Implementing OSPFv3

Last Updated: November 14, 2011

The *Implementing OSPF for IPv6* module expands on Open Shortest Path First version 3 (OSPFv3), or OSPF for IPv6, to provide support for IPv6 routing prefixes.

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 Implementing OSPFv3

- Complete the OSPFv3 network strategy and planning for your IPv6 network. For example, you must decide whether multiple areas are required.
- Enable IPv6 unicast routing.
- Enable IPv6 on the interface.
- Configure the IP Security (IPsec) secure socket application program interface (API) on OSPFv3 in order to enable authentication and encryption.

Americas Headquarters:
Cisco Systems, Inc., 170 West Tasman Drive, San Jose, CA 95134-1706 USA

- To use the IPv4 unicast address families (AF) in OSPFv3, you must enable IPv6 on a link, although the link may not be participating in IPv6 unicast AF.
- With the OSPFv3 Address Families feature, users may have two router processes per interface, but only one process per AF. If the AF is IPv4, an IPv4 address must first be configured on the interface, but IPv6 must be enabled on the interface.

Restrictions for Implementing OSPFv3

- When running a dual-stack IP network with OSPF version 2 for IPv4 and OSPFv3, be careful when changing the defaults for commands used to enable OSPFv3. Changing these defaults may affect your OSPFv3 network, possibly adversely.
- A packet will be rejected on a router if the packet is coming from an IPv6 address that is found on any interface on the same router.

Information About Implementing OSPFv3

How OSPFv3 Works

OSPF is a routing protocol for IP. It is a link-state protocol, as opposed to a distance-vector protocol. Think of a link as being an interface on a networking device. A link-state protocol makes its routing decisions based on the states of the links that connect source and destination machines. The state of a link is a description of that interface and its relationship to its neighboring networking devices. The interface information includes the IPv6 prefix of the interface, the network mask, the type of network it is connected to, the routers connected to that network, and so on. This information is propagated in various type of link-state advertisements (LSAs).

A router's collection of LSA data is stored in a link-state database. The contents of the database, when subjected to the Dijkstra algorithm, result in the creation of the OSPF routing table. The difference between the database and the routing table is that the database contains a complete collection of raw data; the routing table contains a list of shortest paths to known destinations via specific router interface ports.

OSPF version 3, which is described in RFC 5340, supports IPv6 and IPv4 unicast AFs.

Comparison of OSPFv3 and OSPF Version 2

Much of the OSPFv3 feature is the same as in OSPF version 2. OSPFv3, which is described in RFC 5340, expands on OSPF version 2 to provide support for IPv6 routing prefixes and the larger size of IPv6 addresses.

In OSPFv3, a routing process does not need to be explicitly created. Enabling OSPFv3 on an interface will cause a routing process, and its associated configuration, to be created.

In OSPFv3, each interface must be enabled using commands in interface configuration mode. This feature is different from OSPF version 2, in which interfaces are indirectly enabled using the router configuration mode.

In IPv6, users can configure many address prefixes on an interface. In OSPFv3, all address prefixes on an interface are included by default. Users cannot select some address prefixes to be imported into OSPFv3; either all address prefixes on an interface are imported, or no address prefixes on an interface are imported.

Unlike OSPF version 2, multiple instances of OSPFv3 can be run on a link.

In OSPFv3, it is possible that no IPv4 addresses will be configured on any interface. In this case, the user must use the router-id command to configure a router ID before the OSPF process will be started. A router ID is a 32-bit opaque number. OSPF version 2 takes advantage of the 32-bit IPv4 address to pick an IPv4 address as the router ID. If an IPv4 address does exist when OSPFv3 is enabled on an interface, then that IPv4 address is used for the router ID. If more than one IPv4 address is available, a router ID is chosen using the same rules as for OSPF version 2.

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.

OSPFv3 Address Families

The OSPFv3 address families feature enables both IPv4 and IPv6 unicast traffic to be supported. With this feature, users may have two router processes per interface, but only one process per AF. If the IPv4 AF is used, an IPv4 address must first be configured on the interface, but IPv6 must be enabled on the interface. A single IPv4 or IPv6 OSPFv3 process running multiple instances on the same interface is not supported.

Users with an IPv6 network that uses OSPFv3 as its IGP may want to use the same IGP to help carry and install IPv4 routes. All routers on this network have an IPv6 forwarding stack. Some (or all) of the links on this network may be allowed to do IPv4 forwarding and be configured with IPv4 addresses. Pockets of IPv4-only routers exist around the edges running an IPv4 static or dynamic routing protocol. In this scenario, users need the ability to forward IPv4 traffic between these pockets without tunneling overhead, which means that any IPv4 transit router has both IPv4 and IPv6 forwarding stacks (e.g., is dual stack).

This feature allows a separate (possibly incongruent) topology to be constructed for the IPv4 AF. It installs IPv4 routes in IPv4 RIB, and then the forwarding occurs natively. The OSPFv3 process fully supports an IPv4 AF topology and can redistribute routes from and into any other IPv4 routing protocol.

An OSPFv3 process can be configured to be either IPv4 or IPv6. The **address-family** command is used to determine which AF will run in the OSPFv3 process, and only one address family can be configured per instance. Once the AF is selected, users can enable multiple instances on a link and enable address-family-specific commands.

Different instance ID ranges are used for each AF. Each AF establishes different adjacencies, has a different link state database, and computes a different shortest path tree. The AF then installs the routes in AF-specific RIB. LSAs that carry IPv6 unicast prefixes are used without any modification in different instances to carry each AFs' prefixes.

The IPv4 subnets configured on OSPFv3-enabled interfaces are advertised through intra-area prefix LSAs, just as any IPv6 prefixes. External LSAs are used to advertise IPv4 routes redistributed from any IPv4 routing protocol, including connected and static. The IPv4 OSPFv3 process runs the SPF calculations and finds the shortest path to those IPv4 destinations. These computed routes are then inserted in the IPv4 RIB (computed routes are inserted into an IPv6 RIB for an IPv6 AF).

Because the IPv4 OSPFv3 process allocates a unique pdbindex in the IPv4 RIB, all other IPv4 routing protocols can redistribute routes from it. The parse chain for all protocols is same, so the **ospfv3** keyword added to the list of IPv4 routing protocols causes OSPFv3 to appear in the **redistribute** command from any IPv4 routing protocol. With the **ospfv3** keyword, IPv4 OSPFv3 routes can be redistributed into any other IPv4 routing protocol as defined in the **redistribute ospfv3** command.

The OSPFv3 address families feature is supported as of Cisco IOS XE Release 3.4S. Cisco routers that run software older than this release and third-party routers will not neighbor with routers running the AF feature for the IPv4 AF because they do not set the AF bit. Therefore, those routers will not participate in the IPv4 AF SPF calculations and will not install the IPv4 OSPFv3 routes in the IPv6 RIB.

LSA Types for OSPFv3

The following list describes LSA types, each of which has a different purpose:

- Router LSAs (Type 1)--Describes the link state and costs of a router's links to the area. These LSAs are flooded within an area only. The LSA indicates if the router is an Area Border Router (ABR) or Autonomous System Boundary Router (ASBR), and if it is one end of a virtual link. Type 1 LSAs are also used to advertise stub networks. In OSPFv3, these LSAs have no address information and are network-protocol-independent. In OSPFv3, router interface information may be spread across multiple router LSAs. Receivers must concatenate all router LSAs originated by a given router when running the SPF calculation.
- Network LSAs (Type 2)--Describes the link-state and cost information for all routers attached to the network. This LSA is an aggregation of all the link-state and cost information in the network. Only a designated router tracks this information and can generate a network LSA. In OSPFv3, network LSAs have no address information and are network-protocol-independent.
- Interarea-prefix LSAs for ABRs (Type 3)--Advertises internal networks to routers in other areas (interarea routes). Type 3 LSAs may represent a single network or a set of networks summarized into one advertisement. Only ABRs generate summary LSAs. In OSPFv3, addresses for these LSAs are expressed as *prefix* , *prefix length* instead of *address* , *mask* . The default route is expressed as a prefix with length 0.
- Interarea-router LSAs for ASBRs (Type 4)--Advertises the location of an ASBR. Routers that are trying to reach an external network use these advertisements to determine the best path to the next hop. Type 4 LSAs are generated by ABRs on behalf of ASBRs.
- Autonomous system external LSAs (Type 5)--Redistributes routes from another AS, usually from a different routing protocol into OSPFv3. In OSPFv3, addresses for these LSAs are expressed as *prefix*, *prefix length* instead of *address*, *mask*. The default route is expressed as a prefix with length 0.
- Link LSAs (Type 8)--Have local-link flooding scope and are never flooded beyond the link with which they are associated. Link LSAs provide the link-local address of the router to all other routers attached to the link, inform other routers attached to the link of a list of prefixes to associate with the link, and allow the router to assert a collection of Options bits to associate with the network LSA that will be originated for the link.
- Intra-Area-Prefix LSAs (Type 9)--A router can originate multiple intra-area-prefix LSAs for each router or transit network, each with a unique link-state ID. The link-state ID for each intra-area-prefix LSA describes its association to either the router LSA or the network LSA and contains prefixes for stub and transit networks.

An address prefix occurs in almost all newly defined LSAs. The prefix is represented by three fields: PrefixLength, PrefixOptions, and Address Prefix. In OSPFv3, addresses for these LSAs are expressed as *prefix*, *prefix length* instead of *address*, *mask*. The default route is expressed as a prefix with length 0. Type 3 and Type 9 LSAs carry all prefix (subnet) information that, in OSPFv2, is included in router LSAs and network LSAs. The Options field in certain LSAs (router LSAs, network LSAs, interarea-router LSAs, and link LSAs) has been expanded to 24 bits to provide support for OSPFv3.

In OSPFv3, the sole function of link-state ID in interarea-prefix LSAs, interarea-router LSAs, and autonomous-system external LSAs is to identify individual pieces of the link-state database. All addresses or router IDs that are expressed by the link-state ID in OSPF version 2 are carried in the body of the LSA in OSPFv3.

The link-state ID in network LSAs and link LSAs is always the interface ID of the originating router on the link being described. For this reason, network LSAs and link LSAs are now the only LSAs whose size cannot be limited. A network LSA must list all routers connected to the link, and a link LSA must list all of the address prefixes of a router on the link.

-

OSPFv3 Max-Metric Router LSA

The OSPFv3 max-metric router LSA feature enables OSPFv3 to advertise its locally generated router LSAs with a maximum metric. The feature allows OSPFv3 processes to converge but not attract transit traffic through the router if there are better alternate paths. After a specified timeout or a notification from BGP, OSPFv3 advertises the LSAs with normal metrics.

The max-metric LSA control places the OSPFv3 router into the stub router role using its LSA advertisement. A stub router only forwards packets destined to go to its directly connected links. In OSPFv3 networks, a router could become a stub router by advertising large metrics for its connected links, so that the cost of a path through this router becomes larger than that of an alternative path. OSPFv3 stub router advertisement allows a router to advertise the infinity metric (0xFFFF) for its connected links in router LSAs and advertise normal interface cost if the link is a stub network.

Fast Convergence--LSA and SPF Throttling

The OSPFv3 LSA and SPF throttling feature provides a dynamic mechanism to slow down link-state advertisement updates in OSPFv3 during times of network instability. It also allows faster OSPFv3 convergence by providing LSA rate limiting in milliseconds.

Previously, OSPFv3 used static timers for rate-limiting SPF calculation and LSA generation. Although these timers are configurable, the values used are specified in seconds, which poses a limitation on OSPFv3 convergence. LSA and SPF throttling achieves subsecond convergence by providing a more sophisticated SPF and LSA rate-limiting mechanism that is able to react quickly to changes and also provide stability and protection during prolonged periods of instability.

Addresses Imported into OSPFv3

When importing the set of addresses specified on an interface on which OSPFv3 is running into OSPFv3, users cannot select specific addresses to be imported. Either all addresses are imported, or no addresses are imported.

OSPFv3 Authentication Support with IPsec

In order to ensure that OSPFv3 packets are not altered and re-sent to the router, causing the router to behave in a way not desired by its managers, OSPFv3 packets must be authenticated. OSPFv3 uses the IP

Security (IPsec) secure socket application program interface (API) to add authentication to OSPFv3 packets. This API has been extended to provide support for IPv6.

OSPFv3 requires the use of IPsec to enable authentication. Crypto images are required to use authentication, because only crypto images include the IPsec API needed for use with OSPFv3.

In OSPFv3, authentication fields have been removed from OSPFv3 packet headers. When OSPFv3 runs on IPv6, OSPFv3 requires the IPv6 authentication header (AH) or IPv6 ESP header to ensure integrity, authentication, and confidentiality of routing exchanges. IPv6 AH and ESP extension headers can be used to provide authentication and confidentiality to OSPFv3.

To use the IPsec AH, you must enable the **ipv6 ospf authentication** command. To use the IPsec ESP, you must enable the **ipv6 ospf encryption** command. The ESP header may be applied alone or in combination with the AH, and when ESP is used, both encryption and authentication are provided. Security services can be provided between a pair of communicating hosts, between a pair of communicating security gateways, or between a security gateway and a host.

To configure IPsec, users configure a security policy, which is a combination of the security policy index (SPI) and the key (the key is used to create and validate the hash value). IPsec for OSPFv3 can be configured on an interface or on an OSPFv3 area. For higher security, users should configure a different policy on each interface configured with IPsec. If a user configures IPsec for an OSPFv3 area, the policy is applied to all of the interfaces in that area, except for the interfaces that have IPsec configured directly. Once IPsec is configured for OSPFv3, IPsec is invisible to the user.

The secure socket API is used by applications to secure traffic. The API needs to allow the application to open, listen, and close secure sockets. The binding between the application and the secure socket layer also allows the secure socket layer to inform the application of changes to the socket, such as connection open and close events. The secure socket API is able to identify the socket; that is, it can identify the local and remote addresses, masks, ports, and protocol that carry the traffic requiring security.

Each interface has a secure socket state, which can be one of the following:

- NULL: Do not create a secure socket for the interface if authentication is configured for the area.
- DOWN: IPsec has been configured for the interface (or the area that contains the interface), but OSPFv3 either has not requested IPsec to create a secure socket for this interface, or there is an error condition.
- GOING UP: OSPFv3 has requested a secure socket from IPsec and is waiting for a CRYPTO_SS_SOCKET_UP message from IPsec.
- UP: OSPFv3 has received a CRYPTO_SS_SOCKET_UP message from IPsec.
- CLOSING: The secure socket for the interface has been closed. A new socket may be opened for the interface, in which case the current secure socket makes the transition to the DOWN state. Otherwise, the interface will become UNCONFIGURED.
- UNCONFIGURED: Authentication is not configured on the interface.

OSPFv3 will not send or accept packets while in the DOWN state.

OSPFv3 Virtual Links

For each virtual link, a master security information datablock is created for the virtual link. Because a secure socket must be opened on each interface, there will be a corresponding security information datablock for each interface in the transit area. The secure socket state is kept in the interface's security information datablock. The state field in the master security information datablock reflects the status of all

of the secure sockets opened for the virtual link. If all of the secure sockets are UP, then the security state for the virtual link will be set to UP.

OSPFv3 Cost Calculation

Because cost components can change rapidly, it might be necessary to dampen the volume of changes to reduce network-wide churn. The recommended values for S2, S3, and S4 are based on network simulations that may reduce the rate of network changes. The recommended value for S1 is 0 to eliminate this variable from the route cost calculation.

The overall link cost is computed using the following formula shown in the figure below.

Figure 1　　　　*Overall Link Cost Formula*

$$LinkCost = OC + \overset{①}{BW}\left(\frac{Throughput\_weight}{100}\right) + \overset{②}{Resources}\left(\frac{Resources\_weight}{100}\right) + \overset{③}{Latency}\left(\frac{Latency\_weight}{100}\right) + \overset{④}{L2\_factor}\left(\frac{L2\_weight}{100}\right)$$

$$OC = \left[\frac{(ospf\_reference\_bw)}{(MDR)(1000)}\right] \qquad ospf\_reference\_bw = 10^{\wedge}8$$

$$\overset{①}{BW} = \frac{(65535)\left(100 - \frac{CDR}{MDR}(100)\right)}{100}$$

$$\overset{②}{Resources} = \frac{(100 - resources)^3 (65535)}{1000000}$$

$$\overset{③}{Latency} = latency$$

$$\overset{④}{L2\_factor} = \frac{(100 - RLQ)(65535)}{100}$$

231048

The table below defines the symbols used in the OSPFv3 cost calculation.

Table 1　　　　*OSPFv3 Cost Calculation Definitions*

Cost Component	Component Definition
OC	The "default OSPFv3 cost." Calculated from reference bandwidth using reference_bw / (MDR*1000), where reference_bw=10^8.
A through D	Various radio-specific data-based formulas that produce results in the 0 through 64,000 range.
A	CDR- and MDR-related formula: (2^16 * (100 - (CDR * 100 / MDR)))/100
B	Resources related formula: ((100 - RESOURCES)^3 * 2^16 / 10^6)

Cost Component	Component Definition
C	Latency as reported by the radio, already in the 0 through 64K range when reported (LATENCY).
D	RLF-related formula: $((100 - RLF) * 2^{16})/100$
S1 through S4	Scalar weighting factors input from the command-line interface (CLI). These scalars scale down the values as computed by A through D. The value of 0 disables and value of 100 enables full 0 through 64,000 range for one component.

Because each network might have unique characteristics that require different settings to optimize actual network performance, these are recommended values intended as a starting point for optimizing an OSPFv3 network. The table below lists the recommended value settings for OSPFv3 cost metrics.

Table 2   *Recommended Value Settings for OSPFv3 Cost Metrics*

Setting	Metric Description	Default Value	Recommended Value
S1	ipv6 ospf dynamic weight throughout	100	0
S2	ipv6 ospf dynamic weight resources	100	29
S3	ipv6 ospf dynamic weight latency	100	29
S4	ipv6 ospf dynamic weight L2 factor	100	29

The default path costs were calculated using this formula, as noted in the following list. If these values do not suit your network, you can use your own method of calculating path costs.

- 56-kbps serial link--Default cost is 1785.
- 64-kbps serial link--Default cost is 1562.
- T1 (1.544-Mbps serial link)--Default cost is 64.
- E1 (2.048-Mbps serial link)--Default cost is 48.
- 4-Mbps Token Ring--Default cost is 25.
- Ethernet--Default cost is 10.
- 16-Mbps Token Ring--Default cost is 6.
- FDDI--Default cost is 1.
- X25--Default cost is 5208.
- Asynchronous--Default cost is 10,000.
- ATM--Default cost is 1.

To illustrate these settings, the following example shows how OSPFv3 cost metrics might be defined for a VMI interface:

```
interface vmi1
```

```
ipv6 ospf cost dynamic weight throughput 0
ipv6 ospf cost dynamic weight resources 29
ipv6 ospf cost dynamic weight latency 29
ipv6 ospf cost dynamic weight L2-factor 29
```

OSPFv3 Customization

You can customize OSPFv3 for your network, but you likely will not need to do so. The defaults for OSPFv3 are set to meet the requirements of most customers and features. If you must change the defaults, refer to the IPv6 command reference to find the appropriate syntax.

⚠

Caution   Be careful when changing the defaults. Changing defaults will affect your OSPFv3 network, possibly adversely.

OSPFv3 Virtual Links

For each virtual link, a master security information datablock is created for the virtual link. Because a secure socket must be opened on each interface, there will be a corresponding security information datablock for each interface in the transit area. The secure socket state is kept in the interface's security information datablock. The state field in the master security information datablock reflects the status of all of the secure sockets opened for the virtual link. If all of the secure sockets are UP, then the security state for the virtual link will be set to UP.

Link Quality Metrics Reporting for OSPFv3 with VMI Interfaces

OSPFv3 is one of the routing protocols that can be used with Virtual Multipoint Interfaces (VMIs) in router-to-radio networks. The quality of a radio link has a direct impact on the throughput that can be achieved by router-router traffic. The PPPoE protocol has been extended to provide a process by which a router can request, or a radio can report, link quality metric information. Cisco's OSFPv3 implementation has been enhanced so that the route cost to a neighbor is dynamically updated based on metrics reported by the radio, thus allowing the best route to be chosen within a given set of radio links.

The routing protocols receive raw radio link data, and compute a composite quality metric for each link. In computing these metrics, the following factors may be considered:

- Maximum Data Rate--the theoretical maximum data rate of the radio link, in bytes per second
- Current Data Rate--the current data rate achieved on the link, in bytes per second
- Latency--the transmission delay packets encounter, in milliseconds
- Resources--a percentage (0 to 100) that can represent the remaining amount of a resource (such as battery power)
- Relative Link Quality--a numeric value (0-100) representing relative quality, with 100 being the highest quality

Metrics can be weighted during the configuration process to emphasize or de-emphasize particular characteristics. For example, if throughput is a particular concern, the current data rate metric could be weighted so that it is factored more heavily into the composite metric. Similarly, a metric that is of no concern can be omitted from the composite calculation.

Link metrics can change rapidly, often by very small degrees, which could result in a flood of meaningless routing updates. In a worst case scenario, the network would be churning almost continuously as it

struggled to react to minor variations in link quality. To alleviate this concern, Cisco provides a tunable dampening mechanism that allows the user to configure threshold values. Any metric change that falls below the threshold is ignored.The quality of a connection to a neighbor varies, based on various characteristics of the interface when OSPF is used as the routing protocol. The routing protocol receives dynamic raw radio link characteristics and computes a composite metric that is used to reduce the effect of frequent routing changes.

A tunable hysteresis mechanism allows users to adjust the threshold to the routing changes that occur when the router receives a signal that a new peer has been discovered, or that an existing peer is unreachable. The tunable metric is weighted and is adjusted dynamically to account for the following characteristics:

- Current and maximum bandwidth
- Latency
- Resources
- L2 factor

Individual weights can be deconfigured and all weights can be cleared so that the cost is set back to the default value for the interface type. Based on the routing changes that occur, cost can be determined by the application of these metrics.

OSPFv3 External Path Preference Option

Per RFC 5340, the following rules indicate which paths are preferred when multiple intra-AS paths are available to ASBRs or forwarding addresses:

- Intra-area paths using non-backbone areas are always the most preferred.
- The other paths, intra-area backbone paths and inter-area paths, are of equal preference.

These rules apply when the same ASBR is reachable through multiple areas, or when trying to decide which of several AS-external-LSAs should be preferred. In the former case the paths all terminate at the same ASBR, while in the latter the paths terminate at separate ASBRs or forwarding addresses. In either case, each path is represented by a separate routing table entry. This feature only applies when RFC 1583 compatibility is set to disabled using the no compatibility rfc1583 command (RFC 5340 provides an update to RFC 1583).

⚠️

Caution   To minimize the chance of routing loops, all OSPF routers in an OSPF routing domain should have RFC compatibility set identically.

OSPFv3 Graceful Restart

The graceful restart feature in OSPFv3 allows nonstop data forwarding along routes that are already known while the OSPFv3 routing protocol information is being restored. A router can participate in graceful restart either in restart mode (such as in a graceful-restart-capable router) or in helper mode (such as in a graceful-restart-aware router).

To perform the graceful restart function, a router must be in high availability (HA) stateful switchover (SSO) mode (that is, dual RP). A router capable of graceful restart will perform the graceful restart function when the following failures occur:

- A Route Processor (RP) failure that results in switchover to standby RP
- A planned RP switchover to standby RP

The graceful restart feature requires that neighboring routers be graceful-restart aware.

For further information about SSO and nonstop forwarding (NSF), see the Stateful Switchover and Cisco Nonstop Forwarding documents.

How to Implement OSPFv3

Configuring the OSPFv3 Router Process

Once you have completed step 3 and entered OSPFv3 router configuration mode, you can perform any of the subsequent steps in this task as needed to configure OSPFv3 router configuration.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **router ospfv3** [*process-id*]
4. **area** *area-ID* [**default-cost** | **nssa** | **stub**]
5. **auto-cost reference-bandwidth** *Mbps*
6. **bfd all-interfaces**
7. **default** {**area** *area-ID*[**range** *ipv6-prefix* | **virtual-link** *router-id*]} [**default-information originate** [**always** | **metric** | **metric-type** | **route-map**] | **distance** | **distribute-list** *prefix-list prefix-list-name* {**in** | **out**} [*interface*] | **maximum-paths** *paths* | **redistribute** *protocol* | **summary-prefix** *ipv6-prefix*]
8. **ignore lsa mospf**
9. **interface-id snmp-if-index**
10. **log-adjacency-changes** [**detail**]
11. passive-interface [**default** | *interface-type interface-number*]
12. **queue-depth** {**hello** | **update**} {*queue-size* | **unlimited**}
13. router-id {*router-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 ospfv3** [*process-id*] **Example:** Router(config)# router ospfv3 1	Enables OSPFv3 router configuration mode for the IPv4 or IPv6 address family.
Step 4	**area** *area-ID* [**default-cost**	**nssa**	**stub**] **Example:** Router(config-router)# area 1	Configures the OSPFv3 area.

	Command or Action	Purpose
Step 5	**auto-cost reference-bandwidth** *Mbps* **Example:** Router(config-router)# auto-cost reference-bandwidth 1000	Controls the reference value OSPFv3 uses when calculating metrics for interfaces in an IPv4 OSPFv3 process.
Step 6	**bfd all-interfaces** **Example:** Router(config-router)# bfd all-interfaces	Enables BFD for an OSPFv3 routing process
Step 7	**default** {**area** *area-ID*[**range** *ipv6-prefix* | **virtual-link** *router-id*]} [**default-information originate** [**always** | **metric** | **metric-type** | **route-map**] | **distance** | **distribute-list** *prefix-list prefix-list-name* {**in** | **out**} [*interface*] | **maximum-paths** *paths* | **redistribute** *protocol* | **summary-prefix** *ipv6-prefix*] **Example:** Router(config-router)# default area 1	Returns an OSPFv3 parameter to its default value.
Step 8	**ignore lsa mospf** **Example:** Router(config-router)# ignore lsa mospf	Suppresses the sending of syslog messages when the router receives LSA Type 6 multicast OSPFv3 packets, which are unsupported.
Step 9	**interface-id snmp-if-index** **Example:** Router(config-router)# interface-id snmp-if-index	Configures OSPFv3 interfaces with Simple Network Management Protocol (SNMP) MIB-II interface Index (ifIndex) identification numbers in IPv4 and IPv6.
Step 10	**log-adjacency-changes** [**detail**] **Example:** Router(config-router)# log-adjacency-changes	Configures the router to send a syslog message when an OSPFv3 neighbor goes up or down.
Step 11	passive-interface [**default** | *interface-type interface-number*] **Example:** Router(config-router)# passive-interface default	Suppresses sending routing updates on an interface when using an IPv4 OSPFv3 process.

Command or Action	Purpose
Step 12 **queue-depth** {**hello** | **update**} {*queue-size* | **unlimited**}	Configures the number of incoming packets that the IPv4 OSPFv3 process can keep in its queue.
Example:	
Router(config-router)# queue-depth update 1500	
Step 13 router-id {*router-id*}	Use a fixed router ID.
Example:	
Router(config-router)# router-id 10.1.1.1	

Configuring the IPv6 Address Family in OSPFv3

Perform this task to configure the IPv6 address family in OSPFv3. Once you have completed step 4 and entered IPv6 address-family configuration mode, you can perform any of the subsequent steps in this task as needed to configure the IPv6 AF.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **router ospfv3** [*process-id*]
4. **address-family ipv6 unicast**
5. **area** *area-ID* **range** *ipv6-prefix* / *prefix-length*
6. **default** {**area** *area-ID*[**range** *ipv6-prefix* \| **virtual-link** *router-id*]} [**default-information originate** [**always** \| **metric** \| **metric-type** \| **route-map**] \| **distance** \| **distribute-list** *prefix-list prefix-list-name* {**in** \| **out**} [*interface*] \| **maximum-paths** *paths* \| **redistribute** *protocol* \| **summary-prefix** *ipv6-prefix*]
7. **default-information originate** [**always** \| **metric** *metric-value* \| **metric-type** *type-value*\| **route-map** *map-name*]
8. default-metric *metric-value*
9. **distance** *distance*
10. **distribute-list prefix-list** *list-name* {**in**[*interface-type interface-number*] \| **out** *routing-process* [*as-number*]}
11. **maximum-paths** *number-paths*
12. **summary-prefix** *prefix* [**not-advertise** \| **tag** *tag-value*]

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 ospfv3** [*process-id*] **Example:** Router(config)# router ospfv3 1	Enables OSPFv3 router configuration mode for the IPv4 or IPv6 address family.

	Command or Action	**Purpose**
Step 4	**address-family ipv6 unicast**	Enters IPv6 address family configuration mode for OSPFv3.
	Example:	or
		Enters IPv4 address family configuration mode for OSPFv3.
	Example:	
	or	
	Example:	
	address-family ipv4	
	unicast	
	Example:	
	`Router(config-router)# address-family ipv6 unicast`	
	Example:	
	Example:	
	or	
	Example:	
	`Router(config-router)# address-family ipv4 unicast`	
Step 5	**area** *area-ID* **range** *ipv6-prefix* / *prefix-length*	Configures OSPFv3 area parameters.
	Example:	
	`Router(config-router-af)# area 1 range 2001:DB8:0:0::0/128`	

	Command or Action	Purpose
Step 6	**default** {**area** *area-ID*[**range** *ipv6-prefix* | **virtual-link** *router-id*]} [**default-information originate** [**always** | **metric** | **metric-type** | **route-map**] | **distance** | **distribute-list** *prefix-list prefix-list-name* {**in** | **out**} [*interface*] | **maximum-paths** *paths* | **redistribute** *protocol* | **summary-prefix** *ipv6-prefix*]	Returns an OSPFv3 parameter to its default value.
	Example: Router(config-router-af)# default area 1	
Step 7	**default-information originate** [**always** | **metric** *metric-value* | **metric-type** *type-value*| **route-map** *map-name*]	Generates a default external route into an OSPFv3 for a routing domain.
	Example: Router(config-router-af)# default-information originate always metric 100 metric-type 2	
Step 8	default-metric *metric-value*	Sets default metric values for IPv4 and IPv6 routes redistributed into the OSPFv3 routing protocol.
	Example: Router(config-router-af)# default-metric 10	
Step 9	**distance** *distance*	Configures an administrative distance for OSPFv3 routes inserted into the routing table.
	Example: Router(config-router-af)# distance 200	
Step 10	**distribute-list prefix-list** *list-name* {**in**[*interface-type interface-number*] | **out** *routing-process* [*as-number*]}	Applies a prefix list to OSPFv3 routing updates that are received or sent on an interface.
	Example: Router(config-router-af)# distribute-list prefix-list PL1 in Ethernet0/0	
Step 11	**maximum-paths** *number-paths*	Controls the maximum number of equal-cost routes that a process for OSPFv3 routing can support.
	Example: Router(config-router-af)# maximum-paths 4	

Command or Action	Purpose
Step 12 **summary-prefix** *prefix* [**not-advertise** | **tag** *tag-value*]	Configures an IPv6 summary prefix in OSPFv3.
Example:	
`Router(config-router-af)# summary-prefix FEC0::/24`	

Configuring the IPv4 Address Family in OSPFv3

Perform this task to configure the IPv4 address family in OSPFv3. Once you have completed step 4 and entered IPv4 address-family configuration mode, you can perform any of the subsequent steps in this task as needed to configure the IPv4 AF.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **router ospfv3** [*process-id*]
4. **address-family ipv4 unicast**
5. **area** *area-id* **range** *ip-address ip-address-mask* [**advertise** \| **not-advertise**] [**cost** *cost*]
6. **default** {**area** *area-ID*[**range** *ipv6-prefix* \| **virtual-link** *router-id*]} [**default-information originate** [**always** \| **metric** \| **metric-type** \| **route-map**] \| **distance** \| **distribute-list** *prefix-list prefix-list-name* {**in** \| **out**} [*interface*] \| **maximum-paths** *paths* \| **redistribute** *protocol* \| **summary-prefix** *ipv6-prefix*]
7. **default-information originate** [**always** \| **metric** *metric-value* \| **metric-type** *type-value*\| **route-map** *map-name*]
8. default-metric *metric-value*
9. **distance** *distance*
10. **distribute-list prefix-list** *list-name* {**in**[*interface-type interface-number*] \| **out** *routing-process* [*as-number*]}
11. **maximum-paths** *number-paths*
12. **summary-prefix** *prefix* [**not-advertise** \| **tag** *tag-value*]

DETAILED STEPS

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

	Command or Action	**Purpose**
Step 2	**configure terminal** **Example:** Router# configure terminal	Enters global configuration mode.
Step 3	**router ospfv3** [*process-id*] **Example:** Router(config)# router ospfv3 1	Enables OSPFv3 router configuration mode for the IPv4 or IPv6 address family.
Step 4	**address-family ipv4 unicast** **Example:** Router(config-router)# address-family ipv4 unicast	Enters IPv4 address family configuration mode for OSPFv3.
Step 5	**area** *area-id* **range** *ip-address ip-address-mask* [**advertise** | **not-advertise**] [**cost** *cost*] **Example:** Router(config-router-af)# area 0 range 192.168.110.0 255.255.0.0	Consolidates and summarizes routes at an area boundary.
Step 6	**default** {**area** *area-ID*[**range** *ipv6-prefix* | **virtual-link** *router-id*]} [**default-information originate** [**always** | **metric** | **metric-type** | **route-map**] | **distance** | **distribute-list** *prefix-list prefix-list-name* {**in** | **out**} [*interface*] | **maximum-paths** *paths* | **redistribute** *protocol* | **summary-prefix** *ipv6-prefix*] **Example:** Router(config-router-af)# default area 1	Returns an OSPFv3 parameter to its default value.
Step 7	**default-information originate** [**always** | **metric** *metric-value* | **metric-type** *type-value*| **route-map** *map-name*] **Example:** Router(config-router-af)# default-information originate always metric 100 metric-type 2	Generates a default external route into an OSPFv3 for a routing domain.

Command or Action		Purpose
Step 8	default-metric *metric-value*	Sets default metric values for IPv4 and IPv6 routes redistributed into the OSPFv3 routing protocol.
	Example:	
	`Router(config-router-af)# default-metric 10`	
Step 9	**distance** *distance*	Configures an administrative distance for OSPFv3 routes inserted into the routing table.
	Example:	
	`Router(config-router-af)# distance 200`	
Step 10	**distribute-list prefix-list** *list-name* {**in**[*interface-type interface-number*]	**out** *routing-process* [*as-number*]}	Applies a prefix list to OSPFv3 routing updates that are received or sent on an interface.
	Example:	
	`Router(config-router-af)# distribute-list prefix-list PL1 in Ethernet0/0`	
Step 11	**maximum-paths** *number-paths*	Controls the maximum number of equal-cost routes that a process for OSPFv3 routing can support.
	Example:	
	`Router(config-router-af)# maximum-paths 4`	
Step 12	**summary-prefix** *prefix* [**not-advertise**	**tag** *tag-value*]	Configures an IPv6 summary prefix in OSPFv3.
	Example:	
	`Router(config-router-af)# summary-prefix FEC0::/24`	

Configuring Route Redistribution in OSPFv3

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **router ospfv3** [*process-id*]
4. **address-family ipv6 unicast**
5. **redistribute** source-*protocol* [*process-id*] [*options*]

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 ospfv3** [*process-id*] **Example:** `Router(config)# router ospfv3 1`	Enables OSPFv3 router configuration mode for the IPv4 or IPv6 address family.

Command or Action	Purpose
Step 4 **address-family ipv6 unicast**	Enters IPv6 address family configuration mode for OSPFv3.
Example:	or
	Enters IPv4 address family configuration mode for OSPFv3.
Example:	
or	
Example:	
address-family ipv4	
unicast	
Example:	
Router(config-router)# address-family ipv6 unicast	
Example:	
Example:	
or	
Example:	
Router(config-router)# address-family ipv4 unicast	
Step 5 **redistribute** source-*protocol* [*process-id*] [*options*]	Redistributes IPv6 and IPv4 routes from one routing domain into another routing domain.
Example:	

Enabling OSPFv3 on an Interface

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **interface** *type number*
4. Do one of the following:

    - **ospfv3** *process-id* **area** *area-ID* {**ipv4** | **ipv6**} [**instance** *instance-id*]
    -
    -
    - **ipv6 ospf** *process-id* **area** *area-id* [**instance** *instance-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 **interface** *type number* **Example:** `Router(config)# interface ethernet 0/0`	Specifies an interface type and number, and places the router in interface configuration mode.

Command or Action		Purpose

Step 4	Do one of the following:
	
	• **ospfv3** *process-id* **area** *area-ID* {**ipv4** | **ipv6**} [**instance** *instance-id*]
	•
	•
	• **ipv6 ospf** *process-id* **area** *area-id* [**instance** *instance-id*]
	
	Example:
	
	`Router(config-if)# ospfv3 1 area 1 ipv4`
	
	Example:
	
	Example:
	
	or
	
	Example:
	
	`Router(config-if)# ipv6 ospf 1 area 0`
		Enables OSPFv3 on an interface with the IPv4 or IPv6 AF.
		
		or
		
		Enables OSPFv3 on an interface.

Defining an OSPFv3 Area Range for the IPv6 or IPv4 Address Family

The cost of the summarized routes will be the highest cost of the routes being summarized. For example, if the following routes are summarized:

```
OI   2001:DB8:0:7::/64 [110/20]
     via FE80::A8BB:CCFF:FE00:6F00, Ethernet0/0
OI   2001:DB8:0:8::/64 [110/100]
     via FE80::A8BB:CCFF:FE00:6F00, Ethernet0/0
OI   2001:DB8:0:9::/64 [110/20]
     via FE80::A8BB:CCFF:FE00:6F00, Ethernet0/0
```

They become one summarized route, as follows:

```
OI   2001:DB8::/48 [110/100]
     via FE80::A8BB:CCFF:FE00:6F00, Ethernet0/0
```

OSPFv3 routing must be enabled.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **router ospfv3** [*process-id*]
4. **address-family ipv6 unicast**
5. **area** *area-ID* **range** *ipv6-prefix*

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 ospfv3** [*process-id*] **Example:** `Router(config)# router ospfv3 1`	Enables OSPFv3 router configuration mode for the IPv4 or IPv6 address family.

	Command or Action	Purpose
Step 4	**address-family ipv6 unicast**	Enters IPv6 address family configuration mode for OSPFv3.
		or
	Example:	Enters IPv4 address family configuration mode for OSPFv3.
	Example:	
	or	
	Example:	
	address-family ipv4	
	unicast	
	Example:	
	`Router(config-router)# address-family ipv6 unicast`	
	Example:	
	Example:	
	or	
	Example:	
	`Router(config-router)# address-family ipv4 unicast`	
Step 5	**area** *area-ID* **range** *ipv6-prefix*	Configures OSPFv3 area parameters.
	Example:	
	`Router(config-router-af)# area 1 range 2001:DB8:0:0::0/128`	

Defining an OSPFv3 Area Range

This task can be performed in releases prior to Cisco IOS XE Release 3.4S.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ipv6 router ospf** *process-id*
4. **area** *area-id* **range** *ipv6-prefix* **/** *prefix-length* **advertise** | **not-advertise**] [**cost** *cost*

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	**ipv6 router ospf** *process-id* **Example:** Router(config)# ipv6 router ospf 1	Enables OSPFv3 router configuration mode.
Step 4	**area** *area-id* **range** *ipv6-prefix* **/** *prefix-length* **advertise**	**not-advertise**] [**cost** *cost* **Example:** Router(config-rtr)# area 1 range 2001:DB8::/48	Consolidates and summarizes routes at an area boundary.

Example:

Configuring the OSPFv3 Max-Metric Router LSA

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ipv6 router ospf** *process-id*
4. **max-metric router-lsa** [**external-lsa** [*max-metric-value*]] [**include-stub**] [**inter-area-lsas** [*max-metric-value*]] [**on-startup** {*seconds* | **wait-for-bgp**}] [**prefix-lsa**] [**stub-prefix-lsa** [*max-metric-value*]] [**summary-lsa** [*max-metric-value*]]
5. **exit**
6. **show ospfv3** [*process-id*] **max-metric**

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 **ipv6 router ospf** *process-id* **Example:** `Router(config)# ipv6 router ospf 1`	Enables OSPFv3 router configuration mode.
Step 4 **max-metric router-lsa** [**external-lsa** [*max-metric-value*]] [**include-stub**] [**inter-area-lsas** [*max-metric-value*]] [**on-startup** {*seconds*	**wait-for-bgp**}] [**prefix-lsa**] [**stub-prefix-lsa** [*max-metric-value*]] [**summary-lsa** [*max-metric-value*]] **Example:** `Router(config-router)# max-metric router-lsa on-startup wait-for-bgp`	Configures a router that is running the OSPFv3 protocol to advertise a maximum metric so that other routers do not prefer the router as an intermediate hop in their SPF calculations.

Command or Action	Purpose
Step 5 **exit** **Example:** `Router(config-router)# exit`	Leaves the current configuration mode. • In this step, enable the Exit command twice to reach privileged EXEC mode.
Step 6 **show ospfv3** [*process-id*] **max-metric** **Example:** `Router# show ospfv3 max-metric`	Displays OSPFv3 maximum metric origination information.

Configuring IPsec on OSPFv3

Once you have configured OSPFv3 and decided on your authentication, you must define the security policy on each of the routers within the group. The security policy consists of the combination of the key and the SPI. To define a security policy, you must define an SPI and a key.

You can configure an authentication or encryption policy either on an interface or for an OSPFv3 area. When you configure for an area, the security policy is applied to all of the interfaces in the area. For higher security, use a different policy on each interface.

You can configure authentication and encryption on virtual links.

Defining Authentication on an Interface

Before you configure IPsec on an interface, you must configure OSPFv3 on that interface.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **interface** *type number*
4. Do one of the following:

   - **ospfv3 authentication** {**ipsec** *spi*} {**md5** | **sha1**} *key-encryption-type key*} | **null**
   - **ipv6 ospf authentication ipsec spi** *spi* **md5** *key-encryption-type* {*key* | **null**}]

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 gigabitethernet 0/0/0	Specifies an interface type and number, and places the router in interface configuration mode.
Step 4	Do one of the following: • **ospfv3 authentication** {**ipsec** *spi*} {**md5** | **sha1**} *key-encryption-type key*} | **null** • **ipv6 ospf authentication ipsec spi** *spi* **md5** *key-encryption-type* {*key* | **null**}] **Example:** Router(config-if)# ospfv3 authentication md5 0 275761340947681324733020312209727 **Example:** Router(config-if)# ipv6 ospf authentication ipsec spi 500 md5 1234567890abcdef1234567890abcdef	Specifies the authentication type for an interface.

Defining Encryption on an Interface

Before you configure IPsec on an interface, you must configure OSPFv3 on that interface.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **interface** *type number*
4. Do one of the following:

   - **ospfv3 encryption** {**ipsec spi** *spi* **esp** *encryption-algorithm* {*key-encryption-type key*} *authentication-algorithm* {*key-encryption-type key*} | **null**}
   -
   - **ipv6 ospf encryption ipsec spi** *spi* **esp** *encryption-algorithm* [[*key-encryption-type*] *key*] *authentication-algorithm key-encryption-type*] *key* | **null**

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 gigabitethernet 0/0/0	Specifies an interface type and number, and places the router in interface configuration mode.

	Command or Action	Purpose
Step 4	Do one of the following:	Specifies the encryption type for an interface.
	• **ospfv3 encryption** {**ipsec spi** *spi* **esp** *encryption-algorithm* {*key-encryption-type key*} *authentication-algorithm* {*key-encryption-type key*}	**null**}	
	•	
	• **ipv6 ospf encryption ipsec spi** *spi* **esp** *encryption-algorithm* [[*key-encryption-type*] *key*] *authentication-algorithm key-encryption-type*] *key*	**null**	
	Example:	
	`Router(config-if)# ospfv3 encryption ipsec spi 1001 esp null md5 0 275761340947681324733020312 09727`	
	Example:	
	`Router(config-if) ipv6 ospf encryption ipsec spi 1001 esp null sha1 123456789A123456789B123456789C123456789D`	

Defining Authentication in an OSPFv3 Area

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ipv6 router ospf** *process-id*
4. **area** *area-id* **authentication ipsec spi** *spi* **md5** [*key-encryption-type*] *key*

DETAILED STEPS

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

Command or Action	Purpose
Step 3 **ipv6 router ospf** *process-id*	Enables OSPFv3 router configuration mode.
Example: `Router(config)# ipv6 router ospf 1`	
Step 4 **area** *area-id* **authentication ipsec spi** *spi* **md5** [*key-encryption-type*] *key*	Enables authentication in an OSPFv3 area.

Example:
 	
`Router(config-rtr)# area 1 authentication ipsec spi 678 md5`
`1234567890ABCDEF1234567890ABCDEF`	

Defining Encryption in an OSPFv3 Area

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ipv6 router ospf** *process-id*
4. **area** *area-id* **encryption ipsec spi** *spi* **esp** *encryption-algorithm* [[*key-encryption-type*] *key*] *authentication-algorithm key-encryption-type*] *key*

DETAILED STEPS

Command or Action	Purpose
Step 1 **enable**	Enables privileged EXEC mode. • Enter your password if prompted.
Example: `Router> enable`	
Step 2 **configure terminal**	Enters global configuration mode.
Example: `Router# configure terminal`	
Step 3 **ipv6 router ospf** *process-id*	Enables OSPFv3 router configuration mode.
Example: `Router(config)# ipv6 router ospf 1`	

Command or Action	Purpose
Step 4 **area** *area-id* **encryption ipsec spi** *spi* **esp** *encryption-algorithm* [[*key-encryption-type*] *key*] *authentication-algorithm key-encryption-type*] *key*	Enables encryption in an OSPFv3 area.

Example:
 	
`Router(config-rtr)# area 1 encryption ipsec spi 500 esp null md5`
`1aaa2bbb3ccc4ddd5eee6fff7aaa8bbb`	

Tuning LSA and SPF Transmission for OSPFv3 Fast Convergence

The task can be performed in Cisco IOS XE Release 3.4S and later releases.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **router ospfv3** [*process-id*]
4. **timers lsa arrival** *milliseconds*
5. **timers pacing flood** *milliseconds*
6. **timers pacing lsa-group** *seconds*
7. **timers pacing retransmission** *milliseconds*

DETAILED STEPS

Command or Action	Purpose
Step 1 **enable**	Enables privileged EXEC mode.
	• Enter your password if prompted.
Example: `Router> enable`	
Step 2 **configure terminal**	Enters global configuration mode.
Example: `Router# configure terminal`	
Step 3 **router ospfv3** [*process-id*]	Enables OSPFv3 router configuration mode for the IPv4 or IPv6 address family.
Example: `Router(config)# router ospfv3 1`	

	Command or Action	Purpose
Step 4	**timers lsa arrival** *milliseconds*	Sets the minimum interval at which the software accepts the same LSA from OSPFv3 neighbors.
	Example:	
	Router(config-rtr)# timers lsa arrival 300	
Step 5	**timers pacing flood** *milliseconds*	Configures LSA flood packet pacing.
	Example:	
	Router(config-rtr)# timers pacing flood 30	
Step 6	**timers pacing lsa-group** *seconds*	Changes the interval at which OSPFv3 LSAs are collected into a group and refreshed, checksummed, or aged.
	Example:	
	Router(config-router)# timers pacing lsa-group 300	
Step 7	**timers pacing retransmission** *milliseconds*	Configures LSA retransmission packet pacing in IPv4 OSPFv3.
	Example:	
	Router(config-router)# timers pacing retransmission 100	

Configuring LSA and SPF Throttling for OSPFv3 Fast Convergence

The task can be performed in releases prior to Cisco IOS XE Release 3.4S.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ipv6 router ospf** *process-id*
4. **timers throttle spf** *spf-start spf-hold spf-max-wait*
5. **timers throttle lsa** *start-interval hold-interval max-interval*
6. **timers lsa arrival** *milliseconds*
7. **timers pacing flood** *milliseconds*

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable**	Enables privileged EXEC mode.
		• Enter your password if prompted.
	Example:	
	Router> enable	
Step 2	**configure terminal**	Enters global configuration mode.
	Example:	
	Router# configure terminal	
Step 3	**ipv6 router ospf** *process-id*	Enables OSPFv3 router configuration mode.
	Example:	
	Router(config)# ipv6 router ospf 1	
Step 4	**timers throttle spf** *spf-start spf-hold spf-max-wait*	Turns on SPF throttling.
	Example:	
	Router(config-rtr)# timers throttle spf 200 200 200	
Step 5	**timers throttle lsa** *start-interval hold-interval max-interval*	Sets rate-limiting values for OSPFv3 LSA generation.
	Example:	
	Router(config-rtr)# timers throttle lsa 300 300 300	
Step 6	**timers lsa arrival** *milliseconds*	Sets the minimum interval at which the software accepts the same LSA from OSPFv3 neighbors.
	Example:	
	Router(config-rtr)# timers lsa arrival 300	
Step 7	**timers pacing flood** *milliseconds*	Configures LSA flood packet pacing.
	Example:	
	Router(config-rtr)# timers pacing flood 30	

Enabling Event Logging for LSA and SPF Rate Limiting for the IPv6 or IPv4 Address Family

This task can be performed in Cisco IOS XE Release 3.4S and later releases.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **router ospfv3** [*process-id*]
4. **address-family ipv6 unicast**
5. **event-log** [**one-shot** | **pause** | **size** *number-of-events*]

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 ospfv3** [*process-id*] **Example:** Router(config)# router ospfv3	Enables OSPFv3 router configuration mode for the IPv4 or IPv6 address family.

	Command or Action	Purpose

Step 4	**address-family ipv6 unicast**
	
	Example:
	
	Example:
	
	or
	
	Example:
	
	    address-family ipv4
	
	    unicast
	
	Example:
	
	Router(config-router)# address-family ipv6 unicast
	
	Example:
	
	Example:
	
	or
	
	Example:
	
	Router(config-router)# address-family ipv4 unicast
		Enters IPv6 address family configuration mode for OSPFv3.
		
		or
		
		Enters IPv4 address family configuration mode for OSPFv3.

Step 5	**event-log** [**one-shot** | **pause** | **size** *number-of-events*] **Example:** Router(config-router)# event-log	Enable OSPFv3 event logging in an IPv4 OSPFv3 process.

Enabling Event Logging for LSA and SPF Rate Limiting

This task can be performed in releases prior to Cisco IOS XE Release 3.4S.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ipv6 router ospf** *process-id*
4. **event-log** [**size** [*number of events*]] [**one-shot**] [**pause**]

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable**	Enables privileged EXEC mode.
		• Enter your password if prompted.
	Example:	
	Router> enable	
Step 2	**configure terminal**	Enters global configuration mode.
	Example:	
	Router# configure terminal	
Step 3	**ipv6 router ospf** *process-id*	Enables OSPFv3 router configuration mode.
	Example:	
	Router(config)# ipv6 router ospf 1	
Step 4	**event-log** [**size** [*number of events*]] [**one-shot**] [**pause**]	Enables event logging.
	Example:	
	Router(config-rtr)# event-log size 10000 one-shot	

Clearing the Content of an Event Log

SUMMARY STEPS

1. **enable**
2. **clear ipv6 ospf** [*process-id*] **events**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** Router> enable	Enables privileged EXEC mode. Enter your password if prompted.
Step 2	**clear ipv6 ospf** [*process-id*] **events** **Example:** Router# clear ipv6 ospf 1 events	Clears the OSPFv3 event log content based on the OSPFv3 routing process ID.

Calculating OSPFv3 External Path Preferences per RFC 5340

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **router ospfv3** [*process-id*]
4. **no compatible rfc1583**

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 ospfv3** [*process-id*] **Example:** Router(config)# router ospfv3 1	Enables OSPFv3 router configuration mode for the IPv4 or IPv6 address family.

	Command or Action	Purpose
Step 4	**no compatible rfc1583** **Example:** `Router(config-router)# no compatible rfc1583`	Changes the method used to calculate external path preferences per RFC 5340.

Enabling OSPFv3 Graceful Restart

Enabling OSPFv3 Graceful Restart on a Graceful-Restart-Capable Router

The task can be performed in Cisco IOS XE 3.4S and later releases.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **router ospfv3** [*process-id*]
4. **graceful-restart** [**restart-interval** *interval*]

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 ospfv3** [*process-id*] **Example:** `Router(config)# router ospfv3 1`	Enables OSPFv3 router configuration mode for the IPv4 or IPv6 address family.

	Command or Action	Purpose
Step 4	**graceful-restart** [**restart-interval** *interval*] **Example:** `Router(config-rtr)# graceful-restart`	Enables the OSPFv3 graceful restart feature on a graceful-restart-capable router.

Enabling OSPFv3 Graceful Restart on a Graceful-Restart-Capable Router

The task can be performed in releases prior to Cisco IOS XE Release 3.4S.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ipv6 router ospf** *process-id*
4. **graceful-restart** [**restart-interval** *interval*]

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	**ipv6 router ospf** *process-id* **Example:** `Router(config)# ipv6 router ospf 1`	Enables OSPFv3 router configuration mode.
Step 4	**graceful-restart** [**restart-interval** *interval*] **Example:** `Router(config-rtr)# graceful-restart`	Enables the OSPFv3 graceful restart feature on a graceful-restart-capable router.

Enabling OSPFv3 Graceful Restart on a Graceful-Restart-Aware Router

The task can be performed in Cisco IOS XE Release 3.4S and later releases.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **router ospfv3** [*process-id*]
4. **graceful-restart helper** {**disable** | **strict-lsa-checking**

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 ospfv3** [*process-id*] **Example:** `Router(config)# router ospfv3 1`	Enables OSPFv3 router configuration mode for the IPv4 or IPv6 address family.
Step 4	**graceful-restart helper** {**disable**	**strict-lsa-checking** **Example:** `Router(config-rtr)# graceful-restart helper strict-lsa-checking`	Enables the OSPFv3 graceful restart feature on a graceful-restart-aware router.

Example:

Enabling OSPFv3 Graceful Restart on a Graceful-Restart-Aware Router

The task can be performed in releases prior to Cisco IOS XE Release 3.4S.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ipv6 router ospf** *process-id*
4. **graceful-restart helper** {**disable** | **strict-lsa-checking**

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	**ipv6 router ospf** *process-id* **Example:** `Router(config)# ipv6 router ospf 1`	Enables OSPFv3 router configuration mode.
Step 4	**graceful-restart helper** {**disable**	**strict-lsa-checking** **Example:** `Router(config-rtr)# graceful-restart helper strict-lsa-checking`	Enables the OSPFv3 graceful restart feature on a graceful-restart-aware router.

Example:

Forcing an SPF Calculation

SUMMARY STEPS

1. **enable**
2. **clear ospfv3** [*process-id*] force-spf
3. **clear ospfv3** [*process-id*] process
4. **clear ospfv3** [*process-id*] redistribution
5. **clear ipv6 ospf** [*process-id*] {**process** | **force-spf** | **redistribution**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**clear ospfv3** [*process-id*] force-spf **Example:** `Router# clear ospfv3 1 force-spf`	Runs SPF calculations for an OSPFv3 process. • If the **clear ospfv3 force-spf** command is configured, it overwrites the **clear ipv6 ospf** configuration. • Once the **clear ospfv3 force-spf** command has been used, the **clear ipv6 ospf** command cannot be used.
Step 3	**clear ospfv3** [*process-id*] process **Example:** `Router# clear ospfv3 2 process`	Resets an OSPFv3 process. • If the **clear ospfv3 force-spf** command is configured, it overwrites the **clear ipv6 ospf** configuration. • Once the **clear ospfv3 force-spf** command has been used, the **clear ipv6 ospf** command cannot be used.
Step 4	**clear ospfv3** [*process-id*] redistribution **Example:** `Router# clear ospfv3 redistribution`	Clears OSPFv3 route redistribution. • If the **clear ospfv3 force-spf** command is configured, it overwrites the **clear ipv6 ospf** configuration. • Once the **clear ospfv3 force-spf** command has been used, the **clear ipv6 ospf** command cannot be used.
Step 5	**clear ipv6 ospf** [*process-id*] {**process**	**force-spf**	**redistribution** **Example:** `Router# clear ipv6 ospf force-spf`	Clears the OSPFv3 state based on the OSPFv3 routing process ID, and forces the start of the SPF algorithm. • If the **clear ospfv3 force-spf** command is configured, it overwrites the **clear ipv6 ospf** configuration. • Once the **clear ospfv3 force-spf** command has been used, the **clear ipv6 ospf** command cannot be used.

Verifying OSPFv3 Configuration and Operation

This task is optional. The commands in this task are available in Cisco IOS XE Release 3.4S and later releases.

SUMMARY STEPS

1. **enable**
2. **show ospfv3** [*process-id*] **border-routers**
3. **show ospfv3** [*process-id* [*area-id*]] **database** [**database-summary** | **internal** | **external**[*ipv6-prefix*] [*link-state-id*] | **grace** | **inter-area prefix** [*ipv6-prefix* | *link-state-id*] | **inter-area router** [*destination-router-id* | *link-state-id*] | **link** [**interface** *interface-name* | *link-state-id*] | **network** [*link-state-id*] | **nssa-external** [*ipv6-prefix*] [*link-state-id*] | **prefix** [**ref-lsa** {**router** | **network**} | *link-state-id*] | **promiscuous** | **router** [*link-state-id*] | **unknown** [{**a rea** | **as** | **link**} [*link-state-id*]] [**adv-router** *router-id*] [**self-originate**]
4. **show ospfv3** [*process-id*] **events** [**generic** | **interface** | **lsa** | **neighbor** | **reverse** | **rib** | **spf**]
5. show ospfv3 [*process-id*] [*area-id*] flood-list interface-*type interface-number*
6. show ospfv3 [*process-id*] graceful-restart
7. **show ospfv3** [*process-id*] [*area-id*] **interface**[*type number*] [**brief**]
8. **show ospfv3** [*process-id*] [*area-id*] **neighbor**[*interface type interface-number*] [*neighbor-id*] [**detail**]
9. **show ospfv3** [*process-id*] [*area-id*] **request-list**[*neighbor*] [*interface*] [*interface neighbor*]
10. **show ospfv3** [*process-id*] [*area-id*] **retransmission-list** [*neighbor*] [*interface*] [*interface neighbor*]
11. **show ospfv3** [*process-id*] **statistic**[*detail*]
12. **show ospfv3** [*process-id*] **summary-prefix**
13. **show ospfv3** [*process-id*] **timers rate-limit**
14. **show ospfv3** [*process-id*] **traffic**[*interface-type interface-number*]
15. **show ospfv3** [*process-id*] **virtual-links**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**show ospfv3** [*process-id*] **border-routers** **Example:** `Router# show ospfv3 border-routers`	Displays the internal OSPFv3 routing table entries to an ABR and ASBR.

	Command or Action	Purpose
Step 3	**show ospfv3** [*process-id* [*area-id*]] **database** [**database-summary** | **internal** | **external**[*ipv6-prefix*] [*link-state-id*] | **grace** | **inter-area prefix** [*ipv6-prefix* | *link-state-id*] | **inter-area router** [*destination-router-id* | *link-state-id*] | **link** [**interface** *interface-name* | *link-state-id*] | **network** [*link-state-id*] | **nssa-external** [*ipv6-prefix*] [*link-state-id*] | **prefix** [**ref-lsa** {**router** | **network**} | *link-state-id*] | **promiscuous** | **router** [*link-state-id*] | **unknown** [{**a rea** | **as** | **link**} [*link-state-id*]] [**adv-router** *router-id*] [**self-originate**]	Displays lists of information related to the OSPFv3 database for a specific router.
	Example:	
	`Router# show ospfv3 database`	
Step 4	**show ospfv3** [*process-id*] **events** [**generic** | **interface** | **lsa** | **neighbor** | **reverse** | **rib** | **spf**]	Displays detailed information about OSPFv3 events.
	Example:	
	`Router# show ospfv3 events`	
Step 5	show ospfv3 [*process-id*] [*area-id*] flood-list interface-*type interface-number*	Displays a list of OSPFv3 LSAs waiting to be flooded over an interface.
	Example:	
	`Router# show ospfv3 flood-list`	
Step 6	show ospfv3 [*process-id*] graceful-restart	Displays OSPFv3 graceful restart information.
	Example:	
	`Router# show ospfv3 graceful-restart`	
Step 7	**show ospfv3** [*process-id*] [*area-id*] **interface**[*type number*] [**brief**]	Displays OSPFv3-related interface information.
	Example:	
	`Router# show ospfv3 interface`	
Step 8	**show ospfv3** [*process-id*] [*area-id*] **neighbor**[*interface type interface-number*] [*neighbor-id*] [**detail**]	Displays OSPFv3 neighbor information on a per-interface basis.
	Example:	
	`Router# show ospfv3 neighbor`	

	Command or Action	Purpose
Step 9	**show ospfv3** [*process-id*] [*area-id*] **request-list**[*neighbor*] [*interface*] [*interface neighbor*] **Example:** `Router# show ospfv3 request-list`	Displays a list of all LSAs requested by a router.
Step 10	**show ospfv3** [*process-id*] [*area-id*] **retransmission-list** [*neighbor*] [*interface*] [*interface neighbor*] **Example:** `Router# show ospfv3 retransmission-list`	Displays a list of all LSAs waiting to be re-sent.
Step 11	**show ospfv3** [*process-id*] **statistic**[**detail**] **Example:** `Router# show ospfv3 statistics`	Displays OSPFv3 SPF calculation statistics.
Step 12	**show ospfv3** [*process-id*] **summary-prefix** **Example:** `Router# show ospfv3 summary-prefix`	Displays a list of all summary address redistribution information configured under an OSPFv3 process.
Step 13	**show ospfv3** [*process-id*] **timers rate-limit** **Example:** `Router# show ospfv3 timers rate-limit`	Displays all of the LSAs in the rate limit queue.
Step 14	**show ospfv3** [*process-id*] **traffic**[*interface-type interface-number*] **Example:** `Router# show ospfv3 traffic`	Displays OSPFv3 traffic statistics.
Step 15	**show ospfv3** [*process-id*] **virtual-links** **Example:** `Router# show ospfv3 virtual-links`	Displays parameters and the current state of OSPFv3 virtual links.

Verifying OSPFv3 Configuration and Operation

SUMMARY STEPS

1. **enable**
2. **show ipv6 ospf** [*process-id*] [*area-id*] **interface**[*interface-type interface-number*]
3. **show ipv6 ospf** [*process-id*] [*area-id*]
4. **show ipv6 ospf** [*process-ID*] **event** [**generic** | **interface** | **lsa** | **neighbor** | **reverse** | **rib** | **spf**]

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*] [*area-id*] **interface**[*interface-type interface-number*] **Example:** `Router# show ipv6 ospf interface`	Displays OSPFv3-related interface information.
Step 3 **show ipv6 ospf** [*process-id*] [*area-id*] **Example:** `Router# show ipv6 ospf`	Displays general information about OSPFv3 routing processes.
Step 4 **show ipv6 ospf** [*process-ID*] **event** [**generic**	**interface**	**lsa**	**neighbor**	**reverse**	**rib**	**spf**] **Example:** `Router# show ipv6 ospf event spf`	Displays detailed information about OSPFv3 events.

Examples

Sample Output for the show ipv6 ospf interface Command

The following is sample output from the **show ipv6 ospf interface** command with regular interfaces and a virtual link that are protected by encryption and authentication:

```
Router# show ipv6 ospf interface
OSPFv3_VL1 is up, line protocol is up
   Interface ID 69
   Area 0, Process ID 1, Instance ID 0, Router ID 10.0.0.1
   Network Type VIRTUAL_LINK, Cost: 64
   Configured as demand circuit.
   Run as demand circuit.
   DoNotAge LSA allowed.
   NULL encryption SHA-1 auth SPI 3944, secure socket UP (errors: 0)
   Transmit Delay is 1 sec, State POINT_TO_POINT,
   Timer intervals configured, Hello 2, Dead 10, Wait 40, Retransmit 5
     Hello due in 00:00:00
   Index 1/3/5, 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 10.2.0.1  (Hello suppressed)
   Suppress hello for 1 neighbor(s)
OSPFv3_VL0 is up, line protocol is up
   Interface ID 67
   Area 0, Process ID 1, Instance ID 0, Router ID 10.0.0.1
   Network Type VIRTUAL_LINK, Cost: 128
   Configured as demand circuit.
   Run as demand circuit.
   DoNotAge LSA allowed.
   MD5 authentication SPI 940, secure socket UP (errors: 0)
   Transmit Delay is 1 sec, State POINT_TO_POINT,
   Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
     Hello due in 00:00:09
   Index 1/2/4, flood queue length 0
   Next 0x0(0)/0x0(0)/0x0(0)
   Last flood scan length is 1, maximum is 10
   Last flood scan time is 0 msec, maximum is 0 msec
   Neighbor Count is 1, Adjacent neighbor count is 1
     Adjacent with neighbor 10.1.0.1  (Hello suppressed)
   Suppress hello for 1 neighbor(s)
Gigabitethernet1/0/0 is up, line protocol is up
   Link Local Address FE80::A8BB:CCFF:FE00:6601, Interface ID 6
   Area 0, Process ID 1, Instance ID 0, Router ID 10.0.0.1
   Network Type BROADCAST, Cost: 10
   Transmit Delay is 1 sec, State DR, Priority 1
   Designated Router (ID) 10.0.0.1, local address FE80::A8BB:CCFF:FE00:6601
   No backup designated router on this network
   Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
     Hello due in 00:00:09
   Index 1/1/1, 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)
Serial12/0 is up, line protocol is up
   Link Local Address FE80::A8BB:CCFF:FE00:6600, Interface ID 50
   Area 1, Process ID 1, Instance ID 0, Router ID 10.0.0.1
   Network Type POINT_TO_POINT, Cost: 64
   AES-CBC encryption SHA-1 auth SPI 2503, secure socket UP (errors: 0)
   authentication NULL
   Transmit Delay is 1 sec, State POINT_TO_POINT,
   Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
     Hello due in 00:00:09
   Index 1/2/3, flood queue length 0
   Next 0x0(0)/0x0(0)/0x0(0)
   Last flood scan length is 1, maximum is 5
   Last flood scan time is 0 msec, maximum is 0 msec
   Neighbor Count is 1, Adjacent neighbor count is 1
```

```
        Adjacent with neighbor 10.2.0.1
     Suppress hello for 0 neighbor(s)
Serial11/0 is up, line protocol is up
   Link Local Address FE80::A8BB:CCFF:FE00:6600, Interface ID 46
   Area 1, Process ID 1, Instance ID 0, Router ID 10.0.0.1
   Network Type POINT_TO_POINT, Cost: 64
   MD5 authentication (Area) SPI 500, secure socket UP (errors: 0)
   Transmit Delay is 1 sec, State POINT_TO_POINT,
   Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
     Hello due in 00:00:09
   Index 1/1/2, flood queue length 0
   Next 0x0(0)/0x0(0)/0x0(0)
   Last flood scan length is 1, maximum is 5
   Last flood scan time is 0 msec, maximum is 0 msec
   Neighbor Count is 1, Adjacent neighbor count is 1
     Adjacent with neighbor 1.0.0.1
   Suppress hello for 0 neighbor(s)
```

Sample Output for the show ipv6 ospf Command

The following is sample output from the **show ipv6 ospf** command:

```
Router# show ipv6 ospf
Routing Process "ospfv3 1" with ID 172.16.3.3
 It is an autonomous system boundary router
 Redistributing External Routes from,
    static
 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 240 secs
 Interface flood pacing timer 33 msecs
 Retransmission pacing timer 66 msecs
 Number of external LSA 1. Checksum Sum 0x218D
 Number of areas in this router is 1. 1 normal 0 stub 0 nssa
    Area 1
        Number of interfaces in this area is 2
        SPF algorithm executed 9 times
        Number of LSA 15. Checksum Sum 0x67581
        Number of DCbitless LSA 0
        Number of indication LSA 0
        Number of DoNotAge LSA 0
        Flood list length 0
```

Sample Output for the show ipv6 ospf graceful-restart Command

The following is sample output from the **show ipv6 ospf graceful-restart**command:

```
Router# show ipv6 ospf graceful-restart
Routing Process "ospf 1"
 Graceful Restart enabled
    restart-interval limit: 120 sec, last restart 00:00:15 ago (took 36 secs)
  Graceful Restart helper support enabled
  Router status : Active
  Router is running in SSO mode
  OSPF restart state : NO_RESTART
  Router ID 10.1.1.1, checkpoint Router ID 10.0.0.0
```

Configuration Examples for Implementing OSPFv3

Example Enabling OSPFv3 on an Interface Configuration

The following example configures an OSPFv3 routing process 109 to run on the interface and puts it in area 1:

```
ipv6 ospf 109 area 1
```

Example Defining an OSPFv3 Area Range

The following example specifies an OSPFv3 area range:

```
interface gigabitethernet7/0/0
 ipv6 address 2001:DB8:0:7::/64 eui-64
 ipv6 enable
 ipv6 ospf 1 area 1
!
interface gigabitethernet8/0/0
 ipv6 address 2001:DB8:0:8::/64 eui-64
 ipv6 enable
 ipv6 ospf 1 area 1
!
interface gigabitethernet9/0/0
 ipv6 address 2001:DB8:0:9::/64 eui-64
 ipv6 enable
 ipv6 ospf 1 area 1
!
ipv6 router ospf 1
 router-id 10.11.11.1
 area 1 range 2001:DB8::/48
```

Example Configuring LSA and SPF Throttling for OSPFv3 Fast Convergence

The following example displays the configuration values for SPF and LSA throttling timers:

```
Router# show ipv6 ospf


 Routing Process "ospfv3 1" with ID 10.9.4.1

 Event-log enabled, Maximum number of events: 1000, Mode: cyclic

 It is an autonomous system boundary router

 Redistributing External Routes from,

    ospf 2

 Initial SPF schedule delay 5000 msecs

 Minimum hold time between two consecutive SPFs 10000 msecs

 Maximum wait time between two consecutive SPFs 10000 msecs

 Minimum LSA interval 5 secs

 Minimum LSA arrival 1000 msecs
```

Example Forcing SPF Configuration

The following example triggers SPF to redo the SPF and repopulate the routing tables:

```
clear ipv6 ospf force-spf
```

Additional References

Related Documents

Related Topic	Document Title
Configuring a router ID in OSPF	" Configuring OSPF ," *Cisco IOS XE IP Routing Protocols Configuration Guide* *Cisco IOS IP Routing Protocols Command Reference*
LSA throttling	"OSPF Link-State Advertisement (LSA) Throttling ," *Cisco IOS XE IP Routing Protocols Configuration Guide*
OSPFv3 commands	*Cisco IOS IPv6 Command Reference*
IPv6 supported feature list	" Start Here: Cisco IOS XE Software Release Specifics for IPv6 Features ," *Cisco IOS XE IPv6 Configuration Guide*
Implementing basic IPv6 connectivity	" Implementing IPv6 Addressing and Basic Connectivity ," *Cisco IOS XE IPv6 Configuration Guide*
Stateful switchover	"Stateful Switchover ," *Cisco IOS XE High Availability Configuration Guide*
Cisco nonstop forwarding	"Cisco Nonstop Forwarding ," *Cisco IOS XE High Availability Configuration Guide*
OSPF for IPv4 commands	*Cisco IOS IP Routing Protocols Command Reference*
Security configuration tasks (IPv4)	*Cisco IOS XE Security Configuration Guide* , Release 2
Security commands: complete command syntax, command mode, defaults, usage guidelines, and examples (IPv4)	*Cisco IOS Security Command Reference*
Cisco IOS master command list, all releases	Cisco IOS Master Command List, All Releases

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
RFC 1583	*OSPF version 2*
RFC 2401	*Security Architecture for the Internet Protocol*
RFC 2402	*IP Authentication Header*
RFC 2406	*IP Encapsulating Security Payload (ESP)*
RFC 3137	OSPF Stub Router Advertisement
RFC 4552	*Authentication/Confidentiality for OSPFv3*
RFC 5187	*OSPFv3 Graceful Restart*
RFC 5340	*OSPF for IPv6*
RFC 5838	*Support of Address Families in OSPFv3*

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 Implementing OSPFv3

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 Implementing OSPFv3***

Feature Name	Releases	Feature Information
IPv6 Routing--Fast Convergence--LSA and SPF Throttling	Cisco IOS XE Release 2.1	The OSPFv3 LSA and SPF throttling feature provides a dynamic mechanism to slow down link-state advertisement updates in OSPFv3 during times of network instability. The following commands were modified by this feature: **clear ipv6 ospf events**, **event-log**, **ipv6 router ospf**, **show ipv6 ospf event**, **timers lsa arrival**, **timers pacing flood**, **timers throttle lsa**, **timers throttle spf**
IPv6 Routing--LSA Types in OSPFv3	Cisco IOS XE Release 2.1	A router's collection of LSA data is stored in a link-state database. The contents of the database, when subjected to the Dijkstra algorithm, result in the creation of the OSPFv3 routing table.
IPv6 Routing-- OSPFv3	Cisco IOS XE Release 2.1	OSPF version 3 for IPv6 expands on OSPF version 2 to provide support for IPv6 routing prefixes and the larger size of IPv6 addresses. The following commands were modified by this feature: **area range**, **clear ipv6 ospf**, **ipv6 ospf area**, **ipv6 router ospf**, **show ipv6 ospf**, **show ipv6 ospf interface**

Feature Name	Releases	Feature Information
OSPFv3 Address Families	Cisco IOS XE Release 3.4S	The OSPFv3 address families feature enables IPv4 and IPv6 unicast traffic to be supported with a single network topology.
OSPFv3 External Path Preference Option	Cisco IOS XE Release 3.4S	This feature is provides a way to calculate external path preferences per RFC 5340.
OSPFv3 Graceful Restart	Cisco IOS XE Release 2.1	The graceful restart feature in OSPFv3 allows nonstop data forwarding along routes that are already known while the OSPFv3 routing protocol information is being restored. The following commands were modified by this feature: **graceful-restart**, **graceful-restart helper**, **ipv6 router ospf**, **show ipv6 ospf graceful-restart**
OSPFv3 Max-Metric Router LSA	Cisco IOS XE Release 3.4S	The OSPFv3 max-mtric router LSA feature enables OSPF to advertise its locally generated router LSAs with a maximum metric.