# Chapter 7: EIGRP Tuning and Troubleshooting

## Scaling Networks

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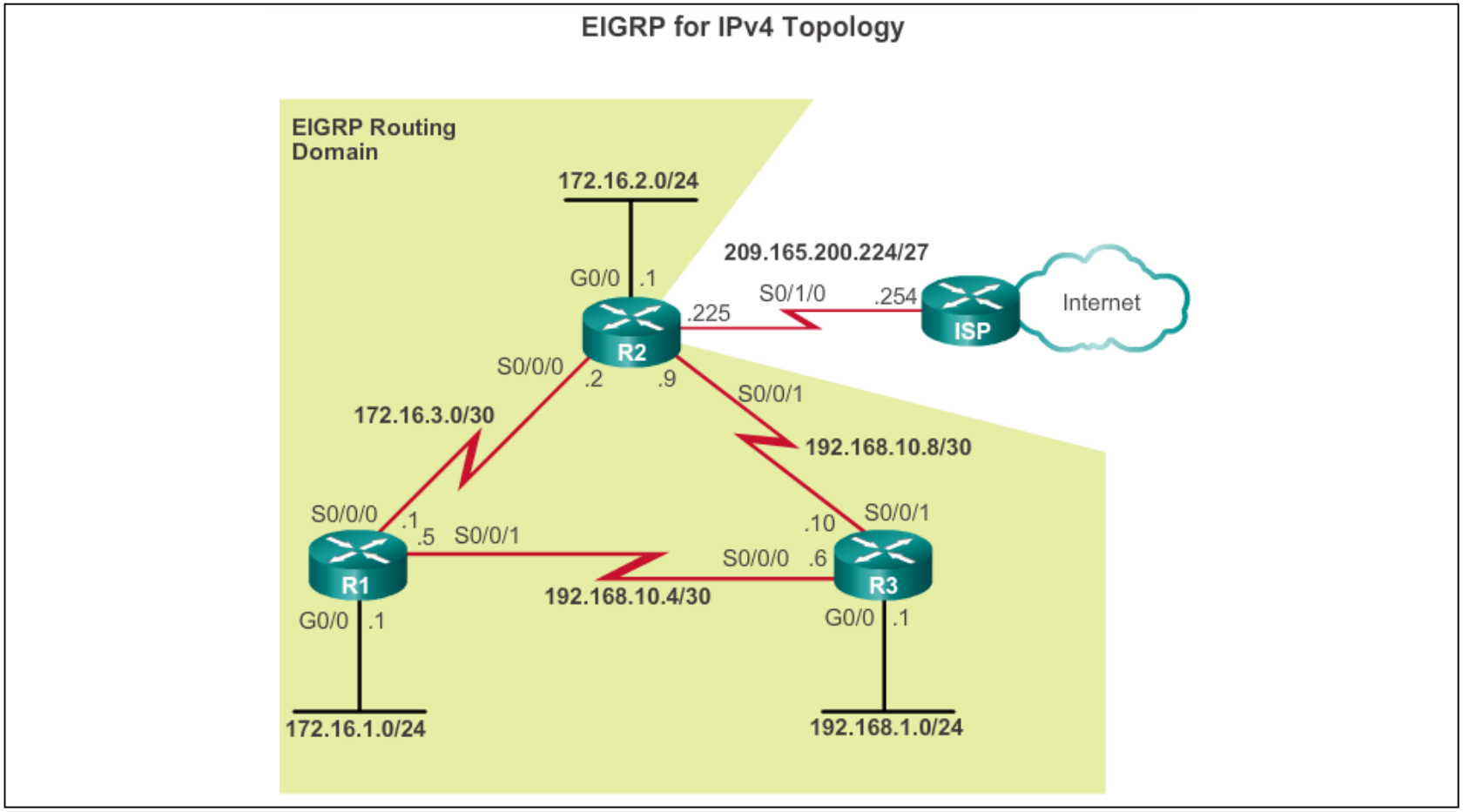
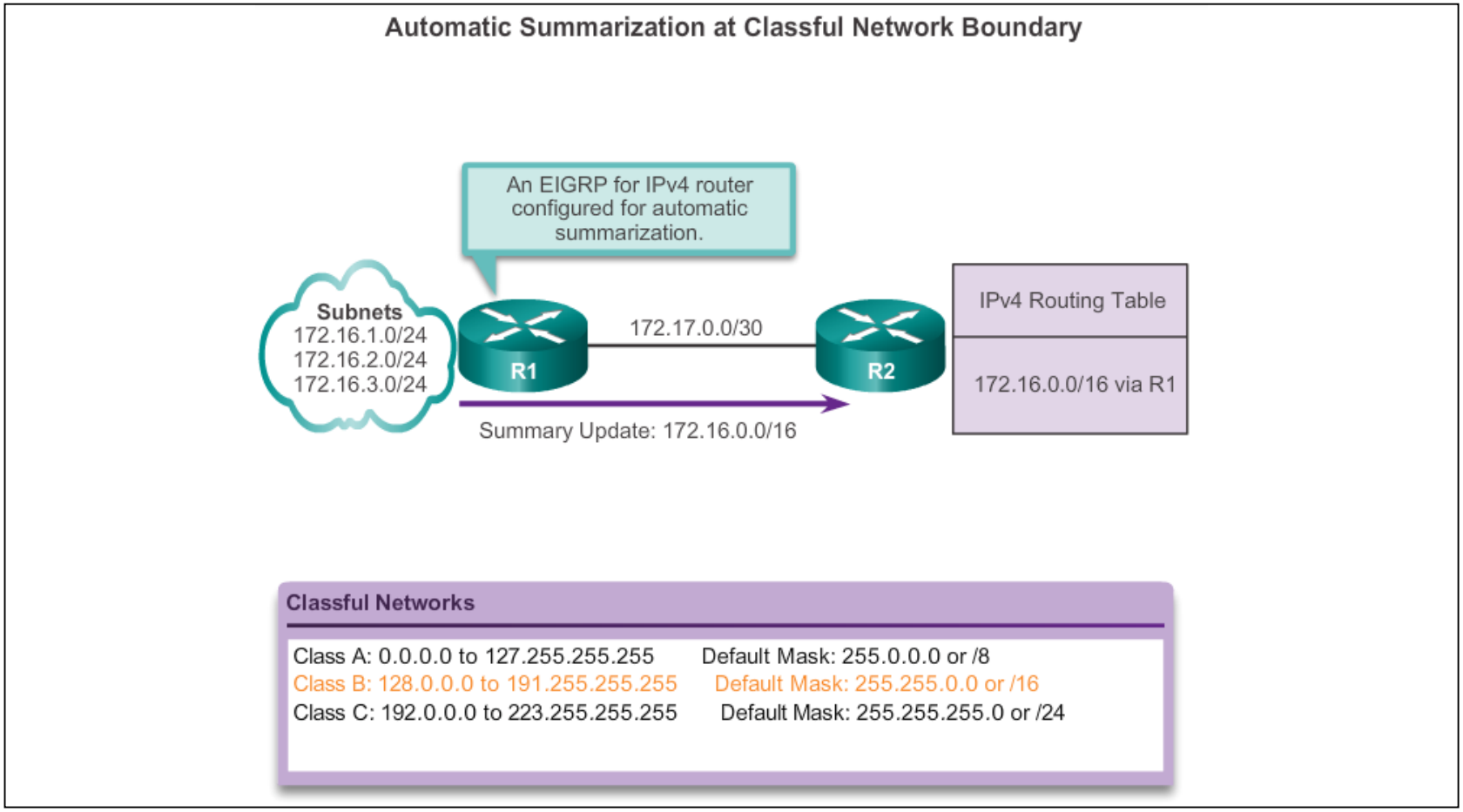
## Automatic Summarization

# Network Technology



# EIGRP Automatic Summarization



# Configuring EIGRP Automatic Summarization

- EIGRP for IPv4 automatic summarization is disabled, by default, beginning with Cisco IOS Release 15.0(1)M and 12.2(33). Prior to this, automatic summarization was enabled, by default.
- To enable automatic summarization for EIGRP, use the **auto-summary** command in router configuration mode.

```
R1(config)# router eigrp autonomous-system
R1(config-router)# auto-summary
```

- Use the **no** form of this command to disable autosummarization.

```
R1(config)# router eigrp autonomous-system
R1(config-router)# no auto-summary
```

# Verifying Autosummarization: show ip protocols

## Verifying Automatic Summarization is Enabled

```
R1# show ip protocols
*** IP Routing is NSF aware ***

Routing Protocol is "eigrp 1"
  Outgoing update filter list for all interfaces is not set
  Incoming update filter list for all interfaces is not set
  Default networks flagged in outgoing updates
  Default networks accepted from incoming updates
  EIGRP-IPv4 Protocol for AS(1)
    Metric weight K1=1, K2=0, K3=1, K4=0, K5=0
<Output omitted>

Automatic Summarization: enabled
    192.168.10.0/24 for Gi0/0, Se0/0/0
      Summarizing 2 components with metric 2169856
    172.16.0.0/16 for Se0/0/1
      Summarizing 3 components with metric 2816
<Output omitted>
```

# Verifying Autosummarization: Routing Table

## Verifying Summary Route in Routing Table

**Automatic Summarization Disabled**

```
R3# show ip route eigrp
<Output omitted>

 172.16.0.0/16 is variably subnetted, 3 subnets, 2 masks
D    172.16.1.0/24 [90/2170112] via 192.168.10.5,
                    02:21:10, Serial0/0/0
D    172.16.2.0/24 [90/3012096] via 192.168.10.9,
                    02:21:10, Serial0/0/1
D    172.16.3.0/30 [90/41024000] via 192.168.10.9,
                    02:21:10, Serial0/0/1
```

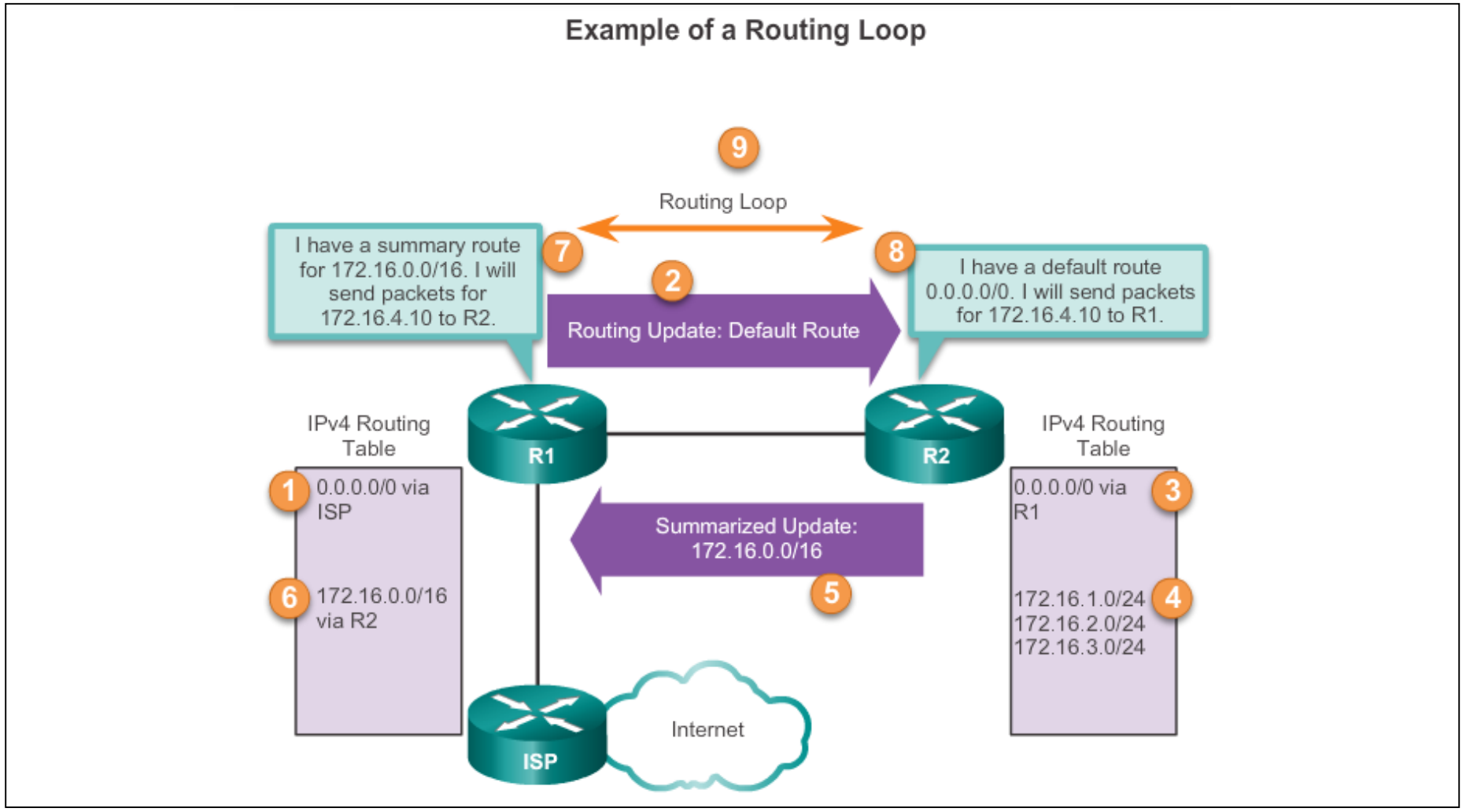
**Automatic Summarization Enabled**

```
R3# show ip route eigrp
<Output omitted>

D    172.16.0.0/16 [90/2170112] via 192.168.10.5, 00:12:05,
     Serial0/0/0
     192.168.10.0/24 is variably subnetted, 5 subnets, 3
     masks
D    192.168.10.0/24 is a summary, 00:11:43, Null0
R3#
```

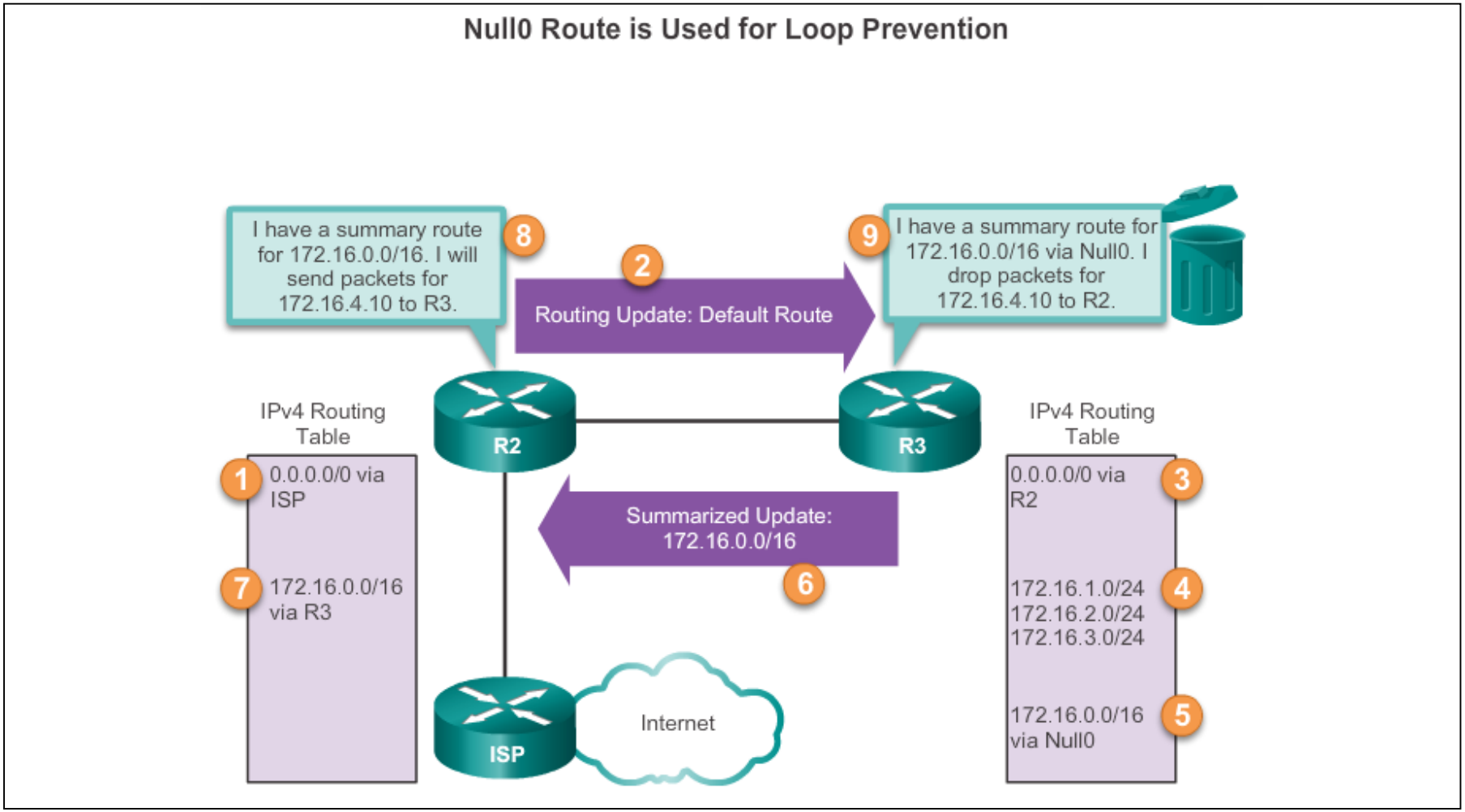
## Autosummarization

# Summary Route



## Autosummarization

# Summary Route (cont.)



# Manual Summary Routes

- EIGRP can be configured to summarize routes, whether or not autosummarization is enabled.
- Because EIGRP is a classless routing protocol and includes the subnet mask in the routing updates, manual summarization can include supernet routes.
- A supernet is an aggregation of multiple major classful network addresses.

## Manual Summarization

# Configuring EIGRP Manual Summary Routes

### Calculating a Summary Route

```
192.168.1.0: 11000000 . 10101000 . 000000001 . 00000000
192.168.2.0: 11000000 . 10101000 . 000000010 . 00000000
192.168.3.0: 11000000 . 10101000 . 000000011 . 00000000
```

22 matching bits

22 matching bits = a/22 subnet mask or 255.255.252.0

```
R3(config)# interface serial 0/0/0
R3(config-if)# ip summary-address eigrp 1 192.168.0.0
255.255.252.0
R3(config-if)#
```

Configure the summary route on all interfaces that send EIGRP packets.

## Manual Summarization

# Verifying Manual Summary Routes

### Verifying Summary Route Received on R1 and R2

```
R1# show ip route
<Output omitted>

D 192.168.0.0/22 [90/2170112] via 192.168.10.6, 01:53:19, Serial0/0/1
R1#
```

```
R2# show ip route
<Output omitted>

D 192.168.0.0/22 [90/3012096] via 192.168.10.10, 01:53:33, Serial0/0/1
R2#
```

# Propagating a Default Static Route

- Using a static route to 0.0.0.0/0 as a default route is not routing protocol-dependent.
- The quad zero static default route can be used with any currently supported routing protocols.
- The static default route is usually configured on the router that has a connection to a network outside the EIGRP routing domain, for example, to an ISP.

```
R2(config)# ip route 0.0.0.0 0.0.0.0 serial 0/1/0
R2(config)# router eigrp 1
R2(config-router)# redistribute static
```

# Verifying the Propagated Default Route

The entry for the EIGRP-learned default route is identified by the following:

- **D** – This route was learned from an EIGRP routing update.
- ***** – The route is a candidate for a default route.
- **EX** – The route is an external EIGRP route; in this case, a static route outside of the EIGRP routing domain.
- **170** – This is the administrative distance of an external EIGRP route.

```
R1# show ip route | include 0.0.0.0
Gateway of last resort is 192.168.10.6 to network 0.0.0.0
D*EX  0.0.0.0/0 [170/3651840] via 192.168.10.6, 00:25:23,
Serial0/0/1
R1#
```

# EIGRP Bandwidth Utilization

## EIGRP Bandwidth for IPv4

- By default, EIGRP uses only up to 50% of an interface's bandwidth for EIGRP information, which prevents the EIGRP process from overutilizing a link and not allowing enough bandwidth for the routing of normal traffic.
- The **ip bandwidth-percent eigrp** command can be used to configure the percentage of bandwidth that may be used by EIGRP on an interface.

```
Router(config-if)# ip bandwidth-percent eigrp as-number
percent
```

## Fine-tuning EIGRP Interfaces

# Hello and Hold Timers

### Configuring EIGRP for IPv4 Hello and Hold Timers

```
R1(config)# interface serial 0/0/0
R1(config-if)# ip hello-interval eigrp 1 60
R1(config-if)# ip hold-time eigrp 1 180
```

**Default Hello Intervals and Hold Times for EIGRP**

| Bandwidth | Example Link | Default Hello Interval | Default Hold Time |
|---|---|---|---|
| 1.544 Mbps | Multipoint Frame Relay | 60 seconds | 180 seconds |
| Greater than 1.544 Mbps | T1, Ethernet | 5 seconds | 15 seconds |

# Load Balancing IPv4

- Equal-cost load balancing is the ability of a router to distribute outbound traffic using all interfaces that have the same metric from the destination address.
- The Cisco IOS will, by default, allow load balancing using up to four equal-cost paths; however, this can be modified. Using the **maximum-paths** router configuration mode command, up to 32 equal-cost routes can be kept in the routing table.

```
Router(config-router)# maximum-paths value
```

- If the value is set to 1, load balancing is disabled.

# Routing Protocol Authentication Overview

- Network administrators must be aware that routers are at risk from attack just as much as end-user devices. Anyone with a packet sniffer, such as Wireshark, can read information propagating between routers.
- A method to protect routing information on the network is to authenticate routing protocol packets using the Message Digest 5 (MD5) algorithm.
- Routing protocols, such as RIPv2, EIGRP, OSPF, IS-IS, and BGP all support various forms of MD5 authentication.

## Secure EIGRP

# Configuring EIGRP with MD5 Authentication

### EIGRP Authentication with MD5

**Step 1: Create a Keychain**

```
Router(config)# key chain name-of-chain
Router(config-keychain)# key key-id
Router(config-keychain-key)# key-string key-string-text
```

**Step 2: Configure EIGRP Authentication Using Keychain and Key**

```
Router(config)# interface type number
Router(config-if)# ip authentication mode eigrp as-number md5
Router(config-if)# ip authentication key-chain eigrp as-number
name-of-chain
```

## Secure EIGRP

# EIGRP Authentication Example

### Configuring EIGRP MD5 Authentication on R1

```
R1(config)# key chain EIGRP_KEY
R1(config-keychain)# key 1
R1(config-keychain-key)# key-string cisco123
R1(config-keychain-key)# exit
R1(config-keychain)# exit
R1(config)# interface serial 0/0/0
R1(config-if)# ip authentication mode eigrp 1 md5
R1(config-if)# ip authentication key-chain eigrp 1 EIGRP_KEY
R1(config-if)# exit
R1(config)# interface serial 0/0/1
R1(config-if)# ip authentication mode eigrp 1 md5
R1(config-if)# ip authentication key-chain eigrp 1 EIGRP_KEY
R1(config-if)# end
R1#
```

## Secure EIGRP

# Verifying Authentication

- Adjacencies are only formed when both connecting devices have authentication configured.
- To verify that the correct EIGRP adjacencies were formed after being configured for authentication, use the **show ip eigrp neighbors** command on each router.
- To verify the neighbor adjacencies EIGRP for IPv6, use the **show ipv6 eigrp neighbors** command.

# Implement EIGRP for IPv6

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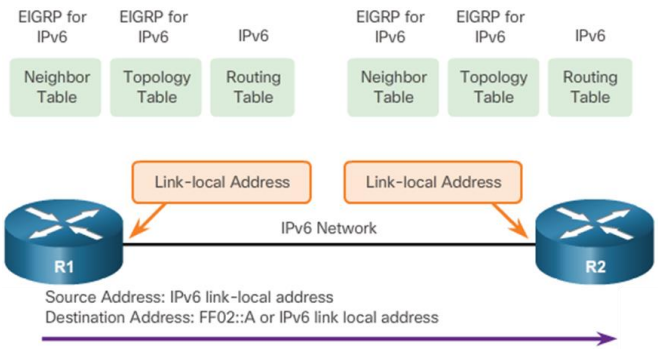
# EIGRP for IPv6

- EIGRP for IPv6
  - Similar functionality as EIGRP for IPv4
  - Uses IPv6 for communication with EIGRP for IPv6 peers and advertising IPv6 routes
  - Uses DUAL
  - EIGRP for IPv6 is a separate process from EIGRP for IPv4

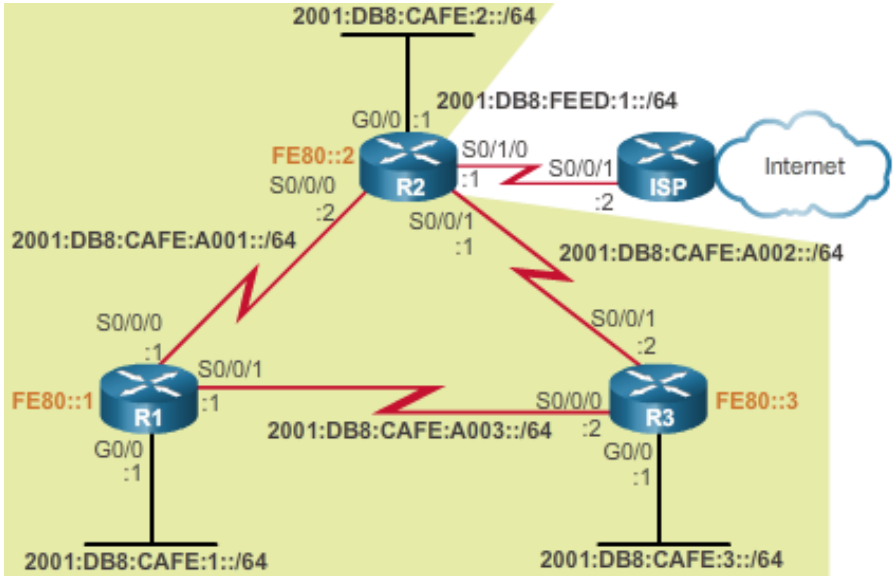
| | EIGRP for IPv4 | EIGRP for IPv6 |
|---|---|---|
| Advertised Routes | IPv4 networks | IPv6 prefixes |
| Distance Vector | Yes | Yes |
| Convergence Technology | DUAL | DUAL |
| Metric | Bandwidth and delay by default, reliability and load are optional | Bandwidth and delay by default, reliability and load are optional |
| Transport Protocol | RTP | RTP |
| Update Messages | Incremental, partial, and bounded updates | Incremental, partial, and bounded updates |
| Neighbor Discovery | Hello packets | Hello packets |
| Source and Destination Addresses | IPv4 source address and 224.0.0.10 IPv4 multicast destination address | IPv6 link-local source address and FF02::A IPv6 multicast destination address |
| Authentication | MD5, SHA256 | MD5, SHA256 |
| Router ID | 32-bit router ID | 32-bit router ID |

- IPv6 Link-local Address
  - Packets with a source or destination link-local address cannot be routed beyond the link from where the packet originated.
  - IPv6 link-local addresses are in the FE80::/10 range.



# Configure EIGRP for IPv6

- Configuring IPv6 Link-local Addresses
  - Link-local address can be automatically created or manually configured
    - When created automatically, the router creates the link-local address using FE80::/10 prefix and the EUI-64 process. Use the **ipv6 address** *link-local-address* **link-local** command to manually configure the link-local address using the FE80::10 prefix
  - Link-local addresses must be unique on the same local link.



# Configure EIGRP for IPv6

- The **ipv6 unicast-routing** command enable IPv6 routing
- The **ipv6 route eigrp** *autonomous-system* command is used to enter the router configuration mode. The process needs to be activated with the **no shutdown** command.
- To configure the Router ID, use the **eigrp router-id** command.
- Both the **no shutdown** command and a router ID are required for the router to form neighbor adjacencies.
- EIGRP for IPv6 is configured directly on the interface.
  - **ipv6 eigrp** *autonomous-system*
- Configure passive interface in the router-configuration mode
  - **passive-interface** *interface*

```
R2(config)# ipv6 unicast-routing
R2(config)# ipv6 router eigrp 2
R2(config-rtr)# eigrp router-id 2.0.0.0
R2(config-rtr)# no shutdown
```

```
R2(config)# ipv6 router eigrp 2
R2(config-rtr)# passive-interface gigabitethernet 0/0
R2(config-rtr)# end
```

```
R2(config)# interface g 0/0
R2(config-if)# ipv6 eigrp 2
R2(config-if)# exit
R2(config)# interface s 0/0/0
R2(config-if)# ipv6 eigrp 2
R2(config-if)# exit
%DUAL-5-NBRCHANGE: EIGRP-IPv6 2: Neighbor FE80::1
(Serial0/0/0) is up: new adjacency
```

# Verify EIGRP for IPv6

- IPv6 Neighbor Table
  - The **show ipv6 eigrp neighbors** command is used to display neighbor adjacencies
- The **show ip protocols** Command
  - Displays the parameters and other information about the state of any active IPv6 routing protocol processes currently configured on the router.
  - Displays different types of output specific to each IPv6 routing protocol.
- The EIGRP for IPv6 Routing Table
  - The **show ipv6 route** command is used to view the IPv6 routing table

```
R1# show ipv6 eigrp neighbors
EIGRP-IPv6 Neighbors for AS(2)
H   Address                 Interface       Hold Uptime   SRTT   RTO  Q  Seq
                                            (sec)         (ms)       Cnt Num
1   Link-local address:     Se0/0/1          13  00:37:17  45    270  0  8
    FE80::3
0   Link-local address:     Se0/0/0          14  00:53:16  32    2370 0  8
    FE80::2
R1#
```

Neighbor's IPv6 Link-local Address.

Local Interface receiving EIGRP for IPv6 Hello packets.

Amount of time since this neighbor was added to the neighbor table.

Seconds remaining before declaring neighbor down.

The current hold time and is reset to the maximum hold time whenever a Hello packet is received.

```
R1# show ipv6 protocols
IPv6 Routing Protocol is "connected"
IPv6 Routing Protocol is "ND"
IPv6 Routing Protocol is "eigrp 2"
EIGRP-IPv6 Protocol for AS(2)
  Metric weight K1=1, K2=0, K3=1, K4=0, K5=0
  NSF-aware route hold timer is 240
  Router-ID: 1.0.0.0
  Topology : 0 (base)
    Active Timer: 3 min
    Distance: internal 90 external 170
    Maximum path: 16
    Maximum hopcount 100
    Maximum metric variance 1

  Interfaces:
    GigabitEthernet0/0
    Serial0/0/0
    Serial0/0/1
  Redistribution:
    None
R1#
```

1 Routing protocol and Process ID (AS Number)

2 K values used in composite metric

3 EIGRP Router ID

4 EIGRP Administrative Distances

5 Interfaces enabled for EIGRP for IPv6

```
R1# show ipv6 route
<output omitted>
C   2001:DB8:CAFE:1::/64 [0/0]
     via GigabitEthernet0/0, directly connected
L   2001:DB8:CAFE:1::1/128 [0/0]
     via GigabitEthernet0/0, receive
D   2001:DB8:CAFE:2::/64 [90/3524096]
     via FE80::3, Serial0/0/1
D   2001:DB8:CAFE:3::/64 [90/2170112]
     via FE80::3, Serial0/0/1
C   2001:DB8:CAFE:A001::/64 [0/0]
     via Serial0/0/0, directly connected
L   2001:DB8:CAFE:A001::1/128 [0/0]
     via Serial0/0/0, receive
D   2001:DB8:CAFE:A002::/64 [90/3523840]
     via FE80::3, Serial0/0/1
C   2001:DB8:CAFE:A003::/64 [0/0]
     via Serial0/0/1, directly connected
L   2001:DB8:CAFE:A003::1/128 [0/0]
     via Serial0/0/1, receive
L   FF00::/8 [0/0]
     via Null0, receive
R1#
```

# EIGRP for IPv6- Default Route

```
R2(config)# ipv6 route ::/0 serial 0/1/0
R2(config)# ipv6 router eigrp 2
R2(config-router)# redistribute static
```

**Note**: Some IOSs may require that the **redistribute static** command include the EIGRP metric parameters and maximum transmission unit (MTU) before the static route can be redistributed. These parameters may vary, but an example for this scenario would be:

```
R2(config)# ipv6 router eigrp 2
```

```
R2(config-router)# redistribute static metric 64 2000
255 1 1500
```

# EIGRP for IPv6: Manual Summary Routes

## IPv6 Manually Summary Configuration on R3

```
R3(config)# interface serial 0/0/0
R3(config-if)# ipv6 summary-address eigrp 2 2001:db8:acad::/48
R3(config-if)# exit
R3(config)# interface serial 0/0/1
R3(config-if)# ipv6 summary-address eigrp 2 2001:db8:acad::/48
R3(config-if)# end

R3# show ipv6 route

D   2001:DB8:ACAD::/48 [5/128256]
     via Null0, directly connected

<Output omitted>
```

# EIGRP Bandwidth Utilization (cont.)

## EIGRP Bandwidth for IPv6

To configure the percentage of bandwidth that may be used by EIGRP for IPv6 on an interface, use the **ipv6 bandwidth-percent eigrp** command in interface configuration mode. To restore the default value, use the **no** form of this command.

```
Router(config-if)# ipv6 bandwidth-percent eigrp as-number percent
```

## Fine-tuning EIGRP Interfaces

# Load Balancing IPv6

### R3's IPv6 Routing Table

```
R3# show ipv6 route eigrp
<Output omitted>

EX   ::/0 [170/3011840]
      via FE80::2, Serial0/0/1
D    2001:DB8:ACAD::/48 [5/128256]
      via Null0, directly connected
D    2001:DB8:CAFE:1::/64 [90/2170112]
      via FE80::1, Serial0/0/0
D    2001:DB8:CAFE:2::/64 [90/3012096]
      via FE80::2, Serial0/0/1
D    2001:DB8:CAFE:A001::/64 [90/41024000]
      via FE80::2, Serial0/0/1
      via FE80::1, Serial0/0/0
R3#
```

## Secure EIGRP

# EIGRP Authentication Example (cont.)

### Configuring EIGRP for IPv6 MD5 Authentication on R1

```
R1(config)# key chain EIGRP_IPV6_KEY
R1(config-keychain)# key 1
R1(config-keychain-key)# key-string cisco123
R1(config-keychain-key)# exit
R1(config-keychain)# exit
R1(config)# interface serial 0/0/0
R1(config-if)# ipv6 authentication mode eigrp 2 md5
R1(config-if)# ipv6 authentication key-chain eigrp 2
               EIGRP_IPV6_KEY
R1(config-if)# exit
R1(config)# interface serial 0/0/1
R1(config-if)# ipv6 authentication mode eigrp 2 md5
R1(config-if)# ipv6 authentication key-chain eigrp 2
               EIGRP_IPV6_KEY
R1(config-if)#
```

# Troubleshooting EIGRP

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# Basic EIGRP Troubleshooting Commands

EIGRP for IPv4

- `Router# show ip eigrp neighbors`
- `Router# show ip route`
- `Router# show ip protocols`
- `Router# show ip eigrp trafic`

EIGRP for IPv6

- `Router# show ipv6 eigrp neighbors`
- `Router# show ipv6 route`
- `Router# show ipv6 protocols`
- `Router# show ipv6 eigrp trafic`