**Module 9.Enhanced IGRP (EIGRP) and Open Shortest Path First (OSPF)**

Beginner Question

1. Explain EIGRP Metrics

Enhanced Interior Gateway Routing Protocol uses composite metric calculation formula to calculate and select the best available route for destination. This formula uses five metric components. These are Bandwidth, Load, Delay, Reliability and MTU. In order to understand how EIGRP composite metric calculation works, first we have to understand these five key metric components.

K-Values and EIGRP Metrics:

K-Values are the most confusing part of EIGRP. Usually newbies take K Values as EIGRP metric components. K Values are not the metric components in themself. They are only the place holder or influencer for actual metric components in metric calculation formula. So when we enable or disable a K value, actually we enable or disable its associate metric component.

EIGRP uses four components out of five to calculate the routing metric.

| 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] |

2. Explain several commands of EIGRP

* [address-family (EIGRP)](https://www.cisco.com/c/en/us/td/docs/routers/ncs6000/software/routing/command/reference/b-routing-cr-ncs6k/b-routing-cr-ncs6k_chapter_011.html#wp5333617880)
* [authentication keychain](https://www.cisco.com/c/en/us/td/docs/routers/ncs6000/software/routing/command/reference/b-routing-cr-ncs6k/b-routing-cr-ncs6k_chapter_011.html#wp2234731244)
* [auto-summary (EIGRP)](https://www.cisco.com/c/en/us/td/docs/routers/ncs6000/software/routing/command/reference/b-routing-cr-ncs6k/b-routing-cr-ncs6k_chapter_011.html#wp4243613510)
* [bandwidth-percent (EIGRP)](https://www.cisco.com/c/en/us/td/docs/routers/ncs6000/software/routing/command/reference/b-routing-cr-ncs6k/b-routing-cr-ncs6k_chapter_011.html#wp1540728310)
* [clear eigrp neighbors](https://www.cisco.com/c/en/us/td/docs/routers/ncs6000/software/routing/command/reference/b-routing-cr-ncs6k/b-routing-cr-ncs6k_chapter_011.html#wp6668313000)
* [clear eigrp topology](https://www.cisco.com/c/en/us/td/docs/routers/ncs6000/software/routing/command/reference/b-routing-cr-ncs6k/b-routing-cr-ncs6k_chapter_011.html#wp9019693170)
* [default-information](https://www.cisco.com/c/en/us/td/docs/routers/ncs6000/software/routing/command/reference/b-routing-cr-ncs6k/b-routing-cr-ncs6k_chapter_011.html#wp4153148243)
* [default-metric (EIGRP)](https://www.cisco.com/c/en/us/td/docs/routers/ncs6000/software/routing/command/reference/b-routing-cr-ncs6k/b-routing-cr-ncs6k_chapter_011.html#wp2827878695)
* [distance (EIGRP)](https://www.cisco.com/c/en/us/td/docs/routers/ncs6000/software/routing/command/reference/b-routing-cr-ncs6k/b-routing-cr-ncs6k_chapter_011.html#wp2106184732)
* [hello-interval (EIGRP)](https://www.cisco.com/c/en/us/td/docs/routers/ncs6000/software/routing/command/reference/b-routing-cr-ncs6k/b-routing-cr-ncs6k_chapter_011.html#wp2323069468)
* [hold-time (EIGRP)](https://www.cisco.com/c/en/us/td/docs/routers/ncs6000/software/routing/command/reference/b-routing-cr-ncs6k/b-routing-cr-ncs6k_chapter_011.html#wp3310748853)
* [interface (EIGRP)](https://www.cisco.com/c/en/us/td/docs/routers/ncs6000/software/routing/command/reference/b-routing-cr-ncs6k/b-routing-cr-ncs6k_chapter_011.html#wp3368574042)
* [log-neighbor-changes](https://www.cisco.com/c/en/us/td/docs/routers/ncs6000/software/routing/command/reference/b-routing-cr-ncs6k/b-routing-cr-ncs6k_chapter_011.html#wp3536274484)
* [log-neighbor-warnings](https://www.cisco.com/c/en/us/td/docs/routers/ncs6000/software/routing/command/reference/b-routing-cr-ncs6k/b-routing-cr-ncs6k_chapter_011.html#wp3012080982)
* [maximum-paths (EIGRP)](https://www.cisco.com/c/en/us/td/docs/routers/ncs6000/software/routing/command/reference/b-routing-cr-ncs6k/b-routing-cr-ncs6k_chapter_011.html#wp8366035500)
* [metric (EIGRP)](https://www.cisco.com/c/en/us/td/docs/routers/ncs6000/software/routing/command/reference/b-routing-cr-ncs6k/b-routing-cr-ncs6k_chapter_011.html#wp4183714253)
* [metric maximum-hops](https://www.cisco.com/c/en/us/td/docs/routers/ncs6000/software/routing/command/reference/b-routing-cr-ncs6k/b-routing-cr-ncs6k_chapter_011.html#wp1315545796)
* [metric weights](https://www.cisco.com/c/en/us/td/docs/routers/ncs6000/software/routing/command/reference/b-routing-cr-ncs6k/b-routing-cr-ncs6k_chapter_011.html#wp1189375024)
* [neighbor (EIGRP)](https://www.cisco.com/c/en/us/td/docs/routers/ncs6000/software/routing/command/reference/b-routing-cr-ncs6k/b-routing-cr-ncs6k_chapter_011.html#wp2323753960)
* [next-hop-self disable](https://www.cisco.com/c/en/us/td/docs/routers/ncs6000/software/routing/command/reference/b-routing-cr-ncs6k/b-routing-cr-ncs6k_chapter_011.html#wp3737103100)
* [nsf disable (EIGRP)](https://www.cisco.com/c/en/us/td/docs/routers/ncs6000/software/routing/command/reference/b-routing-cr-ncs6k/b-routing-cr-ncs6k_chapter_011.html#wp3961049560)
* [passive-interface (EIGRP)](https://www.cisco.com/c/en/us/td/docs/routers/ncs6000/software/routing/command/reference/b-routing-cr-ncs6k/b-routing-cr-ncs6k_chapter_011.html#wp6929370400)
* [redistribute (EIGRP)](https://www.cisco.com/c/en/us/td/docs/routers/ncs6000/software/routing/command/reference/b-routing-cr-ncs6k/b-routing-cr-ncs6k_chapter_011.html#wp3828743505)
* [route-policy (EIGRP)](https://www.cisco.com/c/en/us/td/docs/routers/ncs6000/software/routing/command/reference/b-routing-cr-ncs6k/b-routing-cr-ncs6k_chapter_011.html#wp3824184870)
* [router eigrp](https://www.cisco.com/c/en/us/td/docs/routers/ncs6000/software/routing/command/reference/b-routing-cr-ncs6k/b-routing-cr-ncs6k_chapter_011.html#wp2134251970)
* [router-id (EIGRP)](https://www.cisco.com/c/en/us/td/docs/routers/ncs6000/software/routing/command/reference/b-routing-cr-ncs6k/b-routing-cr-ncs6k_chapter_011.html#wp2106915717)
* [show protocols (EIGRP)](https://www.cisco.com/c/en/us/td/docs/routers/ncs6000/software/routing/command/reference/b-routing-cr-ncs6k/b-routing-cr-ncs6k_chapter_011.html#wp2336341901)
* [split-horizon disable (EIGRP)](https://www.cisco.com/c/en/us/td/docs/routers/ncs6000/software/routing/command/reference/b-routing-cr-ncs6k/b-routing-cr-ncs6k_chapter_011.html#wp4230151426)
* [stub (EIGRP)](https://www.cisco.com/c/en/us/td/docs/routers/ncs6000/software/routing/command/reference/b-routing-cr-ncs6k/b-routing-cr-ncs6k_chapter_011.html#wp3654559475)
* [summary-address (EIGRP)](https://www.cisco.com/c/en/us/td/docs/routers/ncs6000/software/routing/command/reference/b-routing-cr-ncs6k/b-routing-cr-ncs6k_chapter_011.html#wp1265621421)
* [timers active-time](https://www.cisco.com/c/en/us/td/docs/routers/ncs6000/software/routing/command/reference/b-routing-cr-ncs6k/b-routing-cr-ncs6k_chapter_011.html#wp9370521270)
* [timers nsf route-hold (EIGRP)](https://www.cisco.com/c/en/us/td/docs/routers/ncs6000/software/routing/command/reference/b-routing-cr-ncs6k/b-routing-cr-ncs6k_chapter_011.html#wp2847855228)
* [variance](https://www.cisco.com/c/en/us/td/docs/routers/ncs6000/software/routing/command/reference/b-routing-cr-ncs6k/b-routing-cr-ncs6k_chapter_011.html#wp3736724202)

**address-family (EIGRP)**

To enable an IPv4 or IPv6 address family under Enhanced Interior Gateway Routing Protocol (EIGRP), use the address-family command in the appropriate mode. To remove the address family from the EIGRP configuration, use the no form of this command.

address-family {ipv4 | ipv6}

no address-family {ipv4 | ipv6}

## authentication keychain

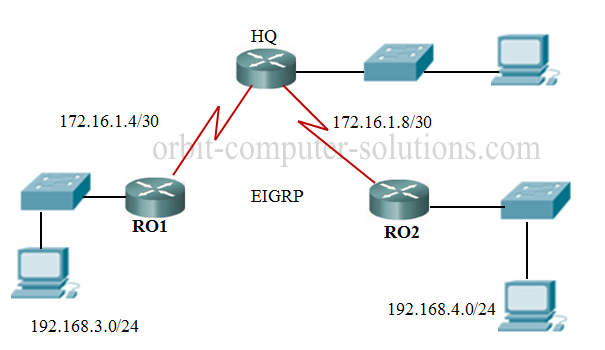
To authenticate all EIGRP protocol traffic on one or more interfaces based on the MD5 algorithm, use the authentication keychain command in an appropriate configuration mode. To disable authentication, use the no form of this command.

## auto-summary (EIGRP)

To allow automatic summarization of subnet routes into network-level routes for an Enhanced Interior Gateway Routing Protocol (EIGRP) process, use the auto-summary command in the appropriate configuration mode. To disable this function and send subprefix routing information across classful network boundaries, use the no form of this command.

Intermediate Question

1. Brief explain Configuring of EIGRP



To configure EIGRP on a network use the following command:

RO1>enable

RO1#configure terminal

RO1(config router)#eigrp 100

RO1(config-router)#network 192.168.3.0

RO1(config-router)#network 172.16.1.0

RO1(config-router)#no auto-summary

RO1(config-router)#end

From the command above, we used the command ***router eigrp 100*** to turn on the protocol, then we declare all directly connected network on router RO1. All other routers on the network must be configured the same way, each router must declare its directly connected network to be seen by other routers on the network, and most importantly, all routers on the same network running EIGRP must be configured with the same process number 100

**How to redistribute routes that were learned by the router into the EIGRP routing process;**

Use the redistribute command:

### Redistributing Routes into EIGRP:

HQ#configure terminal

HQ(config)#ip route 192.168.2.0 255.255.255.0 172.16.1.5

HQ(config)#router eigrp 100

HQ(config-router)#redistribute static

HQ(config-router)#end

HQ#

Setting the properties of the routes that are redistributed from another routing protocol with the default-metric command:

HQ#configure terminal

HQ(config)#router eigrp 100

HQ(config-router)#redistribute rip

HQ(config-router)#default-metric 1000 100 250 100 1500

HQ(config-router)#end

Use the show ip protocols command to view your route redistribution.

#### How to Create a Default Route in EIGRP.

You want to propagate a default route within EIGRP. Configuring EIGRP to propagate a default route is by simply redistributing a static route to 0.0.0.0/0,

Use the following commands;

HQ#configure terminal

HQ(config)#ip route 0.0.0.0 0.0.0.0 172.16.1.5

HQ(config)#access-list 7 permit 0.0.0.0

HQ(config)#router eigrp 100

HQ(config-router)#redistribute static

HQ(config-router)#distribute-list 7 out static

HQ(config-router)#end

Router1#

If you log on to other routers, you will see that EIGRP is forwarding this route, and that it is accepted as a candidate default route. Use the following command to view:

Router2#show ip route 0.0.0.0

2. Explain brief Open Shortest Path First (OSPF) Basics

OSPF Open Shortest Path First  is a link-state routing protocol. It operates as a classless routing protocol that uses the concept of **areas** for network scalability. RFC 2328 defines the OSPF metric as an arbitrary value called **cost**. The Cisco IOS uses bandwidth as the OSPF cost metric.

OSPF’s major advantages over RIP are its fast convergence and its scalability to much larger network implementations.

OSPF has a default administrative distance of 110. As a classless routing protocol, it does not use a Transport layer protocol, as OSPF packets are sent directly over IP.

The OSPF Hello packet is used to establish neighbor adjacencies. By default, OSPF Hello packets are sent :

1. Every 10 seconds on multi-access and point-to-point segments
2. Every 30 seconds on non-broadcast multi-access (NBMA) segments (Frame Relay, X.25, ATM).

The OSPF router ID is used to exclusively identify each router in the OSPF routing domain. Cisco routers derive the router ID based on three criteria and with the following preference:

1. the Use of the IP address configured with the OSPF **router ID** command.
2. If the **router ID** is not configured, the router chooses highest IP address of any of its loopback interfaces.
3. If no loopback interfaces are configured, the router chooses highest active IP address of any of its physical interfaces.
4. Open Shortest Path First (OSPF) is a popular routing protocol for IP networks for several key reasons:-
5. It is classless,
6. Offers full CIDR and VLSM support,
7. It scales well, converges quickly, and guarantees loop free routing.
8. It also supports address summarization and the tagging of external routes, similar to EIGRP.

3. Explain and config OSPF areas

An OSPF network can be divided into sub-domains called areas. An area is a logical collection of OSPF networks, routers, and links that have the same area identification. A router within an area must maintain a topological database for the area to which it belongs. The router does not have detailed information about network topology outside of its area, which thereby reduces the size of its database.

Areas limit the scope of route information distribution. It is not possible to do route update filtering within an area. The link-state database (LSDB) of routers within the same area must be synchronized and be exactly the same; however, route summarization and filtering is possible between different areas. The main benefit of creating areas is a reduction in the number of routes to propagate - by the filtering and the summarization of routes.

Each OSPF network that is divided into different areas must follow these rules:

* A backbone area - which combines a set of independent areas into a single domain - must exist.
* Each non-backbone area must be directly connected to the backbone area (though this connection might be a simple logical connection through a virtual link).
* The backbone area must not be partitioned - divided into smaller pieces - under any failure conditions, such as link or router down events.

Areas are identified by an area ID. Cisco IOS**®** software supports area IDs expressed in IP address format or decimal format, for example, area 0.0.0.0 is equal to area 0. If there are multiple areas in your network, you need to name the backbone area "area 0". Since this backbone connects the areas in your network, it must be a contiguous area. If the backbone is partitioned, parts of the autonomous system will be unreachable, and you will need to configure virtual links to repair the partition.

A router with interfaces in two (or more) different areas is an area border router. An area border router is in the OSPF boundary between two areas. Both sides of any link always belong to the same OSPF area.

An autonomous system boundary router (ASBR) advertises external destinations throughout the OSPF autonomous system. External routes are the routes redistributed into OSPF from any other protocol. In many cases, external link states make up a large percentage of the link states in the databases of every router. A stub area is an area in which you do not allow advertisements of external routes, which thus reduces the size of the database even more. Instead, a default summary route (0.0.0.0) is inserted into the stub area in order to reach these external routes. If you have no external routes in your network, then you have no need to define stub areas.

An OSPF area consists of routers configured with the same area ID. To include a router in a specific area, the common area ID must be assigned and an interface identified.

If your network consists of multiple areas, you must also configure a backbone area (0.0.0.0) on at least one router. The backbone contains the area border routers and other routers not included in other areas. The backbone distributes routing information between areas. To maintain backbone connectivity, there must be at least one interface in the backbone area or a virtual link must be configured to another router in the backbone area.

The minimal configuration must include an area ID and an interface. Modifying other command parameters is optional.

Use the following CLI syntax to configure an OSPF area (in the config>router context):

**CLI Syntax:**

Ospf

area area-id

area-range ip-prefix/mask [advertise | not-advertise]

Advance question

1. Find Troubleshooting command of OSPF

The show ip ospf command is also useful to verify configuration. While most of the output is out of scope of CCNA, a few things such as Router ID, Area related information, and SPF related information is useful.

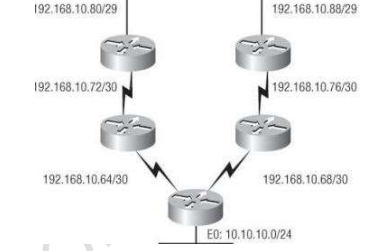
RouterA#show ip ospf

RouterD#sh ip ospf interface

RouterC#show ip ospf neighbor

RouterC#sh ip ospf database

2. Configuring EIGRP and OSPF



**EIGRP:**

**R1:**

R1(config)#router eigrp 1

R1(config-router)#network 10.10.10.0

R1(config-router)#network 192.168.10.64

R1(config-router)#network 192.168.10.68

R1(config-router)#

**R2:**

R2(config)#router eigrp 1

R2(config-router)#network 192.168.10.64

R2(config-router)#network 10.10.10.0

R2(config-router)#network 192.168.10.72

R2(config-router)#

**R3:**

R3(config)#router eigrp 1

R3(config-router)#network 192.168.10.72

R3(config-router)#network 192.168.10.80

R3(config-router)#

**R4:**

R4(config)#router eigrp 1

R4(config-router)#network 192.168.10.68

R4(config-router)#network 10.10.10.0

R4(config-router)#network 192.168.10.76

R4(config-router)#

**R5:**

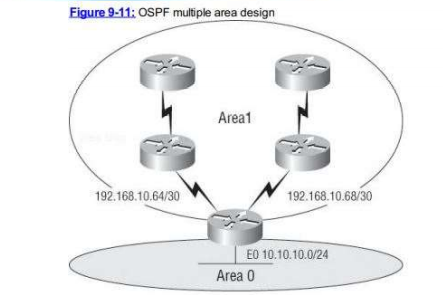
R5(config)#router eigrp 1

R5(config-router)#network 192.168.10.76

R5(config-router)#network 192.168.10.88

R5(config-router)#

3. OSPF Explain with command



**R1:**

R1(config)#router ospf 1

R1(config-router)#network 10.10.10.0 0.0.0.255 area 0

R1(config-router)#network 192.168.10.64 0.0.0.255 area 1

R1(config-router)#network 192.168.10.68 0.0.0.255 area 1

R1(config-router)#

**R2:**

R2(config)#router ospf 1

R2(config-router)#network 192.168.10.64 0.0.0.255 area 1

R2(config-router)#network 10.10.10.0 0.0.0.255 area 0

R2(config-router)#

**R3:**

R3(config)#router ospf 1

R3(config-router)#network 192.168.10.68 0.0.0.255 area 1

R3(config-router)#network 10.10.10.0 0.0.0.255 area 0

R3(config-router)#