



IP Routing: OSPF Configuration Guide, Cisco IOS Release 12.2SY

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Configuring OSPF

This module describes how to configure Open Shortest Path First (OSPF). OSPF is an Interior Gateway Protocol (IGP) developed by the OSPF working group of the Internet Engineering Task Force (IETF). OSPF was designed expressly for IP networks and it supports IP subnetting and tagging of externally derived routing information. OSPF also allows packet authentication and uses IP multicast when sending and receiving packets.

Cisco supports RFC 1253, *OSPF Version 2 Management Information Base*, August 1991. The OSPF MIB defines an IP routing protocol that provides management information related to OSPF and is supported by Cisco routers.

For protocol-independent features that work with OSPF, see the "Configuring IP Routing Protocol-Independent Features" module.

- [Finding Feature Information, page 1](#)
- [Information About OSPF, page 1](#)
- [How to Configure OSPF, page 9](#)
- [Configuration Examples for OSPF, page 25](#)
- [Additional References, page 44](#)
- [Feature Information for Configuring OSPF, page 45](#)

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest feature information and caveats, see the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the Feature Information Table at the end of this document.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Information About OSPF

- [Cisco OSPF Implementation, page 2](#)
- [Router Coordination for OSPF, page 2](#)
- [Route Distribution for OSPF, page 2](#)

Cisco OSPF Implementation

The Cisco implementation conforms to the OSPF Version 2 specifications detailed in the Internet RFC 2328. The list that follows outlines key features supported in the Cisco OSPF implementation:

- Stub areas--Definition of stub areas is supported.
- Route redistribution--Routes learned via any IP routing protocol can be redistributed into any other IP routing protocol. At the intradomain level, OSPF can import routes learned via Interior Gateway Routing Protocol (IGRP), Routing Information Protocol (RIP), and Intermediate System-to-Intermediate System (IS-IS). OSPF routes can also be exported into IGRP, RIP, and IS-IS. At the interdomain level, OSPF can import routes learned via Exterior Gateway Protocol (EGP) and Border Gateway Protocol (BGP). OSPF routes can be exported into BGP and EGP.
- Authentication--Plain text and message-digest algorithm 5 (MD5) authentication among neighboring routers within an area is supported.
- Routing interface parameters--Configurable parameters supported include interface output cost, retransmission interval, interface transmit delay, router priority, router "dead" and hello intervals, and authentication key.
- Virtual links--Virtual links are supported.
- Not-so-stubby area (NSSA)--RFC 3101. In Cisco IOS Release 15.1(2)S and later releases, RFC 3101 replaces RFC 1587.
- OSPF over demand circuit--RFC 1793.

Router Coordination for OSPF

OSPF typically requires coordination among many internal routers: Area Border Routers (ABRs), which are routers connected to multiple areas, and Autonomous System Boundary Routers (ASBRs). At a minimum, OSPF-based routers or access servers can be configured with all default parameter values, no authentication, and interfaces assigned to areas. If you intend to customize your environment, you must ensure coordinated configurations of all routers.

Route Distribution for OSPF

You can specify route redistribution; see the task "Redistribute Routing Information" in the Network Protocols Configuration Guide, Part 1 for information on how to configure route redistribution.

The Cisco OSPF implementation allows you to alter certain interface-specific OSPF parameters, as needed. You are not required to alter any of these parameters, but some interface parameters must be consistent across all routers in an attached network. Those parameters are controlled by the **ip ospf hello-interval**, **ip ospf dead-interval**, and **ip ospf authentication-key** interface configuration commands. Therefore, be sure that if you do configure any of these parameters, the configurations for all routers on your network have compatible values.

OSPF classifies different media into the following three types of networks by default:

- Broadcast networks (Ethernet, Token Ring, and FDDI)
- Nonbroadcast multiaccess (NBMA) networks (Switched Multimegabit Data Service (SMDS), Frame Relay, and X.25)
- Point-to-point networks (High-Level Data Link Control [HDLC] and PPP)

You can configure your network as either a broadcast or an NBMA network.

X.25 and Frame Relay provide an optional broadcast capability that can be configured in the map to allow OSPF to run as a broadcast network. Refer to the **x25 map** and **frame-relay map** command descriptions in the *Cisco IOS Wide-Area Networking Command Reference* publication for more detail.

- [Configuring Your OSPF Network Type, page 3](#)
- [Original LSA Behavior, page 7](#)
- [LSA Group Pacing with Multiple Timers, page 7](#)

Configuring Your OSPF Network Type

You have the choice of configuring your OSPF network type as either broadcast or NBMA, regardless of the default media type. Using this feature, you can configure broadcast networks as NBMA networks when, for example, you have routers in your network that do not support multicast addressing. You also can configure NBMA networks (such as X.25, Frame Relay, and SMDs) as broadcast networks. This feature saves you from needing to configure neighbors, as described in the section "[Configuring OSPF for Nonbroadcast Networks, page 11](#)" later in this module.

Configuring NBMA networks as either broadcast or nonbroadcast assumes that there are virtual circuits (VCs) from every router to every router or fully meshed network. This is not true for some cases, for example, because of cost constraints, or when you have only a partially meshed network. In these cases, you can configure the OSPF network type as a point-to-multipoint network. Routing between two routers not directly connected will go through the router that has VCs to both routers. Note that you need not configure neighbors when using this feature.

An OSPF point-to-multipoint interface is defined as a numbered point-to-point interface having one or more neighbors. It creates multiple host routes. An OSPF point-to-multipoint network has the following benefits compared to NBMA and point-to-point networks:

- Point-to-multipoint is easier to configure because it requires no configuration of neighbor commands, it consumes only one IP subnet, and it requires no designated router election.
- It costs less because it does not require a fully meshed topology.
- It is more reliable because it maintains connectivity in the event of VC failure.

On point-to-multipoint, broadcast networks, there is no need to specify neighbors. However, you can specify neighbors with the **neighbor** router configuration command, in which case you should specify a cost to that neighbor.

Before the **point-to-multipoint** keyword was added to the **ip ospf network** interface configuration command, some OSPF point-to-multipoint protocol traffic was treated as multicast traffic. Therefore, the **neighbor** router configuration command was not needed for point-to-multipoint interfaces because multicast took care of the traffic. Hello, update, and acknowledgment messages were sent using multicast. In particular, multicast hello messages discovered all neighbors dynamically.

- On any point-to-multipoint interface (broadcast or not), the Cisco IOS software assumed that the cost to each neighbor was equal. The cost was configured with the **ip ospf cost** interface configuration command. In reality, the bandwidth to each neighbor is different, so the cost should differ. With this feature, you can configure a separate cost to each neighbor. This feature applies to point-to-multipoint interfaces only.

Because many routers might be attached to an OSPF network, a *designated router* is selected for the network. Special configuration parameters are needed in the designated router selection if broadcast capability is not configured.

These parameters need only be configured in those devices that are themselves eligible to become the designated router or backup designated router (in other words, routers with a nonzero router priority value).

You can specify the following neighbor parameters, as required:

- Priority for a neighboring router
- Nonbroadcast poll interval

On point-to-multipoint, nonbroadcast networks, use the **neighbor** router configuration command to identify neighbors. Assigning a cost to a neighbor is optional.

Prior to Cisco IOS Release 12.0, some customers were using point-to-multipoint on nonbroadcast media (such as classic IP over ATM), so their routers could not dynamically discover their neighbors. This feature allows the **neighbor** router configuration command to be used on point-to-multipoint interfaces.

On any point-to-multipoint interface (broadcast or not), the Cisco IOS software assumed the cost to each neighbor was equal. The cost was configured with the **ip ospf cost** interface configuration command. In reality, the bandwidth to each neighbor is different, so the cost should differ. With this feature, you can configure a separate cost to each neighbor. This feature applies to point-to-multipoint interfaces only.

Our OSPF software allows you to configure several area parameters. These area parameters, shown in the following task table, include authentication, defining stub areas, and assigning specific costs to the default summary route. Authentication allows password-based protection against unauthorized access to an area.

Stub areas are areas into which information on external routes is not sent. Instead, there is a default external route generated by the ABR, into the stub area for destinations outside the autonomous system. To take advantage of the OSPF stub area support, *default routing* must be used in the stub area. To further reduce the number of LSAs sent into a stub area, you can configure the **no-summary** keyword of the **area stub** router configuration command on the ABR to prevent it from sending summary link advertisement (LSAs Type 3) into the stub area.

The OSPF NSSA feature is described by RFC 3101. In Cisco IOS Release 15.1(2)S and later releases, RFC 3101 replaces RFC 1587. RFC 3101 is backward compatible with RFC 1587. For a detailed list of differences between them, see Appendix F of RFC 3101. NSSA support was first integrated into Cisco IOS Release 11.2. OSPF NSSA is a nonproprietary extension of the existing OSPF stub area feature.

RFC 3101 support enhances both the Type 7 autonomous-system external routing calculation and the translation of Type 7 LSAs into Type 5 LSAs. For more information, see RFC 3101.

Use NSSA to simplify administration if you are an Internet service provider (ISP) or a network administrator that must connect a central site that is using OSPF to a remote site that is using a different routing protocol.

Prior to NSSA, the connection between the corporate site border router and the remote router could not be run as an OSPF stub area because routes for the remote site could not be redistributed into the stub area, and two routing protocols needed to be maintained. A simple protocol such as RIP was usually run and handled the redistribution. With NSSA, you can extend OSPF to cover the remote connection by defining the area between the corporate router and the remote router as an NSSA.

As with OSPF stub areas, NSSA areas cannot be injected with distributed routes via Type 5 LSAs. Route redistribution into an NSSA area is possible only with a special type of LSA that is known as Type 7 that can exist only in an NSSA area. An NSSA ASBR generates the Type 7 LSA so that the routes can be redistributed, and an NSSA ABR translates the Type 7 LSA into a Type 5 LSA, which can be flooded throughout the whole OSPF routing domain. Summarization and filtering are supported during the translation.

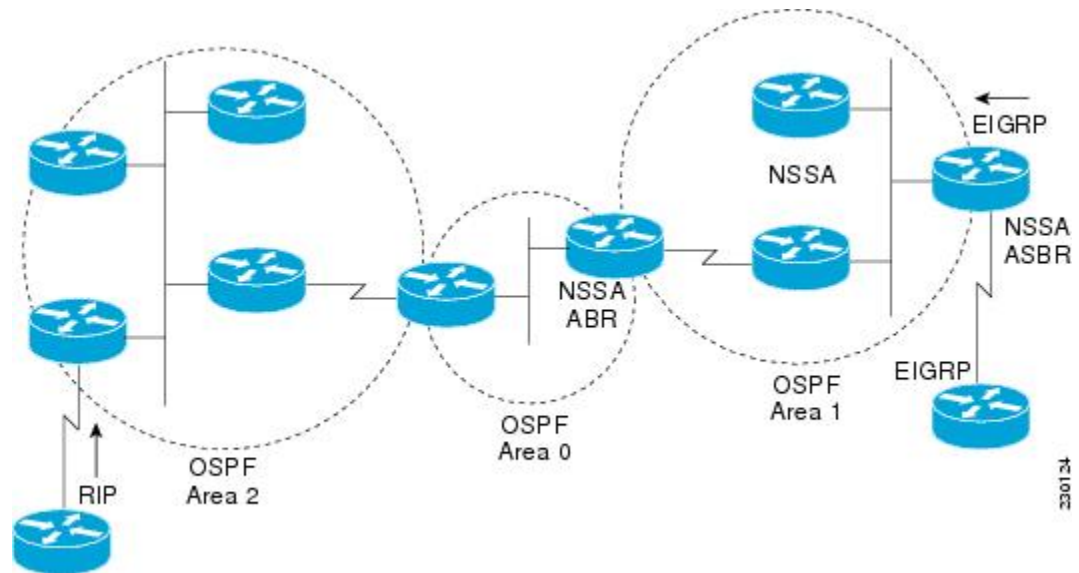
Cisco IOS Release 15.1(2)S and later releases support RFC 3101, which allows you to configure an NSSA ABR router as a forced NSSA LSA translator. This means that the NSSA ABR router will unconditionally assume the role of LSA translator, preempting the default behavior, which would only include it among the candidates to be elected as translator.

**Note**

Even a forced translator might not translate all LSAs; translation depends on the contents of each LSA.

The figure below shows a network diagram in which OSPF Area 1 is defined as the stub area. The Enhanced Interior Gateway Routing Protocol (EIGRP) routes cannot be propagated into the OSPF domain because routing redistribution is not allowed in the stub area. However, once OSPF Area 1 is defined as an NSSA, an NSSA ASBR can inject the EIGRP routes into the OSPF NSSA by creating Type 7 LSAs.

Figure 1



The redistributed routes from the RIP router will not be allowed into OSPF Area 1 because NSSA is an extension to the stub area. The stub area characteristics will still exist, including the exclusion of Type 5 LSAs.

Route summarization is the consolidation of advertised addresses. This feature causes a single summary route to be advertised to other areas by an ABR. In OSPF, an ABR will advertise networks in one area into another area. If the network numbers in an area are assigned in a way such that they are contiguous, you can configure the ABR to advertise a summary route that covers all the individual networks within the area that fall into the specified range.

When routes from other protocols are redistributed into OSPF (as described in the module "Configuring IP Routing Protocol-Independent Features"), each route is advertised individually in an external LSA. However, you can configure the Cisco IOS software to advertise a single route for all the redistributed routes that are covered by a specified network address and mask. Doing so helps decrease the size of the OSPF link-state database.

In OSPF, all areas must be connected to a backbone area. If there is a break in backbone continuity, or the backbone is purposefully partitioned, you can establish a virtual link. The two endpoints of a virtual link are ABRs. The virtual link must be configured in both routers. The configuration information in each router consists of the other virtual endpoint (the other ABR) and the nonbackbone area that the two routers have in common (called the transit area). Note that virtual links cannot be configured through stub areas.

You can force an ASBR to generate a default route into an OSPF routing domain. Whenever you specifically configure redistribution of routes into an OSPF routing domain, the router automatically

becomes an ASBR. However, an ASBR does not, by default, generate a *default route* into the OSPF routing domain.

You can configure OSPF to look up Domain Naming System (DNS) names for use in all OSPF **show EXEC** command displays. You can use this feature to more easily identify a router, because the router is displayed by name rather than by its router ID or neighbor ID.

OSPF uses the largest IP address configured on the interfaces as its router ID. If the interface associated with this IP address is ever brought down, or if the address is removed, the OSPF process must recalculate a new router ID and resend all its routing information out its interfaces.

If a loopback interface is configured with an IP address, the Cisco IOS software will use this IP address as its router ID, even if other interfaces have larger IP addresses. Because loopback interfaces never go down, greater stability in the routing table is achieved.

OSPF automatically prefers a loopback interface over any other kind, and it chooses the highest IP address among all loopback interfaces. If no loopback interfaces are present, the highest IP address in the router is chosen. You cannot tell OSPF to use any particular interface.

In Cisco IOS Release 10.3 and later releases, by default OSPF calculates the OSPF metric for an interface according to the bandwidth of the interface. For example, a 64-kbps link gets a metric of 1562, and a T1 link gets a metric of 64.

The OSPF metric is calculated as the *ref-bw* value divided by the *bandwidth* value, with the *ref-bw* value equal to 108 by default, and the *bandwidth* value determined by the **bandwidth** interface configuration command. The calculation gives FDDI a metric of 1. If you have multiple links with high bandwidth, you might want to specify a larger number to differentiate the cost on those links.

An administrative distance is a rating of the trustworthiness of a routing information source, such as an individual router or a group of routers. Numerically, an administrative distance is an integer from 0 to 255. In general, the higher the value, the lower the trust rating. An administrative distance of 255 means the routing information source cannot be trusted at all and should be ignored.

OSPF uses three different administrative distances: intra-area, interarea, and external. Routes within an area are intra-area; routes to another area are interarea; and routes from another routing domain learned via redistribution are external. The default distance for each type of route is 110.

Because simplex interfaces between two devices on an Ethernet represent only one network segment, for OSPF you must configure the sending interface to be a passive interface. This configuration prevents OSPF from sending hello packets for the sending interface. Both devices are able to see each other via the hello packet generated for the receiving interface.

You can configure the delay time between when OSPF receives a topology change and when it starts a shortest path first (SPF) calculation. You can also configure the hold time between two consecutive SPF calculations.

The OSPF on-demand circuit is an enhancement to the OSPF protocol that allows efficient operation over on-demand circuits such as ISDN, X.25 switched virtual circuits (SVCs), and dialup lines. This feature supports RFC 1793, Extending OSPF to Support Demand Circuits.

Prior to this feature, OSPF periodic hello and LSA updates would be exchanged between routers that connected the on-demand link, even when no changes occurred in the hello or LSA information.

With this feature, periodic hellos are suppressed and the periodic refreshes of LSAs are not flooded over the demand circuit. These packets bring up the link only when they are exchanged for the first time, or when a change occurs in the information they contain. This operation allows the underlying data link layer to be closed when the network topology is stable.

This feature is useful when you want to connect telecommuters or branch offices to an OSPF backbone at a central site. In this case, OSPF for on-demand circuits allows the benefits of OSPF over the entire domain,

without excess connection costs. Periodic refreshes of hello updates, LSA updates, and other protocol overhead are prevented from enabling the on-demand circuit when there is no "real" data to send.

Overhead protocols such as hellos and LSAs are transferred over the on-demand circuit only upon initial setup and when they reflect a change in the topology. This means that critical changes to the topology that require new SPF calculations are sent in order to maintain network topology integrity. Periodic refreshes that do not include changes, however, are not sent across the link.

The OSPF LSA group pacing feature allows the router to group OSPF LSAs and pace the refreshing, checksumming, and aging functions. The group pacing results in more efficient use of the router.

The router groups OSPF LSAs and paces the refreshing, checksumming, and aging functions so that sudden increases in CPU usage and network resources are avoided. This feature is most beneficial to large OSPF networks.

OSPF LSA group pacing is enabled by default. For typical customers, the default group pacing interval for refreshing, checksumming, and aging is appropriate and you need not configure this feature.

Original LSA Behavior

Each OSPF LSA has an age, which indicates whether the LSA is still valid. Once the LSA reaches the maximum age (1 hour), it is discarded. During the aging process, the originating router sends a refresh packet every 30 minutes to refresh the LSA. Refresh packets are sent to keep the LSA from expiring, whether there has been a change in the network topology or not. Checksumming is performed on all LSAs every 10 minutes. The router keeps track of LSAs it generates and LSAs it receives from other routers. The router refreshes LSAs it generated; it ages the LSAs it received from other routers.

Prior to the LSA group pacing feature, the Cisco IOS software would perform refreshing on a single timer, and checksumming and aging on another timer. In the case of refreshing, for example, the software would scan the whole database every 30 minutes, refreshing every LSA the router generated, no matter how old it was. The figure below illustrates all the LSAs being refreshed at once. This process wasted CPU resources because only a small portion of the database needed to be refreshed. A large OSPF database (several thousand LSAs) could have thousands of LSAs with different ages. Refreshing on a single timer resulted in the age of all LSAs becoming synchronized, which resulted in much CPU processing at once. Furthermore, a large number of LSAs could cause a sudden increase of network traffic, consuming a large amount of network resources in a short period of time.

Figure 2

All LSAs refreshed, 120 external LSAs on Ethernet need three packets



LSA Group Pacing with Multiple Timers

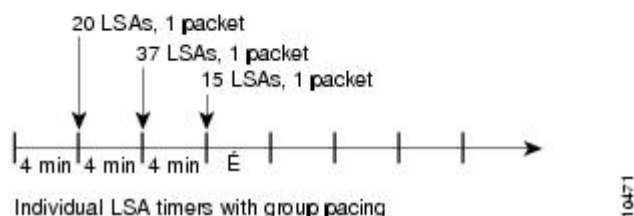
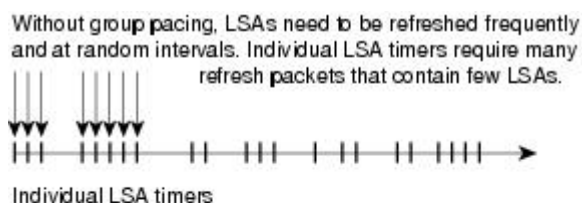
Configuring each LSA to have its own timer avoids excessive CPU processing and sudden network-traffic increase. To again use the example of refreshing, each LSA gets refreshed when it is 30 minutes old, independent of other LSAs. So the CPU is used only when necessary. However, LSAs being refreshed at frequent, random intervals would require many packets for the few refreshed LSAs the router must send out, which would be inefficient use of bandwidth.

Therefore, the router delays the LSA refresh function for an interval of time instead of performing it when the individual timers are reached. The accumulated LSAs constitute a group, which is then refreshed and

sent out in one packet or more. Thus, the refresh packets are paced, as are the checksumming and aging. The pacing interval is configurable; it defaults to 4 minutes, which is randomized to further avoid synchronization.

The figure below illustrates the case of refresh packets. The first timeline illustrates individual LSA timers; the second timeline illustrates individual LSA timers with group pacing.

Figure 3



The group pacing interval is inversely proportional to the number of LSAs the router is refreshing, checksumming, and aging. For example, if you have approximately 10,000 LSAs, decreasing the pacing interval would benefit you. If you have a very small database (40 to 100 LSAs), increasing the pacing interval to 10 to 20 minutes might benefit you slightly.

The default value of pacing between LSA groups is 240 seconds (4 minutes). The range is from 10 seconds to 1800 seconds (30 minutes).

By default, OSPF floods new LSAs over all interfaces in the same area, except the interface on which the LSA arrives. Some redundancy is desirable, because it ensures robust flooding. However, too much redundancy can waste bandwidth and might destabilize the network due to excessive link and CPU usage in certain topologies. An example would be a fully meshed topology.

You can block OSPF flooding of LSAs two ways, depending on the type of networks:

- On broadcast, nonbroadcast, and point-to-point networks, you can block flooding over specified OSPF interfaces.
- On point-to-multipoint networks, you can block flooding to a specified neighbor.

The growth of the Internet has increased the importance of scalability in IGP's such as OSPF. By design, OSPF requires LSAs to be refreshed as they expire after 3600 seconds. Some implementations have tried to improve the flooding by reducing the frequency to refresh from 30 minutes to about 50 minutes. This solution reduces the amount of refresh traffic but requires at least one refresh before the LSA expires. The OSPF flooding reduction solution works by reducing unnecessary refreshing and flooding of already known and unchanged information. To achieve this reduction, the LSAs are now flooded with the higher bit set. The LSAs are now set as "do not age."

Cisco routers do not support LSA Type 6 Multicast OSPF (MOSPF), and they generate syslog messages if they receive such packets. If the router is receiving many MOSPF packets, you might want to configure the router to ignore the packets and thus prevent a large number of syslog messages.

The former OSPF implementation for sending update packets needed to be more efficient. Some update packets were getting lost in cases where the link was slow, a neighbor could not receive the updates quickly enough, or the router was out of buffer space. For example, packets might be dropped if either of the following topologies existed:

- A fast router was connected to a slower router over a point-to-point link.
- During flooding, several neighbors sent updates to a single router at the same time.

OSPF update packets are now automatically paced so they are not sent less than 33 milliseconds apart. Pacing is also added between resends to increase efficiency and minimize lost retransmissions. Also, you can display the LSAs waiting to be sent out an interface. The benefit of the pacing is that OSPF update and retransmission packets are sent more efficiently. There are no configuration tasks for this feature; it occurs automatically.

You can display specific statistics such as the contents of IP routing tables, caches, and databases. Information provided can be used to determine resource utilization and solve network problems. You can also display information about node reachability and discover the routing path that your device packets are taking through the network

How to Configure OSPF

To configure OSPF, perform the tasks described in the following sections. The tasks in the first section are required; the tasks in the remaining sections are optional, but might be required for your application. For information about the maximum number of interfaces, see the [Restrictions, page 24](#).

- [Enabling OSPF, page 10](#)
- [Configuring OSPF Interface Parameters, page 10](#)
- [Configuring OSPF over Different Physical Networks, page 11](#)
- [Configuring OSPF Area Parameters, page 12](#)
- [Configuring OSPF NSSA, page 12](#)
- [Configuring OSPF NSSA Parameters, page 16](#)
- [Configuring Route Summarization Between OSPF Areas, page 17](#)
- [Configuring Route Summarization When Redistributing Routes into OSPF, page 17](#)
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- [Configuring Lookup of DNS Names, page 18](#)
- [Forcing the Router ID Choice with a Loopback Interface, page 18](#)
- [Controlling Default Metrics, page 19](#)
- [Changing the OSPF Administrative Distances, page 19](#)
- [Configuring OSPF on Simplex Ethernet Interfaces, page 19](#)
- [Configuring Route Calculation Timers, page 19](#)
- [Configuring OSPF over On-Demand Circuits, page 19](#)
- [Logging Neighbors Going Up or Down, page 21](#)
- [Blocking OSPF LSA Flooding, page 21](#)
- [Reducing LSA Flooding, page 22](#)
- [Ignoring MOSPF LSA Packets, page 22](#)
- [Displaying OSPF Update Packet Pacing, page 22](#)
- [Monitoring and Maintaining OSPF, page 22](#)
- [Restrictions, page 24](#)

Enabling OSPF

SUMMARY STEPS

1. Router(config)# **router ospf** *process-id*
2. Router(config-router)# **network** *ip-address wildcard-mask area area-id*

DETAILED STEPS

	Command or Action	Purpose
Step 1	Router(config)# router ospf <i>process-id</i>	Enables OSPF routing, which places the router in router configuration mode.
Step 2	Router(config-router)# network <i>ip-address wildcard-mask area area-id</i>	Defines an interface on which OSPF runs and defines the area ID for that interface.

Configuring OSPF Interface Parameters

Command	Purpose
Router(config-if)# ip ospf cost <i>cost</i>	Explicitly specifies the cost of sending a packet on an OSPF interface.
Router(config-if)# ip ospf retransmit-interval <i>seconds</i>	Specifies the number of seconds between link-state advertisement (LSA) retransmissions for adjacencies belonging to an OSPF interface.
Router(config-if)# ip ospf transmit-delay <i>seconds</i>	Sets the estimated number of seconds required to send a link-state update packet on an OSPF interface.
Router(config-if)# ip ospf priority <i>number-value</i>	Sets priority to help determine the OSPF designated router for a network.
Router(config-if)# ip ospf hello-interval <i>seconds</i>	Specifies the length of time between the hello packets that the Cisco IOS software sends on an OSPF interface.
Router(config-if)# ip ospf dead-interval <i>seconds</i>	Sets the number of seconds that a device must wait before it declares a neighbor OSPF router down because it has not received a hello packet.
Router(config-if)# ip ospf authentication-key <i>key</i>	Assigns a password to be used by neighboring OSPF routers on a network segment that is using the OSPF simple password authentication.
Router(config-if)# ip ospf message-digest-key <i>key-id md5 key</i>	Enables OSPF MD5 authentication. The values for the <i>key-id</i> and <i>key</i> arguments must match values specified for other neighbors on a network segment.

Command	Purpose
Router(config-if)# ip ospf authentication [message-digest null]	Specifies the authentication type for an interface.

Configuring OSPF over Different Physical Networks

Command	Purpose
Router(config-if)# ip ospf network {broadcast non-broadcast {point-to-multipoint [non-broadcast] point-to-point}}	Configures the OSPF network type for a specified interface.

- [Configuring Point-to-Multipoint Broadcast Networks, page 11](#)
- [Configuring OSPF for Nonbroadcast Networks, page 11](#)

Configuring Point-to-Multipoint Broadcast Networks

SUMMARY STEPS

1. Router(config-if)# **ip ospf network point-to-multipoint**
2. Router(config-if)# **exit**
3. Router(config)# **router ospf process-id**
4. Router(config-router)# **neighbor ip-address cost number**

DETAILED STEPS

	Command or Action	Purpose
Step 1	Router(config-if)# ip ospf network point-to-multipoint	Configures an interface as point-to-multipoint for broadcast media.
Step 2	Router(config-if)# exit	Enters global configuration mode.
Step 3	Router(config)# router ospf process-id	Configures an OSPF routing process and enters router configuration mode.
Step 4	Router(config-router)# neighbor ip-address cost number	Specifies a neighbor and assigns a cost to the neighbor. Note Repeat this step for each neighbor if you want to specify a cost. Otherwise, neighbors will assume the cost of the interface, based on the ip ospf cost interface configuration command.

Configuring OSPF for Nonbroadcast Networks

Command	Purpose
Router(config-router)# neighbor <i>ip-address</i> [<i>priority number</i>] [<i>poll-interval seconds</i>]	Configures a router interconnecting to nonbroadcast networks.

SUMMARY STEPS

1. Router(config-if)# **ip ospf network point-to-multipoint non-broadcast**
2. Router(config-if)# **exit**
3. Router(config)# **router ospf** *process-id*
4. Router(config-router)# **neighbor** *ip-address* [*cost number*]

DETAILED STEPS

	Command or Action	Purpose
Step 1	Router(config-if)# ip ospf network point-to-multipoint non-broadcast	Configures an interface as point-to-multipoint for nonbroadcast media.
Step 2	Router(config-if)# exit	Enters global configuration mode.
Step 3	Router(config)# router ospf <i>process-id</i>	Configures an OSPF routing process and enters router configuration mode.
Step 4	Router(config-router)# neighbor <i>ip-address</i> [<i>cost number</i>]	Specifies a neighbor and assigns a cost to the neighbor. Note Repeat this step for each neighbor if you want to specify a cost. Otherwise, neighbors will assume the cost of the interface, based on the ip ospf cost interface configuration command.

Configuring OSPF Area Parameters

Command	Purpose
Router(config-router)# area <i>area-id</i> authentication	Enables authentication for an OSPF area.
Router(config-router)# area <i>area-id</i> authentication message-digest	Enables MD5 authentication for an OSPF area.
Router(config-router)# area <i>area-id</i> stub [no-summary]	Defines an area to be a stub area.
Router(config-router)# area <i>area-id</i> default-cost <i>cost</i>	Assigns a specific cost to the default summary route used for the stub area.

Configuring OSPF NSSA

- [Configuring an OSPF NSSA Area and Its Parameters, page 13](#)

- [Configuring an NSSA ABR as a Forced NSSA LSA Translator](#), page 14
- [Disabling RFC 3101 Compatibility and Enabling RFC 1587 Compatibility](#), page 15

Configuring an OSPF NSSA Area and Its Parameters

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **router ospf process-id**
4. **redistribute protocol [process-id] {level-1 | level-1-2 | level-2} [autonomous-system-number] [metric {metric-value | transparent}] [metric-type type-value] [match {internal | external 1 | external 2}] [tag tag-value] [route-map map-tag] [subnets] [nssa-only]**
5. **network ip-address wildcard-mask area area-id**
6. **area area-id nssa [no-redistribution] [default-information-originate [metric] [metric-type]] [no-summary] [nssa-only]**

DETAILED STEPS

Command or Action	Purpose
Step 1 enable Example: <pre>Router> enable</pre>	Enables privileged EXEC mode. <ul style="list-style-type: none"> • Enter your password if prompted.
Step 2 configure terminal Example: <pre>Router# configure terminal</pre>	Enters global configuration mode.
Step 3 router ospf process-id Example: <pre>Router(config)# router ospf 10</pre>	Enables OSPF routing and enters router configuration mode. <ul style="list-style-type: none"> • The process-id argument identifies the OSPF process. In this example the number of the routing process is 10.

Command or Action	Purpose
<p>Step 4 <code>redistribute protocol [process-id] {level-1 level-1-2 level-2} [autonomous-system-number] [metric {metric-value transparent}] [metric-type type-value] [match {internal external 1 external 2}] [tag tag-value] [route-map map-tag] [subnets] [nssa-only]</code></p> <p>Example:</p> <pre>Router(config-router)# redistribute rip subnets</pre>	<p>Redistributes routes from one routing domain into another routing domain.</p> <ul style="list-style-type: none"> The example causes RIP subnets to be redistributed into the OSPF domain.
<p>Step 5 <code>network ip-address wildcard-mask area area-id</code></p> <p>Example:</p> <pre>Router(config-router)# network 172.19.92.0 0.0.0.255 area 1</pre>	<p>Defines the interfaces on which OSPF runs and defines the area ID for those interfaces.</p> <ul style="list-style-type: none"> The example defines 172.19.92.0/0.0.0.255 interfaces for OSPF area 1 for OSPF routing process 10.
<p>Step 6 <code>area area-id nssa [no-redistribution] [default-information-originate [metric] [metric-type]] [no-summary] [nssa-only]</code></p> <p>Example:</p> <pre>Router(config-router)# area 1 nssa</pre>	<p>Configures an NSSA area.</p> <ul style="list-style-type: none"> In the example, area 1 is configured as an NSSA area.

Configuring an NSSA ABR as a Forced NSSA LSA Translator



Note

In Cisco IOS Release 15.1(2)S and later releases, the output of the **show ip ospf** command shows whether the NSSA ABR is configured as a forced translator, and whether the router is running as RFC 3101 or RFC 1587 compatible.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **router ospf process-id**
4. **area area-id nssa translate type7 [always]**
5. **end**

DETAILED STEPS

Command or Action	Purpose
<p>Step 1 <code>enable</code></p> <p>Example:</p> <pre>Router> enable</pre>	<p>Enables privileged EXEC mode.</p> <ul style="list-style-type: none"> Enter your password if prompted.
<p>Step 2 <code>configure terminal</code></p> <p>Example:</p> <pre>Router# configure terminal</pre>	<p>Enters global configuration mode.</p>
<p>Step 3 <code>router ospf process-id</code></p> <p>Example:</p> <pre>Router(config)# router ospf 1</pre>	<p>Enables OSPF routing and enters router configuration mode.</p> <ul style="list-style-type: none"> The <i>process-id</i> argument identifies the OSPF process.
<p>Step 4 <code>area area-id nssa translate type7 [always]</code></p> <p>Example:</p> <pre>Router(config-router)# area 10 nssa translate type7 always</pre>	<p>Configures an NSSA ABR router as a forced NSSA LSA translator.</p> <p>Note In Cisco IOS Release 15.1(2)S and later releases, RFC 3101 replaces RFC 1587, and you can use the always keyword in the area nssa translate command to configure an NSSA ABR router as a forced NSSA LSA translator. This command will work if RFC 3101 is disabled and RFC 1587 is being used.</p>
<p>Step 5 <code>end</code></p> <p>Example:</p> <pre>Router(config-router)# end</pre>	<p>Exits router configuration mode and returns to privileged EXEC mode.</p>

Disabling RFC 3101 Compatibility and Enabling RFC 1587 Compatibility

**Note**

In Cisco IOS Release 15.1(2)S and later releases, the output of the **show ip ospf** command will indicate if the NSSA ABR is configured as RFC 3101 or RFC 1587 compatible.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **router ospf *process-id***
4. **compatible rfc1587**
5. **end**

DETAILED STEPS

Command or Action	Purpose
Step 1 enable Example: Router> enable	Enables privileged EXEC mode. <ul style="list-style-type: none"> • Enter your password if prompted.
Step 2 configure terminal Example: Router# configure terminal	Enters global configuration mode.
Step 3 router ospf <i>process-id</i> Example: Router(config)# router ospf 1	Enables OSPF routing and enters router configuration mode. <ul style="list-style-type: none"> • The process-id argument identifies the OSPF process.
Step 4 compatible rfc1587 Example: Router(config-router)# compatible rfc1587	Changes the method used to perform route selection to RFC 1587 compatibility and disables RFC 3101.
Step 5 end Example: Router(config-router)# end	Exits router configuration mode and returns to privileged EXEC mode.

Configuring OSPF NSSA Parameters

- [Prerequisites, page 17](#)

Prerequisites

Evaluate the following considerations before you implement this feature:

- You can set a Type 7 default route that can be used to reach external destinations. When configured, the router generates a Type 7 default into the NSSA or the NSSA ABR.
- Every router within the same area must agree that the area is NSSA; otherwise, the routers will not be able to communicate.

Command	Purpose
<pre>Router(config-router)# area <i>area-id</i> nssa [no-redistribution] [default-information-originate]</pre>	Defines an area to be an NSSA.
Command	Purpose
<pre>Router(config-router)# summary-address <i>prefix mask</i> [not-advertise] [tag tag] nssa-only</pre>	Controls the summarization and filtering during the translation and limits the summary to NSSA areas.

Configuring Route Summarization Between OSPF Areas

Command	Purpose
<pre>Router(config-router)# area <i>area-id</i> range <i>ip-address mask</i> [advertise not-advertise][cost cost]</pre>	Specifies an address range for which a single route will be advertised.

Configuring Route Summarization When Redistributing Routes into OSPF

Command	Purpose
<pre>Router(config-router)# summary-address {<i>ip-address mask</i> <i>prefix mask</i>} [not-advertise][tag tag]</pre>	Specifies an address and mask that covers redistributed routes, so only one summary route is advertised. Use the optional not-advertise keyword to filter out a set of routes.

Establishing Virtual Links

Command	Purpose
<pre>Router(config-router)# area <i>area-id</i> virtual-link <i>router-id</i> [authentication [message-digest null]] [hello-interval <i>seconds</i>] [retransmit-interval <i>seconds</i>] [transmit-delay <i>seconds</i>] [dead-interval <i>seconds</i>] [authentication-key <i>key</i> message-digest-key <i>key-id</i> md5 <i>key</i>]</pre>	Establishes a virtual link.

Generating a Default Route

Command	Purpose
<pre>Router(config-router)# default-information originate [always] [metric <i>metric-value</i>] [metric-type <i>type-value</i>] [route-map <i>map-name</i>]</pre>	<p>Forces the ASBR to generate a default route into the OSPF routing domain.</p> <p>Note The always keyword includes the following exception when the route map is used. When a route map is used, the origination of the default route by OSPF is not bound to the existence of a default route in the routing table.</p>

Configuring Lookup of DNS Names

Command	Purpose
<pre>Router(config)# ip ospf name-lookup</pre>	Configures DNS name lookup.

Forcing the Router ID Choice with a Loopback Interface

SUMMARY STEPS

1. Router(config)# **interface loopback 0**
2. Router(config-if)# **ip address***ip-address mask*

DETAILED STEPS

Command or Action	Purpose
Step 1 Router(config)# interface loopback 0	Creates a loopback interface, which places the router in interface configuration mode.
Step 2 Router(config-if)# ip address <i>ip-address mask</i>	Assigns an IP address to this interface.

Controlling Default Metrics

Command	Purpose
Router(config-router)# auto-cost reference-bandwidth <i>ref-bw</i>	Differentiates high -bandwidth links.

Changing the OSPF Administrative Distances

Command	Purpose
Router(config-router)# distance ospf {intra-area inter-area external} <i>dist</i>	Changes the OSPF distance values.

Configuring OSPF on Simplex Ethernet Interfaces

Command	Purpose
Router(config-router)# passive-interface <i>interface-type interface-number</i>	Suppresses the sending of hello packets through the specified interface.

Configuring Route Calculation Timers

Command	Purpose
Router(config-router)# timers spf <i>spf-delay spf-holdtime</i>	Configures route calculation timers.

Configuring OSPF over On-Demand Circuits

SUMMARY STEPS

1. Router(config)# **router ospf** *process-id*
2. Router(config)# **interface** *interface-type interface-number*
3. Router(config-if)# **ip ospf demand-circuit**

DETAILED STEPS

	Command or Action	Purpose
Step 1	Router(config)# router ospf <i>process-id</i>	Enables OSPF operation.
Step 2	Router(config)# interface <i>interface-type interface-number</i>	Enters interface configuration mode.

	Command or Action	Purpose
Step 3	Router(config-if)# ip ospf demand-circuit	Configures OSPF over an on-demand circuit.

**Note**

You can prevent an interface from accepting demand-circuit requests from other routers to by specifying the **ignore** keyword in the **ip ospf demand-circuit** command.

- [Prerequisites, page 20](#)

Prerequisites

Evaluate the following considerations before implementing this feature:

- Because LSAs that include topology changes are flooded over an on-demand circuit, we recommend that you put demand circuits within OSPF stub areas or within NSSAs to isolate the demand circuits from as many topology changes as possible.
- Every router within a stub area or NSSA must have this feature loaded in order to take advantage of the on-demand circuit functionality. If this feature is deployed within a regular area, all other regular areas must also support this feature before the demand circuit functionality can take effect because Type 5 external LSAs are flooded throughout all areas.
- Hub-and-spoke network topologies that have a point-to-multipoint (p2mp) OSPF interface type on a hub might not revert to nondemand circuit mode when needed. You must simultaneously reconfigure OSPF on all interfaces on the p2mp segment when reverting them from demand circuit mode to nondemand circuit mode.
- Do not implement this feature on a broadcast-based network topology because the overhead protocols (such as hello and LSA packets) cannot be successfully suppressed, which means the link will remain up.
- Configuring the router for an OSPF on-demand circuit with an asynchronous interface is not a supported configuration. The supported configuration is to use dialer interfaces on both ends of the circuit. For more information, refer to [Why OSPF Demand Circuit Keeps Bringing Up the Link](#).

Logging Neighbors Going Up or Down

Command	Purpose
Router(config-router)# log-adjacency-changes [detail]	Sends syslog message when an OSPF neighbor goes up or down. Note Configure this command if you want to know about OSPF neighbors going up or down without turning on the debug ip ospf adjacencyEXEC command. The log-adjacency-changes router configuration command provides a higher-level view of the peer relationship with less output. Configure the log-adjacency-changes detail command if you want to see messages for each state change.

- [Changing the LSA Group Pacing Interval, page 21](#)

Changing the LSA Group Pacing Interval

Command	Purpose
Router(config-router)# timers pacing lsa-group <i>seconds</i>	Changes the group pacing of LSAs.

Blocking OSPF LSA Flooding

Command	Purpose
Router(config-if)# ip ospf database-filter all out	Blocks the flooding of OSPF LSA packets to the interface.

On point-to-multipoint networks, to block flooding of OSPF LSAs, use the following command in router configuration mode:

Command	Purpose
Router(config-router)# neighbor <i>ip-address</i> database-filter all out	Blocks the flooding of OSPF LSA packets to the specified neighbor.

Reducing LSA Flooding

Command	Purpose
Router(config-if)# ip ospf flood-reduction	Suppresses the unnecessary flooding of LSAs in stable topologies.

Ignoring MOSPF LSA Packets

Command	Purpose
Router(config-router)# ignore lsa mospf	Prevents the router from generating syslog messages when it receives MOSPF LSA packets.

Displaying OSPF Update Packet Pacing

Command	Purpose
Router# show ip ospf flood-list <i>interface-type</i> <i>interface-number</i>	Displays a list of LSAs waiting to be flooded over an interface.

Monitoring and Maintaining OSPF

Command	Purpose
Router# show ip ospf [<i>process-id</i>]	Displays general information about OSPF routing processes.
Router# show ip ospf border-routers	Displays the internal OSPF routing table entries to the ABR and ASBR.

Command	Purpose
Router# show ip ospf [<i>process-id</i>] [<i>area-id</i>] database	Displays lists of information related to the OSPF database.
Router# show ip ospf [<i>process-id</i>] [<i>area-id</i>] database [database-summary]	
Router# show ip ospf [<i>process-id</i>] [<i>area-id</i>] database [router] [self-originate]	
Router# show ip ospf [<i>process-id</i>] [<i>area-id</i>] database [router] [adv-router [<i>ip-address</i>]]	
Router# show ip ospf [<i>process-id</i>] [<i>area-id</i>] database [router] [<i>link-state-id</i>]	
Router# show ip ospf [<i>process-id</i>] [<i>area-id</i>] database [network] [<i>link-state-id</i>]	
Router# show ip ospf [<i>process-id</i>] [<i>area-id</i>] database [summary] [<i>link-state-id</i>]	
Router# show ip ospf [<i>process-id</i>] [<i>area-id</i>] database [asbr-summary] [<i>link-state-id</i>]	
Router# show ip ospf [<i>process-id</i>] [<i>area-id</i>] database [external] [<i>link-state-id</i>]	
Router# show ip ospf [<i>process-id</i>] [<i>area-id</i>] database [nssa-external] [<i>link-state-id</i>]	
Router# show ip ospf [<i>process-id</i>] [<i>area-id</i>] database [opaque-link] [<i>link-state-id</i>]	
Router# show ip ospf [<i>process-id</i>]	

Command	Purpose
<code>[area-id] database [opaque-area] [link-state-id]</code>	
Router# <code>show ip ospf [process-id] [area-id] database [opaque-as] [link-state-id]</code>	
Router# <code>show ip ospf flood-list interface interface-type</code>	Displays a list of LSAs waiting to be flooded over an interface (to observe OSPF packet pacing).
Router# <code>show ip ospf interface [interface-type] interface-number</code>	Displays OSPF-related interface information.
Router# <code>show ip ospf neighbor [interface-name] [neighbor-id] detail</code>	Displays OSPF neighbor information on a per-interface basis.
Router# <code>show ip ospf request-list [neighbor] [interface] [interface-neighbor]</code>	Displays a list of all LSAs requested by a router.
Router# <code>show ip ospf retransmission-list [neighbor] [interface] [interface-neighbor]</code>	Displays a list of all LSAs waiting to be re-sent.
Router# <code>show ip ospf [process-id] summary-address</code>	Displays a list of all summary address redistribution information configured under an OSPF process.
Router# <code>show ip ospf virtual-links</code>	Displays OSPF-related virtual links information.

To restart an OSPF process, use the following command in EXEC mode:

Command	Purpose
Router# <code>clear ip ospf [pid] {process redistribution counters [neighbor [neighbor-id]]}</code>	Clears redistribution based on the OSPF routing process ID. If the <i>pid</i> option is not specified, all OSPF processes are cleared.

Restrictions

On systems with a large number of interfaces, it may be possible to configure OSPF such that the number of links advertised in the router LSA causes the link state update packet to exceed the size of a "huge" Cisco IOS buffer. To resolve this problem, reduce the number of OSPF links or increase the huge buffer size by entering the : **buffers huge size** *size* command.

A link state update packet containing a router LSA typically has a fixed overhead of 196 bytes, and an additional 12 bytes are required for each link description. With a huge buffer size of 18024 bytes there can be a maximum of 1485 link descriptions.

Because the maximum size of an IP packet is 65,535 bytes, there is still an upper bound on the number of links possible on a router.

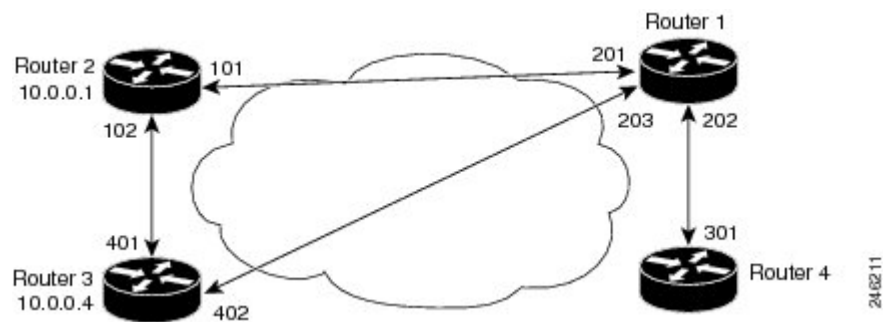
Configuration Examples for OSPF

- [Example OSPF Point-to-Multipoint, page 25](#)
- [Example OSPF Point-to-Multipoint with Broadcast, page 26](#)
- [Example OSPF Point-to-Multipoint with Nonbroadcast, page 27](#)
- [Example Variable-Length Subnet Masks, page 28](#)
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- [Example OSPF NSSA Area with RFC 3101 Disabled and RFC 1587 Active, page 33](#)
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- [Example Ignore MOSPF LSA Packets, page 44](#)

Example OSPF Point-to-Multipoint

In the figure below, the router named Router 1 uses data-link connection identifier (DLCI) 201 to communicate with the router named Router 2, DLCI 202 to the router named Router 4, and DLCI 203 to the router named Router 3. Router 2 uses DLCI 101 to communicate with Router 1 and DLCI 102 to communicate with Router 3. Router 3 communicates with Router 2 (DLCI 401) and Router 1 (DLCI 402). Router 4 communicates with Router 1 (DLCI 301). Configuration examples follow the figure.

Figure 4



Router 1 Configuration

```
hostname Router 1
!
interface serial 1
 ip address 10.0.0.2 255.0.0.0
 ip ospf network point-to-multipoint
 encapsulation frame-relay
 frame-relay map ip 10.0.0.1 201 broadcast
```

```

frame-relay map ip 10.0.0.3 202 broadcast
frame-relay map ip 10.0.0.4 203 broadcast
!
router ospf 1
network 10.0.0.0 0.0.0.255 area 0

```

Router 2 Configuration

```

hostname Router 2
!
interface serial 0
ip address 10.0.0.1 255.0.0.0
ip ospf network point-to-multipoint
encapsulation frame-relay
frame-relay map ip 10.0.0.2 101 broadcast
frame-relay map ip 10.0.0.4 102 broadcast
!
router ospf 1
network 10.0.0.0 0.0.0.255 area 0

```

Router 3 Configuration

```

hostname Router 3
!
interface serial 3
ip address 10.0.0.4 255.0.0.0
ip ospf network point-to-multipoint
encapsulation frame-relay
clock rate 1000000
frame-relay map ip 10.0.0.1 401 broadcast
frame-relay map ip 10.0.0.2 402 broadcast
!
router ospf 1
network 10.0.0.0 0.0.0.255 area 0

```

Router 4 Configuration

```

hostname Router 4
!
interface serial 2
ip address 10.0.0.3 255.0.0.0
ip ospf network point-to-multipoint
encapsulation frame-relay
clock rate 2000000
frame-relay map ip 10.0.0.2 301 broadcast
!
router ospf 1
network 10.0.0.0 0.0.0.255 area 0

```

Example OSPF Point-to-Multipoint with Broadcast

The following example illustrates a point-to-multipoint network with broadcast:

```

interface Serial0
ip address 10.0.1.1 255.255.255.0
encapsulation frame-relay
ip ospf cost 100
ip ospf network point-to-multipoint
frame-relay map ip 10.0.1.3 202 broadcast
frame-relay map ip 10.0.1.4 203 broadcast
frame-relay map ip 10.0.1.5 204 broadcast
frame-relay local-dlci 200
!
router ospf 1
network 10.0.1.0 0.0.0.255 area 0

```

```
neighbor 10.0.1.5 cost 5
neighbor 10.0.1.4 cost 10
```

The following example shows the configuration of the neighbor at 10.0.1.3:

```
interface serial 0
ip address 10.0.1.3 255.255.255.0
ip ospf network point-to-multipoint
encapsulation frame-relay
frame-relay local-dlci 301
frame-relay map ip 10.0.1.1 300 broadcast
no shutdown
!
router ospf 1
network 10.0.1.0 0.0.0.255 area 0
```

The output shown for neighbors in the first configuration is as follows:

```
Router# show ip ospf neighbor
Neighbor ID      Pri   State           Dead Time   Address      Interface
172.16.1.1       1    FULL/ -         00:01:50   10.0.1.5    Serial0
172.16.1.4       1    FULL/ -         00:01:47   10.0.1.4    Serial0
172.16.1.8       1    FULL/ -         00:01:45   10.0.1.3    Serial0
```

The route information in the first configuration is as follows:

```
Router# show ip route
Codes: C - connected, S - static, I - IGRP, 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, E - EGP
       i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, * - candidate default
       U - per-user static route, o - ODR
Gateway of last resort is not set
C    1.0.0.0/8 is directly connected, Loopback0
     10.0.0.0/8 is variably subnetted, 4 subnets, 2 masks
O    10.0.1.3/32 [110/100] via 10.0.1.3, 00:39:08, Serial0
C    10.0.1.0/24 is directly connected, Serial0
O    10.0.1.5/32 [110/5] via 10.0.1.5, 00:39:08, Serial0
O    10.0.1.4/32 [110/10] via 10.0.1.4, 00:39:08, Serial0
```

Example OSPF Point-to-Multipoint with Nonbroadcast

The following example illustrates a point-to-multipoint network with nonbroadcast:

```
interface Serial0
ip address 10.0.1.1 255.255.255.0
ip ospf network point-to-multipoint non-broadcast
encapsulation frame-relay
no keepalive
frame-relay local-dlci 200
frame-relay map ip 10.0.1.3 202
frame-relay map ip 10.0.1.4 203
frame-relay map ip 10.0.1.5 204
no shutdown
!
router ospf 1
network 10.0.1.0 0.0.0.255 area 0
neighbor 10.0.1.3 cost 5
neighbor 10.0.1.4 cost 10
neighbor 10.0.1.5 cost 15
```

The following example is the configuration for the router on the other side:

```
interface Serial9/2
ip address 10.0.1.3 255.255.255.0
encapsulation frame-relay
ip ospf network point-to-multipoint non-broadcast
no ip mroute-cache
```



```

no keepalive
no fair-queue
frame-relay local-dlci 301
frame-relay map ip 10.0.1.1 300
no shutdown
!
router ospf 1
network 10.0.1.0 0.0.0.255 area 0

```

The output shown for neighbors in the first configuration is as follows:

```

Router# show ip ospf neighbor
Neighbor ID      Pri   State           Dead Time   Address        Interface
172.16.1.1       1    FULL/ -         00:01:52    10.0.1.5       Serial0
172.16.1.4       1    FULL/ -         00:01:52    10.0.1.4       Serial0
172.16.1.8       1    FULL/ -         00:01:52    10.0.1.3       Serial0

```

Example Variable-Length Subnet Masks

OSPF, static routes, and IS-IS support variable-length subnet masks (VLSMs). With VLSMs, you can use different masks for the same network number on different interfaces, which allows you to conserve IP addresses and more efficiently use available address space.

In the following example, a 30-bit subnet mask is used, leaving two bits of address space reserved for serial line host addresses. There is sufficient host address space for two host endpoints on a point-to-point serial link.

```

interface ethernet 0
 ip address 172.16.10.1 255.255.255.0
 ! 8 bits of host address space reserved for ethernet
interface serial 0
 ip address 172.16.20.1 255.255.255.252
 ! 2 bits of address space reserved for serial lines
 ! Router is configured for OSPF and assigned AS 107
router ospf 107
 ! Specifies network directly connected to the router
network 172.16.0.0 0.0.255.255 area 0.0.0.0

```

Example OSPF NSSA

In the following example, an OSPF stub network is configured to include OSPF Area 0 and OSPF Area 1, using five routers. OSPF Area 1 is defined as an NSSA, with Router 3 configured to be the NSSA ASBR and Router 2 configured to be the NSSA ABR. Following is the configuration output for the five routers.

Router 1

```

hostname Router1
!
interface Loopback1
 ip address 10.1.0.1 255.255.255.255
!
interface Ethernet0/0
 ip address 192.168.0.1 255.255.255.0
 ip ospf 1 area 0
 no cdp enable
!
interface Serial10/0
 description Router2 interface s11/0
 ip address 192.168.10.1 255.255.255.0
 ip ospf 1 area 1
 serial restart-delay 0
 no cdp enable
!
router ospf 1

```

```
    area 1 nssa
  !
end
```

Router 2

```
hostname Router2
!
!
interface Loopback1
 ip address 10.1.0.2 255.255.255.255
!
interface Serial10/0
 description Router1 interface s11/0
 no ip address
 shutdown
 serial restart-delay 0
 no cdp enable
!
interface Serial11/0
 description Router1 interface s10/0
 ip address 192.168.10.2 255.255.255.0
 ip ospf 1 area 1
 serial restart-delay 0
 no cdp enable
!
interface Serial14/0
 description Router3 interface s13/0
 ip address 192.168.14.2 255.255.255.0
 ip ospf 1 area 1
 serial restart-delay 0
 no cdp enable
!
router ospf 1
 area 1 nssa
!
end
```

Router 3

```
hostname Router3
!
interface Loopback1
 ip address 10.1.0.3 255.255.255.255
!
interface Ethernet3/0
 ip address 192.168.3.3 255.255.255.0
 no cdp enable
!
interface Serial13/0
 description Router2 interface s14/0
 ip address 192.168.14.3 255.255.255.0
 ip ospf 1 area 1
 serial restart-delay 0
 no cdp enable
!
router ospf 1
 log-adjacency-changes
 area 1 nssa
 redistribute rip subnets
!
router rip
 version 2
 redistribute ospf 1 metric 15
 network 192.168.3.0
end
```

Router 4

```
hostname Router4
```

```

!
interface Loopback1
 ip address 10.1.0.4 255.255.255.255
!
interface Ethernet3/0
 ip address 192.168.3.4 255.255.255.0
 no cdp enable
!
interface Ethernet4/1
 ip address 192.168.41.4 255.255.255.0
!
router rip
 version 2
 network 192.168.3.0
 network 192.168.41.0
!
end

```

Router 5

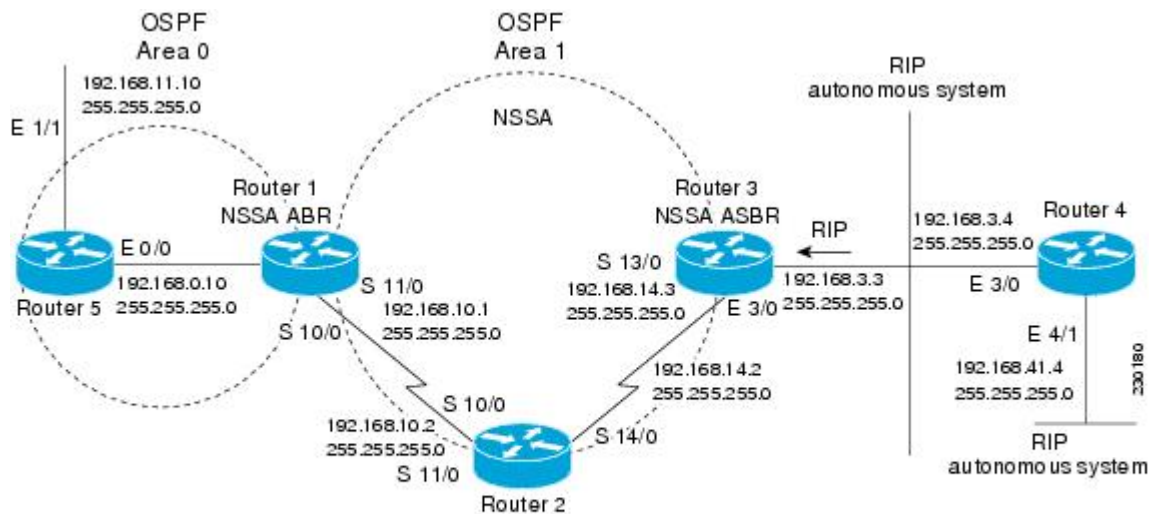
```

hostname Router5
!
interface Loopback1
 ip address 10.1.0.5 255.255.255.255
!
interface Ethernet0/0
 ip address 192.168.0.10 255.255.255.0
 ip ospf 1 area 0
 no cdp enable
!
interface Ethernet1/1
 ip address 192.168.11.10 255.255.255.0
 ip ospf 1 area 0
!
router ospf 1
!
end

```

The figure below shows the OSPF stub network with NSSA Area 1. The redistributed routes that Router 4 is propagating from the two RIP networks will be translated into Type 7 LSAs by NSSA ASBR Router 3. Router 2, which is configured to be the NSSA ABR, will translate the Type 7 LSAs back to Type 5 so that they can be flooded through the rest of the OSPF stub network within OSPF Area 0.

Figure 5



When the **show ip ospf** command is entered on Router 2, the output confirms that OSPF Area 1 is an NSSA area:

```
Router2# show ip ospf
Routing Process "ospf 1" with ID 10.1.0.2
Start time: 00:00:01.392, Time elapsed: 12:03:09.480
Supports only single TOS(TOS0) routes
Supports opaque LSA
Supports Link-local Signaling (LLS)
Supports area transit capability
Router is not originating router-LSAs with maximum metric
Initial SPF schedule delay 5000 msec
Minimum hold time between two consecutive SPF's 10000 msec
Maximum wait time between two consecutive SPF's 10000 msec
Incremental-SPF disabled
Minimum LSA interval 5 secs
Minimum LSA arrival 1000 msec
LSA group pacing timer 240 secs
Interface flood pacing timer 33 msec
Retransmission pacing timer 66 msec
Number of external LSA 0. Checksum Sum 0x000000
Number of opaque AS LSA 0. Checksum Sum 0x000000
Number of DCbitless external and opaque AS LSA 0
Number of DoNotAge external and opaque AS LSA 0
Number of areas in this router is 1. 0 normal 0 stub 1 nssa
Number of areas transit capable is 0
External flood list length 0
  Area 1
    Number of interfaces in this area is 2
! It is a NSSA area
  Area has no authentication
  SPF algorithm last executed 11:37:58.836 ago
  SPF algorithm executed 3 times
  Area ranges are
    Number of LSA 7. Checksum Sum 0x045598
    Number of opaque link LSA 0. Checksum Sum 0x000000
    Number of DCbitless LSA 0
    Number of indication LSA 0
    Number of DoNotAge LSA 0
    Flood list length 0
Router2# show ip ospf data
  OSPF Router with ID (10.1.0.2) (Process ID 1)
    Router Link States (Area 1)
      Link ID      ADV Router      Age           Seq#           Checksum Link count
      10.1.0.1     10.1.0.1       1990         0x80000016    0x00CBCB 2
      10.1.0.2     10.1.0.2       1753         0x80000016    0x009371 4
      10.1.0.3     10.1.0.3       1903         0x80000016    0x004149 2
    Summary Net Link States (Area 1)
      Link ID      ADV Router      Age           Seq#           Checksum
      192.168.0.0  10.1.0.1       1990         0x80000017    0x00A605
      192.168.11.0 10.1.0.1       1990         0x80000015    0x009503
    Type-7 AS External Link States (Area 1)
      Link ID      ADV Router      Age           Seq#           Checksum Tag
      192.168.3.0  10.1.0.3       1903         0x80000015    0x00484F 0
      192.168.41.0 10.1.0.3       1903         0x80000015    0x00A4CC 0
```

Entering the **show ip ospf database data** command displays additional information about redistribution between Type 5 and Type 7 LSAs for routes that have been injected into the NSSA area and then flooded through the OSPF network.

```
Router2# show ip ospf database data
  OSPF Router with ID (10.1.0.2) (Process ID 1)
    Area 1 database summary
      LSA Type      Count  Delete  Maxage
      Router        3      0        0
      Network       0      0        0
      Summary Net   2      0        0
      Summary ASBR  0      0        0
      Type-7 Ext    2      0        0
      Prefixes redistributed in Type-7 0
      Opaque Link   0      0        0
```

```

    Opaque Area    0        0        0
    Subtotal      7        0        0
Process 1 database summary
LSA Type         Count      Delete   Maxage
Router           3          0        0
Network          0          0        0
Summary Net      2          0        0
Summary ASBR     0          0        0
Type-7 Ext       2          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
Total            7          0        0

```

Entering the **show ip ospf database nssa** command also displays detailed information for Type 7 to Type 5 translations:

```

Router2# show ip ospf database nssa
      OSPF Router with ID (10.1.0.2) (Process ID 1)
      Type-7 AS External Link States (Area 1)
Routing Bit Set on this LSA
LS age: 1903
Options: (No TOS-capability, Type 7/5 translation, DC)
LS Type: AS External Link
Link State ID: 192.168.3.0 (External Network Number )
Advertising Router: 10.1.0.3
LS Seq Number: 80000015
Checksum: 0x484F
Length: 36
Network Mask: /24
Metric Type: 2 (Larger than any link state path)
TOS: 0
Metric: 20
Forward Address: 192.168.14.3
External Route Tag: 0
Routing Bit Set on this LSA
LS age: 1903
! Options: (No TOS-capability, Type 7/5 translation, DC)
LS Type: AS External Link
Link State ID: 192.168.41.0 (External Network Number )
Advertising Router: 10.1.0.3
LS Seq Number: 80000015
Checksum: 0xA4CC
Length: 36
Network Mask: /24
Metric Type: 2 (Larger than any link state path)
TOS: 0
Metric: 20
Forward Address: 192.168.14.3
External Route Tag: 0

```

Router 3

Entering the **show ip ospf** command on Router 3 displays the information to confirm that Router 3 is acting as an ASBR and that OSPF Area 1 has been configured to be an NSSA area:

```

Router3# show ip ospf
Routing Process "ospf 1" with ID 10.1.0.3
Start time: 00:00:01.392, Time elapsed: 12:02:34.572
Supports only single TOS(TOS0) routes
Supports opaque LSA
Supports Link-local Signaling (LLS)
Supports area transit capability
!It is an autonomous system boundary router
Redistributing External Routes from,
  rip, includes subnets in redistribution
Router is not originating router-LSAs with maximum metric
Initial SPF schedule delay 5000 msec
Minimum hold time between two consecutive SPFs 10000 msec

```

```

Maximum wait time between two consecutive SPF's 10000 msec
Incremental-SPF disabled
Minimum LSA interval 5 secs
Minimum LSA arrival 1000 msec
LSA group pacing timer 240 secs
Interface flood pacing timer 33 msec
Retransmission pacing timer 66 msec
Number of external LSA 0. Checksum Sum 0x000000
Number of opaque AS LSA 0. Checksum Sum 0x000000
Number of DCbitless external and opaque AS LSA 0
Number of DoNotAge external and opaque AS LSA 0
Number of areas in this router is 1. 0 normal 0 stub 1 nssa
Number of areas transit capable is 0
External flood list length 0
  Area 1
    Number of interfaces in this area is 1
  ! It is a NSSA area
  Area has no authentication
  SPF algorithm last executed 11:38:13.368 ago
  SPF algorithm executed 3 times
  Area ranges are
  Number of LSA 7. Checksum Sum 0x050CF7
  Number of opaque link LSA 0. Checksum Sum 0x000000
  Number of DCbitless LSA 0
  Number of indication LSA 0
  Number of DoNotAge LSA 0
  Flood list length 0

```

Example OSPF NSSA Area with RFC 3101 Disabled and RFC 1587 Active

In the following example, the output for the **show ip ospf** and **show ip ospf database nssa** commands is for an OSPF NSSA area where RFC 3101 is disabled, RFC 1587 is active, and an NSSA ABR router is configured as a forced NSSA LSA translator. As described in the "Configuring OSPF NSSA", if RFC 3101 is disabled, the forced NSSA LSA translator remains inactive. The command output demonstrates this.

```

Router# show ip ospf
Routing Process "ospf 1" with ID 10.0.2.1
Start time: 00:00:25.512, Time elapsed: 00:01:02.200
Supports only single TOS(TOS0) routes
Supports opaque LSA
Supports Link-local Signaling (LLS)
Supports area transit capability
Supports NSSA (compatible with RFC 1587)
Event-log enabled, Maximum number of events: 1000, Mode: cyclic
Router is not originating router-LSAs with maximum metric
Initial SPF schedule delay 5000 msec
Minimum hold time between two consecutive SPF's 10000 msec
Maximum wait time between two consecutive SPF's 10000 msec
Incremental-SPF disabled
Minimum LSA interval 5 secs
Minimum LSA arrival 1000 msec
LSA group pacing timer 240 secs
Interface flood pacing timer 33 msec
Retransmission pacing timer 66 msec
Number of external LSA 0. Checksum Sum 0x000000
Number of opaque AS LSA 0. Checksum Sum 0x000000
Number of DCbitless external and opaque AS LSA 0
Number of DoNotAge external and opaque AS LSA 0
Number of areas in this router is 1. 0 normal 0 stub 1 nssa
Number of areas transit capable is 0
External flood list length 0
IETF NSF helper support enabled
Cisco NSF helper support enabled
Reference bandwidth unit is 100 mbps
Area 1
  Number of interfaces in this area is 1
  It is a NSSA area
  Configured to translate Type-7 LSAs, inactive (RFC3101 support
  disabled)
  Area has no authentication

```

```

SPF algorithm last executed 00:00:07.160 ago
SPF algorithm executed 3 times
Area ranges are
Number of LSA 3. Checksum Sum 0x0245F0
Number of opaque link LSA 0. Checksum Sum 0x000000
Number of DCbitless LSA 0
Number of indication LSA 0
Number of DoNotAge LSA 0
Flood list length 0

```

The "Supports NSSA (compatible with RFC 1587)" line in the output indicates that RFC 1587 is active or that the OSPF NSSA area is RFC 1587 compatible.

The "Configured to translate Type-7 LSAs, inactive (RFC3101 support disabled)" line indicates that the OSPF NSSA area has an ABR router configured to act as a forced translator of Type 7 LSAs, but it is inactive because RFC 3101 is disabled.

```

Router2# show ip ospf database nssa
Router Link States (Area 1)
LS age: 28
Options: (No TOS-capability, DC)
LS Type: Router Links
Link State ID: 10.0.2.1
Advertising Router: 10.0.2.1
LS Seq Number: 80000004
Checksum: 0x5CA2
Length: 36
Area Border Router
AS Boundary Router
Unconditional NSSA translator
Number of Links: 1
Link connected to: a Stub Network
(Link ID) Network/subnet number: 192.0.2.5
(Link Data) Network Mask: 255.255.255.0
Number of MTID metrics: 0
TOS 0 Metrics: 10

```

The "Unconditional NSSA translator" line indicates that the status of the NSSA ASBR router is as a forced NSSA LSA translator.

Example OSPF Routing and Route Redistribution

OSPF typically requires coordination among many internal routers, ABRs, and ASBRs. At a minimum, OSPF-based routers can be configured with all default parameter values, with no authentication, and with interfaces assigned to areas.

Three types of examples follow:

- The first is a simple configuration illustrating basic OSPF commands.
 - The second example illustrates a configuration for an internal router, ABR, and ASBRs within a single, arbitrarily assigned, OSPF autonomous system.
 - The third example illustrates a more complex configuration and the application of various tools available for controlling OSPF-based routing environments.
- [Example Basic OSPF Configuration, page 34](#)
 - [Example Basic OSPF Configuration for Internal Router ABR and ASBRs, page 35](#)
 - [Example Complex Internal Router with ABR and ASBR, page 36](#)
 - [Example Complex OSPF Configuration for ABR, page 38](#)

Example Basic OSPF Configuration

The following example illustrates a simple OSPF configuration that enables OSPF routing process 9000, attaches Ethernet interface 0 to area 0.0.0.0, and redistributes RIP into OSPF, and OSPF into RIP:

```
interface ethernet 0
 ip address 10.93.1.1 255.255.255.0
 ip ospf cost 1
!
interface ethernet 1
 ip address 10.94.1.1 255.255.255.0
!
router ospf 9000
 network 10.93.0.0 0.0.255.255 area 0.0.0.0
 redistribute rip metric 1 subnets
!
router rip
 network 10.94.0.0
 redistribute ospf 9000
 default-metric 1
```

Example Basic OSPF Configuration for Internal Router ABR and ASBRs

The following example illustrates the assignment of four area IDs to four IP address ranges. In the example, OSPF routing process 109 is initialized, and four OSPF areas are defined: 10.9.50.0, 2, 3, and 0. Areas 10.9.50.0, 2, and 3 mask specific address ranges, and area 0 enables OSPF for *all other* networks.

```
router ospf 109
 network 192.168.10.0 0.0.0.255 area 10.9.50.0
 network 192.168.20.0 0.0.255.255 area 2
 network 192.168.30.0 0.0.0.255 area 3
 network 192.168.40.0 255.255.255.255 area 0
!
! Interface Ethernet0 is in area 10.9.50.0:
interface ethernet 0
 ip address 192.168.10.5 255.255.255.0
!
! Interface Ethernet1 is in area 2:
interface ethernet 1
 ip address 192.168.20.5 255.255.255.0
!
! Interface Ethernet2 is in area 2:
interface ethernet 2
 ip address 192.168.20.7 255.255.255.0
!
! Interface Ethernet3 is in area 3:
interface ethernet 3
 ip address 192.169.30.5 255.255.255.0
!
! Interface Ethernet4 is in area 0:
interface ethernet 4
 ip address 192.168.40.1 255.255.255.0
!
! Interface Ethernet5 is in area 0:
interface ethernet 5
 ip address 192.168.40.12 255.255.0.0
```

Each **network arearouter** configuration command is evaluated sequentially, so the order of these commands in the configuration is important. The Cisco IOS software sequentially evaluates the address/wildcard-mask pair for each interface. See the **network arearouter** command in the *Cisco IOS IP Routing: OSPF Command Reference* for more information.

Consider the first **network arearouter** command. Area ID 10.9.50.0 is configured for the interface on which subnet 192.168.10.0 is located. Assume that a match is determined for Ethernet interface 0. Ethernet interface 0 is attached to area 10.9.50.0 only.

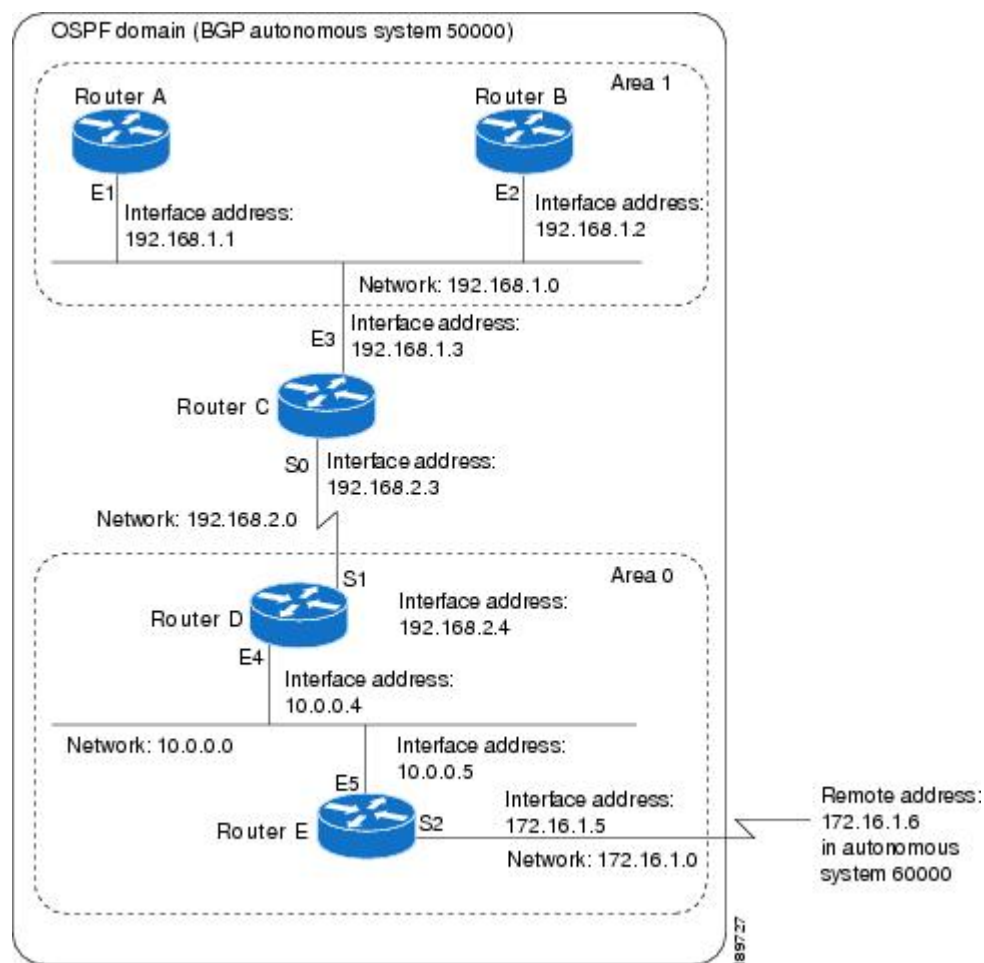
The second **network area** command is evaluated next. For area 2, the same process is then applied to all interfaces (except Ethernet interface 0). Assume that a match is determined for interface Ethernet 1. OSPF is then enabled for that interface and Ethernet interface 1 is attached to area 2.

This process of attaching interfaces to OSPF areas continues for all **network area** commands. Note that the last **network area** command in this example is a special case. With this command, all available interfaces (not explicitly attached to another area) are attached to area 0.

Example Complex Internal Router with ABR and ASBR

The following example outlines a configuration for several routers within a single OSPF autonomous system. The figure below provides a general network map that illustrates this example configuration.

Figure 6



In this configuration, five routers are configured with OSPF:

- Router A and Router B are both internal routers within area 1.
- Router C is an OSPF ABR. Note that for Router C, Area 1 is assigned to E3 and area 0 is assigned to S0.
- Router D is an internal router in area 0 (backbone area). In this case, both **network** router configuration commands specify the same area (area 0, or the backbone area).

- Router E is an OSPF ASBR. Note that BGP routes are redistributed into OSPF and that these routes are advertised by OSPF.

**Note**

You do not need to include definitions of all areas in an OSPF autonomous system in the configuration of all routers in the autonomous system. Only the *directly* connected areas must be defined. In the example that follows, routes in area 0 are learned by the routers in area 1 (Router A and Router B) when the ABR (Router C) injects summary LSAs into area 1.

The OSPF domain in BGP autonomous system 109 is connected to the outside world via the BGP link to the external peer at IP address 10.0.0.6. Example configurations follow.

Following is the sample configuration for the general network map shown in the figure above.

Router A Configuration--Internal Router

```
interface ethernet 1
 ip address 192.168.1.1 255.255.255.0
router ospf 1
 network 192.168.0.0 0.0.255.255 area 1
```

Router B Configuration--Internal Router

```
interface ethernet 2
 ip address 192.168.1.2 255.255.255.0
router ospf 202
 network 192.168.0.0 0.0.255.255 area 1
```

Router C Configuration--ABR

```
interface ethernet 3
 ip address 192.168.1.3 255.255.255.0
interface serial 0
 ip address 192.168.2.3 255.255.255.0
router ospf 999
 network 192.168.1.0 0.0.0.255 area 1
 network 192.168.2.0 0.0.0.255 area 0
```

Router D Configuration--Internal Router

```
interface ethernet 4
 ip address 10.0.0.4 255.0.0.0
interface serial 1
 ip address 192.168.2.4 255.255.255.0
router ospf 50
 network 192.168.2.0 0.0.0.255 area 0
 network 10.0.0.0 0.255.255.255 area 0
```

Router E Configuration--ASBR

```
interface ethernet 5
 ip address 10.0.0.5 255.0.0.0
interface serial 2
 ip address 172.16.1.5 255.255.255.0
router ospf 65001
 network 10.0.0.0 0.255.255.255 area 0
 redistribute bgp 109 metric 1 metric-type 1
router bgp 109
 network 192.168.0.0
```

```
network 10.0.0.0
neighbor 172.16.1.6 remote-as 110
```

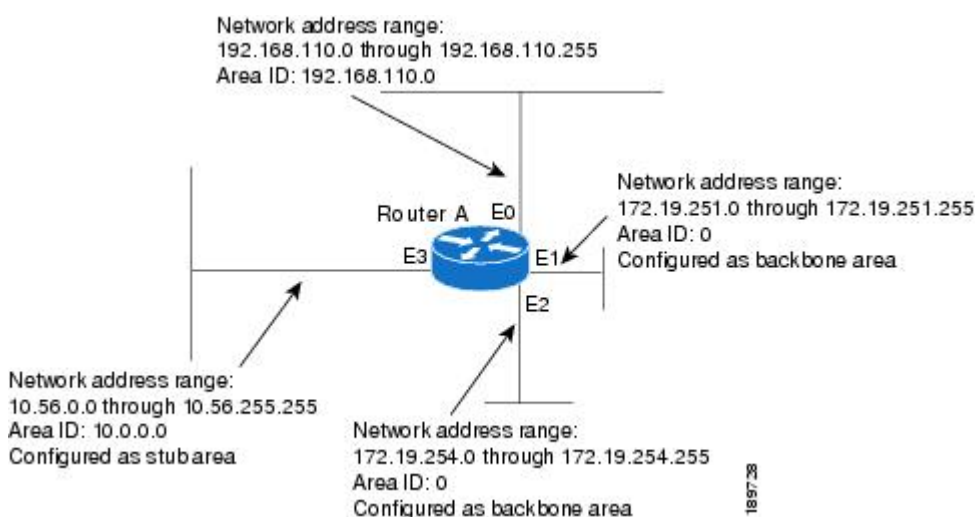
Example Complex OSPF Configuration for ABR

The following example configuration accomplishes several tasks in setting up an ABR. These tasks can be split into two general categories:

- Basic OSPF configuration
- Route redistribution

The specific tasks outlined in this configuration are detailed briefly in the following descriptions. The figure below illustrates the network address ranges and area assignments for the interfaces.

Figure 7



The basic configuration tasks in this example are as follows:

- Configure address ranges for Ethernet interface 0 through Ethernet interface 3.
- Enable OSPF on each interface.
- Set up an OSPF authentication password for each area and network.
- Assign link-state metrics and other OSPF interface configuration options.
- Create a *stub area* with area ID 36.0.0.0. (Note that the **authentication** and **stub** options of the **area** router configuration command are specified with separate **area** command entries, but can be merged into a single **area** command.)
- Specify the backbone area (area 0).

Configuration tasks associated with redistribution are as follows:

- Redistribute IGRP and RIP into OSPF with various options set (including including **metric-type**, **metric**, **tag**, and **subnet**).
- Redistribute IGRP and OSPF into RIP.

The following is an example OSPF configuration:

```
interface ethernet 0
ip address 192.42.110.201 255.255.255.0
ip ospf authentication-key abcdefgh
```

```

ip ospf cost 10
!
interface ethernet 1
ip address 172.19.251.202 255.255.255.0
ip ospf authentication-key ijklmnop
ip ospf cost 20
ip ospf retransmit-interval 10
ip ospf transmit-delay 2
ip ospf priority 4
!
interface ethernet 2
ip address 172.19.254.2 255.255.255.0
ip ospf authentication-key abcdefgh
ip ospf cost 10
!
interface ethernet 3
ip address 10.56.0.0 255.255.0.0
ip ospf authentication-key ijklmnop
ip ospf cost 20
ip ospf dead-interval 80

```

In the following configuration OSPF is on network 172.16.0.0:

```

router ospf 201
network 10.10.0.0 0.255.255.255 area 10.10.0.0
network 192.42.110.0 0.0.0.255 area 192.42.110.0
network 172.16.0.0 0.0.255.255 area 0
area 0 authentication
area 10.10.0.0 stub
area 10.10.0.0 authentication
area 10.10.0.0 default-cost 20
area 192.42.110.0 authentication
area 10.10.0.0 range 10.10.0.0 255.0.0.0
area 192.42.110.0 range 192.42.110.0 255.255.255.0
area 0 range 172.16.251.0 255.255.255.0
area 0 range 172.16.254.0 255.255.255.0
redistribute igrp 200 metric-type 2 metric 1 tag 200 subnets
redistribute rip metric-type 2 metric 1 tag 200

```

In the following configuration, IGRP autonomous system 200 is on 192.0.2.1:

```

router igrp 200
network 172.31.0.0
!
! RIP for 192.168.110
!
router rip
network 192.168.110.0
redistribute igrp 200 metric 1
redistribute ospf 201 metric 1

```

Examples Route Map

The examples in this section illustrate the use of redistribution, with and without route maps. Examples from both the IP and Connectionless Network Service (CLNS) routing protocols are given.

The following example redistributes all OSPF routes into IGRP:

```

router igrp 109
redistribute ospf 110

```

The following example redistributes RIP routes with a hop count equal to 1 into OSPF. These routes will be redistributed into OSPF as external LSAs with a metric of 5, a metric type of Type 1, and a tag equal to 1.

```

router ospf 109
redistribute rip route-map rip-to-ospf
!
route-map rip-to-ospf permit

```

```

match metric 1
set metric 5
set metric-type type1
set tag 1

```

The following example redistributes OSPF learned routes with tag 7 as a RIP metric of 15:

```

router rip
 redistribute ospf 109 route-map 5
!
route-map 5 permit
 match tag 7
 set metric 15

```

The following example redistributes OSPF intra-area and interarea routes with next hop routers on serial interface 0 into BGP with an INTER_AS metric of 5:

```

router bgp 109
 redistribute ospf 109 route-map 10
!
route-map 10 permit
 match route-type internal
 match interface serial 0
 set metric 5

```

The following example redistributes two types of routes into the integrated IS-IS routing table (supporting both IP and CLNS). The first type is OSPF external IP routes with tag 5; these routes are inserted into Level 2 IS-IS link state packets (LSPs) with a metric of 5. The second type is ISO-IGRP derived CLNS prefix routes that match CLNS access list 2000; these routes will be redistributed into IS-IS as Level 2 LSPs with a metric of 30.

```

router isis
 redistribute ospf 109 route-map 2
 redistribute iso-igrp nsfnet route-map 3
!
route-map 2 permit
 match route-type external
 match tag 5
 set metric 5
 set level level-2
!
route-map 3 permit
 match address 2000
 set metric 30

```

With the following configuration, OSPF external routes with tags 1, 2, 3, and 5 are redistributed into RIP with metrics of 1, 1, 5, and 5, respectively. The OSPF routes with a tag of 4 are not redistributed.

```

router rip
 redistribute ospf 109 route-map 1
!
route-map 1 permit
 match tag 1 2
 set metric 1
!
route-map 1 permit
 match tag 3
 set metric 5
!
route-map 1 deny
 match tag 4
!
route map 1 permit
 match tag 5
 set metric 5

```

In the following configuration, a RIP learned route for network 160.89.0.0 and an ISO-IGRP learned route with prefix 49.0001.0002 will be redistributed into an IS-IS Level 2 LSP with a metric of 5:

```
router isis
 redistribute rip route-map 1
 redistribute iso-igrp remote route-map 1
!
route-map 1 permit
 match ip address 1
 match clns address 2
 set metric 5
 set level level-2
!
access-list 1 permit 192.168.0.0 0.0.255.255
 clns filter-set 2 permit 49.0001.0002...
```

The following configuration example illustrates how a route map is referenced by the **default-information** router configuration command. This type of reference is called *conditional default origination*. OSPF will originate the default route (network 0.0.0.0) with a Type 2 metric of 5 if 140.222.0.0 is in the routing table.

**Note**

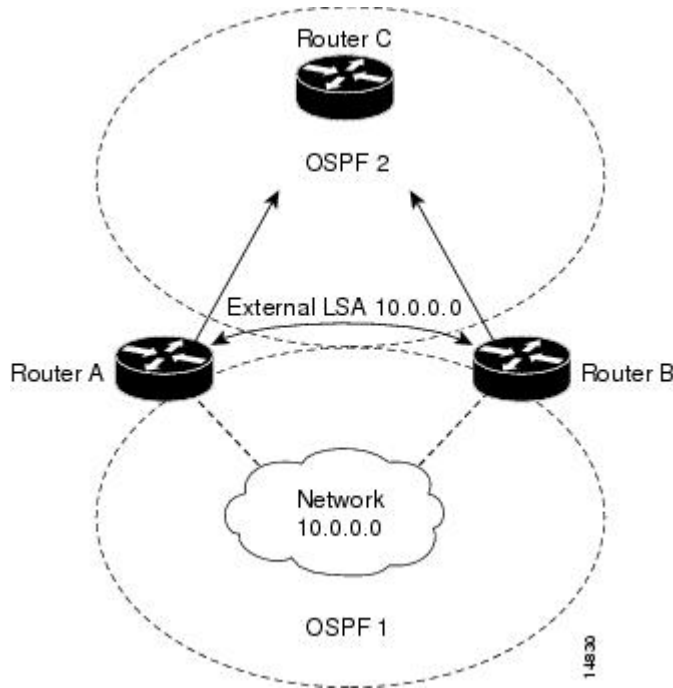
Only routes external to the OSPF process can be used for tracking, such as non-OSPF routes or OSPF routes from a separate OSPF process.

```
route-map ospf-default permit
 match ip address 1
 set metric 5
 set metric-type type-2
!
access-list 1 permit 172.16.0.0 0.0.255.255
!
router ospf 109
 default-information originate route-map ospf-default
```

Example Changing OSPF Administrative Distance

The following configuration changes the external distance to 200, making it less trustworthy. The figure below illustrates the example.

Figure 8



Router A Configuration

```
router ospf 1
 redistribute ospf 2 subnet
 distance ospf external 200
!
router ospf 2
 redistribute ospf 1 subnet
 distance ospf external 200
```

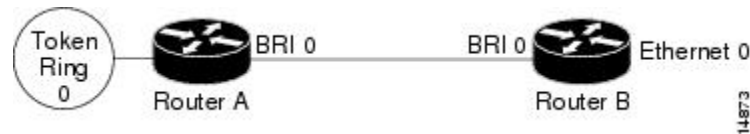
Router B Configuration

```
router ospf 1
 redistribute ospf 2 subnet
 distance ospf external 200
!
router ospf 2
 redistribute ospf 1 subnet
 distance ospf external 200
```

Example OSPF over On-Demand Routing

The following configuration allows OSPF over an on-demand circuit, as shown in the figure below. Note that the on-demand circuit is defined on one side only (BRI 0 on Router A); it is not required to be configured on both sides.

Figure 9



Router A Configuration

```

username RouterB password 7 060C1A2F47
isdn switch-type basic-5ess
ip routing
!
interface TokenRing0
 ip address 192.168.50.5 255.255.255.0
 no shutdown
!
interface BRI0
 no cdp enable
 description connected PBX 1485
 ip address 192.168.45.30 255.255.255.0
 encapsulation ppp
 ip ospf demand-circuit
 dialer map ip 140.10.10.6 name RouterB broadcast 61484
 dialer-group 1
 ppp authentication chap
 no shutdown
!
router ospf 100
 network 192.168.45.0 0.0.0.255 area 0
 network 192.168.45.50 0.0.0.255 area 0
!
dialer-list 1 protocol ip permit
  
```

Router B Configuration

```

username RouterA password 7 04511E0804
isdn switch-type basic-5ess
ip routing
!
interface Ethernet0
 ip address 192.168.50.16 255.255.255.0
 no shutdown
!
interface BRI0
 no cdp enable
 description connected PBX 1484
 ip address 192.168.45.17 255.255.255.0
 encapsulation ppp
 dialer map ip 192.168.45.19 name RouterA broadcast 61485
 dialer-group 1
 ppp authentication chap
 no shutdown
!
router ospf 100
 network 192.168.45.0 0.0.0.255 area 0
 network 192.168.45.50 0.0.0.255 area 0
  
```



```
!
dialer-list 1 protocol ip permit
```

Example LSA Group Pacing

The following example changes the OSPF pacing between LSA groups to 60 seconds:

```
router ospf
 timers pacing lsa-group 60
```

Example Block LSA Flooding

The following example prevents flooding of OSPF LSAs to broadcast, nonbroadcast, or point-to-point networks reachable through Ethernet interface 0:

```
interface ethernet 0
 ip ospf database-filter all out
```

The following example prevents flooding of OSPF LSAs to point-to-multipoint networks to the neighbor at IP address 10.10.10.45:

```
router ospf 109
 neighbor 10.10.10.45 database-filter all out
```

Example Ignore MOSPF LSA Packets

The following example configures the router to suppress the sending of syslog messages when it receives MOSPF packets:

```
router ospf 109
 ignore lsa mospf
```

Additional References

Related Documents

Related Topic	Document Title
Cisco IOS commands	Cisco IOS Master Commands List, All Releases
OSPF commands	<i>Cisco IOS IP Routing: OSPF Command Reference</i>
Protocol-independent features that work with OSPF	"Configuring IP Routing Protocol-Independent Features"

Standards

Standard	Title
No new or modified standards are supported, and support for existing standards has not been modified.	--

MIBs

MIB	MIBs Link
No new or modified MIBs are supported, and support for existing MIBs has not been modified.	To locate and download MIBs for selected platforms, Cisco software releases, and feature sets, use Cisco MIB Locator found at the following URL: http://www.cisco.com/go/mibs

RFCs

RFC	Title
RFC 1253	OSPF Version 2 Management Information Base , August 1991.
RFC 1587	The OSPF NSSA Option , March 1994
RFC 1793	Extending OSPF to Support Demand Circuits , April 1995
RFC 2328	OSPF Version 2 , April 1998
RFC 3101	The OSPF NSSA Option , January 2003

Technical Assistance

Description	Link
The Cisco Support and Documentation website provides online resources to download documentation, software, and tools. Use these resources to install and configure the software and to troubleshoot and resolve technical issues with Cisco products and technologies. Access to most tools on the Cisco Support and Documentation website requires a Cisco.com user ID and password.	http://www.cisco.com/cisco/web/support/index.html

Feature Information for Configuring OSPF

The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software

release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Table 1 **Feature Information for OSPF**

Feature Name	Releases	Feature Information
OSPF	11.2.1	OSPF is an IGP developed by the OSPF working group of the IETF. Designed expressly for IP networks, OSPF supports IP subnetting and tagging of externally derived routing information. OSPF also allows packet authentication and uses IP multicast when sending and receiving packets.
OSPF Flooding Reduction	12.1(2)T	The OSPF flooding reduction solution works by reducing unnecessary refreshing and flooding of already known and unchanged information. This feature is documented in the following section:
OSPF Not-So-Stubby Areas	11.2.1	OSPF NSSA is a nonproprietary extension of the existing OSPF stub area feature. This feature is documented in the following sections:
OSPF Packet Pacing	12.0(1)T	OSPF update packets are automatically paced so they are not sent less than 33 milliseconds apart. This feature is documented in the following section:

Feature Name	Releases	Feature Information
OSPF Support for NSSA RFC 3101	15.1(2)S	<p>This feature adds support for the OSPF NSSA specification described by RFC 3101. RFC3101 replaced RFC 1587 and is backward compatible with RFC1587.</p> <p>The following section provides information about this feature:</p> <p>The following commands were introduced or modified: area nssa translate, compatible rfc1587.</p>

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OSPF Stub Router Advertisement

The OSPF Stub Router Advertisement feature allows you to bring a new router into a network without immediately routing traffic through the new router and allows you to gracefully shut down or reload a router without dropping packets that are destined for other networks.

- [Finding Feature Information, page 49](#)
- [Information About OSPF Stub Router Advertisement, page 49](#)
- [Supported Platforms, page 51](#)
- [How to Configure OSPF Stub Router Advertisement, page 52](#)
- [Configuration Examples of OSPF Stub Router Advertisement, page 56](#)
- [Additional References, page 56](#)
- [Feature Information for OSPF Stub Router Advertisement, page 57](#)

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest feature information and caveats, see the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the Feature Information Table at the end of this document.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Information About OSPF Stub Router Advertisement

- [OSPF Stub Router Advertisement Functionality, page 49](#)
- [Allowing Routing Tables to Converge, page 50](#)
- [Configuring a Graceful Shutdown, page 50](#)
- [Benefits of OSPF Stub Router Advertisement, page 51](#)
- [Related Features and Technologies, page 51](#)

OSPF Stub Router Advertisement Functionality

The OSPF Stub Router Advertisement feature allows you to bring a new router into a network without immediately routing traffic through the new router and allows you to gracefully shut down or reload a router without dropping packets that are destined for other networks. This feature introduces three

configuration options that allow you to configure a router that is running the Open Shortest Path First (OSPF) protocol to advertise a maximum or infinite metric to all neighbors.

When any of these three configuration options are enabled on a router, the router will originate link-state advertisements (LSAs) with a maximum metric (LSInfinity: 0xFFFF) through all nonstub links. The advertisement of a maximum metric causes other routers to assign a cost to the new router that is higher than the cost of using an alternate path. Because of the high cost assigned to paths that pass through the new router, other routers will not use a path through the new router as a transit path to forward traffic that is destined for other networks, which allows switching and routing functions to be up and running and routing tables to converge before transit traffic is routed through this router.

**Note**

Directly connected links in a stub network are not affected by the configuration of a maximum or infinite metric because the cost of a stub link is always set to the output interface cost.

Allowing Routing Tables to Converge

Two configuration options introduced by the OSPF Stub Router Advertisement feature allow you to bring a new router into a network without immediately routing traffic through the new router. These configuration options are useful because Interior Gateway Protocols (IGPs) converge very quickly upon a router during startup or after a reload, often before Border Gateway Protocol (BGP) routing tables have completely converged. If neighbor routers forward traffic through a router while that router is building BGP routing tables, packets that have been received for other destinations may be dropped. Advertising a maximum metric during startup will allow routing tables to converge before traffic that is destined for other networks is sent through the router. The following two configuration options enable a router to advertise a maximum metric at startup:

- You can configure a timer to advertise a maximum metric when the router is started or reloaded. When this option is configured, the router will advertise a maximum metric, which forces neighbor routers to select alternate paths until the timer expires. When the timer expires, the router will advertise accurate (normal) metrics, and other routers will send traffic to this router depending on the cost. The configurable range of the timer is from 5 to 86,400 seconds.
- You can configure a router to advertise a maximum metric at startup until BGP routing tables converge or until the default timer expires (600 seconds). Once BGP routing tables converge or the default timer expires, the router will advertise accurate (normal) metrics and other routers will send traffic to this router, depending on the cost.

Configuring a Graceful Shutdown

The third configuration option introduced by the OSPF Stub Router Advertisement feature allows you to gracefully remove a router from the network by advertising a maximum metric through all links, which allows other routers to select alternate paths for transit traffic to follow before the router is shut down. There are many situations where you may need to remove a router from the network. If a router is removed from a network and neighbor routers cannot detect that the physical interface is down, neighbors will need to wait for dead timers to expire before the neighbors will remove the adjacency and routing tables will reconverge. This situation may occur when there is a switch between other routers and the router that is shut down. Packets may be dropped while the neighbor routing tables reconverge.

When this third option is configured, the router advertises a maximum metric, which allows neighbor routers to select alternate paths before the router is shut down. This configuration option could also be used to remove a router that is in a critical condition from the network without affecting traffic that is destined for other networks.

**Note**

You should not save the running configuration of a router when it is configured for a graceful shutdown because the router will continue to advertise a maximum metric after it is reloaded.

Benefits of OSPF Stub Router Advertisement

Improved Stability and Availability

Advertising a maximum metric through all links at startup or during a reload will prevent neighbor routers from using a path through the router as a transit path, thereby reducing the number of packets that are dropped and improving the stability and availability of the network.

Graceful Removal from the Network

Advertising a maximum metric before shutdown allows other routers to select alternate paths before the transit path through a router becomes inaccessible.

Related Features and Technologies

The OSPF Stub Router Advertisement feature is an extension of the OSPF routing protocol. For more information about configuring OSPF and BGP, refer to the *Cisco IOS IP Routing Configuration Guide* and the *Cisco IOS IP Routing Command Reference*.

Supported Platforms

The OSPF Stub Router Advertisement feature is supported by the following platforms in Cisco IOS Release 12.2(14)S that support OSPF:

- Cisco 7200 series
- Cisco 7400 series
- Cisco 7500 series

Determining Platform Support Through Cisco Feature Navigator

Cisco IOS software is packaged in feature sets that support specific platforms. To get updated information regarding platform support for this feature, access Cisco Feature Navigator. Cisco Feature Navigator dynamically updates the list of supported platforms as new platform support is added for the feature.

Cisco Feature Navigator is a web-based tool that enables you to determine which Cisco IOS software images support a specific set of features and which features are supported in a specific Cisco IOS image. You can search by feature or release. Under the release section, you can compare releases side by side to display both the features unique to each software release and the features in common.

Cisco Feature Navigator is updated regularly when major Cisco IOS software releases and technology releases occur. For the most current information, go to the Cisco Feature Navigator home page at the following URL:

<http://www.cisco.com/go/fn>

Availability of Cisco IOS Software Images

Platform support for particular Cisco IOS software releases is dependent on the availability of the software images for those platforms. Software images for some platforms may be deferred, delayed, or changed without prior notice. For updated information about platform support and availability of software images for each Cisco IOS software release, refer to the online release notes or, if supported, Cisco Feature Navigator.

How to Configure OSPF Stub Router Advertisement

See the following sections for configuration tasks to configure OSPF to advertise a maximum metric. This feature has three different configuration options. All tasks are optional and should be individually configured.

- [Configuring Advertisement on Startup, page 52](#)
- [Configuring Advertisement Until Routing Tables Converge, page 52](#)
- [Configuring Advertisement for a Graceful Shutdown, page 53](#)
- [Verifying the Advertisement of a Maximum Metric, page 53](#)
- [Monitoring and Maintaining OSPF Stub Router Advertisement, page 55](#)

Configuring Advertisement on Startup

SUMMARY STEPS

1. Router(config)# **router ospf** *process-id*
2. Router(config-router)# **max-metric router-lsa on-startup** *announce-time*

DETAILED STEPS

	Command or Action	Purpose
Step 1	Router(config)# router ospf <i>process-id</i>	Places the router in router configuration mode and enables an OSPF routing process.
Step 2	Router(config-router)# max-metric router-lsa on-startup <i>announce-time</i>	Configures OSPF to advertise a maximum metric during startup for a configured period of time. The <i>announce-time</i> argument is a configurable timer that must follow the on-startup keyword to be configured. There is no default timer value. The configurable time range is from 5 to 86,400 seconds.

Configuring Advertisement Until Routing Tables Converge

SUMMARY STEPS

1. Router(config)# **router ospf** *process-id*
2. Router(config-router)# **max-metric router-lsa on-startup wait-for-bgp**

DETAILED STEPS

	Command or Action	Purpose
Step 1	Router(config)# router ospf <i>process-id</i>	Places the router in router configuration mode and enables an OSPF routing process.
Step 2	Router(config-router)# max-metric router-lsa on-startup wait-for-bgp	Configures OSPF to advertise a maximum metric until BGP routing tables have converged or until the default timer has expired. The wait-for-bgp keyword must follow the on-startup keyword to be configured. The default timer value is 600 seconds.

Configuring Advertisement for a Graceful Shutdown

SUMMARY STEPS

1. Router(config)# **router ospf** *process-id*
2. Router(config-router)# **max-metric router-lsa**
3. Router(config-router)# **exit**
4. Router(config)# **exit**
5. Router# **show ip ospf**

DETAILED STEPS

	Command or Action	Purpose
Step 1	Router(config)# router ospf <i>process-id</i>	Places the router in router configuration mode and enables an OSPF routing process.
Step 2	Router(config-router)# max-metric router-lsa	Configures OSPF to advertise a maximum metric until the router is shut down.
Step 3	Router(config-router)# exit	Exits router configuration mode.
Step 4	Router(config)# exit	Exits configuration mode and places the router in privileged EXEC mode.
Step 5	Router# show ip ospf	Displays general information about OSPF routing processes. The show ip ospf command is entered in order to verify that the max-metric router-lsa command has been enabled before the router is shut down or reloaded.

**Note**

You should not save the running configuration of a router when it is configured for a graceful shutdown because the router will continue to advertise a maximum metric after it is reloaded.

Verifying the Advertisement of a Maximum Metric

To verify that the advertisement of a maximum metric has been configured correctly, use the **show ip ospf** or **show ip ospf database** command.

The output of the **show ip ospf** command will display the condition, state, and remaining time delay of the advertisement of a maximum metric, depending on which options were configured with the **max-metric router-lsa** command.

The following sample output is similar to the output that will be displayed when the **on-startup** keyword and *announce-time* argument are configured with the **max-metric router-lsa** command:

```
Router# show ip ospf
Routing Process "ospf 1998" with ID 10.18.134.155
  Supports only single TOS(TOS0) routes
  Supports opaque LSA
  It is an area border and autonomous system boundary router
  Redistributing External Routes from,
    static, includes subnets in redistribution
  Originating router-LSAs with maximum metric, Time remaining: 00:01:18
  Condition: on startup for 300 seconds, State: active
  SPF schedule delay 5 secs, Hold time between two SPFs 10 secs
  Minimum LSA interval 5 secs. Minimum LSA arrival 1 secs
  Number of external LSA 7. Checksum Sum 0x47261
  Number of opaque AS LSA 0. Checksum Sum 0x0
  Number of DCbitless external and opaque AS LSA 0
  Number of DoNotAge external and opaque AS LSA 0
  Number of areas in this router is 2. 1 normal 0 stub 1 nssa
  External flood list length 0
    Area BACKBONE(0)
      Number of interfaces in this area is 1
      Area has no authentication
      SPF algorithm executed 3 times
      Area ranges are
      Number of LSA 8. Checksum Sum 0x474AE
      Number of opaque link LSA 0. Checksum Sum 0x0
```

The following sample output is similar to the output that will be displayed when the **on-startup** and **wait-for-bgp** keywords are configured with the **max-metric router-lsa** command:

```
Router# show ip ospf
Routing Process "ospf 1998" with ID 10.18.134.155
  Supports only single TOS(TOS0) routes
  Supports opaque LSA
  It is an area border and autonomous system boundary router
  Redistributing External Routes from,
    static, includes subnets in redistribution
  Originating router-LSAs with maximum metric, Time remaining: 00:01:18
  Condition: on startup while BGP is converging, State: active
  SPF schedule delay 5 secs, Hold time between two SPFs 10 secs
  Minimum LSA interval 5 secs. Minimum LSA arrival 1 secs
  Number of external LSA 7. Checksum Sum 0x47261
  Number of opaque AS LSA 0. Checksum Sum 0x0
  Number of DCbitless external and opaque AS LSA 0
  Number of DoNotAge external and opaque AS LSA 0
  Number of areas in this router is 2. 1 normal 0 stub 1 nssa
  External flood list length 0
    Area BACKBONE(0)
      Number of interfaces in this area is 1
      Area has no authentication
      SPF algorithm executed 3 times
      Area ranges are
      Number of LSA 8. Checksum Sum 0x474AE
      Number of opaque link LSA 0. Checksum Sum 0x0
```

The following sample output is similar to the output that will be displayed when the **max-metric router-lsa** command is configured without any keywords or arguments:

```
Router# show ip ospf
Routing Process "ospf 1998" with ID 10.18.134.155
  Supports only single TOS(TOS0) routes
  Supports opaque LSA
  It is an area border and autonomous system boundary router
  Redistributing External Routes from,
```

```

static, includes subnets in redistribution
Originating router-LSAs with maximum metric
Condition: always, State: active
SPF schedule delay 5 secs, Hold time between two SPFs 10 secs
Minimum LSA interval 5 secs. Minimum LSA arrival 1 secs
Number of external LSA 7. Checksum Sum 0x47261
Number of opaque AS LSA 0. Checksum Sum 0x0
Number of DCbitless external and opaque AS LSA 0
Number of DoNotAge external and opaque AS LSA 0
Number of areas in this router is 2. 1 normal 0 stub 1 nssa
External flood list length 0
Area BACKBONE(0)
  Number of interfaces in this area is 1
  Area has no authentication
  SPF algorithm executed 3 times
  Area ranges are
  Number of LSA 8. Checksum Sum 0x474AE
  Number of opaque link LSA 0. Checksum Sum 0x0

```

The output of the **show ip ospf database** command will display information about OSPF LSAs and indicate if the router is announcing maximum cost links. The following sample output is similar to the output that will be displayed when any form of the **max-metric router-lsa** command is configured:

```

Router# show ip ospf database
Exception Flag: Announcing maximum link costs
LS age: 68
Options: (No TOS-capability, DC)
LS Type: Router Links
Link State ID: 172.18.134.155
Advertising Router: 172.18.134.155
LS Seq Number: 80000002
Checksum: 0x175D
Length: 60
Area Border Router
AS Boundary Router
Number of Links: 3

Link connected to: a Transit Network
(Link ID) Designated Router address: 192.168.1.11
(Link Data) Router Interface address: 192.168.1.14
Number of TOS metrics: 0
  TOS 0 Metrics: 65535 (metric used for local calculation: 10)

Link connected to: a Transit Network
(Link ID) Designated Router address: 10.1.145.11
(Link Data) Router Interface address: 10.1.145.14
Number of TOS metrics: 0
  TOS 0 Metrics: 65535 (metric used for local calculation: 10)

Link connected to: a Stub Network
(Link ID) Network/subnet number: 10.11.12.0
(Link Data) Network Mask: 255.255.255.0
Number of TOS metrics: 0
  TOS 0 Metrics: 1

```

Monitoring and Maintaining OSPF Stub Router Advertisement

Command	Purpose
Router# show ip ospf	Displays general information about OSPF routing processes and provides information about the configuration settings and status of the OSPF Stub Router Advertisement feature.

Command	Purpose
Router# show ip ospf database router	Displays information about router LSAs, and indicates if a router is announcing maximum link costs.

Configuration Examples of OSPF Stub Router Advertisement

- [Example Advertisement on Startup, page 56](#)
- [Example Advertisement Until Routing Tables Converge, page 56](#)
- [Example Graceful Shutdown, page 56](#)

Example Advertisement on Startup

In the following example, a router that is running OSPF is configured to advertise a maximum metric at startup for 300 seconds:

```
Router(config)# router ospf 100
Router(config-router)# max-metric router-lsa on-startup 300
```

Example Advertisement Until Routing Tables Converge

In the following example, a router that is running OSPF is configured to advertise a maximum metric until BGP routing tables converge or until the default timer expires (600 seconds):

```
Router(config)# router ospf 100
Router(config-router)# max-metric router-lsa on-startup wait-for-bgp
```

Example Graceful Shutdown

In the following example, a router that is running OSPF is configured to advertise a maximum metric until the router is shut down:

```
Router(config)# router ospf 100
Router(config-router)# max-metric router-lsa
Router(config-router)# exit
Router(config)# exit
Router# show ip ospf
```

Additional References

Related Documents

Related Topic	Document Title
Configuring OSPF	"Configuring OSPF"

Related Topic	Document Title
OSPF commands	<i>Cisco IOS IP Routing: OSPF Command Reference</i>
Cisco IOS master command list, all releases	Cisco IOS Master Command List, All Releases

Standards	
Standard	Title
None	--

MIBs	
MIB	MIBs Link
No new or modified MIBs are supported by this feature, and support for existing MIBs has not been modified by this feature.	To locate and download MIBs for selected platforms, Cisco software releases, and feature sets, use Cisco MIB Locator found at the following URL: http://www.cisco.com/go/mibs

RFCs	
RFC	Title
RFC 3137	OSPF Stub Router Advertisement

Technical Assistance	
Description	Link
The Cisco Support and Documentation website provides online resources to download documentation, software, and tools. Use these resources to install and configure the software and to troubleshoot and resolve technical issues with Cisco products and technologies. Access to most tools on the Cisco Support and Documentation website requires a Cisco.com user ID and password.	http://www.cisco.com/cisco/web/support/index.html

Feature Information for OSPF Stub Router Advertisement

The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Table 2 *Feature Information for OSPF Stub Router Advertisement*

Feature Name	Releases	Feature Information
OSPF Stub Router Advertisement	12.1(8)E 12.0(15)S 12.0(15)SC 12.0(16)ST 12.2(4)T 12.2(4)T3 12.2(14)S Cisco IOS XE 3.1.0 SG	<p>The OSPF Stub Router Advertisement feature allows you to bring a new router into a network without immediately routing traffic through the new router and allows you to gracefully shut down or reload a router without dropping packets that are destined for other networks.</p> <p>The following commands are introduced or modified in the feature documented in this module:</p> <ul style="list-style-type: none"> • max-metric router-lsa • show ip ospf

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Any Internet Protocol (IP) addresses and phone numbers used in this document are not intended to be actual addresses and phone numbers. Any examples, command display output, network topology diagrams, and other figures included in the document are shown for illustrative purposes only. Any use of actual IP addresses or phone numbers in illustrative content is unintentional and coincidental.



OSPF Update Packet-Pacing Configurable Timers

This module describes the OSPF Update Packet-Pacing Configurable Timers feature, which allows you to configure the rate at which OSPF LSA flood pacing, retransmission pacing, and group pacing updates occur.

- [Finding Feature Information, page 59](#)
- [Restrictions on OSPF Update Packet-Pacing Configurable Timers, page 59](#)
- [Information About OSPF Update Packet-Pacing Configurable Timers, page 60](#)
- [Supported Platforms, page 60](#)
- [How to Configure OSPF Packet-Pacing Timers, page 61](#)
- [Configuration Examples of OSPF Update Packet-Pacing, page 64](#)
- [Additional References, page 64](#)
- [Feature Information for OSPF Update Packet-Pacing Configurable Timers, page 66](#)

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest feature information and caveats, see the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the Feature Information Table at the end of this document.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Restrictions on OSPF Update Packet-Pacing Configurable Timers

Do not change the packet pacing timers unless all other options to meet OSPF packet flooding requirements have been exhausted. Specifically, network operators should prefer summarization, stub area usage, queue tuning, and buffer tuning before changing the default timers. Furthermore, there are no guidelines for changing timer values; each OSPF deployment is unique and should be considered on a case-by-case basis. The network operator assumes risks associated with changing the default timer values.

Information About OSPF Update Packet-Pacing Configurable Timers

- [Functionality of the OSPF Update Packet-Pacing Timers, page 60](#)
- [Benefits of OSPF Update Packet-Pacing Configurable Timers, page 60](#)
- [Related Features and Technologies, page 60](#)

Functionality of the OSPF Update Packet-Pacing Timers

In rare situations, you might need to change Open Shortest Path First (OSPF) packet-pacing default timers to mitigate CPU or buffer utilization issues associated with flooding very large numbers of link-state advertisements (LSAs). The OSPF Update Packet-Pacing Configurable Timers feature allows you to configure the rate at which OSPF LSA flood pacing, retransmission pacing, and group pacing updates occur.

Configuring OSPF flood pacing timers allows you to control interpacket spacing between consecutive link-state update packets in the OSPF transmission queue. Configuring OSPF retransmission pacing timers allows you to control interpacket spacing between consecutive link-state update packets in the OSPF retransmission queue. Cisco IOS software groups the periodic refresh of LSAs to improve the LSA packing density for the refreshes in large topologies. The group timer controls the interval used for group LSA refreshment; however, this timer does not change the frequency that individual LSAs are refreshed (the default refresh occurs every 30 minutes).

**Note**

The default settings for OSPF packet pacing timers are suitable for the majority of OSPF deployments. You should change the default timers only as a last resort.

Benefits of OSPF Update Packet-Pacing Configurable Timers

The OSPF Update Packet-Pacing Configurable Timers feature provides the administrator with a mechanism to control the rate at which LSA updates occur in order to reduce high CPU or buffer utilization that can occur when an area is flooded with a very large number of LSAs.

Related Features and Technologies

The OSPF Update Packet-Pacing Configurable Timers feature is an extension of the OSPF routing protocol. For more information about configuring OSPF, packet pacing, area border router (ABR) and autonomous system boundary router (ASBR) summarization, and stub router configuration, refer to the "Configuring OSPF" module of the *Cisco IOS IP Routing Configuration Guide* and the *Cisco IOS IP Routing: OSPF Command Reference*.

Supported Platforms

The OSPF Update Packet-Pacing Configurable Timers feature is supported by the following platforms in Cisco IOS Release 12.2(14)S that support OSPF:

- Cisco 7200 series

- Cisco 7400 series
- Cisco 7500 series

Determining Platform Support Through Cisco Feature Navigator

Cisco IOS software is packaged in feature sets that support specific platforms. To get updated information regarding platform support for this feature, access Cisco Feature Navigator. Cisco Feature Navigator dynamically updates the list of supported platforms as new platform support is added for the feature.

Cisco Feature Navigator is a web-based tool that enables you to determine which Cisco IOS software images support a specific set of features and which features are supported in a specific Cisco IOS image. You can search by feature or release. Under the release section, you can compare releases side by side to display both the features unique to each software release and the features in common.

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<http://www.cisco.com/go/fn>

Availability of Cisco IOS Software Images

Platform support for particular Cisco IOS software releases is dependent on the availability of the software images for those platforms. Software images for some platforms may be deferred, delayed, or changed without prior notice. For updated information about platform support and availability of software images for each Cisco IOS software release, refer to the online release notes or, if supported, Cisco Feature Navigator.

How to Configure OSPF Packet-Pacing Timers

See the following sections for configuration tasks for the OSPF Update Packet-Pacing Configurable Timers feature. Each task in the list is identified as either required or optional:

- [Configuring OSPF Packet-Pacing Timers, page 61](#)
- [Configuring a Group Packet Pacing Timer, page 62](#)
- [Verifying OSPF Packet-Pacing Timers, page 63](#)
- [Monitoring and Maintaining OSPF Packet-Pacing Timers, page 63](#)

Configuring OSPF Packet-Pacing Timers

SUMMARY STEPS

1. Router(config)# router ospf *process-id*
2. Router(config-router)# timers pacing flood *milliseconds*

DETAILED STEPS

	Command or Action	Purpose
Step 1	Router(config)# router ospf <i>process-id</i>	Places the router in router configuration mode and enables an OSPF routing process.

Command or Action	Purpose
Step 2 Router(config-router)# timers pacing flood <i>milliseconds</i>	Configures a flood packet pacing timer delay (in milliseconds).

Configuring a Group Packet Pacing Timer

To configure a retransmission packet pacing timer, use the following commands beginning in router configuration mode:

SUMMARY STEPS

1. Router(config)# **router ospf** *process-id*
2. Router(config-router)# **timers pacing lsa-group** *seconds*

DETAILED STEPS

Command or Action	Purpose
Step 1 Router(config)# router ospf <i>process-id</i>	Places the router in router configuration mode and enables an OSPF routing process.
Step 2 Router(config-router)# timers pacing lsa-group <i>seconds</i>	Configures an LSA group packet pacing timer delay (in seconds).

Configuring a Group Packet Pacing Timer

To configure a retransmission packet pacing timer, use the following commands beginning in router configuration mode:

SUMMARY STEPS

1. Router(config)# **router ospf** *process-id*
2. Router(config-router)# **timers pacing lsa-group** *seconds*

DETAILED STEPS

Command or Action	Purpose
Step 1 Router(config)# router ospf <i>process-id</i>	Places the router in router configuration mode and enables an OSPF routing process.
Step 2 Router(config-router)# timers pacing lsa-group <i>seconds</i>	Configures an LSA group packet pacing timer delay (in seconds).

Verifying OSPF Packet-Pacing Timers

To verify that OSPF packet pacing has been configured, use the **show ip ospf** privileged EXEC command. The output of the **show ip ospf** command will display the type and delay time of the configurable pacing timers (flood, retransmission, group). The following example output is from the **show ip ospf** command:

```
Router# show ip ospf
Routing Process "ospf 1" with ID 10.0.0.1 and Domain ID 10.20.0.1
Supports only single TOS(TOS0) routes
Supports opaque LSA
SPF schedule delay 5 secs, Hold time between two SPFs 10 secs
Minimum LSA interval 5 secs. Minimum LSA arrival 1 secs
LSA group pacing timer 100 secs
Interface flood pacing timer 55 msec
Retransmission pacing timer 100 msec
Number of external LSA 0. Checksum Sum 0x0
Number of opaque AS LSA 0. Checksum Sum 0x0
Number of DCbitless external and opaque AS LSA 0
Number of DoNotAge external and opaque AS LSA 0
Number of areas in this router is 2. 2 normal 0 stub 0 nssa
External flood list length 0
  Area BACKBONE(0)
    Number of interfaces in this area is 2
    Area has message digest authentication
    SPF algorithm executed 4 times
    Area ranges are
      Number of LSA 4. Checksum Sum 0x29BEB
      Number of opaque link LSA 0. Checksum Sum 0x0
      Number of DCbitless LSA 3
      Number of indication LSA 0
      Number of DoNotAge LSA 0
      Flood list length 0
  Area 172.16.26.0
    Number of interfaces in this area is 0
    Area has no authentication
    SPF algorithm executed 1 times
    Area ranges are
      192.168.0.0/16 Passive Advertise
      Number of LSA 1. Checksum Sum 0x44FD
      Number of opaque link LSA 0. Checksum Sum 0x0
      Number of DCbitless LSA 1
      Number of indication LSA 1
      Number of DoNotAge LSA 0
      Flood list length 0
```

- [Troubleshooting Tips, page 63](#)

Troubleshooting Tips

If the number of OSPF packet retransmissions rapidly increases, increase the value of the packet pacing timers. The number of OSPF packet retransmissions is displayed in the output of the **show ip ospf neighbor** command.

Monitoring and Maintaining OSPF Packet-Pacing Timers

Command	Purpose
Router# show ip ospf	Displays general information about OSPF routing processes.

Command	Purpose
router# show ip ospf neighbor	Displays OSPF neighbor information on a per-interface basis.
Router# clear ip ospf redistribution	Clears route redistribution based on the OSPF routing process ID.

Configuration Examples of OSPF Update Packet-Pacing

- [Example Flood Pacing, page 64](#)
- [Example Retransmission Pacing, page 64](#)
- [Example Group Pacing, page 64](#)

Example Flood Pacing

The following example configures LSA flood pacing updates to occur in 50-millisecond intervals for OSPF routing process 1:

```
Router(config)# router ospf 1
Router(config-router)# timers pacing flood 50
```

Example Retransmission Pacing

The following example configures retransmission pacing updates to occur in 100-millisecond intervals for OSPF routing process 1:

```
Router(config)# router ospf 1
Router(config-router)# timers pacing retransmission 100
```

Example Group Pacing

The following example configures OSPF group pacing updates between LSA groups to occur in 75-second intervals for OSPF routing process 1:

```
Router(config)# router ospf 1
Router(config-router)# timers pacing lsa-group 75
```

Additional References

Related Documents

Related Topic	Document Title
Configuring OSPF	Configuring OSPF"

Related Topic	Document Title
OSPF commands	<i>Cisco IOS IP Routing: OSPF Command Reference</i>
Cisco IOS master command list, all releases	Cisco IOS Master Command List, All Releases

Standards

Standard	Title
No new or modified standards are supported by this feature, and support for existing standards has not been modified by this feature.	--

MIBs

MIB	MIBs Link
No new or modified MIBs are supported by this feature, and support for existing MIBs has not been modified by this feature.	To locate and download MIBs for selected platforms, Cisco IOS XE software releases , and feature sets, use Cisco MIB Locator found at the following URL: http://www.cisco.com/go/mibs

RFCs

RFC	Title
No new or modified RFCs are supported by this feature, and support for existing RFCs has not been modified by this feature.	--

Technical Assistance

Description	Link
The Cisco Support and Documentation website provides online resources to download documentation, software, and tools. Use these resources to install and configure the software and to troubleshoot and resolve technical issues with Cisco products and technologies. Access to most tools on the Cisco Support and Documentation website requires a Cisco.com user ID and password.	http://www.cisco.com/cisco/web/support/index.html

Feature Information for OSPF Update Packet-Pacing Configurable Timers

The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Table 3 Feature Information for OSPF Update Packet-Pacing Configurable Timers

Feature Name	Releases	Feature Information
OSPF Update Packet-Pacing Configurable Timers	12.2(4)T 12.2(4)T3 12.2(8)T 12.2(8)T1 12.2(14)S Cisco IOS XE 3.1.0 SG	<p>The OSPF Update Packet-Pacing Configurable Timers feature allows you to configure the rate at which OSPF LSA flood pacing, retransmission pacing, and group pacing updates occur.</p> <p>The following commands are introduced or modified in the feature documented in this module:</p> <ul style="list-style-type: none"> • timers pacing flood • timers pacing lsa-group • timers pacing retransmission • show ip ospf

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Any Internet Protocol (IP) addresses and phone numbers used in this document are not intended to be actual addresses and phone numbers. Any examples, command display output, network topology diagrams, and other figures included in the document are shown for illustrative purposes only. Any use of actual IP addresses or phone numbers in illustrative content is unintentional and coincidental.



OSPF Sham-Link Support for MPLS VPN

Feature History

Release	Modification
12.2(8)T	This feature was introduced.

This module describes how to configure and use a sham-link to connect Virtual Private Network (VPN) client sites that run the Open Shortest Path First (OSPF) protocol and share backdoor OSPF links in a Multiprotocol Label Switching (MPLS) VPN configuration.

- [Finding Feature Information, page 67](#)
- [Feature Overview, page 67](#)
- [Supported Platforms, page 73](#)
- [Supported Standards MIBs and RFCs, page 74](#)
- [Prerequisites, page 75](#)
- [Configuration Tasks, page 75](#)
- [Monitoring and Maintaining a Sham-Link, page 77](#)
- [Configuration Examples, page 77](#)
- [Glossary, page 78](#)

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest feature information and caveats, see the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the Feature Information Table at the end of this document.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Feature Overview

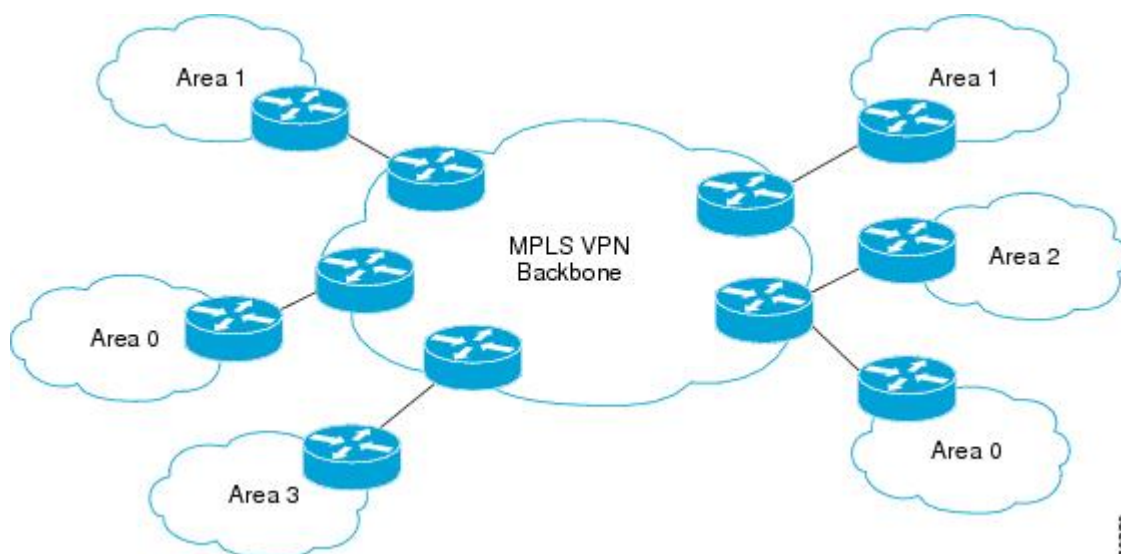
- [Using OSPF in PE-CE Router Connections, page 68](#)
- [Using a Sham-Link to Correct OSPF Backdoor Routing, page 68](#)
- [Sham-Link Configuration Example, page 71](#)
- [Benefits, page 73](#)
- [Restrictions, page 73](#)

- [Related Features and Technologies, page 73](#)
- [Related Documents, page 73](#)

Using OSPF in PE-CE Router Connections

In an MPLS VPN configuration, the OSPF protocol is one way you can connect customer edge (CE) routers to service provider edge (PE) routers in the VPN backbone. OSPF is often used by customers that run OSPF as their intrasite routing protocol, subscribe to a VPN service, and want to exchange routing information between their sites using OSPF (during migration or on a permanent basis) over an MPLS VPN backbone.

The figure below shows an example of how VPN client sites that run OSPF can connect over an MPLS VPN backbone.



When OSPF is used to connect PE and CE routers, all routing information learned from a VPN site is placed in the VPN routing and forwarding (VRF) instance associated with the incoming interface. The PE routers that attach to the VPN use the Border Gateway Protocol (BGP) to distribute VPN routes to each other. A CE router can then learn the routes to other sites in the VPN by peering with its attached PE router. The MPLS VPN superbackbone provides an additional level of routing hierarchy to interconnect the VPN sites running OSPF.

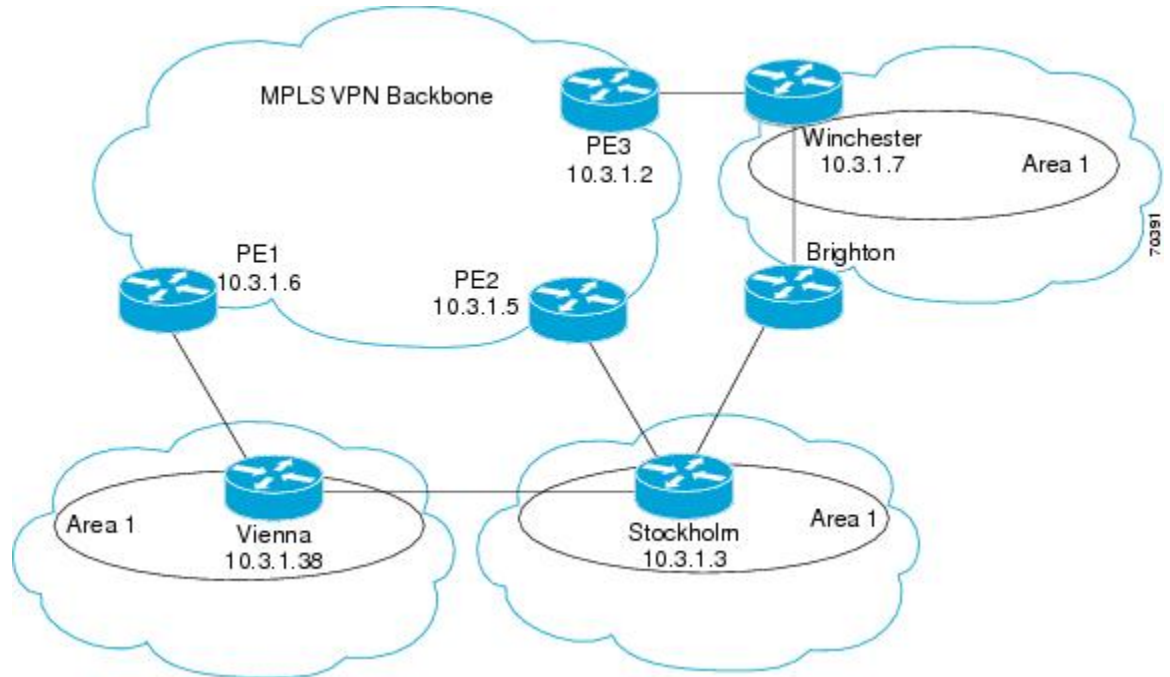
When OSPF routes are propagated over the MPLS VPN backbone, additional information about the prefix in the form of BGP extended communities (route type, domain ID extended communities) is appended to the BGP update. This community information is used by the receiving PE router to decide the type of link-state advertisement (LSA) to be generated when the BGP route is redistributed to the OSPF PE-CE process. In this way, internal OSPF routes that belong to the same VPN and are advertised over the VPN backbone are seen as interarea routes on the remote sites.

For basic information about how to configure an MPLS VPN, refer to the "MPLS Virtual Private Networks Configuration" module.

Using a Sham-Link to Correct OSPF Backdoor Routing

Although OSPF PE-CE connections assume that the only path between two client sites is across the MPLS VPN backbone, backdoor paths between VPN sites (shown in grey in the figure below) may exist. If these

sites belong to the same OSPF area, the path over a backdoor link will always be selected because OSPF prefers intraarea paths to interarea paths. (PE routers advertise OSPF routes learned over the VPN backbone as interarea paths.) For this reason, OSPF backdoor links between VPN sites must be taken into account so that routing is performed based on policy.



For example, the figure above shows three client sites, each with backdoor links. Because each site runs OSPF within the same Area 1 configuration, all routing between the three sites follows the intraarea path across the backdoor links, rather than over the MPLS VPN backbone.

The following example shows BGP routing table entries for the prefix 10.3.1.7/32 in the PE-1 router in the figure above. This prefix is the loopback interface of the Winchester CE router. As shown in bold in this example, the loopback interface is learned via BGP from PE-2 and PE-3. It is also generated through redistribution into BGP on PE-1.

```
PE-1# show ip bgp vpnv4 all 10.3.1.7
BGP routing table entry for 100:251:10.3.1.7/32, version 58
Paths: (3 available, best #2)
  Advertised to non peer-group peers:
    10.3.1.2 10.3.1.5
  Local
    10.3.1.5 (metric 30) from 10.3.1.5 (10.3.1.5)
      Origin incomplete, metric 22, localpref 100, valid, internal
      Extended Community: RT:1:793 OSPF DOMAIN ID:0.0.0.100 OSPF
      RT:1:2:0 OSPF 2
  Local
    10.2.1.38 from 0.0.0.0 (10.3.1.6)
      Origin incomplete, metric 86, localpref 100, weight 32768,
      valid, sourced, best
      Extended Community: RT:1:793 OSPF DOMAIN ID:0.0.0.100 OSPF
      RT:1:2:0 OSPF 2
  Local
    10.3.1.2 (metric 30) from 10.3.1.2 (10.3.1.2)
      Origin incomplete, metric 11, localpref 100, valid, internal
      Extended Community: RT:1:793 OSPF DOMAIN ID:0.0.0.100 OSPF
      RT:1:2:0 OSPF 2
```

Within BGP, the locally generated route (10.2.1.38) is considered to be the best route. However, as shown in bold in the next example, the VRF routing table shows that the selected path is learned via OSPF with a next hop of 10.2.1.38, which is the Vienna CE router.

```
PE-1# show ip route vrf ospf 10.3.1.7
Routing entry for 10.3.1.7/32
  Known via "ospf 100", distance 110, metric 86, type intra area
  Redistributing via bgp 215
  Advertised by bgp 215
  Last update from 10.2.1.38 on Serial0/0/0, 00:00:17 ago
  Routing Descriptor Blocks:
  * 10.2.1.38
    , from 10.3.1.7, 00:00:17 ago, via Serial0/0/0
      Route metric is 86, traffic share count is 1
```

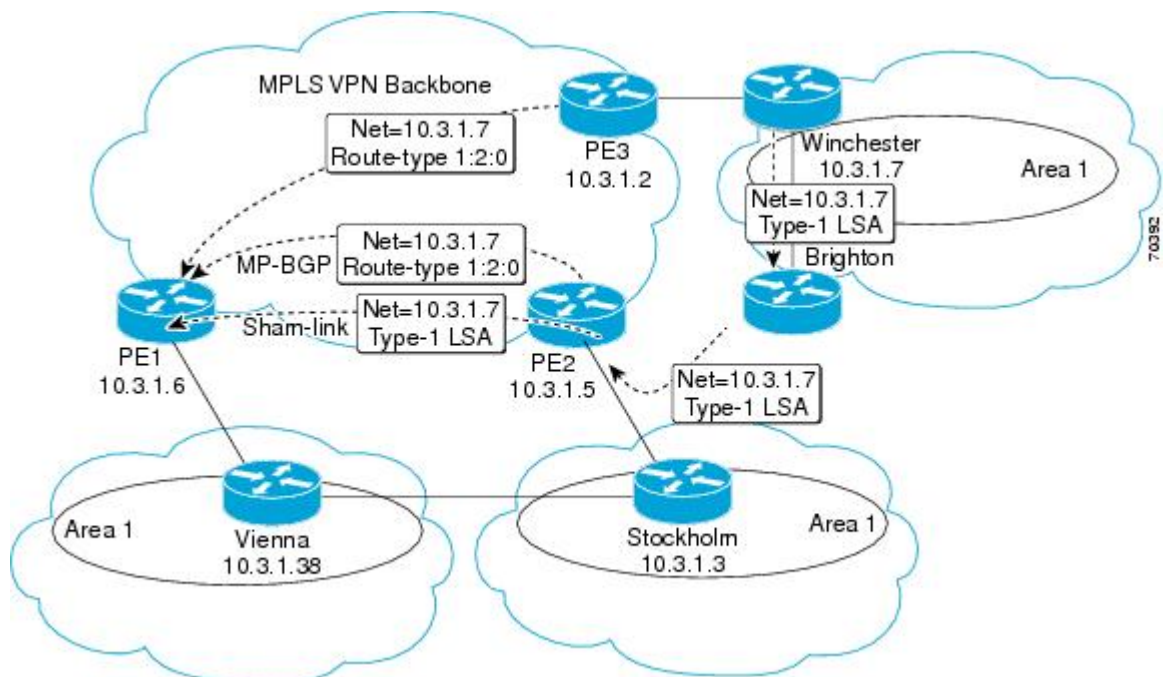
This path is selected because:

- The OSPF intra-area path is preferred over the interarea path (over the MPLS VPN backbone) generated by the PE-1 router.
- OSPF has a lower administrative distance (AD) than internal BGP (BGP running between routers in the same autonomous system).

If the backdoor links between sites are used only for backup purposes and do not participate in the VPN service, then the default route selection shown in the preceding example is not acceptable. To reestablish the desired path selection over the MPLS VPN backbone, you must create an additional OSPF intra-area (logical) link between ingress and egress VRFs on the relevant PE routers. This link is called a sham-link.

A sham-link is required between any two VPN sites that belong to the same OSPF area and share an OSPF backdoor link. If no backdoor link exists between the sites, no sham-link is required.

The figure below shows a sample sham-link between PE-1 and PE-2. A cost is configured with each sham-link and is used to decide whether traffic will be sent over the backdoor path or the sham-link path. When a sham-link is configured between PE routers, the PEs can populate the VRF routing table with the OSPF routes learned over the sham-link.



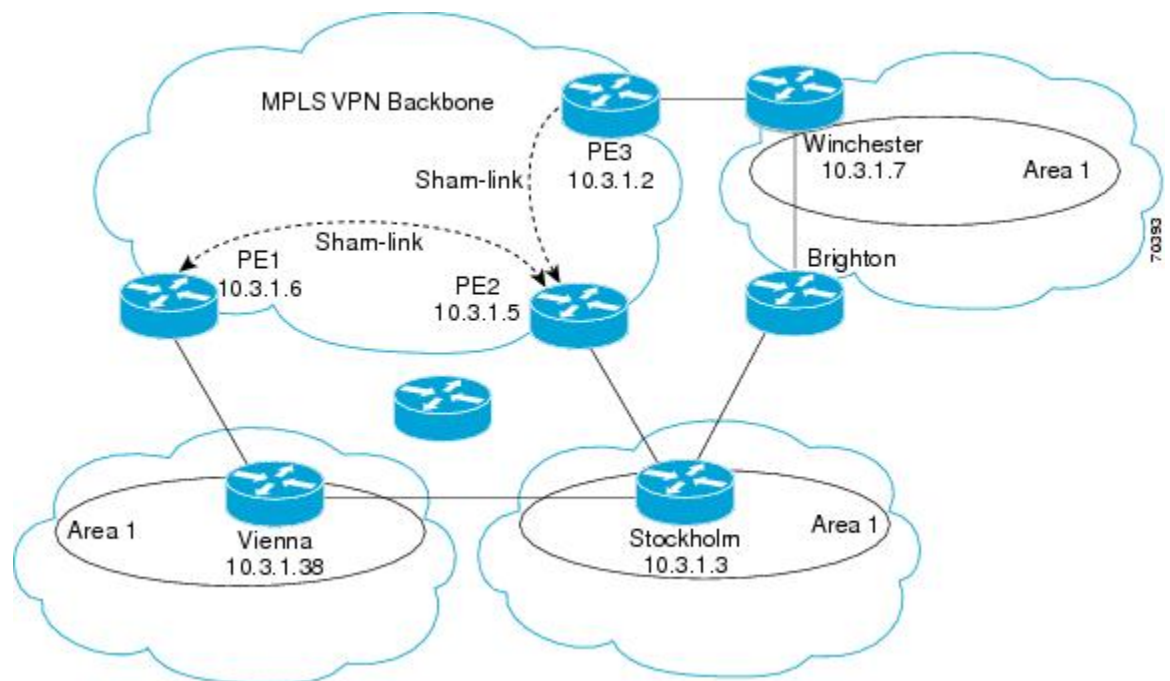
Because the sham-link is seen as an intra-area link between PE routers, an OSPF adjacency is created and database exchange (for the particular OSPF process) occurs across the link. The PE router can then flood LSAs between sites from across the MPLS VPN backbone. As a result, the desired intra-area connectivity is created.

The section, "[Creating a Sham-Link, page 75](#)", describes how to configure a sham-link between two PE routers. For more information about how to configure OSPF, refer to the "Configuring OSPF" module.

Sham-Link Configuration Example

The example in this section is designed to show how a sham-link is used only to affect the OSPF intra-area path selection of the PE and CE routers. The PE router also uses the information received from MP-BGP to set the outgoing label stack of incoming packets, and to decide to which egress PE router to label switch the packets.

The figure below shows a sample MPLS VPN topology in which a sham-link configuration is necessary. A VPN client has three sites, each with a backdoor link. Two sham-links have been configured, one between PE-1 and PE-2, and another between PE-2 and PE-3. A sham-link between PE-1 and PE-3 is not necessary in this configuration because the Vienna and Winchester sites do not share a backdoor link.



The following example shows the forwarding that occurs between sites from the standpoint of how PE-1 views the 10.3.1.7/32 prefix, the loopback1 interface of the Winchester CE router in the figure above.

```
PE-1# show ip bgp vpnv4 all 10.3.1.7
BGP routing table entry for 100:251:10.3.1.7/32, version 124
Paths: (1 available, best #1)
  Local
    10.3.1.2 (metric 30) from 10.3.1.2
  (10.3.1.2)
    Origin incomplete, metric 11, localpref 100, valid, internal,
    best
    Extended Community: RT:1:793 OSPF DOMAIN ID:0.0.0.100 OSPF
    RT:1:2:0 OSPF 2
```

```

PE-1# show ip route vrf ospf 10.3.1.7
Routing entry for 10.3.1.7/32
  Known via "ospf 100
", distance 110, metric 13, type intra area
  Redistributing via bgp 215
  Last update from 10.3.1.2 00:12:59 ago
  Routing Descriptor Blocks:
10.3.1.2 (Default-IP-Routing-Table), from 10.3.1.7, 00:12:59 ago

```

The next example shows forwarding information in which the next hop for the route, 10.3.1.2, is the PE-3 router rather than the PE-2 router (which is the best path according to OSPF). The reason the OSPF route is not redistributed to BGP on the PE is because the other end of the sham-link already redistributed the route to BGP and there is no need for duplication. The OSPF sham-link is used only to influence intra-area path selection. When sending traffic to a particular destination, the PE router uses the MP-BGP forwarding information.

```

PE-1# show ip bgp vpnv4 all tag | begin 10.3.1.7
10.3.1.7/32      10.3.1.2
                notag/38

PE-1# show tag-switching forwarding 10.3.1.2
Local  Outgoing  Prefix          Bytes tag  Outgoing  Next Hop
tag    tag or VC  or Tunnel Id    switched  interface
31     42         10.3.1.2/32
      0         PO3/0/0        point2point
PE-1# show ip cef vrf ospf 10.3.1.7
10.3.1.7/32, version 73, epoch 0, cached adjacency to POS3/0/0
0 packets, 0 bytes
  tag information set
    local tag: VPN-route-head
    fast tag rewrite with PO3/0/0, point2point, tags imposed: {42 38
}
  via 10.3.1.2
, 0 dependencies, recursive
  next hop 10.1.1.17, POS3/0/0 via 10.3.1.2/32
  valid cached adjacency
  tag rewrite with PO3/0/0, point2point, tags imposed: {42 38}

```

If a prefix is learned across the sham-link and the path via the sham-link is selected as the best, the PE router does not generate an MP-BGP update for the prefix. It is not possible to route traffic from one sham-link over another sham-link.

In the following example, PE-2 shows how an MP-BGP update for the prefix is not generated. Although 10.3.1.7/32 has been learned via OSPF across the sham-link as shown in bold, no local generation of a route into BGP is performed. The only entry within the BGP table is the MP-BGP update received from PE-3 (the egress PE router for the 10.3.1.7/32 prefix).

```

PE-2# show ip route vrf ospf 10.3.1.7
Routing entry for 10.3.1.7/32
  Known via "ospf 100
", distance 110, metric 12, type intra area
  Redistributing via bgp 215
  Last update from 10.3.1.2 00:00:10 ago
  Routing Descriptor Blocks:
* 10.3.1.2 (Default-IP-Routing-Table), from 10.3.1.7, 00:00:10 ago
  Route metric is 12, traffic share count is 1
PE-2# show ip bgp vpnv4 all 10.3.1.7
BGP routing table entry for 100:251:10.3.1.7/32, version 166
Paths: (1 available, best #1)
  Not advertised to any peer
Local
  10.3.1.2 (metric 30) from 10.3.1.2 (10.3.1.2)
    Origin incomplete, metric 11, localpref 100, valid, internal,
    best
    Extended Community: RT:1:793 OSPF DOMAIN ID:0.0.0.100 OSPF
    RT:1:2:0 OSPF 2

```

The PE router uses the information received from MP-BGP to set the ongoing label stack of incoming packets, and to decide to which egress PE router to label switch the packets.

Benefits

Client Site Connection Across the MPLS VPN Backbone

A sham-link overcomes the OSPF default behavior for selecting an intra-area backdoor route between VPN sites instead of an interarea (PE-to-PE) route. A sham-link ensures that OSPF client sites that share a backdoor link can communicate over the MPLS VPN backbone and participate in VPN services.

Flexible Routing in an MPLS VPN Configuration

In an MPLS VPN configuration, the OSPF cost configured with a sham-link allows you to decide if OSPF client site traffic will be routed over a backdoor link or through the VPN backbone.

Restrictions

When OSPF is used as a protocol between PE and CE routers, the OSPF metric is preserved when routes are advertised over the VPN backbone. The metric is used on the remote PE routers to select the correct route. For this reason, you should not modify the metric value when OSPF is redistributed to BGP, and when BGP is redistributed to OSPF. If you modify the metric value, routing loops may occur.

Related Features and Technologies

- MPLS
- OSPF
- BGP

Related Documents

- *Cisco IOS IP Routing: OSPF Command Reference*
- "MPLS Virtual Private Networks" module
- "Configuring OSPF" module
- *Cisco IOS IP Routing: BGP Configuration Guide, Release 15.0*
- RFC 1163, A Border Gateway Protocol
- RFC 1164, Application of the Border Gateway Protocol in the Internet
- RFC 2283, Multiprotocol Extensions for BGP-4
- RFC 2328, Open Shortest Path First, Version 2
- RFC 2547, BGP/MPLS VPNs

Supported Platforms

- Cisco 1400 series

- Cisco 1600
- Cisco 1600R
- Cisco 1710
- Cisco 1720
- Cisco 1721
- Cisco 1750
- Cisco 1751
- Cisco 2420
- Cisco 2600
- Cisco 2691
- Cisco 3620
- Cisco 3631
- Cisco 3640
- Cisco 3660
- Cisco 3725
- Cisco 3745
- Cisco 7100
- Cisco 7200
- Cisco 7500
- Cisco 7700
- URM
- Cisco uBR7200

Determining Platform Support Through Cisco Feature Navigator

Cisco IOS software is packaged in feature sets that support specific platforms. To get updated information regarding platform support for this feature, access Cisco Feature Navigator. Cisco Feature Navigator dynamically updates the list of supported platforms as new platform support is added for the feature.

Cisco Feature Navigator is a web-based tool that enables you to quickly determine which Cisco IOS software images support a specific set of features and which features are supported in a specific Cisco IOS image. You can search by feature or release. Under the release section, you can compare releases side by side to display both the features unique to each software release and the features in common.

Cisco Feature Navigator is updated regularly when major Cisco IOS software releases and technology releases occur. For the most current information, go to the Cisco Feature Navigator home page at the following URL:

<http://www.cisco.com/go/fn>

Supported Standards MIBs and RFCs

Standards

No new or modified standards are supported by this feature.

MIBs

No new or modified MIBs are supported by this feature.

To obtain lists of supported MIBs by platform and Cisco IOS release, and to download MIB modules, go to the Cisco MIB website on Cisco.com at the following URL:

<http://www.cisco.com/public/sw-center/netmgmt/cmtk/mibs.shtml>

RFCs

No new or modified RFCs are supported by this feature.

Prerequisites

Before you can configure a sham-link in an MPLS VPN, you must first enable OSPF as follows:

- Create an OSPF routing process.
- Specify the range of IP addresses to be associated with the routing process.
- Assign area IDs to be associated with the range of IP addresses.

For more information on these OSPF configuration procedures, go to:

http://www.cisco.com/en/US/docs/ios/iproute_ospf/command/reference/iro_book.html

Configuration Tasks

See the following sections for configuration tasks for the sham-link feature. Each task in the list is identified as either required or optional.

- [Creating a Sham-Link, page 75](#) (required)
- [Verifying Sham-Link Creation, page 77](#) (optional)
- [Creating a Sham-Link, page 75](#)
- [Verifying Sham-Link Creation, page 77](#)

Creating a Sham-Link

Before you create a sham-link between PE routers in an MPLS VPN, you must:

- Configure a separate /32 address on the remote PE so that OSPF packets can be sent over the VPN backbone to the remote end of the sham-link. The /32 address must meet the following criteria:
 - Belong to a VRF.
 - Not be advertised by OSPF.
 - Be advertised by BGP.

You can use the /32 address for other sham-links.

- Associate the sham-link with an existing OSPF area.

SUMMARY STEPS

1. Router1# **configure terminal**
2. Router1(config)# **interface loopback** *interface-number*
3. Router1(config-if)# **ip vrf forwarding** *vrf-name*
4. Router1(config-if)# **ip address** *ip-address mask*
5. Router1(config)# **end**
6. Router2# **configure terminal**
7. Router2(config)# **interface loopback** *interface-number*
8. Router2(config-if)# **ip vrf forwarding** *vrf-name*
9. Router2(config-if)# **ip address** *ip-address mask*
10. Router1(config)# **end**
11. Router1(config)# **router ospf** *process-id vrf vrf-name*
12. Router1(config-if)# **area** *area-id sham-link* *source-address destination-address cost number*
13. Router2(config)# **router ospf** *process-id vrf vrf-name*
14. Router2(config-if)# **area** *area-id sham-link* *source-address destination-address cost number*

DETAILED STEPS

	Command or Action	Purpose
Step 1	Router1# configure terminal	Enters global configuration mode on the first PE router.
Step 2	Router1(config)# interface loopback <i>interface-number</i>	Creates a loopback interface to be used as an endpoint of the sham-link on PE-1 and enters interface configuration mode.
Step 3	Router1(config-if)# ip vrf forwarding <i>vrf-name</i>	Associates the loopback interface with a VRF. Removes the IP address.
Step 4	Router1(config-if)# ip address <i>ip-address mask</i>	Reconfigures the IP address of the loopback interface on PE-1.
Step 5	Router1(config)# end	Returns to EXEC mode.
Step 6	Router2# configure terminal	Enters global configuration mode on the second PE router.
Step 7	Router2(config)# interface loopback <i>interface-number</i>	Creates a loopback interface to be used as the endpoint of the sham-link on PE-2 and enters interface configuration mode.
Step 8	Router2(config-if)# ip vrf forwarding <i>vrf-name</i>	Associates the second loopback interface with a VRF. Removes the IP address.
Step 9	Router2(config-if)# ip address <i>ip-address mask</i>	Reconfigures the IP address of the loopback interface on PE-2.
Step 10	Router1(config)# end	Returns to EXEC mode.
Step 11	Router1(config)# router ospf <i>process-id vrf vrf-name</i>	Configures the specified OSPF process with the VRF associated with the sham-link interface on PE-1 and enters interface configuration mode.

	Command or Action	Purpose
Step 12	Router1(config-if)# area <i>area-id</i> sham-link <i>source-address destination-address</i> cost <i>number</i>	Configures the sham-link on the PE-1 interface within a specified OSPF area and with the loopback interfaces specified by the IP addresses as endpoints. cost <i>number</i> configures the OSPF cost for sending an IP packet on the PE-1 sham-link interface.
Step 13	Router2(config)# router ospf <i>process-id</i> <i>vrf vrf-name</i>	Configures the specified OSPF process with the VRF associated with the sham-link interface on PE-2 and enters interface configuration mode.
Step 14	Router2(config-if)# area <i>area-id</i> sham-link <i>source-address destination-address</i> cost <i>number</i>	Configures the sham-link on the PE-2 interface within a specified OSPF area and with the loopback interfaces specified by the IP addresses as endpoints. cost <i>number</i> configures the OSPF cost for sending an IP packet on the PE-2 sham-link interface.

Verifying Sham-Link Creation

To verify that the sham-link was successfully created and is operational, use the **show ip ospf sham-links** command in EXEC mode:

```
Router1# show ip ospf sham-links
Sham Link OSPF_SL0 to address 10.2.1.2 is up
Area 1 source address 10.2.1.1
Run as demand circuit
DoNotAge LSA allowed. Cost of using 40 State POINT_TO_POINT,
Timer intervals configured, Hello 10, Dead 40, Wait 40,
Hello due in 00:00:04
Adjacency State FULL (Hello suppressed)
Index 2/2, retransmission queue length 4, number of
retransmission 0
First 0x63311F3C(205)/0x63311FE4(59) Next
0x63311F3C(205)/0x63311FE4(59)
Last retransmission scan length is 0, maximum is 0
Last retransmission scan time is 0 msec, maximum is 0 msec
Link State retransmission due in 360 msec
```

Monitoring and Maintaining a Sham-Link

Command	Purpose
Router# show ip ospf sham-links	Displays the operational status of all sham-links configured for a router.
Router# show ip ospf data router <i>ip-address</i>	Displays information about how the sham-link is advertised as an unnumbered point-to-point connection between two PE routers.

Configuration Examples

The following example shows how to configure a sham-link between two PE routers:

```
Router1(config)
```

```
# interface loopback 1
Router1(config-if)# ip vrf forwarding ospf
Router1(config-if)# ip address 10.2.1.1 255.255.255.255
!
Router2(config)# interface loopback 1
Router2(config-if)# ip vrf forwarding ospf
Router2(config-if)# ip address 10.2.1.2 255.255.255.255
!
Router1(config)# router ospf 100 vrf ospf
Router1(config-if)# area 1 sham-link 10.2.1.1 10.2.1.2 cost 40
!
Router2(config)# router ospf 100 vrf ospf
Router2(config-if)# area 1 sham-link 10.2.1.2 10.2.1.1 cost 40
```

Glossary

BGP --Border Gateway Protocol. Interdomain routing protocol that exchanges reachability information with other BGP systems. It is defined in RFC 1163.

CE router --customer edge router. A router that is part of a customer network and that interfaces to a provider edge (PE) router. CE routers are not aware of associated VPNs.

CEF -- Cisco Express Forwarding. An advanced Layer 3 IP switching technology. CEF optimizes network performance and scalability for networks with large and dynamic traffic patterns.

OSPF --Open Shortest Path First protocol.

IGP --Interior Gateway Protocol. An Internet protocol used to exchange routing information within an autonomous system. Examples of common IGPs include IGRP, OSPF, and RIP.

LSA --link-state advertisement. A broadcast packet used by link-state protocols. The LSA contains information about neighbors and path costs and is used by the receiving router to maintain a routing table.

MPLS --Multiprotocol Label Switching. Emerging industry standard upon which tag switching is based.

PE router --provider edge router. A router that is part of a service provider network connected to a customer edge (CE) router. All VPN processing occurs in the PE router.

SPF --shortest path first calculation.

VPN --Virtual Private Network. A secure IP-based network that shares resources on one or more physical networks. A VPN contains geographically dispersed sites that can communicate securely over a shared backbone.

VRF --VPN routing and forwarding instance. A VRF consists of an IP routing table, a derived forwarding table, a set of interfaces that use the forwarding table, and a set of rules and routing protocols that determine what goes into the forwarding table. In general, a VRF includes the routing information that defines a customer VPN site that is attached to a PE router.

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OSPF Support for Multi-VRF on CE Routers

The OSPF Support for Multi-VRF on CE Routers feature provides the capability of suppressing provider edge (PE) checks that are needed to prevent loops when the PE is performing a mutual redistribution of packets between the OSPF and BGP protocols. When VPN routing and forward (VRF) is used on a router that is not a PE (that is, one that is not running BGP), the checks can be turned off to allow for correct population of the VRF routing table with routes to IP prefixes.

OSPF multi-VRF allows you to split the router into multiple virtual routers, where each router contains its own set of interfaces, routing table, and forwarding table.

- [Finding Feature Information, page 81](#)
- [Information About OSPF Support for Multi-VRF on CE Routers, page 81](#)
- [How to Configure OSPF Support for Multi-VRF on CE Routers, page 82](#)
- [Configuration Examples for OSPF Support for Multi-VRF on CE Routers, page 83](#)
- [Additional References, page 85](#)
- [Feature Information for OSPF Support for Multi-VRF on CE Routers, page 86](#)
- [Glossary, page 86](#)

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest feature information and caveats, see the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the Feature Information Table at the end of this document.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Information About OSPF Support for Multi-VRF on CE Routers

The OSPF Support for Multi-VRF on CE Routers feature provides the capability of suppressing provider edge (PE) checks that are needed to prevent loops when the PE is performing a mutual redistribution of packets between the OSPF and BGP protocols. When VPN routing and forward (VRF) is used on a router that is not a PE (that is, one that is not running BGP), the checks can be turned off to allow for correct population of the VRF routing table with routes to IP prefixes.

OSPF multi-VRF allows you to split the router into multiple virtual routers, where each router contains its own set of interfaces, routing table, and forwarding table. OSPF multi-VRF gives you the ability to segment parts of your network and configure those segments to perform specific functions, yet still maintain correct routing information.

How to Configure OSPF Support for Multi-VRF on CE Routers

- [Configuring the Multi-VRF Capability for OSPF Routing](#), page 82
- [Verifying the OSPF Multi-VRF Configuration](#), page 83

Configuring the Multi-VRF Capability for OSPF Routing

CEF must be running on the network.

SUMMARY STEPS

1. **enable**
2. **show ip ospf** [*process-id*]
3. **configure terminal**
4. **router ospf** *process-id* [**vrf** *vpn-name*]
5. **capability vrf-lite**

DETAILED STEPS

Command or Action	Purpose
<p>Step 1 enable</p> <p>Example:</p> <pre>Router> enable</pre>	<p>Enables higher privilege levels, such as privileged EXEC mode.</p> <ul style="list-style-type: none"> • Enter your password if prompted.
<p>Step 2 show ip ospf [<i>process-id</i>]</p> <p>Example:</p> <pre>Router> show ip ospf 1</pre>	<p>Displays the status of the router. If the display indicates that the router is connected to the VPN backbone, you can use the capability vrf-lite command to decouple the PE router from the VPN backbone.</p>
<p>Step 3 configure terminal</p> <p>Example:</p> <pre>Router# configure terminal</pre>	<p>Enters global configuration mode.</p>
<p>Step 4 router ospf <i>process-id</i> [vrf <i>vpn-name</i>]</p> <p>Example:</p> <pre>Router(config)# router ospf 1 vrf grc</pre>	<p>Enables OSPF routing and enters router configuration mode.</p> <ul style="list-style-type: none"> • The <i>process-id</i> argument identifies the OSPF process. • Use the vrf keyword and <i>vpn-name</i> argument to identify a VPN.

Command or Action	Purpose
Step 5 <code>capability vrf-lite</code> Example: <code>Router(config)# capability vrf-lite</code>	Applies the multi-VRF capability to the OSPF process.

Verifying the OSPF Multi-VRF Configuration

No specific **debug** or **show** commands are associated with this feature. You can verify the success of the OSPF multi-VRF configuration by using the **show ip ospf**[*process-id*] command to verify that the router is not connected to the VPN backbone.

This output from the **show ip ospf process** command indicates that the PE router is currently connected to the backbone.

```
Router# show ip ospf 12
Routing Process "ospf 12" with ID 151.1.1.1 and Domain ID 0.0.0.12
Supports only single TOS(TOS0) routes
Supports opaque LSA
Connected to MPLS VPN Superbackbone
SPF schedule delay 5 secs, Hold time between two SPFs 10 secs
Minimum LSA interval 5 secs. Minimum LSA arrival 1 secs
Number of external LSA 0. Checksum Sum 0x0
Number of opaque AS LSA 0. Checksum Sum 0x0
Number of DChitless external and opaque AS LSA 0
Number of DoNotAge external and opaque AS LSA 0
Number of areas in this router is 0. 0 normal 0 stub 0 nssa
External flood list length 0
```

When the OSPF VRF process is configured with the **capability vrf-lite** command under the **router ospf** command, the "Connected to MPLS VPN Superbackbone" line will not be present in the display.

Configuration Examples for OSPF Support for Multi-VRF on CE Routers

- [Example Configuring the Multi-VRF Capability, page 83](#)
- [Example Verifying the OSPF Multi-VRF Configuration, page 84](#)

Example Configuring the Multi-VRF Capability

This example shows a basic OSPF network with a VRF named `grc` configured. The **capability vrf-lite** command is entered to suppress the PE checks.

```
!
ip cef
ip vrf grc
  rd 1:1
interface Serial12/0
  ip vrf forwarding grc
  ip address 192.168.1.1 255.255.255.252
!
```



```

interface Serial3/0
 ip vrf forwarding grc
 ip address 192.168.2.1 255.255.255.252
...
!
router ospf 9000 vrf grc
 log-adjacency-changes
 capability vrf-lite
 redistribute rip metric 1 subnets
 network 192.168.1.0 0.0.0.255 area 0
!
router rip
 address-family ipv4 vrf grc
 redistribute ospf 9000 vrf grc
 network network 192.168.2.0
 no auto-summary
 end
Router# show ip route vrf grc
Routing Table: grc
Codes: 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
Gateway of last resort is not set
O IA 192.168.192.0/24 [110/138] via 192.168.1.13, 00:06:08, Serial2/0
    [110/138] via 192.168.1.9, 00:06:08, Serial3/0
O IA 192.168.242.0/24 [110/74] via 192.168.1.13, 00:06:08, Serial2/0
O IA 192.168.193.0/24 [110/148] via 192.168.1.13, 00:06:08, Serial2/0
    [110/148] via 192.168.1.9, 00:06:08, Serial3/0
O IA 192.168.128.0/24 [110/74] via 192.168.1.9, 00:06:08, Serial3/0
O IA 192.168.129.0/24 [110/84] via 192.168.1.9, 00:06:08, Serial3/0
O IA 192.168.130.0/24 [110/84] via 192.168.1.9, 00:06:08, Serial3/0
    172.16.0.0/24 is subnetted, 2 subnets
O E2   172.16.9.0 [110/5] via 192.168.1.13, 00:06:08, Serial2/0
O E2   172.16.10.0 [110/5] via 192.168.1.13, 00:06:08, Serial2/0
O IA 192.168.131.0/24 [110/94] via 192.168.1.9, 00:06:20, Serial3/0
    192.168.1.0/30 is subnetted, 4 subnets
C     192.168.1.8 is directly connected, Serial3/0
C     192.168.1.12 is directly connected, Serial2/0
O     192.168.1.0 [110/128] via 192.168.1.9, 00:06:20, Serial3/0
O     192.168.1.4 [110/128] via 192.168.1.13, 00:06:20, Serial2/0

```

Example Verifying the OSPF Multi-VRF Configuration

This example illustrates the output display from the **show ip ospf process** command after OSPF multi-VRF has been configured on the router.

```

Router# show ip ospf database external 172.16.0.0 self
      OSPF Router with ID (10.0.0.1) (Process ID 100)
      Type-5 AS External Link States

LS age: 175
Options: (No TOS-capability, DC)
LS Type: AS External Link
Link State ID: 172.16.0.0 (External Network Number )
Advertising Router: 10.0.0.1
LS Seq Number: 80000001
Checksum: 0xEA9E
Length: 36
Network Mask: /8
  Metric Type: 2 (Larger than any link state path)
  MTID: 0
  Metric: 20
  Forward Address: 0.0.0.0
  External Route Tag: 0

```

Additional References

Related Documents

Related Topic	Document Title
Configuring OSPF	Configuring OSPF
Multiprotocol Label Switching (MPLS)	MPLS Multi-VRF (VRF Lite) Support

Standards

Standards	Title
No new or modified standards are supported by this feature, and support for existing standards has not been modified by this feature.	--

MIBs

MIBs	MIBs Link
No new or modified MIBs are supported by this feature, and support for existing MIBs has not been modified by this feature.	To locate and download MIBs for selected platforms, Cisco software releases, and feature sets, use Cisco MIB Locator found at the following URL: http://www.cisco.com/go/mibs

RFCs

RFCs	Title
No new or modified RFCs are supported by this feature, and support for existing RFCs has not been modified by this feature.	--

Technical Assistance

Description	Link
The Cisco Support and Documentation website provides online resources to download documentation, software, and tools. Use these resources to install and configure the software and to troubleshoot and resolve technical issues with Cisco products and technologies. Access to most tools on the Cisco Support and Documentation website requires a Cisco.com user ID and password.	http://www.cisco.com/cisco/web/support/index.html

Feature Information for OSPF Support for Multi-VRF on CE Routers

The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Table 4 Feature Information for OSPF Support for Multi-VRF on CE Routers

Feature Name	Releases	Feature Information
OSPF Support for Multi-VRF on CE Routers	12.0(21)ST 12.0(22)S 12.2(8)B 12.2(13)T 12.2(14)S Cisco IOS XE 3.1.0 SG	<p>The OSPF Support for Multi-VRF on CE Routers feature provides the capability to suppress provider edge (PE) checks that are needed to prevent loops when the PE is performing a mutual redistribution of packets between the OSPF and BGP protocols. When VPN routing and forwarding (VRF) is used on a router that is not a PE (that is, one that is not running BGP), the checks can be turned off to allow for correct population of the VRF routing table with routes to IP prefixes.</p> <p>The following commands are introduced or modified in the feature documented in this module:</p> <ul style="list-style-type: none"> • capability vrf-lite

Glossary

CE Router --Customer Edge router, an edge router in the C network, defined as a C router which attaches directly to a P router.

C Network --Customer (enterprise or service provider) network.

C Router --Customer router, a router in the C network.

LSA --link-state advertisement . Broadcast packet used by link-state protocols that contains information about neighbors and path costs. LSAs are used by the receiving routers to maintain their routing tables.

PE Router --Provider Edge router, an edge router in the P network, defined as a P router which attaches directly to a C router.

P Network --MPLS-capable service provider core network. P routers perform MPLS.

P Router --Provider router, a router in the P network.

SPF --shortest path first. A routing algorithm that iterates on length of path to determine a shortest-path spanning tree.

VPN --Virtual Private Network. Enables IP traffic to travel securely over a public TCP/IP network by encrypting all traffic from one network to another.

VRF --VPN Routing and Forwarding.

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OSPF Forwarding Address Suppression in Translated Type-5 LSAs

The OSPF Forwarding Address Suppression in Translated Type-5 LSAs feature causes a not-so-stubby area (NSSA) area border router (ABR) to translate Type-7 link state advertisements (LSAs) to Type-5 LSAs, but use the address 0.0.0.0 for the forwarding address instead of that specified in the Type-7 LSA. This feature causes routers that are configured not to advertise forwarding addresses into the backbone to direct forwarded traffic to the translating NSSA ABRs.

- [Finding Feature Information, page 89](#)
- [Prerequisites for OSPF Forwarding Address Suppression in Translated Type-5 LSAs, page 89](#)
- [Information About OSPF Forwarding Address Suppression in Translated Type-5 LSAs, page 90](#)
- [How to Suppress OSPF Forwarding Address in Translated Type-5 LSAs, page 91](#)
- [Configuration Examples for OSPF Forwarding Address Suppression in Translated Type-5 LSAs, page 92](#)
- [Additional References, page 93](#)
- [Feature Information for OSPF Forwarding Address Suppression in Translated Type-5 LSAs, page 94](#)

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest feature information and caveats, see the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the Feature Information Table at the end of this document.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Prerequisites for OSPF Forwarding Address Suppression in Translated Type-5 LSAs

This document presumes you have OSPF configured on the networking device; it does not document other steps to configure OSPF.

Information About OSPF Forwarding Address Suppression in Translated Type-5 LSAs

- [Benefits of OSPF Forwarding Address Suppression in Translated Type-5 LSAs, page 90](#)
- [When to Suppress OSPF Forwarding Address in Translated Type-5 LSAs, page 90](#)

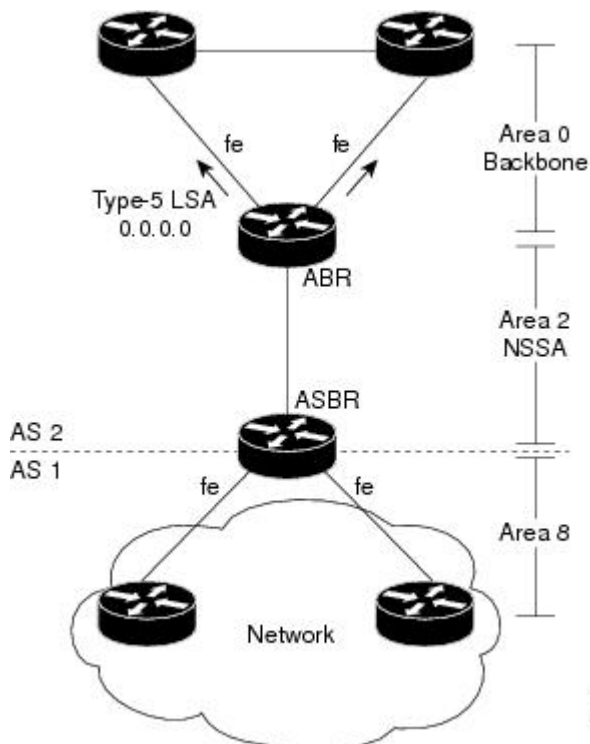
Benefits of OSPF Forwarding Address Suppression in Translated Type-5 LSAs

The OSPF Forwarding Address Suppression in Translated Type-5 LSAs feature causes an NSSA ABR to translate Type-7 LSAs to Type-5 LSAs, but use the 0.0.0.0 as the forwarding address instead of that specified in the Type-7 LSA. This feature causes routers that are configured not to advertise forwarding addresses into the backbone to direct forwarded traffic to the translating NSSA ASBRs.

When to Suppress OSPF Forwarding Address in Translated Type-5 LSAs

In the figure below, it would be advantageous to filter Area 2 addresses from Area 0 to minimize the number of routes introduced into the backbone (Area 0). However, using the **area range** command to consolidate and summarize routes at the area boundary--filtering the Area 2 addresses--will not work because the Area 2 addresses include forwarding addresses for Type-7 LSAs that are generated by the ASBR. If these Type-7 LSA forwarding addresses have been filtered out of Area 0, the backbone routers cannot reach the prefixes advertised in the translated Type-5 LSAs (autonomous system external LSAs).

Figure 10



This problem is solved by suppressing the forwarding address on the ABR so that the forwarding address is set to 0.0.0.0 in the Type-5 LSAs that were translated from Type-7 LSAs. A forwarding address set to 0.0.0.0 indicates that packets for the external destination should be forwarded to the advertising OSPF router, in this case, the translating NSSA ABR.

Before configuring this feature, consider the following caution.



Caution Configuring this feature causes the router to be noncompliant with RFC 1587. Also, suboptimal routing might result because there might be better paths to reach the destination’s forwarding address. This feature should not be configured without careful consideration and not until the network topology is understood.

How to Suppress OSPF Forwarding Address in Translated Type-5 LSAs

- [Suppressing OSPF Forwarding Address in Translated Type-5 LSAs, page 91](#)

Suppressing OSPF Forwarding Address in Translated Type-5 LSAs



Caution Configuring this feature causes the router to be noncompliant with RFC 1587. Also, suboptimal routing might result because there might be better paths to reach the destination’s forwarding address. This feature should not be configured without careful consideration and not until the network topology is understood.

SUMMARY STEPS

1. enable
2. configure terminal
3. router ospf process-id
4. area area-id nssa translate type7 suppress-fa
5. end

DETAILED STEPS

Command or Action	Purpose
Step 1 enable Example: Router> enable	Enables higher privilege levels, such as privileged EXEC mode. <ul style="list-style-type: none"> • Enter your password if prompted.

Command or Action	Purpose
Step 2 <code>configure terminal</code> Example: <pre>Router# configure terminal</pre>	Enters global configuration mode.
Step 3 <code>router ospf process-id</code> Example: <pre>Router(config)# router ospf 1</pre>	Enables OSPF routing and enters router configuration mode. <ul style="list-style-type: none"> The <i>process-id</i> argument identifies the OSPF process.
Step 4 <code>area area-id nssa translate type7 suppress-fa</code> Example: <pre>Router(config-router)# area 10 nssa translate type7 suppress-fa</pre>	Configures an area as a not-so-stubby-area (NSSA) and suppresses the forwarding address in translated Type-7 LSAs.
Step 5 <code>end</code> Example: <pre>Router(config-router)# end</pre>	Exits configuration mode and returns to privileged EXEC mode.

Configuration Examples for OSPF Forwarding Address Suppression in Translated Type-5 LSAs

- [Example Suppressing OSPF Forwarding Address in Translated Type-5 LSAs, page 92](#)

Example Suppressing OSPF Forwarding Address in Translated Type-5 LSAs

This example suppresses the forwarding address in translated Type-5 LSAs:

```
interface ethernet 0
 ip address 10.93.1.1 255.255.255.0
 ip ospf cost 1
!
interface ethernet 1
 ip address 10.94.1.1 255.255.255.0
!
router ospf 1
 network 10.93.0.0 0.0.255.255 area 0.0.0.0
 network 10.94.0.0 0.0.255.255 area 10
 area 10 nssa translate type7 suppress-fa
```

Additional References

Related Documents

Related Topic	Document Title
OSPF commands	<i>Cisco IOS IP Routing: OSPF Command Reference</i>

Standards

Standards	Title
No new or modified standards are supported by this feature, and support for existing standards has not been modified by this feature.	--

MIBs

MIBs	MIBs Link
No new or modified MIBs are supported by this feature, and support for existing MIBs has not been modified by this feature.	To locate and download MIBs for selected platforms, Cisco software releases, and feature sets, use Cisco MIB Locator found at the following URL: http://www.cisco.com/go/mibs

RFCs

RFCs	Title
Configuring the OSPF Forwarding Address Suppression in Translated Type-5 LSAs feature causes the router to be noncompliant with RFC 1587.	<i>The OSPF NSSA Option</i>

Technical Assistance

Description	Link
The Cisco Support and Documentation website provides online resources to download documentation, software, and tools. Use these resources to install and configure the software and to troubleshoot and resolve technical issues with Cisco products and technologies. Access to most tools on the Cisco Support and Documentation website requires a Cisco.com user ID and password.	http://www.cisco.com/cisco/web/support/index.html

Feature Information for OSPF Forwarding Address Suppression in Translated Type-5 LSAs

The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

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Table 5 Feature Information for OSPF Forwarding Address Suppression in Translated Type-5 LSAs

Feature Name	Releases	Feature Information
OSPF Forwarding Address Suppression in Translated Type-5 LSAs	12.2(15)T 12.2(18)S 12.2(27)SBC Cisco IOS XE 3.1.0 SG	<p>The OSPF Forwarding Address Suppression in Translated Type-5 LSAs feature causes a not-so-stubby area (NSSA) area border router (ABR) to translate Type-7 link state advertisements (LSAs) to Type-5 LSAs, but to use the address 0.0.0.0 for the forwarding address instead of that specified in the Type-7 LSA. This feature causes routers that are configured not to advertise forwarding addresses into the backbone to direct forwarded traffic to the translating NSSA ABRs.</p> <p>The following commands are introduced or modified:</p> <ul style="list-style-type: none"> • area nssa translate • show ip ospf

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OSPF Inbound Filtering Using Route Maps with a Distribute List

The OSPF Inbound Filtering Using Route Maps with a Distribute List feature allows users to define a route map to prevent Open Shortest Path First (OSPF) routes from being added to the routing table. In the route map, the user can match on any attribute of the OSPF route.

- [Finding Feature Information, page 95](#)
- [Prerequisites for OSPF Inbound Filtering Using Route Maps with a Distribute List, page 95](#)
- [Information About OSPF Inbound Filtering Using Route Maps with a Distribute List, page 95](#)
- [How to Configure OSPF Inbound Filtering Using Route Maps, page 97](#)
- [Configuration Examples for OSPF Inbound Filtering Using Route Maps with a Distribute List, page 98](#)
- [Additional References, page 99](#)
- [Feature Information for OSPF Inbound Filtering Using Route Maps with a Distribute List, page 100](#)

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest feature information and caveats, see the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the Feature Information Table at the end of this document.

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Prerequisites for OSPF Inbound Filtering Using Route Maps with a Distribute List

It is presumed that you have OSPF configured in your network.

Information About OSPF Inbound Filtering Using Route Maps with a Distribute List

Users can define a route map to prevent OSPF routes from being added to the routing table. This filtering happens at the moment when OSPF is installing the route in the routing table. This feature has no effect on

link-state advertisement (LSA) flooding. In the route map, the user can match on any attribute of the OSPF route. That is, the route map could be based on the following **match** options:

- **match interface**
- **match ip address**
- **match ip next-hop**
- **match ip route-source**
- **match metric**
- **match route-type**
- **match tag**

This feature can be useful during redistribution if the user tags prefixes when they get redistributed on Autonomous System Boundary Routers (ASBRs) and later uses the tag to filter the prefixes from being installed in the routing table on other routers.

Filtering Based on Route Tag

Users can assign tags to external routes when they are redistributed to OSPF. Then the user can deny or permit those routes in the OSPF domain by identifying that tag in the **route-map** and **distribute-list in** commands.

Filtering Based on Route Type

In OSPF, the external routes could be Type 1 or Type 2. Users can create route maps to match either Type 1 or Type 2 and then use the **distribute-list in** command to filter certain prefixes. Also, route maps can identify internal routes (interarea and intra-area) and then those routes can be filtered.

Filtering Based on Route Source

When a match is done on the route source, the route source represents the OSPF Router ID of the LSA originator of the LSA in which the prefix is advertised.

Filtering Based on Interface

When a match is done on the interface, the interface represents the outgoing interface for the route that OSPF is trying to install in the routing table.

Filtering Based on Next Hop

When a match is done on the next hop, the next hop represents the next hop for the route that OSPF is trying to install in the routing table.



Note

The **distribute-list in** command can be configured to prevent routes from being installed in the global Routing Information Base (RIB). Prior to the implementation of OSPF local RIB (for feature information on OSPF local RIB, see OSPFv2 Local RIB), OSPF would attempt to install a less preferred route (e.g. an inter-area route when the intra-area path is filtered). With OSPF local RIB, only the best route is considered (because this is the only route the local RIB maintains). There is no concept of a "second-best" OSPF route. For more information on the routing algorithm used by Cisco OSPF routers, please refer to RFC 2328.

How to Configure OSPF Inbound Filtering Using Route Maps

- [Configuring OSPF Route Map-Based Filtering, page 97](#)

Configuring OSPF Route Map-Based Filtering

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **route-map** *map-tag* [**permit** | **deny**] [*sequence-number*]
4. **match tag** *tag-name*
5. Repeat Steps 3 and 4 with other **route-map** and **match** commands.
6. **exit**
7. **router ospf** *process-id*
8. **distribute-list route-map** *map-tag in*
9. **end**

DETAILED STEPS

Command or Action	Purpose
Step 1 enable Example: Router> enable	Enables privileged EXEC mode. <ul style="list-style-type: none"> • Enter your password if prompted.
Step 2 configure terminal Example: Router# configure terminal	Enters global configuration mode.
Step 3 route-map <i>map-tag</i> [permit deny] [<i>sequence-number</i>] Example: Router(config)# route-map tag-filter deny 10	Defines a route map to control filtering.

Command or Action	Purpose
<p>Step 4 <code>match tag tag-name</code></p> <p>Example:</p> <pre>Router(config-router)# match tag 777</pre>	<p>Matches routes with a specified name, to be used as the route map is referenced.</p> <ul style="list-style-type: none"> At least one match command is required, but it need not be this match command. This is just an example. The list of match commands available to be used in this type of route map appears on the distribute-list in command reference page. This type of route map will have no set commands.
<p>Step 5 Repeat Steps 3 and 4 with other route-map and match commands.</p>	Optional.
<p>Step 6 <code>exit</code></p> <p>Example:</p> <pre>Router(config-router)# exit</pre>	Exits router configuration mode.
<p>Step 7 <code>router ospf process-id</code></p> <p>Example:</p> <pre>Router(config)# router ospf 1</pre>	Configures an OSPF routing process.
<p>Step 8 <code>distribute-list route-map map-tag in</code></p> <p>Example:</p> <pre>Router(config-router)# distribute-list route-map tag-filter in</pre>	Enables filtering based on an OSPF route map.
<p>Step 9 <code>end</code></p> <p>Example:</p> <pre>Router(config-router)# end</pre>	Exits router configuration mode.

Configuration Examples for OSPF Inbound Filtering Using Route Maps with a Distribute List

- [Example OSPF Route Map-Based Filtering, page 99](#)

Example OSPF Route Map-Based Filtering

In this example, OSPF external LSAs have a tag. The value of the tag is examined before the prefix is installed in the routing table. All OSPF external prefixes that have the tag value of 777 are filtered (prevented from being installed in the routing table). The permit statement with sequence number 20 has no match conditions, and there are no other route-map statements after sequence number 20, so all other conditions are permitted.

```
route-map tag-filter deny 10
  match tag 777
route-map tag-filter permit 20
!
router ospf 1
router-id 10.0.0.2
log-adjacency-changes
network 172.16.2.1 0.0.0.255 area 0
distribute-list route-map tag-filter in
```

Additional References

Related Documents

Related Topic	Document Title
OSPF commands	<i>Cisco IOS IP Routing: OSPF Command Reference</i>

Standards

Standards	Title
No new or modified standards are supported by this feature, and support for existing standards has not been modified by this feature.	--

MIBs

MIBs	MIBs Link
None	To locate and download MIBs for selected platforms, Cisco software releases, and feature sets, use Cisco MIB Locator found at the following URL: http://www.cisco.com/go/mibs

RFCs

RFCs	Title
No new or modified RFCs are supported by this feature, and support for existing RFCs has not been modified by this feature.	--

Technical Assistance

Description	Link
The Cisco Support and Documentation website provides online resources to download documentation, software, and tools. Use these resources to install and configure the software and to troubleshoot and resolve technical issues with Cisco products and technologies. Access to most tools on the Cisco Support and Documentation website requires a Cisco.com user ID and password.	http://www.cisco.com/cisco/web/support/index.html

Feature Information for OSPF Inbound Filtering Using Route Maps with a Distribute List

The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Table 6 Feature Information for OSPF Inbound Filtering Using Route Maps with a Distribute List

Feature Name	Releases	Feature Information
OSPF Inbound Filtering Using Route Maps with a Distribute List	12.0(24)S 12.2(15)T 12.2(18)S 12.2(27)SBC Cisco IOS XE 3.1.0 SG	<p>The OSPF Inbound Filtering Using Route Maps with a Distribute List feature allows users to define a route map to prevent Open Shortest Path First (OSPF) routes from being added to the routing table. In the route map, the user can match on any attribute of the OSPF route..</p> <p>The following command was introduced or modified: distribute-list in (IP).</p>

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Any Internet Protocol (IP) addresses and phone numbers used in this document are not intended to be actual addresses and phone numbers. Any examples, command display output, network topology diagrams, and other figures included in the document are shown for illustrative purposes only. Any use of actual IP addresses or phone numbers in illustrative content is unintentional and coincidental.



OSPF Shortest Path First Throttling

The OSPF Shortest Path First Throttling feature makes it possible to configure SPF scheduling in millisecond intervals and to potentially delay shortest path first (SPF) calculations during network instability. SPF is scheduled to calculate the Shortest Path Tree (SPT) when there is a change in topology. One SPF run may include multiple topology change events.

The interval at which the SPF calculations occur is chosen dynamically and is based on the frequency of topology changes in the network. The chosen interval is within the boundary of the user-specified value ranges. If network topology is unstable, SPF throttling calculates SPF scheduling intervals to be longer until topology becomes stable.

Feature Specifications for OSPF Shortest Path First Throttling

Feature History

Release	Modification
12.2(14)S	This feature was introduced.
12.0(23)S	This feature was integrated into Cisco Release 12.0(23)S.
12.2(15)T	This feature was integrated into Cisco IOS Release 12.2(15)T.

Finding Support Information for Platforms and Cisco IOS Software Images

Use Cisco Feature Navigator to find information about platform support and Cisco IOS software image support. Access Cisco Feature Navigator at <http://www.cisco.com/go/fn>. You must have an account on Cisco.com. If you do not have an account or have forgotten your username or password, click **Cancel** at the login dialog box and follow the instructions that appear.

- [Finding Feature Information, page 103](#)
- [Information About OSPF SPF Throttling, page 104](#)
- [How to Configure OSPF SPF Throttling, page 105](#)
- [Configuration Examples for OSPF SPF Throttling, page 108](#)
- [Additional References, page 108](#)

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest feature information and caveats, see the release notes for your platform and software release. To find information

about the features documented in this module, and to see a list of the releases in which each feature is supported, see the Feature Information Table at the end of this document.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Information About OSPF SPF Throttling

- [Shortest Path First Calculations](#), page 104

Shortest Path First Calculations

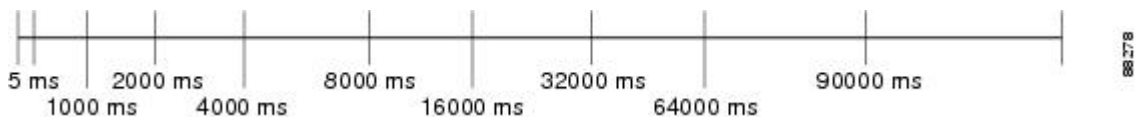
SPF calculations occur at the interval set by the **timers throttle spf** command. The wait interval indicates the amount of time to wait until the next SPF calculation occurs. Each wait interval after that calculation is twice as long as the previous one until the wait interval reaches the maximum wait time specified.

The SPF timing can be better explained using an example. In this example the start interval is set at 5 milliseconds (ms), the wait interval at 1000 milliseconds, and the maximum wait time is set at 90,000 milliseconds.

```
timers throttle spf 5 1000 90000
```

The figure below shows the intervals at which the SPF calculations occur so long as at least one topology change event is received in a given wait interval.

Figure 11

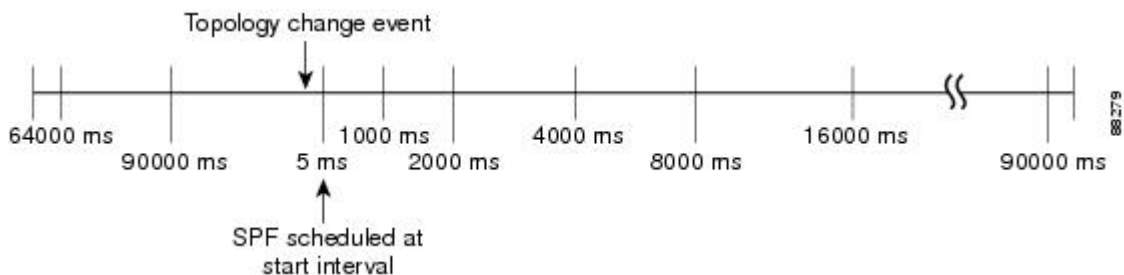


Notice that the wait interval between SPF calculations doubles when at least one topology change event is received during the previous wait interval. Once the maximum wait time is reached, the wait interval remains the same until the topology stabilizes and no event is received in that interval.

If the first topology change event is received after the current wait interval, the SPF calculation is delayed by the amount of time specified as the start interval. The subsequent wait intervals continue to follow the dynamic pattern.

If the first topology change event occurs after the maximum wait interval begins, the SPF calculation is again scheduled at the start interval and subsequent wait intervals are reset according to the parameters specified in the **timers throttle spf** command. Notice in the figure below that a topology change event was received after the start of the maximum wait time interval and that the SPF intervals have been reset.

Figure 12



How to Configure OSPF SPF Throttling

- [Configuring OSPF SPF Throttling, page 105](#)
- [Verifying SPF Throttle Values, page 106](#)

Configuring OSPF SPF Throttling

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **interface** *type slot / port*
4. **ip address** *ip-address mask [secondary]*
5. **exit**
6. **router ospf** *process-id*
7. **network** *network-number [mask | prefix-length]*
8. **timers throttle spf** *spf-start spf-hold spf-max-wait*
9. **end**

DETAILED STEPS

Command or Action	Purpose
Step 1 enable Example: Router> enable	Enables higher privilege levels, such as privileged EXEC mode. Enter your password if prompted.
Step 2 configure terminal Example: Router# configure terminal	Enters global configuration mode.
Step 3 interface <i>type slot / port</i> Example: Router(config)# interface ethernet 1/1/1	Enters interface configuration mode for the interface specified.

Command or Action	Purpose
<p>Step 4 <code>ip address ip-address mask [secondary]</code></p> <p>Example:</p> <pre>Router(config-if)# ip address 192.168.0.2 255.255.255.0</pre>	Sets a primary or secondary IP address for an interface.
<p>Step 5 <code>exit</code></p> <p>Example:</p> <pre>router# exit</pre>	Exits interface configuration mode.
<p>Step 6 <code>router ospf process-id</code></p> <p>Example:</p> <pre>Router(config)# router ospf 1</pre>	Configures an OSPF routing process.
<p>Step 7 <code>network network-number [mask prefix-length]</code></p> <p>Example:</p> <pre>Router(config-router)# network 192.168.0.0 0.0.255.255 area 0</pre>	Configures the subnet number and mask for a Dynamic Host Configuration Protocol (DHCP) address pool on a Cisco IOS DHCP Server.
<p>Step 8 <code>timers throttle spf spf-start spf-hold spf-max-wait</code></p> <p>Example:</p> <pre>Router(config-router)# timers throttle spf 10 4800 90000</pre>	Sets OSPF throttling timers.
<p>Step 9 <code>end</code></p> <p>Example:</p> <pre>Router(config-router)# end</pre>	Exits configuration mode.

Verifying SPF Throttle Values

To verify SPF throttle timer values, use the **show ip ospf** command. The values are displayed in the lines that begin, "Initial SPF schedule delay...," "Minimum hold time between two consecutive SPF's...," and "Maximum wait time between two consecutive SPF's..."

```
Router# show ip ospf
Routing Process "ospf 1" with ID 10.10.10.2 and Domain ID 0.0.0.1
Supports only single TOS(TOS0) routes
Supports opaque LSA
```

```

It is an autonomous system boundary router
Redistributing External Routes from,
    static, includes subnets in redistribution
Initial SPF schedule delay 5 msec
Minimum hold time between two consecutive SPFs 1000 msec
Maximum wait time between two consecutive SPFs 9000 msec
Minimum LSA interval 5 secs. Minimum LSA arrival 1 sec
LSA group pacing timer 240 secs
Interface flood pacing timer 33 msec
Retransmission pacing timer 66 msec
Number of external LSA 4. Checksum Sum 0x17445
Number of opaque AS LSA 0. Checksum Sum 0x0
Number of DCbitless external and opaque AS LSA 0
Number of DoNotAge external and opaque AS LSA 0
Number of areas in this router is 1. 1 normal 0 stub 0 nssa
External flood list length 0
  Area BACKBONE(0)
    Number of interfaces in this area is 2
    Area has no authentication
    SPF algorithm last executed 19:11:15.140 ago
    SPF algorithm executed 28 times
    Area ranges are
    Number of LSA 4. Checksum Sum 0x2C1D4
    Number of opaque link LSA 0. Checksum Sum 0x0
    Number of DCbitless LSA 0
    Number of indication LSA 0
    Number of DoNotAge LSA 0
    Flood list length 0

```

The table below describes the **show ip ospf** display fields and their descriptions.

Table 7 *show ip ospf Field Descriptions*

Field	Description
Routing process "ospf 201" with ID 192.42.110.200	Process ID and OSPF router ID.
Supports ...	Number of types of service supported (Type 0 only).
It is ...	Possible types are internal, area border, or autonomous system boundary.
Summary Link update interval	Specifies summary update interval in hours:minutes:seconds, and time until next update.
External Link update interval	Specifies external update interval in hours:minutes:seconds, and time until next update.
Redistributing External Routes from	Lists of redistributed routes, by protocol.
SPF calculations	Lists start, hold, and maximum wait interval values in milliseconds.
Number of areas	Number of areas in router, area addresses, and so on.
SPF algorithm last executed	Shows the last time an SPF calculation was performed in response to topology change event records.

Field	Description
Link State Update Interval	Specifies router and network link-state update interval in hours:minutes:seconds, and time until next update.
Link State Age Interval	Specifies max-aged update deletion interval, and time until next database cleanup, in hours:minutes:seconds.

Configuration Examples for OSPF SPF Throttling

- [Throttle Timers Example, page 108](#)

Throttle Timers Example

This example shows a router configured with the start, hold, and maximum interval values for the **timers throttle spf** command set at 5, 1,000, and 90,000 milliseconds, respectively.

```
router ospf 1
router-id 10.10.10.2
log-adjacency-changes
timers throttle spf 5 1000 90000
redistribute static subnets
network 21.21.21.0 0.0.0.255 area 0
network 22.22.22.0 0.0.0.255 area 00
```

Additional References

For additional information related to OSPF, refer to the following references:

Related Documents

Related Topic	Document Title
OSPF commands	<i>Cisco IOS IP Routing: OSPF Command Reference</i>
OSPF configuration tasks	"Configuring OSPF" module in the <i>Cisco IOS IP Routing Protocols Configuration Guide</i>

Standards

Standards	Title
	No new or modified RFCs are supported by this feature, and support for existing RFCs has not been modified by this feature.

MIBs

MIBs	MIBs Link
No new or modified MIBs are supported by this feature, and support for existing MIBs has not been modified by this feature.	To locate and download MIBs for selected platforms, Cisco IOS releases, and feature sets, use Cisco MIB Locator found at the following URL: http://www.cisco.com/go/mibs

RFCs

RFCs	Title
No new or modified standards are supported by this feature, and support for existing standards has not been modified by this feature.	

Technical Assistance

Description	Link
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OSPF Support for Fast Hello Packets

The OSPF Support for Fast Hello Packets feature provides a way to configure the sending of hello packets in intervals less than 1 second. Such a configuration would result in faster convergence in an Open Shortest Path First (OSPF) network.

- [Finding Feature Information, page 111](#)
- [Prerequisites for OSPF Support for Fast Hello Packets, page 111](#)
- [Information About OSPF Support for Fast Hello Packets, page 111](#)
- [How to Configure OSPF Fast Hello Packets, page 112](#)
- [Configuration Examples for OSPF Support for Fast Hello Packets, page 114](#)
- [Additional References, page 114](#)
- [Feature Information for OSPF Support for Fast Hello Packets, page 115](#)

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest feature information and caveats, see the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the Feature Information Table at the end of this document.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Prerequisites for OSPF Support for Fast Hello Packets

OSPF must be configured in the network already or configured at the same time as the OSPF Support for Fast Hello Packets feature.

Information About OSPF Support for Fast Hello Packets

- [OSPF Hello Interval and Dead Interval, page 112](#)
- [OSPF Fast Hello Packets, page 112](#)
- [Benefits of OSPF Fast Hello Packets, page 112](#)

OSPF Hello Interval and Dead Interval

OSPF hello packets are packets that an OSPF process sends to its OSPF neighbors to maintain connectivity with those neighbors. The hello packets are sent at a configurable interval (in seconds). The defaults are 10 seconds for an Ethernet link and 30 seconds for a non broadcast link. Hello packets include a list of all neighbors for which a hello packet has been received within the dead interval. The dead interval is also a configurable interval (in seconds), and defaults to four times the value of the hello interval. The value of all hello intervals must be the same within a network. Likewise, the value of all dead intervals must be the same within a network.

These two intervals work together to maintain connectivity by indicating that the link is operational. If a router does not receive a hello packet from a neighbor within the dead interval, it will declare that neighbor to be down.

OSPF Fast Hello Packets

OSPF fast hello packets refer to hello packets being sent at intervals of less than 1 second. To understand fast hello packets, you should already understand the relationship between OSPF hello packets and the dead interval. See the section [OSPF Hello Interval and Dead Interval, page 112](#).

OSPF fast hello packets are achieved by using the **ip ospf dead-interval** command. The dead interval is set to 1 second, and the hello-multiplier value is set to the number of hello packets you want sent during that 1 second, thus providing subsecond or "fast" hello packets.

When fast hello packets are configured on the interface, the hello interval advertised in the hello packets that are sent out this interface is set to 0. The hello interval in the hello packets received over this interface is ignored.

The dead interval must be consistent on a segment, whether it is set to 1 second (for fast hello packets) or set to any other value. The hello multiplier need not be the same for the entire segment as long as at least one hello packet is sent within the dead interval.

Benefits of OSPF Fast Hello Packets

The benefit of the OSPF Fast Hello Packets feature is that your OSPF network will experience faster convergence time than it would without fast hello packets. This feature allows you to detect lost neighbors within 1 second. It is especially useful in LAN segments, where neighbor loss might not be detected by the Open System Interconnection (OSI) physical layer and data-link layer.

How to Configure OSPF Fast Hello Packets

- [Configuring OSPF Fast Hello Packets, page 113](#)

Configuring OSPF Fast Hello Packets

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **interface** *type number*
4. **ip ospf dead-interval minimal hello-multiplier** *multiplier*
5. **end**
6. **show ip ospf interface** [*interface-type interface-number*]

DETAILED STEPS

Command or Action	Purpose
<p>Step 1 enable</p> <p>Example:</p> <pre>Router> enable</pre>	<p>Enables higher privilege levels, such as privileged EXEC mode.</p> <p>Enter your password if prompted.</p>
<p>Step 2 configure terminal</p> <p>Example:</p> <pre>Router# configure terminal</pre>	<p>Enters global configuration mode.</p>
<p>Step 3 interface <i>type number</i></p> <p>Example:</p> <pre>Router(config)# interface ethernet 0</pre>	<p>Configures an interface type and enters interface configuration mode.</p>
<p>Step 4 ip ospf dead-interval minimal hello-multiplier <i>multiplier</i></p> <p>Example:</p> <pre>Router(config-if)# ip ospf dead-interval minimal hello-multiplier 5</pre>	<p>Sets the interval during which at least one hello packet must be received, or else the neighbor is considered down.</p> <ul style="list-style-type: none"> • In the example, OSPF Support for Fast Hello Packets is enabled by specifying the minimal keyword and the hello-multiplier keyword and value. Because the multiplier is set to 5, five hello packets will be sent every second.
<p>Step 5 end</p> <p>Example:</p> <pre>Router(config-if)# end</pre>	<p>(Optional) Saves configuration commands to the running configuration file, exits configuration mode, and returns to privileged EXEC mode.</p> <ul style="list-style-type: none"> • Use this command when you are ready to exit configuration mode and save the configuration to the running configuration file.

Command or Action	Purpose
<p>Step 6 <code>show ip ospf interface</code> [<i>interface-type</i> <i>interface-number</i>]</p> <p>Example:</p> <pre>Router# show ip ospf interface ethernet 1/3</pre>	<p>(Optional) Displays OSPF-related interface information.</p> <ul style="list-style-type: none"> The relevant fields that verify OSPF fast hello packets are indicated in the sample output following this table.

Examples

The following example output verifies that OSPF Support for Fast Hello Packets is configured. In the line that begins with "Timer intervals configured," the hello interval is 200 milliseconds, the dead interval is 1 second, and the next hello packet is due in 76 milliseconds.

```
Router# show ip ospf interface ethernet 1/3
Ethernet1/3 is up, line protocol is up
 Internet Address 172.16.1.2/24, Area 0
  Process ID 1, Router ID 172.17.0.2, Network Type BROADCAST, Cost:1
  Transmit Delay is 1 sec, State DR, Priority 1
  Designated Router (ID) 172.17.0.2, Interface address 172.16.1.2
  Backup Designated router (ID) 172.16.0.1, Interface address 172.16.1.1
  Timer intervals configured, Hello 200 msec, Dead 1, Wait 1, Retransmit 5
    Hello due in 76 msec
Index 2/2, flood queue length 0
Next 0x0(0)/0x0(0)
Last flood scan length is 2, maximum is 3
Last flood scan time is 0 msec, maximum is 0 msec
Neighbor Count is 1, Adjacent neighbor count is 1
  Adjacent with neighbor 172.16.0.1 (Backup Designated Router)
Suppress hello for 0 neighbor(s)
```

Configuration Examples for OSPF Support for Fast Hello Packets

- [Example OSPF Fast Hello Packets, page 114](#)

Example OSPF Fast Hello Packets

The following example configures OSPF fast hello packets; the dead interval is 1 second and five hello packets are sent every second:

```
interface ethernet 1
 ip ospf dead-interval minimal hello-multiplier 5
```

Additional References

The following sections provide references related to OSPF Support for Fast Hello Packets.

Related Documents

Related Topic	Document Title
OSPF commands: complete command syntax, command mode, command history, defaults, usage guidelines, and examples	<i>Cisco IOS IP Routing: OSPF Command Reference</i>

Standards

Standards	Title
No new or modified standards are supported by this feature, and support for existing standards has not been modified by this feature.	--

MIBs

MIBs	MIBs Link
None	To locate and download MIBs for selected platforms, Cisco IOS releases, and feature sets, use Cisco MIB Locator found at the following URL: http://www.cisco.com/go/mibs

RFCs

RFCs	Title
None	--

Technical Assistance

Description	Link
The Cisco Support and Documentation website provides online resources to download documentation, software, and tools. Use these resources to install and configure the software and to troubleshoot and resolve technical issues with Cisco products and technologies. Access to most tools on the Cisco Support and Documentation website requires a Cisco.com user ID and password.	http://www.cisco.com/cisco/web/support/index.html

Feature Information for OSPF Support for Fast Hello Packets

The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software

release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Table 8 **Feature Information for OSPF Support for Fast Hello Packets**

Feature Name	Releases	Feature Information
OSPF Support for Fast Hello Packets	12.0(23)S 12.2(18)S 12.2(27)SBC 12.2(15)T	The OSPF Support for Fast Hello Packets feature provides a way to configure the sending of hello packets in intervals less than 1 second. Such a configuration would result in faster convergence in an Open Shortest Path First (OSPF) network. The following command was introduced: ip ospf dead-interval .

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OSPF Incremental SPF

The Open Shortest Path First (OSPF) protocol can be configured to use an incremental SPF algorithm for calculating the shortest path first routes. Incremental SPF is more efficient than the full SPF algorithm, thereby allowing OSPF to converge faster on a new routing topology in reaction to a network event.

Your software release may not support all the features documented in this module. For the latest feature information and caveats, see the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the [Feature Information for OSPF Incremental SPF](#), page 120.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to <http://www.cisco.com/go/cfn>. An account on Cisco.com is not required.

- [Finding Feature Information](#), page 117
- [Prerequisites for OSPF Incremental SPF](#), page 117
- [Information About OSPF Incremental SPF](#), page 117
- [How to Enable OSPF Incremental SPF](#), page 118
- [Configuration Examples for OSPF Incremental SPF](#), page 119
- [Additional References](#), page 119
- [Feature Information for OSPF Incremental SPF](#), page 120

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest feature information and caveats, see the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the Feature Information Table at the end of this document.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Prerequisites for OSPF Incremental SPF

It is presumed that you have OSPF configured in your network.

Information About OSPF Incremental SPF

OSPF uses Dijkstra's SPF algorithm to compute the shortest path tree (SPT). During the computation of the SPT, the shortest path to each node is discovered. The topology tree is used to populate the routing table with routes to IP networks. When changes to a Type-1 or Type-2 link-state advertisement (LSA) occur in an area, the entire SPT is recomputed. In many cases, the entire SPT need not be recomputed because most of the tree remains unchanged. Incremental SPF allows the system to recompute only the affected part of the tree. Recomputing only a portion of the tree rather than the entire tree results in faster OSPF convergence and saves CPU resources. Note that if the change to a Type-1 or Type-2 LSA occurs in the calculating router itself, then the full SPT is performed.

Incremental SPF is scheduled in the same way as the full SPF. Routers enabled with incremental SPF and routers not enabled with incremental SPF can function in the same internetwork.

How to Enable OSPF Incremental SPF

- [Enabling Incremental SPF, page 118](#)

Enabling Incremental SPF

This section describes how to enable incremental SPF.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **router ospf** *process-id*
4. **ispf**
5. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	enable Example: Router> enable	Enables privileged EXEC mode. <ul style="list-style-type: none"> • Enter your password if prompted.
Step 2	configure terminal Example: Router# configure terminal	Enters global configuration mode.

	Command or Action	Purpose
Step 3	router ospf <i>process-id</i> Example: Router(config)# router ospf 1	Configures an OSPF routing process.
Step 4	ispf Example: Router(config-router)# ispf	Enables incremental SPF.
Step 5	end Example: Router(config-router)# end	Exits router configuration mode.

Configuration Examples for OSPF Incremental SPF

- [Example Incremental SPF, page 119](#)

Example Incremental SPF

This example enables incremental SPF:

```
router ospf 1
 ispf
```

Additional References

Related Documents

Related Topic	Document Title
OSPF commands	<i>Cisco IOS IP Routing: OSPF Command Reference</i>

Standards

Standards	Title
No new or modified standards are supported by this feature, and support for existing standards has not been modified by this feature.	--

MIBs

MIBs	MIBs Link
None	To locate and download MIBs for selected platforms, Cisco software releases, and feature sets, use Cisco MIB Locator found at the following URL: http://www.cisco.com/go/mibs

RFCs

RFCs	Title
No new or modified RFCs are supported by this feature, and support for existing RFCs has not been modified by this feature.	--

Technical Assistance

Description	Link
The Cisco Support and Documentation website provides online resources to download documentation, software, and tools. Use these resources to install and configure the software and to troubleshoot and resolve technical issues with Cisco products and technologies. Access to most tools on the Cisco Support and Documentation website requires a Cisco.com user ID and password.	http://www.cisco.com/cisco/web/support/index.html

Feature Information for OSPF Incremental SPF

The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

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Table 9 Feature Information for OSPF Incremental SPF

Feature Name	Releases	Feature Information
OSPF Incremental SPF	12.0(24)S 12.3(2)T 12.2(18)S 12.2(27)SBC 12.2(33)SRA 12.2(33)XNE Cisco IOS XE 3.1.0 SG	<p>OSPF can be configured to use an incremental SPF algorithm for calculating the shortest path first routes. Incremental SPF is slightly more efficient than the full SPF algorithm, thereby allowing OSPF to converge faster on a new routing topology in reaction to a network event</p> <p>The following commands are introduced or modified in the feature documented in this module:</p> <ul style="list-style-type: none"> • ispf

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OSPF Limit on Number of Redistributed Routes

Open Shortest Path First (OSPF) supports a user-defined maximum number of prefixes (routes) that are allowed to be redistributed into OSPF from other protocols or other OSPF processes. Such a limit could help prevent the router from being flooded by too many redistributed routes.

- [Finding Feature Information, page 123](#)
- [Prerequisites for OSPF Limit on Number of Redistributed Routes, page 123](#)
- [Information About OSPF Limit on Number of Redistributed Routes, page 123](#)
- [How to Configure OSPF Limit the Number of OSPF Redistributed Routes, page 124](#)
- [Configuration Examples for OSPF Limit on Number of Redistributed Routes, page 127](#)
- [Additional References, page 128](#)
- [Feature Information for OSPF Limit on Number of Redistributed Routes, page 129](#)

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest feature information and caveats, see the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the Feature Information Table at the end of this document.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Prerequisites for OSPF Limit on Number of Redistributed Routes

It is presumed that you have OSPF configured in your network, along with another protocol or another OSPF process you are redistributing.

Information About OSPF Limit on Number of Redistributed Routes

If someone mistakenly injects a large number of IP routes into OSPF, perhaps by redistributing Border Gateway Protocol (BGP) into OSPF, the network can be severely flooded. Limiting the number of redistributed routes prevents this potential problem.

How to Configure OSPF Limit the Number of OSPF Redistributed Routes

This section contains the following procedures, which are mutually exclusive. That is, you cannot both limit redistributed prefixes and also choose to be warned.

- [Limiting the Number of OSPF Redistributed Routes](#), page 124
- [Requesting a Warning About the Number of Routes Redistributed into OSPF](#), page 126

Limiting the Number of OSPF Redistributed Routes

This task describes how to limit the number of OSPF redistributed routes. If the number of redistributed routes reaches the maximum value configured, no more routes will be redistributed.

The redistribution limit applies to all IP redistributed prefixes, including summarized ones. The redistribution limit does not apply to default routes or prefixes that are generated as a result of Type-7 to Type-5 translation.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **router ospf** *process-id*
4. **redistribute protocol** [*process-id*][*as-number*] [**metric** *metric-value*] [**metric-type** *type-value*] [**match**{**internal**| **external 1**| **external 2**}] [**tag** *tag-value*] [**route-map** *map-tag*] [**subnets**]
5. **redistribute maximum-prefix** *maximum* [*threshold*]
6. **end**
7. **show ip ospf** [*process-id*]

DETAILED STEPS

	Command or Action	Purpose
Step 1	enable Example: Router> enable	Enables privileged EXEC mode. <ul style="list-style-type: none"> • Enter your password if prompted.
Step 2	configure terminal Example: Router# configure terminal	Enters global configuration mode.

Command or Action	Purpose
<p>Step 3 <code>router ospf <i>process-id</i></code></p> <p>Example:</p> <pre>Router(config)# router ospf 1</pre>	<p>Configures an OSPF routing process.</p>
<p>Step 4 <code>redistribute <i>protocol</i> [<i>process-id</i>][<i>as-number</i>] [metric <i>metric-value</i>] [metric-type <i>type-value</i>] [match{internal external 1 external 2}] [tag <i>tag-value</i>] [route-map <i>map-tag</i>] [subnets]</code></p> <p>Example:</p> <pre>Router(config-router)# redistribute eigrp 10</pre>	<p>Redistributes routes from one routing domain into another routing domain.</p>
<p>Step 5 <code>redistribute maximum-prefix <i>maximum</i> [<i>threshold</i>]</code></p> <p>Example:</p> <pre>Router(config-router)# redistribute maximum-prefix 100 80</pre>	<p>Sets a maximum number of IP prefixes that are allowed to be redistributed into OSPF.</p> <ul style="list-style-type: none"> • There is no default value for the <i>maximum</i> argument. • The <i>threshold</i> value defaults to 75 percent. <p>Note If the warning-only keyword had been configured in this command, no limit would be enforced; a warning message is simply logged.</p>
<p>Step 6 <code>end</code></p> <p>Example:</p> <pre>Router(config-router)# end</pre>	<p>Exits router configuration mode.</p>
<p>Step 7 <code>show ip ospf [<i>process-id</i>]</code></p> <p>Example:</p> <pre>Router# show ip ospf 1</pre>	<p>(Optional) Displays general information about OSPF routing processes.</p> <ul style="list-style-type: none"> • If a redistribution limit was configured, the output will include the maximum limit of redistributed prefixes and the threshold for warning messages.

Requesting a Warning About the Number of Routes Redistributed into OSPF

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **router ospf** *process-id*
4. **redistribute protocol** [*process-id*][*as-number*] [**metric** *metric-value*] [**metric-type** *type-value*] [**match**{**internal**| **external 1**| **external 2**}] [**tag** *tag-value*] [**route-map** *map-tag*] [**subnets**]
5. **redistribute maximum-prefix** *maximum* [*threshold*] **warning-only**
6. **end**

DETAILED STEPS

Command or Action	Purpose
Step 1 enable Example: <pre>Router> enable</pre>	Enables privileged EXEC mode. <ul style="list-style-type: none"> • Enter your password if prompted.
Step 2 configure terminal Example: <pre>Router# configure terminal</pre>	Enters global configuration mode.
Step 3 router ospf <i>process-id</i> Example: <pre>Router(config)# router ospf 1</pre>	Configures an OSPF routing process.
Step 4 redistribute protocol [<i>process-id</i>][<i>as-number</i>] [metric <i>metric-value</i>] [metric-type <i>type-value</i>] [match { internal external 1 external 2 }] [tag <i>tag-value</i>] [route-map <i>map-tag</i>] [subnets] Example: <pre>Router(config-router)# redistribute eigrp 10</pre>	Redistributes routes from one routing domain into another routing domain. Note The redistribution count applies to external IP prefixes, including summarized routes. Default routes and prefixes that are generated as a result of Type-7 to Type-5 translation are not considered.

Command or Action	Purpose
<p>Step 5 <code>redistribute maximum-prefix <i>maximum</i> [<i>threshold</i>] warning-only</code></p> <p>Example:</p> <pre>Router(config-router)# redistribute maximum- prefix 1000 80 warning-only</pre>	<p>Causes a warning message to be logged when the maximum number of IP prefixes has been redistributed into OSPF.</p> <ul style="list-style-type: none"> Because the warning-only keyword is included, no limit is imposed on the number of redistributed prefixes into OSPF. There is no default value for the <i>maximum</i> argument. The <i>threshold</i> value defaults to 75 percent. This example causes two warnings: one at 80 percent of 1000 (800 routes redistributed) and another at 1000 routes redistributed.
<p>Step 6 <code>end</code></p> <p>Example:</p> <pre>Router(config-router)# end</pre>	<p>Exits router configuration mode.</p>

Configuration Examples for OSPF Limit on Number of Redistributed Routes

- [Example OSPF Limit on Number of Redistributed Routes, page 127](#)
- [Example Requesting a Warning About the Number of Redistributed Routes, page 128](#)

Example OSPF Limit on Number of Redistributed Routes

This example sets a maximum of 1200 prefixes that can be redistributed into OSPF process 1. Prior to reaching the limit, when the number of prefixes redistributed reaches 80 percent of 1200 (960 prefixes), a warning message is logged. Another warning is logged when the limit is reached and no more routes are redistributed.

```
router ospf 1
router-id 10.0.0.1
domain-id 5.6.7.8
log-adjacency-changes
timers lsa-interval 2
network 10.0.0.1 0.0.0.0 area 0
network 10.1.5.1 0.0.0.0 area 0
network 10.2.2.1 0.0.0.0 area 0
redistribute static subnets
redistribute maximum-prefix 1200 80
```

Example Requesting a Warning About the Number of Redistributed Routes

This example allows two warning messages to be logged, the first if the number of prefixes redistributed reaches 85 percent of 600 (510 prefixes), and the second if the number of redistributed routes reaches 600. However, the number of redistributed routes is not limited.

```
router ospf 1
 network 10.0.0.0 0.0.0.255 area 0
 redistribute eigrp 10 subnets
 redistribute maximum-prefix 600 85 warning-only
```

Additional References

Related Documents

Related Topic	Document Title
OSPF commands	<i>Cisco IOS IP Routing: OSPF Command Reference</i>

Standards

Standards	Title
No new or modified standards are supported by this feature, and support for existing standards has not been modified by this feature.	--

MIBs

MIBs	MIBs Link
None	To locate and download MIBs for selected platforms, Cisco software releases, and feature sets, use Cisco MIB Locator found at the following URL: http://www.cisco.com/go/mibs

RFCs

RFCs	Title
No new or modified RFCs are supported by this feature, and support for existing RFCs has not been modified by this feature.	--

Technical Assistance

Description	Link
<p>The Cisco Support and Documentation website provides online resources to download documentation, software, and tools. Use these resources to install and configure the software and to troubleshoot and resolve technical issues with Cisco products and technologies. Access to most tools on the Cisco Support and Documentation website requires a Cisco.com user ID and password.</p>	<p>http://www.cisco.com/cisco/web/support/index.html</p>

Feature Information for OSPF Limit on Number of Redistributed Routes

The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

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Table 10 Feature Information for OSPF Limit on Number of Redistributed Routes

Feature Name	Releases	Feature Information
<p>OSPF Limit on Number of Redistributed Routes</p>	<p>12.0(25)S 12.3(2)T 12.2(18)S 12.2(27)SBC Cisco IOS XE 3.1.0 SG</p>	<p>OSPF supports a user-defined maximum number of prefixes (routes) that are allowed to be redistributed into OSPF from other protocols or other OSPF processes. Such a limit could help prevent the router from being flooded by too many redistributed routes.</p> <p>The following commands are introduced or modified in the feature documented in this module:</p> <ul style="list-style-type: none"> • redistribute maximum-prefix • show ip ospf • show ip ospf database

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OSPF Link-State Advertisement Throttling

The OSPF Link-State Advertisement (LSA) Throttling feature provides a dynamic mechanism to slow down link-state advertisement (LSA) updates in OSPF during times of network instability. It also allows faster Open Shortest Path First (OSPF) convergence by providing LSA rate limiting in milliseconds.

History for the OSPF LSA Throttling Feature

Release	Modification
12.0(25)S	This feature was introduced.
12.3(2)T	This feature was integrated into Cisco IOS Release 12.3(2)T.
12.2(18)S	This feature was integrated into Cisco IOS Release 12.2(18)S.
12.2(27)SBC	This feature was integrated into Cisco IOS Release 12.2(27)SBC.

Finding Support Information for Platforms and Cisco IOS Software Images

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- [Finding Feature Information, page 131](#)
- [Prerequisites for OSPF LSA Throttling, page 132](#)
- [Information About OSPF LSA Throttling, page 132](#)
- [How to Customize OSPF LSA Throttling, page 132](#)
- [Configuration Examples for OSPF LSA Throttling, page 138](#)
- [Additional References, page 139](#)

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest feature information and caveats, see the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the Feature Information Table at the end of this document.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Prerequisites for OSPF LSA Throttling

It is presumed that you have OSPF configured in your network.

Information About OSPF LSA Throttling

- [Benefits of OSPF LSA Throttling, page 132](#)
- [How OSPF LSA Throttling Works, page 132](#)

Benefits of OSPF LSA Throttling

Prior to the OSPF LSA Throttling feature, LSA generation was rate-limited for 5 seconds. That meant that changes in an LSA could not be propagated in milliseconds, so the OSPF network could not achieve millisecond convergence.

The OSPF LSA Throttling feature is enabled by default and allows faster OSPF convergence (in milliseconds). This feature can be customized. One command controls the generation (sending) of LSAs and another command controls the receiving interval. This feature also provides a dynamic mechanism to slow down the frequency of LSA updates in OSPF during times of network instability.

How OSPF LSA Throttling Works

The **timers throttle lsa all** command controls the generation (sending) of LSAs. The first LSA is always generated immediately upon an OSPF topology change, and the next LSA generated is controlled by the minimum start interval. The subsequent LSAs generated for the same LSA are rate-limited until the maximum interval is reached. The "same LSA" is defined as an LSA instance that contains the same LSA ID number, LSA type, and advertising router ID.

The **timers lsa arrival** command controls the minimum interval for accepting the same LSA. If an instance of the same LSA arrives sooner than the interval that is set, the LSA is dropped. It is recommended that the arrival interval be less than or equal to the hold-time interval of the **timers throttle lsa all** command.

How to Customize OSPF LSA Throttling

- [Customizing OSPF LSA Throttling, page 133](#)

Customizing OSPF LSA Throttling

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **router ospf *process-id***
4. **timers throttle lsa all *start-interval hold-interval max-interval***
5. **timers lsa arrival *milliseconds***
6. **end**
7. **show ip ospf timers rate-limit**
8. **show ip ospf**

DETAILED STEPS

Command or Action	Purpose
<p>Step 1 enable</p> <p>Example:</p> <pre>Router> enable</pre>	<p>Enables privileged EXEC mode.</p> <ul style="list-style-type: none"> • Enter your password if prompted.
<p>Step 2 configure terminal</p> <p>Example:</p> <pre>Router# configure terminal</pre>	<p>Enters global configuration mode.</p>
<p>Step 3 router ospf <i>process-id</i></p> <p>Example:</p> <pre>Router(config)# router ospf 1</pre>	<p>Configures an OSPF routing process.</p>
<p>Step 4 timers throttle lsa all <i>start-interval hold-interval max-interval</i></p> <p>Example:</p> <pre>Router(config-router)# timers throttle lsa all 100 10000 45000</pre>	<p>(Optional) Sets the rate-limiting values (in milliseconds) for LSA generation.</p> <ul style="list-style-type: none"> • The default values are as follows: <ul style="list-style-type: none"> ◦ <i>start-interval</i> is 0 milliseconds ◦ <i>hold-interval</i> is 5000 milliseconds ◦ <i>max-interval</i> is 5000 milliseconds

Command or Action	Purpose
<p>Step 5 <code>timers lsa arrival <i>milliseconds</i></code></p> <p>Example:</p> <pre>Router(config-router)# timers lsa arrival 2000</pre>	<p>(Optional) Sets the minimum interval (in milliseconds) between instances of receiving the same LSA.</p> <ul style="list-style-type: none"> The default value is 1000 milliseconds. We suggest you keep the <i>milliseconds</i> value of the LSA arrival timer less than or equal to the neighbors' <i>hold-interval</i> value of the timers throttle lsa all command.
<p>Step 6 <code>end</code></p> <p>Example:</p> <pre>Router(config-router)# end</pre>	<p>Exits router configuration mode.</p>
<p>Step 7 <code>show ip ospf timers rate-limit</code></p> <p>Example:</p> <pre>Router# show ip ospf timers rate-limit</pre> <p>Example:</p> <pre>LSAID: 10.1.1.1 Type: 1 Adv Rtr: 172.16.2.2 Due in: 00:00:00.028</pre> <p>Example:</p> <pre>LSAID: 192.168.4.1 Type: 3 Adv Rtr: 172.17.2.2 Due in: 00:00:00.028</pre>	<p>(Optional) Displays a list of the LSAs in the rate limit queue (about to be generated).</p> <ul style="list-style-type: none"> The example shows two LSAs in the queue. Each LSA is identified by LSA ID number, Type (of LSA), Advertising router ID, and the time in hours:minutes:seconds (to the milliseconds) when the LSA is due to be generated.

Command or Action	Purpose
<p>Step 8 <code>show ip ospf</code></p> <p>Example:</p> <pre>Router# show ip ospf</pre> <p>Example:</p> <pre>Routing Process "ospf 4" with ID 10.10.24.4</pre> <p>Example:</p> <pre>Supports only single TOS(TOS0) routes</pre> <p>Example:</p> <pre>Supports opaque LSA</pre> <p>Example:</p> <pre>Supports Link-local Signaling (LLS)</pre> <p>Example:</p> <pre>Initial SPF schedule delay 5000 msecs</pre> <p>Example:</p> <pre>Minimum hold time between two consecutive SPF's 10000 msecs</pre> <p>Example:</p> <pre>Maximum wait time between two consecutive SPF's 10000 msecs</pre> <p>Example:</p> <pre>Incremental-SPF disabled</pre>	<p>(Optional) Displays information about OSPF.</p> <ul style="list-style-type: none"> The output lines shown in bold in the example indicate the LSA throttling values.

Command or Action	Purpose
<p>Example:</p> <p>Initial LSA throttle delay 100 msecs</p>	
<p>Example:</p> <p>Minimum hold time for LSA throttle 10000 msecs</p>	
<p>Example:</p> <p>Maximum wait time for LSA throttle 45000 msecs</p>	
<p>Example:</p> <p>Minimum LSA arrival 1000 msecs</p>	
<p>Example:</p> <p>LSA group pacing timer 240 secs</p>	
<p>Example:</p> <p>Interface flood pacing timer 33 msecs</p>	
<p>Example:</p> <p>Retransmission pacing timer 66 msecs</p>	
<p>Example:</p> <p>Number of external LSA 0. Checksum Sum 0x0</p>	
<p>Example:</p> <p>Number of opaque AS LSA 0. Checksum Sum 0x0</p>	

Command or Action	Purpose
<p>Example:</p> <pre>Number of DCbitless external and opaque AS LSA 0</pre>	
<p>Example:</p> <pre>Number of DoNotAge external and opaque AS LSA 0</pre>	
<p>Example:</p> <pre>Number of areas in this router is 1. 1 normal 0 stub 0 nssa</pre>	
<p>Example:</p> <pre>External flood list length 0</pre>	
<p>Example:</p> <pre>Area 24</pre>	
<p>Example:</p> <pre>Number of interfaces in this area is 2</pre>	
<p>Example:</p> <pre>Area has no authentication</pre>	
<p>Example:</p> <pre>SPF algorithm last executed 04:28:18.396 ago</pre>	
<p>Example:</p> <pre>SPF algorithm executed 8 times</pre>	
<p>Example:</p> <pre>Area ranges are</pre>	

Command or Action	Purpose
<p>Example:</p> <pre>Number of LSA 4. Checksum Sum 0x23EB9</pre>	
<p>Example:</p> <pre>Number of opaque link LSA 0. Checksum Sum 0x0</pre>	
<p>Example:</p> <pre>Number of Dcbitless LSA 0</pre>	
<p>Example:</p> <pre>Number of indication LSA 0</pre>	
<p>Example:</p> <pre>Number of DoNotAge LSA 0</pre>	
<p>Example:</p> <pre>Flood list length 0</pre>	

Configuration Examples for OSPF LSA Throttling

- [Example OSPF LSA Throttling, page 138](#)

Example OSPF LSA Throttling

This example customizes OSPF LSA throttling so that the start interval is 200 milliseconds, the hold interval is 10,000 milliseconds, and the maximum interval is 45,000 milliseconds. The minimum interval between instances of receiving the same LSA is 2000 milliseconds.

```
router ospf 1
 log-adjacency-changes
 timers throttle lsa all 200 10000 45000
 timers lsa arrival 2000
 network 10.10.4.0 0.0.0.255 area 24
 network 10.10.24.0 0.0.0.255 area 24
```

Additional References

The following sections provide references related to OSPF LSA throttling.

Related Documents

Related Topic	Document Title
OSPF commands	<i>Cisco IOS IP Routing: OSPF Command Reference</i>

Standards

Standards	Title
No new or modified standards are supported by this feature, and support for existing standards has not been modified by this feature.	--

MIBs

MIBs	MIBs Link
None	To locate and download MIBs for selected platforms, Cisco IOS releases, and feature sets, use Cisco MIB Locator found at the following URL: http://www.cisco.com/go/mibs

RFCs

RFCs	Title
No new or modified RFCs are supported by this feature, and support for existing RFCs has not been modified by this feature.	--

Technical Assistance

Description	Link
The Cisco Support and Documentation website provides online resources to download documentation, software, and tools. Use these resources to install and configure the software and to troubleshoot and resolve technical issues with Cisco products and technologies. Access to most tools on the Cisco Support and Documentation website requires a Cisco.com user ID and password.	http://www.cisco.com/cisco/web/support/index.html

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OSPF Support for Unlimited Software VRFs per PE Router

In a Multiprotocol Label Switching--Virtual Private Network (MPLS-VPN) deployment, each VPN routing and forwarding instance (VRF) needs a separate Open Shortest Path First (OSPF) process when configured to run OSPF. The OSPF Support for Unlimited Software VRFs per Provider Edge (PE) Router feature addresses the scalability issue for OSPF VPNs by eliminating the OSPF VPN limit of 32 processes.

History for the OSPF Support for Unlimited Software VRFs per Provider Edge Router Feature

Release	Modification
12.3(4)T	This feature was introduced.
12.0(27)S	This feature was integrated into Cisco IOS Release 12.0(27)S.
12.2(25)S	This feature was integrated into Cisco IOS Release 12.2(25)S.
12.2(18)SXE	This feature was integrated into Cisco IOS Release 12.2(18)SXE.
12.2(27)SBC	This feature was integrated into Cisco IOS Release 12.2(27)SBC.

Finding Support Information for Platforms and Cisco IOS Software Images

Use Cisco Feature Navigator to find information about platform support and Cisco IOS software image support. Access Cisco Feature Navigator at <http://www.cisco.com/go/fn>. You must have an account on Cisco.com. If you do not have an account or have forgotten your username or password, click **Cancel** at the login dialog box and follow the instructions that appear.

- [Finding Feature Information, page 142](#)
- [Prerequisites for OSPF Support for Unlimited Software VRFs per PE Router, page 142](#)
- [Restrictions for OSPF Support for Unlimited Software VRFs per PE Router, page 142](#)
- [Information About OSPF Support for Unlimited Software VRFs per PE Router, page 142](#)
- [How to Configure OSPF Support for Unlimited Software VRFs per PE Router, page 142](#)
- [Configuration Examples for OSPF Support for Unlimited Software VRFs per PE Router, page 144](#)
- [Additional References, page 145](#)
- [Glossary, page 146](#)

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest feature information and caveats, see the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the Feature Information Table at the end of this document.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Prerequisites for OSPF Support for Unlimited Software VRFs per PE Router

You must have OSPF configured in your network.

Restrictions for OSPF Support for Unlimited Software VRFs per PE Router

Only 32 processes per VRF can be supported. For different VRF processes, there is no limit.

Information About OSPF Support for Unlimited Software VRFs per PE Router

Before Cisco IOS Releases 12.3(4)T and 12.0(27)S, a separate OSPF process was necessary for each VRF that receives VPN routes via OSPF. When VPNs are deployed, an MPLS Provider Edge (PE) router will be running both multiprotocol Border Gateway Protocol (BGP) for VPN distribution, and Interior Gateway Protocol (IGP) for PE-P connectivity. It is a common scenario when OSPF is used as the IGP between a customer edge (CE) router and a PE router. OSPF was not scalable in VPN deployment because of the limit of 32 processes. By default one process is used for connected routes and another process is used for static routes, therefore only 28 processes can be created for VRFs.

The OSPF Support for Unlimited Software VRFs per Provider Edge Router feature allows for an approximate range of 300 to 10,000 VRFs, depending on the particular platform and on the applications, processes, and protocols that are currently running on the platform.

How to Configure OSPF Support for Unlimited Software VRFs per PE Router

- [Configuring and Verifying Unlimited Software VRFs per Provider Edge Router, page 143](#)

Configuring and Verifying Unlimited Software VRFs per Provider Edge Router

SUMMARY STEPS

1. enable
2. configure terminal
3. router ospf *process-id* [vrf *vpn-name*]
4. end
5. show ip ospf [*process-id*]

DETAILED STEPS

Command or Action	Purpose
<p>Step 1 enable</p> <p>Example:</p> <pre>Router> enable</pre>	<p>Enables privileged EXEC mode.</p> <ul style="list-style-type: none"> • Enter your password if prompted.
<p>Step 2 configure terminal</p> <p>Example:</p> <pre>Router# configure terminal</pre>	<p>Enters global configuration mode.</p>
<p>Step 3 router ospf <i>process-id</i> [vrf <i>vpn-name</i>]</p> <p>Example:</p> <pre>Router(config)# router ospf 1 vrf crf-1</pre>	<p>Enables OSPF routing.</p> <ul style="list-style-type: none"> • The <i>process-id</i> argument identifies the OSPF process. • Use the vrf keyword and <i>vpn-name</i> argument to identify a VPN. <p>Note You now can configure as many OSPF VRF processes as needed.</p>
<p>Step 4 end</p> <p>Example:</p> <pre>Router(config-router)# end</pre>	<p>Returns to privileged EXEC mode.</p>
<p>Step 5 show ip ospf [<i>process-id</i>]</p> <p>Example:</p> <pre>Router# show ip ospf 1</pre>	<p>Displays general information about OSPF routing processes.</p>

Configuration Examples for OSPF Support for Unlimited Software VRFs per PE Router

- [Example Configuring OSPF Support for Unlimited Software VRFs per PE Router, page 144](#)
- [Example Verifying OSPF Support for Unlimited Software VRFs per PE Router, page 144](#)

Example Configuring OSPF Support for Unlimited Software VRFs per PE Router

This example shows a basic OSPF configuration using the **router ospf** command to configure OSPF VRF processes for the VRFs first, second, and third:

```
Router> enable
Router# configure terminal
Router(config)# router ospf 12 vrf first
Router(config)# router ospf 13 vrf second
Router(config)# router ospf 14 vrf third
Router(config)#
exit
```

Example Verifying OSPF Support for Unlimited Software VRFs per PE Router

This example illustrates the output display from the **show ip ospf** command to verify that the OSPF VRF process 12 has been created for the VRF named first. The output that relates to the VRF first appears in bold.

```
Router# show ip ospf 12
main ID type 0x0005, value 0.0.0.100
Supports only single TOS(TOS0) routes
Supports opaque LSA
Supports Link-local Signaling (LLS)
Supports area transit capability
Connected to MPLS VPN Superbackbone, VRF first
It is an area border router
Initial SPF schedule delay 5000 msec
Minimum hold time between two consecutive SPF 10000 msec
Maximum wait time between two consecutive SPF 10000 msec
Incremental-SPF disabled
Minimum LSA interval 5 secs
Minimum LSA arrival 1000 msec
LSA group pacing timer 240 secs
Interface flood pacing timer 33 msec
Retransmission pacing timer 66 msec
Number of external LSA 0. Checksum Sum 0x0
Number of opaque AS LSA 0. Checksum Sum 0x0
Number of DCbitless external and opaque AS LSA 0
Number of DoNotAge external and opaque AS LSA 0
Number of areas in this router is 1. 1 normal 0 stub 0 nssa
Number of areas transit capable is 0
External flood list length 0
Area BACKBONE(0)
Number of interfaces in this area is 1
Area has no authentication
SPF algorithm last executed 00:00:15.204 ago
SPF algorithm executed 2 times
Area ranges are
Number of LSA 1. Checksum Sum 0xD9F3
Number of opaque link LSA 0. Checksum Sum 0x0
Number of DCbitless LSA 0
```

```

Number of indication LSA 0
Number of DoNotAge LSA 0
Flood list length 0

```

Additional References

The following sections provide references related to the OSPF Support for Unlimited Software VRFs per Provider Edge Router feature.

Related Documents

Related Topic	Document Title
Configuring OSPF	<i>Cisco IOS IP Routing: OSPF Configuration Guide</i>

Standards

Standards	Title
None	--

MIBs

MIBs	MIBs Link
None	To locate and download MIBs for selected platforms, Cisco IOS releases, and feature sets, use Cisco MIB Locator found at the following URL: http://www.cisco.com/go/mibs

RFCs

RFCs	Title
None	--

Technical Assistance

Description	Link
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Glossary

multiprotocol BGP --Border Gateway Protocol (BGP) can be used as an interdomain routing protocol in networks that use Connectionless Network Service (CLNS) as the network-layer protocol.

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OSPF Area Transit Capability

The OSPF Area Transit Capability feature provides an OSPF Area Border Router (ABR) with the ability to discover shorter paths through the transit area for forwarding traffic that would normally need to travel through the virtual-link path. This functionality allows Cisco IOS software to be compliant with RFC 2328.

- [Finding Feature Information, page 147](#)
- [Information About OSPF Area Transit Capability, page 147](#)
- [How to Disable OSPF Area Transit Capability, page 147](#)
- [Additional References, page 148](#)
- [Feature Information for OSPF Area Transit Capability, page 149](#)

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest feature information and caveats, see the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the Feature Information Table at the end of this document.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Information About OSPF Area Transit Capability

The OSPF Area Transit Capability feature is enabled by default. RFC 2328 defines OSPF area transit capability as the ability of the area to carry data traffic that neither originates nor terminates in the area itself. This capability enables the OSPF ABR to discover shorter paths through the transit area and forward traffic along those paths rather than using the virtual link or path, which are not as optimal.

For a detailed description of OSPF area transit capability, see RFC 2328, *OSPF Version 2*, at the following URL:

<http://www.faqs.org/rfcs/rfc2328.html>

How to Disable OSPF Area Transit Capability

- [Disabling OSPF Area Transit Capability on an Area Border Router, page 148](#)

Disabling OSPF Area Transit Capability on an Area Border Router

This task describes how to disable the OSPF Area Transit Capability feature on an OSPF ABR.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **router ospf** *process-id* [**vrf** *vpn-name*]
4. **no capability transit**

DETAILED STEPS

Command or Action	Purpose
Step 1 enable Example: Router> enable	Enables privileged EXEC mode. <ul style="list-style-type: none"> • Enter your password if prompted.
Step 2 configure terminal Example: Router# configure terminal	Enters global configuration mode.
Step 3 router ospf <i>process-id</i> [vrf <i>vpn-name</i>] Example: Router(config)# router ospf 100	Enables OSPF routing and enters router configuration mode. <ul style="list-style-type: none"> • The <i>process-id</i> argument identifies the OSPF process.
Step 4 no capability transit Example: Router(config-router)# no capability transit	Disables OSPF area capability transit on all areas for a router process.

Additional References

Related Documents

Related Topic	Document Title
Configuring OSPF	"Configuring OSPF" module

Standards

Standard	Title
None	--

MIBs

MIB	MIBs Link
None	To locate and download MIBs for selected platforms, Cisco software releases, and feature sets, use Cisco MIB Locator found at the following URL: http://www.cisco.com/go/mibs

RFCs

RFC	Title
RFC 2328	<i>OSPF Version 2</i>

Technical Assistance

Description	Link
The Cisco Support and Documentation website provides online resources to download documentation, software, and tools. Use these resources to install and configure the software and to troubleshoot and resolve technical issues with Cisco products and technologies. Access to most tools on the Cisco Support and Documentation website requires a Cisco.com user ID and password.	http://www.cisco.com/cisco/web/support/index.html

Feature Information for OSPF Area Transit Capability

The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Table 11 **Feature Information for OSPF Area Transit Capability**

Feature Name	Releases	Feature Information
OSPF Area Transit Capability	12.0(27)S 12.3(7)T 12.2(25)S 12.2(27)SBC 12.2(33)SRA 12.2(33)SXH Cisco IOS XE 3.1.0 SG	<p>The OSPF Area Transit Capability feature provides an OSPF Area Border Router (ABR) the ability to discover shorter paths through the transit area for forwarding traffic that would normally need to travel through the virtual-link path. This functionality allows Cisco IOS software to be compliant with RFC 2328.</p> <p>The following commands are introduced or modified in the feature documented in this module:</p> <ul style="list-style-type: none"> • capability transit

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OSPF Per-Interface Link-Local Signaling

The OSPF Per-Interface Link-Local Signaling feature allows you to selectively enable or disable Link-Local Signaling (LLS) for a specific interface regardless of the global (router level) setting that you have previously configured.

- [Finding Feature Information, page 151](#)
- [Information About OSPF Per-Interface Link-Local Signaling, page 151](#)
- [How to Configure OSPF Per-Interface Link-Local Signaling, page 152](#)
- [Configuration Examples for OSPF Per-Interface Link-Local Signaling, page 153](#)
- [Additional References, page 155](#)
- [Feature Information for OSPF Per-Interface Link-Local Signaling, page 156](#)

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest feature information and caveats, see the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the Feature Information Table at the end of this document.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Information About OSPF Per-Interface Link-Local Signaling

- [Benefits of the OSPF Per-Interface Link-Local Signaling Feature, page 151](#)

Benefits of the OSPF Per-Interface Link-Local Signaling Feature

LLS allows for the extension of existing OSPF packets in order to provide additional bit space. The additional bit space enables greater information per packet exchange between OSPF neighbors. This functionality is used, for example, by the OSPF Nonstop Forwarding (NSF) Awareness feature that allows customer premises equipment (CPE) routers that are NSF-aware to help NSF-capable routers perform nonstop forwarding of packets.

When LLS is enabled at the router level, it is automatically enabled for all interfaces. The OSPF Per-Interface Link-Local Signaling feature allows you to selectively enable or disable LLS for a specific interface. You may want to disable LLS on a per-interface basis depending on your network design. For example, disabling LLS on an interface that is connected to a non-Cisco device that may be noncompliant

with RFC 2328 can prevent problems with the forming of Open Shortest Path First (OSPF) neighbors in the network.

How to Configure OSPF Per-Interface Link-Local Signaling

- [Turning Off LLS on a Per-Interface Basis, page 152](#)

Turning Off LLS on a Per-Interface Basis

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **interface** *type slot /port*
4. **ip address** *ip-address mask [secondary]*
5. **no ip directed-broadcast** [*access-list-number | extended access-list-number*]
6. **ip ospf message-digest-key** *key-id encryption-type md5 key*
7. [**no | default**] **ip ospf lls** [**disable**]

DETAILED STEPS

Command or Action	Purpose
Step 1 enable Example: Router> enable	Enables privileged EXEC mode. <ul style="list-style-type: none"> • Enter your password if prompted.
Step 2 configure terminal Example: Router# configure terminal	Enters global configuration mode.
Step 3 interface <i>type slot /port</i> Example: Router(config)# interface Ethernet 1/0 Example:	Configures an interface type and enters interface configuration mode.

Command or Action	Purpose
<p>Step 4 <code>ip address ip-address mask [secondary]</code></p> <p>Example:</p> <pre>Router(config-if)# ip address 10.2.145.20 255.255.255.0</pre>	Sets a primary or secondary IP address for an interface.
<p>Step 5 <code>no ip directed-broadcast [access-list-number extended access-list-number]</code></p> <p>Example:</p> <pre>Router(config-if)# no ip directed-broadcast</pre>	<p>Drops directed broadcasts destined for the subnet to which that interface is attached, rather than broadcasting them.</p> <ul style="list-style-type: none"> The forwarding of IP directed broadcasts on Ethernet interface 1/0 is disabled.
<p>Step 6 <code>ip ospf message-digest-key key-id encryption-type md5 key</code></p> <p>Example:</p> <pre>Router(config-if)# ip ospf message-digest-key 100 md5 testing</pre>	Enables OSPF Message Digest 5 (MD5) algorithm authentication.
<p>Step 7 <code>[no default] ip ospf lls [disable]</code></p> <p>Example:</p> <pre>Router(config-if)# ip ospf lls disable</pre>	Disables LLS on an interface, regardless of the global (router level) setting.

- [What to Do Next, page 153](#)

What to Do Next

To verify that LLS has been enabled or disabled for a specific interface, use the **show ip ospf interface** command. See the "Example: Configuring and Verifying the OSPF Per-Interface Link-Local Signaling Feature" section for an example of the information displayed.

Configuration Examples for OSPF Per-Interface Link-Local Signaling

- [Example OSPF Per-Interface Link-Local Signaling, page 154](#)

Example OSPF Per-Interface Link-Local Signaling

In the following example, LLS has been enabled on Ethernet interface 1/0 and disabled on Ethernet interface 2/0:

```
interface Ethernet1/0
 ip address 10.2.145.2 255.255.255.0
 no ip directed-broadcast
 ip ospf message-digest-key 1 md5 testing
 ip ospf lls
!
interface Ethernet2/0
 ip address 10.1.145.2 255.255.0.0
 no ip directed-broadcast
 ip ospf message-digest-key 1 md5 testing
!
 ip ospf lls disable
interface Ethernet3/0
 ip address 10.3.145.2 255.255.255.0
 no ip directed-broadcast
!
router ospf 1
 log-adjacency-changes detail
 area 0 authentication message-digest
 redistribute connected subnets
 network 10.0.0.0 0.255.255.255 area 1
 network 10.2.3.0 0.0.0.255 area 1
```

In the following example, the **show ip ospf interface** command has been entered to verify that LLS has been enabled for Ethernet interface 1/0 and disabled for interface Ethernet 2/0:

```
Router# show ip ospf interface
Ethernet1/0 is up, line protocol is up
 Internet Address 10.2.145.2/24, Area 1
 Process ID 1, Router ID 10.22.222.2, Network Type BROADCAST, Cost: 10
 Transmit Delay is 1 sec, State BDR, Priority 1
 Designated Router (ID) 10.2.2.3, Interface address 10.2.145.1
 Backup Designated router (ID) 10.22.222.2, Interface address 10.2.145.2
 Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
   oob-resync timeout 40
   Hello due in 00:00:00
! Supports Link-local Signaling (LLS)
Index 1/1, flood queue length 0
 Next 0x0(0)/0x0(0)
 Last flood scan length is 2, 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 10.2.2.3 (Designated Router)
 Suppress hello for 0 neighbor(s)
Ethernet2/0 is up, line protocol is up
 Internet Address 10.1.145.2/16, Area 1
 Process ID 1, Router ID 10.22.222.2, Network Type BROADCAST, Cost: 10
 Transmit Delay is 1 sec, State BDR, Priority 1
 Designated Router (ID) 10.2.2.3, Interface address 10.1.145.1
 Backup Designated router (ID) 10.22.222.2, Interface address 10.1.145.2
 Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
   oob-resync timeout 40
   Hello due in 00:00:04
! Does not support Link-local Signaling (LLS)
Index 2/2, flood queue length 0
 Next 0x0(0)/0x0(0)
 Last flood scan length is 2, maximum is 11
 Last flood scan time is 0 msec, maximum is 0 msec
 Neighbor Count is 1, Adjacent neighbor count is 1
   Adjacent with neighbor 45.2.2.3 (Designated Router)
 Suppress hello for 0 neighbor(s)
Ethernet3/0 is up, line protocol is up
 Internet Address 10.3.145.2/24, Area 1
 Process ID 1, Router ID 10.22.222.2, Network Type BROADCAST, Cost: 10
```

```

Transmit Delay is 1 sec, State BDR, Priority 1
Designated Router (ID) 10.2.2.3, Interface address 10.3.145.1
Backup Designated router (ID) 10.22.222.2, Interface address 10.3.145.2
Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
  oob-resync timeout 40
  Hello due in 00:00:07
! Supports Link-local Signaling (LLS)
Index 3/3, flood queue length 0
  Next 0x0(0)/0x0(0)
  Last flood scan length is 2, maximum is 11
  Last flood scan time is 0 msec, maximum is 0 msec
  Neighbor Count is 1, Adjacent neighbor count is 1
    Adjacent with neighbor 10.2.2.3 (Designated Router)
  Suppress hello for 0 neighbor(s)

```

Additional References

The following sections provide references related to the OSPF Per-Interface Link-Local Signaling feature.

Related Documents

Related Topic	Document Title
Configuring OSPF	"Configuring OSPF"
Configuring OSPF NSF Awareness	"NSF-OSPF"
OSPF commands	<i>Cisco IOS IP Routing: OSPF Command Reference</i>

Standards

Standards	Title
None	--

MIBs

MIBs	MIBs Link
None	To locate and download MIBs for selected platforms, Cisco IOS releases, and feature sets, use Cisco MIB Locator found at the following URL: http://www.cisco.com/go/mibs

RFCs

RFCs	Title
RFC 2328	<i>OSPF Version 2</i>

Technical Assistance

Description	Link
The Cisco Support and Documentation website provides online resources to download documentation, software, and tools. Use these resources to install and configure the software and to troubleshoot and resolve technical issues with Cisco products and technologies. Access to most tools on the Cisco Support and Documentation website requires a Cisco.com user ID and password.	http://www.cisco.com/cisco/web/support/index.html

Feature Information for OSPF Per-Interface Link-Local Signaling

The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Table 12 Feature Information for OSPF Per-Interface Link-Local Signaling

Feature Name	Releases	Feature Information
OSPF Per-Interface Link-Local Signaling	12.0(27)S 12.3(7)T 12.2(25)S 12.2(18)SXE 12.2(27)SBC 12.2(33)SRA	The OSPF Per-Interface Link-Local Signaling feature allows you to selectively enable or disable Link-Local Signaling (LLS) for a specific interface regardless of the global (router level) setting that you have previously configured. The following command was introduced or modified: ip ospf lls .

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OSPF Link-State Database Overload Protection

The OSPF Link-State Database Overload Protection feature allows you to limit the number of nonself-generated link-state advertisements (LSAs) for a given Open Shortest Path First (OSPF) process. Excessive LSAs generated by other routers in the OSPF domain can substantially drain the CPU and memory resources of the router.

History for the OSPF Link-State Database Overload Protection Feature

Release	Modification
12.0(27)S	This feature was introduced.
12.3(7)T	This feature was integrated into Cisco IOS Release 12.3(7)T.
12.2(25)S	This feature was integrated into Cisco IOS Release 12.2(25)S.
12.2(18)SXE	This feature was integrated into Cisco IOS Release 12.2(18)SXE.
12.2(27)SBC	This feature was integrated into Cisco IOS Release 12.2(27)SBC.

Finding Support Information for Platforms and Cisco IOS Software Images

Use Cisco Feature Navigator to find information about platform support and Cisco IOS software image support. Access Cisco Feature Navigator at <http://www.cisco.com/go/fn>. You must have an account on Cisco.com. If you do not have an account or have forgotten your username or password, click **Cancel** at the login dialog box and follow the instructions that appear.

- [Finding Feature Information, page 160](#)
- [Prerequisites for OSPF Link-State Database Overload Protection, page 160](#)
- [Information About OSPF Link-State Database Overload Protection, page 160](#)
- [How to Configure OSPF Link-State Database Overload Protection, page 161](#)
- [Configuration Examples for OSPF Link-State Database Overload Protection, page 163](#)
- [Additional References, page 164](#)
- [Glossary, page 165](#)

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest feature information and caveats, see the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the Feature Information Table at the end of this document.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Prerequisites for OSPF Link-State Database Overload Protection

It is presumed you have OSPF running on your network.

Information About OSPF Link-State Database Overload Protection

- [Benefits of Using OSPF Link-State Database Overload Protection, page 160](#)
- [How OSPF Link-State Database Overload Protection Works, page 160](#)

Benefits of Using OSPF Link-State Database Overload Protection

The OSPF Link-State Database Overload Protection feature provides a mechanism at the OSPF level to limit the number of nonself-generated LSAs for a given OSPF process. When other routers in the network have been misconfigured, they may generate a high volume of LSAs, for instance, to redistribute large numbers of prefixes. This protection mechanism prevents routers from receiving a large number of LSAs and therefore experiencing CPU and memory shortages.

How OSPF Link-State Database Overload Protection Works

When the OSPF Link-State Database Overload Protection feature is enabled, the router keeps a count of the number of received (nonself-generated) LSAs it has received. When the configured threshold number of LSAs is reached, an error message is logged. When the configured maximum number of LSAs is exceeded, the router will send a notification. If the count of received LSAs is still higher than the configured maximum after one minute, the OSPF process takes down all adjacencies and clears the OSPF database. In this ignore state, all OSPF packets received on any interface that belongs to this OSPF process are ignored and no OSPF packets are generated on any of these interfaces. The OSPF process remains in the ignore state for the time configured by the **ignore-time** keyword of the **max-lsa** command. Each time the OSPF process gets into an ignore state a counter is incremented. If this counter exceeds the number counts configured by the **ignore-count** keyword, the OSPF process stays permanently in the same ignore state and manual intervention is required to get the OSPF process out of the ignore state. The ignore state counter is reset to 0 when the OSPF process remains in the normal state of operation for the amount of time that was specified by the **reset-time** keyword.

If the **warning-only** keyword of the **max-lsa** command has been configured, the OSPF process will send only a warning that the LSA maximum has been exceeded.

How to Configure OSPF Link-State Database Overload Protection

- [Limiting the Number of NonSelf-Generating LSAs for an OSPF Process, page 161](#)

Limiting the Number of NonSelf-Generating LSAs for an OSPF Process

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **router ospf** *process-id*
4. **router-id** *ip-address*
5. **log -adjacency-changes** [**detail**]
6. **max-lsa** *maximum-number* [*threshold-percentage*] [**warning-only**] [**ignore-time** *minutes*] [**ignore-count** *count-number*] [**reset-time** *minutes*]
7. **network** *ip-address wildcard-mask area* *area-id*

DETAILED STEPS

	Command or Action	Purpose
Step 1	enable Example: Router> enable	Enables privileged EXEC mode. <ul style="list-style-type: none"> • Enter your password if prompted.
Step 2	configure terminal Example: Router# configure terminal	Enters global configuration mode.
Step 3	router ospf <i>process-id</i> Example: Router(config)# router ospf 1	Enables OSPF routing. <ul style="list-style-type: none"> • The <i>process-id</i> argument identifies the OSPF process.

Command or Action	Purpose
Step 4 <code>router-id ip-address</code> Example: <pre>Router(config-router)# router-id 10.0.0.1</pre>	Specifies a fixed router ID for an OSPF process.
Step 5 <code>log -adjacency-changes [detail]</code> Example: <pre>Router(config-router)# log-adjacency-changes</pre>	Configures the router to send a syslog message when an OSPF neighbor goes up or down.
Step 6 <code>max-lsa maximum-number [threshold-percentage] [warning-only] [ignore-time minutes] [ignore-count count-number] [reset-time minutes]</code> Example: <pre>Router(config-router)# max-lsa 12000</pre>	Limits the number of nonself-generated LSAs an OSPF routing process can keep in the OSPF link-state database (LSDB).
Step 7 <code>network ip-address wildcard-mask area area-id</code> Example: <pre>Router(config-router)# network 209.165.201.1 255.255.255.255 area 0</pre>	Defines the interfaces on which OSPF runs and defines the area ID for those interfaces.

- [Verifying the Number of Nonself-Generated LSAs on a Router, page 162](#)

Verifying the Number of Nonself-Generated LSAs on a Router

The `show ip ospf` command is entered with the `database-summary` keyword to verify the actual number of nonself-generated LSAs on a router. This command can be used at any given point in time to display lists of information related to the OSPF database for a specific router.

```
Router# show ip ospf 2000 database database-summary

          OSPF Router with ID (192.168.1.3) (Process ID 2000)
Area 0 database summary
  LSA Type      Count   Delete   Maxage
  Router        5         0         0
  Network       2         0         0
  Summary Net   8         2         2
  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     15         2         2
Process 2000 database summary
  LSA Type      Count   Delete   Maxage
  Router        5         0         0
```

```

Network          2          0          0
Summary Net     8          2          2
Summary ASBR    0          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       16
Total          19          2          2

```

Configuration Examples for OSPF Link-State Database Overload Protection

- [Example Setting a Limit for LSA Generation, page 163](#)

Example Setting a Limit for LSA Generation

In the following example, the router is configured to not accept any more nonself-generated LSAs once a maximum of 14,000 has been exceeded:

```

Router(config)# router ospf 1
Router(config-router)# router-id 192.168.0.1
Router(config-router)# log-adjacency-changes
Router(config-router)# max-lsa 14000
Router(config-router)# area 33 nssa
Router(config-router)# network 192.168.0.1 0.0.0.0 area 1
Router(config-router)# network 192.168.5.1 0.0.0.0 area 1
Router(config-router)# network 192.168.2.1 0.0.0.0 area 0

```

In the following example, the **show ip ospf** command has been entered to confirm the configuration:

```

Router# show ip ospf 1
Routing Process "ospf 1" with ID 192.168.0.1
Supports only single TOS(TOS0) routes
Supports opaque LSA
Supports Link-local Signaling (LLS)
Supports area transit capability
Maximum number of non self-generated LSA allowed 14000
  Threshold for warning message 75%
  Ignore-time 5 minutes, reset-time 10 minutes
  Ignore-count allowed 5, current ignore-count 0
It is an area border and autonomous system boundary router

```

In the following example, the following output appears when the **show ip ospf** command has been entered during the time when the router is in the ignore state:

```

Router# show ip ospf 1
Routing Process "ospf 1" with ID 192.168.0.1
Supports only single TOS(TOS0) routes
Supports opaque LSA
Supports Link-local Signaling (LLS)
Supports area transit capability
Maximum number of non self-generated LSA allowed 14000
  Threshold for warning message 75%
  Ignore-time 5 minutes, reset-time 10 minutes
  Ignore-count allowed 5, current ignore-count 1
  Ignoring all neighbors due to max-lsa limit, time remaining: 00:04:52
It is an area border and autonomous system boundary router

```


The following output appears when the **show ip ospf** command has been entered after the router left the ignore state:

```
Router# show ip ospf 1
Routing Process "ospf 1" with ID 192.168.0.1
Supports only single TOS(TOS0) routes
Supports opaque LSA
Supports Link-local Signaling (LLS)
Supports area transit capability
Maximum number of non self-generated LSA allowed 14000
  Threshold for warning message 75%
  Ignore-time 5 minutes, reset-time 10 minutes
  Ignore-count allowed 5, current ignore-count 1 - time remaining: 00:09:51
It is an area border and autonomous system boundary router
```

The following output appears when the **show ip ospf** command has been entered for a router that is permanently in the ignore state:

```
Router# show ip ospf 1
Routing Process "ospf 1" with ID 192.168.0.1
Supports only single TOS(TOS0) routes
Supports opaque LSA
Supports Link-local Signaling (LLS)
Supports area transit capability
Maximum number of non self-generated LSA allowed 14000
  Threshold for warning message 75%
  Ignore-time 5 minutes, reset-time 10 minutes
  Ignore-count allowed 5, current ignore-count 6
  Permanently ignoring all neighbors due to max-lsa limit
It is an area border and autonomous system boundary router
```

Additional References

The following sections provide references related to the OSPF Link-State Database Overload Protection feature.

Related Documents

Related Topic	Document Title
Configuring OSPF	<ul style="list-style-type: none"> "Configuring OSPF" module

Standards

Standards	Title
None	--

MIBs

MIBs	MIBs Link
None	To locate and download MIBs for selected platforms, Cisco IOS releases, and feature sets, use Cisco MIB Locator found at the following URL: http://www.cisco.com/go/mibs

RFCs

RFCs	Title
None	--

Technical Assistance

Description	Link
The Cisco Support and Documentation website provides online resources to download documentation, software, and tools. Use these resources to install and configure the software and to troubleshoot and resolve technical issues with Cisco products and technologies. Access to most tools on the Cisco Support and Documentation website requires a Cisco.com user ID and password.	http://www.cisco.com/cisco/web/support/index.html

Glossary

LSDB --link-state database.

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OSPF MIB Support of RFC 1850 and Latest Extensions

The OSPF MIB Support of RFC 1850 and Latest Extensions feature introduces the capability for Simple Network Management Protocol (SNMP) monitoring on the Open Shortest Path First (OSPF) routing protocol. Users have an improved ability to constantly monitor the changing state of an OSPF network by use of MIB objects to gather information relating to protocol parameters and trap notification objects that can signal the occurrence of significant network events such as transition state changes. The protocol information collected by the OSPF MIB objects and trap objects can be used to derive statistics that will help monitor and improve overall network performance.

- [Finding Feature Information, page 167](#)
- [Prerequisites for OSPF MIB Support of RFC 1850 and Latest Extensions, page 167](#)
- [Restrictions for OSPF MIB Support of RFC 1850 and Latest Extensions, page 168](#)
- [Information About OSPF MIB Support of RFC 1850 and Latest Extensions, page 168](#)
- [How to Enable OSPF MIB Support of RFC 1850 and Latest Extensions, page 173](#)
- [Configuration Examples for OSPF MIB Support of RFC 1850 and Latest Extensions, page 178](#)
- [Where to Go Next, page 178](#)
- [Additional References, page 178](#)
- [Feature Information for OSPF MIB Support of RFC 1850 and Latest Extensions, page 179](#)

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest feature information and caveats, see the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the Feature Information Table at the end of this document.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Prerequisites for OSPF MIB Support of RFC 1850 and Latest Extensions

- OSPF must be configured on the router.

- Simple Network Management Protocol (SNMP) must be enabled on the router before notifications (traps) can be configured or before SNMP GET operations can be performed.

Restrictions for OSPF MIB Support of RFC 1850 and Latest Extensions

For routers that are running Cisco IOS Release 12.0(26)S, 12.2(25)S, 12.2(27)SBC, 12.2(31)SB2 and later releases, the OSPF MIB and CISCO OSPF MIB will be supported only for the first OSPF process (except for MIB objects that are related to virtual links and sham links, and in cases where support for multiple topologies is provided). SNMP traps will be generated for OSPF events that are related to any of the OSPF processes. There is no workaround for this situation.

Information About OSPF MIB Support of RFC 1850 and Latest Extensions

The following sections contain information about MIB objects standardized as part of RFC 1850 and defined in OSPF-MIB and OSPF-TRAP-MIB. In addition, extensions to RFC 1850 objects are described as defined in the two Cisco private MIBs, CISCO-OSPF-MIB and CISCO-OSPF-TRAP-MIB.

- [OSPF MIB Changes to Support RFC 1850, page 168](#)
- [Benefits of the OSPF MIB, page 172](#)

OSPF MIB Changes to Support RFC 1850

- [OSPF MIB, page 168](#)
- [OSPF TRAP MIB, page 169](#)
- [CISCO OSPF MIB, page 170](#)
- [CISCO OSPF TRAP MIB, page 171](#)

OSPF MIB

This section describes the new MIB objects that are provided by RFC 1850 definitions. These OSPF MIB definitions provide additional capacity that is not provided by the standard OSPF MIB that supported the previous RFC 1253. To see a complete set of OSPF MIB objects, see the OSPF-MIB file.

The table below shows the new OSPF-MIB objects that are provided by RFC 1850 definitions. The objects are listed in the order in which they appear within the OSPF-MIB file, per the tables that describe them.

Table 13 *New OSPF-MIB Objects*

OSPF-MIB Table	New MIB Objects
OspfAreaEntry table	<ul style="list-style-type: none"> • OspfAreaSummary • OspfAreaStatus

OSPF-MIB Table	New MIB Objects
OspfStubAreaEntry	<ul style="list-style-type: none"> OspfStubMetricType
OspfAreaRangeEntry	<ul style="list-style-type: none"> OspfAreaRangeEffect
OspfHostEntry	<ul style="list-style-type: none"> OspfHostAreaID
OspfIfEntry	<ul style="list-style-type: none"> OspfIfStatus OspfIfMulticastForwarding OspfIfDemand OspfIfAuthType
OspfVirtIfEntry	<ul style="list-style-type: none"> OspfVirtIfAuthType
OspfNbrEntry	<ul style="list-style-type: none"> OspfNbmaNbrPermanence OspfNbrHelloSuppressed
OspfVirtNbrEntry	<ul style="list-style-type: none"> OspfVirtNbrHelloSuppressed
OspfExtLsdbEntry	<ul style="list-style-type: none"> OspfExtLsdbType OspfExtLsdbLsid OspfExtLsdbRouterId OspfExtLsdbSequence OspfExtLsdbAge OspfExtLsdbChecksum OspfExtLsdbAdvertisement
OspfAreaAggregateEntry	<ul style="list-style-type: none"> OspfAreaAggregateAreaID OspfAreaAggregateLsdbType OspfAreaAggregateNet OspfAreaAggregateMask OspfAreaAggregateStatusospfSetTrap OspfAreaAggregateEffect

OSPF TRAP MIB

This section describes scalar objects and MIB objects that are provided to support FRC 1850.

The following scalar objects are added to OSPF-TRAP-MIB and are listed in the order in which they appear in the OSPF-TRAP-MIB file:

- OspfExtLsdbLimit
- OspfMulticastExtensions
- OspfExitOverflowInterval
- OspfDemandExtensions

The ospfSetTrap control MIB object contains the OSPF trap MIB objects that enable and disable OSPF traps in the IOS CLI. These OSPF trap MIB objects are provided by the RFC 1850 standard OSPF MIB. To

learn how to enable and disable the OSPF traps, see the [How to Enable OSPF MIB Support of RFC 1850 and Latest Extensions](#), page 173.

The table below shows the OSPF trap MIB objects, listed in the order in which they appear within the OSPF-TRAP-MIB file.

Table 14 ***New OSPF-TRAP-MIB Objects***

OSPF Control MIB Object	Trap MIB Objects
ospfSetTrap	<ul style="list-style-type: none"> • ospfIfStateChange • ospfVirtIfStateChange • ospfNbrStateChange • ospfVirtNbrState • ospfIfConfigError • ospfVirtIfConfigError • ospfIfAuthFailure • ospfVirtIfAuthFailure • ospfIfRxBadPacket • ospfVirtIfRxBadPacket • ospfTxRetransmit • ospfVirtIfTxRetransmit • ospfOriginateLsa • ospfMaxAgeLsa

CISCO OSPF MIB

This section describes scalar and Cisco-specific OSPF MIB objects that are provided as extensions to support the RFC 1850 OSPF MIB definitions, to provide capability that the standard MIB cannot provide.

The following scalar objects are added to CISCO-OSPF-MIB:

- cospfRFC1583Compatibility
- cospfOpaqueLsaSupport
- cospfOpaqueASLsaCount
- cospfOpaqueASLsaCksumSum

For each of the following table entries, the new Cisco-specific MIB objects that are provided as extensions to support the RFC 1850 OSPF MIB definitions are listed. To see the complete set of objects for the Cisco-specific OSPF MIB, refer to the CISCO-OSPF-MIB file.

The table below shows the new CISCO-OSPF-MIB objects that are provided by RFC 1850 definitions. The objects are listed in the order in which they appear within the CISCO-OSPF-MIB file, per the tables that describe them.

Table 15 New CISCO-OSPF-MIB Objects

CISCO-OSPF-MIB Table	New MIB Objects
cospfAreaEntry	<ul style="list-style-type: none"> • cospfOpaqueAreaLsaCount • cospfOpaqueAreaLsaCksumSum • cospfAreaNssaTranslatorRole • cospfAreaNssaTranslatorState • cospfAreaNssaTranslatorEvents
cospfLsdbEntry	<ul style="list-style-type: none"> • cospfLsdbType • cospfLsdbSequence • cospfLsdbAge • cospfLsdbChecksum • cospfLsdbAdvertisement
cospfIfEntry	<ul style="list-style-type: none"> • cospfIfLsaCount • cospfIfLsaCksumSum
cospfVirtIfEntry	<ul style="list-style-type: none"> • cospfVirtIfLsaCount • cospfVirtIfLsaCksumSum
cospfLocalLsdbEntry	<ul style="list-style-type: none"> • cospfLocalLsdbIpAddress • cospfLocalLsdbAddressLessIf • cospfLocalLsdbType • cospfLocalLsdbLsid • cospfLocalLsdbRouterId • cospfLocalLsdbSequence • cospfLocalLsdbAge • cospfLocalLsdbChecksum • cospfLocalLsdbAdvertisement
cospfVirtLocalLsdbEntry	<ul style="list-style-type: none"> • cospfVirtLocalLsdbTransitArea • cospfVirtLocalLsdbNeighbor • cospfVirtLocalLsdbType • cospfVirtLocalLsdbLsid • cospfVirtLocalLsdbRouterId • cospfVirtLocalLsdbSequence • cospfVirtLocalLsdbAge • cospfVirtLocalLsdbChecksum • cospfVirtLocalLsdbAdvertisement

CISCO OSPF TRAP MIB

The cospfSetTrapMIB object represents trap events in CISCO-OSPF-TRAP-MIB. This is a bit map, where the first bit represents the first trap. The following MIB objects are TRAP events that have been added to

support RFC 1850. To see a complete set of Cisco OSPF Trap MIB objects, see the CISCO-OSPF-TRAP-MIB file.

The table below shows the trap events described within the cospfSetTrap MIB object in the CISCO-OSPF-TRAP-MIB:

Table 16 *CISCO-OSPF Trap Events*

CISCO-OSPF-TRAP-MIB Trap Events	Trap Event Description
cospfIfConfigError	This trap is generated for mismatched MTU parameter errors that occur when nonvirtual OSPF neighbors are forming adjacencies.
cospfVirtIfConfigError	This trap is generated for mismatched MTU parameter errors when virtual OSPF neighbors are forming adjacencies.
cospfTxRetransmit	This trap is generated in the case of opaque LSAs when packets are sent by a nonvirtual interface. An opaque link-state advertisement (LSA) is used in MPLS traffic engineering to distribute attributes such as capacity and topology of links in a network. The scope of this LSA can be confined to the local network (Type 9, Link-Local), OSPF area (Type 20, Area-Local), or autonomous system (Type 11, AS scope). The information in an opaque LSA can be used by an external application across the OSPF network.
cospfVirtIfTxRetransmit	This trap is generated in the case of opaque LSAs when packets are sent by a virtual interface.
cospfOriginateLsa	This trap is generated when a new opaque LSA is originated by the router when a topology change has occurred.
cospfMaxAgeLsa	The trap is generated in the case of opaque LSAs.
cospfNssaTranslatorStatusChange	The trap is generated if there is a change in the ability of a router to translate OSPF type-7 LSAs into OSPF type-5 LSAs.

For information about how to enable OSPF MIB traps, see the [How to Enable OSPF MIB Support of RFC 1850 and Latest Extensions](#), page 173.

Benefits of the OSPF MIB

The OSPF MIBs (OSPF-MIB and OSPF-TRAP-MIB) and Cisco private OSPF MIBs (CISCO-OSPF-MIB and CISCO-OSPF-TRAP-MIB) allow network managers to more effectively monitor the OSPF routing protocol through the addition of new table objects and trap notification objects that previously were not supported by the RFC 1253 OSPF MIB.

New CLI commands have been added to enable SNMP notifications for OSPF MIB support objects, Cisco-specific errors, retransmission and state-change traps. The SNMP notifications are provided for errors and other significant event information for the OSPF network.

How to Enable OSPF MIB Support of RFC 1850 and Latest Extensions

- [Enabling OSPF MIB Support, page 173](#)
- [Enabling Specific OSPF Traps, page 175](#)
- [Verifying OSPF MIB Traps on the Router, page 177](#)

Enabling OSPF MIB Support

Before the OSPF MIB Support of RFC 1850 and Latest Extensions feature can be used, the SNMP server for the router must be configured.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **snmp-server community *string1* ro**
4. **snmp-server community *string2* rw**
5. **snmp-server host {*hostname* | *ip-address*} [*vrf vrf-name*] [**traps** | **informs**] [**version** {**1** | **2c** | **3** [**auth** | **noauth** | **priv**]}] *community-string* [**udp-port** *port*] [*notification-type*]**
6. **snmp-server enable traps ospf**
7. **end**

DETAILED STEPS

Command or Action	Purpose
Step 1 enable Example: Router> enable	Enables privileged EXEC mode. <ul style="list-style-type: none"> • Enter your password if prompted.
Step 2 configure terminal Example: Router# configure terminal	Enters global configuration mode.

Command or Action	Purpose
<p>Step 3 <code>snmp-server community <i>string1</i> ro</code></p> <p>Example:</p> <pre>Router(config)# snmp-server community public ro</pre>	Enables read access to all objects in the MIB, but does not allow access to the community strings.
<p>Step 4 <code>snmp-server community <i>string2</i> rw</code></p> <p>Example:</p> <pre>Router(config)# snmp-server community private rw</pre>	Enables read and write access to all objects in the MIB, but does not allow access to the community strings.
<p>Step 5 <code>snmp-server host {<i>hostname</i> <i>ip-address</i>} [<i>vrf vrf-name</i>] [<i>traps</i> <i>informs</i>] [<i>version</i> {1 2c 3 [<i>auth</i> <i>noauth</i> <i>priv</i>]}] <i>community-string</i> [<i>udp-port port</i>] [<i>notification-type</i>]</code></p> <p>Example:</p> <pre>Router(config)# snmp-server host 172.20.2.162 version 2c public ospf</pre>	<p>Specifies a recipient (target host) for SNMP notification operations.</p> <ul style="list-style-type: none"> • If no <i>notification-type</i> is specified, all enabled notifications (traps or informs) will be sent to the specified host. • If you want to send only the OSPF notifications to the specified host, you can use the optional ospf keyword as one of the <i>notification-types</i>. (See the example.) Entering the ospf keyword enables the ospfSetTrap trap control MIB object.
<p>Step 6 <code>snmp-server enable traps ospf</code></p> <p>Example:</p> <pre>Router(config)# snmp-server enable traps ospf</pre>	<p>Enables all SNMP notifications defined in the OSPF MIBs.</p> <p>Note This step is required only if you wish to enable all OSPF traps. When you enter the no snmp-server enable traps ospf command, all OSPF traps will be disabled.</p>
<p>Step 7 <code>end</code></p> <p>Example:</p> <pre>Router(config)# end</pre>	Ends your configuration session and exits global configuration mode.

- [What to Do Next, page 174](#)

What to Do Next

If you did not want to enable all OSPF traps, follow the steps in the following section to selectively enable one or more type of OSPF trap:

Enabling Specific OSPF Traps

SUMMARY STEPS

1. `enable`
2. `configure terminal`
3. `snmp-server enable traps ospf cisco-specific errors [config-error] [virt-config-error]`
4. `snmp-server enable traps ospf cisco-specific retransmit [packets] [virt-packets]`
5. `snmp-server enable traps ospf cisco-specific state-change [nssa-trans-change] [shamlink-state-change]`
6. `snmp-server enable traps ospf cisco-specific lsa [lsa-maxage] [lsa-originate]`
7. `snmp-server enable traps ospf errors [authentication-failure] [bad-packet] [config-error] [virt-authentication-failure] [virt-config-error]`
8. `snmp-server enable traps ospf lsa [lsa-maxage] [lsa-originate]`
9. `snmp-server enable traps ospf rate-limit seconds trap-number`
10. `snmp-server enable traps ospf retransmit [packets] [virt-packets]`
11. `snmp-server enable traps ospf state-change [if-state-change] [neighbor-state-change] [virtif-state-change] [virtneighbor-state-change]`

DETAILED STEPS

	Command or Action	Purpose
Step 1	<p><code>enable</code></p> <p>Example:</p> <pre>Router> enable</pre>	<p>Enables privileged EXEC mode.</p> <ul style="list-style-type: none"> • Enter your password if prompted.
Step 2	<p><code>configure terminal</code></p> <p>Example:</p> <pre>Router# configure terminal</pre>	<p>Enters global configuration mode.</p>
Step 3	<p><code>snmp-server enable traps ospf cisco-specific errors [config-error] [virt-config-error]</code></p> <p>Example:</p> <pre>Router(config)# snmp-server enable traps ospf cisco-specific errors config-error</pre>	<p>Enables SNMP notifications for Cisco-specific OSPF configuration mismatch errors.</p> <ul style="list-style-type: none"> • Entering the <code>snmp-server enable traps ospf cisco-specific errors</code> command with the optional <code>virt-config-error</code> keyword enables only the SNMP notifications for configuration mismatch errors on virtual interfaces.

	Command or Action	Purpose
Step 4	<p>snmp-server enable traps ospf cisco-specific retransmit [packets] [virt-packets]</p> <p>Example:</p> <pre>Router(config)# snmp-server enable traps ospf cisco-specific retransmit packets virt-packets</pre>	<p>Enables error traps for Cisco-specific OSPF errors that involve re-sent packets.</p> <ul style="list-style-type: none"> Entering the snmp-server enable traps ospf cisco-specific retransmit command with the optional virt-packets keyword enables only the SNMP notifications for packets that are re-sent on virtual interfaces.
Step 5	<p>snmp-server enable traps ospf cisco-specific state-change [nssa-trans-change] [shamlink-state-change]</p> <p>Example:</p> <pre>Router(config)# snmp-server enable traps ospf cisco-specific state-change</pre>	<p>Enables all error traps for Cisco-specific OSPF transition state changes.</p>
Step 6	<p>snmp-server enable traps ospf cisco-specific lsa [lsa-maxage] [lsa-originate]</p> <p>Example:</p> <pre>Router(config)# snmp-server enable traps ospf cisco-specific lsa</pre>	<p>Enables error traps for opaque LSAs.</p>
Step 7	<p>snmp-server enable traps ospf errors [authentication-failure] [bad-packet] [config-error] [virt-authentication-failure] [virt-config-error]</p> <p>Example:</p> <pre>Router(config)# snmp-server enable traps ospf errors virt-config-error</pre>	<p>Enables error traps for OSPF configuration errors.</p> <ul style="list-style-type: none"> Entering the snmp-server enable traps ospf errors command with the optional virt-config-error keyword enables only the SNMP notifications for OSPF configuration errors on virtual interfaces.
Step 8	<p>snmp-server enable traps ospf lsa [lsa-maxage] [lsa-originate]</p> <p>Example:</p> <pre>Router(config)# snmp-server enable traps ospf lsa</pre>	<p>Enables error traps for OSPF LSA errors.</p>
Step 9	<p>snmp-server enable traps ospf rate-limit <i>seconds trap-number</i></p> <p>Example:</p> <pre>Router(config)# snmp-server enable traps ospf rate- limit 20 20</pre>	<p>Sets the rate limit for how many SNMP OSPF notifications are sent in each OSPF SNMP notification rate-limit window.</p>

	Command or Action	Purpose
Step 10	snmp-server enable traps ospf retransmit [packets] [virt-packets] Example: Router(config)# snmp-server enable traps ospf retransmit	Enables SNMP OSPF notifications for re-sent packets.
Step 11	snmp-server enable traps ospf state-change [if-state-change] [neighbor-state-change] [virtif-state-change] [virtneighbor-state-change] Example: Router(config)# snmp-server enable traps ospf state-change	Enables SNMP OSPF notifications for OSPF transition state changes.

Verifying OSPF MIB Traps on the Router

SUMMARY STEPS

1. enable
2. show running-config [options]

DETAILED STEPS

	Command or Action	Purpose
Step 1	enable Example: Router> enable	Enables privileged EXEC mode. <ul style="list-style-type: none"> • Enter your password if prompted.
Step 2	show running-config [options] Example: Router# show running-config include traps	Displays the contents of the currently running configuration file and includes information about enabled traps. <ul style="list-style-type: none"> • Verifies which traps are enabled.

Configuration Examples for OSPF MIB Support of RFC 1850 and Latest Extensions

- [Example Enabling and Verifying OSPF MIB Support Traps, page 178](#)

Example Enabling and Verifying OSPF MIB Support Traps

The following example enables all OSPF traps.

```
Router# configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)# snmp-server enable traps ospf
Router(config)# end
```

The **show running-config** command is entered to verify that the traps are enabled:

```
Router# show running-config | include traps
snmp-server enable traps ospf
```

Where to Go Next

For more information about SNMP and SNMP operations, see the "Configuring SNMP Support" chapter of the *Cisco IOS Configuration Fundamentals and Network Management Configuration Guide*, Release 12.2.

Additional References

The following sections provide references related to the OSPF MIB Support of RFC 1850 and Latest Extensions feature.

Related Documents

Related Topic	Document Title
SNMP commands	<i>Cisco IOS Configuration Fundamentals and Network Management Command Reference</i>

Standards

Standard	Title
No new or modified standards are supported by this feature, and support for existing standards has not been modified by this feature.	--

MIB

MIB	MIBs Link
<ul style="list-style-type: none"> • CISCO-OSPF-MIB • CISCO-OSPF-TRAP-MIB • OSPF-MIB • OSPF-TRAP-MIB 	To locate and download MIBs for selected platforms, Cisco IOS releases, and feature sets, use Cisco MIB Locator found at the following URL: http://www.cisco.com/go/mibs

RFC

RFC	Title
RFC 1850	<i>OSPF MIB Support</i>

Technical Assistance

Description	Link
The Cisco Support and Documentation website provides online resources to download documentation, software, and tools. Use these resources to install and configure the software and to troubleshoot and resolve technical issues with Cisco products and technologies. Access to most tools on the Cisco Support and Documentation website requires a Cisco.com user ID and password.	http://www.cisco.com/cisco/web/support/index.html

Feature Information for OSPF MIB Support of RFC 1850 and Latest Extensions

The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Table 17 **Feature Information for OSPF MIB Support of RFC 1850 and Latest Extensions**

Feature Name	Releases	Feature Information
OSPF MIB Support of RFC 1850 and Latest Extensions	12.0(26)S 12.3(4)T 12.2(25)S 12.2(27)SBC 12.2(31)SB2	OSPF MIB Support of RFC 1850 and Latest Extensions feature introduces the capability for Simple Network Management Protocol (SNMP) monitoring on the Open Shortest Path First (OSPF) routing protocol. Users have an improved ability to constantly monitor the changing state of an OSPF network by use of MIB objects to gather information relating to protocol parameters and trap notification objects that can signal the occurrence of significant network events such as transition state changes. The protocol information collected by the OSPF MIB objects and trap objects can be used to derive statistics that will help monitor and improve overall network performance.

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Any Internet Protocol (IP) addresses and phone numbers used in this document are not intended to be actual addresses and phone numbers. Any examples, command display output, network topology diagrams, and other figures included in the document are shown for illustrative purposes only. Any use of actual IP addresses or phone numbers in illustrative content is unintentional and coincidental.



OSPF Support for Forwarding Adjacencies over MPLS TE Tunnels

The OSPF Support for Forwarding Adjacencies over MPLS Traffic Engineered Tunnels feature adds Open Shortest Path First (OSPF) support to the Multiprotocol Label Switching (MPLS) Traffic Engineering (TE) Forwarding Adjacency feature, which allows a network administrator to handle a traffic engineering, label-switched path (LSP) tunnel as a link in an Interior Gateway Protocol (IGP) network based on the shortest path first (SPF) algorithm. An OSPF forwarding adjacency can be created between routers in the same area.

History for the OSPF Support for Forwarding Adjacencies over MPLS Traffic Engineered Tunnels Feature

Release	Modification
12.0(24)S	This feature was introduced.
12.2(25)S	This feature was integrated into Cisco IOS Release 12.2(25)S.
12.2(18)SXE	This feature was integrated into Cisco IOS Release 12.2(18)SXE.
12.2(27)SBC	This feature was integrated into Cisco IOS Release 12.2(27)SBC.

Finding Support Information for Platforms and Cisco IOS Software Images

Use Cisco Feature Navigator to find information about platform support and Cisco IOS software image support. Access Cisco Feature Navigator at <http://www.cisco.com/go/fn> . You must have an account on Cisco.com. If you do not have an account or have forgotten your username or password, click **Cancel** at the login dialog box and follow the instructions that appear.

- [Contents, page 182](#)
- [Prerequisites for OSPF Forwarding Adjacency, page 182](#)
- [Information About OSPF Forwarding Adjacency, page 182](#)
- [How to Configure OSPF Forwarding Adjacency, page 182](#)
- [Configuration Examples for OSPF Forwarding Adjacency, page 186](#)
- [Additional References, page 187](#)

Contents

Prerequisites for OSPF Forwarding Adjacency

- OSPF must be configured in your network.
- Cisco Express Forwarding (CEF) must be enabled.
- You should understand MPLS TE tunnels for forwarding adjacency as described in the "[MPLS Traffic Engineering Forwarding Adjacency](#)" module.

Information About OSPF Forwarding Adjacency

Before you configure the OSPF Forwarding Adjacency feature, you should understand the concept described in this section.

- [Benefits of OSPF Forwarding Adjacency, page 182](#)

Benefits of OSPF Forwarding Adjacency

OSPF includes MPLS TE tunnels in the OSPF link-state database in the same way that other links appear for purposes of routing and forwarding traffic. When an MPLS TE tunnel is configured between networking devices, that link is considered a forwarding adjacency. The user can assign a cost to the tunnel to indicate the link's preference. Other networking devices will see the tunnel as a link in addition to the physical link.

How to Configure OSPF Forwarding Adjacency

This section contains the following procedure:

- [Configuring OSPF Forwarding Adjacency, page 182](#)

Configuring OSPF Forwarding Adjacency

This section describes how to configure the OSPF Forwarding Adjacency feature. You must configure a forwarding adjacency on two LSP tunnels bidirectionally, from A to B and B to A. Otherwise, the forwarding adjacency is advertised, but not used in the IGP network.

For the configuration to work, you need to set up a loopback interface with a 32-bit mask, enable CEF, enable MPLS traffic engineering, and set up a routing protocol (OSPF) for the MPLS network.

SUMMARY STEPS

1. enable
2. configure terminal
3. ip cef distributed
4. mpls traffic-eng tunnels
5. interface loopback *number*
6. ip address *ip-address mask*
7. no shutdown
8. exit
9. interface tunnel *number*
10. tunnel mode mpls traffic-eng
11. tunnel mpls traffic-eng forwarding-adjacency {holdtime *value*}
12. ip ospf cost *cost*
13. exit
14. router ospf *process-id*
15. mpls traffic-eng router-id *interface*
16. mpls traffic-eng area *number*
17. end

DETAILED STEPS

	Command or Action	Purpose
Step 1	<p>enable</p> <p>Example:</p> <pre>Router> enable</pre>	<p>Enables privileged EXEC mode.</p> <ul style="list-style-type: none"> • Enter your password if prompted.
Step 2	<p>configure terminal</p> <p>Example:</p> <pre>Router# configure terminal</pre>	<p>Enters global configuration mode.</p>
Step 3	<p>ip cef distributed</p> <p>Example:</p> <pre>Router(config)# ip cef distributed</pre>	<p>Enables Cisco Express Forwarding (CEF).</p>

	Command or Action	Purpose
Step 4	mpls traffic-eng tunnels Example: <pre>Router(config)# mpls traffic-eng tunnels</pre>	Enables MPLS traffic engineering tunnel signaling on a device.
Step 5	interface loopback <i>number</i> Example: <pre>Router(config)# interface loopback0</pre>	Configures a loopback interface and enters interface configuration mode.
Step 6	ip address <i>ip-address mask</i> Example: <pre>Router(config-if)# ip address 10.1.1.1 255.255.255.255</pre>	Configures the IP address and subnet mask of the loopback interface.
Step 7	no shutdown Example: <pre>Router(config-if)# no shutdown</pre>	Enables the interface.
Step 8	exit Example: <pre>Router(config-if)# exit</pre>	Exits interface configuration mode.
Step 9	interface tunnel <i>number</i> Example: <pre>Router(config)# interface tunnel 1</pre>	Designates a tunnel interface for the forwarding adjacency and enters interface configuration mode.
Step 10	tunnel mode mpls traffic-eng Example: <pre>Router(config-if)# tunnel mode mpls traffic-eng</pre>	Sets the mode of a tunnel to MPLS for traffic engineering.

Command or Action	Purpose
<p>Step 11 <code>tunnel mpls traffic-eng forwarding-adjacency {holdtime value}</code></p> <p>Example:</p> <pre>Router(config-if)# tunnel mpls traffic-eng forwarding-adjacency holdtime 10000</pre>	<p>Advertises a TE tunnel as a link in an IGP network.</p> <ul style="list-style-type: none"> The holdtime value keyword argument combination is the time in milliseconds (ms) that a TE tunnel waits after going down before informing the network. The range is 0 to 4,294,967,295 ms. The default value is 0.
<p>Step 12 <code>ip ospf cost cost</code></p> <p>Example:</p> <pre>Router(config-if)# ip ospf cost 4</pre>	<p>(Optional) Configures the cost metric for a tunnel interface to be used as a forwarding adjacency.</p>
<p>Step 13 <code>exit</code></p> <p>Example:</p> <pre>Router(config-if)# exit</pre>	<p>Exits interface configuration mode.</p>
<p>Step 14 <code>router ospf process-id</code></p> <p>Example:</p> <pre>Router(config)# router ospf 1</pre>	<p>Configures an OSPF routing process and enters router configuration mode.</p>
<p>Step 15 <code>mpls traffic-eng router-id interface</code></p> <p>Example:</p> <pre>Router(config-router)# mpls traffic-eng router-id ethernet 1/0</pre>	<p>Specifies that the traffic engineering router identifier for the node is the IP address associated with a given interface.</p>
<p>Step 16 <code>mpls traffic-eng area number</code></p> <p>Example:</p> <pre>Router(config-router)# mpls traffic-eng area 1</pre>	<p>Configures a router running OSPF MPLS so that it floods traffic engineering for the indicated OSPF area.</p>
<p>Step 17 <code>end</code></p> <p>Example:</p> <pre>Router(config-router)# end</pre>	<p>Exits router configuration mode.</p>

Configuration Examples for OSPF Forwarding Adjacency

This section contains an example of configuring OSPF forwarding adjacency:

- [OSPF Forwarding Adjacency Example, page 186](#)

OSPF Forwarding Adjacency Example

In the following example, the tunnel destination is the loopback interface on the other router. The router is configured with OSPF TE extensions and it floods traffic engineering link-state advertisements (LSAs) in OSPF area 0. The traffic engineering router identifier for the node is the IP address associated with Loopback 0. The last five lines of the example set up the routing protocol for the MPLS network, which is OSPF in this case.



Note

Do not use the **mpls traffic-eng autoroute announce** command if you configure a forwarding adjacency in the tunnel.

```
ip routing
ip cef distributed
mpls traffic-eng tunnels
!
interface Loopback0
 ip address 127.0.0.1 255.255.255.255
 no shutdown
!
interface Tunnell
 ip unnumbered Loopback0
 no ip directed-broadcast
 tunnel destination 10.1.1.1
 tunnel mode mpls traffic-eng
 tunnel mpls traffic-eng forwarding-adjacency holdtime 10000
 ip ospf cost 4
 tunnel mpls traffic-eng priority 2 2
 tunnel mpls traffic-eng bandwidth 10
 tunnel mpls traffic-eng path-option 2 dynamic
router ospf 5
 log-adjacency-changes
 network 10.1.1.1 0.0.0.0 area 0
 mpls traffic-eng router-id loopback0
 mpls traffic-eng area 0
```

When you look at the self-generated router LSA, you will see it as one of the links in router LSA (shown in bold in the following output).

```
Router# show ip ospf database route self-originate
OSPF Router with ID (10.5.5.5) (Process ID 5)
      Router Link States (Area 0)

LS age:332
Options:(No TOS-capability, DC)
LS Type:Router Links
Link State ID:10.5.5.5
Advertising Router:10.5.5.5
LS Seq Number:80000004
Checksum:0x1D24
Length:72
Number of Links:4
  Link connected to another Router (point-to-point)
    (Link ID) Neighboring Router ID:10.3.3.3
    (Link Data) Router Interface address:0.0.0.23
    Number of TOS metrics:0
      TOS 0 Metrics:1562
```

```

Link connected to:a Transit Network
(Link ID) Designated Router address:172.16.0.1
(Link Data) Router Interface address:172.16.0.2
Number of TOS metrics:0
TOS 0 Metrics:10
Link connected to:a Transit Network
(Link ID) Designated Router address:172.16.0.3
(Link Data) Router Interface address:172.16.0.4
Number of TOS metrics:0
TOS 0 Metrics:10
Link connected to:a Stub Network
(Link ID) Network/subnet number:10.5.5.5
(Link Data) Network Mask:255.255.255.255
Number of TOS metrics:0
TOS 0 Metrics:1

```

Additional References

The following sections provide references related to OSPF Forwarding Adjacency.

Related Documents

Related Topic	Document Title
MPLS traffic engineering forwarding adjacency	MPLS Traffic Engineering Forwarding Adjacency
Configuring OSPF for MPLS traffic engineering	MPLS Traffic Engineering and Enhancements
MPLS Traffic Engineering - LSP Attributes	MPLS Traffic Engineering - LSP Attributes

Standards

Standards	Title
No new or modified standards are supported by this feature, and support for existing standards has not been modified by this feature.	--

MIBs

MIBs	MIBs Link
None	To locate and download MIBs for selected platforms, Cisco IOS releases, and feature sets, use Cisco MIB Locator found at the following URL: http://www.cisco.com/go/mibs

RFCs

RFCs	Title
No new or modified RFCs are supported by this feature, and support for existing RFCs has not been modified by this feature.	--

Technical Assistance

Description	Link
<p>The Cisco Support website provides extensive online resources, including documentation and tools for troubleshooting and resolving technical issues with Cisco products and technologies.</p>	http://www.cisco.com/techsupport
<p>To receive security and technical information about your products, you can subscribe to various services, such as the Product Alert Tool (accessed from Field Notices), the Cisco Technical Services Newsletter, and Really Simple Syndication (RSS) Feeds.</p>	
<p>Access to most tools on the Cisco Support website requires a Cisco.com user ID and password.</p>	