisco. |
| **VRRP (Virtual Router Redundancy Protocol)** | Standar (RFC) | Digunakan di berbagai vendor. |
| **GLBP (Gateway Load Balancing Protocol)** | Cisco | Mendukung load balancing antar router. |

## HSRP (Hot Standby Router Protocol)

HSRP adalah protokol FHRP dari Cisco yang memungkinkan dua atau lebih router untuk secara otomatis menyediakan gateway cadangan.

**Cara kerja HSRP:**

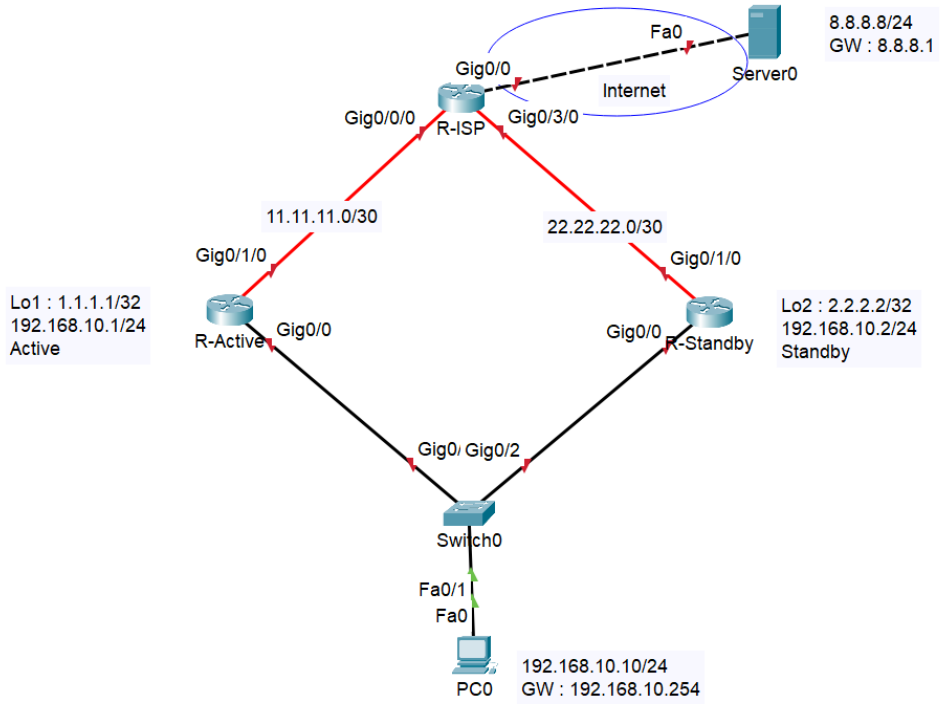
1. **Virtual IP** dibuat dan digunakan oleh semua perangkat sebagai gateway.
2. Salah satu router menjadi **Active**, yang lain menjadi **Standby**.
3. Jika router Active mati, router Standby **otomatis mengambil alih**.

**Contoh Sederhana:**

- **Router 1:** IP = 192.168.1.1
- **Router 2:** IP = 192.168.1.2
- **Virtual IP (HSRP):** 192.168.1.254

Semua PC mengarah ke **192.168.1.254** sebagai gateway. Kalau Router 1 gagal, Router 2 akan otomatis menggantikannya menggunakan IP virtual yang sama, **tanpa mengubah konfigurasi di PC**.

## Lab 11 HSRP




| Hostname | Interface | IP Address | Description |
|---|---|---|---|
| R-ISP | Loopback 3 | 3.3.3.3/32 | IP Loopback |
| | Gi0/0 | 8.8.8.1/24 | To_LAN |
| | Gi0/0/0 | 11.11.11.1/32 | To_R-Active |
| | Gi0/3/0 | 22.22.22.1/32 | To_R-Standby |
| R-Active | Gi0/1/0 | 11.11.11.2/32 | To_ISP |
| | Gi0/0 | 192.168.10.1/24 | To_LAN |
| | Loopback 1 | 1.1.1.1/32 | IP Loopback |
| R-Standby | Gi0/1/0 | 22.22.22.2/32 | To_ISP |
| | Gi0/0 | 192.168.10.2/24 | To_LAN |
| | Loopback 2 | 2.2.2.2/32 | IP Loopback |
| PC0 | Fa0 | 192.168.10.10/24 | IP LAN |
| Virtual IP | | 192.168.10.254 | GW LAN |

Sesuai dengan topologi diatas, Kita akan melakukan konfigurasi HSRP yang dimana ada Router Active dan Router Standby. Tujuan dari konfigurasi ini adalah ketika ada problem pada router active, maka traffic ke-arah internet akan tetap lewat melalui router standby.

**R-ISP**

```
Router>
Router>enable
Router#conf t
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#hostname R-ISP
R-ISP(config)#
R-ISP(config)#interface loopback 3
R-ISP(config-if)#ip address 3.3.3.3 255.255.255.255
R-ISP(config-if)#exit
R-ISP(config)#
R-ISP(config)#interface gi0/0
R-ISP(config-if)#no shutdown
R-ISP(config-if)#ip address 8.8.8.1 255.255.255.0
R-ISP(config-if)#exit
R-ISP(config)#
R-ISP(config)#interface gi0/0/0
R-ISP(config-if)#no shutdown
R-ISP(config-if)#description To_R-Active
R-ISP(config-if)#ip address 11.11.11.1 255.255.255.252
R-ISP(config-if)#exit
R-ISP(config)#
R-ISP(config)#interface gi0/3/0
R-ISP(config-if)#no shutdown
R-ISP(config-if)#description To_R-Standby
R-ISP(config-if)#ip address 22.22.22.1 255.255.255.252
R-ISP(config-if)#exit
R-ISP(config)#
R-ISP(config)#ip route 1.1.1.1 255.255.255.255 11.11.11.2
R-ISP(config)#ip route 2.2.2.2 255.255.255.255 22.22.22.2
R-ISP(config)#end
R-ISP#
R-ISP#wr
Building configuration...
[OK]
R-ISP#
```

**R-Active**

```
Router>enable
Router#conf t
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#hostname R-Active
R-Active(config)#
R-Active(config)#interface loopback 1
R-Active(config-if)#ip address 1.1.1.1 255.255.255.255
R-Active(config-if)#exit
R-Active(config)#
```

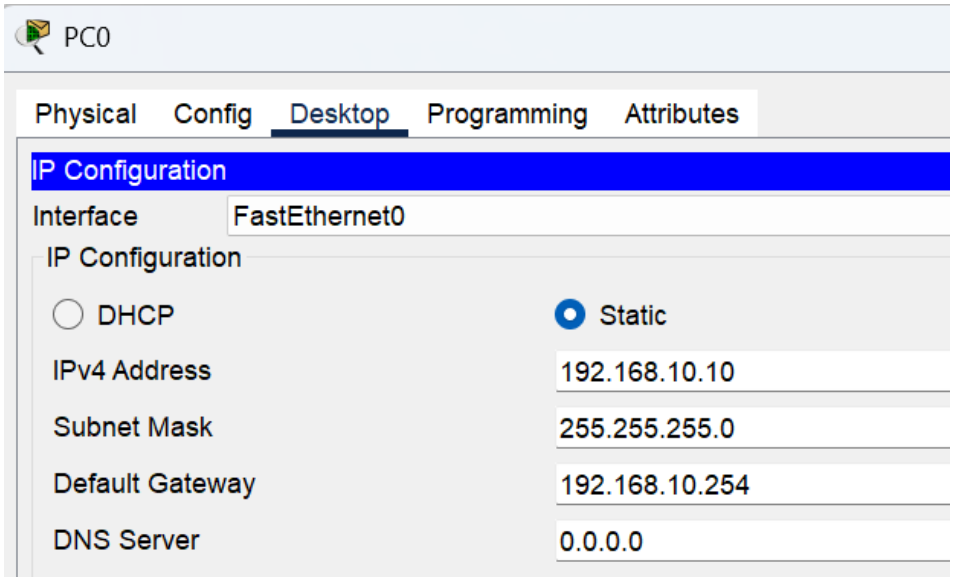
```
R-Active(config)#interface gi0/1/0
R-Active(config-if)#no shutdown
R-Active(config-if)#description To_R-ISP
R-Active(config-if)#ip address 11.11.11.2 255.255.255.252
R-Active(config-if)#exit
R-Active(config)#interface gi0/0
R-Active(config-if)#no shutdown
R-Active(config-if)#description To_LAN
R-Active(config-if)#ip address 192.168.10.1 255.255.255.0
R-Active(config-if)#standby ip 192.168.10.254
R-Active(config-if)#standby priority 150
R-Active(config-if)#standby preempt
R-Active(config-if)#exit
R-Active(config)#
R-Active(config)#ip route 3.3.3.3 255.255.255.255 11.11.11.1
R-Active(config)#ip route 8.8.8.0 255.255.255.0 11.11.11.1
R-Active(config)#
R-Active(config)#ip nat inside source list 10 interface gi0/1/0 overload
R-Active(config)#access-list 10 permit 192.168.10.0 0.0.0.255
R-Active(config)#interface gi0/1/0
R-Active(config-if)#ip nat outside
R-Active(config-if)#exit
R-Active(config)#
R-Active(config)#interface gi0/0
R-Active(config-if)#ip nat inside
R-Active(config-if)#end
R-Active#wr
Building configuration...
[OK]
R-Active#
```

**R-Standby**

```
Router>
Router>enable
Router#conf t
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#hostname R-Standby
R-Standby(config)#
R-Standby(config)#interface loopback 2
R-Standby(config-if)#ip address 2.2.2.2 255.255.255.255
R-Standby(config-if)#exit
R-Standby(config)#
R-Standby(config)#interface gi0/1/0
R-Standby(config-if)#no shutdown
R-Standby(config-if)#description To_R-ISP
R-Standby(config-if)#ip address 22.22.22.2 255.255.255.252
R-Standby(config-if)#ip nat outside
```

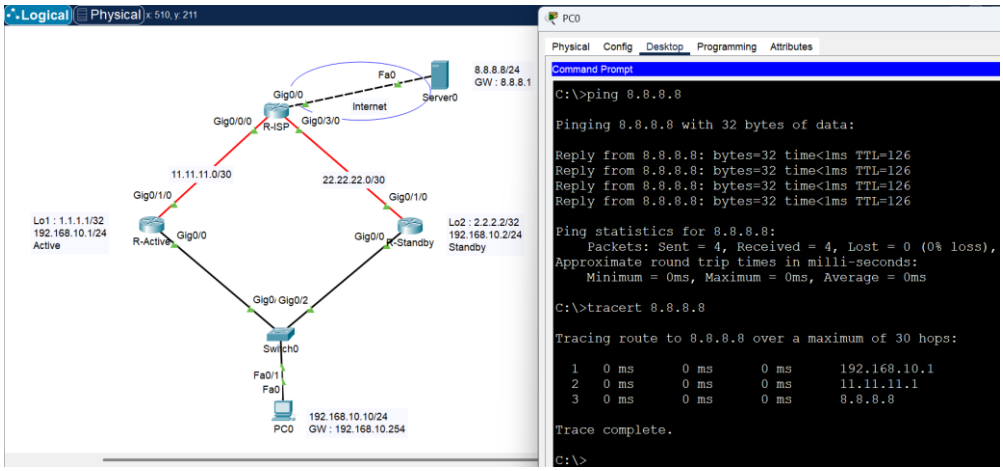
```
R-Standby(config-if)#exit
R-Standby(config)#
R-Standby(config)#interface gi0/0
R-Standby(config-if)#no shutdown
R-Standby(config-if)#description To_LAN
R-Standby(config-if)#ip address 192.168.10.2 255.255.255.0
R-Standby(config-if)#standby ip 192.168.10.254
R-Standby(config-if)#standby priority 100
R-Standby(config-if)#ip nat inside
R-Standby(config-if)#exit
R-Standby(config)#
R-Standby(config)#ip route 1.1.1.1 255.255.255.255 22.22.22.1
R-Standby(config)#ip route 8.8.8.0 255.255.255.0 22.22.22.1
R-Standby(config)#
R-Standby(config)#ip nat inside source list 10 interface gi0/1/0 overload
R-Standby(config)#access-list 10 permit 192.168.10.0 0.0.0.255
R-Standby(config)#end
R-Standby#
R-Standby#wr
Building configuration...
[OK]
R-Standby#
```

**PC0**



## Verifikasi HSRP

### Ping PC0 to Server lewat R-Active

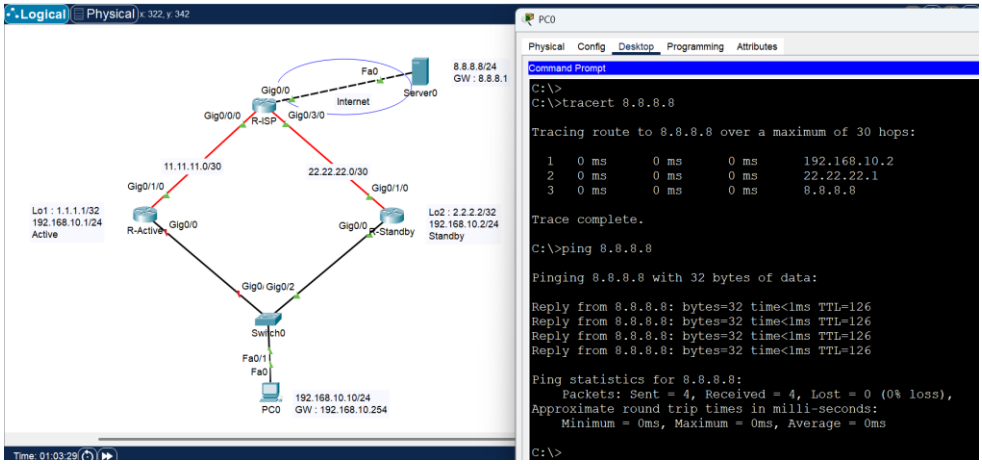



### Via R-Standby

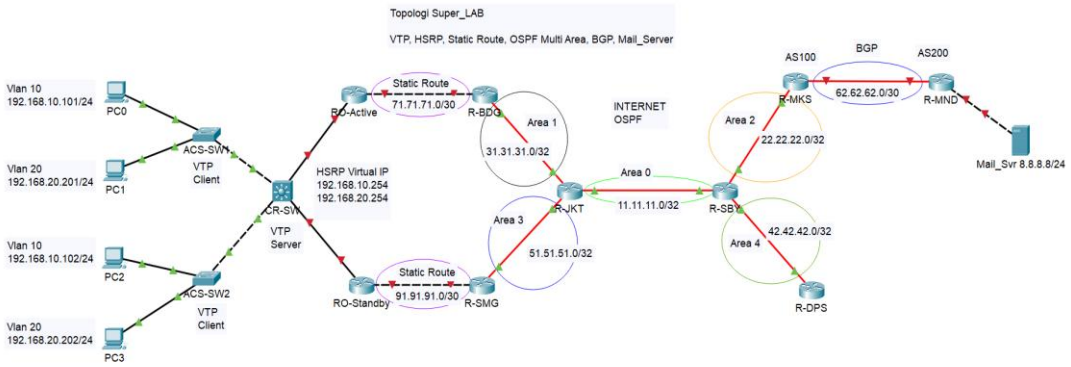
Non-aktifkan terlebih dahulu interface Gi0/0 ke arah LAN yang ada pada R-Active.

```
R-Active#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
R-Active(config)#int gi0/0
R-Active(config-if)#shutdown

R-Active(config-if)#
 %HSRP-6-STATECHANGE: GigabitEthernet0/0 Grp 0 state Active -> Init

%LINK-5-CHANGED: Interface GigabitEthernet0/0, changed state to administratively down

%LINEPROTO-5-UPDOWN: Line protocol on Interface GigabitEthernet0/0, changed state to down

R-Active(config-if)#
```

### Ping dan Traceroute Server 8.8.8.8 dari PC0



# 4. Simulasi Lab Internet – Advanced Routing




| Device | Interface | IP Address | Description |
|---|---|---|---|
| R-JKT | Gi0/1/0 | 11.11.11.1/30 | To_R-SBY |
| | Gi0/2/0 | 31.31.31.1/30 | To_R-BDG |
| | Gi0/3/0 | 51.51.51.1/30 | To_R-SMG |
| | Loopback 1 | 1.1.1.1/32 | IP_Loopback |
| R-SBY | Gi0/1/0 | 11.11.11.2/30 | To_R-JKT |
| | Gi0/2/0 | 42.42.42.1/30 | To_R-MKS |
| | Gi0/3/0 | 22.22.22.1/30 | To_R-DPS |
| | Loopback 2 | 2.2.2.2/32 | IP_Loopback |
| R-BDG | Gi0/3/0 | 31.31.31.2/30 | To_R-JKT |
| | Gi0/0 | 71.71.71.1/30 | To_R-Active |
| | Loopback 3 | 3.3.3.3/32 | IP_Loopback |
| R-SMG | Gi0/3/0 | 51.51.51.2/30 | To_R-JKT |
| | Gi0/0 | 91.91.91.1/30 | To_LAN |
| | Loopback 4 | 4.4.4.4/32 | IP_Loopback |
| R-MKS | Gi0/3/0 | 22.22.22.2/30 | To_R-SBY |
| | Gi0/0/0 | 62.62.62.1/30 | To_R-MND |
| | Loopback 5 | 5.5.5.5/32 | IP_Loopback |
| R-MND | Gi0/3/0 | 62.62.62.2/30 | To_R-MKS |
| | Gi0/0 | 8.8.8.1/24 | To_Mail-SVR |
| | Loopback 9 | 9.9.9.9/32 | IP_Loopback |
| R-DPS | Gi0/3/0 | 42.42.42.2/30 | To_R-SBY |
| | Loopback 6 | 6.6.6.6/32 | IP_Loopback |
| R-Active | Gi0/0 | 71.71.71.2/30 | To_R-BDG |
| | Gi0/1.10 | 192.168.10.1/24 | To_VLAN10 |
| | Gi0/1.20 | 192.168.20.1/24 | To_VLAN20 |
| | Loopback 7 | 7.7.7.7/33 | IP_Loopback |
| R-Standby | Gi0/0 | 91.91.91.2/30 | To_R-SMG |
| | Gi0/1.10 | 192.168.10.2/24 | To_VLAN10 |
| | Gi0/1.20 | 192.168.20.2/24 | To_VLAN20 |
| | Loopback 10 | 10.10.10.10/32 | IP_Loopback |

**Requirement Configuration :**

1. Vlan to PC0 & PC1
2. HSRP to R-Active & R-Standby
3. Static Route R-Active to R-ISP1 & R-Standby to R-ISP2
4. Redistribute Static Route to OSPF
5. OSPF Area 2(R-ISP1 to R-ISP3)
6. OSPF Area 4(R-ISP2 to R-ISP4)
7. OSPF Area 0{Backbone}(R-ISP3, R-ISP4, R-ISP5)
8. OSPF Area 1 (R-ISP5 to R-ISP6)
9. OSPF Area 3 (R-ISP4 to R-Office2)
10. Send E-mail PC0 to PC2

**Konfigurasi semua Router**

**R-JKT**

```
Router>enable
Router#conf t
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#
Router(config)#hostname R-JKT
R-JKT(config)#
R-JKT(config)#interface loopback 1
R-JKT(config-if)#ip address 1.1.1.1 255.255.255.255
R-JKT(config-if)#exit
R-JKT(config)#
R-JKT(config)#interface gi0/1/0
R-JKT(config-if)#no shutdown
R-JKT(config-if)#description To_R-SBY
R-JKT(config-if)#ip address 11.11.11.1 255.255.255.252
R-JKT(config-if)#exit
R-JKT(config)#
R-JKT(config)#interface gi0/2/0
R-JKT(config-if)#no shutdown
R-JKT(config-if)#description To_R-BDG
R-JKT(config-if)#ip address 31.31.31.1 255.255.255.252
R-JKT(config-if)#exit
R-JKT(config)#
R-JKT(config)#interface gi0/3/0
R-JKT(config-if)#no shutdown
R-JKT(config-if)#description To_R-SMG
R-JKT(config-if)#ip address 51.51.51.1 255.255.255.252
R-JKT(config-if)#exit
R-JKT(config)#
R-JKT(config)#router ospf 1
R-JKT(config-router)#router-id 1.1.1.1
R-JKT(config-router)#network 1.1.1.1 0.0.0.0 area 0
R-JKT(config-router)#network 11.11.11.0 0.0.0.3 area 0
```

```
R-JKT(config-router)#network 31.31.31.0 0.0.0.3 area 1
R-JKT(config-router)#network 51.51.51.0 0.0.0.3 area 3
R-JKT(config-router)#exit
R-JKT(config)#
R-JKT(config)#interface gi0/1/0
R-JKT(config-if)#ip ospf network point-to-point
R-JKT(config-if)#exit
R-JKT(config)#
R-JKT(config)#interface gi0/2/0
R-JKT(config-if)#ip ospf network point-to-point
R-JKT(config-if)#exit
R-JKT(config)#interface gi0/3/0
R-JKT(config-if)#ip ospf network point-to-point
R-JKT(config-if)#exit
R-JKT(config)#end
R-JKT#
R-JKT#wr
Building configuration...
[OK]
R-JKT#
```

**R-SBY**

```
Router>enable
Router#conf t
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#hostname R-SBY
R-SBY(config)#
R-SBY(config)#interface loopback 2
R-SBY(config-if)#ip address 2.2.2.2 255.255.255.255
R-SBY(config-if)#exit
R-SBY(config)#
R-SBY(config)#interface gi0/1/0
R-SBY(config-if)#no shutdown
R-SBY(config-if)#description To_R-JKT
R-SBY(config-if)#ip address 11.11.11.2 255.255.255.252
R-SBY(config-if)#exit
R-SBY(config)#
R-SBY(config)#interface gi0/2/0
R-SBY(config-if)#no shutdown
R-SBY(config-if)#description To_R-DPS
R-SBY(config-if)#ip address 42.42.42.1 255.255.255.252
R-SBY(config-if)#exit
R-SBY(config)#
R-SBY(config)#interface gi0/3/0
R-SBY(config-if)#no shutdown
R-SBY(config-if)#description To_R-MKS
R-SBY(config-if)#ip address 22.22.22.1 255.255.255.252
```

```
R-SBY(config-if)#exit
R-SBY(config)#
R-SBY(config)#router ospf 2
R-SBY(config-router)#router-id 2.2.2.2
R-SBY(config-router)#network 2.2.2.2 0.0.0.0 area 0
R-SBY(config-router)#network 11.11.11.0 0.0.0.3 area 0
R-SBY(config-router)#network 22.22.22.0 0.0.0.3 area 2
R-SBY(config-router)#network 42.42.42.0 0.0.0.3 area 4
R-SBY(config-router)#exit
R-SBY(config)#interface gi0/1/0
R-SBY(config-if)#ip ospf network point-to-point
R-SBY(config-if)#exit
R-SBY(config)#
R-SBY(config)#interface gi0/2/0
R-SBY(config-if)#ip ospf network point-to-point
R-SBY(config-if)#exit
R-SBY(config)#
R-SBY(config)#interface gi0/3/0
R-SBY(config-if)#ip ospf network point-to-point
R-SBY(config-if)#exit
R-SBY(config)#end
R-SBY#
R-SBY#wr
Building configuration...
[OK]
R-SBY#
```

**R-BDG**

```
Router>enable
Router#conf t
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#hostname R-BDG
R-BDG(config)#interface loopback 3
R-BDG(config-if)#ip address 3.3.3.3 255.255.255.255
R-BDG(config-if)#exit
R-BDG(config)#
R-BDG(config)#interface gi0/3/0
R-BDG(config-if)#no shutdown
R-BDG(config-if)#description To_R-JKT
R-BDG(config-if)#ip address 31.31.31.2 255.255.255.252
R-BDG(config-if)#exit
R-BDG(config)#int gi0/0
R-BDG(config-if)#no shutdown
R-BDG(config-if)#ip add 71.71.71.1 255.255.255.252
R-BDG(config-if)#description To_R-Active
R-BDG(config-if)#exit
R-BDG(config)#
```

```
R-BDG(config)#ip route 7.7.7.7 255.255.255.255 71.71.71.2
R-BDG(config)#
R-BDG(config)#router ospf 3
R-BDG(config-router)#router-id 3.3.3.3
R-BDG(config-router)#network 3.3.3.3 0.0.0.0 area 1
R-BDG(config-router)#network 31.31.31.0 0.0.0.3 area 1
R-BDG(config-router)#network 71.71.71.0 0.0.0.3 area 1
R-BDG(config-router)#redistribute static subnets
R-BDG(config-router)#default-information originate
R-BDG(config-router)#exit
R-BDG(config)#
R-BDG(config)#interface gi0/3/0
R-BDG(config-if)#ip ospf network point-to-point
R-BDG(config-if)#end
R-BDG#
R-BDG#wr
Building configuration...
[OK]
R-BDG#
```

**R-SMG**

```
Router>enable
Router#conf t
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#hostname R-SMG
R-SMG(config)#interface loopback 4
R-SMG(config-if)#ip address 4.4.4.4 255.255.255.255
R-SMG(config-if)#exit
R-SMG(config)#
R-SMG(config)#interface gi0/3/0
R-SMG(config-if)#no shutdown
R-SMG(config-if)#description To_R-JKT
R-SMG(config-if)#ip address 51.51.51.2 255.255.255.252
R-SMG(config-if)#exit
R-SMG(config)#
R-SMG(config)#interface gi0/0
R-SMG(config-if)#no shutdown
R-SMG(config-if)#description To_R-Standby
R-SMG(config-if)#ip address 91.91.91.1 255.255.255.252
R-SMG(config-if)#exit
R-SMG(config)#
R-SMG(config)#ip route 10.10.10.10 255.255.255.255 91.91.91.2
R-SMG(config)#
R-SMG(config)#router ospf 4
R-SMG(config-router)#router-id 4.4.4.4
R-SMG(config-router)#network 4.4.4.4 0.0.0.0 area 3
R-SMG(config-router)#network 51.51.51.0 0.0.0.3 area 3
```

```
R-SMG(config-router)#network 172.16.2.0 0.0.0.255 area 3
R-SMG(config-router)#network 91.91.91.1 0.0.0.3 area 3
R-SMG(config-router)#redistribute static subnets
R-SMG(config-router)#default-information originate
R-SMG(config-router)#exit
R-SMG(config)#
R-SMG(config)#interface gi0/3/0
R-SMG(config-if)#ip ospf network point-to-point
R-SMG(config-if)#end
R-SMG#
R-SMG#wr
Building configuration...
[OK]
R-SMG#
```

**R-MKS**

```
Router>enable
Router#conf t
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#hostname R-MKS
R-MKS(config)#interface loopback 5
R-MKS(config-if)#ip address 5.5.5.5 255.255.255.255
R-MKS(config-if)#exit
R-MKS(config)#interface gi0/3/0
R-MKS(config-if)#no shutdown
R-MKS(config-if)#description To_R-SBY
R-MKS(config-if)#ip address 22.22.22.2 255.255.255.252
R-MKS(config-if)#exit
R-MKS(config)#
R-MKS(config)#interface gi0/0
R-MKS(config-if)#no shutdown
R-MKS(config-if)#description To_LAN
R-MKS(config-if)#ip address 192.168.3.1 255.255.255.0
R-MKS(config-if)#exit
R-MKS(config)#
R-MKS(config)#router ospf 5
R-MKS(config-router)#router-id 5.5.5.5
R-MKS(config-router)#network 5.5.5.5 0.0.0.0 area 2
R-MKS(config-router)#network 22.22.22.0 0.0.0.3 area 2
R-MKS(config-router)#network 192.168.3.0 0.0.0.255 area 2
R-MKS(config-router)#redistribute bgp 100 subnets
R-MKS(config-router)#exit
R-MKS(config)#
R-MKS(config)#interface gi0/3/0
R-MKS(config-if)#ip ospf network point-to-point
R-MKS(config-if)#exit
R-MKS(config)#
```

```
R-MKS(config)#router bgp 100
R-MKS(config-router)#neighbor 62.62.62.2 remote-as 200
R-MKS(config-router)#network 5.5.5.5 mask 255.255.255.255
R-MKS(config-router)#network 62.62.62.0 mask 255.255.255.252
R-MKS(config-router)#network 22.22.22.0 mask 255.255.255.252
R-MKS(config-router)#redistribute ospf 5
R-MKS(config-router)#redistribute connected
R-MKS(config-router)#exit
R-MKS#
R-MKS#wr
Building configuration...
[OK]
R-MKS#
```

**R-DPS**

```
Router>enable
Router#conf t
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#hostname R-DPS
R-DPS(config)#interface loopback 6
R-DPS(config-if)#ip address 6.6.6.6 255.255.255.255
R-DPS(config-if)#exit
R-DPS(config)#interface gi0/3/0
R-DPS(config-if)#no shutdown
R-DPS(config-if)#description To_R-SBY
R-DPS(config-if)#ip address 42.42.42.2 255.255.255.252
R-DPS(config-if)#exit
R-DPS(config)#interface gi0/0
R-DPS(config-if)#no shutdown
R-DPS(config-if)#description To_LAN
R-DPS(config-if)#ip address 192.168.4.1 255.255.255.0
R-DPS(config-if)#exit
R-DPS(config)#
R-DPS(config)#router ospf 6
R-DPS(config-router)#router-id 6.6.6.6
R-DPS(config-router)#network 6.6.6.6 0.0.0.0 area 4
R-DPS(config-router)#network 42.42.42.0 0.0.0.3 area 4
R-DPS(config-router)#network 192.168.4.0 0.0.0.255 area 4
R-DPS(config-router)#exit
R-DPS(config)#
R-DPS(config)#interface gi0/3/0
R-DPS(config-if)#ip ospf network point-to-point
R-DPS(config-if)#end
R-DPS#
R-DPS#wr
R-DPS#
```

**R-MND**

```
Router>enable
Router#configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#hostname R-MND
R-MND(config)#
R-MND(config)#interface loopback 9
R-MND(config-if)#ip address 9.9.9.9 255.255.255.255
R-MND(config-if)#exit
R-MND(config)#interface gi0/0
R-MND(config-if)#no shutdown
R-MND(config-if)#description To_Mail-SVR
R-MND(config-if)#ip address 8.8.8.1 255.255.255.0
R-MND(config-if)#exit
R-MND(config)#
R-MND(config)#interface gi0/0/0
R-MND(config-if)#no shutdwon
R-MND(config-if)#ip address 62.62.62.2 255.255.255.252
R-MND(config-if)#description To_R-MKS
R-MND(config-if)#exit
R-MND(config)#
R-MND(config)#router bgp 200
R-MND(config-router)#neighbor 62.62.62.1 remote-as 100
R-MND(config-router)#network 9.9.9.9 mask 255.255.255.255
R-MND(config-router)#network 8.8.8.0 mask 255.255.255.0
R-MND(config-router)#network 62.62.62.0 mask 255.255.255.252
R-MND(config-router)#end
R-MND#
R-MND#wr
Building configuration...
[OK]
R-MND#
```

**RO-Active**

```
Router>
Router>enable
Router#configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#hostname R-Active
R-Active(config)#
R-Active(config)#interface gi0/0
R-Active(config-if)#no shutdown
R-Active(config-if)#description To_R-BDG
R-Active(config-if)#ip address 71.71.71.2 255.255.255.252
R-Active(config-if)#exit
R-Active(config)#
R-Active(config)#interface gi0/1
```

```
R-Active(config-if)#no shutdown
R-Active(config-if)#exit
R-Active(config)#interface gi0/1.10
R-Active(config-subif)#encapsulation dot1Q 10
R-Active(config-subif)#ip address 192.168.10.1 255.255.255.0
R-Active(config-subif)#description To_LAN10
R-Active(config-subif)#standby ip 192.168.10.254
R-Active(config-subif)#standby priority 150
R-Active(config-subif)#standby preempt
R-Active(config-subif)#exit
R-Active(config)#
R-Active(config)#interface gi0/1.20
R-Active(config-subif)#encapsulation dot1Q 20
R-Active(config-subif)#ip address 192.168.20.1 255.255.255.0
R-Active(config-subif)#description To_LAN20
R-Active(config-subif)#standby ip 192.168.20.254
R-Active(config-subif)#standby priority 150
R-Active(config-subif)#standby preempt
R-Active(config-subif)#exit
R-Active(config)#
R-Active(config)#interface loopback 7
R-Active(config-if)#ip address 7.7.7.7 255.255.255.255
R-Active(config-if)#exit
R-Active(config)#
R-Active(config)#ip route 0.0.0.0 0.0.0.0 71.71.71.1
R-Active(config)#
R-Active(config)#ip nat inside source list 10 interface gi0/0 overload
R-Active(config)#access-list 10 permit 192.168.10.0 0.0.0.255
R-Active(config)#access-list 10 permit 192.168.20.0 0.0.0.255
R-Active(config)#
R-Active(config)#interface gi0/0
R-Active(config-if)#ip nat outside
R-Active(config-if)#exit
R-Active(config)#
R-Active(config)#interface gi0/1.10
R-Active(config-subif)#ip nat inside
R-Active(config-subif)#exit
R-Active(config)#
R-Active(config)#interface gi0/1.20
R-Active(config-subif)#ip nat inside
R-Active(config-subif)#end
R-Active#
R-Active#wr
Building configuration...
[OK]
R-Active#
```

**RO-Standby**

```
Router>enable
Router#conf t
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#hostname R-Standby
R-Standby(config)#
R-Standby(config)#interface loopback 8
R-Standby(config-if)#ip address 8.8.8.8 255.255.255.255
R-Standby(config-if)#exit
R-Standby(config)#
R-Standby(config)#int gi0/0
R-Standby(config-if)#no shutdown
R-Standby(config-if)#description To_R-SMG
R-Standby(config-if)#ip address 91.91.91.2 255.255.255.252
R-Standby(config-if)#exit
R-Standby(config)#
R-Standby(config)#int gi0/1
R-Standby(config-if)#no shutdown
R-Standby(config-if)#exit
R-Standby(config)#interface gi0/1.10
R-Standby(config-subif)#encapsulation dot1Q 10
R-Standby(config-subif)#ip address 192.168.10.2 255.255.255.0
R-Standby(config-subif)#standby ip 192.168.10.254
R-Standby(config-subif)#standby priority 100
R-Standby(config-subif)#exit
R-Standby(config)#
R-Standby(config)#interface gi0/1.20
R-Standby(config-subif)#encapsulation dot1Q 20
R-Standby(config-subif)#ip address 192.168.20.2 255.255.255.0
R-Standby(config-subif)#standby ip 192.168.20.254
R-Standby(config-subif)#standby priority 100
R-Standby(config-subif)#exit
R-Standby(config)#ip route 0.0.0.0 0.0.0.0 91.91.91.1
R-Standby(config)#
R-Standby(config)#ip nat inside source list 10 interface gi0/0 overload
R-Standby(config)#access-list 10 permit 192.168.10.0 0.0.0.255
R-Standby(config)#access-list 10 permit 192.168.20.0 0.0.0.255
R-Standby(config)#
R-Standby(config)#interface gi0/0
R-Standby(config-if)#ip nat outside
R-Standby(config-if)#exit
R-Standby(config)#
R-Standby(config)#interface gi0/1.10
R-Standby(config-subif)#ip nat inside
R-Standby(config-subif)#exit
R-Standby(config)#interface gi0/1.20
R-Standby(config-subif)#ip nat inside
```

```
R-Standby(config-subif)#end
R-Standby#
R-Standby#wr
Building configuration...
[OK]
R-Standby#
```

**CR-SW**

```
Switch>enable
Switch#configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
Switch(config)#hostname CR-SW
CR-SW(config)#
CR-SW(config)#vlan 10
CR-SW(config-vlan)#name LAN-10
CR-SW(config-vlan)#exit
CR-SW(config)#vlan 20
CR-SW(config-vlan)#name LAN-20
CR-SW(config-vlan)#exit
CR-SW(config)#
CR-SW(config)#vtp mode server
Device mode already VTP SERVER.
CR-SW(config)#vtp domain cisco.com
Changing VTP domain name from NULL to cisco.com
CR-SW(config)#vtp password cisco123
Setting device VLAN database password to cisco123
CR-SW(config)#
CR-SW(config)#interface gi1/0/1
CR-SW(config-if)#switchport mode trunk
CR-SW(config-if)#switchport trunk allowed vlan all
CR-SW(config-if)#description To_ACS-SW1
CR-SW(config-if)#exit
CR-SW(config)#
CR-SW(config)#interface gi1/0/2
CR-SW(config-if)#switchport mode trunk
CR-SW(config-if)#switchport trunk allowed vlan all
CR-SW(config-if)#description To_ACS-SW2
CR-SW(config-if)#exit
CR-SW(config)#
CR-SW(config)#interface gi1/0/23
CR-SW(config-if)#switchport mode trunk
CR-SW(config-if)#switchport trunk allowed vlan all
CR-SW(config-if)#description To_R-Active
CR-SW(config-if)#exit
CR-SW(config)#
CR-SW(config)#interface gi1/0/24
CR-SW(config-if)#switchport mode trunk
```

```
CR-SW(config-if)#switchport trunk allowed vlan all
CR-SW(config-if)#description To_R-Standby
CR-SW(config-if)#end
CR-SW#
CR-SW#wr
Building configuration...
Compressed configuration from 7383 bytes to 3601 bytes[OK]
[OK]
CR-SW#
```

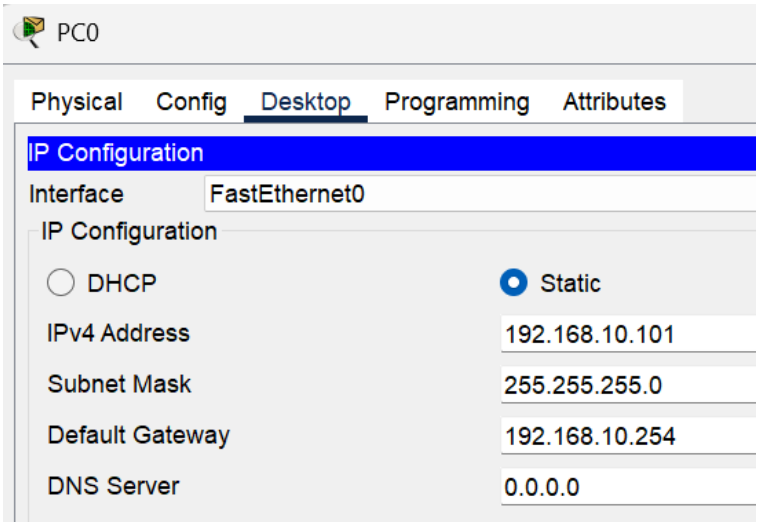
**ACS-SW1**

```
Switch>enable
Switch#configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
Switch(config)#hostname ACS-SW1
ACS-SW1(config)#
ACS-SW1(config)#vtp mode client
Setting device to VTP CLIENT mode.
ACS-SW1(config)#vtp domain cisco.com
Domain name already set to cisco.com.
ACS-SW1(config)#vtp password cisco123
Setting device VLAN database password to cisco123
ACS-SW1(config)#
ACS-SW1(config)#interface gi0/1
ACS-SW1(config-if)#description To_CR-SW
ACS-SW1(config-if)#switchport mode trunk
ACS-SW1(config-if)#switchport trunk allowed vlan all
ACS-SW1(config-if)#exit
ACS-SW1(config)#
ACS-SW1(config)#interface fa0/1
ACS-SW1(config-if)#description To_PC-LAN10
ACS-SW1(config-if)#switchport mode access
ACS-SW1(config-if)#switchport access vlan 10
ACS-SW1(config-if)#exit
ACS-SW1(config)#
ACS-SW1(config)#interface fa0/2
ACS-SW1(config-if)#description To_PC-LAN20
ACS-SW1(config-if)#switchport mode access
ACS-SW1(config-if)#switchport access vlan 20
ACS-SW1(config-if)#end
ACS-SW1(config)#
ACS-SW1#
ACS-SW1#wr
Building configuration...
[OK]
ACS-SW1#
```

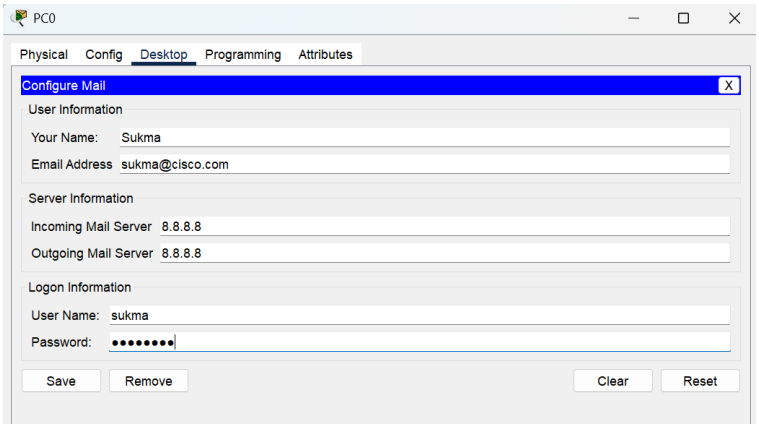
**ACS-SW2**

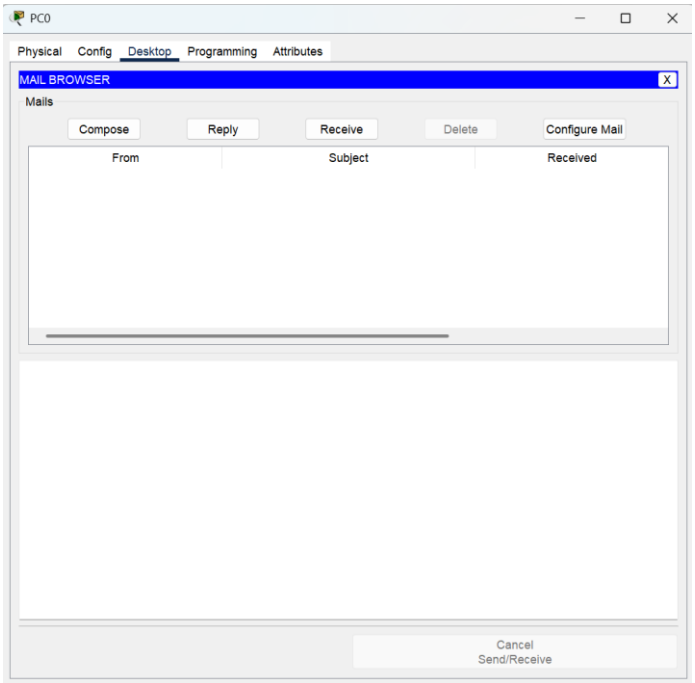
```
Switch>enable
Switch#configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
Switch(config)#hostname ACS-SW2
ACS-SW2(config)#
ACS-SW2(config)#vtp mode client
Setting device to VTP CLIENT mode.
ACS-SW2(config)#vtp domain cisco.com
Domain name already set to cisco.com.
ACS-SW2(config)#vtp password cisco123
Setting device VLAN database password to cisco123
ACS-SW2(config)#
ACS-SW2(config)#interface gi0/1
ACS-SW2(config-if)#description To_CR-SW
ACS-SW2(config-if)#switchport mode trunk
ACS-SW2(config-if)#switchport trunk allowed vlan all
ACS-SW2(config-if)#exit
ACS-SW2(config)#
ACS-SW2(config)#interface fa0/1
ACS-SW2(config-if)#switchport mode access
ACS-SW2(config-if)#switchport access vlan 10
ACS-SW2(config-if)#description To_PC-LAN10
ACS-SW2(config-if)#exit
ACS-SW2(config)#
ACS-SW2(config)#interface fa0/2
ACS-SW2(config-if)#switchport mode access
ACS-SW2(config-if)#switchport access vlan 20
ACS-SW2(config-if)#description To_PC-LAN20
ACS-SW2(config-if)#end
ACS-SW2#
ACS-SW2#wr
Building configuration...
[OK]
ACS-SW2#
```

**PC0**

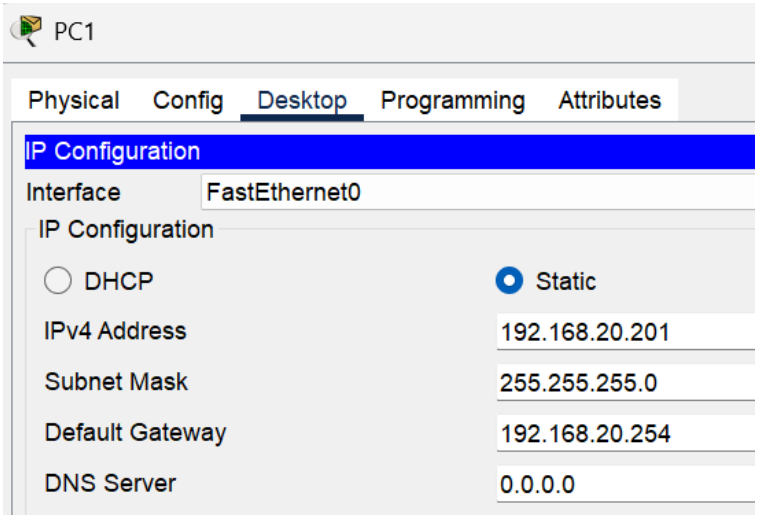



**Setting E-mail**

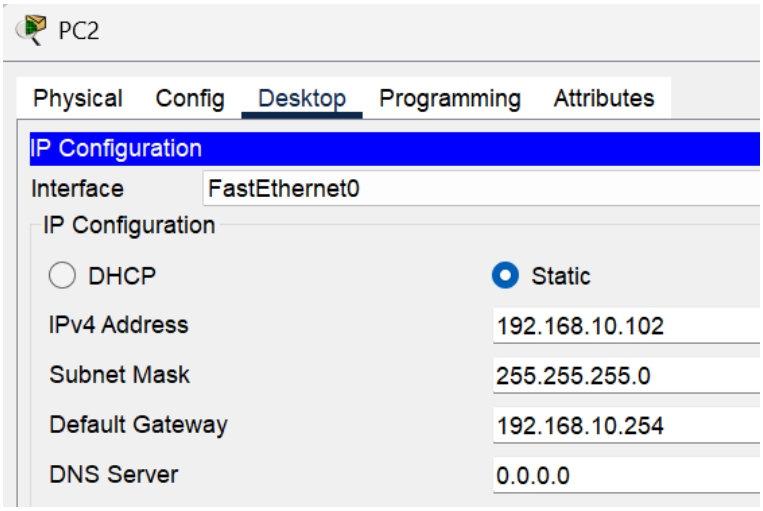


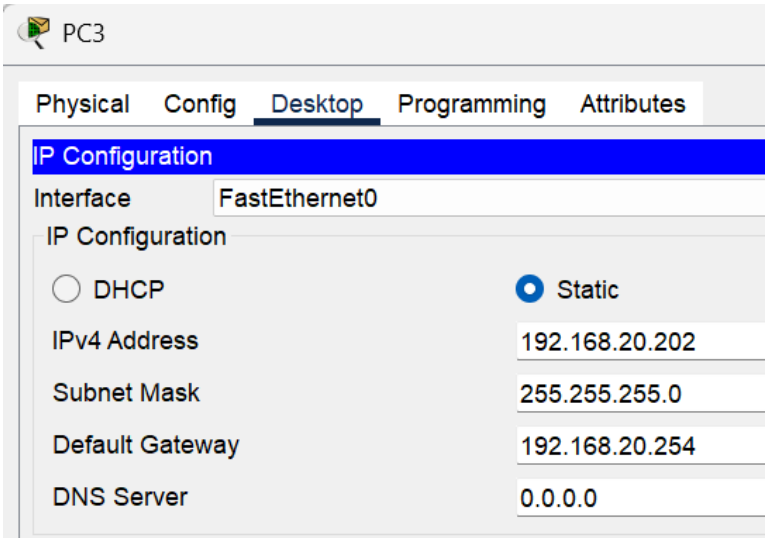
**PC1**


PC1
Physical
Config
Desktop
Programming
Attributes
IP Configuration
Interface
FastEthernet0
IP Configuration
DHCP
Static
IPv4 Address
192.168.20.201
Subnet Mask
255.255.255.0
Default Gateway
192.168.20.254
DNS Server
0.0.0.0

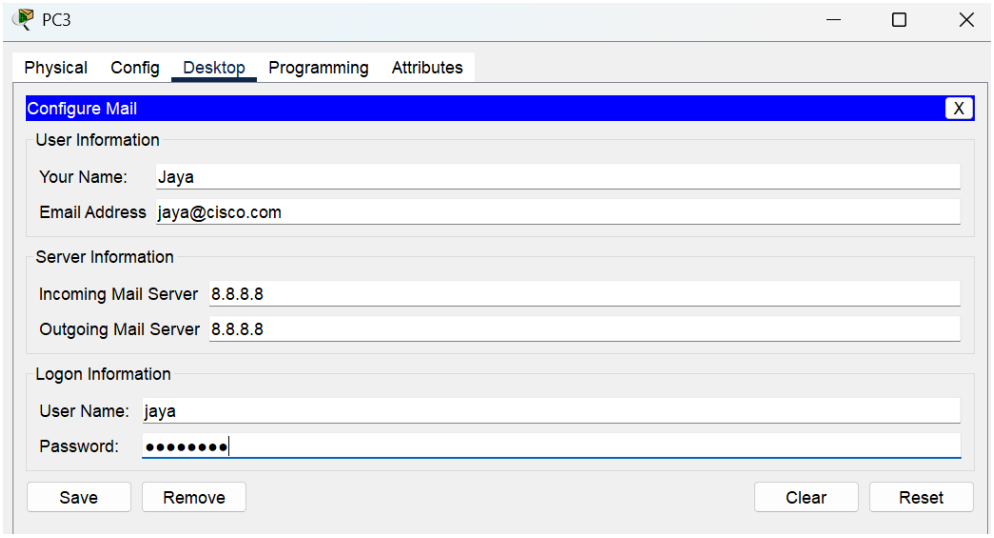
**PC2**

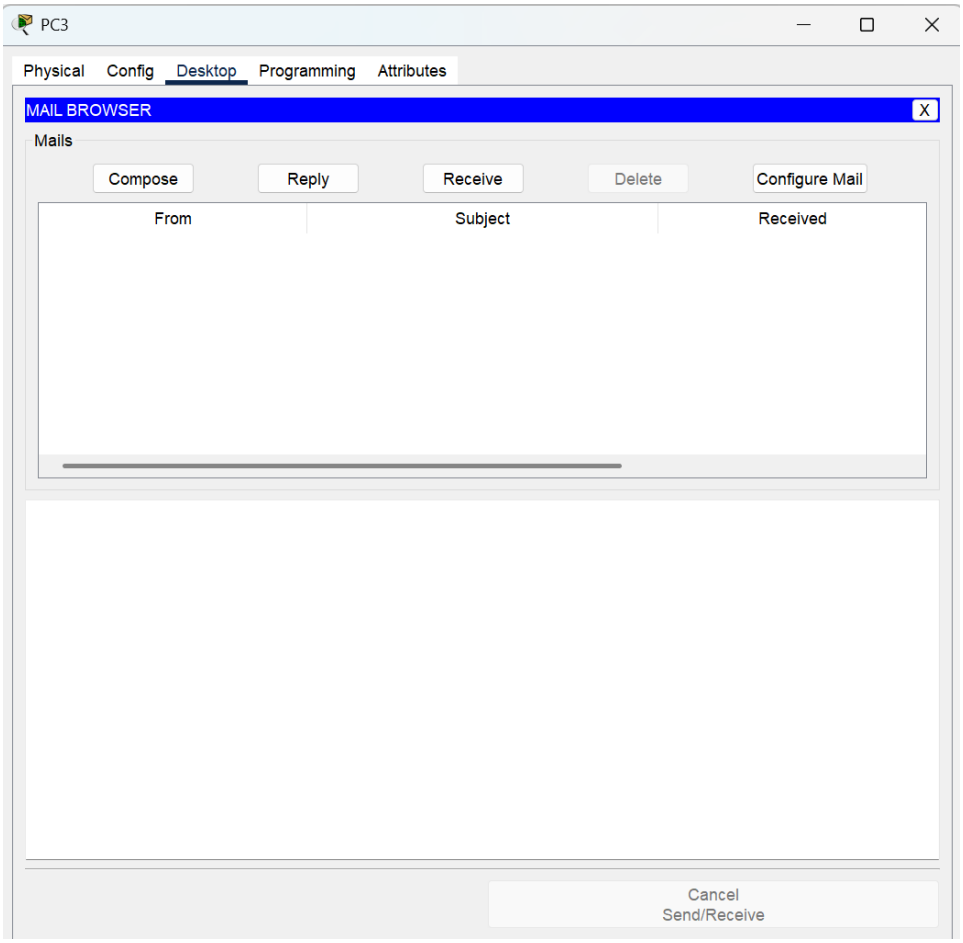

PC2
Physical
Config
Desktop
Programming
Attributes
IP Configuration
Interface
FastEthernet0
IP Configuration
DHCP
Static
IPv4 Address
192.168.10.102
Subnet Mask
255.255.255.0
Default Gateway
192.168.10.254
DNS Server
0.0.0.0

**PC3**

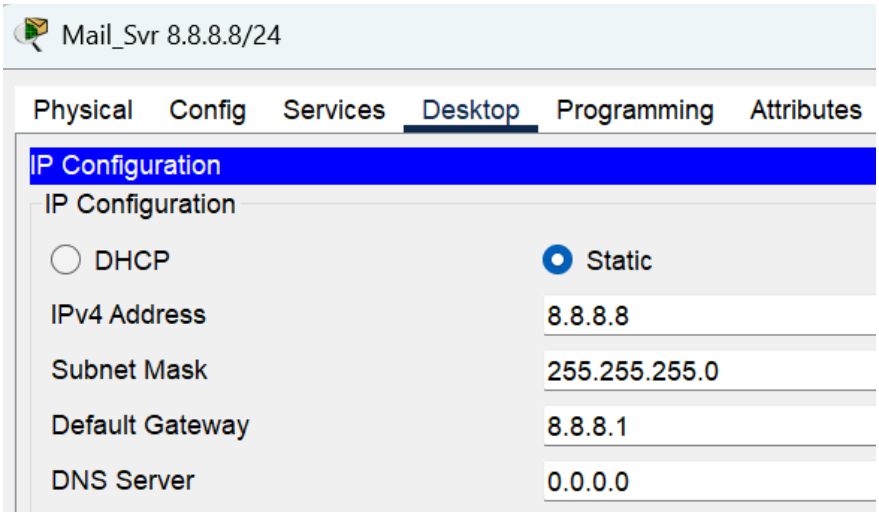

PC3
Physical
Config
Desktop
Programming
Attributes
IP Configuration
Interface
FastEthernet0
IP Configuration
DHCP
Static
IPv4 Address
192.168.20.202
Subnet Mask
255.255.255.0
Default Gateway
192.168.20.254
DNS Server
0.0.0.0

## Setting E-mail

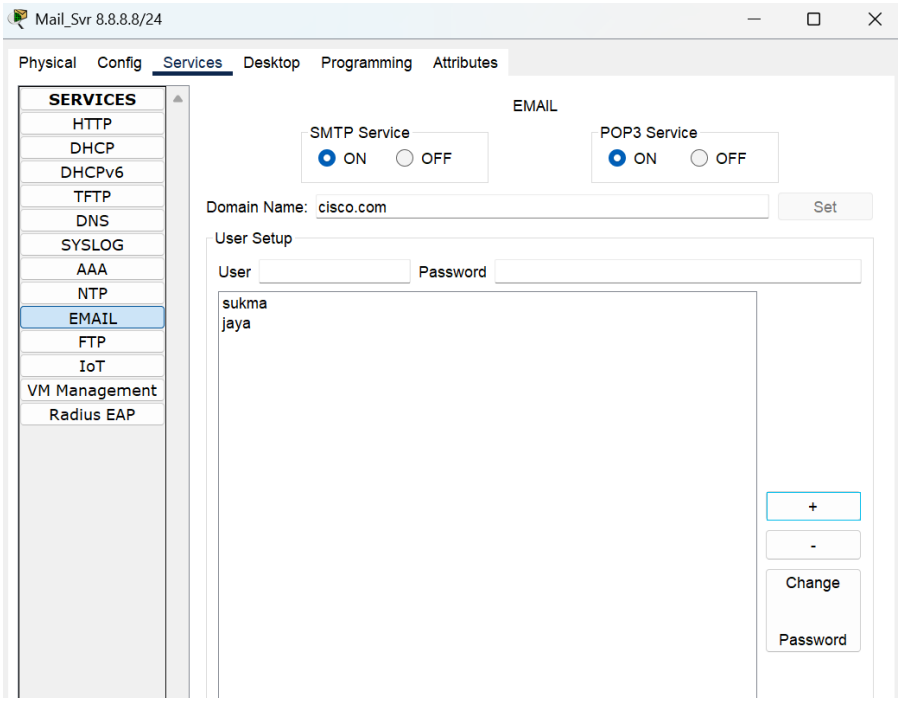


## Mail_SVR




## Setting E-mail Server



**Verifikasi Routing Protocol**

**R-JKT**

```
R-JKT#show run | begin ospf
 ip ospf network point-to-point
 ip ospf priority 1
!
interface GigabitEthernet0/2/0
 description To_R-BDG
 ip address 31.31.31.1 255.255.255.252
 ip ospf network point-to-point
 ip ospf priority 1
!
interface GigabitEthernet0/3/0
 description To_R-SMG
 ip address 51.51.51.1 255.255.255.252
 ip ospf network point-to-point
 ip ospf priority 1
!
interface Vlan1
 no ip address
 shutdown
!
router ospf 1
 router-id 1.1.1.1
 log-adjacency-changes
 network 1.1.1.1 0.0.0.0 area 0
 network 11.11.11.0 0.0.0.3 area 0
 network 31.31.31.0 0.0.0.3 area 1
 network 51.51.51.0 0.0.0.3 area 3
!
```

```
R-JKT#show ip route ospf
     2.0.0.0/32 is subnetted, 1 subnets
O       2.2.2.2 [110/2] via 11.11.11.2, 00:43:01, GigabitEthernet0/1/0
     3.0.0.0/32 is subnetted, 1 subnets
O       3.3.3.3 [110/2] via 31.31.31.2, 00:43:11, GigabitEthernet0/2/0
     4.0.0.0/32 is subnetted, 1 subnets
O       4.4.4.4 [110/2] via 51.51.51.2, 00:43:06, GigabitEthernet0/3/0
     5.0.0.0/32 is subnetted, 1 subnets
O IA    5.5.5.5 [110/3] via 11.11.11.2, 00:43:01, GigabitEthernet0/1/0
     6.0.0.0/32 is subnetted, 1 subnets
O IA    6.6.6.6 [110/3] via 11.11.11.2, 00:43:01, GigabitEthernet0/1/0
     7.0.0.0/32 is subnetted, 1 subnets
O E2    7.7.7.7 [110/20] via 31.31.31.2, 00:43:11, GigabitEthernet0/2/0
     8.0.0.0/24 is subnetted, 1 subnets
O E2    8.8.8.0 [110/20] via 11.11.11.2, 00:00:09, GigabitEthernet0/1/0
     9.0.0.0/32 is subnetted, 1 subnets
O E2    9.9.9.9 [110/20] via 11.11.11.2, 00:00:09, GigabitEthernet0/1/0
     10.0.0.0/32 is subnetted, 1 subnets
O E2    10.10.10.10 [110/20] via 51.51.51.2, 00:43:06, GigabitEthernet0/3/0
     22.0.0.0/30 is subnetted, 1 subnets
O IA    22.22.22.0 [110/2] via 11.11.11.2, 00:43:01, GigabitEthernet0/1/0
     42.0.0.0/30 is subnetted, 1 subnets
O IA    42.42.42.0 [110/2] via 11.11.11.2, 00:43:01, GigabitEthernet0/1/0
     62.0.0.0/30 is subnetted, 1 subnets
O E2    62.62.62.0 [110/20] via 11.11.11.2, 00:00:09, GigabitEthernet0/1/0
     71.0.0.0/30 is subnetted, 1 subnets
O       71.71.71.0 [110/2] via 31.31.31.2, 00:43:11, GigabitEthernet0/2/0
     91.0.0.0/30 is subnetted, 1 subnets
O       91.91.91.0 [110/2] via 51.51.51.2, 00:43:06, GigabitEthernet0/3/0

R-JKT#
```

**R-BDG**

```
R-BDG#show run | begin ospf
 ip ospf network point-to-point
 ip ospf priority 1
!
interface Vlan1
 no ip address
 shutdown
!
router ospf 3
 router-id 3.3.3.3
 log-adjacency-changes
 redistribute static subnets
 network 3.3.3.3 0.0.0.0 area 1
 network 31.31.31.0 0.0.0.3 area 1
 network 10.1.1.0 0.0.0.255 area 1
 network 71.71.71.0 0.0.0.3 area 1
 default-information originate
!
ip classless
ip route 7.7.7.7 255.255.255.255 71.71.71.2
!
ip flow-export version 9
!
```

```
R-BDG#show ip route ospf
     1.0.0.0/32 is subnetted, 1 subnets
O IA    1.1.1.1 [110/2] via 31.31.31.1, 01:06:36, GigabitEthernet0/3/0
     2.0.0.0/32 is subnetted, 1 subnets
O IA    2.2.2.2 [110/3] via 31.31.31.1, 01:06:36, GigabitEthernet0/3/0
     4.0.0.0/32 is subnetted, 1 subnets
O IA    4.4.4.4 [110/3] via 31.31.31.1, 01:06:36, GigabitEthernet0/3/0
     5.0.0.0/32 is subnetted, 1 subnets
O IA    5.5.5.5 [110/4] via 31.31.31.1, 01:06:36, GigabitEthernet0/3/0
     6.0.0.0/32 is subnetted, 1 subnets
O IA    6.6.6.6 [110/4] via 31.31.31.1, 01:06:36, GigabitEthernet0/3/0
     8.0.0.0/24 is subnetted, 1 subnets
O E2    8.8.8.0 [110/20] via 31.31.31.1, 00:03:09, GigabitEthernet0/3/0
     9.0.0.0/32 is subnetted, 1 subnets
O E2    9.9.9.9 [110/20] via 31.31.31.1, 00:03:09, GigabitEthernet0/3/0
     10.0.0.0/32 is subnetted, 1 subnets
O E2    10.10.10.10 [110/20] via 31.31.31.1, 01:06:36, GigabitEthernet0/3/0
     11.0.0.0/30 is subnetted, 1 subnets
O IA    11.11.11.0 [110/2] via 31.31.31.1, 01:06:36, GigabitEthernet0/3/0
     22.0.0.0/30 is subnetted, 1 subnets
O IA    22.22.22.0 [110/3] via 31.31.31.1, 01:06:36, GigabitEthernet0/3/0
     42.0.0.0/30 is subnetted, 1 subnets
O IA    42.42.42.0 [110/3] via 31.31.31.1, 01:06:36, GigabitEthernet0/3/0
     51.0.0.0/30 is subnetted, 1 subnets
O IA    51.51.51.0 [110/2] via 31.31.31.1, 01:06:36, GigabitEthernet0/3/0
     62.0.0.0/30 is subnetted, 1 subnets
O E2    62.62.62.0 [110/20] via 31.31.31.1, 01:06:36, GigabitEthernet0/3/0
     91.0.0.0/30 is subnetted, 1 subnets
O IA    91.91.91.0 [110/3] via 31.31.31.1, 01:06:36, GigabitEthernet0/3/0

R-BDG#
```

**R-SMG**

```
R-SMG#show run | begin ospf
 ip ospf network point-to-point
 ip ospf priority 1
!
interface Vlan1
 no ip address
 shutdown
!
router ospf 4
 router-id 4.4.4.4
 log-adjacency-changes
 redistribute static subnets
 network 4.4.4.4 0.0.0.0 area 3
 network 51.51.51.0 0.0.0.3 area 3
 network 172.16.2.0 0.0.0.255 area 3
 network 91.91.91.0 0.0.0.3 area 3
 default-information originate
!
ip classless
ip route 10.10.10.10 255.255.255.255 91.91.91.2
!
ip flow-export version 9
!
```

```
R-SMG#show ip route ospf
     1.0.0.0/32 is subnetted, 1 subnets
O IA    1.1.1.1 [110/2] via 51.51.51.1, 01:08:44, GigabitEthernet0/3/0
     2.0.0.0/32 is subnetted, 1 subnets
O IA    2.2.2.2 [110/3] via 51.51.51.1, 01:08:44, GigabitEthernet0/3/0
     3.0.0.0/32 is subnetted, 1 subnets
O IA    3.3.3.3 [110/3] via 51.51.51.1, 01:08:54, GigabitEthernet0/3/0
     5.0.0.0/32 is subnetted, 1 subnets
O IA    5.5.5.5 [110/4] via 51.51.51.1, 01:08:44, GigabitEthernet0/3/0
     6.0.0.0/32 is subnetted, 1 subnets
O IA    6.6.6.6 [110/4] via 51.51.51.1, 01:08:44, GigabitEthernet0/3/0
     7.0.0.0/32 is subnetted, 1 subnets
O E2    7.7.7.7 [110/20] via 51.51.51.1, 01:08:54, GigabitEthernet0/3/0
     8.0.0.0/24 is subnetted, 1 subnets
O E2    8.8.8.0 [110/20] via 51.51.51.1, 00:05:22, GigabitEthernet0/3/0
     9.0.0.0/32 is subnetted, 1 subnets
O E2    9.9.9.9 [110/20] via 51.51.51.1, 00:05:22, GigabitEthernet0/3/0
     11.0.0.0/30 is subnetted, 1 subnets
O IA    11.11.11.0 [110/2] via 51.51.51.1, 01:08:44, GigabitEthernet0/3/0
     22.0.0.0/30 is subnetted, 1 subnets
O IA    22.22.22.0 [110/3] via 51.51.51.1, 01:08:44, GigabitEthernet0/3/0
     31.0.0.0/30 is subnetted, 1 subnets
O IA    31.31.31.0 [110/2] via 51.51.51.1, 01:08:54, GigabitEthernet0/3/0
     42.0.0.0/30 is subnetted, 1 subnets
O IA    42.42.42.0 [110/3] via 51.51.51.1, 01:08:44, GigabitEthernet0/3/0
     62.0.0.0/30 is subnetted, 1 subnets
O E2    62.62.62.0 [110/20] via 51.51.51.1, 00:26:02, GigabitEthernet0/3/0
     71.0.0.0/30 is subnetted, 1 subnets
O IA    71.71.71.0 [110/3] via 51.51.51.1, 01:08:54, GigabitEthernet0/3/0

R-SMG#
```

**R-SBY**

```
R-SBY#show run | begin ospf
 ip ospf network point-to-point
 ip ospf priority 1
!
interface GigabitEthernet0/2/0
 description To_R-DPS
 ip address 42.42.42.1 255.255.255.252
 ip ospf network point-to-point
 ip ospf priority 1
!
interface GigabitEthernet0/3/0
 description To_R-MKS
 ip address 22.22.22.1 255.255.255.252
 ip ospf network point-to-point
 ip ospf priority 1
!
interface Vlan1
 no ip address
 shutdown
!
router ospf 2
 router-id 2.2.2.2
 log-adjacency-changes
 network 2.2.2.2 0.0.0.0 area 0
 network 11.11.11.0 0.0.0.3 area 0
 network 22.22.22.0 0.0.0.3 area 2
 network 42.42.42.0 0.0.0.3 area 4
!
```

```
R-SBY#show ip route ospf
     1.0.0.0/32 is subnetted, 1 subnets
O       1.1.1.1 [110/2] via 11.11.11.1, 01:15:47, GigabitEthernet0/1/0
     3.0.0.0/32 is subnetted, 1 subnets
O IA    3.3.3.3 [110/3] via 11.11.11.1, 01:15:47, GigabitEthernet0/1/0
     4.0.0.0/32 is subnetted, 1 subnets
O IA    4.4.4.4 [110/3] via 11.11.11.1, 01:15:47, GigabitEthernet0/1/0
     5.0.0.0/32 is subnetted, 1 subnets
O       5.5.5.5 [110/2] via 22.22.22.2, 01:15:52, GigabitEthernet0/3/0
     6.0.0.0/32 is subnetted, 1 subnets
O       6.6.6.6 [110/2] via 42.42.42.2, 01:15:57, GigabitEthernet0/2/0
     7.0.0.0/32 is subnetted, 1 subnets
O E2    7.7.7.7 [110/20] via 11.11.11.1, 01:15:47, GigabitEthernet0/1/0
     8.0.0.0/24 is subnetted, 1 subnets
O E2    8.8.8.0 [110/20] via 22.22.22.2, 01:15:52, GigabitEthernet0/3/0
     9.0.0.0/32 is subnetted, 1 subnets
O E2    9.9.9.9 [110/20] via 22.22.22.2, 01:15:52, GigabitEthernet0/3/0
     10.0.0.0/32 is subnetted, 1 subnets
O E2    10.10.10.10 [110/20] via 11.11.11.1, 01:15:47, GigabitEthernet0/1/0
     31.0.0.0/30 is subnetted, 1 subnets
O IA    31.31.31.0 [110/2] via 11.11.11.1, 01:15:47, GigabitEthernet0/1/0
     51.0.0.0/30 is subnetted, 1 subnets
O IA    51.51.51.0 [110/2] via 11.11.11.1, 01:15:47, GigabitEthernet0/1/0
     62.0.0.0/30 is subnetted, 1 subnets
O E2    62.62.62.0 [110/20] via 22.22.22.2, 01:15:52, GigabitEthernet0/3/0
     71.0.0.0/30 is subnetted, 1 subnets
O IA    71.71.71.0 [110/3] via 11.11.11.1, 01:15:47, GigabitEthernet0/1/0
     91.0.0.0/30 is subnetted, 1 subnets
O IA    91.91.91.0 [110/3] via 11.11.11.1, 01:15:47, GigabitEthernet0/1/0

R-SBY#
```

**R-MKS**

```
R-MKS#show run | begin ospf
 ip ospf network point-to-point
 ip ospf priority 1
!
interface Vlan1
 no ip address
 shutdown
!
router ospf 5
 router-id 5.5.5.5
 log-adjacency-changes
 redistribute bgp 100 subnets
 network 5.5.5.5 0.0.0.0 area 2
 network 22.22.22.0 0.0.0.3 area 2
 network 192.168.3.0 0.0.0.255 area 2
!
router bgp 100
 bgp log-neighbor-changes
 no synchronization
 neighbor 62.62.62.2 remote-as 200
 network 5.5.5.5 mask 255.255.255.255
 network 62.62.62.0 mask 255.255.255.252
 network 22.22.22.0 mask 255.255.255.252
 redistribute ospf 5
 redistribute connected
!
```

```
R-MKS#show ip route ospf
     1.0.0.0/32 is subnetted, 1 subnets
O IA    1.1.1.1 [110/3] via 22.22.22.1, 01:18:37, GigabitEthernet0/3/0
     2.0.0.0/32 is subnetted, 1 subnets
O IA    2.2.2.2 [110/2] via 22.22.22.1, 01:18:47, GigabitEthernet0/3/0
     3.0.0.0/32 is subnetted, 1 subnets
O IA    3.3.3.3 [110/4] via 22.22.22.1, 01:18:37, GigabitEthernet0/3/0
     4.0.0.0/32 is subnetted, 1 subnets
O IA    4.4.4.4 [110/4] via 22.22.22.1, 01:18:37, GigabitEthernet0/3/0
     6.0.0.0/32 is subnetted, 1 subnets
O IA    6.6.6.6 [110/3] via 22.22.22.1, 01:18:47, GigabitEthernet0/3/0
     7.0.0.0/32 is subnetted, 1 subnets
O E2    7.7.7.7 [110/20] via 22.22.22.1, 01:18:47, GigabitEthernet0/3/0
     10.0.0.0/32 is subnetted, 1 subnets
O E2    10.10.10.10 [110/20] via 22.22.22.1, 01:18:37, GigabitEthernet0/3/0
     11.0.0.0/30 is subnetted, 1 subnets
O IA    11.11.11.0 [110/2] via 22.22.22.1, 01:18:47, GigabitEthernet0/3/0
     31.0.0.0/30 is subnetted, 1 subnets
O IA    31.31.31.0 [110/3] via 22.22.22.1, 01:18:37, GigabitEthernet0/3/0
     42.0.0.0/30 is subnetted, 1 subnets
O IA    42.42.42.0 [110/2] via 22.22.22.1, 01:18:47, GigabitEthernet0/3/0
     51.0.0.0/30 is subnetted, 1 subnets
O IA    51.51.51.0 [110/3] via 22.22.22.1, 01:18:37, GigabitEthernet0/3/0
     71.0.0.0/30 is subnetted, 1 subnets
O IA    71.71.71.0 [110/4] via 22.22.22.1, 01:18:37, GigabitEthernet0/3/0
     91.0.0.0/30 is subnetted, 1 subnets
O IA    91.91.91.0 [110/4] via 22.22.22.1, 01:18:37, GigabitEthernet0/3/0

R-MKS#show ip route bgp
B    8.8.8.0 [20/0] via 62.62.62.2, 00:00:00
B    9.9.9.9 [20/0] via 62.62.62.2, 00:00:00

R-MKS#
```

**R-DPS**

```
R-DPS#show run | begin ospf
 ip ospf network point-to-point
 ip ospf priority 1
!
interface Vlan1
 no ip address
 shutdown
!
router ospf 6
 router-id 6.6.6.6
 log-adjacency-changes
 network 6.6.6.6 0.0.0.0 area 4
 network 42.42.42.0 0.0.0.3 area 4
!
ip classless
!
ip flow-export version 9
!
```

```
R-DPS#show ip route ospf
     1.0.0.0/32 is subnetted, 1 subnets
O IA    1.1.1.1 [110/3] via 42.42.42.1, 01:20:05, GigabitEthernet0/3/0
     2.0.0.0/32 is subnetted, 1 subnets
O IA    2.2.2.2 [110/2] via 42.42.42.1, 01:20:05, GigabitEthernet0/3/0
     3.0.0.0/32 is subnetted, 1 subnets
O IA    3.3.3.3 [110/4] via 42.42.42.1, 01:20:05, GigabitEthernet0/3/0
     4.0.0.0/32 is subnetted, 1 subnets
O IA    4.4.4.4 [110/4] via 42.42.42.1, 01:20:05, GigabitEthernet0/3/0
     5.0.0.0/32 is subnetted, 1 subnets
O IA    5.5.5.5 [110/3] via 42.42.42.1, 01:20:05, GigabitEthernet0/3/0
     7.0.0.0/32 is subnetted, 1 subnets
O E2    7.7.7.7 [110/20] via 42.42.42.1, 01:20:05, GigabitEthernet0/3/0
     8.0.0.0/24 is subnetted, 1 subnets
O E2    8.8.8.0 [110/20] via 42.42.42.1, 00:16:38, GigabitEthernet0/3/0
     9.0.0.0/32 is subnetted, 1 subnets
O E2    9.9.9.9 [110/20] via 42.42.42.1, 00:16:38, GigabitEthernet0/3/0
     10.0.0.0/32 is subnetted, 1 subnets
O E2    10.10.10.10 [110/20] via 42.42.42.1, 01:20:05, GigabitEthernet0/3/0
     11.0.0.0/30 is subnetted, 1 subnets
O IA    11.11.11.0 [110/2] via 42.42.42.1, 01:20:05, GigabitEthernet0/3/0
     22.0.0.0/30 is subnetted, 1 subnets
O IA    22.22.22.0 [110/2] via 42.42.42.1, 01:20:05, GigabitEthernet0/3/0
     31.0.0.0/30 is subnetted, 1 subnets
O IA    31.31.31.0 [110/3] via 42.42.42.1, 01:20:05, GigabitEthernet0/3/0
     51.0.0.0/30 is subnetted, 1 subnets
O IA    51.51.51.0 [110/3] via 42.42.42.1, 01:20:05, GigabitEthernet0/3/0
     62.0.0.0/30 is subnetted, 1 subnets
O E2    62.62.62.0 [110/20] via 42.42.42.1, 00:17:18, GigabitEthernet0/3/0
     71.0.0.0/30 is subnetted, 1 subnets
O IA    71.71.71.0 [110/4] via 42.42.42.1, 01:20:05, GigabitEthernet0/3/0
     91.0.0.0/30 is subnetted, 1 subnets
O IA    91.91.91.0 [110/4] via 42.42.42.1, 01:20:05, GigabitEthernet0/3/0
```

**R-MND**

```
R-MND#show run | begin bgp
router bgp 200
 bgp log-neighbor-changes
 no synchronization
 neighbor 62.62.62.1 remote-as 100
 network 9.9.9.9 mask 255.255.255.255
 network 8.8.8.0 mask 255.255.255.0
 network 62.62.62.0 mask 255.255.255.252
!
ip classless
!
ip flow-export version 9
```

```
R-MND#show ip route bgp
B    1.1.1.1 [20/3] via 62.62.62.1, 00:00:00
B    2.2.2.2 [20/2] via 62.62.62.1, 00:00:00
B    3.3.3.3 [20/4] via 62.62.62.1, 00:00:00
B    4.4.4.4 [20/4] via 62.62.62.1, 00:00:00
B    5.5.5.5 [20/0] via 62.62.62.1, 00:00:00
B    6.6.6.6 [20/3] via 62.62.62.1, 00:00:00
B    11.11.11.0 [20/2] via 62.62.62.1, 00:00:00
B    22.22.22.0 [20/0] via 62.62.62.1, 00:00:00
B    31.31.31.0 [20/3] via 62.62.62.1, 00:00:00
B    42.42.42.0 [20/2] via 62.62.62.1, 00:00:00
B    51.51.51.0 [20/3] via 62.62.62.1, 00:00:00
B    71.71.71.0 [20/4] via 62.62.62.1, 00:00:00
B    91.91.91.0 [20/4] via 62.62.62.1, 00:00:00

R-MND#
```

**R-Active**

```
R-Active#show ip nat translations
Pro  Inside global     Inside local       Outside local      Outside global
icmp 71.71.71.2:1024   192.168.20.201:1   8.8.8.8:1          8.8.8.8:1024
icmp 71.71.71.2:1025   192.168.20.201:2   8.8.8.8:2          8.8.8.8:1025
icmp 71.71.71.2:1026   192.168.20.201:3   8.8.8.8:3          8.8.8.8:1026
icmp 71.71.71.2:1027   192.168.20.201:4   8.8.8.8:4          8.8.8.8:1027
icmp 71.71.71.2:1      192.168.10.101:1   8.8.8.8:1          8.8.8.8:1
icmp 71.71.71.2:2      192.168.10.101:2   8.8.8.8:2          8.8.8.8:2
icmp 71.71.71.2:3      192.168.10.101:3   8.8.8.8:3          8.8.8.8:3
icmp 71.71.71.2:4      192.168.10.101:4   8.8.8.8:4          8.8.8.8:4
icmp 71.71.71.2:5      192.168.10.101:5   8.8.8.8:5          8.8.8.8:5
icmp 71.71.71.2:6      192.168.10.101:6   8.8.8.8:6          8.8.8.8:6
icmp 71.71.71.2:7      192.168.10.101:7   8.8.8.8:7          8.8.8.8:7
icmp 71.71.71.2:8      192.168.10.101:8   8.8.8.8:8          8.8.8.8:8
```

```
R-Active#show standby br
                    P indicates configured to preempt.
                    |
Interface   Grp  Pri P State    Active          Standby         Virtual IP
Gig         0    150 P Active   local           192.168.10.2    192.168.10.254
Gig         0    150 P Active   local           192.168.20.2    192.168.20.254
R-Active#
R-Active#show ip route
Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2, E - EGP
       i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, ia - IS-IS inter area
       * - candidate default, U - per-user static route, o - ODR
       P - periodic downloaded static route

Gateway of last resort is 71.71.71.1 to network 0.0.0.0

     7.0.0.0/32 is subnetted, 1 subnets
C       7.7.7.7/32 is directly connected, Loopback7
     71.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
C       71.71.71.0/30 is directly connected, GigabitEthernet0/0
L       71.71.71.2/32 is directly connected, GigabitEthernet0/0
     192.168.10.0/24 is variably subnetted, 2 subnets, 2 masks
C       192.168.10.0/24 is directly connected, GigabitEthernet0/1.10
L       192.168.10.1/32 is directly connected, GigabitEthernet0/1.10
     192.168.20.0/24 is variably subnetted, 2 subnets, 2 masks
C       192.168.20.0/24 is directly connected, GigabitEthernet0/1.20
L       192.168.20.1/32 is directly connected, GigabitEthernet0/1.20
S*   0.0.0.0/0 [1/0] via 71.71.71.1

R-Active#
```

## R-Standby

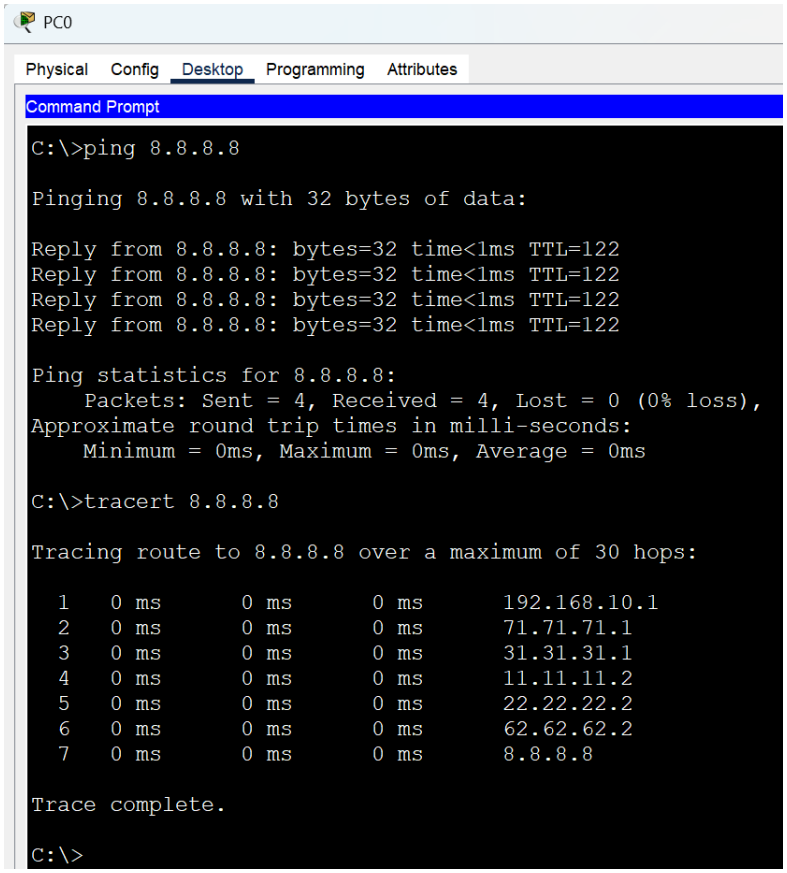
```
R-Standby#show ip nat translations
Pro  Inside global     Inside local       Outside local      Outside global
icmp 91.91.91.2:1024   192.168.20.202:1   8.8.8.8:1          8.8.8.8:1024
icmp 91.91.91.2:1025   192.168.20.202:2   8.8.8.8:2          8.8.8.8:1025
icmp 91.91.91.2:1026   192.168.20.202:3   8.8.8.8:3          8.8.8.8:1026
icmp 91.91.91.2:1027   192.168.20.202:4   8.8.8.8:4          8.8.8.8:1027
icmp 91.91.91.2:1      192.168.10.102:1   8.8.8.8:1          8.8.8.8:1
icmp 91.91.91.2:2      192.168.10.102:2   8.8.8.8:2          8.8.8.8:2
icmp 91.91.91.2:3      192.168.10.102:3   8.8.8.8:3          8.8.8.8:3
icmp 91.91.91.2:4      192.168.10.102:4   8.8.8.8:4          8.8.8.8:4
```

```
R-Standby#show standby br
                     P indicates configured to preempt.
                     |
Interface   Grp  Pri P State    Active          Standby         Virtual IP
Gig         0    100   Active   local           unknown         192.168.10.254
Gig         0    100   Active   local           unknown         192.168.20.254
R-Standby#
R-Standby#show ip route
Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2, E - EGP
       i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, ia - IS-IS inter area
       * - candidate default, U - per-user static route, o - ODR
       P - periodic downloaded static route

Gateway of last resort is 91.91.91.1 to network 0.0.0.0

     10.0.0.0/32 is subnetted, 1 subnets
C       10.10.10.10/32 is directly connected, Loopback10
     91.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
C       91.91.91.0/30 is directly connected, GigabitEthernet0/0
L       91.91.91.2/32 is directly connected, GigabitEthernet0/0
     192.168.10.0/24 is variably subnetted, 2 subnets, 2 masks
C       192.168.10.0/24 is directly connected, GigabitEthernet0/1.10
L       192.168.10.2/32 is directly connected, GigabitEthernet0/1.10
     192.168.20.0/24 is variably subnetted, 2 subnets, 2 masks
C       192.168.20.0/24 is directly connected, GigabitEthernet0/1.20
L       192.168.20.2/32 is directly connected, GigabitEthernet0/1.20
S*   0.0.0.0/0 [1/0] via 91.91.91.1

R-Standby#
```

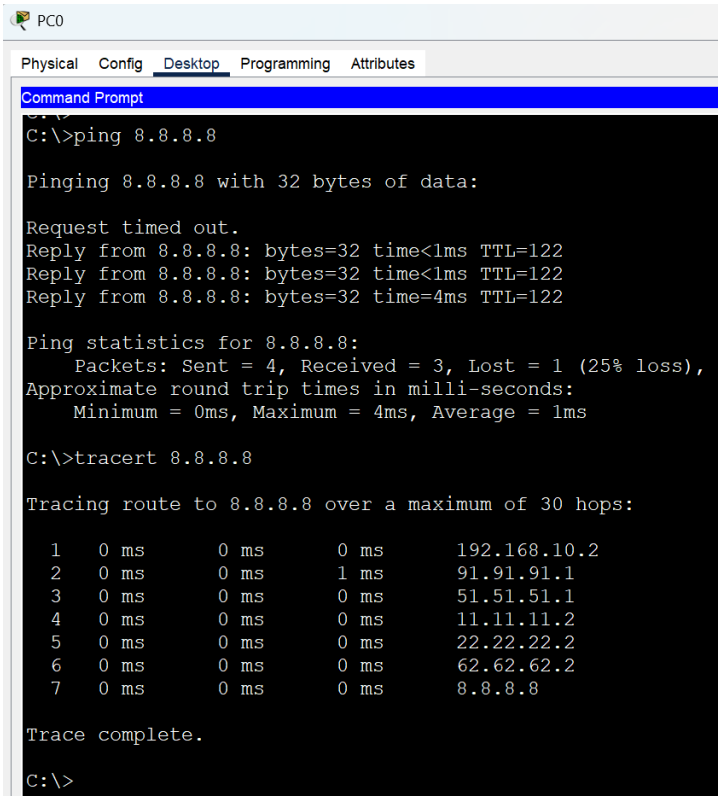
**Test PING & Traceroute**

**PC0 to Mail_SVR**

**Lewat R-Active**

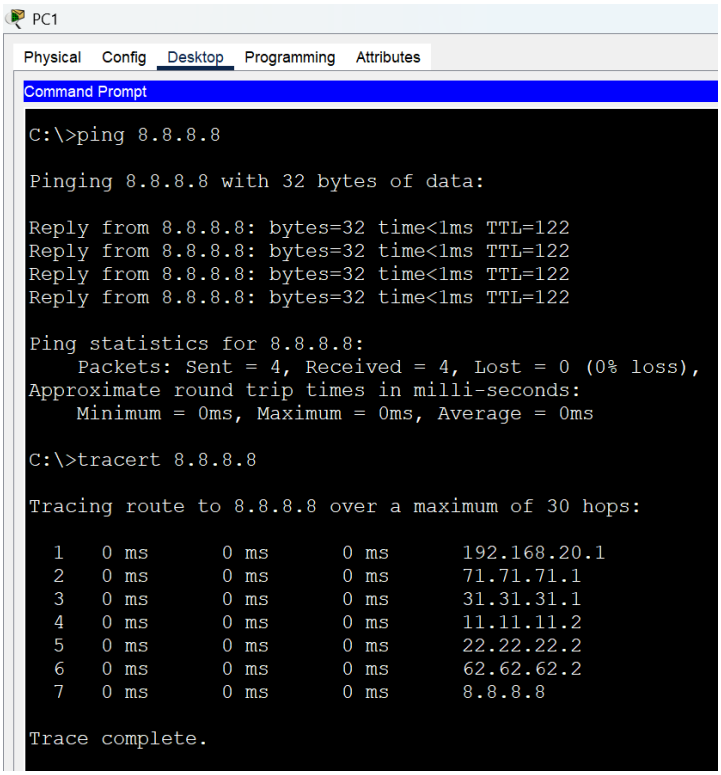


## Lewat R-Standby

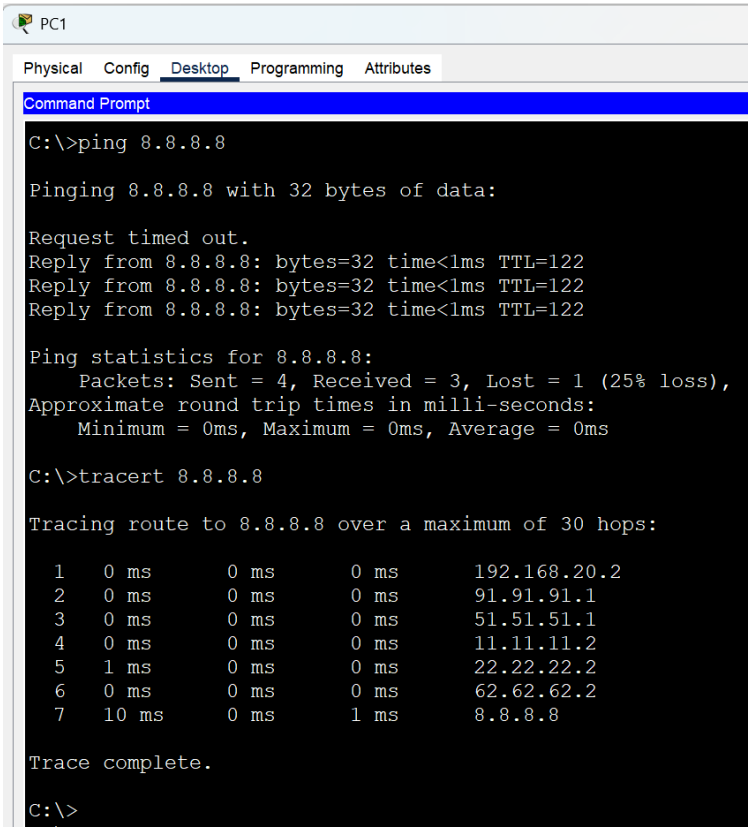



## PC1 to Mail_SVR

## Lewat R-Active

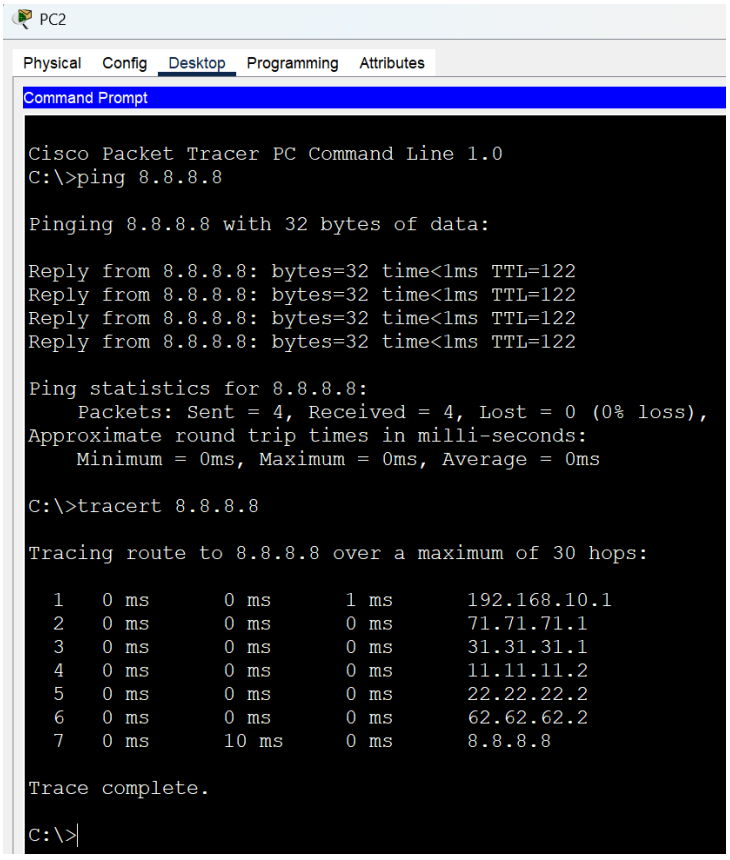


## Lewat R-Standby

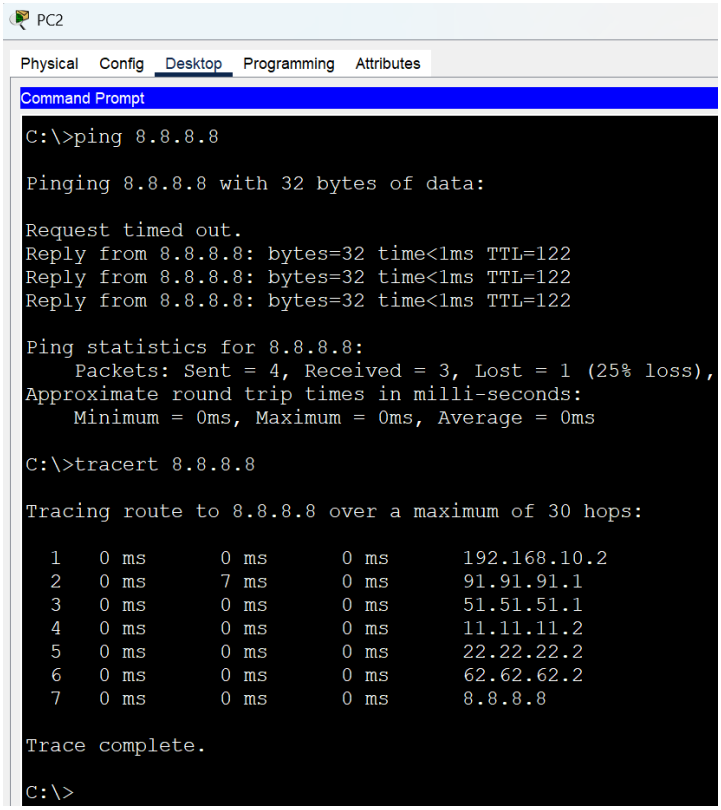



## PC2 to Mail_SVR

## Lewat R-Active

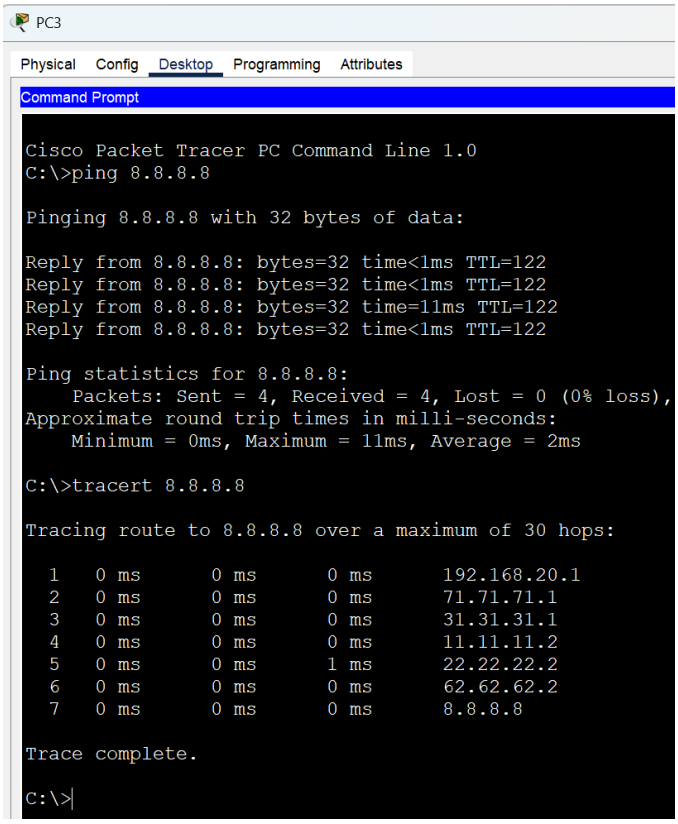


## Lewat R-Standby

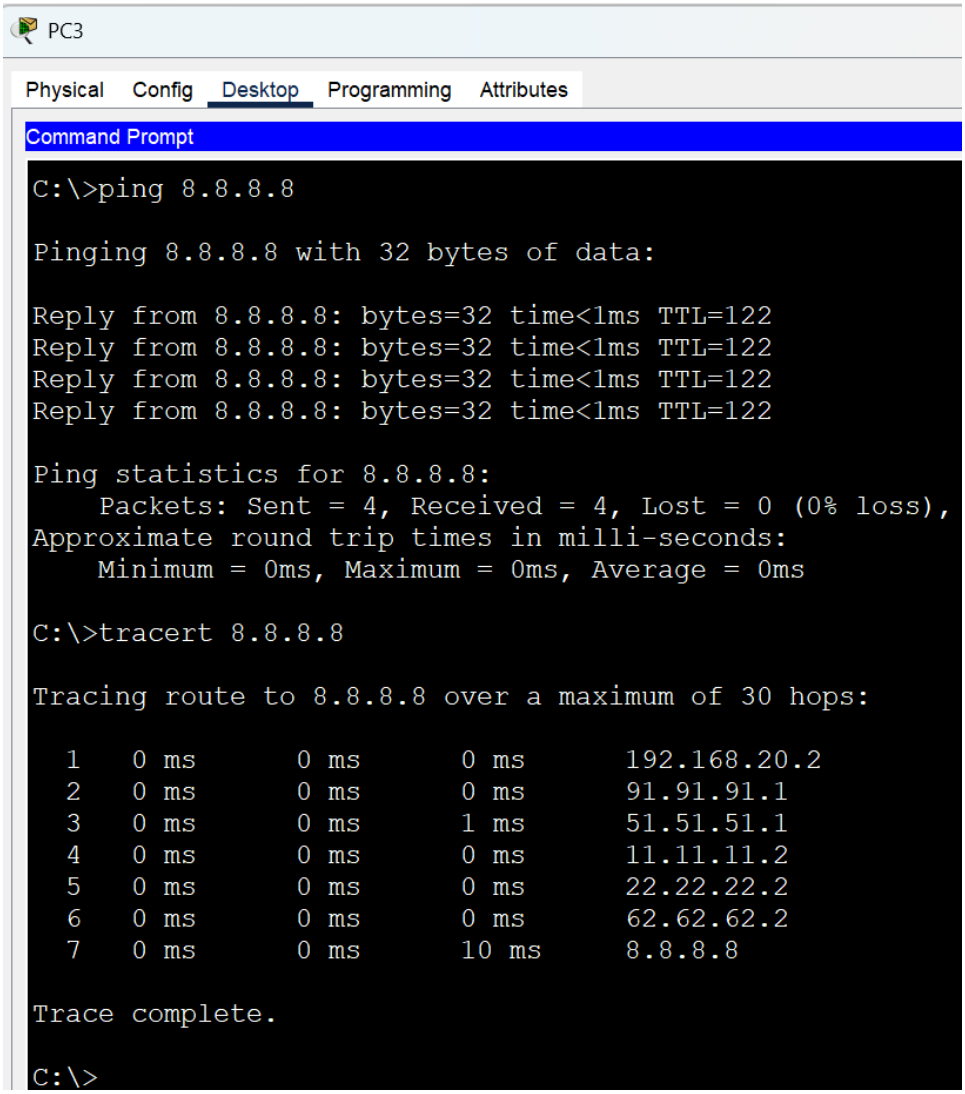



## PC3 to Mail_SVR

## Lewat R-Active

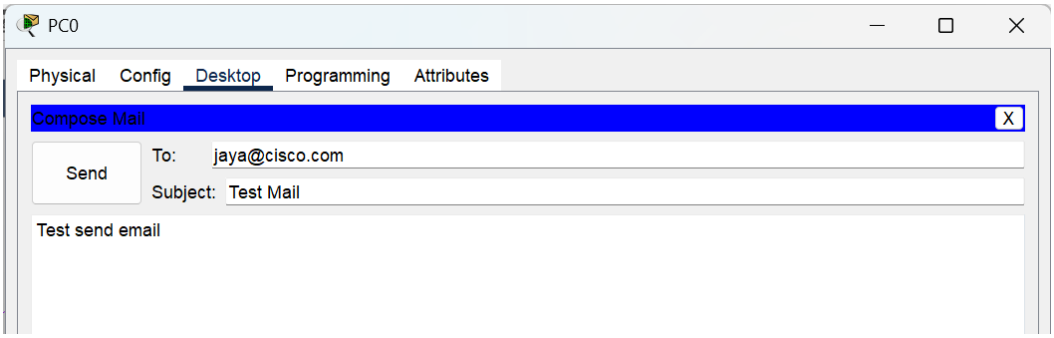


**Lewat R-Standby**




**Testing Send and Receive E-mail**

**Send E-mail from PC1 to PC3**



## Receive E-mail from PC3