



Chapter 8: EIGRP Advanced Configurations and Troubleshooting



Scaling Networks

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Chapter 8

8.1 Advanced EIGRP Configurations

8.2 Troubleshooting EIGRP

8.3 Summary



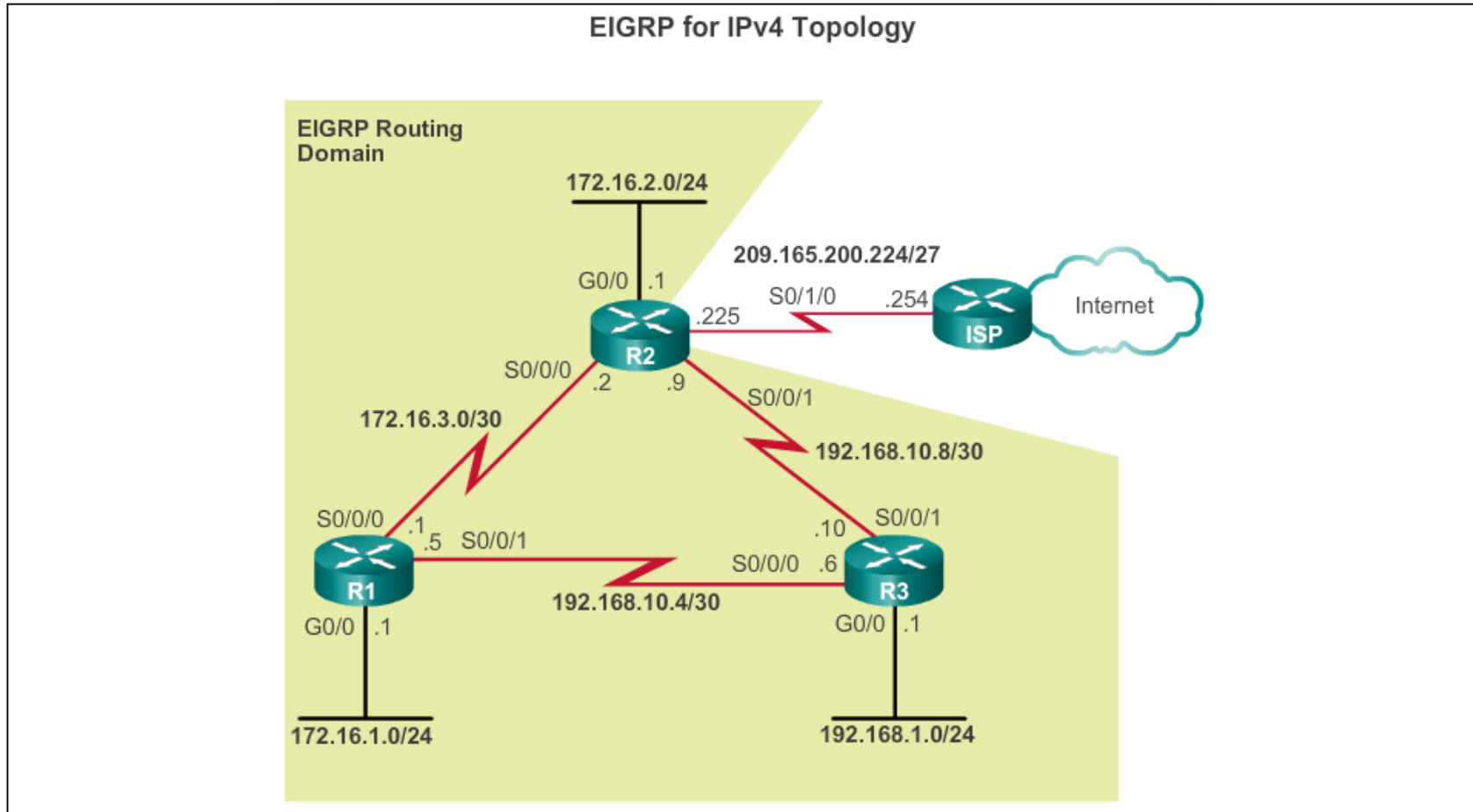
Chapter 8: Objectives

After completing this chapter, you will be able to:

- Configure EIGRP automatic summarization.
- Configure EIGRP manual summarization.
- Configure a router to propagate a default route in an EIGRP network.
- Modify EIGRP interface settings to improve network performance.
- Configure EIGRP authentication to ensure secure routing updates.
- Explain the process and tools used to troubleshoot an EIGRP network.
- Troubleshoot neighbor adjacency issues in an EIGRP network.
- Troubleshoot missing route entries in an EIGRP routing table.



Automatic Summarization Network Technology

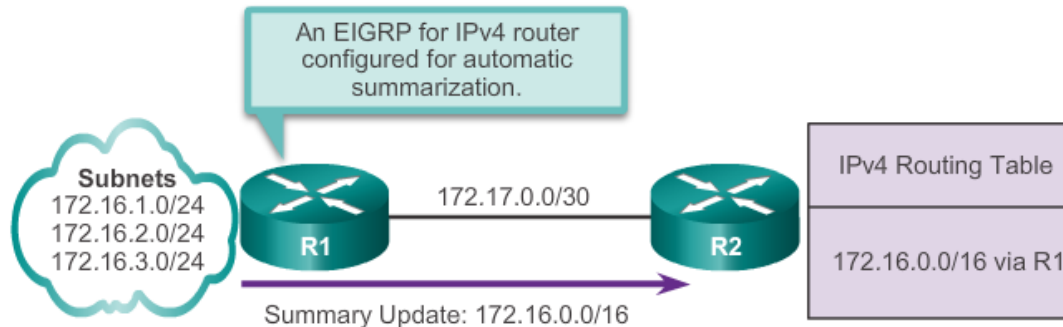




Automatic Summarization

EIGRP Automatic Summarization

Automatic Summarization at Classful Network Boundary



Classful Networks

Class A: 0.0.0.0 to 127.255.255.255	Default Mask: 255.0.0.0 or /8
Class B: 128.0.0.0 to 191.255.255.255	Default Mask: 255.255.0.0 or /16
Class C: 192.0.0.0 to 223.255.255.255	Default Mask: 255.255.255.0 or /24



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
```



Autosummarization

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>
```



Autosummarization

Verifying Autosummarization: Topology Table

```
R3# show ip eigrp topology all-links
```

```
P 172.16.0.0/16, 1 successors, FD is 2170112, serno 9
    via 192.168.10.5 (2170112/2816), Serial0/0/0
    via 192.168.10.9 (3012096/2816), Serial0/0/1
```

<Output omitted>

Autosummarization

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

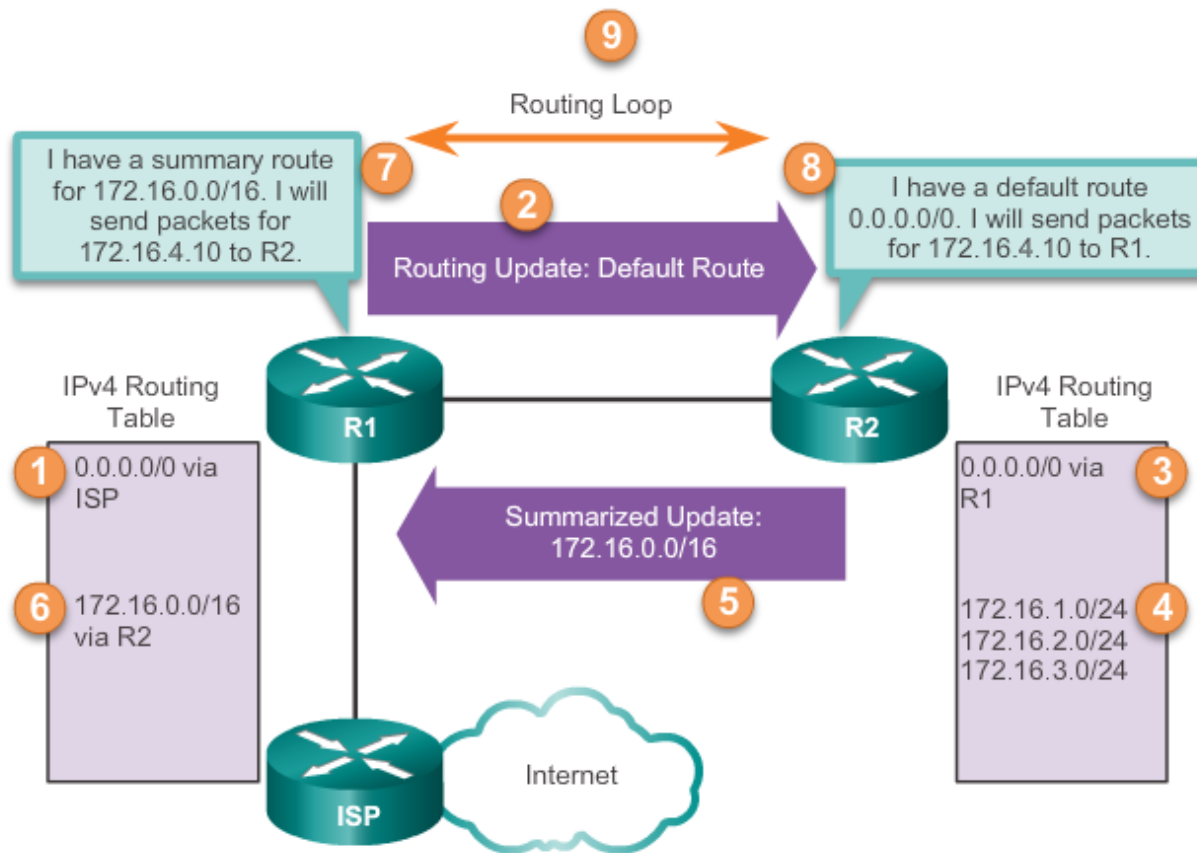
```
R3# show ip route eigrp
<Output omitted>

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

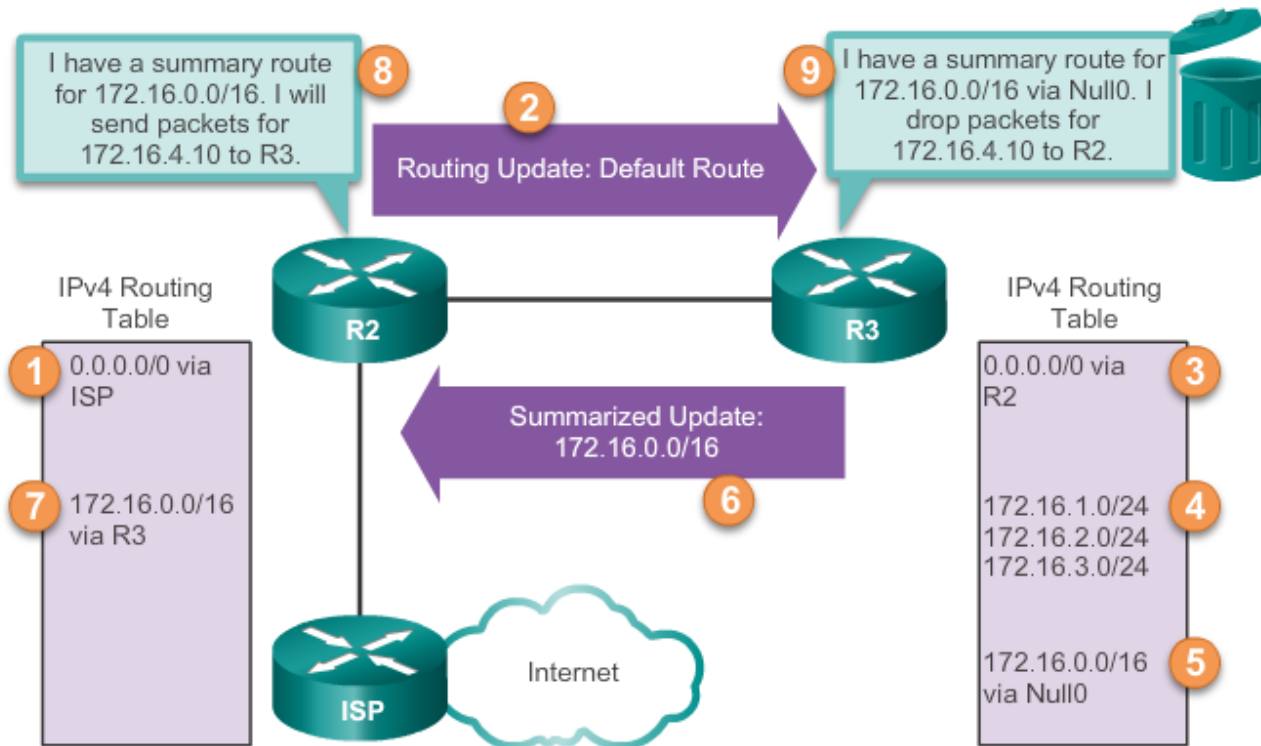
Example of a Routing Loop





Autosummarization Summary Route (cont.)

Null0 Route is Used for Loop Prevention





Manual Summarization

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	.	00000000	01	.	00000000
192.168.2.0:	11000000	.	10101000	.	00000000	10	.	00000000
192.168.3.0:	11000000	.	10101000	.	00000000	11	.	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, Serial10/0/1
R1#
```

```
R2# show ip route
```

<Output omitted>

```
D 192.168.0.0/22 [90/3012096] via 192.168.10.10, 01:53:33, Serial10/0/1
R2#
```



Manual Summarization

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>
```



Default Route Propagation

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
```




Default Route Propagation

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#
```



Default Route Propagation

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
```



Fine-tuning EIGRP Interfaces

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

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

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



Fine-tuning EIGRP Interfaces

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.



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

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

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)#
```



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.



8.2 Troubleshooting EIGRP



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Components of Troubleshooting EIGRP

Basic EIGRP Troubleshooting Commands

EIGRP for IPv4

- Router# **show ip eigrp neighbors**
- Router# **show ip route**
- Router# **show ip protocols**

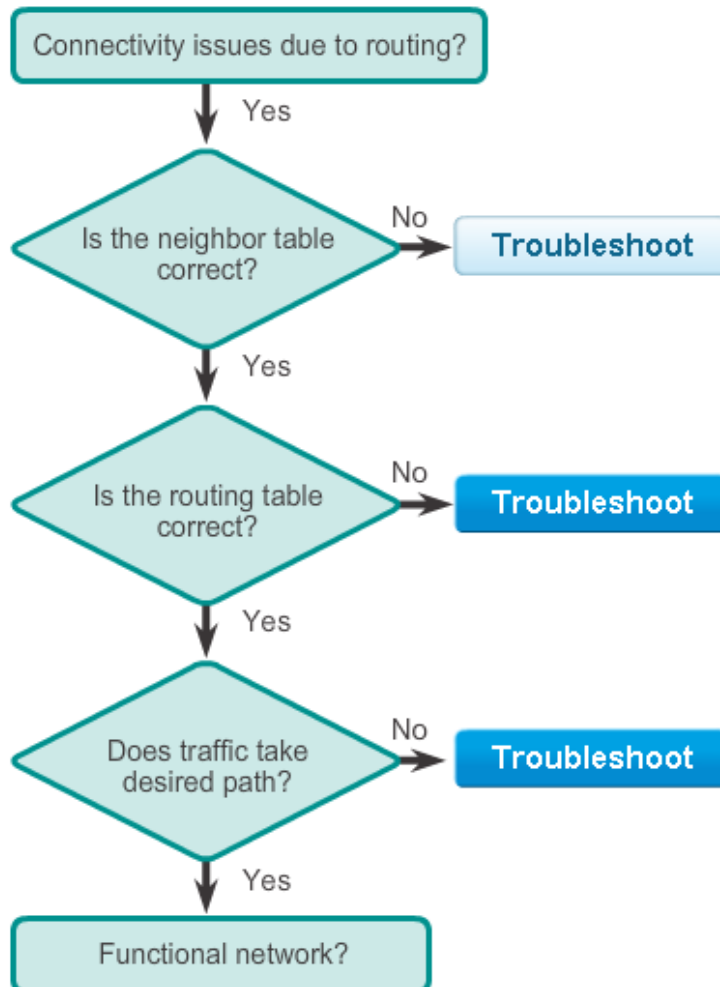
EIGRP for IPv6

- Router# **show ipv6 eigrp neighbors**
- Router# **show ipv6 route**
- Router# **show ipv6 protocols**



Components of Troubleshooting EIGRP Components

Diagnosing EIGRP Connectivity Issues



Troubleshoot

- Are the interfaces operational?
- Are the interfaces enabled for EIGRP?
- Does the EIGRP AS match?
- Is there an interface that is configured as passive?

Show commands

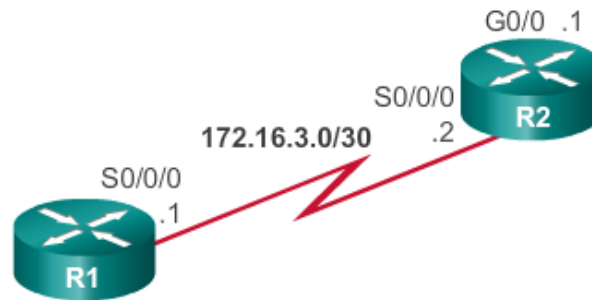
```
show ip eigrp neighbors
show ip interface brief
show ip eigrp interface
```



Troubleshoot EIGRP Neighbor Issues

Layer 3 Connectivity

A prerequisite for a neighbor adjacency to form between two directly connected routers is Layer 3 connectivity.



```
R1# show ip interface brief
Interface                               IP-Address      OK? Method Status
Protocol
GigabitEthernet0/0                     172.16.1.1      YES manual up
Serial0/0/0                             172.16.3.1      YES manual up
Serial0/0/1                             192.168.10.5    YES manual up
R1# ping 172.16.3.2
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 172.16.3.2, timeout is 2 seconds:
!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max =
28/28/28 ms
R1#
```




Troubleshoot EIGRP Neighbor Issues

EIGRP Parameters

When troubleshooting an EIGRP network, one of the first things to verify is that all routers that are participating in the EIGRP network are configured with the same autonomous system number.

EIGRP for IPv4

- Router# **show ip protocols**

EIGRP for IPv6

- Router# **show ipv6 protocols**



Troubleshoot EIGRP Neighbor Issues

EIGRP Interfaces

- In addition to verifying the autonomous system number, it is necessary to verify that all interfaces are participating in the EIGRP network.
- The **network** command that is configured under the EIGRP routing process indicates which router interfaces participate in EIGRP.

```

R1# show ip eigrp interfaces
EIGRP-IPv4 Interfaces for AS(1)

```

Interface	Peers	Xmit Queue Un/Reliable	PeerQ Un/Reliable	Mean SRTT	Pacing Time Un/Reliable
Gi0/1	0	0/0	0/0	0	0/0
Se0/0/0	1	0/0	0/0	1295	0/23
Se0/0/1	1	0/0	0/0	1044	0/15

```

R1#

```



Troubleshoot EIGRP Routing Table Issues

Passive Interface

- One reason that route tables may not reflect the correct routes is due to the **passive-interface** command.
- The show ip protocols can be used to check if an interface is configured as passive.

```
R2# show ip protocols
*** IP Routing is NSF aware ***
Routing Protocol is "eigrp 1"
<output omitted>
Routing for Networks:
  172.16.0.0
  192.168.10.8/30
Passive Interface(s):
  GigabitEthernet0/0
Routing Information Sources:
  Gateway          Distance      Last Update
  192.168.10.10     90           00:08:59
  172.16.3.1        90           00:08:59
Distance: internal 90 external 170
R2#
```



Troubleshoot EIGRP Routing Table Issues

Passive Interface

- With EIGRP running on a network, the **passive-interface** command stops both outgoing and incoming routing updates. For this reason, routers do not become neighbors.

Configuring Network to ISP as a Passive Interface

```
R2(config)# router eigrp 1
R2(config-router)# network 209.165.200.0
R2(config-router)# passive-interface serial 0/1/0
R2(config-router)# end
R2# show ip eigrp neighbors
EIGRP-IPv4 Neighbors for AS(1)
H   Address           Interface   Hold Uptime    SRTT   RTO   Q   Seq
                        (sec)              (ms)        Cnt  Num
1   172.16.3.1          Se0/0/0     175 01:09:18     80    2340  0   16
0   192.168.10.10       Se0/0/1     11 01:09:33    1037   5000  0   17
R2#
```



Troubleshoot EIGRP Routing Table Issues

Missing Network Statement

10.10.10.0/24 Unreachable from R3

```
R3# ping 10.10.10.1
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.10.10.1, timeout is 2
seconds:
.....
Success rate is 0 percent (0/5)
R3#
```



Troubleshoot EIGRP Routing Table Issues

Missing Network Statement (cont.)

10.10.10.0/24 R1 Updates

```
R1# show ip protocols | begin Routing for Networks
```

```
Routing for Networks:
```

```
172.16.0.0
```

```
192.168.10.0
```

```
Passive Interface(s):
```

```
GigabitEthernet0/0
```

```
Routing Information Sources:
```

Gateway	Distance	Last Update
192.168.10.6	90	01:34:19
172.16.3.2	90	01:34:19

```
Distance: internal 90 external 170
```

```
R1#
```



Troubleshoot EIGRP Routing Table Issues

Missing Network Statement (cont.)

Add Missing Network Statement

```
R1(config)# router eigrp 1  
R1(config-router)# network 10.0.0.0
```



Troubleshooting EIGRP Routing Table Issues

Autosummarization

- Another issue that may create problems for the network administrator is EIGRP autosummarization.
- EIGRP for IPv4 can be configured to automatically summarize routes at classful boundaries. If there are discontinuous networks, autosummarization causes inconsistent routing.
- Classful networks do not exist in IPv6; therefore, EIGRP for IPv6 does not support autosummarization. All summarization must be accomplished using EIGRP manual summary routes.



Chapter 8: Summary

- EIGRP is one of the routing protocols commonly used in large enterprise networks.
- Modifying EIGRP features and troubleshooting problems is one of the most essential skills for a network engineer involved in the implementation and maintenance of large, routed enterprise networks that use EIGRP.
- Summarization decreases the number of entries in routing updates and lowers the number of entries in local routing tables. It also reduces bandwidth utilization for routing updates and results in faster routing table lookups.
- EIGRP for IPv4 autosummarization is disabled, by default, beginning with Cisco IOS Release 15.0(1)M and 12.2(33). Prior to this, autosummarization was enabled, by default.

