OSPFv3 VRF-Lite/PE-CE

The OSPFv3 VRF-Lite/PE-CE feature adds Open Shortest Path First version 3 (OSPFv3) support for nondefault VPN routing and forwarding (VRF) instances. OSPFv3 can be used as a provider-edge-customer-edge (PE-CE) routing protocol as specified in RFC 6565, *OSPFv3 as a Provider Edge to Customer Edge (PE-CE) Routing Protocol*. OSPFv3 in a nondefault VRF instance supports routing of IPv4 and IPv6 address families.

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest caveats and feature information, see Bug Search Tool and the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the feature information table.

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

Restrictions for OSPFv3 VRF-Lite/PE-CE

In Cisco IOS Release 15.2(2)S and later releases, OSPFv3 interface commands in the **ipv6 ospf** format are no longer supported in VRF interface configuration mode. You must configure them in the new format, **ospfv3**.

The **ospfv3** commands can have one of following formats:

- **ospfv3** —Applies to all OSPFv3 processes and address families on a given interface.

- **ospfv3** *process-id* —Applies to an OSPFv3 process with the configured process ID and to both IPv4 and IPv6 address families.

- **ospfv3** *process-id address-family-ID* —Applies to an OSPFv3 process with the configured process ID and the configured address family.

More specific commands take precedence over less specific commands, as shown in the following descending order:

1 Commands that specify a process ID and an address family.

2 Commands that specify only a process ID.

3 Commands that specify neither a process ID nor an address family.

In Cisco IOS Release 15.2(2)S and later releases, you cannot use the **ipv6 ospf router** *process-id* command to configure OSPFv3 VRF instances. You must configure the **router ospfv3** *process-id* command in global configuration mode and specify the address family for the configured VRF in router configuration mode.

Information About OSPFv3 VRF-Lite/PE-CE

Support for OSPFv3 VRF-Lite and PE-CE

Open Shortest Path First version 3 (OSPFv3) operates in nondefault VPN routing and forwarding (VRF) instances for both IPv6 and IPv4 address families and, transports the routes across a Border Gateway Protocol (BGP) or a Multiprotocol Label Switching (MPLS) backbone. On the provider edge (PE) device, customer routes are installed together by OSPFv3 and BGP in a common VRF or address family and each protocol is configured to redistribute the routes of the other. BGP combines the prefixes redistributed into it with a route-distinguisher value defined for the VRF and advertises them to other MPLS-BGP speakers in the same autonomous system using the VPNv4 or VPNv6 address family as appropriate.

The OSPFv3 route selection algorithm prefers intra-area routes across the back-door link over inter-area routes through the MPLS backbone. Sham-links are a type of virtual link across the MPLS backbone that connect OSPFv3 instances on different PEs. OSPFv3 instances tunnel protocol packets through the backbone and form adjacencies. Because OSPFv3 considers the sham-link as an intra-area connection, sham-link serves as a valid alternative to an intra-area back-door link.

Domain IDs are used to determine whether the routes are internal or external. They describe the administrative domain of the OSPFv3 instance from which the route originates. Every PE has a 48-bit primary domain ID (which may be NULL) and zero or more secondary domain IDs.

How to Configure VRF-Lite/PE-CE

Configuring a VRF in an IPv6 Address Family for OSPFv3

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **vrf definition** *vrf-name*
4. **rd** *route-distinguisher*
5. **exit**
6. **router ospfv3** [*process-id*]
7. **address-family ipv6** [**unicast**] [**vrf** *vrf-name*]
8. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** Device> enable	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** Device# configure terminal	Enters global configuration mode.
Step 3	**vrf definition** *vrf-name* **Example:** Device(config)# vrf definition vrfsample	Configures a VRF routing table and enters VRF configuration mode.
Step 4	**rd** *route-distinguisher* **Example:** Device(config-vrf)# rd 10:1	Creates routing and forwarding tables for a VRF.
Step 5	**exit** **Example:** Device(config-vrf)# exit	Exists VRF configuration mode and returns to global configuration mode.

	Command or Action	**Purpose**
Step 6	**router ospfv3** [*process-id*] **Example:** `Device(config)# router ospfv3 2`	Configures an OSPF routing process and enters router configuration mode.
Step 7	**address-family ipv6** [**unicast**] [**vrf** *vrf-name*] **Example:** `Device(config-router)# address-family ipv6 unicast vrf vrfsample`	Configures an instance of the OSPFv3 process in the VRF routing table for the IPv6 address family and enters router address family configuration mode.
Step 8	**end** **Example:** `Device(config-router-af)# end`	Exists router address family configuration mode and returns to privileged EXEC mode.

Enabling an OSPFv3 IPv6 Address Family on a VRF Interface

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **interface** *type number*
4. **vrf forwarding** *vrf-name* [**downstream** *vrf-name2*]
5. **ipv6 enable**
6. **ospfv3** *process-id* {**ipv4** | **ipv6**} **area** *area-id* [**instance** *instance-id*]
7. **end**

DETAILED STEPS

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

	Command or Action	Purpose
Step 2	**configure terminal** **Example:** Device# configure terminal	Enters global configuration mode.
Step 3	**interface** *type number* **Example:** Device(config)# interface Serial6/0	Specifies an interface type and number and enters interface configuration mode.
Step 4	**vrf forwarding** *vrf-name* [**downstream** *vrf-name2*] **Example:** Device(config-if)# vrf forwarding v1	Associates an interface with a VRF.
Step 5	**ipv6 enable** **Example:** Device(config-if)# ipv6 enable	Enables IPv6 processing on the interface that is associated with the VRF.
Step 6	**ospfv3** *process-id* {**ipv4**	**ipv6**} **area** *area-id* [**instance** *instance-id*] **Example:** Device(config-if)# ospfv3 1 ipv6 area 0	Enables the OSPFv3 IPv6 address family on the VRF interface.
Step 7	**end** **Example:** Device(config-if)# end	Exits interface configuration mode and returns to privileged EXEC mode.

Configuring a Sham-Link for OSPFv3 PE-CE

Before You Begin

The OSPFv3 PE-CE feature supports direct forwarding on Border Gateway Protocol (BGP) routes.

Before you configure a sham-link, you must create a Multiprotocol Label Switching (MPLS) backbone, configure a device as an MPLS VPN PE device, and configure OSPFv3 as the provider-edge-customer-edge (PE-CE) protocol in a virtual routing and forwarding (VRF) instance.

SUMMARY STEPS

1. **enable**

2. **configure terminal**

3. **interface loopback** *interface-number*

4. **description** *string*

5. **vrf forwarding** *vrf-name*

6. **ipv6 address** *ipv6-address/prefix-length*

7. **ipv6 enable**

8. **end**

9. **router ospfv3** *process-id*

10. **address-family** {**ipv4** | **ipv6**} [**unicast** | **multicast**] [**vrf** *vrf-name*]

11. **redistribute** *process-id* [*options*]

12. **area** *area-id* **sham-link** *source-address destination-address* [**cost** *number*] [**ttl-security hops** *hop-count*]

13. **end**

DETAILED STEPS

	Command or Action	**Purpose**
Step 1	**enable** **Example:** Device> enable	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** Device# configure terminal	Enters global configuration mode.
Step 3	**interface loopback** *interface-number* **Example:** Device(config)# interface loopback 0	Creates a loopback interface to be used as an endpoint of the sham-link on a provider edge device and enters interface configuration mode.
Step 4	**description** *string* **Example:** Device(config-if)# description Sham-link endpoint	Provides a description of the interface to help you track its status.
Step 5	**vrf forwarding** *vrf-name* **Example:** Device(config-if)# vrf forwarding vrf1	Associates the loopback interface with a VRF.

	Command or Action	Purpose

Step 6	**ipv6 address** *ipv6-address/prefix-length*
	
	Example:
	
	`Device(config-if)# ipv6 address`
	`2001:DB8:0:ABCD::1/48`
		Configures an IPv6 address of the loopback interface on a provider edge device.

Step 7	**ipv6 enable** **Example:** `Device(config-if)# ipv6 enable`	Enables IPv6 processing on the loopback interface.
Step 8	**end** **Example:** `Device# end`	Exits interface configuration mode and returns to global configuration mode.
Step 9	**router ospfv3** *process-id* **Example:** `Device(config)# router ospfv3 1`	Enters router configuration mode.

Step 10	**address-family** {**ipv4** | **ipv6**} [**unicast** | **multicast**] [**vrf** *vrf-name*]
	
	Example:
	
	`Device(config-router)# address-family ipv6`
	`unicast vrf vrf1`
		Enters IPv6 address family configuration mode for OSPFv3.

Step 11	**redistribute** *process-id* [*options*] **Example:** `Device(config-router-af)# redistribute bgp 2`	Redistributes IPv6 routes from the specified source BGP routing domain into the specified destination routing domain. **Note** PE-CE redistribution is always from BGP.

Step 12	**area** *area-id* **sham-link** *source-address destination-address* [**cost** *number*] [**ttl-security hops** *hop-count*]
	
	Example:
	
	`Device(config-router-af)# area 0 sham-link`
	`2001:DB8:0:ABCD::1 2001:DB8:0:ABCD::2 cost 100`
		Enables the sham-link and specifies its source and destination addresses.

Step 13	**end** **Example:** `Device(config-router-af)# end`	Exits address family configuration mode and returns to privileged EXEC mode.

Configuring a Domain ID for an OSPFv3 PE-CE

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **vrf definition** *vrf-name*
4. **rd** *route-distinguisher*
5. **exit**
6. **router ospfv3** [*process-id*]
7. **address-family ipv6** [**unicast**] [**vrf** *vrf-name*]
8. **domain-id type** *type* **value** *hex-value*
9. **end**

DETAILED STEPS

	Command or Action	**Purpose**
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	**vrf definition** *vrf-name* **Example:** `Device(config)# vrf definition vrfsample`	Configures a VRF routing table and enters VRF configuration mode.
Step 4	**rd** *route-distinguisher* **Example:** `Device(config-vrf)# rd 10:1`	Creates routing and forwarding tables for a VRF.

	Command or Action	Purpose
Step 5	**exit** **Example:** Device(config-vrf)# exit	Exists VRF configuration mode and returns to global configuration mode.
Step 6	**router ospfv3** [*process-id*] **Example:** Device(config)# router ospfv3 2	Enters router configuration mode.
Step 7	**address-family ipv6** [**unicast**] [**vrf** *vrf-name*] **Example:** Device(config-router)# address-family ipv6 unicast vrf vrfsample	Configures an instance of the OSPFv3 process in the VRF routing table for the IPv6 address family and enters address family configuration mode..
Step 8	**domain-id type** *type* **value** *hex-value* **Example:** Device(config-router-af)# domain-id type 0205 value 800EFFFF12AB	Configures the BGP domain ID. • The value for **type** can be 0005, 0105, 0205, or 8005. • The value for **value** is an arbitrary 48-bit number encoded as 12 hexadecimal digits.
Step 9	**end** **Example:** Device(config-router-af)# end	Exists router address family mode and returns to privileged EXEC mode.

Configuring VRF-Lite Capability for OSPFv3

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **vrf definition** *vrf-name*
4. **rd** *route-distinguisher*
5. **exit**
6. **router ospfv3** [*process-id*]
7. **address-family ipv6** [**unicast**] [**vrf** *vrf-name*]
8. **capability vrf-lite**
9. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** Device> enable	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** Device# configure terminal	Enters global configuration mode.
Step 3	**vrf definition** *vrf-name* **Example:** Device(config)# vrf definition vrfsample	Configures a VRF routing table and enters VRF configuration mode.
Step 4	**rd** *route-distinguisher* **Example:** Device(config-vrf)# rd 10:1	Creates routing and forwarding tables for a VRF.
Step 5	**exit** **Example:** Device(config-vrf)# exit	Exists VRF configuration mode and returns to global configuration mode.
Step 6	**router ospfv3** [*process-id*] **Example:** Device(config)# router ospfv3 2	Enables router configuration mode for the IPv4 or IPv6 address family.
Step 7	**address-family ipv6** [**unicast**] [**vrf** *vrf-name*] **Example:** Device(config-router)# address-family ipv6 unicast vrf vrfsample	Configures an instance of the OSPFv3 process in the VRF routing table for the IPv6 address family and enters address family configuration mode.
Step 8	**capability vrf-lite** **Example:** Device(config-router-af)# capability vrf-lite	Applies the multi-VRF capability to the OSPF process.

	Command or Action	Purpose
Step 9	**end** **Example:** `Device(config-router-af)# end`	Exists router address family mode and returns to privileged EXEC mode.

Configuration Examples for OSPFv3 VRF-Lite/PE-CE

Example: Configuring a Provider Edge Device to Provide IPv6 and IPv4 Routing

The following example shows how to configure a provider edge (PE) device to provide IPv6 and IPv4 routing for a user on VRF "v1" and IPv6 routing for a user on VRF "v2":

```
vrf definition v1
 rd 1:1
 route-target export 100:1
 route-target import 100:1
!
address-family ipv4
 exit-address-family
!
address-family ipv6
 exit-address-family
!
vrf definition v2
 rd 2:2
 route-target export 200:2
 route-target import 200:2
!
address-family ipv6
 exit-address-family
!
interface Loopback1
 vrf forwarding v1
 ipv6 address 2001:DB8:0:ABCD::1/48
!
interface Serial5/0
 vrf forwarding v2
 no ip address
 ipv6 address 2001:DB8:0:ABCD::3/48
 ospfv3 1 ipv6 area 1
!
interface Serial6/0
 vrf forwarding v1
 ip address 10.0.0.1 255.255.255.0
 ipv6 enable
 ospfv3 1 ipv6 area 0
 ospfv3 1 ipv4 area 10.1.1.1
!
router ospfv3
!
log-adjacency-changes detail
!
address-family ipv4 unicast vrf v1
 router-id 10.2.2.2
 redistribute bgp 1
```

```
          exit-address-family
         !
         address-family ipv6 unicast vrf v1
          router-id 2001:DB8:1::1
          domain-id type 0205 value 111111222222
          area 0 sham-link 2001:DB8:0:ABCD::5 2001:DB8:0:ABCD::7
          redistribute bgp 1
          exit-address-family
         address-family ipv6 unicast vrf v2
          router-id 2001:DB8:1::3
          redistribute bgp 1
          exit
         !
         router bgp 1
          bgp router-id 10.3.3.3
          no bgp default ipv4-unicast
          neighbor 10.0.0.4 remote-as 1
          neighbor 10.0.0.4 update-source-Loopback0
         !
         address-family ipv4
          exit-address-family
         !
         address-family vpnv4
          neighbor 10.0.0.4
          neighbor 10.0.0.4 send-community extended
          exit-address-family
         !
         address-family vpnv6
          neighbor 10.0.0.4 activate
          neighbor 10.0.0.4 send-community extended
          exit-address-family
         !
         address-family ipv4 vrf v1
          redistribute ospfv3 1
          exit-address-family
         !
         address-family ipv6 vrf v1
          redistribute ospf 1
          exit-address-family
         !
         address-family ipv6 vrf v2
          redistribute ospf 1
          exit-address-family
         !
```

Example: Configuring a Provider Edge Device for VRF-Lite

```
         vrf definition v1
          rd 1:1
          !
         address-family ipv4
          exit-address-family
         !
         address-family ipv6
          exit-address-family
         !
         vrf definition v2
          rd 2:2
          !
         address-family ipv6
          exit-address-family
         !
         interface FastEthernet0/0
          no ip address
          !
         interface FastEthernet0/0.100
          encapsulation dot1Q 100
          vrf forwarding v1
          ip address 192.168.1.1 255.255.255.0
```

```
 ipv6 enable
 ospfv3 1 ipv6 area 0
 ospfv3 1 ipv4 area 0
!
interface FastEthernet0/0.200
 encapsulation dot1Q 200
 vrf forwarding v2
 ipv6 enable
 ospfv3 1 ipv6 area 0
!
interface FastEthernet0/1
 rf forwarding v1
 ip address 10.1.1.1 255.255.255.0
 ipv6 enable
 ospfv3 1 ipv6 area 1
 ospfv3 1 ipv4 area 0
 no keepalive
!
interface FastEthernet0/2
 vrf forwarding v2
 no ip address
 ipv6 address 2001:DB8:1::1
 ipv6 enable
 ospfv3 1 ipv6 area 1
!
router ospfv3 1
!
address-family ipv6 unicast vrf v2
 router-id 192.168.2.1
 capability vrf-lite
 exit-address-family
!
address-family ipv4 unicast vrf v1
  router-id 192.168.1.4
  capability vrf-lite
exit-address-family
!
address-family ipv6 unicast vrf v1
 router-id 192.168.1.1
 capability vrf-lite
 exit-address-family
!
```

Additional References for OSPFv3 VRF-Lite/PE-CE

Related Documents

Related Topic	Document Title
Cisco IOS commands	Cisco IOS Master Command List, All Releases
OSPF commands	Cisco IOS IP Routing: OSPF Command Reference

RFCs

RFC	Title
RFC 5838	Support of Address Families in OSPFv3

RFC	Title
RFC 6565	OSPFv3 as a Provider Edge to Customer Edge (PE-CE) Routing Protocol

Technical Assistance

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

Feature Information for OSPFv3 VRF-Lite/PE-CE

The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

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

Table 1: Feature Information for OSPFv3 VRF-Lite/PE-CE

Feature Name	Releases	Feature Information
OSPFv3 VRF-Lite/PE-CE	Cisco IOS XE Release 3.6S	The OSPFv3 VRF-Lite/PE-CE feature adds OSPFv3 support for nondefault VRF instances. The following commands were introduced or modified: **area sham-link** (OSPFv3), **capability vrf-lite** (OSPFv3).