

Lecture 14- EIGRP (Enhanced Interior Gateway Routing Protocol)

What is EIGRP?

EIGRP (Enhanced Interior Gateway Routing Protocol) is an advanced dynamic routing protocol used inside an organization (IGP).

History:

- Introduced by Cisco in 1990
- From 1990–2013 → Cisco proprietary (worked only on Cisco routers)
- In 2013 → Open standard

 Earlier, both routers had to be Cisco devices.
Now it can work in multi-vendor environments.

Why EIGRP is Powerful?

EIGRP is:

-  Very fast
-  Loop-free
-  Uses bandwidth efficiently
-  Uses smart metric calculation
-  Sends partial updates (not full table like RIP)

Which Algorithm Does EIGRP Use?

EIGRP uses:

DUAL (Diffusing Update Algorithm)

DUAL is the **brain of EIGRP**.

Unlike RIP:

- RIP sends full routing table every 30 seconds
- EIGRP sends only changes

👉 That makes it faster and more efficient.

Real-Life Example of DUAL

Imagine you have:

- One main road (best path)
- One backup road (alternate path)

If main road closes 

You immediately use backup road without recalculating entire city map.

That is how DUAL works.

EIGRP Metrics

EIGRP uses **Composite Metric**, not just hop count.

Main Metrics:

-  Bandwidth (lowest bandwidth in path)
-  Delay (total delay in path)

Optional:

- Reliability
 - Load
 - MTU
-

EIGRP Metric Formula

Metric = $256 \times [(10^7 / \text{bandwidth}) + \text{delay}]$

- 👉 More accurate than RIP
 - 👉 Chooses better quality path
-

How EIGRP Works – Step by Step

1 Router Discovery & Neighbor Formation

- EIGRP sends **Hello packets**
- Multicast address: **224.0.0.10**
- If:
 - AS number matches
 - K values match

Then routers become neighbors 



Multicast Address Meaning

Multicast = Send message to group of devices in network.

Protocol Multicast IP

EIGRP 224.0.0.10

RIP 224.0.0.9

OSPF 224.0.0.5

2 DUAL Algorithm

DUAL finds:

- 🏆 Successor (Best Route)
- 💰 Feasible Successor (Backup Route)

◆ Feasibility Condition

A route becomes Feasible Successor if:

Reported Distance < Feasible Distance

This prevents routing loops.

3 Routing Table Formation

EIGRP has:

- Neighbor Table
- Topology Table
- Routing Table



4 Partial & Bounded Updates

Unlike RIP:

- ❌ RIP sends full table
- ✅ EIGRP sends only changed routes
- ✅ Sends only to specific neighbor

This saves:

- Bandwidth
 - CPU
 - Memory
-

EIGRP Timers

Timer LAN WAN

Hello 5 sec 60 sec

Hold 15 sec 180 sec

 Hold Timer = 3 × Hello Time

Active Timer

- 3 minutes
 - Used when route is recalculating
-



EIGRP Packet Types

Packet Purpose

Hello Discover neighbors

Update Send route changes

Query Ask neighbors

Reply Respond to query

ACK Confirm update



Administrative Distance (AD)

Route Type AD

Internal EIGRP 90

External EIGRP 170

Summary Route 5

Lower AD = More trusted.

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What is AS Number in EIGRP?

Example:

```
router eigrp 100
```

👉 100 = Autonomous System number

AS number is:

- A logical grouping
- Routers must have same AS number to become neighbors

If AS mismatch ✗

No neighbor relationship.



What is Passive Interface?

Passive interface:

- ✗ Does NOT send routing updates
- ✓ Still advertises network
- ✓ Receives updates

Why use it?

- Improve security
- Reduce unnecessary traffic
- Prevent fake neighbors

Used when:

Router interface connects to PCs (not routers)

Wildcard Mask in Networking

Wildcard Mask = Inverse of Subnet Mask

Formula:

Wildcard = 255.255.255.255 - Subnet Mask

Example:

Subnet: 255.255.255.0

Wildcard: 0.0.0.255

Used in:

- EIGRP
- OSPF
- ACL





EIGRP LAB (3 Router Topology)

█ Topology Design

PC1 PC2

\ /

Switch1

|

R1 ----- R2 ----- R3

| |

Switch2 Switch3

| |

PC3 PC4 PC5

🌐 IP Addressing Plan

Router Links

Link Network

R1–R2 192.168.10.0/24

R2–R3 192.168.20.0/24

LAN Networks

Router Network

R1 192.168.30.0/24

R2 192.168.40.0/24

R3 192.168.50.0/24

Router 1 Configuration (Step-by-Step)

```
Router> en
```

```
Router# conf t
```

```
hostname R1
```

Configure R1–R2 Link

```
int g0/0
```

```
ip address 192.168.10.1 255.255.255.0
```

```
no shutdown
```

Configure LAN Interface

```
int g0/1
```

```
ip address 192.168.30.1 255.255.255.0
```

```
no shutdown
```

Router 2 Configuration

```
en
```

```
conf t
```

```
hostname R2
```

R2–R1

```
int g0/0
```

```
ip address 192.168.10.2 255.255.255.0
```

```
no shutdown
```

R2–R3

```
int g0/1
```

```
ip address 192.168.20.1 255.255.255.0
```

```
no shutdown
```

LAN

```
int g0/2
ip address 192.168.40.1 255.255.255.0
no shutdown
```



Router 3 Configuration

```
en
conf t
hostname R3
```

R3–R2

```
int g0/0
ip address 192.168.20.2 255.255.255.0
no shutdown

LAN
int g0/1
ip address 192.168.50.1 255.255.255.0
no shutdown
```



PC Configuration

R1 LAN PCs

| PC | IP | Gateway |
|-----------|-----------|----------------|
|-----------|-----------|----------------|

| | | |
|-----|--------------|--------------|
| PC1 | 192.168.30.2 | 192.168.30.1 |
| PC2 | 192.168.30.3 | 192.168.30.1 |

R2 LAN PC

| PC3 | 192.168.40.2 |
Gateway: 192.168.40.1 |

R3 LAN PCs

PC IP

PC4 192.168.50.2

PC5 192.168.50.3

Gateway: 192.168.50.1



Apply EIGRP

◆ R1

router eigrp 100

network 192.168.10.0 0.0.0.255

network 192.168.30.0 0.0.0.255

passive-interface g0/1

👉 Passive because g0/1 connects to PCs.

◆ R2

router eigrp 100

network 192.168.10.0 0.0.0.255

network 192.168.20.0 0.0.0.255

network 192.168.40.0 0.0.0.255

passive-interface g0/2

◆ R3

```
router eigrp 100  
network 192.168.20.0 0.0.0.255  
network 192.168.50.0 0.0.0.255  
passive-interface g0/1
```



Verification Commands

1 Check Neighbors

```
show ip eigrp neighbors
```

Shows:

- Neighbor IP
- Interface
- Hold time
- SRTT
- RTO



2 Check Topology Table

```
show ip eigrp topology
```

Shows:

- Successor
- Feasible Successor
- FD (Feasible Distance)
- RD (Reported Distance)

3 Check Routing Table

show ip route

Look for:

D 192.168.x.x

D = EIGRP route



Why Passive Interface Used in This Lab?

Because:

- LAN side connects to PCs
 - PCs are not routers
 - No need to send EIGRP hello to them
 - Improves security
 - Reduces traffic
-

🏁 Final Testing

From PC1:

ping 192.168.50.2

If reply comes → EIGRP working successfully 🎉



Important Points

- EIGRP uses DUAL
- Metric = Bandwidth + Delay
- Multicast = 224.0.0.10
- AD = 90 (internal)
- Uses Partial Updates

- AS number must match
 - Passive interface improves security
-

Final Understanding

EIGRP = Smart + Fast + Efficient routing protocol 

It is much better than RIP

Faster convergence

Better metric

Loop-free design





1 COMPLETE DETAILED SUMMARY

💡 What is EIGRP?

EIGRP (Enhanced Interior Gateway Routing Protocol) is an advanced dynamic routing protocol used inside an organization (IGP).

📅 History

- Introduced by Cisco in 1990
- 1990–2013 → Cisco proprietary
- 2013 → Became open standard

👉 Earlier: Only Cisco routers

👉 Now: Works in multi-vendor environments

🔥 Why EIGRP is Powerful?

EIGRP is:

- ⚡ Very fast convergence
- 🔄 Loop-free (uses DUAL)
- 💻 Efficient bandwidth usage
- 📊 Uses intelligent composite metric
- 📦 Sends partial updates

Unlike RIP:

- ❌ RIP sends full table every 30 sec
 - ✅ EIGRP sends only changes
-

🧠 DUAL Algorithm (Brain of EIGRP)

EIGRP uses:

🧠 DUAL (Diffusing Update Algorithm)

DUAL:

- Finds best path
 - Keeps backup path ready
 - Prevents loops
 - Converges very fast
-

📍 Real-Life Example

Main road = Best path (Successor)

Backup road = Feasible Successor

If main road closes 🚧

Router instantly uses backup without recalculating whole network.



EIGRP Metrics

EIGRP uses **Composite Metric**

Main Metrics:

- Bandwidth (lowest in path)
- Delay (total delay)



Optional:

- Reliability
 - Load
 - MTU
-



Metric Formula

$$\text{Metric} = 256 \times [(10^7 / \text{bandwidth}) + \text{delay}]$$

👉 More accurate than RIP

👉 Chooses better quality path

EIGRP Working Process (Step-by-Step)

1 Neighbor Discovery

- Sends Hello packets
- Multicast address: **224.0.0.10**
- Conditions:
 - Same AS number
 - Same K-values

If mismatch ✗ → No neighbor

Multicast Comparison Table

Protocol Multicast IP

| | |
|-------|------------|
| EIGRP | 224.0.0.10 |
| RIP | 224.0.0.9 |
| OSPF | 224.0.0.5 |



2 DUAL Route Selection

DUAL finds:

-  Successor (Best Route)
-  Feasible Successor (Backup Route)

◆ Feasibility Condition

A route becomes backup if:

Reported Distance < Feasible Distance

This prevents routing loops 

EIGRP Tables

EIGRP maintains:

-  Neighbor Table
 -  Topology Table
 -  Routing Table
-

Partial & Bounded Updates

EIGRP:

- Sends only changed routes
 - Sends only to affected neighbors
 - Saves CPU, bandwidth & memory
-

EIGRP Timers

Timer LAN WAN

Hello 5 sec 60 sec

Hold 15 sec 180 sec

 Hold = 3 × Hello

Active Timer

- 3 minutes
 - Used during recalculation
-

EIGRP Packet Types

Packet Purpose

Hello Discover neighbors

Update Send route changes

Packet Purpose

Query Ask neighbors

Reply Respond

ACK Confirm receipt

💡 Administrative Distance (AD)

Route Type AD

Internal EIGRP 90

External EIGRP 170

Summary Route 5

👉 Lower AD = More trusted

🔢 AS Number in EIGRP

Example:

router eigrp 100

100 = Autonomous System number

✓ Routers must match AS

✗ AS mismatch = No neighbor

🔒 Passive Interface

Passive interface:

- ✗ Stops sending hello packets
- ✓ Still advertises network
- ✓ Improves security
- ✓ Reduces traffic

Used when interface connects to PCs.

Wildcard Mask

Formula:

$$\text{Wildcard} = 255.255.255.255 - \text{Subnet Mask}$$

Example:

Subnet → 255.255.255.0

Wildcard → 0.0.0.255

Used in:

- EIGRP
 - OSPF
 - ACL
-



LAB SUMMARY

Topology:

R1 — R2 — R3



Networks:

- 192.168.10.0
- 192.168.20.0
- 192.168.30.0
- 192.168.40.0
- 192.168.50.0

Verification:

- show ip eigrp neighbors
 - show ip eigrp topology
 - show ip route
-

COMPLETE MIND MAP

EIGRP

|

 └— Definition

|

 | └— IGP Protocol

|

 | └— Fast convergence

|

 └— Uses DUAL

|

 └— History

|

 | └— 1990 Cisco proprietary

|

 └— 2013 Open standard

|

 └— Metrics

|

 | └— Bandwidth

|

 | └— Delay

|

 | └— Reliability

|

 | └— Load

|

 └— MTU

|

 └— Formula

|

 └— $256[(10^7/BW)+Delay]$

|

 └— Algorithm

|

 └— DUAL

|

 | └— Successor



- | └— Feasible Successor
- | └— Feasibility Condition
- |
- | └— Tables
- | | └— Neighbor
- | | └— Topology
- | | └— Routing
- |
- | └— Timers
- | | └— Hello
- | | └— Hold
- | | └— Active
- |
- | └— Packets
- | | └— Hello
- | | └— Update
- | | └— Query
- | | └— Reply
- | | └— ACK
- |
- | └— AD
- | | └— Internal 90
- | | └— External 170
- | | └— Summary 5
- |
- | └— AS Number



|

|— Passive Interface

|

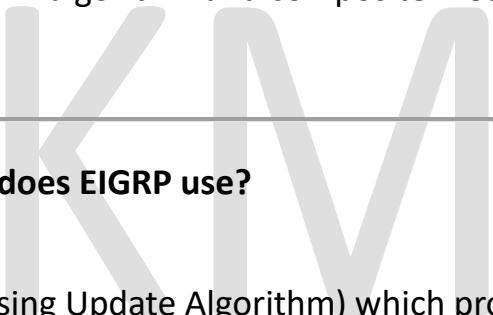
— Wildcard Mask

Q & A

Q 1 What is EIGRP?

Answer:

EIGRP is an advanced distance-vector routing protocol used inside an organization. It uses DUAL algorithm and composite metric for fast and loop-free routing.



Q 2 Which algorithm does EIGRP use?

Answer:

EIGRP uses DUAL (Diffusing Update Algorithm) which provides fast convergence and loop-free paths.

Q 3 What is Successor?

Answer:

Successor is the best path selected by DUAL and installed in routing table.

Q 4 What is Feasible Successor?

Answer:

Feasible Successor is a backup path that satisfies feasibility condition and is ready to use if main path fails.

Q 5 What is Feasibility Condition?

Answer:

Reported Distance < Feasible Distance.
It ensures loop-free backup path.

Q 6 What metrics does EIGRP use?

Answer:

Main: Bandwidth and Delay
Optional: Reliability, Load, MTU

Q 7 What is EIGRP multicast address?

Answer:

224.0.0.10

Q 8 What are EIGRP packet types?

Answer:

Hello, Update, Query, Reply, ACK

Q 9 What is AD of EIGRP?

Answer:

Internal → 90

External → 170

Summary → 5

Q 10 Difference between RIP and EIGRP?

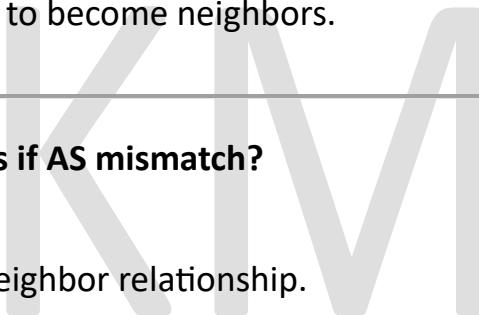
| RIP | EIGRP |
|--------------|------------------|
| Hop count | Composite metric |
| Slow | Fast |
| Full updates | Partial updates |
| Max 15 hops | No such limit |

Q 1 1 What is AS number?

Answer:

AS number is logical group number.

Routers must match AS to become neighbors.



Q 1 2 What happens if AS mismatch?

Answer:

Routers will not form neighbor relationship.

Q 1 3 What is Passive Interface?

Answer:

It disables hello packets on interface but still advertises network.

Q 1 4 What are EIGRP tables?

Answer:

Neighbor Table, Topology Table, Routing Table.

Q 1 5 Why is EIGRP faster than RIP?

Answer:

Because:

- Uses DUAL
 - Has backup route ready
 - Sends partial updates
-

FINAL CONCLUSION

- 🔥 EIGRP is one of the most powerful IGP protocols.
 - 🔥 It provides fast convergence.
 - 🔥 Uses intelligent metric calculation.
 - 🔥 Loop-free due to DUAL.
 - 🔥 More efficient than RIP.
 - 🔥 Ideal for medium to large enterprise networks.
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