



## Configuring VRF-lite

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## Information About VRF-lite

VRF-lite is a feature that enables a service provider to support two or more VPNs, where IP addresses can be overlapped among the VPNs. VRF-lite uses input interfaces to distinguish routes for different VPNs and forms virtual packet-forwarding tables by associating one or more Layer 3 interfaces with each VRF. Interfaces in a VRF can be either physical, such as Ethernet ports, or logical, such as VLAN SVIs, but a Layer 3 interface cannot belong to more than one VRF at any time.



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**Note** VRF-lite interfaces must be Layer 3 interfaces.

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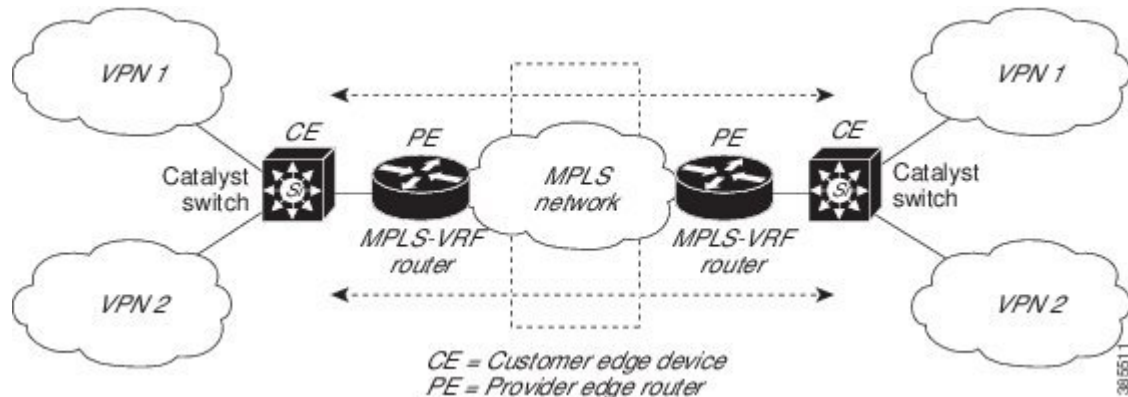
VRF-lite includes these devices:

- Customer edge (CE) devices provide customer access to the service provider network over a data link to one or more provider edge routers. The CE device advertises the site's local routes to the provider edge router and learns the remote VPN routes from it. A Cisco Catalyst Switch can be a CE.
- Provider routers (or core routers) are any routers in the service provider network that do not attach to CE devices.

With VRF-lite, multiple customers can share one CE, and only one physical link is used between the CE and the PE. The shared CE maintains separate VRF tables for each customer and switches or routes packets for each customer based on its own routing table. VRF-lite extends limited PE functionality to a CE device, giving it the ability to maintain separate VRF tables to extend the privacy and security of a VPN to the branch office.

The following figure displays a configuration where each Cisco Catalyst switch acts as multiple virtual CEs. Because VRF-lite is a Layer 3 feature, each interface in a VRF must be a Layer 3 interface.

Figure 1: Cisco Catalyst Switches Acting as Multiple Virtual CEs



This figure illustrates the packet-forwarding process in a VRF-lite CE-enabled network.

- When the CE receives a packet from a VPN, it looks up the routing table based on the input interface. When a route is found, the CE forwards the packet to the PE.
- When the ingress PE receives a packet from the CE, it performs a VRF lookup. When a route is found, the router adds a corresponding MPLS label to the packet and sends it to the MPLS network.
- When an egress PE receives a packet from the network, it strips the label and uses the label to identify the correct VPN routing table. The egress PE then performs the normal route lookup. When a route is found, it forwards the packet to the correct adjacency.
- When a CE receives a packet from an egress PE, it uses the input interface to look up the correct VPN routing table. If a route is found, the CE forwards the packet within the VPN.

To configure VRF, create a VRF table and specify the Layer 3 interface associated with the VRF. You then configure the routing protocols in the VPN and between the CE and the PE. BGP is the preferred routing protocol used to distribute VPN routing information across the providers' backbone. The VRF-lite network has three major components:

- VPN route target communities—Lists all other members of a VPN community. You need to configure VPN route targets for each VPN community member.
- Multiprotocol BGP peering of VPN community PE routers—Propagates VRF reachability information to all members of a VPN community. You need to configure BGP peering in all PE routers within a VPN community.
- VPN forwarding—Transports all traffic between all VPN community members across a VPN service-provider network.

## Guidelines for Configuring VRF-lite

### IPv4 and IPv6

- A switch with VRF-lite is shared by multiple customers, and all customers have their own routing tables.

- Because customers use different VRF tables, you can reuse the same IP addresses. Overlapped IP addresses are allowed in different VPNs.
- VRF-lite lets multiple customers share the same physical link between the PE and the CE. Trunk ports with multiple VLANs separate packets among customers. All customers have their own VLANs.
- For the PE router, there is no difference between using VRF-lite or using multiple CEs. In [Information About VRF-lite, on page 1](#), multiple virtual Layer 3 interfaces are connected to the VRF-lite device.
- The Cisco Catalyst switch supports configuring VRF by using physical ports, VLAN SVIs, or a combination of both. You can connect SVIs through an access port or a trunk port.
- A customer can use multiple VLANs as long because they do not overlap with those of other customers. A customer's VLANs are mapped to a specific routing table ID that is used to identify the appropriate routing tables stored on the switch.
- The Layer 3 TCAM resource is shared between all VRFs. To ensure that any one VRF has sufficient CAM space, use the **maximum routes** command.
- A Cisco Catalyst switch using VRF can support one global network and multiple VRFs. The total number of routes supported is limited by the size of the TCAM.
- A single VRF can be configured for both IPv4 and IPv6.
- If an incoming packet's destination address is not found in the vrf table, the packet is dropped. Also, if insufficient TCAM space exists for a VRF route, hardware switching for that VRF is disabled and the corresponding data packets are sent to software for processing.

### IPv4 Specific

- You can use most routing protocols (BGP, OSPF, EIGRP, RIP and static routing) between the CE and the PE. However, we recommend using external BGP (EBGP) for these reasons:
  - BGP does not require multiple algorithms to communicate with multiple CEs.
  - BGP is designed for passing routing information between systems run by different administrations.
  - BGP makes simplifies passing attributes of the routes to the CE.
- The Cisco Catalyst switch supports PIM-SM and PIM-SSM protocols.
- The **capability vrf-lite** subcommand under **router ospf** should be used when configuring OSPF as the routing protocol between the PE and the CE.

### IPv6 specific

- VRF-aware OSPFv3, BGPv6, EIGRPv6, and IPv6 static routing are supported.
- VRF-aware IPv6 route applications include: ping, telnet, ssh, tftp, ftp and traceroute. (This list does not include the management interface, which is handled differently even though you can configure both IPv4 or IPv6 VRF under it.)

# How to Configure VRF-lite

This section provides information about configuring VRF-lite.

## Configuring VRF-lite for IPv4

This section provides information about configuring VRF-lite for IPv4.

### Configuring VRF-Aware Services

IP services can be configured on global interfaces and within the global routing instance. IP services are enhanced to run on multiple routing instances; they are VRF-aware. Any configured VRF in the system can be specified for a VRF-aware service.

VRF-aware services are implemented in platform-independent modules. VRF provides multiple routing instances in Cisco IOS. Each platform has its own limit on the number of VRFs it supports.

VRF-aware services have the following characteristics:

- The user can ping a host in a user-specified VRF.
- ARP entries are learned in separate VRFs. The user can display Address Resolution Protocol (ARP) entries for specific VRFs.

### Configuring the User Interface for ARP

#### Procedure

	Command or Action	Purpose
<b>Step 1</b>	<b>show ip arp vrf</b> <i>vrf-name</i> <b>Example:</b> Device# show ip arp vrf vrf-name	Displays the ARP table (static and dynamic entries) in the specified VRF.
<b>Step 2</b>	<b>arp vrf</b> <i>vrf-name ip-address mac-address ARPA</i> <b>Example:</b> Device(config)# arp vrf vrf-name ip-address mac-address ARPA	Creates a static ARP entry in the specified VRF.

### Configuring Per-VRF for TACACS+ Servers

The per-VRF for TACACS+ servers feature enables you to configure per-virtual route forwarding (per-VRF) authentication, authorization, and accounting (AAA) on TACACS+ servers.

You can create the VRF routing table (shown in Steps 3 and 4) and configure the interface (Steps 6, 7, and 8). The actual configuration of per-VRF on a TACACS+ server is done in Steps 10 through 13.

#### Before you begin

Before configuring per-VRF on a TACACS+ server, you must have configured AAA and a server group.

## Procedure

	Command or Action	Purpose
<b>Step 1</b>	<b>enable</b> <b>Example:</b> Device> enable	Enables privileged EXEC mode. Enter your password if prompted.
<b>Step 2</b>	<b>configure terminal</b> <b>Example:</b> Device# configure terminal	Enters global configuration mode.
<b>Step 3</b>	<b>vrf definition vrf-name</b> <b>Example:</b> Device(config)# vrf definition vrf-name	Configures a VRF table and enters VRF configuration mode.
<b>Step 4</b>	<b>rd route-distinguisher</b> <b>Example:</b> Device(config-vrf)# rd route-distinguisher	Creates routing and forwarding tables for a VRF instance.
<b>Step 5</b>	<b>exit</b> <b>Example:</b> Device(config-vrf)# exit	Exits VRF configuration mode.
<b>Step 6</b>	<b>interface interface-name</b> <b>Example:</b> Device(config)# interface interface-name	Configures an interface and enters interface configuration mode.
<b>Step 7</b>	<b>vrf forwarding vrf-name</b> <b>Example:</b> Device(config-if)# vrf forwarding vrf-name	Configures a VRF for the interface.
<b>Step 8</b>	<b>ip address ip-address mask [secondary]</b> <b>Example:</b> Device(config-if)# ip address ip-address mask [secondary]	Sets a primary or secondary IP address for an interface.
<b>Step 9</b>	<b>exit</b> <b>Example:</b> Device(config-vrf)# exit	Exits interface configuration mode.
<b>Step 10</b>	<b>aaa group server tacacs+ group-name</b> <b>Example:</b> Device(config)# aaa group server tacacs+ tacacs1	Groups different TACACS+ server hosts into distinct lists and distinct methods and enters server-group configuration mode.

	Command or Action	Purpose
<b>Step 11</b>	<b>server-private</b> <i>{ip-address   name}</i> [ <b>nat</b> ] <b>[single-connection]</b> [ <b>port</b> <i>port-number</i> ] <b>[timeout</b> <i>seconds</i> ] [ <b>key</b> [ <b>0</b>   <b>7</b> ] <i>string</i> ]  <b>Example:</b> Device(config-sg-tacacs)# server-private 10.1.1.1 port 19 key cisco	Configures the IP address of the private TACACS+ server for the group server.
<b>Step 12</b>	<b>vrf forwarding</b> <i>vrf-name</i>  <b>Example:</b> Device(config-sg-tacacs)# vrf forwarding vrf-name	Configures the VRF reference of a AAA TACACS+ server group.
<b>Step 13</b>	<b>ip tacacs source-interface</b> <i>subinterface-name</i>  <b>Example:</b> Device(config-sg-tacacs)# ip tacacs source-interface subinterface-name	Uses the IP address of a specified interface for all outgoing TACACS+ packets.
<b>Step 14</b>	<b>exit</b>  <b>Example:</b> Device(config-sg-tacacs)# exit	Exits server-group configuration mode.

### Example

The following example lists all the steps to configure per-VRF TACACS+:

```

Device> enable
Device# configure terminal
Device(config)# vrf definition cisco
Device(config-vrf)# rd 100:1
Device(config-vrf)# exit
Device(config)# interface Loopback0
Device(config-if)# vrf forwarding cisco
Device(config-if)# ip address 10.0.0.2 255.0.0.0
Device(config-if)# exit
Device(config-sg-tacacs)# vrf forwarding cisco
Device(config-sg-tacacs)# ip tacacs source-interface Loopback0
Device(config-sg-tacacs)# exit

```

## Configuring Multicast VRFs

### Procedure

	Command or Action	Purpose
<b>Step 1</b>	<b>configure terminal</b>  <b>Example:</b> Device# configure terminal	Enters global configuration mode.

	Command or Action	Purpose
<b>Step 2</b>	<b>ip routing</b> <b>Example:</b> Device(config)# ip routing	Enables IP routing.
<b>Step 3</b>	<b>vrf definition vrf-name</b> <b>Example:</b> Device(config)# vrf definition vrf-name	Configures a VRF table and enters VRF configuration mode.
<b>Step 4</b>	<b>ip multicast-routing vrf vrf-name</b> <b>Example:</b> Device(config-vrf)# ip multicast-routing vrf vrf-name	(Optional) Enables global multicast routing for VRF table.
<b>Step 5</b>	<b>rd route-distinguisher</b> <b>Example:</b> Device(config-vrf)# rd route-distinguisher	Creates a VRF table by specifying a route distinguisher. Enter either an AS number and an arbitrary number (xxx:y) or an IP address and arbitrary number (A.B.C.D:y).
<b>Step 6</b>	<b>route-target {export   import   both} route-target-ext-community</b> <b>Example:</b> Device(config-vrf)# route-target {export   import   both} route-target-ext-community	Creates a list of import, export, or import and export route target communities for the specified VRF. Enter either an AS system number and an arbitrary number (xxx:y) or an IP address and an arbitrary number (A.B.C.D:y).  The route-target-ext-community value should be the same as the route-distinguisher value entered in Step 4.
<b>Step 7</b>	<b>import map route-map</b> <b>Example:</b> Device(config-vrf)# import map route-map	(Optional) Associates a route map with the VRF.
<b>Step 8</b>	<b>interface interface-id</b> <b>Example:</b> Device(config)# interface interface-id	Enters interface configuration mode and specifies the Layer 3 interface to be associated with the VRF. The interface can be a routed port or a SVI.
<b>Step 9</b>	<b>vrf forwarding vrf-name</b> <b>Example:</b> Device(config-if)# vrf forwarding vrf-name	Associates the VRF with the Layer 3 interface.
<b>Step 10</b>	<b>ip address ip-address mask</b> <b>Example:</b> Device(config-if)# ip address ip-address mask	Configures IP address for the Layer 3 interface.

	Command or Action	Purpose
<b>Step 11</b>	<b>ip pim sparse-mode</b> <b>Example:</b> Device(config-if)# ip pim sparse-mode	Enables PIM on the VRF-associated Layer 3 interface.
<b>Step 12</b>	<b>end</b> <b>Example:</b> Device(config-if)# end	Returns to privileged EXEC mode.
<b>Step 13</b>	<b>show vrf definition [brief   detail   interfaces] [vrf-name]</b> <b>Example:</b> Device# show vrf definition brief	Verifies the configuration. Display information about the configured VRFs.
<b>Step 14</b>	<b>copy running-config startup-config</b> <b>Example:</b> Device# copy running-config startup-config	(Optional) Saves your entries in the configuration file.

**Example**

The following example shows how to configure multicast within a VRF table:

```
Device(config)# ip routing
Device(config)# vrf definition multiVrfA
Device(config-vrf)# ip multicast-routing vrf multiVrfA
Device(config-vrf)# interface GigabitEthernet3/1/0
Device(config-if)# vrf forwarding multiVrfA
Device(config-if)# ip address 172.21.200.203 255.255.255.0
Device(config-if)# ip pim sparse-mode
```

**Configuring a VPN Routing Session****Procedure**

	Command or Action	Purpose
<b>Step 1</b>	<b>configure terminal</b> <b>Example:</b> Device# configure terminal	Enters global configuration mode.
<b>Step 2</b>	<b>router ospf process-id vrf vrf-name</b> <b>Example:</b> Device(config)# router ospf process-id vrf vrf-name	Enables OSPF routing, specifies a VPN forwarding table, and enters router configuration mode.



	Command or Action	Purpose
<b>Step 3</b>	<b>log-adjacency-changes</b> <b>Example:</b> Device(config-router)# log-adjacency-changes	(Optional) Logs changes in the adjacency state (the default state).
<b>Step 4</b>	<b>redistribute bgp <i>autonomous-system-number subnets</i></b> <b>Example:</b> Device(config-router)# redistribute bgp autonomous-system-number subnets	Sets the switch to redistribute information from the BGP network to the OSPF network.
<b>Step 5</b>	<b>network <i>network-number area area-id</i></b> <b>Example:</b> Device(config-router)# network network-number area area-id	Defines a network address and mask on which OSPF runs and the area ID for that network address.
<b>Step 6</b>	<b>end</b> <b>Example:</b> Device(config-router)# end	Returns to privileged EXEC mode.
<b>Step 7</b>	<b>show ip ospf <i>process-id</i></b> <b>Example:</b> Device# show ip ospf process-id	Verifies the configuration of the OSPF network.
<b>Step 8</b>	<b>copy running-config startup-config</b> <b>Example:</b> Device# copy running-config startup-config	(Optional) Saves your entries in the configuration file.  Use the <b>no router ospf <i>process-id</i> vrf <i>vrf-name</i></b> global configuration command to disassociate the VPN forwarding table from the OSPF routing process.

### Example

```

Device(config)# vrf definition VRF-RED
Device(config-vrf)# rd 1:1
Device(config-vrf)# exit
Device(config)# router eigrp virtual-name
Device(config-router)# address-family ipv4 vrf VRF-RED autonomous-system 1
Device(config-router-af)# network 10.0.0.0 0.0.0.255
Device(config-router-af)# topology base
Device(config-router-topology)# default-metric 10000 100 255 1 1500
Device(config-router-topology)# exit-af-topology
Device(config-router-af)# exit-address-family

```

## Configuring BGP PE to CE Routing Sessions

### Procedure

	Command or Action	Purpose
<b>Step 1</b>	<b>configure terminal</b> <b>Example:</b> Device# configure terminal	Enters global configuration mode.
<b>Step 2</b>	<b>router bgp <i>autonomous-system-number</i></b> <b>Example:</b> Device(config)# router bgp autonomous-system-number	Configures the BGP routing process with the AS number passed to other BGP routers and enters router configuration mode.
<b>Step 3</b>	<b>network <i>network-number</i> mask <i>network-mask</i></b> <b>Example:</b> Device(config-router)# network network-number mask network-mask	Specifies a network and mask to announce using BGP.
<b>Step 4</b>	<b>redistribute ospf <i>process-id</i> match <i>internal</i></b> <b>Example:</b> Device(config-router)# redistribute ospf process-id match internal	Sets the switch to redistribute OSPF internal routes.
<b>Step 5</b>	<b>network <i>network-number</i> area <i>area-id</i></b> <b>Example:</b> Device(config-router)# network network-number area area-id	Defines a network address and mask on which OSPF runs and the area ID for that network address.
<b>Step 6</b>	<b>address-family ipv4 vrf <i>vrf-name</i></b> <b>Example:</b> Device(config-router-af)# address-family ipv4 vrf vrf-name	Defines BGP parameters for PE to CE routing sessions and enters VRF address-family mode.
<b>Step 7</b>	<b>neighbor <i>address</i> remote-as <i>as-number</i></b> <b>Example:</b> Device(config-router-af)# neighbor address remote-as as-number	Defines a BGP session between PE and CE routers.
<b>Step 8</b>	<b>neighbor <i>address</i> activate</b> <b>Example:</b> Device(config-router-af)# neighbor address activate	Activates the advertisement of the IPv4 address family.
<b>Step 9</b>	<b>end</b> <b>Example:</b> Device(config-router-af)# end	Returns to privileged EXEC mode.

	Command or Action	Purpose
<b>Step 10</b>	<b>show ip bgp [ipv4] [neighbors]</b> <b>Example:</b> Device# show ip bgp [ipv4] [neighbors]	Verifies BGP configuration.  Use the <b>no router bgp autonomous-system-number</b> global configuration command to delete the BGP routing process. Use the command with keywords to delete routing characteristics.

## Configuring IPv4 VRFs

### Procedure

	Command or Action	Purpose
<b>Step 1</b>	<b>configure terminal</b> <b>Example:</b> Device# configure terminal	Enters global configuration mode.
<b>Step 2</b>	<b>ip routing</b> <b>Example:</b> Device# configure terminal	Enters global configuration mode.
<b>Step 3</b>	<b>vrf definition vrf-name</b> <b>Example:</b> Device(config)# vrf definition vrf-name	Names the VRF and enters VRF configuration mode.
<b>Step 4</b>	<b>rd route-distinguisher</b> <b>Example:</b> Device(config-vrf)# rd route-distinguisher	Creates a VRF table by specifying a route distinguisher. Enter either an Autonomous System number and an arbitrary number (xxx:y) or an IP address and arbitrary number (A.B.C.D:y).
<b>Step 5</b>	<b>route-target {export   import   both} route-target-ext-community</b> <b>Example:</b> Device(config-vrf)# route-target {export   import   both} route-target-ext-community	Creates a list of import, export, or import and export route target communities for the specified VRF. Enter either an AS system number and an arbitrary number (xxx:y) or an IP address and an arbitrary number (A.B.C.D:y).  <b>Note</b> This command is effective only if BGP is running.
<b>Step 6</b>	<b>import map route-map</b> <b>Example:</b> Device(config-vrf)# import map route-map	(Optional) Associates a route map with the VRF.
<b>Step 7</b>	<b>interface interface-id</b> <b>Example:</b>	Enters interface configuration mode and specify the Layer 3 interface to be associated

	Command or Action	Purpose
	<code>Device(config-vrf)# interface interface-id</code>	with the VRF. The interface can be a routed port or SVI.
<b>Step 8</b>	<b>vrf forwarding</b> <i>vrf-name</i>  <b>Example:</b> <code>Device(config-if)# vrf forwarding vrf-name</code>	Associates the VRF with the Layer 3 interface.
<b>Step 9</b>	<b>end</b>  <b>Example:</b> <code>Device(config-if)# end</code>	Returns to privileged EXEC mode.
<b>Step 10</b>	<b>show vrf definition</b> [ <b>brief</b>   <b>detail</b>   <b>interfaces</b> ] [ <i>vrf-name</i> ]  <b>Example:</b> <code>Device# show vrf definition [brief   detail   interfaces] [vrf-name]</code>	Verifies the configuration. Displays information about the configured VRFs.
<b>Step 11</b>	<b>copy running-config startup-config</b>  <b>Example:</b> <code>Device# copy running-config startup-config</code>	(Optional) Saves your entries in the configuration file.  Use the <b>no vrf definition</b> <i>vrf-name</i> global configuration command to delete a VRF and to remove all interfaces from it. Use the <b>no vrf forwarding</b> interface configuration command to remove an interface from the VRF.

## Configuring VRF-lite for IPv6

This section provides information about configuring VRF-lite for IPv6.

### Configuring VRF-Aware Services

IPv6 services can be configured on global interfaces and within the global routing instance. IPv6 services are enhanced to run on multiple routing instances; they are VRF-aware. Any configured VRF in the system can be specified for a VRF-aware service.

VRF-aware services are implemented in platform-independent modules. VRF provides multiple routing instances in Cisco IOS. Each platform has its own limit on the number of VRFs it supports.

VRF-aware services have the following characteristics:

- The user can ping a host in a user-specified VRF.
- Neighbor Discovery entries are learned in separate VRFs. The user can display Neighbor Discovery (ND) entries for specific VRFs.

The following services are VRF-aware:

- Ping

- Unicast Reverse Path Forwarding (uRPF)
- Traceroute
- FTP and TFTP
- Telnet and SSH
- NTP

### Configuring the User Interface for PING

Perform the following task to configure a VRF-aware ping:

#### Procedure

	Command or Action	Purpose
<b>Step 1</b>	<b>ping vrf <i>vrf-name</i> ipv6-host</b> <b>Example:</b> Device# ping vrf vrf-name ipv6-host	Pings an IPv6 host or address in the specified VRF.

### Configuring the User Interface for uRPF

You can configure uRPF on an interface assigned to a VRF. Source lookup is performed in the VRF table

#### Procedure

	Command or Action	Purpose
<b>Step 1</b>	<b>configure terminal</b> <b>Example:</b> Device# configure terminal	Enters global configuration mode.
<b>Step 2</b>	<b>interface <i>interface-id</i></b> <b>Example:</b> Device(config)# interface interface-id	Enters interface configuration mode and specifies the Layer 3 interface to configure.
<b>Step 3</b>	<b>no switchport</b> <b>Example:</b> Device(config-if)# no switchport	Removes the interface from Layer 2 configuration mode if it is a physical interface.
<b>Step 4</b>	<b>vrf forwarding <i>vrf-name</i></b> <b>Example:</b> Device(config-if)# vrf forwarding vrf-name	Configures VRF on the interface.
<b>Step 5</b>	<b>ipv6 address <i>ip-address</i> subnet-mask</b> <b>Example:</b> Device(config-if)# ip address ip-address mask	Enters the IPv6 address for the interface.

	Command or Action	Purpose
<b>Step 6</b>	<b>ipv6 verify unicast source reachable-via rx allow-default</b>  <b>Example:</b> Device(config-if)# ipv6 verify unicast source reachable-via rx allow-default	Enables uRPF on the interface.
<b>Step 7</b>	<b>end</b>  <b>Example:</b> Device(config-if)# end	Returns to privileged EXEC mode.

### Configuring the User Interface for Traceroute

#### Procedure

	Command or Action	Purpose
<b>Step 1</b>	<b>traceroute vrf vrf-name ipv6address</b>  <b>Example:</b> Device# traceroute vrf vrf-name ipv6address	Specifies the name of a VPN VRF in which to find the destination address.

### Configuring the User Interface for Telnet and SSH

#### Procedure

	Command or Action	Purpose
<b>Step 1</b>	<b>telnet ipv6-address/vrf vrf-name</b>  <b>Example:</b> Device# telnet ipv6-address/vrf vrf-name	Connects through Telnet to an IPv6 host or address in the specified VRF.
<b>Step 2</b>	<b>ssh -l username -vrf vrf-name ipv6-host</b>  <b>Example:</b> Device# ssh -l username -vrf vrf-name ipv6-host	Connects through SSH to an IPv6 host or address in the specified VRF.

### Configuring the User Interface for NTP

#### Procedure

	Command or Action	Purpose
<b>Step 1</b>	<b>configure terminal</b>  <b>Example:</b>	Enters global configuration mode.

	Command or Action	Purpose
	Device# <code>configure terminal</code>	
<b>Step 2</b>	<b>ntp server vrf <i>vrf-name</i> ipv6-host</b> <b>Example:</b> Device(config)# <code>ntp server vrf vrf-name ipv6-host</code>	Configure the NTP server in the specified VRF.
<b>Step 3</b>	<b>ntp peer vrf <i>vrf-name</i> ipv6-host</b> <b>Example:</b> Device(config)# <code>ntp peer vrf vrf-name ipv6-host</code>	Configure the NTP peer in the specified VRF.

## Configuring IPv6 VRFs

### Procedure

	Command or Action	Purpose
<b>Step 1</b>	<b>configure terminal</b> <b>Example:</b> Device# <code>configure terminal</code>	Enters global configuration mode.
<b>Step 2</b>	<b>vrf definition <i>vrf-name</i></b> <b>Example:</b> Device(config)# <code>vrf definition vrf-name</code>	Names the VRF and enters VRF configuration mode.
<b>Step 3</b>	<b>rd <i>route-distinguisher</i></b> <b>Example:</b> Device(config-vrf)# <code>rd route-distinguisher</code>	(Optional) Creates a VRF table by specifying a route distinguisher. Enter either an Autonomous System number and an arbitrary number (xxx:y) or an IP address and arbitrary number (A.B.C.D:y).
<b>Step 4</b>	<b>address-family <i>ipv4</i>   <i>ipv6</i></b> <b>Example:</b> Device(config-vrf)# <code>address-family ipv4   ipv6</code>	(Optional) IPv4 by default. Configuration MUST for IPv6.
<b>Step 5</b>	<b>route-target {<i>export</i>   <i>import</i>   <i>both</i>}</b> <b><i>route-target-ext-community</i></b> <b>Example:</b> Device(config-vrf)# <code>route-target {export   import   both} route-target-ext-community</code>	Creates a list of import, export, or import and export route target communities for the specified VRF. Enter either an AS system number and an arbitrary number (xxx:y) or an IP address and an arbitrary number (A.B.C.D:y).  <b>Note</b> This command is effective only if BGP is running.

	Command or Action	Purpose
<b>Step 6</b>	<b>exit-address-family</b> <b>Example:</b> Device(config-vrf)# exit-address-family	Exits VRF address-family configuration mode and return to VRF configuration mode.
<b>Step 7</b>	<b>vrf definition vrf-name</b> <b>Example:</b> Device(config)# vrf definition vrf-name	Enters VRF configuration mode.
<b>Step 8</b>	<b>ipv6 multicast mult topology</b> <b>Example:</b> Device(config-vrf-af)# ipv6 multicast mult topology	Enables multicast specific RPF topology.
<b>Step 9</b>	<b>address-family ipv6 multicast</b> <b>Example:</b> Device(config-vrf)# address-family ipv6 multicast	Enter multicast IPv6 address-family.
<b>Step 10</b>	<b>end</b> <b>Example:</b> Device(config-vrf-af)# end	Returns to privileged EXEC mode.

**Example**

This example shows how to configure VRFs:

```
Device(config)# vrf definition red
Device(config-vrf)# rd 100:1
Device(config-vrf)# address family ipv6
Device(config-vrf-af)# route-target both 200:1
Device(config-vrf)# exit-address-family
Device(config-vrf)# vrf definition red
Device(config-vrf)# ipv6 multicast mult topology
Device(config-vrf)# address-family ipv6 multicast
Device(config-vrf-af)# end
```

**Associating Interfaces to the Defined VRFs****Procedure**

	Command or Action	Purpose
<b>Step 1</b>	<b>interface interface-id</b> <b>Example:</b> Device(config-vrf)# interface interface-id	Enters interface configuration mode and specify the Layer 3 interface to be associated with the VRF. The interface can be a routed port or SVI.



	Command or Action	Purpose
<b>Step 2</b>	<b>no switchport</b> <b>Example:</b> Device(config-if)# no switchport	Removes the interface from configuration mode if it is a physical interface.
<b>Step 3</b>	<b>vrf forwarding vrf-name</b> <b>Example:</b> Device(config-if)# vrf forwarding vrf-name	Associates the VRF with the Layer 3 interface.
<b>Step 4</b>	<b>ipv6 enable</b> <b>Example:</b> Device(config-if)# ipv6 enable	Enable IPv6 on the interface.
<b>Step 5</b>	<b>ipv6 address ip-address subnet-mask</b> <b>Example:</b> Device(config-if)# ipv6 address ip-address subnet-mask	Enters the IPv6 address for the interface.
<b>Step 6</b>	<b>show ipv6 vrf [brief   detail   interfaces] [vrf-name]</b> <b>Example:</b> Device# show ipv6 vrf [brief   detail   interfaces] [vrf-name]	Verifies the configuration. Displays information about the configured VRFs.
<b>Step 7</b>	<b>copy running-config startup-config</b> <b>Example:</b> Device# copy running-config startup-config	(Optional) Saves your entries in the configuration file.

**Example**

This example shows how to associate an interface to VRFs:

```
Switch(config-vrf)# interface ethernet0/1
Switch(config-if)# vrf forwarding red
Switch(config-if)# ipv6 enable
Switch(config-if)# ipv6 address 5000::72B/64
```

**Populate VRF with Routes via Routing Protocols**

This section provides information about populating VRF with routes via routing protocols.

## Configuring VRF Static Routes

### Procedure

	Command or Action	Purpose
<b>Step 1</b>	<b>configure terminal</b>  <b>Example:</b> Device# configure terminal	Enters global configuration mode.
<b>Step 2</b>	<b>ipv6 route [vrf vrf-name]</b> <i>ipv6-prefix/prefix-length {ipv6-address   interface-type interface-number [ipv6-address]}</i>  <b>Example:</b> Device(config)# ipv6 route [vrf vrf-name] ipv6-prefix/prefix-length {ipv6-address   interface-type interface-number [ipv6-address]}	To configure static routes specific to VRF.

### Example

```
Device(config)# ipv6 route vrf v6a 7000::/64 TenGigabitEthernet32 4000::2
```

## Configuring OSPFv3 Router Process

### Procedure

	Command or Action	Purpose
<b>Step 1</b>	<b>configure terminal</b>  <b>Example:</b> Device# configure terminal	Enters global configuration mode.
<b>Step 2</b>	<b>router ospfv3 process-id</b>  <b>Example:</b> Device(config)# router ospfv3 process-id	Enables OSPFv3 router configuration mode for the IPv6 address family.
<b>Step 3</b>	<b>area area-ID [default-cot   nssa   stub]</b>  <b>Example:</b> Device(config-router)# area area-ID [default-cot   nssa   stub]	Configures the OSPFv3 area.
<b>Step 4</b>	<b>router-id router-id</b>  <b>Example:</b> Device(config-router)# router-id router-id	Use a fixed router ID.

	Command or Action	Purpose
<b>Step 5</b>	<b>address-family ipv6 unicast vrf <i>vrf-name</i></b> <b>Example:</b> Device(config-router)# address-family ipv6 unicast vrf vrf-name	Enters IPv6 address family configuration mode for OSPFv3 in VRF vrf-name
<b>Step 6</b>	<b>redistribute source-protocol [<i>process-id</i> options]</b> <b>Example:</b> Device(config-router)# redistribute source-protocol [ <i>process-id</i> ] options	Redistributes IPv6 routes from one routing domain into another routing domain.
<b>Step 7</b>	<b>end</b> <b>Example:</b> Device(config-router)# end	Returns to privileged EXEC mode.

**Example**

This example shows how configure the OSPFv3 router process:

```
Device(config-router)# router ospfv3 1
Device(config-router)# router-id 1.1.1.1
Device(config-router)# address-family ipv6 unicast
Device(config-router-af)# exit-address-family
```

**Enabling OSPFv3 on an Interface****Procedure**

	Command or Action	Purpose
<b>Step 1</b>	<b>configure terminal</b> <b>Example:</b> Device# configure terminal	Enters global configuration mode.
<b>Step 2</b>	<b>interface <i>type-number</i></b> <b>Example:</b> Device(config-vrf)# interface <i>type-number</i>	Specifies an interface type and number, and places the switch in interface configuration mode.
<b>Step 3</b>	<b>ospfv3 <i>process-id</i> area <i>area-ID</i> ipv6 [<i>instance instance-id</i>]</b> <b>Example:</b> Device(config-if)# ospfv3 <i>process-id</i> area <i>area-ID</i> ipv6 [ <i>instance instance-id</i> ]	Enables OSPFv3 on an interface with IPv6 AF.
<b>Step 4</b>	<b>end</b> <b>Example:</b> Device(config-if)# end	Returns to privileged EXEC mode.

**Example**

This example show how to enable OSPFv3 on an interface:

```
Device(config)# interface GigabitEthernet2/1
Device(config-if)# no switchport
Device(config-if)# ipv6 address 4000::2/64
Device(config-if)# ipv6 enable
Device(config-if)# ipv6 ospf 1 area 0
Device(config-if)# end
```

**Configuring EIGRPv6 Routing Process**

**Procedure**

	<b>Command or Action</b>	<b>Purpose</b>
<b>Step 1</b>	<b>configure terminal</b>  <b>Example:</b> Device# configure terminal	Enters global configuration mode.
<b>Step 2</b>	<b>router eigrp <i>virtual-instance-name</i></b>  <b>Example:</b> Device(config)# router eigrp virtual-instance-name	Configures the EIGRP routing process and enters router configuration mode.
<b>Step 3</b>	<b>address-family ipv6 vrf <i>vrf-name</i> autonomous-system <i>autonomous-system-number</i></b>  <b>Example:</b> Device(config-router)# address-family ipv6 vrf vrf-name autonomous-system autonomous-system-number	Enables EIGRP IPv6 VRF-Lite and enters address family configuration mode.
<b>Step 4</b>	<b>topology {base   topology-name tid number}</b>  <b>Example:</b> Device(config-router-af)# topology {base   topology-name tid number	Configures an EIGRP process to route IP traffic under the specified topology instance and enters address family topology configuration mode.
<b>Step 5</b>	<b>exit-aftopology</b>  <b>Example:</b> Device(config-router-af-topology) # exit-aftopology	Exits address family topology configuration mode.
<b>Step 6</b>	<b>eigrp router-id <i>ip-address</i></b>  <b>Example:</b> Device(config-router)# eigrp router-id ip-address	Enables the use of a fixed router-id.

	Command or Action	Purpose
<b>Step 7</b>	end  <b>Example:</b> Device(config-router)# end	Exits router configuration mode.

### Example

This example shows how to configure an EIGRP routing process:

```
Device(config)# router eigrp test
Device(config-router)# address-family ipv6 unicast vrf b1 autonomous-system 10
Device(config-router-af)# topology base
Device(config-router-af-topology)# exit-af-topology
Device(config-router)# eigrp router-id 2.3.4.5
Device(config-router)# exit-address-family
```

## Configuring EBGpV6 Routing Process

### Procedure

	Command or Action	Purpose
<b>Step 1</b>	<b>configure terminal</b>  <b>Example:</b> Device# configure terminal	Enters global configuration mode.
<b>Step 2</b>	<b>router bgp <i>as-number</i></b>  <b>Example:</b> Device(config)# router bgp <i>as-number</i>	Enters router configuration mode for the specified routing process.
<b>Step 3</b>	<b>neighbor <i>peer-group-name peer-group</i></b>  <b>Example:</b> Device(config-router)# neighbor <i>peer-group-name peer-group</i>	Creates a multiprotocol BGP peer group.
<b>Step 4</b>	<b>neighbor {<i>ip-address</i>   <i>ipv6-address</i>[%]   <i>peer-group-name</i>} remote-as <i>autonomous-system-number</i> [<b>alternate-as</b> <i>autonomous-system-number</i> ...]</b>  <b>Example:</b> Device(config-router)# neighbor { <i>ip-address</i>   <i>ipv6-address</i> [%]   <i>peer-group-name</i> } remote-as <i>autonomous-system-number</i> [ <b>alternate-as</b> <i>autonomous-system-number</i> ...]	Adds the IPv6 address of the neighbor in the specified autonomous system to the IPv6 multiprotocol BGP neighbor table of the local router.
<b>Step 5</b>	<b>address-family ipv6 [<b>vrf</b> <i>vrf-name</i>] [<b>unicast</b>   <b>multicast</b>   <b>vpn6</b>]</b>	Specifies the IPv6 address family, and enters address family configuration mode.

	Command or Action	Purpose
	<p><b>Example:</b></p> <pre>Device(config-router)# address-family ipv6 [vrf vrf-name] [unicast   multicast   vpv6]</pre>	<ul style="list-style-type: none"> <li>• The unicast keyword specifies the IPv6 unicast address family. By default, the switch is placed in configuration mode for the IPv6 unicast address family if the unicast keyword is not specified with the address-family ipv6 command.</li> <li>• The multicast keyword specifies IPv6 multicast address prefixes.</li> </ul>
<b>Step 6</b>	<p><b>neighbor ipv6-address peer-group peer-group-name</b></p> <p><b>Example:</b></p> <pre>Device(config-router-af)# neighbor ipv6-address peer-group peer-group-name</pre>	Assigns the IPv6 address of a BGP neighbor to a peer group.
<b>Step 7</b>	<p><b>neighbor {ip-address   peer-group-name   ipv6-address[%]} route-map map-name {in   out}</b></p> <p><b>Example:</b></p> <pre>Device(config-router-af)# neighbor {ip-address   peer-group-name   ipv6-address[%]} route-map map-name {in   out}</pre>	Applies a route map to incoming or outgoing routes. Changes to the route map will not take effect for existing peers until the peering is reset or a soft reset is performed. Using the clear bgp ipv6 command with the soft and in keywords will perform a soft reset.
<b>Step 8</b>	<p><b>exit</b></p> <p><b>Example:</b></p> <pre>Device(config-router-af)# exit</pre>	Exits address family configuration mode, and returns the router to router configuration mode.

### Example

This example shows how to configure EBGpV6:

```
Device(config)# router bgp 2
Device(config-router)# bgp router-id 2.2.2.2
Device(config-router)# bgp log-neighbor-changes
Device(config-router)# no bgp default ipv4-unicast
Device(config-router)# neighbor 2500::1 remote-as 1
Device(config-router)# neighbor 4000::2 remote-as 3
Device(config-router)# address-family ipv6 vrf b1
Device(config-router-af)# network 2500::/64
Device(config-router-af)# network 4000::/64
Device(config-router-af)# neighbor 2500::1 remote-as 1
Device(config-router-af)# neighbor 2500::1 activate
Device(config-router-af)# neighbor 4000::2 remote-as 3
Device(config-router-af)# neighbor 4000::2 activate
Device(config-router-af)# exit-address-family
```

## Additional Information for VRF-lite

This section provides additional information about VRF-lite.

### VPN Co-existence Between IPv4 and IPv6

Backward compatibility between the “older” CLI for configuring IPv4 and the “new” CLI for IPv6 exists. This means that a configuration might contain both CLI. The IPv4 CLI retains the ability to have on the same interface, an IP address defined within a VRF as well as an IPv6 address defined in the global routing table.

For example:

```
vrf definition red
  rd 100:1
  address family ipv6
  route-target both 200:1
  exit-address-family
!
vrf definition blue
  rd 200:1
  route-target both 200:1
!
interface Ethernet0/0
  vrf forwarding red
  ip address 50.1.1.2 255.255.255.0
  ipv6 address 4000::72B/64
!
interface Ethernet0/1
  vrf forwarding blue
  ip address 60.1.1.2 255.255.255.0
  ipv6 address 5000::72B/64
```

In this example, all addresses (v4 and v6) defined for Ethernet0/0 refer to VRF red whereas for Ethernet0/1, the IP address refers to VRF blue but the ipv6 address refers to the global IPv6 routing table.

## Verifying VRF-lite Configuration

This section provides steps for verifying VRF-lite configuration.

### Displaying IPv4 VRF-lite Status

To display information about VRF-lite configuration and status, perform one of the following tasks:

Command	Purpose
Device# <b>show ip protocols vrf</b> <i>vrf-name</i>	Displays routing protocol information associated with a VRF.
Device# <b>show ip route vrf</b> <i>vrf-name</i> [ <b>connected</b> ] [ <i>protocol</i> ] [ <i>as-number</i> ] [ <b>list</b> ] [ <b>mobile</b> ] [ <b>odr</b> ] [ <b>profile</b> ] [ <b>static</b> ] [ <b>summary</b> ] [ <b>supernets-only</b> ]	Displays IP routing table information associated with a VRF.

Command	Purpose
Device# <b>show vrf definition</b> [brief   detail   interfaces] [vrf-name]	Displays information about the defined VRF instances.
Device# <b>bidir vrf</b> instance-name a.b.c.d   active   bidirectional   count   interface   proxy   pruned   sparse   ssm   static   summary	Displays information about the defined VRF instances.

This example shows how to display multicast route table information within a VRF instance:

```
Switch# show ip mroute 226.0.0.2
IP Multicast Routing Table
Flags: S - Sparse, B - Bidir Group, s - SSM Group, C - Connected,
      L - Local, P - Pruned, R - RP-bit set, F - Register flag,
      T - SPT-bit set, J - Join SPT, M - MSDP created entry, E - Extranet,
      X - Proxy Join Timer Running, A - Candidate for MSDP Advertisement,
      U - URD, I - Received Source Specific Host Report,
      Z - Multicast Tunnel, z - MDT-data group sender,
      Y - Joined MDT-data group, y - Sending to MDT-data group,
      G - Received BGP C-Mroute, g - Sent BGP C-Mroute,
      N - Received BGP Shared-Tree Prune, n - BGP C-Mroute suppressed,
      Q - Received BGP S-A Route, q - Sent BGP S-A Route,
      V - RD & Vector, v - Vector, p - PIM Joins on route,
      x - VxLAN group, c - PFP-SA cache created entry
Outgoing interface flags: H - Hardware switched, A - Assert winner, p - PIM Join
Timers: Uptime/Expires
Interface state: Interface, Next-Hop or VCD, State/Mode

(*, 226.0.0.2), 00:01:17/stopped, RP 1.11.1.1, flags: SJCF
  Incoming interface: Null, RPF nbr 0.0.0.0
  Outgoing interface list:
    Vlan100, Forward/Sparse, 00:01:17/00:02:36

(5.0.0.11, 226.0.0.2), 00:01:17/00:01:42, flags: FT
  Incoming interface: Vlan5, RPF nbr 0.0.0.0
  Outgoing interface list:
    Vlan100, Forward/Sparse, 00:01:17/00:02:36
```

## Configuration Examples for VRF-lite

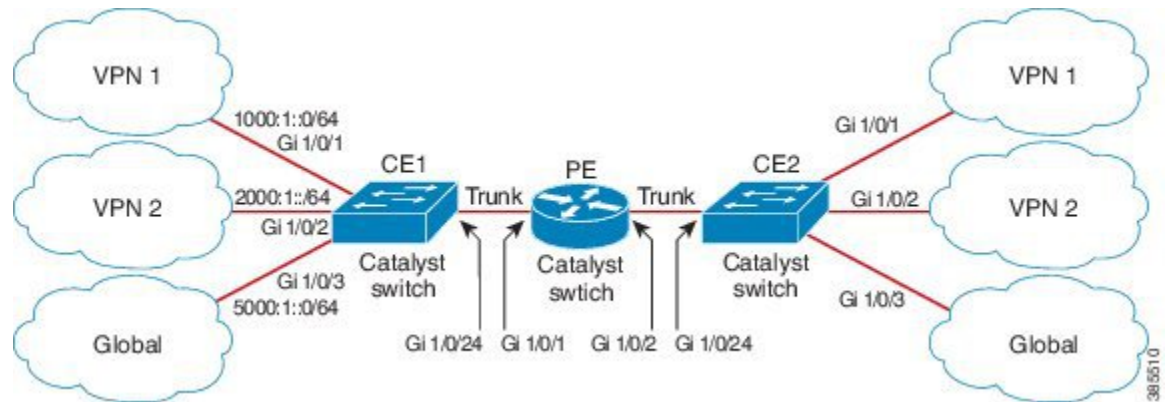
This section provides configuration examples for VRF-lite.

### Configuration Example for IPv6 VRF-lite

The following topology illustrates how to use OSPFv3 for CE-PE routing.



Figure 2: VRF-lite Configuration Example



### Configuring CE1 Switch

```

ipv6 unicast-routing
vrf definition v1
  rd 100:1
  !
address-family ipv6
  exit-address-family
!

vrf definition v2
  rd 200:1
  !
address-family ipv6
  exit-address-family
!

interface Vlan100
  vrf forwarding v1
  ipv6 address 1000:1::1/64
  ospfv3 100 ipv6 area 0
!

interface Vlan200
  vrf forwarding v2
  ipv6 address 2000:1::1/64
  ospfv3 200 ipv6 area 0
!

interface GigabitEthernet 1/0/1
  switchport access vlan 100
end

interface GigabitEthernet 1/0/2
  switchport access vlan 200
end

interface GigabitEthernet 1/0/24
  switchport trunk encapsulation dot1q

  switchport mode trunk
end

router ospfv3 100
  router-id 10.10.10.10

```

```

!
address-family ipv6 unicast vrf v1
 redistribute connected
 area 0 normal
exit-address-family
!

router ospfv3 200
 router-id 20.20.20.20
!
address-family ipv6 unicast vrf v2
 redistribute connected
 area 0 normal
exit-address-family
!

```

### Configuring PE Switch

```

ipv6 unicast-routing

vrf definition v1
 rd 100:1
!
address-family ipv6
exit-address-family
!

vrf definition v2
 rd 200:1
!
address-family ipv6
exit-address-family
!

interface Vlan600
 vrf forwarding v1
 no ipv6 address
 ipv6 address 1000:1::2/64
 ospfv3 100 ipv6 area 0
!

interface Vlan700
 vrf forwarding v2
 no ipv6 address
 ipv6 address 2000:1::2/64
 ospfv3 200 ipv6 area 0
!

interface Vlan800
 vrf forwarding v1
 ipv6 address 3000:1::7/64
 ospfv3 100 ipv6 area 0
!

interface Vlan900
 vrf forwarding v2
 ipv6 address 4000:1::7/64
 ospfv3 200 ipv6 area 0
!

interface GigabitEthernet 1/0/1
 switchport trunk encapsulation dot1q
 switchport mode trunk
 exit

interface GigabitEthernet 1/0/2

```

```
switchport trunk encapsulation dot1q

switchport mode trunk
exit

router ospfv3 100
router-id 30.30.30.30
!
address-family ipv6 unicast vrf v1
redistribute connected
area 0 normal
exit-address-family
!
address-family ipv6 unicast vrf v2
redistribute connected
area 0 normal
exit-address-family
!
```

### Configuring CE2 Switch

```
ipv6 unicast-routing

vrf definition v1
rd 100:1
!
address-family ipv6
exit-address-family
!

vrf definition v2
rd 200:1
!
address-family ipv6
exit-address-family
!

interface Vlan100
vrf forwarding v1

ipv6 address 1000:1::3/64
ospfv3 100 ipv6 area 0
!

interface Vlan200
vrf forwarding v2
ipv6 address 2000:1::3/64
ospfv3 200 ipv6 area 0
!

interface GigabitEthernet 1/0/1
switchport access vlan 100
end

interface GigabitEthernet 1/0/2
switchport access vlan 200
end

interface GigabitEthernet 1/0/24
switchport trunk encapsulation dot1q
switchport mode trunk
end

router ospfv3 100
```

```

router-id 40.40.40.40
!
address-family ipv6 unicast vrf v1
 redistribute connected
  area 0 normal
exit-address-family
!

router ospfv3 200
router-id 50.50.50.50
!
address-family ipv6 unicast vrf v2
 redistribute connected

area 0 normal
exit-address-family
!
```

## Additional References for VRF-Lite

### Related Documents

Related Topic	Document Title
For complete syntax and usage information for the commands used in this chapter.	See the IP Multicast Routing Commands section of the <i>Command Reference (Catalyst 9400 Series Switches)</i>

### Standards and RFCs

Standard/RFC	Title
RFC 6763	<i>DNS-Based Service Discovery</i>
Multicast DNS Internet-Draft	<a href="#">Multicast</a>

## Feature History and Information for Multicast VRF-lite

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](http://www.cisco.com/go/cfn). An account on Cisco.com is not required.

Feature Name	Release	Feature Information
IPv6 Multicast support with VRF-Lite	Cisco IOS XE Everest 16.6.1	IPv6 VRF-Lite allows a service provider to support two or more VPNs with overlapping IP addresses using one interface.