VRF-Aware Cisco IOS XE Firewall

Last Updated: January 20, 2012

The VRF-Aware Cisco IOS XE Firewall applies the Cisco IOS XE Firewall functionality to VPN Routing and Forwarding (VRF) interfaces when the firewall is configured on a service provider (SP) or large enterprise edge routers. SPs provide managed services to small and medium business markets.

The VRF-Aware Cisco IOS XE Firewall supports VRF-lite (also known as Multi-VRF CE) and Application Inspection and Control (AIC) for various protocols.

Note Cisco IOS XE Releases do not support Context-Based Access Control (CBAC) firewalls.

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest feature information and caveats, see the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the Feature Information Table at the end of this document.

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

Americas Headquarters:
Cisco Systems, Inc., 170 West Tasman Drive, San Jose, CA 95134-1706 USA

Prerequisites for VRF-Aware Cisco IOS XE Firewall

- Understand Cisco IOS XE firewalls.
- Configure VRFs.

Restrictions for VRF-Aware Cisco IOS XE Firewall

- If two VPN networks have overlapping addresses, VRF-aware Network Address Translation (NAT) is required for them to support VRF-aware firewalls. NAT does not support inter-VRF routing. You can use the VRF-aware software infrastructure (VASI) for the inter-VRF routing functionality.
- When crypto tunnels that belong to multiple VPNs terminate on a single interface, you cannot apply per-VRF firewall policies.
- The same zone cannot be applied to interfaces that are configured on different VRFs.

Information About VRF-Aware Cisco IOS XE Firewall

VRF-Aware Cisco IOS XE Firewall

A VRF-aware firewall inspects IP packets that are sent or received within a VRF. VRF allows multiple instances of routing tables to coexist within a single router. This allows VPN segregation and the ability to have independent overlapping of IP address spaces. VRF allows traffic from the customers of one service provider to be isolated from another. The Cisco IOS XE VRF support splits the router into multiple routing domains, with each routing domain consisting of its own set of interfaces and routing and forwarding tables. Each routing domain is referenced by a unique identifier called the table ID. The global routing domain and the default routing domain (that is not associated with any VRF) is addressed with the table ID, zero. VRF supports overlapping of IP address space, thereby allowing the traffic from nonintersecting VRFs to have the same IP address.

The VRF-Aware Cisco IOS XE Firewall provides the following benefits:

- Scalable deployment—Scales to meet any network’s bandwidth and performance requirements.

- VPN support—Provides a complete VPN solution based on Cisco IOS XE IPsec and other software-based technologies, including Layer 2 Tunneling Protocol (L2TP) tunneling, and quality of service (QoS).
- AIC support—Provides policy maps for the Internet Message Access Protocol (IMAP), Post Office Protocol 3 (POP3), Simple Mail Transfer Protocol (SMTP), and Sun Remote Procedure Call (SUN RPC)
- Allows users to configure a per-VRF firewall. The firewall inspects IP packets that are sent and received within a VRF. The firewall also inspects traffic between two different VRFs (intersecting VRFs).
- Allows SPs to deploy the firewall on the provider edge (PE) router.
- Supports overlapping IP address space, thereby allowing traffic from nonintersecting VRFs to have the same IP address.
- Supports VRF (not global) firewall command parameters and Denial-of-Service (DoS) parameters so that the VRF-aware firewall can run as multiple instances (with VRF instances) that are allocated to various VPN customers.
- Generates high-speed logging (HSL) messages that contain the VRF ID; however these messages are collected by a single collector.

The VRF-aware firewall allows you to limit the number of firewall sessions. If the firewall sessions are not limited, it would be difficult for VRFs to share router resources because one VRF may consume a maximum amount of resources, leaving few resources for other VRFs and thereby causing the denial of service to other VRFs.

Address Space Overlap

A VRF splits the router into multiple routing domains. Each of these routing domains contain their own set of interfaces and routing tables. A routing table is referenced by using a per-VRF unique table ID. Zero is the default global routing table ID that is not associated with a VRF.

Nonintersecting VRFs are allowed to have overlapping address spaces (that is, the IP address of one VRF may be contained in others).

VRF

VRF allows multiple instances of routing tables to coexit within a single router. A VRF contains a template of a VRF table in a PE router.

The overlapping addresses, usually resulting from the use of private IP addresses in customer networks, are one of the major obstacles to the successful deployment of a peer-to-peer VPN implementation. You can use the MPLS VPN technology to overcome the overlapping addresses issue.

Each VPN has its own routing and forwarding table in the router so that any customer or site that belongs to a VPN is provided access only to the set of routes contained within that table. Any PE router in the MPLS VPN network therefore contains a number of per-VPN routing tables and a global routing table that is used to reach other routers in the service provider network. Effectively, a number of virtual routers are created in a single physical router.

VRF-Lite

The VRF-Lite Aware Firewall feature, also called the VRF without MPLS-aware firewall, allows a firewall zone to be applied to non-MPLS-enabled VRF interfaces.

The VRF-Lite Aware Firewall feature enables a service provider to support two or more VPNs, in which 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 physical, such as Ethernet ports, or logical, such as VLAN switched virtual interfaces (SVIs). However, a Layer 3 interface cannot belong to more than one VRF at a time.

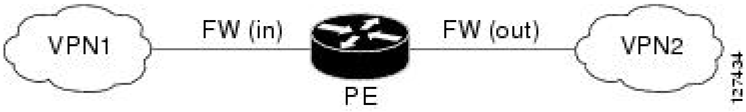
Note All VRF-lite interfaces must be Layer 3 interfaces.

VRF-lite includes the following devices:

- Customer edge (CE) devices provide customers access to the service provider network over a data link. The CE device advertises the site’s local routes to the PE router and learns about the remote VPN routes from the PE router.
- PE routers exchange routing information with CE devices by using static routing or a routing protocol such as Border Gateway Protocol (BGP), Routing Information Protocol Version 1 (RIPv1), or RIPv2.
- Provider routers (or core routers) are any routers in the service provider network that are not attached to CE devices.
- A PE router is only required to maintain VPN routes for those VPNs to which it is directly attached, eliminating the need for the PE router to maintain all the service provider VPN routes. Each PE router maintains a VRF for each of its directly connected sites. Multiple interfaces on a PE router can be associated with a single VRF, if all of these sites are part of the same VPN. Each VPN is mapped to a specified VRF. After learning local VPN routes from CE routers, a PE router exchanges VPN routing information with other PE routers by using internal BGP (iBPG).

With VRF-lite, multiple customers can share one CE router, and only one physical link is used between the CE router and the PE router. The shared CE router maintains a separate VRF table for each customer, and switches or routes packets for each customer based on its own routing table. VRF-lite extends the limited PE router 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.

Figure 1 ***Firewall in a VRF-to-VRF Scenario***



MPLS VPN

The MPLS VPN feature allows multiple sites to interconnect transparently through a service provider network. One service provider network can support several IP VPNs. Each VPN appears to its users as a private network, separate from all other networks. Within a VPN, each site can send IP packets to any other site in the same VPN.

Each VPN is associated with one or more VPN VRF instances. A VRF consists of an IP routing table, a derived Cisco Express Forwarding table, and a set of interfaces that use the forwarding table.

The router maintains a separate routing and Cisco Express Forwarding tables for each VRF. This prevents information from being sent outside the VPN and allows the same subnet to be used in several VPNs without causing duplicate IP address problems.

The router using Multiprotocol BGP (MP-BGP) distributes the VPN routing information using the MP-BGP extended communities.

VRF-Aware NAT

Network Address Translation (NAT) allows a single device, such as a router, to act as an agent between the Internet (or public network) and a local (or private) network. Although NAT systems can provide broad levels of security advantages, their main objective is to economize on address space.

NAT allows organizations to resolve the problem of IP address depletion when they have existing networks and need to access the Internet. Sites that do not possess Network Information Center (NIC)-registered IP addresses must acquire them. Cisco IOS XE NAT eliminates the concern of NIC-registered IP addresses by dynamically mapping thousands of hidden internal addresses to a range of easy-to-get addresses.

A NAT system makes it difficult for an attacker to determine the following:

- The number of systems running on a network.
- Type of machines and operating systems running on the network.
- Network topology and arrangement.

NAT integration with Multiprotocol Label Switching (MPLS) VPNs allows multiple MPLS VPNs to be configured on a single device to work together. NAT can differentiate the MPLS VPNs from which it receives the IP traffic, even if all the MPLS VPNs use the same IP addressing scheme. This enables multiple MPLS VPN customers to share services while ensuring that each MPLS VPN is completely separate from the other.

To provide value-added services, such as, Internet connectivity, domain name servers (DNS), and VoIP service to customers, the MPLS service providers must use NAT. NAT helps the MPLS VPN customers to use overlapped IP addresses in their network.

NAT can be implemented on a customer edge (CE) router or on a provider edge (PE) router. The NAT integration with the MPLS VPNs feature enables the implementation of NAT on a PE router in an MPLS cloud.

VRF-Aware ALG

An application-layer gateway (ALG) is an application that translates the IP address information inside the payload of an application packet. The ALGs identify the address information in the packet payload that needs to be overwritten by NAT and supply the address information to NAT and firewall to create subordinate flows or doors to allow data to flow properly (an example of data flow is FTP data flow. Doors are transient structures that allow incoming traffic that matches a specific criterion. A door is created when there is not enough information to create a complete NAT session entry. A door contains information about the source and destination IP address and the destination port. However, it does not have information about the source port. When media data arrives, the source port information is known and the door is promoted to a real NAT session.

VRF-Aware IPsec

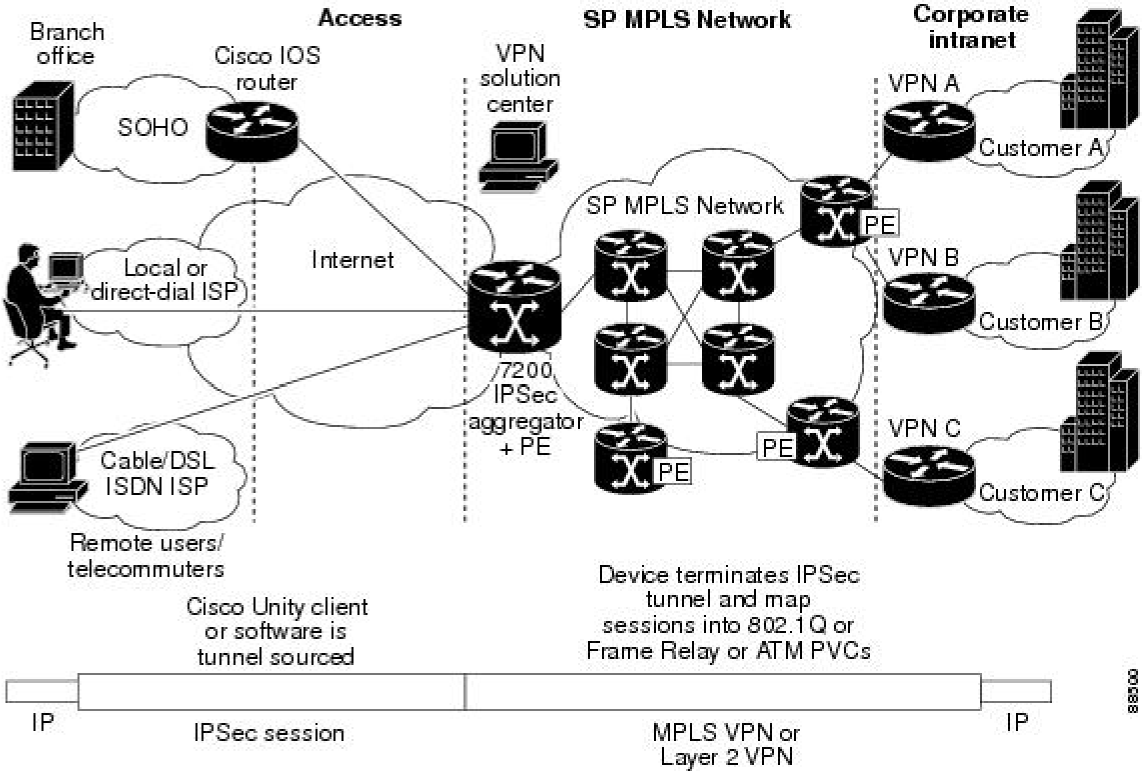
The VRF-Aware IPsec feature maps an IPsec tunnel to an MPLS VPN. Using the VRF-Aware IPsec feature, you can map IPsec tunnels to VRF instances using a single public-facing IP address.

Each IPsec tunnel is associated with two VRF domains. The outer encapsulated packet belongs to a VRF domain called the Front Door VRF (FVRF). The inner, protected IP packet belongs to a domain called the Inside VRF (IVRF). In other words, the local endpoint of the IPsec tunnel belongs to the FVRF, whereas the source and destination addresses of the inside packet belong to the IVRF.

One or more IPsec tunnels can terminate on a single interface. The FVRF of all these tunnels is the same and is set to the VRF that is configured on that interface. The IVRF of these tunnels can be different and depends on the VRF that is defined in the Internet Security Association and Key Management Protocol (ISAKMP) profile that is attached to a crypto map entry.

The figure below illustrates a scenario showing IPsec to MPLS and Layer 2 VPNs.

Figure 2 IPsec-to-MPLS and Layer 2 VPNs



VRF-Aware Software Infrastructure

The VRF-Aware Software Infrastructure (VASI) allows you to apply services such as access control lists (ACLs), NAT, policing, and zone-based firewalls to traffic that is flowing across two different VRF instances. The VASI interfaces support redundancy of the Route Processor (RP) and Forwarding Processor (FP). This feature supports IPv4 and IPv6 unicast traffic on VASI interfaces.

The primary use of VASI is to allow better isolation of VRFs. The VASI allows for per-VRF-specific features to be applied to the VASI interface without any impact to other VRFs that may share a common interface (for example, all VRFs may share the same interface to the Internet). For the firewall, this feature allows zones to be applied to the VASI.

VASI is implemented by using virtual interface pairs, where each of the interfaces in the pair is associated with a different VRF. The VASI virtual interface is the next hop interface for any packet that needs to be switched between these two VRFs. VASI interfaces provide the framework necessary to support NAT between two VRFs.

Each interface pair is associated with two different VRF instances. The two virtual interfaces, called vasileft and vasiright, in a pair are logically wired back-to-back and are completely symmetrical. Each interface has an index. The association of the pairing is done automatically based on the two interface indexes such that vasileft automatically gets paired to vasiright. You can configure either static routing or dynamic routing with BGP, Enhanced Interior Gateway Routing Protocol (EIGRP), or Open Shortest Path

First (OSPF). BGP dynamic routing protocol restrictions and configuration are valid for BGP routing configurations between VASI interfaces. For more information on VASI, see the "Configuring the VRF-Aware Software Infrastructure" feature.

Security Zones

A security zone is a group of interfaces to which a policy can be applied.

Grouping interfaces into zones involves two procedures:

- Creating a zone so that interfaces can be attached to it.
- Configuring an interface to be a member of a given zone.

By default, traffic flows among interfaces that are members of the same zone.

When an interface is a member of a security zone, all traffic (except traffic going to the router or initiated by the router) between that interface and an interface within a different zone is dropped by default. To permit traffic to and from a zone-member interface and another interface, you must make that zone part of a zone pair and apply a policy to that zone pair. If the policy permits traffic (through **inspect** or **pass** actions), traffic can flow through the interface.

Basic rules to consider when setting up zones are as follows:

- Traffic from a zone interface to a nonzone interface or from a nonzone interface to a zone interface is always dropped; unless default zones are enabled (default zone is a nonzone interface).
- Traffic between two zone interfaces is inspected if there is a zone-pair relationship for each zone and if there is a configured policy for that zone pair.
- By default, all traffic between two interfaces in the same zone is always allowed.
- A zone pair can be configured with a zone as both the source and the destination zones. An inspect policy can be configured on this zone pair to inspect or drop the traffic between two interfaces in the same zone.

A policy is applied to the initiating packet of a traffic flow. After the initial packet has been classified and permitted, traffic flows between peers with no further reclassification of the packet (this means that bidirectional traffic flow is allowed after the initial classification). If you have a zone pair between Zone Z1 and Zone Z2, and no zone pair between Zone Z2 and Zone Z1, all traffic that is initiated from Zone Z2 is blocked. Traffic from Zone Z1 to Zone Z2 is permitted or denied based on the zone pair policy.

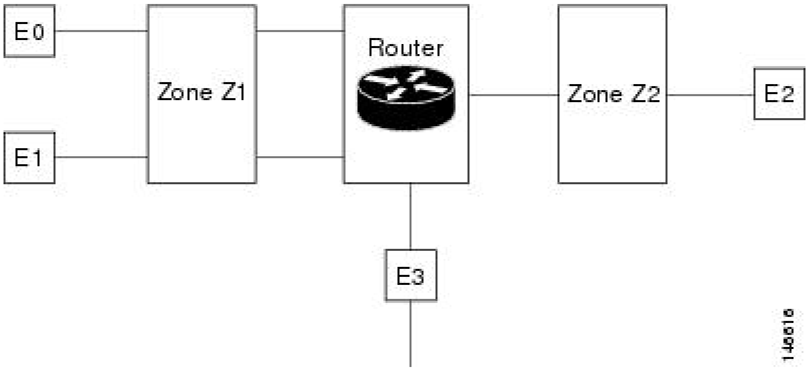
For traffic to flow among all the interfaces in a router, all interfaces must be members of security zones or the default zone.

It is not necessary for all router interfaces to be members of security zones.

The figure below illustrates the following:

- Interfaces E0 and E1 are members of security zone Z1.
- Interface E2 is a member of security zone Z2.
- Interface E3 is not a member of any security zone.

Figure 3 Security Zone Restrictions



The following situations exist:

- The zone pair and policy are configured in the same zone. If no policy is configured for Z1 and Z2, traffic will flow freely between E0 and E1, but not between E0 or E1 to E2. A zone pair and policy may be created to inspect this traffic.
- If no policies are configured, traffic will not flow between any other interfaces (for example, E0 and E2, E1 and E2, E3 and E1, and E3 and E2).
- Traffic can flow between E0 or E1 and E2 only when an explicit policy permitting traffic is configured between zone Z1 and zone Z2.
- Traffic can never flow between E3 and E0/E1/E2 unless default zones are enabled and a zone-pair is created between the default zone and the other zones.

VRF-Aware Cisco IOS XE Firewall Deployment

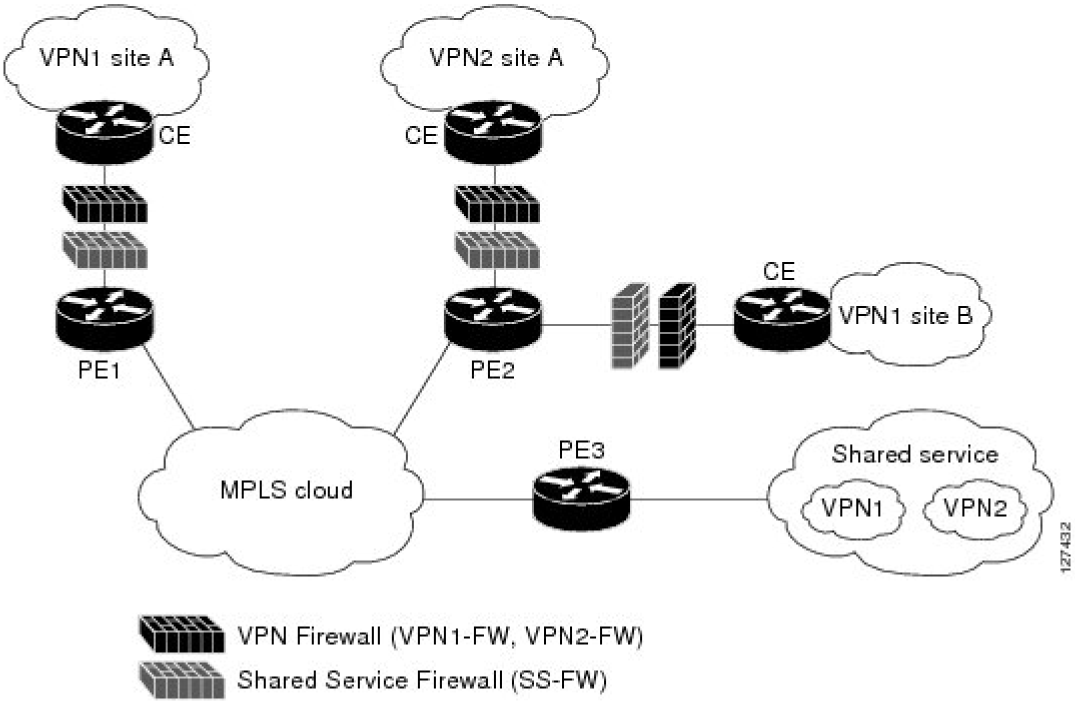
A firewall can be deployed at many points within the network to protect VPN sites from shared service (or the Internet) and vice versa. This section describes the following firewall deployment scenarios:

- Distributed Network Inclusion of VRF-Aware Cisco IOS XE Firewall, page 8
- Hub-and-Spoke Network Inclusion of VRF-Aware Cisco IOS XE Firewall, page 9

Distributed Network Inclusion of VRF-Aware Cisco IOS XE Firewall

The figure below illustrates a typical situation in which an SP offers firewall services to VPN customers VPN1 and VPN2, thereby protecting VPN sites from the external network (for example, shared services and the Internet) and vice versa.

Figure 4 Distributed Network



In this example, VPN1 has two sites, Site A and Site B, that span across the MPLS core. Site A is connected to PE1, and Site B is connected to PE2. VPN2 has only one site that is connected to PE2. Each VPN has a VLAN segment in the shared service that is connected to the corresponding VLAN subinterface on PE3.

Each of the VPNs (VPN1 and VPN2) has two firewall rules--one to protect the VPN site from the shared service and another to protect the shared service from the VPN site. The firewall that protects the VPN site from the shared service is called the VPN firewall, and the firewall that protects the shared service from the VPN site is called the Shared Service firewall. Both the firewall rules are applied on the VRF interface of each ingress PE that is connected to the VPN site. The VPN firewall rule is applied in the ingress direction, because the VRF interface is ingress to the VPN site; and the Shared Service Firewall rule is applied in the egress direction, because the VRF interface is egress to the shared service.

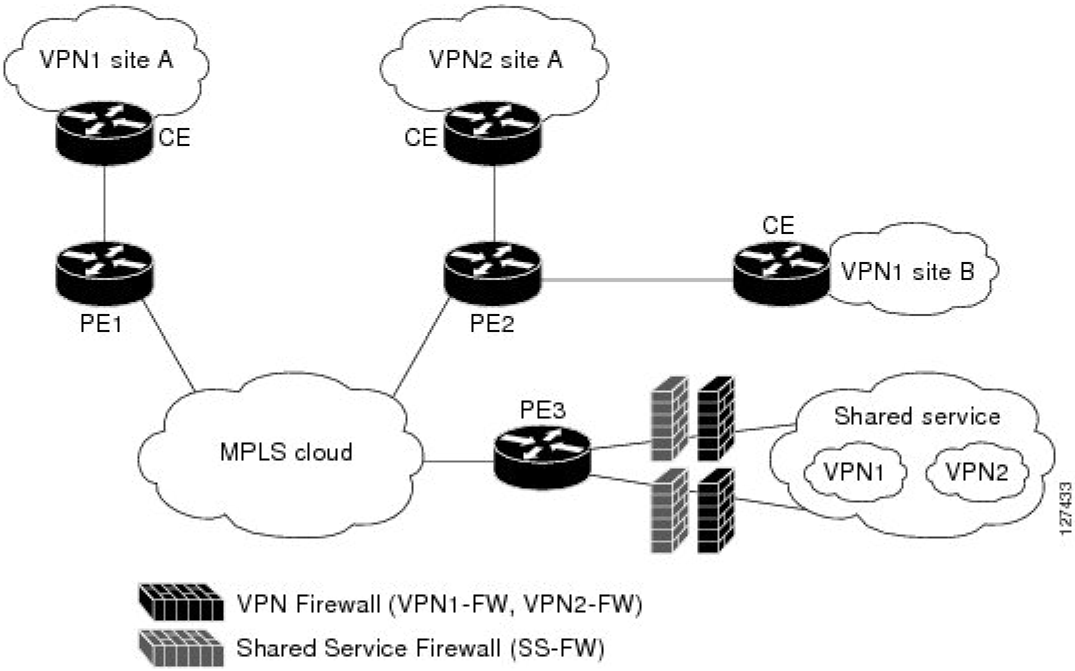
The benefits of using a distributed network are as follows:

- Because the firewall deployment is distributed across an MPLS cloud, the firewall processing load is distributed to all ingress PEs.
- The shared service is protected from VPN sites at the ingress PE, and hence malicious packets from VPN sites will be filtered at the ingress PE before they enter the MPLS cloud.
- VPN firewall features can be deployed in the ingress direction.

Hub-and-Spoke Network Inclusion of VRF-Aware Cisco IOS XE Firewall

The figure below illustrates a hub-and-spoke network where the firewalls for all VPN sites are applied on the egress PE router, PE3, which is connected to the shared service.

Figure 5 Hub-and-Spoke Network



Typically, each VPN has a VLAN and/or a VRF subinterface that is connected to the shared service. When a packet arrives at an MPLS interface, MPLS routes the packet to the corresponding subinterface that is connected to the shared service. The firewall policies on each VPN are applied on the corresponding subinterface (VRF interface) as shown in the above figure. The VPN firewall rule is applied in the egress direction because the subinterface is egress to the VPN site. And the Shared Service firewall rule is applied in the ingress direction because the subinterface is ingress to the shared service.

The benefits of a hub-and-spoke network are as follows:

- Because the firewall deployment is centralized to the egress PE (PE3), deploying and managing the firewall is easy.
- The Shared Service firewall features can be applied in the ingress direction.
- The VPN site is protected from the shared service at the egress PE, and hence malicious packets from the shared service are filtered at the PE before they enter the MPLS cloud.

How to Configure VRF-Aware Cisco IOS XE Firewall

Defining VRFs, Class Maps, and Policy Maps

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ip vrf** *vrf-name*
4. **rd** *route-distinguisher*
5. **route-target export** *route-target-ext-community*
6. **route-target import** *route-target-ext-community*
7. **exit**
8. **class-map type inspect match-any** *class-map-name*
9. **match protocol tcp**
10. **match protocol h323**
11. **exit**
12. **policy-map type inspect** *policy-map-name*
13. **class type inspect** *class-map-name*
14. **inspect** [*parameter-map-name*]
15. **exit**
16. **class class-default**
17. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**ip vrf** *vrf-name* **Example:** `Router(config)# ip vrf vrf1`	Defines a VRF instance and to enter VRF configuration mode.
Step 4	**rd** *route-distinguisher* **Example:** `Router(config-vrf)# rd 10:1`	Specifies a route distinguisher (RD) for a VRF instance.
Step 5	**route-target export** *route-target-ext-community* **Example:** `Router(config-vrf)# route-target export 10:1`	Creates a route-target extended community for a VRF instance and exports routing information to the target VPN extended community.
Step 6	**route-target import** *route-target-ext-community* **Example:** `Router(config-vrf)# route-target import 10:1`	Creates a route-target extended community for a VRF instance and imports routing information to the target VPN extended community.
Step 7	**exit** **Example:** `Router(config-vrf)# exit`	Exits VRF configuration mode and enters global configuration mode.
Step 8	**class-map type inspect match-any** *class-map-name* **Example:** `Router(config)# class-map type inspect match-any class-map1`	Creates a Layer 3 and Layer 4 (application-specific) inspect type class map and enters class-map configuration mode.

	Command or Action	Purpose
Step 9	**match protocol tcp** **Example:** `Router(config-cmap)# match protocol tcp`	Configures the match criterion for a class map on the basis of the specified protocol.
Step 10	**match protocol h323** **Example:** `Router(config-cmap)# match protocol h323`	Configures the match criterion for a class map on the basis of the specified protocol.
Step 11	**exit** **Example:** `Router(config-cmap)# exit`	Exits class-map configuration mode and enters global configuration mode.
Step 12	**policy-map type inspect** *policy-map-name* **Example:** `Router(config)# policy-map type inspect global-vpn1-pmap`	Creates a Layer 3 and Layer 4 (protocol-specific) inspect type policy map and enters policy-map configuration mode.

Step 13	**class type inspect** *class-map-name*
	Example:
	`Router(config-pmap)# class type inspect class-map1`
		Specifies the traffic (class) on which an action is to be performed and enters policy-map-class configuration mode.

Step 14	**inspect** [*parameter-map-name*] **Example:** `Router(config-pmap-c)# inspect class-map1`	Enables Cisco IOS XE stateful packet inspection.
Step 15	**exit** **Example:** `Router(config-pmap-c)# exit`	Exits policy-map-class configuration mode and enters policy-map configuration mode.

Step 16	**class class-default**
	Example:
	`Router(config-pmap)# class class-default`
		Specifies the default class so that you can configure or modify its policy.
		• The class-default class is defined by default. Configure the **class class-default** command to change the default drop attribute that is associated with the class-default.

	Command or Action	Purpose

Step 17	**end**
	Example:
	`Router(config-pmap)# end`
		Exits policy-map configuration mode and enters global configuration mode.

Defining Zones and Zone Pairs

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **zone security** *security-zone-name*
4. **exit**
5. **zone security** *security-zone-name*
6. **exit**
7. **zone-pair security** *zone-pair-name* **source** *source-zone* **destination** *destination-zone*
8. **service-policy type inspect** *policy-map-name*
9. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**zone security** *security-zone-name* **Example:** `Router(config)# zone security vpn1-zone`	Creates a security zone and enters security zone configuration mode.

	Command or Action	Purpose
Step 4	**exit** **Example:** `Router(config-sec-zone)# exit`	Exits security zone configuration mode and enters global configuration mode.
Step 5	**zone security** *security-zone-name* **Example:** `Router(config)# zone security global-zone`	Creates a security zone and enters security zone configuration mode.
Step 6	**exit** **Example:** `Router(config-sec-zone)# exit`	Exits security zone configuration mode and enters global configuration mode.
Step 7	**zone-pair security** *zone-pair-name* **source** *source-zone* **destination** *destination-zone* **Example:** `Router(config)# zone-pair security vpn1-global-zone-pair source vpn1-zone destination global-zone`	Creates a zone pair and enters security zone-pair configuration mode. • *zone-pair-name*--Name of the zone being attached to an interface. • **source** *source-zone*--Specifies the name of the router from which traffic is originating. • **destination** *destination-zone*--Specifies the name of the router to which traffic is bound.
Step 8	**service-policy type inspect** *policy-map-name* **Example:** `Router(config-sec-zone-pair)# service-policy type inspect global-vpn1-pmap`	Attaches a Layer 7 policy map to a top-level policy map.

Step 9	**end**
	Example:
	`Router(config-sec-zone-pair)# end`
		Exits zone-pair configuration mode and enters privileged EXEC mode.

Applying Zones to Interfaces and Defining Routes

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **interface** *type number*
4. **ip vrf forwarding** *name*
5. **ip address** *ip-address mask*
6. **zone-member security** *zone-name*
7. **negotiation auto**
8. **exit**
9. **interface** *type number*
10. **ip address** *ip-address mask*
11. **zone-member security** *zone-name*
12. **negotiation auto**
13. **exit**
14. **ip route vrf** *vrf-name destination-ip-address destination-prefix interface-type number* [**global**]
15. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**interface** *type number* **Example:** `Router(config)# interface gigabitethernet 0/0/0`	Configures an interface and enters interface configuration mode.
Step 4	**ip vrf forwarding** *name* **Example:** `Router(config-if)# ip vrf forwarding vrf1`	Associates a VRF with an interface or subinterface.

	Command or Action	Purpose
Step 5	**ip address** *ip-address mask* **Example:** `Router(config-if)# ip address 10.1.1.1 255.255.255.0`	Sets a primary or secondary IP address for an interface.
Step 6	**zone-member security** *zone-name* **Example:** `Router(config-if)# zone-member security  vpn1-zone`	Attaches an interface to a security zone.
Step 7	**negotiation auto** **Example:** `Router(config-if)# negotiation auto`	Enables the autonegotiation protocol to configure the speed, duplex, and automatic flow control of the Gigabit Ethernet interface.
Step 8	**exit** **Example:** `Router(config-if)# exit`	Exits interface configuration mode and enters global configuration mode.
Step 9	**interface** *type number* **Example:** `Router(config)# interface gigabitethernet 1/1/1`	Configures an interface and enters interface configuration mode.
Step 10	**ip address** *ip-address mask* **Example:** `Router(config-if)# ip address 10.111.111.111 255.255.255.0`	Sets a primary or secondary IP address for an interface.
Step 11	**zone-member security** *zone-name* **Example:** `Router(config-if)# zone-member security global-zone`	Attaches an interface to a security zone.
Step 12	**negotiation auto** **Example:** `Router(config-if)# negotiation auto`	Enables the autonegotiation protocol to configure the speed, duplex, and automatic flow control of the Gigabit Ethernet interface.

	Command or Action	Purpose
Step 13	**exit** **Example:** `Router(config-if)# exit`	Exits interface configuration mode and enters global configuration mode.
Step 14	**ip route vrf** *vrf-name destination-ip-address destination-prefix interface-type number* [**global**] **Example:** `Router(config)# ip route vrf vpn1 10.111.111.0 255.255.255.0 gigabitethernet 1/1/1 global`	Establishes static routes for a VRF instance.

Step 15	**end**
	Example:
	`Router(config)# end`
		Exits global configuration mode and enters privileged EXEC mode.

Configuration Examples for VRF-Aware Cisco IOS XE Firewall

- Example: Defining VRFs, Class Maps, and Policy Maps, page 17
- Example: Defining Policy Maps, Zones, and Zone Pairs, page 17
- Example: Applying Zones to Interfaces and Defining Routes, page 18

Example: Defining VRFs, Class Maps, and Policy Maps

```
Router# configure terminal
Router(config)# ip vrf vrf1
Router(config-vrf)# rd 10:1
Router(config-vrf)# route-target export 10:1
Router(config-vrf)# route-target import 10:1
Router(config-vrf)# exit
Router(config)# class-map type inspect match-any class-map1
Router(config-cmap)# match protocol tcp
Router(config-cmap)# match protocol h323
Router(config-cmap)# exit
Router(config)# policy-map type inspect global-vpn1-pmap
Router(config-pmap)# class type inspect match-acl-111
Router(config-pmap-c)# inspect match-acl-111
Router(config-pmap-c)# exit
Router(config-pmap)# class class-default
Router(config-pmap)# end
```

Example: Defining Policy Maps, Zones, and Zone Pairs

```
Router# configure terminal
Router(config)# zone security vpn1-zone
Router(config-sec-zone)# exit
Router(config)# zone security global-zone
Router(config-sec-zone)# exit
Router(config)# zone-pair security vpn1-global-zone-pair source vpn1-zone destination
global-zone
Router(config-sec-zone-pair)# service-policy type inspect vpn1-global-pmap
Router(config-sec-zone-pair)# end
```

Example: Applying Zones to Interfaces and Defining Routes

```
Router# configure terminal
Router(config)# interface gigabitethernet 0/0/0
Router(config-if)# ip vrf forwarding vrf1
Router(config-if)# ip address 10.1.1.1 255.255.255.0
Router(config-if)# zone-member security vpn1-zone
Router(config-if)# negotiation auto
Router(config-if)# exit
Router(config)# interface gigabitethernet 1/1/1
Router(config-if)# ip address 10.111.111.111 255.255.255.0
Router(config-if)# zone-member security global-zone
Router(config-if)# negotiation auto
Router(config-if)# exit
Router(config)# ip route vrf vpn1 10.111.111.0 255.255.255.0 gigabitethernet 1/1/1 global
Router(config)# end
```

Additional References

Related Documents

Related Topic	Document Title
Cisco IOS commands	*Cisco IOS Master Commands List, All Releases*
Security commands	• *Cisco IOS Security Command Reference Commands A to C* • *Cisco IOS Security Command Reference Commands D to L* • *Cisco IOS Security Command Reference Commands M to R* • *Cisco IOS Security Command Reference Commands S to Z*
NAT	*Configuring Network Address Translation: Getting Started*
MPLS VPN	*Configuring a Basic MPLS VPN*
Zone-based Policy Firewall	*Zone-based Policy Firewall*

Standards and RFCs

Standard/RFC	Title
No new or modified standards or RFCs are supported, and support for existing standards has not been modified.	--

MIBs

MIBs	MIBs Link
No new or modified MIBs are supported, and support for existing MIBs has not been modified.	To locate and download MIBs for selected platforms, Cisco IOS XE software releases, and feature sets, use Cisco MIB Locator found at the following URL: http://www.cisco.com/go/mibs

Technical Assistance

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

Feature Information for VRF-Aware Cisco IOS XE Firewall

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

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

Table 1 Feature Information for VRF-Aware Cisco IOS XE Firewall

Feature Name	Releases	Feature Information
VRF-Aware Cisco IOS XE Firewall	Cisco IOS XE Release 2.5	The VRF-Aware Cisco IOS XE Firewall feature applies the Cisco IOS XE Firewall functionality to VRF interfaces when the firewall is configured on an SP or large enterprise edge router.

Feature Name	Releases	Feature Information
Firewall--VRF-Aware ALG Support	Cisco IOS XE Release 2.5	The Firewall--VRF-Aware ALG Support feature allows ALG to extract the correct IP address and VRF ID from cached information when creating ALG tokens that require correct IP address VRF ID pairs.

Glossary

CE router--customer edge router. A router that is part of a customer network and that interfaces to a provider edge router.

data authentication--Refers to one or both of the following: data integrity, which verifies that data has not been altered, or data origin authentication, which verifies that the data was actually sent by the claimed sender.

data confidentiality--A security service where the protected data cannot be observed.

edge router--A router that turns unlabeled packets into labeled packets, and vice versa.

firewall--A router or access server, or several routers or access servers, designated as a buffer between any connected public networks and a private network. A firewall router uses access lists and other methods to ensure the security of the private network.

IPsec--IP Security Protocol. A framework of open standards developed by the IETF. IPsec provides security for transmission of sensitive data over unprotected networks such as the Internet.

managed security services--A comprehensive set of programs that enhance service providers' abilities to meet the growing demands of their enterprise customers. Services based on Cisco solutions include managed firewall, managed VPN (network based and premises based), and managed intrusion detection.

NAT--Network Address Translation. Translates a private IP address used inside the corporation to a public, routable address for use outside of the corporation, such as the Internet. NAT is considered a one-to-one mapping of addresses from private to public.

PE router--provider edge router. A router that is part of a service provider's network and is connected to a customer edge (CE) router.

UDP--User Datagram Protocol. Connectionless transport layer protocol in the TCP/IP protocol stack. UDP is a simple protocol that exchanges datagrams without acknowledgments or guaranteed delivery, requiring that error processing and retransmission be handled by other protocols.

VPN--Virtual Private Network. Enables IP traffic to travel securely over a public TCP/IP network by encrypting all traffic from one network to another. A VPN uses "tunneling" to encrypt all information at the IP level.

vrf--A VPN routing and forwarding instance. A VRF consists of an IP routing table, a derived forwarding table, a set of interfaces that use the forwarding table, and a set of rules and routing protocols that determine what goes into the forwarding table. In general, a VRF includes the routing information that defines a customer VPN site that is attached to a provider edge (PE) router.

VRF table--A table that stores routing data for each VPN. The VRF table defines the VPN membership of a customer site attached to the network access server (NAS). Each VRF table comprises an IP routing table, a derived Cisco Express Forwarding table, and guidelines and routing protocol parameters that control the information that is included in the routing table.

Any Internet Protocol (IP) addresses and phone numbers used in this document are not intended to be actual addresses and phone numbers. Any examples, command display output, network topology diagrams, and other figures included in the document are shown for illustrative purposes only. Any use of actual IP addresses or phone numbers in illustrative content is unintentional and coincidental.