IPsec Virtual Tunnel Interfaces

IPsec virtual tunnel interfaces (VTIs) provide a routable interface type for terminating IPsec tunnels and an easy way to define protection between sites to form an overlay network. IPsec VTIs simplify the configuration of IPsec for protection of remote links, support multicast, and simplify network management and load balancing.

Note Security threats, as well as the cryptographic technologies to help protect against them, are constantly changing. For more information about the latest Cisco cryptographic recommendations, see the Next Generation Encryption (NGE) white paper.

Restrictions for IPsec Virtual Tunnel Interfaces

Fragmentation

Fragmentation is not supported over IPsec tunnel. You can choose to set the lower MTU on hosts to avoid packet fragments or choose to fragment the packets on any device.

IPsec Transform Set

The IPsec transform set must be configured in tunnel mode only.

IKE Security Association

The Internet Key Exchange (IKE) security association (SA) is bound to the VTI.

IPsec SA Traffic Selectors

Static VTIs (SVTIs) support only a single IPsec SA that is attached to the VTI interface. The traffic selector for the IPsec SA is always "IP any any."

By default, Static VTIs (SVTIs) support only a single IPSec SA that is attached to the virtual tunnel interface. The traffic selector for the IPsec SA is always “IP any any”.

IPv4

This feature supports SVTIs that are configured to encapsulate IPv4 packets .

Tunnel Protection

Do not configure the **shared** keyword when using the **tunnel mode ipsec ipv4** command for IPsec IPv4 mode.

Traceroute

The traceroute function with crypto offload on VTIs is not supported.

VxLAN GPE Tunnel Interface

The VxLAN GPE Tunnel Interface cannot use the same source interface as IPsec VTI.

Information About IPsec Virtual Tunnel Interfaces

The use of IPsec VTIs can simplify the configuration process when you need to provide protection for remote access and it provides an alternative to using generic routing encapsulation (GRE) or Layer 2 Tunneling Protocol (L2TP) tunnels for encapsulation. A benefit of using IPsec VTIs is that the configuration does not require static mapping of IPsec sessions to a physical interface. The IPsec tunnel endpoint is associated with an actual (virtual) interface. Because there is a routable interface at the tunnel endpoint, many common interface capabilities can be applied to the IPsec tunnel.

The IPsec VTI allows for the flexibility of sending and receiving both IP unicast and multicast encrypted traffic on any physical interface, such as in the case of multiple paths. Traffic is encrypted or decrypted when it is forwarded from or to the tunnel interface and is managed by the IP routing table. Using IP routing to forward the traffic to the tunnel interface simplifies the IPsec VPN configuration . Because DVTIs function like any other real interface you can apply quality of service (QoS), firewall, and other security services as soon as the tunnel is active.

The following sections provide details about the IPSec VTI:

Benefits of Using IPsec Virtual Tunnel Interfaces

IPsec VTIs allow you to configure a virtual interface to which you can apply features. Features for clear-text packets are configured on the VTI. Features for encrypted packets are applied on the physical outside interface. When IPsec VTIs are used, you can separate the application of features such as Network Address Translation (NAT), ACLs, and QoS and apply them to clear-text, or encrypted text, or both.

There are two types of VTI interfaces: static VTIs (SVTIs) and dynamic VTIs (DVTIs).

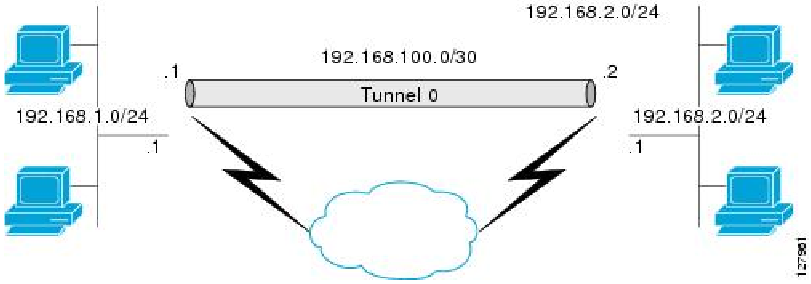
Static Virtual Tunnel Interfaces

SVTI configurations can be used for site-to-site connectivity in which a tunnel provides always-on access between two sites.

Additionally, multiple Cisco IOS software features can be configured directly on the tunnel interface and on the physical egress interface of the tunnel interface. This direct configuration allows users to have solid control on the application of the features in the pre- or post-encryption path.

The figure below illustrates how a SVTI is used.

Figure 1: IPsec SVTI



The IPsec VTI supports native IPsec tunneling and exhibits most of the properties of a physical interface.

Multi-SA Support for SVTI

By default, the traffic selector for an SVTI is set to ‘any any’. As a result, a single IPSec SA is attached for the SVTI corresponding to the ‘any any’ traffic selector.

From Cisco IOS XE Gibraltar 16.12.1, you can define and associate an Access Control List (ACL) with an SVTI to select traffic between specific source and destination proxies instead of the ‘any any’ proxy defined by the default. IPSec SAs are created for each non-any-any traffic selector, and thus, multiple SAs are attached to an SVTI.

This feature is supports IPv4 and IPv6 traffic protection with IPSec encapsulation in tunnel mode. The feature supports both IKEv1 and IKEv2.

Restrictions

- This feature is not supported with tunnel protection shared.
- This feature is not supported with IPSec Mixed Mode.
- Traffic selectors associated with the SVTIs at both the ends of a tunnel must have matching source and destination proxies. Do not narrow down the traffic selector at one of the SVTIs forming a tunnel.
- With a VTI configuration, an IOS router will send the IKEv2 configuration request payload by default. This may result in IKEv2 negotiation failures if the peer device does not process this payload correctly. To mitigate this condition, use the following commands under the IKEv2 profile configuration: **crypto ikev2 profile <profile_name>** and **no config-exchange request**

ACL Characteristics and Effects on SVTI IPSec SAs

- An ACL associated with an SVTI must not contain an ‘any any’ proxy. For an ‘any any’ traffic selector, use the default behaviour of the SVTI and do not associate an ACL with the SVTI.
- An ACL associated with an SVTI supports only **permit** statements and must not contain **deny** statements.

- Run-time modification of an ACL associated with an SVTI is not supported. Shut the tunnel down before adding or modifying ACEs in the ACL.
- If you disassociate an ACL from an SVTI, existing IPSec SAs are deleted and a new IPSec SA for default traffic selector of 'IP any any' is formed.
- We recommend that you associate a maximum of 100 Access Control Entries (ACEs) with an SVTI. Further, all the ACLs associated with the various tunnel interfaces should together use a maximum of 2000 ACEs.

Reverse Route Injection

Reverse Route Injection is not supported for Multi-SA SVTI.

If you use extended ACL or ACE options, such as protocol, port number, and DHCP, use other means such as route maps for routing.

Dual Stack Support for SVTI

SVTI Dual Stack feature provides the capabilities to carry both IPv4 and IPv6 traffic using a single IPsec Security Association (SA) that is tunnelled over IPv4. From IOS XE release 17.9 onwards, Cisco supports specific subnets in ACL when the ingress end of the tunnel interface is configured with a third party IPSec client. Also, based on the third party IPsec client configuration, it responds with a specific traffic selector. In this case, the IPsec supports non-any non-any proxy configuration and allows to carry IPv4 or IPv6 type of traffic in the tunnel interface. This feature is supported only with IKEv2.

Restrictions

- Tunnel-mode configuration is allowed only under the IPsec profiles when you use the tunnel interface in dual-overlay mode.
- In Cisco IOS XE, ACL filtering infrastructure does not work on traffic generated locally on the device.
- You have to use the same set of traffic selectors for rekeying an IPsec SA. You cannot change the traffic selectors during the rekey process but when you change, the rekey request is rejected with the message *TS_UNACCEPTABLE*.
- A maximum of 16 traffic selectors are accepted at the IKEv2 level.
- ACLs on dual-stack tunnel interface are not supported. Any ACL configured on this interface is overwritten by dual-stack ACLs.

Dynamic Virtual Tunnel Interfaces

DVTIs can provide highly secure and scalable connectivity for remote-access VPNs. The DVTI technology replaces dynamic crypto maps and the dynamic hub-and-spoke method for establishing tunnels.

Note You can configure DVTIs with IKEv1 or IKEv2. The legacy crypto map based configuration supports DVTIs with IKEv1 only. A DVTI configuration with IKEv2 is supported only in FlexVPN.

DVTIs can be used for both the server and the remote configuration. The tunnels provide an on-demand separate virtual access interface for each VPN session. The configuration of the virtual access interfaces is cloned from a virtual template configuration, which includes the IPsec configuration and any Cisco IOS software feature configured on the virtual template interface, such as QoS, NetFlow, or ACLs.

DVTIs function like any other real interface, so you can apply QoS, firewall, or other security services as soon as the tunnel is active. QoS features can be used to improve the performance of various applications across the network. Any combination of QoS features offered in Cisco IOS software can be used to support voice, video, or data applications.

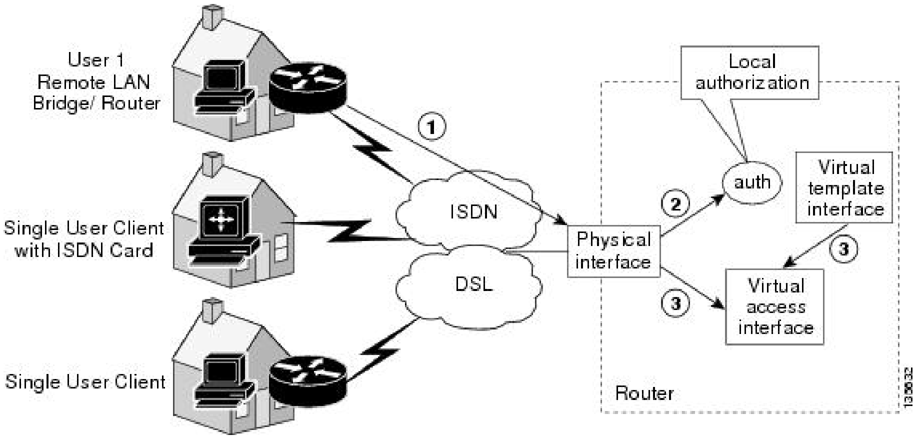
DVTIs provide efficiency in the use of IP addresses and provide secure connectivity. DVTIs allow dynamically downloadable per-group and per-user policies to be configured on a RADIUS server. The per-group or per-user definition can be created using an extended authentication (Xauth) User or Unity group, or can be derived from a certificate. DVTIs are standards based, so interoperability in a multiple-vendor environment is supported. IPsec DVTIs allow you to create highly secure connectivity for remote access VPNs and can be combined with Cisco Architecture for Voice, Video, and Integrated Data (AVVID) to deliver converged voice, video, and data over IP networks. The DVTI simplifies VPN routing and forwarding- (VRF-) aware IPsec deployment. The VRF is configured on the interface.

A DVTI requires minimal configuration on the router. A single virtual template can be configured and cloned.

The DVTI creates an interface for IPsec sessions and uses the virtual template infrastructure for dynamic instantiation and management of dynamic IPsec VTIs. The virtual template infrastructure is extended to create dynamic virtual-access tunnel interfaces. DVTIs are used in hub-and-spoke configurations. A single DVTI can support several static VTIs.

The figure below illustrates the DVTI authentication path.

Figure 2: Dynamic IPsec VTI



The authentication shown in the figure above follows this path:

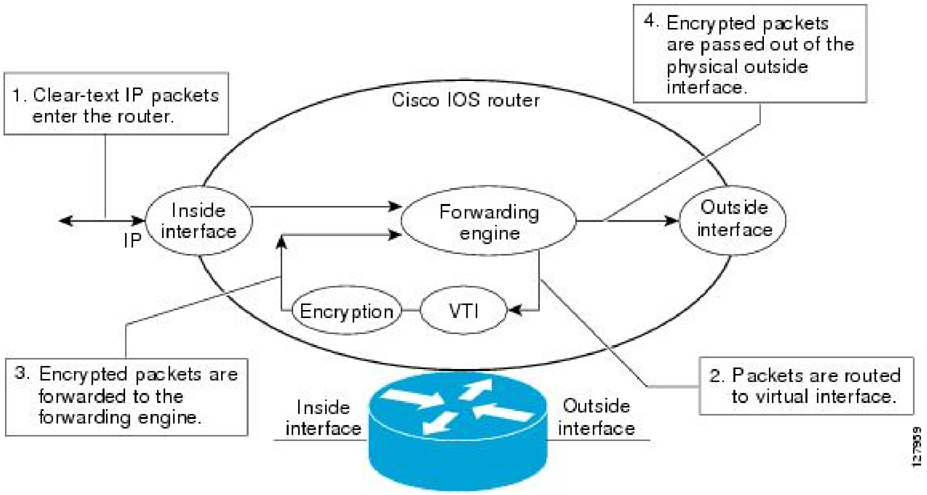
1. User 1 calls the router.
2. Router 1 authenticates User 1.
3. IPsec clones the virtual access interface from the virtual template interface.

Traffic Encryption with the IPsec Virtual Tunnel Interface

When an IPsec VTI is configured, encryption occurs in the tunnel. Traffic is encrypted when it is forwarded to the tunnel interface. Traffic forwarding is handled by the IP routing table, and dynamic or static routing can be used to route traffic to the SVTI. DVTI uses reverse route injection to further simplify the routing configurations. Using IP routing to forward the traffic to encryption simplifies the IPsec VPN configuration . The IPsec virtual tunnel also allows you to encrypt multicast traffic with IPsec.

IPsec packet flow into the IPSec tunnel is illustrated in the figure below.

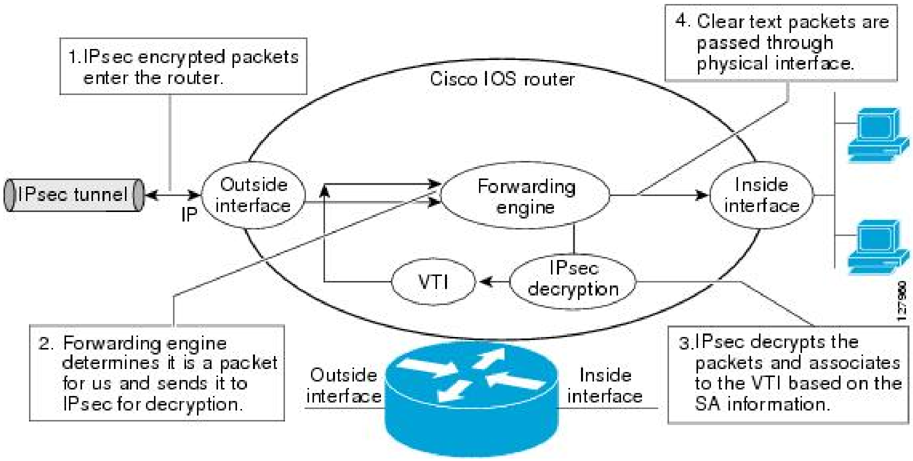
Figure 3: Packet Flow into the IPsec Tunnel


1. Clear-text IP packets enter the router.
Cisco IOS router
4. Encrypted packets are passed out of the physical outside interface.
IP
Inside interface
Forwarding engine
Outside interface
Encryption
VTI
3. Encrypted packets are forwarded to the forwarding engine.
2. Packets are routed to virtual interface.
Inside interface
Outside interface
127959

After packets arrive on the inside interface, the forwarding engine switches the packets to the VTI, where they are encrypted. The encrypted packets are handed back to the forwarding engine, where they are switched through the outside interface.

The figure below shows the packet flow out of the IPsec tunnel.

Figure 4: Packet Flow out of the IPsec Tunnel


1.IPsec encrypted packets enter the router.
Cisco IOS router
4. Clear text packets are passed through physical interface.
IPsec tunnel
IP
Outside interface
Forwarding engine
Inside interface
VTI
IPsec decryption
2. Forwarding engine determines it is a packet for us and sends it to IPsec for decryption.
Outside interface
Inside interface
3.IPsec decrypts the packets and associates to the VTI based on the SA information.
127960

Dynamic Virtual Tunnel Interface Life Cycle

IPsec profiles define the policy for DVTIs. The dynamic interface is created at the end of IKE Phase 1 and IKE Phase 1.5. The interface is deleted when the IPsec session to the peer is closed. The IPsec session is closed when both IKE and IPsec SAs to the peer are deleted.

Routing with IPsec Virtual Tunnel Interfaces

Because VTIs are routable interfaces, routing plays an important role in the encryption process. Traffic is encrypted only if it is forwarded out of the VTI, and traffic arriving on the VTI is decrypted and routed accordingly. VTIs allow you to establish an encryption tunnel using a real interface as the tunnel endpoint. You can route to the interface or apply services such as QoS, firewalls, network address translation (NAT), and NetFlow statistics as you would to any other interface. You can monitor the interface and route to it, and the interface provides benefits similar to other Cisco IOS interface.

FlexVPN Mixed Mode Support

The FlexVPN Mixed Mode feature provides support for carrying IPv4 traffic over IPsec IPv6 transport. This is the first phase towards providing dual stack support on the IPsec stack. This implementation does not support using a single IPsec security association (SA) pair for both IPv4 and IPv6 traffic.

This feature is only supported for Remote Access VPN with IKEv2 and Dynamic VTI.

The FlexVPN Mixed Mode feature provides support for carrying IPv6 traffic over IPsec IPv4 transport from Cisco IOS XE Everest 16.4.1.

Auto Tunnel Mode Support in IPsec

When configuring a VPN headend in a multiple vendor scenario, you must be aware of the technical details of the peer or responder. For example, some devices may use IPsec tunnels while others may use generic routing encapsulation (GRE) or IPsec tunnel, and sometimes, a tunnel may be IPv4 or IPv6. In the last case, you must configure an Internet Key Exchange (IKE) profile and a virtual template.

The Tunnel Mode Auto Selection feature eases the configuration and spares you about knowing the responder's details. This feature automatically applies the tunneling protocol (GRE or IPsec) and transport protocol (IPv4 or IPv6) on the virtual template as soon as the IKE profile creates the virtual access interface. This feature is useful on dual stack hubs aggregating multivendor remote access, such as Cisco AnyConnect VPN Client, Microsoft Windows7 Client, and so on.

Note The Tunnel Mode Auto Selection feature eases the configuration for a responder only. The tunnel must be statically configured for an initiator.

IPSec Mixed Mode Support for VTI

The IPSec Mixed Mode feature provides support for carrying IPv4 traffic over IPsec IPv6 transport. This is the first phase towards providing dual stack support on the IPsec stack. This implementation does not support using a single IPsec security association (SA) pair for both IPv4 and IPv6 traffic.

This feature is supported for SVTI as well as DVTI and IKEv1 as well as IKEv2.

How to Configure IPsec Virtual Tunnel Interfaces

Configuring Static IPsec Virtual Tunnel Interfaces

Before you begin

Before configuring the tunnel protection for an IPsec profile, it is mandatory to shut down the tunnel interface. After configuration, enable the tunnel interface manually.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **crypto IPsec profile** *profile-name*
4. **set transform-set** *transform-set-name* [*transform-set-name2...transform-set-name6*]
5. **exit**
6. **interface** *type number*
7. **ip address** *address mask*
8. **tunnel mode ipsec ipv4**
9. **tunnel source** *interface-type interface-number*
10. **tunnel destination** *ip-address*
11. **tunnel protection IPsec profile** *profile-name*
12. **end**

DETAILED STEPS

Procedure

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	**crypto IPsec profile** *profile-name* **Example:** `Device(config)# crypto IPsec profile PROF`	Defines the IPsec parameters that are to be used for IPsec encryption between two IPsec devices, and enters IPsec profile configuration mode.

	Command or Action	Purpose
Step 4	**set transform-set** *transform-set-name* [*transform-set-name2...transform-set-name6*] **Example:** `Device(ipsec-profile)# set transform-set tset`	Specifies which transform sets can be used .
Step 5	**exit** **Example:** `Device(ipsec-profile)# exit`	Exits IPsec profile configuration mode, and enters global configuration mode.
Step 6	**interface** *type number* **Example:** `Device(config)# interface tunnel 0`	Specifies the interface on which the tunnel will be configured and enters interface configuration mode.
Step 7	**ip address** *address mask* **Example:** `Device(config-if)# ip address 10.1.1.1 255.255.255.0`	Specifies the IP address and mask.
Step 8	**tunnel mode ipsec ipv4** **Example:** `Device(config-if)# tunnel mode ipsec ipv4`	Defines the mode for the tunnel.
Step 9	**tunnel source** *interface-type interface-number* **Example:** `Device(config-if)# tunnel source loopback 0`	Specifies the tunnel source as a loopback interface.* **Note** *If you are configuring the Tunnel Mode Auto Selection feature using a virtual-template, omit the tunnel source and tunnel mode in interface virtual-template number type tunnel command. If the tunnel source and tunnel mode are specified, clients using IPv6 transport will fail to connect.
Step 10	**tunnel destination** *ip-address* **Example:** `Device(config-if)# tunnel destination 172.16.1.1`	Identifies the IP address of the tunnel destination.
Step 11	**tunnel protection IPsec profile** *profile-name* **Example:** `Device(config-if)# tunnel protection IPsec profile PROF`	Associates a tunnel interface with an IPsec profile.
Step 12	**end** **Example:**	Exits interface configuration mode and returns to privileged EXEC mode.

	Command or Action	Purpose
	`Device(config-if)# end`	

Configuring BGP over IPsec Virtual Tunnel Interfaces

Perform this task to optionally configure BGP over the virtual tunnel interfaces of two routers.

Before you begin

Perform steps in Configuring Static IPsec Virtual Tunnel Interfaces, on page 8.

SUMMARY STEPS

1. **router bgp** *autonomous-system-number*
2. **neighbor** *ip-address* **remote-as** *autonomous-system-number*
3. **network** *network-ip-address* **mask** *subnet-mask*
4. **exit**
5. Enter the following commands on the second router.
6. **router bgp** *autonomous-system-number*
7. **neighbor** *ip-address* **remote-as** *autonomous-system-number*
8. **network** *network-ip-address* **mask** *subnet-mask*

DETAILED STEPS

Procedure

	Command or Action	Purpose
Step 1	**router bgp** *autonomous-system-number* **Example:** `Device(config)# router bgp 65510`	Enters router configuration mode and creates a BGP routing process. *autonomous-system-number* —Number of an autonomous system that identifies the router to other BGP routers and tags the routing information that is passed along. Number in the range from 1 to 65535. In the example, the first router in this procedure is identified as "65510".
Step 2	**neighbor** *ip-address* **remote-as** *autonomous-system-number* **Example:** `Device(config-router)# neighbor 10.1.1.2 remote-as 65511`	*ip-address* —IP address of the adjacent router's tunnel interface. *autonomous-system-number* —Number of an autonomous system that identifies the router of the second router. Number in the range from 1 to 65535.
Step 3	**network** *network-ip-address* **mask** *subnet-mask* **Example:** `Device(config-router)# network 2.2.2.0 mask 255.255.255.0`	*network-ip-address*—IP address of the network advertised in BGP. For example, the IP address of a loopback interface. *subnet-mask*—subnet mask of the network advertised in BGP.

	Command or Action	Purpose
		Note The BGP network command network and mask *must* exactly match a route that is already in the routing table for it to be brought into BGP and advertised to BGP neighbors. This is different from EIGRP, OSPF where the network statement just has to "cover" an interface network and it will pick up the network with mask from the interface.
Step 4	**exit** **Example:** `Device(config-router)# exit`	Exits router configuration mode.
Step 5	Enter the following commands on the second router.	
Step 6	**router bgp** *autonomous-system-number* **Example:** `Device(config)# router bgp 65511`	Enters router configuration mode and creates a BGP routing process. *autonomous-system-number* —Number of an autonomous system that identifies the router to other BGP routers and tags the routing information that is passed along. Number in the range from 1 to 65535. In the example, the second router in this procedure is identified as "65511".
Step 7	**neighbor** *ip-address* **remote-as** *autonomous-system-number* **Example:** `Device(config-router)# neighbor 10.1.1.1 remote-as 65510`	*ip-address* —IP address of the adjacent router's tunnel interface.
Step 8	**network** *network-ip-address* **mask** *subnet-mask* **Example:** `Device(config-router)# network 1.1.1.0 mask 255.255.255.0`	*network-ip-address*—IP address of the network advertised in BGP. For example, the IP address of a loopback interface. *subnet-mask*—subnet mask of the network advertised in BGP. **Note** Use the exact network IP address and subnet mask.

Configuring Dynamic IPsec Virtual Tunnel Interfaces

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **crypto ipsec profile** *profile-name*
4. **set transform-set** *transform-set-name* [*transform-set-name2...transform-set-name6*]
5. **exit**

6. **interface virtual-template** *number* **type tunnel**
7. **tunnel mode ipsec ipv4**
8. **tunnel protection IPsec profile** *profile-name*
9. **exit**
10. **crypto isakamp profile** *profile-name*
11. **match identity address** *ip-address mask*
12. **virtual template** *template-number*
13. **end**

DETAILED STEPS

Procedure

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	**crypto ipsec profile** *profile-name* **Example:** `Device(config)# crypto ipsec profile PROF`	Defines the IPsec parameters that are to be used for IPsec encryption between two IPsec devices and enters IPsec profile configuration mode.
Step 4	**set transform-set** *transform-set-name* [*transform-set-name2...transform-set-name6*] **Example:** `Device(ipsec-profile)# set transform-set tset`	Specifies which transform sets can be used with the crypto map entry.
Step 5	**exit** **Example:** `Device(ipsec-profile)# exit`	Exits ipsec profile configuration mode and enters global configuration mode.
Step 6	**interface virtual-template** *number* **type tunnel** **Example:** `Device(config)# interface virtual-template 2 type tunnel`	Defines a virtual-template tunnel interface and enters interface configuration mode.
Step 7	**tunnel mode ipsec ipv4** **Example:** `Device(config-if)# tunnel mode ipsec ipv4`	Defines the mode for the tunnel.

	Command or Action	Purpose
Step 8	**tunnel protection IPsec profile** *profile-name* **Example:** `Device(config-if)# tunnel protection ipsec profile PROF`	Associates a tunnel interface with an IPsec profile.
Step 9	**exit** **Example:** `Device(config-if)# exit`	Exits interface configuration mode.
Step 10	**crypto isakamp profile** *profile-name* **Example:** `Device(config)# crypto isakamp profile profile1`	Defines the ISAKMP profile to be used for the virtual template.
Step 11	**match identity address** *ip-address mask* **Example:** `Device(conf-isa-prof)# match identity address 10.1.1.0 255.255.255.0`	Matches an identity from the ISAKMP profile and enters isakmp-profile configuration mode.
Step 12	**virtual template** *template-number* **Example:** `Device(config)# virtual-template 1`	Specifies the virtual template attached to the ISAKMP profile.

Step 13	**end**
	Example:
	`Device(config)# end`
		Exits global configuration mode and enters privileged EXEC mode.

Configuring Multi-SA Support for Dynamic Virtual Tunnel Interfaces Using IKEv1

Note Security threats, as well as the cryptographic technologies to help protect against them, are constantly changing. For more information about the latest Cisco cryptographic recommendations, see the Next Generation Encryption (NGE) white paper.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ip vrf** *vrf-name*
4. **rd** *route-distinguisher*
5. **exit**
6. **crypto keyring** *keyring-name*
7. **pre-shared-key** *address* **key** *key*

8. **exit**
9. **crypto isakmp profile** *profile-name*
10. **keyring** *keyring-name*
11. **match identity** *address mask*
12. **virtual-template** *template-number*
13. **exit**
14. **crypto ipsec transform-set** *transform-set-name transform1* [*transform2*] [*transform3*]
15. **exit**
16. **crypto ipsec profile** *name*
17. **set security-policy limit** *maximum-limit*
18. **set transform-set** *transform-set-name* [*transform-set-name2 .... transform-set-name6*]
19. **exit**
20. **interface virtual-template** *number type tunnel*
21. **ip vrf forwarding** *vrf-name*
22. **ip unnumbered** *type number*
23. **tunnel mode ipsec ipv4**
24. **tunnel protection profile ipsec** *profile-name*
25. **end**

DETAILED STEPS

Procedure

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	**ip vrf** *vrf-name* **Example:** `Device(config)# ip vrf VRF-100-1`	Defines the VRF instance and enters VRF configuration mode.
Step 4	**rd** *route-distinguisher* **Example:** `Device(config-vrf)# rd 100:21`	Creates routing and forwarding tables for a VRF.
Step 5	**exit** **Example:** `Device(config-vrf)# exit`	Exits VRF configuration mode and enters global configuration mode.

	Command or Action	Purpose
Step 6	**crypto keyring** *keyring-name* **Example:** `Device(config)# crypto keyring cisco-100-1`	Defines a crypto key ring and enters key ring configuration mode.
Step 7	**pre-shared-key** *address* **key** *key* **Example:** `Device(config-keyring)# pre-shared-key address 10.1.1.1 key cisco-100-1`	Defines the preshared key to be used for Internet Key Exchange (IKE) authentication.
Step 8	**exit** **Example:** `Device(config-keyring)# exit`	Exits keyring configuration mode and enters global configuration mode.
Step 9	**crypto isakmp profile** *profile-name* **Example:** `Device(config)# crypto isakmp profile cisco-isakmp-profile-100-1`	Defines an ISAKMP profile and enters ISAKMP configuration mode.
Step 10	**keyring** *keyring-name* **Example:** `Device(conf-isa-prof)# keyring cisco-100-1`	Configures a key ring in ISAKMP mode.
Step 11	**match identity** *address mask* **Example:** `Device(conf-isa-prof)# match identity address 10.1.1.0 255.255.255.0`	Matches an identity from the ISAKMP profile.
Step 12	**virtual-template** *template-number* **Example:** `Device(conf-isa-prof)# virtual-template 101`	Specifies the virtual template that will be used to clone virtual access interfaces.
Step 13	**exit** **Example:** `Device(conf-isa-prof)# exit`	Exits ISAKMP profile configuration mode and enters global configuration mode.
Step 14	**crypto ipsec transform-set** *transform-set-name transform1* [*transform2*] [*transform3*] **Example:** `Device(config)# crypto ipsec transform-set cisco esp-aes esp-sha-hmac`	Defines the transform set and enters crypto transform configuration mode.
Step 15	**exit** **Example:** `Device(conf-crypto-trans)# exit`	Exits crypto transform configuration mode and enters global configuration mode.

	Command or Action	Purpose
Step 16	**crypto ipsec profile** *name* **Example:** `Device(config)# crypto ipsec profile cisco-ipsec-profile-101`	Defines the IPsec parameters used for IPsec encryption between two IPsec devices, and enters IPsec profile configuration mode.
Step 17	**set security-policy limit** *maximum-limit* **Example:** `Device(ipsec-profile)# set security-policy limit 3`	Defines an upper limit to the number of flows that can be created for an individual virtual access interface.
Step 18	**set transform-set** *transform-set-name* [*transform-set-name2 .... transform-set-name6*] **Example:** `Device(ipsec-profile)# set transform-set cisco`	Specifies the transform sets to be used with the crypto map entry.
Step 19	**exit** **Example:** `Device(ipsec-profile)# exit`	Exits IPsec profile and enters global configuration mode.
Step 20	**interface virtual-template** *number type tunnel* **Example:** `Device(config)# interface virtual-template 101 type tunnel`	Creates a virtual template interface that can be configured interface and enters interface configuration mode.
Step 21	**ip vrf forwarding** *vrf-name* **Example:** `Device(config-if)# ip vrf forwarding VRF-100-1`	Associates a VRF instance with a virtual-template interface.
Step 22	**ip unnumbered** *type number* **Example:** `Device(config-if)# ip unnumbered GigabitEthernet 0.0`	Enables IP processing on an interface without assigning an explicit IP address to the interface.
Step 23	**tunnel mode ipsec ipv4** **Example:** `Device(config-if)# tunnel mode ipsec ipv4`	Defines the mode for the tunnel.
Step 24	**tunnel protection profile ipsec** *profile-name* **Example:** `Device(config-if)# tunnel protection ipsec profile PROF`	Associates a tunnel interface with an IPsec profile.

Step 25	**end**
	Example:
	`Device(config-if)# end`
		Exits interface configuration mode, and returns to privileged EXEC mode.

Configuring IPsec Mixed Mode Support for SVTIs

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **crypto IPsec profile** *profile-name*
4. **set transform-set** *transform-set-name* [*transform-set-name2...transform-set-name6*]
5. **exit**
6. **interface** *type number*
7. **ip address** *address mask*
8. Do one of the following:
   - **tunnel mode ipsec ipv4 v6-overlay**
   - **tunnel mode ipsec ipv6 v4-overlay**
9. **tunnel source** *interface-type interface-type*
10. **tunnel destination** *ip-address*
11. **tunnel protection IPsec profile** *profile-name*
12. **end**

DETAILED STEPS

Procedure

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	**crypto IPsec profile** *profile-name* **Example:** `Device(config)# crypto IPsec profile PROF`	Defines the IPsec parameters that are to be used for IPsec encryption between two IPsec devices, and enters IPsec profile configuration mode.
Step 4	**set transform-set** *transform-set-name* [*transform-set-name2...transform-set-name6*] **Example:** `Device(ipsec-profile)# set transform-set tset`	Specifies which transform sets can be used with the crypto map entry.

	Command or Action	Purpose
Step 5	**exit** **Example:** `Device(ipsec-profile)# exit`	Exits IPsec profile configuration mode, and enters global configuration mode.
Step 6	**interface** *type number* **Example:** `Device(config)# interface tunnel 0`	Specifies the interface on which the tunnel will be configured and enters interface configuration mode.
Step 7	**ip address** *address mask* **Example:** `Device(config-if)# ip address 10.1.1.1 255.255.255.0`	Specifies the IP address and mask.
Step 8	Do one of the following: • **tunnel mode ipsec ipv4 v6-overlay** • **tunnel mode ipsec ipv6 v4-overlay** **Example:** `Device(config-if)# tunnel mode ipsec ipv4 v6-overlay`	Defines the mode for the tunnel.
Step 9	**tunnel source** *interface-type interface-type* **Example:** `Device(config-if)# tunnel source loopback 0`	Specifies the tunnel source as a loopback interface.
Step 10	**tunnel destination** *ip-address* **Example:** `Device(config-if)# tunnel destination 172.16.1.1`	Identifies the IP address of the tunnel destination.
Step 11	**tunnel protection IPsec profile** *profile-name* **Example:** `Device(config-if)# tunnel protection IPsec profile PROF`	Associates a tunnel interface with an IPsec profile.

Step 12	**end**
	Example:
	`Device(config-if)# end`
		Exits interface configuration mode and returns to privileged EXEC mode.

Configuring IPsec Mixed Mode Support for Dynamic VTIs

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **crypto ipsec profile** *profile-name*
4. **set mixed mode**
5. **set transform-set** *transform-set-name* [*transform-set-name2...transform-set-name6*]
6. **exit**
7. **interface virtual-template** *number* **type tunnel**
8. **tunnel mode ipsec ipv4**
9. **tunnel protection IPsec profile** *profile-name*
10. **exit**
11. **crypto isakamp profile** *profile-name*
12. **match identity address** *ip-address mask*
13. **virtual template** *template-number*
14. **end**

DETAILED STEPS

Procedure

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	**crypto ipsec profile** *profile-name* **Example:** `Device(config)# crypto ipsec profile PROF`	Defines the IPsec parameters that are to be used for IPsec encryption between two IPsec devices and enters IPsec profile configuration mode.
Step 4	**set mixed mode** **Example:** `Device(config)# set mixed mode`	Defines the IPsec parameters that are to be used for IPsec encryption between two IPsec devices and enters IPsec profile configuration mode.
Step 5	**set transform-set** *transform-set-name* [*transform-set-name2...transform-set-name6*] **Example:** `Device(ipsec-profile)# set transform-set tset`	Specifies which transform sets can be used with the crypto map entry.

	Command or Action	Purpose
Step 6	**exit** **Example:** `Device(ipsec-profile)# exit`	Exits ipsec profile configuration mode and enters global configuration mode.
Step 7	**interface virtual-template** *number* **type tunnel** **Example:** `Device(config)# interface virtual-template 2 type tunnel`	Defines a virtual-template tunnel interface and enters interface configuration mode.
Step 8	**tunnel mode ipsec ipv4** **Example:** `Device(config-if)# tunnel mode ipsec ipv4`	Defines the mode for the tunnel.
Step 9	**tunnel protection IPsec profile** *profile-name* **Example:** `Device(config-if)# tunnel protection ipsec profile PROF`	Associates a tunnel interface with an IPsec profile.
Step 10	**exit** **Example:** `Device(config-if)# exit`	Exits interface configuration mode.
Step 11	**crypto isakmp profile** *profile-name* **Example:** `Device(config)# crypto isakmp profile profile1`	Defines the ISAKMP profile to be used for the virtual template.
Step 12	**match identity address** *ip-address mask* **Example:** `Device(conf-isa-prof)# match identity address 10.1.1.0 255.255.255.0`	Matches an identity from the ISAKMP profile and enters isakmp-profile configuration mode.
Step 13	**virtual template** *template-number* **Example:** `Device(config)# virtual-template 1`	Specifies the virtual template attached to the ISAKMP profile.

Step 14	**end**
	Example:
	`Device(config)# end`
		Exits global configuration mode and enters privileged EXEC mode.

Configuring Multi-SA Support for Static IPsec Virtual Tunnel Interfaces

Procedure

Step 1 **enable**

Example:

```
Device> enable
```

Enables privileged EXEC mode. Enter your password if prompted.

Step 2 **configure terminal**

Example:

```
Device# configure terminal
```

Enters global configuration mode.

Step 3 **crypto IPsec profile** *profile-name*

Example:

```
Device(config)# crypto IPsec profile PROF
```

Defines the IPsec parameters that are to be used for IPsec encryption between two IPsec devices, and enters IPsec profile configuration mode.

Step 4 **set transform-set** *transform-set-name* [*transform-set-name2...transform-set-name6*]

Example:

```
Device(ipsec-profile)# set transform-set tset
```

Specifies the transform sets that can be used.

Step 5 **exit**

Example:

```
Device(ipsec-profile)# exit
```

Exits IPsec profile configuration mode, and enters global configuration mode.

Step 6 **interface** *type number*

Example:

```
Device(config)# interface tunnel 0
```

Specifies the interface on which the tunnel will be configured and enters interface configuration mode.

Step 7 **ip address** *address mask*

Example:

```
Device(config-if)# ip address 10.1.1.1 255.255.255.0
```

Specifies the IP address and mask.

Step 8 **tunnel mode ipsec** {**ipv4** | **ipv6**}

Example:

```
Device(config-if)# tunnel mode ipsec ipv4
```

Defines the mode for the tunnel.

Step 9 **tunnel source** *interface-type interface-number*

Example:

```
Device(config-if)# tunnel source loopback 0
```

Specifies the tunnel source as a loopback interface.

Step 10 **tunnel destination** *ip-address*

Example:

```
Device(config-if)# tunnel destination 172.16.1.1
```

Identifies the IP address of the tunnel destination.

Step 11 **tunnel protection ipsec policy** {**ipv4** | **ipv6**} *acl*

Example:

```
Device(config-if)# tunnel protection ipsec policy ipv4 ipsec-acl1
```

Associates an ACL with an SVTI to define non-any-any traffic selectors.

Step 12 **tunnel protection ipsec profile** *profile-name*

Example:

```
Device(config-if)# tunnel protection IPsec profile PROF
```

Associates a tunnel interface with an IPsec profile.

Step 13 **exit**

Example:

```
Device(config-if)# exit
```

Exits interface configuration mode and enters global configuration mode.

Step 14 **ip access-list extended** *name* OR **ipv6 access-list** *name*

Example:

IPv4:

```
Device(config)# ip access-list extended ipsec-acl1
```

IPv6:

```
Device(config)# ipv6 access-list ipsec-acl1
```

Defines an extended IP access list using a name and enters extended named access list configuration mode.

Step 15 **permit** *protocol source* [*source-wildcard*] *destination* [*destination-wildcard*] [**option** *option-name*]

Example:

```
Device(config-ext-nacl)# permit ip 30.0.1.0 0.0.0.255 10.0.1.0 0.0.0.255
```

Permits traffic that matches all of the conditions specified in the statement.

Do not use the keyword **any** as the wildcard for both the source and destination proxies. For the ‘any any’ traffic selector, use the default SVTI without an attached ACL.

Do not use **deny** statements.

Step 16 **end**

Example:

```
Device(config-ext-nacl)# end
```

Exits standard named access list configuration mode and enters privileged EXEC mode.

Configuring Tunnel Mode as Dual-overlay

To configure the tunnel mode as dual-overlay, perform these steps:

Procedure

Step 1 **enable**

Example:

```
Device> enable
```

Enables privileged EXEC mode. Enter your password if prompted.

Step 2 **configure terminal**

Example:

```
Device# configure terminal
```

Enters global configuration mode.

Step 3 **interface tunnel** *type number*

Example:

```
Device(config)# interface tunnel 1
```

Specifies a tunnel interface and number, and enters interface configuration mode.

Step 4 **ipv6 enable**

Example:

```
Device(config-if)# ipv6 enable
```

Enables IPv6 processing on an interface that has not been configured with an explicit IPv6 address.

Step 5 **tunnel source** { **ipv4-address | interface-type | interface-number**}

Example:

```
Device(config-if)# tunnel source Gigabitethernet 1
```

Specifies the source IPv4 address or the source interface type and number for the tunnel interface. If an interface type and number are specified, that interface must be configured with an IPv4 address.

Step 6 **tunnel mode ipsec dual-overlay**

Example:

```
Device(config-if)# tunnel mode ipsec dual-overlay
```

Specifies a dual-overlay tunnel. The **tunnel mode ipsec dual-overlay** command specifies the encapsulation protocol for the tunnel.

Step 7 **tunnel destination ip address** *address*

Example:

```
Device(config-if)# tunnel destination 89.89.89.1
```

Specifies the destination IPv4 address for the tunnel interface.

Step 8 **tunnel protection ipsec profile** *ipserc profile-name*

Example:

```
Device(config-if)# tunnel protection IPsec profile ipsecprof
```

Associates a tunnel interface with an IPsec profile. The *name* argument specifies the name of the IPsec profile; this value must match the *name* specified in the **crypto IPsec profile** *name* command

Step 9 **exit**

Example:

```
Device(config-if)# exit
```

Exits interface configuration mode and enters global configuration mode.

Step 10 **end**

Example:

```
Device(config-if)# end
```

Exits interface configuration mode and returns to privileged EXEC mode.

Configuration Examples for IPsec Virtual Tunnel Interfaces

Example: Static Virtual Tunnel Interface with IPsec

The following example configuration uses a preshared key for authentication between peers. VPN traffic is forwarded to the IPsec VTI for encryption and then sent out the physical interface. The tunnel on subnet 10 checks packets for the IPsec policy and passes them to the Crypto Engine (CE) for IPsec encapsulation. The figure below illustrates the IPsec VTI configuration.

Figure 5: VTI with IPsec

Router Configuration

```
version 12.3
service timestamps debug datetime
service timestamps log datetime
hostname 7200-3
no aaa new-model
ip subnet-zero
ip cef
controller ISA 6/1
!
crypto isakmp policy 1
encr aes
authentication pre-share
group 14
crypto isakmp key Cisco12345 address 0.0.0.0 0.0.0.0
crypto ipsec transform-set T1 esp-aes esp-sha-hmac
crypto ipsec profile P1
set transform-set T1
!
interface Tunnel0
 ip address 10.0.51.203 255.255.255.0

 load-interval 30
 tunnel source 10.0.149.203
 tunnel destination 10.0.149.217
 tunnel mode IPsec ipv4
 tunnel protection IPsec profile P1
!

 ip address 10.0.149.203 255.255.255.0
 duplex full
!

 ip address 10.0.35.203 255.255.255.0
 duplex full
!
ip classless
ip route 10.0.36.0 255.255.255.0 Tunnel0
line con 0
line aux 0
line vty 0 4
end
```

Router Configuration

```
version 12.3
hostname c1750-17
no aaa new-model
ip subnet-zero
ip cef
crypto isakmp policy 1
encr aes
authentication pre-share
group 14
crypto isakmp key Cisco12345 address 0.0.0.0 0.0.0.0
crypto ipsec transform-set T1 esp-aes esp-sha-hmac
crypto ipsec profile P1
set transform-set T1
!
interface Tunnel0
 ip address 10.0.51.217 255.255.255.0

 tunnel source 10.0.149.217
 tunnel destination 10.0.149.203
 tunnel mode ipsec ipv4
 tunnel protection ipsec profile P1
!
interface
 ip address 10.0.149.217 255.255.255.0
 speed 100
 full-duplex
!
interface
 ip address 10.0.36.217 255.255.255.0
 load-interval 30
 full-duplex
!
ip classless
ip route 10.0.35.0 255.255.255.0 Tunnel0
line con 0
line aux 0
line vty 0 4
end
```

Example: Verifying the Results for the IPsec Static Virtual Tunnel Interface

This section provides information that you can use to confirm that your configuration is working properly. In this display, Tunnel 0 is “up,” and the line protocol is “up.” If the line protocol is “down,” the session is not active.

Verifying the IPsec Static Virtual Tunnel Interface

```
Router# show interface tunnel 0

Tunnel0 is up, line protocol is up
Hardware is Tunnel
Internet address is 10.0.51.203/24
MTU 1514 bytes, BW 9 Kbit, DLY 500000 usec,
reliability 255/255, txload 103/255, rxload 110/255
Encapsulation TUNNEL, loopback not set
Keepalive not set
Tunnel source 10.0.149.203, destination 10.0.149.217
Tunnel protocol/transport ipsec/ip, key disabled, sequencing disabled
Tunnel TTL 255
Checksumming of packets disabled, fast tunneling enabled
Tunnel transmit bandwidth 8000 (kbps)
Tunnel receive bandwidth 8000 (kbps)
Tunnel protection via IPsec (profile "P1")
Last input never, output never, output hang never
Last clearing of "show interface" counters never
Input queue: 1/75/0/0 (size/max/drops/flushes); Total output drops: 0
Queueing strategy: fifo
Output queue: 0/0 (size/max)
30 second input rate 13000 bits/sec, 34 packets/sec
30 second output rate 36000 bits/sec, 34 packets/sec
191320 packets input, 30129126 bytes, 0 no buffer
Received 0 broadcasts, 0 runts, 0 giants, 0 throttles
0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored, 0 abort
59968 packets output, 15369696 bytes, 0 underruns
0 output errors, 0 collisions, 0 interface resets
0 output buffer failures, 0 output buffers swapped out

Router# show crypto session

Crypto session current status
Interface: Tunnel0
Session status: UP-ACTIVE
Peer: 10.0.149.217 port 500
IKE SA: local 10.0.149.203/500 remote 10.0.149.217/500 Active
IPsec FLOW: permit ip 0.0.0.0/0.0.0.0 0.0.0.0/0.0.0.0
Active SAs: 4,
Router# show ip route

Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
E1 - OSPF external type 1, E2 - OSPF external type 2
i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
ia - IS-IS inter area, * - candidate default, U - per-user static route
o - ODR, P - periodic downloaded static route
Gateway of last resort is not set
10.0.0.0/8 is variably subnetted, 4 subnets, 2 masks
C 10.0.35.0/24 is directly connected, Ethernet3/3
S 10.0.36.0/24 is directly connected, Tunnel0
C 10.0.51.0/24 is directly connected, Tunnel0
C 10.0.149.0/24 is directly connected, Ethernet3/0
```

Example: VRF-Aware Static Virtual Tunnel Interface

To add the VRF to the static VTI example, include the **ipvrf** and **ip vrf forwarding** commands to the configuration as shown in the following example.

C8000 Router Configuration

```
hostname c8000
.
.
ip vrf sample-vti1
 rd 1:1
 route-target export 1:1
 route-target import 1:1
!
.
.
interface Tunnel0
 ip vrf forwarding sample-vti1
 ip address 10.0.51.217 255.255.255.0
 tunnel source 10.0.149.217
 tunnel destination 10.0.149.203
 tunnel mode ipsec ipv4
 tunnel protection ipsec profile P1
.
.
!
end
```

Example: Static Virtual Tunnel Interface with QoS

You can apply any QoS policy to the tunnel endpoint by including the **service-policy** statement under the tunnel interface. The following example shows how to police traffic out the tunnel interface.

C8000 Router Configuration

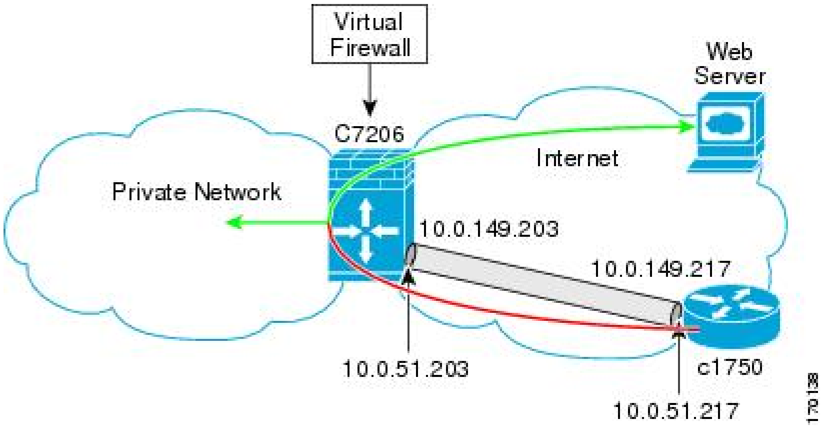
```
hostname c8000
.
.
class-map match-all VTI
 match any
```

```
!
policy-map VTI
  class VTI
  police cir 2000000
    conform-action transmit
    exceed-action drop
!
.
.
interface Tunnel0
 ip address 10.0.51.217 255.255.255.0
 tunnel source 10.0.149.217
 tunnel destination 10.0.149.203
 tunnel mode ipsec ipv4
 tunnel protection ipsec profile P1
 service-policy output VTI
!
.
.
!
end
```

Example: Static Virtual Tunnel Interface with Virtual Firewall

Applying the virtual firewall to the SVTI tunnel allows traffic from the spoke to pass through the hub to reach the Internet. The figure below illustrates an SVTI with the spoke protected inherently by the corporate firewall.

Figure 6: Static VTI with Virtual Firewall



The basic SVTI configuration has been modified to include the virtual firewall definition:

C8000 Router Configuration

```
hostname c8000
.
.
ip inspect max-incomplete high 1000000
ip inspect max-incomplete low 800000
ip inspect one-minute high 1000000
ip inspect one-minute low 800000
ip inspect tcp synwait-time 60
ip inspect tcp max-incomplete host 100000 block-time 2
ip inspect name IOSFW1 tcp timeout 300
ip inspect name IOSFW1 udp
!
.
.
interface GigabitEthernet0/1
 description Internet Connection
 ip address 172.18.143.246 255.255.255.0
 ip access-group 100 in
 ip nat outside
!
interface Tunnel0
 ip address 10.0.51.217 255.255.255.0
 ip nat inside
 ip inspect IOSFW1 in
 tunnel source 10.0.149.217
 tunnel destination 10.0.149.203
 tunnel mode ipsec ipv4
 tunnel protection ipsec profile P1
!
ip classless
ip route 0.0.0.0 0.0.0.0 172.18.143.1
!
ip nat translation timeout 120
ip nat translation finrst-timeout 2
ip nat translation max-entries 300000
ip nat pool test1 10.2.100.1 10.2.100.50 netmask 255.255.255.0
ip nat inside source list 110 pool test1 vrf test-vti1 overload
!
access-list 100 permit esp any any
access-list 100 permit udp any eq isakmp any
access-list 100 permit udp any eq non500-isakmp any
access-list 100 permit icmp any any
access-list 110 deny   esp any any
access-list 110 deny   udp any eq isakmp any
access-list 110 permit ip any any
access-list 110 deny   udp any eq non500-isakmp any
!
end
```

Example: Dynamic Virtual Tunnel Interface Easy VPN Server

The following example illustrates the use of the DVTI Easy VPN server, which serves as an IPsec remote access aggregator. The client can be a home user running a Cisco VPN client or a Cisco IOS router configured as an Easy VPN client.

C8000 Router Configuration

```
hostname c8000
!
aaa new-model
aaa authentication login local_list local
aaa authorization network local_list local
aaa session-id common
!
ip subnet-zero
ip cef
!
username cisco password 0 cisco123
!
controller ISA 1/1
!
```

```
crypto isakmp policy 1
 encr aes
 authentication pre-share
 group 14
!
crypto isakmp client configuration group group1
 key cisco123
 pool group1pool
 save-password
!
crypto isakmp profile vpn1-ra
   match identity group group1
   client authentication list local_list
   isakmp authorization list local_list
   client configuration address respond
   virtual-template 1
!
crypto ipsec transform-set VTI-TS esp-aes esp-sha-hmac
!
crypto ipsec profile test-vti1
 set transform-set VTI-TS
!
interface GigabitEthernet0/1
 description Internet Connection
 ip address 172.18.143.246 255.255.255.0
!
interface GigabitEthernet0/2
 description Internal Network
 ip address 10.2.1.1 255.255.255.0
!
interface Virtual-Template1 type tunnel
 ip unnumbered GigabitEthernet0/1
 ip virtual-reassembly
 tunnel mode ipsec ipv4
 tunnel protection ipsec profile test-vti1
!
ip local pool group1pool 192.168.1.1 192.168.1.4
ip classless
ip route 0.0.0.0 0.0.0.0 172.18.143.1
!
end
```

Example: Verifying the Results for the Dynamic Virtual Tunnel Interface Easy VPN Server

The following examples show that a DVTI has been configured for an Easy VPN server.

```
Router# show running-config interface Virtual-Access2

Building configuration...
Current configuration : 250 bytes
!
interface Virtual-Access2
 ip unnumbered GigabitEthernet0/1
 ip virtual-reassembly
 tunnel source 172.18.143.246
 tunnel destination 172.18.143.208
 tunnel mode ipsec ipv4
 tunnel protection ipsec profile test-vti1
 no tunnel protection ipsec initiate
end
Router# show ip route

Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
```

```
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
       ia - IS-IS inter area, * - candidate default, U - per-user static route
       o - ODR, P - periodic downloaded static route
Gateway of last resort is 10.2.1.10 to network 0.0.0.0
     172.18.0.0/24 is subnetted, 1 subnets
C       172.18.143.0 is directly connected, GigabitEthernet0/1
     192.168.1.0/32 is subnetted, 1 subnets
S       192.168.1.1 [1/0] via 0.0.0.0, Virtual-Access2
     10.0.0.0/24 is subnetted, 1 subnets
C       10.2.1.0 is directly connected, GigabitEthernet0/2
S*   0.0.0.0/0 [1/0] via 172.18.143.1
```

Example: VRF-Aware IPsec with a Dynamic VTI When VRF Is Configured Under a Virtual Template

The following example shows how to configure VRF-aware IPsec under a virtual template to take advantage of the DVTI:

```
hostname c8000
!
ip vrf VRF-100-1
  rd 1:1
!
ip vrf VRF-100-2
  rd 1:1
!
!
!
crypto keyring cisco-100-1
  pre-shared-key address 10.1.1.1 key cisco-100-1
crypto keyring cisco-100-2
  pre-shared-key address 10.1.2.1 key cisco-100-2
crypto isakmp profile cisco-isakmp-profile-100-1
  keyring cisco-100-1
  match identity address 10.1.1.0 255.255.255.0
  virtual-template 101
crypto isakmp profile cisco-isakmp-profile-100-2
  keyring cisco-100-2
  match identity address 10.1.2.0 255.255.255.0
  virtual-template 102
!
!
crypto ipsec transform-set cisco esp-aes esp-sha-hmac
!
crypto ipsec profile cisco-ipsec-profile-101
  set security-policy limit 3
  set transform-set cisco
!
crypto ipsec profile cisco-ipsec-profile-102
  set security-policy limit 5
  set transform-set Cisco
!
interface Virtual-Template101 type tunnel
  ip vrf forwarding VRF-100-1
  ip unnumbered Ethernet 0/0
  tunnel mode ipsec ipv4
  tunnel protection ipsec profile cisco-ipsec-profile-101
```

```
!
interface Virtual-Template102 type tunnel
  ip vrf forwarding VRF-100-2
  ip unnumbered Ethernet 0/0
  tunnel mode ipsec ipv4
  tunnel protection ipsec profile cisco-ipsec-profile-102
!
```

Example: VRF-Aware IPsec with Dynamic VTI When VRF Is Configured Under a Virtual Template with the Gateway Option in an IPsec Profile

The following example shows how to configure VRF-aware IPsec to take advantage of the DVTI, when the VRF is configured under a virtual template with the gateway option in an IPsec profile.

```
hostname c8000
!
ip vrf VRF-100-1
 rd 1:1
!
ip vrf VRF-100-2
 rd 1:1
!
!
!
crypto keyring cisco-100-1
 pre-shared-key address 10.1.1.1 key cisco-100-1
crypto keyring cisco-100-2
 pre-shared-key address 10.1.2.1 key cisco-100-2
crypto isakmp profile cisco-isakmp-profile-100-1
 keyring cisco-100-1
 match identity address 10.1.1.0 255.255.255.0
 virtual-template 101
crypto isakmp profile cisco-isakmp-profile-100-2
 keyring cisco-100-2
 match identity address 10.1.2.0 255.255.255.0
 virtual-template 102
!
!
crypto ipsec transform-set cisco esp-3des esp-sha-hmac
!
crypto ipsec profile cisco-ipsec-profile-101
 set security-policy limit 3
 set transform-set cisco
 set reverse-route gateway 172.16.0.1
!
crypto ipsec profile cisco-ipsec-profile-102
 set security-policy limit 5
 set transform-set cisco
 set reverse-route gateway 172.16.0.1
!
interface Virtual-Template101 type tunnel
 ip vrf forwarding VRF-100-1
 ip unnumbered Ethernet 0/0
 tunnel mode ipsec ipv4
 tunnel protection ipsec profile cisco-ipsec-profile-101
!
interface Virtual-Template102 type tunnel
 ip vrf forwarding VRF-100-2
 ip unnumbered Ethernet 0/0
 tunnel mode ipsec ipv4
 tunnel protection ipsec profile cisco-ipsec-profile-102
!
```

Example: VRF-Aware IPsec with a Dynamic VTI When VRF Is Configured Under an ISAKMP Profile

```
hostname c8000
!
ip vrf VRF-100-1
  rd 1:1
!
ip vrf VRF-100-2
  rd 1:1
!
crypto keyring cisco-100-1
  pre-shared-key address 10.1.1.1 key cisco-100-1
crypto keyring cisco-100-2
  pre-shared-key address 10.1.2.1 key cisco-100-2
crypto isakmp profile cisco-isakmp-profile-100-1
  vrf VRF-100-1
  keyring cisco-100-1
  match identity address 10.1.1.0 255.255.255.0
  virtual-template 1
crypto isakmp profile cisco-isakmp-profile-100-2
  vrf VRF-100-2
  keyring cisco-100-2
  match identity address 10.1.2.0 255.255.255.0
  virtual-template 1
!
!
crypto ipsec transform-set cisco esp-aes esp-sha-hmac
crypto ipsec profile cisco-ipsec-profile
  set security-policy limit 3
  set transform-set cisco
!
!
!
interface Virtual-Template 1 type tunnel
  ip unnumbered ethernet 0/0
  tunnel mode ipsec ipv4
  tunnel protection ipsec profile cisco-ipsec-profile
!
!
```

Example: VRF-Aware IPsec with a Dynamic VTI When VRF Is Configured Under an ISAKMP Profile and a Gateway Option in an IPsec Profile

The following example shows how to configure VRF-aware IPsec to take advantage of the DVTI, when the VRF is configured under an ISAKMP profile and a gateway option in an IPsec profile:

```
hostname C8000 server
!
ip vrf VRF-100-1
```

```
 rd 1:1
!
ip vrf VRF-100-2
 rd 1:1
!
crypto keyring cisco-100-1
 pre-shared-key address 10.1.1.1 key cisco-100-1
crypto keyring cisco-100-2
 pre-shared-key address 10.1.2.1 key cisco-100-2
crypto isakmp profile cisco-isakmp-profile-100-1
 vrf VRF-100-1
 keyring cisco-100-1
 match identity address 10.1.1.0 255.255.255.0
 virtual-template 1
crypto isakmp profile cisco-isakmp-profile-100-2
 vrf VRF-100-2
 keyring cisco-100-2
 match identity address 10.1.2.0 255.255.255.0
 virtual-template 1
!
!
crypto ipsec transform-set cisco esp-3des esp-sha-hmac
crypto ipsec profile cisco-ipsec-profile
 set security-policy limit 3
 set transform-set cisco
 set reverse-route gateway 172.16.0.1
!
!
!
interface Virtual-Template1 type tunnel
 ip unnumbered Ethernet 0/0
 tunnel mode ipsec ipv4
 tunnel protection ipsec profile cisco-ipsec-profile
!
!
```

Example: VRF-Aware IPsec with a Dynamic VTI When a VRF Is Configured Under Both a Virtual Template and an ISAKMP Profile

Note When separate VRFs are configured under an ISAKMP profile and a virtual template, the VRF configured under the virtual template takes precedence. This configuration is not recommended.

The following example shows how to configure VRF-aware IPsec to take advantage of the DVTI when the VRF is configured under both a virtual template and an ISAKMP profile:

```
hostname C8000 server
.
.
.
ip vrf test-vti2
 rd 1:2
 route-target export 1:1
 route-target import 1:1
!
.
```

```
.
.
ip vrf test-vti1
 rd 1:1
 route-target export 1:1
 route-target import 1:1
!
.
.
.
crypto isakmp profile cisco-isakmp-profile
 vrf test-vti2
 keyring key
 match identity address 10.1.1.0 255.255.255.0
!
.
.
.
interface Virtual-Template1 type tunnel
 ip vrf forwarding test-vti1
 ip unnumbered Loopback 0
 ip virtual-reassembly
 tunnel mode ipsec ipv4
 tunnel protection ipsec profile test-vti1
!
.
.
.
end
```

Example: Dynamic Virtual Tunnel Interface with Virtual Firewall

The DVTI Easy VPN server can be configured behind a virtual firewall. Behind-the-firewall configuration allows users to enter the network, while the network firewall is protected from unauthorized access. The virtual firewall uses Context-Based Access Control (CBAC) and NAT applied to the Internet interface as well as to the virtual template.

```
hostname c8000
.
.
ip inspect max-incomplete high 1000000
ip inspect max-incomplete low 800000
ip inspect one-minute high 1000000
ip inspect one-minute low 800000
ip inspect tcp synwait-time 60
ip inspect tcp max-incomplete host 100000 block-time 2
ip inspect name IOSFW1 tcp timeout 300
ip inspect name IOSFW1 udp
!
.
.
interface GigabitEthernet0/1
 description Internet Connection
 ip address 172.18.143.246 255.255.255.0
 ip access-group 100 in
 ip nat outside
!
interface GigabitEthernet0/2
 description Internal Network
 ip address 10.2.1.1 255.255.255.0
```

```
!
interface Virtual-Template1 type tunnel
 ip unnumbered Loopback0
 ip nat inside
 ip inspect IOSFW1 in
 tunnel mode ipsec ipv4
 tunnel protection ipsec profile test-vti1
!
ip classless
ip route 0.0.0.0 0.0.0.0 172.18.143.1
!
ip nat translation timeout 120
ip nat translation finrst-timeout 2
ip nat translation max-entries 300000
ip nat pool test1 10.2.100.1 10.2.100.50 netmask 255.255.255.0
ip nat inside source list 110 pool test1 vrf test-vti1 overload
!
access-list 100 permit esp any any
access-list 100 permit udp any eq isakmp any
access-list 100 permit udp any eq non500-isakmp any
access-list 100 permit icmp any any
access-list 110 deny   esp any any
access-list 110 deny   udp any eq isakmp any
access-list 110 permit ip any any
access-list 110 deny   udp any eq non500-isakmp any
!
end
```

Example: Dynamic Virtual Tunnel Interface with QoS

You can add QoS to the DVTI tunnel by applying the service policy to the virtual template. When the template is cloned to make the virtual access interface, the service policy will also be applied to the virtual access interface. The following example shows the basic DVTI configuration with QoS added.

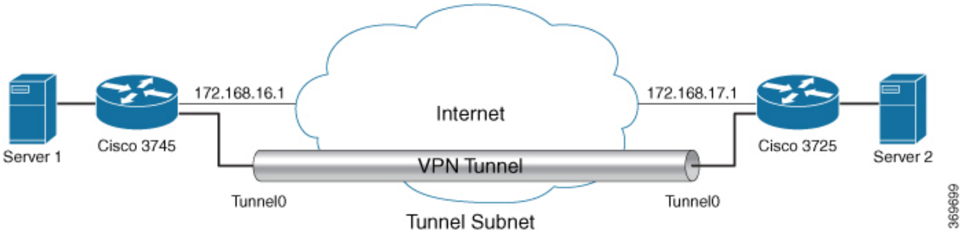
```
hostname c8000
.
.
class-map match-all VTI
 match any
!
policy-map VTI
  class VTI
  police cir 2000000
    conform-action transmit
    exceed-action drop
!
.
.
interface Virtual-Template1 type tunnel
 ip vrf forwarding test-vti1
 ip unnumbered Loopback0
 ip virtual-reassembly
 tunnel mode ipsec ipv4
 tunnel protection ipsec profile test-vti1
 service-policy output VTI
!
.
.
!
end
```

Example: Static Virtual Tunnel Interface with Multiple IPsec SAs

In the following examples an IPSec tunnel is to be established between two routers Cisco 3745 and Cisco 3725 using SVTI. The configuration uses non-any-any traffic selectors and enables the formation of multiple IPSec SAs.

Sample configuration on a Router with the IPv4 Tunnel Mode:

The following figure illustrates the reference topology for the configuration.



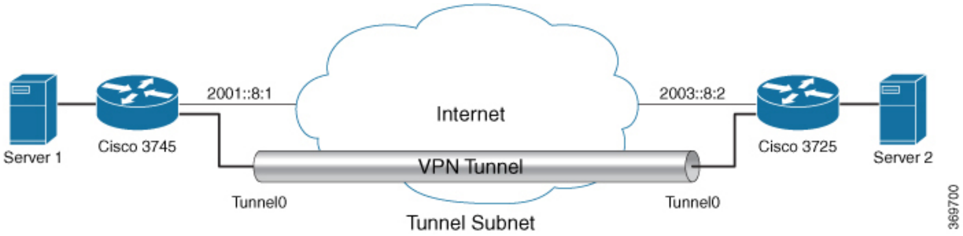
Sample configuration for the router Cisco 3745 is as follows:

```
crypto isakmp policy 1
 authentication pre-share
 group 2
!
crypto isakmp policy 5
 encr 3des
 authentication pre-share
 group 2
crypto isakmp key example address 172.168.17.1
!
!
crypto ipsec transform-set svti1 esp-3des esp-sha-hmac
 mode tunnel
!
!
crypto ipsec profile ipsec_prof
 set transform-set svti1
!
!
!
interface Loopback0
 ip address 30.0.0.1 255.255.255.0
!
interface Loopback1
 ip address 50.0.0.1 255.255.255.0
!
interface Tunnel0
 ip address 11.1.1.2 255.255.255.0
 tunnel source Ethernet0/0
 tunnel mode ipsec ipv4
 tunnel destination 172.168.17.1
 tunnel protection ipsec policy ipv4 ipsec_acl1
 tunnel protection ipsec profile ipsec_prof
!
interface Ethernet0/0
 ip address 172.168.16.1 255.255.255.0
!
!
ip access-list extended ipsec_acl1
```

```
permit ip 30.0.0.0 0.0.0.255 40.0.0.0 0.0.0.255
permit ip 50.0.0.0 0.0.0.255 60.0.0.0 0.0.0.255
```

Sample configuration on a Router with the IPv6 Tunnel Mode:

The following figure illustrates the reference topology for the configuration.



Sample configuration for the router Cisco 3745 is as follows:

```
crypto isakmp policy 1
 authentication pre-share
 group 2
!
crypto isakmp policy 5
 encr 3des
 authentication pre-share
 group 2
crypto isakmp key example address ipv6 2003::8:2/112
!
!
crypto ipsec transform-set svti1 esp-3des esp-sha-hmac
 mode tunnel
!
!
crypto ipsec profile ipsec_prof
 set transform-set svti1
!
!
!
interface Loopback0
 ipv6 address 2005::10:1/112
 ipv6 enable
!
interface Loopback1
 ipv6 address 2005::15:1/112
 ipv6 enable
!
interface Loopback2
 ipv6 address 2005::20:1/112
 ipv6 enable
!
interface Tunnel0
 ip address 11.1.1.2 255.255.255.0
 ipv6 address 400::10:1/112
 ipv6 enable
 tunnel source Ethernet0/0
 tunnel mode ipsec ipv6
 tunnel destination 2003::8:2
 tunnel protection ipsec policy ipv6 ipsec_acl2
 tunnel protection ipsec profile ipsec_prof
!
interface Ethernet0/0
 ipv6 address 2001::8:1/112
 ipv6 enable
```

```
!
!
ipv6 access-list ipsec_acl2
sequence 10 permit ipv6 host 2005::10:1 host 2005::11:1
sequence 20 permit ipv6 host 2005::15:1 host 2005::16:1
sequence 30 permit ipv6 host 2005::20:1 host 2005::21:1
```

Example: Configuring Tunnel Mode as Dual-overlay

The following example shows how to configure tunnel mode as dual-overlay:

```
Device# configure terminal
Router(config)# interface tunnel 1
Router(config-if)# ipv4 enable
Router(config-if)# tunnel source ethernet 0/0
Router(config-if)# tunnel mode ipsec dual-overlay
Router(config-if)# tunnel destination 89.89.89.1
Device(config-if)# tunnel protection IPsec profile ipsecprof
```

Verifying the Tunnel Mode as Dual-overlay Configuration

Use the following commands to troubleshoot your configuration:

- **Show crypto session [detail]**
- **Show crypto ipsec sa**
- **Show crypto map**
- **Show crypto socket**
- **Show crypto ikev2 session [detail]**

```
Device# show crypto map
Crypto Map: "Tunnel0-head-0" IKEv2 profile: prof

Crypto Map IPv4 "Tunnel0-head-0" 65536 ipsec-isakmp
 IKEv2 Profile: prof
 Profile name: prof
 Security association lifetime: 4608000 kilobytes/120 seconds
 Dualstack (Y/N): N

 Responder-Only (Y/N): N
 PFS (Y/N): N
 Mixed-mode : Disabled
 Transform sets={
  default:  { esp-aes esp-sha-hmac  } ,
 }

Crypto Map IPv4 "Tunnel0-head-0" 65537 ipsec-isakmp
 Map is a PROFILE INSTANCE.
 Peer = 10.10.10.2
 IKEv2 Profile: prof
 Extended IP access list
     access-list  permit ip any any
 Current peer: 10.10.10.2
 Security association lifetime: 4608000 kilobytes/120 seconds
        Dualstack (Y/N): Y
        TRUE  ident (addr/mask/prot/port): {LOCAL -> REMOTE}
             0.0.0.0/0.0.0.0/0/0 -> 0.0.0.0/0.0.0.0/0/0
             ::/0.0.0.0/0/0 -> ::/0/0/0
 Responder-Only (Y/N): N
 PFS (Y/N): N
 Mixed-mode : Disabled
 Transform sets={
  default:  { esp-aes esp-sha-hmac  } ,
 }
 Always create SAs
 Interfaces using crypto map Tunnel0-head-0:
  Tunnel0

Device# show  crypto ipsec sa

interface: Tunnel0
    Crypto map tag: Tunnel0-head-0, local addr 10.10.10.1

   protected vrf: (none)
   local  ident (addr/mask/prot/port): (0.0.0.0/0.0.0.0/0/0)
   remote ident (addr/mask/prot/port): (0.0.0.0/0.0.0.0/0/0)
    TRUE  ident (addr/mask/prot/port): {LOCAL -> REMOTE}
             0.0.0.0/0.0.0.0/0/0 -> 0.0.0.0/0.0.0.0/0/0
             ::/0.0.0.0/0/0 -> ::/0/0/0
   current_peer 10.10.10.2 port 500
     PERMIT, flags={origin_is_acl,}
    #pkts encaps: 0, #pkts encrypt: 0, #pkts digest: 0
    #pkts decaps: 0, #pkts decrypt: 0, #pkts verify: 0
    #pkts compressed: 0, #pkts decompressed: 0
    #pkts not compressed: 0, #pkts compr. failed: 0
    #pkts not decompressed: 0, #pkts decompress failed: 0
    #send errors 0, #recv errors 0

     local crypto endpt.: 10.10.10.1, remote crypto endpt.: 10.10.10.2
     plaintext mtu 1438, path mtu 1500, ip mtu 1500, ip mtu idb Ethernet0/0
     current outbound spi: 0x4776A36B(1198957419)
     PFS (Y/N): N, DH group: none

     inbound esp sas:
      spi: 0xA97EDEE7(2843664103)
        transform: esp-aes esp-sha-hmac ,
        in use settings ={Tunnel, }
        conn id: 4, flow_id: 4, sibling_flags FFFFFFFF80000040, crypto map: Tunnel0-head-0
         sa timing: remaining key lifetime (k/sec): (4377587/76)
        IV size: 16 bytes
        replay detection support: Y
        Status: ACTIVE(ACTIVE)

     inbound ah sas:

     inbound pcp sas:

     outbound esp sas:
      spi: 0x4776A36B(1198957419)
        transform: esp-aes esp-sha-hmac ,
        in use settings ={Tunnel, }
        conn id: 3, flow_id: 3, sibling_flags FFFFFFFF80000040, crypto map: Tunnel0-head-0
         sa timing: remaining key lifetime (k/sec): (4377587/76)
        IV size: 16 bytes
        replay detection support: Y
        Status: ACTIVE(ACTIVE)

     outbound ah sas:

     outbound pcp sas:

Device# show crypto socket
```

```
Number of Crypto Socket connections 1

   Tu0 Peers (local/remote): 10.10.10.1/10.10.10.2
       Local Ident  (addr/mask/port/prot): (0.0.0.0/0.0.0.0/0/0)
       Remote Ident (addr/mask/port/prot): (0.0.0.0/0.0.0.0/0/0)
        TRUE  ident (addr/mask/prot/port): {LOCAL -> REMOTE}
             0.0.0.0/0.0.0.0/0/0 -> 0.0.0.0/0.0.0.0/0/0
             ::/0.0.0.0/0/0 -> ::/0/0/0
       IPSec Profile: "prof"
       Socket State: Open
       Client: "TUNNEL SEC" (Client State: Active)
Crypto Sockets in Listen state:
Client: "TUNNEL SEC" Profile: "prof" Map-name: "Tunnel0-head-0"

Device# show cry ikev2 session
 IPv4 Crypto IKEv2 Session

Session-id:1, Status:UP-ACTIVE, IKE count:1, CHILD count:1

Tunnel-id Local                 Remote                fvrf/ivrf            Status
1         10.10.10.1/500        10.10.10.2/500        none/none            READY
      Encr: AES-CBC, keysize: 256, PRF: SHA512, Hash: SHA512, DH Grp:19, Auth sign: PSK,
Auth verify: PSK
      Life/Active Time: 86400/145 sec
      CE id: 1001, Session-id: 1
      Local spi: 25A0B173944015D3       Remote spi: 9F0C7677425670E1
Child sa:
          local selector  0.0.0.0/0 - 255.255.255.255/65535
          local selector  ::/0 - FFFF:FFFF:FFFF:FFFF:FFFF:FFFF:FFFF:FFFF/65535
          remote selector 0.0.0.0/0 - 255.255.255.255/65535
          remote selector ::/0 - FFFF:FFFF:FFFF:FFFF:FFFF:FFFF:FFFF:FFFF/65535
          ESP spi in/out: 0xA97EDEE7/0x4776A36B

 IPv6 Crypto IKEv2 Session

Device# show crypto session
Crypto session current status

Interface: Tunnel0
Profile: prof
Session status: UP-ACTIVE
Peer: 10.10.10.2 port 500
  Session ID: 1
  IKEv2 SA: local 10.10.10.1/500 remote 10.10.10.2/500 Active
  IPSEC FLOW: permit ip   0.0.0.0/0.0.0.0 0.0.0.0/0.0.0.0
  TRUE IDENT (addr/mask/prot/port): {LOCAL -> REMOTE}
             0.0.0.0/0.0.0.0/0/0 -> 0.0.0.0/0.0.0.0/0/0
             ::/0.0.0.0/0/0 -> ::/0/0/0
        Active SAs: 2, origin: crypto map
```

Additional References for IPsec Virtual Tunnel Interface

Related Documents

Related Topic	Document Title
Cisco IOS commands	Cisco IOS Master Command List, All Releases

Related Topic	Document Title
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
IPsec configuration	*Configuring Security for VPNs with IPsec*
QoS configuration	*Cisco IOS Quality of Service Solutions Configuration Guide*
EasyVPN configuration	- *Cisco Easy VPN Remote* - *Easy VPN Server*
Recommended cryptographic algorithms	Next Generation Encryption

Standards and RFCs

Standard/RFC	Title
RFC 2401	*Security Architecture for the Internet Protocol*
RFC 2408	*Internet Security Association and Key Management Protocol*
RFC 2409	*The Internet Key Exchange (IKE)*

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 IPsec Virtual Tunnel Interfaces

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 IPsec Virtual Tunnel Interfaces

Feature Name	Releases	Feature Configuration Information
Dynamic IPsec VTIs	12.3(7)T 12.3(14)T	Dynamic VTIs enable efficient use of IP addresses and provide secure connectivity. Dynamic VTIs allow dynamically downloadable per-group and per-user policies to be configured on a RADIUS server. IPsec dynamic VTIs allow you to create highly secure connectivity for remote access VPNs. The dynamic VTI simplifies VRF-aware IPsec deployment. The following commands were introduced or modified: **crypto isakmp profile, interface virtual-template, show vtemplate, tunnel mode, virtual-template.**
FlexVPN Mixed Mode Support	15.4(2)T Cisco IOS XE Release 3.10S	The FlexVPN Mixed Mode feature provides support for carrying IPv4 traffic over IPsec IPv6 transport. This is the first phase towards providing dual stack support on the IPsec stack. This implementation does not support using a single IPsec security association (SA) pair for both IPv4 and IPv6 traffic. This feature is only supported for Remote Access VPN with IKEv2 and Dynamic VTI.

Feature Name	Releases	Feature Configuration Information
Multi-SA for Dynamic VTIs	15.2(1)T Cisco IOS XE Release 3.2S	The DVTI can accept multiple IPsec selectors that are proposed by the initiator. The following commands were introduced or modified: **set security-policy limit, set reverse-route.**
Static IPsec VTIs	12.2(33)SRA 12.2(33)SXH 12.3(7)T 12.3(14)T Cisco IOS XE Release 2.1	IPsec VTIs provide a routable interface type for terminating IPsec tunnels and an easy way to define protection between sites to form an overlay network. IPsec VTIs simplify configuration of IPsec for protection of remote links, support multicast, and simplify network management and load balancing.
Tunnel Mode Auto Selection	15.4(2)T Cisco IOS XE Release 3.12S	The Tunnel Mode Auto Selection feature eases the configuration and spares you about knowing the responder’s details. This feature automatically applies the tunneling protocol (GRE or IPsec) and transport protocol (IPv4 or IPv6) on the virtual template as soon as the IKE profile creates the virtual access interface. The following command was introduced or modified: **virtual-template**
FlexVPN Mixed Mode v6 over v4 Transport	Cisco IOS XE Everest 16.4.1	The FlexVPN Mixed Mode v6 over v4 Transport feature provides support for carrying IPv6 traffic over IPsec IPv4 transport. This implementation does not support using a single IPsec security association (SA) pair for both IPv4 and IPv6 traffic.

Feature Name	Releases	Feature Configuration Information
IPsec Dual Stack Support on Non Cisco Devices	Cisco IOS XE Cupertino 17.9.x	This feature provides the capabilities to carry both IPv4 and IPv6 traffic using a single IPsec Security Association (SA) that is tunnelled over IPv4. From IOS XE release 17.9.1a onwards, Cisco supports specific subnets in the access control list when the ingress end of the tunnel interface is configured with a third party IPsec client. With the introduction of the SVTI single security association dual stack feature, you can now manage the business-to-business services and other IOT business efficiently.