Chapter 5

Configuring OSPF

This chapter provides information for configuring the Open Shortest Path First (OSPF) routing protocol on your E-series router; it contains the following sections:

Overview

OSPF is an interior gateway protocol (IGP) that runs within a single autonomous system (AS). Exterior gateway protocols (EGPs), such as Border Gateway Protocol (BGP), exchange routing information between ASs.

OSPF is a link-state routing protocol, similar to the Intermediate System–to–Intermediate System (IS-IS) routing protocol. It advertises the states of its local network links. This link advertisement distinguishes OSPF from some IGPs, such as Routing Information Protocol (RIP). A distance vector protocol, such as RIP, advertises the distances (that is, the number of hops) to each known destination within the network.

Each participating OSPF router within the AS has an identical database describing the AS's topology. Each individual piece of this database is a particular router's local state. From this database, OSPF calculates a routing table by constructing a shortest-path tree.

OSPF learns the best routes to reachable destinations. It can quickly detect changes in the topology of an AS and, after a short convergence period, calculate new loop-free routes. This protocol has been designed expressly for the TCP/IP Internet environment, including explicit support for classless interdomain routing (CIDR) and the tagging of externally derived routing information.

This chapter provides direction for customizing basic OSPF settings if you need to do so. For detailed information about the OSPF commands, see the *JUNOSe Command Reference Guide N to Z*.

OSPF Terms

Table 10 defines commonly used OSPF terms.

Table 10: OSPF-Related Terms

Term	Meaning
adjacency	The relationship between selected neighboring routers for exchanging routing information. Not every pair of neighboring routers is adjacent.
area	A collection of network segments interconnected by routers. It is a region in an OSPF routing domain.
area border router (ABR)	A router that sits on the edge of an OSPF area and routes link-state advertisements (LSAs) between areas.
area ID	A unique number that identifies an area. Typically, formatted as an IP address.

Table 10: OSPF-Related Terms (continued)

Term	Meaning
authentication	A process whereby a user or data source proves that it is what it claims to be.
authentication type	The method by which authentication is achieved—null (or none), simple, or MD5. For example, simple authentication requires a 64-bit password in each OSPF packet.
autonomous system (AS)	A set of networks or IP prefixes within a single routing policy domain.
autonomous system boundary router (AS boundary router)	An OSPF router that redistributes routing information from other routing protocol sources.
classless interdomain routing (CIDR)	An addressing method that replaces the traditional class structure of IP addresses. In CIDR, the boundary between the network and host portions of an IP address can be on any bit boundary. CIDR addresses have no class restrictions, enabling more efficient used of the IP address space. CIDR addresses are represented by a prefix and a notation that indicates the IP address and mask; for example, 10.12.8.3/16.
designated router	A designated device (OSPF router) with which other routers form adjacencies, reducing the number of adjacencies required on a broadcast or NBMA network.
domain	A collection of routers that use a common interior gateway protocol.
flooding	The distribution and synchronization of the link-state database between OSPF routers.
hello protocol	A protocol that establishes and maintains neighbor relationships and that communication between neighbors is bidirectional. The hello protocol also dynamically discovers neighboring routers on broadcast or point-to-point networks.
interior gateway protocol (IGP)	A routing protocol that routers within an AS use to exchange information.
link-state advertisement (LSA)	A unit of data that describes the local state of a router or network. LSAs are flooded throughout their respective flooding domains. For example, router LSAs are flooded within the area to which the router belongs, summary LSAs are flooded to other areas through the backbone, and external LSAs are flooded throughout the OSPF domain.

Table 10: OSPF-Related Terms (continued)

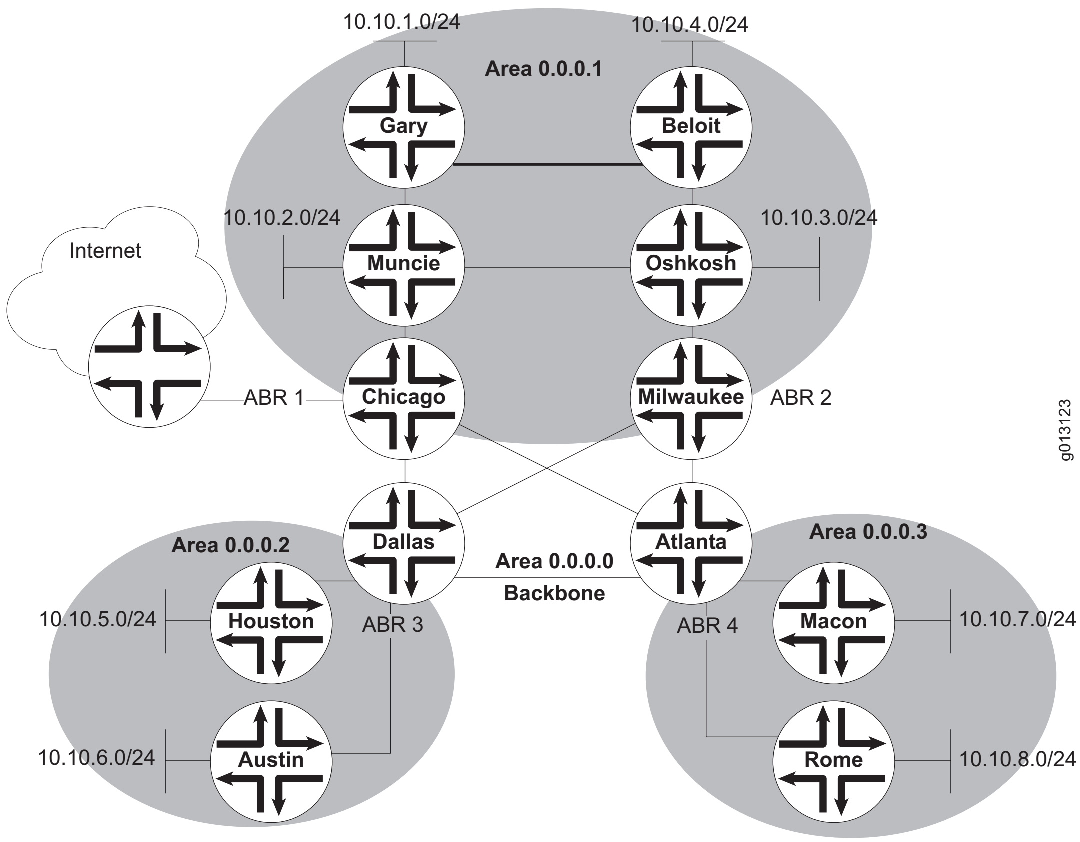
Term	Meaning
LSA types	OSPF LSAs are categorized into the following types: ■ Type 1—LSAs generated by an OSPF router for each area that it belongs to. Type 1 LSAs are flooded to only a single area. These LSAs carry information about directly connected links. Also known as router LSA. ■ Type 2—LSAs generated by an OSPF designated router to describe the set of routers in a network. Type 2 LSAs are flooded to the area that contains that network. Also known as network LSA. ■ Type 3—LSAs generated by an ABR to describe inter-area routes to networks outside of that area and internal to the AS; used for route summarization. Also known as inter-area prefix LSA. ■ Type 4—LSAs generated by an ABR to describe inter-area routes to ASBRs outside of that area and internal to the AS; used for route summarization. Also known as inter-area router LSA. ■ Type 5—LSAs generated by an ASBR to describe links that are external to the AS. Type 5 LSAs are reflooded from other protocols into OSPF, and are flooded by OSPF throughout the routing domain to all area types other than stub areas. OSPF sets the forwarding address for a type 5 LSA when the next hop is directly connected to the OSPF interface. Also known as AS-external LSA. ■ Type 6—Not supported. ■ Type 7—LSAs generated by an ASBR to describe routes that are external to an NSSA. Type 7 LSAs are flooded only to NSSAs. ■ Type 8—Not supported. ■ Type 9—Opaque LSA with a link-local scope. Type 9 LSAs are not flooded beyond the local network (local link). ■ Type 10—Opaque LSA with an area-local scope. Type-10 LSAs are not flooded beyond the borders of their associated area. ■ Type 11—Opaque LSA flooded throughout the AS. Type 11 LSAs are flooded throughout all transit areas, are not flooded into stub areas from the backbone, and are not originated by routers into their connected stub areas. Any type 11 LSA received in a stub area from a neighboring router within the stub area is rejected. ■ Link LSA—OSPFv3 LSA that Provides the router's link-local address to all other routers attached to the link; informs other routers attached to the link of a list of IPv6 prefixes to associate with the link; enables the router to assert a collection of options bits in the network LSA to be originated for the link ■ Intra-area prefix LSA—OSPFv3 LSA that associates a list of IPv6 address prefixes with a transit network link by referencing a network LSA, or associates a list of IPv6 address prefixes with a router by referencing a router LSA. The intra-area prefix LSA includes the IPv6 prefix information that OSPFv2 includes in type 1 and type 2 LSAs.
neighboring routers	Routers that have interfaces to a common network.
nonbroadcast network	A network that has no broadcast capability but supports more than two routers.
Not-so-stubby area (NSSA)	Similar to a stub area, but can also import selected external LSAs.
router ID	A 32-bit number that uniquely identifies a router within an AS; for example, 10.10.1.5.

Table 10: OSPF-Related Terms (continued)

Term	Meaning
stub area	An area that does not get flooded with external LSAs but does carry intra-area and interarea routes and a default route.
Totally stubby area	A stub area that also blocks type 3 summary LSAs from flowing into the area; however, type 3 LSAs carrying default route information alone are injected into the area.
virtual link	A logical link between two backbone routers for which the link tunnels through a nonbackbone area.

Figure 16 illustrates the topology of an OSPF routing domain.

Figure 16: OSPF Topology



Platform Considerations

For information about modules that support OSPF on the ERX-7xx models, ERX-14xx models, and the ERX-310 router:

- See *ERX Module Guide, Table 1, Module Combinations* for detailed module specifications.
- See *ERX Module Guide, Appendix A, Module Protocol Support* for information about the modules that support OSPF.

For information about modules that support OSPF on the E120 router and the E320 router:

- See *E120 and E320 Module Guide, Table 1, Modules and IOAs* for detailed module specifications.
- See *E120 and E320 Module Guide, Appendix A, IOA Protocol Support* for information about the modules that support OSPF.

References

If you need more information about the OSPF protocol, see the following documents:

- *JUNOSe Release Notes*, *Appendix A*, *System Maximums*—See the Release Notes corresponding to your software release for information about maximum values.
- OSPFv3 Graceful Restart—draft-ietf-ospf-ospfv3-graceful-restart-04.txt (November 2006 expiration)
- RFC 2328—OSPF Version 2 (April 1998)
- RFC 2370—The OSPF Opaque LSA Option (July 1998)
- RFC 2740—OSPF for IPv6
- RFC 3623—Graceful OSPF Restart (November 2003)
- RFC 3630—Traffic Engineering (TE) Extensions to OSPF Version 2 (September 2003)

NOTE: IETF drafts are valid for only 6 months from the date of issuance. They must be considered works in progress. Please refer to the IETF Web site at http://www.ietf.org for the latest drafts.

For information about the OSPF protocol working group, see http://www.ietf.org/html.charters/ospf-charter.html.

Features

The following sections provide brief descriptions of key OSPF features supported in our implementation of OSPF.

Intra-area, Interarea, and External Routes

You can split up an OSPF AS into areas. Doing this reduces the size of the link-state database (LSDB). Each OSPF area runs as a separate network and maintains its own LSDB. OSPF computes routes only to destinations within the area, and does not flood routes beyond the area boundaries.

Routing Priority

OSPF areas receive routes based on priority. Table 11 describes the routing priority.

Table 11: Routing Priority

Priority	Type	Description
1 (highest)	Intra-area	Intra-area routing. Refers to routing within a single OSPF area.
2	Interarea	Interarea routing. Refers to routing between OSPF areas within a single OSPF routing domain.
3	External	External type 1. Refers to routing from other protocols that can be imported into the OSPF domain and readvertised by OSPF as type 1 external. Type 1 metric is comparable to the link-state metric; the cost is equal to the sum of the internal costs plus the external cost.
4 (lowest)	External	External type 2. Refers to routing from other protocols that can be imported into the OSPF domain and readvertised by OSPF as type 2 external. Type 2 metric is much larger than the cost of any intra-AS path; the cost is equal to the external cost. This is the OSPF default.

If you use the **redistribute** command to import routes from other protocols or sources, the routes default to external type 2. You can specify a route map with the **redistribute** command to modify the type. Alternatively, you can use the **metric-type** keyword with the **redistribute** command to specify the type.

Virtual Links

Each OSPF area must be directly connected to the backbone area. The backbone is responsible for distributing routing information between nonbackbone areas. All routers in the backbone must be contiguous, but they need not be physically adjacent. You can configure backbone routers to be logically adjacent by creating OSPF virtual links.

Authentication

OSPF supports three modes of authentication:

- Null authentication—Implies that no authentication is in use.
- Simple password authentication—Requires a 64-bit unencrypted password in each OSPF packet.
- Cryptographic authentication—Uses a shared secret key that is configured on each router on a network. RFC 2328 defines the use of OSPF cryptographic authentication with the MD5 algorithm.

Opaque LSAs

OSPF opaque LSAs provide a generalized way of extending OSPF. The router generates opaque LSAs to carry traffic engineering information, accepts them from other routers, and floods them accordingly. OSPF uses the traffic engineering information to build a database from which paths can be computed for MPLS label-switched paths.

Route Leakage

Routes can be leaked into OSPF or from OSPF as follows:

- Route leakage into OSPF—When another routing protocol adds a new route to the routing table, or when a static route is added to the routing table, OSPF can be informed through the **redistribute** commands. When OSPF learns the new route, it floods the information into the routing domain by using external LSAs.
- Route leakage from OSPF—OSPF adds routing information to the routing table, which is used in forwarding IP packets.

Equal-Cost Multipath

OSPF inherently supports equal-cost multipath (ECMP). When building the shortest-path tree, OSPF calculates all paths of equal cost to a given destination. If equal-cost paths exist, OSPF inserts into the routing table the next hops for all equal-cost paths to a destination.

OSPF MIB

See the *JUNOSe Software CD,* shipped with your router, for complete information about the OSPF Management Information Base (MIB) supported by your router. The MIBs folder contains information about all supported standard and Juniper Networks E-series enterprise (proprietary) MIBs. OSPF does not act as a host within the router and therefore does not support the ospfIfMetric and ospfHost tables.

Interacting with Other Routing Protocols

OSPF interacts seamlessly with the following routing protocols:

- IS-IS—OSPF was developed originally from an early version of the IS-IS intradomain routing protocol. OSPF can import IS-IS routing information. See *Chapter 6, Configuring IS-IS*.
- RIP—E-series routers can simultaneously run OSPF and RIP. When doing so, OSPF routes are preferred over RIP. In general, use of the OSPF protocol is preferred because of its robustness, responsiveness, and decreased bandwidth requirements. See *Chapter 4, Configuring RIP*.
- BGP—The default expectation is that your routing environment is an AS running OSPF and exchanging BGP routes with other ASs. See *JUNOSe BGP and MPLS Configuration Guide, Chapter 1, Configuring BGP Routing*.

Implementing OSPF for IPv6

OSPF version 3 (OSPFv3) specifies IPv6 support in the OSPF protocol. Compared with OSPF version 2, the fundamental mechanisms for OSPF remain unchanged. These mechanisms include the following:

- OSPF designated router/border designated router election
- OSPF adjacency maintenance
- OSPF interface states, events, and interface state machine
- OSPF flooding mechanism
- OSPF LSA management
- SPF calculation

Understanding the OSPFv3 Difference

OSPFv3 changes the way it describes the network topology. All addressing semantics have been removed from the LSA header and from router-LSAs and network-LSAs. These two LSAs now describe the topology of the routing domain in a network-protocol-independent manner (using interface identifiers and router identifiers). New LSAs have been added to distribute IPv6 address information and data required for next-hop resolution.

In addition to the obvious address and processing modifications to handle IPv6 addressing, changes in OSPFv3 include the following:

- Authentication-related information is removed from the OSPF packet headers. Instead, OSPFv3 uses an authentication header in IPv6.
- OSPFv3 requires that each OSPF interface attached to a link be assigned a link-local unicast address.
- The option field for hello packets, database description (DD) packets, and LSAs has been expanded from 8 bits to 24 bits. In addition, two new LSA types have been added—link LSAs and intra-area prefix LSAs.

- The LSA flooding scope is more explicit in OSPFv3 and now appears in the LS type field. The LS type field also encodes a specific action to take for unknown LS types, allowing OSPF to function with unknown LS types instead of simply discarding them.
- The flooding process is modified to manage unrecognized LSAs and the new LSA flooding scope.
- The route calculation has been updated to handle modifications in the LSA database.

Supported LSA Types

OSPFv3 supports the following LSA types:

- Router LSA—Describes link state and costs of router links to the area; flooded within an area only
- Network LSA—Originated by the designated router for every broadcast or nonbroadcast multiaccess (NBMA) link having two or more attached routers; lists all routers attached to the link
- Interarea prefix LSA—Known as the type-3 summary LSA in OSPFv2; describes a prefix external to the area, yet internal to the AS
- Interarea router LSA—Called type 4 summary-LSAs in OSPFv2; describes a path to a destination OSPF router (that is, an AS boundary router) that is external to the area, yet internal to the AS
- AS-external LSA—Describes a path to a prefix external to the AS
- Link LSA (new for OSPFv3)—Provides the router's link-local address to all other routers attached to the link; informs other routers attached to the link of a list of IPv6 prefixes to associate with the link; enables the router to assert a collection of options bits in the Network-LSA to be originated for the link
- Intra-area prefix LSA (new for OSPFv3)—Associates a list of IPv6 address prefixes with a transit network link by referencing a network LSA, or associates a list of IPv6 address prefixes with a router by referencing a router LSA

An LSA in OSPFv3 is still identified by its type, link-state ID, and the advertising router ID. However, the link-state ID (for all LSA types) no longer carries IP address information. Instead, the LSA carries either an arbitrarily assigned number or an interface ID.

The link-state ID always has a fixed length of 4 bytes. The LS type field is extended to 16 bits and encodes LSA flooding scope and specific actions to take when the router encounters unrecognized LS types.

An IPv6 address, if it is specified in an LSA, is represented by its prefix length, prefix options, and prefix address.

Unsupported OSPF Components

This release does not support the following OSPF components when implementing OSPF for IPv6:

- Virtual link
- Not-so-stubby-area (NSSA)
- Nonbroadcast multiaccess (NBMA)
- Remote neighbor
- Traffic engineering extensions
- SNMP traps
- Features specified in “OSPF as the PE/CE Protocol in BGP/MPLS IP VPNs” (draft-ietf-l3vpn-ospf-2547)

Configuration Tasks

Configuring OSPF requires careful coordination among a variety of routing devices:

- Routers internal to a single area
- Routers that link multiple areas within a single routing domain; these routers are called area border routers (ABRs)
- Routers that link multiple routing domains; these routers are called autonomous system boundary routers (AS boundary routers)

To minimally configure OSPF, you must:

1. Enable OSPF.
2. Configure and aggregate network ranges.
3. Create the router’s OSPF network interfaces.
4. Define the OSPF areas attached to the router.

The following sections describe how to perform these tasks.

Starting OSPF

You enable OSPFv2 and OSPFv3 differently. When you enable OSPFv2 on your router, you can create either a range of OSPFv2 interfaces or a single OSPFv2 interface. When enabling OSPFv3, you create the OSPFv3 interface and assign the interface to an area.

Enabling OSPFv2

You can create OSPFv2 interfaces in the following ways:

- You can issue the **network area** command, which creates OSPF interfaces for all IP interfaces with IP addresses within the specified range.
- You can issue the **address area** command, which creates an OSPF interface in the specified area that sits on top of the IP interface at the given IP address (or on the unnumbered interface, if that is specified).

NOTE: Do not enable OSPF on any unidirectional interfaces (such as an MPLS tunnel), because it can never form an adjacency.

You can delete OSPFv2 interfaces in the following ways:

- You can issue the **no network area** command, which deletes all OSPF interfaces within the specified range.
- If the OSPF interface was created with the **address area** command, you can issue the **no address area** command to delete the specified interface.
- You can issue the **no ip address** command to delete the IP interface associated with the OSPF interface and also the OSPF interface itself.

NOTE: If an OSPF interface is configured on top of an IP interface and you delete the IP interface, the corresponding OSPF interface is also deleted. The previously configured network range, however, is not deleted. You must issue the **no network area** command to delete the range.

Enabling OSPFv3

NOTE: Before you can enable OSPFv3, you must specify an IPv6 license key. For additional information about configuring an IPv6 license key, see *Configuring an IPv6 License* on page 126.

OSPFv3 provides IPv6 support in the OSPF protocol. To enable OSPFv3:

1. Issue the **ipv6 router ospf** command, and specify a process ID.
2. Use the **router id** command to specify a router ID for OSPFv3.

   See *Specifying an OSPF Router ID* on page 244.
3. Issue the **ipv6 ospf area** command (in interface configuration mode) to create an OSPFv3 interface under an area ID.

You can delete OSPFv3 interfaces in the following ways:

- You can issue the **no ipv6 router ospf** command, which deletes OSPFv3.
- You can issue the **no ipv6 ospf area** command to remove the OSPF interface from a specific area.

Creating a Range of OSPF Interfaces

To create a range of OSPFv2 interfaces:

1. Create an OSPF routing process.
2. Create the range of IP addresses associated with the routing process and the corresponding OSPF interfaces.
3. Assign an area ID associated with each range of IP addresses.

Each router running OSPFv2 has a database describing a map of the routing domain. This map needs to be identical in all participating routers.

network area

- Use to configure a range of OSPFv2 interfaces and their related area.
- If the specified range matches one or more of the IP addresses configured for IP interfaces, one or more corresponding OSPF interfaces are created and placed in the specified area.
- Create address ranges that do not overlap; you can attach only the same range of interfaces to a single area.
- You cannot use this command for unnumbered interfaces.
- If the range specified by this command includes an address on an interface that is being referred to by unnumbered interfaces, all of the unnumbered interfaces begin trying to form adjacencies. If this behavior is not intended, you must reevaluate the interface assignment or the range specified by the command.

- Example 1—shows the creation of one OSPF interface in the backbone area

  host1(config-if)#**ip address 2.2.2.1 255.255.0.0**
  host1(config-if)#**ip address 2.2.1.1 255.255.0.0 secondary**
  host1(config)#**router ospf 2**
  host1(config-router)#**network 2.2.2.0 0.0.0.255 area 0**

- Example 2—shows the creation of two OSPF interfaces, one in the backbone area and one in a non-backbone area

  host1(config-if)#**ip address 2.2.2.1 255.255.255.0**
  host1(config-if)#**ip address 2.2.1.1 255.255.255.0 secondary**
  host1(config)#**router ospf 2**
  host1(config-router)#**network 2.2.2.0 0.0.0.255 area 0**
  host1(config-router)#**network 2.2.1.0 0.0.0.255 area 1**

  This sequence of commands creates two OSPF ranges (2.2.2.0/24 and 2.2.1.0/24), with each range belonging to a different area. Area 0 is configured for 2.2.2.0/24, and area 1 is configured for 2.2.1.0/24. This sequence also creates two OSPF interfaces: one in the backbone area (area 0) using IP address 2.2.2.1, the second in a nonbackbone area (area 1) using IP address 2.2.1.1. This command also creates the two areas if they do not already exist.

- Use the **no** version to delete OSPF interfaces, ranges, and areas.

NOTE: Until you activate the configured network range for summaries by issuing the **area range** command, the range is not active for summarization; the network range is summarized through area summaries—for ABRs only. (See *Aggregating OSPF Networks* on page 244.) The only range that is active by default if you do not issue the **area range** command is the network that matches the IP interface's network exactly. (In other words, by default the exact network of the IP interface is going to be summarized into other areas.)

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ospf enable

- Use to enable OSPF on the router.
- OSPF is enabled by default.
- Example

  host1(config-router)#**ospf enable**

- The **no** version of this command is deprecated and may be removed in a future release. Use the **ospf shutdown** command to disable OSPF on the router.

router ospf
ipv6 router ospf

- Use to set an OSPF process ID.
- The process ID can be any positive integer in the range 1–65535.
- You must assign a unique ID for the OSPF routing process.
- From a virtual router context you can specify a VRF name (OSPFv2 only). Doing so changes the context to that of the specified VRF and remains so until you exit from the OSPFv2 router context.

- Example 1

  host1(config)#**router ospf 5**

- Example 2

  host1(config)#**ipv6 router ospf 5**

- Use the **no** version to end the designated OSPF routing process.

Creating a Single OSPFv2 Interface

To create a single OSPFv2 interface:

1. Create an OSPF routing process.
2. Create the OSPF interface associated with the IP interface at the specified address.

Each router running OSPF has a database describing a map of the routing domain. This map needs to be identical in all participating routers.

address area

- Use to create an interface in an area on which OSPFv2 runs, on top of the IP interface at the specified IP address.
- You can specify either an IP address or an unnumbered interface.
- Configures OSPFv2 with the default values. You can configure the interface with a nondefault value by using the other **address** commands. You must first issue the **address area** command before issuing any other **address** commands. See *Configuring OSPF Interfaces* on page 246 for more information.
- Example

  host1(config-router)#**address 10.10.32.100 area 0.0.0.0**

- Use the **no** version to delete the OSPFv2 interface.

ospf enable

- Use to enable OSPF on the router.
- OSPF is enabled by default.
- Example

  host1(config-router)#**ospf enable**

- The **no** version of this command is deprecated and might be removed in a future release. Use the **ospf shutdown** command to disable OSPF on the router.

router ospf

- Use to set an OSPF process ID.
- The process ID can be any positive integer in the range 1–65535.
- You must assign a unique ID for each OSPF routing process.
- Example

  host1(config)#**router ospf 5**

- Use the **no** version to end the designated OSPF routing process.

Specifying an OSPF Router ID

The router ID is typically derived by each router from its interface IP addresses. However, you can use the **router-id** command to specify a different router ID for OSPF.

NOTE: You must specify a router ID to enable OSPFv3.

router-id

- Use to specify a different IP address for the router to use as the OSPF router ID.
- Example

  host1(config-if)#**router-id 192.168.50.5**

- Use the **no** version to force OSPF to use the previous OSPF router ID behavior.

Aggregating OSPF Networks

You can aggregate OSPF networks at the border of an OSPF area by using the **area range** command. You can also aggregate OSPF networks when entering the border of the OSPF domain by using the **summary-address** command for IP routes and the **summary-prefix** command for IPv6 routes.

To create an area range:

1. Configure the interface's IP addresses using the **ip address** command.
2. Enable OSPF using the **router ospf** command.
3. Configure the network area with the **network area** command.
4. Configure the area range with the **area range** command.

area range

- Use to aggregate OSPF routes at an OSPF area border.
- Use only for ABRs.
- You can configure multiple instances of the **area range** command for a single OSPF area.

- By default, the range of configured networks is advertised in type 3 (summary) LSAs.
- Use the **advertise** keyword (IPv6 only) to specify advertisement of configured networks.
- Use the **do-not-advertise** keyword to prevent advertisement of configured networks.
- Use the **cost** keyword (IPv6 only) to define the cost value (0–16777215) for the specified range of networks.
- Use the command **no area** *area-id* (with no other keywords) to remove the specified area from the configuration.
- Use the **summary-address** or **summary-prefix** command to summarize external routes being redistributed into OSPF.
- Example

  host1(config-if)#**ip address 2.2.10.1 255.255.255.0**
  host1(config-if)#**ip address 2.2.11.1 255.255.255.0 secondary**
  host1(config)#**router ospf 2**
  host1(config-router)#**network 2.2.0.0 0.0.255.255 area 0**

  At this point, the OSPF process is configured with two OSPF interfaces. If your router is an ABR, two networks must be summarized: 2.2.10.0/24 and 2.2.11.0/24.

  host1(config-router)#**area 0 range 2.2.0.0 255.255.0.0**

  After you enter this **area range** command, only the aggregated range 2.2.0.0/16 is going to be summarized.

- Use the **no** version to disable the aggregation of routes at the OSPF area border.

summary-address
summary-prefix

- Use to aggregate external routes at the border of the OSPF routing domain.
- Use the **summary-address** command for IP routes. Use the **summary-prefix** command for IPv6 routes.
- Use only for AS boundary routers.
- The AS boundary router advertises one external route as an aggregate for all redistributed routes that are covered by the address.
- For OSPF, these commands summarize only routes from other routing protocols that are being redistributed into OSPF.
- With these commands, you can reduce the load of advertising many OSPF external routes by specifying a range that includes some (or all) of these external routes.
- Example

  host1(config-router)#**summary-address 10.1.0.0 255.255.0.0**

- Use the **area range** command for route summarization between OSPF areas.
- Use the **no** version to restore the default.

Configuring OSPF Interfaces

You can configure OSPF attributes for either a single OSPF network by using the **address** commands, or for all OSPF networks on a particular media interface by using the **ip ospf** commands.

The size of the OSPF maximum transmission unit (MTU) is negotiated rather than configured. OSPF database description exchange uses the interface MTU to signal the largest OSPF MTU that can be sent over an OSPF interface without fragmentation.

Configuring OSPF attributes for OSPF networks includes setting the following:

- Cost
- Dead interval
- Hello interval
- Router priority
- Retransmit interval
- Transmit delay

NOTE: Before using the **address** or **ip ospf** commands, see *Precedence of Commands* on page 253 for information about the relationship between these commands.

address Commands

You can use the **address area** command to create a new OSPF interface. Use the other **address** commands to configure parameters for OSPF interfaces that already exist.

The **address** commands configure OSPF attributes for a single OSPF network. The **ip ospf** commands configure OSPF attributes for all OSPF networks in the given interface context—for example, in a multinet environment where multiple IP networks sit on top of an Ethernet interface.

NOTE: You must first issue the **address area** command before issuing any other **address** command.

address area

- Use to create a new OSPF interface and configure the area ID.
- The interface can have an IP address, or it can be unnumbered.
- Example

  host1(config-router)#**address 10.12.10.2 area 3**

- You must first issue the **address area** command before issuing any other **address** commands.
- Use the **no** version to delete the area ID from the specified interface.

address cost

- Use to specify the cost metric for the interface. The cost is used in calculating the SPF routing table and can be in the range 0–65535.
- The interface can have an IP address, or it can be unnumbered.
- Example

  host1(config-router)#**address unnumbered atm 4/0.1 area 3**
  host1(config-router)#**address unnumbered atm 4/0.1 cost 50**

- Use the **no** version to reset the path cost to the default value, 1.

address dead-interval

- Use to specify the time period for the router's neighbors to wait without seeing hello packets from the router before they declare the router to be down.
- The dead interval can be in the range 0–2147483647 seconds, and is advertised by the router's hello packets.
- For the OSPF routers to become adjacent, the dead interval must be identical on each router.
- The interface can have an IP address, or it can be unnumbered.
- Example

  host1(config-router)#**address 192.168.10.32 area 6**
  host1(config-router)#**address 192.168.10.32 dead-interval 60**

- Use the **no** version to reset the dead interval to the default value, 40 seconds.

address hello-interval

- Use to specify the interval between hello packets that the router sends on the interface.
- The hello interval can be in the range 1–65535 seconds.
- The interface can have an IP address, or it can be unnumbered.
- Example

  host1(config-router)#**address 192.168.1.1 area 5**
  host1(config-router)#**address 192.168.1.1 hello-interval 25**

- Use the **no** version to reset the hello interval to the default value, 10 seconds.

address passive-interface

- Use to disable the transmission of routing updates on the interface, meaning that OSPF routing information is neither sent by nor received through the interface.
- The interface can have an IP address, or it can be unnumbered.
- Example

```
host1(config-router)#address 192.168.100.20 area 5
host1(config-router)#address 192.168.100.20 passive-interface
```

- Use the **no** version to reenable the transmission of routing updates.

address priority

- Use to specify the router priority, an 8-bit number in the range 1–255. Used in determining the designated router for the particular network.
- Applies only to nonbroadcast multiaccess (NBMA) networks. Every broadcast and NBMA network has a designated router.
- The interface can have an IP address, or it can be unnumbered.
- Example

```
host1(config-router)#address unnumbered loopback 0 area 6
host1(config-router)#address unnumbered loopback 0 priority
```

- Use the **no** version to restore the default value, 1.

address retransmit-interval

- Use to specify the time between LSA retransmissions for the interface when an acknowledgment for the LSA is not received.
- Specify an interval in the range 0–3600 seconds; the default value is 5.
- The interface can have an IP address, or it can be unnumbered.
- Example

```
host1(config-router)#address 192.168.10.200 area 6
host1(config-router)#address 192.168.10.200 retransmit-interval 500
```

- Use the **no** version to restore the default value, 5 seconds.

address transmit-delay

- Use to specify the estimated time it takes to transmit a link-state update packet on the interface.
- Specify an interval in the range 0–3600 seconds; the default value is 1.
- The interface can have an IP address, or it can be unnumbered.
- Example

```
host1(config-router)#address 10.100.25.38 area 7
host1(config-router)#address 10.100.25.38 transmit-delay 30
```

- Use the **no** version to restore the default value, 1 second.

ip ospf and ipv6 ospf Commands

The **ip ospf** commands have two effects on interface configuration. These effects apply to all **ip ospf** commands:

- Configuration per logical IP interface (for example, Fast Ethernet 0/1.3 or ATM 5/0.1):

  The **ip ospf** command configures the specified OSPF parameters for all networks configured on the given IP interface—for example, all multinetted addresses on an interface.

  The **no** version of the command resets the specified parameters to *unspecified*.

  If the **no** version of the command takes effect for a specified IP interface, there is no default value for the specified parameters. The parameter is set back to unspecified values. However, the value of the specified parameter for the OSPF interface is set back to the default value or the value previously specified by the **address** command.

NOTE: The **ip ospf** commands configure OSPF attributes for all OSPF networks in the given interface context—for example, in a multinet environment where multiple IP networks sit on top of an Ethernet interface. The **address** commands configure OSPF attributes for a single OSPF interface.

- Configuration per OSPF interface:

  The **ip ospf** command configures the specified OSPF parameters for *each* OSPF interface that sits on top of the IP interface.

  The **no** version of the command restores the specified parameters to the default values.

NOTE: We recommend using **address** commands to set attributes of OSPF interfaces created using the **address area** command.

---

ipv6 ospf area

- Use to create an OSPFv3 interface under the specified area ID or move the OSPFv3 interface from its current area to the specified area.
- Specify an optional process ID in the range 1–65535.
- Example

  host1(config)#**interface fastethernet 0/0**
  host1(config-if)#**ipv6 ospf area 50**

- Use the **no** version to remove this interface from the specified area.

ip ospf cost
ipv6 ospf cost

- Use to configure the cost of sending a packet on the network.
- Cost is a metric value in the range 0–65535; the default value is 1.
- The router LSA advertises the link-state metric as the link cost.
- For the IPv6 command, you can specify an optional process ID in the range 1–65535.
- Example 1

  host1(config)#**interface fastethernet 0/0**
  host1(config-if)#**ip ospf cost 50**

- Example 2

  host1(config)#**interface fastethernet 0/0**
  host1(config-if)#**ipv6 ospf cost 50**

- Use the **no** version to reset the path cost to the default value, 1.

ip ospf dead-interval
ipv6 ospf dead-interval

- Use to configure the interval since the last hello packet was seen.
- Specify an interval in the range 0–2147483647 seconds; the default value is 40 seconds.
- For the OSPF routers to become adjacent, the dead interval must be identical on each router.
- The router's hello packets advertise this interval.
- For the IPv6 command, you can specify an optional process ID in the range 1–65535.
- Example 1

  host1(config-if)#**ip ospf dead-interval 60**

- Example 2

  host1(config-if)#**ipv6 ospf dead-interval 60**

- Use the **no** version to restore the default value, 40 seconds.

ip ospf hello-interval
ipv6 ospf hello-interval

- Use to configure the interval between hello packets.
- Specify an interval in the range 1–65535 seconds; the default value is 10 seconds.
- For the OSPF routers to become adjacent, the hello interval must be identical on each router.
- For the IPv6 command, you can specify an optional process ID in the range 1–65535.

- Example 1

  host1(config-if)#**ip ospf hello-interval 8**

- Example 2

  host1(config-if)#**ipv6 ospf hello-interval 8**

- Use the **no** version to restore the default value, 10 seconds.

ipv6 ospf mtu-ignore

- Use to specify that the interface disregard the MTU size contained in the data description packet.
- When enabled, the interface accepts data description packets from its neighbor even if it has a different MTU size (the MTU size must be less than 18000).
- Specify an optional process ID in the range 1–65535.
- Example

  host1(config-if)#**ipv6 ospf mtu-ignore**

- Use the **no** version to reset the default: that the neighbor MTU size must match the MTU size of the OSPFv3 interface from which the packet is received.

ipv6 ospf network

- Use to configure the OSPF network type for an interface.
- Specify a network type (broadcast or point-to-point) for the interface.
- Example

  host1(config)#**interface fastethernet 0/0**
  host1(config-if)#**ipv6 ospf network broadcast**

- Use the **no** version to revert the network type to the default for the interface.

ip ospf priority
ipv6 ospf priority

- Use to configure the router's priority.
- Select a priority level in the range 0–255; the default value is 1.
- This setting determines the designated router for the particular network.
- A router whose priority is set to 0 cannot be a designated router.
- Configure priority only for interfaces to multiaccess networks.
- For the IPv6 command, you can specify an optional process ID in the range 1–65535.

- Example 1

  host1(config-if)#**ip ospf priority 2**

- Example 2

  host1(config-if)#**ipv6 ospf priority 2**

- Use the **no** version to restore the default value, 1.

ip ospf retransmit-interval
ipv6 ospf retransmit-interval

- Use to configure the time interval between retransmission of an LSA.
- Specify an interval in the range 0–3600 seconds; the default value is 5 seconds.
- For the IPv6 command, you can specify an optional process ID in the range 1–65535.
- Example 1

  host1(config-if)#**ip ospf retransmit-interval 10**

- Example 2

  host1(config-if)#**ipv6 ospf retransmit-interval 10**

- Use the **no** version to return to the default value, 5 seconds.

ip ospf transmit-delay
ipv6 ospf transmit-delay

- Use to configure the time it takes to transmit a link-state update on the interface.
- This is the time between transmissions of LSAs.
- Specify an interval in the rang 0–3600 seconds; the default value is 1 second.
- In setting the time, consider the interface's transmission and propagation delays.
- For the IPv6 command, you can specify an optional process ID in the range 1–65535.
- Example 1

  host1(config-if)#**ip ospf transmit-delay 4**

- Example 2

  host1(config-if)#**ipv6 ospf transmit-delay 4**

- Use the **no** version to return to the default value, 1 second.

Comparison Example

In the following example you configure a range of OSPF interfaces with the **network area** command.

```
host1(config)#interface fastEthernet 0/0
host1(config-if)#ip address 1.1.1.1 255.255.255.0
host1(config-if)#ip address 2.2.2.2 255.255.255.0 secondary
host1(config-if)#exit
host1(config)#router ospf 1
host1(config-router)#network 1.1.1.0 0.0.0.255 area 0
host1(config-router)#network 2.2.2.0 0.0.0.255 area 0
```

If you want to specify the cost, you can do so for both interfaces simultaneously.

```
host1(config)#interface fastEthernet 0/0
host1(config-if)#ip ospf cost 30
```

You can use **address** commands to create a third OSPF interface over the Ethernet interface. When you specify a cost, you set it for only that interface.

```
host1(config)#interface fastEthernet 0/0
host1(config-if)#ip address 3.3.3.3 255.255.255.0 secondary
host1(config-if)#exit
host1(config)#router ospf 1
host1(config-router)#address 3.3.3.3 area 0
host1(config-router)#address 3.3.3.3 cost 25
```

Precedence of Commands

For a single OSPF interface, when you modify the same OSPF attribute by issuing both the **ip ospf** command and the **address** command, the value configured with the **address** command takes precedence. In other words, the most specific command for a single OSPF interface takes precedence.

Consider the following example. Suppose you have a numbered IP interface with an IP address of 10.10.1.1/24 sitting on top of Fast Ethernet interface 0/0. Configure a single OSPF interface on top of the IP interface.

```
host1(config)#router ospf 100
host1(router-config)#address 10.10.1.1 area 0
```

The default cost for this OSPF interface is 10. Change the cost for this OSPF interface by using the **address cost** command.

```
host1(router-config)#address 10.10.1.1 cost 45
```

The cost for OSPF interface 10.10.1.1 is now 45.

Now use the **ip ospf cost** command to change the cost for this OSPF interface.

```
host1(config)#int fastEthernet 0/0
host1(config-if)#ip ospf cost 23
```

The cost of OSPF interface 10.10.1.1 does *not* change. The previously issued **address cost** command is more specific for the interface and takes precedence over the **ip ospf cost** command. You must use the **address cost** command if you want to change the cost again.

host1(router-config)#**address 10.10.1.1 cost 23**

Configuring OSPF Areas

You can divide your OSPF routing domain into OSPF areas. Dividing into areas provides the following benefits:

- Reduces resource demands placed on routers and links
- Reduces the router CPU usage by the OSPF routing calculation
- Reduces the amount of memory used for link-state databases
- Hides subnets within areas from the rest of the routing domain
- Increases routing security within the area

You must attach each area in your routing domain to an area called the backbone area (0.0.0.0).

Disadvantages of using OSPF areas include the following:

- Areas hide information, which can result in less-than-optimal data paths.
- Creating areas complicates the task of configuring OSPF routing domains.

You can optionally define an area to be a stub area, totally stubby area, or a not-so-stubby area. You can configure virtual links for areas that are not directly connected to a backbone area.

area default-cost

- Use to configure the cost for the default summary route sent into a stub area.
- Cost is a metric value in the range 1–65535; the default value is 1.
- Use only on an ABR attached to a stub area.
- Provides the metric for the summary default route that the ABR generates into the stub area.
- Example

  host1(config-router)#**area 47.0.0.0 default-cost 1**

- Use the **no** version to remove the configured default route cost.

area nssa

- Use to configure the area as an NSSA.
- You must configure each router in a stub area as belonging to the stub area.
- An NSSA is like a stub area, but it can also import external AS routes in a limited way.
- To cause NSSA border routers to generate a type 7 default LSA in the OSPF database if there is a default route in the routing table, you must specify the **default-information-originate** option.
- You can specify a metric cost, metric type, or a route map to be applied to the generated type 7 default LSAs.
- Use the **no-summary** keyword to create a "totally stubby area" and restrict type 3 summary LSAs from flowing into the area. However, type 3 default-route LSAs can continue to flow into the area and a type 3 default-route LSA is advertised into the NSSA.

NOTE: We recommend that you do not use the **default-information-originate** keyword with the **no-summary** keyword for an NSSA.

- Example

  host1(config-router)#**area 35.0.0.0 nssa**

- Use the **no** version to remove the NSSA designation from the area, to stop the generation of type 7 default LSAs, to reinitiate type 3 summary LSAs into the area (with the **no-summary** keyword), or to stop the application of the specified metric cost, metric type, or a route map to the type 7 default LSAs.

area stub

- Use to configure a stub area. Stub areas do not get flooded with external LSAs but do carry a default route, intra-area routes, and interarea routes. The lack of flooding in stub areas reduces the size of the OSPF database for the area and decreases memory usage for external routers in the stub area.
- You must configure each router in a stub area as belonging to the stub area.
- You cannot configure virtual links across a stub area.
- Stub areas cannot contain AS boundary routers.
- Use the **no-summary** keyword to create a "totally stubby area" and restrict type 3 summary LSAs from entering the stub area. However, type 3 default-route LSAs can continue to flow into the area.
- Example

  host1(config-router)#**area 47.0.0.0 stub**

- Use the **no** version to disable this function.

area virtual-link

- Use to configure an OSPF virtual link.
- A virtual link is used for areas that do not have a direct connection to the backbone area.
- To have configured virtual links, the router itself must be an ABR.
- Virtual links are identified by the router ID of the other endpoint, which is also an ABR.
- The two endpoint routers must be attached to a common area, called the virtual link's transit area.
- Virtual links are part of the backbone and behave as if they were unnumbered point-to-point networks between the two routers.
- A virtual link uses the intra-area routing of its transit area to forward packets.
- Example

  host1(config-router)#**area 27.0.0.0 virtual-link 27.8.4.2**

- Use the **no** version to remove an OSPF virtual link.

area virtual-link dead-interval

- Use to set the time in seconds to wait before declaring a neighbor down after not receiving packets from that neighbor.
- Specify an interval in the range 0–2147483647 seconds; the default value is 40 seconds.
- Example

  host1(config-router)#**area 27.0.0.0 virtual-link 27.8.4.2 dead-interval 10**

- Use the **no** version to remove the virtual link's dead interval.

area virtual-link hello-interval

- Use to configure the hello interval on an OSPF virtual link.
- Specify an interval in the range 1–65535 seconds; the default value is 10 seconds.
- The hello interval is the time between the transmission of hello packets.
- The hello interval must be the same for all routers attached to a common network.
- Example

  host1(config-router)#**area 27.0.0.0 virtual-link 27.8.4.2 hello-interval 10**

- Use the **no** version to remove the virtual link's hello interval.

area virtual-link retransmit-interval

- Use to configure the retransmission interval on an OSPF virtual link.
- The retransmit interval is the time between retransmissions of link-state advertisements for adjacencies belonging to the interface.
- Specify an interval in the range 0–3600 seconds; the default value is 5 seconds.
- Set the value greater than the expected round-trip delay.
- Example

  host1(config-router)#**area 27.0.0.0 virtual-link 27.8.4.2 retransmit-interval 6**

- Use the **no** version to remove the interface's retransmit interval.

area virtual-link transmit-delay

- Use to configure the estimated time it takes to transmit a link-state update packet on the virtual link.
- Specify an interval in the range 0–3600 seconds; the default value is 1 second.
- Example

  host1(config-router)#**area 27.0.0.0 virtual-link 27.8.4.2 transmit-delay 1**

- Use the **no** version to remove the interface's transmit delay.

automatic-virtual-link

- Use to enable an automatic virtual link configuration.
- If this feature is enabled, then backbone connectivity is ensured by the automatic creation of a virtual link between this backbone router that has an interface to a common nonbackbone area and other backbone routers that have interfaces to a common nonbackbone area.
- Example

  host1(config-router)#**automatic-virtual-link**

- Use the **no** version to disable an automatic virtual link.

no area

- Use to remove the specified area only if no OSPF interfaces are configured in the area.
- Example

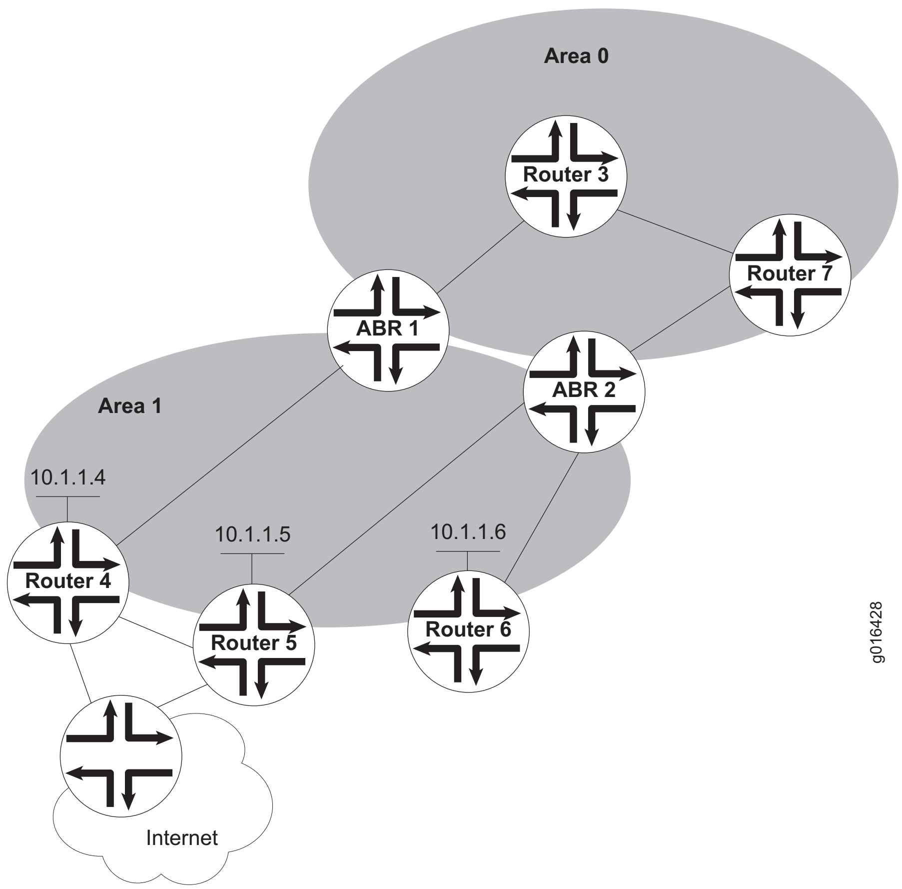
  host1(config-router)#**no area 47.0.0.0**

- There is no affirmative version of this command; there is only a **no** version.

Optimizing the Cost to Reach a Range of OSPF Routers Within an Area

OSPF automatically calculates a cost for an area based on the individual costs from an area border router to each OSPF router within that area. The highest individual cost is advertised by the area border router as the aggregate cost for routers in an adjacent area to reach any router within the first area. Consider the topology shown in Figure 17 on page 258.

Figure 17: Optimizing OSPF Area Aggregate Costs



In this example, the router IDs of the OSPF routers in area 1 are announced by OSPF into area 0. ABR 1 and ABR 2 aggregates the 10.1.1.x networks in area 1 at the border. Each individual OSPF link has a cost of 1.

ABR 1 calculates the following costs:

- A cost of 5 to reach Router 6:
  ABR 1-- > Router 4-- > Router 5-- > ABR 2-- > Router 6
- A cost of 3 to reach Router 5:
  ABR 1-- > Router 4-- > Router 5
- A cost of 2 to reach Router 4:
  ABR 1- > Router 4

The highest individual cost is 5. ABR 1 subsequently advertises a cost of 5 for the aggregate 10.1.1.0 to be announced into area 0.

ABR 2 calculates the following costs:

- A cost of 2 to reach Router 6:
  ABR 2-->Router 6

- A cost of 2 to reach Router 5:
  ABR 2-->Router 5

- A cost of 3 to reach Router 4:
  ABR 2-->Router 5-->Router 4

The highest individual cost is 3. ABR 2 subsequently calculates a cost of 3 for the aggregate 10.1.1.0 to be announced into area 0.

When Router 3 sends traffic to Router 4, it routes the traffic via ABR 2 because ABR 2 advertises a lower cost than does ABR 1. However, this path is not optimal, because the traffic must traverse Router 3-->Router 7-->ABR 2--> Router 5-->Router 4. The path through ABR 1, Router 3-->ABR 1-->Router 4 is a better path, even though ABR 1 advertised a higher aggregate cost.

You can avoid this kind of suboptimal routing by manually configuring a cost for the aggregate. The summary LSA then announces the configured cost instead of the automatically calculated cost. Use the **cost** keyword with the **area range** command to specify a cost for a range of OSPF networks aggregated at an area boundary.

Configuring Authentication

The router supports the following authentication capabilities:

- Null authentication
- Simple password authentication
- MD5 authentication

The MD5 algorithm takes as input a message of arbitrary length and produces a 128-bit *fingerprint* or *message digest* of the input. MD5 is used to create digital signatures. It is a one-way *hash* function, meaning that it takes a message and converts it into a fixed string of digits, called a message digest.

When using a one-way hash function, you can compare a calculated message digest with the message digest that is decrypted by using a public key (password). The key verifies that the message has not been tampered with. This comparison process is called a hashcheck.

NOTE: You must first issue the **address area** command before issuing any other **address** command.

Authentication Requirements

If you configure either simple password or MD5 authentication, the password or authentication key must be the same on both sides of an adjacency. When you change the password or key on one side of an established adjacency, you must also change it on the other side within the dead interval. Doing this enables a hello packet that has the latest authentication information to be sent before the dead interval expires. If the packet is not sent within the dead interval, the adjacency breaks down and is not reestablished until both sides of the adjacency have the same password or key.

address authentication-key

- Use to assign a password used by neighboring routers for OSPF simple password authentication.
- The interface can have an IP address, or it can be unnumbered.
- You can specify whether the key is entered in unencrypted or encrypted format. If you do not specify which, the string is assumed to be unencrypted.
- The password, or key, is a character string up to 8 characters long.
- Example

  host1(config-router)#**address 10.12.10.2 authentication-key 9rdf7**

- Use the **no** version to delete the password from the specified interface.

address authentication message-digest

- Use to specify that MD5 authentication is used for the OSPF interface.
- You must configure the MD5 key ID and password with the **address message-digest-key md5** command.
- Switching between authentication types does not delete a configured MD5 key ID or password; only using the **no** version of that configuration command can delete the MD5 key ID and password.
- Example

  host1(config-router)#**address 10.12.10.2 authentication message-digest**

- Use the **no** version to set authentication for the interface to none without removing any configured MD5 key. You can subsequently apply MD5 authentication to the interface without having to reconfigure the key.

address authentication-none

- Use to disable authentication on the interface.
- The interface can have an IP address, or it can be unnumbered.
- Example

  host1(config-router)#**address 192.168.10.32 authentication-none**

- The **no** version has no effect.

address message-digest-key md5

- Use to enable OSPF MD5 authentication and configure the MD5 key.
- The MD5 key is a character string up to 16 characters long. You must also specify a key identifier and whether the key is entered in unencrypted or encrypted format. If you do not specify which, the string is assumed to be unencrypted.
- Configures an interface already created, or creates a new OSPF interface and configures the MD5 key. The interface can have an IP address, or it can be unnumbered.
- Example

  host1(config-router)#**address 10.1.1.1 message-digest-key 1 md5 0 9mwk6gdr76**

- Use the **no** version to delete the MD5 key.

area virtual-link authentication-key

- Use to configure a simple password for a virtual link.
- You can specify whether the key is entered in unencrypted or encrypted format. If you do not specify which, the string is assumed to be unencrypted.
- The password can be up to eight characters long.
- Example

  host1(config-router)#**area 27.0.0.0 virtual-link 27.3.4.5 authentication-key sadsa29c**

- Use the **no** version to remove the password.

area virtual-link authentication message-digest

- Use to specify that MD5 authentication is used for the particular virtual link.
- You must configure the MD5 key ID and password with the **area virtual-link message-digest-key md5** command.
- Switching between authentication types does not delete a configured MD5 key ID or password; only using the **no** version of that configuration command can delete the MD5 key ID and password.
- Example

  host1(config-router)#**area 27.0.0.0 virtual-link 27.2.3.4 authentication message-digest**

- Use the **no** version to set authentication for the virtual link to none without removing any configured MD5 key. You can subsequently apply MD5 authentication to the virtual link without having to reconfigure the key.

area virtual-link authentication-none

- Use to specify that no authentication is used for the particular virtual link.
- Example

  host1(config-router)#**area 27.0.0.0 virtual-link 27.2.3.4 authentication-none**

- The **no** version has no effect.

area virtual-link message-digest-key md5

- Use to enable MD5 authentication and to configure MD5 keys for virtual links.
- The MD5 key is a character string up to 16 characters long. You must also specify a key identifier and whether the key is entered in unencrypted or encrypted format. If you do not specify which, the string is assumed to be unencrypted.
- Example

  host1(config-router)#**area 27.0.0.0 virtual-link 327.3.4.5 message-digest-key 2 md5 rc45lsm2c**

- Use the **no** version to remove the password.

ip ospf authentication-key

- Use to configure a type 1 authentication (a simple password) on the interface.
- Neighboring OSPF routers use the password to access the router's interface.
- Use the same password on all neighboring routers on the same network.
- Use this password only when you enable authentication for the interface.
- You can specify whether the key is entered in unencrypted or encrypted format. If you do not specify which, the string is assumed to be unencrypted.
- Use a password that is a continuous string up to 8 characters long.
- Example

  host1(config-if)#**ip ospf authentication-key yourpwd**

- Use the **no** version to remove the password on the interface.

ip ospf authentication message-digest

- Use to specify the authentication method for the interface as MD5.
- You must configure the MD5 key ID and password with the **ip ospf message-digest-key md5** command.
- Switching between authentication types does not delete a configured MD5 key ID or password; only using the **no** version of that configuration command can delete the MD5 key ID and password.
- Example

  host1(config-if)#**ip ospf authentication message-digest**

- Use the **no** version to set authentication for the interface to none without removing any configured MD5 key. You can subsequently apply MD5 authentication to the interface without having to reconfigure the key.

ip ospf authentication-none

- Use to specify that no authentication is used for the OSPF interface.
- Example

  host1(config-if)#**ip ospf authentication-none**

- The **no** version has no effect.

ip ospf message-digest-key md5

- Use to enable MD5 authentication on the OSPF interface and configure the MD5 key.

NOTE: If all the MD5 keys have been deleted, the authentication type is still MD5, but you need to configure MD5 keys.

- The MD5 key is a character string up to 16 characters long. You must also specify a key identifier and whether the key is entered in unencrypted or encrypted format. If you do not specify which, the string is assumed to be unencrypted.

NOTE: To display the password only in encrypted text, use the **service password-encryption** command.

- Example

  host1(config-if)#**ip ospf message-digest-key 3 md5 0 tre987is**

- Use the **no** version to delete an MD5 key from the OSPF interface.

NOTE: To disable MD5 authentication for the interface, use the **ip ospf authentication-none** command.

Configuring the BFD Protocol for OSPF

The **ip ospf bfd-liveness-detection** and **ipv6 ospf bfd-liveness-detection** commands configure the Bidirectional Forwarding Detection (BFD) protocol for OSPFv2 and OSPFv3 (respectively). The BFD protocol uses control packets and shorter detection time limits to more rapidly detect failures in a network. Also, because they are adjustable, you can modify the BFD timers for more or less aggressive failure detection.

When you issue the **ip ospf bfd-liveness-detection** or **ipv6 ospf bfd-liveness-detection** command on an OSPF peer, the peer establishes BFD liveness detection with all BFD-enabled OSPF peers. When the local peer receives an update from a remote OSPF peer—if BFD is enabled and if the session is not already present—the local peer attempts to create a BFD session to the remote peer.

Each adjacent pair of peers negotiates an acceptable transmit interval for BFD packets. The negotiated value can be different on each peer. Each peer then calculates a BFD liveness detection interval. When a peer does not receive a BFD packet within the detection interval, it declares the BFD session to be down and purges all routes learned from the remote peer.

NOTE: Before the router can use the **ip ospf bfd-liveness-detection** or **ipv6 ospf bfd-liveness-detection** command, you must specify a BFD license key. To view an already configured license, use the **show license bfd** command.

For general information about configuring and monitoring the BFD protocol, see *JUNOSe IP Services Configuration Guide, Chapter 5, Configuring BFD*.

ip ospf bfd-liveness-detection

ipv6 ospf bfd-liveness-detection

- Use to enable BFD (bidirectional forwarding detection) and define BFD values to more quickly detect OSPFv2 or OSPFv3 data path failures.
- The peers in an OSPF adjacency use the configured values to negotiate the actual transmit intervals for BFD packets.
  - You can use the **minimum-transmit-interval** keyword to specify the interval at which the local peer proposes to transmit BFD control packets to the remote peer. The default value is 300 milliseconds.
  - You can use the **minimum-receive-interval** keyword to specify the minimum interval at which the local peer must receive BFD control packets from the remote peer. The default value is 300 milliseconds.
  - You can use the **minimum-interval** keyword to specify the same value for both of those intervals. Configuring a minimum interval has the same effect as configuring the minimum receive interval and the minimum transmit interval to the same value. The default value is 300 milliseconds.
- You can use the **multiplier** keyword to specify the detection multiplier value. The calculated BFD liveness detection interval can be different on each peer. The multiplier value is roughly equivalent to the number of packets that can be missed before the BFD session is declared to be down. The default value is 3.
- For details on liveness detection negotiation, see *Negotiation of the BFD Liveness Detection Interval* section in *JUNOSe IP Services Configuration Guide, Chapter 5, Configuring BFD*.
- You can change the BFD liveness detection parameters at any time without stopping or restarting the existing session; BFD automatically adjusts to the new parameter value. However, no changes to BFD parameters take place until the values resynchronize with each peer.
- Example 1 (OSPFv2)

  host1(config)#**ip ospf bfd-liveness-detection minimum-interval 800**

- Example 2 (OSPFv3)

  host1(config)#**ipv6 ospf bfd-liveness-detection minimum-interval 800**

- Use the **no** version to disable BFD on the OSPF interface.

Configuring Additional Parameters

The commands presented in this section include both OSPF-specific commands and routing protocol–independent commands that are not limited to OSPF. You can use these commands to perform the tasks listed in Table 12.

Table 12: Additional Configuration Tasks

Filter and apply policy to routes.	Set the maximum paths.
Set a baseline for statistics.	Enable automatic cost calculation.
Clear statistics for access lists, counters, redistributed routes, or processes.	Enable logs for OSPF neighbor changes.
Set the redistribution routes.	Set SPF hold time.
Set the distance for OSPF routes.	Set a default metric.
Administratively disable OSPF.	

access-list
route-map

- Use the **access-list** command to create a standard or extended access list.
- Use the **route-map** command to create a route map.
- For detailed information about configuring access lists and route maps, see *JUNOSe IP Services Configuration Guide, Chapter 1, Configuring Routing Policy*.
- Example
  1. Configure three static routes.

     host1(config)#**ip route 20.20.20.0 255.255.255.0 192.168.1.0**
     host1(config)#**ip route 20.20.21.0 255.255.255.0 192.168.1.0**
     host1(config)#**ip route 20.21.0.0 255.255.255.0 192.168.1.0**

  2. Configure an access list with filters on routes 20.20.20.0/24 and 20.20.21.0/24.

     host1(config)#**access-list boston permit 20.20.0.0 0.0.255.255**

  3. Configure a route map that matches the previous access list and applies a metric type 1 (OSPF).

     host1(config)#**route-map boston**
     host1(config-route-map)#**match ip address boston**
     host1(config-route-map)#**set metric-type type-1**

  4. Configure redistribution of the static routes into OSPF with route map boston.

     host1(config)#**router ospf 2**
     host1(config-router)#**redistribute static route-map boston**

5. Use the **show ip ospf database** command to verify the effect of the redistribution (that the two static routes matching the route map are redistributed as external type 1).

```
host1#show ip ospf database
    OSPF Database
      Router Link States (Area 0.0.0.0)
Link ID         ADV Router      Age         Seq#        Checksum
192.168.1.250   192.168.1.250   3           0x80000006  0x39a1
192.168.254.7   192.168.254.7   220         0x80000169  0xd2b5
      Network Link States (Area 0.0.0.0)
Link ID         ADV Router      Age         Seq#        Checksum
192.168.1.214   192.168.254.7   220         0x80000001  0xe0f2
      AS External Link States
Link ID         ADV Router      Age         Seq#        Checksum
20.20.20.0      192.168.1.250   3           0x80000001  0x6045
20.20.21.0      192.168.1.250   3           0x80000001  0x554f
```

- Use the **no** version of the **access-list** command to remove the access list or the specified entry in the access list.
- Use the **no** version of the **route-map** command to remove an entry.

auto-cost reference-bandwidth

ospf auto-cost reference-bandwidth

- Use to calculate the OSPFv2 or OSPFv3 interface cost according to bandwidth.
- Sets the OSPF metric for an interface according to the bandwidth specified.
- Affects OSPF metrics for existing OSPFv2 interfaces and OSPFv2 interfaces created after the execution of this command.
- Affects OSPF metrics for only OSPFv3 interfaces created after the execution of this command.
- This command's value overrides the cost resulting from the command.
- If you want this command to apply to OSPF interfaces already configured, you need to bounce the existing interfaces: Use the **no network** and then the **network** command for the selected OSPF interfaces.
- Example 1—OSPFv2

  host1(config-router)#**ospf auto-cost reference-bandwidth 1000**

- Example 2—OSPFv3

  host1((config-router)#)#**auto-cost reference-bandwidth 1000**

- When you issue this command, the metric is calculated as follows:

  OSPF metric = bandwidth*1,000,000/link speed

  For the previous example, a 64K link yields a metric of 15625, whereas a T1 link yields a metric of 647. The minimum value for the metric is 1.

- If you never issue the **ospf auto-cost reference-bandwidth** command, OSPF calculates the cost as 10^8/link speed.
- Use the **no** version to assign cost based only on the interface type.

baseline ip ospf
baseline ipv6 ospf

- Use to set a baseline for OSPF statistics and counters.
- The following example first displays the output of the **show ip ospf** command, which is shown before you run the **baseline ip ospf** command; then it displays the execution of the **baseline ip ospf** command; and finally, it displays the **show ip ospf** command run after you execute the **baseline ip ospf** command.
  - The output of the **show ip ospf** command run before the **baseline ip ospf** command reflects the up-to-date packet counters.
  - The output of the **show ip ospf delta** command run after you run the **baseline ip ospf** command reflects the baseline set for OSPF statistics and counters.
- Example

```
host1#show ip ospf

Routing Process OSPF 1 with Router ID 5.106.7.1
 OSPF Statistics:
      Rcvd: 217935 total, 0 checksum errors
            8987 hello, 8367 database desc, 188 link state req
            159898 link state updates, 40484 link state acks
      Sent: 265026 total, 0 pkts dropped
            8927 hello, 8341 database desc, 53 link state req
            158571 link state updates, 89134 link state acks
 Supports only single TOS(TOS0) routes
 SPF schedule delay 0 secs, Hold time between two SPFs 3 secs
 Maximum path splits 1
 Area BACKBONE(0.0.0.0)
    Area is a transit area
    SPF algorithm executed 425 times
    ABR count 0
    ASBR count 1
    LSA Count 12
    Number of interfaces in this area is 24
    Area ranges are:
 Number of active areas in this router is 1
 1  normal, 0 stub, 0 NSSA.

host1#baseline ip ospf
host1#show ip ospf delta

Routing Process OSPF 1 with Router ID 5.106.7.1
 OSPF Statistics:
      Rcvd: 0 total, 0 checksum errors
            0 hello, 0 database desc, 0 link state req
            0 link state updates, 0 link state acks
      Sent: 0 total, 0 pkts dropped
            0 hello, 0 database desc, 0 link state req
            0 link state updates, 0 link state acks
 Supports only single TOS(TOS0) routes
 SPF schedule delay 0 secs, Hold time between two SPFs 3 secs
 Maximum path splits 1
```

```
Area BACKBONE(0.0.0.0)
   Area is a transit area
   SPF algorithm executed 425 times
   ABR count 0
   ASBR count 1
   LSA Count 12
   Number of interfaces in this area is 24
   Area ranges are:
Number of active areas in this router is 1
1  normal, 0 stub, 0 NSSA.
```

- There is no **no** version.

clear ipv6 ospf counters

- Use to clear all OSPF IPv6 statistical counters for the virtual router.
- Example

  host1#**clear ipv6 ospf counters**

- There is no **no** version.

clear ipv6 ospf process

- Use to clear the OSPF IPv6 process on the virtual router.
- Example

  host1#**clear ipv6 ospf process**

- There is no **no** version.

clear ip ospf database

- Use to delete all entries from the OSPF link-state database and to reset all adjacencies.
- Example

  host1#**clear ip ospf database**

- There is no **no** version.

clear ip ospf neighbor

- Use to clear an IP OSPF neighbor by specifying the IP address.

NOTE: When OSPF is configured and running over an NBMA network, do not issue the **clear ip ospf neighbor** command simultaneously on both ends of the OSPF link. Doing so brings the OSPF link down completely. In this event, you must do one of the following on both sides of the link to bring the link back up:

- Reconfigure the OSPF neighbors on the NBMA interface with the **neighbor** command.
- Issue the **clear ip ospf database** command to clear and reset the OSPF adjacencies.
- Issue the **shutdown** command followed by the **no shutdown** command on the interface.

- Example

  host1#**clear ip ospf neighbor** *neighborAddress*

- There is no **no** version.

clear ip ospf redistribution

clear ipv6 ospf redistribution

- Use to clear and readvertise all of the routes that have been previously redistributed into OSPF.

CAUTION: Using this command purges all external LSAs and reoriginates.

- Example 1

  host1#**clear ip ospf redistribution**

- Example 2

  host1#**clear ipv6 ospf redistribution**

- There is no **no** version.

default-information originate

- Use to generate a default route into an OSPF routing domain.
- When you use this command to redistribute routes into an OSPF routing domain, the router automatically becomes an AS boundary router.
- An AS boundary router, however, does not, by default, generate a default route into the OSPF routing domain. The software must have a default route before it generates one, except when you have specified the **always** keyword.

- You can specify a metric for the route or specify that the route be OSPF external type 1 or 2.
- Example

  host1(config)#**router ospf 1**
  host1(config-router)#**default-information originate route-map 5**

- Use the **no** version to disable this feature.

disable-dynamic-redistribute

- Use to halt the dynamic redistribution of routes that are initiated by changes to a route map.
- Dynamic redistribution is enabled by default.
- Example

  host1(config-router)#**disable-dynamic-redistribute**

- Use the **no** version to reenable dynamic redistribution.

distance

- Use to configure the administrative distance for OSPF routes.
- Example

  host1(config-router)#**distance ospf external 60**

- Default settings:
  - Intra-area routes—110
  - Interarea routes—112
  - External routes—114
- Use the **no** version to restore the default values.

ip ospf shutdown
ipv6 ospf shutdown

- Use to disable OSPF on the interface.
- Example 1

  host1(config-if)#**ip ospf shutdown**

- Example 2

  host1(config-if)#**ipv6 ospf shutdown**

- Use the **no** version to enable OSPF on the interface.

log-adjacency-changes
ospf log-adjacency-changes

- Use to configure the router to send a log message when the state of an OSPF neighbor changes.
- Use the **log-adjacency-changes** command for OSPFv3 interfaces; use the **ospf log-adjacency-changes** command for OSPFv2 interfaces.
- Example 1

  host1(config-router)#**log-adjacency-changes severity 3 verbosity low**

- Example 2

  host1(config-router)#**ospf log-adjacency-changes severity 3 verbosity low**

- Use the **no** version to halt logging of neighbor changes.

maximum-paths

- Use to control the maximum number of parallel routes that OSPF can support.
- The maximum number of routes can be in the range 1–16.
- The default for OSPF is 4 paths.
- To enable equal-cost multipath (ECMP) for OSPF, you need to specify a value for maximum paths greater than 1.
- Example

  host1(config-router)#**maximum-paths 2**

- Use the **no** version to restore the default value, 4.

ospf shutdown

- Use to administratively disable OSPF on the router.
- Example

  host1(config-router)#**ospf shutdown**

- Use the **no** version to reenable OSPF on the interface.

passive-interface

- Use to disable the transmission of routing updates on the interface, meaning that OSPFv2 or OSPFv3 routing information is neither sent by nor received through the interface.
- The specified interface appears as a stub network in the OSPF domain.
- By default, OSPF is enabled on a configured OSPF interface.
- Example

  host1(config-router)#**passive-interface ethernet 1/0**

- Use the **no** version to reenable the transmission of OSPF routing updates on the specified interface.

redistribute

- Use to redistribute information from a routing domain other than OSPF into the OSPF domain.
- You can set the OSPF metric type—type 1 or type 2—and set a metric for all redistributed routes.
- If you do not specify **route-map**, all routes are redistributed. By default, all routes are imported as external type 2 routes.
- If you specify **route-map** but do not list any route map tags, no routes are imported.
- Use to redistribute routes from OSPF into other non-OSPF routing domains.
- Example 1

```
host1(config)#router ospf 5
host1(config-router)#redistribute bgp route-map 4
```

- Example 2

```
host1(config)#router bgp 100
host1(config-router)#redistribute ospf 5
```

- Use the **no** version to disable redistribution.

table-map

- Use to apply a policy to modify distance, metric, metric type, route type, or tag values of OSPF routes about to be added to the IP routing table.
- The new route map is applied to all routes currently in and those subsequently placed in the forwarding table. Previously redistributed routes are redistributed with the changes caused by the route map.
- To remove from the forwarding table any old routes that are now disallowed by the specified route map, you must refresh the IP routing table with the **clear ip routes *** command.
- Example

```
host1(config)#route-map dist1 permit 5
host1(config-route-map)#match community boston42
host1(config-route-map)#set distance 33
host1(config-route-map)#exit
host1(config)#router ospf 100
host1(config-router)#table-map dist1
host1(config-router)#exit
host1(config)#exit
host1#clear ip routes *
```

- Use the **no** version to halt application of the route map.

timers spf

- Use to configure the time between two consecutive SPF calculations.
- Set the time (in seconds) in the range 1–5; the default value is 3 seconds.
- If you set the hold time to 0, there is no delay between two consecutive SPF calculations. They can be done one immediately after the other.
- Example

  host1(config-router)#**timers spf 2**

- Use the **no** version to return to the default value, 3 seconds.

Default Metrics

Although the router does not support a **default-metric** command, the **redistribute** command provides two ways to set a default metric for redistributed routes.

You can simply configure a metric with the **redistribute** command to apply to all routes redistributed from the specified source protocol:

```
host1(config)#router ospf 5
host1(config-router)#redistribute bgp metric 5
```

Alternatively, you can create one or more route maps that set the metric and apply them selectively to redistributed routes:

```
host1(config)#access-list 1 permit any any
host1(config)#route-map defmetric
host1(config-route-map)#match ip address 1
host1(config-route-map)#set metric 10
host1(config-route-map)#exit
host1(config)#router ospf 5
host1(config-router)#redistribute bgp route-map defmetric
host1(config-router)#redistribute isis route-map defmetric
```

See *JUNOSe IP Services Configuration Guide, Chapter 1, Configuring Routing Policy*, for information about configuring route maps.

Configuring OSPF for NBMA Networks

You can configure OSPF nonbroadcast multiaccess (NBMA) networks. You can configure your OSPF network type as NBMA, regardless of the default medium. This configuration is useful when, for example, you have routers in your network that do not support multicast addressing.

You must use the **neighbor** command to specify the router's OSPF neighbors.

To configure OSPF for an NBMA network:

1. Configure an interface network type as NBMA for OSPF.

   host1(config-subif)#**ip ospf network non-broadcast**

2. Exit Interface Configuration mode. Enter Global Configuration mode.

   host1(config-subif)#**exit**

3. Configure an OSPF routing process, and enter Router Configuration mode.

   host1(config)#**router ospf 5**

4. Specify an OSPF neighbor, and optionally assign a priority number or poll interval to the neighbor.

   host1(config-router)#**neighbor 10.12.14.1 priority 5 poll-interval 180**

5. Repeat Step 4 for each neighbor in the OSPF network.

If you want to configure the network type for a specific interface or OSPF area, rather than for all OSPF interfaces, you can use the **address network** command rather than the **ip ospf network** command.

address network

- Use to configure the network type on a specific OSPF interface or for a specific OSPF area to a type other than the default for the medium.
- You must first issue the **address area** command before issuing the **address network** command.
- Example

  host1(config-router)#**address 10.12.10.2 network broadcast**

- Use the **no** version to restore the default value for the medium.

ip ospf network

- Use to configure the network type on all OSPF interfaces on the OSPF network to a type other than the default for the medium.
- Example

  host1(config-if)#**ip ospf network broadcast**

- Use the **no** version to restore the default value for the medium.

neighbor

- Use to configure OSPF neighbors on the NBMA network.
- Specify priority and poll interval only for routers that are eligible to become the designated router or backup designated router—that is, a router with a nonzero router priority value. The default priority value is 0, and the default polling interval is 120 seconds.
- Example

  host1(config-router)#**neighbor 10.12.11.5 priority 100**

- Use the **no** version to remove the neighbor or restore the default values 0 and 120.

Traffic Engineering

Traffic engineering enables more effective use of network resources by providing for the setup of explicitly routed Multiprotocol Label Switching (MPLS) label-switched paths (LSPs) that satisfy resource and administrative constraints. You can use OSPF to exchange link resource and traffic-engineering administrative information between routers. OSPF uses this information to calculate paths in the network that satisfy the administrative constraints. MPLS can then set up LSPs along these paths. See *JUNOSe BGP and MPLS Configuration Guide, Chapter 2, Configuring MPLS* for a detailed discussion of MPLS.

Configuring OSPF for Traffic Engineering

For OSPF to support traffic engineering, you must issue both of the following commands:

- **mpls traffic-eng area**—Enables the router to flood traffic engineering resource and administrative information in the specified area using type 10 opaque LSAs. These LSAs have an area-wide scope and therefore are flooded only within the indicated area.

- **mpls traffic-eng router-id**—Designates a router as traffic engineering capable and specifies the address of a stable router interface as the router ID of the node for traffic engineering purposes. The traffic engineering router ID serves as the tunnel endpoint for tunnels terminating at the node. Each node advertises its traffic engineering router ID in type 10 LSAs.

By default, OSPF always uses the MPLS tunnel to reach the MPLS endpoint. Best paths determined by SPF calculations are not considered. You can enable the consideration of best paths by issuing the **mpls spf-use-any-best-path** command. As a result, OSPF considers metrics for IGP paths and the tunnel metric, and might forward traffic along a best path, through the MPLS tunnel, or both.

You can use the **show ip ospf database opaque-area** command to display information about traffic engineering opaque LSAs.

For OSPF routes to use established MPLS tunnels as next hops—so that traffic can be mapped to use these tunnels—you must configure the tunnels with the **tunnel mpls autoroute announce ospf** command. See *JUNOSe BGP and MPLS Configuration Guide, Chapter 2, Configuring MPLS*, for information about configuring MPLS on a router.

mpls spf-use-any-best-path

- Use to enable SPF calculations to consider the IGP (OSPF) best paths as well as the MPLS tunnel for forwarding traffic to the MPLS endpoint.
- By default, the MPLS tunnel is always selected for traffic to the tunnel endpoint; IGP paths are not considered. For traffic beyond the endpoint, the tunnel is considered equally with any other path.
- Example

  host1(config-router)#**mpls spf-use-any-best-path**

- Use the **no** version to disable the use of IGP best paths.

mpls traffic-eng area

- Use to enable flooding of MPLS traffic engineering link information into the specified OSPF area. Flooding is disabled by default.
- Example

  host1(config-router)#**mpls traffic-eng area 0**

- Use the **no** version to disable flooding.

mpls traffic-eng router-id

- Use to specify a stable interface to be used as a router ID for MPLS traffic engineering. Typically you specify a loopback interface to provide the greatest stability, because this is flooded to all nodes. The interface acts as the destination node for tunnels originating at other nodes.
- Example

  host1(config-router)#**mpls traffic-eng router-id loopback 0**

- Use the **no** version to remove the interface as a router ID.

Using OSPF Routes for Multicast RPF Checks

You can use the **ip route-type** or **ipv6 route-type** command to specify whether OSPF routes are available for only unicast forwarding protocols or only multicast reverse-path-forwarding (RPF) checks. Routes available for unicast forwarding appear in the unicast view of the routing table, whereas routes available for multicast RPF checks appear in the multicast view of the routing table.

To enable a multicast protocol and MPLS traffic engineering (TE) to interoperate on a router running OSPF, use the **mpls traffic-eng multicast-intact** command.

ip route-type

ipv6 route-type

- Use to specify whether OSPF routes are available only for unicast forwarding, only for multicast RPF checks, or for both.
- Use the **show ip route** or **show ipv6 route** command to view the routes available for unicast forwarding.
- Use the **show ip rpf-routes** or **show ipv6 rpf-routes** command to view the routes available for multicast RPF checks.
- By default, OSPF routes are available for both unicast forwarding and multicast RPF checks.
- Example 1

  ```
  host1(config)#router ospf
  host1(config-router)#ip route-type unicast
  ```

- Example 2

  ```
  host1(config)#router ospf
  host1((config-router)#)#ipv6 route-type unicast
  ```

- Use the **no** version to restore the default value, both.

mpls traffic-eng multicast-intact

- Use to enable a multicast protocol and MPLS traffic engineering (TE) to interoperate on a router running OSPF.
- Example

  ```
  host1(config-router)#mpls traffic-eng multicast-intact
  ```

- Use the **no** version to disable interoperability between a multicast protocol and MPLS-TE when running on an OSPF router.

OSPF and BGP/MPLS VPNs

Some network topologies use OSPF as the routing protocol between CE and PE routers in BGP/MPLS VPNs. See *JUNOSe BGP and MPLS Configuration Guide, Chapter 3, Configuring BGP-MPLS Applications*, for information about configuring OSPF for this purpose.

Remote Neighbors

You can create OSPF remote neighbors to enable the router to establish neighbor adjacencies through unidirectional interfaces, such as MPLS tunnels, rather than the standard practice of using the same interface for receipt and transmission of OSPF packets. The remote neighbor can be more than one hop away through intermediate routers that are not running OSPF. OSPF uses the interface associated with the best route to reach the remote neighbor. A best route to the neighbor must exist in the IP routing table.

You must explicitly configure a remote neighbor on an OSPF router. You must specify the remote neighbor with which the router forms an adjacency and the source IP address the router uses for OSPF packets destined to its peer remote neighbor.

To form an adjacency with its remote neighbor, all OSPF packets are sent to the remote neighbor as unicast packets with the destination IP address equal to the source IP address of the remote neighbor. Use the **update-source loopback** command to assign the source IP address to a remote neighbor.

The connection between two remote neighbors is treated as an unnumbered point-to-point link that resides in the same area as that to which the pair of remote neighbors belongs.

The rules of OSPF adjacency must be followed for remote neighbors to form an adjacency with each other; for example, the neighbors must be in the same OSPF area and have the same hello interval and dead interval, and so on.

After you have used the **remote-neighbor** command to specify the remote neighbors and the update-source loopback to assign the source IP address, you must set a TTL value with the **ttl** command, because a remote neighbor can be more than one hop away. Configuration of all other remote-neighbor attributes is optional.

authentication-key

- Use to enable simple password authentication and assign a password for communication with OSPF remote neighbors.
- Example

  host1(config-router-rn)#**authentication-key 0 br549hee**

- Use the **no** version to delete the password.

authentication message-digest

- Use to specify that MD5 authentication is to be used on the OSPF remote neighbor interface.
- Example

  host1(config-router-rn)#**authentication message-digest**

- There is no **no** version.

authentication-none

- Use to specify that no authentication is to be used on the OSPF remote neighbor interface.
- Example

  host1(config-router-rn)#**authentication-none**

- There is no **no** version.

cost

- Use to specify a cost metric for the OSPF remote-neighbor interface; the metric is used in the calculation of the SPF routing table.
- The default value is 10 if there is no route to the remote neighbor; otherwise, the default is calculated based on the bandwidth of the physical interface used to reach the remote neighbor and the OSPF autocost reference bandwidth.
- Example

  host1(config-router-rn)#**cost 235**

- Use the **no** version to restore the default value.

dead-interval

- Use to set the time period, in seconds, that the OSPF router waits without receiving hello packets from a remote neighbor before declaring the neighbor to be down.
- Example

  host1(config-router-rn)#**dead-interval 180**

- Use the **no** version to restore the default value, 40 seconds.

hello-interval

- Use to set the time interval between hello packets that the router sends on the OSPF remote-neighbor interface.
- Specify a value in the range 1–65535 seconds; the default value is 40 seconds.
- Example

  host1(config-router-rn)#**hello-interval 15**

- Use the **no** version to restore the default value, 40 seconds.

message-digest-key md5

- Use to enable MD5 authentication for the OSPF remote-neighbor interface and configure the MD5 key.
- If you delete all MD5 keys, MD5 authentication is still enabled; you must either configure an MD5 key or disable MD5 authentication with the **authentication-none** command.
- Example

  host1(config-router-rn)#**message-digest-key 42 md5 0 sal29ute**

- Use the **no** version to delete the MD5 key.

remote-neighbor

- Use to configure an OSPF remote neighbor.
- Use the **update-source** command to configure source IP address for packets sent to the remote neighbor. We recommend that you do not leave the update source unconfigured for a remote neighbor.
- Example

  host1(config-router)#**remote-neighbor 10.25.100.14 area 35672**

- Use the **no** version to remove the remote neighbor and any attributes configured for the remote neighbor.

retransmit-interval

- Use to set the time between LSA retransmissions for the OSPF remote-neighbor interface when an acknowledgment for the LSA is not received.
- Specify a value in the range 1–3600 seconds; the default value is 5 seconds.
- Example

  host1(config-router-rn)#**retransmit-interval 10**

- Use the **no** version to restore the default value, 5 seconds.

transmit-delay

- Use to set the estimated time it takes to transmit a link-state update packet on the OSPF remote-neighbor interface.
- Specify a value in the range 0–3600 seconds; the default value is 1 second.
- Example

  host1(config-router-rn)#**transmit-delay 3**

- Use the **no** version to restore the default value, 1 second.

ttl

- Use to configure a hop count by setting the value of the time-to-live field used by packets sent to an OSPF remote neighbor.
- Specify a value in the range 1–255 seconds; the default value is 1 second.
- Example

  host1(config-router-rn)#**ttl 35**

- Use the **no** version to restore the default value, 1 second.

update-source

- Use to specify the loopback interface whose local IP address is used as the source address for the OSPF connection to a remote neighbor.
- We recommend that you do not leave the update source unconfigured for a remote neighbor.
- Example

  host1(config-router-rn)#**update-source loopback 1**

- Use the **no** version to delete the source address from the connection to the remote neighbor.

Remote Neighbors and Sham Links

You can configure OSPF remote neighbors to act as sham links for BGP/MPLS VPNs. See *JUNOSe BGP and MPLS Configuration Guide, Chapter 3, Configuring BGP-MPLS Applications*, for more information.

Configuring OSPF Graceful Restart

E-series routers support OSPF graceful restart extensions as defined in RFC 3623 (Graceful OSPF Restart). Graceful restart enables a router to continue forwarding OSPF traffic based on routing information it receives prior to an unplanned restart, while the E-series router switches from the primary SRP to the secondary SRP module.

Graceful restart helps to avoid interruptions in traffic forwarding and network-wide route changes when a route processor restarts or switches over to a redundant route processor.

To accomplish OSPF graceful restart, communication must take place between the router that is restarting and its OSPF neighbors. These neighboring routers must cooperate with (or help) the restarting router by keeping it in the forwarding path while it is restarting.

The restarting router sends a grace LSA (a link-local LSA) to inform its neighbors that it is restarting. After receiving this grace LSA, the neighbors act as if the router still exists in the network topology and continue forwarding traffic through the restarting router (for the specified grace period as defined in the grace LSA). If the restarting router does not become fully adjacent with the helper router before the grace period expires, the helper abandons the helper role and determines its adjacency with the restarting router to be down. Also, based on your configuration, the helper can abandon a restart if it detects a topology change before the restart is complete.

After the router restarts, the restarting router purges the grace LSA from the OSPF domain.

To configure the router as a graceful restart helper, use the graceful restart helper commands. These commands include **graceful-restart helper** and **graceful-restart helper-abort-topology-change**.

To configure the router for a restart scenario, use the graceful restart commands. These commands include **graceful-restart**, **graceful-restart notify-time**, and **graceful-restart restart-time**.

NOTE: Graceful restart mode is supported only for OSPFv2 routers. OSPF graceful restart helper mode is supported for both OSPFv2 and OSPFv3 routers.

graceful-restart

- Use to enable OSPF graceful restart on the OSPFv2 router.
- Example

  host1(config-router)#**graceful-restart**

- Use the **no** version to disable OSPF graceful restart capability on the router.

graceful-restart helper

- Use to configure the OSPFv2 or OSPFv3 router to function as an OSPF graceful restart helper router.
- Example

  host1(config-router)#**graceful-restart helper**

- Use the **no** version to disable OSPF graceful restart helper mode capability on the router.

graceful-restart helper-abort-topology-change

- Use to specify conditions under which the OSPFv2 or OSPFv3 router abandons its role as an OSPF graceful restart helper router.
- Use the **any** keyword to abandon the helper role when any LSA changes during the restart. Use the **non-externals** keyword to abandon the helper role only when any nonexternal LSA changes during the restart.
- Example

  host1(config-router)#**graceful-restart helper-abort-topology-change any**

- Use the **no** version to return the router to its default behavior of helping a restarting OSPF router during topology changes.

graceful-restart notify-time

- Use to specify the time (in the range 1–3600 seconds) expected for the router to remove grace LSAs over all interfaces.
- The restarting router sends the sum of the restart duration and notify duration as the *grace period* to the helping neighbors in the grace LSA. Receiving a maximum-aged grace LSA is an indication to the helper that the restart has been successfully completed on the restarting router.
- If the grace period on the helper router expires before the receipt of max-aged grace LSAs, the helper router stops the restart process and does not respond to the restarting router. The helper router then originates its own LSAs with the real current state of the adjacency with the restarting router reflected in them.
- Example

  host1(config-router)#**graceful-restart notify-time 500**

- Use the **no** version to return the notify duration to its default value, 15 seconds.

graceful-restart restart-time

- Use to specify the time (in the range 1–3600 seconds) expected for the router to reacquire OSPF neighbors that were fully operational prior to the restart.
- When this timer expires, the restarting router exits the restart procedure, originates any LSAs that were suppressed during the restart, removes any self-originated LSAs that it received from helping neighbors, runs SPF, and updates any routes in the routing table.
- Example

  host1(config-router)#**graceful-restart restart-time 350**

- Use the **no** version to return the restart duration to its default value, 180 seconds.

Disabling and Reenabling Incremental SPF

By default, when changes occur to a type 5 or type 7 LSA, OSPF recalculates new, loop-free routes for only the LSAs that change. When a subset of LSAs in the external link-state database change, a full recalculation is not necessary. However, through the CLI, you can disable incremental SPF so the router can perform a full SPF on all external LSAs in the link-state database.

disable-incremental-external-spf

- Use to disable incremental external SPF on the router. When issued, this command results in a full SPF when an event occurs to trigger an external SPF.
- Example

  host1(config-router)#**disable-incremental-external-spf**

- Use the **no** version to reenable incremental SPF on this router.

Configuring OSPF Traps

You can use the **traps** command to specify OSPF traps. This command enables you to specify all or any number of the following trap settings:

- virtIfStateChange—To indicate any state change on an OSPF virtual interface
- nbrStateChange—To indicate any state change on a nonvirtual OSPF neighbor
- virtNbrStateChange—To indicate any state change on a virtual OSPF neighbor
- ifConfigErro—To indicate any configuration mismatch with a nonvirtual neighbor
- virtIfConfigError—To indicate any configuration mismatch with a virtual neighbor
- ifAuthFailure—To indicate any authentication failure on a nonvirtual interface
- virtIfAuthFailure—To indicate any authentication failure on a virtual interface
- ifRxBadPkt—To indicate the receipt of a packet that the router cannot parse
- virtIfRxBadPkt—To indicate the receipt of a packet on a virtual interface that the router cannot parse
- txRetransmit—To indicate the retransmittal of a packet on a nonvirtual interface
- virtTxRetransmit—To indicate the retransmittal of a packet on a virtual interface

- originateLsa—To indicate the origination of a new LSA by this router
- maxAgeLsa—To indicate that an LSA in this router LSDB has reached its maximum age value
- ifStateChange—To indicate a state change on an OSPF interface

traps

- Use to specify traps for OSPF.
- Example

  host1(config-router-rn)#**traps all**
- Use the **no** version to delete the specified trap, group of traps, or all traps.

Neighbor Uptime Tracking

You can use the **history** keyword with the **show ip ospf neighbors** command to display a history of up to 10 events for all OSPF neighbors or a specific OSPF neighbor. This history can aid in troubleshooting network problems related to neighbor flapping. The history includes the interface for the neighbor, a timestamp for the event, whether the neighbor transition is seen (up) or down, and the cause of down events.

You can track up to 50 neighbors; when that number is exceeded, the history of the least recently tracked neighbor is overwritten. Similarly, when a neighbor's events exceed 10, the oldest event is overwritten, because no more than 10 events can be tracked per neighbor. Neighbor uptime tracking is not available for OSPFv3. See **show ip ospf neighbors** on page 304 for output field definitions.

```
host1#show ip ospf neighbors history
Transition log for neighbor 10.10.8.2:
Interface           Event Cause           Time
==============================================
ATM2/0.8            Seen  NA              WED DEC 14 07:02:27

Transition log for neighbor 10.10.12.2:
Interface           Event Cause           Time
==============================================
ATM2/0.12           Seen  NA              WED DEC 14 07:09:12
ATM2/0.12           DOWN  Interface down  WED DEC 14 07:05:47
ATM2/0.12           Seen  NA              WED DEC 14 07:02:32
```

Monitoring OSPF

Two sets of commands enable you to monitor OSPF operation on your router: the **debug** and the **show** commands. Both sets of commands provide information about your router's OSPF state and configuration.

The task you are performing with each of these monitoring commands is basically the same for each command; that is, you are requesting information. The results of this request can vary. For instance, the **debug** commands provide information (some of which is dynamically obtained from router logs) about problems with the network or the router, whereas the **show** commands provide information about the actual state and configuration of your router.

debug Commands

The **debug** commands provide information about the following OSPF items:

- Adjacencies
- Designated router
- General events
- Link-state advertisements
- Neighbors
- Packets received
- Packets sent
- Route events
- SPF events

debug ip ospf
debug ipv6 ospf

- Use to display information about selected OSPF events. This command has many keywords so you can specify a variety of OSPF events.
- You can set the level of severity for the events you want displayed: 0–7.
- You can set the verbosity of the messages you want displayed: low, medium, high.
- Example 1

  host1#**debug ip ospf adj**
- Example 2

  host1#**debug ipv6 ospf lsa**
- Use the **no** version to cancel the display of any information about the designated variable.

ospf log-adjacency-changes

- Use to enable the logging of changes in the state of an OSPF neighbor.
- Example

  host1(config-router)#**ospf log-adjacency-changes**

- Use the **no** version to disable the logging of changes in the state of an OSPF neighbor.

undebug ip ospf
undebug ipv6 ospf

- Use to cancel the display of information about a selected event.
- The same OSPF variables can be designated as in the **debug ip ospf** or **debug ipv6 ospf** commands.
- Example 1

  host1#**undebug ip ospf adj**

- Example 2

  host1#**undebug ipv6 ospf lsa**

- There is no **no** version.

show Commands

The **show** commands provide information about the following OSPFv2 and OSPFv3 items:

- Routing processes
- Border routers
- Database
- Interfaces
- Neighbors
- Traffic
- Virtual links
- Internal statistics
- MPLS tunnels and opaque LSAs

You can use the output filtering feature of the **show** command to include or exclude lines of output based on a text string you specify. See *JUNOSe System Basics Configuration Guide, Chapter 2, Command-Line Interface*, for details.

show ip ospf
show ipv6 ospf

- Use to display general information about OSPF routing processes.
- Field descriptions
  - Routing Process—Process ID, router ID, domain ID
  - OSPF administrative state—Enabled or disabled
  - OSPF operational state—Enabled or disabled
  - Incremental External SPF—On or off
  - Graceful Restart Capability—On or off
  - Time limit to complete graceful restart—Amount of time (in seconds) during which the router can reacquire OSPF neighbors that were fully operational prior to the restart
  - Time limit to flush grace LSAs—Amount of time (in seconds) during which the router can remove grace LSAs over all interfaces
  - Graceful Restart Helper Capability—On or off
  - Graceful Restart Help:
    - Not Aborted On Topology Change
    - Aborted On Any Topology Change
    - Aborted On Any Non-External Topology Change
  - OSPF set trap field—Enabled or disabled
  - Router—Router types: internal, area border, or autonomous system boundary routers
  - OSPF Statistics—Packets received and sent; LSA discard count
  - TOS type—Number of types of service supported
  - SPF timers—Timers configured on the router
  - Maximum path splits—Maximum equal-cost paths supported
  - Areas—Areas configured and their parameters
  - Number of areas—Number of areas in the router
- Example 1

```
host1#show ip ospf

Routing Process OSPF 1 with Router ID, 0.0.0.0, Domain ID 0.0.0.0
OSPF administrative state is enabled
OSPF operational state is disabled
Incremental External SPF is ON
Graceful Restart Capability is ON
Time limit to complete graceful restart 180 seconds
Time limit to flush grace LSAs 15 seconds
Graceful Restart Helper Capability is OFF
Graceful Restart Help Not Aborted On Topology Change
Ospf set trap field disabled
OSPF Statistics:
Rcvd: 0 total, 0 checksum errors
0 hello, 0 database desc, 0 link state req
0 link state updates, 0 link state acks
```

```
Sent: 0 total, 0 pkts dropped
0 hello, 0 database desc, 0 link state req
0 link state updates, 0 link state acks
LSA discard count: 0
Supports only single TOS(TOS0) routes
SPF schedule delay 0 secs, Hold time between two SPFs 3 secs
Maximum path splits 4
Number of active areas in this router is 0
0 normal, 0 stub, 0 NSSA.
```

- Example 2

```
host1#show ip ospf

Routing Process OSPF 4 with Router ID, 10.0.0.1, Domain ID 0.0.0
 OSPF administrative state is enabled
 OSPF operational state is enabled
 Incremental External SPF is ON
 Graceful Restart Capability is OFF
 Graceful Restart Helper Capability is OFF
 Graceful Restart Help Not Aborted On Topology Change
 Ospf set trap field disabled
 OSPF Statistics:
      Rcvd: 0 total, 0 pkts dropped, 0 checksum errors
            0 hello, 0 database desc, 0 link state req
            0 link state updates, 0 link state acks
      Sent: 1 total, 0 pkts dropped
            1 hello, 0 database desc, 0 link state req
            0 link state updates, 0 link state acks
      LSA discard count: 0
 Supports only single TOS(TOS0) routes
 SPF schedule delay 0 secs, Hold time between two SPFs 3 secs
 Maximum path splits 4
 Area BACKBONE(0.0.0.0)
    SPF algorithm executed 5 times
    ABDR count 0
    ASBDR count 0
    LSA Count 1
    Number of interfaces in this area is 1
    Area ranges are:
 Area 0.0.0.1
    Area is a stub area
    Type-3 summary is filtered
    SPF algorithm executed 5 times
    ABDR count 0
    ASBDR count 0
    LSA Count 0
    Number of interfaces in this area is 0
    Area ranges are:
 Area 0.0.0.2
    Area is nssa
    Type-3 summary is filtered
    SPF algorithm executed 4 times
    ABDR count 0
    ASBDR count 0
    LSA Count 0
    Number of interfaces in this area is 0
    Area ranges are:
 Area 0.0.0.5
    Area is nssa
    SPF algorithm executed 3 times
    ABDR count 0
    ASBDR count 0
```

```
      LSA Count 0
      Number of interfaces in this area is 0
      Area ranges are:
   Number of active areas in this router is 4
   1  normal, 1 stub, 2 NSSA.
```

- Example 3

```
host1#show ipv6 ospf
Routing Process OSPFv3 1 with Router ID 10.1.1.1
 OSPFv3 administrative state is enabled
 OSPFv3 operational state is enabled
 Incremental External SPF is OFF
 Graceful Restart capability is OFF
 Graceful Restart helper capability is OFF
Ospf set trap field disabled
 SPF schedule delay 0 secs, Hold time between two SPFs 3 secs
 Maximum path splits 4
 Area BACKBONE(0.0.0.0)
SPF algorithm executed 13 times
ABDR count 1
ASBDR count 1
LSA Count 117
Number of interfaces in this area is 3
Area ranges are:
 Number of active areas in this router is 1
1   normal, 0 stub, 0 NSSA.
```

show ip ospf border-routers

show ipv6 ospf border-routers

- Use to display a list of OSPF border routers.
- Field descriptions
  - Destination—Destination's router ID
  - NEXT HOP—Next hop toward the destination
  - Interface—Interface for which you are obtaining the information
  - Router Type—Router type of the destination: either an ABR or AS boundary router, or both
  - Route Type—Type of this route: either an intra-area or interarea route
  - Area—Area ID of the area from which this route is learned
- Example 1

```
host1#show ip ospf border-routers
Destination NEXT HOP   Interface      Router Type  Route Type Area
5.5.0.250   5.5.6.250  fastethernet0  ABR/ASBR     INTRA      0.0.0.0
5.5.0 250   4.4.4.250  fastethernet0  ABR/ASBR     INTRA      0.0.0.1
6.6.6.250   4.4.4.13   fastethernet0  ABR          INTRA      0.0.0.1
```

- Example 2

```
host1#show ipv6 ospf border-routers
OSPF Area Border Routers
    Destination       NEXT_HOP       Interface  RouteType       Area
      10.0.0.10       FE80::3       ATM4/1.39   INTRA        0.0.0.0
      10.0.0.11       FE80::4       ATM4/0.41   INTRA        0.0.0.0
      10.0.0.11     FE80::5      ATM4/1.48   INTRA      100.0.0.1
```

```
OSPF Autonomous System Border Routers

    Destination       NEXT_HOP       Interface  RouteType       Area
       10.1.1.4         FE80::3       ATM4/1.39   INTER        0.0.0.0
       10.1.1.5         FE80::4       ATM4/0.41   INTER        0.0.0.0
```

show ip ospf database
show ipv6 ospf database

- Use to display the full IP OSPF database, a summary of the database, or LSAs specific to the given area.
- Field descriptions
  - Link ID—Link-state ID of the LSA; for OSPFv2:
    - For router links, set to the router's OSPF router ID
    - For network links, set to the IP interface address of the network's designated router
    - For type 3 summary LSAs, set to an IP network number
    - For type 4 summary LSAs, set to an AS boundary router ID
    - For type 5 externals, set to an IP network number
  - Link ID—Link-state ID of the LSA; for OSPFv3:
    - For link LSAs, set to the interface ID
    - For network links, set to the interface ID
    - For router links, set to integer
    - For intra-area prefix links, set to integer
    - For interarea prefix links, set to integer
    - For interarea router links, set to integer
    - For external links, set to integer
    - For grace links, set to integer
  - ADV Router—ID of the advertising router
  - Age—Link-state age
  - Seq#—Link-state sequence number (detects old or duplicate LSAs)
  - Checksum—Fletcher checksum of the complete contents of the LSA
  - Area—Area for which data is displayed
  - Router—Number of router LSAs
  - Network—Number of network LSAs
  - Intra-Prefix—Number of intra-prefix LSAs
  - Inter-Prefix—Number of inter-prefix LSAs
  - Inter-Router—Number of inter-outer LSAs
  - Link LSAs—Number of link LSAs
  - Grace LSAs—Number of graceful restart LSAs
  - External LSAs—Number of external LSAs

- MaxAge—Number of LSAs that have reached the maximum age
- Area—Area for this LSA
- LS age—LSA age
- Options—Optional capabilities supported by this router
- LS Type—LSA type
- Link State ID—Link-state ID of the link local LSA
- Length—Length of the LSA (in bytes)
- Bit set—Bit set used by this LSA type
- Link connected to—Type of network to which the link connects
- Neighboring router’s Router ID—Router ID of the neighboring router
- Neighboring router’s Interface ID—Interface ID of the neighboring router
- Local Interface ID—Local interface ID
- Metric—Cost of this interface
- Attached Router—Addresses of any attached routers
- Router Priority—Priority value configured for the router
- Link Local Address—Originating router's link-local interface address on the link
- Prefixes—Prefixes associated with this LSA
- Number of Prefixes—Number of prefixes associated with this LSA
- Referenced LSA Type—Router LSA or network LSA with which the IPv6 address prefixes should be associated
- Referenced LSA Advertising Router—Router LSA or network LSA with which the IPv6 address prefixes should be associated
- Referenced LSA ID—Router LSA or network LSA with which the IPv6 address prefixes should be associated
- asbr—Address of the AS boundary router
- LS Seq Number—Sequence number of the LSA
- TLVs—Type of TLV included in LSA
  - 1(Restart duration)—Duration of the restart, in seconds
  - 2(Restart Reason)—Reason that the peer restarted: Unknown, Software Restart, Software Reload, Software Upgrade, Switch to redundant control processor
  - 3(Unknown)—Any recognized type is listed as type 3, unknown; consequently the meaning and units of the value are unknown as well
- length—Length of the TLV; varies according to the TLV
- Value—Value of the TLV; varies according to TLV

- Example 1—OSPFv2 output

```
host1#show ip ospf database
OSPF Database

  Router Link States (Area 0.0.0.0)

  Link ID    ADV Router   Age  Seq#        Checksum
5.1.101.1    5.1.101.1    932  0x80000069  0x102f
192.168.1.13 192.168.1.13 1763 0x80000099  0xaa4e
192.168.1.10 192.168.1.10 285  0x80000087  0xada6
192.168.1.11 192.168.1.11 401  0x80000087  0xaba5
192.168.24.6 192.168.24.6 622  0x800005bf  0x6087

Network Link States (Area 0.0.0.0)

  Link ID    ADV Router    Age Seq#       Checksum
56.56.56.220 5.6.6.1       499 0x80000069 0x26a0
192.168.1.12 192.168.254.6 622 0x8000009e 0xebc2

  Summary Link States (Area 0.0.0.0)

  Link ID ADV Router   Age Seq#       Checksum
4.4.4.0   5.5.0.250    497 0x8000005a 0x2ca6
4.4.4.0   192.168.1.13 528 0x80000059 0x 45d

  AS Summary Link States (Area 0.0.0.0)

  Link ID ADV Router   Age Seq#       Checksum
5.5.0.250 192.168.1.13 491 0x80000002 0xe9d4

  AS External Link States

Link ID ADV Router Age Seq#       Checksum
8.8.8.0 5.5.0.250  502 0x8000005f 0x2d67

  Router Link States (Area 0.0.0.1)

Link ID      ADV Router   Age Seq#       Checksum
5.5.0.250    5.5.0.250    498 0x80000067 0xdec1
192.168.1.13 192.168.1.13 505 0x800000a5 0x3b32

Network Link States (Area 0.0.0.1)

Link ID     ADV Router     Age Seq#        Checksum
4.4.4.13    192.168.1.13   505 0x80000001  0x410b
5.1.0.0     192.168.1.13   940 0x80000059  0x82c4
5.2.0.0     5.5.0.250      495 0x80000001  0x51bf
5.2.0.0     192.168.1.13   932 0x80000059  0x76cf
5.3.0.0     5.5.0.250      495 0x80000001  0x45ca
5.3.0.0     192.168.1.13   932 0x80000059  0x6ada
56.56.56.0  5.5.0.250      495 0x80000062  0xc469

AS Summary Link States (Area 0.0.0.1)

Link ID   ADV Router Age Seq#        Checksum
5.5.0.250 5.5.0.250  496 0x800000001  0x51c0
```

- Example 2—OSPFv3 general output

```
host1#show ipv6 ospf database
OSPF Database
     V3 Router Link States (Area 0.0.0.0)

Link ID         ADV Router      Age         Seq#        Checksum
0.0.0.0         2.2.2.2         167         0x80000003  0xa9e3
0.0.0.0         3.3.3.3         168         0x80000002  0x2c63

      V3 Inter-Area Net Link States (Area 0.0.0.0)

Link ID         ADV Router      Age         Seq#        Checksum
0.0.0.1         2.2.2.2         33          0x80000004  0x5288

      V3 Inter-Area Router Link States (Area 0.0.0.0)

Link ID         ADV Router      Age         Seq#        Checksum
0.0.0.1         2.2.2.2         33          0x80000001  0x a0f

      V3 Intra-Area Prefix Link States (Area 0.0.0.0)

Link ID         ADV Router      Age         Seq#        Checksum
0.0.0.1         2.2.2.2         167         0x80000003  0xc8ba
0.0.0.1         3.3.3.3         168         0x80000003  0xdc9e

      V3 Link Link States (Area 0.0.0.0)

Link ID         ADV Router      Age         Seq#        Checksum
50.0.0.10       2.2.2.2         178         0x80000001  0xb51d
50.0.0.13       3.3.3.3         178         0x80000001  0x8c3e

     V3 Router Link States (Area 0.0.0.1)

Link ID         ADV Router      Age         Seq#        Checksum
0.0.0.0         1.1.1.1         40          0x80000003  0xf7a4
0.0.0.0         2.2.2.2         168         0x80000003  0x7825

      V3 Inter-Area Net Link States (Area 0.0.0.1)

Link ID         ADV Router      Age         Seq#        Checksum
0.0.0.2         2.2.2.2         33          0x80000004  0x6a4f

      V3 Intra-Area Prefix Link States (Area 0.0.0.1)

Link ID         ADV Router      Age         Seq#        Checksum
0.0.0.1         1.1.1.1         169         0x80000003  0x911a
0.0.0.1         2.2.2.2         168         0x80000003  0xa5fd

      V3 Link Link States (Area 0.0.0.1)

Link ID         ADV Router      Age         Seq#        Checksum
50.0.0.6        1.1.1.1         180         0x80000001  0x44b7
50.0.0.9        2.2.2.2         178         0x80000001  0x1bd8

      V3 External Link States

Link ID         ADV Router      Age         Seq#        Checksum
0.0.0.1         1.1.1.1         40          0x80000001  0xe5a0
```

- Example 3—OSPFv3 database summary information

```
host1:v2#show ipv6 ospf database database-summary
 Area     Router   Network   Intra-Prefix   Inter-Prefix   Inter-Router
-------   ------   -------   ------------   ------------   ------------
0.0.0.0   2        1         3              0              0
 Area     MaxAge
-------   ------
0.0.0.0   0

Link LSAs: 2, Max age: 0
Grace LSAs: 1, Max age: 0
External LSAs: 0, Max age: 0
```

- Example 4—OSPFv3 LSA output (router)

```
host1#show ipv6 ospf database router
V3 Router Link States (Area 0.0.0.0)
  LS age: 433
  Options: (  V6-Bit , R-Bit , ExternalRoutingCapability,  No Nssa-LSA)
  LS Type: Router Links
  Link State ID: 0.0.0.0
  Advertising Router: 1.1.1.1
  LS Seq Number: 0x80000002
  Checksum: 0x c90
  Length: 40
  Bit E set
     Link connected to: a Point To Point Network
      Neighboring  router's Router Id: 2.2.2.2
      Neighboring  router's Interface Id: 0x3200000a
      Local Interface ID : 0x32000006
      Metric 1

  LS age: 432
  Options: (  V6-Bit , R-Bit , ExternalRoutingCapability,  No Nssa-LSA)
  LS Type: Router Links
  Link State ID: 0.0.0.0
  Advertising Router: 2.2.2.2
  LS Seq Number: 0x80000002
  Checksum: 0x8519
  Length: 40

     Link connected to: a Point To Point Network
      Neighboring  router's Router Id: 1.1.1.1
      Neighboring  router's Interface Id: 0x32000006
      Local Interface ID : 0x3200000a
      Metric 1
```

- Example 5—OSPFv3 LSA output (network)

```
host1#show ipv6 ospf database network
        (Area 0.0.0.1)
    LS Type: Network LSA
    Link State ID: 0.0.0.14
    Advertising Router: 3.3.3.3
      LS age: 131
    LS Seq Number: 0x80000001
    Checksum: 0x6c69
    Length: 32
Options:   V6-bit set, ExternalRoutingCapability, R-bit set
      Attached Router: 3.3.3.3
      Attached Router: 2.2.2.2
```

- Example 6—OSPFv3 LSA output (link)

```
host1#show ipv6 ospf database link
V3 Link Link States (Area 0.0.0.0)

Link ID        ADV Router      Age         Seq#        Checksum

  LS age: 280
  LS Type: Link
  Link State ID: 0x32000006
  Advertising Router: 1.1.1.1
  LS Seq Number: 0x80000001
  Checksum: 0x44b7
  Length: 56
  Router Priority 0
  Link Local Address fe80::90:1a00:200:670
  Prefixes
       1:1:1:1000:: / 60      options 0      metric 0

  LS age: 282
  LS Type: Link
  Link State ID: 0x3200000a
  Advertising Router: 2.2.2.2
  LS Seq Number: 0x80000001
  Checksum: 0x11e1
  Length: 56
  Router Priority 0
  Link Local Address fe80::90:1a00:300:670
  Prefixes
       1:1:1:1000:: / 60      options 0      metric 0
```

- Example 7—OSPFv3 LSA output (intra-area-prefix)

```
host1#show ipv6 ospf database intra-area-prefix

      V3 Intra Area Prefix Link States (Area 0.0.0.0)
  LS age: 162
  LS Type: Intra Area Prefix Links
  Link State ID: 0.0.0.1
  Advertising Router: 1.1.1.1
  LS Seq Number: 0x80000003
  Checksum: 0x911a
  Length: 44
  Number of Prefixes 1
  Referenced LSA Type 0x    2001
  Referenced LSA Advertising Router 1.1.1.1
  Referenced LSA ID 0
  Prefixes
       1:1:1:1000:: / 60      options 0      metric 1

  LS age: 161
  LS Type: Intra Area Prefix Links
  Link State ID: 0.0.0.1
  Advertising Router: 2.2.2.2
  LS Seq Number: 0x80000003
  Checksum: 0xa5fd
  Length: 44
  Number of Prefixes 1
  Referenced LSA Type 0x    2001
  Referenced LSA Advertising Router 2.2.2.2
  Referenced LSA ID 0
  Prefixes
       1:1:1:1000:: / 60      options 0      metric 1
```

- Example 8—OSPFv3 LSA output (interarea router)

```
host1#show ipv6 ospf database inter-area-router

      V3 Inter-Area-Router Link States (Area 0.0.0.0)
  LS age: 304
  LS Type: Inter Area Net Links
  Link State ID: 0.0.0.1
  Advertising Router: 2.2.2.2
  LS Seq Number: 0x80000001
  Checksum: 0x a0f
  Length: 32
     Metric: 1
     Options: 19
     asbr: 1.1.1.1
```

- Example 9—OSPFv3 LSA output (graceful restart helper)

```
host1#show ipv6 ospf database grace
      V3 Grace Link States (Area 0.0.0.1)
LS age: 3
  LS Type: Grace
  Link State ID: 0x00000002
  Advertising Router: 2.2.2.2
  LS Seq Number: 0x80000001
  Checksum: 0x8409
  Length: 44
 TLVs
Type: 1(Restart duration), length: 4, Value: 150
Type: 2(Restart Reason), length: 1, Value: 2(Software Reload)
Type: 3(Unknown), length: 4, Value: 33686018
```

show ip ospf database link-local

- Use to display OSPF database link local states.
- Field descriptions
  - Interface—Interface for which you are obtaining link-local LSA
  - LS age—Age of LSA
  - LS Type—Type of LSA (Link Local)
  - Link State ID—Link-state ID of the link local LSA
  - Advertising Router—Router ID of the router that originated the LSA
  - LS Seq Number—Link-state sequence number to identify duplicate or old LSIDs
  - Checksum—Checksum of the complete contents of the LSA
  - Length—Length of the LSA in bytes
  - Opaque LSA Type—Type of opaque LSA
  - Neighbor—Neighbor IP address
  - Grace Period—Helper grace period in seconds
  - Restart Reason—Reason for restart; Planned Restart or Unplanned Restart

- Example

```
host1#show ip ospf database link-local
Link-Local States

 Interface : ATM1/3.80
  LS age: 17
  LS Type: Link Local
  Link State ID: 3.0.0.0
  Advertising Router: 100.1.1.67
  LS Seq Number: 0x80000002
  Checksum: 0xac91
  Length: 36
  Opaque LSA Type : Restart Grace
  Neighbor 0.0.0.0
  Grace Period 90 seconds
  Restart Reason : Unplanned Restart
```

show ip ospf database opaque-area

- Use to display lists of information about the TE opaque LSAs.
- The TE router address LSA describes a stable IP address on the originating router that can be used for TE purposes—such as setting up TE LSPs to this address.
- The TE link LSA describes TE information about an interface on the originating router.
- Field descriptions
  - LS age—Age of LSA
  - Options—Optional capabilities supported by the described portion of the routing domain
  - LS Type—Type of LSA; opaque area TE router address or opaque area TE link LSA
  - Link State ID—Link-state ID of the opaque LSA
  - Advertising Router—Router ID of the router that originated the LSA
  - LS Seq Number—Link-state sequence number to identify duplicate or old LSIDs
  - Checksum—Checksum of the complete contents of the LSA
  - Length—Length of the LSA in bytes
  - TE Router-ID—Traffic engineering router ID of the originating router
  - Link Type—Point-to-point or multiaccess
  - Link ID—For point-to-point interfaces, this is the router ID of the router at the remote end; for multiaccess interfaces, this is the address of the DR
  - Local Address—IP address of the local interface for the link
  - Remote Address—IP address of the remote (neighbor's) interface for the link
  - TE Metric—Link metric for traffic engineering purposes; can be different from the standard OSPF link
  - Max BW—Maximum bandwidth that can be used on this link in this direction

  - Max Reservable BW—Maximum bandwidth that can be reserved on this link; can exceed the maximum bandwidth in the event of oversubscription
  - Max Unreserved BW—Amount of bandwidth not yet reserved at each of the eight priority levels; each value is less than or equal to the maximum reservable bandwidth
  - Color—Bitmask that specifies the administrative group membership for this link; a link that is a member of more than one group will have multiple bits set

- Example

```
host1#show ip ospf database opaque-area

      Opaque-area Link States (Area 0.0.0.0)

  LS age: 914
  Options:   (TOS-capable, No Type7-LSA, ExternalRoutingCapability, No
  Multicast Capability, No External Attributes    LSA)
  LS Type: Opaque-Area (TE Router Address)
  Link State ID: 1.0.0.0(Instance)
  Advertising Router: 100.1.1.1
  LS Seq Number: 0x80000003
  Checksum: 0xd293
  Length: 28
  TE Router-ID: 100.1.1.1

  LS age: 919
  Options:   (TOS-capable, No Type7-LSA, ExternalRoutingCapability, No
  Multicast Capability, No External Attributes    LSA)
  LS Type: Opaque-Area (TE Links)
  Link State ID: 1.0.0.1(Instance)
  Advertising Router: 100.1.1.1
  LS Seq Number: 0x80000003
  Checksum: 0xf66e
  Length: 124
  Link Type: P2P
  Link ID: 1744896257
 Local Address 14.1.1.2
 Remote Address 14.1.1.1
 TE Metric 0
 Max BW 1000 kb/sec (125000 Bps)
 Max Reservable BW 1000 kb/sec (125000 Bps)
 Max Unreserved BW : pri 0 1000 kb/sec (125000 Bps)
 Max Unreserved BW : pri 1 1000 kb/sec (125000 Bps)
 Max Unreserved BW : pri 2 1000 kb/sec (125000 Bps)
 Max Unreserved BW : pri 3 1000 kb/sec (125000 Bps)
 Max Unreserved BW : pri 4 1000 kb/sec (125000 Bps)
 Max Unreserved BW : pri 5 1000 kb/sec (125000 Bps)
 Max Unreserved BW : pri 6 1000 kb/sec (125000 Bps)
 Max Unreserved BW : pri 7 1000 kb/sec (125000 Bps)
 Color 0
```

show ip ospf interface
show ipv6 ospf interface

- Use to display a list of OSPFv2 or OSPFv3 interfaces.
- Use the optional *areaId* or *areaIdInt* values to specify an OSPF area ID in either IP or decimal format.
- Field descriptions
  - Interface value (fastEthernet)—Status of the physical link and the operational status of the protocol
  - Internet Address—Interface IP address
  - Area—Area identifier: IP address
  - Network type—Broadcast, NBMA, Point-to-Point, or Point-to-Multipoint
  - Authentication type—None, simple, or MD5
  - Cost—Metric for OSPF transmission
  - Transmit Delay—Time between transmissions from the specified interface
  - Interface State—Current state of the specified interface
  - Priority—Router's priority on the specified interface
  - Designated Router—Designated router ID and respective interface IP address
  - Backup Designated Router—Designated router ID and respective interface IP address of the backup router
  - Timer intervals—Configuration of timer intervals: Hello, Dead, Wait, and Retransmit
  - Neighbor Count—Number of neighbors and their state; adjacent neighbors
  - LDP is configured through LDP autoconfig—Indicates whether LDP is configured on the interface by means of autoconfiguration; supported only for OSPFv2
  - LDP-IGP Synchronization—Status of synchronization, Achieved or Pending; supported only for OSPFv2
- Example 1

```
host1#show ip ospf interface
FastEthernet0 is up, OSPF line protocol is up
OSPF interface configuration:
  Internet Address 192.168.1.250, Area 0.0.0.0
  Network type BROADCAST, No authentication
  Cost: 1
  Transmit Delay is 1 sec, Interface State DROTHER, Priority 1
  Designated Router (Interface address) 192.168.1.107
  Backup Designated Router (Interface address) 192.168.1.214
  Timer intervals configured, Hello 10, Dead 40, Wait 120, Retransmit 5
  Neighbor Count is 2, Adjacent neighbor count is 2
  Adjacent with neighbor 192.168.1.107 (Designated Router)
  Adjacent with neighbor 192.168.254.7 (Backup Designated Router)
  LDP is configured through LDP autoconfig
  LDP-IGP Synchronization: Achieved
```

- Example 2

```
host1#show ipv6 ospf interface
ATM4/0.12 is up, OSPFv3 line protocol is up
 Area 0.0.0.0, Intf ID: 0x320004, Instance ID: 0
 Link Local Address: fe80::90:1a00:100:80
 Interface is active
 Network type POINT-TO-POINT
 Interface State POINT-TO-POINT
 Cost: 1, Priority 1
 No designated router on this network
 No backup designated router on this network
 Timer intervals configured:
 Hello 10, Dead 40, Wait 40
 Transmit Delay is 1 sec(s)
 Retransmit interval is 5 secs
 Neighbor Count is 1
  FULL Adjacent neighbor count is 1
  Adjacent with neighbor 11.0.0.2

FastEthernet0/0 is up, OSPFv3 line protocol is up
OSPF interface configuration:
 Interface ID 0.0.1.1
 IPv6 link-local address FE80::3/128
 IPv6 prefix address 3000::1/64, Area 0.0.0.0
 Network type BROADCAST
 Cost: 1
 Transmit Delay is 1 sec, Interface State BACKUPDR, Priority 1
 Designated Router's router ID 1.1.1.1
 Backup Designated Router's router ID 2.2.2.2
 Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
 Neighbor Count is 1, Adjacent neighbor count is 1
  Adjacent with neighbor 3.3.3.3 (Designated Router)
```

show ip ospf internal-statistics
show ipv6 ospf internal-statistics

- Use to display internal OSPFv2 or OSPFv3 statistics, such as allocation failures for different OSPF components.
- Use the **delta** keyword to display statistics relative to the current baseline.
- Field descriptions
  - LSA bytes allocated—Number of bytes allocated for LSAs
  - Router LSA bytes allocated—Number of bytes allocated for router LSAs
  - Summary bytes allocated—Number of bytes allocated for summary LSAs
  - Neighbor RTX bytes allocated—Number of bytes allocated for neighbor retransmissions
  - Timers bytes allocated—Number of bytes allocated for OSPF timers
  - Ospf total bytes free—Total number of bytes free
  - Ospf heap total bytes allocated—Total number of bytes allocated from the OSPF heap
  - Neighbor allocation failures—Number of neighbor allocation failures
  - LSA allocation failures—Number of LSA allocation failures
  - LSA HDR allocation failures—Number of LSA header allocation failures

  - DB Request allocation failures—Number of database request allocation failures
  - RTX allocation failures—Number of neighbor retransmission allocation failures
  - LS Ack allocation failures—Number of LSA acknowledgment packet allocation failures
  - DD pkt allocation failures—Number of database description packet allocation failures
  - OSPF interface allocation failures—Number of interface allocation failures
  - OSPF general packet allocation failures—Number of general packet allocation failures

- Example 1

```
host1#show ip ospf internal-statistics
 Routing Process OSPF 1 with Router ID 5.72.3.1
 Internal OSPF Statistics, bytes allocated/free:
      LSA bytes allocated:216
      Router LSA bytes allocated:936
      Summary bytes allocated:0
      Neighbor RTX bytes allocated:0
      Timers bytes allocated:352
      Ospf total bytes free:824368
      Ospf heap total bytes allocated:1048576
 Internal OSPF Statistics, allocation failures:
      Neighbor allocation failures:0
      LSA allocation failures:0
      LSA HDR allocation failures:0
      DB Request allocation failures:0
      RTX allocation failures:0
      LS Ack allocation failures:0
      DD pkt allocation failures:0
      OSPF interface allocation failures:0
      OSPF general packet allocation failures:0
```

- Example 2

```
host1#show ipv6 ospf internal-statistics
Routing Process OSPFv3 1 with Router ID 1.1.1.1
 Internal OSPF Statistics, bytes allocated/free:
      LSA bytes allocated:                     39
      Router LSA bytes allocated:              1314774
      Summary bytes allocated:                 0
      Timers bytes allocated:                  96
      Ospf total bytes free:                   16
      Ospf heap total bytes allocated:         1000
 Internal OSPF Statistics, allocation failures:
      Neighbor allocation failures:            0
      LSA allocation failures:                 0
      LSA HDR allocation failures:             0
      DB Request allocation failures:          0
      RTX allocation failures:                 0
      LS Ack allocation failures:              0
      DD pkt allocation failures:              0
      OSPF interface allocation failures:      0
      OSPF general packet allocation failures: 0
```

show ip ospf neighbors

show ipv6 ospf neighbors

- Use to display information about OSPF neighbors on a per-interface basis.
- Use the optional *areaId* or *areaIdInt* values, in the **show ipv6 ospf neighbors command**, to specify an OSPFv3 area ID in either IP or decimal format.
- You can use the **history** keyword with the **show ip ospf neighbors** command to display a history of up to 10 events for all OSPF neighbors or a specific OSPF neighbor. This neighbor uptime tracking feature is not available for OSPFv3. For more information, see *Neighbor Uptime Tracking* on page 286.
- Field descriptions
  - Neighbor ID—Neighbor's router ID
  - Pri—Router priority of neighbor
  - State—OSPF neighbor's state
    - DR—Designated router
    - BDR—Backup designated router
    - DR Other—Neighbor to a designated router or a backup designated router
  - Dead Time—Interval since last hello packet from neighbor
  - Address—IP address of the neighbor's interface
  - Intf ID—Interface ID of the neighbor's interface
  - Interface—Name of the specified interface and its port number
  - Transition log—List of transitions events for a neighbor
  - Interface—Interface for the neighbor
  - Event—Transition event
  - Cause—Cause of transition event
  - Time—Time stamp for the event in *day month date HH*:*MM*:*SS* format
- Example 1

```
host1#show ip ospf neighbors
    Neighbor ID  Pri  State             Dead Time     Address    Interface
10.0.8.1     1    TWO-WAY/DR Other  00:00:39      10.0.76.1  fastEthernet11/0
10.0.71.1    1    FULL/DR           00:00:42      10.0.76.2  fastEthernet11/0
10.0.96.1    1    FULL/BDR          00:00:28      10.0.76.4  fastEthernet11/0
```

- Example 2

```
host1#show ipv6 ospf neighbors
    Neighbor ID  Pri  State            Dead Time Intf ID     Interface
1.1.1.1      1    TWO-WAY/DROTHER  00:00:40  0x3200042a  FastEthernet13/1.172
3.3.3.3      1    FULL/BDR         00:00:40  0x32000494  FastEthernet13/1.172
4.4.4.4      1    FULL/DR          00:00:40  0x320004c9  FastEthernet13/1.172
```

- Example 3

```
host1#show ip ospf neighbors history
Transition log for neighbor 10.10.8.2:
Interface           Event Cause           Time
==============================================
ATM2/0.8            Seen  NA              WED DEC 14 07:02:27

Transition log for neighbor 10.10.12.2:
Interface           Event Cause           Time
==============================================
ATM2/0.12           Seen  NA              WED DEC 14 07:09:12
ATM2/0.12           DOWN  Interface down  WED DEC 14 07:05:47
ATM2/0.12           Seen  NA              WED DEC 14 07:02:32
```

show ip ospf remote-neighbor interface

- Use to display all interfaces that are associated with OSPF remote neighbors.
- Field descriptions
  - OSPF remote-neighbor—Remote neighbor address for this interface
  - Update-source—Update source for this interface
  - Remote-neighbor reachable—Reachable status of the remote neighbor, yes or no
  - Area—Area of this interface
  - Network type—Network type for this interface
  - Cost—Cost value for this interface
  - Transmit Delay—Transmit delay for this interface, in seconds
  - Interface State—Interface state
  - Priority—Priority value for this interface
  - Designated router—Designated router on this network, if any
  - Backup designated router—Backup designated router on this network, if any
  - Hello—Hello timer value, in seconds
  - Dead—Dead interval timer value, in seconds
  - Wait—Wait interval timer value, in seconds
  - Retransmit—Retransmit interval timer value, in seconds
  - Neighbor Count—Number of neighbors to this interface
  - Adjacent neighbor count—Number of adjacent neighbors to this interface
  - Adjacent with neighbor—Address of the neighbor adjacent to this interface
- Example

```
host1#show ip ospf remote-neighbor interface
OSPF remote-neighbor 221.221.221.221 interface configuration:
 Update-source loopback0
 Remote-neighbor reachable: yes
 Area 0.0.0.0
 Network type POINT-TO-POINT, No authentication
 Cost: 1
```

```
 Transmit Delay is 1 sec, Interface State POINT-TO-POINT, Priority 1
 No designated router on this network
 No backup designated router on this network
 Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
 Neighbor Count is 1, Adjacent neighbor count is 1
  Adjacent with neighbor 221.221.221.221
```

show ip ospf spf-log

- Use to display how often and why the router has run a full SPF calculation.
- Field descriptions
  - Intra SPF log—Log for SPF calculations run to compute intra-area LSAs
  - Inter SPF log—Log for SPF calculations run to compute interarea LSAs
  - External SPF log—Log for SPF calculations run to compute routes outside the OSPF routing domain
  - When—Amount of time since a full SPF calculation took place, in *hours:minutes:seconds*; the previous 20 calculations are logged
  - Duration—Number of milliseconds to complete this SPF run; the elapsed time is in actual clock time, not CPU time
  - LSA Router Id—Whenever a full SPF calculation is triggered by a new LSA, the router ID is stored in the router
  - Triggers—List of reasons that triggered a full SPF calculation
- Example

```
host1#show ip ospf spf-log

Intra SPF log
When     Duration      LSA Router Id    Triggers
00:04:42 0.000         23.23.23.3       Protocol Off
00:04:38 0.000         23.23.23.3       LSA Add
00:04:34 0.000         12.12.12.2       LSA Add
00:04:30 0.010         23.23.23.3       LSA Update
00:03:51 0.000         23.23.23.3       Protocol Off
00:03:47 0.000         23.23.23.3       LSA Add
00:03:43 0.000         12.12.12.2       LSA Add
00:03:39 0.000         23.23.23.3       LSA Update

Inter SPF log
When     Duration      LSA Router Id    Triggers
00:04:46 0.010         23.23.23.3       Protocol Off
00:04:42 0.000         23.23.23.3       LSA Add
00:04:38 0.000         12.12.12.2       LSA Add
00:04:34 0.000         23.23.23.3       LSA Update
00:03:55 0.000         23.23.23.3       Protocol Off
00:03:51 0.000         23.23.23.3       LSA Add
00:03:47 0.000         12.12.12.2       LSA Add
00:03:43 0.000         23.23.23.3       LSA Update
```

```
External SPF log
When     Duration      LSA Router Id    Triggers
00:04:47 0.000         23.23.23.3       Protocol Off
00:04:43 0.000         23.23.23.3       LSA Add
00:04:39 0.000         12.12.12.2       LSA Add
00:04:35 0.010         23.23.23.3       LSA Update
00:03:56 0.000         23.23.23.3       Protocol Off
00:03:52 0.000         23.23.23.3       LSA Add
00:03:48 0.000         12.12.12.2       LSA Add
00:03:44 0.000         23.23.23.3       LSA Update
```

show ipv6 ospf summary-prefix

- Use to display summary prefixes configured to summarize externals.
- Example

```
host1#show ipv6 ospf summary-prefix
Summary Prefixes
4:: / 64
5:: / 64
```

show ipv6 ospf traffic

- Use to display OSPFv3 packet statistics.
- Use the **delta** keyword to display statistics relative to the current baseline.
- Field descriptions
  - Rcvd
    - total—Total number of packets received
    - checksum errors—Total number of packets received that contained checksum errors
    - hello—Total number of hello packets received
    - database desc—Total number of database description packets received
    - link state req—Total number of link-state request packets received
    - link state updates—Total number of link-state update packets received
    - link state acks—Total number of link-state acknowledge packets received
  - Sent
    - total—Total number of sent packets
    - pkts dropped—Total number of packets dropped
    - hello—Total number of hello packets sent
    - database desc—Total number of database description packets sent
    - link state req—Total number of link-state request packets sent
    - link state updates—Total number of link-state update packets sent
    - link state acks—Total number of link-state acknowledge packets sent
  - LSA discard count—Total number of packets discarded

- Example

```
host1#show ipv6 ospf traffic
OSPFv3 Statistics:
      Rcvd: 249 total, 0 checksum errors
            242 hello, 2 database desc, 1 link state req
            4 link state updates, 1 link state acks
      Sent: 251 total, 0 pkts dropped
            242 hello, 3 database desc, 1 link state req
            4 link state updates, 1 link state acks
      LSA discard count: 0
```

show ip ospf virtual-links

- Use to display the parameters and the current state of OSPF virtual links.
- Field descriptions
  - Virtual link to router—OSPF neighbor and the current state of the virtual link
  - Transmit Delay—Time (in seconds) between transmissions from the specified interface
  - Timer intervals—Timer intervals (in seconds) configured for the link: Hello, Dead, and Retransmit
- Example

```
host1#show ip ospf virtual-links
Virtual link to router 192.168.1.13 in state POINT-TO-POINT
Transmit Delay is 1 sec
Timer intervals configured, Hello 10 sec, Dead 40 sec, Retransmit 5 sec
```