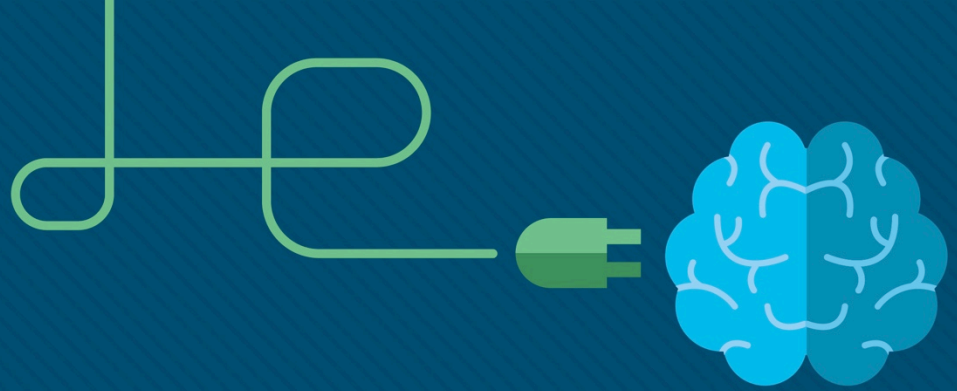

EIGRP

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CCNA Routing and Switching

Scaling Networks v6.0

EIGRP Basic Features

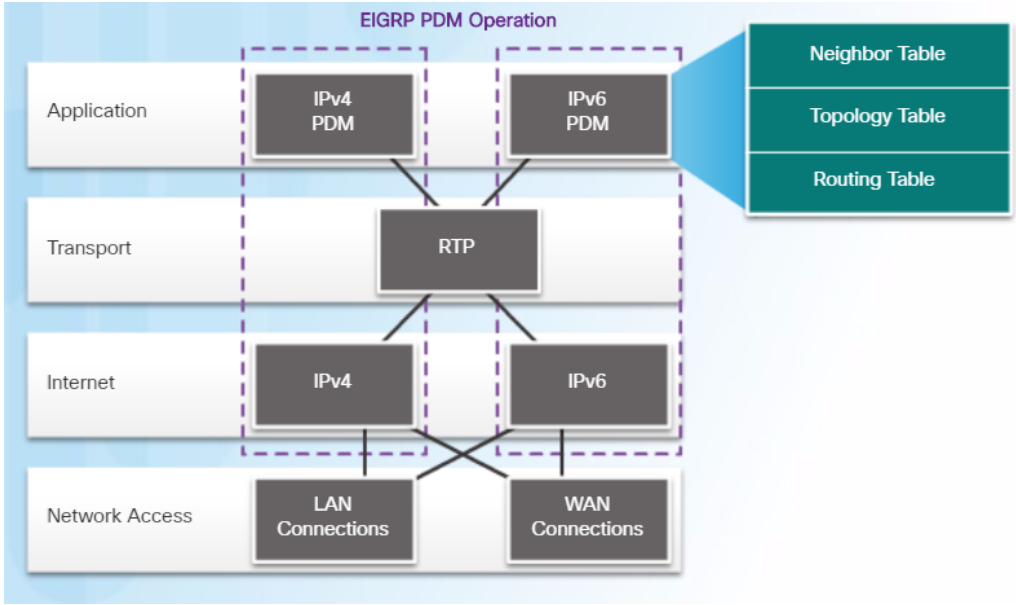
- Enhanced IGRP is a Cisco-proprietary distance-vector routing protocol released in 1992.
  - EIGRP was created as a classless version of IGRP.
  - Ideal choice for large, multiprotocol networks built primarily on Cisco routers.

EIGRP Feature	Description
Diffusing Update Algorithm (DUAL)	• EIGRP uses DUAL as its routing algorithm. • DUAL guarantees loop-free and backup paths throughout the routing domain.
Establishing Neighbor Adjacencies	• EIGRP establishes relationships with directly connected EIGRP routers. • Adjacencies are used to track the status of these neighbors.
Reliable Transport Protocol	• EIGRP RTP provides delivery of EIGRP packets to neighbors. • RTP and neighbor adjacencies are used by DUAL.
Partial and Bounded updates	• Instead of periodic updates, EIGRP sends partial triggered updates when a path or metric changes. • Only those routers that require the information are updated minimizing bandwidth use.
Equal and Unequal Cost Load Balancing	• EIGRP supports equal cost load balancing and unequal cost load balancing, which allows administrators to better distribute traffic flow in their networks.

EIGRP Basic Features

- RTP is the EIGRP Transport layer protocol used for the delivery and reception of EIGRP packets.

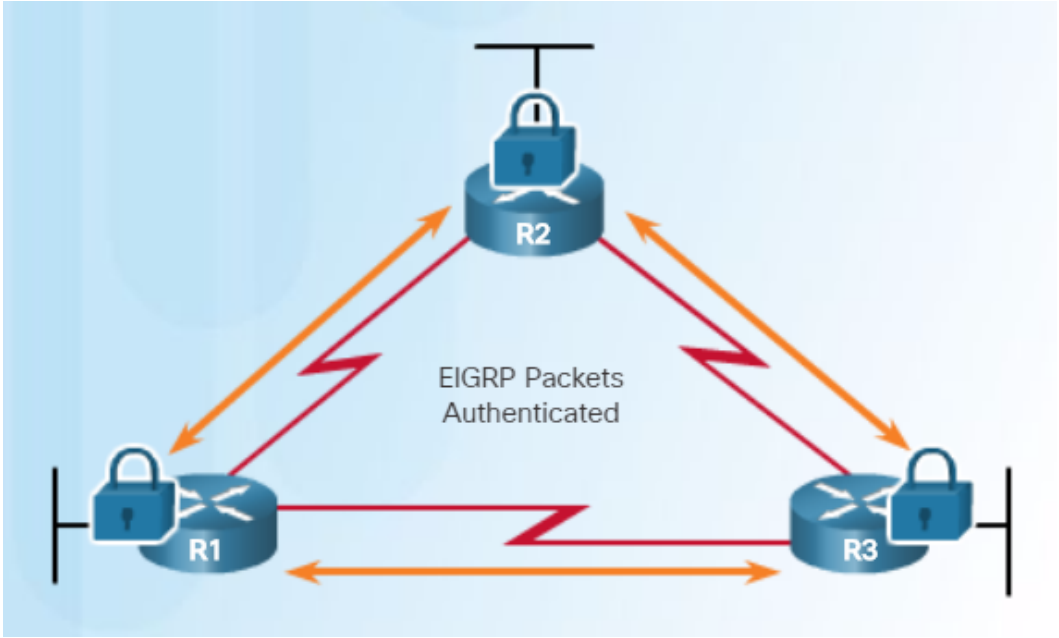
- Not all RTP packets are sent reliably.
  - Reliable packets require explicit acknowledgement from destination
  - Update, Query, Reply
  - Unreliable packets do not require acknowledgement from destination
  - Hello, ACK



EIGRP Basic Features

- EIGRP supports authentication and is recommended.
  - EIGRP authentication ensures that routers only accept routing information from other routers that have been configured with the same password or authentication information.

- **Note**:
  - Authentication does not encrypt the EIGRP routing updates.



EIGRP Packet Types

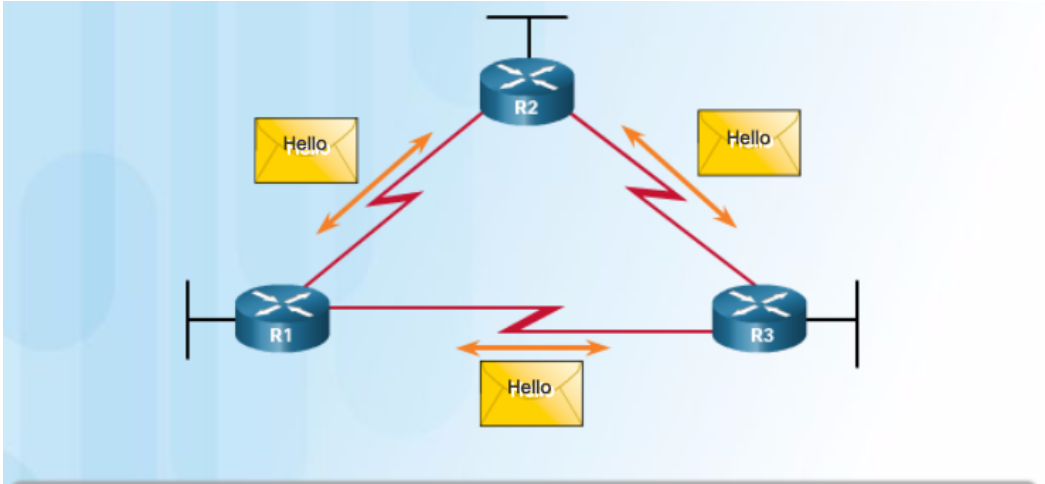
- IP EIGRP relies on 5 types of packets to maintain its various tables and establish complex relationships with neighbor routers.

Packet Type	Description
Hello	• Used to discover other EIGRP routers in the network. • Sent unreliably to multicast address 224.0.0.5 (or 224.0.0.6).
Acknowledgement	• Used to acknowledge the receipt of any EIGRP packet. • Sent unreliably as unicasts.
Update	• Convey routing information to known destinations. • Sent reliably as unicasts or multicasts.
Query	• Used to get specific information from a neighbor router. • Sent reliably as unicasts or multicasts.
Reply	• Used to respond to a query. • Sent reliably as unicasts.

EIGRP Packet Types

- Hello packets are used to discover & form adjacencies with neighbors.
  - On hearing Hellos, a router creates a neighbor table and the continued receipt of Hellos maintains the table.

- Hello packets are always sent unreliably.
  - Therefore Hello packets do not require acknowledgment.

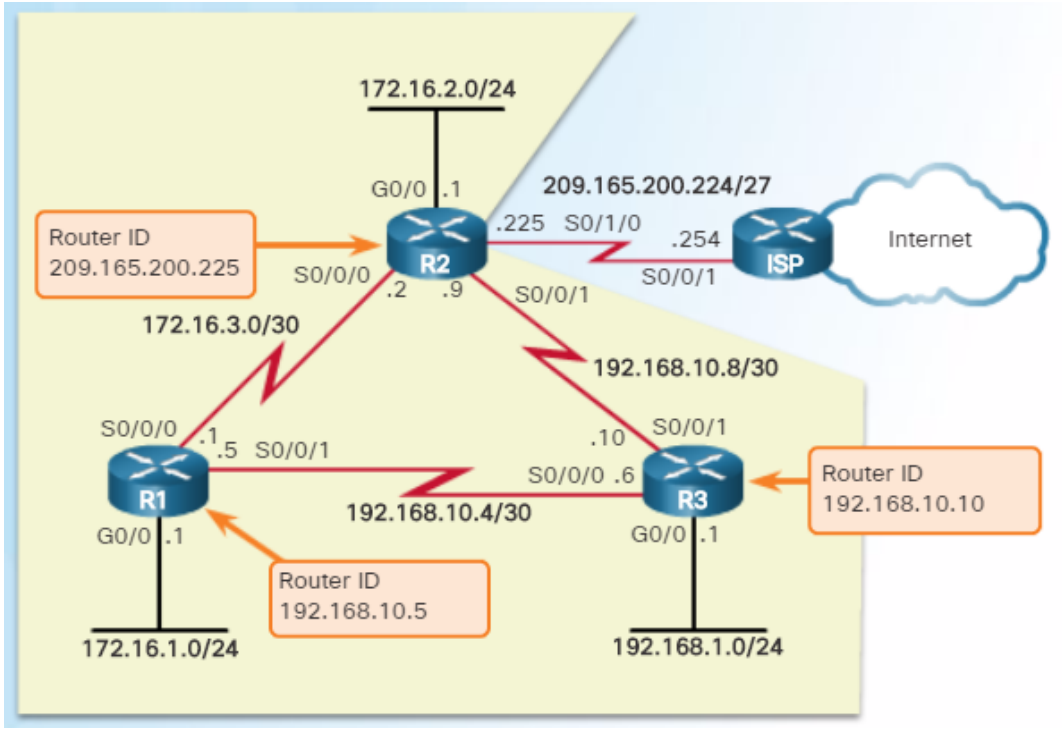


Bandwidth	Example Link	Default Hello Interval	Default Hold Time
1.544 Mb/s	Multipoint Frame Relay	60 seconds	180 seconds
Greater than 1.544 Mb/s	T1, Ethernet	5 seconds	15 seconds

EIGRP uses multicast and unicast rather than broadcast.
- As a result, end stations are unaffected by routing updates or queries.
- The EIGRP multicast IPv4 address is **224.0.0.10**
- The EIGRP multicast IPv6 address is **FF02::A**.

Configure EIGRP with IPv4

- The EIGRP router ID is used to uniquely identify each router in the EIGRP routing domain.
- Routers use the following three criteria to determine its router ID:
  1. Use the address configured with the **eigrp router-id** *ipv4-address* router config command.
  2. If the router ID is not configured, choose the highest IPv4 address of any of its loopback interfaces.
  3. If no loopback interfaces are configured, choose the highest active IPv4 address of any of its physical interfaces.



Configure EIGRP with IPv4

- Passive interfaces prevent EIGRP updates out a specified router interface.

```
Router(config-router)#
passive-interface type number [default]
```

```
R3(config)# router eigrp 1
R3(config-router)# passive-interface gigabitethernet 0/0
```

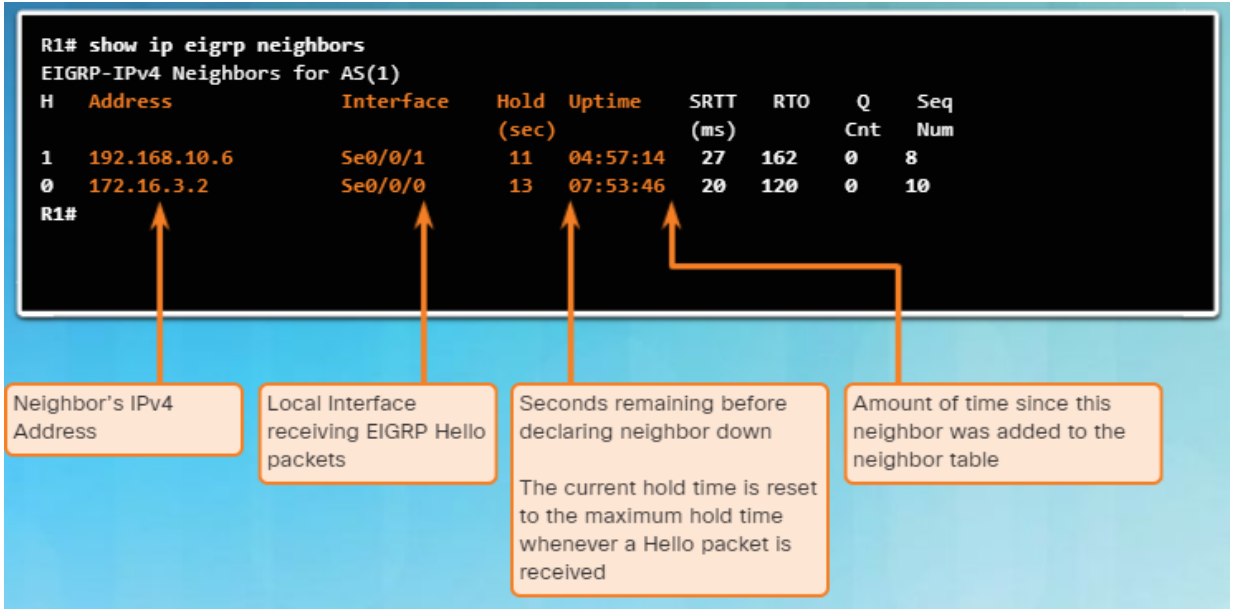
- Set a particular interface or all router interfaces to passive.
  - The **default** option sets all router interfaces to passive.
  - Prevents neighbor relationships from being established.
  - Routing updates from a neighbor are ignored.

```
R3# show ip protocols
*** IP Routing is NSF aware ***

Routing Protocol is "eigrp 1"
<output omitted>
Routing for Networks:
    192.168.1.0
    192.168.10.4/30
    192.168.10.8/30
 Passive Interface(s):
   GigabitEthernet0/0
 Routing Information Sources:
    Gateway         Distance      Last Update
    192.168.10.5           90      01:37:57
    192.168.10.9           90      01:37:57
  Distance: internal 90 external 170
R3#
```

Verify EIGRP with IPv4

- Use the **show ip eigrp neighbors** command to view the neighbor table and verify that EIGRP has established an adjacency with its neighbors.
  - The output displays a list of each adjacent neighbor.

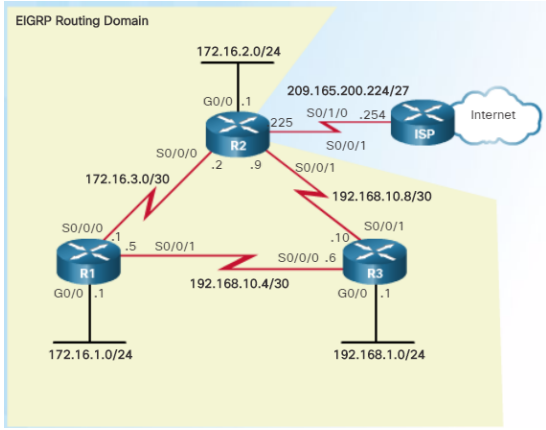


Implement EIGRP for IPv4

Verify EIGRP with IPv4

```
R2# 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
<output omitted>
Gateway of last resort is not set

 172.16.0.0/16 is variably subnetted, 5 subnets, 3 masks
D   172.16.1.0/24 [90/2170112] via 172.16.3.1, 00:11:05, Serial0/0/0
C   172.16.2.0/24 is directly connected, GigabitEthernet0/0
L   172.16.2.1/32 is directly connected, GigabitEthernet0/0
C   172.16.3.0/30 is directly connected, Serial0/0/0
L   172.16.3.2/32 is directly connected, Serial0/0/0
D  192.168.1.0/24 [90/2170112] via 192.168.10.10, 00:15:16,Serial0/0/1
  192.168.10.0/24 is variably subnetted, 3 subnets, 2 masks
D   192.168.10.4/30 [90/2681856] via 192.168.10.10, 00:52:00,Serial0/0/1
                    [90/2681856] via 172.16.3.1, 00:52:00,Serial0/0/0
C   192.168.10.8/30 is directly connected, Serial0/0/1
L   192.168.10.9/32 is directly connected, Serial0/0/1
  209.165.200.0/24 is variably subnetted, 2 subnets, 2 masks
C   209.165.200.224/27 is directly connected, Loopback209
L   209.165.200.225/32 is directly connected, Loopback209
R2#
```




```
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
<output omitted>
Gateway of last resort is not set

     172.16.0.0/16 is variably subnetted, 5 subnets, 3 masks
C      172.16.1.0/24 is directly connected,GigabitEthernet0/0
L      172.16.1.1/32 is directly connected,GigabitEthernet0/0
D      172.16.2.0/24 [90/2170112] via 172.16.3.2,00:14:35, Serial0/0/0
C      172.16.3.0/30 is directly connected, Serial0/0/0
L      172.16.3.1/32 is directly connected, Serial0/0/0
D 192.168.1.0/24 [90/2170112] via 192.168.10.6,00:13:57, Serial0/0/1
   192.168.10.0/24 is variably subnetted, 3 subnets, 2 masks
C      192.168.10.4/30 is directly connected, Serial0/0/1
L      192.168.10.5/32 is directly connected, Serial0/0/1
D      192.168.10.8/30 [90/2681856] via 192.168.10.6,00:50:42, Serial0/0/1
                       [90/2681856] via 172.16.3.2,00:50:42, Serial0/0/0

R1#
```

```
R3# 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
<output omitted>
Gateway of last resort is not set

 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, 00:12:00, Serial0/0/0
D    172.16.2.0/24 [90/2170112] via 192.168.10.9, 00:16:49, Serial0/0/1
D    172.16.3.0/30 [90/2681856] via 192.168.10.9, 00:52:55, Serial0/0/1
                   [90/2681856] via 192.168.10.5, 00:52:55, Serial0/0/0
  192.168.1.0/24 is variably subnetted, 2 subnets, 2 masks
C    192.168.1.0/24 is directly connected, GigabitEthernet0/0
L    192.168.1.1/32 is directly connected, GigabitEthernet0/0
  192.168.10.0/24 is variably subnetted, 4 subnets, 2 masks
C    192.168.10.4/30 is directly connected, Serial0/0/0
L    192.168.10.6/32 is directly connected, Serial0/0/0
C    192.168.10.8/30 is directly connected, Serial0/0/1
L    192.168.10.10/32 is directly connected, Serial0/0/1
R3#
```

EIGRP Metrics

- EIGRP uses a composite metric which can be based on the following metrics:
  - **Bandwidth**: The lowest bandwidth between source and destination.
  - **Delay**: The cumulative interface delay along the path
  - **Reliability**: (Optional) Worst reliability between source and destination.
  - **Load**: (Optional) Worst load on a link between source and destination.

Note.
- It is often incorrectly stated that EIGRP can also use the smallest MTU in the path.

- The EIGRP composite metric formula consists metric weights with values K1 to K5.
  - K1 represents bandwidth, K3 delay, K4 load, and K5 reliability.

Default Values:
K1 (bandwidth) = 1
K2 (load) = 0
K3 (delay) = 1
K4 (reliability) = 0
K5 (reliability) = 0

Default Composite Formula:

metric = [K1*bandwidth + K3*delay] * 256

Complete Composite Formula:

metric = [K1*bandwidth + (K2*bandwidth) / (256 - load) + K3*delay] * [K5 / (reliability + K4)]

(Not used if " K" values are 0)

Note: This is a conditional formula. If K5 = 0, the last term is replaced by 1 and the formula becomes: Metric = [K1*bandwidth + (K2*bandwidth) / (256-load) + K3*delay] * 256

```
Router(config-router)# metric weights tos k1 k2 k3 k4 k5
```

EIGRP Metrics

- Use the **show interfaces** command to examine the values used for bandwidth, delay, reliability, and load.

- **BW** - Bandwidth of the interface (in kb/s).
- **DLY** - Delay of the interface (in microseconds).
- **Reliability** - Reliability of the interface as a fraction of 255 (255/255 is 100% reliability).
- **Txload, Rxload** - Transmit and receive load on the interface as a fraction of 255 (255/255 is completely saturated), calculated as an exponential average over five minutes.

```
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
<output omitted>
R1#

R1# show interfaces gigabitethernet 0/0
GigabitEthernet0/0 is up, line protocol is up
  Hardware is CN Gigabit Ethernet, address is fc99.4775.c3e0
(bia fc99.4775.c3e0)
  Internet address is 172.16.1.1/24
  MTU 1500 bytes, BW 100000 Kbit/sec, DLY 100 usec,
     reliability 255/255, txload 1/255, rxload 1/255
  Encapsulation ARPA, loopback not set
<output omitted>
R1#
```

EIGRP Metrics

- Delay is a measure of the time it takes for a packet to traverse a route.

- The delay (DLY) metric is not measured dynamically.
  - It is a static value measured in microseconds (µs or usec) based on the type of link to which the interface is connected.

- The delay value is calculated using the cumulative (sum) of all interface delays along the path, divided by 10.

Media	Delay In usec
Gigabit Ethernet	10
Fast Ethernet	100
FDDI	100
16M Token Ring	630
Ethernet	1,000
T1 (Serial Default)	20,000
DS0 (64 Kbps)	20,000
1024 Kbps	20,000
56 Kbps	20,000

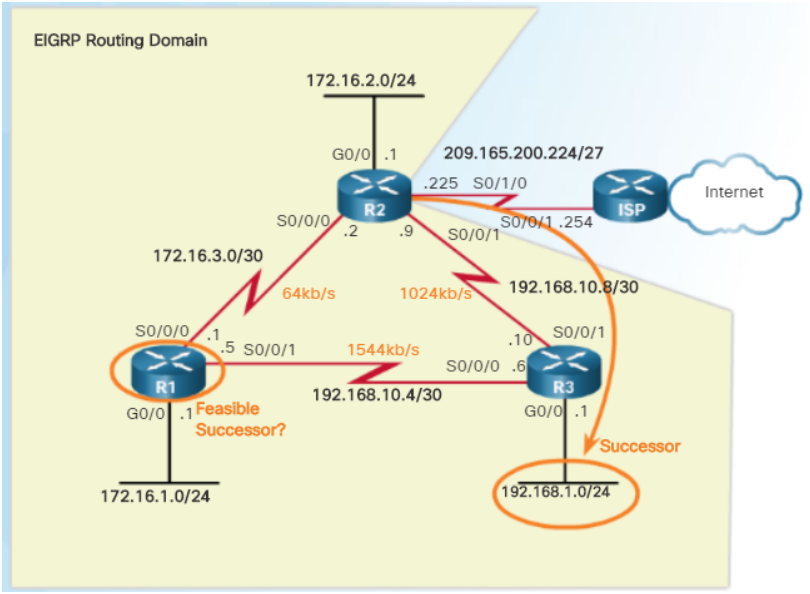
DUAL and the Topology Table

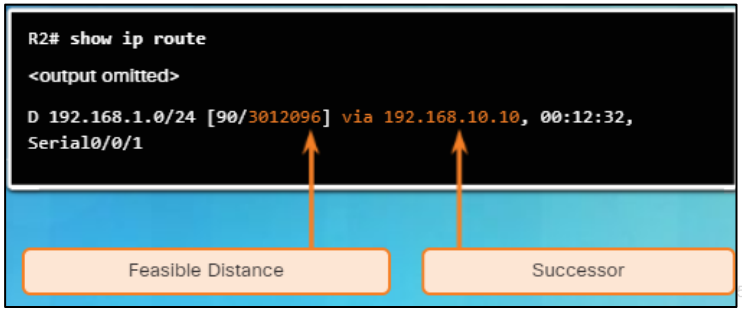
- EIGRP uses the Diffusing Update Algorithm (DUAL) to provide the best and backup loop-free paths.
- DUAL uses several terms, which are discussed in more detail throughout this section:

Term	Description
Successor	• Is a neighboring router that is used for packet forwarding and is the least-cost route to the destination network. • The IP address of a successor is shown in a routing table entry right after the word “via”.
Feasible Successors (FS)	• These are the “Backup paths” that are a loop-free. • Must comply to a feasibility condition.
Reported Distance (RD)	• Also called “advertised distance”, this is the reported metric from the neighbor advertising the route. • If the RD metric is less than the FD, then the next-hop router is downstream and there is no loop.
Feasible Distance (FD)	• This is the actual metric of a route from the current router. • Is the lowest calculated metric to reach the destination network. • FD is the metric listed in the routing table entry as the second number inside the brackets.

DUAL and the Topology Table

- A successor is a neighboring router with the least-cost route to the destination network.
  - The successor IP address is shown right after “via”.
- FD is the lowest calculated metric to reach the destination network.
  - FD is the second number inside the brackets.
  - Also known as the “*metric*” for the route.
- Notice that EIGRP’s best path for the 192.168.1.0/24 network is through router R3, and that the feasible distance is 3,012,096.



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