Single Area OSPFv2 Configuration - Modify Single Area OSPFv2

Modify Single-Area OSPFv2

TASK

Cisco OSPF Cost Metric

Recall that a routing protocol uses a metric to determine the best path of a packet across a network. A metric gives indication of the overhead that is required to send packets across a certain interface. OSPF uses cost as a metric. A lower cost indicates a better path than a higher cost.

The Cisco cost of an interface is inversely proportional to the bandwidth of the interface. Therefore, a higher bandwidth indicates a lower cost. The formula used to calculate the OSPF cost is:

Cost = reference bandwidth / interface bandwidth

The default reference bandwidth is 10^7 (100,000,000); therefore, the formula is:

Cost = 100,000,000 bps / interface bandwidth in bps

Refer to the table for a breakdown of the cost calculation. Because the OSPF cost value must be an integer, FastEthernet, Gigabit Ethernet, and 10 Gigabit Ethernet (10 Gig) interfaces share the same cost. To correct this situation, you can:

- Adjust the reference bandwidth with the **auto cost reference-bandwidth** command on each OSPF router.
- Manually set the OSPF cost value with the **ip ospf cost** command on necessary interfaces.

Default Cisco OSPF Costs

Interface Type	Reference Bandwidth in bps		Default Bandwidth in bps	Cost
10 Gigabit Ethernet 10 Gbps	100,000,000	÷	10,000,000,000	0.01 → 1
Gigabit Ethernet 1 Gbps	100,000,000	÷	1,000,000,000	0.1 → 1
Fast Ethernet 100 Mbps	100,000,000	÷	100,000,000	1
Ethernet 10 Mbps	100,000,000	÷	10,000,000	10

Same Costs due to reference bandwidth

TASK

Adjust the Reference Bandwidth

The cost value must be an integer. If something less than an integer is calculated, OSPF rounds up to the nearest integer. Therefore, the OSPF cost assigned to a Gigabit Ethernet interface with the default reference bandwidth of 100,000,000 bps would equal 1, because the nearest integer for 0.1 is 1 instead of 0.1.

Cost = 100,000,000 bps / 1,000,000,000 = 1

For this reason, all interfaces faster than Fast Ethernet will have the same cost value of 1 as a Fast Ethernet interface. To assist OSPF in making the correct path determination, the reference bandwidth must be changed to a higher value to accommodate networks with links faster than 100 Mbps.

Changing the reference bandwidth does not actually affect the bandwidth capacity on the link; rather, it simply affects the calculation used to determine the metric. To adjust the reference bandwidth, use the **auto cost reference-bandwidth** Mbps router configuration command.

```
R1(config-router)# auto-cost reference-bandwidth Mbps
```

This command must be configured on every router in the OSPF domain. Note that the value is expressed in Mbps; therefore, to adjust the costs for Gigabit Ethernet, use the command **auto cost reference-bandwidth 1000**; for 10 Gigabit Ethernet, use the command **auto cost reference-bandwidth 10000**.

To return to the default reference bandwidth, use the **auto cost reference-bandwidth 100** command.

Whichever method is used, it is important to apply the configuration to all routers in the OSPF routing domain. The table shows the OSPF cost if the reference bandwidth is adjusted to accommodate 10 Gigabit Ethernet links. The reference bandwidth should be adjusted anytime there are links faster than FastEthernet (100 Mbps).

Interface Type	Reference Bandwidth in bps		Default Bandwidth in bps	Cost
10 Gigabit Ethernet 10 Gbps	10,000,000,000	÷	10,000,000,000	1
Gigabit Ethernet 1 Gbps	10,000,000,000	÷	1,000,000,000	10
Fast Ethernet 100 Mbps	10,000,000,000	÷	100,000,000	100
Ethernet 10 Mbps	10,000,000,000	÷	10,000,000	1000

Use the **show ip ospf interface gigabitethernet0/0/0** command to verify the current OSPF(v2) cost assigned to the R1 GigabitEthernet 0/0/0 interface. Notice how it displays a cost of 1 for the default reference bandwidth. No cost is now 10. This will allow for the scaling for 10 Gigabit Ethernet interfaces in the future without having adjust the reference bandwidth.

Note: The **auto-cost reference-bandwidth** command must be configured consistently on all routers in the OSPF domain to ensure accurate route calculations.

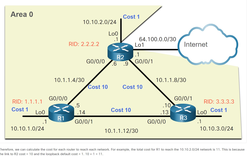
```
R1#show ip ospf interface gigabitethernet0/0/0
gigabitethernet0/0/0 is up, line protocol is up
  Internet Address 10.1.1.1/30, Area 0, Attached via Interface Enable
  Process ID 10, Router ID 3.3.3.3, Network Type POINT_TO_POINT, Cost: 1
  Topology-MTID    Cost    Disabled    Shutdown      Topology Name
        0           1        no          no            Base
  Configuration checksum, one per line - End with CRL:0.
  Prefix-suppression is disabled
  R1(config)# router ospf 10
  R1(config-router)# auto-cost reference-bandwidth 10000
% OSPF: Reference bandwidth is changed.
        Please ensure reference bandwidth is consistent across all routers.
  R1(config-router)# show ip ospf interface gigabitethernet0/0/0
  gigabitethernet0/0/0 is up, line protocol is up
  Internet Address 10.1.1.1/30, Area 0, Attached via Network Statement
  Process ID 10, Router ID 3.3.3.3, Network Type BROADCAST, Cost: 10
  Transmit Delay is 1 sec, State DR, Priority 1
  Designated Router (ID) 3.3.3.3, Interface address 10.1.1.1
  No backup designated router on this network
  Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
    oob-resync timeout 40
    Hello due in 00:00:05
  Supports Link-local Signaling (LLS)
  Cisco NSF helper support enabled
  IETF NSF helper support enabled
  Index 1/2/2, flood queue length 0
  Next 0x0(0)/0x0(0)/0x0(0)
  Last flood scan length is 1, maximum is 1
  Last flood scan time is 0 msec, maximum is 0 msec
  Neighbor Count is 1, Adjacent neighbor count is 1
    Adjacent with neighbor 2.2.2.2
    Suppress hello for 0 neighbor(s)
R1#
```

Use the **show ip ospf neighbor** command to verify the current OSPF(v2) cost assigned to the R1 GigabitEthernet 0/0/0 interface. Notice how it displays a cost of 10 for the new reference bandwidth. No cost is now 10. This will allow for the scaling for 10 Gigabit Ethernet interfaces in the future without having adjust the reference bandwidth.

TASK

OSPF Accumulates Costs

The cost of an OSPF route is the accumulated value from one router to the destination network. Assuming the **auto cost reference-bandwidth 10000** command has been configured on all three routers, the cost of the links between each router is now 10. The loopback interfaces have a default cost of 1, as shown in the figure.



Therefore, we can calculate the cost for each router to reach each network. For example, the total cost for R1 to reach the 10.10.2.0/24 network is 11. This is because the link to R2 cost = 10 and the loopback default cost = 1. 10 + 1 = 11.

The routing table of R1 in Figure 2 confirms that the metric to reach the R2 LAN is a cost of 11:

```
R1# show ip route | include 10.10.2.0
O    10.10.2.0/24 [110/11] via 10.1.1.2, 01:00:42, GigabitEthernet0/0/0
R1# show ip route 10.10.2.0
Routing table for Internet Protocol Version 4
  Known via "ospf 10", distance 110, metric 11, type intra area
  Last update from 10.1.1.2 on GigabitEthernet0/0/0, 01:00:10 ago
  Routing Descriptor Blocks:
  * 10.1.1.2, from 2.2.2.2, 00:00:10 ago, via GigabitEthernet0/0/0
      Route metric is 11, traffic share count is 1
R1#
```

TASK

Manually Set OSPF Cost Value

OSPF cost values can be manipulated to influence the route chosen by OSPF. For example, in the current configuration, R1 is load balancing to the 10.1.1.8/30 network. It will send some traffic to R3 and some traffic to R2. You can see this in the routing table.

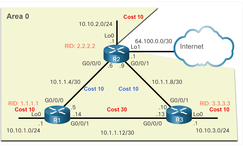
```
R1# show ip route ospf | begin 10
Gateway of last resort is not set
O    10.10.2.0/24 [110/11] via 10.1.1.2, 1 week, 1 day
     [110/11] via 10.1.1.6, 00:19:14, GigabitEthernet0/0/1
O    10.1.1.8/30 [110/20] via 10.1.1.6, 00:19:14, GigabitEthernet0/0/1
R1#
```

Note: Changing the cost of one may have undesired consequences. Therefore, adjusting interface cost values should only be configured when the outcome is fully understood.

The administrator may want traffic to go through R2 and use R3 as a backup route in case the link between R1 and R3 goes down.

Another reason to change the cost value is because other vendors may calculate OSPF in a different manner. By manipulating the cost value, the administrator can make sure the route costs shared between OSPF multivendor routers are accurately reflected in routing tables.

To change the cost value reported by the local OSPF router to other OSPF routers, use the interface configuration command **ip ospf cost** value. In the figure, we need to change the cost value of the R1 GigabitEthernet 0/0/1 to 30 to simulate Gigabit Ethernet speeds. In addition, we will change the cost of the link between R2 and R3 to 30 so that this link is used as a backup link.



The following example is the configuration for R1:

```
R1(config)# interface g0/0/1
R1(config-if)# ip ospf cost 30
R1(config-if)# interface g0/0/0
R1(config-if)# ip ospf cost 10
R1(config-if)# end
R1#
```

Assuming OSPF costs for R2 and R3 have been configured to match the topology in the above figure, the OSPF routes for R1 should have the following cost values. Notice that R1 is no longer load balancing to the 10.1.1.8/30 network. In fact, all routes go through R2 (at 10.1.1.2), as desired by the network administrator.

```
R1# show ip route ospf | begin 10
Gateway of last resort is not set
O    10.10.2.0/24 [110/11] via 10.1.1.2, 1 week, 1 day
O    10.1.1.8/30 [110/20] via 10.1.1.2, 00:00:31, GigabitEthernet0/0/0
R1# show ip route | include 10.1.1.8
O    10.1.1.8/30 [110/20] via 10.1.1.2, 00:00:31, GigabitEthernet0/0/0
R1#
```

Note: Although using the **ip ospf cost** command is the recommended method to manipulate the OSPF cost value, an administrator could also do this by using the interface configuration **bandwidth** kbps command. However, that would only work if all the routers are Cisco routers.

TASK

Test Failover to Backup Route

What happens if the link between R1 and R2 goes down? We can simulate that by shutting down the Gigabit Ethernet 0/0/0 interface and verifying the routing table is updated to use R3 as the next hop router. Notice that R1 can now reach the 10.1.1.8/30 network via 10.1.1.13 through R3 with a cost value of 30.

```
R1(config)# interface g0/0/0
R1(config-if)# shutdown
*Mar 1, 01:31:11.000: %OSPF-5-ADJCHG: Process 10, Nbr 2.2.2.2 on GigabitEthernet0/0/0 from full to DOWN, Neighbor Down: Interface down or detached
*Mar 1, 01:31:11.000: %LINEPROTO-5-UPDOWN: Line protocol on Interface GigabitEthernet0/0/0, changed state to down
*Mar 1, 01:31:13.000: %LINK-5-CHANGED: Interface GigabitEthernet0/0/0, changed state to down
R1(config-if)# end
R1# show ip route | begin 10
O    10.10.2.0/24 [110/11] via 10.1.1.13, 4 minutes, 1 week
     [110/11] via 10.1.1.6, 00:19:14, GigabitEthernet0/0/1
O    10.1.1.8/30 [110/20] via 10.1.1.6, 00:19:14, GigabitEthernet0/0/1
R1#
```

TASK

Syntax Checker - Modify the Cost Values for R2 and R3

Use the Syntax Checker to modify the cost values for R2 and R3.

Reset | Show Me | Show All

TASK

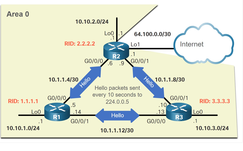
Hello Packet Intervals

As shown in the figure, OSPFv2 Hello packets are transmitted to multicast address 224.0.0.5 (all OSPF routers) every 10 seconds. This is the default timer value on multiaccess and point to point networks.

Note: Hello packets are not sent on the broadcast the LAN interfaces because those interfaces were set to passive by using the router configuration **passive interface** command.

The Dead interval is the period that the router waits to receive a Hello packet before declaring the neighbor down. If the Dead interval expires before the routers receive a Hello packet, OSPF removes that neighbor from its link-state database (LSDB). The router floods the LSDB with information about the down neighbor out all OSPF-enabled interfaces. Cisco uses a default of 4 times the Hello interval. This is 40 seconds on multiaccess and point to point networks.

Note: On non-broadcast multiaccess (NBMA) networks, the default Hello interval is 30 seconds and the default dead interval is 120 seconds. NBMA networks are beyond the scope of this module.



TASK

Verify Hello and Dead Intervals

The OSPF Hello and Dead intervals are configurable on a per-interface basis. The OSPF intervals must match on a neighbor adjacency does not occur. To verify the currently configured OSPF(v2) interface intervals, use the **show ip ospf interface** command, as shown in the example. The Gigabit Ethernet 0/0/0 Hello and Dead intervals are set to the default 10 seconds and 40 seconds respectively.

```
R1# show ip ospf interface g0/0/0
GigabitEthernet0/0/0 is up, line protocol is up
  Internet Address 10.1.1.1/30, Area 0, Attached via Interface Enable
  Process ID 10, Router ID 3.3.3.3, Network Type POINT_TO_POINT, Cost: 10
  Topology-MTID    Cost    Disabled    Shutdown      Topology Name
        0           10        no          no            Base
  Configuration checksum, one per line - End with CRL:0.
  Prefix-suppression is disabled
  Transmit Delay is 1 sec, State POINT_TO_POINT,
  No designated router on this network
  No backup designated router on this network
    oob-resync timeout 40
    Hello due in 00:00:05
  Supports Link-local Signaling (LLS)
  Cisco NSF helper support enabled
  IETF NSF helper support enabled
  Index 1/2/2, flood queue length 0
  Next 0x0(0)/0x0(0)/0x0(0)
  Last flood scan length is 1, maximum is 1
  Last flood scan time is 0 msec, maximum is 0 msec
  Neighbor Count is 1, Adjacent neighbor count is 1
    Adjacent with neighbor 2.2.2.2
    Suppress hello for 0 neighbor(s)
R1#
```

Use the **show ip ospf neighbor** command to see the Dead Timer counting down from 40 seconds, as shown in the following example. By default, this value is refreshed every 10 seconds when R1 receives a Hello from the neighbor.

```
R1# show ip ospf neighbor
Neighbor ID     Pri   State           Dead Time   Address         Interface
3.3.3.3         0     FULL/  -        00:00:35    10.1.1.13       GigabitEthernet0/0/1
2.2.2.2         0     FULL/  -        00:00:35    10.1.1.2        GigabitEthernet0/0/0
R1#
```

TASK

Modify OSPFv2 Intervals

It may be desirable to change the OSPF timers so that routers detect network failures in less time. Doing this increases traffic, but sometimes the need for quick convergence is more important than the extra traffic it creates.

Note: The default Hello and Dead intervals are based on best practices and should only be altered in rare situations.

OSPFv2 Hello and Dead intervals can be modified manually using the following interface configuration mode commands:

```
R1(config)# ip ospf hello-interval seconds
R1(config)# ip ospf dead-interval seconds
```

Use the **no ip ospf hello-interval** and **no ip ospf dead-interval** commands to reset the intervals to their default.

In the example, the Hello interval for the link between R1 and R2 is changed to 5 seconds. Immediately after changing the Hello interval, the Cisco IOS automatically modifies the Dead interval for four times the Hello interval. However, you can document the new dead interval in the configuration by manually setting it to 20 seconds, as shown.

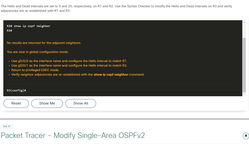
As displayed by the highlighted OSPFv2 adjacency message, when the Dead Timer on R1 expires, R1 and R2 lose adjacency. The reason is because the R1 and R2 routers have different Dead intervals. To correct this, use the **ip ospf dead-interval** command to verify the neighbor adjacencies. Notice that the only neighbor listed is the 3.3.3.3 (R3) router and that R1 is no longer adjacent with the 2.2.2.2 (R2) neighbor.

```
R1(config)# interface g0/0/0
R1(config-if)# ip ospf hello-interval 5
R1(config-if)# ip ospf dead-interval 20
R1(config-if)#
*Mar 1, 01:40:47.000: %OSPF-5-ADJCHG: Process 10, Nbr 2.2.2.2 on GigabitEthernet0/0/0 from FULL to DOWN, Neighbor Down: Dead timer expired
R1(config-if)# end
R1# show ip ospf neighbor
Neighbor ID     Pri   State           Dead Time   Address         Interface
3.3.3.3         0     FULL/  -        00:00:35    10.1.1.13       GigabitEthernet0/0/1
2.2.2.2         0     FULL/  -        00:00:17    10.1.1.2        GigabitEthernet0/0/0
R1#
```

TASK

Syntax Checker - Modifying Hello and Dead Intervals on R3

The Hello and Dead intervals are set to 5 and 20, respectively, on R1 and R2. Use the Syntax Checker to modify the Hello and Dead intervals on R3 and verify adjacencies are re-established with R1 and R2.



Reset | Show Me | Show All

TASK

Packet Tracer - Modify Single-Area OSPFv2

In this Packet Tracer activity, you will complete the following:

- Adjust the reference bandwidth to account for gigabit and faster speeds
- Adjust OSPF costs
- Modify the OSPF Hello timers
- Verify the modifications are accurately reflected in the routers.

Modify Single Area OSPFv2

2. Modify Single Area OSPFv2