Security Configuration Guide: Zone-Based Policy Firewall Cisco IOS Release 12.4

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VRF Aware Cisco IOS Firewall

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

The VRF Aware Cisco IOS Firewall supports VRF-aware URL filtering and VRF-lite (also known as Multi-VRF CE).

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.

Prerequisites for VRF Aware Cisco IOS Firewall

- Understand Cisco IOS firewalls.
- Configure VRFs.
- Verify that the VRFs are operational.

Restrictions for VRF Aware Cisco IOS Firewall

- VRF Aware Cisco IOS Firewall is not supported on Multiprotocol Label Switching (MPLS) interfaces.

- If two VPN networks have overlapping addresses, VRF-aware network address translation (NAT) is required for them to support VRF-aware Firewalls.
- When crypto tunnels belonging to multiple VPNs terminate on a single interface, you cannot apply per-VRF firewall policies.

Information About VRF Aware Cisco IOS Firewall

Cisco IOS Firewall

The Cisco IOS Firewall provides robust, integrated firewall and intrusion detection functionality for every perimeter of the network. Available for a wide range of Cisco IOS software-based routers, the Cisco IOS Firewall offers sophisticated security and policy enforcement for connections within an organization (intranet) and between partner networks (extranets), as well as for securing Internet connectivity for remote and branch offices.

The Cisco IOS Firewall enhances existing Cisco IOS security capabilities such as authentication, encryption, and failover, with state-of-the-art security features such as stateful, application-based filtering (context-based access control), defense against network attacks, per-user authentication and authorization, and real-time alerts.

The Cisco IOS Firewall is configurable via Cisco ConfigMaker software, an easy-to-use Microsoft Windows 95, Windows 98, NT 4.0 based software tool.

The Cisco IOS Firewall provides great value in addition to these benefits:

- Flexibility--Provides multiprotocol routing, perimeter security, intrusion detection, VPN functionality, and dynamic per-user authentication and authorization.
- Scalable deployment--Scales to meet any network's bandwidth and performance requirements.
- Investment protection--Leverages existing multiprotocol router investment.
- VPN support--Provides a complete VPN solution based on Cisco IOS IPSec and other CISCO IOS software-based technologies, including L2TP tunneling and quality of service (QoS).

The VRF Aware Cisco IOS Firewall is different from the non-VRF Aware Firewall because it does the following:

- Allows users to configure a per-VRF Firewall. The firewall inspects IP packets that are sent and received within a VRF.
- 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 per-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) allocated to various Virtual Private Network (VPN) customers.
- Performs per-VRF URL filtering.
- Generates VRF-specific syslog messages that can be seen only by a particular VPN. These alert and audit-trail messages allow network administrators to manage the firewall; that is, they can adjust firewall parameters, detect malicious sources and attacks, add security policies, and so forth. The vrf name is tagged to syslog messages being logged to the syslog server.

Both VFR Aware and non-VFR Aware Firewalls now allow you to limit the number of firewall sessions. Otherwise, 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. That would cause the denial of service to other VRFs. To limit the number of sessions, enter the **ipinspectname** command.

VRF

VPN Routing and Forwarding (VRF) is an IOS route table instance for connecting a set of sites to a VPN service. A VRF contains a template of a VPN Routing/Forwarding 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 successful deployment of peer-to-peer VPN implementation. The MPLS VPN technology provides a solution to this dilemma.

Each VPN has its own routing and forwarding table in the router, so 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

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 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 VRF-lite interfaces must be Layer 3 interfaces.

VRF-lite includes these devices:

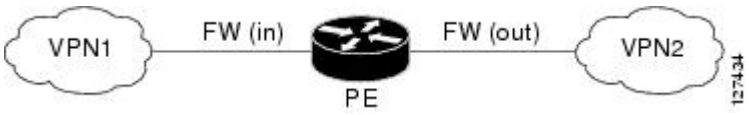
- Customer edge (CE) devices provide customer access to the service provider network over a data link to one or more provider edge (PE) routers. The CE device advertises the site's local routes to the PE router and learns the remote VPN routes from it. A Catalyst 4500 switch can be a CE.
- Provider edge (PE) routers exchange routing information with CE devices by using static routing or a routing protocol such as BGP, RIPv1, or RIPv2.
- Provider routers (or core routers) are any routers in the service provider network that do not attach to CE devices.
- The PE is only required to maintain VPN routes for those VPNs to which it is directly attached, eliminating the need for the PE to maintain all of 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 participate in the same VPN. Each VPN is mapped to

a specified VRF. After learning local VPN routes from CEs, 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, 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.

In a VRF-to-VRF situation, if firewall policies are applied on both inbound and outbound interfaces as shown in the figure below, the firewall on the inbound interface takes precedence over the firewall on the outbound interface. If the incoming packets do not match against the firewall rules (that is, the inspection protocols) configured on the inbound interface, the firewall rule on the outbound interface is applied to the packet.

Figure 1 Firewall in a VRF-to-VRF Scenario



Per-VRF URL Filtering

The VRF-aware firewall supports per-VRF URL filtering. Each VPN can have its own URL filter server. The URL filter server typically is placed in the shared service segment of the corresponding VPN. (Each VPN has a VLAN segment in the shared service network.) The URL filter server can also be placed at the customer site.

AlertsandAuditTrails

CBAC generates real-time alerts and audit trails based on events tracked by the firewall. Enhanced audit trail features use SYSLOG to track all network transactions; recording time stamps, the source host, the destination host, ports used, and the total number of transmitted bytes, for advanced, session-based reporting. Real-time alerts send SYSLOG error messages to central management consoles upon detecting suspicious activity. Using CBAC inspection rules, you can configure alerts and audit trail information on a per-application protocol basis. For example, if you want to generate audit trail information for HTTP traffic, you can specify that in the CBAC rule covering HTTP inspection.

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 yet possess NIC-registered IP addresses must acquire them. Cisco IOS NAT eliminates concern and bureaucratic delay by dynamically mapping thousands of hidden internal addresses to a range of easy-to-get addresses.

In general, a NAT system makes it more difficult for an attacker to determine the following:

- Number of systems running on a network
- Type of machines and operating systems they are running
- Network topology and arrangement

NAT integration with MPLS VPNs allows multiple MPLS VPNs to be configured on a single device to work together. NAT can differentiate which MPLS VPN it receives IP traffic from even if the MPLS VPNS are all using 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.

MPLS service providers would like to provide value-added services such as Internet connectivity, domain name servers (DNS), and VoIP service to their customers. This requires that their customers IP addresses be different when reaching the services. Because MPLS VPN allows customers to use overlapped IP addresses in their networks, NAT must be implemented to make the services possible.

There are two approaches to implementing NAT in the MPLS VPN network. NAT can be implemented on the CE router, which is already supported by NAT, or it can be implemented on a PE router. The NAT Integration with MPLS VPNs feature enables the implementation of NAT on a PE router in an MPLS cloud.

VRF-aware IPSec

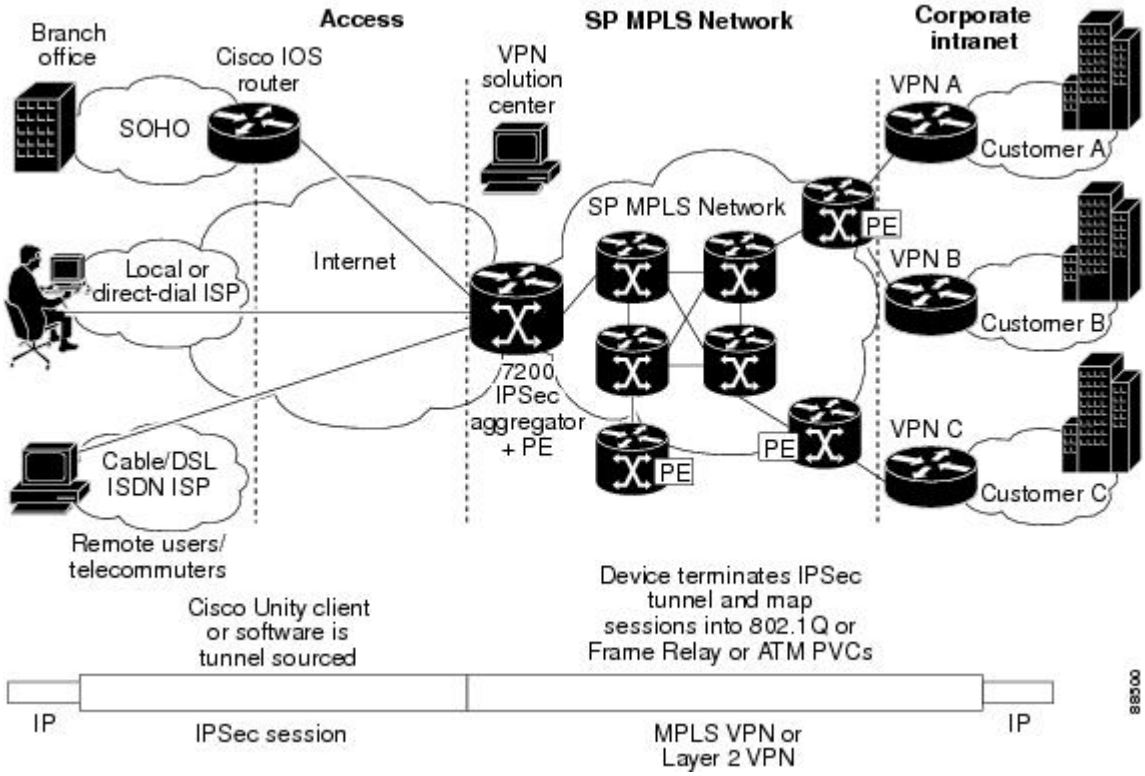
The VRF-aware IPSec feature maps an IP Security (IPSec) tunnel to an MPLS VPN. Using the VRF-aware IPSec feature, you can map IPSec tunnels to VRF instances using a single public-facing address.

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 Cisco IOS 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. The following firewall deployments are described:

- Distributed Network Inclusion of VRF Aware Cisco IOS Firewall, page 6
- Hub-and-Spoke Network Inclusion of VRF Aware Cisco IOS Firewall, page 8

Distributed Network Inclusion of VRF Aware Cisco IOS Firewall

A VRF Aware Cisco IOS Firewall in a distributed network has the following advantages:

- The firewall is distributed across the MPLS core, so the firewall processing load is distributed to all ingress PE routers.
- VPN Firewall features can be deployed in the inbound direction.
- Shared Service is protected from the VPN site at the ingress PE router; therefore, malicious packets from VPN sites are filtered at the ingress PE router before they enter the MPLS core.

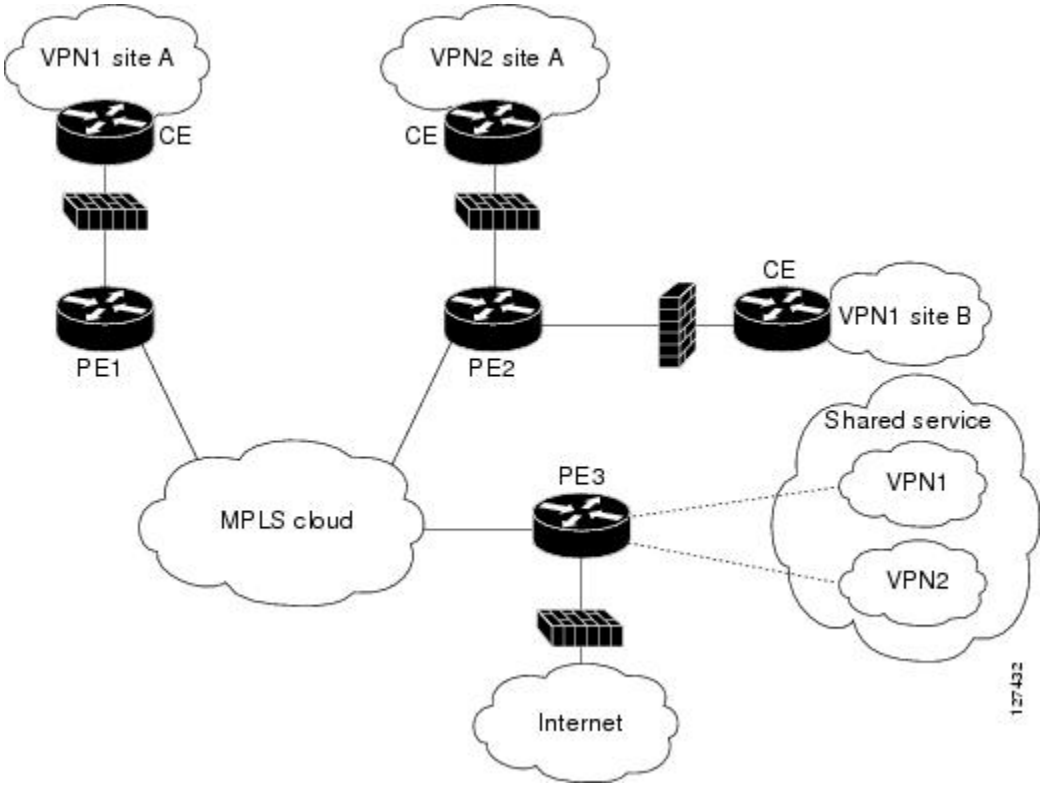
However, the following disadvantages exist:

- There is no centralized firewall deployment, which complicates the deployment and management of the firewall.
- Shared Service firewall features cannot be deployed in the inbound direction.

- The MPLS core is open to the Shared Service. Therefore, malicious packets from Shared Service are filtered only at the ingress PE router after traveling through all core routers.

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 3 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 (VPN1 and VPN2) has the following:

- A VLAN segment in the Shared Service that is connected to the corresponding VLAN subinterface on PE3.
- Internet access through the PE3 router that is connected to the Internet

A distributed network requires the following firewall policies:

- VPN Firewall (VPN1-FW and VPN2-FW)--Inspects VPN-generated traffic that is destined to Shared Service or the Internet and blocks all non-firewall traffic that is coming from outside (Shared Service or the Internet), thereby protecting the VPN sites from outside traffic. This firewall typically is deployed on the VRF interface of the ingress PE router that is connected to the VPN site being protected. It is deployed in the inbound direction because the VRF interface is inbound to the VPN site being protected.
- Shared Service Firewall (SS-FW)--Inspects Shared Service-originated traffic that is destined to VPN sites and blocks all non-firewall traffic that is coming from outside (the VPN site), thereby protecting

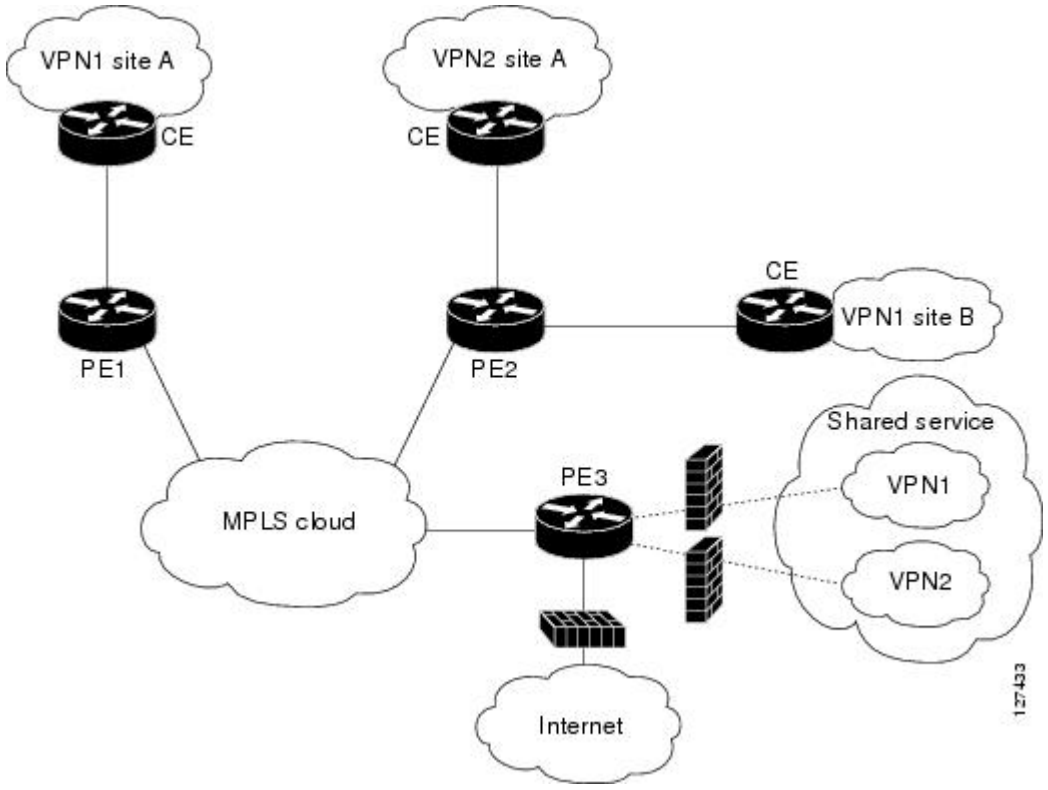
the Shared Service network from VPN sites. This firewall typically is deployed on the VRF interface of the ingress PE router that is connected to the VPN site from where the Shared Service is being protected. It is deployed in the outbound direction because the VRF interface is outbound to the Shared Service that is being protected.

- Generic-VPN Firewall (GEN-VPN-FW)--Inspects VPN-generated traffic that is destined to the Internet and blocks all non-firewall traffic that is coming from the Internet, thereby protecting all VPNs from the Internet. This firewall typically is deployed on the Internet-facing interface of the PE router that is connected to the Internet. It is deployed in the outbound direction because the Internet-facing interface is outbound to VPNs being protected.
- Internet Firewall (INET-FW)--Inspects Internet-generated traffic that is destined to Shared Service and blocks all non-firewall traffic that is coming from VPNs or Shared Service, thereby protecting the Internet from VPNs. This firewall typically is deployed on the Internet-facing interface of the PE router that is connected to the Internet. It is deployed in the inbound direction because the Internet-facing interface is inbound to the Internet being protected.

Hub-and-Spoke Network Inclusion of VRF Aware Cisco IOS 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 that is connected to the Shared Service.

Figure 4 Hub-and-Spoke Network



Typically each VPN has a VLAN and/or VRF subinterface connected to the Shared Service. When a packet arrives from an MPLS interface, the inner tag represents the VPN-ID. MPLS routes the packet to the corresponding subinterface that is connected to Shared Service.

A Hub-and-Spoke network requires the following firewall policies:

- VPN Firewall (VPN1-FW and VPN2-FW)--Inspects VPN-generated traffic that is destined to Shared Service and blocks all non-firewall traffic that is coming from Shared Service, thereby protecting the VPN sites from Shared Service traffic. This firewall typically is deployed on the VLAN subinterface of the egress PE router that is connected to the Shared Service network. It is deployed in the outbound direction because the VLAN interface is outbound to the VPN site being protected.
- Shared Service Firewall (SS-FW)--Inspects Shared Service originated traffic that is destined to the VPN/Internet and blocks all non-firewall traffics that is coming from outside, thereby protecting the Shared Service network from VPN/Internet traffic. This firewall typically is deployed on the VLAN interface of the egress PE router that is connected to the Shared Service being protected. It is deployed in the inbound direction because the VLAN interface is inbound to the Shared Service being protected.
- Generic-VPN firewall (GEN-VPN-FW)--Inspects VPN-generated traffic that is destined to the Internet and blocks all non-firewall traffic that is coming from the Internet, thereby protecting all VPNs from the Internet. This firewall typically is deployed on the Internet-facing interface of the PE router that is connected to the Internet. It is deployed in the outbound direction because the Internet-facing interface is outbound to the VPNs being protected.
- Internet firewall (INET-FW)--Inspects Internet-generated traffic that is destined to Shared Service and blocks all non-firewall traffic that is coming from VPNs or Shared Service, thereby protecting the Internet from VPNs. This firewall typically is deployed on the Internet-facing interface of the PE router that is connected to the Internet. It is deployed in the inbound direction because the Internet-facing interface is inbound to the Internet being protected.

How to Configure VRF Aware Cisco IOS Firewall

Configuring and Checking ACLs to Ensure that Non-Firewall Traffic is Blocked

To configure ACLs and verify that only inspected traffic can pass through the firewall, perform the following steps.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ip access-list extended** *access-list-name*
4. **interface** *interface-type*
5. **ip access-group** {*access-list-number* | *access-list-name*} {**in** | **out**}
6. **exit**

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 access-list extended** *access-list-name* **Example:** `Router(config)# ip access-list extended vpn-ac1`	Defines an extended IP ACL to block non-firewall traffic in both inbound and outbound directions.
Step 4	**interface** *interface-type* **Example:** `Router(config)# interface ethernet0/1.10`	Enters interface configuration mode and specifies an interface that is associated with a VRF.
Step 5	**ip access-group** {*access-list-number* | *access-list-name*} {**in** | **out**} **Example:** `Router(config-if)# ip access-group vpn-acl in`	Controls access to an interface. Applies the previously defined IP access list to a VRF interface whose non-firewall traffic is blocked.
Step 6	**exit** **Example:** `Router(config-if)# exit`	Exits interface configuration mode. Returns to global configuration mode.

Creating and Naming Firewall Rules and Applying the Rules to the Interface

To create and name firewall rules and apply the rules to the interface, perform the following steps.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ip inspect name** *inspection-name* [**parametermax-sessions***number*] *protocol* [**alert** {**on** | **off**}] [**audit-trail** {**on** | **off**}] [**timeout***seconds*]
4. **interface** *interface-id*
5. **ip inspect** *rule-name* {**in** | **out**}
6. **exit**

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 inspect name** *inspection-name* [**parametermax-sessions***number*] *protocol* [**alert** {**on** | **off**}] [**audit-trail** {**on** | **off**}] [**timeout***seconds*] **Example:** `Router(config)# ip inspect name vpn_fw ftp`	Defines a set of inspection rules.
Step 4	**interface** *interface-id* **Example:** `Router(config)# interface ethernet0/1.10`	Enters interface configuration mode and specifies an interface that is associated with a VRF.
Step 5	**ip inspect** *rule-name* {**in** | **out**} **Example:** `Router(config-if)# ip inspect vpn_fw in`	Applies the previously defined inspection role to a VRF interface whose traffic needs to be inspected.

	Command or Action	Purpose
Step 6	**exit** **Example:** `Router(config-if)# exit`	Exits interface configuration mode and returns to global configuration mode.

Identifying and Setting Firewall Attributes

To identify and set firewall attributes, perform the following steps.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ip inspect tcp max-incomplete host** *number* **block-time** *minutes* [**vrf***vrf-name*]
4. **exit**

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 inspect tcp max-incomplete host** *number* **block-time** *minutes* [**vrf***vrf-name*] **Example:** `Router(config)# ip inspect tcp max-incomplete host 256 vrf bank-vrf`	Specifies threshold and blocking time values for TCP host-specific denial-of-service detection and prevention.

	Command or Action	Purpose
Step 4	**exit** **Example:** `Router(config)# exit`	Exits global configuration mode.

Verifying the VRF Aware Cisco IOS Firewall Configuration and Functioning

Verify the configuration and functioning of the firewall by entering the commands shown below.

SUMMARY STEPS

1. **show ip inspect** {**name***inspection-name* | **config** | **interfaces** | **session** [**detail**] | **statistics** | **all**}[**vrf***vrf-name*]
2. **show ip urlfilter** {**config** | **cache** | **statistics**} [**vrf***vrf-name*]

DETAILED STEPS

Step 1 **show ip inspect** {**name***inspection-name* | **config** | **interfaces** | **session** [**detail**] | **statistics** | **all**}[**vrf***vrf-name*]
Use this command to view the firewall configurations, sessions, statistics, and so forth, pertaining to a specified VRF. For example, to view the firewall sessions pertaining to the VRF bank, enter the following command:

Example:

```
Router# show ip inspect interfaces vrf bank
```

Step 2 **show ip urlfilter** {**config** | **cache** | **statistics**} [**vrf***vrf-name*]
Use this command to view the configurations, cache entries, statistics, and so forth, pertaining to a specified VRF. For example, to view the URL filtering statistics pertaining to the VRF bank, enter the following command:

Example:

```
Router# show ip urlfilter statistics vrf bank
```

Configuration Examples for VRF Aware Cisco IOS Firewall

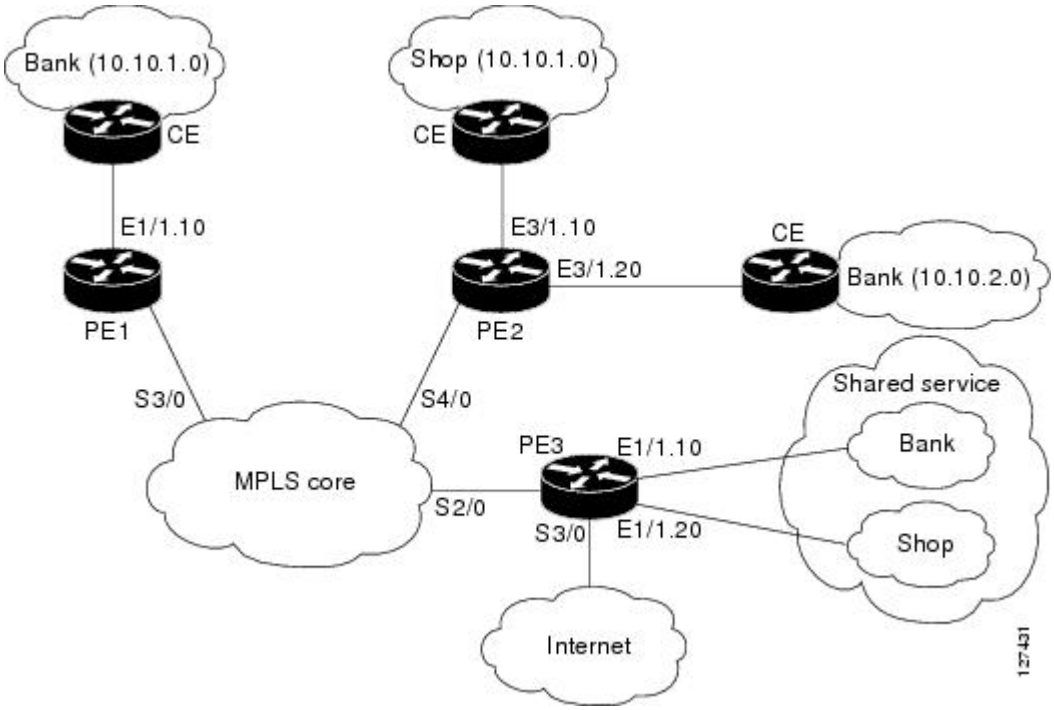
In the example illustrated in the figure below, a service provider offers firewall service to VPN customers Bank and Shop. The Bank VPN has the following two sites in an MPLS network:

- Site connected to PE1, whose network address is 10.10.1.0/24
- Site connected to PE2, whose network address is 10.10.2.0/24

The Bank VPN also has a VLAN network segment in Shared Service that is connected to PE3.

The Shop VPN has only one site, which is connected to PE4. The network address 10.10.1.0/24 is the same network address to which the Bank VPN site is connected.

Figure 5 VPN with Two Sites Across MPLS Network



Each VPN needs the following two firewalls:

- VPN firewall to protect the VPN site from Shared Services
- Shared Service (SS) firewall to protect SS from the VPN site

In addition, the following two firewalls are required:

- Internet firewall to protect VPNs from the Internet
- Generic VPN firewall to protect the Internet from VPNs

In this example, the security policies for Bank and Shop VPNs are as follows:

- Bank VPN Firewall--bank_vpn_fw (Inspects FTP, HTTP, and ESMTP protocols)
- Bank SS Firewall--bank_ss_fw (Inspects ESMTP protocol)
- Shop VPN Firewall--shop_vpn_fw (Inspects HTTP and RTSP protocols)
- Shop SS Firewall--shop_ss_fw (Inspects H323 protocol)

The security policies for the Internet firewall and generic VPN firewall are as follows:

- Internet firewall--inet_fw (Inspects HTTP and ESMTP protocols)
- Generic VPN firewall--gen_vpn_fw (Inspects FTP, HTTP, ESMTP, and RTSP protocols)

DISTRIBUTED NETWORK

PE1:

```
! VRF instance for the Bank VPN
ip vrf bank
rd 100:10
route-target export 100:10
route-target import 100:10

!
! VPN Firewall for Bank VPN protects Bank VPN from Shared Service
ip inspect name bank_vpn_fw ftp
ip inspect name bank_vpn_fw http
ip inspect name bank_vpn_fw esmtp

!
! Shared Service firewall for Bank VPN protects Shared Service from Bank VPN
ip inspect name bank_ss_fw esmtp

!
! VRF interface for the Bank VPN
interface ethernet0/1.10

!
! description of VPN site Bank to PE1
encapsulation dot1Q 10
ip vrf forwarding bank
ip address 10.10.1.2 255.255.255.0
ip access-group bank_ss_acl in
ip access-group bank_vpn_acl out
ip inspect bank_vpn_fw in
ip inspect bank_ss_fw out

!
! MPLS interface
interface Serial3/0
 ip unnumbered Loopback0

 tag-switching ip

 serial restart-delay 0

!
! ACL that protects the VPN site Bank from Shared Service
ip access-list extended bank_vpn_acl

 permit ip 10.10.2.0 0.0.0.255 10.10.1.0 0.0.0.255

 permit tcp any any eq smtp

 deny   ip  any any log
!
! ACL that protects Shared Service from VPN site Bank
ip access-list extended bank_ss_acl

 permit ip 10.10.1.0 0.0.0.255 10.10.2.0 0.0.0.255

 permit tcp any any eq ftp

 permit tcp any any eq http
 permit tcp any any eq smtp

 deny   ip  any any log
```

PE2:

```
! VRF instance for the Bank VPN
ip vrf bank
```

```
rd 100:10
route-target export 100:10
route-target import 100:10

!
! VRF instance for the Shop VPN
ip vrf shop
rd 200:20
route-target export 200:20
route-target import 200:20

!
! VPN firewall for Bank BPN protects Bank VPN from Shared Service
ip inspect name bank_vpn_fw ftp
ip inspect name bank_vpn_fw http
ip inspect name bank_vpn_fw esmtp

!
! Shared Service firewall for Bank VPN protects Shared Service from Bank VPN
ip inspect name bank_ss_fw esmtp

!
! VPN firewall for Shop VPN protects Shop VPN from Shared Service
ip inspect name shop_vpn_fw http
ip inspect name shop_vpn_fw rtsp

!
! Shared Service firewall for Shop VPN protects Shared Service from Shop VPN
ip inspect name shop_ss_fw h323
!
! VRF interface for the Bank VPN
interface Ethernet3/1.10

!
! description of VPN site Bank to PE2
encapsulation dot1Q 10
ip vrf forwarding bank
ip address 10.10.2.2 255.255.255.0
ip access-group bank_ss_acl in
ip access-group bank_vpn_acl out
ip inspect bank_vpn_fw in
ip inspect bank_ss_fw out

!
interface Ethernet3/1.20

!
! description of VPN site Shop to PE2
encapsulation dot1Q 20
ip vrf forwarding shop
ip address 10.10.1.2 255.255.255.0
ip access-group shop_ss_acl in
ip access-group shop_vpn_acl out
ip inspect shop_vpn_fw in
ip inspect shop_ss_fw out
interface Serial4/0

 ip unnumbered Loopback0

 tag-switching ip

 serial restart-delay 0

!
! ACL that protects the VPN site Bank from Shared Service
ip access-list extended bank_vpn_acl

 permit ip 10.10.1.0 0.0.0.255 10.10.2.0 0.0.0.255

 permit tcp any any eq smtp

 deny   ip  any any log
```

```
!
! ACL that protects Shared Service from VPN site Bank
ip access-list extended bank_ss_acl
 permit ip 10.10.2.0 0.0.0.255 10.10.1.0 0.0.0.255

 permit tcp any any eq ftp

 permit tcp any any eq http

 permit tcp any any eq smtp

 deny   ip  any any log

!
! ACL that protects VPN site Shop from Shared Service
ip access-list extended shop_vpn_acl

 permit tcp any any eq h323

 deny   ip any any log

!
ip access-list extended shop_ss_acl

 permit tcp any any eq http

 permit tcp any any eq rtsp
deny   ip  any any log
```

PE3:

```
! VRF instance for the Bank VPN
ip vrf bank
rd 100:10
route-target export 100:10
route-target import 100:10

!
! VRF instance for the Shop VPN
ip vrf shop
rd 200:20
route-target export 200:20
route-target import 200:20

!
! Generic VPN firewall to protect Shop and Bank VPNs from internet
ip inspect name gen_vpn_fw esmtp
ip inspect name gen_vpn_fw ftp
ip inspect name gen_vpn_fw http
ip inspect name gen_vpn_fw rtsp

!
! Internet firewall to prevent malicious traffic from being passed
! to internet from Bank and Shop VPNs
ip inspect name inet_fw esmtp
ip inspect name inet_fw http

!
! VRF interface for the Bank VPN
interface Ethernet1/1.10

!
! Description of Shared Service to PE3
encapsulation dot1Q 10
ip vrf forwarding bank
ip address 10.10.1.50 255.255.255.0

!
! VRF interface for the Shop VPN
interface Ethernet1/1.20
```

```
!
! Description of Shared Service to PE3
encapsulation dot1Q 20
ip vrf forwarding shop
ip address 10.10.1.50 255.255.255.0
interface Serial2/0

 ip unnumbered Loopback0

 tag-switching ip

 serial restart-delay 0

!
! VRF interface for the Bank VPN
interface Serial3/0

!
! Description of Internet-facing interface
ip address 192.168.10.2 255.255.255.0
ip access-group inet_acl out
ip access-group gen_vpn_acl in
ip inspect gen_vpn_fw out
ip inspect inet_fw in

!
! ACL that protects the Bank and Shop VPNs from internet
ip access-list extended gen_vpn_acl

 permit tcp any any eq smtp

 permit tcp any any eq www

 deny   ip  any any log

!
! ACL that protects internet from Bank and Shop VPNs
ip access-list extended inet_acl

 permit tcp any any eq ftp

 permit tcp any any eq http

 permit tcp any any eq smtp

 permit tcp any any eq rtsp

 deny   ip  any any log
```

HUB-AND-SPOKE NETWORK

PE3:

```
! VRF instance for the VPN Bank
ip vrf bank
rd 100:10
route-target export 100:10
route-target import 100:10

!
! VRF instance for the VPN Shop
ip vrf shop
rd 200:20
route-target export 200:20
route-target import 200:20

!
! VPN firewall for Bank BPN protects Bank VPN from Shared Service
ip inspect name bank_vpn_fw ftp
ip inspect name bank_vpn_fw http
```

```
ip inspect name bank_vpn_fw esmtp

!
! Shared Service firewall for Bank VPN protects Shared Service from Bank VPN
ip inspect name bank_ss_fw esmtp

!
! VPN firewall for Shop VPN protects Shop VPN from Shared Service
ip inspect name shop_vpn_fw http
ip inspect name shop_vpn_fw rtsp

!
! Shared Service firewall for Shop VPN protects Shared Service from Shop VPN
ip inspect name shop_ss_fw h323

!
! Generic VPN firewall protects Shop and Bank VPNs from internet
ip inspect name gen_vpn_fw esmtp
ip inspect name gen_vpn_fw ftp
ip inspect name gen_vpn_fw http
ip inspect name gen_vpn_fw rtsp

!
! Internet firewall prevents malicious traffic from being passed
! to internet from Bank and Shop VPNs
ip inspect name inet_fw esmtp
ip inspect name inet_fw http

!
! VRF interface for the Bank VPN
interface Ethernet1/1.10

!
! description of Shared Service to PE3
encapsulation dot1Q 10
ip vrf forwarding bank
ip address 10.10.1.50 255.255.255.0
ip access-group bank_ss_acl out
ip access-group bank_vpn_acl in
ip inspect bank_vpn_fw out
ip inspect bank_ss_fw in

!
! VRF interface for the Shop VPN
interface Ethernet1/1.20
!
! description of Shared Service to PE3
encapsulation dot1Q 20
ip vrf forwarding shop
ip address 10.10.1.50 255.255.255.0
ip access-group shop_ss_acl out
ip access-group shop_vpn_acl in
ip inspect shop_vpn_fw out
ip inspect shop_ss_fw in
interface Serial2/0

 ip unnumbered Loopback0

 tag-switching ip

 serial restart-delay 0
!
! VRF interface for the Bank VPN
interface Serial3/0

!
! description of Internet-facing interface
ip address 192.168.10.2 255.255.255.0
ip access-group inet_acl out
ip access-group gen_vpn_acl in
ip inspect gen_vpn_fw out
ip inspect inet_fw in
```

```
!
! ACL that protects the VPN site Bank from Shared Service
ip access-list extended bank_vpn_acl

 permit tcp any any eq smtp

 deny   ip  any any log
!
! ACL that protects Shared Service from VPN site Bank
ip access-list extended bank_ss_acl

 permit tcp any any eq ftp

 permit tcp any any eq http

 permit tcp any any eq smtp

 deny   ip  any any log

!
! ACL that protects VPN site Shop from Shared Service
ip access-list extended shop_vpn_acl

 permit tcp any any eq h323

 deny   ip any any log

!
ip access-list extended shop_ss_acl

 permit tcp any any eq http
 permit tcp any any eq rtsp
 deny   ip  any any log
!
! ACL that protects the Bank and Shop VPNs from internet
ip access-list extended gen_vpn_acl

 permit tcp any any eq smtp

 permit tcp any any eq www
 deny   ip  any any log
!
! ACL that protects internet from Bank and Shop VPNs
ip access-list extended inet_acl

 permit tcp any any eq ftp
 permit tcp any any eq http

 permit tcp any any eq smtp

 permit tcp any any eq rtsp

 deny   ip  any any log
```

In the example illustrated in the figure below, the Cisco IOS Firewall is configured on PE1 on the VRF interface E3/1. The host on NET1 wants to reach the server on NET2.

Figure 6 Sample VRF Aware Cisco IOS Firewall Network

The configuration steps are followed by a sample configuration and log messages.

1. Configure VRF on PE routers.
2. Ensure that your network supports MPLS traffic engineering.
3. Confirm that the VRF interface can reach NET1 and NET2.
4. Configure the VRF Aware Cisco IOS Firewall.
   a. Configure and apply ACLs.
   b. Create Firewall rules and apply them to the VRF interface.
5. Check for VRF firewall sessions.

VRF Configuration on PE1

```
! configure VRF for host1
ip cef
ip vrf vrf1
rd 100:1
route-target export 100:1
route-target import 100:1
exit
end
!
! apply VRF to the interface facing CE
interface ethernet3/1
ip vrf forwarding vrf1
ip address 190.1.1.2 255.255.0.0
!
! make the interface facing the MPLS network an MPLS interface
interface serial2/0
mpls ip
ip address 191.171.151.1 255.255.0.0
!
! configure BGP protocol for MPLS network
router bgp 100
no synchronization
bgp log-neighbor-changes
neighbor 191.171.151.2 remote-as 100
neighbor 191.171.151.2 update-source serial2/0
no auto-summary
address-family vpnv4
neighbor 191.171.151.2 activate
neighbor 191.171.151.2 send-community both
exit-address-family
address-family ipv4 vrf vrf1
redistribute connected
redistribute static
no auto-summary
no synchronization
exit-address-family
!
! configure VRF static route to reach CE network
ip route vrf vrf1 192.168.4.0 255.255.255.0 190.1.1.1
```

VRF Configuration on PE2

```
! configure VRF for host2
ip cef
ip vrf vrf1
rd 100:1
route-target export 100:1
route-target import 100:1
!
! apply VRF on CE-facing interface
interface fastethernet0/0
ip vrf forwarding vrf1
ip address 193.1.1.2 255.255.255.0
!
! make MPLS network-facing interface an MPLS interface
interface serial1/0
mpls ip
ip address 191.171.151.2 255.255.0.0
!
! configure BGP protocol for MPLS network
router bgp 100
no synchronization
bgp log-neighbor-changes
neighbor 191.171.151.1 remote-as 100
neighbor 191.171.151.1 update-source serial1/0
no auto-summary
address-family vpnv4
neighbor 191.171.151.1 activate
neighbor 191.171.151.1 send-community both
```

```
exit-address-family
address-family ipv4 vrf vrf1
redistribute connected
redistribute static
no auto-summary
no synchronization
exit-address-family
!configure VRF static route to reach CE network
ip route vrf vrf1 192.168.4.0 255.255.255.0 193.1.1.1
```

Configuration on CE1

```
interface e0/1
ip address 190.1.1.1 255.255.255.0
interface e0/0
ip address 192.168.4.2 255.255.255.0
ip route 192.168.104.0 255.255.255.0 190.1.1.2
```

Configuration on CE2

```
interface e0/1
ip address 190.1.1.1 255.255.255.0
interface e0/0
ip address 192.168.4.2 255.255.255.0
ip route 192.168.4.0 255.255.255.0 193.1.1.2
```

Configure Firewall on PE1 and Apply on the VRF Interface

```
! configure ACL so that NET2 cannot access NET1
ip access-list extended 105
permit tcp any any fragment
permit udp any any fragment
deny tcp any any
deny udp any any
permit ip any any
!
! apply ACL to VRF interface on PE1
interface ethernet3/1
ip access-group 105 out
!
! configure firewall rule
ip inspect name test tcp
!
! apply firewall rule on VRF interface
interface ethernet3/1
 ip inspect test in
```

Check for VRF Firewall Sessions When Host on NET1 Tries to Telnet to Server on NET2

```
show ip inspect session vrf vrf1
Established Sessions
 Session 659CE534 (192.168.4.1:38772)=>(192.168.104.1:23) tcp SIS_OPEN
!
! checking for ACLs
show ip inspect session detail vrf vrf1 | include ACL 105
  Out SID 192.168.104.1[23:23]=>192.168.4.1[38772:38772] on ACL 105
(34 matches)
```

Additional References

Related Documents

Related Topic	Document Title
Cisco IOS commands	Cisco IOS Master Commands List, All Releases
VRF-lite	*Catalyst 4500 Series Switch Cisco IOS Software Configuration Guide , Release 12.2*
MPLS VPN	*Configuring a Basic MPLS VPN , Document ID 13733*
VRF Aware IPSec	• *VRF-Aware IPSec* feature module, Release 12.2(15)T • *Cisco IOS Security Configuration Guide* , Release 12.3 • *Cisco IOS Security Command Reference* , Release 12.3T
VRF management	*Cisco 12000/10720 Router Manager User's Guide , Release 3.2*
NAT	• *NAT and Stateful Inspection of Cisco IOS Firewall* , White Paper • *Configuring Network Address Translation: Getting Started* --Document ID 13772

Standards

Standards	Title
No new or modified standards are supported by this feature, and support for existing standards has not been modified by this feature.	--

MIBs

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

RFCs

RFCs	Title
No new or modified RFCs are supported by this feature, and support for existing RFCs has not been modified by this feature.	--

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 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 Firewall

Feature Name	Releases	Feature Information
VRF Aware Cisco IOS Firewall	12.3(14)T	VRF Aware Cisco IOS Firewall applies Cisco IOS Firewall functionality to VRF (Virtual Routing and Forwarding) interfaces when the firewall is configured on a service provider (SP) or large enterprise edge router. SPs can provide managed services to small and medium business markets. The VRF Aware Cisco IOS Firewall supports VRF-aware URL filtering and VRF-lite (also known as Multi-VRF CE). The following commands were introduced or modified:**clearipurlfiltercache**, **ipinspectalert-off**, **ipinspectaudittrail**, **ipinspectdns-timeout**, **ipinspectmax-incompletehigh**, **ipinspectmax-incompletelow**, **ipinspectname**, **ipinspectone-minutehigh**, **ipinspectone-minutelow**, **ipinspecttcpfinwait-time**, **ipinspecttcpidle-time**, **ipinspecttcpmax-incompletehost**, **ipinspecttcpsynwait-time**, **ipinspectudpidle-time**, **ipurlfilteralert**, **ipurlfilterallowmode**, **ipurlfilteraudit-trail**, **ipurlfiltercache**, **ipurlfilterexclusive-domain**, **ipurlfilterexclusive-domain**, **ipurlfiltermax-request**, **ipurlfiltermax-resp-pak**, **ipurlfilterservervendor**, **ipurlfilterurlf-server-log**, **showipinspect**, **showipurlfiltercache**, **showipurlfilterconfig**, **showipurlfilterstatistics**.

Glossary

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

CBAC --Context-Based Access Control. A protocol that provides internal users with secure access control for each application and for all traffic across network perimeters. CBAC enhances security by scrutinizing both source and destination addresses and by tracking each application's connection status.

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.

inspection rule --A rule that specifies what IP traffic (which application-layer protocols) will be inspected by CBAC at an interface.

intrusion detection --The Cisco IOS Firewall's Intrusion Detection System (Cisco IOS IDS) identifies the most common attacks, using signatures to detect patterns of misuse in network traffic.

IPSec --IP Security Protocol. A framework of open standards developed by the Internet Engineering Task Force (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.

skinny --Skinny Client Control Protocol (SCCP). A protocol that enables CBAC to inspect Skinny control packets that are exchanged between a Skinny client and the Call Manager (CM); CBAC then configures the router (also known as the Cisco IOS Firewall) to enable the Skinny data channels to traverse through the router.

traffic filtering --A capability that allows you to configure CBAC to permit specified TCP and UDP traffic through a firewall only when the connection is initiated from within the network you want to protect. CBAC can inspect traffic for sessions that originate from either side of the firewall.

traffic inspection --CBAC inspection of traffic that travels through the firewall to discover and manage state information for TCP and UDP sessions. This state information is used to create temporary openings in the firewall’s access lists to allow return traffic and additional data connections for permissible sessions (sessions that originated from within the protected internal network).

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/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 (CEF) table, and guidelines and routing protocol parameters that control the information that is included in the routing table.

Note Refer to *Internetworking Terms and Acronyms* for terms not included in this glossary.

Virtual Fragmentation Reassembly

Currently, the Cisco IOS Firewall--specifically context-based access control (CBAC) and the intrusion detection system (IDS)--cannot identify the contents of the IP fragments nor can it gather port information from the fragment. These inabilities allow the fragments to pass through the network without being examined or without dynamic access control list (ACL) creation.

Virtual fragmentation reassembly (VFR) enables the Cisco IOS Firewall to create the appropriate dynamic ACLs, thereby, protecting the network from various fragmentation attacks.

Feature History for Virtual Fragmentation Reassembly

Release	Modification
12.3(8)T	This feature was introduced.

Finding Support Information for Platforms and Cisco IOS Software Images

Use Cisco Feature Navigator to find information about platform support and Cisco IOS software image support. Access Cisco Feature Navigator at http://www.cisco.com/go/fn . You must have an account on Cisco.com. If you do not have an account or have forgotten your username or password, click **Cancel** at the login dialog box and follow the instructions that appear.

Restrictions for Virtual Fragmentation Reassembly

Performance Impact

VFR will cause a performance impact on the basis of functions such as packet copying, fragment validation, and fragment reorder. This performance impact will vary depending on the number of concurrent IP datagram that are being reassembled.

VFR Configuration Restriction

VFR should not be enabled on a router that is placed on an asymmetric path. The reassembly process requires all of the fragments within an IP datagram. Routers placed in the asymmetric path may not receive all of the fragments, so the fragment reassembly will fail.

SIP and RTSP Limitation

The Session Initiation Protocol (SIP) and the Real-Time Streaming Protocol (RTSP) do not have the ability to parse port information across noncontiguous buffers. Thus, virtual fragmentation reassembly may fail. (If the application fails, the session will be blocked.)

Information About Virtual Fragmentation Reassembly

To use fragmentation support for Cisco IOS Firewall, you should understand the following concept:

- Detected Fragment Attacks, page 30
- Automatically Enabling or Disabling VFR, page 31

Detected Fragment Attacks

VFR is responsible for detecting and preventing the following types of fragment attacks:

- Tiny Fragment Attack--In this type of attack, the attacker makes the fragment size small enough to force Layer 4 (TCP and User Datagram Protocol (UDP)) header fields into the second fragment. Thus, the ACL rules that have been configured for those fields will not match.

VFR drops all tiny fragments, and an alert message such as follows is logged to the syslog server: “VFR-3-TINY_FRAGMENTS.”

- Overlapping Fragment Attack--In this type of attack, the attacker can overwrite the fragment offset in the noninitial IP fragment packets. When the firewall reassembles the IP fragments, it might create wrong IP packets, causing the memory to overflow or your system to crash.

VFR drops all fragments within a fragment chain if an overlap fragment is detected, and an alert message such as follows is logged to the syslog server: “VFR-3-OVERLAP_FRAGMENT.”

- Buffer Overflow Attack--In this type of denial-of-service (DoS) attack, the attacker can continuously send a large number of incomplete IP fragments, causing the firewall to lose time and memory while trying to reassemble the fake packets.

To avoid buffer overflow and control memory usage, configure a maximum threshold for the number of IP datagrams that are being reassembled and the number of fragments per datagram. (Both of these parameters can be specified via the **ip virtual-reassembly** command.)

When the maximum number of datagrams that can be reassembled at any given time is reached, all subsequent fragments are dropped, and an alert message such as the following is logged to the syslog server: “VFR-4_FRAG_TABLE_OVERFLOW.”

When the maximum number of fragments per datagram is reached, subsequent fragments will be dropped, and an alert message such as the following is logged to the syslog server: “VFR-4_TOO_MANY_FRAGMENTS.”

In addition to configuring the maximum threshold values, each IP datagram is associated with a managed timer. If the IP datagram does not receive all of the fragments within the specified time, the timer will expire and the IP datagram (and all of its fragments) will be dropped.

Automatically Enabling or Disabling VFR

VFR is designed to work with any feature that requires fragment reassembly (such as Cisco IOS Firewall and NAT). Currently, NAT enables and disables VFR internally; that is, when NAT is enabled on an interface, VFR is automatically enabled on that interface.

If more than one feature attempts to automatically enable VFR on an interface, VFR will maintain a reference count to keep track of the number of features that have enabled VFR. When the reference count is reduced to zero, VFR is automatically disabled.

How to Use Virtual Fragmentation Reassembly

- Configuring VFR, page 31

Configuring VFR

Use this task to enable VFR on an interface, specify maximum threshold values to combat buffer overflow and control memory usage, and verify any VFR configurations.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **interface** *type number*
4. ip virtual-reassembly [max-reassemblies number] [max-fragments number] [timeout seconds] [drop-fragments]
5. **exit**
6. **exit**
7. show ip virtual-reassembly [interface type]

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.

	Command or Action	Purpose
Step 3	**interface** *type number* **Example:** `Router(config)# interface ethernet1/1`	Configures an interface type and enters interface configuration mode.
Step 4	ip virtual-reassembly [max-reassemblies number] [max-fragments number] [timeout seconds] [drop-fragments] **Example:** `Router(config-if)# ip virtual-reassembly max-reassemblies 64 max-fragments 16 timeout 5`	Enables VFR on an interface.
Step 5	**exit** **Example:** `Router(config-if)# exit`	Exits interface configuration mode.
Step 6	**exit** **Example:** `Router(config)# exit`	Exits global configuration mode.
Step 7	show ip virtual-reassembly [interface type] **Example:** `Router# show ip virtual-reassembly ethernet1/1`	Displays the configuration and statistical information of the VFR. If an interface is not specified, VFR information is shown for all configured interfaces.

- Troubleshooting Tips, page 32

Troubleshooting Tips

To view debugging messages related to the VFR subsystem, use the **debug ip virtual-reassembly** command.

Configuration Examples for Fragmentation Reassembly

Additional References

The following sections provide references related to virtual fragmentation reassembly.

Related Documents

Related Topic	Document Title
Dynamic IDS	*Cisco IOS Intrusion Prevention System*
CBAC	*Configuring Context-Based Access Control*

Standards

Standards	Title
None	--

MIBs

MIBs	MIBs Link
None	To locate and download MIBs for selected platforms, Cisco IOS releases, and feature sets, use Cisco MIB Locator found at the following URL: http://www.cisco.com/go/mibs

RFCs

RFCs	Title
RFC 791	Internet Protocol
RFC 1858	Security Considerations for IP Fragment Filtering

Technical Assistance

Description	Link
Technical Assistance Center (TAC) home page, containing 30,000 pages of searchable technical content, including links to products, technologies, solutions, technical tips, and tools. Registered Cisco.com users can log in from this page to access even more content.	http://www.cisco.com/public/support/tac/home.shtml

Command Reference

The following commands are introduced or modified in the feature or features documented in this module. For information about these commands, see the *Cisco IOS Security Command Reference*. For information

about all Cisco IOS commands, go to the Command Lookup Tool at http://tools.cisco.com/Support/CLILookup or to the *Cisco IOS Master Commands List*.

- **debug ip virtual-reassembly**
- **ip virtual-reassembly**
- **show ip virtual-reassembly**

Glossary

fragment --Part of an IP datagram that is fragmented into multiple pieces. Each piece is called a fragment or an IP fragment.

fragmentation --Process of breaking down an IP datagram into smaller packets (fragments) that are transmitted over different types of network media.

initial fragment -- First fragment within a fragment set. This fragment should have a Layer 4 header and should have an offset of zero.

noninitial fragment --All fragments within a fragment set, except the initial fragment.