

TK 2134

PROTOKOL ROUTING



Materi Minggu ke-3 & 4:
Konsep Routing



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Konsep Routing

Topik yang akan dibahas pada pertemuan ini meliputi :

- Pengertian, fungsi dan Konfigurasi router
- Menjelaskan tentang fungsi dan fitur utama pada router.
- Menjelaskan tentang enkapsulasi dan dekapulasi pada router

Dasar-dasar Routing

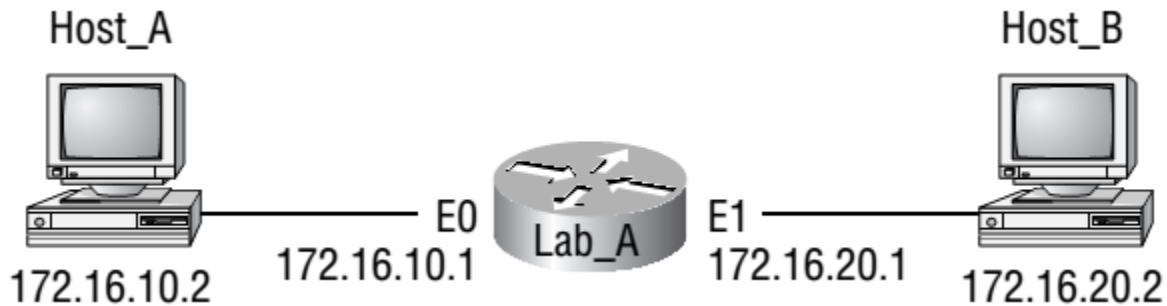
Routing digunakan untuk proses pengambilan sebuah paket dari sebuah alat dan mengirimkannya melalui network ke alat lain di sebuah network yang berbeda.

Untuk melakukan routing paket, setidaknya harus mengetahui hal-hal berikut :

- Alamat Tujuan
- Router-router tetangga (neighbor routers)
- Route yang mungkin ke semua network remote
- Route terbaik untuk setiap network remote
- Bagaimana menjaga dan memverifikasi informasi routing

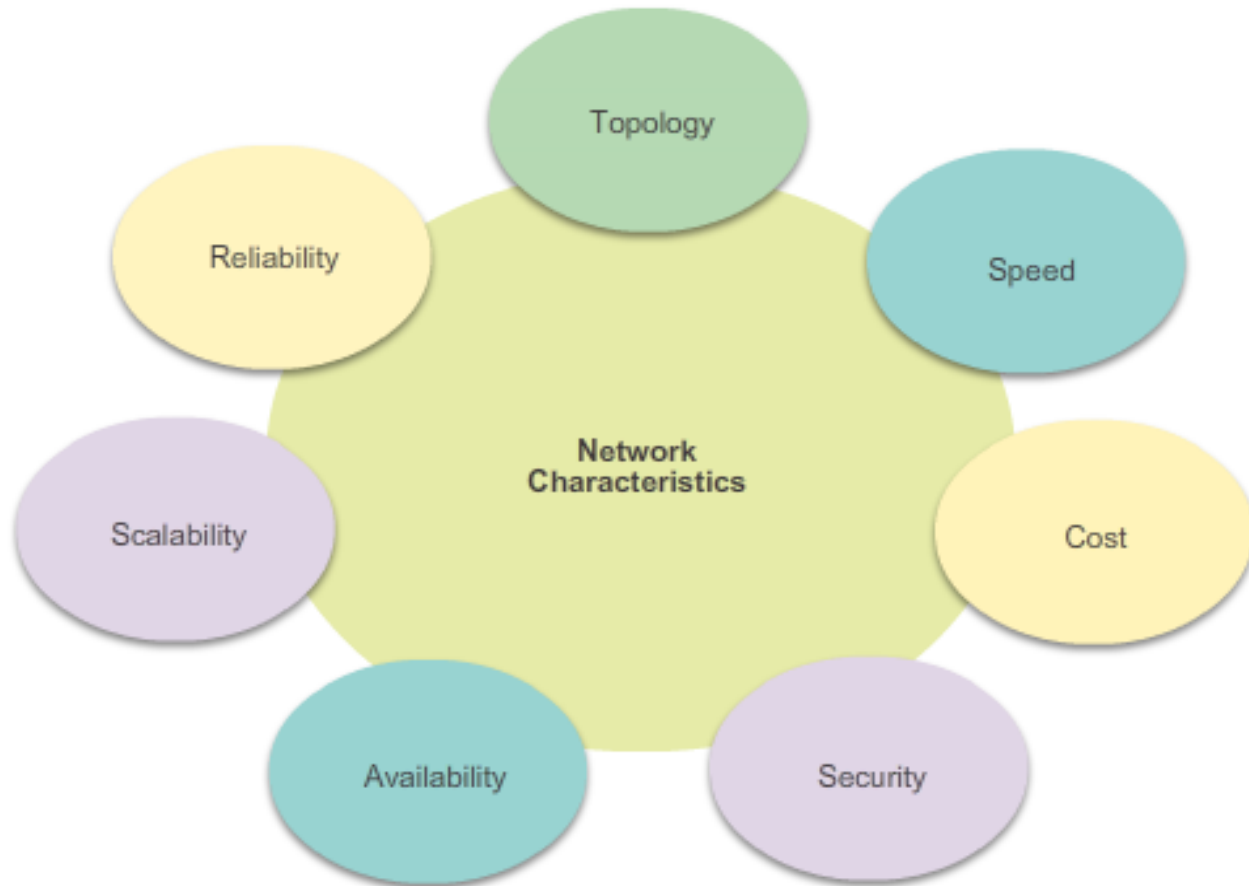
Proses Routing IP

IP routing is the process of moving packets from one network to another network using routers.



Karakteristik dari Jaringan

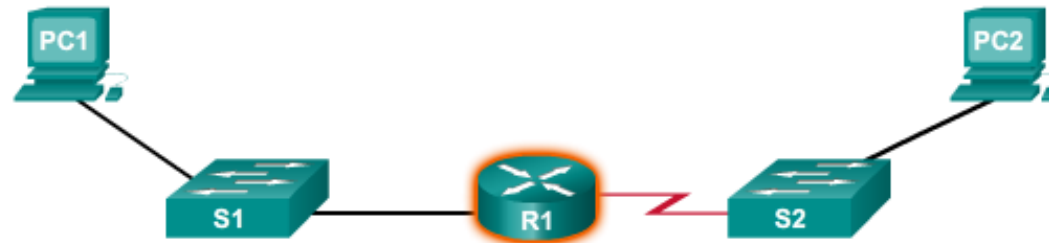
Network Characteristics



Kenapa Routing ?

Router bertanggung jawab untuk lalu lintas routing antara jaringan

Routers Route Packets



```
R1#show ip route
Codes: C - connected, S - static, I - IGRP, 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

C    192.168.1.0/24 is directly connected, FastEthernet0/0
C    192.168.2.0/24 is directly connected, Serial0/0
```

Cisco IOS command line interface (CLI) can be used to view the route table.

Router adalah komputer

Router adalah komputer khusus yang mengandung komponen-komponen berikut yang diperlukan untuk mengoperasikan:

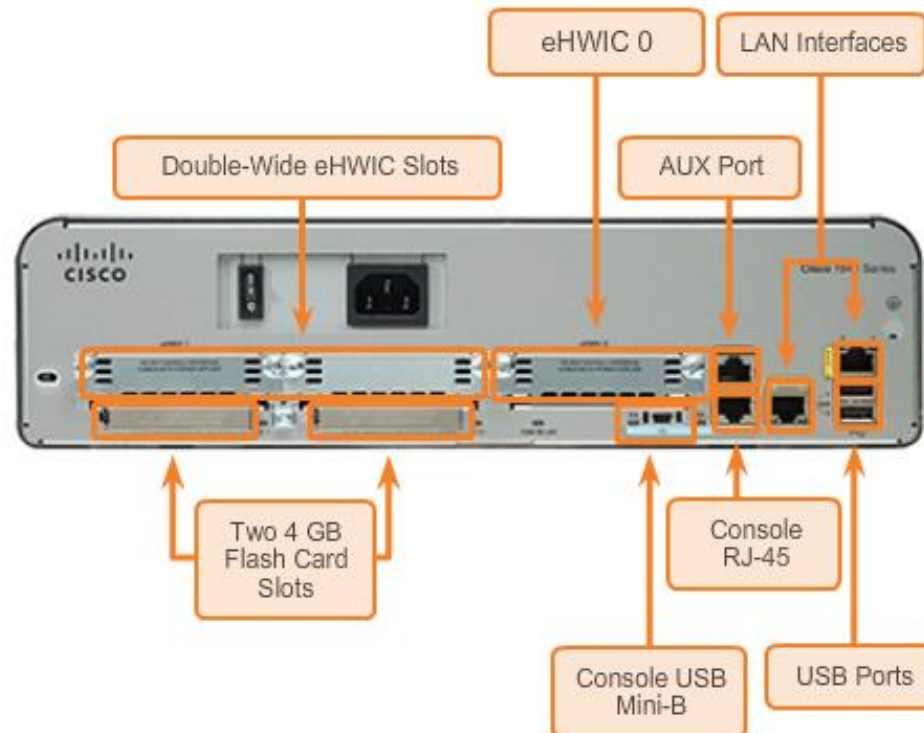
- Central processing unit (CPU)
- Sistem operasi (OS) - Router menggunakan Cisco IOS
- Memori dan penyimpanan (RAM, ROM, NVRAM, Flash, hard drive)

Memory	Volatile / Non-Volatile	Stores
RAM	Volatile	<ul style="list-style-type: none">• Running IOS• Running configuration file• IP routing and ARP tables• Packet buffer
ROM	Non-Volatile	<ul style="list-style-type: none">• Bootup instructions• Basic diagnostic software• Limited IOS
NVRAM	Non-Volatile	<ul style="list-style-type: none">• Startup configuration file
Flash	Non-Volatile	<ul style="list-style-type: none">• IOS• Other system files

Router adalah komputer

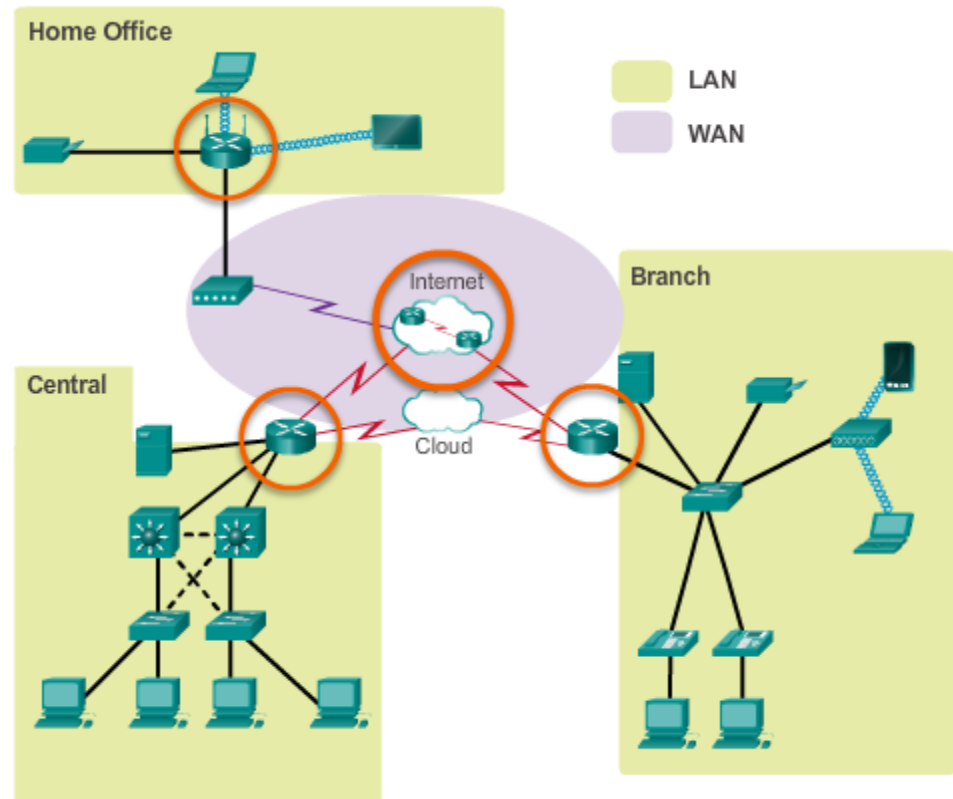
Router menggunakan port khusus dan kartu interface jaringan untuk menghubungkan ke jaringan lain.

Back Panel of a Router



Router terhubung ke jaringan

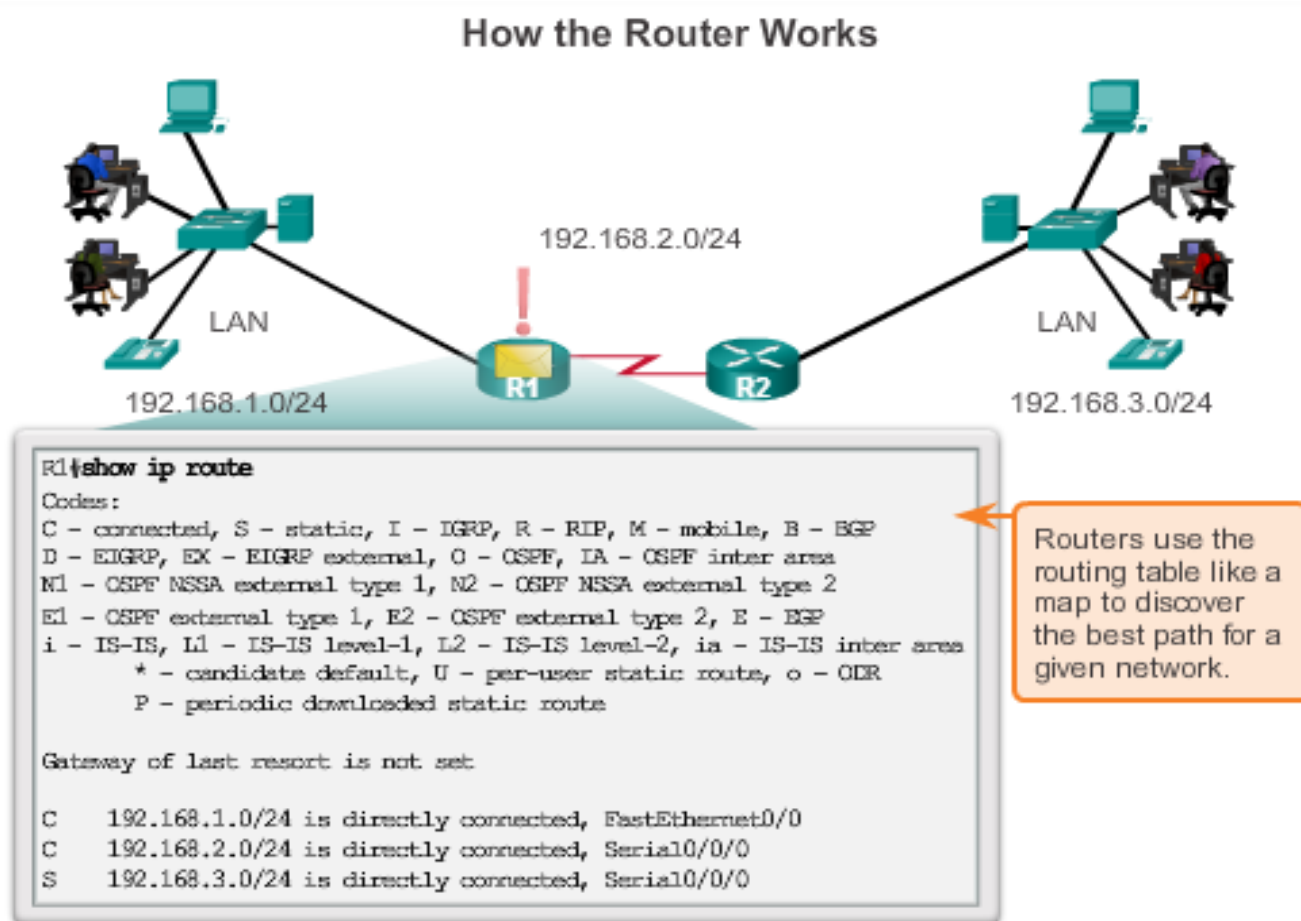
- Router dapat menghubungkan beberapa jaringan.
- Router memiliki beberapa interface, masing-masing pada jaringan IP yang berbeda.



Router memilih jalan terbaik

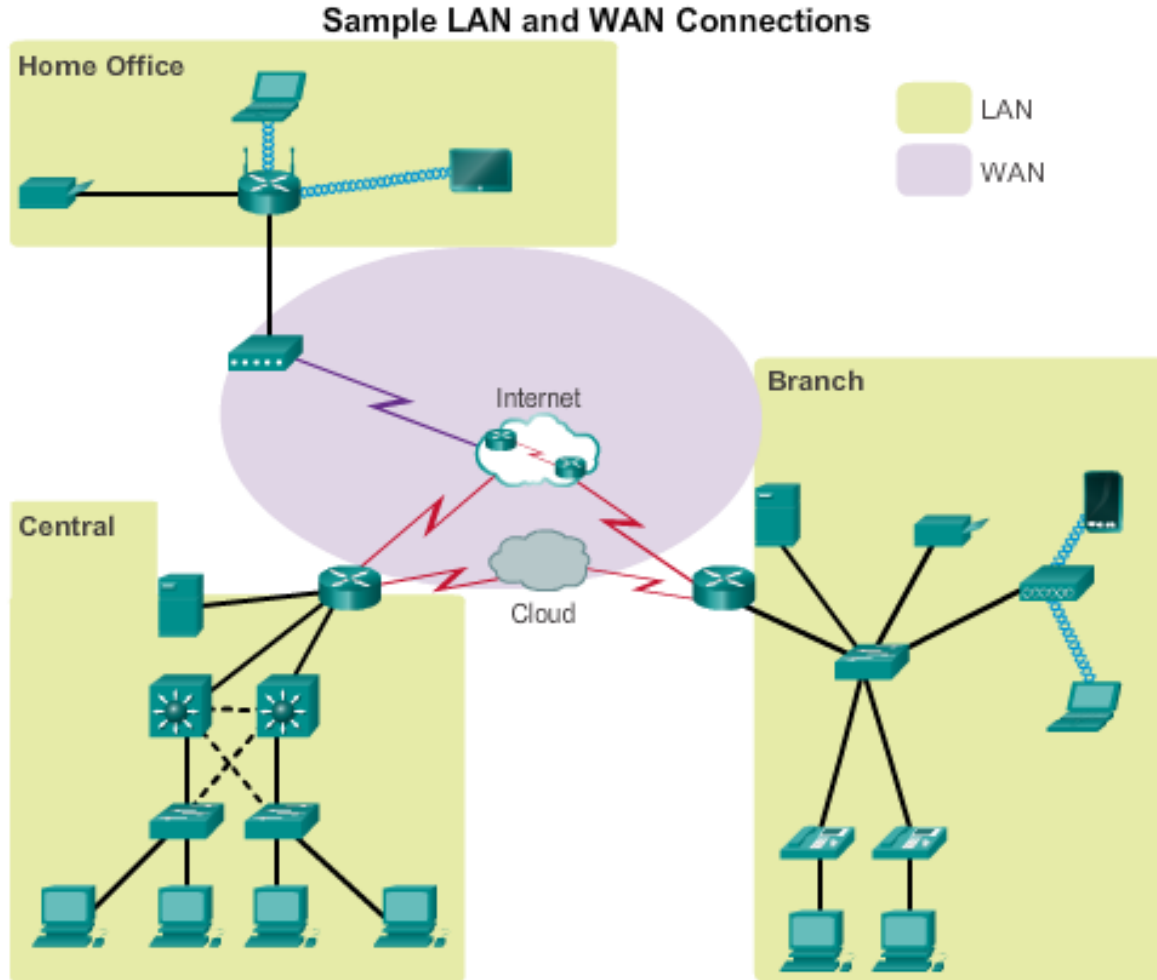
- Router menggunakan Protokol Routing static dan dinamis untuk mempelajari tentang remote networks dan membangun tabel routing
- Router menggunakan tabel routing untuk menentukan jalur terbaik untuk mengirim paket.
- Router mengenkapsulasi paket dan memforward/meneruskannya ke interface yang ditunjukkan dalam tabel routing.

Router memilih jalan terbaik



Menghubungkan perangkat

Terhubung ke Jaringan

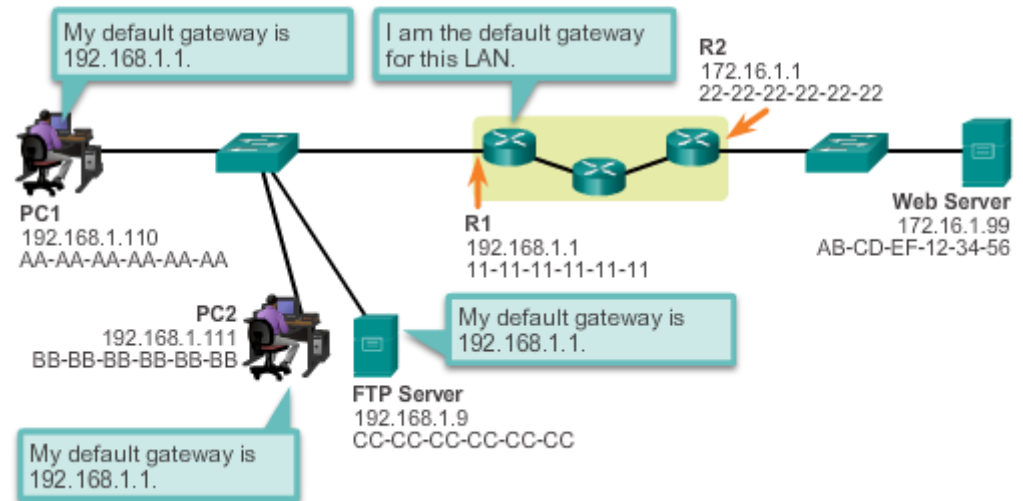


Default Gateway

Untuk mengaktifkan perangkat akses jaringan harus dikonfigurasi

- **Alamat IP** - Mengidentifikasi host yang unik pada jaringan lokal.
- **Subnet mask** - Mengidentifikasi jaringan subnet host.
- **Default gateway** - Mengidentifikasi router paket dikirim ketika tujuan tidak pada subnet jaringan lokal yang sama.

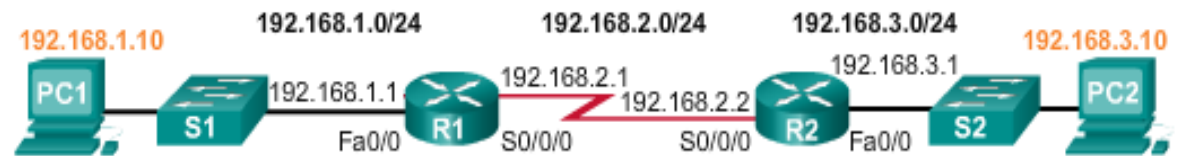
Destination MAC Address	Source MAC Address	Source IP Address	Destination MAC Address	Data
11-11-11-11-11-11	AA-AA-AA-AA-AA-AA	192.168.1.110	172.16.1.99	



Dokumentasi Pengalamatan Jaringan

Dokumentasi jaringan harus mencakup setidaknya pada diagram topologi dan menangani tabel tersebut dibawah ini:

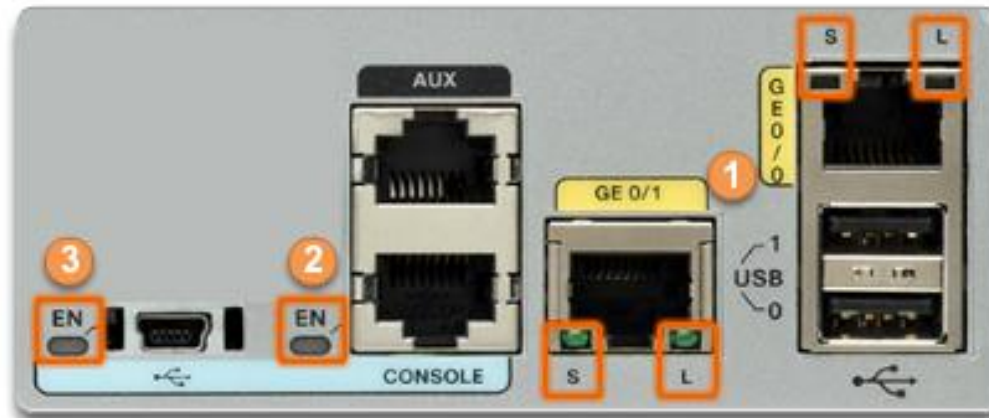
- nama-nama perangkat
- Interface
- Alamat IP dan
- Subnetmask
- Default gateway



Device	Interface	IP Address	Subnet Mask	Default Gateway
R1	Fa0/0	192.168.1.1	255.255.255.0	N/A
	S0/0/0	192.168.2.1	255.255.255.0	N/A
R2	Fa0/0	192.168.3.1	255.255.255.0	N/A
	S0/0/0	192.168.2.2	255.255.255.0	N/A
PC1	N/A	192.168.1.10	255.255.255.0	192.168.1.1
PC2	N/A	192.168.3.10	255.255.255.0	192.168.3.1

Perangkat LED

CISCO 1941 LEDs



#	Port	LED	Color	Description
1	GE0/0 and GE0/1	S (Speed)	1 blink + pause	Port operating at 10 Mb/s
			2 blink + pause	Port operating at 100 Mb/s
			3 blink + pause	Port operating at 1000 Mb/s
		L (Link)	Green	Link is active
			Off	Link is inactive
2	Console	EN	Green	Port is active
			Off	Port is inactive
3	USB	EN	Green	Port is active
			Off	Port is inactive

Akses Console














Console access requires:

Console cable :

RJ-45-to-DB-9 console cable

Terminal emulation software :

Tera Term, PuTTY, HyperTerminal

Port on Computer	Cable Required	Port on ISR	Terminal Emulation
 Serial Port	 Console Cable	 CONSOLE RJ45 Console Port	 Tera Term
 USB Type-A Port	 USB-to-RS-232 Serial Port Adapter  Console Cable	 CONSOLE RJ45 Console Port	 PuTTY
 USB Type-A Port	 USB Type-A to USB Type-B (Mini-B) Cable	 EN USB Type-B (Mini-B USB) Console Port	 PuTTY

Konfigurasi dasar Router

Dasar-dasar tugas yang harus dikonfigurasi pertama kali pada Router Cisco dan Switch Cisco:

Memberi Nama perangkat

Membedakan dari router lain

Mengamankan Akses Manajemen :

Secure privileged EXEC, User EXEC, dan Telnet Access, dan mengenkripsi password ke level tertinggi

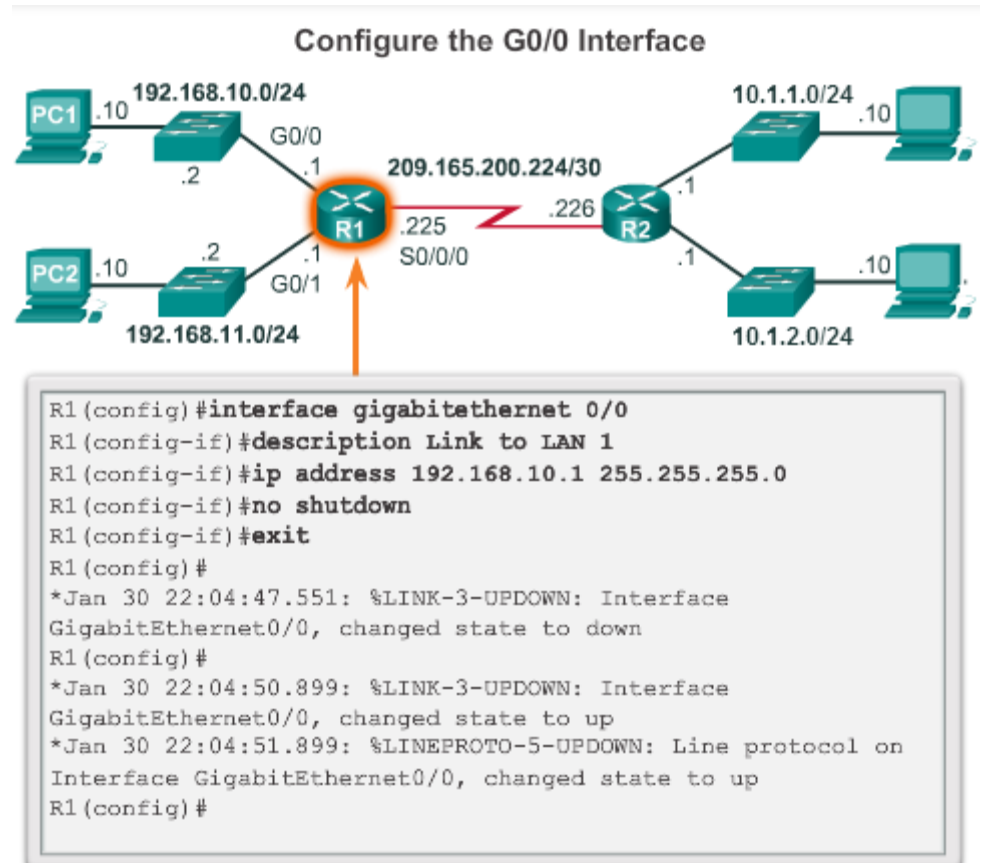
```
R1 (config) #enable secret class
R1 (config) #
R1 (config) #line console 0
R1 (config-line) #password cisco
R1 (config-line) #login
R1 (config-line) #exit
R1 (config) #
R1 (config) #line vty 0 4
R1 (config-line) #password cisco
R1 (config-line) #login
R1 (config-line) #exit
R1 (config) #
R1 (config) #service password-encryption
R1 (config) #
```

Simpan Konfigurasi

Konfigurasi IPv4 Router Interface

Router Interface harus:

- Dikonfigurasi dengan alamat IP dan Subnet mask.
- Harus diaktifkan menggunakan perintah **no shutdown**. Secara default LAN dan WAN interface **tidak diaktifkan**.
- End kabel serial berlabel DCE harus dikonfigurasi dengan perintah clock rate.
- Deskripsi opsional dapat dimasukkan.

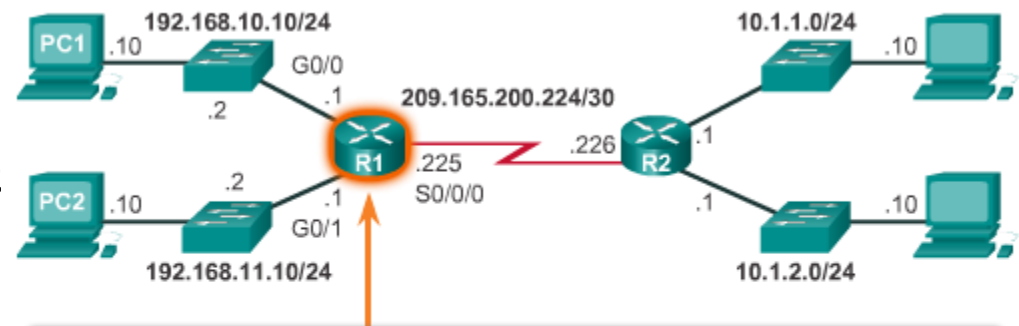


Konfigurasi Interface Loopback

“A loopback interface is a logical interface that is internal to the router”:

- Tidak mengisi alamat IP pada port fisik, tetapi tu dianggap sebagai software interface yang secara otomatis statusnya dalam keadaan UP.
- Interface loopback berguna untuk pengujian.
- Hal ini penting dalam proses routing OSPF.

Configure the Loopback0 Interface



```
R2 (config)#interface loopback 0
R2 (config-if)#ip address 10.0.0.1 255.255.255.0
R2 (config-if)#exit
R1 (config)#
*Jan 30 22:04:50.899: %LINK-3-UPDOWN: Interface loopback0,
changed state to up
*Jan 30 22:04:51.899: %LINEPROTO-5-UPDOWN: Line protocol on
Interface loopback0, changed state to up
```

Verifikasi pengaturan Interface

Menampilkan perintah yang digunakan untuk memverifikasi konfigurasi dan operasi dari interface:

show ip interfaces brief

show ip route

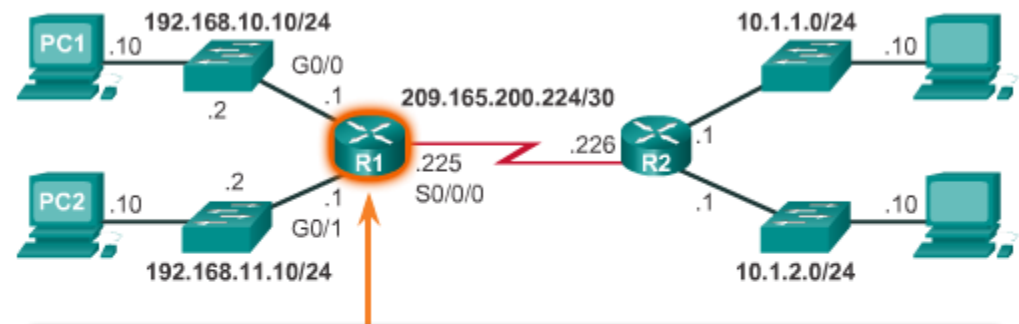
show running-config

Menampilkan perintah yang digunakan untuk mengumpulkan data lebih detail tentang informasi interface

show interfaces

show ip interfaces

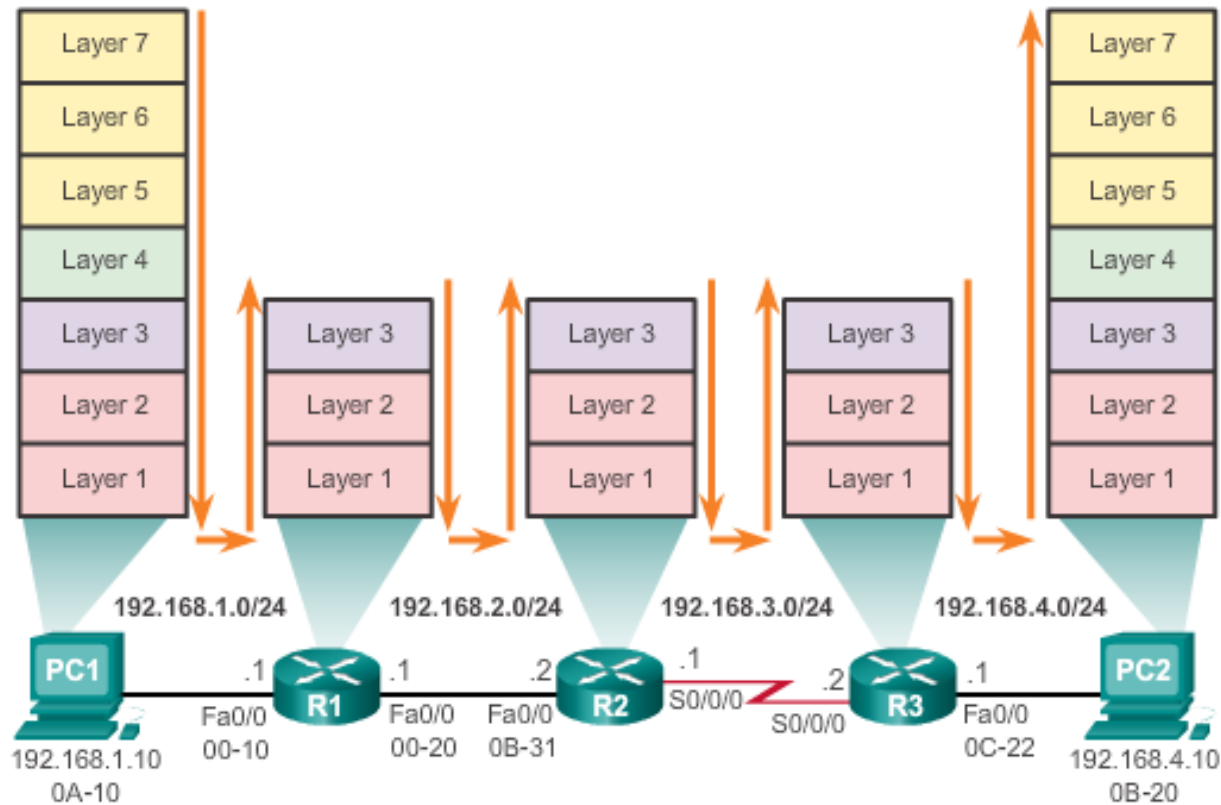
Configure the Loopback0 Interface



```
R2(config)#interface loopback 0
R2(config-if)#ip address 10.0.0.1 255.255.255.0
R2(config-if)#exit
R1(config)#
*Jan 30 22:04:50.899: %LINK-3-UPDOWN: Interface loopback0,
changed state to up
*Jan 30 22:04:51.899: %LINEPROTO-5-UPDOWN: Line protocol on
Interface loopback0, changed state to up
```

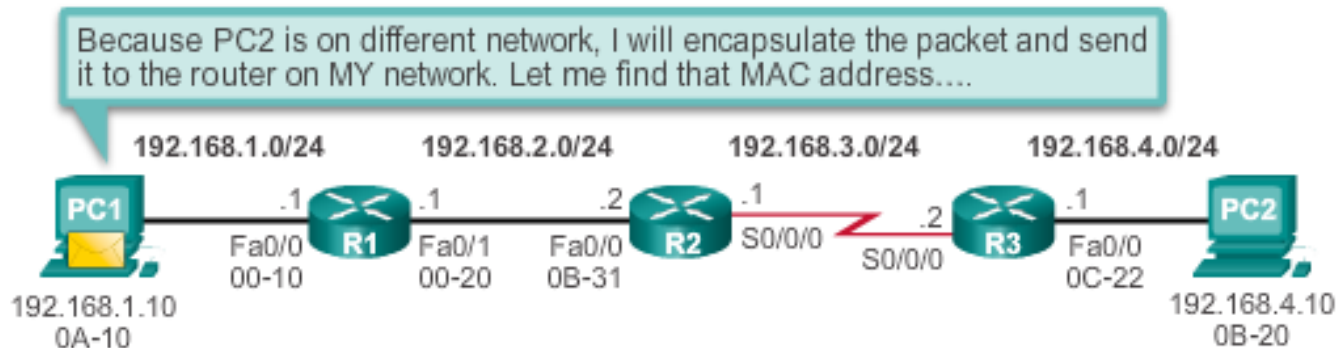
Mengirim Paket

Encapsulating and De-Encapsulating Packets



Mengirim Paket

PC1 Sends a Packet to PC2



Layer 2 Data Link Frame

Packet's Layer 3 data

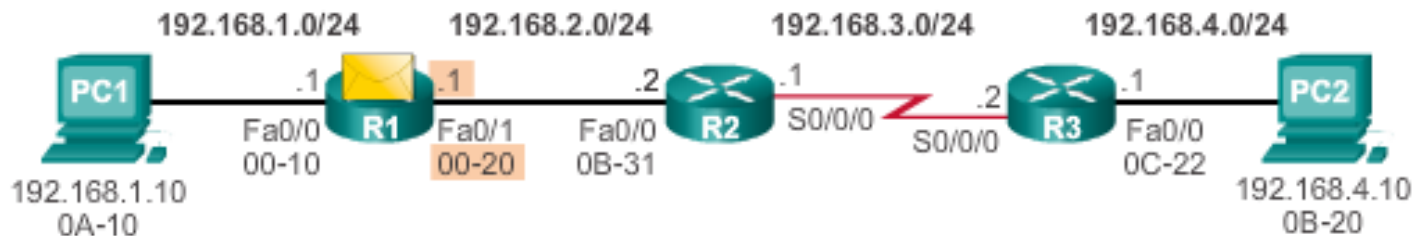
Dest. MAC 00-10	Source MAC 0A-10	Type 800	Source IP 192.168.1.10	Dest. IP 192.168.4.10	IP fields	Data	Trailer
--------------------	---------------------	----------	---------------------------	--------------------------	-----------	------	---------

PC1's ARP Cache for R1

IP Address	MAC Address
192.168.1.1	00-10

Forward ke Next Hop

R3 Forwards the Packet to PC2



Layer 2 Data Link Frame

Packet's Layer 3 data

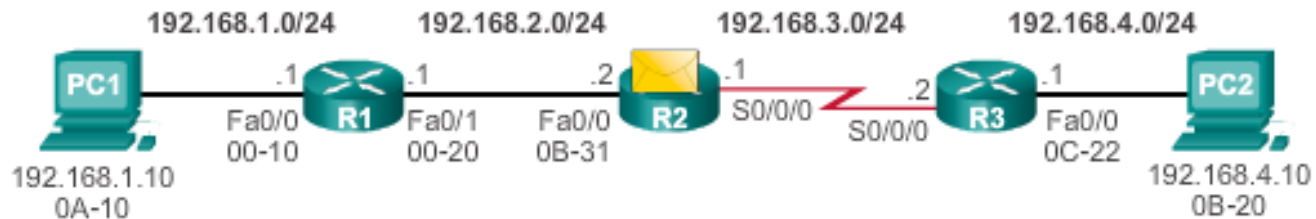
Dest. MAC 0B-31	Source MAC 00-20	Type 800	Source IP 192.168.1.10	Dest. IP 192.168.4.10	IP fields	Data	Trailer
--------------------	---------------------	----------	---------------------------	--------------------------	-----------	------	---------

R1's Routing Table

Network	Hops	Next-hop-IP	Exit Interface
192.168.1.0/24	0	Dir. Connect.	Fa0/0
192.168.2.0/24	0	Dir. Connect.	Fa0/1
192.168.3.0/24	1	192.168.2.2	Fa0/1
192.168.4.0/24	2	192.168.2.2	Fa0/1

Packet Routing

R2 Forwards the Packet to R3



Layer 2 Data Link Frame

Packet's Layer 3 data

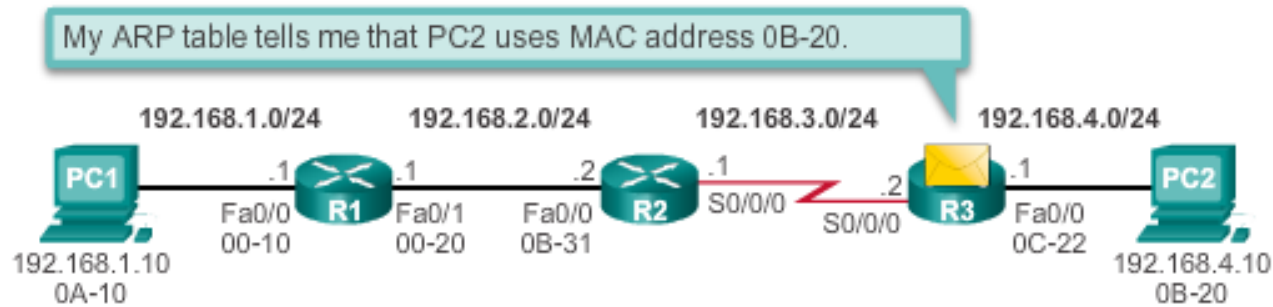
Address 0x8F	Control 0x00	Type 800	Source IP 192.168.1.10	Dest. IP 192.168.4.10	IP fields	Data	Trailer
-----------------	-----------------	----------	---------------------------	--------------------------	-----------	------	---------

R2's Routing Table

Network	Hops	Next-hop-IP	Exit Interface
192.168.1.0/24	1	192.168.3.1	Fa0/0
192.168.2.0/24	0	Dir. Connect.	Fa0/0
192.168.3.0/24	0	Dir. Connect.	S0/0/0
192.168.4.0/24	1	192.162.3.2	S0/0/0

Reach the Destination

R3 Forwards the Packet to PC2



Layer 2 Data Link Frame

Layer 2 Data Link Frame			Packet's Layer 3 data				
Dest. MAC 0B-20	Source MAC 0C-22	Type 800	Source IP 192.168.1.10	Dest. IP 192.168.4.10	IP fields	Data	Trailer

R3's ARP Cache

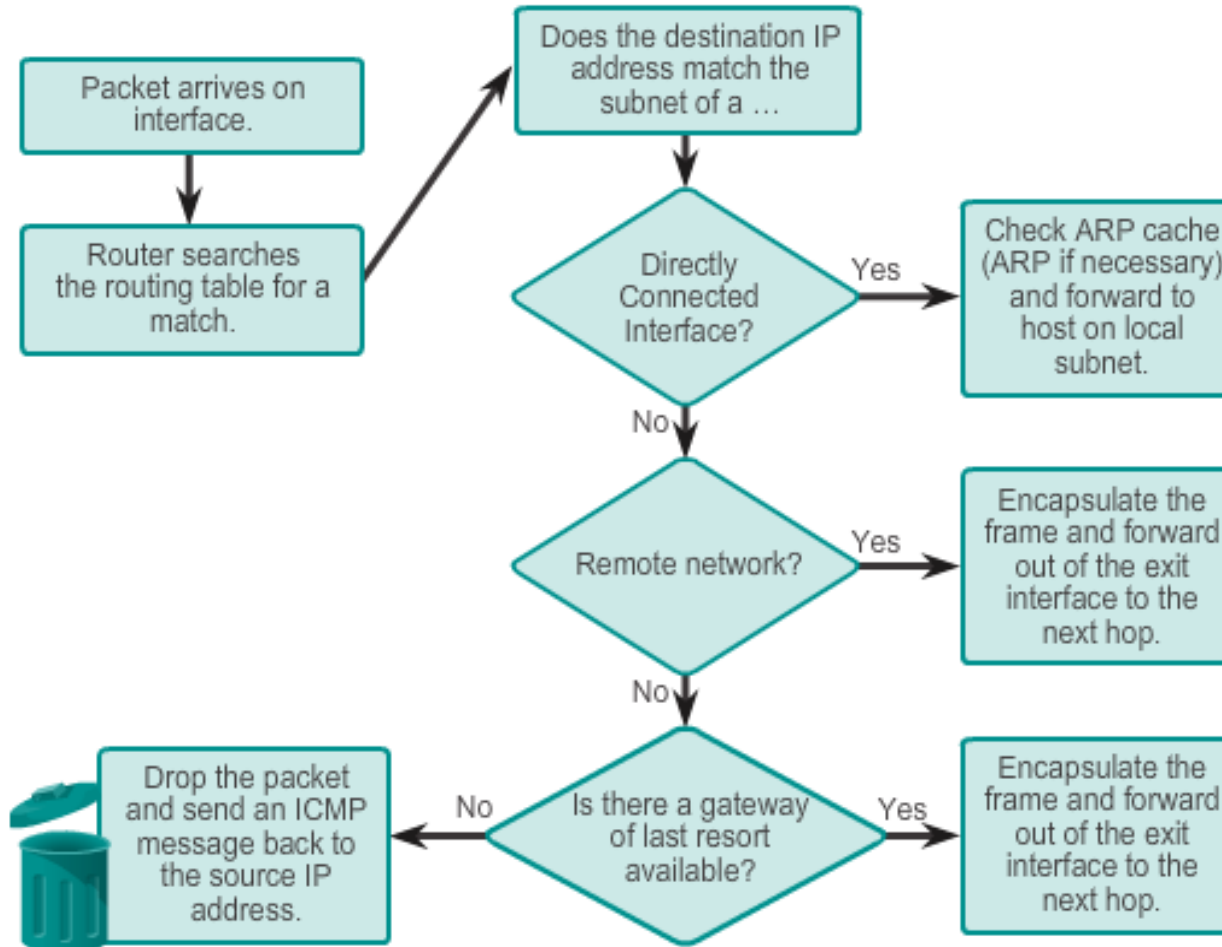
IP Address	MAC Address
192.168.4.10	0B-20

R3's Routing Table

Network	Hops	Next-hop-IP	Exit Interface
192.168.1.0/24v	2	192.168.3.1	S0/0/0
192.168.2.0/24	1	192.162.3.1	S0/0/0
192.168.3.0/24	0	Dir. Connect.	S0/0/0
192.168.4.0/24	0	Dir. Connect.	Fa0/0

Routing Decisions

Packet Forwarding Decision Process



Jalur Terbaik

Jalur terbaik yang dipilih oleh protokol routing berdasarkan nilai atau metric, hal tersebut untuk menentukan jarak supaya sampai ke jaringan :

- Sebuah metric adalah nilai yang digunakan untuk mengukur jarak ke jaringan
- Nilai yang rendah pada metric adalah Jalur terbaik ke jaringan.

Protokol routing dinami menggunakan aturan dan metric sendiri untuk membangun dan mengupdate tabel routing:

- Routing Information Protocol (RIP) - Hop count
- Open Shortest Path First (OSPF) - Biaya berdasarkan bandwidth kumulatif dari sumber ke tujuan
- Enhanced Interior Gateway Routing Protocol (EIGRP) - Bandwidth, delay, load, reliability

Administrative Distance

Route static dengan nilai AD = 1 lebih reliable dibandingkan dengan route EIGRP dengan nilai AD 90

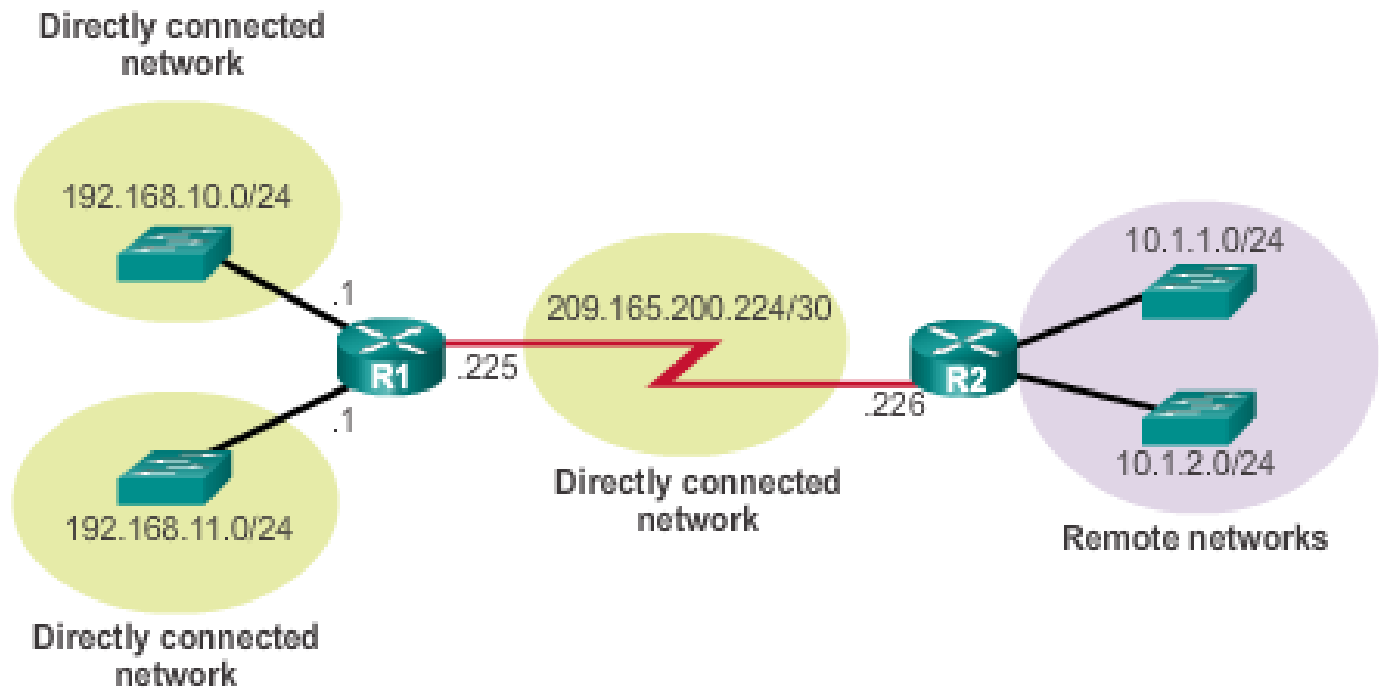
Route Directly Connected dengan nilai AD = 0 lebih reliable dibandingkan dengan route static dengan nilai AD = 1

Route Source	Administrative Distance
Connected	0
Static	1
EIGRP summary route	5
External BGP	20
Internal EIGRP	90
IGRP	100
OSPF	110
IS-IS	115
External EIGRP	170
Internal BGP	200

Tabel Routing

Table routing adalah tempat penyimpanan pada RAM yang berisi informasi tentang :

- Rute Directly Connected
- Rute Remote
- Network atau next hop



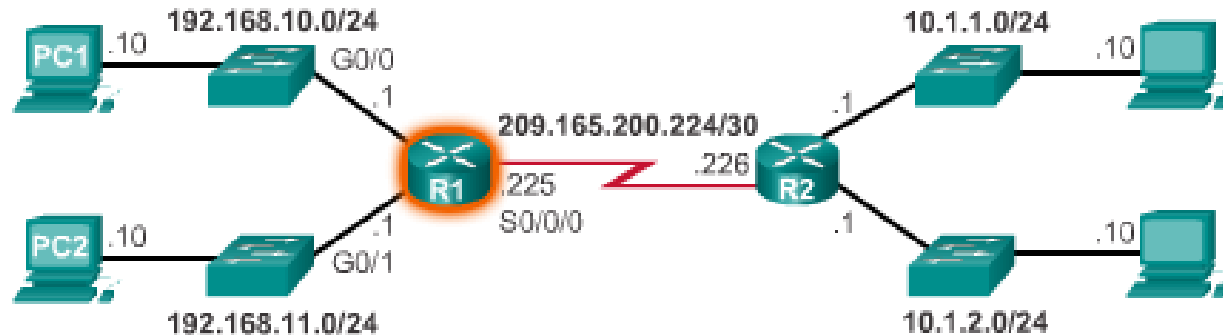
Sumber Tabel Routing

Perintah **Show ip route** digunakan untuk menampilkan konten pada tabel routing diantaranya :

- **Local route interfaces** – ditambahkan pada tabel routing ketika interface tersebut telah dikonfigurasi
- **Directly connected interfaces** – ditambahkan pada tabel routing ketika interface tersebut telah dikonfigurasi dan statusnya aktif
- **Static routes** - ditambahkan ketika rute di konfigurasi secara manual
- **Dynamic routing protocol** - ditambahkan ketika EIGRP atau OSPF diimplementasikan dan network sudah diidentifikasi.

Sumber Tabel Routing

Routing Table of R1



```
R1#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 routes
```

```
Gateway of last resort is not set
```

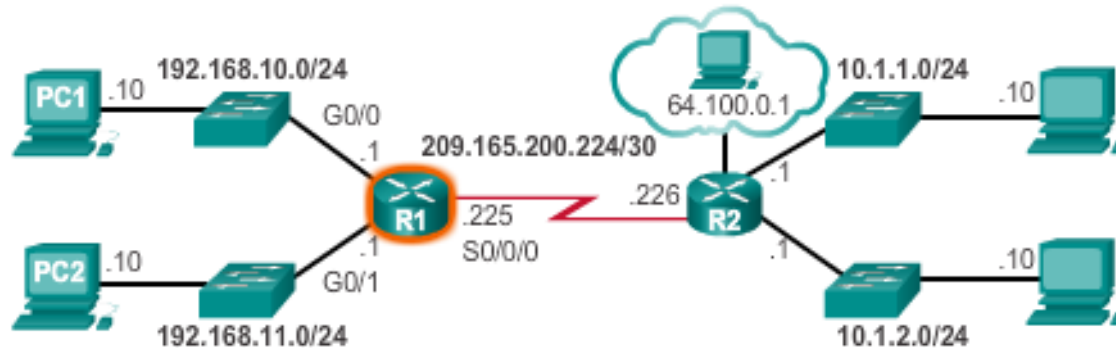
```
10.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
```

```
D 10.1.1.0/24 [90/2170112] via 209.165.200.226, 00:00:05,
```

Remote Network Routing Entries

Interpretasi entri dalam tabel routing.

Remote Network Entry Identifiers



D 10.1.1.0/24 [90/2170112] via 209.165.200.226, 00:00:05, Serial0/0/0

Legend

- Identifies how the network was learned by the router.
- Identifies the destination network.
- Identifies the administrative distance (trustworthiness) of the route source.
- Identifies the metric to reach the remote network.
- Identifies the next-hop IP address to reach the remote network.
- Identifies the amount of elapsed time since the network was discovered.
- Identifies the outgoing interface on the router to reach the destination network.

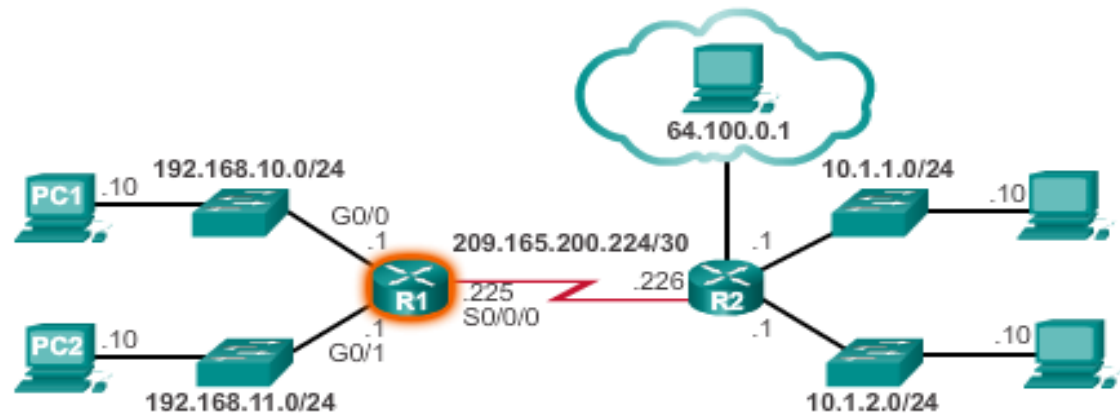
Directly Connected Interfaces

Sebuah router baru digunakan, tanpa dikonfigurasi, mempunyai tabel routing yang kosong.

Sedangkan jika Aktif, dikonfigurasi, interface directly connected membuat dua entri tabel routing:

- Link Local (L)
- Directly Connected (C)

Directly Connected Network Entry Identifiers



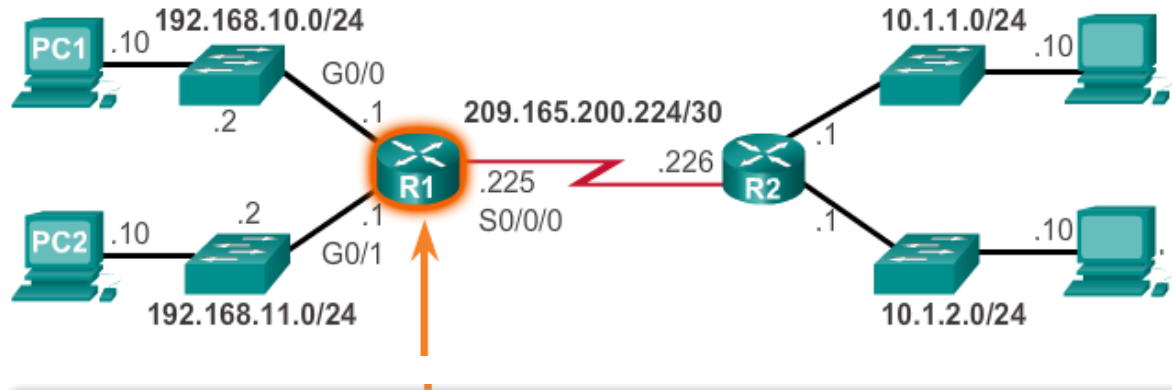
	A	B	C
C	192.168.10.0/24 is directly connected,		GigabitEthernet0/0
L	192.168.10.1/32 is directly connected,		GigabitEthernet0/0

Legend

- Identifies how the network was learned by the router.
- Identifies the destination network and how it is connected.
- Identifies the interface on the router connected to the destination network.

Contoh Directly Connected

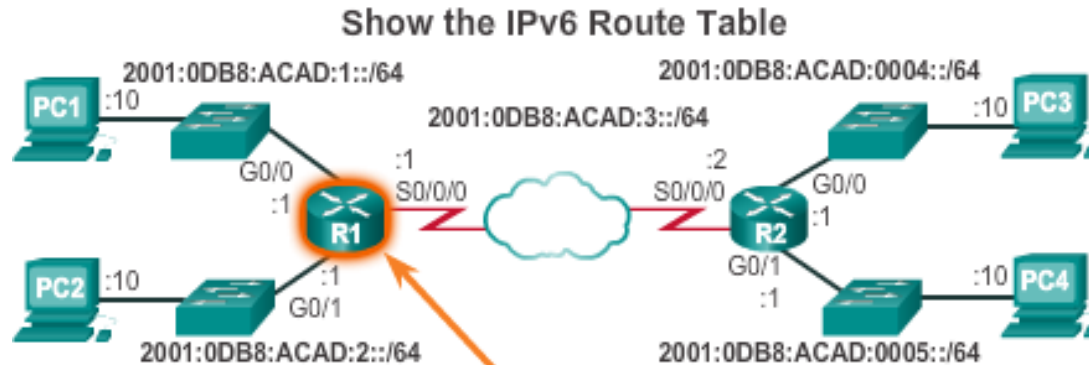
Tabel routing dengan interface directly connected dari R1 yang telah dikonfigurasi dan interface yang telah aktif (no shutdown)



```
R1# show ip route | begin Gateway
Gateway of last resort is not set

      192.168.10.0/24 is variably subnetted, 2 subnets, 2
masks
C       192.168.10.0/24 is directly connected,
GigabitEthernet0/0
L       192.168.10.1/32 is directly connected,
GigabitEthernet0/0
      192.168.11.0/24 is variably subnetted, 2 subnets, 2
masks
C       192.168.11.0/24 is directly connected,
GigabitEthernet0/1
L       192.168.11.1/32 is directly connected,
GigabitEthernet0/1
```

Contoh Directly Connected IPv6



```
R1#show ipv6 route
IPv6 Routing Table - default - 5 entries
Codes: C - Connected, L - Local, S - Static,
       U - Per-user Static route, B - BGP, R - RIP
       H - NHRP, I1 - ISIS L1, I2 - ISIS L2
       IA - ISIS interarea, IS - ISIS summary, D - EIGRP
       EX - EIGRP external, ND - ND Default
       NDp - ND Prefix, DCE - Destination, NDr - Redirect
       O - OSPF Intra, OI - OSPF Inter, OE1 - OSPF ext 1
       OE2 - OSPF ext 2, ON1 - OSPF NSSA ext 1
       ON2 - OSPF NSSA ext 2
C   2001:DB8:ACAD:1::/64 [0/0]
    via GigabitEthernet0/0, directly connected
L   2001:DB8:ACAD:1::1/128 [0/0]
    via GigabitEthernet0/0, receive
```

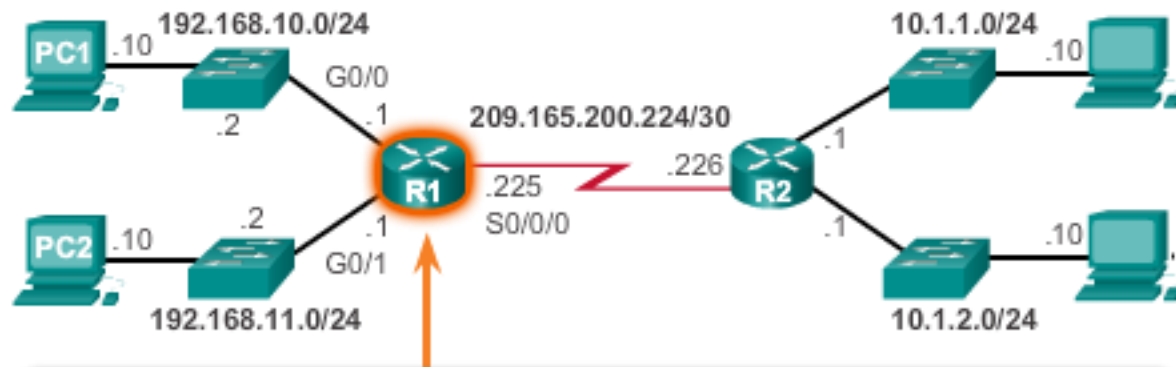
Static Route

Static route dan default route bisa diimplementasikan setelah interface directly connected di tambahkan pada tabel routing :

- Static route dikonfigurasi secara manual
- Mendefinisikan jalur ekspilist antara dua perangkat jaringan
- Static route harus diperbaharui secara manual jika topologi berubah
- Bermanfaat untuk meningkatkan control dan keamanan sumberdaya
- Mengkonfigurasi static route ke jaringan tertentu menggunakan perintah ***ip route network mask*** {next hop ip|exit-intf}
- Standar static route digunakan ketika tabel routing tidak mengandung jalur atau network tujuan
- Konfigurasi default static route menggunakan perintah ***ip route 0.0.0.0 0.0.0.0*** {exit-intf | next-hop-ip}

Contoh Default Static route

Entering and Verifying a Static Default Route



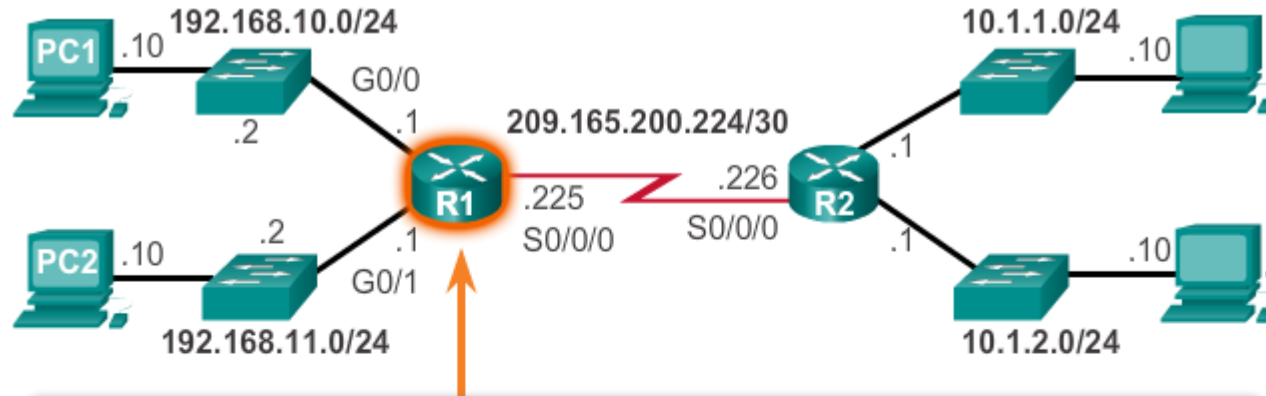
```

R1(config)#ip route 0.0.0.0 0.0.0.0 Serial0/0/0
R1(config)#exit
R1#
*Feb  1 10:19:34.483: %SYS-5-CONFIG_I: Configured from console
by console

R1#show ip route | begin Gateway
Gateway of last resort is 0.0.0.0 to network 0.0.0.0

S* 0.0.0.0/0 is directly connected, Serial0/0/0
  192.168.10.0/24 is variably subnetted, 2 subnets, 2 masks
C   192.168.10.0/24 is directly connected, GigabitEthernet0/0
L   192.168.10.1/32 is directly connected, GigabitEthernet0/0
  192.168.11.0/24 is variably subnetted, 2 subnets, 2 masks
C   192.168.11.0/24 is directly connected, GigabitEthernet0/1
L   192.168.11.1/32 is directly connected, GigabitEthernet0/1
  
```

Contoh Static route



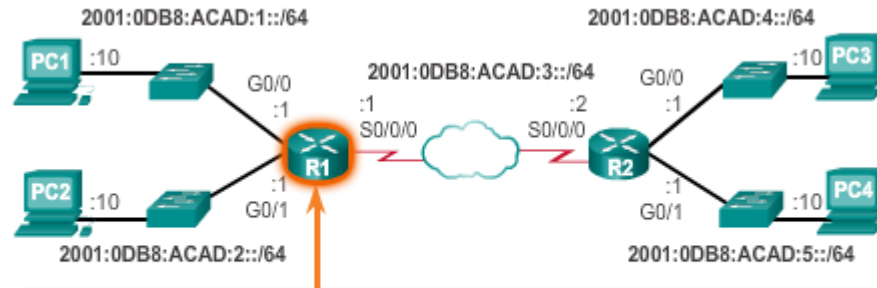
```
R1(config)# ip route 0.0.0.0 0.0.0.0 Serial0/0/0
R1(config)# exit
R1#
*Feb  1 10:19:34.483: %SYS-5-CONFIG_I: Configured from console
by console

R1# show ip route | begin Gateway
Gateway of last resort is 0.0.0.0 to network 0.0.0.0

S* 0.0.0.0/0 is directly connected, Serial0/0/0
  192.168.10.0/24 is variably subnetted, 2 subnets, 2 masks
C   192.168.10.0/24 is directly connected, GigabitEthernet0/0
L   192.168.10.1/32 is directly connected, GigabitEthernet0/0
  192.168.11.0/24 is variably subnetted, 2 subnets, 2 masks
C   192.168.11.0/24 is directly connected, GigabitEthernet0/1
L   192.168.11.1/32 is directly connected, GigabitEthernet0/1
```

Contoh Static route IPv6

Entering and Verifying an IPv6 Static Default Route



```
R1(config)#ipv6 route ::/0 s0/0/0
R1(config)#exit
R1#
```

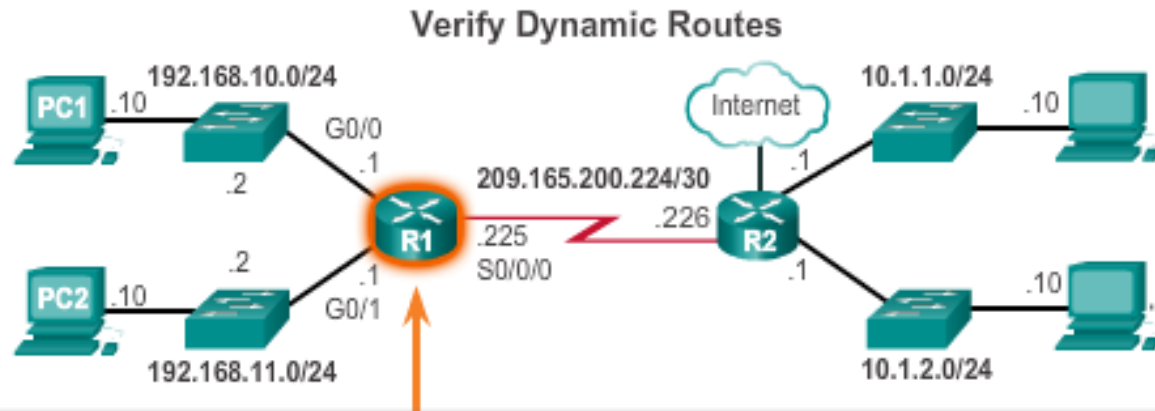
```
R1#show ipv6 route
IPv6 Routing Table - default - 8 entries
Codes: C - Connected, L - Local, S - Static,
       U - Per-user Static route
       B - BGP, R - RIP, H - NHRP, I1 - ISIS L1
       I2 - ISIS L2, IA - ISIS interarea, IS - ISIS summary,
       D - EIGRP
       EX - EIGRP external, ND - ND Default, NDp - ND Prefix,
       DCE - Destination
       NDR - Redirect, O - OSPF Intra, OI - OSPF Inter,
       OE1 - OSPF ext 1
       OE2 - OSPF ext 2, ON1 - OSPF NSSA ext 1,
       ON2 - OSPF NSSA ext 2
S    ::/0 [1/0]
     via Serial0/0/0, directly connected
C    2001:DB8:ACAD:1::/64 [0/0]
     via GigabitEthernet0/0, directly connected
```

Protokol Routing IPv4

Cisco Router mendukung berbagai macam protocol dynamic routing diantaranya adalah :

- **EIGRP** – Enhanced Interior Gateway Routing Protocol
- **OSPF** – Open Shortest Path First
- **IS-IS** – Intermediate System-to-Intermediate System
- **RIP** – Routing Information Protocol

Protokol Routing IPv4



```
R1#show ip route | begin Gateway
Gateway of last resort is 209.165.200.226 to network 0.0.0.0

D*EX 0.0.0.0/0 [170/2297856] via 209.165.200.226, 00:07:29, Serial0/0/0
    10.0.0.0/24 is subnetted, 2 subnets
D      10.1.1.0 [90/2172416] via 209.165.200.226, 00:07:29, Serial0/0/0
D      10.1.2.0 [90/2172416] via 209.165.200.226, 00:07:29, Serial0/0/0
    192.168.10.0/24 is variably subnetted, 2 subnets, 2 masks
C      192.168.10.0/24 is directly connected, GigabitEthernet0/0
L      192.168.10.1/32 is directly connected, GigabitEthernet0/0
    192.168.11.0/24 is variably subnetted, 2 subnets, 2 masks
C      192.168.11.0/24 is directly connected, GigabitEthernet0/1
L      192.168.11.1/32 is directly connected, GigabitEthernet0/1
    209.165.200.0/24 is variably subnetted, 2 subnets, 2 masks
C      209.165.200.224/30 is directly connected, Serial0/0/0
L      209.165.200.225/32 is directly connected, Serial0/0/0
R1#
```

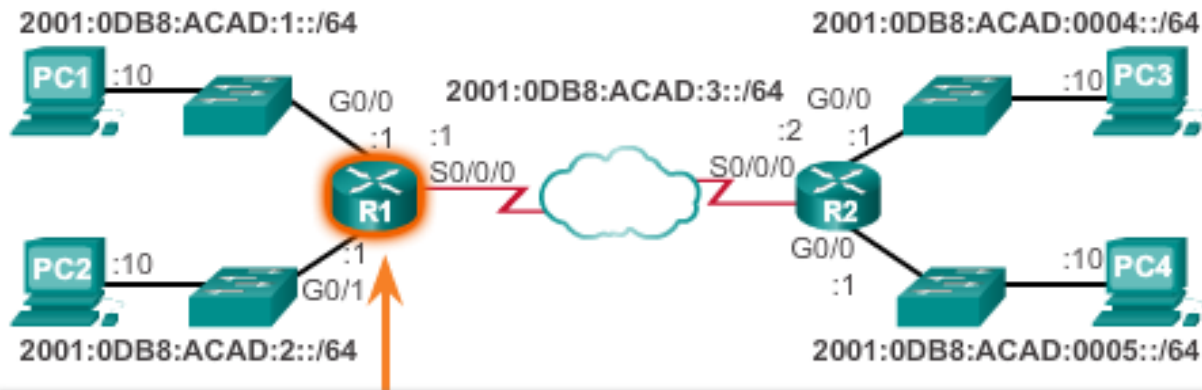
Protokol Routing IPv6

Cisco Router mendukung berbagai macam protocol dynamic routing IPv6 diantaranya adalah :

- **RIPng** - RIP next generation
- **OSPFv3**
- **EIGRP** for IPv6
- **MP-BGP4** - Multicast Protocol-Border Gateway Protocol

Protokol Routing IPv6

Verify Dynamic Routes



```
R1#show ipv6 route
IPv6 Routing Table - default - 9 entries
Codes: C - Connected, L - Local, S - Static, U - Per-user Static route
       B - BGP, R - RIP, H - NHRP, I1 - ISIS L1
       I2 - ISIS L2, IA - ISIS interarea, IS - ISIS summary, D - EIGRP
       EX - EIGRP external, ND - ND Default, NDP - ND Prefix, DCE -
Destination
       NDR - Redirect, O - OSPF Intra, OI - OSPF Inter, OE1 - OSPF ext 1
       OE2 - OSPF ext 2, CN1 - OSPF NSSA ext 1, CN2 - OSPF NSSA ext 2
C   2001:DB8:ACAD:1::/64 [0/0]
    via GigabitEthernet0/0, directly connected
L   2001:DB8:ACAD:1::1/128 [0/0]
    via GigabitEthernet0/0, receive
C   2001:DB8:ACAD:2::/64 [0/0]
    via GigabitEthernet0/1, directly connected
L   2001:DB8:ACAD:2::1/128 [0/0]
```

Referensi

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**CCNA Cisco Certified Network Associate Study Guide Six Edition
Cisco Network Academy**



Selesai.

Pengumpulan Video **OSI Layer** dan atau
Encapsulation dan Decapsulation

3 Februari 2016

Pada jam Kuliah Protokol Routing