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

Americas Headquarters
Cisco Systems, Inc.
170 West Tasman Drive
San Jose, CA 95134-1706
USA
http://www.cisco.com
Tel: 408 526-4000
800 553-NETS (6387)
Fax: 408 527-0883

CONTENTS

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

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

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.

- OSPF Network Types, page 3
- Original LSA Behavior, page 7
- LSA Group Pacing with Multiple Timers, page 7

OSPF Network Types

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 confutation 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.

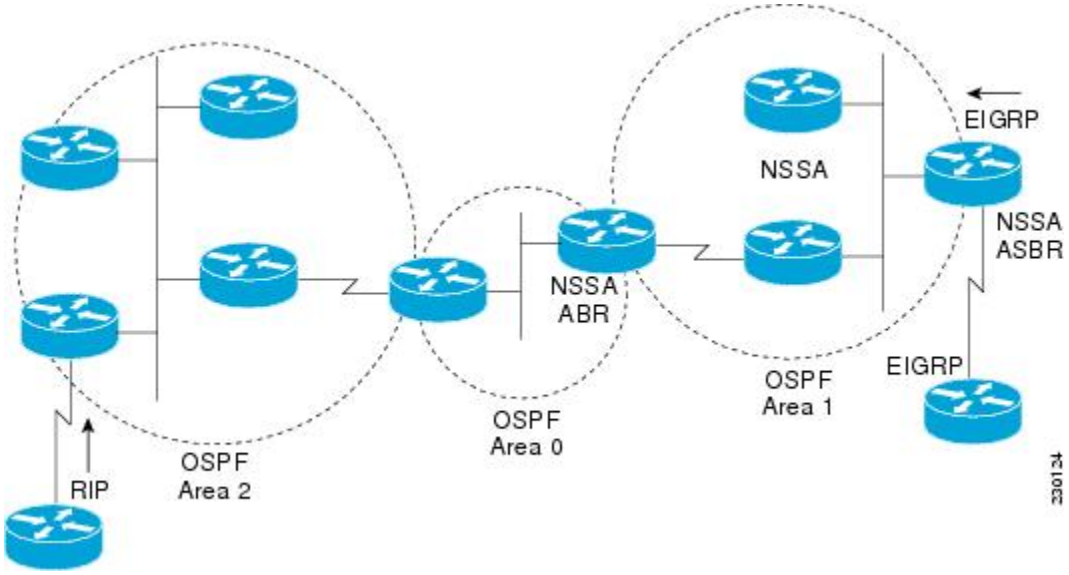
As with OSPF stub areas, NSSA areas cannot be injected with distributed routes via Type 5 LSAs. Route redistribution into an NSSA area is possible only with a special type of LSA that is known as Type 7 that can exist only in an NSSA area. An NSSA ASBR generates the Type 7 LSA so that the routes can 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 OSPF NSSA



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.

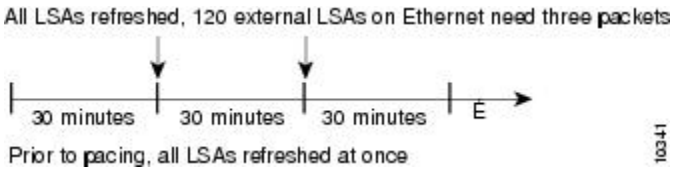
OSPF LSA group pacing is enabled by default. For typical customers, the default group pacing interval for refreshing, checksumming, and aging is appropriate and you need not configure this feature.

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 OSPF LSAs on a Single Timer Without Group Pacing



LSA Group Pacing with Multiple Timers

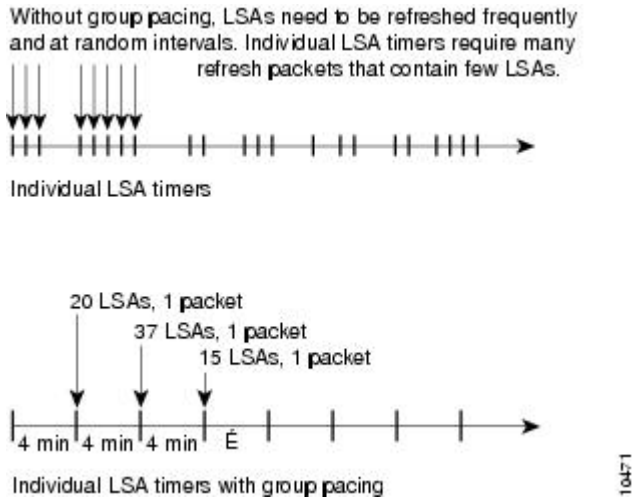
Configuring each LSA to have its own timer avoids excessive CPU processing and sudden network-traffic increase. To again use the example of refreshing, each LSA gets refreshed when it is 30 minutes old, independent of other LSAs. So the CPU is used only when necessary. However, LSAs being refreshed at 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 OSPF LSAs on Individual Timers with Group Pacing



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 IGPs 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 Enabling OSPF 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 23.

Enabling OSPF

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **router ospf** *process-id*
4. **network** *ip-address wildcard-mask* **area** *area-id*
5. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**router ospf** *process-id* **Example:** `Router(config)# router ospf 109`	Enables OSPF routing, which places the router in router configuration mode.
Step 4	**network** *ip-address wildcard-mask* **area** *area-id* **Example:** `Router(config-router)# network 192.168.129.16 0.0.0.3 area 20`	Defines an interface on which OSPF runs and defines the area ID for that interface.
Step 5	**end** **Example:** `Router(config-router)# end`	Exits router configuration mode and returns to privileged EXEC mode.

Configuring OSPF Interface Parameters

Configuring OSPF over Different Physical Networks

Configuring Point-to-Multipoint Broadcast Networks

SUMMARY STEPS

1. **ip ospf network point-to-multipoint**
2. **exit**
3. **router ospf** *process-id*
4. **neighbor** *ip-address* **cost** *number*

DETAILED STEPS

	Command or Action	Purpose
Step 1	**ip ospf network point-to-multipoint**	Configures an interface as point-to-multipoint for broadcast media.
Step 2	**exit**	Enters global configuration mode.
Step 3	**router ospf** *process-id*	Configures an OSPF routing process and enters router configuration mode.
Step 4	**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

SUMMARY STEPS

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

DETAILED STEPS

	Command or Action	Purpose
Step 1	**ip ospf network point-to-multipoint non-broadcast**	Configures an interface as point-to-multipoint for nonbroadcast media.
Step 2	**exit**	Enters global configuration mode.
Step 3	**router ospf** *process-id*	Configures an OSPF routing process and enters router configuration mode.
Step 4	**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 Area Parameters

Configuring OSPF NSSA

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**]
7. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**router ospf** *process-id* **Example:** `Router(config)# router ospf 10`	Enables OSPF routing and enters router configuration mode. • The process-id argument identifies the OSPF process. In this example the number of the routing process is 10.
Step 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**] **Example:** `Router(config-router)# redistribute rip subnets`	Redistributes routes from one routing domain into another routing domain. • The example causes RIP subnets to be redistributed into the OSPF domain.
Step 5	**network** i*p-address wildcard-mask* **area** *area-id* **Example:** `Router(config-router)# network 172.19.92.0 0.0.0.255 area 1`	Defines the interfaces on which OSPF runs and defines the area ID for those interfaces. • The example defines 172.19.92.0/0.0.0.255 interfaces for OSPF area 1 for OSPF routing process 10.
Step 6	**area** *area-id* **nssa** [**no-redistribution**] [**default-information-originate** [**metric**] [**metric-type**]] [**no-summary**] [**nssa-only**] **Example:** `Router(config-router)# area 1 nssa`	Configures an NSSA area. • In the example, area 1 is configured as an NSSA area.

	Command or Action	Purpose
Step 7	**end** **Example:** `Router(config-router)# end`	Exits router configuration mode and returns to privileged EXEC mode.

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
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**router ospf** *process-id* **Example:** `Router(config)# router ospf 1`	Enables OSPF routing and enters router configuration mode. • The *process-id* argument identifies the OSPF process.

	Command or Action	Purpose
Step 4	**area** *area-id* **nssa translate type7 always** **Example:** `Router(config-router)# area 10 nssa translate type7 always`	Configures an NSSA ABR router as a forced NSSA LSA translator. **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.
Step 5	**end** **Example:** `Router(config-router)# end`	Exits router configuration mode and returns to privileged EXEC mode.

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. • 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** *process-id* **Example:** `Router(config)# router ospf 1`	Enables OSPF routing and enters router configuration mode. • 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

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.

Configuring Route Summarization Between OSPF Areas

Configuring Route Summarization When Redistributing Routes into OSPF

Command	Purpose
summary-address {*ip-address mask* | *prefix mask*} [**not-advertise**] [**tag** *tag*]	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
area *area-id* **virtual-link** *router-id* [**authentication** [**message-digest** | **null**]] [**hello-interval** *seconds*] [**retransmit-interval** *seconds*] [**transmit-delay** *seconds*] [**dead-interval** *seconds*] [**authentication-key** *key* | **message-digest-key** *key-id* **md5** *key*]	Establishes a virtual link.

Generating a Default Route

Command	Purpose
default-information originate [**always**] [**metric** *metric-value*] [**metric-type** *type-value*] [**route-map** *map-name*]	Forces the ASBR to generate a default route into the OSPF routing domain. **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.

Configuring Lookup of DNS Names

Command	Purpose
ip ospf name-lookup	Configures DNS name lookup.

Forcing the Router ID Choice with a Loopback Interface

SUMMARY STEPS

1. **interface loopback 0**
2. **ip address** *ip-address mask*

DETAILED STEPS

	Command or Action	Purpose
Step 1	**interface loopback 0**	Creates a loopback interface, which places the router in interface configuration mode.
Step 2	**ip address** *ip-address mask*	Assigns an IP address to this interface.

Controlling Default Metrics

Command	Purpose
auto-cost reference-bandwidth *ref-bw*	Differentiates high -bandwidth links.

Changing the OSPF Administrative Distances

Command	Purpose
distance ospf {**intra-area** | **inter-area** | **external**} *dist*	Changes the OSPF distance values.

Configuring OSPF on Simplex Ethernet Interfaces

Command	Purpose
passive-interface *interface-type interface-number*	Suppresses the sending of hello packets through the specified interface.

Configuring Route Calculation Timers

Command	Purpose
timers spf *spf-delay spf-holdtime*	Configures route calculation timers.

Configuring OSPF over On-Demand Circuits

SUMMARY STEPS

1. **router ospf** *process-id*
2. **interface** *type number*
3. **ip ospf demand-circuit**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**router ospf** *process-id*	Enables OSPF operation.
Step 2	**interface** *type number*	Enters interface configuration mode.
Step 3	**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 19

Prerequisites

Evaluate the following considerations before implementing the On-Demand Circuits 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
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 adjacency** EXEC 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 20

Changing the LSA Group Pacing Interval

Command	Purpose
timers pacing lsa-group *seconds*	Changes the group pacing of LSAs.

Blocking OSPF LSA Flooding

Command	Purpose
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
neighbor *ip-address* **database-filter all out**	Blocks the flooding of OSPF LSA packets to the specified neighbor.

Reducing LSA Flooding

Command	Purpose
ip ospf flood-reduction	Suppresses the unnecessary flooding of LSAs in stable topologies.

Ignoring MOSPF LSA Packets

Command	Purpose
ignore lsa mospf	Prevents the router from generating syslog messages when it receives MOSPF LSA packets.

Displaying OSPF Update Packet Pacing

Command	Purpose
show ip ospf flood-list *interface-type interface-number*	Displays a list of LSAs waiting to be flooded over an interface.

Monitoring and Maintaining OSPF

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

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

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

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

Command	Purpose
clear ip ospf [*pid*] {**process** | **redistribution** | **counters** [**neighbor** [**neighbor** - *interface*] [*neighbor-id*]]*}*	Clears redistribution based on the OSPF routing process ID. If the *pid* 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.

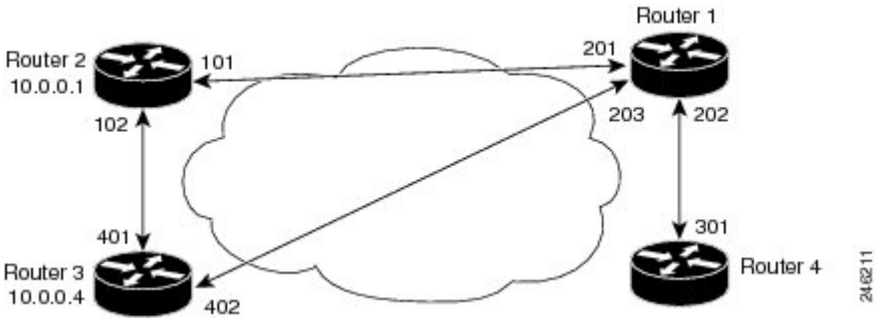
Because the maximum size of an IP packet is 65,535 bytes, there is still an upper bound on the number of links possible on a router.

Configuration Examples for OSPF

Example: OSPF Point-to-Multipoint

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 OSPF Point-to-Multipoint Example



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 ethernets
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
!
```

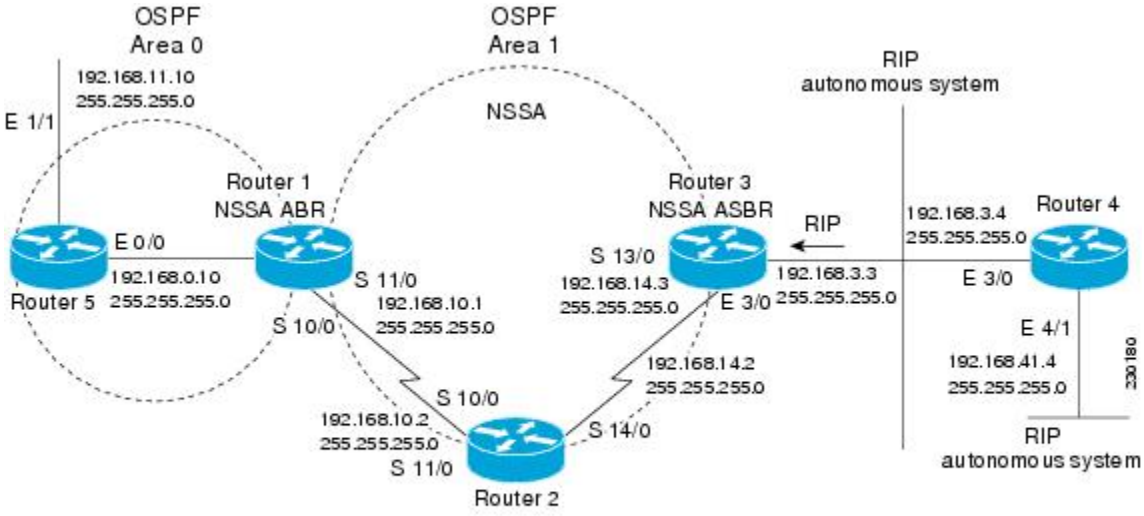
```
router rip
 version 2
 network 192.168.3.0
 network 192.168.41.0
!
end
```

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 OSPF NSSA Network with NSSA ABR and ASBR Routers



When the **show ip ospf** command is entered on Router 2, the output confirms that OSFP 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 msecs
 Minimum hold time between two consecutive SPFs 10000 msecs
 Maximum wait time between two consecutive SPFs 10000 msecs
 Incremental-SPF disabled
 Minimum LSA interval 5 secs
 Minimum LSA arrival 1000 msecs
 LSA group pacing timer 240 secs
 Interface flood pacing timer 33 msecs
 Retransmission pacing timer 66 msecs
 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 msecs
 Minimum hold time between two consecutive SPFs 10000 msecs
 Maximum wait time between two consecutive SPFs 10000 msecs
 Incremental-SPF disabled
 Minimum LSA interval 5 secs
 Minimum LSA arrival 1000 msecs
 LSA group pacing timer 240 secs
```

```
 Interface flood pacing timer 33 msecs
 Retransmission pacing timer 66 msecs
 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 msecs
Minimum hold time between two consecutive SPFs 10000 msecs
Maximum wait time between two consecutive SPFs 10000 msecs
Incremental-SPF disabled
Minimum LSA interval 5 secs
Minimum LSA arrival 1000 msecs
LSA group pacing timer 240 secs
Interface flood pacing timer 33 msecs
Retransmission pacing timer 66 msecs
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 33
- Example: Basic OSPF Configuration for Internal Router ABR and ASBRs, page 34
- Example: Complex Internal Router with ABR and ASBR, page 35
- Example: Complex OSPF Configuration for ABR, page 37

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 area** router 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 area** command in the *Cisco IOS IP Routing: OSPF Command Reference* for more information.

Consider the first **network area** 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.

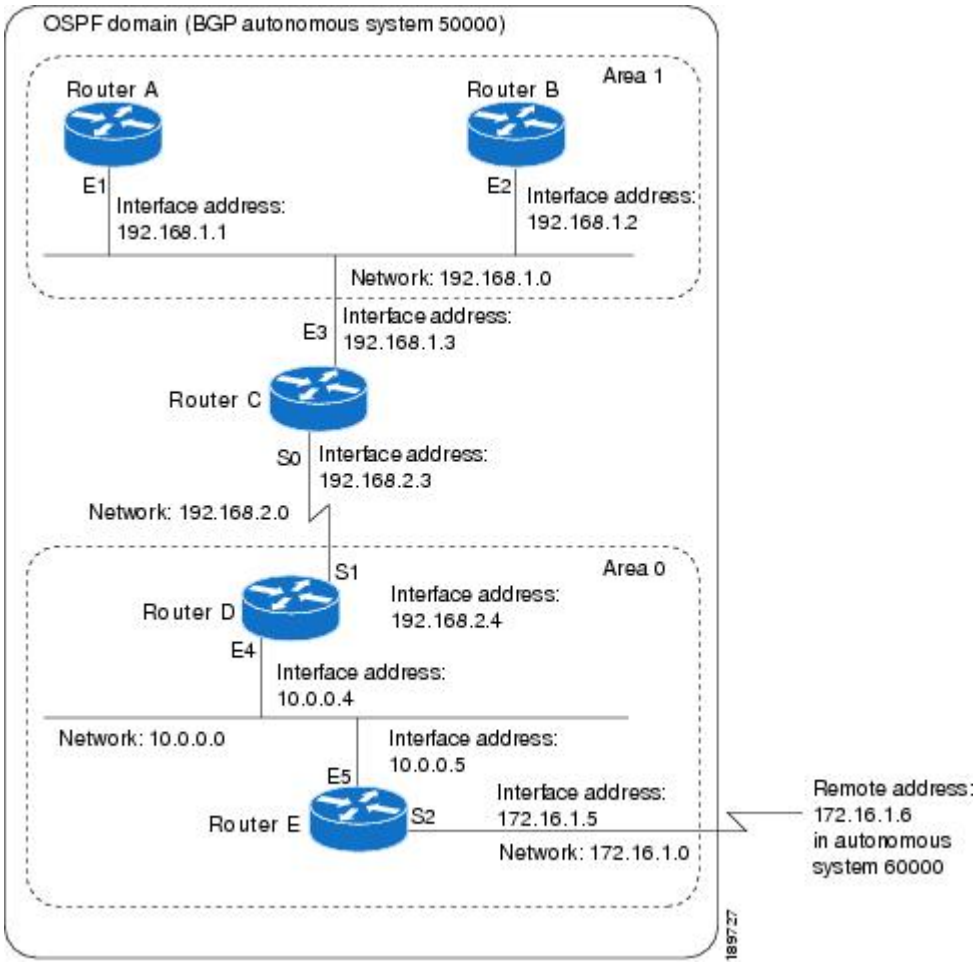
The second **network area** command is evaluated next. For area 2, the same process is then applied to all interfaces (except Ethernet interface 0). Assume that a match is determined for interface Ethernet 1. OSPF is then enabled for that interface and Ethernet interface 1 is attached to area 2.

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 Sample OSPF Autonomous System Network Map



In this configuration, five routers are configured with OSPF:

- Router A and Router Bare 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
```

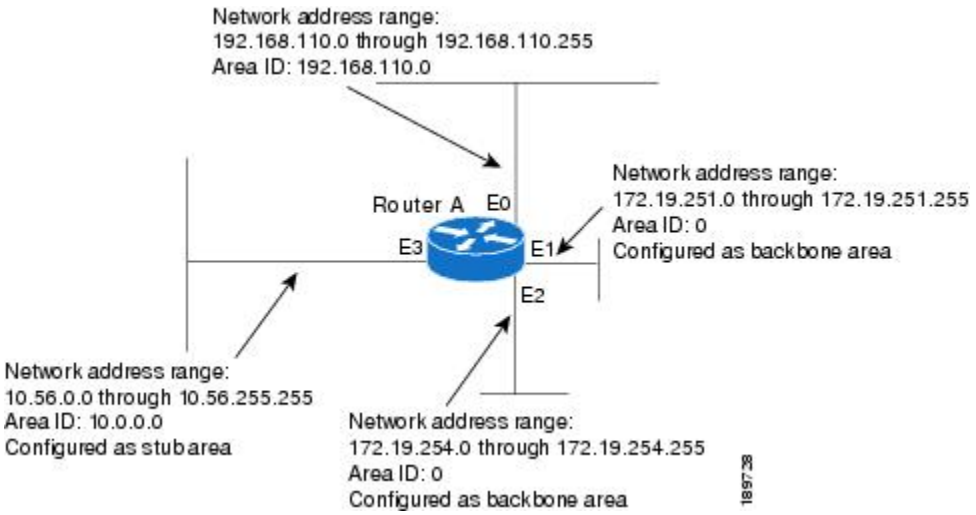
Example: Complex OSPF Configuration for ABR

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 Interface and Area Specifications for OSPF Example Configuration



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.

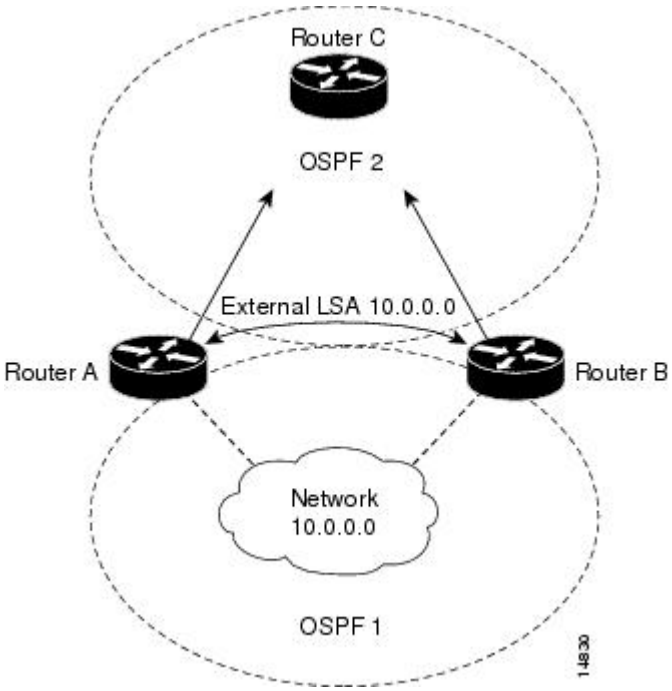
Note Only routes external to the OSPF process can be used for tracking, such as non-OSPF routes or OSPF routes from a separate OSPF process.

```
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 OSPF Administrative Distance



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 OSPF over On-Demand Circuit

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	*Cisco IOS IP Routing: OSPF Command Reference*
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:

Feature Name	Releases	Feature Information
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:
OSPF Support for NSSA RFC 3101	15.1(2)S 15.0(1)SY 15.2(2)T	This feature adds support for the OSPF NSSA specification described by RFC 3101. RFC3101 replaced RFC 1587 and is backward compatible with RFC1587. The following commands were introduced or modified: **area nssa translate**, **compatible rfc1587**.
OSPF - Demand Circuit Disable	15.0(1)SY	The **ignore** keyword was added to the **ip ospf demand-circuit** command, allowing you to prevent an interface from accepting demand-circuit requests from other routers.

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

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

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

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** *process-id*	Places the router in router configuration mode and enables an OSPF routing process.
Step 2	Router(config-router)# **max-metric router-lsa on-startup** *announce-time*	Configures OSPF to advertise a maximum metric during startup for a configured period of time. The *announce-time* 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** *process-id*	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** *process-id*	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

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	*Cisco IOS IP Routing: OSPF Command Reference*
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	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. The following commands are introduced or modified in the feature documented in this module: • **max-metric router-lsa** • **show ip ospf**

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

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

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.

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 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 59
- Configuring a Group Packet Pacing Timer, page 60
- Verifying OSPF Packet-Pacing Timers, page 61
- Monitoring and Maintaining OSPF Packet-Pacing Timers, page 61

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 *process-id*	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 *milliseconds*	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** *process-id*	Places the router in router configuration mode and enables an OSPF routing process.
Step 2	Router(config-router)# **timers pacing lsa-group** *seconds*	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** *process-id*	Places the router in router configuration mode and enables an OSPF routing process.
Step 2	Router(config-router)# **timers pacing lsa-group** *seconds*	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 msecs
  Retransmission pacing timer 100 msecs
  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 61

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

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	*Cisco IOS IP Routing: OSPF Command Reference*
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	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. The following commands are introduced or modified in the feature documented in this module: • **timers pacing flood** • **timers pacing lsa-group** • **timers pacing retransmission** • **show ip ospf**

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

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.

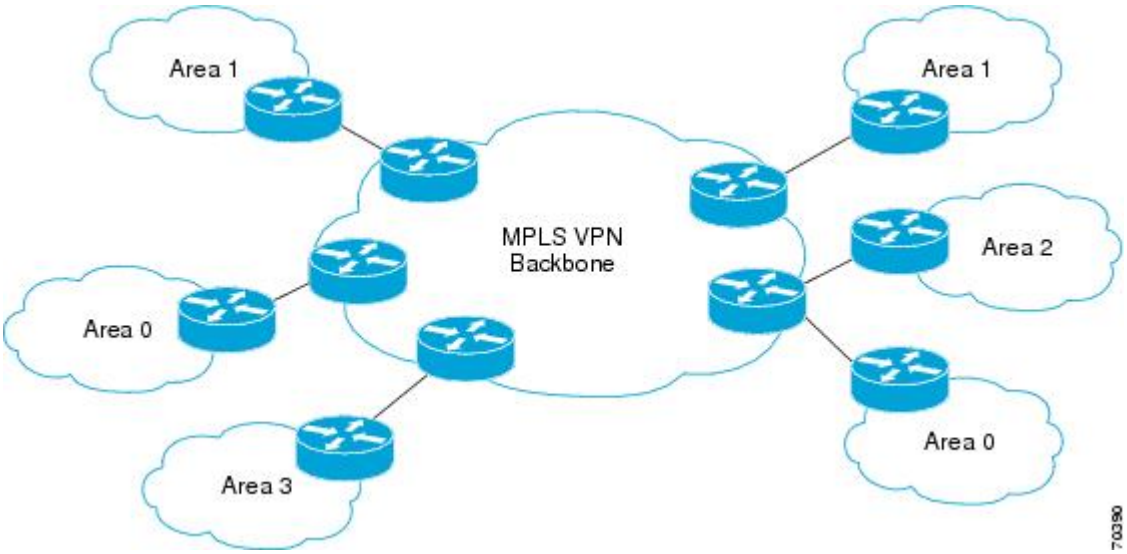
Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Feature Overview

Using OSPF in PE-CE Router Connections

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.

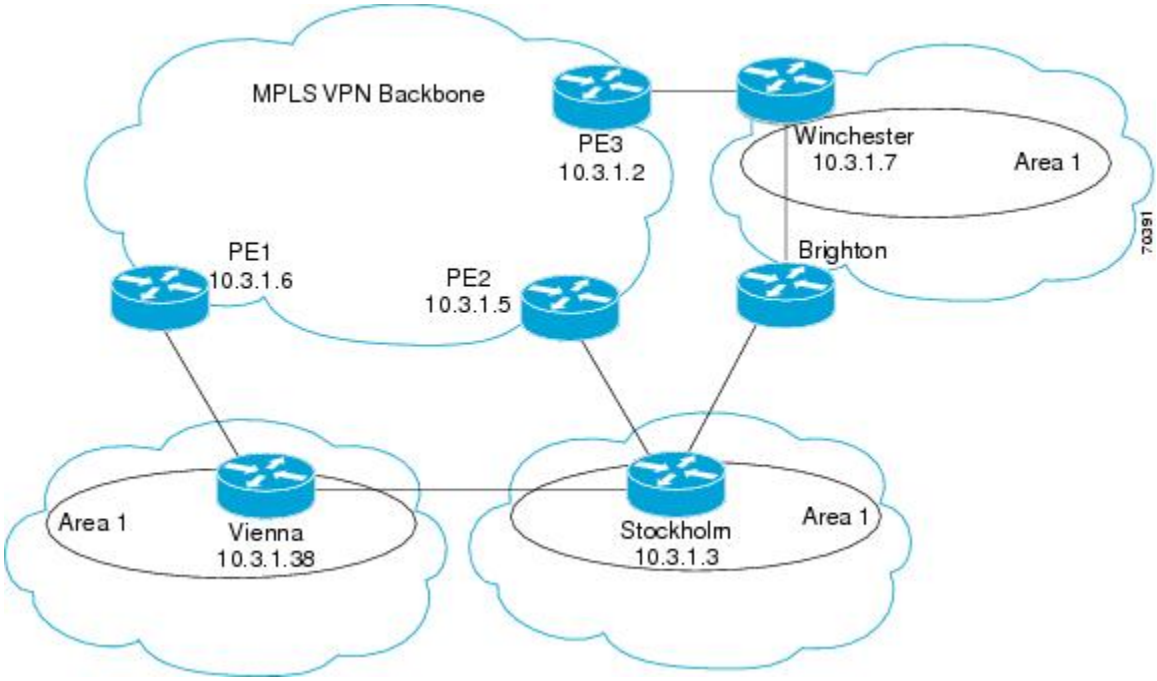
When OSPF routes are propagated over the MPLS VPN backbone, additional information about the prefix in the form of BGP extended communities (route type, domain ID extended communities) is appended to the BGP update. This community information is used by the receiving PE router to decide the type of link-state 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
```

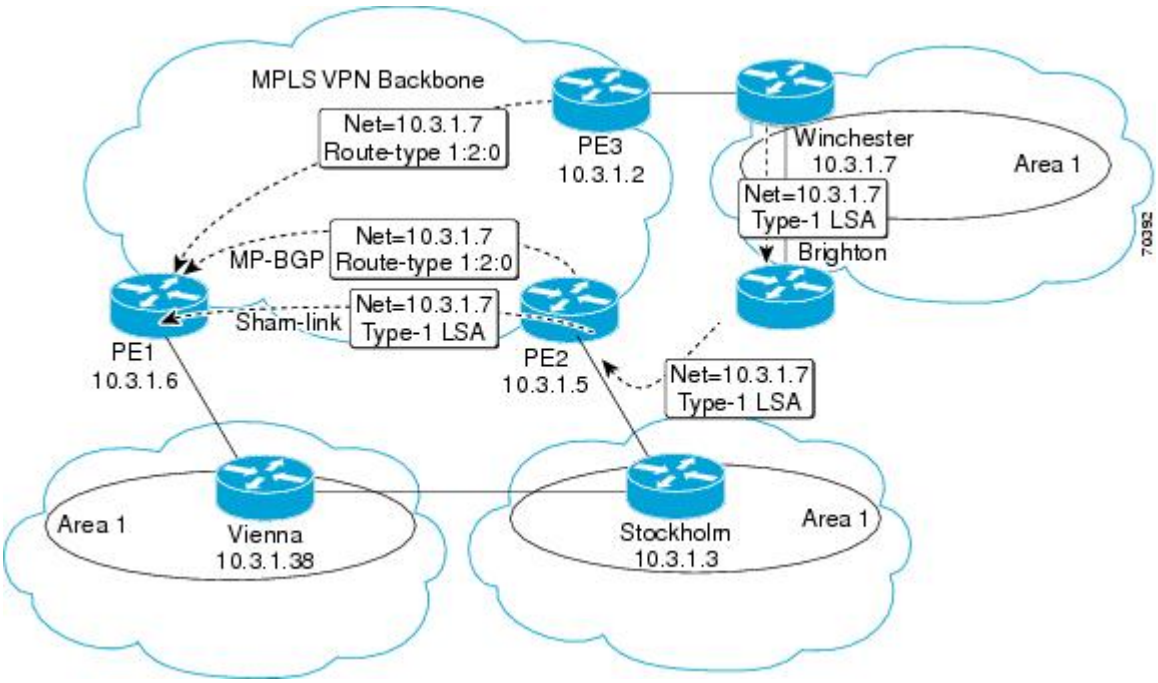
This path is selected because:

- 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.



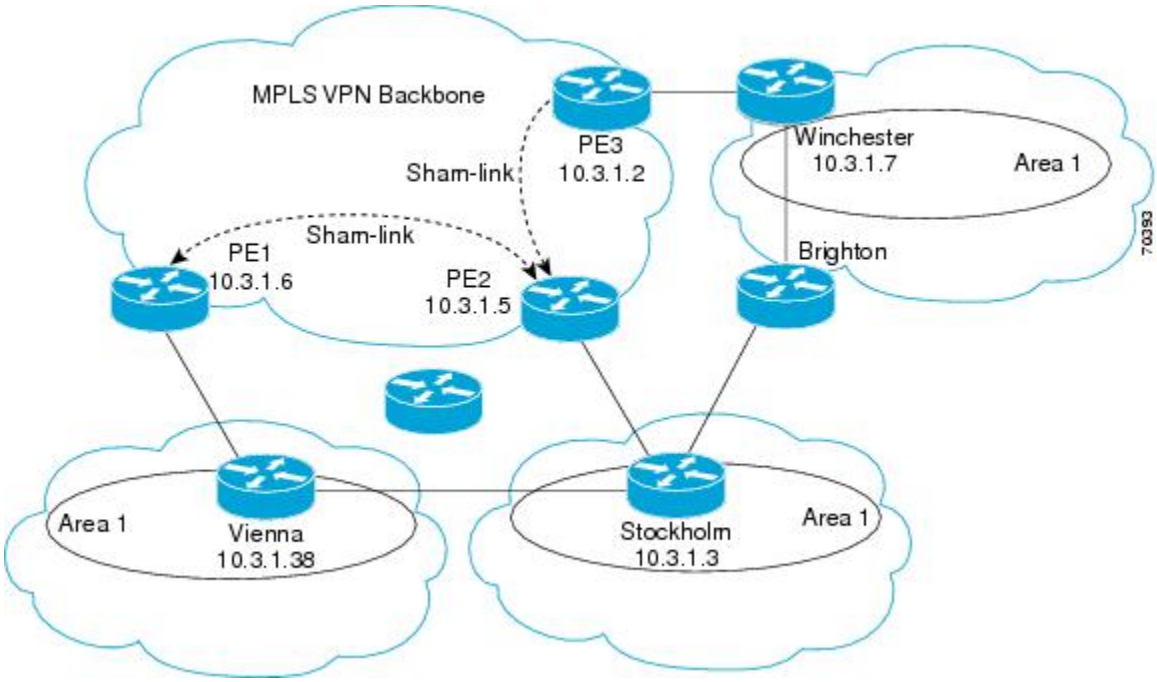
Because the sham-link is seen as an intra-area link between PE routers, an OSPF adjacency is created and database exchange (for the particular OSPF process) occurs across the link. The PE router can then flood LSAs between sites from across the MPLS VPN backbone. As a result, the desired intra-area connectivity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

The section, "Creating a Sham-Link, page 73", 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 73 (required)
- Verifying Sham-Link Creation, page 75 (optional)

- Creating a Sham-Link, page 73
- Verifying Sham-Link Creation, page 75

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** *interface-number*	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** *vrf-name*	Associates the loopback interface with a VRF. Removes the IP address.
Step 4	Router1(config-if)# **ip address** *ip-address mask*	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** *interface-number*	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** *vrf-name*	Associates the second loopback interface with a VRF. Removes the IP address.
Step 9	Router2(config-if)# **ip address** *ip-address mask*	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** *process-id vrf vrf-name*	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***area-id* **sham-link***source-address destination-address* **cost** *number*	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** *number* configures the OSPF cost for sending an IP packet on the PE-1 sham-link interface.
Step 13	Router2(config)# **router ospf** *process-id* *vrf vrf-name*	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** *area-id* **sham-link** *source-address destination-address* **cost** *number*	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** *number* 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** *ip-address*	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.

OSPF Sham-Link MIB Support

This feature introduces MIB support for the OSPF Sham-Link feature through the addition of new tables and trap MIB objects to the Cisco OSPF MIB (CISCO-OSPF-MIB) and the Cisco OSPF Trap MIB (CISCO-OSPF-TRAP-MIB). New commands have been added to enable Simple Network Management Protocol (SNMP) notifications for the Open Shortest Path First (OSPF) sham-link trap objects. Notifications are provided for errors, state changes, and retransmissions across a sham-link interface.

Finding Feature Information in This Module

Your Cisco IOS software release may not support all of the features documented in this module. To reach links to specific feature documentation in this module and to see a list of the releases in which each feature is supported, use the Feature Information for OSPF Sham-Link MIB Support, page 91.

Finding Support Information for Platforms and Cisco IOS and Catalyst OS Software Images

Use Cisco Feature Navigator to find information about platform support and Cisco IOS and Catalyst OS 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

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 Sham-Link MIB Support

- It is presumed that you already have configured an Open Shortest Path First (OSPF) sham-link.
- SNMP must be enabled on the router before notifications (traps) can be configured or before SNMP GET operations can be performed.

Restrictions for OSPF Sham-Link MIB Support

All enhancements that are introduced by this feature are provided only by the Cisco private MIBs CISCO-OSPF-MIB and CISCO-OSPF-TRAP-MIB.

Information About OSPF Sham-Link MIB Support

OSPF Sham-Links in PE-PE Router Connections

In a Multiprotocol Label Switching (MPLS) Virtual Private Network (VPN) configuration, a virtual connection called a sham-link can be configured to interconnect between two VPN sites that want to be in the same OSPF area. The sham-link is configured on top of the MPLS VPN tunnel that connects two provider edge (PE) routers. The OSPF packets are propagated over the sham-link. For more information on configuring sham-links, refer the OSPF Sham-Link Support for MPLS VPN feature at the following URL:

http://www.cisco.com/en/US/docs/ios/iproute_ospf/configuration/guide/iro_sham_link.html

Cisco OSPF MIB and Cisco OSPF Trap MIB Enhancements

The OSPF Sham-Link MIB Support feature introduces MIB support for OSPF sham-links through the addition of new tables and trap MIB objects to the Cisco OSPF MIB (CISCO-OSPF-MIB) and the Cisco OSPF Trap MIB (CISCO-OSPF-TRAP-MIB) for Cisco IOS Releases 12.0(30)S, 12.3(14)T, 12.2(33)SRA, 12.2(31)SB2, and 12.2(33)SXH. New CLI has been added to enable SNMP notifications for the OSPF sham-link trap objects. Notifications are provided for errors, state changes, and retransmissions across a sham-link interface. The following sections describe the enhancements:

OSPF Sham-Link Configuration Support

The cospfShamLinksTable table object stores information about the sham-links that have been configured for the OSPF area. Beginning with Cisco IOS Releases 12.0(30)S, 12.3(14)T, 12.2(33)SRA, 12.2(31)SB2,

and 12.2(33)SXH, the cospfShamLinksTable replaces the cospfShamLinkTable. The cospfShamLinksTable allows access to the following MIB objects:

- cospfShamLinksAreaId
- cospfShamLinksLocalIpAddrType
- cospfShamLinksLocalIpAddr
- cospfShamLinksRemoteIpAddrType
- cospfShamLinksRemoteIpAddr
- cospfShamLinksRetransInterval
- cospfShamLinksHelloInterval
- cospfShamLinksRtrDeadInterval
- cospfShamLinksState
- cospfShamLinksEvents
- cospfShamLinksMetric

OSPF Sham-Link Neighbor Support

The cospfShamLinkNbrTable table object describes all OSPF sham-link neighbor entries. The cospfShamLinkNbrTable allows access to the following MIB objects:

- cospfShamLinkNbrArea
- cospfShamLinkNbrIpAddrType
- cospfShamLinkNbrIpAddr
- cospfShamLinkNbrRtrId
- cospfShamLinkNbrOptions
- cospfShamLinkNbrState
- cospfShamLinkNbrEvents
- cospfShamLinkNbrLsRetransQLen
- cospfShamLinkNbrHelloSuppressed

OSPF Sham-Link Interface Transition State Change Support

The cospfShamLinksStateChange trap object is used to notify the network manager of a transition state change for the OSPF sham-link interface. The cospfShamLinksStateChange trap object replaces the original cospfShamLinkStateChange trap object for Cisco IOS Releases 12.0(30)S, 12.3(14)T, 12.2(33)SRA, and 12.2(31)SB2. The cospfShamLinksStateChange trap objects contains the following MIB objects:

- ospfRouterId
- cospfShamLinksAreaId
- cospfShamLinksLocalIpAddrType
- cospfShamLinksLocalIpAddr
- cospfShamLinksRemoteIpAddrType
- cospfShamLinksRemoteIpAddr
- cospfShamLinksState

OSPF Sham-Link Neighbor Transition State Change Support

The cospfShamLinkNbrStateChange trap object is used to notify the network manager of a transition state change for the OSPF sham-link neighbors. The cospfShamLinkNbrStateChange trap object contains the following MIB objects:

- ospfRouterId
- cospfShamLinkNbrArea
- cospfShamLinksLocalIpAddrType
- cospfShamLinksLocalIpAddr
- cospfShamLinkNbrIpAddrType
- cospfShamLinkNbrIpAddr
- cospfShamLinkNbrRtrId
- cospfShamLinkNbrState

Sham-Link Errors

Trap notifications are provided for OSPF sham-link configuration, authentication, and bad packet errors. These errors include the following trap objects:

- cospfShamLinkConfigError
- cospfShamLinkAuthFailure
- cospfShamLinkRxBadPacket

Note The cospfShamLinkAuthFailure trap will not be generated because Cisco IOS Releases 12.0(30)S, 12.3(14)T, 12.2(33)SRA, and 12.2(31)SB2 do not yet support authentication over sham-links. The cospfShamLinkRxBadPacket trap will not be generated because it also is not supported by Cisco IOS Releases 12.0(30)S, 12.3(14)T, 12.2(33)SRA, and 12.2(31)SB2. However, the information can be retrieved from the existing OSPF bad packet traps.

How to Configure OSPF Sham-Link MIB Support

Configuring the Router to Send SNMP Notifications

Perform this task to enable the router to send SNMP notifications (traps or informs) defined in the OSPF MIBs. SNMP notifications can be configured on the router and GET operations can be performed from an external management station only after MIB support is enabled.

OSPF Configuration Error Notifications

To enable the sending of OSPF configuration errors notifications, enable the following traps:

- cospfShamLinkConfigError
- cospfShamLinkAuthFailure
- cospfShamLinkRxBadPacket

SUMMARY STEPS

1. **enable**
2. **show running-config**
3. **configure terminal**
4. **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*]
5. **snmp-server enable traps ospf**
6. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**show running-config** **Example:** `Router# show running-config`	Displays the running configuration to determine if an SNMP agent is already running. • If no SNMP information is displayed, continue with the next step. If any SNMP information is displayed, you can modify the information or change it as needed.
Step 3	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 4	**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*] **Example:** `Router(config)# snmp-server host 172.20.2.162 version 2c public ospf`	Specifies a recipient (target host) for SNMP notification operations. • If no *notification-type* 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 notification-types. (See the example.)

	Command or Action	Purpose
Step 5	**snmp-server enable traps ospf** **Example:** `Router(config)# snmp-server enable traps ospf`	Enables all SNMP notifications defined in the OSPF MIBs. **Note** This step is required only if you wish to enable all OSPF traps, including the traps for OSPF sham-links. When you enter the **no snmp-server enable traps ospf** command, all OSPF traps, including the OSPF sham-link trap, will be disabled.
Step 6	**end** **Example:** `Router(config)# end`	Ends your configuration session and exits global configuration mode.

Enabling OSPF Sham-Link Error Traps

Notifications are sent when OSPF sham-link configuration errors are detected. To enable the sending of sham-link configuration error notifications, enable the following cospfShamLinkConfigError trap.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **snmp-server enable traps ospf cisco-specific errors config-error**
4. **snmp-server enable traps ospf cisco-specific errors shamlink** [**authentication** [**bad-packet** [**config**] | [**config** [**bad-packet**]]]
5. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.

	Command or Action	Purpose
Step 3	**snmp-server enable traps ospf cisco-specific errors config-error** **Example:** `Router(config)# snmp-server enable traps ospf cisco-specific errors config-error`	Enables error traps for OSPF nonvirtual interface mismatch errors. **Note** You must enter the **snmp-server enable traps ospf cisco-specific errors config-error** command before you enter the **snmp-server enable traps ospf cisco-specific errors shamlink** command, in order for both traps to be generated at the same place and maintain consistency with a similar case for configuration errors across virtual links. If you try to enable the cospfShamLinkConfigError trap before configuring the cospfospfConfigError trap you will receive an error message stating you must first configure the cospfConfigError trap.
Step 4	**snmp-server enable traps ospf cisco-specific errors shamlink** [**authentication** [**bad-packet** [**config**] | [**config** [**bad-packet**]]]] **Example:** `Router(config)# snmp-server enable traps ospf cisco-specific errors shamlink`	Enables error traps for OSPF sham-link errors. • The **authentication** keyword enables SNMP notifications only for authentication failures on OSPF sham-link interfaces. • The **bad-packet** keyword enables SNMP notifications only for packet parsing failures on OSPF sham-link interfaces. • The **config** keyword enables SNMP notifications only for configuration mismatch errors on OSPF sham-link interfaces.
Step 5	**end** **Example:** `Router(config)# end`	Ends your configuration session and exits global configuration mode.

Enabling OSPF Sham-Link Retransmissions Traps

Notifications are sent when OSPF packets retransmissions across a sham-link are detected. To enable the sending of sham-link packet retransmission notifications, enable the following cospfShamLinkTxRetransmit trap.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **snmp-server enable traps ospf cisco-specific retransmit** [**packets** [**shamlink** | **virt-packets**] | **shamlink** [**packets** | **virt-packets**] | **virt-packets** [**shamlink**]]
4. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**snmp-server enable traps ospf cisco-specific retransmit** [**packets** [**shamlink** | **virt-packets**] | **shamlink** [**packets** | **virt-packets**] | **virt-packets** [**shamlink**]] **Example:** `Router(config)# snmp-server enable traps ospf cisco-specific retransmit shamlink`	Enables error traps for OSPF sham-link retransmission errors.
Step 4	**end** **Example:** `Router(config)# end`	Ends your configuration session and exits global configuration mode.

Enabling OSPF Sham-Link State Change Traps

Notifications are sent when sham-link interface and neighbor state changes are detected. To enable the sending of sham-link state changes notifications, you can enable the following cospfShamLinksStateChange trap, which replaces the original cospfShamLinkStateChange trap, as well as the cospfShamLinkNbrStateChange trap, which is new for Cisco IOS Releases 12.0(30)S, 12.3(14)T, 12.2(33)SRA, and 12.2(31)SB2:

- cospfShamLinksStateChange
- cospfShamLinkNbrStateChange

Note The replaced cospfShamLinkChange trap can still be enabled, but not when you want to enable the new cospfShamLinksStateChange trap.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **snmp-server enable traps ospf cisco-specific state-change** [**nssa-trans-change** | **shamlink** [**interface** | **interface-old** | **neighbor**]]
4. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**snmp-server enable traps ospf cisco-specific state-change** [**nssa-trans-change**	**shamlink** [**interface**	**interface-old**	**neighbor**]] **Example:** `Router(config)# snmp-server enable traps ospf cisco-specific state-change`	Enables all Cisco-specific OSPF state change traps including the cospfShamLinksStateChange and cospfShamLinkNbrStateChange traps that are new for Cisco IOS Releases 12.0(30)S, 12.3(14)T, 12.2(33)SRA, and 12.2(31)SB2. • The **neighbor** keyword enables the OSPF sham-link neighbor state change traps. • The **interface** keyword enables the OSPF sham-link interface state change traps. • The **interface-old** keyword enables the original OSPF sham-link interface state change trap that is replaced by the cospfShamLinksStateChange and cospfShamLinkNbrStateChange traps for Cisco IOS Releases 12.0(30)S and 12.3(14)T. **Note** You cannot enter both the **interface** and **interface-old** keywords because you cannot enable both the new and replaced sham-link interface transition state change traps. You can configure only one of the two traps, but not both.
Step 4	**end** **Example:** `Router(config)# end`	Ends your configuration session and exits global configuration mode.

Verifying OSPF Sham-Link MIB Traps on the Router

This task verifies that you have enabled OSPF sham-link MIB support.

SUMMARY STEPS

1. **enable**
2. **show running-config | include traps**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**show running-config | include traps** **Example:** `Router# show running-config | include traps`	Displays the contents of the currently running configuration file and includes information about enabled traps. • Verifies if the trap is enabled.

Configuration Examples for OSPF Sham-Link MIB Support

Enabling and Verifying OSPF Sham-Link Error Traps Example

The following example enables all Cisco-specific OSPF sham-link error traps. Note that the first attempt to enter the **snmp-server enable traps ospf cisco-specific errors shamlink** command results in an error message that the **snmp-server enable traps ospf cisco-specific errors config-error** command must be entered first:

```
Router# configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
Router(config)# snmp-server enable traps ospf cisco-specific errors shamlink

% Sham-link config error trap not enabled.
% Configure "cisco-specific errors config-error" first.
% This requirement allows both traps to be sent.
Router(config)# snmp-server enable traps ospf cisco-specific errors config-error
Router(config)# snmp-server enable traps ospf cisco-specific errors shamlink
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 cisco-specific errors config-error
snmp-server enable traps ospf cisco-specific errors shamlink
```

At the time of disabling the traps, if the **no snmp-server enable traps ospf cisco-specific errors config-error** command is entered before the **snmp-server enable traps ospf cisco-specific errors shamlink** command, a message will be displayed to indicate that the sham-link configuration errors traps have also been disabled:

```
Router# configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
Router(config)# no snmp-server enable traps ospf cisco-specific errors config-error
! This command also disables the previously-enabled shamlink configuration error traps.
```

Router(config)# **end**

Enabling and Verifying OSPF State Change Traps Example

The following example enables all Cisco-specific OSPF state change traps including the cospfShamLinksStateChange and cospfShamLinkNbrStateChange traps that are new for Cisco IOS Releases 12.0(30)S, 12.3(14)T, 12.2(33)SRA, and 12.2(31)SB2:

```
Router# configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
Router(config)# snmp-server enable traps ospf cisco-specific state-change shamlink
```

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 cisco-specific state-change shamlink interface
snmp-server enable traps ospf cisco-specific state-change shamlink neighbor
```

Note that the **snmp-server enable traps ospf cisco-specific state-change shamlink** command enables the sham-link interface state change for the cospfShamLinksStateChange trap that is new for Cisco IOS Releases 12.0(30)S, 12.3(14)T, 12.2(33)SRA, and 12.2(31)SB2.

To enable the original cospfShamLinkStateChange trap, you must first disable the cospfShamLinksStateChange trap. An attempt to enter the **snmp-server enable traps ospf cisco-specific state-change shamlink interface-old** command results in the following error message:

```
Router(config)# snmp-server enable traps ospf cisco-specific state-change shamlink
interface-old
% Cannot enable both sham-link state-change interface traps.
% Deprecated sham link interface trap not enabled.
Router(config)# no snmp-server enable traps ospf cisco-specific state-change shamlink
interface
Router(config)# snmp-server enable traps ospf cisco-specific state-change shamlink
interface-old
```

Enabling and Verifying OSPF Sham-Link Retransmissions Traps Example

The following example enables all OSPF sham-link retransmissions traps:

```
Router# configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
Router(config)# snmp-server enable traps ospf cisco-specific retransmit shamlink
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 cisco-specific retransmit shamlink
```

Where to Go Next

For more information about SNMP and SNMP operations, see the "Configuring SNMP Support" part of the *Cisco IOS Network Management Configuration Guide* .

Additional References

The following sections provide references related to the OSPF Sham-Link MIB Support feature.

Related Documents

Related Topic	Document Title
Configuring OSPF sham-links	OSPF Sham-Link Support for MPLS VPN
SNMP configuration	*Cisco IOS Network Management Configuration Guide.*
SNMP commands	*Cisco IOS Network Management Command Reference.*

Standards

Standard	Title
None	--

MIBs

MIB	MIBs Link
• CISCO-OSPF-MIB • CISCO-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

RFCs

RFC	Title
None	--

Technical Assistance

Description	Link
The Cisco Support website provides extensive online resources, including documentation and tools for troubleshooting and resolving technical issues with Cisco products and technologies. Access to most tools on the Cisco Support website requires a Cisco.com user ID and password. If you have a valid service contract but do not have a user ID or password, you can register on Cisco.com.	http://www.cisco.com/techsupport

Command Reference

The following commands are introduced or modified in the feature or features documented in this module. For information about these commands, see the Cisco IOS IP Routing: OSPF Command Reference. For information about all Cisco IOS commands, go to the Command Lookup Tool at http://tools.cisco.com/Support/CLILookup or to the *Cisco IOS Master Commands List* .

- **snmp-server enable traps ospf cisco-specific errors config-error**
- **snmp-server enable traps ospf cisco-specific errors shamlink**
- **snmp-server enable traps ospf cisco-specific retransmit**
- **snmp-server enable traps ospf cisco-specific state-change**

Feature Information for OSPF Sham-Link MIB Support

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 Sham-Link MIB Support

Feature Name	Releases	Feature Information
OSPF Sham-Link MIB Support	12.0(30)S 12.3(14)T 12.2(33)SRA 12.2(31)SB2 12.2(33)SXH	This feature introduces MIB support for the OSPF Sham-Link feature through the addition of new tables and trap MIB objects to the Cisco OSPF MIB (CISCO-OSPF-MIB) and the Cisco OSPF Trap MIB (CISCO-OSPF-TRAP-MIB). New commands have been added to enable Simple Network Management Protocol (SNMP) notifications for the Open Shortest Path First (OSPF) sham-link trap objects. Notifications are provided for errors, state changes, and retransmissions across a sham-link interface..

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

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

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
Step 1	**enable** **Example:** `Router> enable`	Enables higher privilege levels, such as privileged EXEC mode. • Enter your password if prompted.
Step 2	**show ip ospf** [*process-id*] **Example:** `Router> show ip ospf 1`	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.
Step 3	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 4	**router ospf** *process-id* [**vrf** *vpn-name*] **Example:** `Router(config)# router ospf 1 vrf grc`	Enables OSPF routing and enters router configuration mode. • The *process-id* argument identifies the OSPF process. • Use the **vrf** keyword and *vpn-name* argument to identify a VPN.

	Command or Action	Purpose
Step 5	**capability vrf-lite** **Example:** `Router(config)# capability vrf-lite`	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 DCbitless 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

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 Serial2/0
  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 5 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	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. The following commands are introduced or modified in the feature documented in this module: • **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.

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

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

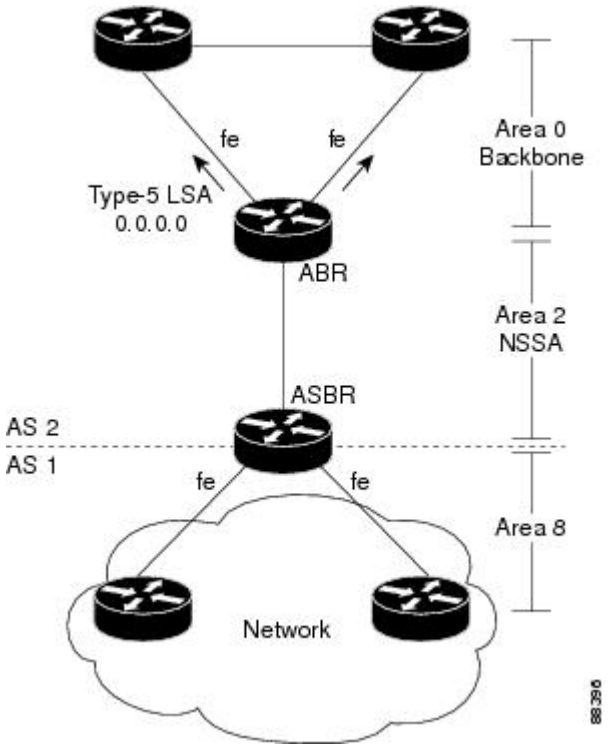
Benefits of OSPF Forwarding Address Suppression in Translated Type-5 LSAs

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 OSPF Forwarding Address Suppression in Translated Type-5 LSAs



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 103

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. • Enter your password if prompted.

	Command or Action	Purpose
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**router ospf** *process-id* **Example:** `Router(config)# router ospf 1`	Enables OSPF routing and enters router configuration mode. • The *process-id* argument identifies the OSPF process.
Step 4	**area** *area-id* **nssa translate type7 suppress-fa** **Example:** `Router(config-router)# area 10 nssa translate type7 suppress-fa`	Configures an area as a not-so-stubby-area (NSSA) and suppresses the forwarding address in translated Type-7 LSAs.
Step 5	**end** **Example:** `Router(config-router)# end`	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

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	*Cisco IOS IP Routing: OSPF Command Reference*

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.	*The OSPF NSSA Option*

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.

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 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	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. The following commands are introduced or modified: • **area nssa translate** • **show ip ospf**

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

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 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

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. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**route-map** *map-tag* [**permit**	**deny**] [*sequence-number*] **Example:** `Router(config)# route-map tag-filter deny 10`	Defines a route map to control filtering.

	Command or Action	Purpose
Step 4	**match tag** *tag-name* **Example:** `Router(config-router)# match tag 777`	Matches routes with a specified name, to be used as the route map is referenced. • 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.
Step 5	Repeat Steps 3 and 4 with other **route-map** and **match** commands.	Optional.
Step 6	**exit** **Example:** `Router(config-router)# exit`	Exits router configuration mode.
Step 7	**router ospf** *process-id* **Example:** `Router(config)# router ospf 1`	Configures an OSPF routing process.
Step 8	**distribute-list route-map** *map-tag* **in** **Example:** `Router(config-router)# distribute-list route-map tag-filter in`	Enables filtering based on an OSPF route map.
Step 9	**end** **Example:** `Router(config-router)# end`	Exits router configuration mode.

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

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	*Cisco IOS IP Routing: OSPF Command Reference*

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

Feature Name	Releases	Feature Information
OSPF Inbound Filterng 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	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.. The following command was introduced or modified: **distribute-list in (IP)**.

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

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

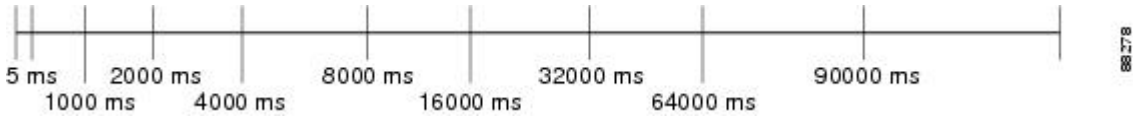
SPF calculations occur at the interval set by the **timers throttle spf**command. The wait interval indicates the amount of time to wait until the next SPF calculation occurs. Each wait interval after that calculation is twice as long as the previous one until the wait interval reaches the maximum wait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

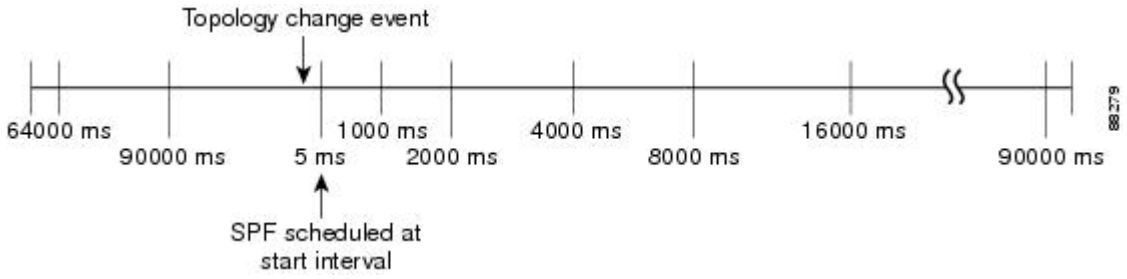


Notice that the wait interval between SPF calculations doubles when at least one topology change event is received during the previous wait interval. Once the maximum wait time is reached, the wait interval remains the same until the topology stabilizes and no event is received in that interval.

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 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 Timer Intervals Reset after Topology Change Event



How to Configure OSPF SPF Throttling

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** *type slot / port* **Example:** `Router(config)# interface ethernet 1/1/1`	Enters interface configuration mode for the interface specified.

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

```
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 msecs
 Minimum hold time between two consecutive SPFs 1000 msecs
 Maximum wait time between two consecutive SPFs 90000 msecs
 Minimum LSA interval 5 secs. Minimum LSA arrival 1 secs
 LSA group pacing timer 240 secs
 Interface flood pacing timer 33 msecs
 Retransmission pacing timer 66 msecs
 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 8 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

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	*Cisco IOS IP Routing: OSPF Command Reference*
OSPF configuration tasks	"Configuring OSPF" module in the *Cisco IOS IP Routing Protocols Configuration Guide*

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
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

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

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

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 124.

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 125

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
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** *type number* **Example:** `Router(config)# interface ethernet 0`	Configures an interface type and enters interface configuration mode.
Step 4	**ip ospf dead-interval minimal hello-multiplier** *multiplier* **Example:** `Router(config-if)# ip ospf dead-interval minimal hello-multiplier 5`	Sets the interval during which at least one hello packet must be received, or else the neighbor is considered down. • 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.
Step 5	**end** **Example:** `Router(config-if)# end`	(Optional) Saves configuration commands to the running configuration file, exits configuration mode, and returns to privileged EXEC mode. • Use this command when you are ready to exit configuration mode and save the configuration to the running configuration file.

Command or Action	Purpose
Step 6 **show ip ospf interface** [*interface-type interface-number*] **Example:** `Router# show ip ospf interface ethernet 1/3`	(Optional) Displays OSPF-related interface information. • 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

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	*Cisco IOS IP Routing: OSPF Command Reference*

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 9 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**.

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 132.

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

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

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. • 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** *process-id* **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

This example enables incremental SPF:

```
router ospf 1
 ispf
```

Additional References

Related Documents

Related Topic	Document Title
OSPF commands	*Cisco IOS IP Routing: OSPF Command Reference*

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.

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 10 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	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 The following commands are introduced or modified in the feature documented in this module: • **ispf**

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

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 136
- Requesting a Warning About the Number of Routes Redistributed into OSPF, page 138

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. • 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** *process-id* **Example:** `Router(config)# router ospf 1`	Configures an OSPF routing process.
Step 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**] **Example:** `Router(config-router)# redistribute eigrp 10`	Redistributes routes from one routing domain into another routing domain.
Step 5	**redistribute maximum-prefix** *maximum* [*threshold*] **Example:** `Router(config-router)# redistribute maximum-prefix 100 80`	Sets a maximum number of IP prefixes that are allowed to be redistributed into OSPF. • There is no default value for the *maximum* argument. • The *threshold* value defaults to 75 percent. **Note** If the **warning-only** keyword had been configured in this command, no limit would be enforced; a warning message is simply logged.
Step 6	**end** **Example:** `Router(config-router)# end`	Exits router configuration mode.
Step 7	**show ip ospf** [*process-id*] **Example:** `Router# show ip ospf 1`	(Optional) Displays general information about OSPF routing processes. • 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:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**router ospf** *process-id* **Example:** `Router(config)# router ospf 1`	Configures an OSPF routing process.
Step 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**] **Example:** `Router(config-router)# redistribute eigrp 10`	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
Step 5	**redistribute maximum-prefix** *maximum* [*threshold*] **warning-only** **Example:** `Router(config-router)# redistribute maximum-prefix 1000 80 warning-only`	Causes a warning message to be logged when the maximum number of IP prefixes has been redistributed into OSPF. • 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 *maximum* argument. • The *threshold* 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.
Step 6	**end** **Example:** `Router(config-router)# end`	Exits router configuration mode.

Configuration Examples for OSPF Limit on Number of Redistributed Routes

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	*Cisco IOS IP Routing: OSPF Command Reference*

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 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.

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 Limit on Number of Redistributed Routes

Feature Name	Releases	Feature Information
OSPF Limit on Number of Redistributed Routes	12.0(25)S 12.3(2)T 12.2(18)S 12.2(27)SBC Cisco IOS XE 3.1.0 SG	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. The following commands are introduced or modified in the feature documented in this module: • **redistribute maximum-prefix** • **show ip ospf** • **show ip ospf database**

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

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

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

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

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
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**router ospf** *process-id* **Example:** `Router(config)# router ospf 1`	Configures an OSPF routing process.
Step 4	**timers throttle lsa all** *start-interval hold-interval max-interval* **Example:** `Router(config-router)# timers throttle lsa all 100 10000 45000`	(Optional) Sets the rate-limiting values (in milliseconds) for LSA generation. • The default values are as follows: ◦ *start-interval*is 0 milliseconds ◦ *hold-interval*is 5000 milliseconds ◦ *max-interval*is 5000 milliseconds

	Command or Action	Purpose
Step 5	**timers lsa arrival** *milliseconds* **Example:** `Router(config-router)# timers lsa arrival 2000`	(Optional) Sets the minimum interval (in milliseconds) between instances of receiving the same LSA. • The default value is 1000 milliseconds. • We suggest you keep the *milliseconds*value of the LSA arrival timer less than or equal to the neighbors' *hold-interval* value of the **timers throttle lsa all** command.
Step 6	**end** **Example:** `Router(config-router)# end`	Exits router configuration mode.

Step 7	**show ip ospf timers rate-limit**
	
	Example:
	`Router# show ip ospf timers rate-limit`
	
	Example:
	`LSAID: 10.1.1.1  Type: 1  Adv Rtr: 172.16.2.2 Due in: 00:00:00.028`
	
	Example:
	`LSAID: 192.168.4.1  Type: 3  Adv Rtr: 172.17.2.2 Due in: 00:00:00.028`
		(Optional) Displays a list of the LSAs in the rate limit queue (about to be generated).
		• 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

Step 8 **show ip ospf**
 	
Example:
`Router# show ip ospf`
 	
Example:
`Routing Process "ospf 4" with ID 10.10.24.4`
 	
Example:
`Supports only single TOS(TOS0) routes`
 	
Example:
`Supports opaque LSA`
 	
Example:
`Supports Link-local Signaling (LLS)`
 	
Example:
`Initial SPF schedule delay 5000 msecs`
 	
Example:
`Minimum hold time between two consecutive SPFs 10000 msecs`
 	
Example:
`Maximum wait time between two consecutive SPFs 10000 msecs`
 	
Example:
`Incremental-SPF disabled`
	(Optional) Displays information about OSPF.
	• The output lines shown in bold in the example indicate the LSA throttling values.

Command or Action	Purpose

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

Command or Action	Purpose

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

Command or Action	Purpose

Example:
`Number of LSA 4. Checksum Sum 0x23EB9`
Example:
`Number of opaque link LSA 0. Checksum Sum 0x0`
Example:
`Number of DCbitless LSA 0`
Example:
`Number of indication LSA 0`
Example:
`Number of DoNotAge LSA 0`
Example:
`Flood list length 0`	

Configuration Examples for OSPF LSA Throttling

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	*Cisco IOS IP Routing: OSPF Command Reference*

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

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

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 155

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
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**router ospf** *process-id* [**vrf** *vpn-name*] **Example:** `Router(config)# router ospf 1 vrf crf-1`	Enables OSPF routing. • The *process-id* argument identifies the OSPF process. • Use the **vrf** keyword and *vpn-name* argument to identify a VPN. **Note** You now can configure as many OSPF VRF processes as needed.
Step 4	**end** **Example:** `Router(config-router)# end`	Returns to privileged EXEC mode.
Step 5	**show ip ospf** [*process-id*] **Example:** `Router# show ip ospf 1`	Displays general information about OSPF routing processes.

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

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 msecs
 Minimum hold time between two consecutive SPFs 10000 msecs
 Maximum wait time between two consecutive SPFs 10000 msecs
 Incremental-SPF disabled
 Minimum LSA interval 5 secs
 Minimum LSA arrival 1000 msecs
 LSA group pacing timer 240 secs
 Interface flood pacing timer 33 msecs
 Retransmission pacing timer 66 msecs
 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	*Cisco IOS IP Routing: OSPF Configuration Guide*

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

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.

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

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

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. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**router ospf** *process-id* [**vrf** *vpn-name*] **Example:** `Router(config)# router ospf 100`	Enables OSPF routing and enters router configuration mode. • The *process-id* 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	*OSPF Version 2*

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 12 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	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. The following commands are introduced or modified in the feature documented in this module: • **capability transit**

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

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

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

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. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**interface** *type slot /port* **Example:** `Router(config)# interface Ethernet 1/0` **Example:**	Configures an interface type and enters interface configuration mode.

	Command or Action	Purpose
Step 4	**ip address** *ip-address mask* [**secondary**] **Example:** `Router(config-if)# ip address 10.2.145.20 255.255.255.0`	Sets a primary or secondary IP address for an interface.
Step 5	**no ip directed-broadcast** [*access-list-number* | *extended access-list-number*] **Example:** `Router(config-if)# no ip directed-broadcast`	Drops directed broadcasts destined for the subnet to which that interface is attached, rather than broadcasting them. • The forwarding of IP directed broadcasts on Ethernet interface 1/0 is disabled.
Step 6	**ip ospf message-digest-key** *key-id encryption-type* **md5** *key* **Example:** `Router(config-if)# ip ospf message-digest-key 100 md5 testing`	Enables OSPF Message Digest 5 (MD5) algorithm authentication.
Step 7	[**no** | **default**] **ip ospf lls** [**disable**] **Example:** `Router(config-if)# ip ospf lls disable`	Disables LLS on an interface, regardless of the global (router level) setting.

- What to Do Next, page 165

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 166

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	*Cisco IOS IP Routing: OSPF Command Reference*

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	*OSPF Version 2*

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 13 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**.

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 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

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

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

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. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**router ospf** *process-id* **Example:** `Router(config)# router ospf 1`	Enables OSPF routing. • The *process-id* argument identifies the OSPF process.

	Command or Action	Purpose
Step 4	**router-id** *ip-address* **Example:** `Router(config-router)# router-id 10.0.0.1`	Specifies a fixed router ID for an OSPF process.
Step 5	**log -adjacency-changes** [**detail**] **Example:** `Router(config-router)# log-adjacency-changes`	Configures the router to send a syslog message when an OSPF neighbor goes up or down.
Step 6	**max-lsa** *maximum-number* [*threshold-percentage*] [**warning-only**] [**ignore-time** *minutes*] [**ignore-count** *count-number*] [**reset-time** *minutes*] **Example:** `Router(config-router)# max-lsa 12000`	Limits the number of nonself-generated LSAs an OSPF routing process can keep in the OSPF link-state database (LSDB).
Step 7	**network** *ip-address wildcard-mask* **area** *area-id* **Example:** `Router(config-router)# network 209.165.201.1 255.255.255.255 area 0`	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 174

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

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	• "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.

OSPF Enhanced Traffic Statistics for OSPFv2 and OSPFv3

This document describes new and modified commands that provide enhanced OSPF traffic statistics for OSPFv2 and OSPFv3. The ability to collect and display more detailed traffic statistics increases high availability for the OSPF network by making the troubleshooting process more efficient.

New OSPF traffic statistics are collected and displayed to include the following information:

- OSPF Hello input queue and OSPF process queue status and statistics.
- Global OSPF traffic statistics.
- Per OSPF interface traffic statistics.
- Per OSPF process traffic statistics.

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 Enhanced Traffic Statistics

OSPFv2 or OSPFv3 must be configured on the router.

Information About OSPF Enhanced Traffic Statistics

The OSPF enhanced traffic statistics are enabled by default and cannot be disabled. The detailed OSPF traffic statistics are especially beneficial for troubleshooting the following types of OSPF instabilities:

- OSPF process queue status and statistical information can help the network administrator determine if an OSPF process can handle the amount of traffic sent to OSPF.
- OSPF packet header errors and LSA errors statistics keep a record of different errors found in received OSPF packets.

OSPF enhanced traffic control statistics also monitor the amount of traffic control exchanged between OSPF processes--an important consideration in network environments with slow links and frequent topology changes.

How to Display and Clear OSPF Enhanced Traffic Statistics

- Displaying and Clearing OSPF Traffic Statistics for OSPFv2, page 180
- Displaying and Clearing OSPF Traffic Statistics for OSPFv3, page 181

Displaying and Clearing OSPF Traffic Statistics for OSPFv2

Your network must run IPv4 to collect, display and clear detailed traffic statistics for Hello output, process queue status, global OSPF traffic statistics, per OSPF interface traffic statistics and per OSPF process traffic statistics.

SUMMARY STEPS

1. **enable**
2. **show ip ospf** [*process-id*] **traffic**[*interface-type interface-number*]
3. **clear ip ospf traffic**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**show ip ospf** [*process-id*] **traffic**[*interface-type interface-number*] **Example:** `Router# show ip ospf traffic statistics`	Displays OSPFv2 traffic statistics.

	Command or Action	Purpose
Step 3	**clear ip ospf traffic** **Example:** `Router# clear ip ospf traffic`	Clears OSPFv2 traffic statistics.

Displaying and Clearing OSPF Traffic Statistics for OSPFv3

Your network must run IPv6 to collect, display and clear detailed traffic statistics for Hello output, process queue status, global OSPF traffic statistics, per OSPF interface traffic statistics and per OSPF process traffic statistics.

SUMMARY STEPS

1. **enable**
2. **show ipv6 ospf** [*process-id*] **traffic**[*interface-type interface-number*]
3. **clear ipv6 ospf traffic**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**show ipv6 ospf** [*process-id*] **traffic**[*interface-type interface-number*] **Example:** `Router# show ipv6 ospf traffic statistics`	Displays OSPFv3 traffic statistics.
Step 3	**clear ipv6 ospf traffic** **Example:** `Router# clear ipv6 ospf traffic`	Clears OSPFv3 traffic statistics.

Configuration Examples for OSPF Enhanced Traffic Commands

Displaying and Clearing Enhanced Traffic Statistics for OSPFv2 Example

The following example shows display output for the **show ip ospf traffic** command for OSPFv2:

```
Router# show ip ospf traffic
OSPF statistics:
 Rcvd: 55 total, 0 checksum errors
       22 hello, 7 database desc, 2 link state req
       6 link state updates, 6 link state acks
  Sent: 68 total
       45 hello, 7 database desc, 2 link state req
       10 link state updates, 4 link state acks
           OSPF Router with ID (10.1.1.1) (Process ID 8)
OSPF queues statistic for process ID 8:
  OSPF Hello queue size 0, no limit, drops 0, max size 0
  OSPF Router queue size 0, limit 200, drops 0, max size 0
Interface statistics:
    Interface Ethernet0/0.1
OSPF packets received/sent
  Type          Packets              Bytes
  RX Invalid    0                    0
  RX Hello      0                    0
  RX DB des     0                    0
  RX LS req     0                    0
  RX LS upd     0                    0
  RX LS ack     0                    0
  RX Total      0                    0
  TX Failed     0                    0
  TX Hello      16                   1216
  TX DB des     0                    0
  TX LS req     0                    0
  TX LS upd     0                    0
  TX LS ack     0                    0
  TX Total      16                   1216
OSPF header errors
  Length 0, Checksum 0, Version 0, Bad Source 0,
  No Virtual Link 0, Area Mismatch 0, No Sham Link 0,
  Self Originated 0, Duplicate ID 0, Hello 0,
  MTU Mismatch 0, Nbr Ignored 0, LLS 0,
  Authentication 0,
OSPF LSA errors
  Type 0, Length 0, Data 0, Checksum 0,
Summary traffic statistics for process ID 8:
OSPF packets received/sent
  Type          Packets              Bytes
  RX Invalid    0                    0
  RX Hello      0                    0
  RX DB des     0                    0
  RX LS req     0                    0
  RX LS upd     0                    0
  RX LS ack     0                    0
  RX Total      0                    0
  TX Failed     0                    0
  TX Hello      16                   1216
  TX DB des     0                    0
  TX LS req     0                    0
  TX LS upd     0                    0
  TX LS ack     0                    0
  TX Total      16                   1216
OSPF header errors
  Length 0, Checksum 0, Version 0, Bad Source 0,
  No Virtual Link 0, Area Mismatch 0, No Sham Link 0,
  Self Originated 0, Duplicate ID 0, Hello 0,
  MTU Mismatch 0, Nbr Ignored 0, LLS 0,
  Authentication 0,
OSPF LSA errors
```

```
  Type 0, Length 0, Data 0, Checksum 0,
           OSPF Router with ID (10.1.1.4) (Process ID 1)
OSPF queues statistic for process ID 1:
  OSPF Hello queue size 0, no limit, drops 0, max size 2
  OSPF Router queue size 0, limit 200, drops 0, max size 2
Interface statistics:
    Interface Serial2/0
OSPF packets received/sent
  Type          Packets              Bytes
  RX Invalid    0                    0
  RX Hello      11                   528
  RX DB des     4                    148
  RX LS req     1                    60
  RX LS upd     3                    216
  RX LS ack     2                    128
  RX Total      21                   1080
  TX Failed     0                    0
 TX Hello      14                   1104
  TX DB des     3                    252
  TX LS req     1                    56
  TX LS upd     3                    392
  TX LS ack     2                    128
  TX Total      23                   1932
OSPF header errors
  Length 0, Checksum 0, Version 0, Bad Source 0,
  No Virtual Link 0, Area Mismatch 0, No Sham Link 0,
  Self Originated 0, Duplicate ID 0, Hello 0,
  MTU Mismatch 0, Nbr Ignored 0, LLS 0,
  Authentication 0,
OSPF LSA errors
  Type 0, Length 0, Data 0, Checksum 0,
    Interface Ethernet0/0
OSPF packets received/sent
  Type          Packets              Bytes
  RX Invalid    0                    0
  RX Hello      13                   620
  RX DB des     3                    116
  RX LS req     1                    36
  RX LS upd     3                    228
  RX LS ack     4                    216
  RX Total      24                   1216
  TX Failed     0                    0
  TX Hello      17                   1344
  TX DB des     4                    276
  TX LS req     1                    56
  TX LS upd     7                    656
  TX LS ack     2                    128
  TX Total      31                   2460
OSPF header errors
  Length 0, Checksum 0, Version 0, Bad Source 13,
  No Virtual Link 0, Area Mismatch 0, No Sham Link 0,
  Self Originated 0, Duplicate ID 0, Hello 0,
  MTU Mismatch 0, Nbr Ignored 0, LLS 0,
  Authentication 0,
OSPF LSA errors
  Type 0, Length 0, Data 0, Checksum 0,

Summary traffic statistics for process ID 1:
OSPF packets received/sent
  Type          Packets              Bytes
  RX Invalid    0                    0
  RX Hello      24                   1148
  RX DB des     7                    264
  RX LS req     2                    96
  RX LS upd     6                    444
  RX LS ack     6                    344
  RX Total      45                   2296
  TX Failed     0                    0
  TX Hello      31                   2448
  TX DB des     7                    528
  TX LS req     2                    112
  TX LS upd     10                   1048
  TX LS ack     4                    256
```

```
  TX Total      54                  4392
OSPF header errors
  Length 0, Checksum 0, Version 0, Bad Source 13,
  No Virtual Link 0, Area Mismatch 0, No Sham Link 0,
  Self Originated 0, Duplicate ID 0, Hello 0,
  MTU Mismatch 0, Nbr Ignored 0, LLS 0,
  Authentication 0,
OSPF LSA errors
  Type 0, Length 0, Data 0, Checksum 0,
```

The network administrator can issue the **clear ip ospf traffic** command to reset all counters and restart all statistics collections:

```
Router# clear ip ospf traffic
```

Displaying and Clearing Enhanced Traffic Statistics for OSPFv3 Example

The following example shows display output for the **show ipv6 ospf traffic** command for OSPFv3:

```
Router# show ipv6 ospf traffic

OSPFv3 statistics:
  Rcvd: 32 total, 0 checksum errors
        10 hello, 7 database desc, 2 link state req
        9 link state updates, 4 link state acks
        0 LSA ignored
  Sent: 45 total, 0 failed
        17 hello, 12 database desc, 2 link state req
        8 link state updates, 6 link state acks
            OSPFv3 Router with ID (10.1.1.4) (Process ID 6)
OSPFv3 queues statistic for process ID 6
  Hello queue size 0, no limit, max size 2
  Router queue size 0, limit 200, drops 0, max size 2
Interface statistics:
    Interface Serial2/0
OSPFv3 packets received/sent
  Type          Packets             Bytes
  RX Invalid    0                   0
  RX Hello      5                   196
  RX DB des     4                   172
  RX LS req     1                   52
  RX LS upd     4                   320
  RX LS ack     2                   112
  RX Total      16                  852
  TX Failed     0                   0
  TX Hello      8                   304
  TX DB des     3                   144
  TX LS req     1                   52
  TX LS upd     3                   252
  TX LS ack     3                   148
  TX Total      18                  900
OSPFv3 header errors
  Length 0, Checksum 0, Version 0, No Virtual Link 0,
  Area Mismatch 0, Self Originated 0, Duplicate ID 0,
  Instance ID 0, Hello 0, MTU Mismatch 0,
  Nbr Ignored 0, Authentication 0,
OSPFv3 LSA errors
  Type 0, Length 0, Data 0, Checksum 0,
    Interface Ethernet0/0
OSPFv3 packets received/sent
  Type          Packets             Bytes
  RX Invalid    0                   0
  RX Hello      6                   240
  RX DB des     3                   144
  RX LS req     1                   52
  RX LS upd     5                   372
  RX LS ack     2                   152
  RX Total      17                  960
  TX Failed     0                   0
  TX Hello      11                  420
```

```
  TX DB des     9                   312
  TX LS req     1                   52
  TX LS upd     5                   376
  TX LS ack     3                   148
  TX Total      29                  1308
OSPFv3 header errors
  Length 0, Checksum 0, Version 0, No Virtual Link 0,
  Area Mismatch 0, Self Originated 0, Duplicate ID 0,
  Instance ID 0, Hello 0, MTU Mismatch 0,
  Nbr Ignored 0, Authentication 0,
OSPFv3 LSA errors
  Type 0, Length 0, Data 0, Checksum 0,
Summary traffic statistics for process ID 6:
OSPFv3 packets received/sent
  Type          Packets             Bytes
  RX Invalid    0                   0
  RX Hello      11                  436
  RX DB des     7                   316
  RX LS req     2                   104
  RX LS upd     9                   692
  RX LS ack     4                   264
  RX Total      33                  1812
  TX Failed     0                   0
  TX Hello      19                  724
  TX DB des     12                  456
  TX LS req     2                   104
  TX LS upd     8                   628
  TX LS ack     6                   296
  TX Total      47                  2208
OSPFv3 header errors
  Length 0, Checksum 0, Version 0, No Virtual Link 0,
  Area Mismatch 0, Self Originated 0, Duplicate ID 0,
  Instance ID 0, Hello 0, MTU Mismatch 0,
  Nbr Ignored 0, Authentication 0,
OSPFv3 LSA errors
  Type 0, Length 0, Data 0, Checksum 0,
```

The network administrator can issue the **clear ipv6 ospf traffic** command to reset all counters and restart all statistics collections:

```
Router# clear ipv6 ospf traffic
```

Additional References

The following sections provide references related to the OSPF Enhanced Traffic Statistics for OSPFv2 and OSPFv3 feature.

Related Documents

Related Topic	Document Title
OSPF commands	*Cisco IOS IP Routing: OSPF Command Reference*
OSPF configuration	Configuring OSPF

Standards

Standard	Title
None	--

MIBs

MIB	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

RFC	Title
	--

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 Enhanced Traffic Statistics

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 14 Feature Information for OSPF Enhanced Traffic Statistics for OSPFv2 and OSPFv3

Feature Name	Releases	Feature Information
OSPF Enhanced Traffic Statistics for OSPFv2 and OSPFv3	12.4(6)T 12.2(31)SB2 12.2(33)SRB	This document describes the detailed OSPF traffic statistics that are provided when the user enters the new and modified commands show commands for OSPFv2 and OSPFv3. The following commands were introduced or modified: **clear ipv6 ospf traffic**, **show ip ospf traffic**, **show ipv6 ospf traffic**.

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

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 190
- Benefits of the OSPF MIB, page 194

OSPF MIB Changes to Support RFC 1850

- OSPF MIB, page 190
- OSPF TRAP MIB, page 191
- CISCO OSPF MIB, page 192
- CISCO OSPF TRAP MIB, page 193

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 15 New OSPF-MIB Objects

OSPF-MIB Table	New MIB Objects
OspfAreaEntry table	• OspfAreaSummary • OspfAreaStatus

OSPF-MIB Table	New MIB Objects
OspfStubAreaEntry	• OspfStubMetricType
OspfAreaRangeEntry	• OspfAreaRangeEffect
OspfHostEntry	• OspfHostAreaID
OspfIfEntry	• OspfIfStatus • OspfIfMulticastForwarding • OspfIfDemand • OspfIfAuthType
OspfVirtIfEntry	• OspfVirtIfAuthType
OspfNbrEntry	• OspfNbmaNbrPermanence • OspfNbrHelloSuppressed
OspfVirtNbrEntry	• OspfVirtNbrHelloSuppressed
OspfExtLsdbEntry	• OspfExtLsdbType • OspfExtLsdbLsid • OspfExtLsdbRouterId • OspfExtLsdbSequence • OspfExtLsdbAge • OspfExtLsdbChecksum • OspfExtLsdbAdvertisement
OspfAreaAggregateEntry	• 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 195.

The table below shows the OSPF trap MIB objects, listed in the order in which they appear within the OSPF-TRAP-MIB file.

Table 16 New OSPF-TRAP-MIB Objects

OSPF Control MIB Object	Trap MIB Objects
ospfSetTrap	• 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 17 New CISCO-OSPF-MIB Objects

CISCO-OSPF-MIB Table	New MIB Objects
cospfAreaEntry	• cospfOpaqueAreaLsaCount • cospfOpaqueAreaLsaCksumSum • cospfAreaNssaTranslatorRole • cospfAreaNssaTranslatorState • cospfAreaNssaTranslatorEvents
cospfLsdbEntry	• cospfLsdbType • cospfLsdbSequence • cospfLsdbAge • cospfLsdbChecksum • cospfLsdbAdvertisement
cospfIfEntry	• cospfIfLsaCount • cospfIfLsaCksumSum
cospfVirtIfEntry	• cospfVirtIfLsaCount • cospfVirtIfLsaCksumSum
cospfLocalLsdbEntry	• cospfLocalLsdbIpAddress • cospfLocalLsdbAddressLessIf • cospfLocalLsdbType • cospfLocalLsdbLsid • cospfLocalLsdbRouterId • cospfLocalLsdbSequence • cospfLocalLsdbAge • cospfLocalLsdbChecksum • cospfLocalLsdbAdvertisement
cospfVirtLocalLsdbEntry	• 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 18 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 trapis generated for mismatched MTU parameter errors when virtual OSPF neighbors are forming adjacencies.
cospfTxRetransmit	This trapis 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 trapis generated in the case of opaque LSAs when packets are sent by a virtual interface.
cospfOriginateLsa	This trapis generated when a new opaque LSA is originated by the router when a topology change has occurred.
cospfMaxAgeLsa	The trapis 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 195.

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

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. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.

Command or Action	Purpose
Step 3 **snmp-server community** *string1* **ro** **Example:** `Router(config)# snmp-server community public ro`	Enables read access to all objects in the MIB, but does not allow access to the community strings.
Step 4 **snmp-server community** *string2* **rw** **Example:** `Router(config)# snmp-server community private rw`	Enables read and write access to all objects in the MIB, but does not allow access to the community strings.
Step 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*] **Example:** `Router(config)# snmp-server host 172.20.2.162 version 2c public ospf`	Specifies a recipient (target host) for SNMP notification operations. • If no *notification-type* 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 *notification-types*. (See the example.) Entering the **ospf** keyword enables the ospfSetTrap trap control MIB object.
Step 6 **snmp-server enable traps ospf** **Example:** `Router(config)# snmp-server enable traps ospf`	Enables all SNMP notifications defined in the OSPF MIBs. **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.
Step 7 **end** **Example:** `Router(config)# end`	Ends your configuration session and exits global configuration mode.

• What to Do Next, page 196

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	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**snmp-server enable traps ospf cisco-specific errors** [**config-error**] [**virt-config-error**] **Example:** `Router(config)# snmp-server enable traps ospf cisco-specific errors config-error`	Enables SNMP notifications for Cisco-specific OSPF configuration mismatch errors. • Entering the **snmp-server enable traps ospf cisco-specific errors** command with the optional **virt-config-error** keyword enables only the SNMP notifications for configuration mismatch errors on virtual interfaces.

	Command or Action	Purpose
Step 4	**snmp-server enable traps ospf cisco-specific retransmit** [**packets**] [**virt-packets**] **Example:** `Router(config)# snmp-server enable traps ospf cisco-specific retransmit packets virt-packets`	Enables error traps for Cisco-specific OSPF errors that involve re-sent packets. • 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	**snmp-server enable traps ospf cisco-specific state-change** [**nssa-trans-change**] [**shamlink-state-change**] **Example:** `Router(config)# snmp-server enable traps ospf cisco-specific state-change`	Enables all error traps for Cisco-specific OSPF transition state changes.
Step 6	**snmp-server enable traps ospf cisco-specific lsa** [**lsa-maxage**] [**lsa-originate**] **Example:** `Router(config)# snmp-server enable traps ospf cisco-specific lsa`	Enables error traps for opaque LSAs.
Step 7	**snmp-server enable traps ospf errors** [**authentication-failure**] [**bad-packet**] [**config-error**] [**virt-authentication-failure**] [**virt-config-error**] **Example:** `Router(config)# snmp-server enable traps ospf errors virt-config-error`	Enables error traps for OSPF configuration errors. • 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	**snmp-server enable traps ospf lsa** [**lsa-maxage**] [**lsa-originate**] **Example:** `Router(config)# snmp-server enable traps ospf lsa`	Enables error traps for OSPF LSA errors.
Step 9	**snmp-server enable traps ospf rate-limit** *seconds trap-number* **Example:** `Router(config)# snmp-server enable traps ospf rate-limit 20 20`	Sets the rate limit for how many SNMP OSPF notifications are sent in each OSPF SNMP notification rate-limit window.

	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. • 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. • 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

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	*Cisco IOS Configuration Fundamentals and Network Management Command Reference*

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
• 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	*OSPF MIB Support*

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 19 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.

SNMP ifIndex Value for Interface ID in OSPFv2 and OSPFv3 Data Fields

This document describes the configuration command that allows you to use either the current interface number or the SNMP MIB-II interface index (ifIndex) value for the interface ID in OSPFv2 and OSPFv3 data fields. The advantage to using the SNMP MIB-II ifIndex value is that this number corresponds to the number that the user will see reported by SNMP.

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 Interface ID in Data Fields

OSPF must be configured on the router.

Information About Interface ID in Data Fields

Before choosing to switch from the current interface numbers to the SNMP MIB-II interface ID numbers, you should understand the following concepts:

Benefits of Choosing to Identify Interfaces by the SNMP MIB-II ifIndex Value

If you use Simple Network Management Protocol (SNMP) for your OSPF network, configuring the OSPF: SNMP ifIndex Value for Interface ID in OSPFv2 and OSPFv3 Data Fields feature can be beneficial for the following reasons:

- Using the SNMP MIB-II ifIndex (interface index) identification numbers to identify OSPF interfaces makes it easier for network administrators to identify interfaces because the numbers will correspond to the numbers that they will see reported by SNMP.
- When examining link-state advertisements (LSAs), the value used in fields that have the interface ID will be the same as the value that is reported by SNMP.
- When looking at the output of the **show ipv6 ospf interface** command, the interface ID number will have the same value that is reported by SNMP.
- Using the SNMP MIB-II IfIndex is also suggested, but not required, by the OSPF RFC 2328 for OSPFv2 and the RFC 2740 for OSPFv3.

How OSPFv2 and OSPFv3 Use the SNMP MIB-II ifIndex Value

The user chooses for OSPF interfaces to use the SNMP MIB-II ifIndex number by entering the **interface-id snmp-if-index** command for a specific OSPF process. If an interface under the specific OSPF process does not have an SNMP ifIndex number, OSPF will not be enabled on that interface.

For OSPFv2, the ifIndex number is used for the Link Data field in the Router LSA for unnumbered point-to-point interfaces and sham links. When the **interface-id snmp-if-index** command is entered, the affected LSAs will immediately be reoriginated.

For OSPFv3, the ifIndex number is used for the interface ID in router LSAs, as the LSID in Network and Link LSAs, and also as the interface ID in Hello packets. Intra-Area-Prefix LSAs that reference Network LSAs have the network LSAs LSID in the Referenced LSID field, so they will also be updated when the **interface-id snmp-if-index** command is entered. The old Network, Link and Intra-Area-Prefix LSAs that are associated with a Network LSA will be flushed.

For both OSPFv2 and OSPFv3, adjacencies are not flapped, except for affected OSPFv3 demand circuits (including virtual links) with full adjacencies.

For both OSPFv2 and OSPFv3, if an interface does not have an SNMP ifIndex number and an interface ID is needed (for OSPFv2 this applies only to unnumbered interfaces and sham links), an error message will be generated and the interface will be disabled. The interface will be reenabled if the **no interface-id snmp-if-index** command is entered.

How to Configure the Interface ID in Data Fields

- Using SNMP MIB-II ifIndex Numbers, page 204

Using SNMP MIB-II ifIndex Numbers

Follow the steps in this task to configure OSPF interfaces to use the SNMP MIB-II ifIndex numbers. These steps work for both OSPFv2 and OSPFv3. All OSPF interfaces must use the SNMP MIB-II ifIndex

numbers or the interfaces will not be enabled for OSPF. Therefore, repeat the steps within this task for each OSPF process for which you want the interfaces to use the SNMP MIB-II ifIndex numbers.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. Do one of the following:
   - **router ospf** *process-id* [**vrf** *vpn-name*]
   - **ipv6 router ospf** *process-id*
4. **interface-id snmp-if-index**
5. **end**
6. **show snmp mib ifmib ifindex** [*interface-type*] [*slot* /][*port-adapter* /][*port*]

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.

Step 3	Do one of the following:
	• **router ospf** *process-id* [**vrf** *vpn-name*]
	• **ipv6 router ospf** *process-id*
	
	Example:
	`Router(config)# router ospf 4`
	
	Example:
	
	Example:
	`Router(config)# ipv6 router ospf 4`
		Configures an OSPFv2 routing process and enters router configuration mode.
		Configures an OSPFv3 routing process and enters router configuration mode.

	Command or Action	Purpose
Step 4	**interface-id snmp-if-index** **Example:** `Router(config-router)# interface-id snmp-if-index`	Configures OSPF interfaces with the SNMP interface index identification numbers (ifIndex values).
Step 5	**end** **Example:** `Router(config-router)# end`	Returns to privileged EXEC mode.
Step 6	**show snmp mib ifmib ifindex** [*interface-type*] [*slot* /][*port-adapter* /][*port*] **Example:** `Router# show snmp mib ifmib ifindex Ethernet 0/1`	Displays SNMP interface index identification numbers (ifIndex values) for all the system interfaces or the specified system interface.

Configuration Examples for the Interface ID in Data Fields

Configuring the SNMP ifIndex Value for Interface ID for OSPFv2 Example

The following example configures the OSPF interfaces to use the SNMP ifIndex values for the interfaces IDs. The **show snmp mib ifmib ifindex** command confirms that the SNMP MIB-II ifIndex values are used for the Interface ID values in the OSPFv2 data fields.

```
Router# configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
Router(config)# router ospf 1
Router(config-router)# interface-id snmp-if-index
Router(config-router)# ^Z
Router# show ip ospf 1 1 data router self
            OSPF Router with ID (172.16.0.1) (Process ID 1)
                Router Link States (Area 1)
  LS age: 6
  Options: (No TOS-capability, DC)
  LS Type: Router Links
  Link State ID: 172.16.0.1
  Advertising Router: 172.16.0.1
  LS Seq Number: 80000007
  Checksum: 0x63AF
  Length: 48
  Area Border Router
  Number of Links: 2
    Link connected to: another Router (point-to-point)
     (Link ID) Neighboring Router ID: 172.17.0.1
```

```
      (Link Data) Router Interface address: 0.0.0.53
       Number of TOS metrics: 0
        TOS 0 Metrics: 64
     Link connected to: a Stub Network
      (Link ID) Network/subnet number: 192.168.0.11
      (Link Data) Network Mask: 255.255.255.255
       Number of TOS metrics: 0
        TOS 0 Metrics: 1
Router# show snmp mib ifmib ifindex s13/0
Serial13/0: Ifindex = 53
```

Configuring the SNMP ifIndex Value for Interface ID for OSPFv3 Example

The following example configures the OSPFv3 interfaces to use the SNMP ifIndex values for the interface IDs.

```
Router# configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
Router(config)# ipv6 router ospf 1
Router(config-router)# interface-id snmp-if-index
```

The output from the **show snmp mib ifmib ifindex** command confirms that the SNMP MIB-II ifIndex values are being used for the Interface ID values in the OSPFv3 data fields.

```
Router# show snmp mib ifmib ifindex Ethernet1/0
Ethernet1/0: Ifindex = 5
Router#
Router# show ipv6 ospf int
OSPF_VL0 is up, line protocol is up
  Interface ID 71
  Area 0, Process ID 1, Instance ID 0, Router ID 172.16.0.1
  Network Type VIRTUAL_LINK, Cost: 10
  Configured as demand circuit.
  Run as demand circuit.
  DoNotAge LSA allowed.
  Transmit Delay is 1 sec, State POINT_TO_POINT,
  Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
    Hello due in 00:00:02
  Index 1/2/3, flood queue length 0
  Next 0x0(0)/0x0(0)/0x0(0)
  Last flood scan length is 1, maximum is 1
  Last flood scan time is 0 msec, maximum is 0 msec
  Neighbor Count is 1, Adjacent neighbor count is 1
    Adjacent with neighbor 10.0.0.1  (Hello suppressed)
  Suppress hello for 1 neighbor(s)
Ethernet2/0 is up, line protocol is up
  Link Local Address FE80::A8BB:CCFF:FE00:6F02, Interface ID 10
  Area 0, Process ID 1, Instance ID 0, Router ID 172.16.0.1
  Network Type BROADCAST, Cost: 10
  Transmit Delay is 1 sec, State DR, Priority 1
  Designated Router (ID) 172.16.0.1, local address FE80::A8BB:CCFF:FE00:6F02
  No backup designated router on this network
  Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
    Hello due in 00:00:06
  Index 1/1/2, flood queue length 0
  Next 0x0(0)/0x0(0)/0x0(0)
  Last flood scan length is 0, maximum is 0
  Last flood scan time is 0 msec, maximum is 0 msec
  Neighbor Count is 0, Adjacent neighbor count is 0
  Suppress hello for 0 neighbor(s)
Ethernet1/0 is up, line protocol is up
  Link Local Address FE80::A8BB:CCFF:FE00:6F01, Interface ID 6
  Area 1, Process ID 1, Instance ID 2, Router ID 172.16.0.1
  Network Type BROADCAST, Cost: 10
  Transmit Delay is 1 sec, State DR, Priority 1
  Designated Router (ID) 172.16.0.1, local address FE80::A8BB:CCFF:FE00:6F01
  Backup Designated router (ID) 10.0.0.1, local address FE80::A8BB:CCFF:FE00:6E01
  Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
    Hello due in 00:00:06
  Index 1/1/1, flood queue length 0
```

```
  Next 0x0(0)/0x0(0)/0x0(0)
  Last flood scan length is 1, maximum is 2
  Last flood scan time is 0 msec, maximum is 0 msec
  Neighbor Count is 1, Adjacent neighbor count is 1
    Adjacent with neighbor 10.0.0.1  (Backup Designated Router)
  Suppress hello for 0 neighbor(s)
Router#
Router# show ipv6 ospf data net adv 172.16.0.1
            OSPFv3 Router with ID (172.16.0.1) (Process ID 1)
                Net Link States (Area 1)
  LS age: 144
  Options: (V6-Bit E-Bit R-bit DC-Bit)
  LS Type: Network Links
  Link State ID: 6 (Interface ID of Designated Router)
  Advertising Router: 172.16.0.1
  LS Seq Number: 80000001
  Checksum: 0x1FC0
  Length: 32
        Attached Router: 172.16.0.1
        Attached Router: 10.0.0.1
Router# show ipv6 ospf data prefix adv 172.16.0.1
            OSPFv3 Router with ID (172.16.0.1) (Process ID 1)
                Intra Area Prefix Link States (Area 0)
  Routing Bit Set on this LSA
  LS age: 196
  LS Type: Intra-Area-Prefix-LSA
  Link State ID: 0
  Advertising Router: 172.16.0.1
  LS Seq Number: 80000001
  Checksum: 0x6F11
  Length: 44
  Referenced LSA Type: 2001
  Referenced Link State ID: 0
  Referenced Advertising Router: 172.16.0.1
  Number of Prefixes: 1
  Prefix Address: 2002:0:2::
  Prefix Length: 64, Options: None, Metric: 10
                Intra Area Prefix Link States (Area 1)
  Routing Bit Set on this LSA
  LS age: 161
  LS Type: Intra-Area-Prefix-LSA
  Link State ID: 0
  Advertising Router: 172.16.0.1
  LS Seq Number: 80000001
  Checksum: 0xB6E7
  Length: 52
  Referenced LSA Type: 2001
  Referenced Link State ID: 0
  Referenced Advertising Router: 172.16.0.1
  Number of Prefixes: 1
  Prefix Address: 2002:0:2:0:A8BB:CCFF:FE00:6F02
  Prefix Length: 128, Options: LA , Metric: 0
  Routing Bit Set on this LSA
  LS age: 151
  LS Type: Intra-Area-Prefix-LSA
  Link State ID: 1006
  Advertising Router: 172.16.0.1
  LS Seq Number: 80000001
  Checksum: 0x6E24
  Length: 44
  Referenced LSA Type: 2002
  Referenced Link State ID: 6
  Referenced Advertising Router: 172.16.0.1
  Number of Prefixes: 1
  Prefix Address: 2002:0:1::
  Prefix Length: 64, Options: None, Metric: 0
Router#
Router# show ipv6 ospf data router
            OSPFv3 Router with ID (10.0.0.1) (Process ID 1)
                Router Link States (Area 0)
  Routing Bit Set on this LSA
  LS age: 5 (DoNotAge)
  Options: (V6-Bit E-Bit R-bit DC-Bit)
```

```
  LS Type: Router Links
  Link State ID: 0
  Advertising Router: 10.0.0.1
  LS Seq Number: 80000004
  Checksum: 0xEE5C
  Length: 40
  Area Border Router
  Number of Links: 1
    Link connected to: a Virtual Link
      Link Metric: 10
      Local Interface ID: 70
      Neighbor Interface ID: 71
      Neighbor Router ID: 172.16.0.1
  LS age: 162
  Options: (V6-Bit E-Bit R-bit DC-Bit)
  LS Type: Router Links
  Link State ID: 0
  Advertising Router: 172.16.0.1
  LS Seq Number: 80000004
  Checksum: 0xCE7C
  Length: 40
  Area Border Router
  Number of Links: 1
    Link connected to: a Virtual Link
      Link Metric: 10
      Local Interface ID: 71
      Neighbor Interface ID: 70
      Neighbor Router ID: 10.0.0.1
                Router Link States (Area 1)
  Routing Bit Set on this LSA
  LS age: 176
  Options: (V6-Bit E-Bit R-bit DC-Bit)
  LS Type: Router Links
  Link State ID: 0
  Advertising Router: 10.0.0.1
  LS Seq Number: 80000003
  Checksum: 0xC807
  Length: 40
  Area Border Router
  Number of Links: 1
    Link connected to: a Transit Network
      Link Metric: 10
      Local Interface ID: 6
      Neighbor (DR) Interface ID: 6
      Neighbor (DR) Router ID: 172.16.0.1
  LS age: 175
  Options: (V6-Bit E-Bit R-bit DC-Bit)
  LS Type: Router Links
  Link State ID: 0
  Advertising Router: 172.16.0.1
  LS Seq Number: 80000004
  Checksum: 0xBD10
  Length: 40
  Area Border Router
  Number of Links: 1
    Link connected to: a Transit Network
      Link Metric: 10
      Local Interface ID: 6
      Neighbor (DR) Interface ID: 6
      Neighbor (DR) Router ID: 172.16.0.1
Router#
Router# show ipv6 ospf data link adv 172.16.0.1
            OSPFv3 Router with ID (172.16.0.1) (Process ID 1)
                Link (Type-8) Link States (Area 0)
  LS age: 245
  Options: (V6-Bit E-Bit R-bit DC-Bit)
  LS Type: Link-LSA (Interface: Ethernet2/0)
  Link State ID: 10 (Interface ID)
  Advertising Router: 172.16.0.1
  LS Seq Number: 80000002
  Checksum: 0xA0CB
  Length: 56
  Router Priority: 1
```

```
Link Local Address: FE80::A8BB:CCFF:FE00:6F02
Number of Prefixes: 1
Prefix Address: 2002:0:2::
Prefix Length: 64, Options: None
              Link (Type-8) Link States (Area 1)
LS age: 250
Options: (V6-Bit E-Bit R-bit DC-Bit)
LS Type: Link-LSA (Interface: Ethernet1/0)
Link State ID: 6 (Interface ID)
Advertising Router: 172.16.0.1
LS Seq Number: 80000001
Checksum: 0x4F94
Length: 44
Router Priority: 1
Link Local Address: FE80::A8BB:CCFF:FE00:6F01
Number of Prefixes: 0
```

Additional References

The following sections provide references related to the OSPF: SNMP ifIndex Value for Interface ID in OSPFv2 and OSPFv3 Data Fields feature.

Related Documents

Related Topic	Document Title
OSPF commands	*Cisco IOS IP Routing: OPSF Command Reference*
OSPF configuration	"Configuring OSPF"

Standards

Standard	Title
None	--

MIBs

MIB	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

RFC	Title
RFC 2328	*OSPF Version 2*
RFC 2740	*OSPF Version 3*

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 SNMP ifIndex Value for Interface ID in Data Fields

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 20 Feature Information for OSPF: SNMP ifIndex Value for Interface ID in OSPFv2 and OSPFv3 Data Fields

Feature Name	Releases	Feature Information
OSPF: SNMP ifIndex Value for Interface ID in OSPFv2 and OSPFv3 Data Fields	12.4(6)T 12.2(31)SB2 12.2(33)SRB	This document describes the configuration command that allows you the choice to use either the current interface number or the SNMP ifIndex value for the interface ID in OSPFv2 and OSPFv3 data fields. The advantage to using the SNMP MIB-II ifIndex value is that this number corresponds to the number that the user will see reported by SNMP.

Glossary

SNMP --Simple Network Management Protocol (SNMP) is an application layer protocol that facilitates the exchange of management information between network devices. It is part of the Transmission Control Protocol/Internet Protocol (TCP/IP) protocol suite.

Note See *Internetworking Terms and Acronyms* for terms not included in this glossary.

NSF-OSPF RFC 3623 OSPF Graceful Restart

This document focuses on nonstop forwarding (NSF) for OSPFv2 in Cisco IOS software, using the IETF standardized graceful restart functionality that is described in RFC 3623. Under very specific situations, a router may undergo certain well-known failure conditions that should not affect packet forwarding across the switching platform. NSF capability allows for the forwarding of data packets to continue along routes that are already known, while the routing protocol information is being restored. This capability is useful in cases in which there is a component failure (for example, a Route Processor [RP] crash with a backup RP taking over) or in which there is a scheduled hitless software upgrade.

Prior to RFC 3623, Cisco implemented Cisco-proprietary NSF, referred to as Cisco NSF. The OSPF RFC 3623 Graceful Restart feature allows you to configure IETF NSF in multivendor networks. Configuring IETF NSF increases the availability of your network by allowing OSPF routers to stay on the forwarding path even as their OSPF software is restarted. This document refers to the two forms of NSF as Cisco NSF and IETF NSF. The OSPF RFC 3623 Graceful Restart feature is the latest addition to the Cisco High Availability portfolio.

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 Configuring IETF NSF or Cisco NSF

- OSPF must be configured on the router.
- The router undergoing OSPF graceful restart must be capable of performing a stateful switchover (SSO) operation.

Restrictions for Configuring IETF NSF or Cisco NSF

- Only one of the possible methods for nonstop forwarding (Cisco NSF or IETF NSF) is supported at a time. For example, the restarting router uses either Cisco NSF or IETF NSF during switchover, depending on the configuration of the router. The helper mode for both methods is supported by default, based on the restarting method used by the restarting router. For example, if the restarting router is IETF NSF-capable, the helper router will use IETF NSF helper mode by default.
- Neither Cisco NSF nor IETF NSF is supported over sham-links.
- Cisco NSF is not support over virtual links.

Information About IETF NSF and Cisco NSF

Cisco NSF Routing and Forwarding Operation

Cisco NSF is supported by the BGP, EIGRP, OSPF, and IS-IS protocols for routing and by Cisco Express Forwarding (CEF) for forwarding. The BGP, EIGRP, OSPF, and IS-IS routing protocols have been enhanced with NSF capability and awareness, which means that routers that run these protocols can detect a switchover and take the necessary actions to continue forwarding network traffic and to recover route information from the neighbor routers.

In this document, a networking device is said to be NSF-aware if it is running NSF-compatible software. A device is said to be NSF-capable if it has been configured to support NSF; therefore, it would rebuild routing information from NSF-aware or NSF-capable neighbors. The NSF router modes of operation common to the Cisco and IETF NSF implementations are as follows:

- Restarting Mode--Also known as NSF-restarting mode or graceful-restarting mode. In this mode, the OSPF router process is performing nonstop forwarding recovery because of an RP switchover; this may result from an RP crash or a software upgrade on the active RP.
- Helper Mode--Also known as NSF-awareness. In this mode, a neighboring router is restarting, and this router is helping in the nonstop forwarding recovery.

Cisco Express Forwarding for NSF

A key element of NSF is packet forwarding. The OSPF protocol depends on CEF to continue forwarding packets during switchover while the routing protocols rebuild the Routing Information Base (RIB) tables. Once OSPF has converged, CEF updates the Forwarding Information Base (FIB) table and removes stale route entries. CEF then updates the line cards with the new FIB information. CEF maintains the FIB and uses the FIB information that was current at the time of a switchover to continue forwarding packets during the switchover. This feature reduces traffic interruption during the switchover.

During normal NSF operation, CEF on the active RP synchronizes its current FIB and adjacency databases with the FIB and adjacency databases on the standby RP. Upon switchover of the active RP, the standby RP initially has FIB and adjacency databases that are mirror images of those that were current on the active RP. For platforms with intelligent line cards, the line cards maintain the current forwarding information over a switchover; for platforms with forwarding engines, CEF keeps the forwarding engine on the standby RP current with changes that are sent to it by CEF on the active RP. In this way, the line cards or forwarding engines can continue forwarding after a switchover as soon as the interfaces and a data path are available.

As the OSPF routing protocol starts to repopulate the RIB on a prefix-by-prefix basis, the updates in turn cause prefix-by-prefix updates that CEF uses to update the FIB and adjacency databases. Existing and new entries receive the new version number, indicating that they have been refreshed. The forwarding information is updated on the line cards or forwarding engines during convergence. The RP signals when the RIB has converged. The software removes all FIB and adjacency entries that have an epoch older than the current switchover epoch. The FIB now reflects the newest routing protocol forwarding information.

The OSPF routing protocol runs on only the active RP, and OSPF receives routing updates from OSPF neighbor routers. The OSPF routing protocol does not run on the standby RP. Following a switchover, OSPF requests that the NSF-aware neighbor devices send state information to help rebuild the routing tables.

Note For NSF operation, OSPF depends on CEF to continue forwarding packets while OSPF rebuilds the routing information.

OSPF Graceful Restart Functionality per RFC 3623

This section describes the RFC 3623 graceful restart nonstop forwarding enhancement to the OSPF routing protocol. An OSPF NSF-capable router that is reloading and attempting a graceful restart originates grace-lsas to notify its neighbors that it will perform graceful restart within the specified amount of time or grace period. During this grace period, the neighboring OSPF routers, called helper routers, continue to announce the restarting router in their LSAs as if it were fully adjacent, as long as the network topology remains static.

The following sections contain more detailed information about the graceful restart process:

- Graceful Restart Router Operation, page 215
- Graceful Restart Helper Mode Operation, page 216

Graceful Restart Router Operation

Graceful Restart Initiation

The restarting router becomes aware that it should start the graceful restart process when the network administrator issues the appropriate command or when an RP reloads and forces and Redundancy Facility (RF) switchover. The length of the grace period can be set by the network administrator or calculated by the OSPF software of the restarting router. In order to prevent the LSAs from the restarting router from aging out, the grace period should no t exceed an LSA refresh time of 1800 seconds.

In preparation for graceful restart, the restarting router must perform the following action before its software can be reloaded: The restarting router must ensure that its forwarding table is updated and will

remain in place during the restart. No OSPF shutdown procedures are performed since neighbor routers must act as if the restarting router is still in service.

The OSPF software is reloaded on the router (it undergoes graceful restart).

OSPF Processes During Graceful Restart

After the router has reloaded, it must modify its OSPF processes until it reestablishes full adjacencies with all former fully adjacent OSPF neighbors. During graceful restart, the restarting router modifies its OSPF processes in the following ways:

- The restarting router does not originate LSAs with LS types 1, 5, or 7 so that the other routers in the OSPF domain will use the LSAs that the restarting router had originated prior to reloading. The router does not modify or flush any self-originated LSAs.
- The restarting router runs its OSPF routing calculations in order to return any OSPF virtual links to operation. However, the restarting router does not install OSPF routes into the system's forwarding table, and the router relies on the forwarding entries that it had installed prior to undergoing the graceful restart process.
- If the restarting router determines that is was the Designated Router on a given segment prior to the graceful restart, it will reelect itself.

Graceful Restart Process Exit

The restarting router exits the graceful restart process when one of the following events occur:

- The router has reestablished all adjacencies. The graceful restart was successful.
- The router receives an LSA that is inconsistent with an LSA from the same router prior to the graceful restart. The inconsistency can be mean either that the router does not support the graceful restart feature or that the router has terminated its helper mode for some reason. The graceful restart was unsuccessful.
- The grace period has expired. The graceful restart was not successful.
- Once the restarting router has completed the graceful restart process, it returns to normal OSPF operation, reoriginating LSAs based on the current state of the router and updating its forwarding tables based on current link-state database contents. At this time, it flushes the grace-lsas that it had originated during the initiation of the graceful restart process.

Graceful Restart Helper Mode Operation

Helper Mode Initiation

When a neighbor router that is on the same network segment as the restarting router receives a grace-lsa from the restarting router, the neighbor enters helper mode as long as the following criteria are met:

- The neighbor must have a full adjacency with the restarting router over the associated network segment.
- There have been no changes to the link-state database since the restarting router began restarting.
- The grace period has not yet expired.
- Local policy allows the neighbor router to act as a helper router.
- The neighbor router must not be in its own graceful restart process.
- Helper mode for this router has not been disabled by the network administrator.

Helper Mode Exit

The helper router stops performing helper mode for its neighbor when one of the following events occur:

- The grace-lsa that was originated by the restarting router is flushed, to signify that the restarting router has exited the graceful restart process successfully.
- The grace period of the grace-lsa expires.
- A change in link-state database contents indicates a network topology change, forcing the termination of the graceful restart process when the strict-lsa-checking option is enabled on the helper.

For complete information regarding graceful restart functionality, see RFC 3623:

http://www.ietf.org/rfc/rfc3623.txt

How to Configure IETF NSF or Cisco NSF

Enabling IETF NSF or Cisco NSF on the Router

Complete the steps in the following task to configure and verify configuration of Cisco NSF or IETF NSF on the router.

In order for the graceful restart process to work successfully, the OSPF neighbor (helper) routers need to run a version of Cisco IOS software that supports Cisco NSF or IETF NSF, or both.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **router ospf** *process-id* [**vrf** *vpn-name*]
4. **nsf ietf** [**restart-interval** *seconds*]
5. **end**
6. **show ip ospf** [*process-id*]

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.

	Command or Action	Purpose
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**router ospf** *process-id* [**vrf** *vpn-name*] **Example:** `Router(config)# router ospf 4`	Configures an Open Shortest Path First (OSPF) routing process and enters router configuration mode.

Step 4	**nsf ietf** [**restart-interval** *seconds*]
	
	Example:
	nsf cisco [**enforce global**]
	
	Example:
	`Router(config-router)# nsf ietf restart-interval 600`
	
	Example:
	`Router(config-router)# nsf cisco`
		(Optional) Enables IETF NSF, or graceful restart, on the router.
		• Optionally configures a maximum graceful restart interval, in seconds, after the graceful restart process.
		or
		(Optional) Enables Cisco NSF on a Cisco router.

Step 5	**end** **Example:** `Router(config-router)# end`	Returns to privileged EXEC mode.
Step 6	**show ip ospf** [*process-id*] **Example:** `Router# show ip ospf 4`	Displays general information about OSPF routing processes and whether OSPF graceful restart is configured.

Enabling Graceful Restart Strict LSA Checking on a Helper Router

Graceful restart helper mode is enabled by default. It is not recommended to disable helper mode because the disabled neighbor will detect the lost adjacency and the graceful restart process will be terminated.

The strict LSA checking feature allows a helper router to terminate the graceful restart process if it detects a changed LSA that would cause flooding during the graceful restart process. Strict LSA checking is disabled by default. You can enable strict LSA checking on an OSPF helper to have the router terminate graceful restart when there is a change to an LSA that would be flooded to the restarting router. You can configure strict LSA checking on both NSF-aware and NSF-capable routers; however, this feature will become effective only when the router is in helper mode.

Complete the steps in the following task to disable helper mode or enable strict LSA checking on the NSF-aware (helper) router.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **router ospf** *process-id* [**vrf** *vpn-name*]
4. **nsf cisco helper disable**
5. **nsf ietf helper strict-lsa-checking**
6. **end**
7. **show ip ospf** [*process-id*]

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**router ospf** *process-id* [**vrf** *vpn-name*] **Example:** `Router(config)# router ospf 454`	Configures an Open Shortest Path First (OSPF) routing process and enters router configuration mode.

	Command or Action	Purpose

Step 4	**nsf cisco helper disable**
	
	Example:
	
	nsf ietf helper disable
	
	Example:
	
	`Router(config-router)# nsf cisco helper disable`
	
	Example:
	
	`Router(config-router)# nsf ietf helper disable`
		(Optional) Disables helper mode for Cisco NSF.
		
		or
		
		(Optional) Disables helper mode for IETF NSF.

Step 5	**nsf ietf helper strict-lsa-checking** **Example:** `Router(config-router)# nsf ietf helper strict-lsa-checking`	Enables strict LSA checking on an NSF-aware (helper) router.
Step 6	**end** **Example:** `Router(config-router)# end`	Returns to privileged EXEC mode.
Step 7	**show ip ospf** [*process-id*] **Example:** `Router# show ip ospf 454`	Displays general information about OSPF routing processes and whether helper mode or strict LSA checking is enabled for the NSF-aware (helper) router.

Configuration Examples for IETF NSF or Cisco NSF

Enabling and Verifying IETF NSF for OSPF Example

The following example enables IETF NSF for OSPF process 10 on the router. The restart interval has been changed from the 120-second default value to 200 seconds.

```
Router(config)# router ospf 10
Router(config-router)# nsf ietf restart-interval 200
Router(config-router)# end
```

When the **show ip ospf** command is entered for OSPF process 10, the output verifies that IETF NSF was configured on the router, with a maximum route lifetime interval set for 200 seconds. The command output also confirms that NSF helper mode is enabled by default for IETF NSF, as well as for Cisco NSF.

```
Router# show ip ospf 10
 Routing Process "ospf 10" with ID 172.16.2.2
 Supports only single TOS(TOS0) routes
 Supports opaque LSA
 Supports Link-local Signaling (LLS)
 Supports area transit capability
 Initial SPF schedule delay 5000 msecs
 Minimum hold time between two consecutive SPFs 10000 msecs
 Maximum wait time between two consecutive SPFs 10000 msecs
 Incremental-SPF disabled
 Minimum LSA interval 5 secs
 Minimum LSA arrival 1000 msecs
 LSA group pacing timer 240 secs
 Interface flood pacing timer 33 msecs
 Retransmission pacing timer 66 msecs
 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
 IETF Non-Stop Forwarding enabled
    restart-interval limit: 200 sec
 IETF NSF helper support enabled
 Cisco NSF helper support enabled
 Reference bandwidth unit is 100 mbps
    Area BACKBONE(0)
        Number of interfaces in this area is 4 (1 loopback)
        Area has no authentication
        SPF algorithm last executed 02:03:02.468 ago
        SPF algorithm executed 4 times
        Area ranges are
        Number of LSA 3. Checksum Sum 0x175DA
        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
```

Disabling Helper Mode for IETF NSF Example

The following configuration disables helper support for IETF NSF on an OSPF router.

```
Router(config)# router ospf 200
Router(config-router)# nsf ietf helper disable
```

Additional References

The following sections provide references related to the OSPF RFC 3623 Graceful Restart feature.

Related Documents

Related Topic	Document Title
OSPF commands	*Cisco IOS IP Routing: OSPF Command Reference*
OSPF configuration	Configuring OSPF
Cisco nonstop forwarding	Cisco Nonstop Forwarding

Standards

Standard	Title
None	--

MIBs

MIB	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

RFC	Title
RFC 2328	*OSPF Version 2*
RFC 3623	*Graceful OSPF Restart*

Technical Assistance

Description	Link
The Cisco Support website provides extensive online resources, including documentation and tools for troubleshooting and resolving technical issues with Cisco products and technologies. Access to most tools on the Cisco Support website requires a Cisco.com user ID and password. If you have a valid service contract but do not have a user ID or password, you can register on Cisco.com.	http://www.cisco.com/techsupport

Feature Information for NSF-OSPF RFC 3623 Graceful Restart

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 21 Feature Information for NSF-OSPF RFC 3623 Graceful Restart

Feature Name	Releases	Feature Information
NSF--OSPF (RFC 3623 OSPF Graceful Restart)	12.0(32)S 12.2(33)SRA 12.2(31)SB2 12.2(33)SXH	This document focuses on nonstop forwarding (NSF) for OSPFv2 in Cisco IOS software, using the IETF standardized graceful restart functionality as described in RFC 3623.

Glossary

cutover --An event in which system control and routing protocol execution are transferred from an active processor to a standby processor. This may include transfer of the packet forwarding function as well.

NSF --nonstop forwarding. The continuation of forwarding packets across line cards during RP cutover.

OSPF --Open Shortest Path First. An interior gateway routing protocol.

RF --Redundancy Facility. A state machine that controls the progression and state of the redundant processor cards.

RP --Route Processor. A processor module in the Cisco 7000 series routers that contains the CPU, system software, and most of the memory components that are used in the router. Sometimes called a *supervisory processor* .

switchover --*See* cutover.

Area Command in Interface Mode for OSPFv2

This document describes how to enable Open Shortest Path First version 2 (OSPFv2) on a per-interface basis to simplify the configuration of unnumbered interfaces. The **ip ospf area** command allows you to enable OSPFv2 explicitly on an interface. The **ip ospf area** command is an alternative to enabling OSPFv2 through the address of the interface that matches the address range specified by the **network area** command.

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 Area Command in Interface Mode for OSPFv2

OSPFv2 must be running on your network.

Restrictions for Area Command in Interface Mode for OSPFv2

The **ip ospf area** command is supported only for OSPFv2.

Information About Area Command in Interface Mode for OSPFv2

Benefits of Area Command in Interface Mode for OSPFv2 Feature

OSPF is enabled on an interface when the network address for the interface matches the range of addresses that is specified by the **network area** command that is entered in router configuration mode. You can enable OSPFv2 explicitly on an interface with the **ip ospf area** command that is entered in interface configuration mode. This capability simplifies the configuration of unnumbered interfaces with different areas.

Because the **ip ospf area** command is configured explicitly for an interface, it will supersede the effects of the **network area** command that is entered at the network level to affect the interfaces whose addresses fall within the address range specified for the **network area** command.

If you later disable the **ip ospf area** command, the interface still will run OSPFv2 as long as its network address matches the range of addresses that is specified by the **network area** command.

Configuration Guidelines for the Area Command in Interface Mode for OSPFv2 Feature

When you use the **ip ospf area** command in interface configuration mode to enable OSPFv2 on an interface, we recommend that you be familiar with the following guidelines.

Interface Is Already OSPFv2-Enabled by network area Command with Same Area and Process

If you enter the **ip ospf area** command on an interface that is enabled in OSPFv2 by the **network area** command, the process ID or area ID of the interface does not change, and the interface status will not be changed. However, the interface will be flagged as being configured from interface configuration mode and the configuration data will be saved in the interface description block (IDB).

Interface Is Already Configured by network area Command with Different Area or Process

If you enter the **ip ospf area** command on an interface that is enabled in OSPFv2 by the **network area** command, but change the configuration by changing the process ID and area ID of the interface, after the new configuration information is stored in the IDB, the interface will be removed and reattached. Therefore, the interface will be removed from the original area and process and be added to the new ones. The state of the interface will also be reset.

Interface Is Not Configured by network area Command

If the interface is not enabled in OSPFv2 by the **network area** command, the area and OSPF router instance will be created if needed. When the router is reloaded, the OSPF process will not begin running until system initialization is complete. To remove an OSPF router instance, enter the **no router ospf** command. Removing the **ip ospf area** command in interface mode will not result in removing an OSPF router instance.

Removing an interface enable Command

When the **interface enable** command is removed, the interface will be detached from the area. The area will be removed if it has no other attached interfaces. If the interface address is covered by the **network area** command, the interface will be enabled once again in the area for the network that it is in.

New Processes

If an OSPF process does not already exist, and a router ID cannot be chosen when either the **router ospf** command or the **interface** command is configured, a Proximity Database (PDB) and a process will be created, but the process will be inactive. The process will become active when a router ID is chosen, either when it is explicitly configured using the **router-id** command or when an IP address becomes available. Note that the **router ospf** command will now be accepted even if a router ID cannot be chosen, putting the command-line interface (CLI) into the OSPF configuration context. Therefore, the **router-id** command is to be entered before an IP address is available. If the process is not active and the **show ip ospf** command is entered, the message "%OSPF: Router process X is not running, please provide a router-id" will be displayed.

Link-State Advertisements and Shortest Path First

If a state change occurs as a result of the **interface enable** command, new router link-state advertisements (LSAs) will be generated (also for the old area, if the interface is changing areas) and shortest path first (SPF) will be scheduled to run in both the old and new areas.

How to Enable the Area Command in Interface Mode for OSPFv2

- Enabling OSPFv2 on an Interface, page 227

Enabling OSPFv2 on an Interface

Perform this task to enable OSPFv2 on an interface.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **interface** *type number*
4. **ip ospf** *process-id* **area** *area-id* [**secondaries none**]
5. **end**
6. **show ip ospf interface** [*interface-type interface-number*]

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**interface** *type number* **Example:** `Router(config)# interface FastEthernet 0/2`	Configures an interface type and enters interface configuration mode.
Step 4	**ip ospf** *process-id* **area** *area-id* [**secondaries none**] **Example:** `Router(config-if)# ip ospf 1 area 0 secondaries none`	Enables OSPFv2 on an interface. • To prevent secondary IP addresses on the interface from being advertised, you must enter the optional **secondaries** keyword followed by the **none** keyword.
Step 5	**end** **Example:** `Router(config-if)# end`	Exits interface configuration mode and returns to privileged EXEC mode.
Step 6	**show ip ospf interface** [*interface-type interface-number*] **Example:** `Router# show ip ospf interface FastEthernet 0/2`	Displays OSPF-related interface information. • Once you have enabled OSPFv2 on the interface, you can enter the **show ip ospf interface** command to verify the configuration.

Configuration Examples for Area Command in Interface Mode for OSPFv2 Feature

• Example: Enabling OSPFv2 on an Interface , page 229

Example: Enabling OSPFv2 on an Interface

In the following example, OSPFv2 is configured explicitly on Ethernet interface 0/0/0:

```
Router(config)# interface Ethernet 0/0/0
Router(config-if)# bandwidth 10000
Router(config-if)# ip address 172.16.1.1 255.255.255.0
Router(config-if)# ip ospf hello-interval 1
Router(config-if)# ip ospf 1 area 0
```

When the **show ip ospf interface** command is entered, the following output shows that Ethernet interface 0/0/0 was configured in interface configuration mode to run OSPFv2. The secondary IP addresses on the interface will also be advertised:

```
Router# show ip ospf interface Ethernet 0/0/0
Ethernet0/0/0 is up, line protocol is up
  Internet Address 172.16.1.1/24, Area 0
  Process ID 1, Router ID 172.16.11.11, Network Type BROADCAST, Cost: 10
  Enabled by interface config, including secondary ip addresses
  Transmit Delay is 1 sec, State DR, Priority 1
  Designated Router (ID) 172.16.11.11, Interface address 172.16.1.1
  Backup Designated router (ID) 172.16.22.11, Interface address 172.16.1.2
  Timer intervals configured, Hello 1, Dead 4, Wait 4, Retransmit 5
    oob-resync timeout 40
    Hello due in 00:00:00
  Supports Link-local Signaling (LLS)
  Index 2/2, flood queue length 0
  Next 0x0(0)/0x0(0)
  Last flood scan length is 1, maximum is 1
  Last flood scan time is 0 msec, maximum is 0 msec
  Neighbor Count is 1, Adjacent neighbor count is 1
    Adjacent with neighbor 172.26.22.11  (Backup Designated Router)
  Suppress hello for 0 neighbor(s)
```

Additional References

The following sections provide references related to the Area Command in Interface Mode for OSPFv2 feature.

Related Documents

Related Topic	Document Title
OSPF commands	*Cisco IOS IP Routing: OSPF Command Reference*
OSPF configuration tasks	"Configuring OSPF" module

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 releases, and feature sets, use Cisco MIB Locator found at the following URL: http://www.cisco.com/go/mibs

RFCs

RFC	Title
RFC 2328	*OSPF Version 2*

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 Area Command in Interface Mode for OSPFv2

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 22 Feature Information for Area Command in Interface Mode for OSPFv2

Feature Name	Releases	Feature Information
Area Command in Interface Mode for OSPFv2	12.0(29)S 12.3(11)T 12.2(28)SB 12.2(33)SRB 15.0(1)SY	This document describes how to enable Open Shortest Path First version 2 (OSPFv2) on a per-interface basis to simplify the configuration of unnumbered interfaces. The **ip ospf area** command allows you to enable OSPFv2 explicitly on an interface. The **ip ospf area** command is an alternative to enabling OSPFv2 through the address of the interface that matches the address range specified by the **network area** command.