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**Welcome
To
Network for you
EIGRP**



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EIGRP:

- EIGRP stands for Enhanced Interior Gateway Routing Protocol.
- EIGRP is a Cisco Proprietary routing protocol however open in 2013.
- It is hybrid routing protocol sometime called Advanced Distance Vector.
- It has characteristics of both distance vector and link state protocols.
- It uses DUAL (Diffusing Update Algorithm) algorithm to select best path.
- It uses RTP (Reliable Transport Protocol) to communicate with neighbors.
- It use multicast for updates.
- It supports both Internet Protocol V4 and IPV6 routed protocols.
- It includes subnet mask information in the routing updates message.
- It supports route summarization.
- It supports VLSM, CIDR.
- Hello time of EIGRP protocol is 5 seconds and the dead time is 15 seconds.
- The Default Internal Administrative Distance of EIGRP protocol is 90.
- The Default External Administrative Distance of EIGRP protocol is 170.
- The EIGRP default hop count support is 100 but it can be tune to 255.
- EIGRP protocol support Equal cost Load and Unequal Cost load balancing.
- It take load balancing by default up-to 4 paths can configure up to 32.
- It updates are sent to through on Multicast (224.0.0.10).
- It Support MD5 Authentication.
- By default, Auto Summarization is enabling for Version below 15 and disable on 15 and above.

EIGRP Tables:

- It maintains three tables
- Neighbor table
- Topology table
- Routing table

Configuring EIGRP:

```
Router(config)# router eigrp <as no>
```

```
Router(config-router)# network <Network ID>
```

```
Router(config-router)# no auto-summary
```

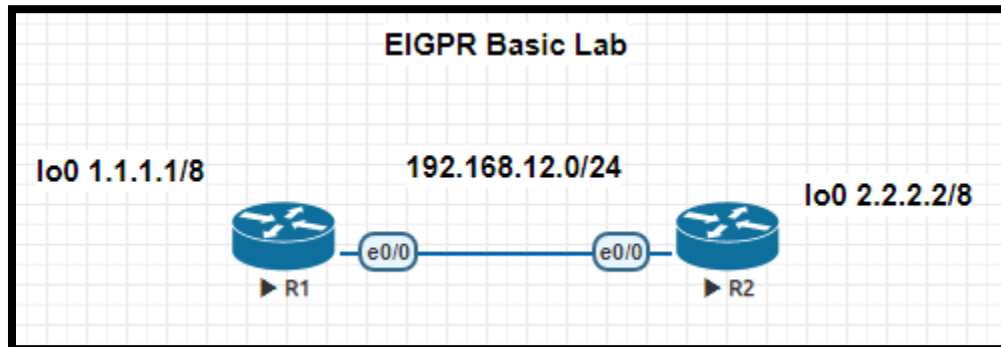
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Eigrp Basic Lab:



R1 Configuration:	R2 Configuration:
<pre>en config t hostname R1 int e0/0 ip add 192.168.12.1 255.255.255.0 no sh int lo0 ip add 1.1.1.1 255.0.0.0 router eigrp 1 network 192.168.12.0 network 1.0.0.0 no auto-summary</pre>	<pre>en config t hostname R2 int e0/0 ip add 192.168.12.2 255.255.255.0 no sh int lo0 ip add 2.2.2.2 255.0.0.0 router eigrp 1 network 192.168.12.0 network 2.0.0.0 no auto-summary</pre>
To Check	Sh ip route or sh ip router eigrp

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```

R2#sh 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
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, 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, H - NHRP, l - LISP
       a - application route
       + - replicated route, % - next hop override

Gateway of last resort is not set

  1.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
C       1.0.0.0/8 is directly connected, Loopback0
L       1.1.1.1/32 is directly connected, Loopback0
D       2.0.0.0/8 [90/409600] via 192.168.12.2, 00:00:07, Ethernet0/0
       192.168.12.0/24 is variably subnetted, 2 subnets, 2 masks
C       192.168.12.0/24 is directly connected, Ethernet0/0
L       192.168.12.1/32 is directly connected, Ethernet0/0

```

Eigrp Neighbor Table Explanation:

R1#show ip eigrp neighbors

```

R2#sh ip eigrp neighbors
EIGRP-IPv4 Neighbors for AS(1)
H   Address          Interface          Hold  Uptime    SRTT    RTO    Q  Seq
   (sec)              (ms)              (sec)  (sec)     (ms)    (ms)   Cnt  Num
0   192.168.12.2      Et0/0             13    00:15:10  10      100    0   3

```

H (Handle)	Lists the neighbors in the order this router was learned.
Address	The IP address of the neighbors
Interface	The interface of the local router on which this Hello packet was received.
Hold	The amount of time left before neighbor is considered in "Down" Status.
Uptime	How long the neighbor has been up
SRTT	(Smooth Round Trip Timer): The number of milliseconds it takes to send an EIGRP packet to neighbor and receive an acknowledgment packet back.
Q Cnt	(Q Count): Shows the number of queued EIGRP packets. It is usually 0.
RTO	(Retransmission Timeout): if a multicast has failed, then a unicast is sent to that particular router, the RTO is the time in milliseconds that the

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	router waits for an acknowledgement of that unicast.
Seq Num	The sequence number of the last update EIGRP packet received.

Eigrp Topology Table Explanation:

```

R1#sh ip eigrp topology
EIGRP-IPv4 Topology Table for AS(1)/ID(1.1.1.1)
Codes: P - Passive, A - Active, U - Update, Q - Query, R - Reply,
       r - reply Status, s - sia Status

P 192.168.12.0/24, 1 successors, FD is 281600
   via Connected, Ethernet0/0
P 2.0.0.0/8, 1 successors, FD is 409600
   via 192.168.12.2 (409600/128256), Ethernet0/0
P 1.0.0.0/8, 1 successors, FD is 128256
   via Connected, Loopback0

```

As	Autonomous System number 1
Codes	Passive is good and Active is bad
Sia Status (Struck in Active)	EIGRP has not received a reply to a query packet from one of the neighbors within the allowed time about 3 minutes.
1 Successors	The best path in this case only one way to get to the destination
FD is 281600	Feasible Distance: Total distance to get to the destination

Eigrp Routing Table Explanation:

R1#sh ip route eigrp

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```

R1#sh ip route eigrp
Codes: L - local, C - connected, S - static, 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
i - IS-IS, su - IS-IS summary, 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, H - NHRP, l - LISP
a - application route
+ - replicated route, % - next hop override

Gateway of last resort is not set

D 2.0.0.0/8 [90/409600] via 192.168.12.2, 00:09:41, Ethernet0/0

```

D	Shows this is an EIGRP learnt route
2.0.0.0/8	Destination learn network and 8 is subnet mask.
90	90 is the Administrative Distance of EIGRP
409600	This is the metric, Total distance to get to the destination
192.168.12.2	The neighbor that advertised the route.
00:09:41	Time since the route was learnt.
Ethernet 0/0	The outbound interface going towards the destination.

EIGRP Metric:

- EIGRP uses metric to select the best route from all available routes for destination.
- Metric has five components. 1. Bandwidth, 2. Load, 3. Delay, 4. Reliability and 5. MTU. From these only bandwidth and delay are by default enabled.

K Value	Component	Description
K1	Bandwidth	Lowest bandwidth of route
K2	Load	Worst load on route based on packet rate
K3	Delay	Cumulative interface delay of route
K4	Reliability	Worst reliability of route based on keep alive
K5	MTU	Smallest MTU in path [Not used in route Calculation]

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

Routing Protocol is "application"
  Sending updates every 0 seconds
  Invalid after 0 seconds, hold down 0, flushed after 0
  Outgoing update filter list for all interfaces is not set
  Incoming update filter list for all interfaces is not set
  Maximum path: 32
  Routing for Networks:
  Routing Information Sources:
    Gateway         Distance         Last Update
  Distance: (default is 4)

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
```

Bandwidth (K1):

- EIGRP picks lowest bandwidth from all outgoing interfaces of route to the destination network.
- Bandwidth is amount of data that can be transmitted in a fixed amount of time.

Load (K2):

- Load is a dynamic value that changes frequently.
- It is based on packet rate and bandwidth of interface.
- It calculates the volume of traffic passing through the interface in comparison of maximum capacity.
- It is expressed on a scale of 255 where 1 represent that an interface is empty and 255 represent that an interface is fully utilized.
- Since data flows from both directions, router maintains two separate metric counters; TXload for outgoing traffic and RXload for incoming traffic.

Delay (K3):

- Delay reflects the time taken by a packet in crossing the interface.
- It is measured in fractions of seconds.

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Reliability (K4):

- Just like load, reliability is also a dynamic value.
- It compares all successfully received frames against all received frames.
- 100 % reliability indicates that all the frames, which we received, were good.
- We do not have any issue with physical link.
- If we have any issue with physical link, this value will be decrease.

MTU (K5):

- MTU stands for Maximum Transmission Unit.
- It is advertised with routing update but it does not actively participate in metric calculation.

```
R1#sh int e0/0
Ethernet0/0 is up, line protocol is up
  Hardware is AmdP2, address is aabb.cc00.1000 (bia aabb.cc00.10
00)
  Internet address is 192.168.12.1/24
  MTU 1500 bytes, BW 10000 Kbit/sec, DLY 1000 usec,
    reliability 255/255, txload 1/255, rxload 1/255
  Encapsulation ARPA, loopback not set
  Keepalive set (10 sec)
  ARP type: ARPA, ARP Timeout 04:00:00
  Last input 00:00:00, output 00:00:00, output hang never
  Last clearing of "show interface" counters never
  Input queue: 0/75/0/0 (size/max/drops/flushes); Total output d
```

Autonomous System:

- EIGRP shares routing information only with neighbors.
- In order to become a neighbor AS number must be matched.
- AS create a logical boundary for route information. By default, router will not propagate route information outside the AS.

Path Metric Calculation:

EIGRP Metric = $256 * ((10^7 / \text{min. BW of outgoing interface}) + (\text{sum of outgoing interface Delay}/10))$

= $256 * ((10000000 / \text{Minimum BW of outgoing interface}) + (\text{Sum of outgoing Interface Delays}/10))$

Where Bandwidth = $10000000 / \text{bandwidth (i)}$, where bandwidth (i) is the least bandwidth of all outgoing interfaces on the route to the destination network represented in kilobits.

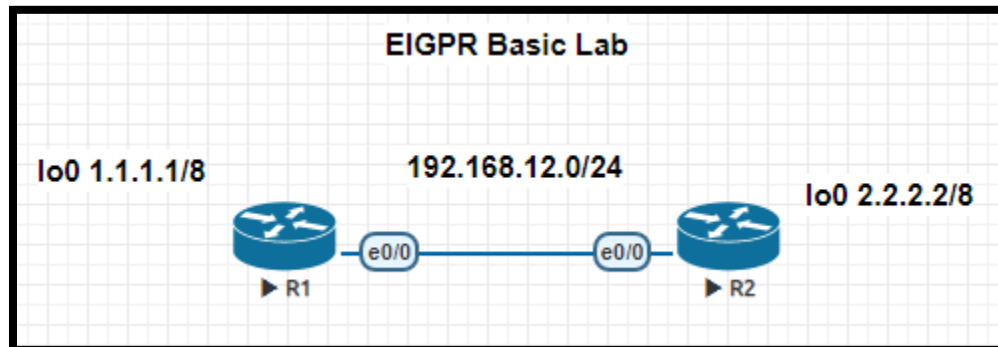
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Delay = delay (i) where delay (i) is the sum of the delays configured on the interfaces, on the route to the destination network, in tens of microseconds.



```
R1#sh ip route eigrp
Codes: L - local, C - connected, S - static, 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
i - IS-IS, su - IS-IS summary, 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, H - NHRP, l - LISP
a - application route
+ - replicated route, % - next hop override

Gateway of last resort is not set

D 2.0.0.0/8 [90/409600] via 192.168.12.2, 01:19:37, Ethernet0/0
```

```
R1#sh int e0/0
Ethernet0/0 is up, line protocol is up
Hardware is AmdP2, address is aabb.cc00.1000 (bia aabb.cc00.1000)
Internet address is 192.168.12.1/24
MTU 1500 bytes, BW 10000 kbit/sec, DLY 1000 usec,
```

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```
R2#sh int lo0
Loopback0 is up, line protocol is up
Hardware is Loopback
Internet address is 2.2.2.2/8
MTU 1514 bytes, BW 8000000 Kbit/sec, DLY 5000 usec,
reliability 255/255, txload 1/255, rxload 1/255
```

EIGRP Metric = $256 * ((10000000 / \text{Minimum BW}) + (\text{Sum of Interface Delays} / 10))$

EIGRP Metric = $256 * ((10000000 / 10000) + (1000 + 5000 / 10))$

EIGRP Metric = $256 * ((1000) + (6000 / 10))$

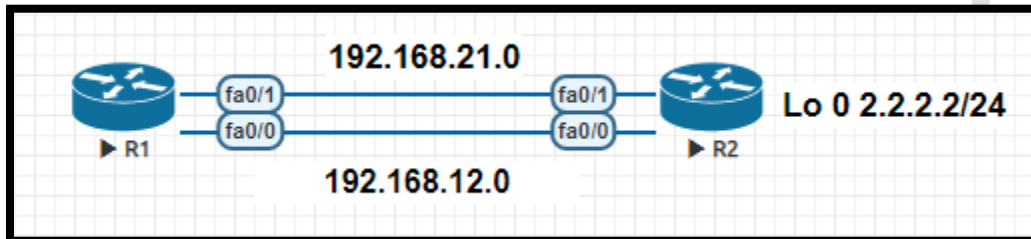
EIGRP Metric = $256 * ((1000) + (600))$

EIGRP Metric = $256 * (1600)$

EIGRP Metric = 409600

Path Selection Optimization:

- Change EIGRP metrics by manipulating the bandwidth and or delay values.



Configuration:

R1 Configuration	R2 Configuration
en Config t hostname R1 int f0/0 ip add 192.168.12.1 255.255.255.0 no sh	en Config t hostname R2 int f0/0 ip add 192.168.12.2 255.255.255.0 no sh

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```
int f0/1
ip add 192.168.21.1 255.255.255.0
no sh
```

```
router eigrp 1
no auto-summary
network 192.168.21.0
network 192.168.12.0
```

```
int f0/1
ip add 192.168.21.2 255.255.255.0
no sh
```

```
int lo0
ip add 2.2.2.2 255.255.255.0
```

```
router eigrp 1
no auto-summary
network 192.168.21.0
network 192.168.12.0
network 2.2.2.0
```

```
R1#sh ip route
Codes: C - connected, S - static, 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
       i - IS-IS, su - IS-IS summary, 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

C    192.168.12.0/24 is directly connected, FastEthernet0/0
     2.0.0.0/24 is subnetted, 1 subnets
D    2.2.2.0 [90/409600] via 192.168.21.2, 00:00:44, FastEthernet0/1
     [90/409600] via 192.168.12.2, 00:00:44, FastEthernet0/0
C    192.168.21.0/24 is directly connected, FastEthernet0/1
-- "
```

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```

R1#sh int f0/0
FastEthernet0/0 is up, line protocol is up
  Hardware is Gt96k FE, address is c201.1bc0.0000 (bia c201.1bc0.0000)
  Internet address is 192.168.12.1/24
  MTU 1500 bytes, BW 10000 Kbit/sec, DLY 1000 usec,
    reliability 255/255, txload 1/255, rxload 1/255
  Encapsulation ARPA, loopback not set
  Keepalive set (10 sec)
  Half-duplex, 10Mb/s, 100BaseTX/FX
  ARP type: ARPA, ARP Timeout 04:00:00
  Last input 00:00:10, output 00:00:00, output hang never
  Last clearing of "show interface" counters never
  Input queue: 0/75/0/0 (size/max/drops/flushes); Total output drops: 0
  Queueing strategy: fifo
  Output queue: 0/40 (size/max)
  5 minute input rate 0 bits/sec, 0 packets/sec
  5 minute output rate 0 bits/sec, 0 packets/sec
    86 packets input, 7795 bytes
    Received 78 broadcasts, 0 runts, 0 giants, 0 throttles
    0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored
    0 watchdog

```

Commands	Description
R1#Sh ip route eigrp D 2.2.2.0 [90/409600] via 192.168.21.2, 00:13:50, F0/1 [90/409600] via 192.168.12.2, 00:13:50, F0/0	First verify both routes in routing table Equal path load balancing
R1(config)#int f0/0 R1(config-if)#bandwidth 1000	Enter interface mode Decrease the bandwidth to 1000
R1#sh ip route eigrp D 2.2.2.0 [90/409600] via 192.168.21.2, 00:00:38, F0/1	Verify again only one path now
R1(config)#int f0/0 R1(config-if)#no band R1(config-if)#no bandwidth 1000 R1#sh ip route eigrp 2.0.0.0/24 is subnetted, 1 subnets D 2.2.2.0 [90/409600] via 192.168.21.2, 00:00:25, F0/1 [90/409600] via 192.168.12.2, 00:00:25, F0/0	Verify again two path now
R1(Config-if)# delay 10000 R1#sh ip route eigrp 2.0.0.0/24 is subnetted, 1 subnets	Enter interface mode Increase the delay this time

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D 2.2.2.0 [90/409600] via 192.168.21.2, 00:00:21, F0/1	Verify again only one path now
R1(config)#int f0/0 R1(config-if)#no delay 10000	Enter interface mode Make the default delay again
R1#sh ip route eigrp 2.0.0.0/24 is subnetted, 1 subnets D 2.2.2.0 [90/409600] via 192.168.21.2, 00:00:13, F0/1 [90/409600] via 192.168.12.2, 00:00:13, Fa0/0	Verify again two path now

EIGRP Packet Types:

- EIGRP uses five packet types in communication with its neighbors.
- As given below.

Packet	Description
Hello	Used to identify neighbors. They are sent as periodic multicasts.
Update	Used to advertise routes, only sent as multicasts when something is changed.
Ack	Acknowledges receipt of an update.
Query	Used to find alternate paths when all paths to a destination have failed.
Reply	Used to response to query packets about routing information.

Hello:

- Hello packets are used for neighbor discovery.
- As soon as the hello packets send and receive EIGRP routers will try to form the neighbor adjacency.
- They are multicast to 224.0.0.10. By default, EIGRP sends hello packets every 5 seconds.

Update:

- Update packets contain routing information for destinations.
- EIGRP unicasts update packets to newly discovered neighbors; otherwise, it multicasts update packets to 224.0.0.10 when a link or metric changes.
- Update packets are acknowledged to ensure reliable transmission.

Query:

- EIGRP sends query packets used to find alternate paths when all paths to a destination have failed.
- Query packets are always multicast.

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Reply:

- EIGRP sends reply packets to respond to query packets.
- Reply packets provide a feasible successor to the sender of the query.
- Reply packets are unicast to the sender of the query packet.

ACK:

- ACK packets are used to acknowledge the receipt of update, query and replay packets.
- ACK packets are sent by using unicast.

```
R2#sh ip eigrp traffic
EIGRP-IPv4 Traffic Statistics for AS(1)
Hello sent/received: 28/27
Updates sent/received: 5/4
Queries sent/received: 0/0
Replies sent/received: 0/0
Acks sent/received: 2/3
SIA-Queries sent/received: 0/0
SIA-Replies sent/received: 0/0
Hello Process ID: 226
PDM Process ID: 209
Socket Queue: 0/10000/2/0 (current/max/highest/drops)
Input Queue: 0/2000/2/0 (current/max/highest/drops)
```

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66	84.122424	192.168.12.2	224.0.0.10	EIGRP	74 Hello
67	84.132460	192.168.12.1	224.0.0.10	EIGRP	84 Hello
70	86.150346	192.168.12.1	192.168.12.2	EIGRP	60 Update
72	88.497135	192.168.12.2	224.0.0.10	EIGRP	74 Hello
73	88.770066	192.168.12.1	224.0.0.10	EIGRP	84 Hello
74	88.784889	192.168.12.2	224.0.0.10	EIGRP	84 Hello
75	88.796966	192.168.12.2	192.168.12.1	EIGRP	60 Update
76	89.161925	192.168.12.1	192.168.12.2	EIGRP	60 Update
77	89.176894	192.168.12.2	224.0.0.10	EIGRP	96 Update
78	89.191993	192.168.12.2	192.168.12.1	EIGRP	60 Hello (Ack)
79	89.206884	192.168.12.1	224.0.0.10	EIGRP	96 Update
80	89.221841	192.168.12.2	192.168.12.1	EIGRP	60 Hello (Ack)
81	89.235826	192.168.12.1	224.0.0.10	EIGRP	96 Update
82	89.246882	192.168.12.2	192.168.12.1	EIGRP	60 Hello (Ack)
83	91.376722	192.168.12.2	192.168.12.1	EIGRP	96 Update
84	91.388825	192.168.12.1	192.168.12.2	EIGRP	60 Hello (Ack)
85	91.400827	192.168.12.2	224.0.0.10	EIGRP	96 Update
86	91.412769	192.168.12.1	192.168.12.2	EIGRP	60 Hello (Ack)
88	94.244359	192.168.12.1	224.0.0.10	EIGRP	84 Hello
89	96.412239	192.168.12.2	224.0.0.10	EIGRP	84 Hello
91	98.648012	192.168.12.1	224.0.0.10	EIGRP	84 Hello
92	100.985692	192.168.12.2	224.0.0.10	EIGRP	84 Hello
94	103.231635	192.168.12.1	224.0.0.10	EIGRP	84 Hello
95	105.458167	192.168.12.2	224.0.0.10	EIGRP	84 Hello
96	107.845914	192.168.12.1	224.0.0.10	EIGRP	74 Hello
98	109.991116	192.168.12.2	224.0.0.10	EIGRP	84 Hello

134	157.884828	192.168.12.1	224.0.0.10	EIGRP	74 Hello
136	161.887428	192.168.12.2	224.0.0.10	EIGRP	74 Hello
146	166.458617	192.168.12.2	224.0.0.10	EIGRP	74 Hello
148	167.481464	192.168.12.2	224.0.0.10	EIGRP	96 Update
150	168.907339	192.168.12.2	192.168.12.1	EIGRP	96 Update
151	170.383208	192.168.12.1	224.0.0.10	EIGRP	74 Hello
152	171.052941	192.168.12.2	224.0.0.10	EIGRP	96 Query
154	174.258715	192.168.12.2	192.168.12.1	EIGRP	96 Query
156	175.353447	192.168.12.1	224.0.0.10	EIGRP	74 Hello
157	176.059489	192.168.12.2	224.0.0.10	EIGRP	74 Hello
158	176.069383	192.168.12.1	224.0.0.10	EIGRP	84 Hello
161	178.086161	192.168.12.1	192.168.12.2	EIGRP	60 Update
162	180.452714	192.168.12.2	224.0.0.10	EIGRP	74 Hello
163	180.736753	192.168.12.1	224.0.0.10	EIGRP	84 Hello
164	180.746799	192.168.12.2	224.0.0.10	EIGRP	84 Hello
165	180.758826	192.168.12.2	192.168.12.1	EIGRP	60 Update
166	181.094939	192.168.12.1	192.168.12.2	EIGRP	60 Update
167	181.106634	192.168.12.2	192.168.12.1	EIGRP	60 Hello (Ack)
168	181.118592	192.168.12.1	224.0.0.10	EIGRP	96 Update
169	181.130618	192.168.12.2	192.168.12.1	EIGRP	60 Hello (Ack)
170	181.142712	192.168.12.2	224.0.0.10	EIGRP	96 Update
171	181.154737	192.168.12.1	192.168.12.2	EIGRP	60 Hello (Ack)
174	186.119341	192.168.12.1	224.0.0.10	EIGRP	84 Hello
175	186.143123	192.168.12.2	224.0.0.10	EIGRP	84 Hello
176	190.989526	192.168.12.1	224.0.0.10	EIGRP	84 Hello

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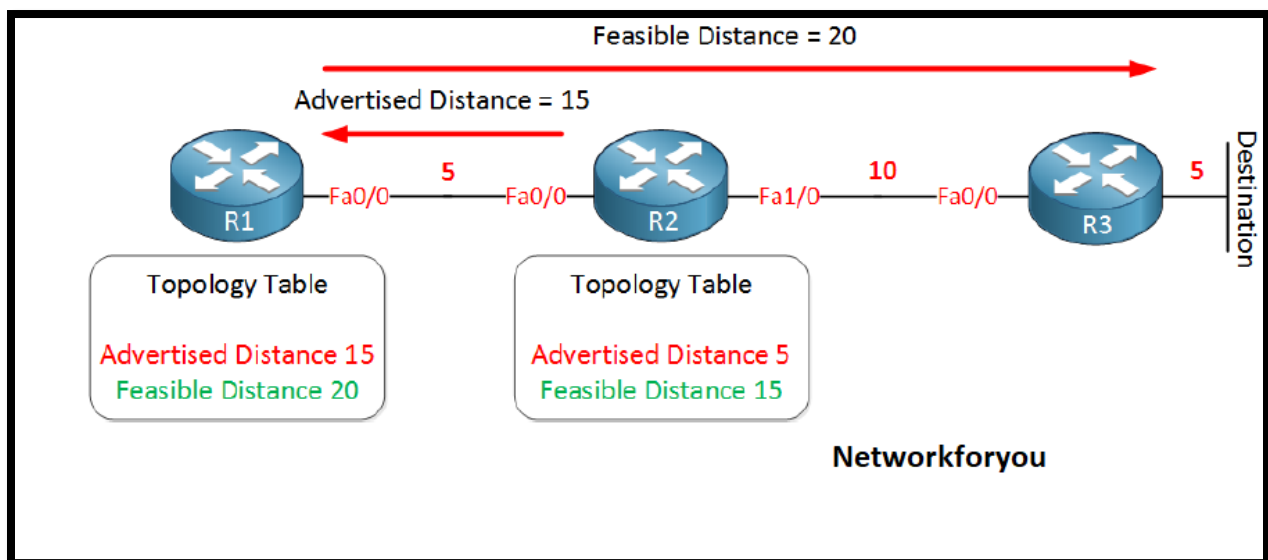
EIGRP Terminologies:

Advertised Distance (AD)/Reported Distance (RD): The cost from the neighbor to the destination.

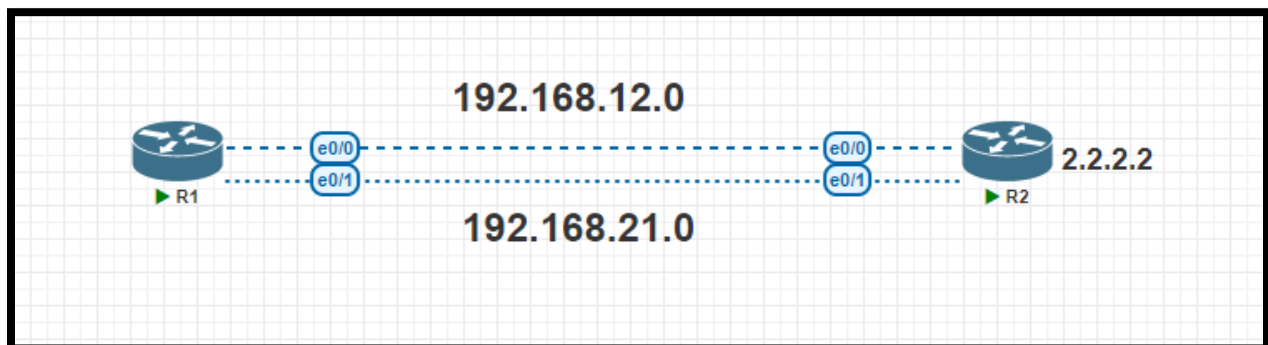
Feasible Distance (FD): The total cost to reach a destination network.

Successor: **The primary route used to reach a destination.** The successor route is kept in the routing table. Notice that successor is the **best route to that destination.**

Feasible Successor: The backup route. To be a feasible successor, the route must have an AD less than the FD of the current successor route.



Lab Time:



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R1 Configuration	R2 Configuration
En Config t Hostname R1 Int e0/0 Ip add 192.168.12.1 255.255.255.0 No sh Int e0/1 Ip add 192.168.21.1 255.255.255.0 No sh Router eigrp 1 Network 192.168.12.0 Network 192.168.21.0	En Config t Hostname R2 Int e0/0 Ip add 192.168.12.2 255.255.255.0 No sh Int e0/1 Ip add 192.168.21.2 255.255.255.0 No sh Int lo 0 Ip add 2.2.2.2 255.0.0.0 Router eigrp 1 Network 192.168.12.0 Network 192.168.21.0 Network 2.0.0.0

```
R1#sh ip eigrp topology
EIGRP-IPv4 Topology Table for AS(1)/ID(192.168.12.1)
Codes: P - Passive, A - Active, U - Update, Q - Query, R - Reply,
       r - reply Status, s - sia Status

P 192.168.21.0/24, 1 successors, FD is 281600
   via Connected, Ethernet0/1
P 192.168.12.0/24, 1 successors, FD is 281600
   via Connected, Ethernet0/0
P 2.0.0.0/8, 2 successors, FD is 409600
   via 192.168.12.2 (409600/128256), Ethernet0/0
   via 192.168.21.2 (409600/128256), Ethernet0/1
...
```

```
R2#sh ip eigrp topology
EIGRP-IPv4 Topology Table for AS(1)/ID(192.168.12.2)
Codes: P - Passive, A - Active, U - Update, Q - Query, R - Reply,
       r - reply Status, s - sia Status

P 192.168.21.0/24, 1 successors, FD is 281600
   via Connected, Ethernet0/1
P 192.168.12.0/24, 1 successors, FD is 281600
   via Connected, Ethernet0/0
P 2.0.0.0/8, 1 successors, FD is 128256
   via Connected, Loopback0
```

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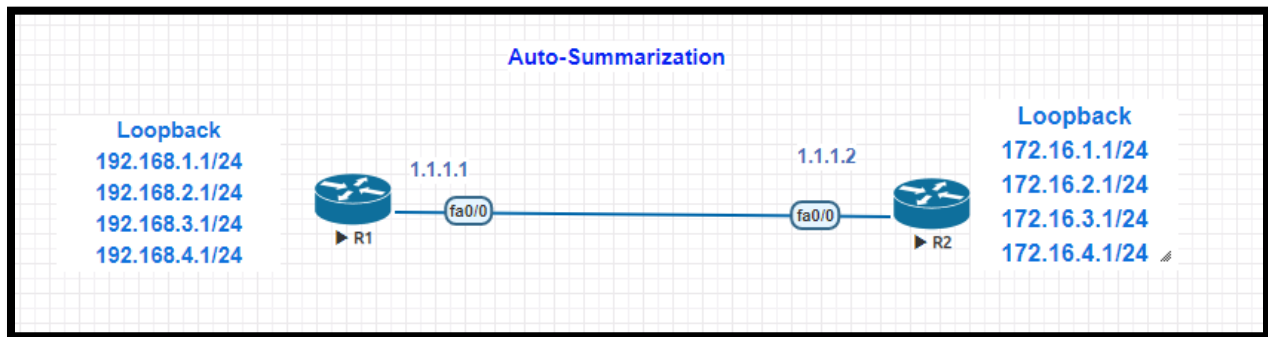
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EIGRP Summarization:

Auto-Summarization:

- Auto Summarization is a feature, which allows Routing Protocols to summarize its routes to their classful networks automatically.
- By default, EIGRP has auto summary feature enabled in old version but in new version v15 it is disable. Because of this, routes are summarized to classful address at network boundaries in the routing updates.
- The Auto-Summarization can be disabled with a command of no auto-summary from the router prompt.



R1 Configuration	R2 Configuration
<pre> en config t hostname R1 int f0/0 ip add 1.1.1.1 255.0.0.0 no sh int lo 0 ip add 192.168.1.1 255.255.255.0 int lo 1 ip add 192.168.2.1 255.255.255.0 int lo 2 ip add 192.168.3.1 255.255.255.0 int lo 3 ip add 192.168.4.1 255.255.255.0 </pre>	<pre> en config t hostname R2 int f0/0 ip add 1.1.1.2 255.0.0.0 no sh int lo 0 ip add 172.16.1.1 255.255.255.0 int lo 1 ip add 172.16.2.1 255.255.255.0 int lo 2 ip add 172.16.3.1 255.255.255.0 int lo 3 ip add 172.16.4.1 255.255.255.0 </pre>

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```
router eigrp 1
network 0.0.0.0
no auto-summary
```

```
router eigrp 1
network 0.0.0.0
no auto-summary
```

```
R2#sh ip route eigrp
Codes: L - local, C - connected, S - static, 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
       i - IS-IS, su - IS-IS summary, 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, H - NHRP, l - LISP
       + - replicated route, % - next hop override

Gateway of last resort is not set

D      192.168.1.0/24 [90/156160] via 1.1.1.1, 00:08:19, FastEthernet0/0
D      192.168.2.0/24 [90/156160] via 1.1.1.1, 00:08:19, FastEthernet0/0
D      192.168.3.0/24 [90/156160] via 1.1.1.1, 00:08:19, FastEthernet0/0
D      192.168.4.0/24 [90/156160] via 1.1.1.1, 00:08:19, FastEthernet0/0
```

Commands	Description
R1(config)#router eigrp 1	Enter EIGRP mode
R1(config-router)#network 0.0.0.0	Advertise all networks
R1(config-router)#no auto-summary	Disable auto summary feature
R2(config)#router eigrp 1	Enter EIGRP mode
R2(config-router)#network 0.0.0.0	Advertise all network
R2(config-router)#no auto-summary	Disable auto summary feature
R1#show ip route eigrp	View routing table for EIGRP all four networks of 172 present in table
R2(config)#router eigrp 1	Enter EIGRP mode
R2(config-router)#auto-summary	Enable auto summary feature
R1#show ip route eigrp	Again, view routing table for EIGRP Only summary route 172.16.0.0/16

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```
R1#sh ip route eigrp
Codes: L - local, C - connected, S - static, 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
       i - IS-IS, su - IS-IS summary, 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, H - NHRP, l - LISP
       + - replicated route, % - next hop override

Gateway of last resort is not set

D   172.16.0.0/16 [90/156160] via 1.1.1.2, 00:01:57, FastEthernet0/0
```

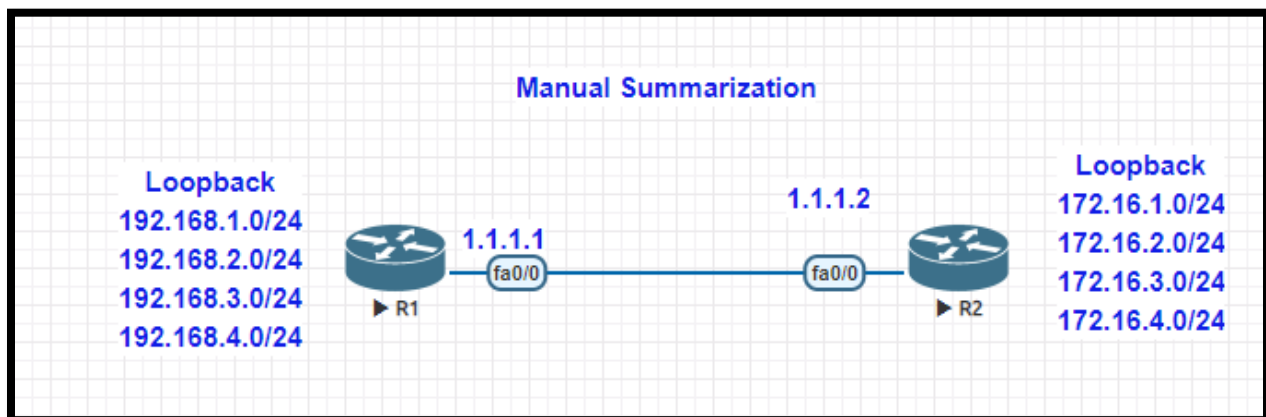
Manual Summarization:

- The manual summarization is a process of creating a summary route that will be used to represent multiple routes and can be used to reduce the sizes of routing tables in a network.
- Manual summarization is configured differently on different protocols.
- The syntax of the command is (config-if) ip summary-address eigrp ASN SUMMARY_ADDRESS SUBNET_MASK.

Advantages of Summarization:

- Saves Memory: Routing tables will be smaller which reduces memory requirements.
- Saves Bandwidth: There are less routes to advertise so we save some bandwidth.
- Saves CPU Cycles: Less packets to process and smaller routing tables to work on.
- Stability: Prevents routing table instability due to flapping networks.

Lab-Manual Summarization:



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Calculating the Summarize route:

192.168.1.0

192.168.4.0

192.168.00000 001. 0 = 8 + 8 + 5 = 21 => 255.255.248.0

192.168.00000 100. 0

So IP will be 192.168.0.0 and subnet mask is 255.255.248.0

Commands	Description
R1(config)#router eigrp 1	Enter EIGRP mode
R1(config-router)#network 0.0.0.0	Advertise all networks
R1(config-router)#no auto-summary	Disable auto summary feature
R2(config)#router eigrp 1	Enter EIGRP mode
R2(config-router)#network 1.0.0.0	Advertise only 1 network
R2(config-router)#no auto-summary	Disable auto summary feature
R2#show ip route eigrp	View routing table for EIGRP all four networks of 192.168. present
R1(config)#interface f0/0	Enter interface mode facing R2
R1(config-if)#ip summary-address eigrp 1 192.168.0.0 255.255.248.0	Enter summary route to send
R2#show ip route eigrp	Check again routing table only summary route 192.168.0.0/21 only
R1#show ip route eigrp	Checking summary route in R1 192.168.0.0/21 is a summary, Null0

EIGRP Load Balancing:

- Load balancing is a router's capability to distribute traffic over all of its network ports that are the same metric from the destination address.
- By default, the CISCO IOS balances between a maximum of four equal-cost paths for IP.
- EIGRP support Equal Cost and Unequal Cost loading balancing.

EIGRP Equal Cost:

- By default, EIGRP supports equal-cost load balancing over four links.
- Equal-cost means that multiple routes must have the same metric to reach a destination, so that router can choose to load balance across equal cost links.

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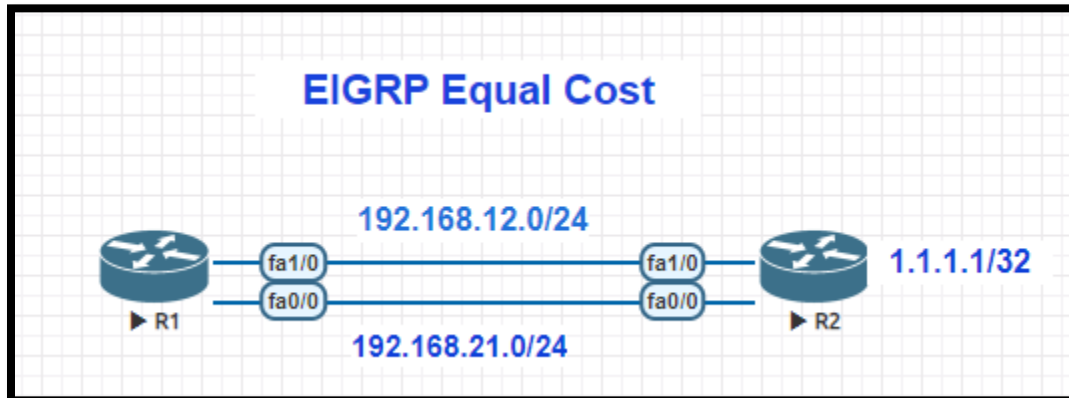
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- Using maximum-path router configuration command, to request up to 16 equally good routes to be kept in the routing table. Set maximum-path to 1 to disable load balancing.

Lab EIGRP Equal Cost:



Commands	Description
(config)#router eigrp 1	Apply this on both R1 and R2
(config-router)#no auto-summary	Disable auto summary
(config-router)#network 0.0.0.0	Enable EIGRP for all networks
R1#show ip route eigrp	Check routing table for EIGRP equal 2 paths
R1#show ip eigrp topology	Check EIGRP topology table for all paths
R1(config)#router eigrp 1	Enters EIGRP routing mode
R1(config-router)# maximum-paths 1	To disable equal cost load balancing set 1
R1#show ip route eigrp	Check routing table for EIGRP now 1 path
R1(config)#router eigrp 1	Enters EIGRP routing mode
R1(config-router)# maximum-paths 4	Enable back equal cost load balancing

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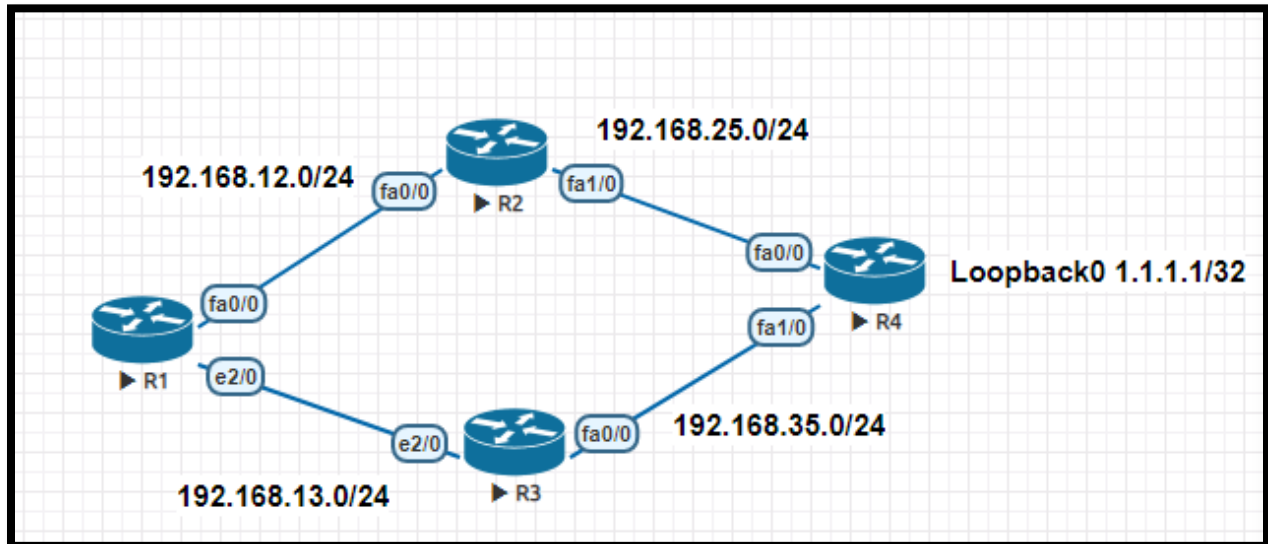
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EIGRP Unequal Cost:

- EIGRP can also balance traffic across multiple routes that have different metrics and it is called Unequal-Cost Load Balancing.



R1 Configuration:	R2 Configuration:
<pre>en config t hostname R1 int f0/0 ip add 192.168.12.1 255.255.255.0 no sh int e2/0 ip add 192.168.13.1 255.255.255.0 no sh router eigrp 1 no auto-summary network 0.0.0.0 Enters EIGRP routing mode Set variance 3 to install other route</pre>	<pre>en config t hostname R2 int f0/0 ip add 192.168.12.2 255.255.255.0 no sh int f1/0 ip add 192.168.25.1 255.255.255.0 no sh router eigrp 1 no auto-summary network 0.0.0.0</pre>

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R3 Configuration:	R4 Configuration:
<pre> en config t hostname R3 int e2/0 ip add 192.168.13.2 255.255.255.0 no sh int f0/0 ip add 192.168.35.1 255.255.255.0 no sh router eigrp 1 no auto-summary network 0.0.0.0 </pre>	<pre> en config t hostname R4 int f0/0 ip add 192.168.25.2 255.255.255.0 no sh int f1/0 ip add 192.168.35.2 255.255.255.0 no sh int lo 0 ip add 1.1.1.1 255.255.255.255 router eigrp 1 no auto-summary network 0.0.0.0 </pre>

```

R1#sh ip route ei
R1#sh ip route eigrp
Codes: L - local, C - connected, S - static, 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
i - IS-IS, su - IS-IS summary, 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, H - NHRP, l - LISP
+ - replicated route, % - next hop override

Gateway of last resort is not set

1.0.0.0/32 is subnetted, 1 subnets
D 1.1.1.1 [90/158720] via 192.168.12.2, 00:03:14, FastEthernet0/0
D 192.168.25.0/24 [90/30720] via 192.168.12.2, 00:03:14, FastEthernet0/0
D 192.168.35.0/24 [90/33280] via 192.168.12.2, 00:03:14, FastEthernet0/0

```

Now we can see topology table show two route but in routing table only one is coming which is best.

So we will calculate variance

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```
R1#sh ip eigrp topology
EIGRP-IPv4 Topology Table for AS(1)/ID(192.168.13.1)
Codes: P - Passive, A - Active, U - Update, Q - Query, R - Reply,
       r - reply Status, s - sia Status

P 192.168.25.0/24, 1 successors, FD is 30720
   via 192.168.12.2 (30720/28160), FastEthernet0/0
P 192.168.35.0/24, 1 successors, FD is 33280
   via 192.168.12.2 (33280/30720), FastEthernet0/0
   via 192.168.13.2 (284160/28160), Ethernet2/0
P 192.168.12.0/24, 1 successors, FD is 28160
   via Connected, FastEthernet0/0
P 192.168.13.0/24, 1 successors, FD is 281600
   via Connected, Ethernet2/0
P 1.1.1.1/32, 1 successors, FD is 158720
   via 192.168.12.2 (158720/156160), FastEthernet0/0
   via 192.168.13.2 (412160/156160), Ethernet2/0
```

Variance = $412160/158720 = 2.596774193548387$ so we will take 3

Then go to eigrp

```
R1(config)#router eigrp 1
```

```
R1(config-router)#variance 3
```

```
R1#sh 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: 192.168.13.1
    Topology : 0 (base)
      Active Timer: 3 min
      Distance: internal 90 external 170
      Maximum path: 4
      Maximum hopcount 100
      Maximum metric variance 1

  Automatic Summarization: disabled
  Maximum path: 4
  Routing for Networks:
    0.0.0.0
  Routing Information Sources:
```

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```
R1(config)#router eigrp 1
R1(config-router)#v
R1(config-router)#variance 3
R1(config-router)#do sh ip rou
R1(config-router)#do sh ip rou
R1(config-router)#do sh ip rou eig
R1(config-router)#do sh ip rou eig
Codes: L - local, C - connected, S - static, 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
       i - IS-IS, su - IS-IS summary, 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, H - NHRP, l - LISP
       + - replicated route, % - next hop override

Gateway of last resort is not set

      1.0.0.0/32 is subnetted, 1 subnets
D       1.1.1.1 [90/412160] via 192.168.13.2, 00:00:06, Ethernet2/0
          [90/158720] via 192.168.12.2, 00:00:06, FastEthernet0/0
D       192.168.25.0/24 [90/30720] via 192.168.12.2, 00:00:06, FastEthernet0/0
D       192.168.35.0/24 [90/33280] via 192.168.12.2, 00:00:06, FastEthernet0/0
R1(config-router)#
```

```
R1#sh 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: 192.168.13.1
    Topology : 0 (base)
      Active Timer: 3 min
      Distance: internal 90 external 170
      Maximum path: 4
      Maximum hopcount 100
      Maximum metric variance 3

  Automatic Summarization: disabled
  Maximum path: 4
  Routing for Networks:
    0.0.0.0
  Routing Information Sources:
```

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