



Implementing OSPFv3

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The *Implementing OSPFv3* module expands on Open Shortest Path First version 3 (OSPFv3) 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 for Implementing OSPFv3](#)” section on page 56.

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.

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Prerequisites for Implementing OSPFv3

Before you enable OSPFv3 on an interface, you must do the following:

- 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.
- 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.
- Authentication is supported as of Cisco IOS Release 12.3(4)T.
- ESP authentication and encryption are supported as of Cisco IOS Release 12.4(9)T.
- 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

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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 OSPF version 3 and OSPF Version 2

Much of OSPF version 3 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.

When using a nonbroadcast multiaccess (NBMA) interface in OSPFv3, users must manually configure the router with the list of neighbors. Neighboring routers are identified by their router ID.

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.

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 `pdindex` 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 Release 15.1(3)S and Cisco IOS Release 15.2(1)T. Cisco routers that run software older than these releases 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.

NBMA in OSPFv3

On NBMA networks, the designated router (DR) or backup DR (BDR) performs the LSA flooding. On point-to-point networks, flooding simply goes out an interface directly to a neighbor.

Routers that share a common segment (Layer 2 link between two interfaces) become neighbors on that segment. OSPFv3 uses the Hello protocol, periodically sending hello packets out each interface. Routers become neighbors when they see themselves listed in the neighbor's hello packet. After two routers become neighbors, they may proceed to exchange and synchronize their databases, which creates an adjacency. Not all neighboring routers have an adjacency.

On point-to-point and point-to-multipoint networks, the software floods routing updates to immediate neighbors. There is no DR or BDR; all routing information is flooded to each networking device.

On broadcast or NBMA segments only, OSPFv3 minimizes the amount of information being exchanged on a segment by choosing one router to be a DR and one router to be a BDR. Thus, the routers on the segment have a central point of contact for information exchange. Instead of each router exchanging routing updates with every other router on the segment, each router exchanges information with the DR and BDR. The DR and BDR relay the information to the other routers.

The software looks at the priority of the routers on the segment to determine which routers will be the DR and BDR. The router with the highest priority is elected the DR. If there is a tie, then the router with the higher router ID takes precedence. After the DR is elected, the BDR is elected the same way. A router with a router priority set to zero is ineligible to become the DR or BDR.

When using NBMA in OSPFv3, you cannot automatically detect neighbors. On an NBMA interface, you must configure your neighbors manually using interface configuration mode.

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.

Force SPF in OSPFv3

When the **process** keyword is used with the **clear ipv6 ospf** command, the OSPFv3 database is cleared and repopulated, and then the SPF algorithm is performed. When the **force-spf** keyword is used with the **clear ipv6 ospf** command, the OSPFv3 database is not cleared before the SPF algorithm is performed.

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.

Load Balancing in OSPFv3

When a router learns multiple routes to a specific network via multiple routing processes (or routing protocols), it installs the route with the lowest administrative distance in the routing table. Sometimes the router must select a route from among many learned via the same routing process with the same

administrative distance. In this case, the router chooses the path with the lowest cost (or metric) to the destination. Each routing process calculates its cost differently and the costs may need to be manipulated in order to achieve load balancing.

OSPFv3 performs load balancing automatically in the following way. If OSPFv3 finds that it can reach a destination through more than one interface and each path has the same cost, it installs each path in the routing table. The only restriction on the number of paths to the same destination is controlled by the **maximum-paths** command. The default maximum paths is 16, and the range is from 1 to 64.

Address Import 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 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 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.

For further information on IPsec, refer to the [Implementing IPsec in IPv6 Security](#) document.

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.

Packets sent on a virtual link with IPsec must use predetermined source and destination addresses. The first local area address found in the router's intra-area-prefix LSA for the area is used as the source address. This source address is saved in the area data structure and used when secure sockets are opened and packets sent over the virtual link. The virtual link will not transition to the point-to-point state until a source address is selected. Also, when the source or destination address changes, the previous secure sockets must be closed and new secure sockets opened.



Note

Virtual links are not supported for the IPv4 AF.

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 [Figure 1](#).

Figure 1 Overall Link Cost Formula



Table 1 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: $((100 - RESOURCES)^3 * 2^{16} / 10^6)$
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. Table 2 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 throughput	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 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.

BFD Support for OSPFv3

Bidirectional Forwarding Detection (BFD) supports OSPFv3. For information on how to configure BFD for OSPFv3, see the *Implementing Bidirectional Forwarding Detection for IPv6* module.

How to Implement OSPFv3

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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.

This task can be performed in Cisco IOS Release 15.1(3)S and 15.2(1)T and later releases.

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. <ul style="list-style-type: none">• Enter your password if prompted.
Step 2	configure terminal Example: Router# configure terminal	Enters global configuration mode.
Step 3	router ospfv3 [<i>process-id</i>] 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.
Step 5	auto-cost reference-bandwidth <i>Mbps</i> 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.

	Command or Action	Purpose
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 <i>interface-type interface-number</i>] Example: Router(config-router)# passive-interface default	Suppresses sending routing updates on an interface when using an IPv4 OSPFv3 process.
Step 12	queue-depth { hello update } { <i>queue-size</i> unlimited } Example: Router(config-router)# queue-depth update 1500	Configures the number of incoming packets that the IPv4 OSPFv3 process can keep in its queue.
Step 13	router-id { <i>router-id</i> } Example: Router(config-router)# router-id 10.1.1.1	Use a fixed router ID.

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.

The task can be performed in Cisco IOS Release 15.1(3)S and 15.2(1)T and later releases.

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	<p>enable</p> <p>Example: Router> enable</p>	<p>Enables privileged EXEC mode.</p> <ul style="list-style-type: none"> Enter your password if prompted.
Step 2	<p>configure terminal</p> <p>Example: Router# configure terminal</p>	<p>Enters global configuration mode.</p>
Step 3	<p>router ospfv3 [<i>process-id</i>]</p> <p>Example: Router(config)# router ospfv3 1</p>	<p>Enables OSPFv3 router configuration mode for the IPv4 or IPv6 address family.</p>
Step 4	<p>address-family ipv6 unicast</p> <p>or</p> <p>address-family ipv4 unicast</p> <p>Example: Router(config-router)# address-family ipv6 unicast</p> <p>or</p> <p>Router(config-router)# address-family ipv4 unicast</p>	<p>Enters IPv6 address family configuration mode for OSPFv3.</p> <p>or</p> <p>Enters IPv4 address family configuration mode for OSPFv3.</p>
Step 5	<p>area <i>area-ID</i> range <i>ipv6-prefix/prefix-length</i></p> <p>Example: Router(config-router-af)# area 1 range 2001:DB8:0:0::0/128</p>	<p>Configures OSPFv3 area parameters.</p>
Step 6	<p>default {area <i>area-ID</i> [range <i>ipv6-prefix</i> virtual-link <i>router-id</i>]} [default-information originate [always metric metric-type route-map] distance distribute-list <i>prefix-list prefix-list-name</i> {in out} [<i>interface</i>] maximum-paths <i>paths</i> redistribute <i>protocol</i> summary-prefix <i>ipv6-prefix</i>]</p> <p>Example: Router(config-router-af)# default area 1</p>	<p>Returns an OSPFv3 parameter to its default value.</p>
Step 7	<p>default-information originate [always metric <i>metric-value</i> metric-type <i>type-value</i> route-map <i>map-name</i>]</p> <p>Example: Router(config-router-af)# default-information originate always metric 100 metric-type 2</p>	<p>Generates a default external route into an OSPFv3 for a routing domain.</p>

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

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.

The task can be performed in Cisco IOS Release 15.1(3)S and 15.2(1)T and later releases.

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	<p>enable</p> <p>Example: Router> enable</p>	<p>Enables privileged EXEC mode.</p> <ul style="list-style-type: none"> Enter your password if prompted.
Step 2	<p>configure terminal</p> <p>Example: Router# configure terminal</p>	<p>Enters global configuration mode.</p>
Step 3	<p>router ospfv3 [process-id]</p> <p>Example: Router(config)# router ospfv3 1</p>	<p>Enables OSPFv3 router configuration mode for the IPv4 or IPv6 address family.</p>
Step 4	<p>address-family ipv4 unicast</p> <p>Example: Router(config-router)# address-family ipv4 unicast</p>	<p>Enters IPv4 address family configuration mode for OSPFv3.</p>
Step 5	<p>area area-id range ip-address ip-address-mask [advertise not-advertise] [cost cost]</p> <p>Example: Router(config-router-af)# area 0 range 192.168.110.0 255.255.0.0</p>	<p>Consolidates and summarizes routes at an area boundary.</p>
Step 6	<p>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]</p> <p>Example: Router(config-router-af)# default area 1</p>	<p>Returns an OSPFv3 parameter to its default value.</p>
Step 7	<p>default-information originate [always metric metric-value metric-type type-value route-map map-name]</p> <p>Example: Router(config-router-af)# default-information originate always metric 100 metric-type 2</p>	<p>Generates a default external route into an OSPFv3 for a routing domain.</p>
Step 8	<p>default-metric metric-value</p> <p>Example: Router(config-router-af)# default-metric 10</p>	<p>Sets default metric values for IPv4 and IPv6 routes redistributed into the OSPFv3 routing protocol.</p>

	Command or Action	Purpose
Step 9	distance <i>distance</i> Example: Router(config-router-af)# distance 200	Configures an administrative distance for OSPFv3 routes inserted into the routing table.
Step 10	distribute-list prefix-list <i>list-name</i> { in [<i>interface-type interface-number</i>] out <i>routing-process [as-number]</i> }	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 <i>number-paths</i> Example: Router(config-router-af)# maximum-paths 4	Controls the maximum number of equal-cost routes that a process for OSPFv3 routing can support.
Step 12	summary-prefix <i>prefix</i> [not-advertise tag <i>tag-value</i>] Example: Router(config-router-af)# summary-prefix FEC0::/24	Configures an IPv6 summary prefix in OSPFv3.

Configuring Route Redistribution in OSPFv3

The task can be performed in Cisco IOS Release 15.1(3)S and 15.2(1)T and later releases.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **router ospfv3** [*process-id*]
4. **address-family ipv6 unicast**
or
address-family ipv4 unicast
5. **redistribute** *source-protocol* [*process-id*] [*options*]

DETAILED STEPS

	Command or Action	Purpose
Step 1	<p>enable</p> <p>Example: Router> enable</p>	<p>Enables privileged EXEC mode.</p> <ul style="list-style-type: none"> • Enter your password if prompted.
Step 2	<p>configure terminal</p> <p>Example: Router# configure terminal</p>	<p>Enters global configuration mode.</p>
Step 3	<p>router ospfv3 [<i>process-id</i>]</p> <p>Example: Router(config)# router ospfv3 1</p>	<p>Enables OSPFv3 router configuration mode for the IPv4 or IPv6 address family.</p>
Step 4	<p>address-family ipv6 unicast</p> <p>or</p> <p>address-family ipv4 unicast</p> <p>Example: Router(config-router)# address-family ipv6 unicast</p> <p>or</p> <p>Router(config-router)# address-family ipv4 unicast</p>	<p>Enters IPv6 address family configuration mode for OSPFv3.</p> <p>or</p> <p>Enters IPv4 address family configuration mode for OSPFv3.</p>
Step 5	<p>redistribute <i>source-protocol</i> [<i>process-id</i>] [<i>options</i>]</p> <p>Example:</p>	<p>Redistributes IPv6 and IPv4 routes from one routing domain into another routing domain.</p>

Enabling OSPFv3 on an Interface

SUMMARY STEPS

1. **enable**
 2. **configure terminal**
 3. **interface** *type number*
 4. **ospfv3** *process-id* **area** *area-ID* {**ipv4** | **ipv6**} [**instance** *instance-id*]
- or
- 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. <ul style="list-style-type: none"> Enter your password if prompted.
Step 2	configure terminal Example: Router# configure terminal	Enters global configuration mode.
Step 3	interface <i>type number</i> Example: Router(config)# interface ethernet 0/0	Specifies an interface type and number, and places the router in interface configuration mode.
Step 4	ospfv3 <i>process-id area area-ID {ipv4 ipv6} [instance instance-id]</i> OR ipv6 ospf <i>process-id area area-id [instance instance-id]</i> Example: Router(config-if)# ospfv3 1 area 1 ipv4 OR 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
```

The task can be performed in Cisco IOS Release 15.1(3)S and 15.2(1)T and later releases.

Prerequisites

OSPFv3 routing must be enabled.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **router ospfv3** [*process-id*]
4. **address-family ipv6 unicast**
or
address-family ipv4 unicast
5. **area** *area-ID* **range** *ipv6-prefix*

DETAILED STEPS

	Command or Action	Purpose
Step 1	enable Example: Router> enable	Enables privileged EXEC mode. <ul style="list-style-type: none">• Enter your password if prompted.
Step 2	configure terminal Example: Router# configure terminal	Enters global configuration mode.
Step 3	router ospfv3 [<i>process-id</i>] Example: Router(config)# router ospfv3 1	Enables OSPFv3 router configuration mode for the IPv4 or IPv6 address family.
Step 4	address-family ipv6 unicast or address-family ipv4 unicast Example: Router(config-router)# address-family ipv6 unicast or 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	area <i>area-ID</i> range <i>ipv6-prefix</i> Example: Router(config-router-af)# area 1 range 2001:DB8:0:0::0/128	Configures OSPFv3 area parameters.

Defining an OSPFv3 Area Range

The task can be performed in releases prior to Cisco IOS Release 15.1(3)S and 15.2(1)T.

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. <ul style="list-style-type: none"> • Enter your password if prompted.
Step 2	configure terminal Example: Router# configure terminal	Enters global configuration mode.
Step 3	ipv6 router ospf <i>process-id</i> Example: Router(config)# ipv6 router ospf 1	Enables OSPFv3 router configuration mode.
Step 4	area <i>area-id</i> range <i>ipv6-prefix/prefix-length</i> [advertise not-advertise] [cost <i>cost</i>] Example: Router(config-rtr)# area 1 range 2001:DB8::/48	Consolidates and summarizes routes at an area boundary.

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, page 25](#)
- [Defining Encryption on an Interface, page 26](#)
- [Defining Authentication in an OSPFv3 Area, page 27](#)
- [Defining Encryption in an OSPFv3 Area, page 28](#)
- [Defining Authentication and Encryption for a Virtual Link in an OSPFv3 Area, page 29](#)

Defining Authentication on an Interface

Prerequisites

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. **ospfv3 authentication** {*ipsec spi*} {**md5** | **sha1**} {*key-encryption-type key*} | **null**
or
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. <ul style="list-style-type: none">Enter your password if prompted.
Step 2	configure terminal Example: Router# configure terminal	Enters global configuration mode.
Step 3	interface <i>type number</i> Example: Router(config)# interface ethernet 0/0	Specifies an interface type and number, and places the router in interface configuration mode.
Step 4	ospfv3 authentication {ipsec spi} {md5 sha1} {key-encryption-type key} null or ipv6 ospf authentication ipsec spi spi md5 [key-encryption-type {key null}] Example: Router(config-if)# ospfv3 authentication md5 0 27576134094768132473302031209727 or Router(config-if)# ipv6 ospf authentication ipsec spi 500 md5 1234567890abcdef1234567890abcdef	Specifies the authentication type for an interface.

Defining Encryption on an Interface

Prerequisites

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

SUMMARY STEPS

- enable**
- configure terminal**
- interface** *type number*
- ospfv3 encryption** {ipsec spi spi esp encryption-algorithm {key-encryption-type key} authentication-algorithm {key-encryption-type key} | null}
or
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	<p>enable</p> <p>Example: Router> enable</p>	<p>Enables privileged EXEC mode.</p> <ul style="list-style-type: none"> • Enter your password if prompted.
Step 2	<p>configure terminal</p> <p>Example: Router# configure terminal</p>	<p>Enters global configuration mode.</p>
Step 3	<p>interface <i>type number</i></p> <p>Example: Router(config)# interface ethernet 0/0</p>	<p>Specifies an interface type and number, and places the router in interface configuration mode.</p>
Step 4	<p>ospfv3 encryption {ipsec spi spi esp encryption-algorithm {<i>key-encryption-type key</i>} authentication-algorithm {<i>key-encryption-type key</i>} null}</p> <p>or</p> <p>ipv6 ospf encryption {ipsec spi spi esp encryption-algorithm [[<i>key-encryption-type key</i>] authentication-algorithm [<i>key-encryption-type key</i>] null}</p> <p>Example: Router(config-if)# ospfv3 encryption ipsec spi 1001 esp null md5 0 27576134094768132473302031209727</p> <p>or</p> <p>Router(config-if) ipv6 ospf encryption ipsec spi 1001 esp null sha1 123456789A123456789B123456789C123456789D</p>	<p>Specifies the encryption type for an interface.</p>

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 Example: Router> enable	Enables privileged EXEC mode. <ul style="list-style-type: none">• Enter your password if prompted.
Step 2	configure terminal Example: Router# configure terminal	Enters global configuration mode.
Step 3	ipv6 router ospf process-id Example: Router(config)# ipv6 router ospf 1	Enables OSPFv3 router configuration mode.
Step 4	area area-id authentication ipsec spi spi md5 [key-encryption-type] key Example: Router(config-rtr)# area 1 authentication ipsec spi 678 md5 1234567890ABCDEF1234567890ABCDEF	Enables authentication in an OSPFv3 area.

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 Example: Router> enable	Enables privileged EXEC mode. <ul style="list-style-type: none">• Enter your password if prompted.
Step 2	configure terminal Example: Router# configure terminal	Enters global configuration mode.
Step 3	ipv6 router ospf process-id Example: Router(config)# ipv6 router ospf 1	Enables OSPFv3 router configuration mode.
Step 4	area area-id encryption ipsec spi spi esp encryption-algorithm [[key-encryption-type] key] authentication-algorithm [key-encryption-type] key Example: Router(config-rtr)# area 1 encryption ipsec spi 500 esp null md5 1aaa2bbb3ccc4ddd5eee6fff7aaa8bbb	Enables encryption in an OSPFv3 area.

Defining Authentication and Encryption for a Virtual Link in an OSPFv3 Area

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ipv6 router ospf process-id**
4. **area area-id virtual-link router-id authentication ipsec spi spi authentication-algorithm** [key-encryption-type] key
5. **area area-id virtual-link router-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 Example: Router> enable	Enables privileged EXEC mode. <ul style="list-style-type: none"> Enter your password if prompted.
Step 2	configure terminal Example: Router# configure terminal	Enters global configuration mode.
Step 3	ipv6 router ospf process-id Example: Router(config)# ipv6 router ospf 1	Enables OSPFv3 router configuration mode.
Step 4	area area-id virtual-link router-id authentication ipsec spi spi authentication-algorithm [key-encryption-type] key Example: Router(config-rtr)# area 1 virtual-link 10.0.0.1 authentication ipsec spi 940 md5 1234567890ABCDEF1234567890ABCDEF	Enables authentication for virtual links in an OSPFv3 area.
Step 5	area area-id virtual-link router-id encryption ipsec spi spi esp encryption-algorithm [[key-encryption-type] key] authentication-algorithm [key-encryption-type] key Example: Router(config-rtr)# area 1 virtual-link 10.1.0.1 hello-interval 2 dead-interval 10 encryption ipsec spi 3944 esp null sha1 123456789A123456789B123456789C123456789D	Enables encryption for virtual links in an OSPFv3 area.

Configuring NBMA Interfaces in OSPFv3

You can customize OSPFv3 in your network to use NBMA interfaces. OSPFv3 cannot automatically detect neighbors over NBMA interfaces. On an NBMA interface, you must configure your neighbors manually using interface configuration mode.

Prerequisites

Before you configure NBMA interfaces, you must perform the following tasks:

- Configure your network to be an NBMA network
- Identify each neighbor

Restrictions

- You cannot automatically detect neighbors when using NBMA interfaces. You must manually configure your router to detect neighbors when using an NBMA interface.
- When configuring the **ipv6 ospf neighbor** command, the IPv6 address used must be the link-local address of the neighbor.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **interface** *type number*
4. **frame-relay map ipv6** *ipv6-address dlc* [**broadcast**] [**cisco**] [**ietf**] [**payload-compression** {**packet-by-packet** | **frf9 stac** [*hardware-options*] | **data-stream stac** [*hardware-options*]}]
5. **ipv6 ospf neighbor** *ipv6-address* [**priority number**] [**poll-interval seconds**] [**cost number**] [**database-filter all out**]

DETAILED STEPS

	Command or Action	Purpose
Step 1	enable Example: Router> enable	Enables privileged EXEC mode. <ul style="list-style-type: none"> Enter your password if prompted.
Step 2	configure terminal Example: Router# configure terminal	Enters global configuration mode.
Step 3	interface <i>type number</i> Example: Router(config)# interface serial 0	Specifies an interface type and number, and places the router in interface configuration mode.
Step 4	frame-relay map ipv6 <i>ipv6-address dlci</i> [broadcast] [cisco] [ietf] [payload-compression { packet-by-packet frf9 stac [hardware-options] data-stream stac [hardware-options]}] Example: Router(config-if)# frame-relay map ipv6 FE80::A8BB:CCFF:FE00:C01 120	Defines the mapping between a destination IPv6 address and the data-link connection identifier (DLCI) used to connect to the destination address. <ul style="list-style-type: none"> In this example, the NBMA link is frame relay. For other kinds of NBMA links, different mapping commands are used.
Step 5	ipv6 ospf neighbor <i>ipv6-address</i> [priority number] [poll-interval seconds] [cost number] [database-filter all out] Example: Router(config-if) ipv6 ospf neighbor FE80::A8BB:CCFF:FE00:C01	Configures an OSPFv3 neighboring router.

Configuring the OSPFv3 Max-Metric Router LSA

SUMMARY STEPS

- enable**
- configure terminal**
- ipv6 router ospf** *process-id*
- 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*]]
- exit**
- show ospfv3** [*process-id*] [*address-family*] **max-metric**

DETAILED STEPS

	Command or Action	Purpose
Step 1	enable Example: Router> enable	Enables privileged EXEC mode. <ul style="list-style-type: none">Enter your password if prompted.
Step 2	configure terminal Example: Router# configure terminal	Enters global configuration mode.
Step 3	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.
Step 5	exit Example: Router(config-router)# exit	Leaves the current configuration mode. <ul style="list-style-type: none">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.

Tuning LSA and SPF Timers for OSPFv3 Fast Convergence

The task can be performed in Cisco IOS Release 15.1(3)S and 15.2(1)T and later releases.

SUMMARY STEPS

- enable
- configure terminal
- router ospfv3 [process-id]
- timers lsa arrival milliseconds
- timers pacing flood milliseconds
- timers pacing lsa-group seconds

7. timers pacing retransmission *milliseconds*

DETAILED STEPS

	Command or Action	Purpose
Step 1	enable Example: Router> enable	Enables privileged EXEC mode. <ul style="list-style-type: none"> Enter your password if prompted.
Step 2	configure terminal Example: Router# configure terminal	Enters global configuration mode.
Step 3	router ospfv3 [<i>process-id</i>] Example: Router(config)# router ospfv3 1	Enables OSPFv3 router configuration mode for the IPv4 or IPv6 address family.
Step 4	timers lsa arrival <i>milliseconds</i> Example: Router(config-rtr)# timers lsa arrival 300	Sets the minimum interval at which the software accepts the same LSA from OSPFv3 neighbors.
Step 5	timers pacing flood <i>milliseconds</i> Example: Router(config-rtr)# timers pacing flood 30	Configures LSA flood packet pacing.
Step 6	timers pacing lsa-group <i>seconds</i> Example: Router(config-router)# timers pacing lsa-group 300	Changes the interval at which OSPFv3 LSAs are collected into a group and refreshed, checksummed, or aged.
Step 7	timers pacing retransmission <i>milliseconds</i> Example: Router(config-router)# timers pacing retransmission 100	Configures LSA retransmission packet pacing in IPv4 OSPFv3.

Configuring LSA and SPF Throttling for OSPFv3 Fast Convergence

The task can be performed in releases prior to Cisco IOS Release 15.1(3)S and 15.2(1)T.

SUMMARY STEPS

- enable**
- configure terminal**
- ipv6 router ospf** *process-id*
- 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 Example: Router> enable	Enables privileged EXEC mode. <ul style="list-style-type: none">• Enter your password if prompted.
Step 2	configure terminal Example: Router# configure terminal	Enters global configuration mode.
Step 3	ipv6 router ospf process-id Example: Router(config)# ipv6 router ospf 1	Enables OSPFv3 router configuration mode.
Step 4	timers throttle spf spf-start spf-hold spf-max-wait Example: Router(config-rtr)# timers throttle spf 200 200 200	Turns on SPF throttling.
Step 5	timers throttle lsa start-interval hold-interval max-interval Example: Router(config-rtr)# timers throttle lsa 300 300 300	Sets rate-limiting values for OSPFv3 LSA generation.
Step 6	timers lsa arrival milliseconds Example: Router(config-rtr)# timers lsa arrival 300	Sets the minimum interval at which the software accepts the same LSA from OSPFv3 neighbors.
Step 7	timers pacing flood milliseconds Example: Router(config-rtr)# timers pacing flood 30	Configures LSA flood packet pacing.

Enabling Event Logging

This task can be performed in Cisco IOS Release 15.1(3)S and 15.2(1)T and later releases.

SUMMARY STEPS

1. **enable**

2. **configure terminal**
3. **router ospfv3** [*process-id*]
4. **address-family ipv6 unicast**
or
address-family ipv4 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. <ul style="list-style-type: none"> • Enter your password if prompted.
Step 2	configure terminal Example: Router# configure terminal	Enters global configuration mode.
Step 3	router ospfv3 [<i>process-id</i>] Example: Router(config)# router ospfv3 1	Enables OSPFv3 router configuration mode for the IPv4 or IPv6 address family.
Step 4	address-family ipv6 unicast or address-family ipv4 unicast Example: Router(config-router)# address-family ipv6 unicast or 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 <i>number-of-events</i>] Example: Router(config-router)# event-log	Enable OSPFv3 event logging in an IPv4 OSPFv3 process.

Enabling Event Logging in Releases Prior to Cisco IOS Release 15.1(3)S and 15.2(1)T

This task can be performed in releases prior to Cisco IOS Release 15.1(3)S and 15.2(1)T.

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 Example: Router> enable	Enables privileged EXEC mode. <ul style="list-style-type: none"> • Enter your password if prompted.
Step 2	configure terminal Example: Router# configure terminal	Enters global configuration mode.
Step 3	ipv6 router ospf <i>process-id</i> Example: Router(config)# ipv6 router ospf 1	Enables OSPFv3 router configuration mode.
Step 4	event-log [size [number of events]] [one-shot] [pause] Example: Router(config-router)# event-log size 10000 one-shot	Enables event logging.

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	<code>enable</code> Example: Router> enable	Enables privileged EXEC mode. Enter your password if prompted.
Step 2	<code>clear ipv6 ospf [process-id] events</code> 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	<code>enable</code> Example: Router> enable	Enables privileged EXEC mode. <ul style="list-style-type: none"> • Enter your password if prompted.
Step 2	<code>configure terminal</code> Example: Router# configure terminal	Enters global configuration mode.
Step 3	<code>router ospfv3 [process-id]</code> Example: Router(config)# router ospfv3 1	Enables OSPFv3 router configuration mode for the IPv4 or IPv6 address family.
Step 4	<code>no compatible rfc1583</code> 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, page 39](#)
- [Enabling OSPFv3 Graceful Restart on a Graceful-Restart-Aware Router, page 41](#)

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

The task can be performed in Cisco IOS Release 15.1(3)S and 15.2(1)T 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. <ul style="list-style-type: none"> • Enter your password if prompted.
Step 2	configure terminal Example: Router# configure terminal	Enters global configuration mode.
Step 3	router ospfv3 [<i>process-id</i>] Example: Router(config)# router ospfv3 1	Enables OSPFv3 router configuration mode for the IPv4 or IPv6 address family.
Step 4	graceful-restart [restart-interval <i>interval</i>] 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 Release 15.1(3)S and 15.2(1)T.

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. <ul style="list-style-type: none">• Enter your password if prompted.
Step 2	configure terminal Example: Router# configure terminal	Enters global configuration mode.
Step 3	ipv6 router ospf <i>process-id</i> Example: Router(config)# ipv6 router ospf 1	Enables OSPFv3 router configuration mode.
Step 4	graceful-restart [<i>restart-interval interval</i>] 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 Release 15.1(3)S and 15.2(1)T 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. <ul style="list-style-type: none">• Enter your password if prompted.
Step 2	configure terminal Example: Router# configure terminal	Enters global configuration mode.
Step 3	router ospfv3 [<i>process-id</i>] 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.

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

The task can be performed in releases prior to Cisco IOS Release 15.1(3)S and 15.2(1)T.

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	<code>enable</code> Example: Router> enable	Enables privileged EXEC mode. <ul style="list-style-type: none">• Enter your password if prompted.
Step 2	<code>configure terminal</code> Example: Router# configure terminal	Enters global configuration mode.
Step 3	<code>ipv6 router ospf process-id</code> Example: Router(config)# ipv6 router ospf 1	Enables OSPFv3 router configuration mode.
Step 4	<code>graceful-restart helper {disable strict-lsa-checking}</code> Example: Router(config-rtr)# graceful-restart helper strict-lsa-checking	Enables the OSPFv3 graceful restart feature on a graceful-restart-aware router.

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. <ul style="list-style-type: none"> Enter your password if prompted.
Step 2	clear ospfv3 [<i>process-id</i>] force-spf Example: Router# clear ospfv3 1 force-spf	Runs SPF calculations for an OSPFv3 process. <ul style="list-style-type: none"> 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 [<i>process-id</i>] process Example: Router# clear ospfv3 2 process	Resets an OSPFv3 process. <ul style="list-style-type: none"> 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 [<i>process-id</i>] redistribution Example: Router# clear ospfv3 redistribution	Clears OSPFv3 route redistribution. <ul style="list-style-type: none"> 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 [<i>process-id</i>] { 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. <ul style="list-style-type: none"> 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 Release 15.1(3)S and 15.2(1)T and later releases.

SUMMARY STEPS

- enable
- show ospfv3 [*process-id*] [*address-family*] border-routers
- show ospfv3 [*process-id* [*area-id*]] [*address-family*] 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** [{**area** | **as** | **link**] [*link-state-id*]] [**adv-router** *router-id*] [**self-originate**]

4. **show ospfv3** [*process-id*] [*address-family*] **events** [**generic** | **interface** | **lsa** | **neighbor** | **reverse** | **rib** | **spf**]
5. **show ospfv3** [*process-id*] [*area-id*] [*address-family*] **flood-list** *interface-type interface-number*
6. **show ospfv3** [*process-id*] [*address-family*] **graceful-restart**
7. **show ospfv3** [*process-id*] [*area-id*] [*address-family*] **interface** [*type number*] [**brief**]
8. **show ospfv3** [*process-id*] [*area-id*] [*address-family*] **neighbor** [*interface-type interface-number*] [*neighbor-id*] [**detail**]
9. **show ospfv3** [*process-id*] [*area-id*] [*address-family*] **request-list** [*neighbor*] [*interface*] [*interface-neighbor*]
10. **show ospfv3** [*process-id*] [*area-id*] [*address-family*] **retransmission-list** [*neighbor*] [*interface*] [*interface-neighbor*]
11. **show ospfv3** [*process-id*] [*address-family*] **statistic** [**detail**]
12. **show ospfv3** [*process-id*] [*address-family*] **summary-prefix**
13. **show ospfv3** [*process-id*] [*address-family*] **timers rate-limit**
14. **show ospfv3** [*process-id*] [*address-family*] **traffic** [*interface-type interface-number*]
15. **show ospfv3** [*process-id*] [*address-family*] **virtual-links**

DETAILED STEPS

	Command or Action	Purpose
Step 1	<p>enable</p> <p>Example: Router> enable</p>	<p>Enables privileged EXEC mode.</p> <ul style="list-style-type: none"> Enter your password if prompted.
Step 2	<p>show ospfv3 [process-id] [address-family] border-routers</p> <p>Example: Router# show ospfv3 border-routers</p>	<p>Displays the internal OSPFv3 routing table entries to an ABR and ASBR.</p>
Step 3	<p>show ospfv3 [process-id [area-id]] [address-family] 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 [{area as link} [link-state-id]] [adv-router router-id] [self-originate]</p> <p>Example: Router# show ospfv3 database</p>	<p>Displays lists of information related to the OSPFv3 database for a specific router.</p>
Step 4	<p>show ospfv3 [process-id] [address-family] events [generic interface lsa neighbor reverse rib spf]</p> <p>Example: Router# show ospfv3 events</p>	<p>Displays detailed information about OSPFv3 events.</p>
Step 5	<p>show ospfv3 [process-id] [area-id] [address-family] flood-list interface-type interface-number</p> <p>Example: Router# show ospfv3 flood-list</p>	<p>Displays a list of OSPFv3 LSAs waiting to be flooded over an interface.</p>
Step 6	<p>show ospfv3 [process-idS[address-family] graceful-restart</p> <p>Example: Router# show ospfv3 graceful-restart</p>	<p>Displays OSPFv3 graceful restart information.</p>
Step 7	<p>show ospfv3 [process-id] [area-id] [address-family] interface [type number] [brief]</p> <p>Example: Router# show ospfv3 interface</p>	<p>Displays OSPFv3-related interface information.</p>

	Command or Action	Purpose
Step 8	<pre>show ospfv3 [process-id] [area-id] [address-family] neighbor [interface-type interface-number] [neighbor-id] [detail]</pre> <p>Example: Router# show ospfv3 neighbor</p>	Displays OSPFv3 neighbor information on a per-interface basis.
Step 9	<pre>show ospfv3 [process-id] [area-id] [address-family] request-list [neighbor] [interface] [interface-neighbor]</pre> <p>Example: Router# show ospfv3 request-list</p>	Displays a list of all LSAs requested by a router.
Step 10	<pre>show ospfv3 [process-id] [area-id] [address-family] retransmission-list [neighbor] [interface] [interface-neighbor]</pre> <p>Example: Router# show ospfv3 retransmission-list</p>	Displays a list of all LSAs waiting to be re-sent.
Step 11	<pre>show ospfv3 [process-id] [address-family] statistic [detail]</pre> <p>Example: Router# show ospfv3 statistics</p>	Displays OSPFv3 SPF calculation statistics.
Step 12	<pre>show ospfv3 [process-id] [address-family] summary-prefix</pre> <p>Example: Router# show ospfv3 summary-prefix</p>	Displays a list of all summary address redistribution information configured under an OSPFv3 process.
Step 13	<pre>show ospfv3 [process-id] [address-family] timers rate-limit</pre> <p>Example: Router# show ospfv3 timers rate-limit</p>	Displays all of the LSAs in the rate limit queue.
Step 14	<pre>show ospfv3 [process-id] [address-family] traffic [interface-type interface-number]</pre> <p>Example: Router# show ospfv3 traffic</p>	Displays OSPFv3 traffic statistics.
Step 15	<pre>show ospfv3 [process-id] [address-family] virtual-links</pre> <p>Example: Router# show ospfv3 virtual-links</p>	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 crypto ipsec policy** [**name** *policy-name*]
5. **show crypto ipsec sa** [**map** *map-name* | **address** | **identity** | **interface** *type number* | **peer** [*vrf fvrf-name*] **address** | **vrf** *ivrf-name* | **ipv6** [*interface-type interface-number*]] [**detail**]
6. **show ipv6 ospf** [*process-ID*] **event** [**generic** | **interface** | **lsa** | **neighbor** | **reverse** | **rib** | **spf**]

DETAILED STEPS

	Command or Action	Purpose
Step 1	<p>enable</p> <p>Example: Router> enable</p>	<p>Enables privileged EXEC mode.</p> <ul style="list-style-type: none"> Enter your password if prompted.
Step 2	<p>show ipv6 ospf [<i>process-id</i>] [<i>area-id</i>] interface [<i>interface-type interface-number</i>]</p> <p>Example: Router# show ipv6 ospf interface</p>	<p>Displays OSPFv3-related interface information.</p>
Step 3	<p>show ipv6 ospf [<i>process-id</i>] [<i>area-id</i>]</p> <p>Example: Router# show ipv6 ospf</p>	<p>Displays general information about OSPFv3 routing processes.</p>
Step 4	<p>show crypto ipsec policy [<i>name policy-name</i>]</p> <p>Example: Router# show crypto ipsec policy</p>	<p>Displays the parameters for each IPsec parameter.</p>
Step 5	<p>show crypto ipsec sa [<i>map map-name</i> address identity interface <i>type number</i> peer [<i>vrf fvrf-name</i>] address vrf ivrf-name ipv6 [<i>interface-type interface-number</i>]] [detail]</p> <p>Example: Router# show crypto ipsec sa ipv6</p>	<p>Displays the settings used by current security associations (SAs).</p>
Step 6	<p>show ipv6 ospf [<i>process-ID</i>] event [generic interface lsa neighbor reverse rib spf]</p> <p>Example: Router# show ipv6 ospf event spf</p>	<p>Displays detailed information about OSPFv3 events.</p>

Examples

- [Sample Output from the show ipv6 ospf interface Command, page 48](#)
- [Sample Output from the show ipv6 ospf Command, page 50](#)
- [Sample Output from the show crypto ipsec policy Command, page 50](#)
- [Sample Output from the show crypto ipsec sa ipv6 Command, page 50](#)
- [Sample Output from the show ipv6 ospf graceful-restart Command, page 51](#)

Sample Output from 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)
Ethernet1/0 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 10.0.0.1
    Suppress hello for 0 neighbor(s)

```

Sample Output from 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 msec
  Retransmission pacing timer 66 msec
  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 from the show crypto ipsec policy Command

The following is sample output from the **show crypto ipsec policy** command:

```

Router# show crypto ipsec policy

Crypto IPsec client security policy data

Policy name:      OSPFv3-1-1000
Policy refcount: 1
Inbound AH SPI:  1000 (0x3E8)
Outbound AH SPI: 1000 (0x3E8)
Inbound AH Key:  1234567890ABCDEF1234567890ABCDEF
Outbound AH Key: 1234567890ABCDEF1234567890ABCDEF
Transform set:   ah-md5-hmac

```

Sample Output from the show crypto ipsec sa ipv6 Command

The following is sample output from the **show crypto ipsec sa ipv6** command:

```

Router# show crypto ipsec sa ipv6

IPv6 IPsec SA info for interface Ethernet0/0

protected policy name:OSPFv3-1-1000
IPsec created ACL name:Ethernet0/0-ipsecv6-ACL

local ident (addr/prefixlen/proto/port):(FE80::/10/89/0)
remote ident (addr/prefixlen/proto/port):(::/0/89/0)
current_peer:::
  PERMIT, flags={origin_is_acl,}
  #pkts encaps:21, #pkts encrypt:0, #pkts digest:21
  #pkts decaps:20, #pkts decrypt:0, #pkts verify:20
  #pkts compressed:0, #pkts decompressed:0
  #pkts not compressed:0, #pkts compr. failed:0
  #pkts not decompressed:0, #pkts decompress failed:0
  #send errors 0, #recv errors 0

local crypto endpt. ::, remote crypto endpt. ::
path mtu 1500, media mtu 1500
current outbound spi:0x3E8(1000)

inbound ESP SAs:

inbound AH SAs:
spi:0x3E8(1000)
  transform:ah-md5-hmac ,
  in use settings ={Transport, }
  slot:0, conn_id:2000, flow_id:1, crypto map:N/R
  no sa timing (manual-keyed)
  replay detection support:N

inbound PCP SAs:

outbound ESP SAs:

outbound AH SAs:
spi:0x3E8(1000)
  transform:ah-md5-hmac ,
  in use settings ={Transport, }
  slot:0, conn_id:2001, flow_id:2, crypto map:N/R
  no sa timing (manual-keyed)
  replay detection support:N

outbound PCP SAs:

```

Sample Output from the show ipv6 ospf graceful-restart Command

The following is sample output from the **show crypto ipsec sa ipv6** 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, page 52](#)
- [Example: Defining an OSPFv3 Area Range, page 52](#)
- [Example: Defining Authentication on an Interface, page 52](#)
- [Example: Defining Authentication in an OSPFv3 Area, page 53](#)
- [Example: Configuring NBMA Interfaces Configuration, page 53](#)
- [Example: Configuring LSA and SPF Throttling for OSPFv3 Fast Convergence, page 53](#)
- [Example: Forcing SPF Configuration, page 53](#)

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 Ethernet7/0
  ipv6 address 2001:DB8:0:7::/64 eui-64
  ipv6 enable
  ipv6 ospf 1 area 1
!
interface Ethernet8/0
  ipv6 address 2001:DB8:0:8::/64 eui-64
  ipv6 enable
  ipv6 ospf 1 area 1
!
interface Ethernet9/0
  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: Defining Authentication on an Interface

The following example defines authentication on the Ethernet 0/0 interface:

```
interface Ethernet0/0
  ipv6 enable
  ipv6 ospf 1 area 0
  ipv6 ospf authentication ipsec spi 500 md5 1234567890ABCDEF1234567890ABCDEF

interface Ethernet0/0
  ipv6 enable
  ipv6 ospf authentication null
  ipv6 ospf 1 area 0
```

Example: Defining Authentication in an OSPFv3 Area

The following example defines authentication on OSPFv3 area 0:

```
ipv6 router ospf 1
router-id 10.11.11.1
area 0 authentication ipsec spi 1000 md5 1234567890ABCDEF1234567890ABCDEF
```

Example: Configuring NBMA Interfaces Configuration

The following example configures an OSPFv3 neighboring router with the IPv6 address of FE80::A8BB:CCFF:FE00:C01.

```
interface serial 0
ipv6 enable
ipv6 ospf 1 area 0
encapsulation frame-relay
frame-relay map ipv6 FE80::A8BB:CCFF:FE00:C01 120
ipv6 ospf neighbor FE80::A8BB:CCFF:FE00:C0
```

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 msec
Minimum hold time between two consecutive SPF's 10000 msec
Maximum wait time between two consecutive SPF's 10000 msec
Minimum LSA interval 5 secs
Minimum LSA arrival 1000 msec
```

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	<ul style="list-style-type: none"> “Configuring OSPF,” <i>Cisco IOS IP Routing Protocols Configuration Guide</i> Cisco IOS IP Routing Protocols Command Reference
OSPFv3 commands	Cisco IOS IPv6 Command Reference
IPv6 supported feature list	“ Start Here: Cisco IOS Software Release Specifics for IPv6 Features ,” <i>Cisco IOS IPv6 Configuration Guide</i>
Implementing basic IPv6 connectivity	“ Implementing IPv6 Addressing and Basic Connectivity ,” <i>Cisco IOS IPv6 Configuration Guide</i>
IPsec for IPv6	“ Implementing IPsec for IPv6 Security ,” <i>Cisco IOS IPv6 Configuration Guide</i>
BFD support for OSPFv3	“ Implementing Bidirectional Forwarding Detection for IPv6 ,” <i>Cisco IOS IPv6 Configuration Guide</i>
Stateful switchover	“ Stateful Switchover ,” <i>Cisco IOS High Availability Configuration Guide</i>
Cisco nonstop forwarding	“ Cisco Nonstop Forwarding ,” <i>Cisco IOS High Availability Configuration Guide</i>

Standards

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

MIBs

MIBs	MIBs Link
<ul style="list-style-type: none"> CISCO-IETF-IP-FORWARD-MIB CISCO-IETF-IP-MIB 	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	<i>OSPF version 2</i>
RFC 2401	<i>Security Architecture for the Internet Protocol</i>
RFC 2402	<i>IP Authentication Header</i>
RFC 2406	<i>IP Encapsulating Security Payload (ESP)</i>
RFC 3137	<i>OSPF Stub Router Advertisement</i>
RFC 4552	<i>Authentication/Confidentiality for OSPFv3</i>
RFC 5187	<i>OSPFv3 Graceful Restart</i>
RFC 5340	<i>OSPF for IPv6</i>
RFC 5838	<i>Support of Address Families in OSPFv3</i>

Technical Assistance

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

Feature Information for Implementing OSPFv3

Table 3 lists the features in this module and provides links to specific configuration information.

Use Cisco Feature Navigator to find information about platform support and software image support. Cisco Feature Navigator enables you to determine which software images support a specific software release, feature set, or platform. To access Cisco Feature Navigator, go to <http://www.cisco.com/go/cfn>. An account on Cisco.com is not required.


Note

Table 3 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.

Table 3 Feature Information for Implementing OSPFv3

Feature Name	Releases	Feature Information
IPv6 Routing—Fast Convergence—LSA and SPF Throttling	12.2(33)SB 12.2(33)SRC 12.2(33)XNE 15.0(1)M 15.0(1)SY	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 sections provide information about this feature: <ul style="list-style-type: none"> • Fast Convergence—LSA and SPF Throttling, page 6 • Configuring LSA and SPF Throttling for OSPFv3 Fast Convergence, page 34 • Enabling Event Logging, page 35 • Clearing the Content of an Event Log, page 37 • Example: Configuring LSA and SPF Throttling for OSPFv3 Fast Convergence, page 53
IPv6 Routing—Force SPF in OSPFv3	12.0(24)S 12.2(18)S 12.2(28)SB 12.2(15)T 12.3 12.3(2)T 12.4 12.4(2)T	This feature enables the OSPFv3 database to be cleared and repopulated, and then the SPF algorithm is performed. The following sections provide information about this feature: <ul style="list-style-type: none"> • Force SPF in OSPFv3, page 6 • Enabling OSPFv3 Graceful Restart, page 38
IPv6 Routing—Load Balancing in OSPFv3	12.0(24)S 12.2(18)S 12.2(28)SB 12.2(15)T 12.3 12.3(2)T 12.4 12.4(2)T	OSPFv3 performs load balancing automatically. The following section provides information about this feature: <ul style="list-style-type: none"> • Load Balancing in OSPFv3, page 6

Table 3 **Feature Information for Implementing OSPFv3**

Feature Name	Releases	Feature Information
IPv6 Routing—LSA Types in OSPFv3	12.0(24)S 12.2(18)S 12.2(28)SB 12.2(15)T 12.3 12.3(2)T 12.4 12.4(2)T	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. The following sections provide information about this feature: <ul style="list-style-type: none"> • How OSPFv3 Works, page 3 • LSA Types for OSPFv3, page 4
IPv6 Routing—NBMA Interfaces in OSPFv3	12.0(24)S 12.2(18)S 12.2(28)SB 12.2(15)T 12.3 12.3(2)T 12.4 12.4(2)T	On NBMA networks, the DR or backup DR performs the LSA flooding. The following sections provide information about this feature: <ul style="list-style-type: none"> • NBMA in OSPFv3, page 5 • Configuring NBMA Interfaces in OSPFv3, page 30
IPv6 Routing—OSPF for IPv6 (OSPFv3)	12.0(24)S 12.2(18)S 12.2(28)SB 12.2(25)SG 12.2(33)SRA 12.2(15)T 12.3 12.3(2)T 12.4 12.4(2)T 15.0(1)M 15.0(1)S	OSPF version 3 for IPv6 expands on OSPF version 2 to provide support for IPv6 routing prefixes and the larger size of IPv6 addresses. This entire document provides information about this feature.
IPv6 Routing—OSPF for IPv6 Authentication Support with IPsec	12.3(4)T 12.4 12.4(2)T	OSPF for IPv6 uses the IPsec secure socket API to add authentication to OSPFv3 packets. The following sections provide information about this feature: <ul style="list-style-type: none"> • OSPFv3 Authentication Support with IPsec, page 7 • Configuring IPsec on OSPFv3, page 24 • Defining Authentication on an Interface, page 25 • Defining Authentication in an OSPFv3 Area, page 27

Table 3 Feature Information for Implementing OSPFv3

Feature Name	Releases	Feature Information
IPv6 Routing—OSPF IPv6 (OSPFv3) IPsec ESP Encryption and Authentication	12.4(9)T	<p>IPv6 ESP extension headers can be used to provide authentication and confidentiality to OSPFv3.</p> <p>The following sections provide information about this feature:</p> <ul style="list-style-type: none"> • Restrictions for Implementing OSPFv3, page 2 • OSPFv3 Authentication Support with IPsec, page 7 • Defining Encryption on an Interface, page 26 • Defining Encryption in an OSPFv3 Area, page 28 • Defining Authentication and Encryption for a Virtual Link in an OSPFv3 Area, page 29
OSPFv3 Address Families	15.1(3)S 15.2(1)T	<p>The OSPFv3 address families feature enables IPv4 and IPv6 unicast traffic to be supported with a single network topology.</p> <p>The following sections provide information about this feature:</p> <ul style="list-style-type: none"> • OSPFv3 Address Families, page 3 • Configuring the OSPFv3 Router Process, page 12 • Configuring the IPv6 Address Family in OSPFv3, page 14 • Configuring the IPv4 Address Family in OSPFv3, page 17 • Configuring Route Redistribution in OSPFv3, page 20 • Enabling OSPFv3 on an Interface, page 21 • Defining an OSPFv3 Area Range for the IPv6 or IPv4 Address Family, page 22 • Example: Enabling OSPFv3 on an Interface Configuration, page 52 • Example: Defining an OSPFv3 Area Range, page 52
OSPFv3 Dynamic Interface Cost Support	12.4(15)T	<p>OSPFv3 dynamic interface cost support provides enhancements to the OSPFv3 cost metric for supporting mobile ad hoc networking.</p> <p>The following section provides information about this feature:</p> <ul style="list-style-type: none"> • OSPFv3 Cost Calculation, page 8

Table 3 Feature Information for Implementing OSPFv3

Feature Name	Releases	Feature Information
OSPFv3 External Path Preference Option	15.1(3)S 15.2(1)T	This feature provides a way to calculate external path preferences per RFC 5340. The following sections provide information about this feature: <ul style="list-style-type: none"> • OSPFv3 External Path Preference Option, page 10 • Calculating OSPFv3 External Path Preferences per RFC 5340, page 38
OSPFv3 for BFD	12.2(33)SRE 15.0(1)S 15.0(1)SY 15.1(2)T	BFD supports the dynamic routing protocol OSPFv3. The following section provides information about this feature: <ul style="list-style-type: none"> • BFD Support for OSPFv3, page 11
OSPFv3 Graceful Restart	12.2(33)SRE 12.2(33)XNE 12.2(58)SE 15.0(1)M 15.0(1)SY	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 sections provide information about this feature: <ul style="list-style-type: none"> • OSPFv3 Graceful Restart, page 11 • Enabling OSPFv3 Graceful Restart, page 38
OSPFv3 Max-Metric Router LSA	15.1(3)S 15.2(1)T	The OSPFv3 max-metric router LSA feature enables OSPF to advertise its locally generated router LSAs with a maximum metric. The following sections provide information about this feature: <ul style="list-style-type: none"> • OSPFv3 Max-Metric Router LSA, page 6 • Configuring the OSPFv3 Max-Metric Router LSA, page 32

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