Chapter 6: EIGRP

Scaling Networks

Cisco | Networking Academy®
Mind Wide Open™

Chapter 6 - Sections & Objectives

- 6.1 EIGRP Characteristics
- Explain the features and characteristics of EIGRP
- 6.2 Implement EIGRP for IPv4
- Implement EIGRP for IPv4 in a small to medium-sized business network
- 6.3 EIGRP Operation
- Explain how EIGRP operates in a small to medium-sized business network
- 6.4 Implement EIGRP for IPv6
- Implement EIGRP for IPv6 in a small to medium-sized business network

6.1 EIGRP Characteristics

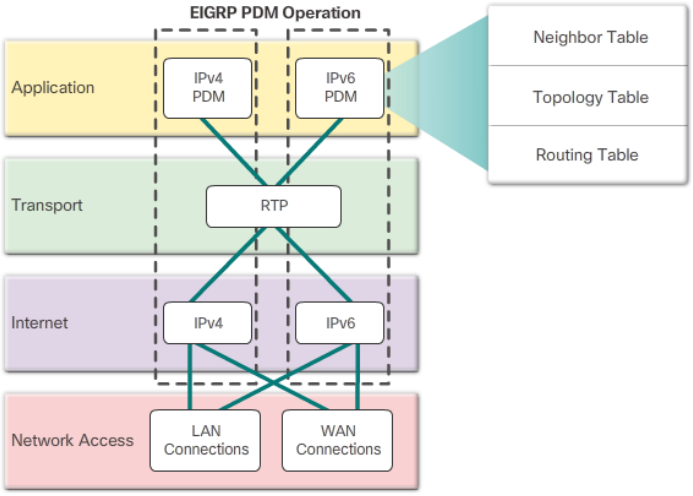
Cisco | Networking Academy®
Mind Wide Open™

EIGRP Characteristics
EIGRP Basic Features

- Features of EIGRP
  - Uses the Diffusing Update Algorithm (DUAL) to calculate paths and back-up paths.
  - Establishes Neighbor Adjacencies.
  - Uses the Reliable Transport Protocol (RTP) to provide delivery of EIGRP packets to neighbors.
  - Partial and Bounded Updates. Sends updates only when there is a change and only to the routers that need the information.
  - Supports Equal and Unequal Cost Load Balancing.
  - Protocol Dependent Modules (PDMs) – responsible for network layer protocol-specific tasks
  - Sends and receives EIGRP packets that are encapsulated in IPv4
  - Parses EIGRP packets and informs DUAL of the new information and DUAL makes routing decisions. The results are stored in the IPv4 routing table.

EIGRP Characteristics
EIGRP Basic Features (Cont.)

- Reliable Transport Protocol (RTP)
  - Used for the delivery and reception of EIGRP packets
  - Can send EIGRP packets as unicast or multicast.
  - Reserved IPv4 multicast address 224.0.0.10.
  - Reserved IPv6 multicast address FF02::A.
- Authentication
  - Only accepts routing information from other routers with the same authentication information
  - Does not encrypt the routing updates



EIGRP Characteristics
EIGRP Packet Types

- EIGRP Hello Packets
  - Are sent as multicasts (224.0.0.10) and uses RTP for unreliable delivery
  - Used to form and maintain EIGRP neighbor adjacencies

Bandwidth	Example Link	Default Hello Interval	Default Hold Time
1.544 Mb/s	Multipoint Frame Relay	60 seconds	180 seconds
Greater than 1.544 Mb/s	T1, Ethernet	5 seconds	15 seconds

- EIGRP Update and Acknowledgment Packets
- Update packets propagate updated routing information when necessary to the routers that require the information using RTP
- Acknowledgment packets are send to acknowledge the update was received.
- EIGRP Query and Reply Packets
  - Searches for networks
  - Uses reliable delivery
  - Queries are multicast or unicast. Replies are always unicast.

6.2 Implement EIGRP for IPv4

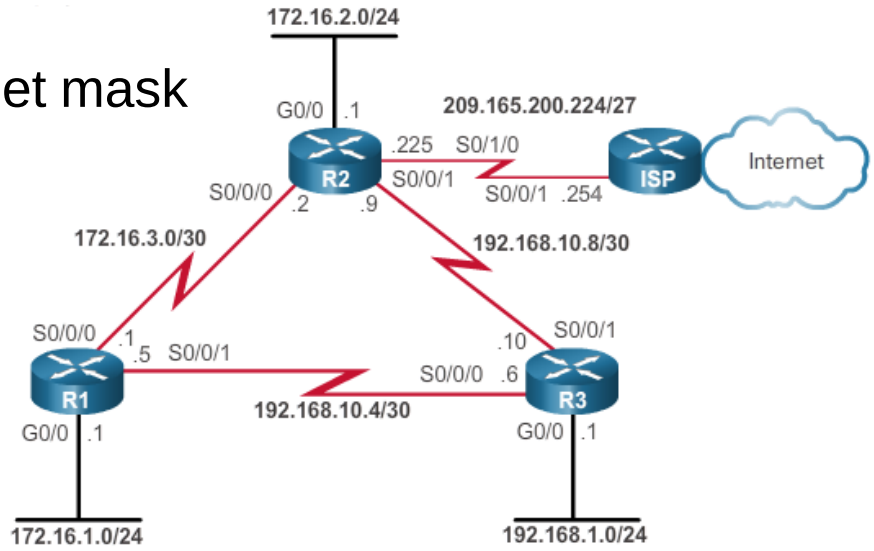
Cisco | Networking Academy®
Mind Wide Open™

Implement EIGRP for IPv4
Configure EIGRP with IPv4

- Autonomous System Numbers
  - IANA globally assigned autonomous numbers
  - Used by ISP and other large institutions
  - Used in exterior routing protocol, such as BGP, to propagate routing information
  - *router eigrp autonomous-system* command
  - Autonomous system number is only significant to local EIGRP local domain
  - Autonomous system number functions as a process ID
  - All routers within the same domain must have the same autonomous system number
- The command used to begin the EIGRP routing protocol
- EIGRP Router ID – uniquely identifies each router in the EIGRP routing domain
  - Determined in 3 ways using the following order:
    - The router router-id ipv4-address command
    - The highest active IPv4 address of any of the loopback address
    - The highest active IPv4 address of any of the physical interface

Implement EIGRP for IPv4
Configure EIGRP with IPv4 (Cont.)

- The *network ipv4-network-address* router configuration mode command
  - Enables any interface on the router that matches the network address in the network command to send and receive EIGRP updates
  - By default, ipv4-network-address is the classful network address for each directly connected network
- The network command and Wildcard Mask
  - network network-address [wildcard-mask]
- Wildcard mask is the inverse of a subnet mask
  - To calculate the wildcard mask:
  - 255.255.255.255
  - - 255.255.255.252 Subnet mask
  - ----------
  - 0. 0. 0. 3 Wildcard mask
- Passive Interface - prevent the neighbor adjacencies
  - Suppress unnecessary update traffic
  - Increase security controls
  - passive-interface interface-type interface-number



Implement EIGRP for IPv4
Verify EIGRP with IPv4

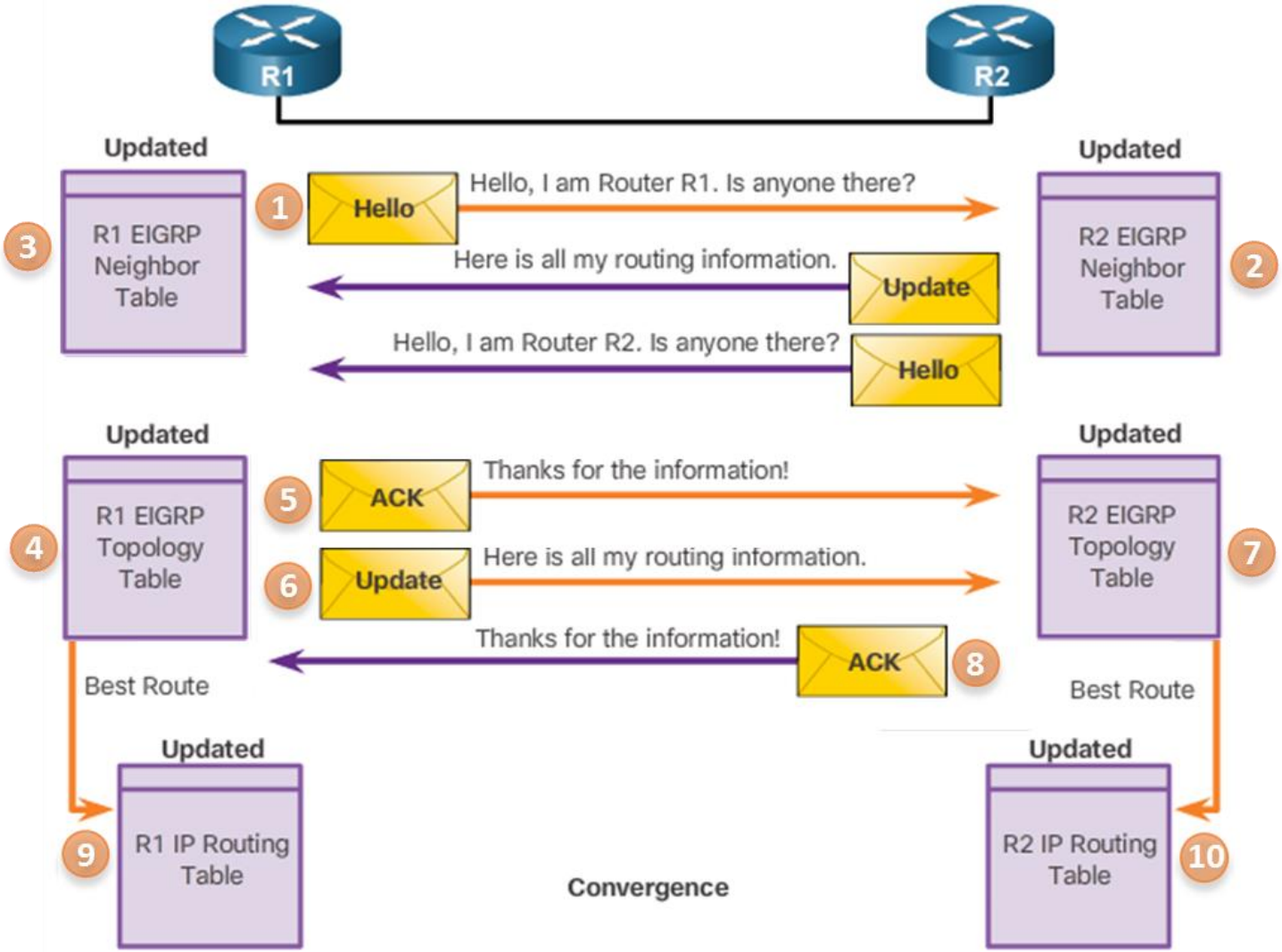
- The show commands are useful in verifying EIGRP operations and for debugging and troubleshooting purposes.
- *show ip eigrp neighbors* command
  - View the neighbor table
  - Verify neighbor adjacencies have been established
- show ip protocols Command
  - Identify the parameters and other information about the current state of any active IPv4 routing protocol processes configured on the router
- show ip route
  - Verify the routes are installed in the IPv4 routing table as expected
  - Check for convergence

6.3 EIGRP Operation

Cisco | Networking Academy®
Mind Wide Open™

EIGRP Operation
EIGRP Initial Route Discovery

- Can you describe the initial route discovery process?



EIGRP Operation
EIGRP Metrics

- Composite Metric
  - EIGRP uses bandwidth and delay values in the composite metric to calculate the preferred path to a network.

```
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
    NSF-aware route hold timer is 240
    Router-ID: 1.1.1.1
```

- The k values and EIGRP AS number must match to form an adjacency.
- The show ip protocols command can be used to verify k values.
- Bandwidth Metric (BW)
  - The bandwidth kilobits-bandwidth-value command is used to modify the bandwidth metric.
  - Use the show interfaces command to verify the bandwidth changes
  - Delay Metric (DLY)

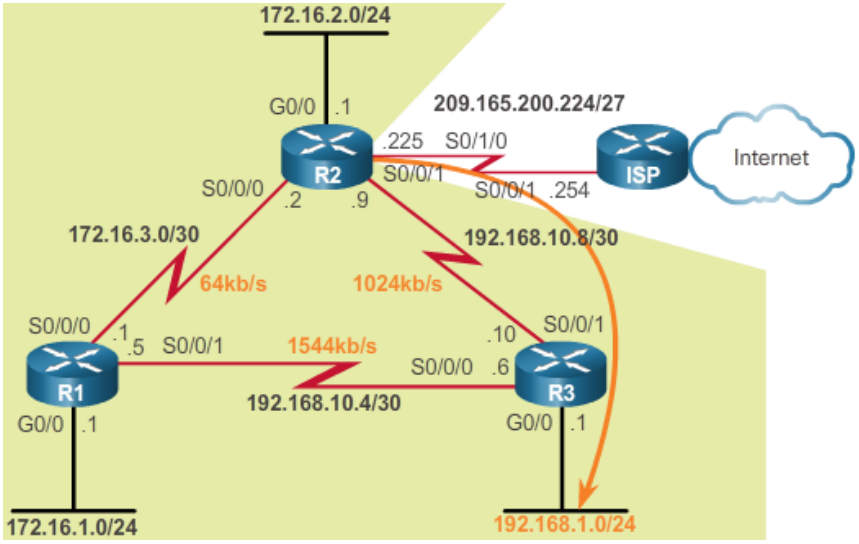
```
R1# show interfaces serial 0/0/0
Serial0/0/0 is up, line protocol is up
  Hardware is WIC MBRD Serial
  Internet address is 172.16.3.1/30
  MTU 1500 bytes, BW 1544 Kbit/sec, DLY 20000 usec,
     reliability 255/255, txload 1/255, rxload 1/255
  Encapsulation HDLC, loopback not set
```

  - Delay is the measure of the time it takes for a packet to traverse a route.
  - Use the show interfaces command to view the delay values.

EIGRP Operation
EIGRP Metrics (Cont.)

Be familiar with K values

- Complete Composite Metric Formula
- $(K1 * bandwidth + K2 * bandwidth\ 256 - load + K3 * delay) * K5\ reliability + K4 * 256$
- Using the default metric weight, the formula becomes
- Metric = $(K1 * bandwidth + K3 * delay) * 256$
- where K1 and K3 equal to 1, K2, K4, and K5 equal to 0 when not in use, and If K5 = 0, $K5\ reliability + K4$ becomes 1.
- Calculate the EIGRP metric between R2 and R3
- Metric = 256 ∗(10 7 $bandwidth$ + sum of delay 10)
- What is bandwidth of the slowest link?
- What is the sum of all delays?
- What command is used to verify the metric?



Media	Delay
Ethernet	1,000
Fast Ethernet	100
Gig Ethernet	10
Serial WAN	20,000

EIGRP Operation
DUAL and the Topology Table

- Diffusing Update Algorithm (DUAL) provides
  - Loop-free paths
  - Loop-free backup paths that can be used immediately
  - Fast convergence
- Successor and Feasible Distance
  - A successor is a neighboring router that is used for packet forwarding and is the least-cost route to the destination network.
  - Feasible Distance is the metric listed in the routing table entry

```
R2# show ip route
<output omitted>
D 192.168.1.0/24 [90/3012096] via 192.168.10.10, 00:12:32,
Serial0/0/1
```

Feasible Distance

Successor

- Feasible Successors, Feasibility Condition, and Reported Distance
  - The reported distance is an EIGRP neighbor's feasible distance to the destination network.
  - A feasible successor is a neighbor that has a loop-free backup path to the same network as the successor, and it satisfies the Feasibility Condition

EIGRP Operation
DUAL and the Topology Table (Cont.)

- The *show ip eigrp topology* command
  - Displays the Topology Table
- Topology Table
  - Lists all successors and FSs to destination networks
  - Only successors are installed in the routing tables

```
R1# show ip eigrp topology all-links

P 192.168.1.0/24, 1 successors, FD is 2170112, serno 9
        via 192.168.10.6 (2170112 /2816), Serial0/0/1
        via 172.16.3.2 (41024256/3012096), Serial0/0/0
```

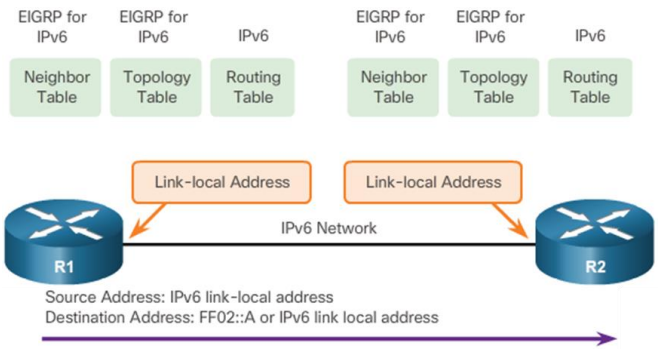
6.4 Implement EIGRP for IPv6

Cisco | Networking Academy®
Mind Wide Open™

Implement EIGRP for IPv6
EIGRP for IPv6

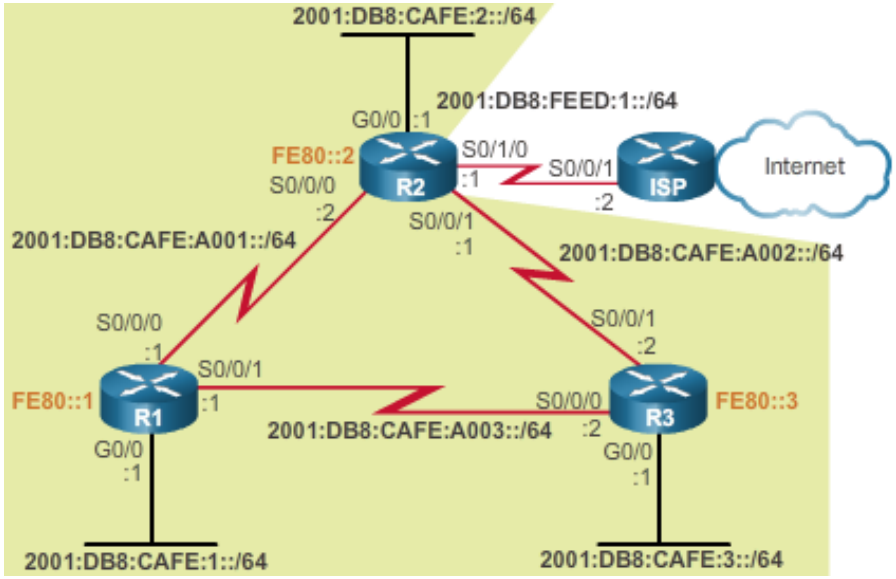
- EIGRP for IPv6
- Similar functionality as EIGRP for IPv4
- Uses IPv6 for communication with EIGRP for IPv6 peers and advertising IPv6 routes
- Uses DUAL
- EIGRP for IPv6 is a separate process from EIGRP for IPv4
- IPv6 Link-local Address
- Packets with a source or destination link-local address cannot be routed beyond the link from where the packet originated.
- IPv6 link-local addresses are in the FE80::/ range.

	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



Implement EIGRP for IPv6
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.



Implement EIGRP for IPv6
Configure EIGRP for IPv6 (Cont.)

- Configuring the EIGRP for IPv6 Routing Process
  - 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.
  - The *ipv6 eigrp interface* Command
  - 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
```

Implement EIGRP for IPv6
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#
```

6.5 Chapter Summary

Cisco | Networking Academy®
Mind Wide Open™