

CCNA (200-301) Cisco Certified Network Associate

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Lecture 7

جامعة الجميع الذكية

تسعى لتكون الكيان الأول الذي يتبنى مبدأ المجتمع التعليمي
التعاوني ويقدم العلم مقابل العمل لتنمية وبناء المجتمعات.

مزيد من التفاصيل

EIGRP



جامعة الجميع الذكية
EVERYONE'S SMART UNIVERSITY

EIGRP (Enhanced Interior Gateway Routing Protocol)

- ❑ **EIGRP** (Hybrid Routing Protocol): merges the features of distance vector routing and link-state routing protocol.
- ❑ Use partial updates.
- ❑ Classless routing protocol.
- ❑ Multicast address protocol (224.0.0.10)
- ❑ Use three tables like OSPF:
 - **Neighbors table**: contains all direct connected routers satisfy neighbors relation ship condition.
 - **Topology table**: contains all information about routers and their routes.
 - **Routing table**: contains information about the best route calculated from topology table.

EIGRP (Enhanced Interior Gateway Routing Protocol)

- ❑ **EIGRP** use Diffusion Update Algorithm (DUAL): to calculate best route from topology table.
 - **Successor** :calculate best route and store it routing table.
 - **Feasible successor(back up route)** : this route is kept on topology table if successor failed , Feasible successor would put on routing table .
 - ❑ **Hello and Hold Down timers**
 - Routers running EIGRP exchange periodical packets called hello packets to:
 - 1.Create neighbors relationship
 - 2.Maintain neighbors relationship
- Hello interval is the timer between every hello packets and depend on bandwidth of interface

EIGRP (Enhanced Interior Gateway Routing Protocol)

Port B.W

<1.5 Mbps

Hello interval = 60 sec

Hold down timer = 3 * hello timer = 180 sec

❑ EIGRP Metric:

❑ Metric = EIGRP Metric * 256

❑ Metric = $\left[\frac{10^7}{\text{Min B.W(kbps)}} * K_1 + \text{delay} * K_3 \right] * 256$

❑ $K_1 = K_3 = 1$ $K_2 = K_4 = K_5 = 0$

>=1.5 Mbps

Hello interval = 5 sec

Hold down timer = 15 sec

EIGRP (Enhanced Interior Gateway Routing Protocol)

☐ Metric parameters =

- 1.B.W
- 2.Delay
- 3.Load
- 4.Reliability
- 5.MTU(maximum transmission unit)

EIGRP Neighbors Relationship Conditions:

- ☐ Routers must use the same subnet numbers and subnet mask on the common link between them
- ☐ Routers must be on the same AS(autonomous system)
- ☐ Routers must use same k-values on metric calculation

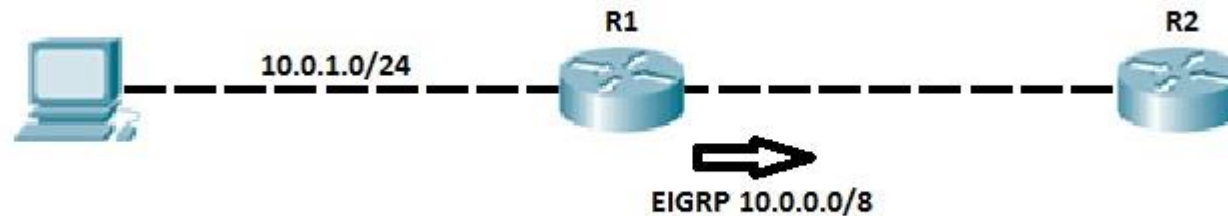
❑ EIGRP Route Summarization

- Route summarization is a method of representing multiple networks with a single summary address. It is often used in large networks with many subnets because it reduces the number of routes that the routers must maintain and minimizes routing updates. Two methods for summarizing routes exist:
 - automatic summarization
 - manual summarization.

EIGRP automatic summarization

- ☐ Depending on your IOS version, the EIGRP auto-summary feature might be enabled or disabled by default (it is more likely to be disabled in modern IOS versions).
- ☐ When auto-summary is enabled, routes are summarized to the classful boundary in the routing updates.
- ☐ To better understand the concept of auto-summarization, consider the following example.

EIGRP (Enhanced Interior Gateway Routing Protocol)



Router R1 and R2 are running EIGRP. Router R1 has the locally connected subnet 10.0.1.0/24 that is advertised to the router R2. Because of the auto summary feature, the router R1 summarizes the network 10.0.1.0/24 before sending the route to R2. With the auto summary feature turned on, R1 sends the classful route 10.0.0.0/8 to R2 instead of the more specific 10.0.1.0/24 route.

EIGRP (Enhanced Interior Gateway Routing Protocol)

On R1, we have configured the following network statement:

```
R1(config)#router eigrp 1
R1(config-router)#network 10.0.1.0
R1(config-router)#
```

But, because of the auto-summary feature, R2 receives the route to the classful network 10.0.0.0/8:

```
R2#show ip route
Codes: C - connected, S - static, I - IGRP, 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

D    10.0.0.0/8 [90/30720] via 192.168.0.1, 00:05:56, FastEthernet0/0
C    192.168.0.0/24 is directly connected, FastEthernet0/0
R2#
```

EIGRP (Enhanced Interior Gateway Routing Protocol)

- ❑ The auto summary feature can cause problems with discontinuous networks. This is why this feature is usually turned off (it is much better to use manual summarization to control exactly where and how summarization affects the network).
- ❑ Use the no auto-summary command to ensure it is turned off (it may already be disabled by default):

```
R1(config)#router eigrp 1
R1(config-router)#network 10.0.1.0
R1(config-router)#no auto-summary
R1(config-router)#
%DUAL-5-NBRCHANGE: IP-EIGRP 1: Neighbor 192.168.0.2 (FastEthernet0/0) is up: new
adjacency
R1(config-router)#
```

EIGRP (Enhanced Interior Gateway Routing Protocol)

Now R2 has the classless route to reach the subnet 10.0.1.0/24:

```
R2#show ip route
Codes: C - connected, S - static, I - IGRP, 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

    10.0.0.0/24 is subnetted, 1 subnets
D       10.0.1.0 [90/30720] via 192.168.0.1, 00:02:47, FastEthernet0/0
C       192.168.0.0/24 is directly connected, FastEthernet0/0
R2#
```

❑ EIGRP manual summarization

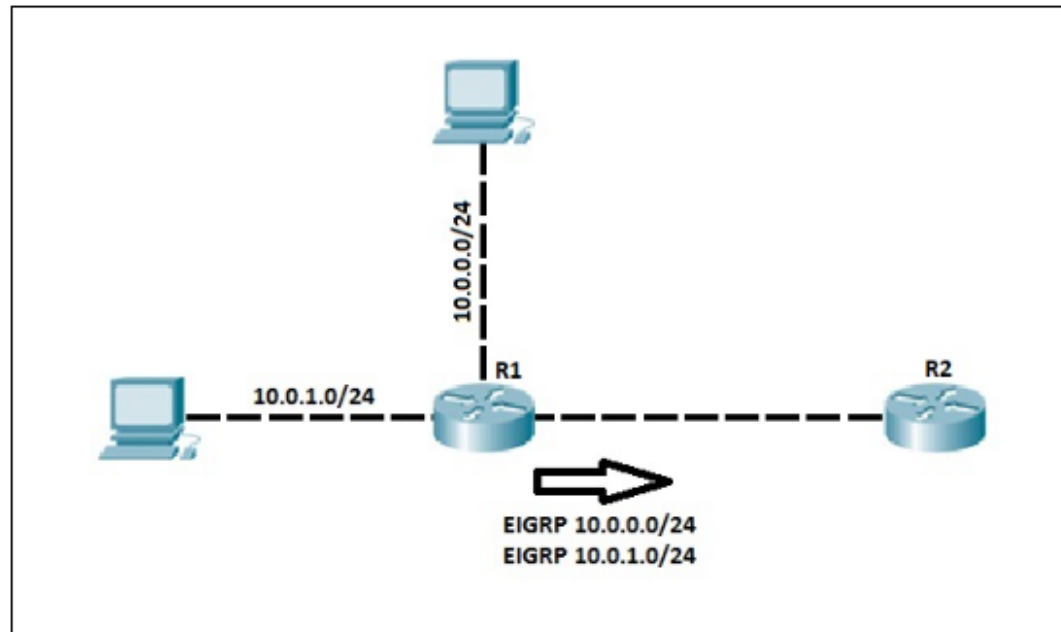
One of the advantages of EIGRP over some other routing protocols (like OSPF) is that manual summarization can be done on any router within a network. A single route can be used to represent multiple routes, which reduces the size of routing tables in a network.

Manual summarization is configured on a per-interface basis. The syntax of the command is:

EIGRP (Enhanced Interior Gateway Routing Protocol)

```
(config-if) ip summary-address eigrp ASN SUMMARY_ADDRESS SUBNET_MASK
```

An example will help you to understand the concept of manual summarization:



EIGRP (Enhanced Interior Gateway Routing Protocol)

- Router R1 and R2 are running EIGRP. Router R1 (on the left) has two directly connected subnets: 10.0.0.0/24 and 10.0.1.0/24. EIGRP advertises these subnets as two separate routes.
- R2 now has two routes for two subnets, which can be confirmed by using the *show ip route* command on R2:

```
R2#show ip route
Codes: C - connected, S - static, I - IGRP, 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

    10.0.0.0/24 is subnetted, 2 subnets
D       10.0.0.0 [90/284160] via 192.168.0.1, 00:00:15, FastEthernet0/0
D       10.0.1.0 [90/30720] via 192.168.0.1, 00:00:28, FastEthernet0/0
C       192.168.0.0/24 is directly connected, FastEthernet0/0
R2#
```

We could configure R1 to advertise only one summary route for both subnets, which helps reduce R2's routing table. To do this, the following command can be used:

```
R1(config)#int fa0/0
R1(config-if)#ip summary-address eigrp 1 10.0.0.0 255.255.0.0
R1(config-if)#
%DUAL-5-NBRCHANGE: IP-EIGRP 1: Neighbor 192.168.0.2 (FastEthernet0/0) is up: new adjacency
```

Now, R1 is sending only one route to reach both subnets to R2. We can verify that by using the show ip route command on R2:

EIGRP (Enhanced Interior Gateway Routing Protocol)

```
R2#show ip route
Codes: C - connected, S - static, I - IGRP, 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

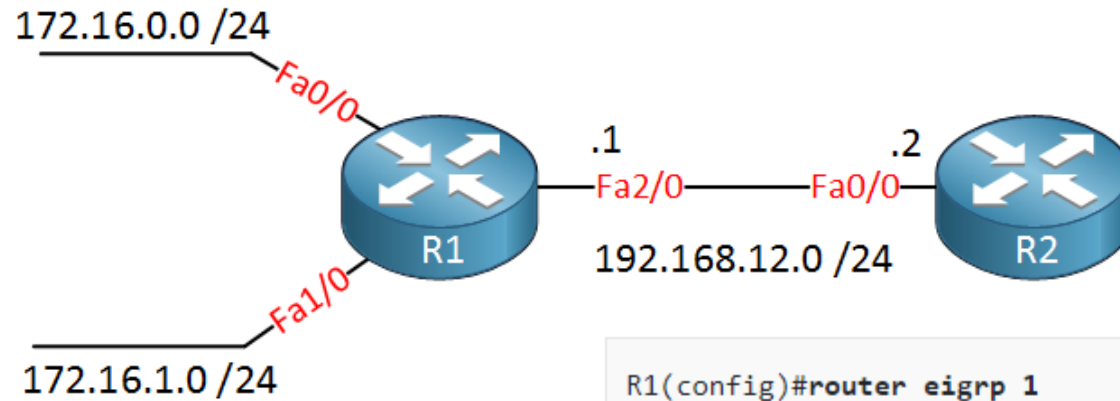
Gateway of last resort is not set

  10.0.0.0/16 is subnetted, 1 subnets
D       10.0.0.0 [90/30720] via 192.168.0.1, 00:00:06, FastEthernet0/0
C       192.168.0.0/24 is directly connected, FastEthernet0/0
```

Now R2 has only one route to reach both subnets on R1.

Chapter 03

EIGRP (Enhanced Interior Gateway Routing Protocol)



```
R1(config)#router eigrp 1
R1(config-router)#no auto-summary
R1(config-router)#network 192.168.12.0
R1(config-router)#network 172.16.0.0
```

```
R2(config)#router eigrp 1
R2(config-router)#no auto-summary
R2(config-router)#network 192.168.12.0
```

EIGRP (Enhanced Interior Gateway Routing Protocol)

```
R2#show ip route eigrp
      172.16.0.0/24 is subnetted, 2 subnets
D       172.16.0.0 [90/30720] via 192.168.12.1, 00:02:28, FastEthernet0/0
D       172.16.1.0 [90/30720] via 192.168.12.1, 00:02:28, FastEthernet0/0
```

Two entries as expected. Now let's create that summary:

```
R1(config)#interface fastEthernet 2/0
R1(config-if)#ip summary-address eigrp 1 172.16.0.0 255.255.254.0
```

□ EIGRP DUAL The Diffusion Update Algorithm

➤ Successor calculation:

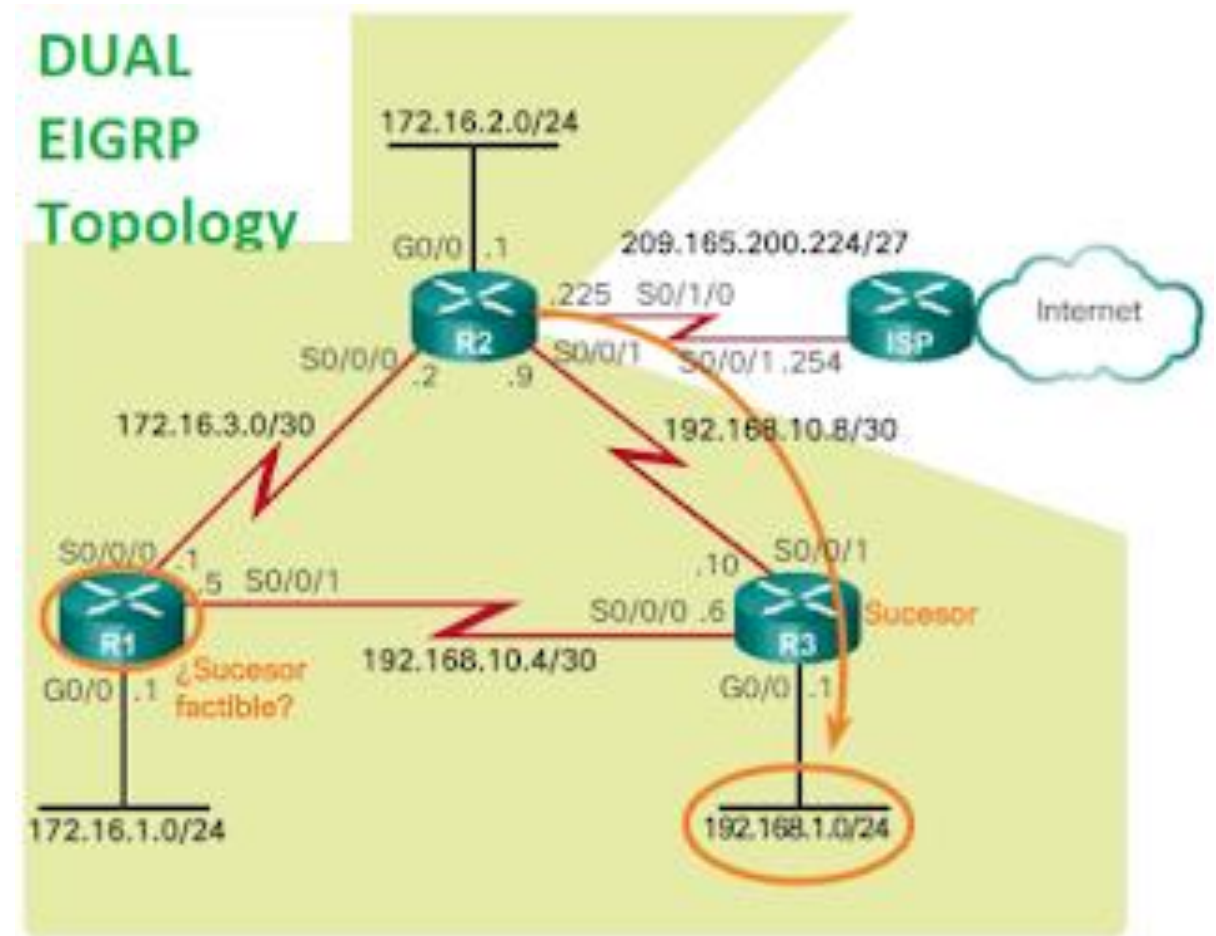
1.AD(advertised distance):

- the cost send from R1 TO R2
- R2 tells to R1 the cost to reach 192.168.1.4

2.FD(feasible distance):summation of

$$FD(R1) = AD(R1) + \text{Cost}(R2-R1)$$

$$FD(R3) = AD(R3) + \text{Cost}(R2-R3)$$



EIGRP (Enhanced Interior Gateway Routing Protocol)

❑ EIGRP DUAL will select route with the least FD as A successor.

❑ Feasible successor := $FD_S > AD_{FS}$

❖ Fs= Feasible successor & s= successor

❑ from topology : **A successor** is a neighboring router that is used for packet forwarding and is the least expensive route to the destination network. The successor's IP address is shown in a routing table entry just after the word via.

❑ **FD is the lowest metric calculated** to reach the destination network. FD is the metric listed in the routing table entry as the second number within the square brackets. As in other routing protocols, this is also known as the “route metric” .

EIGRP (Enhanced Interior Gateway Routing Protocol)

```
R2# show ip route  
<resultado omitido>  
D 192.168.1.0/24 [90/3812896] via 192.168.10.10, 80:12:32,  
Serial8/0/1
```

feasible distance

Successor

Analyze the routing table for R2 in above Image and note that the best EIGRP route for the **192.168.1.0/24** network is through router R3 and that the feasible distance is **3 012 096**.

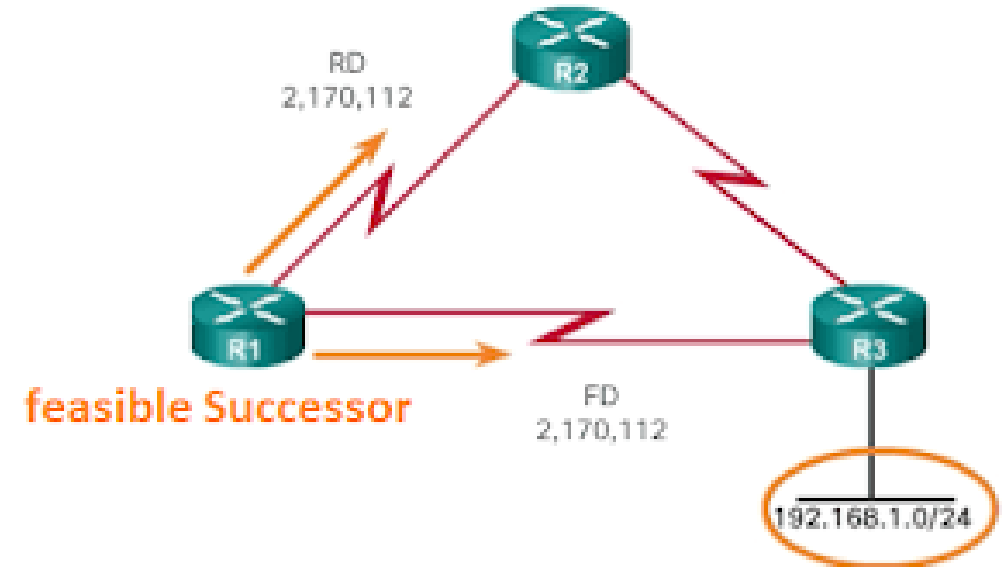
FEASIBLE SUCCESSORS, FEASIBILITY CONDITION AND DISTANCE REPORTED

- ❑ DUAL can converge quickly after a change in the topology, because it can use backup routes to other networks without recalculating DUAL. These backup routes are known as " **feasible successors** " (FS).
- ❑ **An FS is a neighbor** that has a backup route without loops to the same network as the successor and satisfies the feasibility condition (FC). The **successor of R2 for the 192.168.1.0/24 network is R3**, which provides the best route or the lowest metric to the destination network.
- ❑ Note in Figure 1 that R1 provides an alternative route, but is it an FS? Before R1 can be an FS for R2, it must meet the FC (feasible conditions).

- ❑ The FC is met when the notified distance (AD) from a neighbor to a network is less than the feasible distance from the local router to the same destination network.
- ❑ If the reported distance is shorter. The reported distance is simply a feasible distance from the EIGRP neighbor to the same destination network.
- ❑ The reported distance is the metric that a router informs a neighbor about its own cost to that network.

EXAMPLES: Feasible Successor

- ❖ In following figure, the feasible distance from R1 to 192.168.1.0/24 is 2 170 112.
- ❖ R1 informs R2 that its FD at 192.168.1.0/24 is 2 170 112.
- ❖ From the perspective of R2, 2 170 112 is the AD of R1.



```
R1# show ip route
<resultado omitido>

D    192.168.1.0/24 [90/2170112] via 192.168.10.6, 02:44:50,
Serial0/0/1
```

- ❑ R2 uses this information to determine if R1 meets the FC and therefore can be an FS.
- ❑ As shown in following image, because the AD of R1 (2 170 112) is lower than the FD of R2 (3 012 096), R1 meets the FC.

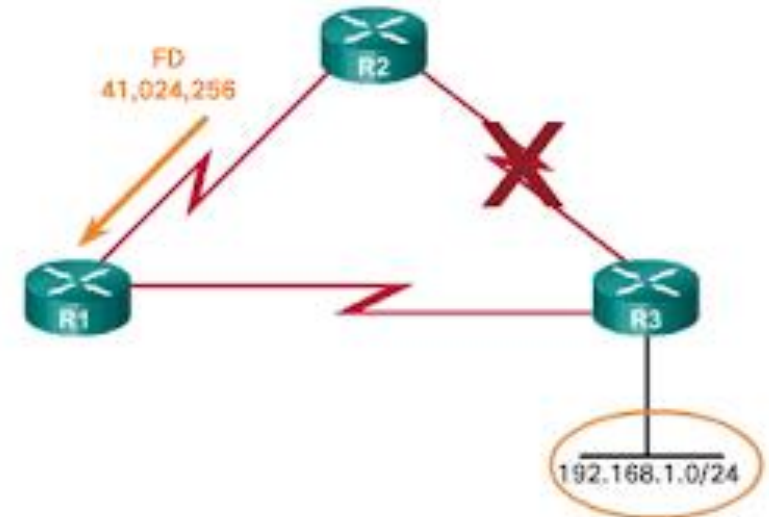
```
R2# show ip route
<resultado omitido>
D    192.168.1.0/24 [90/3012096] via 192.168.10.10,
00:12:32, Serial0/0/1
```

feasible
Distance Successor (R3)

```
R1# show ip route
<resultado omitido>
D    192.168.1.0/24 [90/2170112] via 192.168.10.6, 82:44:50,
Serial0/0/1
```

feasible Distance

- ❑ R1 is now an FS for R2 to the 192.168.1.0/24 network.
- ❑ If there is an error in the route from R2 to 192.168.1.0/24 through R3 (successor), R2 immediately installs the route through R1 (FS) in its routing table.
- ❑ R1 becomes the new successor for the route of R2 to this network, as shown in Image below.



```
R2# show ip route
<resultado omitido>
D    192.168.1.0/24 [90/41024256] via 172.16.3.1, 00:00:13,
Serial0/0/0
```

feasible Distance Successor

EIGRP (Enhanced Interior Gateway Routing Protocol)

```
R2# show ip eigrp topology  
<resultado omitido>  
  
P 192.168.1.0/24, 1 successors, FD is 3012096  
  via 192.168.10.10 (3012096/2816), Serial0/0/1  
  via 172.16.3.1 (41024256/2170112), Serial0/0/0
```

- ❑ As shown in Image, the first sub-entry in the result shows the successor:
via 192.168.10.10 : address of the next hop of the successor, R3. This address is shown in the routing table.
- **3012096 : FD at 192.168.1.0/24**. It is the metric shown in the IP routing table.
- **2816 : RD of the successor**; It is the cost of R3 to reach this network.
- **Serial 0/0/1** : output interface used to reach this network, which is also shown in the routing table.

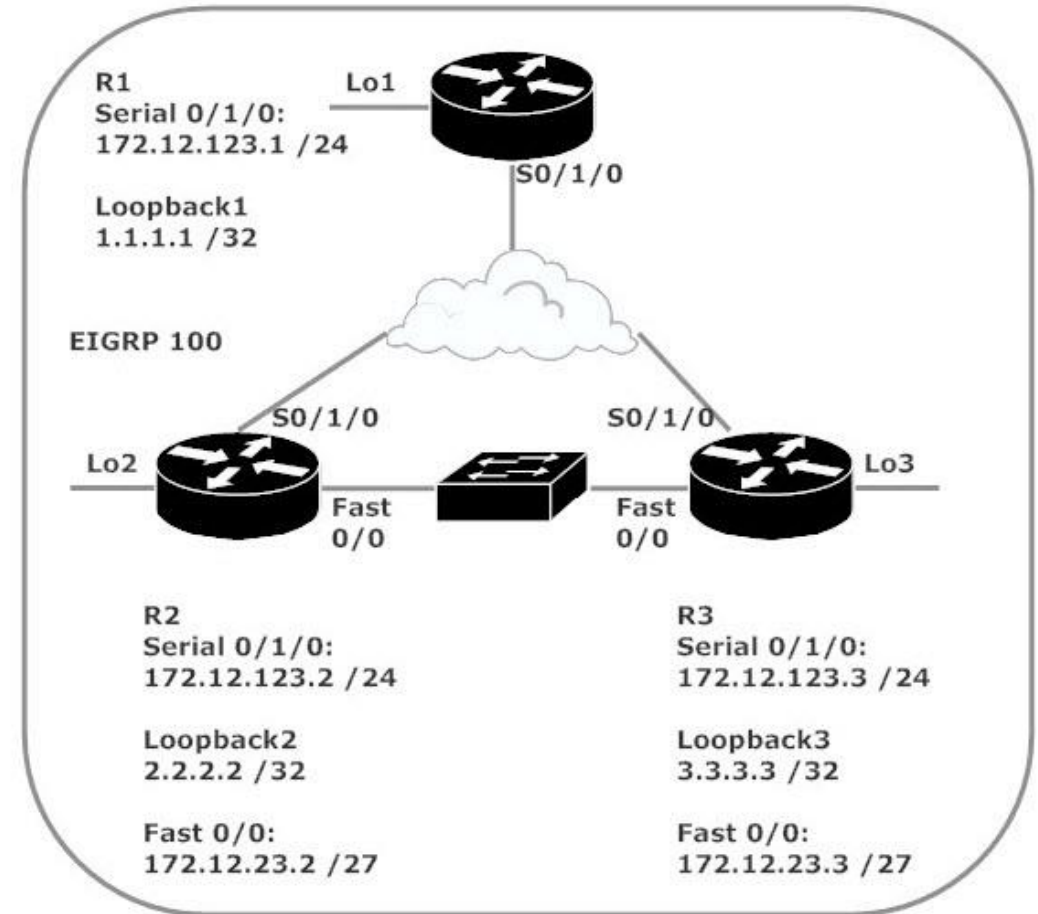
EIGRP Load balance

1.Equal cost load balance

2.UN equal cost load balance

□ Equal cost load balance

➤ If the Dual find more than one route have the same cost , it will use by default 4 routes for load balancing



EIGRP (Enhanced Interior Gateway Routing Protocol)

```
R1#show ip route eigrp
  2.0.0.0/24 is subnetted, 1 subnets
D       2.2.2.0 [90/2297856] via 172.12.123.2, 00:06:03, Serial0/1/0
  3.0.0.0/24 is subnetted, 1 subnets
D       3.3.3.0 [90/2297856] via 172.12.123.3, 00:06:03, Serial0/1/0
 172.12.0.0/16 is variably subnetted, 3 subnets, 3 masks
D       172.12.23.0/27 [90/2172416] via 172.12.123.3, 00:06:03, Serial0/1/0
                        [90/2172416] via 172.12.123.2, 00:06:03, Serial0/1/0
```

- ❑ There are two paths to 172.12.23.0 /27 thanks to equal-cost load balancing, a default behavior of EIGRP.
- ❑ Since the metric for these two paths to 172.12.23.0 /27 is exactly the same (2172416), both paths are put into the EIGRP route table and the load to that network is balanced over the two paths.

EIGRP (Enhanced Interior Gateway Routing Protocol)

```
R1#show ip eigrp topology
EIGRP-IPv4 Topology Table for AS(100)/ID(172.12.123.1)
Codes: P - Passive, A - Active, U - Update, Q - Query, R - Reply,
       r - reply Status, s - sia Status

P 172.12.123.0/24, 1 successors, FD is 2169856
   via Connected, Serial0/1/0
P 172.12.23.0/27, 2 successors, FD is 2172416
   via 172.12.123.2 (2172416/28160), Serial0/1/0
   via 172.12.123.3 (2172416/28160), Serial0/1/0
P 2.2.2.0/24, 1 successors, FD is 2297856
   via 172.12.123.2 (2297856/128256), Serial0/1/0
   via 172.12.123.3 (2300416/156160), Serial0/1/0
P 3.3.3.0/24, 1 successors, FD is 2297856
   via 172.12.123.3 (2297856/128256), Serial0/1/0
   via 172.12.123.2 (2300416/156160), Serial0/1/0
P 1.1.1.0/24, 1 successors, FD is 128256
   via Connected, Loopback0
```

- ❑ Before we look at R1's **topology table**, a quick reminder:
- ❑ all routes in the EIGRP route table **are successors, and you'll find feasible successors and successors in the EIGRP topology table.**
- ❑ When equal-cost load balancing is in effect, you'll see multiple successors for the same route in the topology table. Here, we see two successors for 172.12.23.0/27, and both are in the EIGRP route table, since their metrics are exactly the same.

- ❑ the condition of equal cost load balance is

$$FD_{L.B} \leq \text{Variance} * FD_s$$

If Variance =1 $FD_{L.B} = FD_s$

- ❑ Default value for variance is 1 so , by default EIGRP make an equal cost load balance between 4 routes.

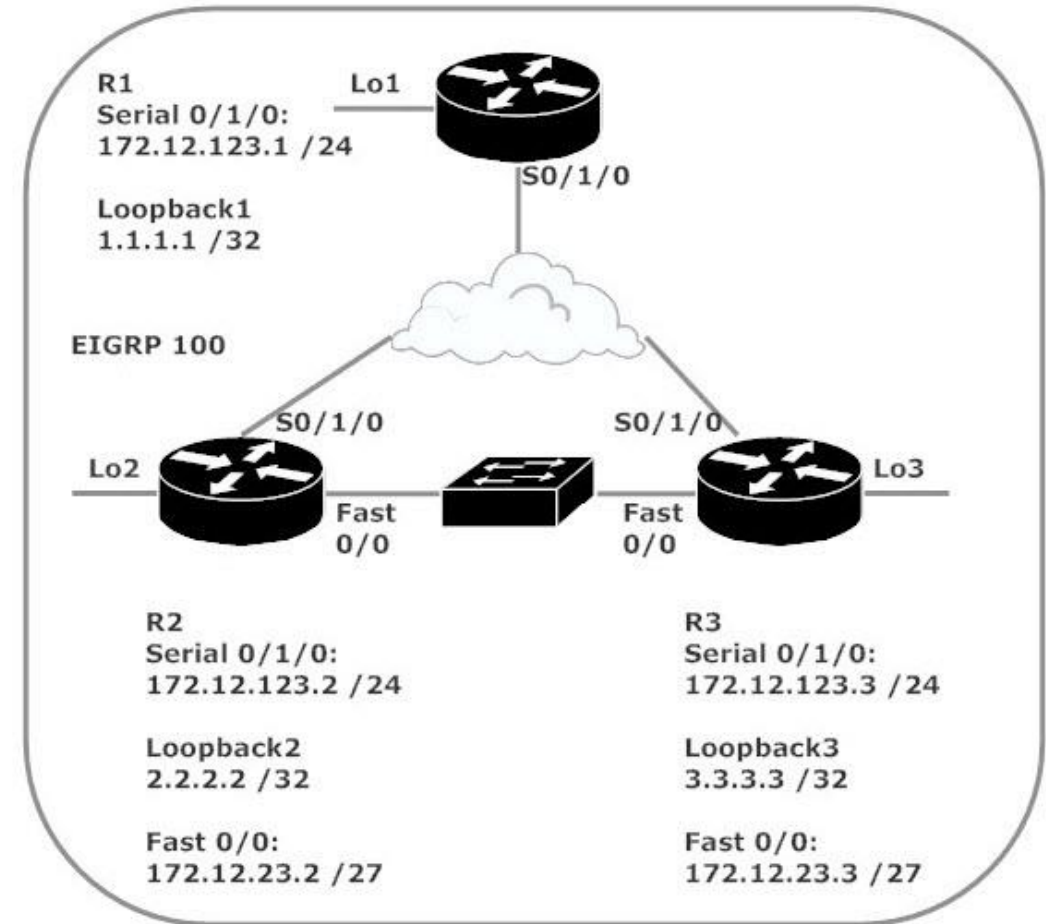
❑ 2.UN equal cost load balance

- ❑ Use Variance >1
- ❑ if Variance =2 this means the cost of load balancing route must be less or equal the twice of feasible of successor

$$FD_{L.B} \leq \text{Variance} * FD_s$$

❑ And also only feasible successor routes can be used for unequal cost load balance

$$\begin{aligned} & \text{❑ } FD_{L.B} > 2 * FD_s \\ & 2 * FD_s > FD_{F.S} \end{aligned}$$



```
R1#show ip route eigrp
  2.0.0.0/24 is subnetted, 1 subnets
D       2.2.2.0 [90/2297856] via 172.12.123.2, 00:06:03, Serial0/1/0
  3.0.0.0/24 is subnetted, 1 subnets
D       3.3.3.0 [90/2297856] via 172.12.123.3, 00:06:03, Serial0/1/0
  172.12.0.0/16 is variably subnetted, 3 subnets, 3 masks
D       172.12.23.0/27 [90/2172416] via 172.12.123.3, 00:06:03, Serial0/1/0
                        [90/2172416] via 172.12.123.2, 00:06:03, Serial0/1/0
```

- ❖ R1's routing table shows EIGRP equal-cost load balancing in action. The metrics for the two available paths to 172.12.23.0 /27 are exactly the same, so both paths are in the routing table.

- ❖ Checking R1's EIGRP topology table,
- ❖ we note there are two entries for both **2.2.2.0 /24** and **3.3.3.0 /24**. Each route has **one successor** and one **feasible successor**.

```
R1#show ip eigrp topology|
EIGRP-IPv4 Topology Table for AS(100)/ID(172.12.123.1)
Codes: P - Passive, A - Active, U - Update, Q - Query, R - Reply,
       r - reply Status, s - sia Status

P 172.12.123.0/24, 1 successors, FD is 2169856
   via Connected, Serial0/1/0
P 172.12.23.0/27, 2 successors, FD is 2172416
   via 172.12.123.2 (2172416/28160), Serial0/1/0
   via 172.12.123.3 (2172416/28160), Serial0/1/0
P 2.2.2.0/24, 1 successors, FD is 2297856
   via 172.12.123.2 (2297856/128256), Serial0/1/0
   via 172.12.123.3 (2300416/156160), Serial0/1/0
P 3.3.3.0/24, 1 successors, FD is 2297856
   via 172.12.123.3 (2297856/128256), Serial0/1/0
   via 172.12.123.2 (2300416/156160), Serial0/1/0
P 1.1.1.0/24, 1 successors, FD is 128256
   via Connected, Loopback0
```

- ❑ Our routing would be more efficient if we balanced the load from R1 to 2.2.2.0 /24 over those two available paths.
- ❑ The metrics of those two paths are so close (2297856 and 2300416) that it doesn't make sense to leave one idle while letting the other path handle the full load for traffic heading for 2.2.2.0 /24.
- ❑ That's where EIGRP unequal-cost load balancing comes in. EIGRP runs equal-cost load balancing by default, but unequal-cost balancing requires a little configuration,

❑ Enables unequal-cost load balancing in EIGRP. The variance command is a multiplier and has a default value of 1. Using variance is a two-step process:

1. The router will multiply the Feasible Distance of the route by the variance value.
2. Any feasible successor with a metric less than that new value will be entered into the routing table.

```
P 2.2.2.0/24, 1 successors, FD is 2297856
    via 172.12.123.2 (2297856/128256), Serial0/1/0
    via 172.12.123.3 (2300416/156160), Serial0/1/0
```

EIGRP (Enhanced Interior Gateway Routing Protocol)

```
R1 (config) #router eigrp 100
R1 (config-router) #variance ?
<1-128> Metric variance multiplier
```

```
R1 (config-router) #variance 2
```

- ❑ The successor has a metric of **2297856**. By setting the EIGRP variance to 2 on R1, any route to 2.2.2.0 /24 with a metric of less than 4595712 (2×2297856) will be entered into the EIGRP routing table and will participate in unequal-cost load sharing.
- ❑ The only feasible successor to that route has a metric of 2300416, so it certainly qualifies! Let's run variance 2 on R1.

EIGRP (Enhanced Interior Gateway Routing Protocol)

```
R1#show ip route eigrp
      2.0.0.0/24 is subnetted, 1 subnets
D       2.2.2.0 [90/2300416] via 172.12.123.3, 00:00:56, Serial0/1/0
          [90/2297856] via 172.12.123.2, 00:00:56, Serial0/1/0
      3.0.0.0/24 is subnetted, 1 subnets
D       3.3.3.0 [90/2297856] via 172.12.123.3, 00:00:56, Serial0/1/0
          [90/2300416] via 172.12.123.2, 00:00:56, Serial0/1/0
```

- ❖ The feasible successor and successor are also showing up for R3's loopback network. This illustrates a very important point regarding variance, and you got to watch out for it – it's an all-or-nothing command.
- ❖ When you change variance, you're changing it for your router's entire EIGRP configuration. (That's one of the important variance tips I mentioned at the top of the page. The second one's coming up.)

EIGRP (Enhanced Interior Gateway Routing Protocol)

```
R1#show ip protocols
```

```
Routing Protocol is "eigrp 100"
  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
  Redistributing: eigrp 100
  EIGRP-IPv4 Protocol for AS(100)
    Metric weight K1=1, K2=0, K3=1, K4=0, K5=0
    NSF-aware route hold timer is 240
    Router-ID: 172.12.123.1
    Topology: 0 (base)
      Active Timer: 3 min
      Distance: internal 90 external 170
      Maximum path: 4
      Maximum hop count 100
      Maximum metric variance 2

  Automatic Summarization: disabled
  Maximum path: 4
  Routing for Networks:
    1.1.1.0/24
      Gateway          Distance      Last Update
    172.12.123.0/24
  Routing Information Sources:
    Gateway          Distance      Last Update
    172.12.123.3          90          00:05:05
    172.12.123.2          90          00:05:05
  Distance: internal 90 external 170
```



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