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# 1 Configuring VRF

## 1.1 Introduction

### 1.1.1 Overview

VPN Routing and Forwarding Table (VRF) is used to resolve local routing conflicts caused by the same IP address space between different Virtual Private Networks (VPNs). One VPN corresponds to one VRF. Each VRF is equivalent to a "virtual router" that receives or advertises VPN routing information. Each VRF includes:

- An independent routing table;
- A set of interfaces belonging to this VRF;
- A set of routing protocols used for this VRF only.

Multiple routing tables on the device that provides the VPN service including a public network routing table and one or more VRFs. The public network routing table is used to forward public network packets, and the VRF is used to forward VPN packets. Routes in the public network routing table are separated from those in VRFs, and routes are separated between VRFs.

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**i** Note

- A VPN is a private dedicated network built in the public network. "Virtual" means that the VPN is logically exclusive, but not physically exclusive.
  - The private dedicated network is called "private network" for short.
- 

### 1.1.2 Principles

#### 1. VPN Instance

A VPN instance is used to provide the VPN service. On a device that provides the VPN service, a VPN instance includes the VRFs, interfaces, routing protocol processes, and configurations that belong to the same VPN. Generally, the VRF represents a VPN instance.

#### 2. VPN Route

A VPN route is only used to forward VPN packets. It comes from:

- Direct route and host route generated after an interface is added to the VRF;
- Direct route and host route imported from an interface that is not added to the VRF;
- Static and dynamic routes (RIP, RIPng, OSPFv2, OSPFv3, ISIS, and BGP) in the configured VPN instance.

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**i** Note

- For configuration of the static route in a VPN instance, see *Configuring IP Route Basics*.
  - For configuration of RIP in a VPN instance, see *Configuring RIP*.
  - For configuration of RIPng in a VPN instance, see *Configuring RIPng*.
  - For configuration of OSPFv2 in a VPN instance, see *Configuring OSPFv2*.
  - For configuration of OSPFv3 in a VPN instance, see *Configuring OSPFv3*.
  - For configuration of ISIS in a VPN instance, see *Configuring ISIS*.
-

- For configuration of BGP in a VPN instance, see *Configuring BGP*.

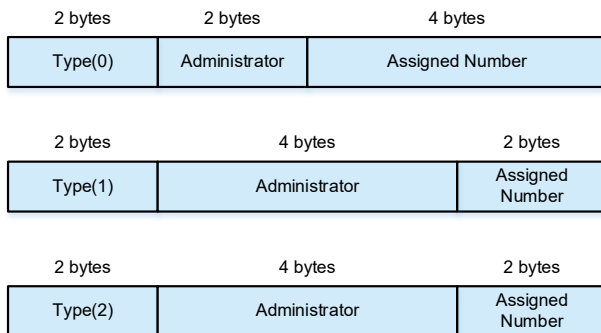
### 3. VPN Route Attribute

A VPN route has two attributes: Route Distinguisher (RD) and Route Target (RT).

- The RD is used to resolve routing conflicts when the Border Gateway Protocol (BGP) advertises routes. If different VPNs have the same network addresses, the BGP only selects an optimum route from these addresses and advertises this route. As a result, some VPNs cannot receive the routing information. To resolve this problem, you can add different RDs to the same addresses. Based on the different RDs carried in VPN information, the BGP can distinguish the same network addresses, and therefore each VPN can receive its own routing information.

Generally, a unique RD value is specified for each VPN. A VPN route carries only one RD value. An RD consists of a **Type** field, an **Administrator** field, and an **Assigned Number** field. As shown in [Figure 1-1](#), based on the value of the **Type** field, the RD is encoded in three formats:

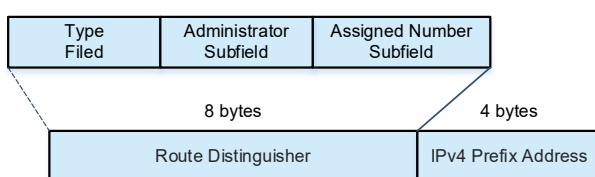
**Figure 1-1 RD structure**



- When **Type** is set to **0**, the **Administrator** field has two bytes and is set to an Autonomous System (AS) number, which must be a public AS number; the **Assigned Number** field has four bytes and is managed by the service provider (SP).
- When **Type** is set to **1**, the **Administrator** field has four bytes and is set to an IPv4, which must be a global IP address; the **Assigned Number** field has two bytes and is managed by the SP.
- When **Type** is set to **2**, the **Administrator** field has four bytes and is set to a 4-byte AS number; the **Assigned Number** field has two bytes and is managed by the SP.

An IPv4 address with the RD is called VPN-IPv4 address, as shown in [Figure 1-2](#). After receiving an IPv4 route, the BGP converts it into a globally unique VPN-IPv4 route, and advertises this route in the public network.

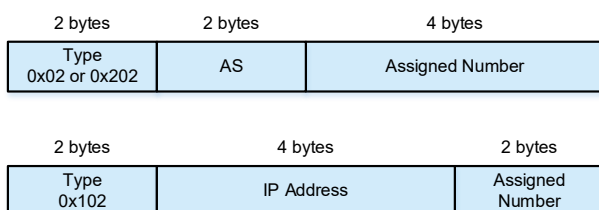
**Figure 1-2 VPN-IPv4 address structure**



- RT is used to control the advertising and installation policies of VPN routes. The RT attribute falls into the following two types:
  - **Import:** When a device receives the advertised VPN-IPv4 route, the device checks the **Export** attribute of this route. If the **Import** attribute of a specified VPN instance on the device matches the **Export** attribute, the device adds the route to the VPN instance.
  - **Export:** After the local device learns an IPv4 route, it converts this route into a VPN-IPv4 route. The **Export** attribute is set for this route and advertised as the BGP extended community attribute to other devices together with the route.

The BGP extended community attribute defines the RT structure, as shown in [Figure 1-3](#).

**Figure 1-3 RT structure**



The RT value and the RD value are similarly defined. When **Type** is set to **0x02** or **0x202**, the AS number must be public. When **Type** is set to **0x102**, the IPv4 address must be a global IP address.

### 1.1.3 Protocols and Standards

- RFC4364: BGP/MPLS IP Virtual Private Networks (VPNs)

## 1.2 Restrictions and Guidelines

- You can configure only one type of VRF: single-protocol VRF or multiprotocol VRF.
- Single-protocol VRFs only support IPv4, whereas multiprotocol VRFs support both IPv4 and IPv6.

## 1.3 Configuration Task Summary

The configuration tasks below are mutually exclusive. Please configure only one task.

- [Configuring a Single-Protocol VRF](#)
  - a. [Creating a Single-Protocol VRF](#)
  - b. (Optional) [Configuring the RD for a Single-Protocol VRF](#)
  - c. (Optional) [Configuring the RT for a Single-Protocol VRF](#)
  - d. (Optional) [Configuring the Label Allocation Mode for a Single-Protocol VRF](#)
  - e. (Optional) [Configuring an Export Policy Associated with a Single-Protocol VRF](#)
  - f. (Optional) [Configuring an Import Policy Associated with a Single-Protocol VRF](#)
  - g. [Adding an Interface to a Single-Protocol VRF](#)
  - h. (Optional) [Importing Routes of an Interface to a Single-Protocol VRF](#)

- i. (Optional) [Configuring the Maximum Number of Routes for a Single-Protocol VRF](#)
- [Configuring a Multiprotocol VRF](#)
  - a. [Creating a Multiprotocol VRF](#)
  - b. (Optional) [Configuring the Address Family for a Multiprotocol VRF](#)
  - c. (Optional) [Configuring the RD for a Multiprotocol VRF](#)
  - d. (Optional) [Configuring the RT for a Multiprotocol VRF](#)
  - e. (Optional) [Configuring the Label Allocation Mode for a Multiprotocol VRF](#)
  - f. (Optional) [Configuring an Export Policy Associated with a Multiprotocol VRF](#)
  - g. (Optional) [Configuring an Import Policy Associated with a Multiprotocol VRF](#)
  - h. [Adding an Interface to a Multiprotocol VRF](#)
  - i. (Optional) [Importing Routes of an Interface to a Multiprotocol VRF](#)
  - j. (Optional) [Configuring the Maximum Number of Routes for a Multiprotocol VRF](#)
- [Configuring a Global VRF](#)
  - a. [Configuring the Address Family for a Global VRF](#)
  - b. (Optional) [Configuring the RD for a Global VRF](#)
  - c. (Optional) [Configuring the RT for a Global VRF](#)
  - d. (Optional) [Configuring the Label Allocation Mode for a Global VRF](#)
  - e. (Optional) [Configuring an Export Policy Associated with a Global VRF](#)
  - f. (Optional) [Configuring an Import Policy Associated with a Global VRF](#)
  - g. (Optional) [Configuring the Maximum Number of Routes for a Global VRF](#)

## 1.4 Configuring a Single-Protocol VRF

### 1.4.1 Overview

A single-protocol VRF is configured to manage VPN routes.

### 1.4.2 Restrictions and Guidelines

- If a device forwards only packets of a specified VPN or only public network packets, you do not need to configure a single-protocol VRF.
- If the device needs to forward both the public network packets and VPN packets or forward packets from multiple VPNs, VRFs must be created to separate routes.
- You need to add static or dynamic routes (RIP, OSPF, ISIS, and BGP) to a VRF.
- Only IPv4 is supported.

### 1.4.3 Configuration Tasks

The configuration of a single-protocol VRF includes the following tasks:

- (1) [Creating a Single-Protocol VRF](#)
- (2) (Optional) [Configuring the RD for a Single-Protocol VRF](#)
- (3) (Optional) [Configuring the RT for a Single-Protocol VRF](#)

- (4) (Optional) [Configuring the Label Allocation Mode for a Single-Protocol VRF](#)
- (5) (Optional) [Configuring an Export Policy Associated with a Single-Protocol VRF](#)
- (6) (Optional) [Configuring an Import Policy Associated with a Single-Protocol VRF](#)
- (7) [Adding an Interface to a Single-Protocol VRF](#)
- (8) (Optional) [Importing Routes of an Interface to a Single-Protocol VRF](#)
- (9) (Optional) [Configuring the Maximum Number of Routes of a Single-Protocol VRF](#)

## 1.4.4 Creating a Single-Protocol VRF

### 1. Overview

This section describes how to create a single-protocol VRF for each VPN.

### 2. Procedure

- (1) Enter the privileged EXEC mode.

**enable**

- (2) Enter the global configuration mode.

**configure terminal**

- (3) Create a single-protocol VRF, and enter the VRF configuration mode.

**ip vrf** *vrf-name*

No single-protocol VRF is configured by default.

- (4) (Optional) Configure the description for a single-protocol VRF.

**description** *description*

No description is configured by default.

## 1.4.5 Configuring the RD for a Single-Protocol VRF

### 1. Overview

This section describes how to configure the RD to resolve routing conflicts when the BGP advertises routes.

### 2. Restrictions and Guidelines

- Configure the RD command in single-protocol VRF configuration mode.
- If you have configured a VRF value and its RD value and want to modify the RD value, you must first delete the VRF, reconfigure the VRF, and then configure the RD value.
- You can configure only one RD value for a VRF.

### 3. Procedure

- (1) Enter the privileged EXEC mode.

**enable**

- (2) Enter the global configuration mode.

**configure terminal**

- (3) Enter the single-protocol VRF configuration mode.



```
ip vrf vrf-name
```

- (4) Configure the RD.

```
rd rd-value
```

No RD value is configured by default.

## 1.4.6 Configuring the RT for a Single-Protocol VRF

### 1. Overview

This section describes how to configure the RT value to control advertisement of VPN routes.

### 2. Restrictions and Guidelines

- Configure the RT value in single-protocol VRF configuration mode.
- You can configure multiple **Import** or **Export** values for each VRF.

### 3. Procedure

- (1) Enter the privileged EXEC mode.

```
enable
```

- (2) Enter the global configuration mode.

```
configure terminal
```

- (3) Enter the single-protocol VRF configuration mode.

```
ip vrf vrf-name
```

- (4) Configure the RT.

```
route-target { both | export | import } route-value
```

No RT is configured by default.

## 1.4.7 Configuring the Label Allocation Mode for a Single-Protocol VRF

### 1. Overview

This section describes how to configure the label allocation mode for a single-protocol VRF.

### 2. Restrictions and Guidelines

- Route-based label allocation mode: One route corresponds to one label. The advantage is that the system can look up the ILM table based on the label value and quickly forward packets to the next hop. The disadvantage is that the capacity of the ILM table must be large.
- VRF-based label allocation mode: One VRF corresponds to one label. The advantage is that all routes in the VRF share this label, which reduces the capacity of the ILM table. The disadvantage is that packet forwarding is slower than that in route-based label allocation mode. This is because the system needs to look up the table twice in the forwarding process. It first looks up the ILM table to find the VRF where the packet is located, and then forwards the packet based on the destination IP address in the routing table of the VRF.

### 3. Procedure

- (1) Enter the privileged EXEC mode.

**enable**

- (2) Enter the global configuration mode.

**configure terminal**

- (3) Enter the single-protocol VRF configuration mode.

**ip vrf vrf-name**

- (4) Configure the label allocation mode.

**alloc-label { per-route | per-vrf }**

No label allocation mode is configured by default.

## 1.4.8 Configuring an Export Policy Associated with a Single-Protocol VRF

### 1. Overview

This section describes how to configure a policy for exporting the extended community attributes of VPN routes from the local VRF to a remote device.

### 2. Restrictions and Guidelines

- To more precisely control the extended community attributes of exported routes, you can define a precise rule as needed in the associated route map.
- You can run this command to add or modify the extended community attributes defined by the **route-target export** command.
- You can only run the **match ip address** and **set extcommunity** commands to configure rules for a route map associated by this command.

### 3. Procedure

- (1) Enter the privileged EXEC mode.

**enable**

- (2) Enter the global configuration mode.

**configure terminal**

- (3) Enter the single-protocol VRF configuration mode.

**ip vrf vrf-name**

- (4) Configure the associated export policy.

**export map route-map-name**

No export policy associated with the VRF is configured by default.

## 1.4.9 Configuring an Import Policy Associated with a Single-Protocol VRF

### 1. Overview

This section describes how to configure a policy for importing VPN routes from a remote device to the local VRF.

### 2. Restrictions and Guidelines

- To more precisely filter routes imported to the local VRF, you can define a precise rule as needed in the

associated route map.

- The rule defined by the **import map** command takes effect after the **Import** extended community attributes defined in the VRF. That is, only after the route matches the extended community attributes defined by the **route-target import** command in the VRF, can the VPN routes received from the remote device be filtered again by rules defined by the **import map** command.
- You can only run the **match ip address** and **match extcommunity** commands to configure rules for a route map associated by the **import map** command.

### 3. Procedure

- (1) Enter the privileged EXEC mode.

**enable**

- (2) Enter the global configuration mode.

**configure terminal**

- (3) Enter the single-protocol VRF configuration mode.

**ip vrf** *vrf-name*

- (4) Configure the associated import policy.

**import map** *route-map-name*

No import policy associated with the VRF is configured by default.

## 1.4.10 Adding an Interface to a Single-Protocol VRF

### 1. Overview

This section describes how to add an interface to a specified VRF. This VRF is used to forward incoming packets of the interface.

### 2. Restrictions and Guidelines

You must add the interface to the single-protocol VRF before configuring the IPv4 address. If you configure the IPv4 address for an interface and then add the interface to the single-protocol VRF, the configuration of the IPv4 address fails, but the configuration of the IPv6 address is retained.

### 3. Procedure

- (1) Enter the privileged EXEC mode.

**enable**

- (2) Enter the global configuration mode.

**configure terminal**

- (3) Enter the interface configuration mode.

**interface** *interface-type interface-number*

- (4) Add the interface to the single-protocol VRF.

**ip vrf forwarding** *vrf-name*

By default, an interface does not belong to any VRF.

## 1.4.11 Importing Routes of an Interface to a Single-Protocol VRF

### 1. Overview

This section describes how to import the host route and direct route of an interface to a specified VRF.

### 2. Restrictions and Guidelines

- If you need to use policy-based routing (PBR) to select the VRF, configure the **ip vrf receive** command on the interface to which PBR is applied, and import the direct route and host route on the interface to each VRF available for choice.
- If you need to import the host route and direct route of an interface to multiple VRFs, run this command multiple times.

### 3. Procedure

- (1) Enter the privileged EXEC mode.

**enable**

- (2) Enter the global configuration mode.

**configure terminal**

- (3) Enter the interface configuration mode.

**interface** *interface-type interface-number*

- (4) Import the host route and direct route of the interface to a specified VRF.

**ip vrf receive** *vrf-name*

The direct route and host route of an interface are not imported to any specified VRF by default.

The **ip vrf forwarding** and **ip vrf receive** commands are mutually exclusive on a specified interface.

Unlike the **ip vrf forwarding** command, the **ip vrf receive** command does not add the interface to the VRF, and the interface does not belong to any VRF.

## 1.4.12 Configuring the Maximum Number of Routes for a Single-Protocol VRF

### 1. Overview

This section describes how to configure the maximum number of routes for a single-protocol VRF.

### 2. Procedure

- (1) Enter the privileged EXEC mode.

**enable**

- (2) Enter the global configuration mode.

**configure terminal**

- (3) Enter the single-protocol VRF configuration mode.

**ip vrf** *vrf-name*

- (4) Enter the single-protocol VRF address family configuration mode.

**address-family** { **ipv4** | **ipv6** }

- (5) Configure the maximum number of routes for a single-protocol VRF.

**maximum routes** *limit* { **warning-only** | *warning-threshold* }

No maximum number of routes is configured by default.

## 1.5 Configuring a Multiprotocol VRF

### 1.5.1 Overview

This section describes how to configure a multiprotocol VRF to manage VPN routes. You can configure the address family to support IPv4 and IPv6. The BGP helps you to flexibly isolate VPNs or allow inter-VPN access, or provide the VPN service in an IP/MPLS backbone network.

### 1.5.2 Restrictions and Guidelines

- If a device forwards only packets of a specified VPN or only public network packets, you do not need to configure a multiprotocol VRF.
- If the device needs to forward both the public network packets and VPN packets or forward packets from multiple VPNs, VRFs must be created to separate routes.
- You need to add static or dynamic routes (RIP, OSPF, ISIS, and BGP) to a VRF.

### 1.5.3 Configuration Tasks

The configuration of a multiprotocol VRF includes the following tasks:

- (1) [Creating a Multiprotocol VRF](#)
- (2) [Configuring the Address Family for a Multiprotocol VRF](#)
- (3) (Optional) [Configuring the RD for a Multiprotocol VRE](#)
- (4) (Optional) [Configuring the RT for a Multiprotocol VRF](#)
- (5) (Optional) [Configuring the Label Allocation Mode for a Multiprotocol VRF](#)
- (6) (Optional) [Configuring an Export Policy Associated with a Multiprotocol VRE](#)
- (7) (Optional) [Configuring an Import Policy Associated with a Multiprotocol VRF](#)
- (8) [Adding an Interface to a Multiprotocol VRF](#)
- (9) (Optional) [Importing Routes of an Interface to a Multiprotocol VRF](#)
- (10) (Optional) [Configuring the Maximum Number of Routes for a Multiprotocol VRF](#)

### 1.5.4 Creating a Multiprotocol VRF

#### 1. Overview

This section describes how to create a multiprotocol VRF for each VPN.

#### 2. Procedure

- (1) Enter the privileged EXEC mode.  
**enable**
- (2) Enter the global configuration mode.  
**configure terminal**
- (3) Create a multiprotocol VRF, and enter the multiprotocol VRF configuration mode.

**vrf definition** *vrf-name*

No multiprotocol VRF exists by default.

- (4) (Optional) Configure the description for a multiprotocol VRF.

**description** *description*

No description is configured by default.

## 1.5.5 Configuring the Address Family for a Multiprotocol VRF

### 1. Overview

This section describes how to enable the IPv4/IPv6 address family for a multiprotocol VRF, and enter the configuration mode.

### 2. Restrictions and Guidelines

You can configure the address family for each created VRF.

### 3. Procedure

- (1) Enter the privileged EXEC mode.

**enable**

- (2) Enter the global configuration mode.

**configure terminal**

- (3) Enter the multiprotocol VRF configuration mode.

**vrf definition** *vrf-name*

- (4) Configure the address family. Configure at least one of the following tasks.

- o Configure the IPv4 address family, and enter the VRF IPv4 address family submode.

**address-family ipv4**

- o Configure the IPv6 address family, and enter the VRF IPv6 address family submode.

**address-family ipv6**

No address family is configured for a multiprotocol VRF by default.

## 1.5.6 Configuring the RD for a Multiprotocol VRF

### 1. Overview

This section describes how to configure the RD to resolve routing conflicts when the BGP advertises routes.

### 2. Restrictions and Guidelines

- Configure the RD command in multiprotocol VRF configuration mode.
- If you have configured a VRF value and its RD value and want to modify the RD value, you must first delete the VRF, reconfigure the VRF, and then configure the RD value.
- You can configure only one RD value for a VRF.

### 3. Procedure

- (1) Enter the privileged EXEC mode.

**enable**

- (2) Enter the global configuration mode.

**configure terminal**

- (3) Enter the multiprotocol VRF configuration mode.

**vrf definition** *vrf-name*

- (4) Configure the RD.

**rd** *rd-value*

No RD value is configured by default.

## 1.5.7 Configuring the RT for a Multiprotocol VRF

### 1. Overview

This section describes how to configure the RT group to control advertisement of VPN routes.

### 2. Restrictions and Guidelines

- Configure the RT value in multiprotocol VRF mode or multiprotocol VRF address family mode.
- You can configure multiple **Import** or **Export** values for each VRF.

### 3. Procedure

- (1) Enter the privileged EXEC mode.

**enable**

- (2) Enter the global configuration mode.

**configure terminal**

- (3) Enter the multiprotocol VRF configuration mode.

**vrf definition** *vrf-name*

- (4) Configure the RT. Configure one of the following tasks.

- In multiprotocol VRF configuration mode, run the following command to configure the RT:

```
route-target { both | export | import } route-value
```

- In multiprotocol VRF address family configuration mode, run the following command to configure the RT:

```
address-family { ipv4 | ipv6 }
```

No IPv4 or IPv6 protocol is enabled for the multiprotocol VRF by default.

```
route-target { both | export | import } route-value
```

No RT is configured by default.

## 1.5.8 Configuring the Label Allocation Mode for a Multiprotocol VRF

### 1. Overview

This section describes how to configure the label allocation mode for a multiprotocol VRF.

### 2. Restrictions and Guidelines

- Route-based label allocation mode: One route corresponds to one label. The advantage is that the system

can look up the ILM table based on the label value and quickly forward packets to the next hop. The disadvantage is that the capacity of the ILM table must be large.

- VRF-based label allocation mode: One VRF corresponds to one label. The advantage is that all routes in the VRF share this label, which reduces the capacity of the ILM table. The disadvantage is that packet forwarding is slower than that in route-based label allocation mode. This is because the system needs to look up the table twice in the forwarding process. It first looks up the ILM table to find the VRF where the packet is located, and then forwards the packet based on the destination IP address in the routing table of the VRF.

### 3. Procedure

- (1) Enter the privileged EXEC mode.

**enable**

- (2) Enter the global configuration mode.

**configure terminal**

- (3) Enter the multiprotocol VRF configuration mode.

**vrf definition** *vrf-name*

- (4) Enter the address family configuration mode. Configure at least one of the following tasks.

- Enter the IPv4 address family configuration mode.

**address-family ipv4**

- Enter the IPv6 address family configuration mode.

**address-family ipv6**

A multiprotocol VRF does not enter any address family configuration mode by default.

- (5) Configure the label allocation mode.

**alloc-label** { **per-route** | **per-vrf** }

No label allocation mode is configured by default.

## 1.5.9 Configuring an Export Policy Associated with a Multiprotocol VRF

### 1. Overview

This section describes how to configure a policy for exporting the extended community attributes of VPN routes from the local VRF to the remote device

### 2. Restrictions and Guidelines

- To more precisely control the extended community attributes of exported routes, you can define a precise rule as needed in the associated route map.
- You can run this command to add or modify the extended community attributes defined by the **route-target export** command.
- You can only run the **match ip address** and **set extcommunity** commands to configure rules for a route map associated by this command.

### 3. Procedure

- (1) Enter the privileged EXEC mode.



**enable**

- (2) Enter the global configuration mode.

**configure terminal**

- (3) Enter the multiprotocol VRF configuration mode.

**vrf definition** *vrf-name*

- (4) Enter the address family configuration mode. Configure at least one of the following tasks.

- o Enter the IPv4 address family configuration mode.

**address-family ipv4**

- o Enter the IPv6 address family configuration mode.

**address-family ipv6**

A multiprotocol VRF does not enter any address family configuration mode by default.

- (5) Configure the associated export policy.

**export map** *route-map-name*

No export policy associated with the VRF is configured by default.

## 1.5.10 Configuring an Import Policy Associated with a Multiprotocol VRF

### 1. Overview

This section describes how to configure a policy for importing VPN routes from a remote device to the local VRF.

### 2. Restrictions and Guidelines

- To more precisely filter routes imported to the local VRF, you can define a precise rule as needed in the associated route map.
- The rule defined by the **import map** command takes effect after the **import** extended community attributes defined in the VRF. That is, only after these routes match the extended community attributes defined by the **route-target import** command in the VRF, can the VPN routes received from the remote device be filtered again by rules defined the **import map** command.
- You can only run the **match ip address** and **match extcommunity** commands to configure rules for a route map associated by the import map command.

### 3. Procedure

- (1) Enter the privileged EXEC mode.

**enable**

- (2) Enter the global configuration mode.

**configure terminal**

- (3) Enter the multiprotocol VRF configuration mode.

**vrf definition** *vrf-name*

- (4) Enter the address family configuration mode. Configure at least one of the following tasks.

- o Enter the IPv4 address family configuration mode.

**address-family ipv4**

- o Enter the IPv6 address family configuration mode.

**address-family ipv6**

A multiprotocol VRF does not enter any address family configuration mode by default.

- (5) Configure the associated import policy.

**import map** *route-map-name*

No import policy associated with the VRF is configured by default.

## 1.5.11 Adding an Interface to a Multiprotocol VRF

### 1. Overview

This section describes how to add an interface to a specified VRF. This VRF is used to forward incoming packets of the interface.

### 2. Restrictions and Guidelines

- After this command is executed, the direct route and host route on the interface are automatically imported to the VRF.
- Before you add an interface to a multiprotocol VRF, enable the address family for the table. If the IPv4 address family is disabled when you add an interface to a multiprotocol VRF, you are not allowed to configure the IPv4 and VRRP IPv4 addresses on this interface. If the IPv6 address family is disabled when you add an interface to a multiprotocol VRF, you are not allowed to configure the IPv6 and VRRP IPv6 addresses on this interface.
- You must add an interface to the multiprotocol VRF before configuring the IPv4/IPv6 or VRRP IPv4/IPv6 addresses on the interface. When you add an interface to a multiprotocol VRF, existing IPv4/IPv6 or VRRP IPv4/IPv6 addresses on the interface are deleted, and the IPv6 protocol is disabled on the interface.
- If the IPv4 address family is deleted from the multiprotocol VRF, the IPv4 and VRRP IPv4 addresses of all interfaces added to this VRF are deleted, and the IPv4 static routes in the VRF or the IPv4 static routes with this VRF as their next-hop VRF are also deleted.
- If the IPv6 address family is deleted from the multiprotocol VRF, the IPv6 and VRRP IPv6 addresses of all interfaces added to the VRF are deleted, the IPv6 protocol is disabled on the interface, and the IPv6 static routes in the VRF or the IPv6 static routes with this VRF as their next-hop VRF are also deleted.

### 3. Procedure

- (1) Enter the privileged EXEC mode.

**enable**

- (2) Enter the global configuration mode.

**configure terminal**

- (3) Enter the interface configuration mode.

**interface** *interface-type interface-number*

- (4) Add the interface to the multiprotocol VRF.

**vrf forwarding** *vrf-name*

By default, an interface does not belong to any VRF.

## 1.5.12 Importing Routes of an Interface to a Multiprotocol VRF

### 1. Overview

This section describes how to import the host route and direct route of an interface to a specified VRF.

### 2. Restrictions and Guidelines

- If you need to use PBR to select the VRF, configure the **vrf receive** command on the interface to which PBR is applied to import the direct route and host route on the interface to each VRF available for choice.
- If you need to import the host route and direct route of an interface to multiple VRFs, run this command multiple times.

### 3. Procedure

- (1) Enter the privileged EXEC mode.

**enable**

- (2) Enter the global configuration mode.

**configure terminal**

- (3) Enter the interface configuration mode.

**interface** *interface-type interface-number*

- (4) Import the host route and direct route of the interface to a specified VRF.

**vrf receive** *vrf-name*

The **vrf forwarding** and **vrf receive** commands are mutually exclusive on a specified interface. Unlike the **vrf forwarding** command, the **vrf receive** command does not add an interface to the specified VRF, and the interface does not belong to any VRF.

## 1.5.13 Configuring the Maximum Number of Routes for a Multiprotocol VRF

### 1. Overview

This section describes how to configure the maximum number of routes for a multiprotocol VRF.

### 2. Procedure

- (1) Enter the privileged EXEC mode.

**enable**

- (2) Enter the global configuration mode.

**configure terminal**

- (3) Enter the multiprotocol VRF configuration mode.

**vrf definition** *vrf-name*

- (4) Enter the multiprotocol VRF address family configuration mode.

**address-family** { **ipv4** | **ipv6** }

- (5) Configure the maximum number of routes for a multiprotocol VRF.

**maximum routes** *limit* { **warning-only** | *warning-threshold* }

No maximum number of routes is configured by default.

## 1.6 Configuring a Global VRF

### 1.6.1 Overview

A global VRF is configured to manage VPN routes. The global VRF is created by default.

### 1.6.2 Restrictions and Guidelines

- If a device forwards only packets of a specified VPN or only public network packets, you do not need to configure a VRF.
- If the device needs to forward both the public network packets and VPN packets or forward packets from multiple VPNs, VRFs must be created to separate routes.
- You need to add static or dynamic routes (RIP, OSPF, ISIS, and BGP) to a VRF.

### 1.6.3 Configuration Tasks

The configuration of a global VRF includes the following tasks:

- (1) [Configuring the Address Family for a Global VRF](#)
- (2) (Optional) [Configuring the RD for a Global VRF](#)
- (3) (Optional) [Configuring the RT for a Global VRF](#)
- (4) (Optional) [Configuring the Label Allocation Mode for a Global VRF](#)
- (5) (Optional) [Configuring an Export Policy Associated with a Global VRF](#)
- (6) (Optional) [Configuring an Import Policy Associated with a Global VRF](#)
- (7) (Optional) [Configuring the Maximum Number of Routes for a Global VRF](#)

### 1.6.4 Configuring the Address Family for a Global VRF

#### 1. Overview

This section describes how to enable the IPv4/IPv6 address family for a global VRF, and enter the configuration mode.

#### 2. Restrictions and Guidelines

You can configure the address family for each created VRF.

#### 3. Procedure

- (1) Enter the privileged EXEC mode.  
**enable**
- (2) Enter the global configuration mode.  
**configure terminal**
- (3) Enter the global VRF configuration mode.  
**vrf global-vrf**
- (4) (Optional) Configure description for the global VRF.

**description** *description*

No description is configured by default.

(5) Configure the address family. Configure at least one of the following tasks.

- o Configure the IPv4 address family, and enter the VRF IPv4 address family submode.

**address-family ipv4**

- o Configure the IPv6 address family, and enter the VRF IPv6 address family submode.

**address-family ipv6**

IPv4/IPv6 address family is enabled by default.

## 1.6.5 Configuring the RD for a Global VRF

### 1. Overview

This section describes how to configure the RD to resolve routing conflicts when the BGP advertises routes.

### 2. Restrictions and Guidelines

- Configure the RD command in global VRF configuration mode.
- If you have configured a VRF value and its RD value and want to modify the RD value, you must first delete the VRF, reconfigure the VRF, and then configure the RD value.
- You can configure only one RD value for a VRF.

### 3. Procedure

(1) Enter the privileged EXEC mode.

**enable**

(2) Enter the global configuration mode.

**configure terminal**

(3) Enter the global VRF configuration mode.

**vrf global-vrf**

(4) Configure the RD.

**rd rd-value**

No RD value is configured by default.

## 1.6.6 Configuring the RT for a Global VRF

### 1. Overview

This section describes how to configure the RT value to control advertisement of VPN routes.

### 2. Restrictions and Guidelines

- Configure the RT value in global VRF configuration mode or global VRF address family configuration mode.
- You can configure multiple **Import** or **Export** values for each VRF.

### 3. Procedure

(1) Enter the privileged EXEC mode.

**enable**

- (2) Enter the global configuration mode.

**configure terminal**

- (3) Enter the global VRF configuration mode.

**vrf global-vrf**

- (4) (Optional) Enter the global VRF address family configuration mode.

**address-family { ipv4 | ipv6 }**

- (5) Configure the RT.

**route-target { both | export | import } route-value**

No RT is configured by default.

## 1.6.7 Configuring the Label Allocation Mode for a Global VRF

### 1. Overview

This section describes how to configure the label allocation mode for a global VRF.

### 2. Restrictions and Guidelines

- Route-based label allocation mode: One route corresponds to one label. The advantage is that the system can look up the ILM table based on the label value and quickly forward packets to the next hop. The disadvantage is that the capacity of the ILM table must be large.
- VRF-based label allocation mode: One VRF corresponds to one label. The advantage is that all routes in the VRF share this label, which reduces the capacity of the ILM table. The disadvantage is that packet forwarding is slower than that in route-based label allocation mode. This is because the system needs to look up the table twice in the forwarding process. It first looks up the ILM table to find the VRF where the packet is located, and then forwards the packet based on the destination IP address in the routing table of the VRF.

### 3. Procedure

- (1) Enter the privileged EXEC mode.

**enable**

- (2) Enter the global configuration mode.

**configure terminal**

- (3) Enter the global VRF configuration mode.

**vrf global-vrf**

- (4) (Optional) Enter the global VRF address family configuration mode.

**address-family { ipv4 | ipv6 }**

- (5) Configure the label allocation mode.

**alloc-label { per-route | per-vrf }**

No label allocation mode is configured by default.

## 1.6.8 Configuring an Export Policy Associated with a Global VRF

### 1. Overview

This section describes how to configure a policy for exporting the extended community attributes of VPN routes from the local VRF to a remote device.

### 2. Restrictions and Guidelines

- To more precisely control the extended community attributes of exported routes, you can define a precise rule as needed in the associated route map.
- You can run this command to add or modify the extended community attributes defined by the **route-target export** command.
- You can only run the **match ip address** and **set extcommunity** commands to configure rules for a route map associated by this command.

### 3. Procedure

(1) Enter the privileged EXEC mode.

**enable**

(2) Enter the global configuration mode.

**configure terminal**

(3) Enter the global VRF configuration mode.

**vrf global-vrf**

(4) Enter the global VRF address family configuration mode.

**address-family { ipv4 | ipv6 }**

(5) Configure the associated export policy.

**export map route-map-name**

No export policy associated with the VRF is configured by default.

## 1.6.9 Configuring an Import Policy Associated with a Global VRF

### 1. Overview

This section describes how to configure a policy for importing VPN routes from a remote device to the local VRF.

### 2. Restrictions and Guidelines

- To more precisely filter routes imported to the local VRF, you can define a precise rule as needed in the associated route map.
- The rule defined by the **import map** command takes effect after the **Import** extended community attributes defined in the VRF. That is, only after the route matches the extended community attributes defined by the **route-target import** command in the VRF, can the VPN routes received from the remote device be filtered again by rules defined by the **import map** command.
- You can only run the **match ip address** and **match extcommunity** commands to configure rules for a route map associated by the **import map** command.

### 3. Procedure

- (1) Enter the privileged EXEC mode.

**enable**

- (2) Enter the global configuration mode.

**configure terminal**

- (3) Enter the global VRF configuration mode.

**vrf global-vrf**

- (4) Enter the global VRF address family configuration mode.

**address-family { ipv4 | ipv6 }**

- (5) Configure the associated import policy.

**import map** *route-map-name*

No import policy associated with the VRF is configured by default.

## 1.6.10 Configuring the Maximum Number of Routes for a Global VRF

### 1. Overview

This section describes how to configure the maximum number of routes for a global VRF.

### 2. Procedure

- (1) Enter the privileged EXEC mode.

**enable**

- (2) Enter the global configuration mode.

**configure terminal**

- (3) Enter the global VRF configuration mode.

**vrf global-vrf**

- (4) Enter the global VRF address family configuration mode.

**address-family { ipv4 | ipv6 }**

- (5) Configure the maximum number of routes for a global VRF.

**maximum routes** *limit* { **warning-only** | *warning-threshold* }


No maximum number of routes is configured by default.

## 1.7 Monitoring

Run the **show** command to check the running status of a configured function and verify the configuration effect.

Run the **clear** commands to clear information.

---

 Caution

Running the **clear** commands may interrupt services due to loss of vital information.

---



Run the **debug** command to output debugging information.

**⚠ Caution**

The output debugging information occupies system resources. Therefore, disable the debugging function immediately after use.

**Table 1-1 VRF Monitoring**

Command	Purpose
<b>show ip vrf</b> [ <b>brief</b>   <b>count</b>   <b>detail</b>   <b>interfaces</b> ] [ <i>vrf-name</i> ]	Displays a single-protocol VRF.
<b>show global-vrf</b> [ <b>count</b>   <b>brief</b>   <b>detail</b>   <b>ipv4</b>   <b>ipv6</b> ]	Displays a global VRF.
<b>show vrf</b> [ <b>brief</b>   <b>count</b>   <b>detail</b>   <b>ipv4</b>   <b>ipv6</b> ] [ <i>vrf-name</i> ]	Displays a multiprotocol VRF.
<b>clear ip mroute</b> [ <b>vrf vid</b> ] <b>statistics</b> { *   <i>group-address</i> [ <i>source-address</i> ] }	Clears the multicast route statistics.
<b>clear ip pim dense-mode</b> [ <b>vrf vid</b> ] <b>track</b>	Clears the PIM-DM packet statistics.
<b>clear ip route vrf</b> <i>vrf-name</i>	Clears the routes in a specified VRF.
<b>debug vrf</b>	Displays the debugging information when a VRF is created, an address family is enabled, and an interface is added to the VRF.
<b>debug vrf interface</b>	Displays the debugging information of interface-related VRF operations.

## 1.8 Configuration Examples

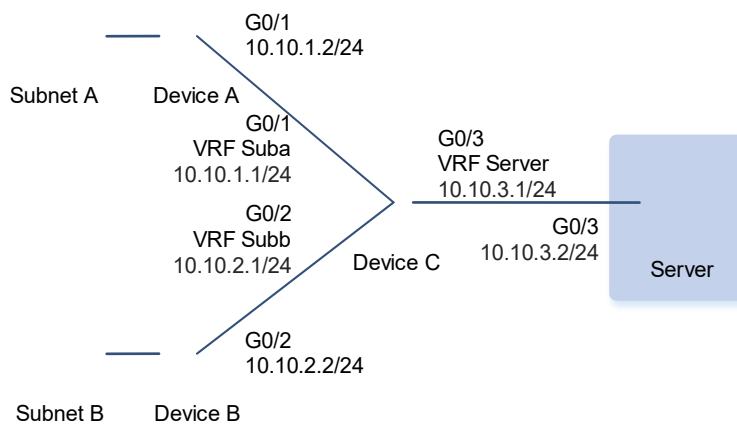
### 1.8.1 Enabling Local Inter-VPN Access

#### 1. Requirements

Subnet A, Subnet B, and Server are three VPNs that have separate address spaces. Subnet A runs RIP, Subnet B runs OSPF, and Servers is a network segment directly connected to Device C. Routes in Subnet A are separated from those in Subnet B, but both Subnet A and Subnet B can access Server.

## 2. Topology

Figure 1-1 Local inter-VPN access



## 3. Notes

- On Device C, create a VRF named **Suba**, add the interface directly connected to Device A to the VRF **Suba**. Associate the VRF **Suba** of Device C with Device A by using RIP.
- On Device C, create a VRF named **Subb**, add the interface directly connected to Device B to the VRF **Subb**. Associate the VRF **Subb** of Device C with Device B by using OSPF.
- On Device C, create a VRF named **Server**, add the interface directly connected to Server to the VRF **Server**.
- On Device C, configure RTs for three VRFs, including **Suba**, **Subb**, and **Server**. Import the routes of **Suba** and **Subb** to **Server**, and the routes of **Server** to **Suba** and **Subb**.
- On Device C, configure the BGP, and import the RIP routes to the IPv4 VRF **Suba**, the OSPF routes to the IPv4 VRF **Subb**, and the direct routes to the IPv4 VRF **Server**.

## 4. Procedure

- (1) (Omitted) Configure the IP address for the device.
- (2) Create VRFs on Device C.

Create a VRF named **Suba**, add the interface G0/1 directly connected to Device A to the VRF **Suba**.

```

DeviceC> enable
DeviceC# configure terminal
DeviceC(config)# ip vrf Suba
DeviceC(config-vrf)# rd 100:1
DeviceC(config-vrf)# route-target import 100:3
DeviceC(config-vrf)# route-target export 100:1
DeviceC(config-vrf)# exit
DeviceC(config)# interface gigabitethernet 0/1
DeviceC(config-GigabitEthernet 0/1)# ip vrf forwarding Suba
DeviceC(config-GigabitEthernet 0/1)# ip address 10.10.1.1 255.255.255.0
DeviceC(config-GigabitEthernet 0/1)# exit
  
```

Create a VRF named **Subb**, add the interface G0/2 directly connected to Device B to the VRF **Subb**.

```
DeviceC(config)# ip vrf Subb
DeviceC(config-vrf)# rd 100:2
DeviceC(config-vrf)# route-target import 100:3
DeviceC(config-vrf)# route-target export 100:2
DeviceC(config-vrf)# exit
DeviceC(config)# interface gigabitethernet 0/2
DeviceC(config-GigabitEthernet 0/2)# ip vrf forwarding Subb
DeviceC(config-GigabitEthernet 0/2)# ip address 10.10.2.1 255.255.255.0
DeviceC(config-GigabitEthernet 0/2)# exit
```

Create a VRF named **Server**, add the interface G0/3 directly connected to Server to the VRF **Server**.

```
DeviceC(config)# ip vrf Server
DeviceC(config-vrf)# rd 100:3
DeviceC(config-vrf)# route-target import 100:1
DeviceC(config-vrf)# route-target import 100:2
DeviceC(config-vrf)# route-target export 100:3
DeviceC(config-vrf)# exit
DeviceC(config)# interface gigabitethernet 0/3
DeviceC(config-GigabitEthernet 0/3)# ip vrf forwarding Server
DeviceC(config-GigabitEthernet 0/3)# ip address 10.10.3.1 255.255.255.0
DeviceC(config-GigabitEthernet 0/3)# exit
```

(3) Enable the routing protocol.

Enable the routing protocol on Device A.

```
DeviceA> enable
DeviceA# configure terminal
DeviceA(config)# router rip
DeviceA(config-router)# version 2
DeviceA(config-router)# no auto-summary
DeviceA(config-router)# network 10.10.1.0 0.0.0.255
```

Enable the routing protocol on Device B.

```
DeviceB> enable
DeviceB# configure terminal
DeviceB(config)# router ospf 1
DeviceB(config-router)# network 10.10.2.0 0.0.0.255 area 0
```

Enable the routing protocol on Device C.

```
DeviceC(config)# router rip
DeviceC(config-router)# address-family ipv4 vrf Suba
DeviceC(config-router-af)# version 2
DeviceC(config-router-af)# no auto-summary
DeviceC(config-router-af)# network 10.10.1.0 0.0.0.255
DeviceC(config-router-af)# exit-address-family
DeviceC(config-router)# exit
DeviceC(config)# router ospf 2 vrf Subb
DeviceC(config-router)# network 10.10.2.0 0.0.0.255 area 0
```

```
DeviceC(config-router)# exit
```

#### (4) Import routes to VRFs.

Import routes to VRFs on Device C.

```
DeviceC> enable
DeviceC# configure terminal
DeviceC(config)# router bgp 200
DeviceC(config-router)# address-family ipv4 vrf Suba
DeviceC(config-router-af)# redistribute rip
DeviceC(config-router-af)# exit-address-family
DeviceC(config-router)# address-family ipv4 vrf Subb
DeviceC(config-router-af)# redistribute ospf 2
DeviceC(config-router-af)# exit-address-family
DeviceC(config-router)# address-family ipv4 vrf Server
DeviceC(config-router-af)# redistribute connected
DeviceC(config-router-af)# exit-address-family
DeviceC(config-router)# exit
```

## 5. Verification

Verify the information of interfaces added to VRFs on Device C.

```
DeviceC> enable
DeviceC# show ip vrf interfaces
Interface                IP-Address  VRF      Protocol
GigabitEthernet 0/1     10.10.1.1  Suba     up
GigabitEthernet 0/2     10.10.2.1  Subb     up
GigabitEthernet 0/3     10.10.3.1  Server   up
```

Verify that the routes in **Suba** are separated from those in **Subb**, and routes of **Server** are shared on Device C.

```
DeviceC# show ip route vrf Suba
Routing Table: Suba

Codes: C - connected, S - static, R - RIP, B - BGP
        O - OSPF, IA - OSPF inter area
        N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
        E1 - OSPF external type 1, E2 - OSPF external type 2
        i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
        ia - IS-IS inter area, * - candidate default

Gateway of last resort is no set
C    10.10.1.0/24 is directly connected, GigabitEthernet 0/1
C    10.10.1.1/32 is local host.
B    10.10.3.0/24 [20/0] via 0.0.0.0, 00:01:21, GigabitEthernet 0/3

DeviceC# show ip route vrf Subb
Routing Table: Subb
```

```

Codes: C - connected, S - static, R - RIP, B - BGP
       O - OSPF, IA - OSPF inter area

       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
       ia - IS-IS inter area, * - candidate default

Gateway of last resort is no set
C    10.10.2.0/24 is directly connected, GigabitEthernet 0/2
C    10.10.2.1/32 is local host.
B    10.10.3.0/24 [20/0] via 0.0.0.0, 00:04:03, GigabitEthernet 0/3

DeviceC# show ip route vrf Server
Routing Table: Server

Codes: C - connected, S - static, R - RIP, B - BGP
       O - OSPF, IA - OSPF inter area

       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
       ia - IS-IS inter area, * - candidate default

Gateway of last resort is no set
B    10.10.1.0/24 [20/1] via 0.0.0.0, 03:00:15, GigabitEthernet 0/1
B    10.10.2.0/24 [20/1] via 0.0.0.0, 00:00:14, GigabitEthernet 0/2
C    10.10.3.0/24 is directly connected, GigabitEthernet 0/3
C    10.10.3.1/32 is local host.

```

## 6. Configuration Files

### Device A configuration file

```

hostname DeviceA
!
interface GigabitEthernet 0/1
 no switchport
 ip address 10.10.1.2 255.255.255.0
!
router rip
 version 2
 network 10.10.1.0 0.0.0.255
 no auto-summary
!

```

### Device B configuration file

```

hostname DeviceB
!
interface GigabitEthernet 0/2

```

```
no switchport
ip address 10.10.2.2 255.255.255.0
!
router ospf 2
network 10.10.2.0 0.0.0.255 area 0
!
```

**Device C configuration file**

```
hostname DeviceC
!
ip vrf Server
rd 100:3
route-target export 100:3
route-target import 100:2
route-target import 100:1
!
ip vrf Suba
rd 100:1
route-target export 100:1
route-target import 100:3
!
ip vrf Subb
rd 100:2
route-target export 100:2
route-target import 100:3
!
interface GigabitEthernet 0/1
no switchport
ip vrf forwarding Suba
ip address 10.10.1.1 255.255.255.0
!
interface GigabitEthernet 0/2
no switchport
ip vrf forwarding Subb
ip address 10.10.2.1 255.255.255.0
!
interface GigabitEthernet 0/3
no switchport
ip vrf forwarding Server
ip address 10.10.3.1 255.255.255.0
!
router bgp 200
address-family ipv4 vrf Suba
redistribute rip
exit-address-family
!
address-family ipv4 vrf Subb
```

```
redistribute ospf 2 match internal
exit-address-family
!
address-family ipv4 vrf Server
redistribute connected
exit-address-family
!
router ospf 2 vrf Subb
network 10.10.2.0 0.0.0.255 area 0
!
router rip
address-family ipv4 vrf Suba
version 2
network 10.10.1.0 0.0.0.255
no auto-summary
exit-address-family
!
```

#### Server configuration file

```
hostname Server
!
interface GigabitEthernet 0/3
no switchport
ip address 10.10.3.2 255.255.255.0
!
```

## 7. Common Errors

- An interface is added to a VRF after the IP address of the interface is configured. In this case, the IP address of the interface is deleted.
- When a physical link is shared by multiple VPNs, the physical interface is added to a VRF.
- VPN routes are not introduced to BGP.