EIGRP Observation Lab – Fundamental Operations

Objective

The purpose of this lab is to observe the basic operation of EIGRP. This is an **observation-focused** lab. The learner should focus on what changes in the **EIGRP topology** table.

Topology Overview

There are 3 routers in the drawing, however **RTR1** will be the focus of this lab.

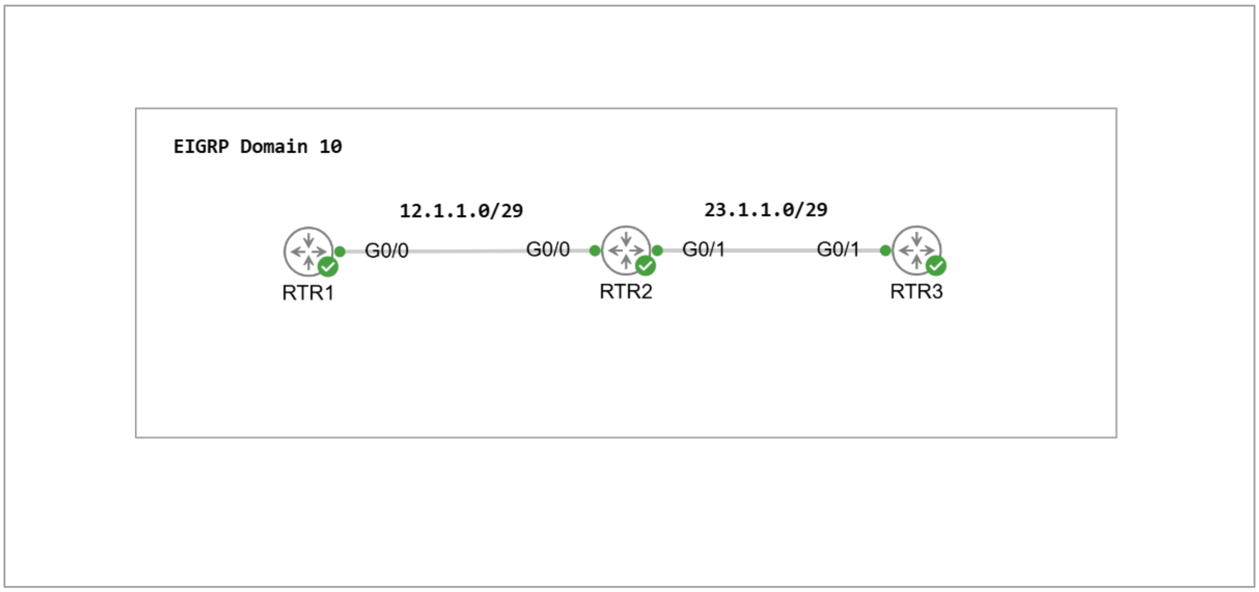

Figure 1 – Lab topology

Task 1 – View EIGRP Tables

View RTR1's EIGRP interface, topology, and neighbor tables. View the configured routing protocols.

```
show ip eigrp interfaces
show ip eigrp topology
show ip eigrp neighbor
show ip protocols
```

Expected Behavior

- EIGRP interface, topology, and neighbor tables are empty.
- No routing protocols configured.

Task 2 – Enable EIGRP

On RTR1, configure EIGRP Autonomous System (AS) 10 and enable interface GigabitEthernet 0/0 for EIGRP AS 10. There are two EIGRP modes: Classic and Named. This lab focuses on Classic mode. Named mode will be discussed in a later lab.

```
router eigrp 10
 network 12.1.1.1 0.0.0.0
```

Expected Behavior

- Interface Gi 0/0 appears in the EIGRP interface table.
- A route for 12.1.1.0/29 is installed in the topology table.
- No neighbors appear in the EIGRP neighbor table.
- EIGRP process 10 appears in the protocol table.

Verification

Figure 2 shows interface Gi0/0 enabled for EIGRP AS 10 and 0 peers. No adjacency is expected due to EIGRP not being enabled on RTR2.

```
EIGRP-IPv4 Interfaces for AS(10)
                        Xmit Queue   PeerQ        Mean   Pacing Time   Multicast    Pending
Interface        Peers  Un/Reliable  Un/Reliable  SRTT   Un/Reliable   Flow Timer   Routes
Gi0/0              0        0/0          0/0         0       0/0            0           0
RTR1#
```

Figure 2 – RTR1 show ip eigrp interface

Figure 3 shows a route for 12.1.1.0/29 installed. The EIGRP topology table stores routes that EIGRP knows about, including connected EIGRP-enabled networks and routes learned from neighbors. An outline of the components is in Table 1.

```
RTR1#sh ip eigrp topology
EIGRP-IPv4 Topology Table for AS(10)/ID(12.1.1.1)
Codes: P - Passive, A - Active, U - Update, Q - Query, R - Reply,
       r - reply Status, s - sia Status

P 12.1.1.0/29, 1 successors, FD is 2816
        via Connected, GigabitEthernet0/0

RTR1#
```

Figure 3 – RTR1 show ip eigrp topology

EIGRP Table Output	
Component	**Explanation**
P	The state of the route is **Passive**. Passive is the normal operating state of an EIGRP route and indicates that **DUAL** has already determined the best path and selected a Successor. You can think of Passive as DUAL having completed its work and being satisfied with the current route. If the current path is lost, DUAL places the route into an **Active** state. In the Active state, DUAL is actively working to determine a new best path to the destination. Once a new path is selected, the route returns to the Passive state. A simple way to remember the difference is: • **Passive** = DUAL knows the best path and the route is stable. • **Active** = DUAL is actively searching for a new best path.

Successor	A Successor is EIGRP's best loop-free path to a destination. The route is installed using the associated next hop. A destination can have one or more Successors when multiple equal-cost paths exist.
12.1.1.0/29	The destination prefix.
FD	FD stands for **Feasible Distance**. It is the best Composite metric selected by DUAL for the destination.

Table 1

Figure 4 shows an empty neighbor table. Previously, there was no output when the command was issued; however, the configured AS is present.

```
RTR1#sh ip eigrp neighbors
EIGRP-IPv4 Neighbors for AS(10)
RTR1#
```

Figure 4 – RTR1 show ip eigrp neighbor

Figure 5 shows the route details. *Table 2* outlines these details.

```
RTR1#sh ip eigrp topology 12.1.1.0/29
EIGRP-IPv4 Topology Entry for AS(10)/ID(12.1.1.1) for 12.1.1.0/29
  State is Passive, Query origin flag is 1, 1 Successor(s), FD is 2816
  Descriptor Blocks:
  0.0.0.0 (GigabitEthernet0/0), from Connected, Send flag is 0x0
      Composite metric is (2816/0), route is Internal
      Vector metric:
        Minimum bandwidth is 1000000 Kbit
        Total delay is 10 microseconds
        Reliability is 255/255
        Load is 1/255
        Minimum MTU is 1500
        Hop count is 0
        Originating router is 12.1.1.1
RTR1#
```

Figure 5 – RTR1 show ip eigrp topology 12.1.1.0/29

EIGRP Topology Table Output	
Component	**Explanation**
Composite metric	The Composite metric (CM) is the result of EIGRP's calculation. The CM of the best path is selected as the FD for the destination.
Internal	The route is **Internal** because it originated in the AS**.** In EIGRP there are **Internal**, **External**, and **Summary** routes.
Vector metrics	"Vector metrics are individual metrics used to calculate the Composite metric."
Originating router	This is the router that originated the route for this prefix.

Table 2

Several Vector metrics are used to calculate the CM. **Reliability**, **Load**, and **MTU**, are populated from the **outgoing interface's, toward the destination,** characteristics. By default, EIGRP uses Minimum bandwidth and Total delay to calculate the CM. The Vector metrics are outlined in *Table 3*. *Figure 6* shows interface Gi 0/0's values used to populate the Vector metrics.

Composite Metric Components	
Minimum bandwidth	The lowest bandwidth along the entire path to the destination network. This value may be local to the local router if it is connected to the lowest bandwidth link or, it could be the lowest bandwidth advertised by another EIGRP speaking router along the path.
Total delay	The sum of all delays to the destination. If the delay on one link along the path is 1 and the delay on another link along the path is 8, the Total delay is 9.
Reliability	How reliable the outgoing interface is.

Load	This is how busy the outgoing interface is.

Table 3

Note: MTU is not used to calculate the CM. It is still a Vector metric.

```
RTR1#sh interfaces gi0/0
GigabitEthernet0/0 is up, line protocol is up
  Hardware is iGbE, address is 5001.0001.0000 (bia 5001.0001.0000)
  Description: RTR2
  Internet address is 12.1.1.1/29
  MTU 1500 bytes, BW 1000000 Kbit/sec, DLY 10 usec,
     reliability 255/255, txload 1/255, rxload 1/255
  Encapsulation ARPA, loopback not set
```

Figure 6 – RTR1 show interface gi0/0

Question:

- There are 4 Vector metrics that can influence the CM. How does EIGRP know to use only Minimum bandwidth and Total delay in calculating the CM?

Task 3 – View EIGRP K-values

On RTR1, view the EIGRP K-values.

```
show ip protocols
```

Verification

Figure 7 shows information about EIGRP AS 10. The Metric weights or **K-values** are the answer. EIGRP knows which Vector metrics to use in the calculation of the Composite metric based on the individual values of K-values. *Table 4* outlines the K-values.

Each K-value is assigned a numerical value of either 1 or 0. A value of 1 results in the metric being included in the calculation while a value of 0 results in the metric being ignored. Observe that the default K-values align with the default behavior of using Minimum bandwidth and Total delay. K1 and K3 values are 1and the others are 0.

```
Routing Protocol is "eigrp 10"
  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(10)
    Metric weight K1=1, K2=0, K3=1, K4=0, K5=0
```

Figure 7 – RTR1 show ip protocols

K-Value Metrics	
K1	Minimum bandwidth
K2	Load
K3	Total delay
K4	Reliability
K5	Reliability weight

Table 4

Question

- How are the Vector metrics used to calculate the CM?

Engineer Insight

Vector metrics are placed in the following equation to calculate the CM.

$$\text{Composite Metric} = 256 \times \left[(K_1 \cdot \text{Bandwidth}) + \left(\frac{K_2 \cdot \text{Bandwidth}}{256 - \text{Load}}\right) + (K_3 \cdot \text{Delay})\right] \times \left[\frac{K_5}{\text{Reliability} + K_4}\right]$$

By default, EIGRP uses Minimum bandwidth and Total delay when calculating the CM allowing the previous equation to be simplified.

$$\text{Composite Metric} = 256 \times \left(\frac{10{,}000{,}000}{\text{Minimum bandwidth}} + \text{Total delay}\right)$$

The metric values are placed in the equation. Total delay is recorded in tens of microseconds. This explains the value of 1, for the Total delay instead of 10. If the Total delay had been 100, it would have resulted in a value of 10 in the equation. Do not concern yourself with the specifics.

$$\text{Composte Metric} = 256 \times \left(\frac{10{,}000{,}000}{1{,}000{,}000} + 1\right)$$

$$\text{Composite Metric} = 256 \times (10+1)$$

$$\text{Composite Metric} = 256 \times (11)$$

$$Composite\ Metric = 2816$$

The CM distance is **2816**. Compare this calculated metric against the CM in *Figure 5*. Observe that the CM and FD are both 2816. This occurs because only one path exists. As additional paths are learned, DUAL compares the CM and selects the best path's CM as the FD.

Task 4 – Calculate Composite Metric Based on Minimum Bandwidth

On RTR1, modify K3 so Minimum bandwidth is the only metric used. The first 0 in the command represents the **TOS** and is not of concern in this lab.

```
router eigrp 10
 metric weight 0 1 0 0 0 0
```

Expected Behavior

- The Composite metric is calculated based on Minimum bandwidth.

Question:

1. What would the equation look like? Write it out.
2. What would be the new value for the CM?

Verification

The equation to calculate the CM based solely on the Minimum bandwidth is below. The modified K-value is shown in *Figure 8*. K1, which represents Minimum bandwidth, has a value of 1. The remaining K-values have a value of 0 and will be ignored.

Composite Metric = 256 x (10,000,000 / 1,000,000)
Composite Metric = 256 x (10)
Composite Metric = 2560

```
Routing Protocol is "eigrp 10"
  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(10)
    Metric weight K1=1, K2=0, K3=0, K4=0, K5=0
```

Figure 8 – RTR1 show ip protocols output

```
P 12.1.1.0/29, 1 successors, FD is 2560
        via Connected, GigabitEthernet0/0

RTR1#
```

Figure 9 – RTR show ip eigrp topology output

Task 5 – Calculate Composite Metric Based on Total Delay

On RTR1, modify K1 so Total delay is the only metric used to calculate the CM.

```
router eigrp 10
  metric weight 0 0 0 1 0 0
```

Expected Behavior

- The Composite metric is calculated based on Total delay.

Question:

1. What would the equation look like? Write it out.
2. What would be the new value for the CM?

Verification

The equation to calculate the CM based solely on the Total delay metric is below. K3, which represents Total delay, has a value of 1. The remaining K-values have a value of 0 and will be ignored. The modified K-value is shown in *Figure 10.*

Composite metric = 256 x (1)
Composite metric = 256

```
Routing Protocol is "eigrp 10"
  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(10)
    Metric weight K1=0, K2=0, K3=1, K4=0, K5=0
```

Figure 10 – RTR1 show ip protocols output

```
P 12.1.1.0/29, 1 successors, FD is 256
        via Connected, GigabitEthernet0/0

RTR1#
```

Figure 11 – RTR show ip eigrp topology output