Routing Concepts and Static Routing

Introduction to Networks v6.0

Chapter 1: Routing Concepts

Pertemuan ke 15

Kompetensi Khusus

- Mahasiswa dapat melakukan konfigurasi routing statis untuk menghubungkan dua kelompok jaringan yang berbeda (C3)

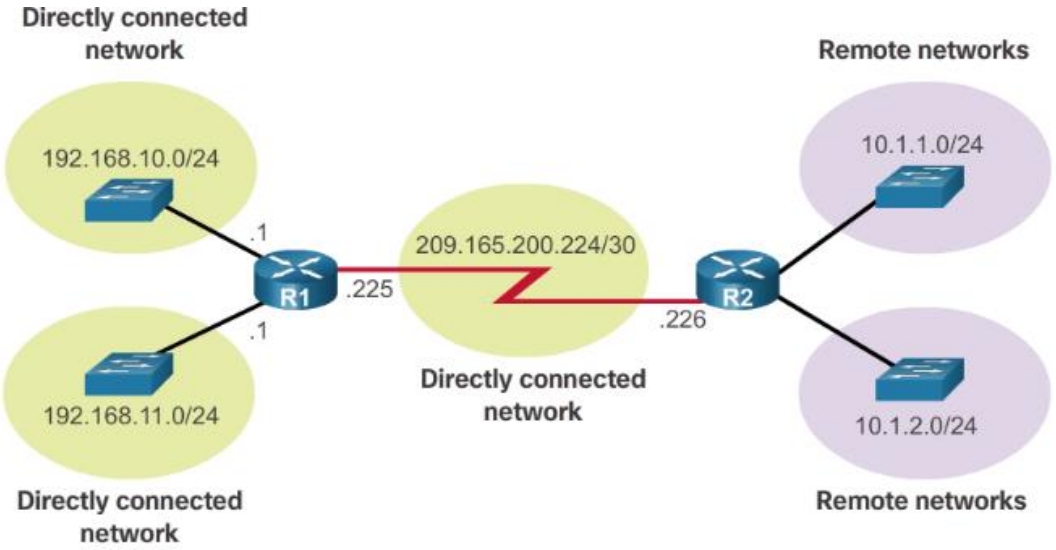
Materi:

1. Router Initial Configuration
2. Routing Decisions
3. Router Operation
4. Implement Static Routers
5. Configure Static and Default Routers
6. Troubleshoot Static and Default Route

3. Router Operation

3.1 The Routing Table

- A routing table is a file stored in RAM that contains information about:
  - Directly connected routes
  - Remote routes

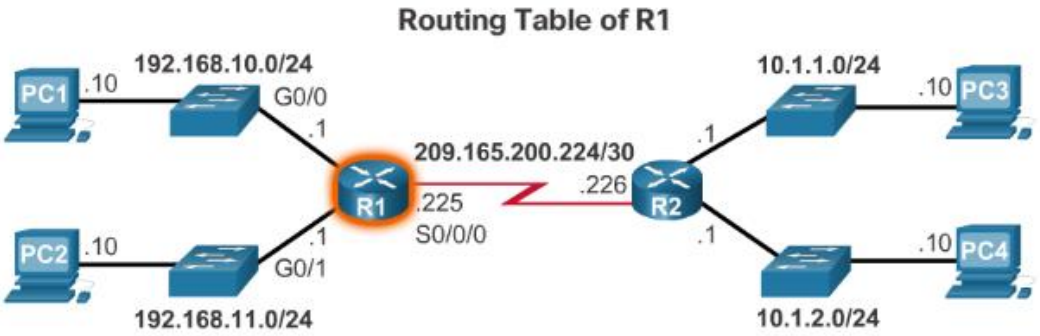


3.2 Routing Table Sources

The **show ip route** command is used to display the contents of the routing table:

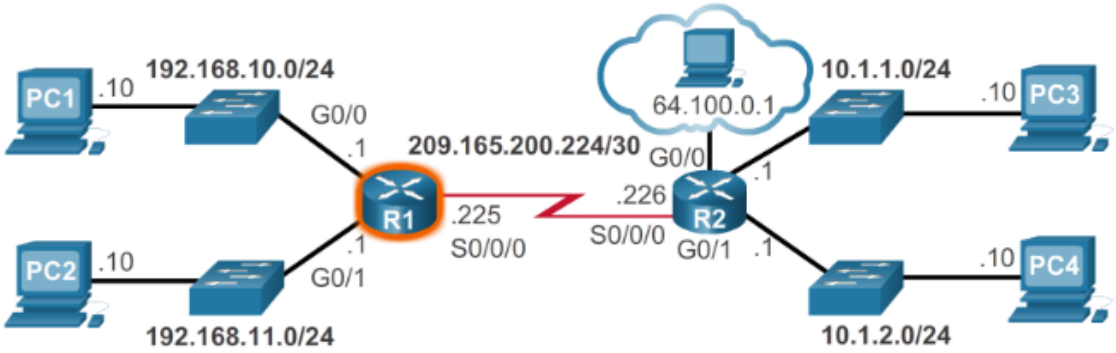
- **Local route interfaces -** Added to the routing table when an interface is configured. (displayed in IOS 15 or newer for IPv4 routes and all IOS releases for IPv6 routes.)
- **Directly connected interfaces -** Added to the routing table when an interface is configured and active.
- **Static routes -** Added when a route is manually configured and the exit interface is active.
- **Dynamic routing protocol -** Added when EIGRP or OSPF are implemented and networks are identified.

3.2 Routing Table Sources




```
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 route
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,
```

3.3 Remote Network Routing Entries



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

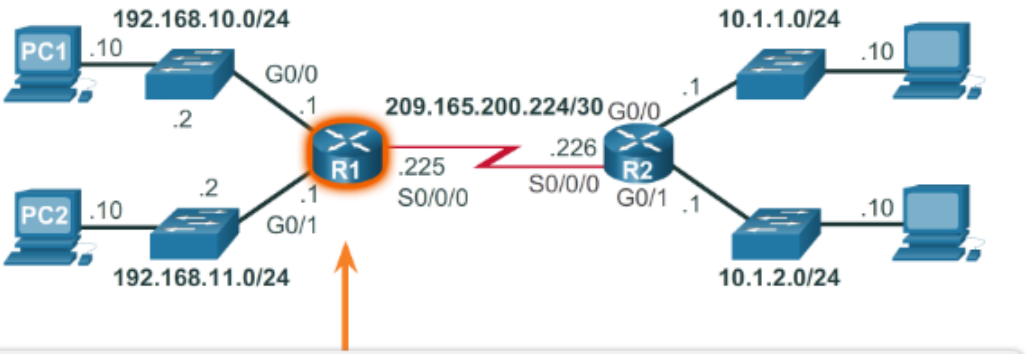
Legend

- 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 amout of elapsed time since the network was discovered.
- Identifies the outgoing interface on the router to reach the destination network.

3.4 Directly Connected Interfaces

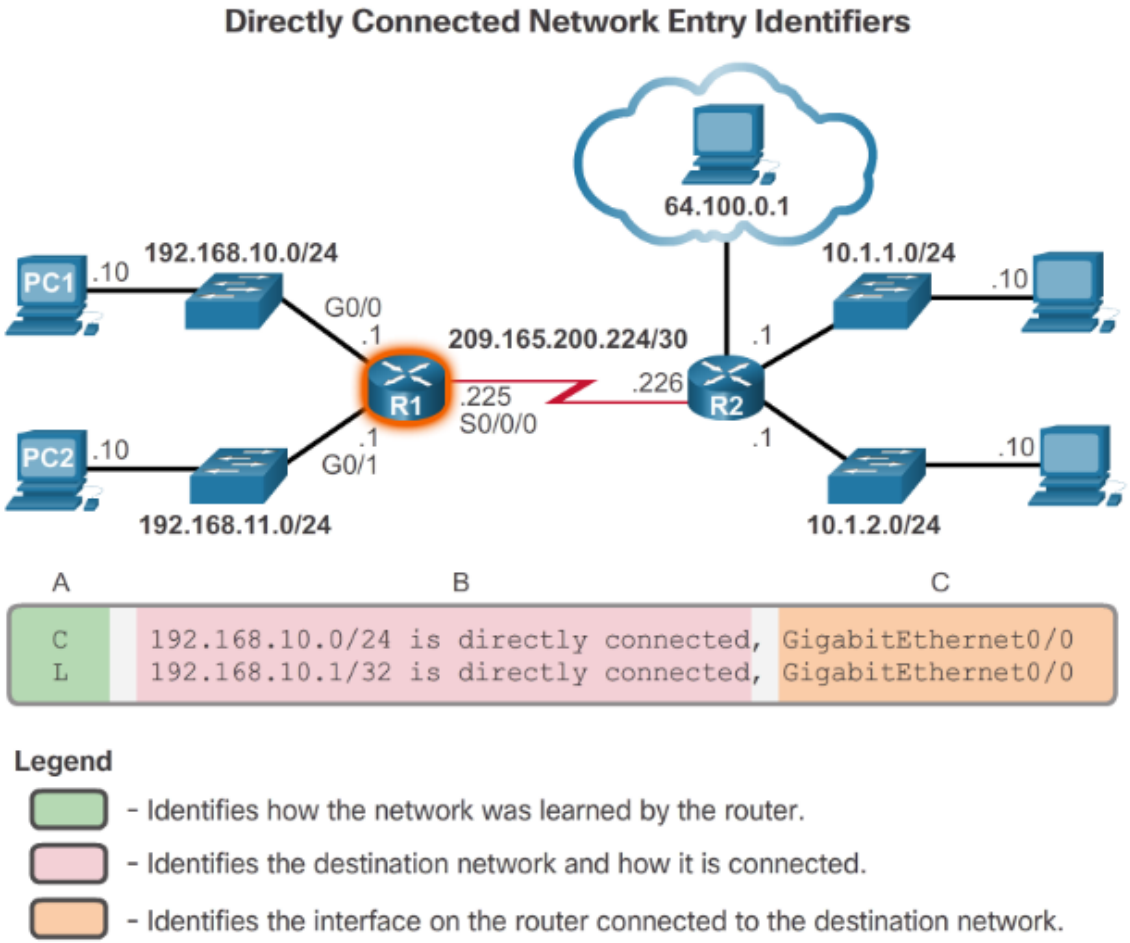
A newly deployed router, without any configured interfaces, has an empty routing table.

Empty Routing Table



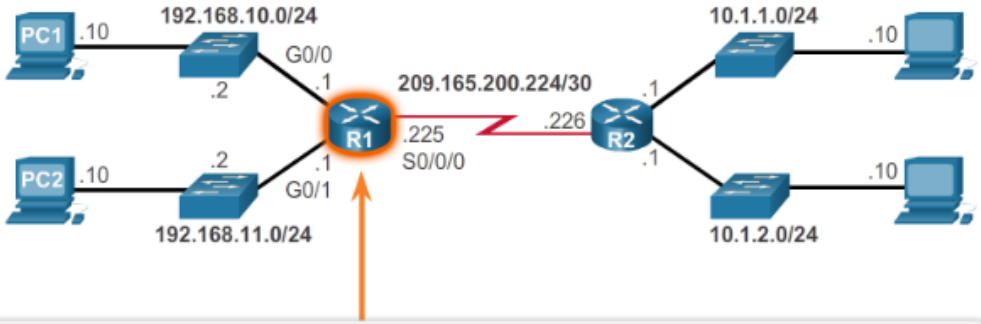

```
R1# show ip route
Codes:L - local, C - connected, S - static, R - RIP, M - mobile, B - BGP
      D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
      N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
      E1 - OSPF external type 1, E2 - OSPF external type 2
      i - IS-IS, su - IS-IS summary, 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, H - NHRP, l - LISP
      + - replicated route, % - next hop override

Gateway of last resort is not set

R1#
```

3.5 Directly Connected Routing Table Entries



3.5 Directly Connected Example

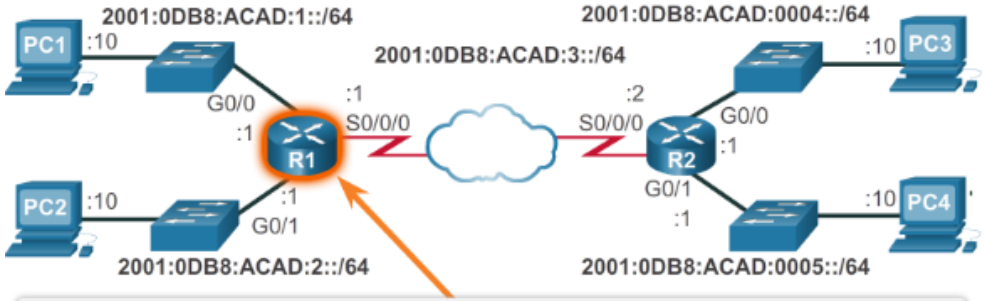
Verifying the Directly Connected Routing Table Entries




```
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
      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#
```

3.6 Directly Connected Example

Show the IPv6 Route Table



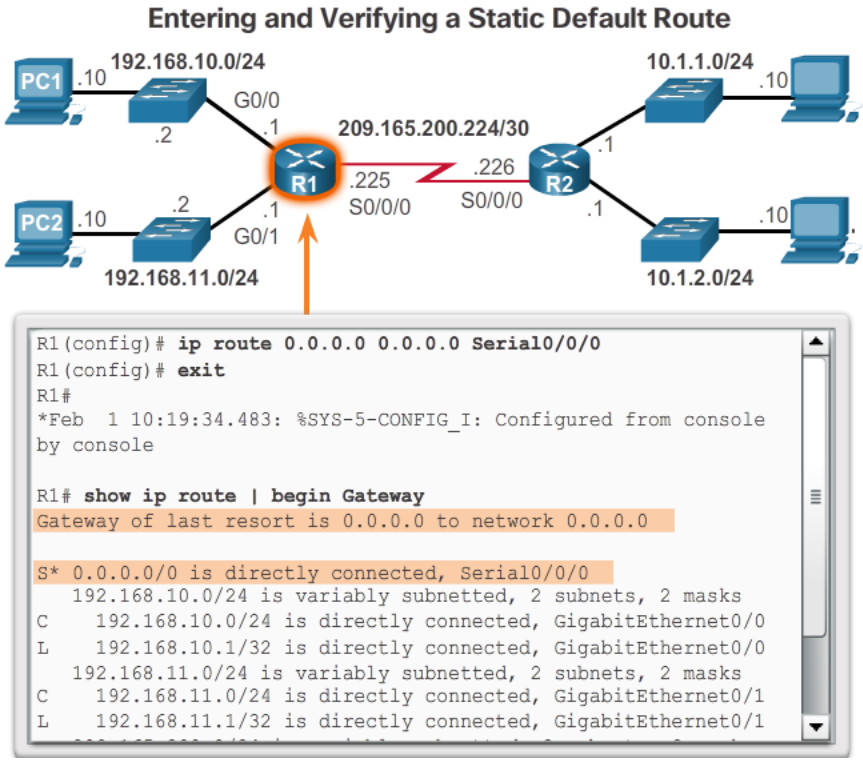

```
R1# show ipv6 route
IPv6 Routing Table - default - 5 entries
Codes: C - Connected, L - Local, S - Static,
       U - Per-user Static route, B - BGP, R - RIP
       H - NHRP, I1 - ISIS L1, I2 - ISIS L2
       IA - ISIS interarea, IS - ISIS summary, D - EIGRP
       EX - EIGRP external, ND - ND Default
       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
```

3.7 Static Routes

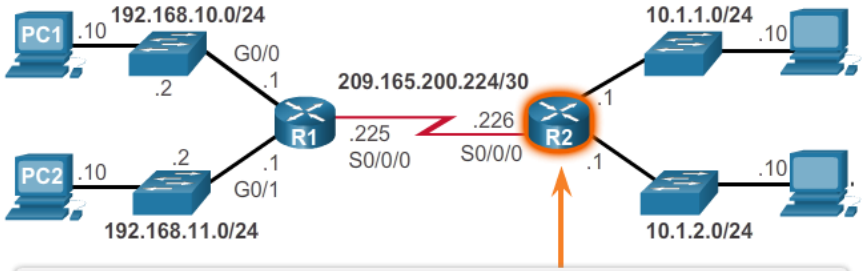
Static routes and default static routes can be implemented after directly connected interfaces are added to the routing table:

- Static routes are manually configured.
- They define an explicit path between two networking devices.
- Static routes must be manually updated if the topology changes.
- Their benefits include improved security and control of resources.
- Configure a static route to a specific network using the **ip route** *network mask* **{***next-hop-ip* **|** *exit-intf***}** command**.**
- A default static route is used when the routing table does not contain a path for a destination network.
- Configure a default static route using the **ip route** 0.0.0.0 0.0.0.0 {*exit-intf* | *next-hop-ip*} command.

3.8 Static Route Example



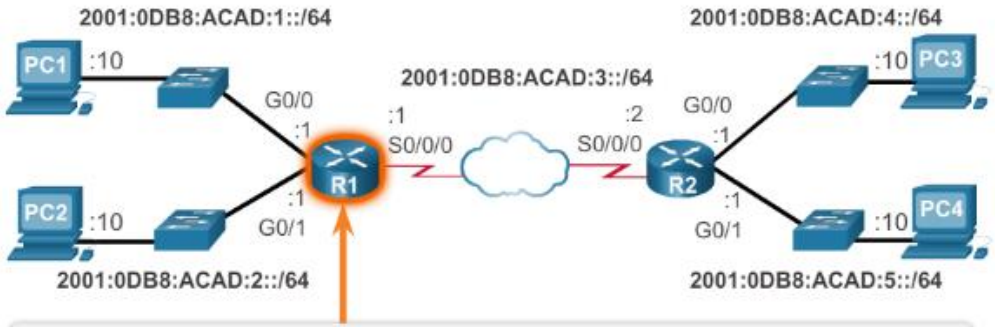
3.8 Static Route Example




```
R2(config)# ip route 192.168.10.0 255.255.255.0 s0/0/0
R2(config)# ip route 192.168.11.0 255.255.255.0 209.165.200.225
R2(config)# exit
R2#
R2# show ip route | begin Gateway
Gateway of last resort is not set

     10.0.0.0/8 is variably subnetted, 4 subnets, 2 masks
C       10.1.1.0/24 is directly connected, GigabitEthernet0/0
L       10.1.1.1/32 is directly connected, GigabitEthernet0/0
C       10.1.2.0/24 is directly connected, GigabitEthernet0/1
L       10.1.2.1/32 is directly connected, GigabitEthernet0/1
S    192.168.10.0/24 is directly connected, Serial0/0/0
S    192.168.11.0/24 [1/0] via 209.165.200.225
     209.165.200.0/24 is variably subnetted, 2 subnets, 2 masks
C       209.165.200.224/30 is directly connected, Serial0/0/0
```

3.9 Static IPv6 Route Examples

Entering and Verifying an IPv6 Static Default Route

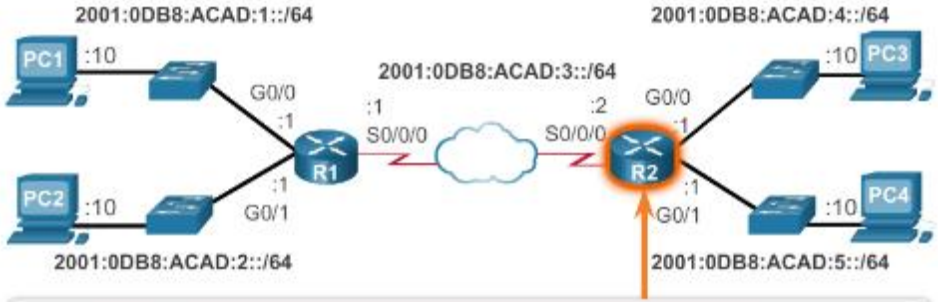



```
R1(config)# ipv6 route ::/0 s0/0/0
R1(config)# exit
R1#
```

```
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   2001:0DB8:ACAD:1::/64 [0/0]
     via GigabitEthernet0/0, directly connected
```

3.9 Static IPv6 Route Examples

Entering and Verifying IPv6 Static Routes

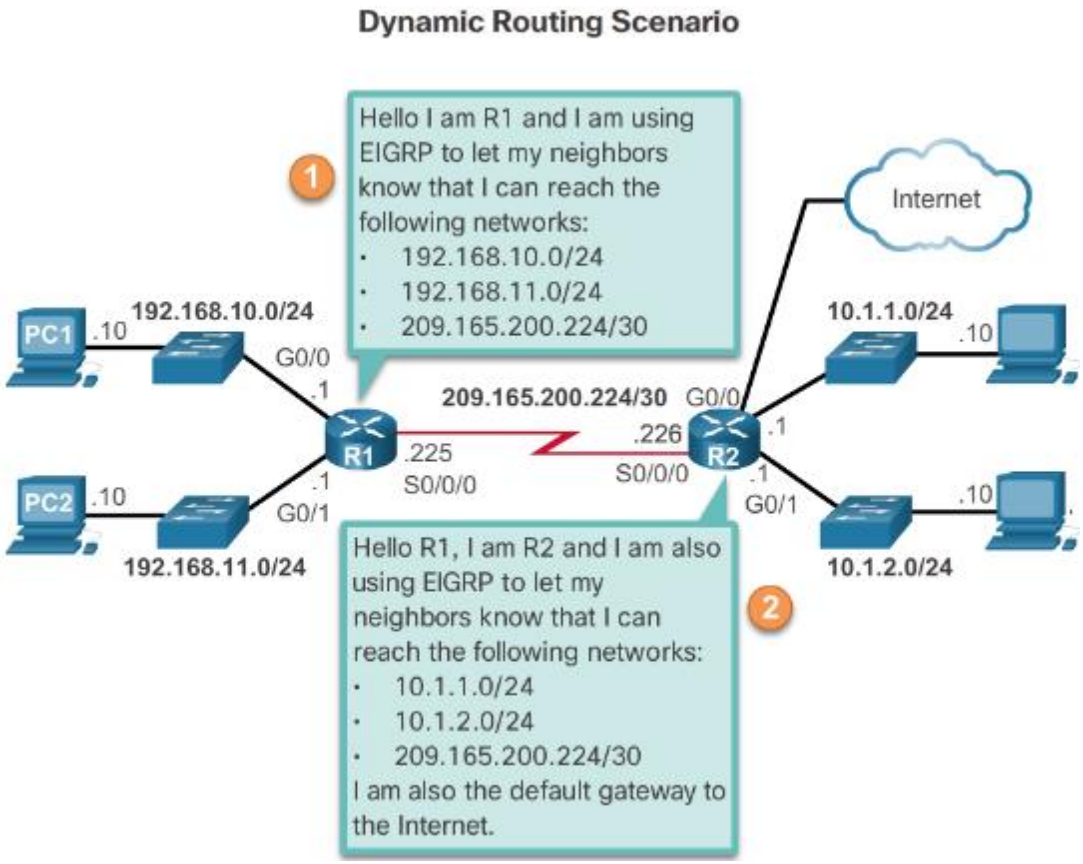



```
R2(config)# ipv6 route 2001:0DB8:ACAD:1::/64 2001:0DB8:ACAD:3::1
R2(config)# ipv6 route 2001:0DB8:ACAD:2::/64 s0/0/0
R2(config)# ^Z
R2#
```

```
R2# 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, ON1 - OSPF NSSA ext 1, ON2 - OSPF NSSA ext 2
S   2001:0DB8:ACAD:1::/64 [1/0]
     via 2001:DB8:ACAD:3::1
S   2001:0DB8:ACAD:2::/64 [1/0]
     via Serial0/0/0, directly connected
```

3.10 Dynamic Routing

- Dynamic routing is used by routers to share information about the reachability and status of remote networks.
- It performs network discovery and maintains routing tables.
- Routers have converged after they have finished exchanging and updating their routing tables.



3.11 IPv4 Routing Protocols

Cisco routers can support a variety of dynamic IPv4 routing protocols including:

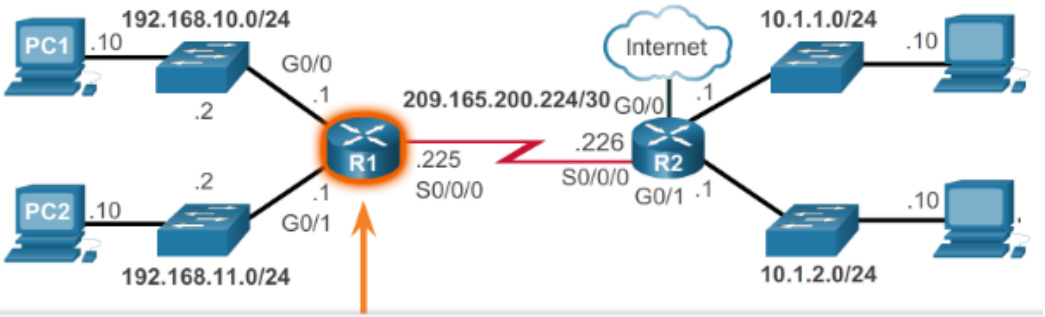
- **EIGRP –** Enhanced Interior Gateway Routing Protocol
- **OSPF –** Open Shortest Path First
- **IS-IS –** Intermediate System-to-Intermediate System
- **RIP –** Routing Information Protocol

Use the **router ?** Command in global configuration mode to determine which routing protocols are supported by the IOS.

```
R1(config)# router ?
  bgp         Border Gateway Protocol (BGP)
  eigrp       Enhanced Interior Gateway Routing Protocol (EIGRP)
  isis        ISO IS-IS
  iso-igrp    IGRP for OSI networks
  mobile      Mobile routes
  odr         On Demand stub Routes
  ospf        Open Shortest Path First (OSPF)
  ospfv3      OSPFv3
  rip         Routing Information Protocol (RIP)

R1(config)# router
```

3.12 IPv4 Dynamic Routing Examples

Verify Dynamic Routes




```
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#
```

3.13 IPv6 Routing Protocols

Cisco routers can support a variety of dynamic IPv6 routing protocols including:

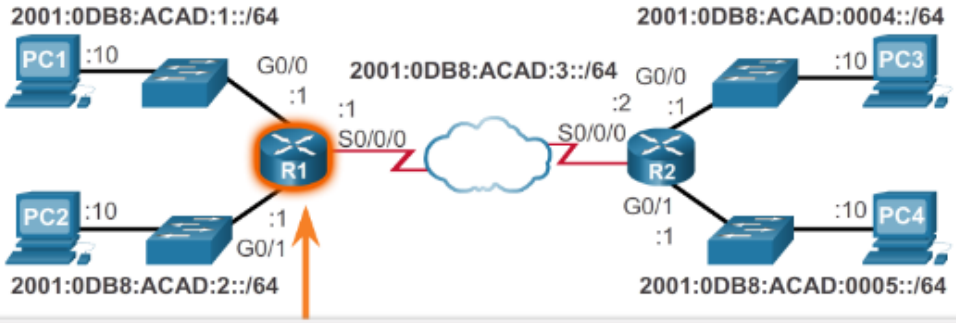
- **RIPng (**RIP next generation)
- **OSPFv3**
- **EIGRP** for IPv6

Use the **ipv6 router ?** command to determine which routing protocols are supported by the IOS

```
R1(config)# ipv6 router ?
  eigrp     Enhanced Interior Gateway Routing Protocol (EIGRP)
  ospf      Open Shortest Path First (OSPF)
  rip       IPv6 Routing Information Protocol (RIPv6)

R1(config)# router
```

3.14 IPv6 Dynamic Routing Examples

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, ON1 - OSPF NSSA ext 1, ON2 - OSPF NSSA ext 2
C   2001:DB8:ACAD:3::/64 [0/0]
     via Serial0/0/0, directly connected
L   2001:DB8:ACAD:3::1/128 [0/0]
     via Serial0/0/0, receive
D   2001:DB8:ACAD:4::/64 [90/2172416]
     via FE80::D68C:B5FF:FECE:A120, Serial0/0/0
D   2001:DB8:ACAD:5::/64 [90/2172416]
     via FE80::D68C:B5FF:FECE:A120, Serial0/0/0
L   FF00::/8 [0/0]
     via Null0, receive
R1#
```

Chapter Summary

Summary

- Describe the primary functions and features of a router.
- Configure basic settings on a router to route between two directly-connected networks, using CLI.
- Verify connectivity between two networks that are directly connected to a router.
- Explain how routers use information in data packets to make forwarding decisions in a small to medium-sized business network.
- Explain the encapsulation and de-encapsulation process used by routers when switching packets between interfaces.
- Explain the path determination function of a router.
- Explain how a router learns about remote networks when operating in a small to medium-sized business network.
- Explain how a router builds a routing table of directly connected networks.
- Explain how a router builds a routing table using static routes.
- Explain how a router builds a routing table using a dynamic routing protocol.

TERIMA KASIH