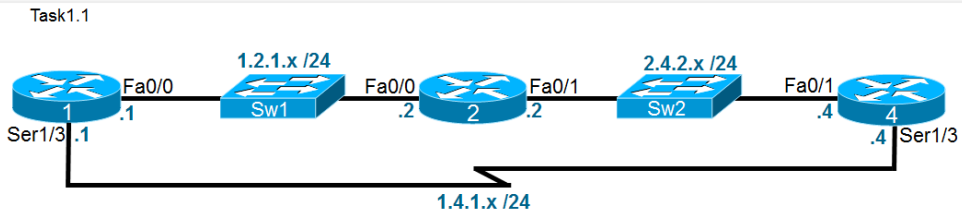
CCNP ROUTE Workbook - EIGRP

EIGRP Initial Configuration

> Load the *task1-1* initial configurations before starting.



Task

- Configure EIGRP on Routers-1, 2, and 4 using the following guidelines:
  - Classic-mode EIGRP configuration should be used (not Named Mode).
  - All routers should be in EIGRP Autonomous System 100.
  - Routes should not be summarized by any EIGRP router.
  - On Router-1, EIGRP should be activated on all physical interfaces using a single "network" command without any wildcard mask.
  - On Router-2, EIGRP should be activated on all physical interfaces with two distinct "network" commands utilizing specific wildcard masks that are the inverse of the configured interface subnet masks.
  - On Router-4, use the command **network 0.0.0.0** without any wildcard mask to activate EIGRP on all interfaces.

Router-1 Configuration

```
Router-1#conf t
Enter configuration commands, one per line.  End with CNTL/Z. Router-1(config)#router eigrp 100
Router-1(config-router)#no auto-summary
Router-1(config-router)#network 1.0.0.0

Router-1(config-router)#end
Router-1#
```

Router-2 Configuration

```
Router-2#conf t
Enter configuration commands, one per line.  End with CNTL/Z. Router-2(config)#router eigrp 100
Router-2(config-router)#no auto-summary
Router-2(config-router)#network 1.2.1.0 0.0.0.255
Router-2(config-router)#network 2.4.2.0 0.0.0.255

Router-2(config-router)#end
Router-2#
```

Router-4 Configuration

```
Router-4#conf t
Enter configuration commands, one per line.  End with CNTL/Z. Router-4(config)#router eigrp 100
Router-4(config-router)#no auto-summary
Router-4(config-router)#network 0.0.0.0

Router-4(config-router)#end
Router-4#
```

Verification

At this point, each router should have two EIGRP neighbors, and each router should have learned a single EIGRP route. Use the following "show" commands to verify that you have successfully configured EIGRP on your routers:

- **show ip eigrp neighbor**
- **show ip eigrp topology**
- **show ip route eigrp**

Router-1 Verification

```
Router-1#show ip eigrp neighbor
EIGRP-IPv4 Neighbors for AS(100)
H   Address                 Interface              Hold Uptime   SRTT   RTO  Q  Seq
                                                   (sec)         (ms)       Cnt Num1
1.4.1.4                     Se1/3
                   14 00:04:37   10  1170  0  6
```

```
0 1.2.1.2                 Fa0/0
                    12 00:06:20    3   100  0  8
Router-1#
```

```
Router-1#show ip eigrp topology
EIGRP-IPv4 Topology Table for AS(100)/ID(1.4.1.1)
Codes: P - Passive, A - Active, U - Update, Q - Query, R - Reply,
       r - reply Status, s - sia Status

P 1.4.1.0/24, 1 successors, FD is 20512000
        via Connected, Serial1/3
P 1.2.1.0/24, 1 successors, FD is 28160
        via Connected, FastEthernet0/0P 2.4.2.0/24, 1 successors, FD is 30720
via 1.2.1.2 (30720/28160), FastEthernet0/0
via 1.4.1.4 (20514560/28160), Serial1/3


Router-1#
```

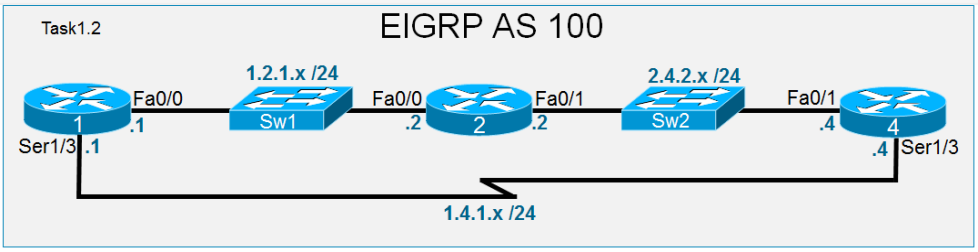
```
Router-1#sho ip route eigrp
Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
...
<output omitted for brevity>
...
Gateway of last resort is not set

      2.0.0.0/24 is subnetted, 1 subnets
D        2.4.2.0 [90/30720] via 1.2.1.2, 00:05:16, FastEthernet0/0

Router-1#
```

Repeat the three commands above on Router-2 and Router-4. Both routers should have two EIGRP neighbors and a single EIGRP-learned route in the IP Routing Table.

CCNP ROUTE Workbook - EIGRP

EIGRP Neighborships

Load the *task1-2* initial configurations before starting.



Task

In this task you will experience how various configuration changes affect EIGRP neighborships. The idea is to intentionally implement a configuration change that will break the EIGRP neighborship between two routers, view any syslogs and/or debug output, and then resolve the problem.

- On Router-2, copy the existing EIGRP configuration into a text editor and change the Autonomous System to AS 200.
- Remove the existing EIGRP configuration from Router-2 and paste in the revised version (with the wrong Autonomous System number) back into Router-2.

Router-2 Configuration

```
Router-2#sh run | section eigrp
router eigrp 100
network 1.2.1.0 0.0.0.255
network 2.4.2.0 0.0.0.255

Router-2#
```

Router-2 with changed configuration

```
Router-2(config)#no router eigrp 100
```

```
Router-2(config)# Router-2(config)#router eigrp 200
Router-2(config-router)#network 1.2.1.0 0.0.0.255
Router-2(config-router)#network 2.4.2.0 0.0.0.255

Router-2(config-router)#end
```

Verification

You should notice that when two routers have mismatched EIGRP Autonomous Systems, there is absolutely no indication of that problem in any syslogs. And no matter what debug you attempt to enable, you will not see any indication of this problem.

Task

- On Router-2, remove the existing EIGRP configuration and reconfigure it to be in the proper Autonomous System (AS 100). Ensure that Router-2 has regained both of its EIGRP neighbors before proceeding to the next bullet.
- On Router-2, reconfigure interface FastEthernet0/0 with the following IP address parameters:
  - An IP address of **2.2.2.2 /24 as the primary address**.
  - An IP address of **1.2.1.2 as the secondary address**.
- Observe the affect (on both R1 and R2) that your IP addressing change has on the EIGRP neighborship between routers R1 and R2.

Router-2 Configuration

```
Router-2(config-router)#int fast 0/0
Router-2(config-if)#ip address 2.2.2.2 255.255.255.0
Router-2(config-if)#
Dec 15 13:43:59.130: %DUAL-5-NBRCHANGE: EIGRP-IPv4 100: Neighbor 1.2.1.1 (FastEthernet0/0) is down: interface down
Router-2(config-if)#ip address 1.2.1.2 255.255.255.0 secondary

Router-2(config-if)#end
```

Router-2 Verification

On Router-2 you should notice that every few seconds it declares Router-1 as its neighbor, and then a few seconds later the neighborship with Router-1 goes down

indicating that "**retry limit exceeded**".

```
Dec 15 13:44:15.842: %DUAL-5-NBRCHANGE: EIGRP-IPv4 100:
Neighbor 1.2.1.1 (FastEthernet0/0) is up: new adjacency
Router-2#Dec 15 13:45:35.354: %DUAL-5-NBRCHANGE: EIGRP-IPv4 100:
Neighbor 1.2.1.1 (FastEthernet0/0) is down: retry limit exceeded

Router-2#
Dec 15 13:45:38.246: %DUAL-5-NBRCHANGE: EIGRP-IPv4 100: Neighbor 1.2.1.1 (FastEthernet0/0) is up: new adjacency
Router-2#
Dec 15 13:46:57.774: %DUAL-5-NBRCHANGE: EIGRP-IPv4 100: Neighbor 1.2.1.1 (FastEthernet0/0) is down: retry limit exce
Router-2#
Dec 15 13:47:02.126: %DUAL-5-NBRCHANGE: EIGRP-IPv4 100: Neighbor 1.2.1.1 (FastEthernet0/0) is up: new adjacency
Router-2#
```

Router-1 Verification

On Router-1 you should notice that roughly every 15 seconds an error message is reported indicating receipt of EIGRP Hello packets from a connected router that does not share the same IP subnet as Router-1.

```
Dec 15 13:49:28.410: %DUAL-6-NBRINFO: EIGRP-IPv4 100:
Neighbor 2.2.2.2 (FastEthernet0/0) is blocked: not on common subnet (1.2.1.1/24)
Router-1#Dec 15 13:49:42.522: %DUAL-6-NBRINFO: EIGRP-IPv4 100:
Neighbor 2.2.2.2 (FastEthernet0/0) is blocked: not on common subnet (1.2.1.1/24)

Router-1#
```

From Router-2's perspective, it is receiving EIGRP Hello packets sourced from the primary (and only) IP address of Router-1 (1.2.1.1). Router-2 does have this subnet configured on its interface as a secondary subnet so it attempts to send an EIGRP Update packet to Router-1.

Router-1 (as is seen by the Syslogs) is blocking Router-2 because the source IP address of Router-2's EIGRP Hello's (2.2.2.2) is not from a subnet that Router-1 recognizes on the link they share. So when Router-1 receives the EIGRP Update from Router-2, it simply discards it without sending any kind of reply.

Because EIGRP has reliability built in to the protocol, Router-2 attempts to resend the EIGRP Update to Router-1 several times before giving up, and bringing down the neighborship with the message, "retry limit exceeded".

Task

- On Router-2, remove all IP addresses from interface FastEthernet0/0 and reconfigure the address of 1.2.1.2/24 as the primary (and only) IP address on this interface.
- On Router-2, issue the command `show ip protocols` and write down the values you see under the EIGRP section, for Metric Weights.
- On Router-2, change the metric weights (K-values) to anything other than the default values and notice what happens to the EIGRP neighborship between R1 and R2.

Router-2 Configuration

```
Router-2#sho ip protocols
...
<output omitted for brevity>
...
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
  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-2(config)#router eigrp 100
Router-2(config-router)#metric weights 4 2 1 3 4 5
Router-2(config-router)#end
Router-2#
Dec 15 14:03:17.398: %DUAL-5-NBRCHANGE: EIGRP-IPv4 100: Neighbor 1.2.1.1 (FastEthernet0/0) is down: metric changed
Dec 15 14:03:17.398: %DUAL-5-NBRCHANGE: EIGRP-IPv4 100: Neighbor 2.4.2.4 (FastEthernet0/1) is down: metric changed
Router-2#
Dec 15 14:03:19.142: %SYS-5-CONFIG_I: Configured from console by console
Dec 15 14:03:19.718: %DUAL-5-NBRCHANGE: EIGRP-IPv4 100:
Neighbor 2.4.2.4 (FastEthernet0/1) is down: K-value mismatch
```

On Router-2, change the metric weights (K-values) back to their default values.

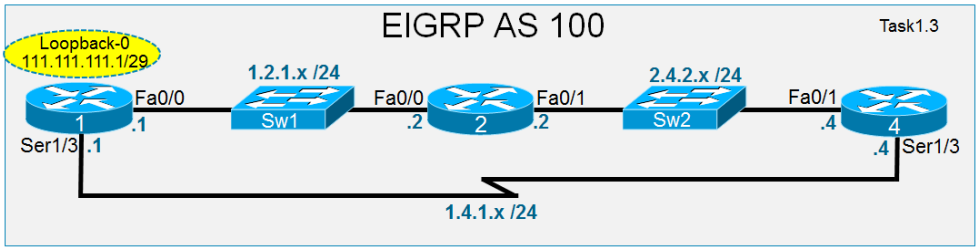
Router-2 Configuration

```
Router-2(config)#router eigrp 100
Router-2(config-router)#metric weights 0 1 0 1 0 0
```

CCNP ROUTE Workbook - EIGRP

EIGRP Metric Manipulation: BW and Delay

> Load the *task1-3* initial configurations before starting.



Task

In the topology diagram, notice that router R1 now has a Loopback interface. In this task you will be advertising that loopback into EIGRP, and then manipulating the EIGRP distance on Router-4 so that it load-balances traffic to this new network across both the Serial and FastEthernet interfaces of router R4.

> If you are doing this lab on your own equipment, ensure that the Bandwidth or clockrate of your Serial interface on R4 connecting to R1 is set to 128 Kbps.

- On router R1, add a new "network" command (along with a specific wildcard mask) to your EIGRP process so that the network on your Loopback0 interface is advertised into EIGRP.
- View the IP routing table on router R4 and verify that the preferred path to reach this new subnet is via the FastEthernet link leading upstream to router R2.
- On router R4, view the EIGRP Topology table, specifically for network 111.111.111.0/29, and notice the difference between the current Feasible Distance and the total Distance of the path to this same network via the Serial link.

Answer this question: If your objective were to load-balance packets destined to 111.111.111.0 equally across your FastEthernet and Serial interfaces on router R4, do you think there would be a way, by changing JUST the bandwidth or JUST the delay of interface Serial1/3 (not both) on R4, that you could achieve that goal?

- If you answered "yes": What value would you select as the new bandwidth, or the new delay?
- If you answered "no": Why do you consider this impossible?

Router-1 Configuration

```
Router-1(config)#router eigrp 100
Router-1(config-router)#network 111.111.111.0 0.0.0.7

Router-1(config-router)#end
Router-1#
```

Verification of received route on R4

```
Router-4#show 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
<output omitted for brevity>
...
Gateway of last resort is not set

      1.0.0.0/8 is variably subnetted, 3 subnets, 2 masks
D        1.2.1.0/24 [90/30720] via 2.4.2.2, 18:01:13, FastEthernet0/1
      111.0.0.0/29 is subnetted, 1 subnets
D        111.111.111.0 [90/158720] via 2.4.2.2, 00:01:08, FastEthernet0/1

Router-4#
```

```
Router-4#sho ip eigrp topology 111.111.111.0/29
EIGRP-IPv4 Topology Entry for AS(100)/ID(2.4.2.4) for 111.111.111.0/29
  State is Passive, Query origin flag is 1, 1 Successor(s), FD is 158720
  Descriptor Blocks: 2.4.2.2 (FastEthernet0/1), from 2.4.2.2
, Send flag is 0x0      Composite metric is (158720
/156160), route is Internal
      Vector metric:
        Minimum bandwidth is 100000 Kbit
        Total delay is 5200 microseconds
        Reliability is 255/255
        Load is 1/255
        Minimum MTU is 1500
```

```
        Hop count is 2
        Originating router is 1.4.1.1
  1.4.1.1 (Serial1/3), from 1.4.1.1, Send flag is 0x0
      Composite metric is (20640000/128256), route is Internal
      Vector metric:
        Minimum bandwidth is 128 Kbit
        Total delay is 25000 microseconds
        Reliability is 255/255
        Load is 1/255
        Minimum MTU is 1500
        Hop count is 1
        Originating router is 1.4.1.1
Router-4#
```

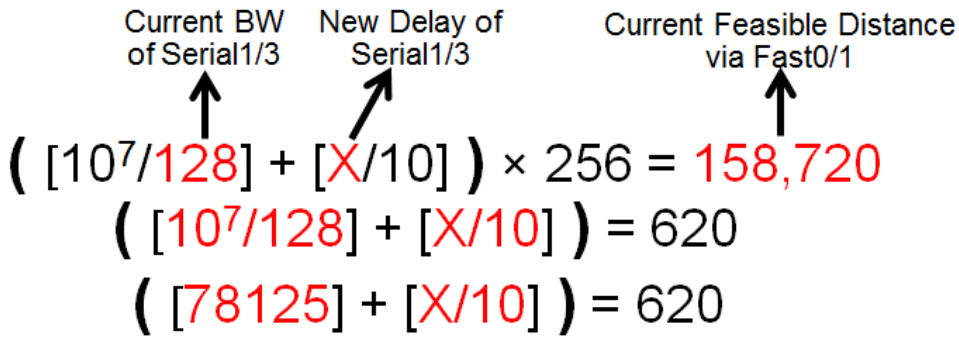
Verification

Because there is such a huge difference between the Feasible Distance (158720) and the total distance via the Serial interface (20640000), you hopefully came to the conclusion that there is no way to manipulate just the delay or just the bandwidth of the Serial interface to accomplish load-balancing.

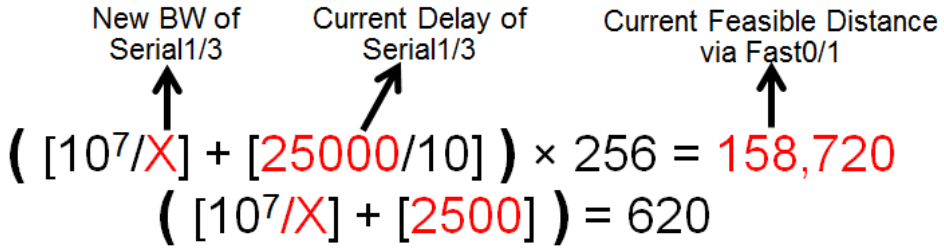
Here is the EIGRP formula, reduced to only the portions that have non-zero K-Values.

$$\left(K1 \times [10^7/BW(Kbps)] + K3 \times [Delay(\mu Secs)/10] \right) \times 256$$

Notice that if we attempt to reduce just the delay, the delay would have to equate to a negative number so that when added against the bandwidth (of 78,125) the total equaled 620. Because there is no way to set an interface delay to a negative number, the objective of equal-cost load-balancing is not achievable by just manipulating the interface delay.



Using the same formula but trying to solve for a new Bandwidth gives us the same dilemma. Any new bandwidth number added to the existing delay of 2500 would have to equate to a negative value, which is impossible.

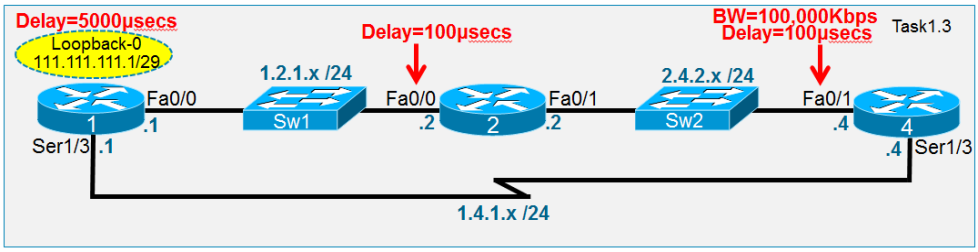


Task

- On router, R4, change both the bandwidth and delay values of interface Serial1/3 to accomplish equal-cost load-balancing across both FastEthernet0/1 and Serial1/3 for any packets destined for 111.111.111.0/29.

Router-4 Configuration

```
Router-4(config)#int ser 1/3
Router-4(config-if)#bandwidth 100000
Router-4(config-if)#delay 20

Router-4(config-if)#end
```



Router-4 Verification

```
Router-4#shoW ip eigrp topology 111.111.111.0/29
EIGRP-IPv4 Topology Entry for AS(100)/ID(2.4.2.4) for 111.111.111.0/29
  State is Passive, Query origin flag is 1, 2 Successor(s), FD is 158720
  Descriptor Blocks:
  1.4.1.1 (Serial1/3), from 1.4.1.1, Send flag is 0x0      Composite metric is (158720
/128256), route is Internal
      Vector metric:
        Minimum bandwidth is 100000 Kbit
```

```
        Total delay is 5200 microseconds
        Reliability is 255/255
        Load is 1/255
        Minimum MTU is 1500
        Hop count is 1
        Originating router is 1.4.1.1
  2.4.2.2 (FastEthernet0/1), from 2.4.2.2, Send flag is 0x0      Composite metric is (158720
/156160), route is Internal
      Vector metric:
        Minimum bandwidth is 100000 Kbit
        Total delay is 5200 microseconds
        Reliability is 255/255
        Load is 1/255
        Minimum MTU is 1500
        Hop count is 2
        Originating router is 1.4.1.1
```

```
Router-4#sho 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
<output omitted for brevity>
...
Gateway of last resort is not set

      1.0.0.0/8 is variably subnetted, 3 subnets, 2 masks
D        1.2.1.0/24 [90/30720] via 2.4.2.2, 00:08:20, FastEthernet0/1
      111.0.0.0/29 is subnetted, 1 subnets
D        111.111.111.0 [90/158720] via 2.4.2.2, 00:08:20, FastEthernet0/1
                       [90/158720] via 1.4.1.1, 00:08:20, Serial1/3
```

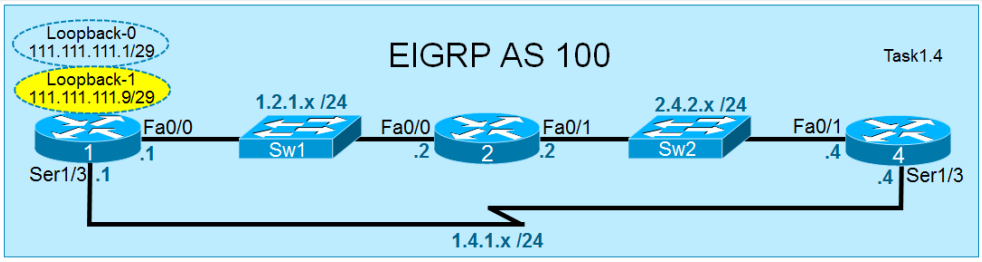
Hopefully by now you have realized that if you want to manipulate EIGRP metrics to accomplish deterministic path selection, changing bandwidth and/or delay variables is a painful way to accomplish that objective.

In the next task you will see an alternative (and much easier) way to accomplish this same objective by utilizing Offset-Lists.

CCNP ROUTE Workbook - EIGRP

EIGRP Metric Manipulation: Offset-Lists

> Load the *task1-4* initial configurations before starting.



Task

Notice in the topology diagram for this task that router R1 now has a second Loopback interface (Loopback-1). The subnet on this loopback is already being advertised into EIGRP and should be seen on routers R2 and R4.

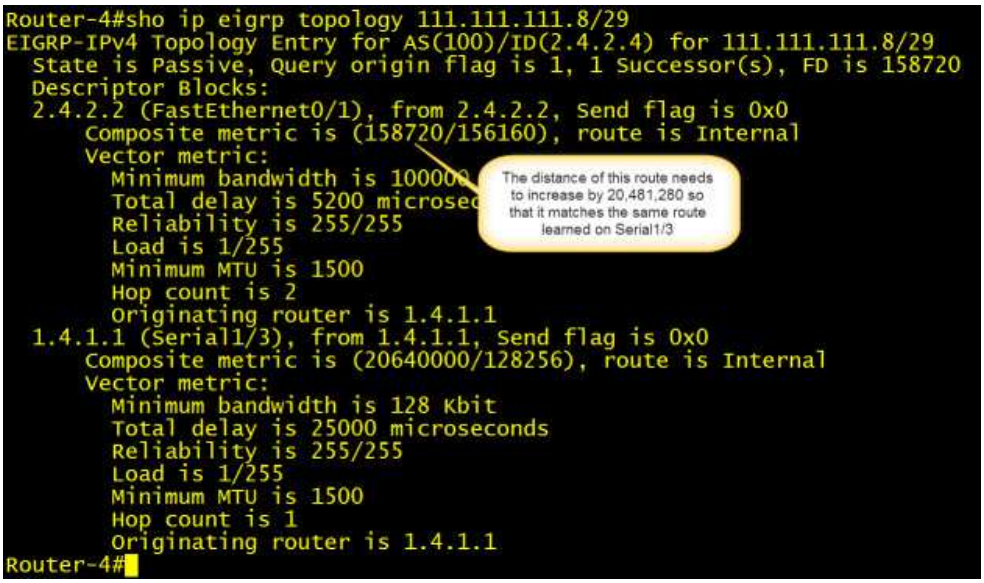
In this task you will manipulate the EIGRP distance on Router-4 using an Offset-List so that it load-balances traffic to this new network (111.111.111.8/29) across both the Serial and FastEthernet interfaces of router R4, without affecting any other EIGRP-learned routes.

> If you are doing this lab on your own equipment, ensure that the Bandwidth or clockrate of your Serial interface on R4 connecting to R1 is set to 128 Kbps.

- On router R4, create an Access-List that matches only on the 111.111.111.8/29 subnet.
- On router R4, within the EIGRP 100 process, apply an Offset-List that:
  - References the Access-List you just created.
  - Increases the EIGRP distance of that route (only when learned on FastEthernet0/1) so that the total distance matches the distance of this same route as learned on Serial1/3.

Router-4 Configuration

```
Router-4(config)#access-list 1 permit 111.111.111.8 0.0.0.7
Router-4(config)#router eigrp 100
Router-4(config-router)#offset-list 1 in 20481280 FastEthernet0/1

Router-4(config-router)#end
Router-4#
```



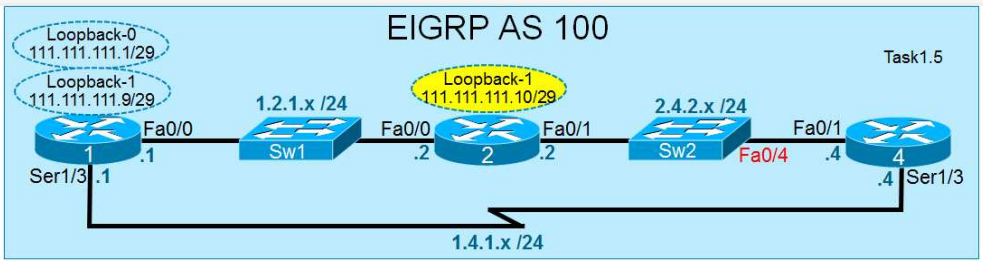
Verification on R4

```
Router-4#sho 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
<output omitted for brevity>
...
Gateway of last resort is not set

      1.0.0.0/8 is variably subnetted, 3 subnets, 2 masks
D        1.2.1.0/24 [90/30720] via 2.4.2.2, 00:15:22, FastEthernet0/1
      111.0.0.0/29 is subnetted, 2 subnets
D        111.111.111.0 [90/158720] via 2.4.2.2, 00:15:22, FastEthernet0/1
D        111.111.111.8 [90/20640000] via 2.4.2.2, 00:00:50, FastEthernet0/1
 [90/20640000] via 1.4.1.1, 00:00:50, Serial1/3
```

CCNP ROUTE Workbook - EIGRP

EIGRP Stuck-In-Active

> Load the *task1-5* initial configurations before starting.



Task

Notice in the topology diagram for this task that router R2 now has a new Loopback interface (Loopback-1) that is in the same subnet as the Loopback-1 interface of router R1. The subnet on this loopback is already being advertised into EIGRP and should be seen in the EIGRP topology tables of routers R1 and R4.

In this task you will artificially cause a route on router R2 to go into the Active state. You will then induce a Stuck-In-Active condition between R2 and R4.

> If you are doing this lab on your own equipment, ensure that the Bandwidth or clockrate of your Serial interface on R4 connecting to R1 is set to 128 Kbps.

- On router R2, view the EIGRP topology table for the specific subnet of 111.111.111.8/29.
  - Is router R1 (which also owns this subnet) listed as a Feasible Successor for this route?
  - Why or why not?
- Manipulate your EIGRP configuration so that when interface FastEthernet0/4 on Switch-2 (connected to Router-4) becomes disabled, that router R2 will not detect the loss of its EIGRP neighbor (router R4) for 600 seconds.

Router-2 EIGRP Topology Table

```
Router-2#sho ip eigrp topology

EIGRP-IPv4 Topology Table for AS(100)/ID(2.4.2.2)
Codes: P - Passive, A - Active, U - Update, Q - Query, R - Reply,
       r - reply Status, s - sia Status

P 1.4.1.0/24, 2 successors, FD is 20514560
        via 1.2.1.1 (20514560/20512000), FastEthernet0/0
        via 2.4.2.4 (20514560/20512000), FastEthernet0/1
P 1.2.1.0/24, 1 successors, FD is 28160
        via Connected, FastEthernet0/0P 111.111.111.8/29, 1 successors, FD is 128256
via Connected, Loopback1

P 2.4.2.0/24, 1 successors, FD is 28160
        via Connected, FastEthernet0/1
P 111.111.111.0/29, 1 successors, FD is 156160
        via 1.2.1.1 (156160/128256), FastEthernet0/0
```

As you can see from the output above, Router-1 is not showing as a Feasible Successor for the subnet of 111.111.111.8/29. This is because R1's Reported Distance is exactly equal to R2's Feasible Distance for this same network. This qualifies as a possible routing loop and does not pass the Feasibility Condition.

```
Router-2#sho ip eigrp topology all-links

EIGRP-IPv4 Topology Table for AS(100)/ID(2.4.2.2)
Codes: P - Passive, A - Active, U - Update, Q - Query, R - Reply,
       r - reply Status, s - sia Status

P 1.4.1.0/24, 2 successors, FD is 20514560, serno 27
        via 1.2.1.1 (20514560/20512000), FastEthernet0/0
        via 2.4.2.4 (20514560/20512000), FastEthernet0/1
P 1.2.1.0/24, 1 successors, FD is 28160, serno 18
        via Connected, FastEthernet0/0P 111.111.111.8/29, 1 successors,FD is 128256
, serno 30
        via Connected, Loopback1via 1.2.1.1 (156160/128256
), FastEthernet0/0
P 2.4.2.0/24, 1 successors, FD is 28160, serno 19
        via Connected, FastEthernet0/1
P 111.111.111.0/29, 1 successors, FD is 156160, serno 22
        via 1.2.1.1 (156160/128256), FastEthernet0/0

Router-2#
```

R4 Configuration of EIGRP Hold-Interval

```
Router-4(config)#interface fast 0/1
Router-4(config-if)#ip hold-time eigrp 100 600

Router-4(config-if)#end
```

Verification of new, received EIGRP Hold-Interval on R2

```
Router-2#sho ip eigrp neighbor

EIGRP-IPv4 Neighbors for AS(100)
H   Address                 Interface              Hold Uptime   SRTT   RTO  Q  Seq
                                                   (sec)         (ms)       Cnt Num
1   1.2.1.1                 Fa0/0                    12 22:20:21    1   100  0  27
0   2.4.2.4                 Fa0/1598
 22:20:25    1   100  0  53
```

```
Router-2#
```

Task

At the moment, Router-2 has a connected network to 111.111.111.8/29. If this network were to fail (you shut down the loopback interface), Router-2 would send an EIGRP Query to its neighbors about this network.

If your network was working as expected, Routers R1 and R4 would respond almost instantly to this EIGRP Query with an EIGRP Reply. R4 would reply that it has no alternative path to this network, and R1 would reply that it DID have an alternative path to this network (because it also has a direct connection to that network). So it would be virtually impossible to see (on Router-2) this network go into the "Active" state because the Query/Reply process would be almost instantaneous.

> Read through the following bullets before you take any further action, so that you are familiar with what you will be doing and why.

- In Router-2, enable the command `ebug eigrp packet query reply .`
- Log in to Switch-2 and **shut down interface FastEthernet0/4** (connecting to Router-4).
  - Router-2 will not immediately notice that it has lost connectivity to its EIGRP neighbor of R4 because it is not directly connected (there is a switch in between) and because R2 has been told to wait 600 seconds before declaring a neighbor down due to a loss of EIGRP Hellos.
- In Router-2, **shut down the Loopback-1 interface**. This should induce this router to generate an EIGRP Query.

- **View the EIGRP Topology** table in R2 and verify that the entry for **111.111.111.8/29** is now in the **Active** state.
- Examine how long it takes for Router-2 to receive an EIGRP Reply.
- Verify that, even after the EIGRP Reply has been received from Router-1, the following are true:
  - Router-2 still believes it has a neighbor with Router-4 (because the Hold-Interval has not expired yet).
  - Router-2 continues to send EIGRP Queries to Router-4 about every 5 seconds.
  - Router-2 does not install the alternative path (via Router-1) to the

111.111.111.8/29 subnet into its IP Routing Table because it is waiting for an EIGRP Reply from Router-4.

- Watch as, after about 3 minutes, Router-2 places its neighbor, Router-4, into the Stuck-In-Active state, which finally allows Router-2 to install the alternative path to network 111.111.111.8/29 subnet via Router-1.

Configuration

```
Router-2#debug eigrp packet query reply

    (QUERY, REPLY)
EIGRP Packet debugging is on
Router-2#
```

```
Sw-2(config)#int fast 0/4
Sw-2(config-if)#shutdown

Sw-2(config-if)#end
Sw-2#
```

```
Router-2#conf t
Enter configuration commands, one per line.  End with CNTL/Z. Router-2(config)#interface loopback 1
Router-2(config-if)#shutdown

Router-2(config-if)#^Z
Router-2#
```

```
Router-2# Dec 16 12:46:28.168: EIGRP: Enqueueing QUERY on Fa0/1
 - paklen 0 tid 0 iidbQ un/rely 0/1 serno 31-31 Dec 16 12:46:28.168: EIGRP: Enqueueing QUERY on Fa0/0
 - paklen 0 tid 0 iidbQ un/rely 0/1 serno 31-31 Dec 16 12:46:28.172: EIGRP: Sending QUERY on Fa0/1
 - paklen 45 tid 0
Dec 16 12:46:28.172:   AS 100, Flags 0x0:(NULL), Seq 61/0 interfaceQ 0/0 iidbQ un/rely 0/0 serno 31-31
Dec 16 12:46:28.172: EIGRP: Sending QUERY on Fa0/0
 - paklen 45 tid 0
Dec 16 12:46:28.172:   AS 100, Flags 0x0:(NULL), Seq 62/0 interfaceQ 0/0 iidbQ un/rely 0/0 serno 31-31
Dec 16 12:46:28.192: EIGRP: Received REPLY on Fa0/0 - paklen 45 nbr 1.2.1.1
Dec 16 12:46:28.192:   AS 100, Flags 0x0:(NULL), Seq 29/62 interfaceQ 0/0 iidbQ un/rely 0/0 peerQ un/rely 0/0
Dec 16 12:46:28.272: EIGRP: Sending QUERY on Fa0/1 - paklen 45 nbr 2.4.2.4, retry 1
, RTO 150 tid 0
```

```
Dec 16 12:46:28.272:   AS 100, Flags 0x0:(NULL), Seq 61/53 interfaceQ 0/0 iidbQ un/rely 0/0 peerQ un/rely 0/1 serno
Dec 16 12:46:28.424: EIGRP:Sending QUERY on Fa0/1 - paklen 45 nbr 2.4.2.4,retry 2
, RTO 225 tid 0
Dec 16 12:46:28.424:   AS 100, Flags 0x0:(NULL), Seq 61/53 interfaceQ 0/0 iidbQ un/rely 0/0 peerQ un/rely 0/1 serno
...
<output omitted for brevity>
...
```

The entry in the EIGRP topology table should now reflect an **Active** state.

```
Router-2#sho ip eigrp topology
EIGRP-IPv4 Topology Table for AS(100)/ID(2.4.2.2)
Codes: P - Passive, A - Active, U - Update, Q - Query, R - Reply,
       r - reply Status, s - sia Status

P 1.4.1.0/24, 2 successors, FD is 20514560
        via 1.2.1.1 (20514560/20512000), FastEthernet0/0
        via 2.4.2.4 (20514560/20512000), FastEthernet0/1
P 1.2.1.0/24, 1 successors, FD is 28160
        via Connected, FastEthernet0/0A 111.111.111.8/29
, 1 successors, FD is Infinity, Q1 replies, active 00:00:05
, query-origin: Local origin
        via 1.2.1.1 (156160/128256), FastEthernet0/0
Remaining replies:          via 2.4.2.4, r, FastEthernet0/1
```

Notice that while the Queries are continually being re-sent by Router-2 toward Router-4, the alternative path to network **111.111.111.8/29** (via Router-1) still has not been installed into Router-2's IP Routing Table.

```
Router-2#sho 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
```

```
      1.0.0.0/8 is variably subnetted, 3 subnets, 2 masks
D        1.4.1.0/24 [90/20514560] via 2.4.2.4, 02:29:13, FastEthernet0/1
                    [90/20514560] via 1.2.1.1, 02:29:13, FastEthernet0/0
      111.0.0.0/29 is subnetted, 1 subnets
D        111.111.111.0 [90/156160] via 1.2.1.1, 04:41:37, FastEthernet0/0
Router-2#
```

As you can see below, almost 3 minutes after the first EIGRP Query was sent to Router-4 (the first EIGRP Query timestamp was 12:**46:28.**168), Router-2 still believes that Router-4 is an EIGRP neighbor.

```
Dec 16 12:49:19.488: EIGRP: Sending QUERY on Fa0/1 - paklen 45 nbr 2.4.2.4, retry 42
, RTO 5000 tid 0
Dec 16 12:49:19.488:   AS 100, Flags 0x0:(NULL), Seq 61/53 interfaceQ 0/0 iidbQ un/rely 0/0 peerQ un/rely 0/2 serno
 Dec 16 12:49:24.488: EIGRP: Sending QUERY on Fa0/1 - paklen 45 nbr 2.4.2.4, retry 43
, RTO 5000 tid 0
Dec 16 12:49:24.488:   AS 100, Flags 0x0:(NULL), Seq 61/53 interfaceQ 0/0 iidbQ un/rely 0/0 peerQ un/rely 0/2 serno
```

```
Router-2#sho ip eigrp neighbor
EIGRP-IPv4 Neighbors for AS(100)
H   Address                 Interface              Hold Uptime   SRTT   RTO  Q  Seq
                                                   (sec)         (ms)       Cnt Num
1   1.2.1.1                 Fa0/0                    11 22:44:03    1   100  0  29
0   2.4.2.4                 Fa0/1                   387 22:44:07    1  5000  2  53

Router-2#
```

After 3 minutes you should have observed the following message indicating that (from Router-2's perspective) Router-4 had gone into the Stuck-In-Active state, and then the neighborship is finally taken down.

```
Router-2#Dec 16 12:49:28.188: %DUAL-3-SIA: Route 111.111.111.8/29 stuck-in-active state
 in base 100.  Cleaning up
Router-2#Dec 16 12:49:28.188:
%DUAL-5-NBRCHANGE: EIGRP-IPv4 100: Neighbor 2.4.2.4 (FastEthernet0/1) is down: stuck in active

Router-2#
```

Immediately following the loss of R4 as a neighbor, R2 is able to place the alternative route to 111.111.111.8/29 (via Router-1) into its Routing Table.

```
Router-2#sho 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
...
<output omitted for brevity>
...

Gateway of last resort is not set

      1.0.0.0/8 is variably subnetted, 3 subnets, 2 masks
D        1.4.1.0/24 [90/20514560] via 1.2.1.1, 00:00:11, FastEthernet0/0
      111.0.0.0/29 is subnetted, 2 subnets
D        111.111.111.0 [90/156160] via 1.2.1.1, 04:44:07, FastEthernet0/0
D        111.111.111.8 [90/156160] via 1.2.1.1, 00:00:11, FastEthernet0/0
```

Turn off all debugging on Router-2.

```
Router-2#un all
```

Task

- Finally, change the Active Timer on R2 so that when any EIGRP entry goes into the Active state, the router will only wait 1 minute for EIGRP Replies from any neighbor (rather than 3 minutes) before declaring that neighbor as Stuck-In-Active.

Configuration

```
Router-2(config-if)# Router-2(config-if)#router eigrp 100

Router-2(config-router)#timers active ?
  <1-65535>  active state time limit in minutes
  disabled   disable time limit for active state
 Router-2(config-router)#timers active 1

Router-2(config-router)#end
```

Verification

```
Router-2(config)#int loop 1
  Router-2(config-if)#shut
```

```
Router-2#sho ip eigrp topology
EIGRP-IPv4 Topology Table for AS(100)/ID(2.4.2.2)
Codes: P - Passive, A - Active, U - Update, Q - Query, R - Reply,
       r - reply Status, s - sia Status

P 1.4.1.0/24, 2 successors, FD is 20514560
        via 1.2.1.1 (20514560/20512000), FastEthernet0/0
        via 2.4.2.4 (20514560/20512000), FastEthernet0/1
P 1.2.1.0/24, 1 successors, FD is 28160
        via Connected, FastEthernet0/0A 111.111.111.8/29
, 1 successors, FD is Infinity, Q    1 replies, active 00:00:10
, query-origin: Local origin
        via 1.2.1.1 (156160/128256), FastEthernet0/0
      Remaining replies:
         via 2.4.2.4, r, FastEthernet0/1
```

```
Router-2#sho ip eigrp topology
EIGRP-IPv4 Topology Table for AS(100)/ID(2.4.2.2)
Codes: P - Passive, A - Active, U - Update, Q - Query, R - Reply,
       r - reply Status, s - sia Status

P 1.4.1.0/24, 2 successors, FD is 20514560
        via 1.2.1.1 (20514560/20512000), FastEthernet0/0
        via 2.4.2.4 (20514560/20512000), FastEthernet0/1
```

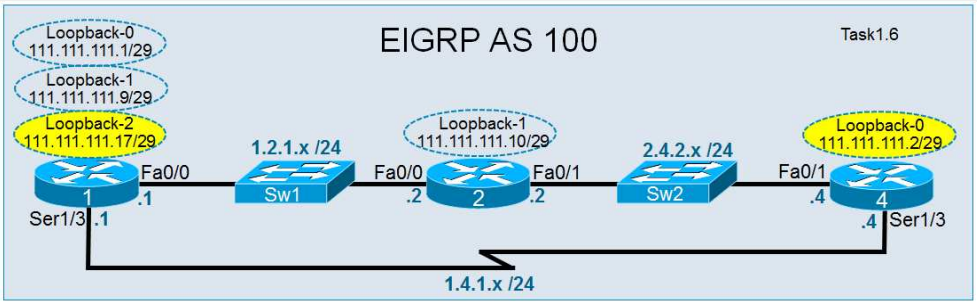
```
P 1.2.1.0/24, 1 successors, FD is 28160
        via Connected, FastEthernet0/0
A 111.111.111.8/29, 1 successors, FD is Infinity, Qq     1 replies, active 00:00:57
, query-origin: Local origin, retries(1)
        via 1.2.1.1 (156160/128256), FastEthernet0/0
      Remaining replies:
         via 2.4.2.4, r, FastEthernet0/1
    SIA-Stuck: 1 peers
      Peers:
         via 2.4.2.4, s, FastEthernet0/1
```

```
Router-2#Dec 16 13:31:17.928: %DUAL-3-SIA: Route 111.111.111.8/29 stuck-in-active state
 in base 100.  Cleaning up
Router-2#Dec 16 13:31:17.928:
%DUAL-5-NBRCHANGE: EIGRP-IPv4 100: Neighbor 2.4.2.4 (FastEthernet0/1) is down: stuck in active


Router-2#
```

CCNP ROUTE Workbook - EIGRP

EIGRP Route Filtering with Distribute-Lists (Standard ACLs)

> Load the *task1-6* initial configurations before starting.



Task

Notice in the topology diagram for this task that routers R1 and R4 now have new Loopback interfaces that are already being advertised via EIGRP.

In this task you will practice EIGRP filtering techniques using Distribute-Lists that reference Standard Access-Lists.

> If you are doing this lab on your own equipment, ensure that the Bandwidth or clockrate of your Serial interface on R4 connecting to R1 is set to 128 Kbps.

- On router R2, create an EIGRP route filter that meets the following criteria:
  - This EIGRP filter should utilize a standard, numbered Access-List for route matching.
  - This filter should only match on (and filter) the subnet 111.111.111.16/29. All other subnets should not be filtered.
  - This filter should be configured in the inbound direction without referencing any specific interface.
- When you have completed this objective, R2 should not have any route or any EIGRP Topology entry for 111.111.111.16/29.

Configuration on R2

```
Router-2#conf t
Enter configuration commands, one per line.  End with CNTL/Z. Router-2(config)#
access-list 1 deny 111.111.111.16 0.0.0.7
Router-2(config)#access-list 1 permit any
Router-2(config)#router eigrp 100
Router-2(config-router)#distribute-list 1 in

Router-2(config-router)#end
Router-2#
```

R2 Verification

Within EIGRP, the only tool available to accomplish route filtering is the Distribute-List. When working with IPv4 routes, a Distribute-List must reference some other feature for the matching of routes. Distribute-Lists can reference Access-Lists, Prefix-Lists, or Route-Maps. Finally, when applying the Distribute-List within your EIGRP process, you must specify a direction (inbound or outbound) and, optionally, reference an interface.

Notice from the output below that when the Distribute-List is applied, the route to **111.111.111.16/29** no longer appears in the IP Routing Table or the EIGRP Topology Table.

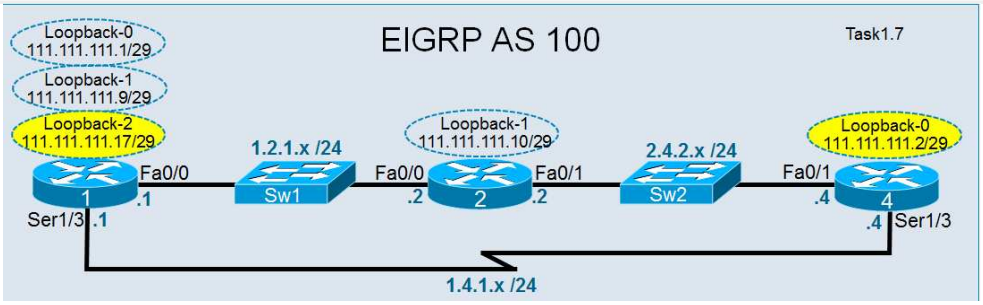
```
Router-2#show ip route eigrp

Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
...
<output omitted for brevity>
...

Gateway of last resort is not set

      1.0.0.0/8 is variably subnetted, 3 subnets, 2 masks
D        1.4.1.0/24 [90/20514560] via 2.4.2.4, 00:29:14, FastEthernet0/1
                    [90/20514560] via 1.2.1.1, 00:29:14, FastEthernet0/0
      111.0.0.0/8 is variably subnetted, 3 subnets, 2 masks
D        111.111.111.0/29 [90/156160] via 2.4.2.4, 00:28:04, FastEthernet0/1
                          [90/156160] via 1.2.1.1, 00:28:04, FastEthernet0/0
Router-2#
```

```
Router-2#sho ip eigrp topology

EIGRP-IPv4 Topology Table for AS(100)/ID(2.4.2.2)
Codes: P - Passive, A - Active, U - Update, Q - Query, R - Reply,
       r - reply Status, s - sia Status

P 1.4.1.0/24, 2 successors, FD is 20514560
        via 1.2.1.1 (20514560/20512000), FastEthernet0/0
        via 2.4.2.4 (20514560/20512000), FastEthernet0/1
P 1.2.1.0/24, 1 successors, FD is 28160
        via Connected, FastEthernet0/0
P 111.111.111.8/29, 1 successors, FD is 128256
        via Connected, Loopback1
P 2.4.2.0/24, 1 successors, FD is 28160
        via Connected, FastEthernet0/1
P 111.111.111.0/29, 2 successors, FD is 156160
        via 1.2.1.1 (156160/128256), FastEthernet0/0
        via 2.4.2.4 (156160/128256), FastEthernet0/1
```

CCNP ROUTE Workbook - EIGRP

EIGRP Route Filtering with Distribute-Lists (Extended ACLs)

> Load the *task1-7* initial configurations before starting.



Task

In this task you will practice EIGRP filtering techniques using Distribute-Lists that reference Extended Access-Lists.

> If you are doing this lab on your own equipment, ensure that the Bandwidth or clockrate of your Serial interface on R4 connecting to R1 is set to 128 Kbps.

- On router R2, create an EIGRP route filter that meets the following criteria:
  - This EIGRP filter should utilize an extended, numbered Access-List for route matching.
  - This filter should only match on (and filter) the subnet **111.111.111.0/29 if it was advertised from router R4**. All other subnets should not be filtered.
  - This filter should be configured in the inbound direction without referencing any specific interface.
- When you have completed this objective, R2 should only have a single EIGRP Topology entry, and a single IP Route entry for **111.111.111.0/29 with R1 as the next-hop**.

Configuration on R2

```
Router-2#conf t
Enter configuration commands, one per line.  End with CNTL/Z. Router-2(config)#
access-list 101 deny ip host 2.4.2.4 111.111.111.0 0.0.0.7
Router-2(config)#access-list 101 permit ip any any
Router-2(config)#       Router-2(config)#router eigrp 100
Router-2(config-router)#distribute-list 101 in

Router-2(config-router)#end
Router-2#
```

R2 Verification

When an EIGRP Distribute-List references an Extended Access-List the portion of the ACL that one normally thinks of as referring to the "source" in this case references the route source (or EIGRP neighbor advertising the route) and the "destination" portion of the ACL matches on the Route that you want to filter.

Before implementation of the Distribute-List, we see that the route for 111.111.111.0/29 is in the IP Routing Table with two next-hops, R1 and R4.

```
Router-2#show 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
...
<Output omitted for brevity>
...

Gateway of last resort is not set

      1.0.0.0/8 is variably subnetted, 3 subnets, 2 masks
C        1.2.1.0/24 is directly connected, FastEthernet0/0
L        1.2.1.2/32 is directly connected, FastEthernet0/0
D        1.4.1.0/24 [90/20514560] via 2.4.2.4, 00:01:27, FastEthernet0/1
                    [90/20514560] via 1.2.1.1, 00:01:27, FastEthernet0/0
      2.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
C        2.4.2.0/24 is directly connected, FastEthernet0/1
L        2.4.2.2/32 is directly connected, FastEthernet0/1
      111.0.0.0/8 is variably subnetted, 4 subnets, 2 masks D111.111.111.0/29 [90/156160]
via 2.4.2.4, 00:01:27, FastEthernet0/1
                          [90/156160]via 1.2.1.1, 00:01:27, FastEthernet0/0

C        111.111.111.8/29 is directly connected, Loopback1
L        111.111.111.10/32 is directly connected, Loopback1
D        111.111.111.16/29 [90/156160] via 1.2.1.1, 00:01:27, FastEthernet0/0
```

After implementation of the Distribute-List, you can see that the route still exists in the IP Routing Table, but now it only has a single next-hop of R1.

```
Router-2#sho 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
...
<output omitted for brevity>
...

Gateway of last resort is not set

      1.0.0.0/8 is variably subnetted, 3 subnets, 2 masks
D        1.4.1.0/24 [90/20514560] via 2.4.2.4, 00:04:56, FastEthernet0/1
                    [90/20514560] via 1.2.1.1, 00:04:56, FastEthernet0/0
      111.0.0.0/8 is variably subnetted, 4 subnets, 2 masks
D        111.111.111.0/29 [90/156160] via 1.2.1.1, 00:00:12, FastEthernet0/0
```

```
D        111.111.111.16/29 [90/156160] via 1.2.1.1, 00:04:56, FastEthernet0/0
Router-2#
```

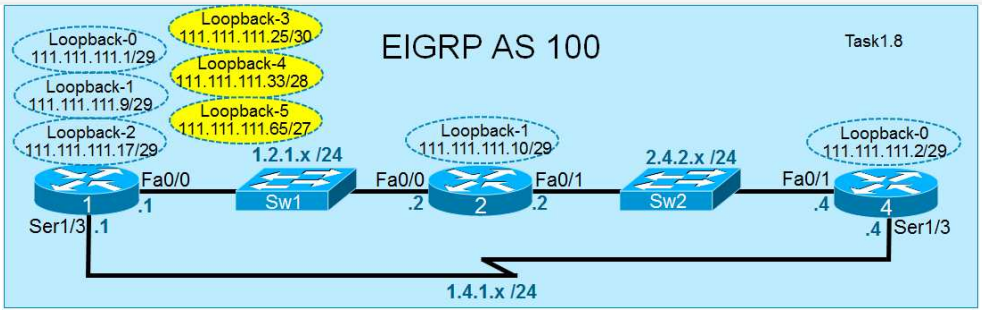
Within the EIGRP Topology Table, we can also verify that there is only a single entry for this route with a next-hop of R1.

```
Router-2#sho ip eigrp topology all-links
EIGRP-IPv4 Topology Table for AS(100)/ID(2.4.2.2)
Codes: P - Passive, A - Active, U - Update, Q - Query, R - Reply,
       r - reply Status, s - sia Status

P 1.4.1.0/24, 2 successors, FD is 20514560, serno 51
        via 1.2.1.1 (20514560/20512000), FastEthernet0/0
        via 2.4.2.4 (20514560/20512000), FastEthernet0/1
P 1.2.1.0/24, 1 successors, FD is 28160, serno 18
        via Connected, FastEthernet0/0
P 111.111.111.16/29, 1 successors, FD is 156160, serno 57
        via 1.2.1.1 (156160/128256), FastEthernet0/0
P 111.111.111.8/29, 1 successors, FD is 128256, serno 50
        via Connected, Loopback1
        via 1.2.1.1 (156160/128256), FastEthernet0/0
P 2.4.2.0/24, 1 successors, FD is 28160, serno 19
        via Connected, FastEthernet0/1P 111.111.111.0/29, 1 successors
, FD is 156160, serno 58 via 1.2.1.1 (156160/128256), FastEthernet0/0
```

CCNP ROUTE Workbook - EIGRP

EIGRP Route Filtering with Distribute-Lists (Prefix-Lists)

> Load the *task1-8* initial configurations before starting.



Task

In this task you will practice EIGRP filtering techniques using Distribute-Lists that reference a Prefix-List.

> If you are doing this lab on your own equipment, ensure that the Bandwidth or clockrate of your Serial interface on R4 connecting to R1 is set to 128 Kbps.

- On router R2, create an EIGRP route filter that meets the following criteria:
  - This EIGRP filter should utilize a Prefix-List named **INE** for route matching.
  - This filter should only match on (and filter) any subnet in which the first 25 bits of the prefix match 111.111.111.0 and the subnet mask is a /28 or /29.
  - The matching criteria above should be configured with just a single line of your Prefix-List.
  - A second line of your Prefix-List should ensure that no other subnets are filtered.
  - This filter should be configured in the inbound direction without referencing any specific interface.
- When you have completed this objective, R2 should **no longer** have any of the following routes or EIGRP Topology entries:
  - **111.111.111.32/28**

- **111.111.111.16/29**
- **111.111.111.0/29**

Configuration on R2

```
Router-2#conf t
Enter configuration commands, one per line.  End with CNTL/Z. Router-2(config)#
ip prefix-list INE seq 10 deny 111.111.111.0/25 ge 28 le 29
Router-2(config)#ip prefix-list INE seq 20 permit 0.0.0.0/0 le 32
Router-2(config)# Router-2(config)#router eigrp 100
Router-2(config-router)#distribute-list prefix INE in

Router-2(config-router)#end
Router-2#
```

R2 Verification

Before implementing the Distribute-List on R2, this is what your IP Routing Table should have looked like:

```
Router-2#show 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
...
<output omitted for brevity>
...

Gateway of last resort is not set

      1.0.0.0/8 is variably subnetted, 3 subnets, 2 masks
D        1.4.1.0/24 [90/20514560] via 2.4.2.4, 00:01:19, FastEthernet0/1
                    [90/20514560] via 1.2.1.1, 00:01:19, FastEthernet0/0
      111.0.0.0/8 is variably subnetted, 7 subnets, 5 masksD         111.111.111.0/29
 [90/156160] via 2.4.2.4, 00:01:09, FastEthernet0/1
                          [90/156160] via 1.2.1.1, 00:01:09, FastEthernet0/0D         111.111.111.16/29
 [90/156160] via 1.2.1.1, 00:01:19, FastEthernet0/0
D        111.111.111.24/30 [90/156160] via 1.2.1.1, 00:00:48, FastEthernet0/0D         111.111.111.32/28
 [90/156160] via 1.2.1.1, 00:00:47, FastEthernet0/0
D        111.111.111.64/27 [90/156160] via 1.2.1.1, 00:00:16, FastEthernet0/0
```

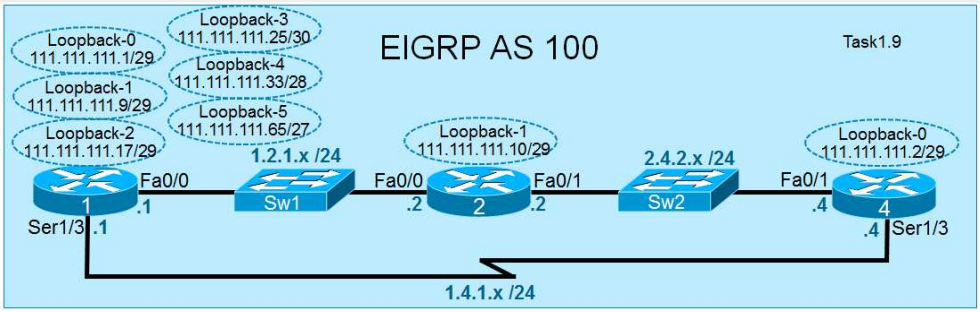
After implementation of the Distribute-List, you should see that all of the routes that have been highlighted above are now gone (have been filtered).

```
Router-2#sho 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
...
<output omitted for brevity>
...

Gateway of last resort is not set

      1.0.0.0/8 is variably subnetted, 3 subnets, 2 masks
D        1.4.1.0/24 [90/20514560] via 2.4.2.4, 00:12:58, FastEthernet0/1
                    [90/20514560] via 1.2.1.1, 00:12:58, FastEthernet0/0
      111.0.0.0/8 is variably subnetted, 4 subnets, 4 masks
D        111.111.111.24/30 [90/156160] via 1.2.1.1, 00:12:27, FastEthernet0/0
D        111.111.111.64/27 [90/156160] via 1.2.1.1, 00:11:55, FastEthernet0/0
```

CCNP ROUTE Workbook - EIGRP

EIGRP Route Filtering with Distribute-Lists (Route-Maps)

> Load the *task1-9* initial configurations before starting.



Task

In this task you will practice EIGRP filtering techniques using Distribute-Lists that reference a Route-Map. Your Route-Map will, in turn, reference a Prefix-List as well an Access-List.

This Route-Map will be admittedly complex, and not something you would design in a production network. But the goal of this task is to ensure that you become familiar with how Prefix-Lists and Access-Lists work in combination with a Route-Map.

> If you are doing this lab on your own equipment, ensure that the Bandwidth or clockrate of your Serial interface on R4 connecting to R1 is set to 128 Kbps.

- On router R2, create an EIGRP route filter that utilizes a Route-Map named **INE** for route matching.
- The Route-Map should **only contain three sequence numbers**.
- The first sequence of the Route-Map called INE should filter all routes **that match a Prefix-List also called INE**.
  - The Prefix-List should match any route in which the first **25 bits of the prefix match 111.111.111.0** and the subnet mask is either a **/27 or /28**.
  - The above-mentioned criteria should be configured with only a single line of your Prefix-List.

- The next sequence of your Route-Map should filter any route **that matches an Access-List**.
  - The matching Access-List **should only contain a single line** (Access-Control Entry), and that single line should match on two routes, **111.111.111.0/29 and 111.111.111.16/29**.

- The third, and last, sequence of your Route-Map should permit all remaining routes that weren't filtered by the previous sequences.

- When you have completed this objective, R2 should only have **TWO** EIGRP-learned routes in its Routing Table and EIGRP Topology Table of **1.4.1.0/24 and 111.111.111.24/30**.

Configuration on R2

```
router eigrp 100 distribute-list route-map INE in

 network 1.2.1.0 0.0.0.255
 network 2.4.2.0 0.0.0.255
 network 111.111.111.8 0.0.0.7
!
!ip prefix-list INE seq 10 permit 111.111.111.0/25 ge 27 le 28
!         route-map INE deny 10
match ip address prefix-list INE
!         route-map INE deny 20
match ip address 1
!         route-map INE permit 30
!
!         access-list 1 permit 111.111.111.0 0.0.0.16
```

R2 Verification

Notice the wildcard mask in the Access-List. Wildcard masks are useful because they can match on non-contiguous bits. In this particular ACL, the wildcard mask of 0.0.0.16 ensures that routes will only be matched if their binary pattern matches 111.111.111.000**any**0000. By wildcarding the 16th bit, the ACL allows that bit to be a one or zero (so this ACL will match both 111.111.111.0 and 111.111.111.16), but it will NOT match 111.111.111.24 because the mask forces the 8-bit to be a zero.

Before implementing the Distribute-List on R2, this is what your IP Routing Table should have looked like:

```
Router-2#show 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
...
<output omitted for brevity>
...

Gateway of last resort is not set

      1.0.0.0/8 is variably subnetted, 3 subnets, 2 masks
D        1.4.1.0/24 [90/20514560] via 2.4.2.4, 00:01:19, FastEthernet0/1
                    [90/20514560] via 1.2.1.1, 00:01:19, FastEthernet0/0
      111.0.0.0/8 is variably subnetted, 7 subnets, 5 masksD         111.111.111.0/29
 [90/156160] via 2.4.2.4, 00:01:09, FastEthernet0/1
                          [90/156160] via 1.2.1.1, 00:01:09, FastEthernet0/0D         111.111.111.16/29
 [90/156160] via 1.2.1.1, 00:01:19, FastEthernet0/0
D        111.111.111.24/30 [90/156160] via 1.2.1.1, 00:00:48, FastEthernet0/0D         111.111.111.32/28
 [90/156160] via 1.2.1.1, 00:00:47, FastEthernet0/0D         111.111.111.64/27
 [90/156160] via 1.2.1.1, 00:00:16, FastEthernet0/0
```

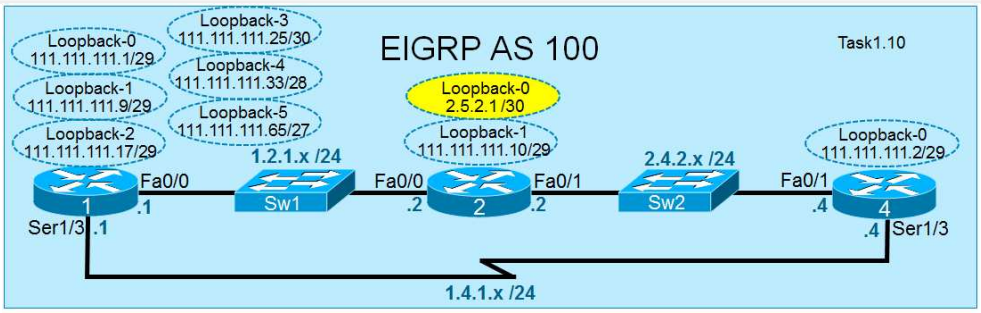
After implementation of the Distribute-List, you should see that all of the routes that have been highlighted above are now gone (have been filtered) and all that is left is **1.4.1.0/24** and **111.111.111.24/30**.

```
Router-2#sho 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
...
<output omitted for brevity>
...

Gateway of last resort is not set

      1.0.0.0/8 is variably subnetted, 3 subnets, 2 masks
D        1.4.1.0/24 [90/20514560] via 2.4.2.4, 00:12:58, FastEthernet0/1
                    [90/20514560] via 1.2.1.1, 00:12:58, FastEthernet0/0
      111.0.0.0/8 is variably subnetted, 4 subnets, 4 masks
D        111.111.111.24/30 [90/156160] via 1.2.1.1, 00:12:27, FastEthernet0/0
```

CCNP ROUTE Workbook - EIGRP

EIGRP Route Summarization (Auto-Summary)

> Load the *task1-10* initial configurations before starting.



Task

In this task you will practice using the "auto-summary" feature of EIGRP to summarize networks. You'll also gain exposure to which networks will (and won't) be summarized by this command.

- To begin, look at the existing EIGRP configurations of routers R1, R2, and R4 and see if you can answer this question:
  - After you implement the "**auto-summary**" feature on all three routers, how do you think it will affect the IP Routing Tables of your routers?

- Within all three routers (R1, R2, and R4), **configure the auto-summary feature**.
- View the IP Routing Tables of all three routers. Was your answer to the question above correct?

Configuration on R1, R2, and R4

```
Router-1(config)#router eigrp 100
Router-1(config-router)#auto-summary

Router-1(config-router)#end
Router-1#
```

Verification (R1)

Starting with the IP Routing Table of R1, we see that the only EIGRP-learned route visible is the route to 2.0.0.0/8. This is the only route we see because:

- All of the routes beginning with 111.111.111.x, as well as 1.2.1.0/24 and 1.4.1.0/24, are directly connected to R1 and have a lower Administrative Distance than any dynamically learned route.
- The subnets of **111.111.111.x/y** and **2.4.2.0/24** have been summarized by R2 down to **111.0.0.0/8** and **2.0.0.0/8**.
- The routes of **111.0.0.0/8** and **1.0.0.0/8** are EIGRP Summary Routes that R1 created itself. The rules of EIGRP state that when creating a Summary Route, an EIGRP router must:
  - Advertise this route as an EIGRP Internal Route to its neighbors.
  - Install the route as an EIGRP Summary Route (with an Administrative Distance of 5) within its own IP Routing Table for loop-prevention purposes.

```
Router-1#show 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

Gateway of last resort is not set

      1.0.0.0/8 is variably subnetted, 7 subnets, 4 masks
D        1.0.0.0/8 is a summary, 16:37:31, Null0
C        1.2.1.0/24 is directly connected, FastEthernet0/0
L        1.2.1.1/32 is directly connected, FastEthernet0/0
C        1.3.1.0/30 is directly connected, Loopback6
L        1.3.1.1/32 is directly connected, Loopback6
C        1.4.1.0/24 is directly connected, Serial1/3
L        1.4.1.1/32 is directly connected, Serial1/3
D     2.0.0.0/8 [90/30720] via 1.2.1.2, 16:37:31, FastEthernet0/0
      111.0.0.0/8 is variably subnetted, 13 subnets, 6 masks
D        111.0.0.0/8 is a summary, 16:37:31, Null0

C        111.111.111.0/29 is directly connected, Loopback0
L        111.111.111.1/32 is directly connected, Loopback0
C        111.111.111.8/29 is directly connected, Loopback1
L        111.111.111.9/32 is directly connected, Loopback1
C        111.111.111.16/29 is directly connected, Loopback2
L        111.111.111.17/32 is directly connected, Loopback2
```

```
C        111.111.111.24/30 is directly connected, Loopback3
L        111.111.111.25/32 is directly connected, Loopback3
C        111.111.111.32/28 is directly connected, Loopback4
L        111.111.111.33/32 is directly connected, Loopback4
C        111.111.111.64/27 is directly connected, Loopback5
L        111.111.111.65/32 is directly connected, Loopback5
Router-1#
```

Verification (R2)

Router-2's IP Routing Table indicates that this router has also created some EIGRP Summary Routes: * 1.0.0.0/8 is an EIGRP Summary, which was advertised by R2 outbound on interface FastEthernet0/1. * 2.0.0.0/8 is an EIGRP Summary, which was advertised by R2 outbound on interface FastEthernet0/0. * 111.0.0.0/8 is an EIGRP Summary, which was advertised by R2 outbound on interfaces FastEthernet0/0 as well as FastEthernet0/1.

The only EIGRP route that R2 has learned from another router is the route to 1.4.1.0/24, which was sent from R1. Because R1 and R2 share a segment that is in the 1.x.x.x network, R1 sent the subnet on its Serial1/3 interface (1.4.1.0/24) **without summarizing it**. Notice that R4 also is connected to this same subnet, but R4 had to summarize that route down to 1.0.0.0./8 because R4 and R2 are connected by a different, classfull network (the 2.x.x.x network).

R4's summarized route of 1.0.0.0/8 has not been installed into the IP Routing Table of R2, but it can be seen in the output of **show ip eigrp topology all-links**.

```
Router-2#sho 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

Gateway of last resort is not set

      1.0.0.0/8 is variably subnetted, 4 subnets, 3 masks
D        1.0.0.0/8 is a summary, 16:44:54, Null0
C        1.2.1.0/24 is directly connected, FastEthernet0/0
L        1.2.1.2/32 is directly connected, FastEthernet0/0
D        1.4.1.0/24 [90/20514560] via 1.2.1.1, 16:44:54, FastEthernet0/0

      2.0.0.0/8 is variably subnetted, 5 subnets, 4 masks
D        2.0.0.0/8 is a summary, 16:44:54, Null0
C        2.4.2.0/24 is directly connected, FastEthernet0/1
L        2.4.2.2/32 is directly connected, FastEthernet0/1
C        2.5.2.0/30 is directly connected, Loopback0
```

```
L        2.5.2.1/32 is directly connected, Loopback0
      111.0.0.0/8 is variably subnetted, 3 subnets, 3 masks
D        111.0.0.0/8 is a summary, 16:44:54, Null0
C        111.111.111.8/29 is directly connected, Loopback1
L        111.111.111.10/32 is directly connected, Loopback1
Router-2#
```

```
Router-2#sho ip eigrp topology all-links
EIGRP-IPv4 Topology Table for AS(100)/ID(111.111.111.10)
Codes: P - Passive, A - Active, U - Update, Q - Query, R - Reply,
       r - reply Status, s - sia Status

P 1.4.1.0/24, 1 successors, FD is 20514560, serno 39
        via 1.2.1.1 (20514560/20512000), FastEthernet0/0
P 1.2.1.0/24, 1 successors, FD is 28160, serno 3
        via Connected, FastEthernet0/0
P 2.0.0.0/8, 1 successors, FD is 28160, serno 31
        via Summary (28160/0), Null0
P 2.5.2.0/30, 1 successors, FD is 128256, serno 1
        via Connected, Loopback0
P 111.0.0.0/8, 1 successors, FD is 128256, serno 34
        via Summary (128256/0), Null0
        via 2.4.2.4 (156160/128256), FastEthernet0/1
        via 1.2.1.1 (156160/128256), FastEthernet0/0
P 111.111.111.8/29, 1 successors, FD is 128256, serno 2
        via Connected, Loopback1
P 2.4.2.0/24, 1 successors, FD is 28160, serno 4
        via Connected, FastEthernet0/1P 1.0.0.0/8
, 1 successors, FD is 28160, serno 33
        via Summary (28160/0), Null0via 2.4.2.4 (20514560/20512000), FastEthernet0/1
```

Verification (R4)

Router-4's IP Routing Table is much like the table of R1. R4 doesn't have nearly the quantity of Loopback interfaces that are configured in R1, so you don't see as many connected routes for subnets of 111.x.x.x.

Here you can see that there are only two EIGRP routes that have been learned from a neighbor. Those two routes are: * 1.2.1.0/24 (which was learned via R1 across the Serial link) * 2.5.2.0/30 (which was learned via R2 across the FastEthernet0/1 interface)

```
Router-4#sho 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

Gateway of last resort is not set

      1.0.0.0/8 is variably subnetted, 4 subnets, 3 masks
D        1.0.0.0/8 is a summary, 16:53:11, Null0
D        1.2.1.0/24 [90/20514560] via 1.4.1.1, 16:53:29, Serial1/3
C        1.4.1.0/24 is directly connected, Serial1/3
L        1.4.1.4/32 is directly connected, Serial1/3
      2.0.0.0/8 is variably subnetted, 4 subnets, 4 masks
D        2.0.0.0/8 is a summary, 16:53:10, Null0
C        2.4.2.0/24 is directly connected, FastEthernet0/1
L        2.4.2.4/32 is directly connected, FastEthernet0/1
D        2.5.2.0/30 [90/156160] via 2.4.2.2, 17:00:53, FastEthernet0/1
      111.0.0.0/8 is variably subnetted, 3 subnets, 3 masks
D        111.0.0.0/8 is a summary, 16:53:11, Null0
C        111.111.111.0/29 is directly connected, Loopback0
L        111.111.111.2/32 is directly connected, Loopback0
Router-4#
```

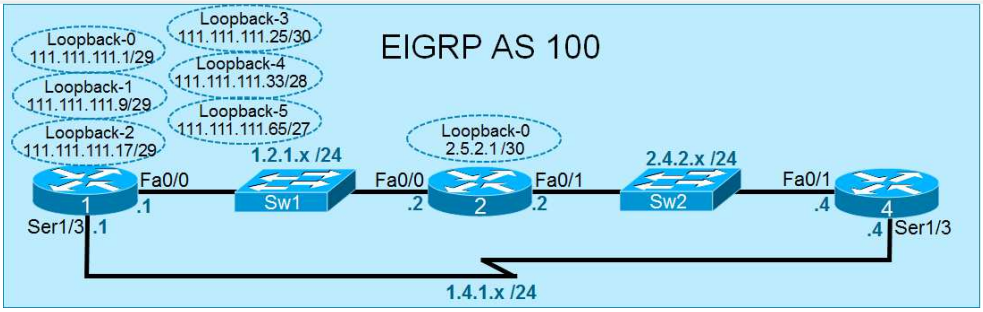
In this task you have seen how the auto-summary feature works. One of the major limitations of using this feature to accomplish EIGRP route summarization is that removes your control over routes will be summarized and which will not. Take, for example, the existing topology. What if your objective were: * On R1, summarize all the loopbacks containing a mask of /30, /29, and /28 down to a single route of 111.111.111.0 /26. * Advertise the subnet on Loopback-5 (111.111.111.64/27) as is, without summarizing it.

That objective would be impossible to accomplish using the auto-summary feature of EIGRP. In the next task you will gain exposure to the technique of manual summarization within EIGRP that gives you the greatest amount of control, and flexibility, when summarizing routes.

CCNP ROUTE Workbook - EIGRP

EIGRP Route Summarization (Manual Summarization)

> Load the *task1-11* initial configurations before starting.



Task

In this task you will practice using the manual-summarization technique of EIGRP to summarize networks.

> By implementing Route Summarization selectively in only certain parts of your network, you can influence the traffic patterns of your data. If a router contains two routes for the destination of a packet—a shorter summarized route, and a longer, more-specific route—that router will always choose the most specific (longer) match.

Implement EIGRP route summarization on router R1 so that the resulting advertised routes will influence router R2 and R4 in the following ways:

- If R2 pings the IP addresses of Loopback-0, 1, 2, 3, or 4 on router R1, those pings will be forwarded to R4, and R4 will forward them across the Serial link to R1.
- If R2 pings the IP address of 111.111.111.65 (on Loopback-6 of R1), those pings will go directly to R1 across the FastEthernet link they share.

You may not configure anything in routers R2 or R4 to accomplish these objectives. All configuration must utilize route summarization commands on router R1.

Configuration on R1

```
!interface FastEthernet0/0
 ip address 1.2.1.1 255.255.255.0 ip summary-address eigrp 100 111.111.111.0 255.255.255.192
```

Verification (R2)

```
Router-2#show 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

Gateway of last resort is not set

      1.0.0.0/8 is variably subnetted, 3 subnets, 2 masks
C        1.2.1.0/24 is directly connected, FastEthernet0/0
L        1.2.1.2/32 is directly connected, FastEthernet0/0
D        1.4.1.0/24 [90/20514560] via 2.4.2.4, 00:06:43, FastEthernet0/1
                    [90/20514560] via 1.2.1.1, 00:06:43, FastEthernet0/0
      2.0.0.0/8 is variably subnetted, 4 subnets, 3 masks
C        2.4.2.0/24 is directly connected, FastEthernet0/1
L        2.4.2.2/32 is directly connected, FastEthernet0/1
C        2.5.2.0/30 is directly connected, Loopback0
L        2.5.2.1/32 is directly connected, Loopback0
      111.0.0.0/8 is variably subnetted, 7 subnets, 5 masks
D        111.111.111.0/26 [90/156160] via 1.2.1.1, 00:01:11, FastEthernet0/0 D 111.111.111.0/29
 [90/20642560] via 2.4.2.4, 00:01:11, FastEthernet0/1
D 111.111.111.8/29 [90/20642560] via 2.4.2.4, 00:01:11, FastEthernet0/1
D EX 111.111.111.16/29
            [170/20642560] via 2.4.2.4, 00:01:11, FastEthernet0/1
D EX 111.111.111.24/30
            [170/20642560] via 2.4.2.4, 00:01:11, FastEthernet0/1
D EX 111.111.111.32/28
            [170/20642560] via 2.4.2.4, 00:01:11, FastEthernet0/1
D EX 111.111.111.64/27 [170/156160] via 1.2.1.1, 00:06:51, FastEthernet0/0

Router-2#
```

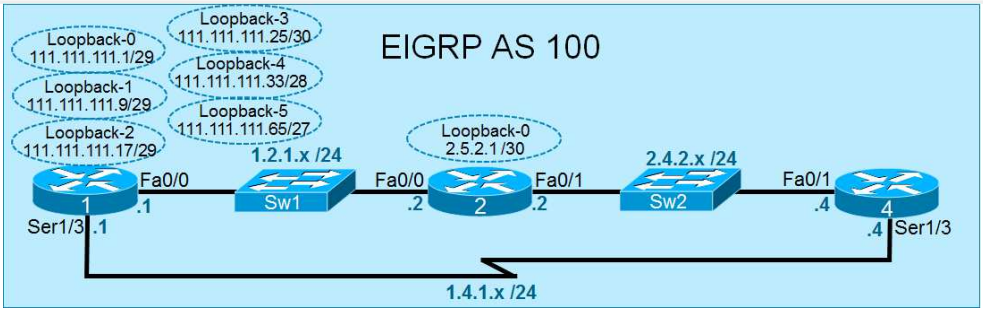
Verification (R4)

```
Router-4#sho 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

Gateway of last resort is not set

      1.0.0.0/8 is variably subnetted, 3 subnets, 2 masks
D        1.2.1.0/24 [90/30720] via 2.4.2.2, 00:51:41, FastEthernet0/1
C        1.4.1.0/24 is directly connected, Serial1/3
L        1.4.1.4/32 is directly connected, Serial1/3
      2.0.0.0/8 is variably subnetted, 3 subnets, 3 masks
C        2.4.2.0/24 is directly connected, FastEthernet0/1
L        2.4.2.4/32 is directly connected, FastEthernet0/1
D        2.5.2.0/30 [90/156160] via 2.4.2.2, 00:51:41, FastEthernet0/1
      111.0.0.0/8 is variably subnetted, 7 subnets, 5 masks
D        111.111.111.0/26 [90/158720] via 2.4.2.2, 00:03:21, FastEthernet0/1D 111.111.111.0/29
 [90/20640000] via 1.4.1.1, 00:03:21, Serial1/3
D 111.111.111.8/29 [90/20640000] via 1.4.1.1, 00:03:21, Serial1/3
D EX 111.111.111.16/29 [170/20640000] via 1.4.1.1, 00:03:21, Serial1/3
D EX 111.111.111.24/30 [170/20640000] via 1.4.1.1, 00:03:21, Serial1/3
D EX 111.111.111.32/28 [170/20640000] via 1.4.1.1, 00:03:21, Serial1/3
D EX 111.111.111.64/27 [170/158720] via 2.4.2.2, 00:09:00, FastEthernet0/1

Router-4#
```

CCNP ROUTE Workbook - EIGRP

Limiting Query Propagation (EIGRP Stub)

> Load the ***task1-12*** initial configurations before starting.



In this task you will practice using the **EIGRP Stub feature** to limit the propagation of EIGRP Query messages.

> By default, when an EIGRP router loses its Successor to a network, if that router has any other EIGRP neighbors it will create an EIGRP Query message for the lost network and send that Query to all of its neighbors.

EIGRP routers that receive an EIGRP Query can take the following actions:

- If the router that received the Query never had the lost route in its Routing Table or EIGRP Topology Table, it will immediately send an EIGRP Reply to that Query and stop any further propagation of that Query.
- If the router that received the Query **does** have an alternative, loop-free path, it will immediately reply to that Query and stop propagation of that Query.
- If the router that received the Query has no alternative paths to that route, but it does have other EIGRP downstream neighbors, it will generate its own Query for that lost route and propagate that Query to its own downstream neighbors.

Task

Confirm that, at present, any Queries generated by R1 are currently being sent to R2...and R2 is propagating its own Queries down to R4:

- On R4, configure the following:
  - (config)#**logging buffer debug**
  - (config)#**logging buffer 100000**
  - **debug eigrp packet query reply**

- On router **R1, shut down the Loopback-0 interface** (any Loopback could be used for this demonstration).
- Go back to router **R4** and view your log file with the command `show log` and you should see evidence that R4 received an EIGRP Query from R2, and R4 sent an EIGRP Reply to that Query.

Verification

```
Router-4#conf t
Enter configuration commands, one per line.  End with CNTL/Z. Router-4(config)#logging buffer debug
Router-4(config)#logging buffer 100000
Router-4(config)#end
Router-4# Router-4#debug eigrp packet query reply

    (QUERY, REPLY)
EIGRP Packet debugging is on
Router-4#
```

```
Router-1#
conf t
Enter configuration commands, one per line.  End with CNTL/Z. Router-1(config)#int loop 0
Router-1(config-if)#shut

Router-1(config-if)#
```

```
Router-4#sho log
Syslog logging: enabled (0 messages dropped, 3 messages rate-limited, 15 flushes, 0 overruns, xml disabled, filterin

Log Buffer (100000 bytes):

Dec 18 08:08:10.158: %SYS-5-CONFIG_I: Configured from console by consoleDec 18 08:08:31.030: EIGRP:
Received QUERY on Fa0/1 - paklen 45 nbr 2.4.2.2
Dec 18 08:08:31.030:   AS 100, Flags 0x0:(NULL), Seq 106/0 interfaceQ 0/0 iidbQ un/rely 0/0 peerQ un/rely 0/0
Dec 18 08:08:31.046: EIGRP: Enqueueing REPLY on Fa0/1 - paklen 0 nbr 2.4.2.2 tid 0 iidbQ un/rely 0/1 peerQ un/rely 0
```

```
Dec 18 08:08:31.054: EIGRP: Sending REPLY on Fa0/1 - paklen 45 nbr 2.4.2.2
 tid 0
Dec 18 08:08:31.054:   AS 100, Flags 0x0:(NULL), Seq 79/106 interfaceQ 0/0 iidbQ un/rely 0/0 peerQ un/rely 0/1 serno
Router-4#
```

Task

In this task your objective is to **configure the EIGRP Stub feature on R4** so that if router R2 receives an EIGRP Query (for any lost route) from router R1, **router R2 should NOT propagate that Query to its downstream neighbor of R4**.

- Configure router R4 as an EIGRP Stub router.
- Perform the same series of steps as in the previous task. Now you should NOT see any Queries propagated to router R4.
- If you perform the same series of verification steps on router R2, you should notice that upon receiving an EIGRP Query from R1, R2 is immediately generating an EIGRP Reply (rather than propagating its own Query to R4).

Configuration (R4)

```
Router-4#conf t
Enter configuration commands, one per line.  End with CNTL/Z. Router-4(config)#router eigrp 100
Router-4(config-router)#eigrp stub

Router-4(config-router)#end
Router-4#
Dec 18 08:25:58.222: %DUAL-5-NBRCHANGE: EIGRP-IPv4 100: Neighbor 2.4.2.2 (FastEthernet0/1) is down: peer info change
Dec 18 08:25:58.602: %DUAL-5-NBRCHANGE: EIGRP-IPv4 100: Neighbor 2.4.2.2 (FastEthernet0/1) is up: new adjacency
Router-4#
```

Verification (R4)

```
Router-4# Router-4#clear log

Clear logging buffer [confirm] Router-4#debug eigrp packet query reply

    (QUERY, REPLY)
EIGRP Packet debugging is on
Router-4#
Router-4#
```

```
Router-2#
conf t
Enter configuration commands, one per line.  End with CNTL/Z. Router-2(config)#logging buffer debug
Router-2(config)#logging buffer 100000
Router-2(config)#exit
Router-2#
Dec 18 08:29:23.922: %SYS-5-CONFIG_I: Configured from console by console Router-2#
debug eigrp packet query reply
    (QUERY, REPLY)
EIGRP Packet debugging is on Router-2#clear log

Clear logging buffer [confirm]
Router-2#
```

```
Router-1
(config)# Router-1(config)#interface loopback 0
Router-1(config-if)#shutdown

Router-1(config-if)#
```

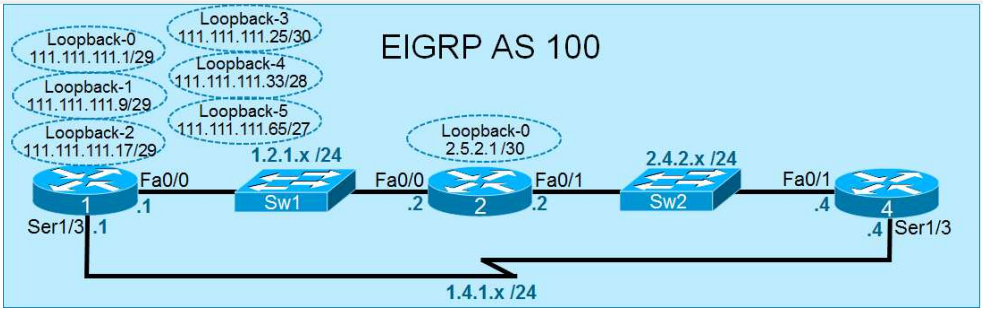
```
Router-2#sho log


Log Buffer (100000 bytes):
 Dec 18 08:30:45.030: EIGRP:Received QUERY on Fa0/0 - paklen 45 nbr 1.2.1.1

Dec 18 08:30:45.030:   AS 100, Flags 0x0:(NULL), Seq 69/0 interfaceQ 0/0 iidbQ un/rely 0/0 peerQ un/rely 0/0
Dec 18 08:30:45.046: EIGRP: Enqueueing REPLY on Fa0/0 - paklen 0 nbr 1.2.1.1 tid 0 iidbQ un/rely 0/1 peerQ un/rely 0
Dec 18 08:30:45.054: EIGRP:Sending REPLY on Fa0/0 - paklen 45 nbr 1.2.1.1
 tid 0
Dec 18 08:30:45.054:   AS 100, Flags 0x0:(NULL), Seq 112/69 interfaceQ 0/0 iidbQ un/rely 0/0 peerQ un/rely 0/1 serno
Router-2#
```

```
Router-4#sho log

Syslog logging: enabled (0 messages dropped, 3 messages rate-limited, 15 flushes, 0 overruns, xml disabled, filterin

No Active Message Discriminator.



No Inactive Message Discriminator.


    Console logging: level debugging, 2778 messages logged, xml disabled,
                     filtering disabled
    Monitor logging: level debugging, 0 messages logged, xml disabled,
                     filtering disabled
    Buffer logging:  level debugging, 22 messages logged, xml disabled,
                    filtering disabled
    Exception Logging: size (4096 bytes)
    Count and timestamp logging messages: disabled
    Persistent logging: disabled

No active filter modules.

    Trap logging: level informational, 373 message lines logged
        Logging Source-Interface:       VRF Name:

Log Buffer (100000 bytes):
Router-4#
```

CCNP ROUTE Workbook - EIGRP

Limiting Query Propagation (Summarization)

> Load the ***task1-13*** initial configurations before starting.



Task

In this task you will practice using the **EIGRP Manual Summarization** to limit the propagation of EIGRP Query messages.

> By default, when an EIGRP router loses its Successor to a network, if that router has any other EIGRP neighbors it will create an EIGRP Query message for the lost network and send that Query to all of its neighbors.

EIGRP routers that receive an EIGRP Query can take the following actions:

- If the router that received the Query never had the lost route in its Routing Table or EIGRP Topology Table, it will immediately send an EIGRP Reply to that Query and stop any further propagation of that Query.
- If the router that received the Query **does** have an alternative, loop-free path, it will immediately reply to that Query and stop propagation of that Query.
- If the router that received the Query has no alternative paths to that route, but it does have other EIGRP downstream neighbors, it will generate its own Query for that lost route and propagate that Query to its own downstream neighbors.

Confirm that, at present, any Queries generated by R1 are currently being sent to R2...and R2 is propagating its own Queries down to R4:

- On R4, configure the following:
  - (config)#**logging buffer debug**
  - (config)#**logging buffer 100000**
  - **debug eigrp packet query reply**

- On router **R1, shut down the Loopback-0 interface** (any Loopback could be used for this demonstration).
- Go back to router **R4** and view your log file with the command `show log` , and you should see evidence that R4 received an EIGRP Query from R2, and R4 sent an EIGRP Reply to that Query.

Verification

```
Router-4#conf t
Enter configuration commands, one per line.  End with CNTL/Z. Router-4(config)#logging buffer debug
Router-4(config)#logging buffer 100000
Router-4(config)#end
Router-4# Router-4#debug eigrp packet query reply

    (QUERY, REPLY)
EIGRP Packet debugging is on
Router-4#
```

```
Router-1#
conf t
Enter configuration commands, one per line.  End with CNTL/Z. Router-1(config)#int loop 0
Router-1(config-if)#shut

Router-1(config-if)#
```

```
Router-4#sho log
Syslog logging: enabled (0 messages dropped, 3 messages rate-limited, 15 flushes, 0 overruns, xml disabled, filterin

Log Buffer (100000 bytes):

Dec 18 08:08:10.158: %SYS-5-CONFIG_I: Configured from console by consoleDec 18 08:08:31.030: EIGRP:
Received QUERY on Fa0/1 - paklen 45 nbr 2.4.2.2
Dec 18 08:08:31.030:   AS 100, Flags 0x0:(NULL), Seq 106/0 interfaceQ 0/0 iidbQ un/rely 0/0 peerQ un/rely 0/0
Dec 18 08:08:31.046: EIGRP: Enqueueing REPLY on Fa0/1 - paklen 0 nbr 2.4.2.2 tid 0 iidbQ un/rely 0/1 peerQ un/rely 0
```

```
Dec 18 08:08:31.054: EIGRP: Sending REPLY on Fa0/1 - paklen 45 nbr 2.4.2.2
 tid 0
Dec 18 08:08:31.054:   AS 100, Flags 0x0:(NULL), Seq 79/106 interfaceQ 0/0 iidbQ un/rely 0/0 peerQ un/rely 0/1 serno
Router-4#
```

Task

In this task your objective is to **configure manual EIGRP summarization R1** so that if router R2 receives an EIGRP Query (for any of the Loopback subnets) from router R1, **router R2 should NOT propagate that Query to its downstream neighbor of R4**.

- Configure **manual EIGRP summarization on router R1 (on interface FastEthernet0/0**) so that it summarizes all of the local subnets on its various Loopback interfaces down to a single, summarized route of **111.111.111.0/25**.
- Perform the same series of steps as in the previous task. Now you should NOT see any Queries propagated to router R4.
- If you perform the same series of verification steps on router R2, you should notice that upon receiving an EIGRP Query from R1, R2 is immediately generating an EIGRP Reply (rather than propagating its own Query to R4).

Configuration (R1)

```
Router-1(config)#interface Fast0/0
Router-1(config-if)#ip summary-address eigrp 100 111.111.111.0 255.255.255.128


Dec 18 08:55:46.610: %DUAL-5-NBRCHANGE: EIGRP-IPv4 100: Neighbor 1.2.1.2 (FastEthernet0/0) is resync: summary config
Router-1(config-if)#end
Router-1#
```

Verification (R4)

```
Router-4# Router-4#clear log

Clear logging buffer [confirm] Router-4#debug eigrp packet query reply

    (QUERY, REPLY)
EIGRP Packet debugging is on
Router-4#
Router-4#
```

```
Router-2#
conf t
Enter configuration commands, one per line.  End with CNTL/Z. Router-2(config)#logging buffer debug
Router-2(config)#logging buffer 100000
Router-2(config)#exit
Router-2#
Dec 18 08:29:23.922: %SYS-5-CONFIG_I: Configured from console by console Router-2#
debug eigrp packet query reply
    (QUERY, REPLY)
EIGRP Packet debugging is on Router-2#clear log

Clear logging buffer [confirm]
Router-2#
```

```
Router-1
(config)# Router-1(config)#interface loopback 0
Router-1(config-if)#shutdown

Router-1(config-if)#
```

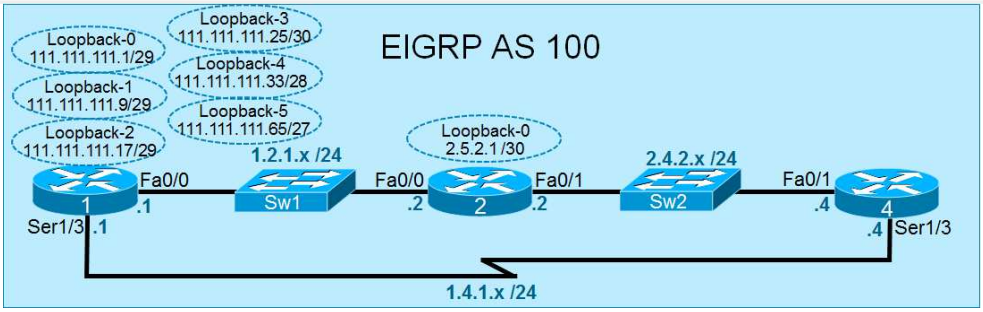
```
Router-2#sho log


Log Buffer (100000 bytes):
 Dec 18 08:30:45.030: EIGRP:Received QUERY on Fa0/0 - paklen 45 nbr 1.2.1.1

Dec 18 08:30:45.030:   AS 100, Flags 0x0:(NULL), Seq 69/0 interfaceQ 0/0 iidbQ un/rely 0/0 peerQ un/rely 0/0
Dec 18 08:30:45.046: EIGRP: Enqueueing REPLY on Fa0/0 - paklen 0 nbr 1.2.1.1 tid 0 iidbQ un/rely 0/1 peerQ un/rely 0
Dec 18 08:30:45.054: EIGRP:Sending REPLY on Fa0/0 - paklen 45 nbr 1.2.1.1
 tid 0
Dec 18 08:30:45.054:   AS 100, Flags 0x0:(NULL), Seq 112/69 interfaceQ 0/0 iidbQ un/rely 0/0 peerQ un/rely 0/1 serno
Router-2#
```

```
Router-4#sho log

Syslog logging: enabled (0 messages dropped, 3 messages rate-limited, 15 flushes, 0 overruns, xml disabled, filterin

No Active Message Discriminator.



No Inactive Message Discriminator.


    Console logging: level debugging, 2778 messages logged, xml disabled,
                     filtering disabled
    Monitor logging: level debugging, 0 messages logged, xml disabled,
                     filtering disabled
    Buffer logging:  level debugging, 22 messages logged, xml disabled,
                    filtering disabled
    Exception Logging: size (4096 bytes)
    Count and timestamp logging messages: disabled
    Persistent logging: disabled

No active filter modules.

    Trap logging: level informational, 373 message lines logged
        Logging Source-Interface:       VRF Name:

Log Buffer (100000 bytes):
Router-4#
```

CCNP ROUTE Workbook - EIGRP

EIGRP Default Route Propagation (Redistribute Static)

> Load the ***task1-14*** initial configurations before starting.



Task

In this task you will practice propagating a default route in EIGRP to give EIGRP neighbors reachability to un-advertised networks.

> Notice that in this task, R1 is no longer advertising any of its Loopback subnets to routers R2 or R4. You will instead configure R1 to advertise a default route (0.0.0.0) to these neighbors so that they can still ping these Loopbacks.

- On router R1, **configure a static, default route with a next-hop of Null0**.
- On router R1, redistribute that static, default route into EIGRP using the command `redistribute static metric 10000 10 255 1 1500 .`
- Verify that this default route has been advertised to neighbor R2, and that R2 has advertised it to R4.
- Verify that both R2 and R4 can still ping any of the IP addresses configured on any of R1's Loopbacks.

Configuration (R1)

```
Router-1#conf t
Enter configuration commands, one per line.  End with CNTL/Z. Router-1(config)#
ip route 0.0.0.0 0.0.0.0 null0
Router-1(config)# Router-1(config)#router eigrp 100
```

```
Router-1(config-router)#redistribute static metric 10000 10 255 1 1500

Router-1(config-router)#end
```

Verification (R2)

```
Router-2#sho 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 1.2.1.1 to network 0.0.0.0
D*EX  0.0.0.0/0 [170/261120] via 1.2.1.1, 00:01:16, FastEthernet0/0

Router-2#
```

```
Router-2#ping 111.111.111.65
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 111.111.111.65, timeout is 2 seconds:
!!!!!Success rate is 100 percent
 (5/5), round-trip min/avg/max = 1/2/4 ms
Router-2#
```

Verification (R4)

```
Router-4#sho 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
```

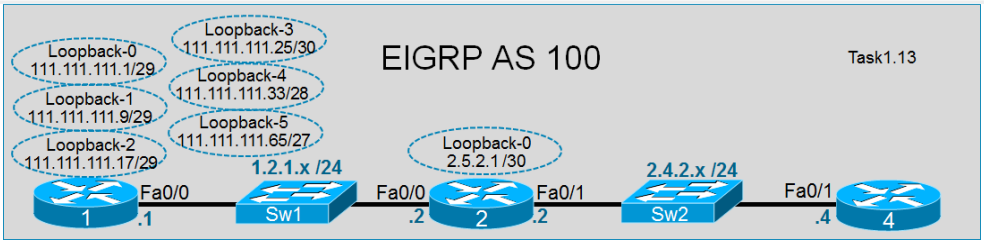
```
       + - replicated route, % - next hop override

Gateway of last resort is 2.4.2.2 to network 0.0.0.0
D*EX  0.0.0.0/0 [170/263680] via 2.4.2.2, 00:02:53, FastEthernet0/1

      1.0.0.0/24 is subnetted, 1 subnets
D        1.2.1.0 [90/30720] via 2.4.2.2, 00:18:36, FastEthernet0/1
      2.0.0.0/8 is variably subnetted, 3 subnets, 3 masks
D        2.5.2.0/30 [90/156160] via 2.4.2.2, 00:18:36, FastEthernet0/1
Router-4#
```

```
Router-4#ping 111.111.111.9

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 111.111.111.9, timeout is 2 seconds:
!!!!!Success rate is 100 percent
 (5/5), round-trip min/avg/max = 1/2/4 ms
Router-4#
```

CCNP ROUTE Workbook - EIGRP

EIGRP Default Route Propagation (Manual Summarization)

> Load the ***task1-15*** initial configurations before starting.



Task

In this task you will practice another method of propagating a default route in EIGRP to give EIGRP neighbors reachability to un-advertised networks.

> Notice that in this task, R1 is no longer advertising any of its Loopback subnets to routers R2 or R4. You will instead configure R1 to advertise a default route (0.0.0.0) to these neighbors so that they can still ping these Loopbacks.

- On router R1, **configure EIGRP Manual Summarization on interface FastEthernet0/0 to advertise a default route** to all neighbors on this interface.
  - Ensure that this summarized, default route is locally installed into R1's IP Routing Table with an **Administrative Distance of 30**.
- Verify that this default route has been advertised to neighbor R2, and that R2 has advertised it to R4.
- Verify that both R2 and R4 can still ping any of the IP addresses configured on any of R1's Loopbacks.

> The Administrative Distance for this default route has been set locally on R1 so that it still has the ability to receive, and install, a default route learned via eBGP from an ISP. eBGP has an Administrative Distance of 20.

Configuration (R1)

```
Router-1(config)#interface Fast0/0Router-1(config-if)#ip summary-address eigrp 100 0.0.0.0 0.0.0.0
Dec 18 09:18:44.413: %DUAL-5-NBRCHANGE: EIGRP-IPv4 100: Neighbor 1.2.1.2 (FastEthernet0/0) is resync: summary config
Router-1(config-if)#exit       Router-1(config)#router eigrp 100

Router-1(config-router)#summary-metric 0.0.0.0/0 distance 30
Router-1(config-router)#end
Router-1#
```

Verification (R1)

```
Router-1#sho ip route 0.0.0.0

Routing entry for 0.0.0.0/0, supernet  Known via "eigrp 100", distance 30
, metric 28160, candidate default path, type internal
  Redistributing via eigrp 100
  Routing Descriptor Blocks:
  * directly connected, via Null0
      Route metric is 28160, traffic share count is 1
      Total delay is 100 microseconds, minimum bandwidth is 100000 Kbit
      Reliability 255/255, minimum MTU 1500 bytes
      Loading 1/255, Hops 0
Router-1#
```

Verification (R2)

```
Router-2#sho 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 1.2.1.1 to network 0.0.0.0
```

```
D*    0.0.0.0/0 [90
/30720] via 1.2.1.1, 00:04:00, FastEthernet0/0
Router-2#
```

```
Router-2#ping 111.111.111.65
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 111.111.111.65, timeout is 2 seconds:
!!!!!Success rate is 100 percent
 (5/5), round-trip min/avg/max = 1/2/4 ms
Router-2#
```

Verification (R4)

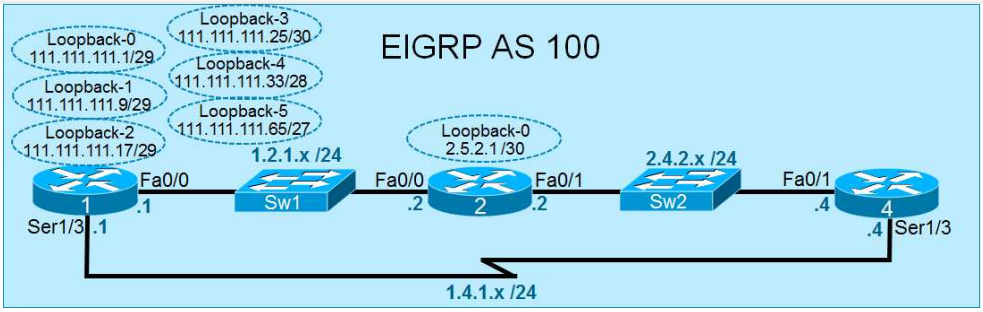
```
Router-4#sho ip route eigrp
Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 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 2.4.2.2 to network 0.0.0.0
D*    0.0.0.0/0 [90
/33280] via 2.4.2.2, 00:04:47, FastEthernet0/1
      1.0.0.0/24 is subnetted, 1 subnets
D        1.2.1.0 [90/30720] via 2.4.2.2, 00:30:25, FastEthernet0/1
      2.0.0.0/8 is variably subnetted, 3 subnets, 3 masks
D        2.5.2.0/30 [90/156160] via 2.4.2.2, 00:30:25, FastEthernet0/1
Router-4#
```

```
Router-4#ping 111.111.111.9

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 111.111.111.9, timeout is 2 seconds:
!!!!!Success rate is 100 percent
 (5/5), round-trip min/avg/max = 1/2/4 ms
Router-4#
```

CCNP ROUTE Workbook - EIGRP

EIGRP: Named Mode Configuration

> Load the *task1-16* initial configurations before starting.



Task

In this task you will practice configuring EIGRP on a router using Named Configuration Mode.

> Notice that in this task, R1 does not have any existing EIGRP configuration.

- On router R1, configure a named instance of EIGRP (use the name **INE**) following these criteria:
  - R1 should be placed into EIGRP Autonomous System 100.
  - R1 should NOT advertise the subnet on Loopback-5 (**111.111.111.64/27**) to any neighbors. **You must NOT use a Distribute-List to accomplish this objective**.
  - R1 should implement an outbound Distribute-List to ensure that it does NOT advertise the subnet on its Loopback-4 interface (**111.111.111.32/28)**.
  - R1 should advertise a default route (0.0.0.0) only from interface Serial1/3. Routers R2 and R4 will use this default route to have reachability to the ip subnets on Loopback-4 and 5.

- Verify that routers R2 and R4 can ping any of the IP addresses on the Loopback interfaces of R1.

Configuration (R1)

```
router eigrp INE
 !address-family ipv4 unicast autonomous-system 100
  !af-interface Loopback5
shutdown
  exit-af-interface
  !af-interface Serial1/3
summary-address 0.0.0.0 0.0.0.0
  exit-af-interface
  !topology base
distribute-list 1 out

  exit-af-topology network 1.0.0.0
network 111.0.0.0
 exit-address-family
!
!         access-list 1 deny   111.111.111.32 0.0.0.15
access-list 1 permit any
```

Verification (R1)

```
Router-1#sho ip eigrp neighbor
EIGRP-IPv4 VR(INE) Address-Family Neighbors for AS(100)
H   Address                 Interface              Hold Uptime   SRTT   RTO  Q  Seq
                                                   (sec)         (ms)       Cnt Num1
1.4.1.4                   Se1/3
                    13 00:05:23   11  1170  0  1080 1.2.1.2                Fa0/0
                    12 00:06:43    2   100  0  165
Router-1#
```

Verification (R2)

```
Router-2#sho 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

Gateway of last resort is 2.4.2.4 to network 0.0.0.0
```

```
D*    0.0.0.0/0 [90/20514592] via 2.4.2.4, 00:06:00, FastEthernet0/1

      1.0.0.0/8 is variably subnetted, 3 subnets, 2 masks
D        1.4.1.0/24 [90/20514560] via 2.4.2.4, 00:06:00, FastEthernet0/1
                    [90/20514560] via 1.2.1.1, 00:06:00, FastEthernet0/0
      111.0.0.0/8 is variably subnetted, 4 subnets, 2 masks
D        111.111.111.0/29 [90/28192] via 1.2.1.1, 00:07:10, FastEthernet0/0
D        111.111.111.8/29 [90/28192] via 1.2.1.1, 00:07:10, FastEthernet0/0
D        111.111.111.16/29 [90/28192] via 1.2.1.1, 00:07:10, FastEthernet0/0
D        111.111.111.24/30 [90/28192] via 1.2.1.1, 00:07:10, FastEthernet0/0
Router-2#
```

```
Router-2#ping 111.111.111.65
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 111.111.111.65, timeout is 2 seconds:
!!!!!Success rate is 100 percent
 (5/5), round-trip min/avg/max = 1/2/4 ms
Router-2#
```

Verification (R4)

```
Router-4#sho 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 1.4.1.1 to network 0.0.0.0
D*    0.0.0.0/0 [90/20512032] via 1.4.1.1, 00:07:32, Serial1/3

      1.0.0.0/8 is variably subnetted, 3 subnets, 2 masks
D        1.2.1.0/24 [90/30720] via 2.4.2.2, 02:23:06, FastEthernet0/1
      2.0.0.0/8 is variably subnetted, 3 subnets, 3 masks
D        2.5.2.0/30 [90/156160] via 2.4.2.2, 02:23:06, FastEthernet0/1
      111.0.0.0/8 is variably subnetted, 4 subnets, 2 masks
D        111.111.111.0/29 [90/30752] via 2.4.2.2, 00:08:43, FastEthernet0/1
D        111.111.111.8/29 [90/30752] via 2.4.2.2, 00:08:43, FastEthernet0/1
```

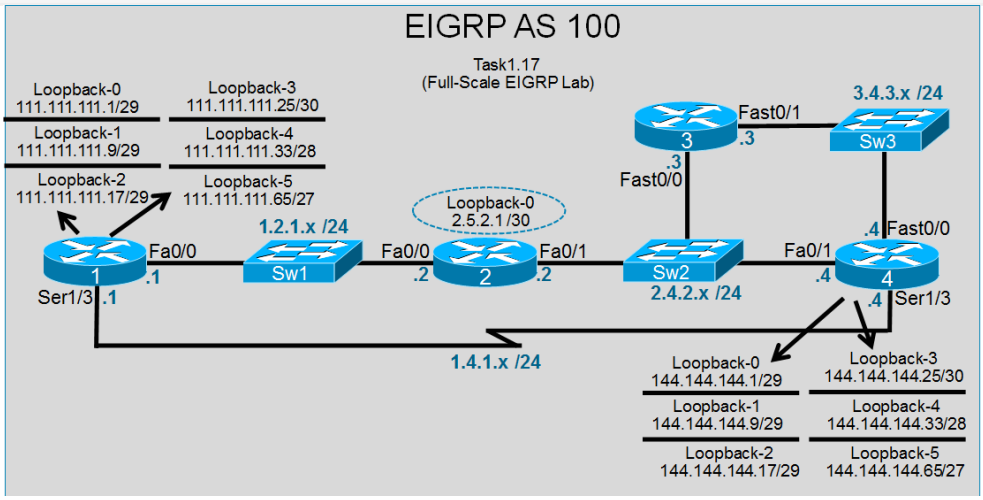
```
D        111.111.111.16/29 [90/30752] via 2.4.2.2, 00:08:43, FastEthernet0/1
D        111.111.111.24/30 [90/30752] via 2.4.2.2, 00:08:43, FastEthernet0/1
Router-4#
```

```
Router-4#ping 111.111.111.9

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 111.111.111.9, timeout is 2 seconds:
!!!!!Success rate is 100 percent
 (5/5), round-trip min/avg/max = 1/2/4 ms
Router-4#
```

CCNP ROUTE Workbook - EIGRP

EIGRP: Full Scale CCNP Lab

> Load the *task1-17* initial configurations before starting.



Task

This task is a full-scale EIGRP CCNP Lab. None of the routers have any existing EIGRP configuration. You will add EIGRP to each router given the criteria below.

- All routers should be configured for EIGRP Autonomous System 100.
- All routers should utilize **network** commands with specific **wildcard masks** to advertise all locally connected subnets.
- All EIGRP configuration in routers R1 and R2 should be completed using Named Mode Configuration.
- All EIGRP configuration in routers R3 and R4 should be completed using Classic Mode Configuration.
- Auto-Summarization may NOT be used anywhere in this lab.

R1 Configuration Criteria

- R1 should summarize its locally connected Loopback-0, Loopback-1, Loopback-2, and Loopback-3 networks into a single, summarized route **that is only advertised on interface Serial1/3**.

- R1 and R2 must be configured for **EIGRP MD5 Authentication** using a Key-Chain called **INE** with a key (password) of **Cisco**.
- R1 must filter the advertised, inbound Loopbacks of R4 using a **Distribute List**.
  - The Distribute-List must be applied in the **inbound direction** and only for routes received on interface **Serial1/3**.
  - The Distribute-List must reference a Route-Map called **INE**.
  - The first sequence of the Route-Map must deny R4's subnets of its Loopback-0, Loopback-1, and Loopback-2 interfaces. This must be done by matching an Access-List.
  - The second sequence of the Route-Map must deny R4's subnets of its Loopback-4 and Loopback-5 interfaces. This must be done by matching a Prefix-List called **INE**.
  - Anything not filtered by the first two sequences of this Route-Map should be permitted (not filtered by the Distribute-List).

R2 Configuration Criteria

- R2 should advertise a default route (**0.0.0.0/0**) to all EIGRP Neighbors. You may **not** use Manual-Summarization for this task.
- See the criteria above in R1's section about **EIGRP authentication between R2 and R1**.
- **R2 should filter R1's Loopback-0, Loopback-1, Loopback-2, and Loopback-3 subnets** from any of its outbound EIGRP updates transmitted on interface FastEthernet0/1.

R3 Configuration Criteria

- R3 should be configured to have **two equal-cost paths** in its IP Routing Table to reach the Loopback-0 subnet of R2 (2.5.2.0/30).
  - The next-hop of one of the routes should be R2.
  - The next-hop of the other route should be R4.
  - You may only use an EIGRP **Offset-List** on R3 to accomplish this objective.

- R3 should utilize a **Distribute-List** in such a way that it is only allowed to learn of R1's Loopback-4 and Loopback-5 subnets via R4. When these same subnets are advertised via R2, they should NOT show up in either the IP Routing Table—or EIGRP Topology Table—of R3.

R4 Configuration Criteria

- R4 should have **two unequal-cost paths** in its IP Routing Table to the Loopback-0 subnet of R2 (**2.5.2.0/30**).
  - The best path should be via R2 directly.
  - The secondary path (which should still be visible in the IP Routing Table) should be via R1.
  - **R4 must NOT consider FastEthernet0/0** as a path in the IP Routing Table to reach this subnet.
  - You may only use the EIGRP **Variance** feature and modification of interface Bandwidths/Delays to accomplish this task.

Configuration (R1)

```
<Only the relevant EIGRP configuration is shown>


!
hostname Router-1
!
!
key chain INE
 key 1
  key-string Cisco
!
!
!
router eigrp INE
 !
 address-family ipv4 unicast autonomous-system 100
  !
  af-interface FastEthernet0/0
   authentication mode md5
   authentication key-chain INE
  exit-af-interface
  !
  af-interface Serial1/3
   summary-address 111.111.111.0 255.255.255.224
  exit-af-interface
  !
  topology base
   distribute-list route-map INE in Serial1/3
  exit-af-topology
```

```
  network 1.2.1.0 0.0.0.255
  network 1.4.1.0 0.0.0.255
  network 111.111.111.0 0.0.0.7
  network 111.111.111.8 0.0.0.7
  network 111.111.111.16 0.0.0.7
  network 111.111.111.24 0.0.0.3
  network 111.111.111.32 0.0.0.15
  network 111.111.111.64 0.0.0.31
 exit-address-family
!
!
ip prefix-list INE seq 10 permit 144.144.144.32/28
ip prefix-list INE seq 15 permit 144.144.144.64/27
!
route-map INE deny 10
 match ip address 1
!
route-map INE deny 20
 match ip address prefix-list INE
!
route-map INE permit 30
!
!
access-list 1 permit 144.144.144.16
access-list 1 permit 144.144.144.0 0.0.0.15
!
```

Configuration (R2)

```
<Only the relevant EIGRP configuration is shown>


!
key chain INE
 key 1
  key-string Cisco
!
!
!
router eigrp INE
 !
 address-family ipv4 unicast autonomous-system 100
  !
  af-interface FastEthernet0/0
   authentication mode md5
```

```
   authentication key-chain INE
  exit-af-interface
  !
  topology base
   distribute-list prefix INE out FastEthernet0/1
   redistribute static metric 10000 10 255 1 1500
  exit-af-topology
  network 1.2.1.0 0.0.0.255
  network 2.4.2.0 0.0.0.255
  network 2.5.2.0 0.0.0.3
 exit-address-family
!
!
ip route 0.0.0.0 0.0.0.0 Null0
!
!
ip prefix-list INE seq 10 deny 111.111.111.0/26 ge 29 le 30
ip prefix-list INE seq 15 permit 0.0.0.0/0 le 32
!
!
```

Configuration (R3)

```
<Only the relevant EIGRP configuration is shown>


!
router eigrp 100
 distribute-list 101 in FastEthernet0/0
 network 2.4.2.0 0.0.0.255
 network 3.4.3.0 0.0.0.255
 offset-list 2 in 2560 FastEthernet0/0
!
ip forward-protocol nd
no ip http server
no ip http secure-server
!
!
!
!
!
access-list 2 permit 2.5.2.0 0.0.0.255
access-list 101 deny   ip host 2.4.2.2 111.111.111.32 0.0.0.31
access-list 101 deny   ip host 2.4.2.2 111.111.111.64 0.0.0.63
access-list 101 permit ip host 2.4.2.2 any
```

```
access-list 101 permit ip host 2.4.2.4 any
!
```

Configuration (R4)

```
<Only the relevant EIGRP configuration is shown>

!
interface FastEthernet0/0
 ip address 3.4.3.4 255.255.255.0 delay 120
 duplex auto
 speed auto
!
interface FastEthernet0/1
 ip address 2.4.2.4 255.255.255.0 delay 11
 duplex auto
 speed auto
!
!
interface Serial1/3 bandwidth 100000
 ip address 1.4.1.4 255.255.255.0 delay 10

!
!
!
router eigrp 100
 variance 2
 network 1.4.1.0 0.0.0.255
 network 2.4.2.0 0.0.0.255
 network 3.4.3.0 0.0.0.255
 network 144.144.144.0 0.0.0.7
 network 144.144.144.8 0.0.0.7
 network 144.144.144.16 0.0.0.7
 network 144.144.144.24 0.0.0.3
 network 144.144.144.32 0.0.0.15
 network 144.144.144.64 0.0.0.31
!
```

For the variance command to work (and not also include the route to 2.5.2.0/30 via FastEthernet0/0), several things had to occur:

- The Reported Distance of this route via Serial1/3 had to be LESS THAN the current

Feasible Distance of the best route (to meet the Feasibility Condition).
    - If a route does not meet the Feasibility Condition, it will never be a candidate for Variance.
    - For this reason, the method selected here was to slightly increase the delay on interface FastEthernet0/1.
    - This ensured that the Feasible Distance of the best route was slightly higher than the Reported Distance of this same route from R1 (via Serial1/3).

- To use a Variance of 2 would also have allowed the router to use FastEthernet0/0 as its next-hop (which would have given three routes to this subnet), but that was expressly prohibited in the instructions.
    - To prevent that, the delay of FastEthernet0/0 was greatly increased so that the total distance to reach 2.5.2.0/30 via this interface was MORE than twice the current Feasible Distance.

CCNP ROUTE Workbook - CCNP Route Workbook Introduction

CCNP Route Introduction

Welcome!

Thank you for using this workbook as part of your preparations for pursuing your CCNP ROUTE certification. The sections and tasks within this workbook are designed to give you hands-on experience with the majority of topics defined as "**Configure and verify**" within the CCNP ROUTE version 2.0 blueprint.

Although it is advisable to begin with the first task in each section and then work progressively through that section, the individual tasks were designed in such a way that you can start with any task you wish without following any specific order. After you have downloaded the initial configurations for a task, you may begin working on that task, even if you have not completed the tasks that preceded it.

Release Notes

The initial release of this Workbook (released April 29th, 2015) contains tasks related to EIGRP. This workbook will have additional tasks released over the next nine (9) months on different CCNP ROUTE topics. Updates to this workbook will be announced periodically here, in the "Release Notes" section.

May 6th, 2015: Five additional tasks (OSPF-related) added to Workbook

- OSPF Initial Configuration
- OSPF Virtual-Links
- OSPF Designated Routers
- OSPF Network Type Mismatches
- OSPF Stub Areas

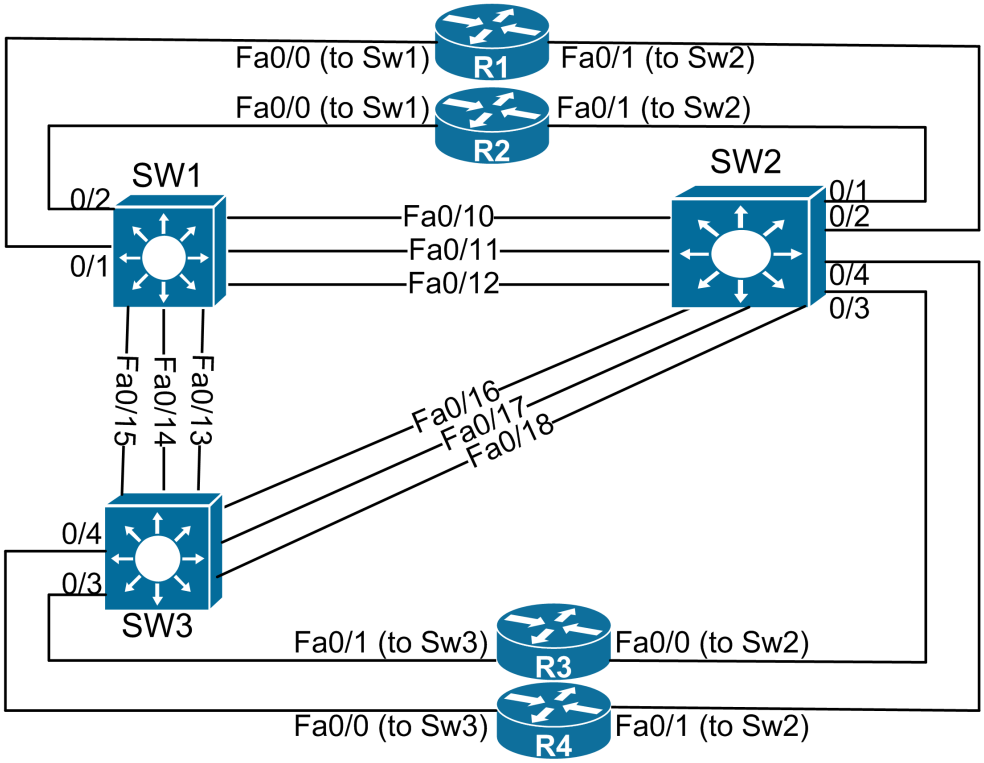
Diagrams

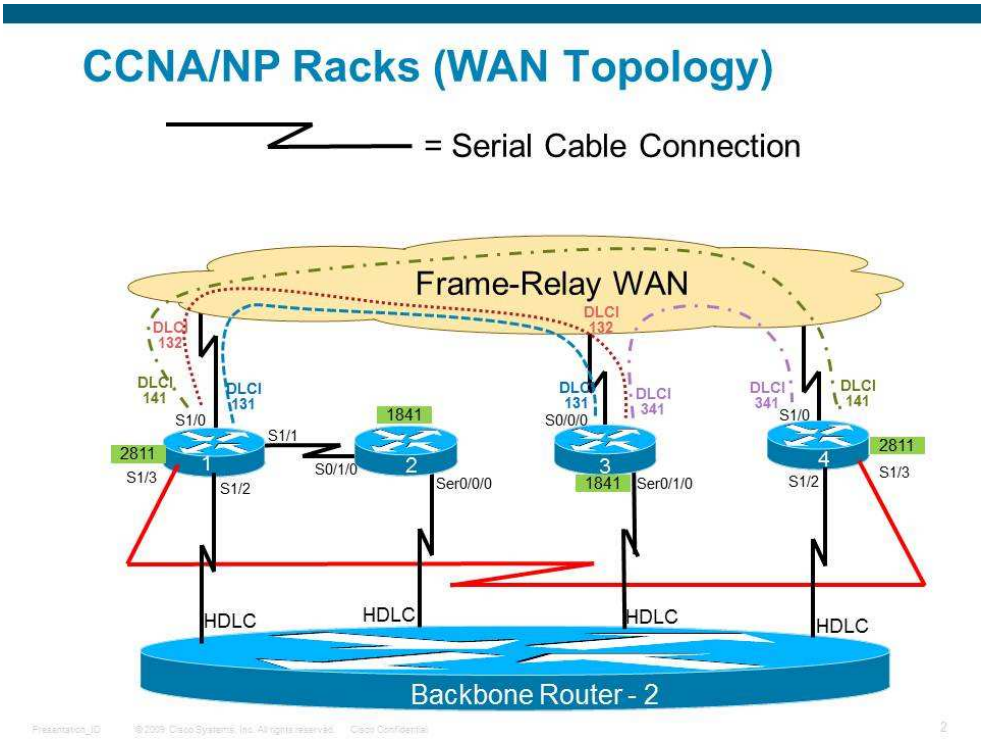
There are two main diagrams supplied with this workbook that should be used to give you a complete understanding of the network topology. Often, you will find that

there are individual diagrams for each section, but these are all permutations of the main diagrams shown below.

Aside from the links shown below, there are other links (not displayed in the topology diagram) that lead to other devices not used in this workbook. To prevent unexpected behavior, **it is always recommended that you shut down all links on all three switches in your LAN topology as your first step, and then enable only those links displayed in the topology for any given task**.

Also, please remember that interfaces on routers are administratively disabled by default. So for most tasks that utilize routers, you will need to administratively enable any of their interfaces that are used for any given task.





Feedback

Please let us know how we're doing! In the upper-right corner of your screen, you will see a **Feedback** link. If you found any errors in this workbook or have any suggestions for improvement, we'd like to know. Also, if you enjoyed this workbook, we'd like to know that as well.

CCNP SWITCH Workbook - CCNP Switch Workbook Introduction

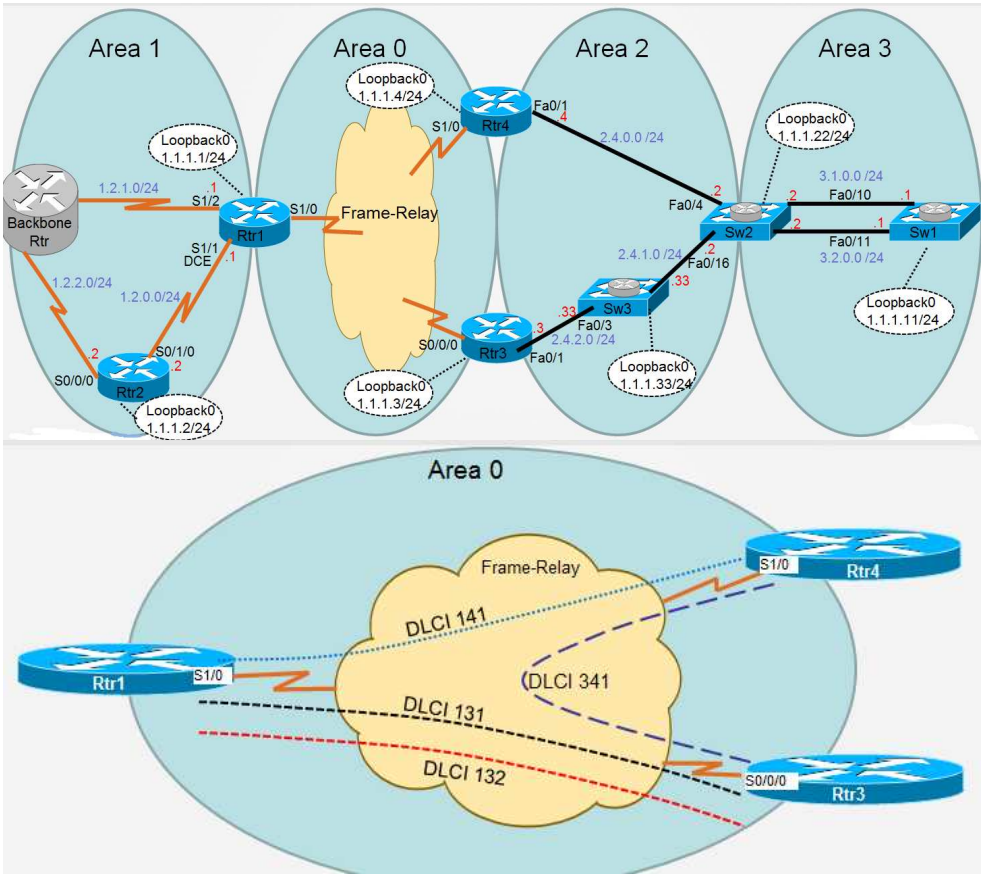
CCNA/CCNP Rack Rental Guide

Click here to access the CCNA/CCNP Rack Rental Guide.

CCNP ROUTE Workbook - OSPF

OSPF Initial Configuration

> Load the ***CCNP ROUTE WB Task OSPF-1 Configs*** initial configurations before starting.



Tasks

- When you load the initial configurations onto all devices for this task, all devices will be:
  - Preconfigured with IP addresses as shown in the topology diagram.
  - OSPF will already be activated on all links connecting to Areas 1, 2, and 3 (Loopbacks are not advertised by OSPF)
  - Routers 1, 3, and 4 will already have functional Frame-Relay PVCs between them.
-

Configure Router-1's, Router-3's, and Router-4's links to the Frame-Relay WAN to all be in the 1.3.4.0/24 subnet. Do ***NOT*** use sub-interfaces for this step.

- Configure OSPF on the same three routers so that you obtain a full-mesh (each router has an OSPF adjacency with the other two routers across the Frame-Relay WAN).
    - Use the command, **"show ip ospf neighbor"** to verify the status of adjacencies
    - Use the command, **"show ip route ospf"** to verify that OSPF LSAs have been exchanged over Area 0.
    - Use the command, **"show ip ospf database"** to confirm that all devices in Areas 1, 0, and 2 have received Type-1, Type-2, Type-3, Type-4 and Type-5 LSAs.
- At the end of this task, you should have end-to-end IP connectivity between Switch-2 and IP Subnets being advertised by the Backbone Router (Switch-1 will not have any OSPF routes yet).

It is advisable that before you move on to the next task, you save your configurations for Routers-1, 3, and 4 into a local text file as you will need to reconfigure the WAN links on these routers for subsequent tasks.

Router Configuration

```
Rtr-1(config)#int ser 1/0
Rtr-1(config-if)#ip address 1.3.4.1 255.255.255.0
Rtr-1(config-if)#exit
Rtr-1(config)#router ospf 1Rtr-1(config-router)#network 1.3.4.0 0.0.0.255 area 0
Rtr-1(config-router)#neighbor 1.3.4.3
Rtr-1(config-router)#neighbor 1.3.4.4
Rtr-1(config-router)#end
Rtr-1#

Rtr-3(config)#int ser 0/0/0
Rtr-3(config-if)#ip address 1.3.4.3 255.255.255.0
Rtr-3(config-if)#exit
Rtr-3(config)#router ospf 1Rtr-3(config-router)#network 1.3.4.0 0.0.0.255 area 0
Rtr-3(config-router)#neighbor 1.3.4.1
Rtr-3(config-router)#neighbor 1.3.4.4
Rtr-3(config-router)#end
Rtr-3#
```

```
Rtr-4(config)#int ser 1/0
Rtr-4(config-if)#ip address 1.3.4.4 255.255.255.0
Rtr-4(config-if)#exit
Rtr-4(config)#router ospf 1Rtr-4(config-router)#network 1.3.4.0 0.0.0.255 area 0
Rtr-4(config-router)#neighbor 1.3.4.3
Rtr-4(config-router)#neighbor 1.3.4.1

Rtr-4(config-router)#end
Rtr-4#
```

Verification - "Show IP OSPF Neighbor"

```
Rtr-1#show ip ospf neighbor

Neighbor ID     Pri   State           Dead Time   Address         Interface
1.1.1.3           1   FULL/BDR
        00:01:42    1.3.4.3         Serial1/01.1.1.4            1   FULL/DROTHER
    00:01:47    1.3.4.4         Serial1/0
1.1.1.2           0   FULL/  -        00:00:34    1.2.0.2         Serial1/1
192.168.1.17      0   FULL/  -        00:00:34    1.2.1.254       Serial1/2
Rtr-1#
Rtr-3#sho ip ospf neighbor

Neighbor ID     Pri   State           Dead Time   Address         Interface
1.1.1.1           1   FULL/DR
         00:01:50    1.3.4.1         Serial0/0/01.1.1.4            1   FULL/DROTHER
    00:01:41    1.3.4.4         Serial0/0/0
1.1.1.33          1   FULL/BDR        00:00:32    2.4.2.33        FastEthernet0/1
Rtr-3#
Rtr-4#sho ip ospf neighbor

Neighbor ID     Pri   State           Dead Time   Address         Interface
1.1.1.1           1   FULL/DR
         00:01:55    1.3.4.1         Serial1/01.1.1.3            1   FULL/BDR
        00:01:40    1.3.4.3         Serial1/0
1.1.1.22          1   FULL/DR         00:00:33    2.4.0.2         FastEthernet0/1
Rtr-4#
```

Verification - "Show IP Route OSPF"

The proof that OSPF is functional across the Frame-Relay WAN (Area 0) is the

presence of OSPF Inter-Area routes (O IA) and OSPF External routes (O E2) within Switch-2's IP Routing Table.

```
Sw-2#show ip route ospf

     1.0.0.0/24 is subnetted, 5 subnets
O IA    1.2.2.0 [110/911] via 2.4.1.33, 00:04:57, FastEthernet0/16
O IA    1.2.1.0 [110/847] via 2.4.1.33, 00:04:57, FastEthernet0/16
O IA    1.2.0.0 [110/847] via 2.4.1.33, 00:04:57, FastEthernet0/16
O IA    1.3.4.0 [110/66] via 2.4.1.33, 00:06:40, FastEthernet0/16
     2.0.0.0/24 is subnetted, 3 subnets
O       2.4.2.0 [110/2] via 2.4.1.33, 00:06:45, FastEthernet0/16
     192.168.1.0/24 is variably subnetted, 4 subnets, 2 masks
O E1    192.168.1.8/30 [110/867] via 2.4.1.33, 00:04:52, FastEthernet0/16
O E1    192.168.1.12/30 [110/867] via 2.4.1.33, 00:04:53, FastEthernet0/16
O E2    192.168.1.4/30 [110/20] via 2.4.1.33, 00:04:53, FastEthernet0/16
O E2    192.168.1.16/28 [110/20] via 2.4.1.33, 00:04:53, FastEthernet0/16
Sw-2#
```

Verification - "Show IP OSPF Database"

The proof that OSPF is functional across the Frame-Relay WAN (Area 0) is the presence of OSPF Type-3 Summary LSAs and Type-5 External LSAs within the OSPF Database of Switch-2.

```
Sw-2#show ip ospf database

            OSPF Router with ID (1.1.1.22) (Process ID 1)

                Router Link States (Area 2)

Link ID         ADV Router      Age         Seq#       Checksum Link count
1.1.1.3         1.1.1.3         541         0x80000003 0x0067A6 1
1.1.1.4         1.1.1.4         503         0x80000006 0x0029E3 1
1.1.1.22        1.1.1.22        721         0x80000005 0x00109B 2
1.1.1.33        1.1.1.33        722         0x80000003 0x00B2A1 2

                Net Link States (Area 2)

Link ID         ADV Router      Age         Seq#       Checksum
2.4.0.2         1.1.1.22        752         0x80000001 0x00F503
2.4.1.33        1.1.1.33        723         0x80000001 0x00DCD3
2.4.2.3         1.1.1.3         768         0x80000001 0x0021DD
```

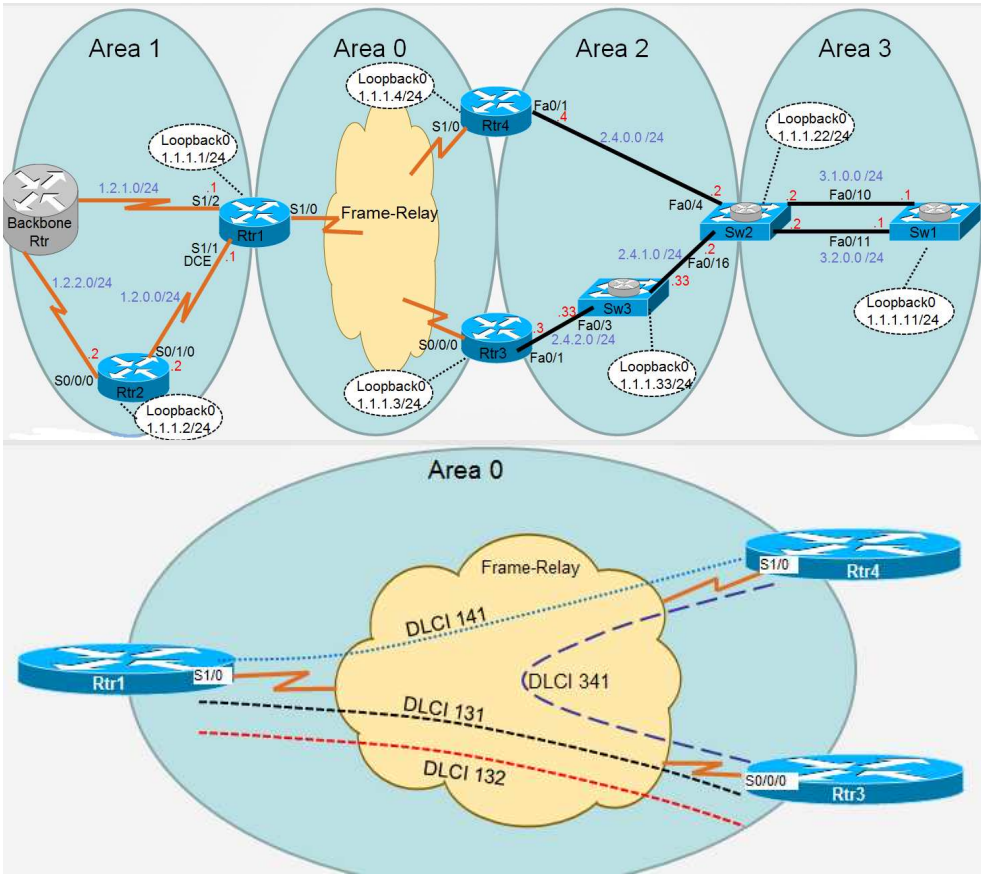
```
Summary Net Link States (Area 2)


Link ID         ADV Router      Age         Seq#       Checksum
1.2.0.0         1.1.1.3         416         0x80000001 0x005A89
1.2.0.0         1.1.1.4         391         0x80000001 0x006FA3
1.2.1.0         1.1.1.3         416         0x80000001 0x004F93
1.2.1.0         1.1.1.4         393         0x80000001 0x0064AD
1.2.2.0         1.1.1.3         418         0x80000001 0x00C6DA
1.2.2.0         1.1.1.4         393         0x80000001 0x00DBF4
1.3.4.0         1.1.1.3         534         0x80000001 0x00846A
1.3.4.0         1.1.1.4         496         0x80000001 0x009984

                Summary ASB Link States (Area 2)

Link ID         ADV Router      Age         Seq#       Checksum
192.168.1.17    1.1.1.3         418         0x80000001 0x000A60
192.168.1.17    1.1.1.4         394         0x80000001 0x001F7A

                Router Link States (Area 3)

Link ID         ADV Router      Age         Seq#       Checksum Link count
1.1.1.11        1.1.1.11        751         0x80000007 0x00D612 2
1.1.1.22        1.1.1.22        750         0x80000003 0x00567E 2

                Net Link States (Area 3)

Link ID         ADV Router      Age         Seq#       Checksum
3.1.0.2         1.1.1.22        755         0x80000001 0x006F84
3.2.0.2         1.1.1.22        751         0x80000001 0x00638F
Type-5 AS External Link States


Link ID         ADV Router      Age         Seq#       Checksum Tag
192.168.1.4     192.168.1.17    136         0x80000E0F 0x00316C 0
192.168.1.8     192.168.1.17    136         0x80000E0F 0x008594 0
192.168.1.12    192.168.1.17    136         0x80000E0F 0x005DB8 0
192.168.1.16    192.168.1.17    135         0x80000E0F 0x00702D 0
Sw-2#
```

#

CCNP ROUTE Workbook - OSPF

OSPF Virtual-Links

> Load the ***CCNP ROUTE WB Task OSPF-1 Configs*** initial configurations before starting.



Tasks

- When you load the initial configurations onto all devices for this task, all devices will be:
  - Preconfigured with IP addresses as shown in the topology diagram.
  - OSPF will already be activated on all links connecting to Areas 1, 2, and 3 (Loopbacks are not advertised by OSPF)
  - Routers 1, 3, and 4 will already have functional Frame-Relay PVCs between them.
-

Configure Router-1's, Router-3's, and Router-4's links to the Frame-Relay WAN to all be in the 1.3.4.0/24 subnet. Do ***NOT*** use sub-interfaces for this step.

- Configure OSPF on the same three routers so that you obtain a full-mesh (each router has an OSPF adjacency with the other two routers across the Frame-Relay WAN).
- Configure two OSPF Virtual-Links (for redundancy) on whatever devices you deem appropriate so that Switch-1 will learn of all OSPF routes (internal and external).
- At the end of this task, you should have end-to-end IP connectivity between Switch-1 and IP Subnets being advertised by the Backbone Router.

It is advisable that before you move on to the next task, you save your configurations for Routers-1, 3, and 4 into a local text file as you will need to reconfigure the WAN links on these routers for subsequent tasks.

Configuration

```
Rtr-4(config)#router ospf 1Rtr-4(config-router)#area 2 virtual-link 1.1.1.22
Rtr-4(config-router)#end
Rtr-4#

Rtr-3(config)#router ospf 1Rtr-3(config-router)#area 2 virtual-link 1.1.1.22
Rtr-3(config-router)#end
Rtr-3#

Sw-2(config)#router ospf 1Sw-2(config-router)#area 2 virtual-link 1.1.1.4
Sw-2(config-router)#area 2 virtual-link 1.1.1.3

Sw-2(config-router)#end
Sw-2#
```

Verification - Syslogs on Switch-2

```
Sw-2# *Mar  1 03:16:42.139: %OSPF-5-ADJCHG: Process 1, Nbr 1.1.1.4 on OSPF_VL0 from LOADING to FULL
, Loading Done *Mar  1 03:16:42.143: %OSPF-5-ADJCHG: Process 1, Nbr 1.1.1.3 on
OSPF_VL1 from LOADING to FULL
, Loading Done
Sw-2#
```

Verification - "show ip ospf virtual-links" on Switch-2

```
Sw-2#show ip ospf virtual-links
Virtual Link OSPF_VL1 to router 1.1.1.3 is up
  Run as demand circuit
  DoNotAge LSA allowed.
  Transit area 2, via interface FastEthernet0/16, Cost of using 2
  Transmit Delay is 1 sec, State POINT_TO_POINT,
  Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
    Hello due in 00:00:06
    Adjacency State FULL (Hello suppressed)
    Index 2/6, retransmission queue length 0, number of retransmission 0
    First 0x0(0)/0x0(0) Next 0x0(0)/0x0(0)
    Last retransmission scan length is 0, maximum is 0
    Last retransmission scan time is 0 msec, maximum is 0 msec
Virtual Link OSPF_VL0 to router 1.1.1.4 is up

  Run as demand circuit
  DoNotAge LSA allowed.
  Transit area 2, via interface FastEthernet0/4, Cost of using 1
  Transmit Delay is 1 sec, State POINT_TO_POINT,
  Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
    Hello due in 00:00:03
    Adjacency State FULL (Hello suppressed)
    Index 1/5, retransmission queue length 0, number of retransmission 0
    First 0x0(0)/0x0(0) Next 0x0(0)/0x0(0)
    Last retransmission scan length is 0, maximum is 0
    Last retransmission scan time is 0 msec, maximum is 0 msec
Sw-2#
```

Verification - OSPF Routes now visible on Switch-1

```
Sw-1#sho ip route ospf

     1.0.0.0/24 is subnetted, 5 subnets
```

```
O IA    1.2.2.0 [110/912] via 3.2.0.2, 00:02:29, FastEthernet0/11
                [110/912] via 3.1.0.2, 00:02:29, FastEthernet0/10
O IA    1.2.1.0 [110/848] via 3.2.0.2, 00:02:29, FastEthernet0/11
                [110/848] via 3.1.0.2, 00:02:29, FastEthernet0/10
O IA    1.2.0.0 [110/848] via 3.2.0.2, 00:02:29, FastEthernet0/11
                [110/848] via 3.1.0.2, 00:02:29, FastEthernet0/10
O IA    1.3.4.0 [110/67] via 3.2.0.2, 00:02:29, FastEthernet0/11
                [110/67] via 3.1.0.2, 00:02:29, FastEthernet0/10
     2.0.0.0/24 is subnetted, 3 subnets
O IA    2.4.2.0 [110/3] via 3.2.0.2, 00:02:39, FastEthernet0/11
                [110/3] via 3.1.0.2, 00:02:39, FastEthernet0/10
O IA    2.4.0.0 [110/2] via 3.2.0.2, 00:02:39, FastEthernet0/11
                [110/2] via 3.1.0.2, 00:02:39, FastEthernet0/10
O IA    2.4.1.0 [110/2] via 3.2.0.2, 00:02:39, FastEthernet0/11
                [110/2] via 3.1.0.2, 00:02:39, FastEthernet0/10
     192.168.1.0/24 is variably subnetted, 4 subnets, 2 masks
O E1    192.168.1.8/30 [110/868] via 3.2.0.2, 00:02:30, FastEthernet0/11
                       [110/868] via 3.1.0.2, 00:02:30, FastEthernet0/10
O E1    192.168.1.12/30 [110/868] via 3.2.0.2, 00:02:30, FastEthernet0/11
                        [110/868] via 3.1.0.2, 00:02:30, FastEthernet0/10
O E2    192.168.1.4/30 [110/20] via 3.2.0.2, 00:02:30, FastEthernet0/11
                       [110/20] via 3.1.0.2, 00:02:30, FastEthernet0/10
O E2    192.168.1.16/28 [110/20] via 3.2.0.2, 00:02:31, FastEthernet0/11
                        [110/20] via 3.1.0.2, 00:02:31, FastEthernet0/10
Sw-1#
```

Notice that Switch-2 is now acting as an OSPF Area Border Router. Because Switch-2 is the termination point for one end of the virtual-link, this means that Area-0 has now been "stretched" through this Virtual-Link and terminates on Switch-2.

As such, Switch-2 is now maintaining three (3) OSPF Databases...an Area-3 DB, an Area-2 DB and an Area-0 DB.

```
Sw-2
#sho ip ospf database

            OSPF Router with ID (1.1.1.22) (Process ID 1)
                Router Link States (Area 0
)

Link ID         ADV Router      Age         Seq#       Checksum Link count
1.1.1.1         1.1.1.1         1926  (DNA) 0x80000005 0x00659F 1
1.1.1.3         1.1.1.3         1     (DNA) 0x80000007 0x00CDC7 2
1.1.1.4         1.1.1.4         1     (DNA) 0x80000006 0x0013B2 2
1.1.1.22        1.1.1.22        277         0x80000002 0x0025A6 2
```

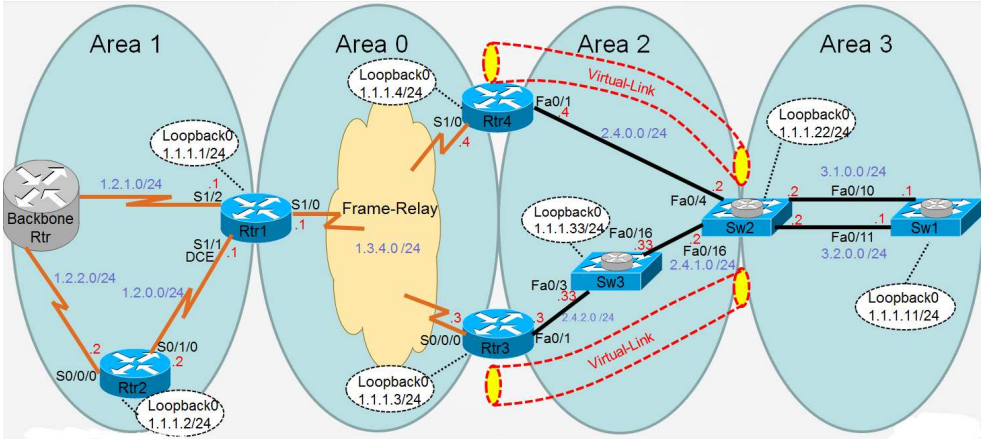
```
                Net Link States (Area 0
)

Link ID         ADV Router      Age         Seq#       Checksum
1.3.4.1         1.1.1.1         1926  (DNA) 0x80000005 0x000311
                Summary Net Link States (Area 0
)

Link ID         ADV Router      Age         Seq#       Checksum
1.2.0.0         1.1.1.1         406   (DNA) 0x80000005 0x00DB46
1.2.1.0         1.1.1.1         406   (DNA) 0x80000005 0x00D050
1.2.2.0         1.1.1.1         406   (DNA) 0x80000005 0x004897

***<output omitted for brevity>***
                Summary ASB Link States (Area 0
)

Link ID         ADV Router      Age         Seq#       Checksum
192.168.1.17    1.1.1.1         406   (DNA) 0x80000005 0x008B1D
                Router Link States (Area 2
)

Link ID         ADV Router      Age         Seq#       Checksum Link count
1.1.1.3         1.1.1.3         283         0x80000008 0x00699B 1
1.1.1.4         1.1.1.4         282         0x8000000B 0x002BD8 1
1.1.1.22        1.1.1.22        282         0x8000000B 0x00138D 2
1.1.1.33        1.1.1.33        586         0x80000007 0x00AAA5 2
                Net Link States (Area 2
)

Link ID         ADV Router      Age         Seq#       Checksum
2.4.0.2         1.1.1.22        784         0x80000005 0x00ED07
2.4.1.33        1.1.1.33        587         0x80000005 0x00D4D7
2.4.2.3         1.1.1.3         737         0x80000005 0x0019E1
                Summary Net Link States (Area 2
)

Link ID         ADV Router      Age         Seq#       Checksum
1.2.0.0         1.1.1.3         488         0x80000005 0x00528D
1.2.1.0         1.1.1.3         488         0x80000005 0x004797

***<output omitted for brevity>***
                Summary ASB Link States (Area 2
)

Link ID         ADV Router      Age         Seq#       Checksum
```

```
192.168.1.17    1.1.1.3         489         0x80000005 0x000264
                Router Link States (Area 3
)

Link ID         ADV Router      Age         Seq#       Checksum Link count
1.1.1.11        1.1.1.11        639         0x8000000B 0x00CE16 2
1.1.1.22        1.1.1.22        290         0x80000008 0x004F7F 2
                Net Link States (Area 3
)

Link ID         ADV Router      Age         Seq#       Checksum
3.1.0.2         1.1.1.22        787         0x80000005 0x006788
3.2.0.2         1.1.1.22        787         0x80000005 0x005B93
                Summary Net Link States (Area 3
)

Link ID         ADV Router      Age         Seq#       Checksum
1.2.0.0         1.1.1.22        276         0x80000001 0x00FBD2
1.2.1.0         1.1.1.22        276         0x80000001 0x00F0DC
1.2.2.0         1.1.1.22        276         0x80000001 0x006824

***<output omitted for brevity>***
                Summary ASB Link States (Area 3
)

Link ID         ADV Router      Age         Seq#       Checksum
192.168.1.17    1.1.1.22        277         0x80000001 0x00ABA9

                Type-5 AS External Link States

Link ID         ADV Router      Age         Seq#       Checksum Tag
192.168.1.4     192.168.1.17    2032        0x80000E12 0x002B6F 0
192.168.1.8     192.168.1.17    2032        0x80000E12 0x007F97 0
192.168.1.12    192.168.1.17    2032        0x80000E12 0x0057BB 0
192.168.1.16    192.168.1.17    2031        0x80000E12 0x006A30 0
Sw-2#
```

CCNP ROUTE Workbook - OSPF

OSPF Designated Routers

> Load the ***CCNP ROUTE WB Task OSPF-1 Configs*** initial configurations before starting.



Preliminary Tasks

- When you load the initial configurations onto all devices for this task, all devices will be:
  - Preconfigured with IP addresses as shown in the topology diagram.
  - OSPF will already be activated on all links connecting to Areas 1, 2, and 3 (Loopbacks are not advertised by OSPF)
  - Routers 1, 3, and 4 will already have functional Frame-Relay PVCs between them.
- Complete the initial configuration of OSPF for Area-0 and the two Virtual-Links as shown in the topology diagram.
- Ensure Switch-1 can ping any of the IP addresses configured on physical interfaces of Router-2

New Tasks

- Identify which device is the Designated Router for the segment shared between

Router-4 and Switch-2.

- Issue a "show" command in Router-4 such that the only thing that is displayed, are details about the Type-2 Network LSA generated from the Designated Router you identified above. No other LSAs should be displayed in the output.
- Make whatever configuration changes are needed so that the device that is ***NOT*** currently the OSPF Designated Router, becomes the Designated Router.

It is advisable that before you move on to the next task, you save your configurations for Routers-1, 3, 4, and Switch-2 into a local text file as you will need to reconfigure the WAN links and Virtual-Links for subsequent tasks.

Configuration and Verification

Identify which device is the Designated Router for the segment shared between Router-4 and Switch-2.

```
Rtr-4#sho ip ospf interface FastEthernet0/1
FastEthernet0/1 is up, line protocol is up
  Internet Address 2.4.0.4/24, Area 2, Attached via Network Statement
  Process ID 1, Router ID 1.1.1.4, Network Type BROADCAST, Cost: 1
  Topology-MTID    Cost    Disabled    Shutdown      Topology Name
        0           1         no          no            Base
  Transmit Delay is 1 sec, State BDR, Priority 1
 Designated Router (ID) 1.1.1.22, Interface address 2.4.0.2

  Backup Designated router (ID) 1.1.1.4, Interface address 2.4.0.4
...
<Output omitted for brevity>
```

Note that in your topology, Router-4 may display as the OSPF Designated Router.

Issue a "show" command in Router-4 such that the only thing that is displayed, are details about the Type-2 Network LSA generated from the Designated Router you identified above. No other LSAs should be displayed in the output.

```
Rtr-4#show ip ospf database network adv-router 1.1.1.22


            OSPF Router with ID (1.1.1.4) (Process ID 1)

                Net Link States (Area 2)
```

```
  Routing Bit Set on this LSA in topology Base with MTID 0
  LS age: 868
  Options: (No TOS-capability, DC)
  LS Type: Network Links
  Link State ID: 2.4.0.2 (address of Designated Router)
  Advertising Router: 1.1.1.22
  LS Seq Number: 80000001
  Checksum: 0xF503
  Length: 32
  Network Mask: /24
        Attached Router: 1.1.1.22
        Attached Router: 1.1.1.4

Rtr-4#
```

Make whatever configuration changes are needed so that the device that is *NOT* currently the OSPF Designated Router, becomes the Designated Router.

In the example below, Router-4 is ***NOT*** the OSPF Designated Router.

```
Rtr-4#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
Rtr-4(config)#int fast0/1 Rtr-4(config-if)#ip ospf priority 2
```

The default OSPF interface priority is one (1). Here we are making the interface priority on Router-4 higher than the default so that it will become the DR.

```
Rtr-4(config-if)#shut

Rtr-4(config-if)#
May  4 12:25:42.955: %OSPF-5-ADJCHG: Process 1, Nbr 1.1.1.22 on FastEthernet0/1 from FULL to DOWN, Neighbor Down: In
Rtr-4(config-if)#
May  4 12:25:44.951: %LINK-5-CHANGED: Interface FastEthernet0/1, changed state to administratively down
May  4 12:25:45.951: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/1, changed state to down
Rtr-4(config-if)#
May  4 12:25:48.455: %OSPF-5-ADJCHG: Process 1, Nbr 1.1.1.22 on OSPF_VL0 from FULL to DOWN, Neighbor Down: Interface
Rtr-4(config-if)#
Rtr-4(config-if)# Rtr-4(config-if)#no shutdown

Rtr-4(config-if)#end
Rtr-4#
```

Once an OSPF Designated Router has been elected on a segment, that router will remain as the DR, even if a higher priority router comes online. The only way for that router to relinquish its role as the DR is to either remove it from the segment, or make it believe that the segment is no longer a "transit" segment. By shutting down R4's direct connection to Switch-2, Switch-2's FastEthernet interface went down/down and so OSPF was deactivated on this interface. Once it came back up again (because R4 was re-enabled) a new DR/BDR election had to take place.

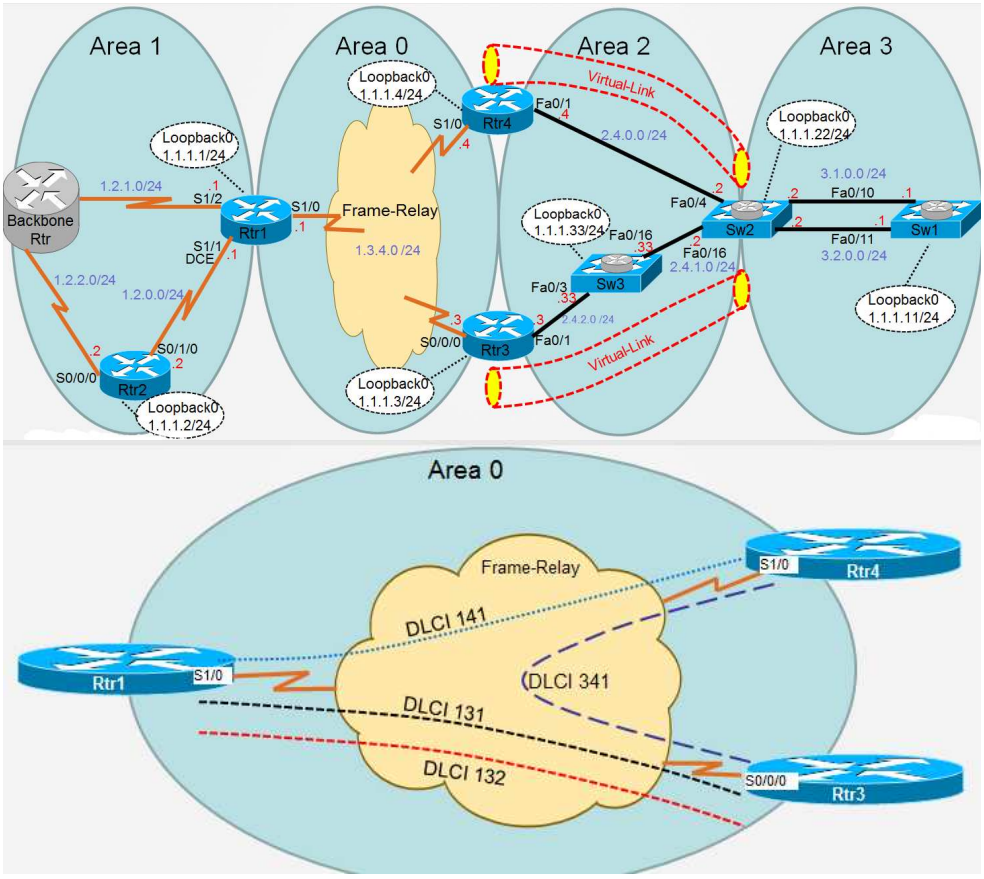
```
Rtr-4#
May  4 12:25:59.995: %SYS-5-CONFIG_I: Configured from console by console
Rtr-4#
May  4 12:26:01.175: %LINK-3-UPDOWN: Interface FastEthernet0/1, changed state to up
May  4 12:26:02.175: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/1, changed state to up
Rtr-4#
Rtr-4#
May  4 12:26:42.895: %OSPF-5-ADJCHG: Process 1, Nbr 1.1.1.22 on FastEthernet0/1 from LOADING to FULL, Loading Done

May  4 12:26:47.911: %OSPF-5-ADJCHG: Process 1, Nbr 1.1.1.22 on OSPF_VL0 from LOADING to FULL, Loading Done
Rtr-4#sho ip ospf interface Fast0/1
FastEthernet0/1 is up, line protocol is up
  Internet Address 2.4.0.4/24, Area 2, Attached via Network Statement
  Process ID 1, Router ID 1.1.1.4, Network Type BROADCAST, Cost: 1
  Topology-MTID    Cost    Disabled    Shutdown      Topology Name
        0           1         no          no            Base
  Transmit Delay is 1 sec, State DR, Priority 2
```

```
 Designated Router (ID) 1.1.1.4, Interface address 2.4.0.4

   Backup Designated router (ID) 1.1.1.22, Interface address 2.4.0.2
   Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
     oob-resync timeout 40
     Hello due in 00:00:06
   Supports Link-local Signaling (LLS)
   Cisco NSF helper support enabled
   IETF NSF helper support enabled
   Index 1/1, flood queue length 0
   Next 0x0(0)/0x0(0)
   Last flood scan length is 1, maximum is 8
   Last flood scan time is 0 msec, maximum is 0 msec
   Neighbor Count is 1, Adjacent neighbor count is 1
     Adjacent with neighbor 1.1.1.22  (Backup Designated Router)
   Suppress hello for 0 neighbor(s)
Rtr-4#
```

CCNP ROUTE Workbook - OSPF

OSPF Network Type Mismatches

> Load the ***CCNP ROUTE WB Task OSPF-1 Configs*** initial configurations before starting.



Preliminary Tasks

- When you load the initial configurations onto all devices for this task, all devices will be:
  - Preconfigured with IP addresses as shown in the topology diagram.
  - OSPF will already be activated on all links connecting to Areas 1, 2, and 3 (Loopbacks are not advertised by OSPF)
  - Routers 1, 3, and 4 will already have functional (full-mesh) Frame-Relay PVCs between them.

New Tasks

- Configure OSPF virtual-links between:
  - Router-4 and Switch-2
  - Router-3 and Switch-2
- Configure the following Serial sub-interfaces on Routers-1, 3, and 4:
  - R1: serial1/0.134 multipoint (ip address 1.3.4.1 /24)
  - R3: serial0/0/0.134 multipoint (ip address 1.3.4.3 /24)
  - R4: serial1/0.134 multipoint (ip address 1.3.4.4 /24)
  - Configure any other frame-relay commands necessary such that all three routers can ping each other's serial sub-interface (use only DLCI 131 to connect Router-1 to Router-3).
- On Switch-3, **shutdown interface FastEthernet0/16**.

> The objective behind these next steps is to observe the behavior of OSPF when two neighbors don't agree on the network type shared between them.

- On the serial sub-interface of R4, configure an OSPF network type of "**point-to-multipoint**"
- Add the necessary OSPF commands to Routers-1, 3, and 4 so that they form OSPF adjacencies between them across the Frame-Relay WAN.

Question-1: On R4, use the command "**show ip ospf interface serial1/0.134**". What is the network type displayed for this interface? _____

Question-2: On R1, use the command "**show ip ospf interface serial1/0.134**". What is the network type displayed for this interface? _____

Question-3: Even though Router-4's connection to the Frame-Relay WAN is now seen as a different OSPF network type than Router-1 and Router-3's connection to this same WAN, did that prevent Router-4 from forming an OSPF Full

Adjacency with Router-1 and Router-3? _____

Question-4: Previously you shutdown FastEthernet0/16 on Switch-3. So at this point, the only way Switch-3 could possibly learn of subnet **2.4.0.0/24** (*the link between Router-4 and Switch-2*) or any of the subnets in Area-3 is via LSAs flooded into Area-0 from from Router-4 and Switch-2. Look in the OSPF database of Router-3;

* Do you see any LSA(s) Advertising this network? _____

* Do you see any Summary LSAs from Advertising Router 1.1.1.22 (Switch-2)? _____

Question-5: Have the same LSAs that Router-3 received in the question above, been translated into OSPF routes in Router-3's IP Routing Table? _____

Question-6: Has Router-3 extracted any of the IP Prefix information from those received LSAs (from Router-4 and Switch-2) and created its own Type-3 Summary LSAs (for injection into Area-2) based on that information? ____

It is advisable that before you move on to the next task, you save your configurations for Routers-1, 3, 4, and Switch-2 into a local text file as you will need to reconfigure the WAN links and Virtual-Links for subsequent tasks.

Configuration and Verification of Frame-Relay/IP Connectivity

Initial Frame-Relay and Subinterface configuration on routers.

```
Rtr-1(config)#int ser 1/0.134 multipoint

Rtr-1(config-subif)#ip address 1.3.4.1 255.255.255.0    Rtr-1(config-subif)#
frame-relay map ip 1.3.4.4 141 broadcast
 Rtr-1(config-subif)#frame-relay map ip 1.3.4.3 131 broadcast

Rtr-1(config-subif)#exit
Rtr-1(config)#
```

```
Rtr-3(config)#int ser 0/0/0.134 multipoint
Rtr-3(config-subif)#ip address 1.3.4.3 255.255.255.0Rtr-3(config-subif)#
frame-relay map ip 1.3.4.1 131 broadcast
```

```
Rtr-3(config-subif)#frame-relay map ip 1.3.4.4 341 broadcast

Rtr-3(config-subif)#end
Rtr-3#
```

```
Rtr-4(config)#int ser 1/0.134 multipoint
Rtr-4(config-subif)#ip add 1.3.4.4 255.255.255.0 Rtr-4(config-subif)#
frame-relay map ip 1.3.4.1 141 broadcast
Rtr-4(config-subif)#frame-relay map ip 1.3.4.3 341 broadcast

Rtr-4(config-subif)#end
Rtr-4#
```

```
Rtr-1#ping 1.3.4.4
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 1.3.4.4, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 56/57/60 ms
 Rtr-1#ping 1.3.4.3

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 1.3.4.3, timeout is 2 seconds:
!!!!!
```

Configuration of OSPF (across Area-0)

```
Rtr-1
#show run | section ospf
router ospf 1
 network 1.2.0.0 0.0.0.255 area 1
 network 1.2.1.0 0.0.0.255 area 1 network 1.3.4.0 0.0.0.255 area 0
neighbor 1.3.4.3

Rtr-1#
```

```
Rtr-3
#sh run | sec ospf
router ospf 1
 area 2 virtual-link 1.1.1.22
```

```
 network 1.3.4.0 0.0.0.255 area 0
 network 2.4.2.0 0.0.0.255 area 2 neighbor 1.3.4.1

Rtr-3#
```

```
Rtr-4
#sh run int ser 1/0.134
Building configuration...

Current configuration : 197 bytes
!
interface Serial1/0.134 multipoint
 ip address 1.3.4.4 255.255.255.0 ip ospf network point-to-multipoint

 frame-relay map ip 1.3.4.1 141 broadcast
 frame-relay map ip 1.3.4.3 341 broadcast
end

Rtr-4#sh run | sec ospf
router ospf 1
 area 2 virtual-link 1.1.1.22
 network 1.3.4.0 0.0.0.255 area 0
 network 2.4.0.0 0.0.0.255 area 2
Rtr-4#
```

```
Rtr-4
#show ip ospf neighbor

Neighbor ID     Pri   State           Dead Time   Address         Interface
1.1.1.22          0   FULL/  -           -        2.4.0.2         OSPF_VL0 1.1.1.3           0   FULL
/  -        00:01:44    1.3.4.3         Serial1/0.134 1.1.1.1           0   FULL
/  -        00:01:37    1.3.4.1         Serial1/0.134
1.1.1.22          1   FULL/DR         00:00:33    2.4.0.2         FastEthernet0/1
Rtr-4#
```

```
Rtr-1
#show ip ospf neighbor

Neighbor ID     Pri   State           Dead Time   Address         Interface
1.1.1.3           1   FULL/DR
         00:01:32    1.3.4.3         Serial1/0.134 1.1.1.4           1   FULL/BDR
       00:01:59    1.3.4.4         Serial1/0.134
```

```
192.168.1.17      0   FULL/  -        00:00:31    1.2.1.254       Serial1/2
1.1.1.2           0   FULL/  -        00:00:30    1.2.0.2         Serial1/1
Rtr-1#
```

Answers: Questions-1 and 2

```
Rtr-4#show ip ospf int ser 1/0.134
Serial1/0.134 is up, line protocol is up
  Internet Address 1.3.4.4/24, Area 0, Attached via Network Statement
  Process ID 1, Router ID 1.1.1.4, Network Type POINT_TO_MULTIPOINT
, Cost: 781
```

```
Rtr-1#show ip ospf interface serial1/0.134
Serial1/0.134 is up, line protocol is up
  Internet Address 1.3.4.1/24, Area 0, Attached via Network Statement
  Process ID 1, Router ID 1.1.1.1, Network Type NON_BROADCAST
, Cost: 781
```

Answers: Question-4

Look in the OSPF database of Router-3;

Do you see any LSA(s) Advertising this network (2.4.0.0/24)? ***YES***

```
Rtr-3#show ip ospf database summary 2.4.0.0


            OSPF Router with ID (1.1.1.3) (Process ID 1)

                Summary Net Link States (Area 0)

  LS age: 360
  Options: (No TOS-capability, DC, Upward)
  LS Type: Summary Links(Network) Link State ID: 2.4.0.0
 (summary Network Number) Advertising Router: 1.1.1.4
  LS Seq Number: 80000002
  Checksum: 0x1717
  Length: 28
  Network Mask: /24
        MTID: 0         Metric: 1
```

```
  LS age: 1355 (DoNotAge)
  Options: (No TOS-capability, DC, Upward)
  LS Type: Summary Links(Network) Link State ID: 2.4.0.0
(summary Network Number) Advertising Router: 1.1.1.22

  LS Seq Number: 8000001F
  Checksum: 0x708E
  Length: 28
  Network Mask: /24
        MTID: 0         Metric: 1
```

Do you see any Summary LSAs from Advertising Router 1.1.1.22 (Switch-2)? ***YES***

```
Rtr-3#show ip ospf database summary adv-router 1.1.1.22

            OSPF Router with ID (1.1.1.3) (Process ID 1)

                Summary Net Link States (Area 0)

  LS age: 1355 (DoNotAge)
  Options: (No TOS-capability, DC, Upward)
  LS Type: Summary Links(Network) Link State ID: 2.4.0.0
(summary Network Number) Advertising Router: 1.1.1.22
  LS Seq Number: 8000001F
  Checksum: 0x708E
  Length: 28
  Network Mask: /24
        MTID: 0         Metric: 1

  LS age: 834 (DoNotAge)
  Options: (No TOS-capability, DC, Upward)
  LS Type: Summary Links(Network) Link State ID: 3.1.0.0
(summary Network Number) Advertising Router: 1.1.1.22
  LS Seq Number: 8000004B
  Checksum: 0x2FA5
  Length: 28
  Network Mask: /24
        MTID: 0         Metric: 1

  LS age: 834 (DoNotAge)
  Options: (No TOS-capability, DC, Upward)
  LS Type: Summary Links(Network) Link State ID: 3.2.0.0
(summary Network Number) Advertising Router: 1.1.1.22
```

```
  LS Seq Number: 8000004B
  Checksum: 0x23B0
  Length: 28
  Network Mask: /24
        MTID: 0         Metric: 1

Rtr-3#
```

Answer(s): Question-5

Have the same LSAs that Router-3 received in the question above, been translated into OSPF routes in Router-3's IP Routing Table? ***NO***

```
Rtr-3#show ip route ospf
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, 7 subnets, 2 masks
O IA     1.2.0.0/24 [110/845] via 1.3.4.1, 00:14:43, Serial0/0/0.134
O IA     1.2.1.0/24 [110/845] via 1.3.4.1, 00:14:43, Serial0/0/0.134
O IA     1.2.2.0/24 [110/909] via 1.3.4.1, 00:14:43, Serial0/0/0.134
      5.0.0.0/8 is variably subnetted, 3 subnets, 2 masks
O E2     5.4.4.0/24 [110/20] via 1.3.4.1, 00:14:43, Serial0/0/0.134
      192.168.1.0/24 is variably subnetted, 4 subnets, 2 masks
O E2     192.168.1.4/30 [110/20] via 1.3.4.1, 00:14:43, Serial0/0/0.134
O E1     192.168.1.8/30 [110/865] via 1.3.4.1, 00:14:43, Serial0/0/0.134
O E1     192.168.1.12/30 [110/865] via 1.3.4.1, 00:14:43, Serial0/0/0.134
O E2     192.168.1.16/28 [110/20] via 1.3.4.1, 00:14:43, Serial0/0/0.134
Rtr-3#
```

As can be seen from the output above, even though Router-3 has received the correct LSAs describing remote subnets in Areas-2 and 3, (**such as network 2.4.0.0/24**

) because of the network-type mismatch between this router and his neighbor who flooded those LSAs (Router-4) they are not "believable" and have not been translated into routes.

Answer(s): Question-6

Has Router-3 extracted any of the IP Prefix information from those received LSAs (from Router-4 and Switch-2) and created its own Type-3 Summary LSAs (for injection into Area-2) based on that information? ***NO***

```
Rtr-3#show ip ospf database summary self-originate


            OSPF Router with ID (1.1.1.3) (Process ID 1)

                Summary Net Link States (Area 0)

  LS age: 63
  Options: (No TOS-capability, DC, Upward)
  LS Type: Summary Links(Network)
  Link State ID: 2.4.2.0 (summary Network Number)
  Advertising Router: 1.1.1.3
  LS Seq Number: 80000002
  Checksum: 0x726
  Length: 28
  Network Mask: /24
        MTID: 0         Metric: 1


                Summary Net Link States (Area 2)

  LS age: 63
  Options: (No TOS-capability, DC, Upward)
  LS Type: Summary Links(Network)
  Link State ID: 1.2.0.0 (summary Network Number)
  Advertising Router: 1.1.1.3
  LS Seq Number: 80000002
  Checksum: 0x588A
  Length: 28
  Network Mask: /24
        MTID: 0         Metric: 845

  LS age: 63
  Options: (No TOS-capability, DC, Upward)
```

```
  LS Type: Summary Links(Network)
  Link State ID: 1.2.1.0 (summary Network Number)
  Advertising Router: 1.1.1.3
  LS Seq Number: 80000002
  Checksum: 0x4D94
  Length: 28
  Network Mask: /24
        MTID: 0         Metric: 845

  LS age: 63
  Options: (No TOS-capability, DC, Upward)
  LS Type: Summary Links(Network)
  Link State ID: 1.2.2.0 (summary Network Number)
  Advertising Router: 1.1.1.3
  LS Seq Number: 80000002
  Checksum: 0xC4DB
  Length: 28
  Network Mask: /24
        MTID: 0         Metric: 909

  LS age: 63
  Options: (No TOS-capability, DC, Upward)
  LS Type: Summary Links(Network)
  Link State ID: 1.3.4.0 (summary Network Number)
  Advertising Router: 1.1.1.3
  LS Seq Number: 80000002
  Checksum: 0x826B
  Length: 28
  Network Mask: /24
        MTID: 0         Metric: 64

Rtr-3#
```

Notice from the output above that the only Type-3 Summary LSAs that Router-3 has created (for injection into Area-2) are LSAs describing prefixes in Area-1, and Area-0. Even though LSAs **HAVE** been received describing prefixes in Area-2 and Area-3, those LSAs:

- Have **NOT** been generated into IP routes for Router-3's own, local routing table.
- Have **NOT** been used as material for Type-3 (Summary LSA) generation by Router-3.

So what have we learned?

- A network type mismatch between OSPF routers will not prevent a Full Adjacency

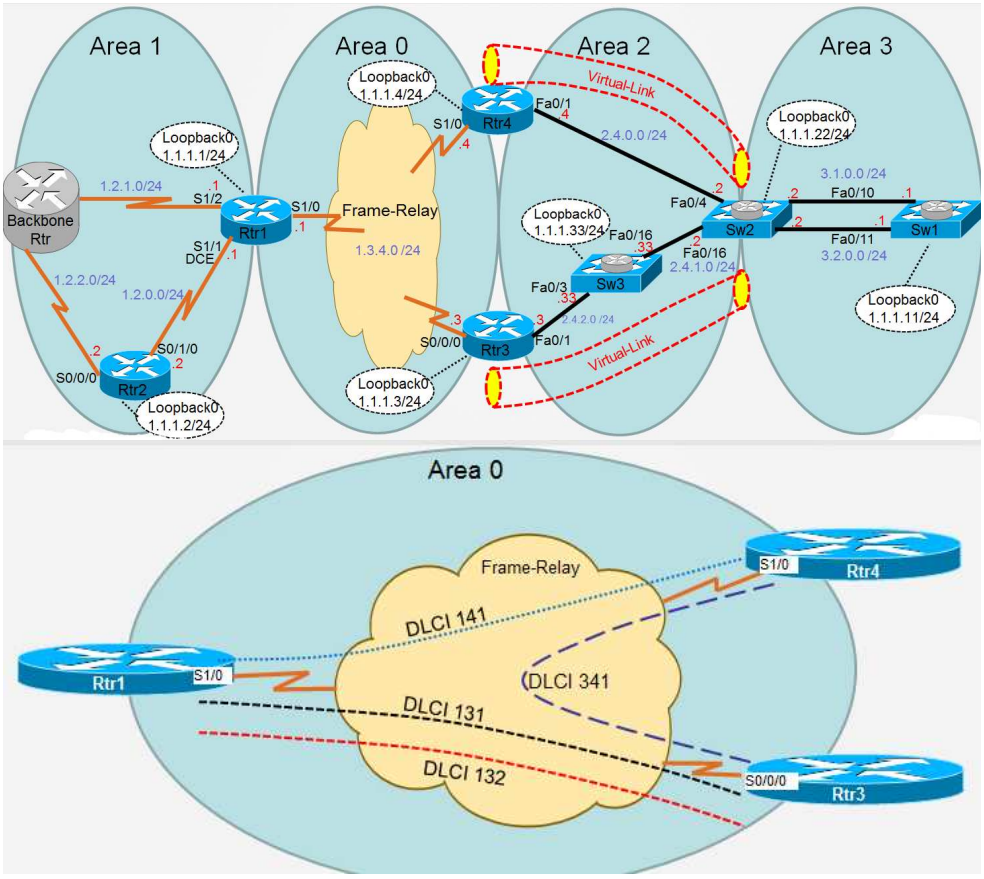
from being formed.

- A network type mismatch between OSPF neighbors will not prevent OSPF LSA flooding between those neighbors (remember the golden rule of OSPF, if you-and-I have a Full Adjacency between us that means our OSPF Databases MUST match for the area we have in common).
- A network type mismatch between OSPF neighbors **WILL** prevent the generation of IP routes.
- A network type mismatch between OSPF neighbors **WILL** prevent the generation of Type-3 Summary LSAs.

CCNP ROUTE Workbook - OSPF

OSPF Stub Areas

> Load the ***CCNP ROUTE WB Task OSPF-2 Configs*** initial configurations before starting.



Preliminary Tasks

- When you load the initial configurations onto all devices for this task, all devices will be:
  - Preconfigured with IP addresses as shown in the topology diagram.
  - OSPF will already be activated on all links and all Areas (Loopbacks are not advertised by OSPF)
  - Routers 1, 3, and 4 will already have functional (full-mesh) Frame-Relay PVCs between them with OSPF running across these links as point-to-

multipoint.
    - OSPF Virtual-Links will already be pre-configured as shown in the topology diagram.

New Tasks

> The objective of this task is to gain exposure to the various types of OSPF Stub areas.

- **View the IP Routing Table of Switch-1**. At present because Area-3 is an OSPF Normal Area, this device should know of all OSPF routes (including External Routes injected from the Backbone Router).

- On Switch-1, issue the command "**show ip route summary**" and take note of the quantity of subnets learned via OSPF, and the memory consumption (in bytes) used by these OSPF subnets.

- On Switch-1, issue the command **show ip ospf database database-summary** and take note of the total count of LSAs known by this router (last line of command output).
    - How many Type-3 Summary LSAs are in the OSPF Database of Switch-1?

      _____
    - How many Type-5 External LSAs are in the OSPF Database of Switch-1?

      _____

> As you take the steps below, discover which of the Stub Area types receive a dynamically-created default route.

- Convert Area-3 to a **Stub** area and once again, view the IP Routing Table, output of "**show ip route summary**", and OSPF Database of Switch-1. Notice any differences from what the output of these commands displayed when Area-3 was a Normal Area.

- Convert Area-3 to a **Totally Stubby** area and once again, view the IP Routing Table, output of "**show ip route summary**", and OSPF Database of Switch-1. Notice any differences from what the output of these commands displayed when Area-3 was a Normal Area.

- Convert Area-3 to a **NSSA** area and once again, view the IP Routing Table, output of "**show ip route summary**", and OSPF Database of Switch-1. Notice any differences

from what the output of these commands displayed when Area-3 was a Normal Area.

- Convert Area-3 to a **Totally NSSA** area and once again, view the IP Routing Table, output of "**show ip route summary**", and OSPF Database of Switch-1. Notice any differences from what the output of these commands displayed when Area-3 was a Normal Area.

> **It is advisable that before you move on to the next task, you save your configurations for Routers-1, 3, 4, and Switch-2 into a local text file as you will need to reconfigure the WAN links and Virtual-Links for subsequent tasks.**

Configuration and Verification (Normal Area)

```
Sw-1#Sw-1#show ip route ospf
     1.0.0.0/8 is variably subnetted, 7 subnets, 2 masks
O IA    1.2.2.0/24 [110/912] via 3.2.0.2, 00:22:29, FastEthernet0/11
                   [110/912] via 3.1.0.2, 00:22:29, FastEthernet0/10
O IA    1.3.4.4/32 [110/2] via 3.2.0.2, 00:22:29, FastEthernet0/11
                   [110/2] via 3.1.0.2, 00:22:29, FastEthernet0/10
O IA    1.2.1.0/24 [110/848] via 3.2.0.2, 00:22:29, FastEthernet0/11
                   [110/848] via 3.1.0.2, 00:22:29, FastEthernet0/10
O IA    1.2.0.0/24 [110/848] via 3.2.0.2, 00:22:29, FastEthernet0/11
                   [110/848] via 3.1.0.2, 00:22:29, FastEthernet0/10
O IA    1.3.4.3/32 [110/3] via 3.2.0.2, 00:22:29, FastEthernet0/11
                   [110/3] via 3.1.0.2, 00:22:29, FastEthernet0/10
O IA    1.3.4.1/32 [110/67] via 3.2.0.2, 00:22:29, FastEthernet0/11
                   [110/67] via 3.1.0.2, 00:22:29, FastEthernet0/10
     2.0.0.0/24 is subnetted, 3 subnets
O IA    2.4.2.0 [110/3] via 3.2.0.2, 00:22:39, FastEthernet0/11
                [110/3] via 3.1.0.2, 00:22:39, FastEthernet0/10
O IA    2.4.0.0 [110/2] via 3.2.0.2, 00:22:39, FastEthernet0/11
                [110/2] via 3.1.0.2, 00:22:39, FastEthernet0/10
O IA    2.4.1.0 [110/2] via 3.2.0.2, 00:22:39, FastEthernet0/11
                [110/2] via 3.1.0.2, 00:22:39, FastEthernet0/10
     192.168.1.0/24 is variably subnetted, 4 subnets, 2 masksO E1
    192.168.1.8/30 [110/868] via 3.2.0.2, 00:22:29, FastEthernet0/11
                     [110/868] via 3.1.0.2, 00:22:29, FastEthernet0/10O E1
    192.168.1.12/30 [110/868] via 3.2.0.2, 00:22:30, FastEthernet0/11
                      [110/868] via 3.1.0.2, 00:22:30, FastEthernet0/10O E2
    192.168.1.4/30 [110/20] via 3.2.0.2, 00:22:31, FastEthernet0/11
                     [110/20] via 3.1.0.2, 00:22:31, FastEthernet0/10O E2
    192.168.1.16/28 [110/20] via 3.2.0.2, 00:22:31, FastEthernet0/11
```

```
                    [110/20] via 3.1.0.2, 00:22:31, FastEthernet0/10
```

```
Sw-1#show ip route summary

IP routing table name is Default-IP-Routing-Table(0)
IP routing table maximum-paths is 32 Route Source    Networks Subnets     Overhead Memory (bytes)
connected       0           3           192         456
static          0           0           0           0 ospf 1           0 13           1664 1976

  Intra-area: 0 Inter-area: 9 External-1: 2 External-2: 2
  NSSA External-1: 0 NSSA External-2: 0
internal        4                                   4688
Total           4           16          1856        7120
Sw-1#
```

```
Sw-1#show ip ospf database database-summary

            OSPF Router with ID (1.1.1.11) (Process ID 1)

Area 3 database summary
  LSA Type      Count    Delete   Maxage
  Router        2        0        0
  Network       2        0        0
  Summary Net   9        0        0
  Summary ASBR  1        0        0
  Type-7 Ext    0        0        0
    Prefixes redistributed in Type-7  0
  Opaque Link   0        0        0
  Opaque Area   0        0        0
  Subtotal      14       0        0

Process 1 database summary
  LSA Type      Count    Delete   Maxage
  Router        2        0        0
  Network       2        0        0       Summary Net    9
        0        0
  Summary ASBR  1        0        0
  Type-7 Ext    0        0        0
  Opaque Link   0        0        0
  Opaque Area   0        0        0       Type-5 Ext     4
        0        0
      Prefixes redistributed in Type-5  0
```

```
  Opaque AS      0         0         0
  Non-self       17        Total           18
       0         0
Sw-1#
```

Configuration and Verification (Stub Area)

Switch-1:

```
router ospf 1
 log-adjacency-changes area 3 stub

 network 3.1.0.0 0.0.0.255 area 3
 network 3.2.0.0 0.0.0.255 area 3
```

Switch-2:

```
Sw-2#sh run | begin router
router ospf 1
 log-adjacency-changes
 area 2 virtual-link 1.1.1.4
 area 2 virtual-link 1.1.1.3 area 3 stub

 network 2.4.0.0 0.0.0.255 area 2
 network 2.4.1.0 0.0.0.255 area 2
 network 3.1.0.0 0.0.0.255 area 3
 network 3.2.0.0 0.0.0.255 area 3
```

Notice in the output below that Switch-1 no longer has any OSPF External routes, but still has IP connectivity to those external networks via a default-route.

```
Sw-1#show ip route ospf
     1.0.0.0/8 is variably subnetted, 7 subnets, 2 masks
O IA    1.2.2.0/24 [110/912] via 3.2.0.2, 00:10:23, FastEthernet0/11
                   [110/912] via 3.1.0.2, 00:10:23, FastEthernet0/10
O IA    1.3.4.4/32 [110/2] via 3.2.0.2, 00:10:23, FastEthernet0/11
                   [110/2] via 3.1.0.2, 00:10:23, FastEthernet0/10
O IA    1.2.1.0/24 [110/848] via 3.2.0.2, 00:10:23, FastEthernet0/11
                   [110/848] via 3.1.0.2, 00:10:23, FastEthernet0/10
O IA    1.2.0.0/24 [110/848] via 3.2.0.2, 00:10:23, FastEthernet0/11
                   [110/848] via 3.1.0.2, 00:10:24, FastEthernet0/10
```

```
O IA    1.3.4.3/32 [110/3] via 3.2.0.2, 00:10:24, FastEthernet0/11
                   [110/3] via 3.1.0.2, 00:10:24, FastEthernet0/10
O IA    1.3.4.1/32 [110/67] via 3.2.0.2, 00:10:24, FastEthernet0/11
                   [110/67] via 3.1.0.2, 00:10:24, FastEthernet0/10
     2.0.0.0/24 is subnetted, 3 subnets
O IA    2.4.2.0 [110/3] via 3.2.0.2, 00:10:24, FastEthernet0/11
                [110/3] via 3.1.0.2, 00:10:24, FastEthernet0/10
O IA    2.4.0.0 [110/2] via 3.2.0.2, 00:10:24, FastEthernet0/11
                [110/2] via 3.1.0.2, 00:10:24, FastEthernet0/10
O IA    2.4.1.0 [110/2] via 3.2.0.2, 00:10:24, FastEthernet0/11
                [110/2] via 3.1.0.2, 00:10:24, FastEthernet0/10O*IA 0.0.0.0/0
 [110/2] via 3.2.0.2, 00:10:24, FastEthernet0/11
               [110/2] via 3.1.0.2, 00:10:24, FastEthernet0/10
Sw-1#
```

```
Sw-1#show ip route summary
IP routing table name is Default-IP-Routing-Table(0)
IP routing table maximum-paths is 32
Route Source    Networks    Subnets     Overhead    Memory (bytes)
connected       0           3           192         456
static          0           0           0           0ospf 1          19           1280 1520

  Intra-area: 0 Inter-area: 10 External-1: 0 External-2: 0
  NSSA External-1: 0 NSSA External-2: 0
internal        3                                   3516
Total           4           12          1472        5492
Sw-1#
```

```
Sw-1#show ip ospf database database-summary

            OSPF Router with ID (1.1.1.11) (Process ID 1)

Area 3 database summary
  LSA Type      Count    Delete   Maxage
  Router        2        0        0
  Network       2        0        0
  Summary Net   10       0        0
  Summary ASBR  0        0        0
  Type-7 Ext    0        0        0
    Prefixes redistributed in Type-7  0
  Opaque Link   0        0        0
  Opaque Area   0        0        0
```

```
  Subtotal      14       0        0

Process 1 database summary
  LSA Type      Count    Delete   Maxage
  Router        2        0        0
  Network       2        0        0       Summary Net    10
       0        0
  Summary ASBR  0        0        0
  Type-7 Ext    0        0        0
  Opaque Link   0        0        0
  Opaque Area   0        0        0       Type-5 Ext     0
        0        0
      Prefixes redistributed in Type-5  0
  Opaque AS     0        0        0
  Non-self      13       Total          14
       0        0
Sw-1#
```

Configuration and Verification (Totally Stubby Area)

```
Sw-2
#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
Sw-2(config)#router ospf 1Sw-2(config-router)#area 3 stub no-summary

Sw-2(config-router)#end
Sw-2#
```

By changing Area-3 to a Totally Stubby Area, Switch-2 is no longer able to forward to Switch-1:

- Any Type-5 External LSAs
- Any Type-3 Summary LSAs (except for one...can you guess which one?)

However all of the networks that would have been advertised in those restricted LSAs are still reachable via a default-route.

```
Sw-1#show ip route ospf
O*IA 0.0.0.0/0
 [110/2] via 3.2.0.2, 00:00:37, FastEthernet0/11
                [110/2] via 3.1.0.2, 00:00:37, FastEthernet0/10
Sw-1#
```

```
Sw-1#show ip route summary
IP routing table name is Default-IP-Routing-Table(0)
IP routing table maximum-paths is 32
Route Source    Networks    Subnets     Overhead    Memory (bytes)
connected       0           3           192         456
static          0           0           0           0 ospf 1          1 0           128 152

  Intra-area: 0 Inter-area: 1 External-1: 0 External-2: 0
  NSSA External-1: 0 NSSA External-2: 0
internal        2                                   2344
Total           3           3           320         2952
Sw-1#
```

```
Sw-1#show ip ospf database database-summary

            OSPF Router with ID (1.1.1.11) (Process ID 1)

Area 3 database summary
  LSA Type      Count    Delete   Maxage
  Router        2        0        0
  Network       2        0        0
  Summary Net   1        0        0
  Summary ASBR  0        0        0
  Type-7 Ext    0        0        0
    Prefixes redistributed in Type-7  0
  Opaque Link   0        0        0
  Opaque Area   0        0        0
  Subtotal      5        0        0

Process 1 database summary
  LSA Type      Count    Delete   Maxage
  Router        2        0        0
  Network       2        0        0       Summary Net    1
        0        0
  Summary ASBR  0        0        0
```

```
  Type-7 Ext    0        0        0
  Opaque Link   0        0        0
  Opaque Area   0        0        0       Type-5 Ext    0
        0        0
      Prefixes redistributed in Type-5  0
  Opaque AS     0        0        0
  Non-self      4        Total          5
        0        0
Sw-1#
```

Configuration and Verification (Not-So-Stubby Area)

```
Sw-1
(config)#router ospf 1Sw-1(config-router)#area 3 nssa
OSPF: Area is configured as stub area already
Sw-1(config-router)#no area 3 stub

*Mar  1 02:19:02.814: %OSPF-5-ADJCHG: Process 1, Nbr 1.1.1.22 on FastEthernet0/11 from FULL to DOWN, Neighbor Down:
*Mar  1 02:19:02.814: %OSPF-5-ADJCHG: Process 1, Nbr 1.1.1.22 on FastEthernet0/10 from FULL to DOWN, Neighbor Down:
 Sw-1(config-router)#area 3 nssa

Sw-1(config-router)#end
```

```
Sw-2
#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
Sw-2(config)#router ospf 1Sw-2(config-router)#no area 3 stub no-summary
Sw-2(config-router)#no area 3 stub
          Sw-2(config-router)#area 3 nssa

Sw-2(config-router)#end
Sw-2#
```

The IP Routing Table for Switch-1 should now exactly match the same output as what you saw when Area-3 was previously defined as a Stub area, with the notable exception that there is **no longer** any default-route visible.

This means that the external networks advertised by the Backbone router are no longer reachable via Switch-1.

```
Sw-1#sho ip route ospf

     1.0.0.0/8 is variably subnetted, 7 subnets, 2 masks
O IA    1.2.2.0/24 [110/912] via 3.2.0.2, 00:11:00, FastEthernet0/11
                   [110/912] via 3.1.0.2, 00:11:00, FastEthernet0/10
O IA    1.3.4.4/32 [110/2] via 3.2.0.2, 00:11:00, FastEthernet0/11
                   [110/2] via 3.1.0.2, 00:11:00, FastEthernet0/10
O IA    1.2.1.0/24 [110/848] via 3.2.0.2, 00:11:00, FastEthernet0/11
                   [110/848] via 3.1.0.2, 00:11:00, FastEthernet0/10
O IA    1.2.0.0/24 [110/848] via 3.2.0.2, 00:11:00, FastEthernet0/11
                   [110/848] via 3.1.0.2, 00:11:00, FastEthernet0/10
O IA    1.3.4.3/32 [110/3] via 3.2.0.2, 00:11:00, FastEthernet0/11
                   [110/3] via 3.1.0.2, 00:11:00, FastEthernet0/10
O IA    1.3.4.1/32 [110/67] via 3.2.0.2, 00:11:00, FastEthernet0/11
                   [110/67] via 3.1.0.2, 00:11:00, FastEthernet0/10
     2.0.0.0/24 is subnetted, 3 subnets
O IA    2.4.2.0 [110/3] via 3.2.0.2, 00:11:00, FastEthernet0/11
                [110/3] via 3.1.0.2, 00:11:00, FastEthernet0/10
O IA    2.4.0.0 [110/2] via 3.2.0.2, 00:11:01, FastEthernet0/11
                [110/2] via 3.1.0.2, 00:11:01, FastEthernet0/10
O IA    2.4.1.0 [110/2] via 3.2.0.2, 00:11:01, FastEthernet0/11
                [110/2] via 3.1.0.2, 00:11:01, FastEthernet0/10
Sw-1#
```

```
Sw-1#show ip route summary
IP routing table name is Default-IP-Routing-Table(0)
IP routing table maximum-paths is 32
Route Source    Networks    Subnets     Overhead    Memory (bytes)
connected       0           3           264         456
static          0           0           0           0 ospf 1          0 9           1152 1368

  Intra-area: 0 Inter-area: 9 External-1: 0 External-2: 0
  NSSA External-1: 0 NSSA External-2: 0
internal        3                                   3516
Total           3           12          1416        5340
Sw-1#
```

```
Sw-1#show ip ospf database database-summary

            OSPF Router with ID (1.1.1.11) (Process ID 1)

Area 3 database summary
```

```
  LSA Type      Count    Delete   Maxage
  Router        2        0        0
  Network       2        0        0
  Summary Net   9        0        0
  Summary ASBR  0        0        0
  Type-7 Ext    0        0        0
    Prefixes redistributed in Type-7  0
  Opaque Link   0        0        0
  Opaque Area   0        0        0
  Subtotal      13       0        0

Process 1 database summary
  LSA Type      Count    Delete   Maxage
  Router        2        0        0
  Network       2        0        0       Summary Net    9
        0        0
  Summary ASBR  0        0        0
  Type-7 Ext    0        0        0
  Opaque Link   0        0        0
  Opaque Area   0        0        0       Type-5 Ext     0
        0        0
      Prefixes redistributed in Type-5  0
  Opaque AS     0        0        0
  Non-self      12
  Total         13       0        0
Sw-1#
```

Configuration and Verification (Totally Not-So-Stubby Area)

```
Sw-2
(config)#router ospf 1Sw-2(config-router)#area 3 nssano-summary

Sw-2(config-router)#end
Sw-2#
```

```
Sw-1#sho ip route ospf
O*IA 0.0.0.0/0
 [110/2] via 3.2.0.2, 00:00:39, FastEthernet0/11
               [110/2] via 3.1.0.2, 00:00:39, FastEthernet0/10
Sw-1#
```

```
Sw-1#sho ip route summary
IP routing table name is Default-IP-Routing-Table(0)
IP routing table maximum-paths is 32
Route Source    Networks    Subnets     Overhead    Memory (bytes)
connected       0           3           264         456
static          0           0           0           0 ospf 1          1 0           128 152

  Intra-area: 0 Inter-area: 1 External-1: 0 External-2: 0
  NSSA External-1: 0 NSSA External-2: 0
internal        2                                   2344
Total           3           3           392         2952
Sw-1#
```

```
Sw-1#sho ip ospf database database-summary

            OSPF Router with ID (1.1.1.11) (Process ID 1)

Area 3 database summary
  LSA Type      Count    Delete   Maxage
  Router        2        0        0
  Network       2        0        0
  Summary Net   1        0        0
  Summary ASBR  0        0        0
  Type-7 Ext    0        0        0
    Prefixes redistributed in Type-7  0
  Opaque Link   0        0        0
  Opaque Area   0        0        0
  Subtotal      5        0        0

Process 1 database summary
  LSA Type      Count    Delete   Maxage
  Router        2        0        0
  Network       2        0        0       Summary Net    1
        0        0
  Summary ASBR  0        0        0
  Type-7 Ext    0        0        0
```

```
   Opaque Link    0        0        0
   Opaque Area    0        0        0        Type-5 Ext    0
        0        0
       Prefixes redistributed in Type-5  0
   Opaque AS      0        0        0
   Non-self       4        Total          5
         0        0
Sw-1#
```