

# OSPFv3 for IPv6

## Feature Overview and Configuration Guide

### OSPFv3 Introduction

This guide introduces OSPFv3 followed by basic configuration examples. OSPFv3 is documented in RFC 2740 and is in essence OSPFv2 with changes and additions necessary for OSPF's operation within an IPv6 network. This introduction focuses on the differences between the two protocol versions, rather than to re-introduce OSPF as a routing method.

### Products and software version that apply to this guide

This guide applies to AlliedWare Plus™ products that support OSPFv3, running version 5.4.4 or later.

To see whether your product supports OSPFv3, see the following documents:

- The [product's Datasheet](#)
- The [AlliedWare Plus Datasheet](#)
- The product's [Command Reference](#)

These documents are available from the above links on our website at [alliedtelesis.com](http://alliedtelesis.com).

Feature support may change in later software versions. For the latest information, see the above documents.



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## Licensing

An AlliedWare Plus™ license may be required to use OSPFv3 on your product. For further information refer to:

- The product's Datasheet
- the Licensing Feature Overview Guide.

## Differences Between OSPFv2 and OSPFv3

Whilst the fundamental principles of OSPFv2 are maintained from those standardized for OSPF with IPv6 (OSPFv3), the following items, listed below, represent the major areas that are applied differently for OSPFv3. For more detail refer to RFC 2740 (OSPF for IPv6).

- Protocol processing applied per-link rather than per-subnet
- Removed address semantics
- Neighbors are identified by Router ID
- Link-local flooding scope for link state advertisements
- Uses link-local addresses
- Support for multiple instances per link
- Unknown LSAs are handled more effectively
- Authentication relies on IPsec features within the IPv6 protocol, rather than integrated authorization within the OSPF protocol itself (as is done for OSPFv2).
- Modified packet types
- Modified LSA types
- No support for IPv4

The following sections expand on these points.

### Protocol processing applied per-link rather than per-subnet

OSPFv3 nodes use links to communicate at the link layer. You can also assign multiple subnets, and multiple IPv6 addresses, to a single link. In addition, two nodes can be assigned to and communicate over the same link without having to share the same subnet.

Thus the term **link** can be compared with the OSPFv2 terms **network** and **subnet**. This change has resulted in changes within the Hello packets and Network Link State Advertisements (LSAs).

In OSPFv2, the Router LSAs and Network LSAs contain IP address information. The Network LSA's LSID (along with the mask) identifies the IP subnet in use on the network in question.

The link entries in Router LSAs contain the IP addresses in use on the link. So, these OSPFv2 LSAs contain both topological information (who is connected to who) and address information (what IP addresses are in use on these topological connections).

In the development of OSPFv3, recognition has been given to the fact that multiple address ranges can co-exist on the same physical network segment. To accommodate this situation, OSPFv3 works by advertising just topological information in Router and Network LSAs, and advertising address information in quite separate LSAs (new LSA types that did not exist in OSPFv2). In this way, the

SPF calculation can work out the optimal topology, and then the IPv6 subnets in use on the different segments of the network can be separately overlaid on that topology.

You can configure multiple IPv6 addresses on an OSPFv3 link. None of the addresses are defined as secondary addresses, as is the case with IPv4. Two routers are adjacent even if no IPv6 prefix is common between the neighbors, except the link-local address. This is different from OSPFv2 for IPv4, in which OSPFv2 neighbors only become adjacent if the neighbors belong to the same IP subnet.

## Removed address semantics

Address semantics have been removed from OSPFv3 protocol packets and network Link State Advertisements (LSAs).

The intention of this change is to enable the core features to be protocol independent. The major changes in this respect are described below:

**Note:** Although the 32 bit Router and ID fields still exist in IPv6 packets, and can still be entered in dotted decimal format, for OSPFv3, they are simply 32-bit-long labels, which no longer represent IP addresses

## Neighbors are identified by router ID

OSPFv2 neighbors were identified by IPv4 addresses on multipoint networks and by router ID on point-to-point networks. OSPFv3 removes this inconsistency by identifying all neighbors by their router ID.

## Intra-Area prefix LSA

An intra-Area-prefix LSA can be a companion to a Router LSA or to a Network LSA (some fields in the intra-Area-prefix LSA identify the particular Router or Network LSA to whom it is a companion). The purpose of the intra-Area prefix LSA is to carry the address information relating to its companion LSA.

## Link-local flooding scope for link state advertisements

OSPFv3 contains the following flooding scopes:

- Area scope flooding (in OSPFv2)
- Autonomous System (AS) flooding (in OSPFv2)
- Link-local flooding (new in OSPFv3)

OSPFv3 adds the Link LSA for carrying information that is only relevant to neighbors on a single link.

## Uses link-local unicast addresses

On all OSPF interfaces except virtual links, OSPF packets are sent using the interface's associated link-local unicast address as the source address.

OSPFv3 uses a router's link-local IPv6 address as the source address and as next-hop address.

## Explicit notification of flooding scope

OSPFv3 introduces a field to the LSA header that explicitly states the flooding scope of the LSA.

## Standard authentication mechanisms

OSPFv3 utilizes the IPv6 IPsec standard which supports authentication Header (AH) and Encapsulation Security Payload (ESP). OSPFv3 messages are encapsulated by either AH, ESP, or both headers, which provides integrity, authentication and confidentiality. Note that these encryption and authentication processes are not specific to OSPFv3, but are generic capabilities within IPv6.

## Support provided for multiple OSPF instances per link

An Instance field has been added to OSPFv3 Hello and LSA packets. By assigning separate **instances**, multiple routers to be attached to a single broadcast link in such a way that separate adjacencies may be configured for selected router groups. See "[Configuring instances and processes](#)" on page 34.

For example: four routers are attached to an Ethernet link. Routers 1 and 2 belong to one OSPF instance, and routers 3 and 4 belong to a different OSPF instance. There are adjacencies between 1 and 2 and between 3 and 4, but not between 1 and 3.

## Unknown LSAs are handled more effectively

In OSPFv2 routers discarded unknown LSA types. In OSPFv3 unknown LSA types are given either link-local flooding scope, or are stored and flooded as if being understood. The options determining which action to take, and flooding scope, is contained in components within the LSA type field.

# LSAs in OSPFv3

## The format for the LSType field

In OSPFv2, the LSType is simply a 2-byte field that holds a number indicating what type of LSA this is. The LSType for a Router LSA is 1, for a Network LSA is 2, and so on.

In OSPFv3, the LSType field has 16 bits, so that it can include some new flags.

- U is the flag that indicates how to handle this LSA if the router does not recognize its type.
- S1, S2 are the two bits that make up the indicator of the LSA's flooding scope.

OSPFv3 introduces two new LSA types, both of which assist with the separation of topology and addressing. The two new LSA types are:

- Link LSA
- Intra-Area Prefix LSA

The following table contains the standard OSPFv3 LSA types:

Table 1: Standard OSPFv3 LSA Types

LSA FUNCTION	LS TYPE	DESCRIPTION
1	0x2001	Router-LSA
2	0x2002	Network-LSA
3	0x2003	Inter-Area-Prefix-LSA
4	0x2004	Inter-Area-Router-LSA
5	0x2005	AS-External-LSA
6	0x2006	Group-membership-LSA
7	0x2007	Type-7-LSA
8	0x2008	Link-LSA
9	0x2009	Intra-Area-Prefix-LSA

## Link LSA

Despite its name, the Link LSA does not end up being a topological entity in the SPF calculation. Instead, it is an entity that enables a router to send its interface address(es), and other information, to its neighbor routers on a given link.

The Link LSA is just a way of filling in other routers with the information they will not have got from the router's Router LSA.

Each interface of a router is attached to a different link. A router will advertise a different Link LSA out each of its interfaces. The main difference between the Link LSA that a router sends on one link and that which sends on another link are the interface addresses that it contains.

Each different Link LSA originated by a router will contain the addresses of the interface out of which the Link LSA is advertised.

In fact, the Link LSA has three information-sharing purposes:

1. To let other routers on a link know the link-local address of the originating router. Then, when those routers need to put a next-hop address onto the routes that they calculate to be via this router, they know what link-local address to use as that next-hop.

You might be thinking “**Well, won’t the other routers on the link learn this router’s link-local LSA from the source address of its Hello packets?**”. In fact, most of the time they will. But in NBMA networks, it is possible that not all routers on the same link (well, in the same subnet) will receive each others’ Hello packets. But, the Designated Router is responsible for ensuring that they all see each other’s Link LSAs.

2. To advertise the IPv6 prefix(es) that the router has been configured with on the interface which is transmitting the Link LSA. In particular, this informs the Designated Router which Prefix(es) the originating router has. The Designated Router needs to keep a list of all the Prefixes in use on its link, so it can advertise this in an Intra-Area Prefix LSA.
3. To send the router’s option values to the Designated Router. Each router on a link effectively tells the Designated Router “**These are my option values; please take note of them when you work out what to send in the Network LSA**”. The Designated Router accumulates all the option values it receives from its neighbors on the link. Then, when it needs to fill in the Options field in its Network LSA, it performs a logical OR on all the Options fields it has received in the Link LSAs from the neighbors on the link that the Network LSA represents. Effectively, if any router on a given link has a “1” for any given option, then the Network LSA for that link will have a “1” for that option.

## Intra-Area Prefix LSA

Because the Router and Network LSAs do not carry around any address information, then some other LSA has to do that job for them. The LSA that picks up the slack is the Intra-Area Prefix LSA.

Every router originates zero or more Intra-Area Prefix LSAs to advertise the addresses on some of the links that are advertised in its Router LSA(s). The rules about which links’ addresses are included are discussed below.

Every router that is a Designated Router on a Broadcast or NBMA segment originates one or more Intra-Area Prefix LSAs to advertise the addresses that it has learnt are in use on that segment.

## Comparison of OSPFv3 and OSPFv2 LSAs

OSPF V3 LSA		OSPF V2 LSA	
LS Type	Name	Type	Name
0x2001	Router LSA	1	Router LSA
0x2002	Network LSA	2	Network LSA
0x2003	Inter-Area Prefix LSA	3	Network Summary LSA
0x2004	Inter-Area Router LSA	4	ASBR Summary LSA

OSPF V3 LSA		OSPF V2 LSA	
0x2005	AS-External LSA	5	AS-External LSA
0x2006	Group Membership LSA	6	Group Membership LSA
0x2007	Type-7 LSA	7	NSSA External LSA
0x2008	Link LSA	No corresponding LSA	
0x2009	Intra-Area Prefix LSA	No corresponding LSA	

# OSPFv3 Authentication and Encryption Overview

To ensure that OSPFv3 packets are not modified, and are not being spoofed, configure OSPFv3 authentication and encryption on your devices.

OSPFv2 defines the AuType and Authentication fields in its protocol header to provide security. In OSPFv3, these OSPFv2 authentication fields were removed from OSPF headers. OSPFv3 requires the IPv6 AH (Authentication Header) to provide authentication of routing information exchanges, and OSPFv3 requires the IPv6 **ESP** (Encapsulating Security Payload) header to provide encryption of routing information exchanges.

OSPFv3 authentication and encryption is specified in RFC 4552 "Authentication/Confidentiality for OSPFv3". RFC 4552 describes the AH/ESP extension headers. See the section "[Configuring OSPFv3 Authentication and Encryption](#)" on page 46 for OSPFv3 authentication and encryption configurations and topologies.

## OSPFv3 authentication and encryption support

The IPv6 ESP header may be applied alone or in combination with the IPv6 AH header. When IPv6 ESP is used, both encryption and authentication are provided.

- Apply the IPsec AH header for OSPFv3 authentication using the **ipv6 ospf authentication spi** command.
- Apply the IPsec ESP header for OSPFv3 encryption using the **ipv6 ospf encryption spi esp** command.
- Confirm OSPFv3 authentication and encryption configuration using the **show ipv6 ospf** and **show debugging ipv6 ospf** commands.

When you only configure the IPv6 ESP header alone with the **ipv6 ospf encryption spi esp** command, note that both encryption and authentication are provided in IPsec ESP headers. You can apply IPv6 ESP headers alone or in combination with IPv6 AH headers.

If you configure IPv6 AH or IPv6 ESP headers for an OSPFv3 Area, note that authentication or encryption is applied to all of the interfaces in the OSPFv3 Area, except for any interfaces which had direct configuration of OSPFv3 authentication and/or encryption.

The authentication algorithms listed below are supported in AlliedWare Plus OSPFv3 authentication as parameter options in the **ipv6 ospf authentication spi** command:

- MD5 (Message Digest Algorithm 5)
- SHA-1 (Secure Hash Algorithm 1)

The encryption algorithms listed below are supported in the AlliedWare Plus OSPFv3 encryption as parameter options in the **ipv6 ospf encryption spi esp** command:

- AES (Advanced Encryption Standard)
- 3DES (Triple Data Encryption Standard)
- NULL (ESP without encryption)

See the sections listed below when configuring OSPFv3 authentication and encryption:

- ["Configuring OSPFv3 authentication on a VLAN" on page 48](#)
- ["Configuring OSPFv3 encryption on a VLAN" on page 48](#)
- ["Configuring OSPFv3 authentication in an OSPFv3 Area" on page 48](#)
- ["Configuring OSPFv3 encryption in an OSPFv3 Area" on page 49](#)

See the sample configurations listed below with topologies that accompany these sections:

- ["OSPFv3 authentication in an OSPFv3 Area" on page 51](#)
- ["OSPFv3 encryption in an OSPFv3 Area" on page 52](#)
- ["OSPFv3 authentication on a VLAN" on page 54](#)
- ["OSPFv3 encryption on a VLAN" on page 55](#)
- ["OSPFv3 authentication with two VLANs" on page 57](#)
- ["OSPFv3 encryption with two VLANs" on page 59](#)

## Authentication and encryption on OSPFv3 virtual links

OSPFv3 authentication and encryption on virtual links requires some restriction on how the source IPv6 address that is used on packets sent over the virtual link is chosen. For non-virtual links, IPv6 link-local addresses are used in packet headers. For virtual links, OSPFv3 uses non-link-local addresses, since packets are routed over intermediate routers.

A router does not necessarily have just one IPv6 address to choose from when deciding the source IPv6 address to use. A router may have more than one IPv6 address on the interfaces that connect it to the virtual link's transit area.

Without OSPFv3 authentication and encryption, multiple IPv6 addresses are not a problem. But multiple IPv6 addresses are a problem with OSPFv3 authentication and encryption, because the calculation of security parameters depends on knowing the addresses being used on both ends of the link.

Before IPv6 packets are exchanged over an OSPFv3 virtual link, the security parameters for the virtual link must be calculated. To calculate the security parameters, the router must know the source and destination addresses that will be used for OSPFv3 packets sent over the link.

A router knows what source IPv6 address it will use, and it knows the destination IPv6 address that it will send the packets to, since RFC 2740 (OSPF for IPv6) defines which of a virtual neighbor's addresses to use. However, a router cannot be sure what IPv6 address its virtual neighbor will use, since RFC 2740 does not specify the choice of source IPv6 address.

To remove any uncertainty, routers that implement OSPFv3 authentication and encryption over virtual links ensure that the source IPv6 address of the packets they send over the virtual link is the same IPv6 address that their neighbor will use as a destination IPv6 address for its packets. Then, IPv6 addresses that will be used over the virtual link are predictable. So, the security parameters can be calculated before the packet exchange begins.

If the IPv6 address at either end of the OSPFv3 virtual link changes, then the existing security parameters are discarded, before new security parameters are calculated.

- Apply the OSPFv3 authentication virtual link authentication using the **area virtual-link authentication ipsec spi** command.
- Apply the OSPFv3 virtual link encryption using the **area virtual-link encryption ipsec spi** command.
- Confirm OSPFv3 virtual link authentication and encryption configuration using the **show ipv6 ospf virtual-links** command.

See the section listed below when configuring OSPFv3 Virtual Links:

- ["Configuring OSPFv3 authentication and encryption for a Virtual Link" on page 49](#)

See sample configurations listed below with topologies that accompany this section:

- ["OSPFv3 authentication for a Virtual Link" on page 62](#)
- ["OSPFv3 encryption for a Virtual Link" on page 64](#)

# Configuring OSPFv3

The following examples show firstly the configuration for a basic three-switch single-Area OSPFv3 network. This network is then modified to become a two-Area network.

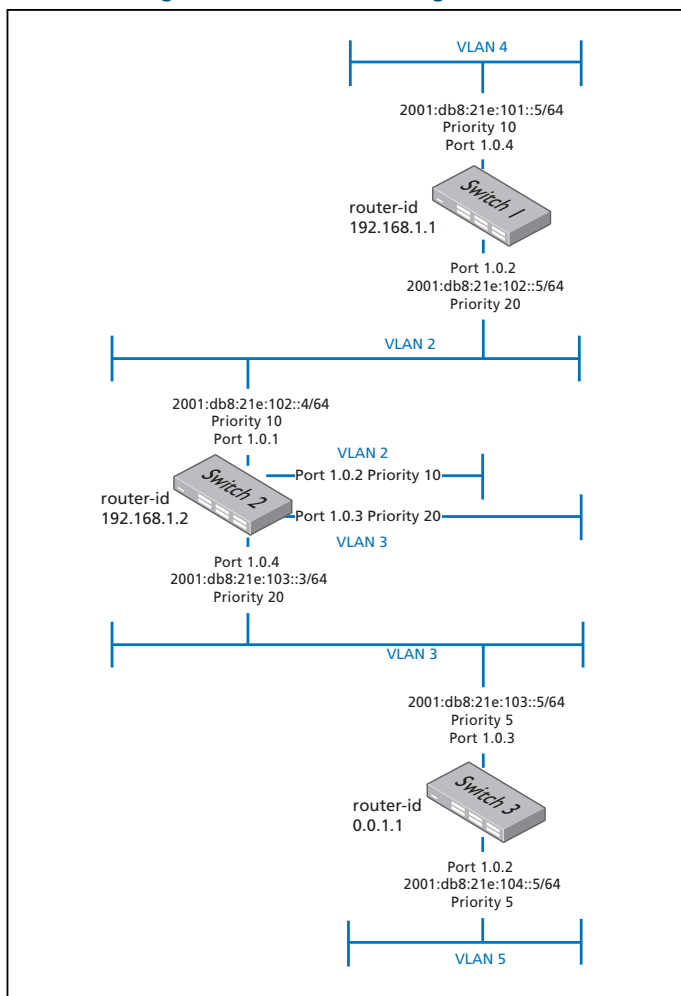
The configuration command sequences shown are presented for understanding, and do **not** necessarily represent the most efficient configuration method.

**Note:** The IPv6 addresses shown use the address space 2001:0db8::/32, defined in RFC 3849 for documentation purposes. These addresses should not be used for practical networks (other than for testing purposes) nor should they appear on any public network.

## Example 1: Single-Area Network Configuration

Figure 1 below shows a basic three-switch, single-Area configuration. Setting the priority value of 20 to VLAN 2 on switch 1 and the priority value 10 on switch 2, will ensure that switch 1 will become the Designated Router for this VLAN. Similarly, the priority settings on VLAN 3, of 20 on switch 2, and 5 on switch 3, will ensure that switch 2 becomes the Designated Router for VLAN 3.

Figure 1: Basic single-Area OSPFv3 configuration



## Switch 1 configuration (single-Area network)

Table 2: Example 1—single-Area network configuration—Switch 1

<b>Step 1. Enable the OSPF6 service. Create and enable VLANs</b>	
<code>awplus# configure terminal</code>	Enter Global Configuration mode.
<code>awplus# service ospf6</code>	Enable the OSPFv3 service for IPv6.
<code>awplus (config) # vlan database</code>	Enter VLAN database mode.
<code>awplus (config-vlan) # vlan 2,4 state enable</code>	Create and enable VLANs 2 and 4.
<code>awplus (config-vlan) # exit</code>	Return to Global Configuration mode.
<b>Step 2. For VLAN 4, assign IPv6 addresses and configure OSPF</b>	
<code>awplus (config) # interface vlan4</code>	Select VLAN 4 for configuring.
<code>awplus (config-if) # ipv6 address 2001:db8:21e:101::5/64</code>	Assign an IPv6 address to VLAN 4.
<code>awplus (config-if) # ipv6 router ospf area 0 tag process1</code>	Assign VLAN 4 to OSPF Area 0. In this configuration, any address within the subnet 2001:db8:21e:101::/64 will be part of OSPF Area 0.
<p>Note that the tag named “process1” denotes a separate router process. Its name can comprise any string of alphanumeric characters. Also note that this tag is local to the router on which it is set and does not appear in any OSPF packets or LSAs. For more information on processes and instances, see <a href="#">"Configuring instances and processes"</a> on page 34.</p>	
<code>awplus (config-if) # ipv6 ospf priority 10</code>	Set the priority for the router to become the Designated Router for a particular VLAN. The router with the highest priority becomes the Designated Router for that VLAN. Defaults to 1.
<code>awplus (config-if) # exit</code>	Return to Global Configuration mode.
<b>Step 3. For VLAN 2, assign IPv6 addresses and configure OSPF</b>	
<code>awplus (config) # interface vlan2</code>	Select VLAN 2 for configuring.
<code>awplus (config-if) # ipv6 address 2001:db8:21e:102::5/64</code>	Assign an IPv6 address to VLAN 2.

Table 2: Example 1—single-Area network configuration—Switch 1 (continued)

<pre>awplus(config-if)# ipv6 router ospf area 0 tag process1</pre>	<p>Assign VLAN 2 to OSPF Area 0.</p> <p>In this configuration, any address within the subnet 2001:db8:21e:102::/64 will be part of OSPF Area 0.</p>
<pre>awplus(config-if)# ipv6 ospf priority 20</pre>	<p>Set the priority for the router to become the designated router for a particular VLAN. The router with the highest priority becomes the Designated Router for that VLAN. Defaults to 1.</p>
<p><b>Step 4. Configure switch ports and assign them to their VLANs</b></p>	
<pre>awplus(config)# interface port1.0.4</pre>	<p>Select port 1.0.4 for configuring.</p>
<pre>awplus(config-if)# switchport access vlan 4</pre>	<p>Assign port 1.0.4 to VLAN 4.</p>
<pre>awplus(config-if)# exit</pre>	<p>Return to Global Configuration mode.</p>
<pre>awplus(config)# interface port1.0.2</pre>	<p>Select port 1.0.2 for configuring.</p>
<pre>awplus(config-if)# switchport access vlan 2</pre>	<p>Assign port 1.0.2 to VLAN 2.</p>
<pre>awplus(config-if)# exit</pre>	<p>Return to Global Configuration mode.</p>
<p><b>Step 5. Set router ID and allocate hardware table space</b></p>	
<pre>awplus# configure terminal</pre>	<p>Enter the Global Configuration mode.</p>
<pre>awplus(config)# platform routingratio ipv4andipv6</pre>	<p>Allocate hardware table resources to IPv6 if necessary, on products that allow you to control the memory allocation. Note that <b>ipv4andipv6</b> is the default platform routing ratio.</p>
<pre>awplus(config)# router ipv6 ospf process1</pre>	<p>Configure an IPv6 OSPF routing process.</p>
<pre>awplus(config-router)# router-id 192.168.1.1</pre>	<p>Set the router ID.</p>
<pre>awplus(config-router)# passive-interface vlan4</pre>	<p>Configure VLAN 4 as a passive interface to suppress IPv6 OSPF routing updates.</p>
<pre>awplus(config-router)# exit</pre>	<p>Return to Global Configuration mode.</p>

Table 2: Example 1—single-Area network configuration—Switch 1 (continued)

<code>awplus (config) # ipv6 forwarding</code>	Turn on IPv6 forwarding.
<code>awplus (config) # exit</code>	Return to Privileged Exec mode.

## Switch 2 configuration (single-Area network)

Table 3: Example 1—single-Area network configuration—Switch 2

<b>Step 1. Enable the OSPF6 service. Create and enable VLANs 2 and 3</b>	
<code>awplus# configure terminal</code>	Enter Global Configuration mode.
<code>awplus# service ospf6</code>	Enable the OSPFv3 service for IPv6.
<code>awplus (config) # vlan database</code>	Enter VLAN database mode.
<code>awplus (config-vlan) # vlan 2,3 state enable</code>	Create and enable VLANs 2 and 3.
<code>awplus (config-vlan) # exit</code>	Return to Global Configuration mode.
<b>Step 2. For VLAN 2, assign IPv6 addresses and configure OSPF</b>	
<code>awplus (config) # interface vlan2</code>	Select VLAN 2 for configuring.
<code>awplus (config-if) # ipv6 address 2001:db8:21e:102::4/64</code>	Assign an IPv6 address to VLAN 2.
<code>awplus (config-if) # ipv6 router ospf area 0 tag process1</code>	Assign VLAN 2 to OSPF Area 0. In this configuration, any address within the subnet 2001:db8:21e:102 will be part of OSPF Area 0.
<code>awplus (config-if) # ipv6 ospf priority 10</code>	Set the priority for the router to become the Designated Router for a particular VLAN. The router with the highest priority becomes the Designated Router for that VLAN. Defaults to 1.
<code>awplus (config-if) # exit</code>	Return to Global Configuration mode.
<b>Step 3. For VLAN 3, assign IPv6 addresses and configure OSPF</b>	
<code>awplus (config) # interface vlan3</code>	Select VLAN 3 for configuring.

Table 3: Example 1—single-Area network configuration—Switch 2 (continued)

<code>awplus (config-if) #     ipv6 address 2001:db8:21e:103::3/64</code>	Assign an IPv6 address to VLAN 3.
<code>awplus (config-if) # ipv6 router ospf area 0     tag process1</code>	Assign VLAN 3 to OSPF Area 0. In this configuration, any address within the subnet 2001:db8:21e:103 will be part of OSPF Area 0.
<code>awplus (config-if) # ipv6 ospf priority 20</code>	Set the priority for the router to become the Designated Router for a particular VLAN. The router with the highest priority becomes the Designated Router for that VLAN. Defaults to 1.
<b>Step 4. Configure switch ports and assign them to their VLANs</b>	
<code>awplus (config) # interface port1.0.1</code>	Select port 1.0.1 for configuring.
<code>awplus (config-if) # switchport access vlan 2</code>	Assign port 1.0.1 to VLAN 2.
<code>awplus (config-if) #     exit</code>	Return to Global Config mode.
<code>awplus (config) # interface port1.0.2</code>	Select port 1.0.2 for configuring.
<code>awplus (config-if) # switchport access vlan 2</code>	Assign port 1.0.2 to VLAN 2.
<code>awplus (config-if) #     exit</code>	Return to Global Configuration mode.
<code>awplus (config) # interface port1.0.3</code>	Select port 1.0.3 for configuring.
<code>awplus (config-if) # switchport access vlan 3</code>	Assign port 1.0.3 to VLAN 3.
<code>awplus (config-if) #     exit</code>	Return to Global Configuration mode.
<code>awplus (config) # interface port1.0.4</code>	Select port 1.0.4 for configuring.
<code>awplus (config-if) # switchport access vlan 3</code>	Assign port 1.0.4 to VLAN 3.
<b>Step 5. Set router ID and allocate hardware table space</b>	
<code>awplus # configure terminal</code>	Enter Global Configuration mode.

Table 3: Example 1—single-Area network configuration—Switch 2 (continued)

<pre>awplus (config) #     platform routingratioipv4andipv6</pre>	Allocate hardware table space resources to IPv6 if necessary, on products that allow you to control the memory allocation. Note that <b>ipv4andipv6</b> is the default platform routing ratio.
<pre>awplus (config) # router ipv6 ospf process1</pre>	Configure an IPv6 routing process.
<pre>awplus (config-router) # router-id 192.168.1.2</pre>	Set the router ID. Note that: <ul style="list-style-type: none"> <li>■ In this configuration, the router-id value 192.168.1.2 makes this switch most likely to be selected as the Designated Router.</li> </ul>
<pre>awplus (config) # ipv6 forwarding</pre>	Turn on IPv6 forwarding.
<pre>awplus (config) # exit</pre>	Return to Privileged Exec mode.

### Switch 3 configuration (single-Area network)

Table 4: Example 1—single-Area network configuration—Switch 3

<b>Step 1. Enable the OSPF6 service. Create and enable VLANs 3 and 5</b>	
<pre>awplus# configure terminal</pre>	Enter Global Configuration mode.
<pre>awplus# service ospf6</pre>	Enable the OSPFv3 service for IPv6.
<pre>awplus (config) # vlan database</pre>	Enter VLAN database mode.
<pre>awplus (config-vlan) # vlan 3,5 state enable</pre>	Create and enable VLANs 3 and 5.
<pre>awplus (config-vlan) # exit</pre>	Return to Global Configuration mode.
<b>Step 2. For VLAN 3, assign IPv6 addresses and configure OSPF</b>	
<pre>awplus (config) # interface vlan 3</pre>	Select VLAN 3 for configuring.
<pre>awplus (config-if) # ipv6 address 2001:db8:21e:103::5/64</pre>	Assign an IPv6 address to VLAN 3.
<pre>awplus (config-if) # ipv6 router ospf area 0 tag process1</pre>	Assign VLAN 3 to OSPF Area 0. In this configuration, any address within the subnet 2001:db8:21e:103: :/64 will be part of OSPF Area 0.

Table 4: Example 1—single-Area network configuration—Switch 3 (continued)

<code>awplus (config-if) # ipv6 ospf priority 5</code>	Set the priority for the router to become the Designated Router for a particular VLAN. The router with the highest priority becomes the Designated Router for that VLAN. Defaults to 1.
<code>awplus (config-if) # exit</code>	Return to Global Configuration mode.
<b>Step 3. For VLAN 5, assign IPv6 addresses and configure OSPF</b>	
<code>awplus (config) # interface vlan5</code>	Select VLAN 5 for configuring.
<code>awplus (config-if) # ipv6 address 2001:db8:21e:104::5/64</code>	Assign an IPv6 address to VLAN 5.
<code>awplus (config-if) # ipv6 router ospf area 0 tag process1</code>	Assign VLAN 5 to OSPF Area 0. In this configuration, any address within the subnet 2001:db8:21e:104: :/64 will be part of OSPF Area 0.
<code>awplus (config-if) # ipv6 ospf priority 5</code>	Set the priority for the router to become the Designated Router for a particular VLAN. The router with the highest priority becomes the Designated Router for that VLAN. Defaults to 1.
<b>Step 4. Configure switch ports and assign them to their VLANs</b>	
<code>awplus (config) # interface port1.0.3</code>	Select port 1.0.3 for configuring.
<code>awplus (config-if) # switchport access vlan 3</code>	Assign port 1.0.3 to VLAN 3
<code>awplus (config-if) # exit</code>	Return to Global Configuration mode.
<code>awplus (config) # interface port1.0.2</code>	Select port1.0.2 for configuring.
<code>awplus (config-if) # switchport access vlan 5</code>	Assign port 1.0.2 to VLAN 5.
<code>awplus (config-if) # exit</code>	Return to Global Configuration mode.
<b>Step 5. Set router ID and allocate hardware table space</b>	
<code>awplus # configure terminal</code>	Enter Global Configuration mode.

Table 4: Example 1—single-Area network configuration—Switch 3 (continued)

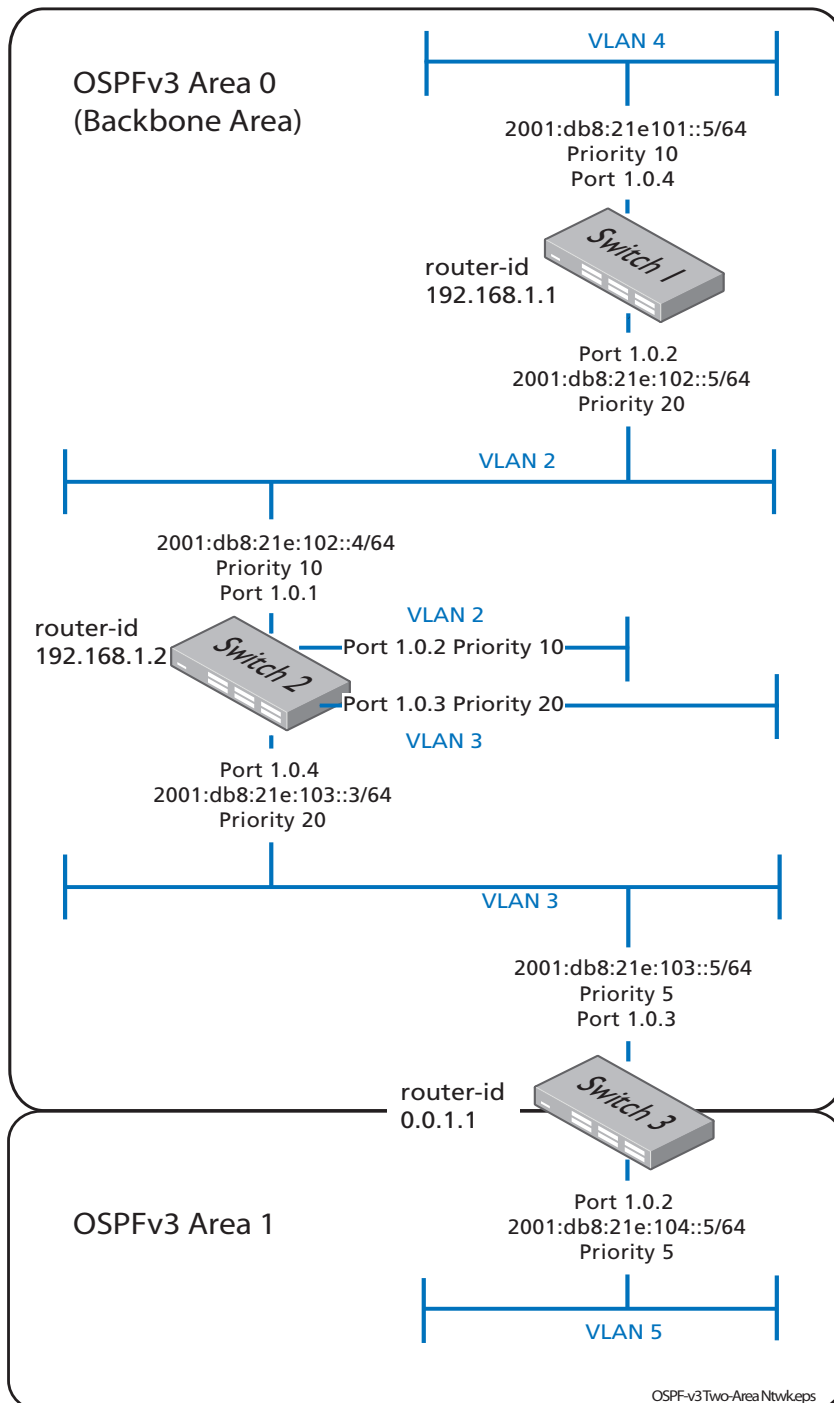
<pre>awplus (config) # platform routingratio   ipv4andipv6</pre>	<p>Allocate hardware table resources to IPv6 if necessary, on products that allow you to control the memory allocation. Note that <b>ipv4andipv6</b> is the default platform routing ratio.</p>
<pre>awplus (config) # router ipv6 ospf   process1</pre>	<p>Configure an IPV6 routing process.</p>
<pre>awplus (config-router) # router-id 0.0.1.1</pre>	<p>Set the router ID. Note that the router-id value 0.0.1.1 has been selected for the following reasons:</p> <ul style="list-style-type: none"> <li>■ so that it is unlikely to be selected as a Designated Router.</li> <li>■ to illustrate that it, although it has an IPv4 address format, it is not an IPv4 address.</li> </ul>
<pre>awplus (config-router) # passive-interface vlan5</pre>	<p>Configure VLAN 5 as a passive interface to suppress IPv6 OSPF routing updates.</p>
<pre>awplus (config-router) # exit</pre>	<p>Return to Global Configuration mode.</p>
<pre>awplus (config) # ipv6 forwarding</pre>	<p>Turn on IPv6 forwarding.</p>
<pre>awplus (config) # exit</pre>	<p>Return to Privileged Exec mode.</p>

## Example 2: Two-Area network configuration

Figure 2 below shows a basic three-switch, two-Area configuration. Setting the priority value of 20 to VLAN 2 on Switch 1 and to the value 10 on Switch 2 will ensure that Switch 1 will become the Designated Router for this VLAN. Similarly the priority settings on VLAN 3 of 20 on Switch 2, and 5 on Switch 3 will ensure that Switch 2 will become the Designated Router for VLAN 3.

Note that Switch 3 now becomes the Area Border router for Areas 0 and 1.

Figure 2: Basic two-Area OSPFv3 configuration



The commands used to configure this two-Area network are the same as those used in the previous example, except for the configuration of VLAN 5 on switch 3, which now becomes part of Area 1. The revised configuration for switch 3 and VLAN 5 is shown below.

### Switch 1 configuration (two-Area network)

Table 5: Example 2—two-Area network configuration—Switch 1

<b>Step 1. Enable the OSPF6 service. Create and enable VLANs</b>	
<code>awplus# configure terminal</code>	Enter Global Configuration mode.
<code>awplus# service ospf6</code>	Enable the OSPFv3 service for IPv6.
<code>awplus (config) # vlan database</code>	Enter VLAN database mode.
<code>awplus (config-vlan) # vlan 2,4 state enable</code>	Create and enable VLANs 2 and 4.
<code>awplus (config-vlan) # exit</code>	Return to Global Configuration mode.
<b>Step 2. For VLAN 4, assign IPv6 addresses and configure OSPF</b>	
<code>awplus (config) # interface vlan4</code>	Select VLAN 4 for configuring.
<code>awplus (config-if) # ipv6 address 2001:db8:21e:101::5/64</code>	Assign an IPv6 address to VLAN 4.
<code>awplus (config-if) # ipv6 router ospf area 0 tag process1</code>	Assign VLAN 4 to OSPF Area 0. In this configuration, any address within the subnet 2001:db8:21e:101::/64 will be part of OSPF Area 0.
Note that the tag named “process1” denotes a separate router process. Its name can comprise any string of alphanumeric characters. Also note that this tag is local to the router on which it is set and does not appear in any OSPF packets or LSAs. For more information on processes and instances, see <a href="#">"Configuring instances and processes"</a> on page 34.	
<code>awplus (config-if) # ipv6 ospf priority 10</code>	Set the priority for the router to become the Designated Router for a particular VLAN. The router with the highest priority becomes the Designated Router for that VLAN. Defaults to 1.
<code>awplus (config-if) # exit</code>	Return to Global Configuration mode.
<b>Step 3. For VLAN 2, assign IPv6 addresses and configure OSPF</b>	
<code>awplus (config) # interface vlan2</code>	Select VLAN 2 for configuring.

Table 5: Example 2—two-Area network configuration—Switch 1 (continued)

<pre>awplus (config-if) #     ipv6 address     2001:db8:21e:102::5/64</pre>	Assign an IPv6 address to VLAN 2.
<pre>awplus (config-if) #     ipv6 router ospf area 0     tag process1</pre>	Assign VLAN 2 to OSPF Area 0. In this configuration, any address within the subnet 2001:db8:21e:102: :/64 will be part of OSPF Area 0.
<pre>awplus (config-if) #     ipv6 ospf priority 20</pre>	Set the priority for the router to become the designated router for a particular VLAN. The router with the highest priority becomes the Designated Router for that VLAN. Defaults to 1.
<b>Step 4. Configure switch ports and assign them to their VLANs</b>	
<pre>awplus (config) #     interface port1.0.4</pre>	Select port 1.0.4 for configuring.
<pre>awplus (config-if) #     switchport access vlan     4</pre>	Assign port 1.0.4 to VLAN 4.
<pre>awplus (config-if) #     exit</pre>	Return to Global Configuration mode.
<pre>awplus (config) #     interface port1.0.2</pre>	Select port 1.0.2 for configuring.
<pre>awplus (config-if) #     switchport access vlan     2</pre>	Assign port 1.0.2 to VLAN 2.
<pre>awplus (config-if) #     exit</pre>	Return to Global Configuration mode.
<b>Step 5. Set router ID and allocate hardware table space</b>	
<pre>awplus #     configure terminal</pre>	Enter the Global Configuration mode.
<pre>awplus (config) #     platform routingratio     ipv4andipv6</pre>	Allocate hardware table resources to IPv6 if necessary, on products that allow you to control the memory allocation. Note that <b>ipv4andipv6</b> is the default platform routing ratio.
<pre>awplus (config) #     router ipv6 ospf     process1</pre>	Configure an IPv6 OSPF routing process.
<pre>awplus (config-router) #     router-id 192.168.1.1</pre>	Set the router ID.
<pre>awplus (config-router) #     passive-interface vlan4</pre>	Configure VLAN 4 as a passive interface to suppress IPv6 OSPF routing updates.

Table 5: Example 2—two-Area network configuration—Switch 1 (continued)

awplus (config-router) # exit	Return to Global Configuration mode.
awplus (config) # ipv6 forwarding	Turn on IPv6 forwarding.
awplus (config) # exit	Return to Privileged Exec mode.

## Switch 2 configuration (two-Area network)

Table 6: Example 2 - two-Area network configuration—Switch 2

<b>Step 1. Enable the OSPF6 service. Create and enable VLANs 2 and 3</b>	
awplus# configure terminal	Enter Global Configuration mode.
awplus# service ospf6	Enable the OSPFv3 service for IPv6.
awplus (config) # vlan database	Enter VLAN database mode.
awplus (config-vlan) # vlan 2,3 state enable	Create and enable VLANs 2 and 3.
awplus (config-vlan) # exit	Return to Global Configuration mode.
<b>Step 2. For VLAN 2, assign IPv6 addresses and configure OSPF</b>	
awplus (config) # interface vlan2	Select VLAN 2 for configuring.
awplus (config-if) # ipv6 address 2001:db8:21e:102::4/64	Assign an IPv6 address to VLAN 2.
awplus (config-if) # ipv6 router ospf area 0 tag process1	Assign VLAN 2 to OSPF Area 0. In this configuration, any address within the subnet 2001:db8:21e:102 will be part of OSPF Area 0.
awplus (config-if) # ipv6 ospf priority 10	Set the priority for the router to become the Designated Router for a particular VLAN. The router with the highest priority becomes the Designated Router for that VLAN. Defaults to 1.
awplus (config-if) # exit	Return to Global Configuration mode.
<b>Step 3. For VLAN 3, assign IPv6 addresses and configure OSPF</b>	

Table 6: Example 2 - two-Area network configuration—Switch 2 (continued)

<code>awplus (config) #</code>	
<code>interface vlan3</code>	Select VLAN 3 for configuring.
<code>awplus (config-if) #</code>	
<code>ipv6 address 2001:db8:21e:103::3/64</code>	Assign an IPv6 address to VLAN 3.
<code>awplus (config-if) #</code>	
<code>ipv6 router ospf area 0</code>	Assign VLAN 3 to OSPF Area 0.
<code>tag process1</code>	In this configuration, any address within the subnet 2001:db8:21e:103 will be part of OSPF Area 0.
<code>awplus (config-if) #</code>	
<code>ipv6 ospf priority 20</code>	Set the priority for the router to become the Designated Router for a particular VLAN. The router with the highest priority becomes the Designated Router for that VLAN. Defaults to 1.
<b>Step 4. Configure switch ports and assign them to their VLANs</b>	
<code>awplus (config) #</code>	
<code>interface port1.0.1</code>	Select port 1.0.1 for configuring.
<code>awplus (config-if) #</code>	
<code>switchport access vlan 2</code>	Assign port 1.0.1 to VLAN 2.
<code>awplus (config-if) #</code>	
<code>exit</code>	Return to Global Config mode.
<code>awplus (config) #</code>	
<code>interface port1.0.2</code>	Select port1.0.2 for configuring.
<code>awplus (config-if) #</code>	
<code>switchport access vlan 2</code>	Assign port 1.0.2 to VLAN 2.
<code>awplus (config-if) #</code>	
<code>exit</code>	Return to Global Configuration mode.
<code>awplus (config) #</code>	
<code>interface port1.0.3</code>	Select port1.0.3 for configuring.
<code>awplus (config-if) #</code>	
<code>switchport access vlan 3</code>	Assign port 1.0.3 to VLAN 3.
<code>awplus (config-if) #</code>	
<code>exit</code>	Return to Global Configuration mode.
<code>awplus (config) #</code>	
<code>interface port1.0.4</code>	Select port1.0.4 for configuring.
<code>awplus (config-if) #</code>	
<code>switchport access vlan 3</code>	Assign port 1.0.4 to VLAN 3.
<b>Step 5. Set router ID and allocate hardware table space</b>	

Table 6: Example 2 - two-Area network configuration—Switch 2 (continued)

<code>awplus#</code>	Enter Global Configuration mode.
<code>configure terminal</code>	
<code>awplus(config)#</code>	Allocate hardware table space resources to IPv6 if necessary, on products that allow you to control the memory allocation. Note that <b>ipv4andipv6</b> is the default platform routing ratio.
<code>platform routingratioipv4andipv6</code>	
<code>awplus(config)#</code>	Configure an IPv6 routing process.
<code>router ipv6 ospf process1</code>	
<code>awplus(config-router)#</code>	Set the router ID. Note that:
<code>router-id 192.168.1.2</code>	<ul style="list-style-type: none"> <li>In this configuration, the router-id value 192.168.1.2 makes this switch most likely to be selected as the Designated Router.</li> </ul>
<code>awplus(config)#</code>	Turn on IPv6 forwarding.
<code>ipv6 forwarding</code>	
<code>awplus(config)#</code>	Return to Privileged Exec mode.
<code>exit</code>	

## Switch 3 configuration (two-Area network)

Table 7: Example 2—two-Area network configuration—Switch 3

Step 1. Enable the OSPF6 service. Create and enable VLANs 3 and 5	
<pre>awplus# configure terminal</pre>	Enter Global Configuration mode.
<pre>awplus# service ospf6</pre>	Enable the OSPFv3 service for IPv6.
<pre>awplus (config) # vlan database</pre>	Enter VLAN database mode.
<pre>awplus (config-vlan) # vlan 3,5 state enable</pre>	Create and enable VLANs 3 and 5.
<pre>awplus (config-vlan) # exit</pre>	Return to Global Configuration mode.
Step 2. For VLAN 3, assign IPv6 addresses and configure OSPF	
<pre>awplus (config) # interface vlan 3</pre>	Select VLAN 3 for configuring.
<pre>awplus (config-if) # ipv6 address 2001:db8:21e:103::5/64</pre>	Assign an IPv6 address to VLAN 3.
<pre>awplus (config-if) # ipv6 router ospf area 0 tag process1</pre>	Assign VLAN 3 to OSPF Area 0. In this configuration, any address within the subnet 2001:db8:21e:103: :/64 will be part of OSPF Area 0.
<pre>awplus (config-if) # ipv6 ospf priority 5</pre>	Set the priority for the router to become the Designated Router for a particular VLAN. The router with the highest priority becomes the Designated Router for that VLAN. Defaults to 1.
<pre>awplus (config-if) # exit</pre>	Return to Global Configuration mode.
Step 3. For VLAN 5, assign IPv6 addresses and configure OSPF	
<pre>awplus (config) # interface vlan5</pre>	Select VLAN 5 for configuring.
<pre>awplus (config-if) # ipv6 address 2001:db8:21e:104::5/64</pre>	Assign an IPv6 address to VLAN 5.
<pre>awplus (config-if) # ipv6 router ospf area 1</pre>	Assign VLAN 5 to OSPF Area 1. In this configuration, any address within the subnet 2001:db8:21e:104: :/64 will be part of OSPF Area 1.

Table 7: Example 2—two-Area network configuration—Switch 3 (continued)

<pre>awplus (config-if) # ipv6 ospf priority 5</pre>	<p>Set the priority for the router to become the Designated Router for a particular VLAN. The router with the highest priority becomes the Designated Router for that VLAN. Defaults to 1.</p>
<p><b>Step 4. Configure switch ports and assign them to their VLANs</b></p>	
<pre>awplus (config) # interface port1.0.3</pre>	<p>Select port 1.0.3 for configuring.</p>
<pre>awplus (config-if) # switchport access vlan 3</pre>	<p>Assign port 1.0.3 to VLAN 3</p>
<pre>awplus (config-if) # exit</pre>	<p>Return to Global Configuration mode.</p>
<pre>awplus (config) # interface port1.0.2</pre>	<p>Select port1.0.2 for configuring.</p>
<pre>awplus (config-if) # switchport access vlan 5</pre>	<p>Assign port 1.0.2 to VLAN 5.</p>
<pre>awplus (config-if) # exit</pre>	<p>Return to Global Configuration mode.</p>
<p><b>Step 5. Set router ID and allocate hardware table space</b></p>	
<pre>awplus# configure terminal</pre>	<p>Enter Global Configuration mode.</p>
<pre>awplus (config) # platform routingratio ipv4andipv6</pre>	<p>Allocate hardware table resources to IPv6 if necessary, on products that allow you to control the memory allocation. Note that <b>ipv4andipv6</b> is the default platform routing ratio.</p>
<pre>awplus (config) # router ipv6 ospf process1</pre>	<p>Configure an IPV6 routing process.</p>
<pre>awplus (config-router) # router-id 0.0.1.1</pre>	<p>Set the router ID. Note that the router-id value 0.0.1.1 has been selected for the following reasons:</p> <ul style="list-style-type: none"> <li>■ so that it is unlikely to be selected as a Designated Router.</li> <li>■ to illustrate that it, although it has an IPv4 address format, it is not an IPv4 address.</li> </ul>
<pre>awplus (config-router) # passive-interface vlan5</pre>	<p>Configure VLAN 5 as a passive interface to suppress IPv6 OSPF routing updates.</p>
<pre>awplus (config-router) # exit</pre>	<p>Return to Global Configuration mode.</p>

Table 7: Example 2—two-Area network configuration—Switch 3 (continued)

<pre>awplus (config) # ipv6 forwarding</pre>	Turn on IPv6 forwarding.
<pre>awplus (config) # exit</pre>	Return to Privileged Exec mode.

## OSPFv3 configuration commands explained

This section explains some of the key configuration commands in the preceding configuration examples.

### IPv6 interface commands

```
awplus-2(config-if)# ipv6 address 2001:db8:21e:101::5/64
```

This is the IPv6 prefix (address) and prefix length (mask) assigned to the interface. A /64 netmask is used, as this is the standard choice of netmask for IPv6 subnets.

```
awplus-2(config-if)# ipv6 router ospf area 0 tag process1
```

This command tells the switch to advertise this OSPFv3 interface's IPv6 network in OSPFv3. It also configures the switch to seek OSPFv3 neighbors on the subnet accessed via this interface.

The **area** parameter configures the OSPF Area this interface is in. Area 0 is the backbone. The **tag** parameter references the **process-id** number used in the global configuration command **router ipv6 ospf [<process-id>]**, explained below.

### IPv6 forwarding commands

```
awplus-2(config)# ipv6 forwarding
```

This command turns on IPv6 forwarding, and is necessary for the operation of OSPFv3. By default, AlliedWare Plus switches do not Layer 3 forward IPv6.

### IPv6 router commands

```
awplus-2(config)#router ipv6 ospf process1
```

This command accesses the OSPFv3 configuration mode. The OSPF process number, in this case `process1`, is a user-configurable number which will match at least one of the numbers configured on an interface with the **ipv6 router ospf area tag <process-id>** command. You can have multiple OSPFv3 processes, allowing different OSPFv3 processes to operate on different interfaces.

```
awplus-2(config-router)#router-id 192.168.1.1
```

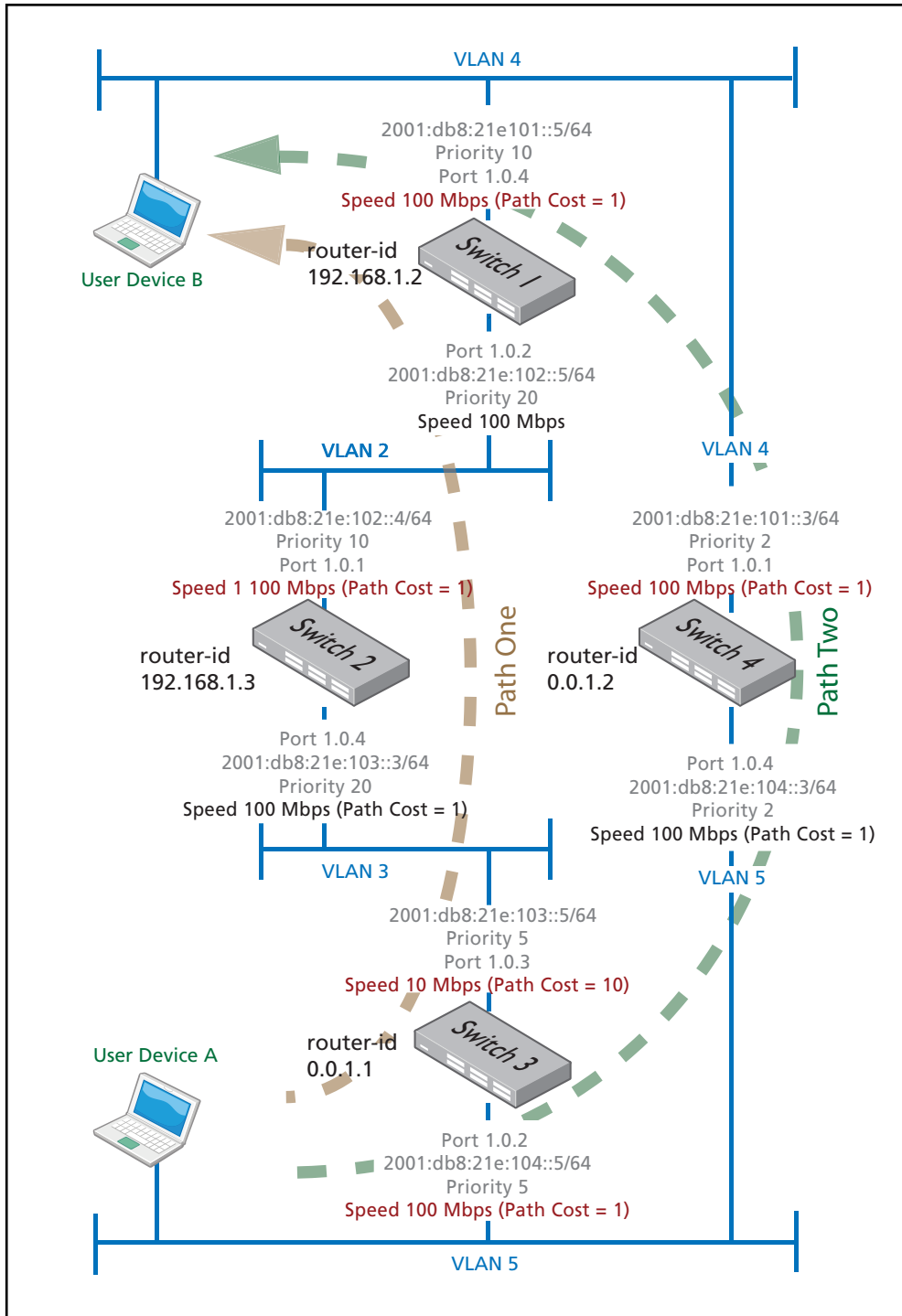
In OSPFv3 for IPv6, it is possible that no IPv4 addresses will be configured on any interface. In this case, you must use the **router-id** command to configure a dotted decimal address as the router ID, before the OSPF process begins. This router-id address does not have to actually be configured on any interface on the switch. Although the router-id is written in the form of an IPv4 address, it is actually just a 32 bit number, so there is no need for it to be an IP address that exists on the router.

## Setting up the metrics

OSPF selects its preferred routes by measuring the cost of each path to a given destination. Each path (or link) has a metric value applied, which by default is 100 000 000 divided by the link bandwidth. The preferred route will be the one that presents the lowest total path cost.

[Figure 3](#) shows the previously configured single-Area network of [Figure 1](#), but with an additional path provided by Switch 4. The diagram also shows port speeds and their resultant path costs.

Figure 3: OSPFv3 multipath metrics example



Using the procedure shown in "Switch 1 configuration (single-Area network)" on page 15, add Switch 4 to the configuration, applying the port numbers, VLANs, and settings shown in Figure 3 above.

### Setting the metric values

The metric values shown are derived from the data rate configured for each port and (unless manually changed) use the formula  $10^8 / \text{port bandwidth in bps}$ .

**Example** To set the speed of a tri-speed port to 100 Mbps, enter the following commands:

```
awplus# configure terminal
awplus(config)# interface port1.0.4
awplus(config-if)# speed 100
```

The above example will produce a path cost of  $100\,000\,000 / \text{port speed (in bps)}$ , or  $100\,000\,000 / 100\,000\,000 = 1$

If the port speed and its resultant metric value does not produce the required best paths and you do not want to change the port speed, you can change the metric by using the **ipv6 ospf cost** command. The following section explains how to do this.

### Best path selection

Figure 3 on page 1.32 shows two paths from User Device A to User Device B, labeled Path One and Path Two. The metric cost for each of these paths is found by adding the individual output path costs: For traffic flowing from User Device A, to User Device B, these are:

Path Cost for Path One =  $10 + 1 + 1 = 12$

Path Cost for Path Two = 1

The preferred route will be via the paths that offer the **lowest** total path cost. Traffic will therefore travel from User Device A to User Device B via Path Two.

However, you can manually adjust the cost metrics to favor one path over another. For example, you can apply the **ipv6 ospf cost** command to manually force the preference for a particular path.

**Example** Using the configuration shown in Figure 3 on page 1.32 use the **ipv6 ospf cost** command to set Path One to be the preferred path.

Existing path cost for Path One is,  $10 + 1 + 1 = 12$

Existing path cost for Path Two = 1

Setting the cost of Path Two to be greater than 12, will force OSPF's path selection algorithm to select Path One as the preferred path between User Device A and User Device B.

Use the following commands on Switch 4 to force the path cost on switchport 1.0.1 to have the metric value of 20:

```
awplus# configure terminal
awplus(config)# service ospf6
awplus(config)# interface vlan4
```

```
awplus(config-if)# ipv6 ospf 2001:0db8:21e:101::5/64 cost 20
```

This has set a higher metric cost for data traveling from Device A to Device B, via Path Two. You now need to set the same metric cost for data traveling in the direction from Device B, to Device A.

```
awplus# configure terminal
```

```
awplus(config)# interface vlan5
```

```
awplus(config-if)# ipv6 ospf 2001:0db8:21e:104::5/64 cost 20
```

Traffic traveling from Devices A to B, and B to A, will now use Path One in preference to Path Two.

### Configuring instances and processes

OSPFv3 introduces the capability of sharing physical links (or VLANs) with multiple OSPF routing **instances**. This is achieved by inserting an Instance ID field in the OSPFv3 **Hello**, and **Link State** packets. In a multi-instance network, the OSPF Hello and LSA frames belonging to different instances can coexist alongside each other, each sharing a physical link and each establishing its own set of metric values and path preferences. New instances are created using the **ipv6 router ospf area** command.

There are solutions where multiple OSPF routers are attached to a single link, but should not form an adjacency between OSPF routers. For example, four OSPF routers are attached to an Ethernet link. OSPF routers 1 and 2 belong to one OSPF domain, and OSPF routers 3 and 4 belong to a different OSPF domain. There should be adjacencies between OSPF routers 1 and 2, and between OSPF routers 3 and 4. But there should not be adjacencies between OSPF routers 1 and 3 or between OSPF routers 2 and 4 in this example.

This type of separation of adjacencies is often accomplished in the case of OSPFv2 by the use of manipulated OSPF authentication. However, this is not ideal since OSPF routers may log authentication failures of any rejected Hello packets associated with the OSPF domain.

OSPFv3 allows for multiple OSPF routing instances per link by adding the new Instance ID field to the OSPF packet header to distinguish OSPF routing instances. An interface assigned to a given interface ID will drop OSPF packets whose Instance IDs do not match.

Some OSPFv2 (and OSPFv3) switches and routers also have a similar (and older) function called **processes**. Processes enable more than one OSPF environment to be configured on the same switch (or router), but not the same VLAN. Processes exist only within the switch or router on which they are created. Although their existence is not explicitly conveyed between OSPF routers, the packets from each process contains its own router ID and will thus appear as if generated by a different OSPF router. New processes are created also using the **ipv6 router ospf area** command.

Although instances and processes apply a similar function and each can be individually created, there are interactions between them that require you to apply some specific rules when creating multi-instance networks. The following table shows those combinations of instances and processes that are workable, and those that are not.

Table 8: Functional combinations of OSPFv3 instances and processes

VLAN	INSTANCES	PROCESSES	WORKABLE COMBINATION
VLAN 5	Instance 1	Process A	Yes
VLAN 5 & VLAN 7	Instance 1	Process D	Yes
VLAN 5	Instance 1	Process D	Yes
If you now add a second instance so that VLAN 5 shares both instances using Process D			
VLAN 5	Instance 2	Process D	No
To make the above configuration work requires adding a new process.			
VLAN5	Instance 1	Process D	Yes
VLAN5	Instance 2	Process E	Yes

**Example 1** To apply the settings shown in the last two rows of Table 8, use the following commands:

```
awplus# configure terminal
awplus(config)# service ospf6
awplus(config)# interface vlan5
awplus(config-if)# ipv6 router ospf area 1 tag D instance-id 1
awplus(config-if)# ipv6 router ospf area 2 tag E instance-id 2
```

**Example 2** See the below entries for another supported combination of OSPFv3 instances and processes:

```
awplus# configure terminal
awplus(config)# service ospf6
awplus(config)# interface vlan5
awplus(config-if)# ipv6 router ospf area 1 tag D instance-id 1
awplus(config-if)# ipv6 router ospf area 1 tag E instance-id 2
awplus(config-if)# ipv6 router ospf area 2 tag F instance-id 3
awplus(config-if)# exit
awplus(config)# interface vlan7
awplus(config-if)# ipv6 router ospf area 1 tag D instance-id 1
```

**Example 3** See the below entries for an unsupported combination of OSPFv3 instances and processes. Note the console error message shown after completing the entries with the same instance ID (1) on different processes (D and E) on the same interface (vlan5):

```
awplus# configure terminal
awplus(config)# service ospf6
awplus(config)# interface vlan5
awplus(config-if)# ipv6 router ospf area 1 tag D instance-id 1
awplus(config-if)# ipv6 router ospf area 1 tag E instance-id 1
```

**% Interface enabled in another process with the same instance ID**

**Example 4** See the below entries for an unsupported combination of OSPFv3 instances and processes. Note the console error message shown after completing the entries with different instances IDs (1 and 2) on the same process (A) on the same interface (vlan5):

```
awplus# configure terminal
awplus(config)# service ospf6
awplus(config)# interface vlan5
awplus(config-if)# ipv6 router ospf area 1 tag A instance-id 1
awplus(config-if)# ipv6 router ospf area 2 tag A instance-id 2
% Interface enabled in the same process with a different instance ID
```

# The Show Commands

Once you have connected and configured OSPFv3, you can view and monitor its operation with a set of **show** commands. This section outlines the OSPFv3 **show** commands available in AlliedWare Plus. Each command's output is described in detail, along with how you can use it to monitor the operation of your OSPFv3 network.

## show ipv6 route

This command uses the switch's IPv6 route table to discover what routes have been learnt via OSPFv3.

### Show output

```
awplus-2#show ipv6 route
IPv6 Routing Table
Codes: C - connected, S - static, R - RIP, O - OSPF, B - BGP
Timers: Uptime
C   2002:1111::/64 via ::, vlan2, 17:58:51
O   2003:1111::/64 [110/20] via fe80::200:cdff:fe27:c1ff, vlan2, 00:00:17
C   2004:1111::/64 via ::, vlan4, 00:00:26
C   fe80::/64 via ::, vlan4, 00:00:26
C   fe80::/64 via ::, vlan2, 17:58:51
```

### Output explained

The table shows each IPv6 route and its prefix, as well as how the route was learned, which interface it was learned on, and the length of time for which the route has been in the route table.

On switch **awplus-2**, you can see that the route to network **2003:1111::/64** (on awplus-3) has been learnt via OSPF.

The route that has been learnt via OSPFv3 from awplus-3 is shown as **[110/20]**. These numbers are, in two parts:

#### ■ 110—the Administrative Distance (AD)

The AD defines the reliability of a routing protocol. OSPF = 110, Connected routes = 0, static routes = 1, and RIP = 120. The lower the AD, the more reliable the protocol is considered.

If the switch has learnt multiple routes to the same network with different ADs, it uses the route with the lowest AD.

#### ■ 20—the Metric

The nexthop IPv6 address **fe80::200:cdff:fe27:c1ff** may seem surprising, given that the IPv6 address on the vlan2 interface of awplus-3 is **2002:1111::1**. In fact, **fe80::200:cdff:fe27:c1ff** is the link-local IPv6 address of awplus-3's vlan2 interface.

Every IPv6 interface, on any device, has an automatically calculated link-local address. It is quite common to use the link-local address as the next-hop in IPv6 routes. Further explanation of link-local IPv6 addresses is beyond the scope of this guide.

On switch **awplus-3** you can see the route to network **2004:1111::/64** (on awplus-2) via OSPF.

```
awplus-3#sh ipv6 route
IPv6 Routing Table
Codes: C - connected, S - static, R - RIP, O - OSPF, B - BGP
Timers: Uptime
C 2002:1111::/64 via ::, vlan2, 17:59:25
C 2003:1111::/64 via ::, vlan3, 00:00:54
O 2004:1111::/64 [110/20] via fe80::200:cdff:fe29:8ed3, vlan2, 00:00:57
C fe80::/64 via ::, vlan3, 00:00:54
C fe80::/64 via ::, vlan2, 17:59:25
```

## show ipv6 ospf

This command gives general information about the current OSPFv3 operation.

```
awplus-2#sh ipv6 ospf
Routing Process "OSPFv3 (10)" with ID 192.168.1.2
Route Licence: Route : Limit=Unlimited, Allocated=3, Visible=2, Internal=1
OSPFv3-FULL Route Licence: Breach: Current=0, Watermark=0
Process uptime is 18 hours 2 minutes
Current grace period is 0 secs
SPF schedule delay min 0.500 secs, SPF schedule delay max 50.0 secs
```

### Output explained

**Routing Process "OSPFv3 (10)" with ID 192.168.1.2** identifies OSPFv3 process-id 10 with router-id 192.168.1.2.

#### Route Licence:

- **Limit=Unlimited** refers to the OSPFv3 route-limit licence status of the switch. There are 2 OSPFv3 licenses available, providing either a maximum of 64 IPv6 routes or unlimited routes. This switch has an unlimited route OSPFv3 license, which you can verify with the **show license** command.
- The number of **Allocated** OSPFv3 routes is 3, of which 2 are **Visible** OSPFv3 routes, and 1 is **Internal**. You can view the visible routes with the **show ipv6 ospf route** command. Internal routes refer to internal OSPFv3 routes to Autonomous System Boundary Routers (ASBRs), which are only used for calculating nexthops for AS-EXT routes, and which are not usable as user routes.

**OSPFv3-FULL Route Licence: Breach:** the output shows you whether the number of OSPFv3 routes learned by the switch has exceeded the number allowed by the license. **Current=** shows the number of OSPFv3 routes that currently exceed the license. **Watermark=** shows the highest number of OSPFv3 routes that have ever exceeded the license.

**Process uptime** is the time elapsed since this OSPFv3 process was configured and started.

**Current grace period** shows the grace restart period. The default is 120 seconds.

**SPF timers** You can configure **SPF schedule delay** timers in the **router ipv6 ospf** command configuration mode. You cannot configure the **Minimum LSA interval** and **arrival** times. The minimum interval is always 5 seconds, and the minimum arrival is always 1 second.

The **Number of incoming current DD exchange neighbors** and the **Number of outgoing current DD exchange neighbors** counters are not incremented.

You can view the **Number of external LSA** by using the **show ipv6 ospf database external** command. This is explained further in the command "[show ipv6 ospf database <LSA-type>](#)" on [page 41](#).

**SPF algorithm executed** shows the number of times that SPF has executed due to a network topology change.

**Number of LSA** refers to the total number of LSAs in the LSDB.

**Number of Unknown LSA** refers to the total number of unknown LSAs in the LSDB. OSPFv3 can either treat Unknown LSAs as having link-local flooding scope, or store and flood them as if they are understood, while ignoring them in their own SPF algorithms.

## show ipv6 ospf route

This command shows the contents of the OSPFv3 route table. These are the routes that OSPFv3 has calculated from its LSA database. Not necessarily all the routes in the OSPFv3 route table are in the router's main IPv6 route table. If any routes in the table clash with routes that are learnt from another routing protocol with a lower Administrative Distance, then the latter protocol's routes are the ones that go into the main IPv6 route table.

### Show output

```
awplus-2#sh ipv6 ospf route
OSPFv3 Process (10)
Codes: C - connected, D - Discard, O - OSPF, IA - OSPF inter area
       E1 - OSPF external type 1, E2 - OSPF external type 2

  Destination                                Metric
  Next-hop
C 2002:1111::/64                             1
   directly connected, vlan2, Area 0.0.0.0
E2 2003:1111::/64                             1/20
   via fe80::200:cdff:fe27:c1ff, vlan2
```

### Output explained

Although the route to network **2002:1111::/64** is shown as **C**, which means connected, it is also learned via OSPFv3 from its neighbor.

The route to **2003:1111::/64** on vlan3 of awplus-3 is an AS-EXT route. This is because OSPFv3 is not configured on vlan3 of awplus-3, so it is not an OSPFv3 interface. Its subnet is only advertised into OSPFv3 because awplus-3 is configured to redistribute connected routes. The route type is **E2**, which is the default for redistributed routes. In the E2 route entry **1/20**, **1** shows the total internal cost for the route, and **20** shows the external cost. Since the route is E2, the route calculation uses only the external cost.

## show ipv6 ospf database

### Show output

```
awplus-2#sh ipv6 ospf database
OSPFv3 Router with ID (192.168.1.2) (Process 10)

          Link-LSA (Interface vlan2)
Link State ID  ADV Router      Age  Seq#          CkSum  Prefix
0.0.0.202     192.168.1.1    1672 0x8000002d    0xb654  1
0.0.0.202     192.168.1.2    1676 0x8000002d    0xd98d  1

          Router-LSA (Area 0.0.0.0)
Link State ID  ADV Router      Age  Seq#          CkSum  Link
0.0.0.0        192.168.1.1    47  0x80000030    0x0b75  1
0.0.0.0        192.168.1.2    236 0x80000030    0x057a  1

          Network-LSA (Area 0.0.0.0)
Link State ID  ADV Router      Age  Seq#          CkSum
0.0.0.202     192.168.1.2    1631 0x8000002d    0xbf2e

          Intra-Area-Prefix-LSA (Area 0.0.0.0)
Link State ID  ADV Router      Age  Seq#          CkSum  Prefix  Reference
0.0.0.2        192.168.1.2    1626 0x8000002d    0x0aa5  1  Network-LSA

          AS-external-LSA
Link State ID  ADV Router      Age  Seq#          CkSum
0.0.0.2        192.168.1.1    1792 0x80000009    0x15ec  E2
0.0.0.3        192.168.1.2    616  0x80000004    0x1be8  E2
```

### Output explained

Central to the operation of OSPFv3 is its LSA database. Each LSA in the database consists of a set of fields, as explained below.

FIELD	DESCRIPTION
Link State ID	For a: <ul style="list-style-type: none"><li>■ Network LSA: the interface ID of the Designated Router's (DR) interface</li><li>■ Link LSA: the interface ID of the egress interface on the router that sent the LSA</li><li>■ Grace LSA: the interface ID of the egress interface on the router that sent the LSA</li><li>■ Other type of LSA: an index number that increments with each new LSA.</li></ul>
ADV Router	Advertising Router ID.
Age	Link-state age in seconds.
Seq#	Link-state sequence number (detects old or duplicate LSAs)
CkSum	Checksum of the LSA.
Prefix	The number of different IPv6 prefixes in the LSA. This is specific to Link and Prefix LSAs.
Link	The number of links in the LSA. This is specific to router LSAs.
Reference	The Intra-Area Prefix LSA tells us that the IPv6 prefixes associated with the Router ID appear in either a Router or Network LSA. The Reference field will therefore show either 'Router' or 'Network'.

The **Link-LSA** communicates information that is significant only to two directly connected neighbors. A separate Link-LSA originates on each of a router's attached links belonging to an OSPFv3 domain, and a receiving router.

VLAN interface IDs (ifindicies) starts at 201, so **Link State ID 0.0.0.202** is that of vlan2.

The **Router-LSA** describes the originating router and its links to neighbors, for use in SPF calculations. Note that the ID is 0.0.0.0, which indicates that this is the first LSA, other than a Link, Network, or Grace LSA, originated by each router.

For broadcast networks only: the DR floods the **Network-LSA** out all of its interfaces. This LSA lists OSPF-speaking routers on the network.

When a link or its prefix changes, the connected router originates an **Intra-Area Prefix LSA** to flood the information throughout the Area. This LSA does not trigger an SPF calculation.

The **AS-external-LSA** advertises prefixes that are external to the OSPF routing domain. One LSA is required for each external prefix advertised.

You can find more detailed information about LSAs in the following section.

### **show ipv6 ospf database <LSA-type>**

The **show ipv6 ospf database** command shows a summary of each of the LSAs in the database. To see the full content of each LSA, you must use one of the **show ipv6 ospf database <LSA-type>** commands. For example, to see the full detail of all the network LSAs, you would use the command **show ipv6 ospf database network**.

## show ipv6 ospf database external

### Show output

```
awplus-2#sh ipv6 ospf database external
OSPFv3 Router with ID (192.168.1.2) (Process 10)
AS-external-LSA
  LS age: 838
  LS Type: AS-External-LSA
  Link State ID: 0.0.0.2
  Advertising Router: 192.168.1.1
  LS Seq Number: 0x80000006
  Checksum: 0x1BE9
  Length: 36
    Metric Type: 2 (Larger than any link state path)
    Metric: 20
    Prefix: 2003:1111::/64
    Prefix Options: 0 (-|-|-|-)
  LS age: 842
  LS Type: AS-External-LSA
  Link State ID: 0.0.0.1
  Advertising Router: 192.168.1.2
  LS Seq Number: 0x80000006
  Checksum: 0x2BD8
  Length: 36
    Metric Type: 2 (Larger than any link state path)
    Metric: 20
    Prefix: 2004:1111::/64
    Prefix Options: 0 (-|-|-|-)
```

### Output explained

**LS age** is the LSA age in seconds.

**AS-External LSA** means that this route was learned by a method other than OSPF and imported (redistributed) into OSPFv3. In this case, these routes were directly connected interfaces.

There are two types of External LSAs—**Metric Type 1** and **2**:

- **Metric Type: 1** includes the metric to get to the ASBR plus the external metric.
- **Metric Type: 2** only includes the external metric.

By default, an imported route is given **Metric: 20**.

## show ipv6 ospf database network

### Show output

```
awplus-2#show ipv6 ospf database network
      OSPFv3 Router with ID (192.168.1.2) (Process 10)
      Network-LSA (Area 0.0.0.0)
LS age: 789
LS Type: Network-LSA
Link State ID: 0.0.0.202
Advertising Router: 192.168.1.2
LS Seq Number: 0x80000189
Checksum: 0x048C
Length: 32
Options: 0x000013 (-|R|-|-|E|V6)
  Attached Router: 192.168.1.2
  Attached Router: 192.168.1.1
```

### Output explained

Compared with OSPFv2, OSPFv3 has the additional **R** and **V6** bits in the **Options** field:

- The **R** bit indicates that the originator is an active router. If the R bit is clear, the switch cannot process routes that transit the advertising node. Clearing the R bit would be appropriate for a multi-homed host that wants to participate in routing, but does not want to forward non-locally addressed packets.
- The **V6** bit indicates that the router/link should be included in IPv6 routing calculations.

The OSPFv3 **Options** are a 24 bit field with the following options.

Table 9: OSPFv3 Options

VALUE	DESCRIPTION	REFERENCE
0x000001	V6-bit	[RFC5340]
0x000002	E-bit	[RFC2328]
0x000004	Deprecated	[RFC5340]
0x000008	N-bit	[RFC3101]
0x000010	R-Bit	[RFC5340]
0x000020	DC-bit	[RFC1793]
0x000040	Reserved for OSPFv2 migrated options	[RFC5340]
0x000080	Reserved for OSPFv2 migrated options	[RFC5340]
0x000100	AF-bit	[RFC5838]
0x000200	L-bit	[RFC5613]

Therefore, **Options: 0x000013** is calculated like this:

```
0x000010 - R-bit
0x000002 - E-bit
0x000001 - V6-bit
```

The **Attached Router** fields are the Router-IDs of the two OSPFv3 routers connected to the 2002:1111::/64 subnet.

## show ipv6 ospf database router

### Show output

```
awplus-2#show ipv6 ospf database router
      OSPFv3 Router with ID (192.168.1.2) (Process 10)
      Router-LSA (Area 0.0.0.0)
LS age: 1095
LS Type: Router-LSA
Link State ID: 0.0.0.0
Advertising Router: 192.168.1.1
LS Seq Number: 0x8000018C
Checksum: 0x4FD3
Length: 40
Flags: 0x02 (-|-|E|-)

Options: 0x000013 (-|R|-|-|E|V6)
  Link connected to: a Transit Network
    Metric: 1
    Interface ID: 202
    Neighbor Interface ID: 202
    Neighbor Router ID: 192.168.1.2
LS age: 783
LS Type: Router-LSA
Link State ID: 0.0.0.0
Advertising Router: 192.168.1.2
LS Seq Number: 0x8000018B
Checksum: 0x4BD7
Length: 40
Flags: 0x02 (-|-|E|-)
Options: 0x000013 (-|R|-|-|E|V6)
  Link connected to: a Transit Network
    Metric: 1
    Interface ID: 202
    Neighbor Interface ID: 202
    Neighbor Router ID: 192.168.1.1
```

### Output explained

The **Flags** parameter shows the values set in the OSPFv3 Router Properties Registry:

Table 10: OSPFv3 Router Properties flags

VALUE	FLAG	REFERENCE	DESCRIPTION
0x01	B-bit	[RFC5340]	When set, shows the router is an Area Border router. <b>B</b> stands for Border.
0x02	E-bit	[RFC5340]	When set, shows the router is an AS boundary router. <b>E</b> stands for External.
0x04	V-bit	[RFC5340]	When set, shows the router is an endpoint of one or more fully adjacent virtual links having the described Area as a transit Area. <b>V</b> stands for Virtual link endpoint.
0x08	Deprecated	[RFC5340]	This bit was previously used by Multicast OSPF (MOSPF) and has been deprecated for OSPFv3. The bit should be set to 0 and ignored when received. It may be reassigned in the future.

Table 10: OSPFv3 Router Properties flags (continued)

VALUE	FLAG	REFERENCE	DESCRIPTION
0x10	Nt-bit	[RFC5340]	When set, shows the router is a Not So Stubby Area (NSSA) border router that is unconditionally translating NSSA-LSAs into AS-external-LSAs. <b>Nt</b> stands for NSSA translation. Note that such routers have their NSSA Translator Role Area configuration parameter set to <b>Always</b> .

The router lists the one OSPF link that is attached to it. The **Interface ID** is the ifindex of the interface (VLAN2). The router LSA will also list all the OSPFv3 routers that this router has neighbored with via that interface. In this case, it has just the one neighbor on **VLAN2**.

## show ipv6 ospf database link

### Show output

```
awplus-2#show ipv6 ospf database link
      OSPFv3 Router with ID (192.168.1.2) (Process 10)
      Link-LSA (Interface vlan2)
LS age: 850
LS Type: Link-LSA
Link State ID: 0.0.0.202
Advertising Router: 192.168.1.1
LS Seq Number: 0x80000189
Checksum: 0xFAB2
Length: 56
Priority: 1
Options: 0x000013 (-|R|-|-|E|V6)
Link-Local Address: fe80::200:cdff:fe27:c1ff
Number of Prefixes: 1
  Prefix: 2002:1111::/64
  Prefix Options: 0 (-|-|-|-)
LS age: 834
LS Type: Link-LSA
Link State ID: 0.0.0.202
Advertising Router: 192.168.1.2
LS Seq Number: 0x80000189
Checksum: 0x1EEB
Length: 56
Priority: 1
Options: 0x000013 (-|R|-|-|E|V6)
Link-Local Address: fe80::200:cdff:fe29:8ed3
Number of Prefixes: 1
  Prefix: 2002:1111::/64
  Prefix Options: 0 (-|-|-|-)
```

### Output explained

Every IPv6 interface has a unique **Link-Local Address**.

There may be multiple IPv6 secondary addresses configured on the interface, in which case they would all be listed here.

# Configuring OSPFv3 Authentication and Encryption

See the section "[OSPFv3 Authentication and Encryption Overview](#)" on page 10 in this guide for introductory OSPFv3 authentication and OSPFv3 encryption information.

Once you configure OSPFv3 and decide on using authentication or encryption, you need to define a security policy on each OSPFv3 interface of each device in the network.

A security policy consists of the following:

- **SPI** (Security Parameter Index), the identification number for the security policy.
- **authentication algorithm**, either MD5 (Message Digest 5) or SHA-1 (Secure Hash Algorithm 1) authentication, if the security policy is to perform authentication.
- **authentication key**, which is a 32 or 40 bit hexadecimal value used with the authentication algorithm, if the security policy is to perform authentication.
- **encryption algorithm**, either AES-CBC (Advanced Encryption Standard-Cipher Block Chaining) or 3DES (Triple Data Encryption Standard) encryption, if the security policy is to perform encryption.
- **encryption key**, which is a 32 to 64 bit hexadecimal value used with the encryption algorithm, if the security policy is to perform encryption.

You can configure authentication and encryption on virtual links, on VLAN interfaces, and on OSPFv3 Areas. When you configure authentication or encryption for an Area, the security policy is applied to all of the VLAN interfaces in the OSPFv3 Area. Note that you should use a different security policy on each VLAN interface to improve the security.

See the sections listed below when configuring OSPFv3 authentication:

- "[Configuring OSPFv3 authentication on a VLAN](#)" on page 48
- "[Configuring OSPFv3 encryption on a VLAN](#)" on page 48
- "[Configuring OSPFv3 authentication in an OSPFv3 Area](#)" on page 48
- "[Configuring OSPFv3 encryption in an OSPFv3 Area](#)" on page 49
- "[Configuring OSPFv3 authentication and encryption for a Virtual Link](#)" on page 49

See sample configurations listed below with topologies that accompany these sections:

- "OSPFv3 authentication in an OSPFv3 Area" on page 51
- "OSPFv3 encryption in an OSPFv3 Area" on page 52
- "OSPFv3 authentication on a VLAN" on page 54
- "OSPFv3 encryption on a VLAN" on page 55
- "OSPFv3 authentication with two VLANs" on page 57
- "OSPFv3 encryption with two VLANs" on page 59
- "OSPFv3 authentication for a Virtual Link" on page 62
- "OSPFv3 encryption for a Virtual Link" on page 64

## Configuring OSPFv3 authentication on a VLAN

Enter the commands below to configure OSPFv3 authentication on a VLAN interface. Note you need to configure OSPFv3 on a VLAN before configuring OSPFv3 authentication.

1. Enter Global Configuration mode.

```
awplus# configure terminal
```

2. Enable the OSPF6 service.

```
awplus# service ospf6
```

3. Specify a VLAN interface, and enter Interface Configuration mode.

```
awplus(config)# interface <interface-list>
```

4. Specify an OSPFv3 authentication type (MD5 or SHA-1) for a specified VLAN interface.

```
awplus(config-if)# ipv6 ospf authentication ipsec spi <256-4294967295>  
{md5 <MD5-key>|sha1 <SHA1-key>}
```

## Configuring OSPFv3 encryption on a VLAN

Enter the below commands to configure OSPFv3 encryption on a VLAN interface. Note you need to configure OSPFv3 on a VLAN before configuring OSPFv3 encryption.

1. Enter Global Configuration mode.

```
awplus# configure terminal
```

2. Enable the OSPF6 service.

```
awplus# service ospf6
```

3. Specify a VLAN interface, and enter Interface Configuration mode.

```
awplus(config)# interface <interface-list>
```

4. Specify an OSPFv3 encryption type (AES-CBC or 3DES) and an OSPFv3 authentication type (MD5 or SHA-1) for a specified VLAN interface.

```
awplus(config-if)# ipv6 ospf encryption ipsec spi <256-4294967295> esp  
{aes-cbc <AES-CBC-key>|3des <3DES-key>|null}{md5 <MD5-key>|  
sha1 <SHA1-key>}
```

## Configuring OSPFv3 authentication in an OSPFv3 Area

Enter the below commands to configure OSPFv3 authentication in an OSPFv3 Area. Note you need to configure an OSPFv3 Area before configuring OSPFv3 authentication.

1. Enter Global Configuration mode.

```
awplus# configure terminal
```

2. Enable the OSPF6 service.

```
awplus# service ospf6
```

3. Specify a VLAN interface, and enter Interface Configuration mode.

```
awplus(config)# interface <interface-list>
```

4. Specify an OSPFv3 Area and, and enter Router Configuration mode.

```
awplus(config-if)# ipv6 router ospf area <area-id> [tag <process-id>]  
[instance <inst-id>]
```

5. Specify an OSPFv3 authentication type (MD5 or SHA-1) for a specified OSPFv3 Area.

```
awplus(config-router)# area <area-id> authentication ipsec spi  
<256-4294967295> {md5 <MD5-key>|sha1 <SHA1-key>}
```

## Configuring OSPFv3 encryption in an OSPFv3 Area

Enter the commands below to configure OSPFv3 encryption in an OSPFv3 Area. Note you need to configure an OSPFv3 Area before configuring OSPFv3 encryption.

1. Enter Global Configuration mode.

```
awplus# configure terminal
```

2. Enable the OSPF6 service.

```
awplus# service ospf6
```

3. Specify a VLAN interface, and enter Interface Configuration mode.

```
awplus(config)# interface <interface-list>
```

4. Specify an OSPFv3 Area and, and enter Router Configuration mode.

```
awplus(config-if)# ipv6 router ospf area <area-id> [tag <process-id>]  
[instance <inst-id>]
```

5. Specify an OSPFv3 encryption type (AES-CBC or 3DES) and an OSPFv3 authentication type (MD5 or SHA-1) for a specified OSPFv3 Area.

```
awplus(config-router)# area <area-id> encryption ipsec spi  
<256-4294967295> esp {aes-cbc <AES-CBC-key>|3des <3DES-key>|null}  
{md5 <MD5-key>|sha1 <SHA1-key>}
```

## Configuring OSPFv3 authentication and encryption for a Virtual Link

Enter the commands below to configure OSPFv3 authentication and OSPFv3 encryption for a OSPFv3 Area Virtual Link. Note you need to configure an OSPFv3 Area and an OSPFv3 Area Virtual Link before configuring OSPFv3 authentication and OSPFv3 encryption for an OSPFv3 Area Virtual Link.

1. Enter Global Configuration mode.

```
awplus# configure terminal
```

2. Enable the OSPF6 service.

```
awplus# service ospf6
```

3. Specify a VLAN interface, and enter Interface Configuration mode.

```
awplus(config)# interface <interface-list>
```

4. Specify an OSPFv3 Area and, and enter Router Configuration mode.

```
awplus(config-if)# ipv6 router ospf area <area-id> [tag <process-id>]
[instance <inst-id>]
```

5. Specify an OSPFv3 Area Virtual Link.

```
awplus(config-router)# area <area-id> virtual-link <router-id>
```

6. Specifies an OSPFv3 encryption type (AES-CBC or 3DES) and an OSPFv3 authentication type (MD5 or SHA-1) for a specified OSPFv3 Area.

```
awplus(config-router)# area <area-id> virtual-link <router-id>
authentication ipsec spi <256-4294967295> {md5 <MD5-key>|sha1 <SHA1-
key>}
```

7. Specifies an OSPFv3 encryption type (AES-CBC or 3DES) and an OSPFv3 authentication type (MD5 or SHA-1) for a specified OSPFv3 Area.

```
awplus(config-router)# area <area-id> virtual-link <router-id>
encryption ipsec spi <256-4294967295> esp {aes-cbc <AES-CBC-key>|
3des <3DES-key>|null} {md5 <MD5-key>|sha1 <SHA1-key>
```

**Commands  
Applied**

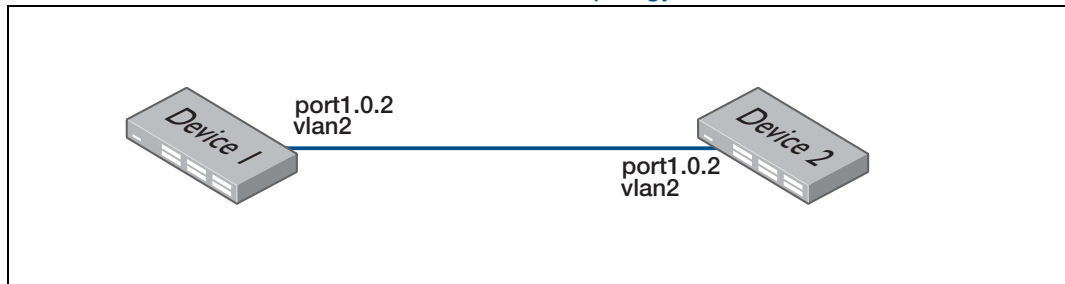
```
configure terminal
service ospf6
interface
ipv6 router ospf area
area virtual-link
area virtual-link authentication ipsec spi
area virtual-link encryption ipsec spi
```

## OSPFv3 authentication in an OSPFv3 Area

This example shows how to configure two devices to form an adjacency to each other with OSPFv3 authentication in an OSPFv3 backbone Area 0. Both devices are configured to use the same process name test1, which is not advertised between peers.

See the section "[Configuring OSPFv3 authentication in an OSPFv3 Area](#)" on page 48 for the sequence of console command entries.

Figure 4: OSPFv3 authentication in an OSPFv3 Area topology:



### Device1 configuration

See the below configuration for a device with the hostname Device1:

```
hostname Device1
!
service ospf6
!
vlan database
  vlan 2 state enable
!
interface port1.0.2
  switchport
  switchport mode access
  switchport access vlan 2
!
interface vlan2
  description Device1_to_Device2
  ipv6 address 2001:db8:2::1/64
  ipv6 enable
  ipv6 router ospf area 0 tag process1
!
ipv6 forwarding
!
router ipv6 ospf process1
  router-id 192.168.1.1
  area 0 authentication ipsec spi 256 sha1
  1234567890123456789012345678901234567890
```

## Device2 configuration

See the below configuration for a device with the hostname Device2:

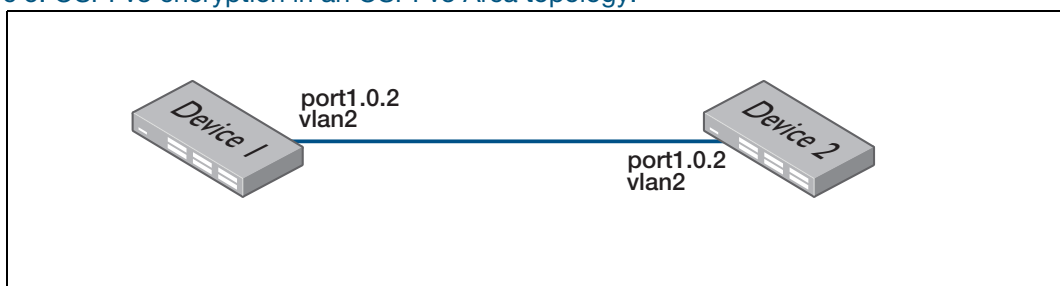
```
hostname Device2
!
service ospf6
!
vlan database
vlan 2 state enable
!
interface port1.0.2
switchport
switchport mode access
switchport access vlan 2
!
interface vlan2
description Device2_to_Device1
ipv6 address 2001:db8:2::2/64
ipv6 enable
ipv6 router ospf area 0 tag process1
!
ipv6 forwarding
!
router ipv6 ospf process1
router-id 192.168.1.2
area 0 authentication ipsec spi 256 sha1
1234567890123456789012345678901234567890
```

## OSPFv3 encryption in an OSPFv3 Area

This example shows how to configure two devices to form an adjacency to each other with OSPFv3 encryption in an OSPFv3 backbone Area 0. Both devices are also configured to use the same internal process name test1. Additionally, both devices insert instance-id 1 into their advertised Hello messages to control adjacency between the two devices.

See the section "[Configuring OSPFv3 encryption in an OSPFv3 Area](#)" on page 49 for the sequence of console command entries.

Figure 5: OSPFv3 encryption in an OSPFv3 Area topology:



## Device1 configuration

See the below configuration for a device with the hostname Device1:

```
hostname Device1
!
service ospf6
!
vlan database
  vlan 2 state enable
!
interface port1.0.2
  switchport
  switchport mode access
  switchport access vlan 2
!
interface vlan2
  description Device1_to_Device2
  ipv6 address 2001:db8:2::1/64
  ipv6 router ospf area 0 tag test1 instance-id 1
!
ipv6 forwarding
!
router ipv6 ospf test1
  router-id 192.168.1.1
  area 0 encryption ipsec spi 555 esp aes-cbc
12345678901234567890123456789012 sha1
1234567890098765432112354678900987654321
```

## Device2 configuration

See the below configuration for a device with the hostname Device2:

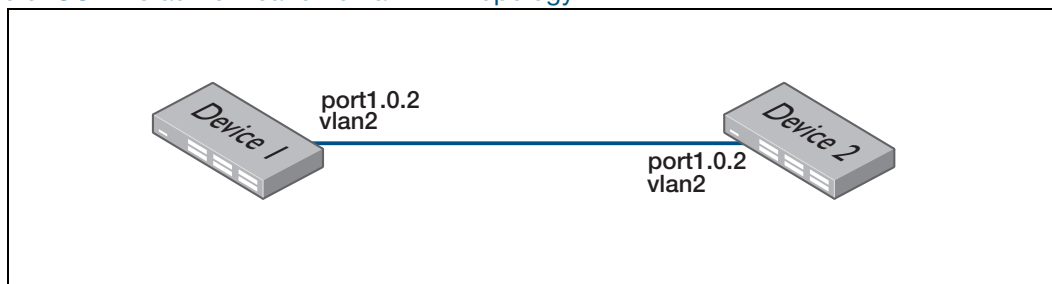
```
hostname Device2
!
service ospf6
!
vlan database
  vlan 2 state enable
!
interface port1.0.2
  switchport
  switchport mode access
  switchport access vlan 2
!
interface vlan2
  description Device2_to_Device1
  ipv6 address 2001:db8:2::2/64
  ipv6 router ospf area 0 tag test1 instance-id 1
!
ipv6 forwarding
!
router ipv6 ospf test1
  router-id 192.168.1.2
  area 0 encryption ipsec spi 555 esp aes-cbc
12345678901234567890123456789012 sha1
1234567890098765432112354678900987654321
```

## OSPFv3 authentication on a VLAN

This example shows how to configure two devices with OSPFv3 authentication on a VLAN.

See the section "[Configuring OSPFv3 authentication on a VLAN](#)" on page 48 for the sequence of console command entries.

Figure 6: OSPFv3 authentication on a VLAN topology:



### Device1 configuration

See the below configuration for a device with the hostname Device1:

```
hostname Device1
!
service ospf6
!
vlan database
  vlan 2 state enable
!
interface port1.0.2
  switchport
  switchport mode access
  switchport access vlan 2
!
interface vlan2
  description Device1_to_Device2
  ipv6 address 2001:db8:2::1/64
  ipv6 enable
  ipv6 router ospf area 0 tag process1
  ipv6 ospf authentication ipsec spi 256 md5
  1234567890abcdef1234567809abcdef
!
ipv6 forwarding
ipv6 ospf display route single-line
!
router ipv6 ospf process1
  router-id 192.168.1.1
```

## Device2 configuration

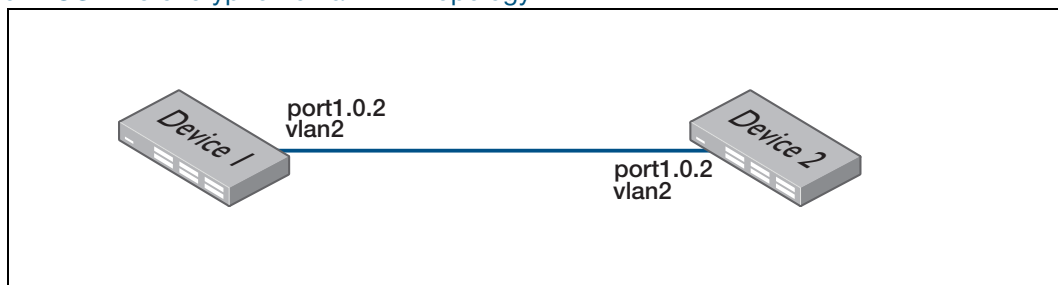
See the below configuration for a device with the hostname Device2:

```
hostname Device2
!
service ospf6
!
vlan database
vlan 2 state enable
!
interface port1.0.2
switchport
switchport mode access
switchport access vlan 2
!
interface vlan2
description Device2_to_Device1
ipv6 address 2001:db8:2::2/64
ipv6 enable
ipv6 router ospf area 0 tag process1
ipv6 ospf authentication ipsec spi 256 md5
1234567890abcdef1234567809abcdef
!
ipv6 forwarding
!
router ipv6 ospf process1
router-id 192.168.1.2
```

## OSPFv3 encryption on a VLAN

This example shows how to configure two devices with OSPFv3 encryption on a VLAN. See the section "[Configuring OSPFv3 encryption on a VLAN](#)" on [page 48](#) for the sequence of console command entries.

Figure 7: OSPFv3 encryption on a VLAN topology:



## Device1 configuration

See the below configuration for a device with the hostname Device1:

```
hostname Device1
!
service ospf6
!
vlan database
  vlan 2 state enable
!
interface port1.0.2
  switchport
  switchport mode access
  switchport access vlan 2
!
interface vlan2
  description Device1_to_Device2
  ipv6 address 2001:db8:2::1/64
  ipv6 enable
  ipv6 router ospf area 0 tag process1
  ipv6 ospf encryption ipsec spi 1000 esp 3des
  1234567890abcdef1234567890abcdef12
!
ipv6 forwarding
ipv6 ospf display route single-line
!
router ipv6 ospf process1
  router-id 192.168.1.1
```

## Device2 configuration

See the below configuration for a device with the hostname Device2:

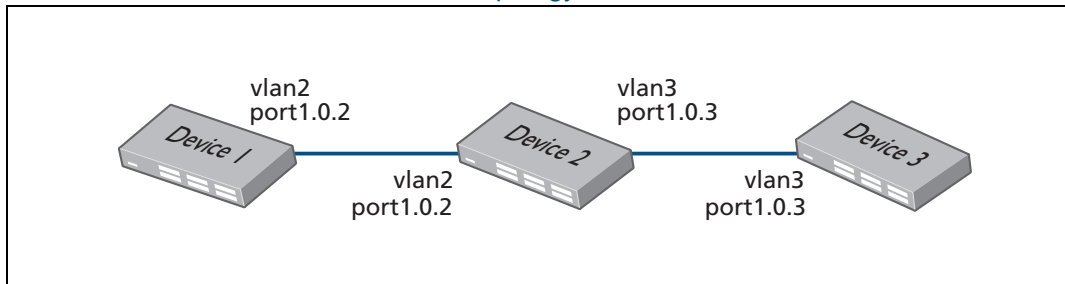
```
hostname Device2
!
service ospf6
!
vlan database
  vlan 2 state enable
!
interface port1.0.2
  switchport
  switchport mode access
  switchport access vlan 2
!
interface vlan2
  description Device2_to_Device1
  ipv6 address 2001:db8:2::2/64
  ipv6 enable
  ipv6 router ospf area 0 tag process1
  ipv6 ospf encryption ipsec spi 1000 esp 3des
  1234567890abcdef1234567890abcdef12
!
ipv6 forwarding
!
router ipv6 ospf process1
  router-id 192.168.1.2
```

## OSPFv3 authentication with two VLANs

This example shows how to configure three devices with OSPFv3 authentication on a per VLAN basis. Note that to increase security, rather than using a single SPI for the entire Area, this example uses a different security profile for each VLAN in the topology shown.

See the section "[Configuring OSPFv3 authentication on a VLAN](#)" on page 48 for the sequence of console command entries.

Figure 8: OSPFv3 authentication on a VLAN topology:



### Device1 configuration

See the below configuration for a device with the hostname Device1:

```
hostname Device1
!
service ospf6
!
vlan database
  vlan 2 state enable
!
interface port1.0.2
  switchport
  switchport mode access
  switchport access vlan 2
!
interface vlan2
  description Device1_to_Device2
  ipv6 address 2001:db8:2::1/64
  ipv6 enable
  ipv6 router ospf area 0 tag process1
  ipv6 ospf authentication ipsec spi 256 md5
  1234567890abcdef1234567809abcdef
!
ipv6 forwarding
ipv6 ospf display route single-line
!
router ipv6 ospf process1
  router-id 192.168.1.1
```

## Device2 configuration

See the below configuration for a device with the hostname Device2:

```
hostname Device2
!
service ospf6
!
vlan database
vlan 2,3 state enable
!
interface port1.0.2
switchport
switchport mode access
switchport access vlan 2
!
interface port1.0.3
switchport
switchport mode access
switchport access vlan 3
!!
interface vlan2
description Device2_to_Device1
ipv6 address 2001:db8:2::2/64
ipv6 enable
ipv6 router ospf area 0 tag process1
ipv6 ospf authentication ipsec spi 256 md5
1234567890abcdef1234567809abcdef
!
interface vlan3
description Device2_to_Device3
ipv6 address 2001:db8:3::1/64
ipv6 enable
ipv6 router ospf area 0 tag process1
ipv6 ospf authentication ipsec spi 512 sha1
1234567890abcdef1234567890abcdef12345678
!
ipv6 forwarding
!
router ipv6 ospf process1
router-id 192.168.1.2
```

## Device3 configuration

See the below configuration for a device with the hostname Device3:

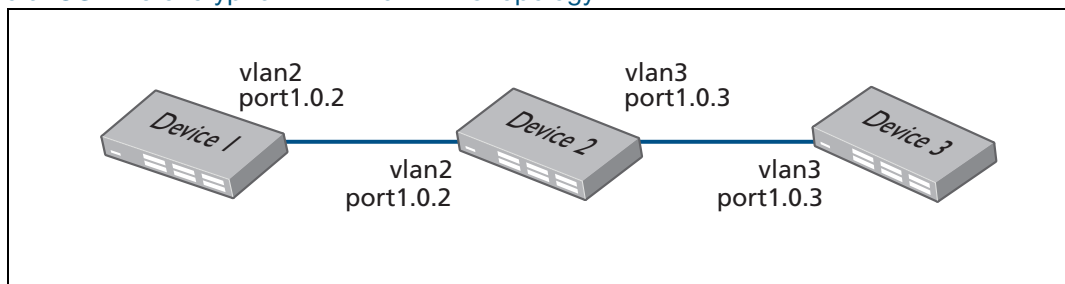
```
hostname Device3
!
service ospf6
!
vlan database
vlan 3 state enable
!
interface port1.0.3
switchport
switchport mode access
switchport access vlan 3
!!
interface vlan3
description Device3_to_Device2
ipv6 address 2001:db8:3::2/64
ipv6 enable
ipv6 router ospf area 0 tag process1
ipv6 ospf authentication ipsec spi 512 sha1
1234567890abcdef1234567890abcdef12345678
!
ipv6 forwarding
!
router ipv6 ospf process1
router-id 3.3.3.3
```

## OSPFv3 encryption with two VLANs

This example shows how to configure three devices with OSPFv3 encryption on a per VLAN basis. Note that to increase security, rather than using a single SPI for the entire Area, this example uses a different security profile for each VLAN in the topology shown.

See the section "[Configuring OSPFv3 encryption on a VLAN](#)" on page 48 for the sequence of console command entries.

Figure 9: OSPFv3 encryption with two VLANs topology:



## Device1 configuration

See the below configuration for a device with the hostname Device1:

```
hostname Device1
!
service ospf6
!
vlan database
vlan 2 state enable
!
interface port1.0.2

    switchport
    switchport mode access
    switchport access vlan 2
!
interface vlan2
description Device1_to_Device2
ipv6 address 2001:db8:2::1/64
ipv6 enable
ipv6 router ospf area 0 tag process1
ipv6 ospf encryption ipsec spi 1000 esp 3des
1234567890abcdef1234567890abcdef12
!
ipv6 forwarding
ipv6 ospf display route single-line
!
router ipv6 ospf process1
router-id 192.168.1.1
```

## Device2 configuration

See the below configuration for a device with the hostname Device2:

```
hostname Device2
!
service ospf6
!
vlan database
  vlan 2,3 state enable
!
interface port1.0.2
  switchport
  switchport mode access
  switchport access vlan 2
!
interface port1.0.3
  switchport
  switchport mode access
  switchport access vlan 3
!
interface vlan2
  description Device2_to_Device1
  ipv6 address 2001:db8:2::2/64
  ipv6 enable
  ipv6 router ospf area 0 tag process1
  ipv6 ospf encryption ipsec spi 1000 esp 3des
  1234567890abcdef1234567890abcdef12
!
interface vlan3
  description Device2_to_Device3
  ipv6 address 2001:db8:3::1/64
  ipv6 enable
  ipv6 router ospf area 0 tag process1
  ipv6 ospf encryption ipsec spi 1200 esp 3des
  7890abcdef1234567890abcdef12123456
!
ipv6 forwarding
!
router ipv6 ospf process1
  router-id 192.168.1.2
```

## Device3 configuration

See the below configuration for a device with the hostname Device3:

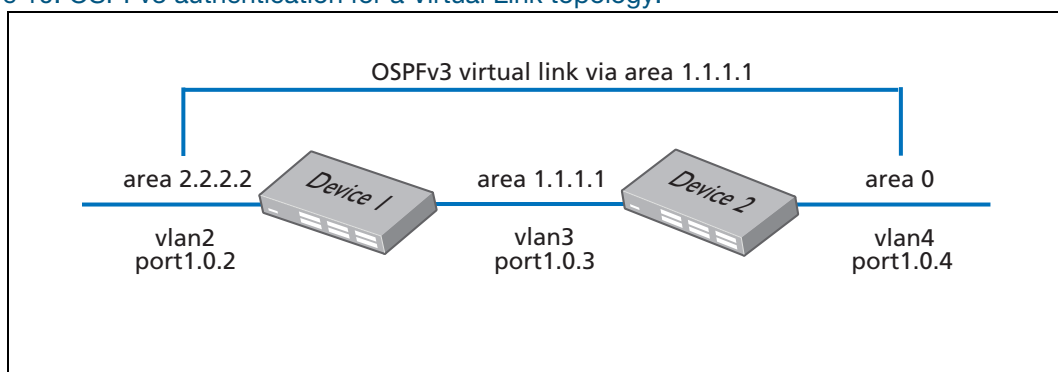
```
hostname Device3
!
service ospf6
!
vlan database
vlan 3 state enable
!
interface port1.0.3
switchport
switchport mode access
switchport access vlan 3
!
interface vlan3
description Device3_to_Device2
ipv6 address 2001:db8:3::2/64
ipv6 enable
ipv6 router ospf area 0 tag process1
ipv6 ospf encryption ipsec spi 1200 esp 3des
7890abcdef1234567890abcdef12123456
!
ipv6 forwarding
!
router ipv6 ospf process1
router-id 3.3.3.3
```

## OSPFv3 authentication for a Virtual Link

In this example, there is an OSPFv3 virtual link configured from Area 2.2.2.2 to the OSPFv3 backbone Area 0, via transit Area 1.1.1.1, with OSPFv3 authentication configured.

See the section "[Configuring OSPFv3 authentication and encryption for a Virtual Link](#)" on page 49 for the sequence of console command entries.

Figure 10: OSPFv3 authentication for a Virtual Link topology:



## Device1 configuration

See the below configuration for a device with the hostname Device1:

```
hostname Device1
!
service ospf6
!
vlan database
vlan 2,3 state enable
!
interface port1.0.2
switchport
switchport mode access
switchport access vlan 2
!
interface port1.0.3
switchport
switchport mode access
switchport access vlan 3
!
interface vlan2
ipv6 address 2001:db8:2::1/64
ipv6 router ospf area 2.2.2.2 tag process1
!
interface vlan3
description Device1_to_Device2
ipv6 address 2001:db8:3::1/64
ipv6 router ospf area 1.1.1.1 tag process1
ipv6 ospf authentication ipsec spi 256 md5
1234567890abcdef1234567809abcdef
!
ipv6 forwarding
!
router ipv6 ospf process1
router-id 192.168.1.1
area 1.1.1.1 virtual-link 192.168.1.2
area 1.1.1.1 virtual-link 192.168.1.2 authentication ipsec spi 256 md5
1234567890abcdef1234567809abcdef
```

## Device2 configuration

See the below configuration for a device with the hostname Device2:

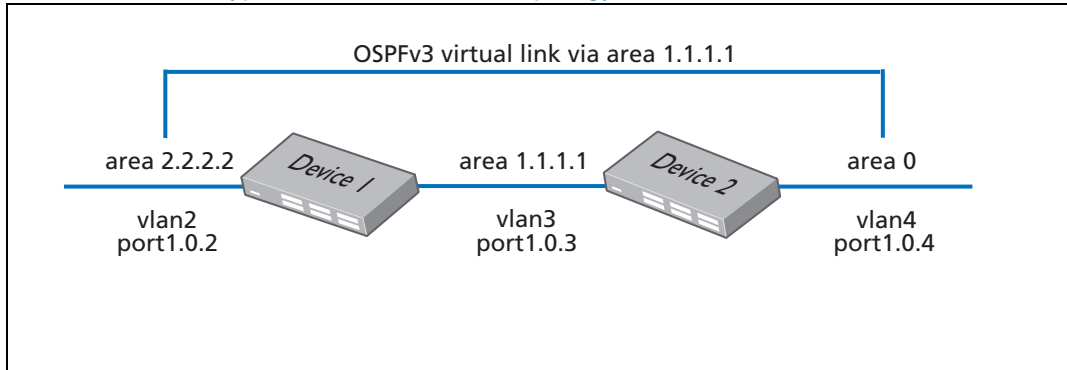
```
hostname Device2
!
service ospf6
!
vlan database
vlan 3,4 state enable
!
interface port1.0.3
switchport
switchport mode access
switchport access vlan 3
!
interface port1.0.4
switchport
switchport mode access
switchport access vlan 4
!
interface vlan3
description Device2_to_Device1
ipv6 address 2001:db8:3::2/64
ipv6 router ospf area 1.1.1.1 tag process1
ipv6 ospf authentication ipsec spi 256 md5
1234567890abcdef1234567809abcdef
!
interface vlan4
ipv6 address 2001:db8:4::1/64
ipv6 router ospf area 0 tag process1
!
ipv6 forwarding
!
router ipv6 ospf process1
router-id 192.168.1.2
area 1.1.1.1 virtual-link 192.168.1.1
area 1.1.1.1 virtual-link 192.168.1.2 authentication ipsec spi 256 md5
1234567890abcdef1234567809abcdef
```

## OSPFv3 encryption for a Virtual Link

In this example, there is an OSPFv3 Virtual Link configured from OSPFv3 Area 2.2.2.2 to the OSPFv3 backbone Area 0, via transit Area 1.1.1.1, with OSPFv3 encryption configured.

See the section "[Configuring OSPFv3 authentication and encryption for a Virtual Link](#)" on page 49 for the sequence of console command entries.

Figure 11: OSPFv3 encryption for a Virtual Link topology:



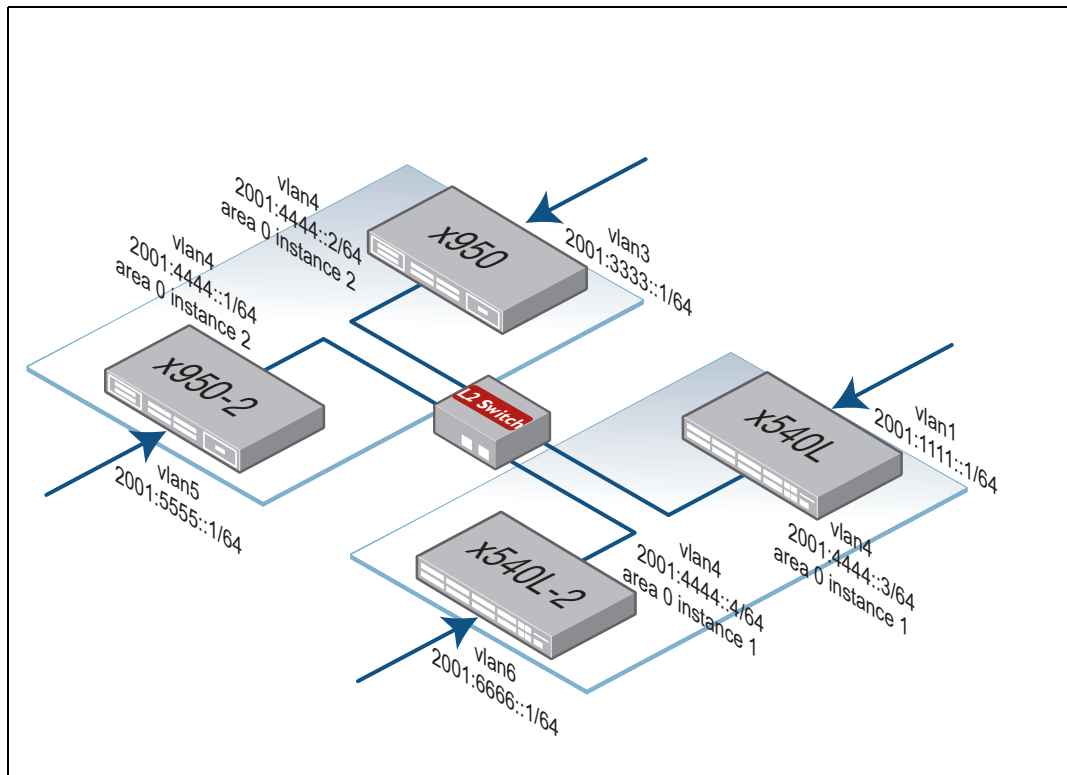
### Device1 configuration

See the below configuration for a device with the hostname Device1:

```
hostname Device1
!
service ospf6
!
vlan database
  vlan 2,3 state enable
!
interface port1.0.2
  switchport
  switchport mode access
  switchport access vlan 2
!
interface port1.0.3
  switchport
  switchport mode access
  switchport access vlan 3
!
interface vlan2
  ipv6 address 2001:db8:2::1/64
  ipv6 router ospf area 2.2.2.2 tag process1
!
interface vlan3
  description Device1_to_Device2
  ipv6 address 2001:db8:3::1/64
  ipv6 router ospf area 1.1.1.1 tag process1
  ipv6 ospf encryption ipsec spi 1000 esp 3des
  1234567890abcdef1234567890abcdef1234567890abcdef md5
  1234567890abcdef1234567890abcdef
!
ipv6 forwarding
!
router ipv6 ospf process1
  router-id 192.168.1.1
  area 1.1.1.1 virtual-link 192.168.1.2
  area 1.1.1.1 virtual-link 192.168.1.2 encryption ipsec spi 2000 esp 3des
  fedcba0987654321fedcba0987654321fedcba0987654321 md5
  fedcba0987654321fedcba0987654321
```

# Further Configuration Examples

## Multi-instance network



### Configuration for x540L

```
!  
service ospf6  
!  
vlan database  
  vlan 4 state enable  
!  
interface port1.0.4  
  switchport access vlan 4  
!  
interface vlan1  
  ipv6 address 2001:1111::1/64  
!  
interface vlan4  
  ipv6 address 2001:4444::3/64  
  ipv6 router ospf area 0 instance-id 1  
!  
ipv6 forwarding  
!  
router ipv6 ospf  
  router-id 192.168.1.1  
  redistribute connected  
!
```

### Configuration for x540L-2

```
!  
service ospf6  
!  
vlan database  
  vlan 4,6 state enable  
!  
interface port1.0.4  
  switchport access vlan 4  
!  
interface port1.0.6  
  switchport access vlan 6  
!  
interface vlan4  
  ipv6 address 2001:4444::4/64  
  ipv6 router ospf area 0 instance-id 1  
!  
interface vlan6  
  ipv6 address 2001:6666::1/64  
!  
router ipv6 ospf  
  router-id 192.168.1.4  
  redistribute connected  
!
```

### Configuration for x950

```
!  
service ospf6  
!  
vlan database  
  vlan 3,4 state enable  
!  
interface port1.0.3  
  switchport access vlan 3  
!  
interface port1.0.4  
  switchport access vlan 4  
!  
interface vlan3  
  ipv6 address 2001:3333::1/64  
!  
interface vlan4  
  ipv6 address 2001:4444::2/64  
  ipv6 router ospf area 0 instance-id 2  
!  
router ipv6 ospf  
  router-id 192.168.1.2  
  redistribute connected  
!
```

### Configuration for x950-2

```
!  
service ospf6  
!  
vlan database  
  vlan 4-5 state enable  
!  
interface port1.0.4  
  switchport access vlan 4  
!  
interface port1.0.5  
  switchport access vlan 5  
!  
interface vlan4  
  ipv6 address 2001:4444::1/64  
  ipv6 router ospf area 0 instance-id 2  
!  
interface vlan5  
  ipv6 address 2001:5555::1/64  
!  
router ipv6 ospf  
  router-id 192.168.1.3  
  redistribute connected  
!
```

In this example, all four switches are connected to the same VLAN. But, two of the switches (x540L and x540L-2) are configured in Instance 1, and the other two (x950 and x950-2) are configured in Instance 2.

As a result, x950-2 peers only with x950, as they both have the same OSPFv3 Instance ID 2. Similarly, the x540L peers only with the x540L-2, as they both have the same Instance ID. Switches with different Instance IDs will not peer with each other.

So, x950 and x950-2 exchange routes only with each other. Similarly x540L and x540L-2 exchange routes only with each other.

x950-2's only neighbor is x950 (router ID 192.168.1.2)

```
x950-2#sh ipv6 ospf nei
OSPFv3 Process (*null*)
Neighbor ID      Pri   State           Dead Time   Interface   Instance ID
192.168.1.2     1    Full/DR         00:00:32   vlan4       2
```

x950-2 does not learn the routes being advertised by x540L and x540L-2 (i.e. 2001:1111::/64 and 2001:6666::/64).

```
x950-2#sh ipv6 route
IPv6 Routing Table
Codes: C - connected, S - static, R - RIP, O - OSPF, B - BGP, D - DHCP
      IA - OSPF inter area E1 - OSPF ext. type 1, E2 - OSPF ext. type 2
Timers: Uptime

OE2  2001:3333::/64 [110/20] via fe80::200:cdf:fe24:ff2d, vlan4, 00:04:11
C    2001:4444::/64 via ::, vlan4, 00:04:53
C    2001:5555::/64 via ::, vlan5, 00:04:53
C    fe80::/64 via ::, vlan5, 00:04:53
C    fe80::/64 via ::, vlan4, 00:05:01
C    fe80::/64 via ::, vlan5, 00:05:01
```

x950's only neighbor is x950-2 (router id 192.168.1.3)

```
x950#sh ipv6 ospf nei
OSPFv3 Process (*null*)
Neighbor ID      Pri   State           Dead Time   Interface   Instance ID
192.168.1.3     1    Full/Backup     00:00:34   vlan4       2
```

x950 does not learn the routes being advertised by x540L and x540L-2 (i.e. 2001:1111::/64 and 2001:6666::/64).

```
x950#sh ipv6 route
IPv6 Routing Table
Codes: C - connected, S - static, R - RIP, O - OSPF, B - BGP, D - DHCP
      IA - OSPF inter area E1 - OSPF ext. type 1, E2 - OSPF ext. type 2
Timers: Uptime

C    2001:3333::/64 via ::, vlan3, 00:14:00
C    2001:4444::/64 via ::, vlan4, 00:21:47
OE2  2001:5555::/64 [110/20] via fe80::200:cdf:fe29:90c7, vlan4, 00:00:25
C    fe80::/64 via ::, vlan3, 00:14:00
C    fe80::/64 via ::, vlan4, 00:21:47
```

x540L's only neighbor is x540L-2 (router id 192.168.1.4)

```
x540L#sh ipv6 ospf nei
OSPFv3 Process (*null*)
Neighbor ID      Pri   State           Dead Time   Interface   Instance ID
192.168.1.4     1    Full/Backup     00:00:39   vlan4       1
```

x540L does not learn the routes being advertised by x950 and x950-2 (i.e. 2001:3333::/64 and 2001:5555::/64)

```
x540L#sh ipv6 route
IPv6 Routing Table
Codes: C - connected, S - static, R - RIP, O - OSPF, B - BGP, D - DHCP
       IA - OSPF inter area E1 - OSPF ext. type 1, E2 - OSPF ext. type 2
Timers: Uptime

C       2001:1111::/64 via ::, vlan1, 00:21:42
C       2001:4444::/64 via ::, vlan4, 00:18:18
OE2     2001:6666::/64 [110/20] via fe80::eecd:6dff:fe48:e54f, vlan4, 00:10:23
C       fe80::/64 via ::, vlan1, 00:21:42
C       fe80::/64 via ::, vlan4, 00:21:49
C       fe80::/64 via ::, vlan1, 00:21:49
```

x540L-2's only neighbor is x540L (router id 192.168.1.1).

```
x540L-2#sh ipv6 ospf nei
OSPFv3 Process (*null*)
Neighbor ID      Pri   State           Dead Time   Interface   Instance ID
192.168.1.1     1    Full/DR         00:00:32   vlan4       1
```

x540L-2 does not learn the routes being advertised by x950 and x950-2 (i.e. 2001:3333::/64 and 2001:5555::/64).

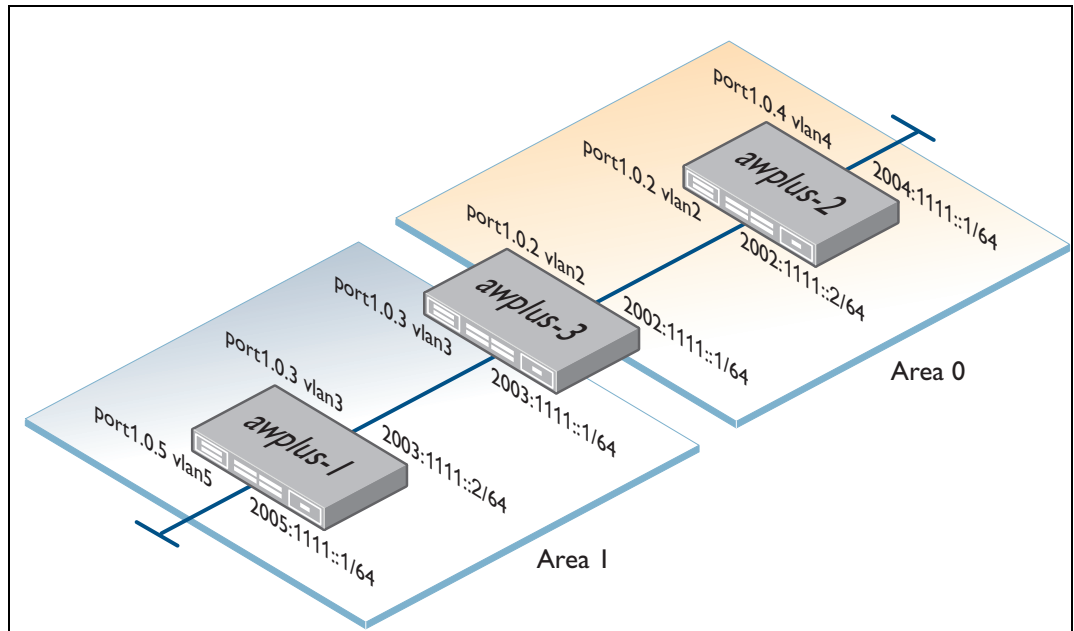
```
x540L-2#sh ipv6 route
IPv6 Routing Table
Codes: C - connected, S - static, R - RIP, O - OSPF, B - BGP, D - DHCP
       IA - OSPF inter area E1 - OSPF ext. type 1, E2 - OSPF ext. type 2
Timers: Uptime

OE2     2001:1111::/64 [110/20] via fe80::eecd:6dff:fe20:c16d, vlan4, 00:22:43
C       2001:4444::/64 via ::, vlan4, 00:23:25
C       2001:6666::/64 via ::, vlan6, 00:16:43
C       fe80::/64 via ::, vlan4, 00:23:25
C       fe80::/64 via ::, vlan6, 00:35:34
C       fe80::/64 via ::, vlan4, 00:36:01
```

## Multiple Areas- Example

This section looks at a slightly larger scenario, involving three routers spread over two Areas. This enables us to introduce some aspects of OSPFv3 inter-Area routing.

In this scenario, there are two Areas—the backbone and Area 1. There are two routers that are each fully within one Area, and one router that is the border router between the two Areas.



### Configuration for awplus-1

```
!  
service ospf6  
!  
vlan database  
  vlan 3  
  vlan 5  
!  
service ospf6  
!  
interface port1.0.3  
  switchport access vlan 3  
!  
interface port1.0.5  
  switchport access vlan 5  
!  
interface vlan3  
  ipv6 address 2003:1111::2/64  
  ipv6 router ospf area 1 tag 10  
!  
interface vlan5  
  ipv6 address 2005:1111::1/64  
!  
ipv6 forwarding  
!  
router ipv6 ospf 10  
  router-id 192.168.1.3  
  redistribute connected
```

### Configuration for awplus-2

```
!  
service ospf6  
!  
vlan database  
  vlan 2  
  vlan 4  
!  
interface port1.0.2  
  switchport access vlan 2  
!  
interface port1.0.4  
  switchport access vlan 4  
!  
interface vlan2  
  ipv6 address 2002:1111::2/64  
  ipv6 router ospf area 0 tag 10  
!  
interface vlan4  
  ipv6 address 2004:1111::1/64  
!  
ipv6 forwarding  
!  
router ipv6 ospf 10  
  router-id 192.168.1.2  
  redistribute connected
```

### Configuration for awplus-3

```
!  
service ospf6  
!  
vlan database  
  vlan 2  
  vlan 3  
!  
interface port2.0.2  
  switchport access vlan 2  
!  
interface port2.0.3  
  switchport access vlan 3  
!  
interface vlan2  
  ipv6 address 2002:1111::1/64  
  ipv6 router ospf area 0 tag 10  
!  
interface vlan3  
  ipv6 address 2003:1111::1/64  
  ipv6 router ospf area 1 tag 10  
!  
ipv6 forwarding  
!  
router ipv6 ospf 10  
  router-id 192.168.1.1
```

## Understanding the results of this configuration

Using **show ipv6 ospf route**, we can now see that there are Inter-Area routes:

```
awplus-3#sh ipv6 ospf route
OSPFv3 Process (10)
Codes: C - connected, D - Discard, O - OSPF, IA - OSPF inter area
       E1 - OSPF external type 1, E2 - OSPF external type 2

  Destination                                Metric
  Next-hop
C 2002:1111::/64                             1
  directly connected, vlan2, Area 0.0.0.0
C 2003:1111::/64                             1
  directly connected, vlan3, Area 0.0.0.1
E2 2004:1111::/64                           1/20
  via fe80::200:cdff:fe29:8ed3, vlan2
E2 2005:1111::/64                           1/20
  via fe80::215:77ff:fec2:4d53, vlan3
```

Now that there are two OSPF Areas, you can see some extra fields in the **show ipv6 ospf database** output for the Inter-Area LSAs:

```
awplus-3#show ipv6 ospf database
          OSPFv3 Router with ID (192.168.1.1) (Process 10)
          Inter-Area-Prefix-LSA (Area 0.0.0.0)
Link State ID  ADV Router      Age  Seq#      CkSum
0.0.0.7        192.168.1.1      231 0x80000001 0x72cb
          Inter-Area-Router-LSA (Area 0.0.0.0)
Link State ID  ADV Router      Age  Seq#      CkSum
0.0.0.2        192.168.1.1      44  0x80000001 0x58f2
          Intra-Area-Prefix-LSA (Area 0.0.0.0)
Link State ID  ADV Router      Age  Seq#      CkSum  Prefix Reference
0.0.0.2        192.168.1.2     961 0x800001ad 0x0628  1 Network-LSA
          Inter-Area-Prefix-LSA (Area 0.0.0.1)
Link State ID  ADV Router      Age  Seq#      CkSum
0.0.0.3        192.168.1.1     226 0x80000002 0x8cb5
          Inter-Area-Router-LSA (Area 0.0.0.1)
Link State ID  ADV Router      Age  Seq#      CkSum
0.0.0.3        192.168.1.1     226 0x80000002 0x3e0c
```

## show ipv6 ospf database inter-prefix

### Show output

```
awplus-3#show ipv6 ospf database inter-prefix
OSPFv3 Router with ID (192.168.1.1) (Process 10)
Inter-Area-Prefix-LSA (Area 0.0.0.0)
LS age: 457
LS Type: Inter-Area-Prefix-LSA
Link State ID: 0.0.0.7
Advertising Router: 192.168.1.1
LS Seq Number: 0x80000001
Checksum: 0x72CB
Length: 36
Metric: 1
Prefix: 2003:1111::/64
Prefix Options: 0
Inter-Area-Prefix-LSA (Area 0.0.0.1)
LS age: 452
LS Type: Inter-Area-Prefix-LSA
Link State ID: 0.0.0.3
Advertising Router: 192.168.1.1
LS Seq Number: 0x80000002
Checksum: 0x8CB5
Length: 36
Metric: 1
Prefix: 2002:1111::/64
Prefix Options: 0
```

### Output explained

#### The Inter-Area Prefix LSA:

- describes the destination outside the Area but still in the Autonomous System
- the summary is created for one Area, but flooded to all other Areas
- originated by an Area Border Router
- only intra-Area routes are advertised into the backbone (Area 0)
- external routes are also advertised into the backbone from non-stub Areas

**Advertising Router: 192.168.1.1** shows the Router ID of this switch (awplus-3).

**Prefix: 2003:1111::/64** is configured on an interface on this switch in Area 1.

**Inter-Area-Prefix-LSA (Area 0.0.0.1)** is a prefix that exists in Area 1.

# OSPFv3 Summarization

OSPFv2 can summarize both AS-External routes with the **summary-address** command, and inter-Area routes with the **area range** command. So too, can OSPFv3.

The inter-Area route summarization in OSPFv3 operates similarly to that of OSPFv2.

## The inter-Area route summarization

The **area range** command defines summarization routes that will be advertised via inter-Area summarization LSAs. The component routes within that range will not be advertised.

At least one component route has to be in the route table before it will advertise the summarization route.

To illustrate the operation of the inter-Area summarization, we can send a summarization for networks 2003:1111::/64 and 2003:2222::/64 from switch awplus-3 to awplus-2 with the following configuration:

### awplus-3 configuration

```
router ipv6 ospf 10
router-id 192.168.1.1
area 1 range 2003::/16
```

Now on switch awplus-2 we see the summarization 2003::/16—rather than the two individual routes:

```
awplus-2#sh ipv6 route
IPv6 Routing Table
Codes: C - connected, S - static, R - RIP, O - OSPF, B - BGP
Timers: Uptime
C   2002:1111::/64 via ::, vlan2, 06:12:46
O   2003::/16 [110/3] via fe80::200:cdff:fe28:801, vlan2, 00:00:19
C   2004:1111::/64 via ::, vlan4, 05:55:28
C   fe80::/64 via ::, vlan4, 05:55:28
C   fe80::/64 via ::, vlan2, 06:12:46
```

## External route summarization

External route summarization is configured with the **summary-address** command.

For example:

```
router ipv6 ospf 1
summary-address 2001:db8: a::/48
```

## Using RIPng and OSPFv3 Together

OSPFv3 can redistribute routes that are learnt via RIPng. In this example we will learn an IPv6 route via RIPng and redistribute it into OSPFv3.

**Example** An IPv6 host running RIPng was connected to port1.0.10 (VLAN 10) on switch awplus-3.

This host is advertising a route to 2010:7777::/64 via RIPng.

The extra configuration added on **awplus-3** is:

```
vlan database
vlan 10
!
interface port1.0.10
switchport access vlan 10
!
interface vlan10
ipv6 address 2010:5555::1/64
ipv6 router rip
!
router ipv6 ospf 10
router-id 192.168.1.1
redistribute connected
redistribute rip
```

On switch **awplus-3** we now see the route 2010:7777::/64 via RIP:

```
awplus-3#sh ipv6 route
IPv6 Routing Table
Codes: C - connected, S - static, R - RIP, O - OSPF, B - BGP
Timers: Uptime

C 2002:1111::/64 via ::, vlan2, 03:40:32
C 2003:1111::/64 via ::, vlan3, 03:40:32
O 2004:1111::/64 [110/20] via fe80::200:cdff:fe29:8ed3, vlan2, 03:39:33
O 2005:1111::/64 [110/20] via fe80::215:77ff:fec9:745e, vlan3, 03:36:29
C 2010:5555::/64 via ::, vlan10, 00:30:31
R 2010:7777::/64 [120/2] via fe80::200:cdff:fe20:f101, vlan10, 00:23:21
C fe80::/64 via ::, vlan10, 00:30:31
C fe80::/64 via ::, vlan3, 03:40:32
C fe80::/64 via ::, vlan2, 03:40:32
```

And the neighboring switches will see this route via OSPFv3:

```
awplus-2#sh ipv6 route
IPv6 Routing Table
Codes: C - connected, S - static, R - RIP, O - OSPF, B - BGP
Timers: Uptime

C 2002:1111::/64 via ::, vlan2, 03:42:41
O 2003:1111::/64 [110/2] via fe80::200:cdff:fe27:c1ff, vlan2, 03:41:50
C 2004:1111::/64 via ::, vlan4, 03:53:41
O 2005:1111::/64 [110/20] via fe80::200:cdff:fe27:c1ff, vlan2, 03:38:38
O 2010:5555::/64 [110/20] via fe80::200:cdff:fe27:c1ff, vlan2, 00:32:37
O 2010:7777::/64 [110/20] via fe80::200:cdff:fe27:c1ff, vlan2, 00:25:27
C fe80::/64 via ::, vlan2, 03:42:41
C fe80::/64 via ::, vlan4, 03:53:41
```

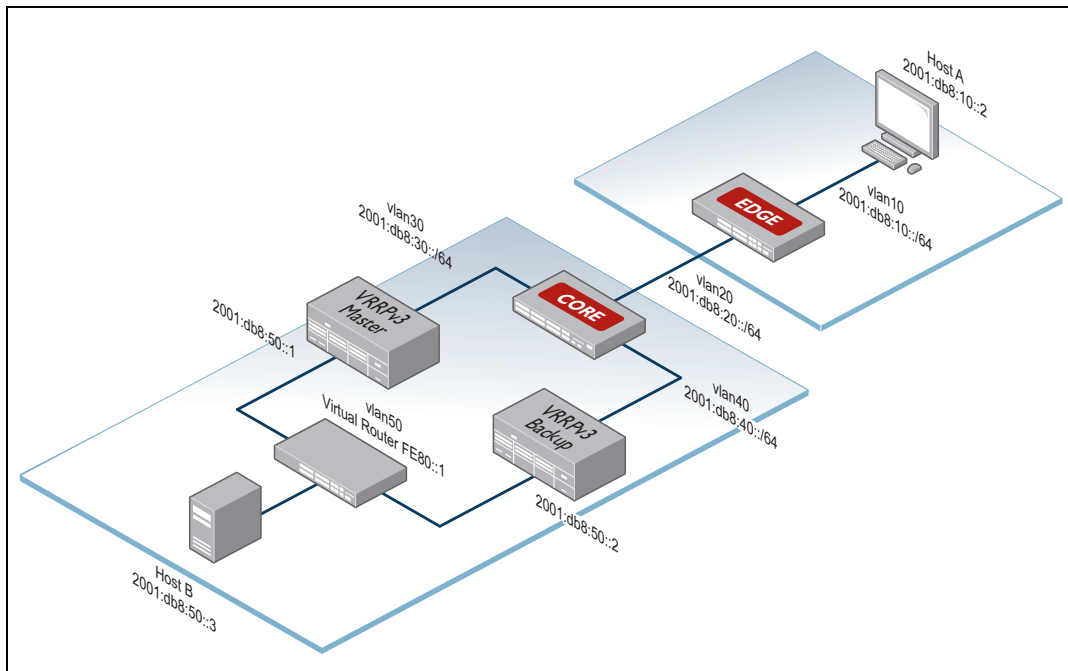
The route learnt by RIP is advertised in OSPFv3 as an AS-external LSA.

### **Distributing OSPFv3 routes into RIPng**

You can also redistribute OSPFv3 learned routes into RIPng (so the IPv6 host will see all of the OSPFv3 routes in the network via RIPng):

```
router ipv6 rip
redistribute ospf
```

## Using OSPFv3 and VRRP to Create Redundant Paths



**Objective** Use redundant pathways to ensure that Host A and Host B have reliable communication.

**Description** To achieve redundancy, VRRPv3 is used to create a virtual router that manages a pair of redundant physical gateways.

OSPFv3 is used to share routes through the network.

## Configuration of the SBx908 GEN3 VRRPv3 master

```
!  
service ospf6  
!  
vlan database  
  vlan 30 state enable  
  vlan 50 state enable  
!  
interface port1.1.1  
  switchport access vlan 30  
!  
interface port1.1.2  
  switchport access vlan 50  
!  
interface vlan 30  
  ipv6 address 2001:db8:30::2/64  
  ipv6 router ospf area 0  
!  
interface vlan 50  
  ipv6 address 2001:db8:50::1/64  
  ipv6 router ospf area 0  
!  
router ipv6 ospf  
  router-id 1.1.1.1  
  passive-interface vlan 50  
!  
router ipv6 vrrp 1 vlan50  
  virtual-ipv6 fe80::1 backup  
  circuit-failover vlan30 60  
  priority 150  
  advertisement interval cses 1  
  enable  
!
```

## Configuration of the SBx908 GEN3 VRRPv3 backup

```
!  
service ospf6  
!  
vlan database  
  vlan 40 state enable  
  vlan 50 state enable  
!  
interface port1.1.1  
  switchport access vlan 40  
!  
interface port1.1.2  
  switchport access vlan 50  
!  
interface vlan 40  
  ipv6 address 2001:db8:30::2/64  
  ipv6 router ospf area 0  
!  
interface vlan 50  
  ipv6 address 2001:db8:50::2/64  
  ipv6 router ospf area 0  
!  
router ipv6 ospf  
  router-id 2.2.2.2  
  passive-interface vlan 50  
!  
router ipv6 vrrp 1 vlan50  
  virtual-ipv6 fe80::1 backup  
  advertisement interval cses 1  
  enable  
!
```

## Configuration of the core switch

```
!  
service ospf6  
!  
vlan database  
  vlan 30 state enable  
  vlan 40 state enable  
  vlan 50 state enable  
!  
interface port1.0.2  
  switchport access vlan 30  
!  
interface port1.0.2  
  switchport access vlan 40  
!  
interface port1.0.47  
  switchport access vlan 20  
!  
interface vlan 20  
  ipv6 address 2001:db8:20::2/64  
  ipv6 router ospf area 0  
!  
interface vlan 30  
  ipv6 address 2001:db8:30::1/64  
  ipv6 router ospf area 0  
!  
interface vlan 40  
  ipv6 address 2001:db8:30::1/64  
  ipv6 router ospf area 0  
!  
router ipv6 ospf  
  router-id 3.3.3.3  
!
```

## Configuration of the edge switch

```
!  
service ospf6  
!  
vlan database  
  vlan 10 state enable  
  vlan 20 state enable  
!  
interface port1.0.12  
  switchport access vlan 20  
!  
interface port1.0.25  
  switchport access vlan 10  
!  
interface port1.0.47-1.0.49  
  switchport access vlan 20  
!  
interface vlan 10  
  ipv6 address 2001:db8:10::1/64  
  ipv6 router ospf area 0  
!  
interface vlan 20  
  ipv6 address 2001:db8:20::1/64  
  ipv6 router ospf area 0  
!  
router ipv6 ospf  
  router-id 4.4.4.4  
  passive-interface vlan 10  
!
```

## Route exists on VRRPv3 routers to the host A's network.

```
x908GEN3-A#show ipv6 route 2001:db8:10::/64  
Routing entry for 2001:db8:10::/64  
  Known via "ospf", distance 110, metric 3, best  
  Last update 00:08:11 ago  
  * via fe80::21a:ebff:fe56:5082, vlan30
```

```
x908GEN3-B#show ipv6 route 2001:db8:10::/64  
Routing entry for 2001:db8:10::/64  
  Known via "ospf", distance 110, metric 3, best  
  Last update 00:16:54 ago  
  * via fe80::21a:ebff:fe56:5082, vlan40
```

## Check VRRP information on the Master and Backup.

```
x908GEN3-A#show vrrp ipv6 1 vlan50
```

```
VMAC enabled
Address family IPv6
VRRP Id: 1 on interface: vlan50
  State: AdminUp   - Master
  Virtual IP address: fe80::1 (Not-owner)
  Configured Priority: 150, Current priority: 150
  Advertisement interval: 1 centiseconds
  Preempt mode: TRUE
  Monitored circuit: vlan30, Priority Delta: 60, Status: UP
  Multicast membership on IPv6 interface vlan50: JOINED
  Transition mode: FALSE
  Accept mode: TRUE
  Master address: fe80::200:cdf:fe2b:5f7
```

```
x908GEN3-B#show vrrp ipv6 1 vlan50
```

```
VMAC enabled
Address family IPv6
VRRP Id: 1 on interface: vlan50
  State: AdminUp   - Backup
  Virtual IP address: fe80::1 (Not-owner)
  Priority is 100
  Advertisement interval: 1 centiseconds
  Preempt mode: TRUE
  Multicast membership on IPv6 interface vlan50: JOINED
  Transition mode: FALSE
  Accept mode: TRUE
  Master address: fe80::200:cdf:fe2b:5f7
```

## Route-maps and OSPFv3

Route-maps can match on the following:

- metric type
- metric value
- nexthop address
- prefix-list
- access-list

In OSPFv3 AlliedWare Plus only supports applying a route-map to redistributed routes—RIPng, static, or connected routes.

If you were learning IPv6 routes from RIPng, and wanted to modify the characteristics of a particular RIPng route and advertise it in OSPFv3, you could create a route-map to do this.

There are multiple options available for what the route-map can match on. The next section considers a few different cases.

### Matching on a prefix-list

#### Step 1: Configure a prefix-list.

Configure a prefix-list, in this case **test1**, which matches on IPv6 route **2010:7777::/64**, which is the prefix being learned via RIPng.

```
ipv6 prefix-list test1 seq 5 permit 2010:7777::/64
```

#### Step 2: Create a route-map.

Create a route-map, in this case **rm1**, and match on the prefix-list. Use the **set** parameters to modify the metric-type and metric.

```
route-map rm1 permit 10
match ipv6 address prefix-list test1
set metric-type type-1
set metric 100
```

#### Step 3: Apply the route-map.

Apply the **rm1** route-map to the **redistribute rip** command.

```
router ipv6 ospf 10
router-id 192.168.1.3
redistribute rip route-map rm1
```

#### Step 4: Review the AS-External LSA.

Using the command **show ipv6 ospf database external**, you can now see in the LSA database that the AS-External LSA for this imported route to 2010:7777::/64 via OSPFv3 has metric-type of **1** and a metric of **100**.

```
LS age: 57
LS Type: AS-External-LSA
Link State ID: 0.0.45.228
Advertising Router: 192.168.1.3
LS Seq Number: 0x80000001
Checksum: 0x8A47
Length: 36
  Metric Type: 1 (Comparable directly to link state metric)
  Metric: 100
  Prefix: 2010:7777::/64
  Prefix Options: 0 (-|-|-|-)
```

As a result, when other routers receive this LSA, they put this route into their OSPFv3 route table as an E1 route with metric 100.

## Matching on an access-list

#### Step 1: Configure an access-list.

Configure an access-list, in this case **test3**, which matches on IPv6 route **2010:7777::/64**, which is the prefix that is being learned via RIPng.

```
ipv6 access-list standard test3 permit 2010:7777::/64
```

#### Step 2: Create a route-map

Create a route-map, in this case **rm5**, and use the **set** parameters to modify the metric:

```
route-map rm5 permit 10
match ipv6 address test3
set metric 35
```

#### Step 3: Apply the route map.

Apply this route-map (**rm5**) to the **redistribute rip** command:

```
router ipv6 ospf 10
router-id 192.168.1.3
redistribute connected
redistribute rip route-map rm5
```

#### Step 4: Confirm.

The neighboring switch sees the route to **2010:7777::/64** via OSPFv3 with a metric of **35**:

```
show ipv6 route 2010:7777::/64
Routing entry for 2010:7777::/64
  Known via "ospf", distance 110, metric 35, best
  Last update 00:00:36 ago
  * via fe80::200:cdf:fe29:8ed3, vlan5
```

## Matching on route-type

### Step 1: Create a route-map.

Create a route-map, in this case **rm3**, and match on **external type-2**. Use the **set** parameters to set the metric of any external type-2 routes to **50**:

```
route-map rm3 permit 10
 match route-type external type-2
 set metric 50
```

### Step 2: Apply the route map

Apply the **rm3** route-map to the **redistribute rip** command:

```
router ipv6 ospf 10
 router-id 192.168.1.3
 redistribute rip route-map rm3
```

The neighboring switch sees any external type-2 routes learned via OSPFv3 advertised with a metric of 50.

## Other possibilities

The other possible route-map matches are as follows:

#### ■ Metric:

```
awplus-2(config-route-map)# match metric ?
<0-4294967295> Metric value
```

#### ■ Next-hop address:

```
awplus-2(config-route-map)# match ip next-hop ?
<1-199> IP access-list number
<1300-2699> IP access-list number (expanded range)
WORD IP Access-list name
prefix-list Match entries of prefix-lists
```

# Altering the Metric Applied to Routes Redistributed into OSPFv3

By default, when routes are redistributed into OSPFv3, they are given a metric value of 20. But it is possible to change this value.

There are two ways to alter the metric that is applied to routes that are redistributed into OSPF:

- configure a metric value on the redistribute command
- configure the value with a route map.

## Default behaviour

When no metric has been defined, either in the **redistribute** command, or via a route-map, the default metric for routes redistributed into the OSPFv3 process is 20.

```
awplus#show running-config router ipv6 ospf
!
router ipv6 ospf
  router-id 1.1.1.3
  redistribute connected
!
```

The metric seen in the external LSAs created from the redistributed routes is 20.

```
awplus#show ipv6 ospf database external adv-router 1.1.1.3
          OSPFv3 Router with ID (1.1.1.3) (Process *null*)
          AS-external-LSA
LS age: 309
LS Type: AS-External-LSA
Link State ID: 0.0.0.2
Advertising Router: 1.1.1.3
LS Seq Number: 0x80000001
Checksum: 0xE699
Length: 48
  Metric Type: 2 (Larger than any link state path)
  Metric: 20
  Prefix: 2001:db8::1/128
  Prefix Options: 0 (-|-|-)
  External Route Tag: 0
```

## Seed metric defined in the redistribute command

If the metric is specified in the redistribute command then this is used as the default seed metric.

```
awplus#show running-config router ipv6 ospf
!
router ipv6 ospf
  router-id 1.1.1.3
  redistribute connected metric 100
!
```

Now the value of the metric in the resulting LSAs is 100.

```

awplus#show ipv6 ospf database external adv-router 1.1.1.3
      OSPFv3 Router with ID (1.1.1.3) (Process *null*)
      AS-external-LSA
LS age: 20
LS Type: AS-External-LSA
Link State ID: 0.0.0.2
Advertising Router: 1.1.1.3
LS Seq Number: 0x80000002
Checksum: 0xC668
Length: 48
  Metric Type: 2 (Larger than any link state path)
  Metric: 100
  Prefix: 2001:db8::1/128
  Prefix Options: 0 (-|-|-|-)
  External Route Tag: 0

```

### No seed metric defined in the redistribute command and a route map is used for route filtering

If a route map is used and no seed metric is defined in either the redistribute command or set in the route map, the metric defaults to 20.

```

awplus#show running-config router ipv6 ospf
!
router ipv6 ospf
  router-id 1.1.1.3
  redistribute connected route-map REDISTRIBUTE_MAP
!

```

```

awplus#show running-config route-map
!
route-map REDISTRIBUTE_MAP permit 10
  match ipv6 address REDISTRIBUTE_LIST
!

```

```

awplus#show ipv6 ospf database external adv-router 1.1.1.3
      OSPFv3 Router with ID (1.1.1.3) (Process *null*)
      AS-external-LSA
LS age: 14
LS Type: AS-External-LSA
Link State ID: 0.0.0.3
Advertising Router: 1.1.1.3
LS Seq Number: 0x80000001
Checksum: 0xDCA2
Length: 48
  Metric Type: 2 (Larger than any link state path)
  Metric: 20
  Prefix: 2001:db8::1/128
  Prefix Options: 0 (-|-|-|-)
  External Route Tag: 0

```

### Seed metric defined in the redistribute command but not set in route map

If a route map is used and a seed metric is defined in the **redistribute** command only, the metric defaults to user value defined in the **redistribute** command.

```
awplus#show running-config router ipv6 ospf
!
router ipv6 ospf
router-id 1.1.1.3
redistribute connected metric 100 route-map REDISTRIBUTE_MAP
!
```

```
awplus#show running-config route-map
!
route-map REDISTRIBUTE_MAP permit 10
match ipv6 address REDISTRIBUTE_LIST
!
```

The metric in the external routes is the value specified in the **redistribute** command (100).

```
awplus#show ipv6 ospf database external adv-router 1.1.1.3
      OSPFv3 Router with ID (1.1.1.3) (Process *null*)
      AS-external-LSA
LS age: 629
LS Type: AS-External-LSA
Link State ID: 0.0.0.3
Advertising Router: 1.1.1.3
LS Seq Number: 0x80000002
Checksum: 0xBC71
Length: 48
  Metric Type: 2 (Larger than any link state path)
  Metric: 100
  Prefix: 2001:db8::1/128
  Prefix Options: 0 (-|-|-|-)
  External Route Tag: 0
```

### Seed metric defined in the redistribute command and also set in the route map

If a route map is used and a seed metric is defined in the **redistribute** command as well as in a **route map set** command, the metric defaults to user value defined in the **route map set** command.

The route map setting the metric supersedes the value of the **redistribute** command.

In this example, the **redistribute** command is set to redistribute connected routes matching route map REDISTRIBUTE\_MAP with a metric of 100. The route map is also set to use metric 200 for the routes matching the REDISTRIBUTE\_LIST.

The result is the route map set metric value of 200 is used.

```
awplus#show running-config router ipv6 ospf
!
router ipv6 ospf
router-id 1.1.1.3
redistribute connected metric 100 route-map REDISTRIBUTE_MAP
!
```

```
awplus#show running-config route-map
!
route-map REDISTRIBUTE_MAP permit 10
match ipv6 address REDISTRIBUTE_LIST
set metric 200
!
```

The metric value in the external LSA is the value specified by the route map (200).

```
awplus#show ipv6 ospf database external adv-router 1.1.1.3
      OSPFv3 Router with ID (1.1.1.3) (Process *null*)
      AS-external-LSA
LS age: 38
LS Type: AS-External-LSA
Link State ID: 0.0.0.3
Advertising Router: 1.1.1.3
LS Seq Number: 0x80000003
Checksum: 0x15B3
Length: 48
  Metric Type: 2 (Larger than any link state path)
  Metric: 200
  Prefix: 2001:db8::1/128
  Prefix Options: 0 (-|-|-)
  External Route Tag: 0
```

The following table summarizes these rules:

CONFIGURATION	METRIC VALUE
Default	20
Metric configured on redistribute command	Value specified by redistribute command
Metric configured by 'set' clause in route-map	Value specified by the 'set' clause
Metric configured on redistribute command AND Metric configured by 'set' clause in route-map	Value specified by the 'set' clause of the route-map

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