Configure DVTI with Multi-SA on Secure Firewall

Contents

Introduction

This document describes how to configure a DVTI on a Cisco Secure Firewall (Hub), with multiple remote extranet devices (spokes).

Background

Dynamic Virtual Tunnel Interfaces

Dynamic Virtual Tunnel Interfaces (DVTI) can provide highly secure and scalable connectivity for remote-access Virtual Prive Networks (VPN).

DVTIs can be used for both the Hub and Spoke configuration. The tunnels provide an on-demand separate virtual access interface for each VPN session.

1. The spoke initiates an IKE exchange request with the hub for a VPN connection.

2. The hub authenticates the spoke.

3. The Cisco Secure Fireawall Management Centerassigns a dynamic virtual template on the hub.

4. The virtual template dynamically generates a virtual access interface on the hub. This interface is unique for the VPN session per spoke.

5. The hub establishes a dynamic VTI tunnel with the spoke throuh the virtual access interface.

6. The hub and spoke exchange traffic over the tunnel with dynamic routing protocols (BGP/OSPF/EIGRP) or with protected networks feature (Multiple-Security Assosiations VTI).

7. Dynamic VTIs function like any other interface so that you can apply QoS, firewall rules, routing protocols and other features as soon as the tunnel is active.

8. A single DVTI is created at the HUB device and multiple Static Tunnel Interfaces for multiple remote/spoke sites.

Note: Cisco Secure Firewall added support fot DVTI on version 7.3 and currently it only supports one single DVTI as per Cisco bug ID CSCwe13781. Only registered Cisco users can access internal Cisco tools and information.

Multiple Security Asssosiation VTI feature was implemented in order to support compatibility between route based VPN and policy based VPN systems,

Prerequisites

- Have at least two Cisco Secure Firewall devices already registered with the Cisco Secure Firewall Management Center with basic routing configuration to work as one hub and one spoke-1 respectively with one Loopback interface on each device to simulate local networks on premises of 192.168.5.0/24 (hub) and remote local network of 192.168.6.0/24 (spoke-1).
- Have one ASA in place with basic routing configuration and IKEv2 support to work as a spoke-2 with one Loopback interface pre configured to simulate remote local network of 192.168.7.0/24.
- Have one Cisco IOS / Cisco IOSXE router with basic routing configuration and IKEV2 support to work as a spoke-3 with one Loopback interface pre configured to simulate remote local network of 192.168.8.0/24.

Requirements

- Knowledge on VPN technologies and IKEv2 protocol.
- Knowledge on Cisco Secure Firewall Management Center GUI (FMC) navigation and configuration for Cisco Secure Firewall devices.
- Basic configuration knowledge on Cisco IOS-XE devices.
- Basic IPV4 routing concepts.

Note: The information in this document was created from the devices in a specific lab environment. All of the devices used in this document started with a cleared (default) configuration. If your network is live, ensure that you understand the potential impact of any command.

Components Used

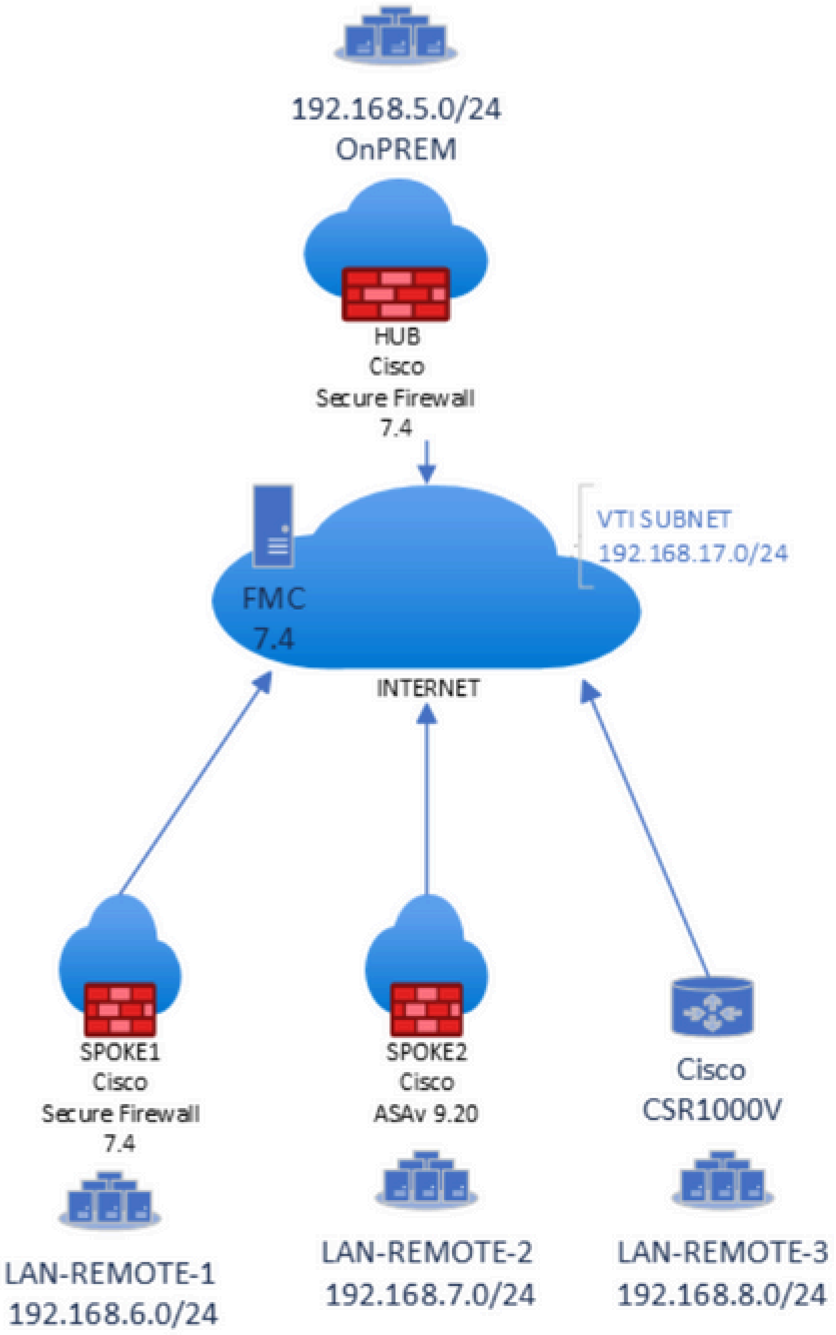
The information in this document is based on these software versions:

- Cisco Secure Firewall Management Center (FMC) 7.3 or later.
- Cisco Secure Firewall 7.3 or later.
- ASAv 9.20 or later
- Cisco CSR

Note: The information in this document was created from the devices in a specific lab environment. All of the devices used in this document started with a cleared (default) configuration. If your network is live, ensure that you understand the potential impact of any command.

Configure

Network Diagram

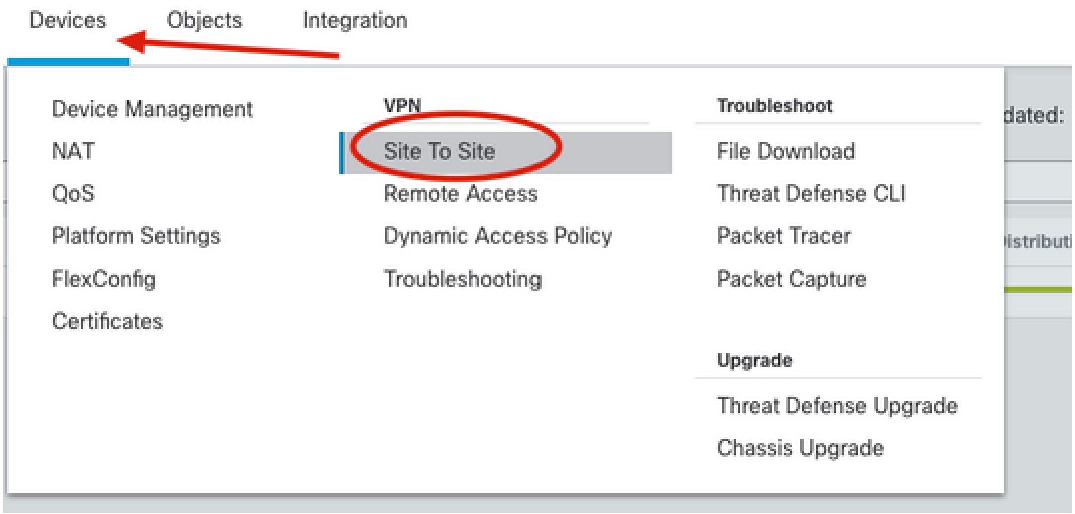


Note: All local and remote subnets are simulated with Loopback interfaces previously configured on each device.

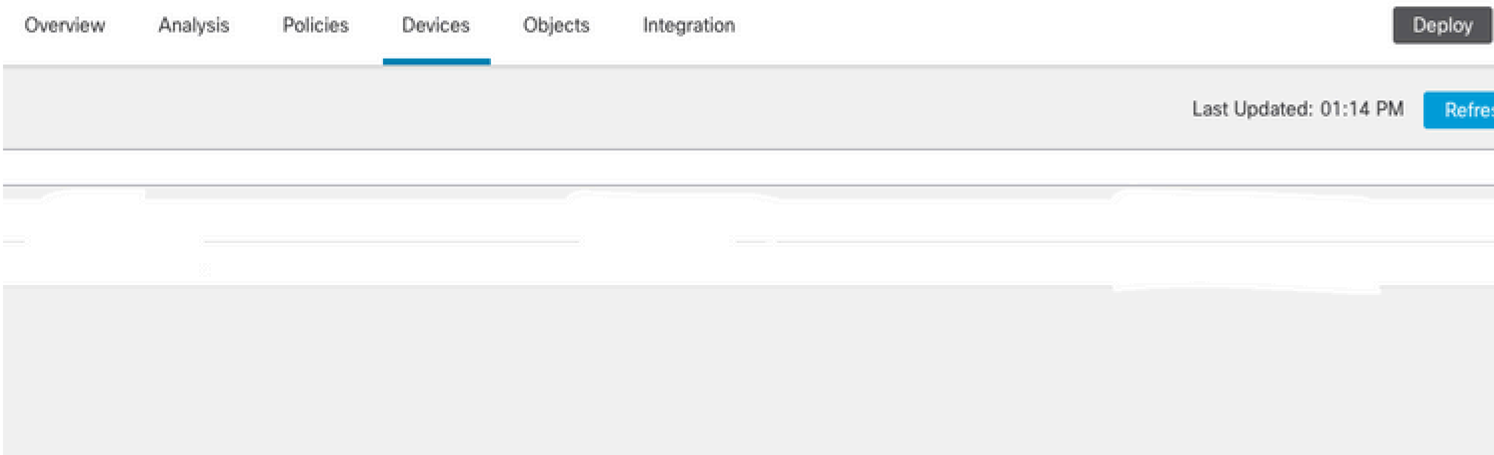
Configurations

1.Log in into FMC GUI with administrator credentials.

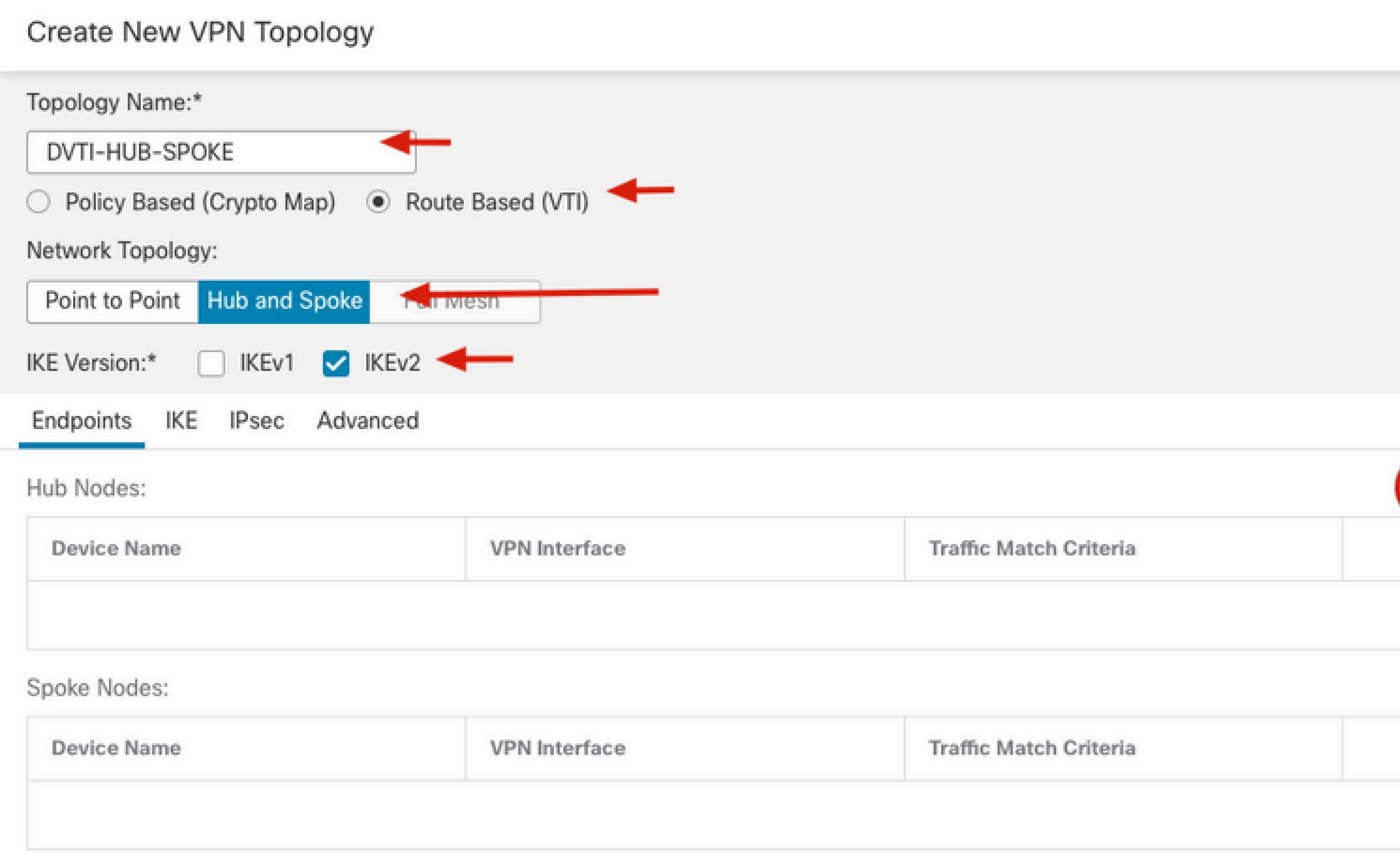
2. From the FMC dashboard view, go to **Devices** and click on **Site To Site** under **VPN** options.



3.From the **Site to Site** dashboard, click on **+ Site to Site VPN** to create a new Site to Site topology.



4. From the **Create New VPN Topology** menu, specify the new name and select **Route Based (VTI)** as the VPN type of the new topology, check I**KEv2** protocol from the **IKE Version** options, select **Hub and Spoke** under the **Network Topology** settings and click on the **+** icon from the **Hub Nodes** section to designate a new Hub device.



Create New VPN Topology

Topology Name:* DVTI-HUB-SPOKE

○ Policy Based (Crypto Map) ● Route Based (VTI)

Network Topology: Point to Point | **Hub and Spoke** | Full Mesh

IKE Version:* □ IKEv1 ☑ IKEv2

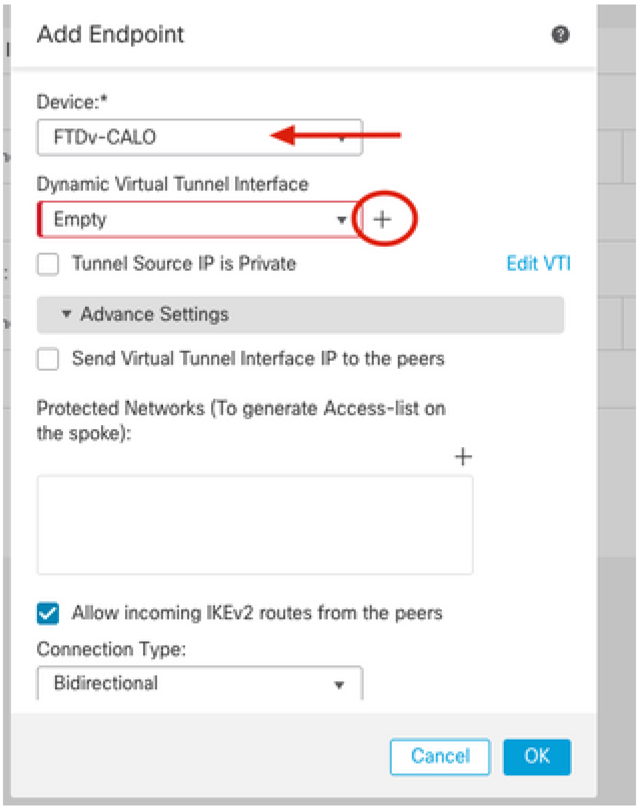
Hub Nodes:

Device Name	VPN Interface	Traffic Match Criteria

Spoke Nodes:

Device Name	VPN Interface	Traffic Match Criteria

5. From the **Add Endpoint** window, select the device that works as the hub and click on the + icon next to **Dynamic Virtual Tunnel Interface** dropdown menu to create a new DVTI.



Add Endpoint

Device:* FTDv-CALO

Dynamic Virtual Tunnel Interface: Empty +

□ Tunnel Source IP is Private

□ Send Virtual Tunnel Interface IP to the peers

Protected Networks (To generate Access-list on the spoke):

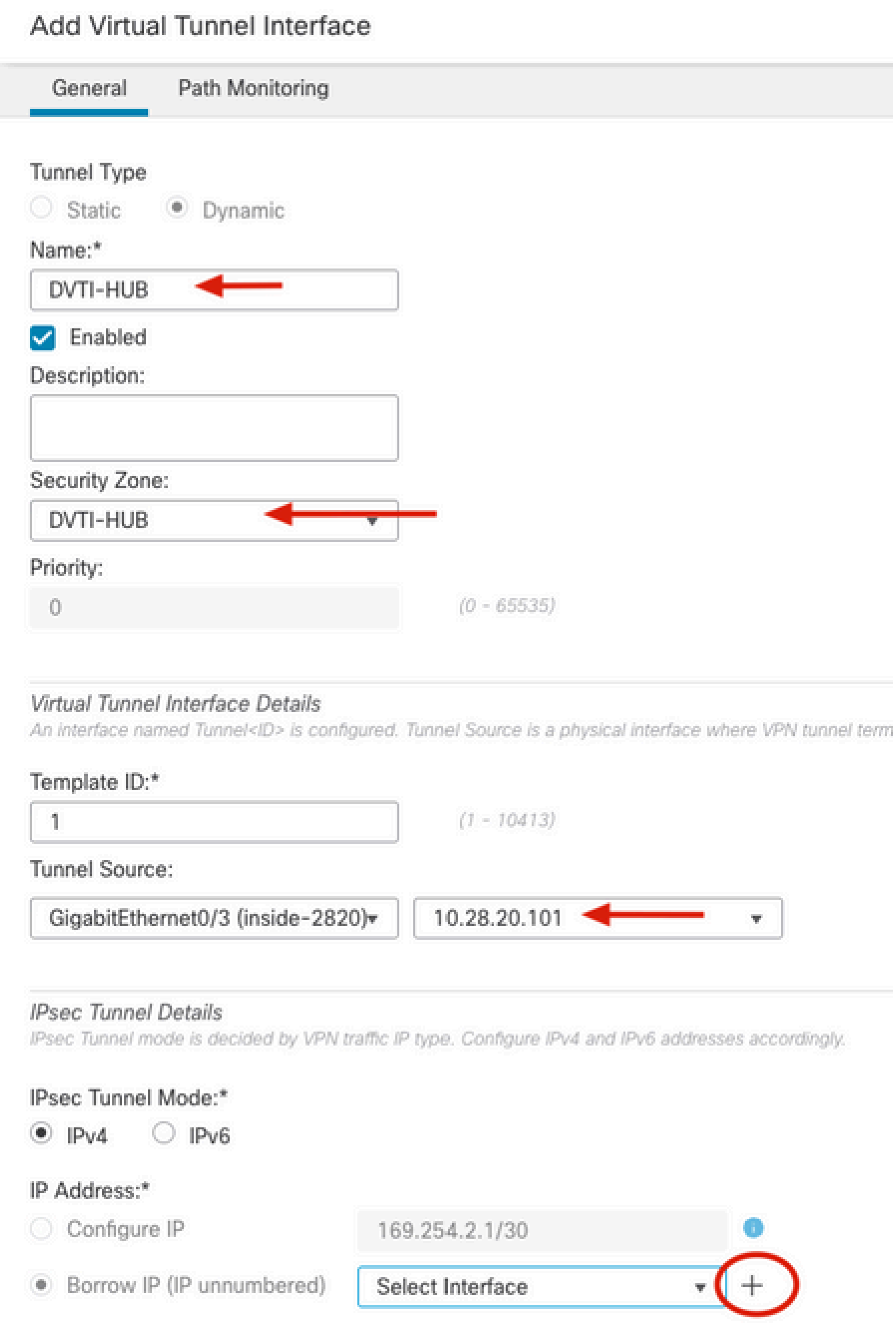
☑ Allow incoming IKEv2 routes from the peers

Connection Type: Bidirectional

6. From the **Add Virtual Tunnel Interface** menu, specify the name of the new Tunnel interface, assign it to the desired **Security Zone**, select the **Tunnel Source** with its IP and click on the **+** icon under the **IP Address** configuration in order to create a new Loopback interface next to the **Borrow IP** option.

Cisco recommends to configure the Borrowed IP for the dynamic interface from a Loopback interface.

Note: Tunnel source interface needs to be routable and able to reach remote spokes peer IPs



Add Virtual Tunnel Interface

General | Path Monitoring

Tunnel Type

○ Static ● Dynamic

Name:* DVTI-HUB

☑ Enabled

Description:

Security Zone: DVTI-HUB

Priority: 0 (0 - 65535)

Virtual Tunnel Interface Details

An interface named Tunnel<ID> is configured. Tunnel Source is a physical interface where VPN tunnel term

Template ID:* 1 (1 - 10413)

Tunnel Source: GigabitEthernet0/3 (inside-2820) 10.28.20.101

IPsec Tunnel Details

IPsec Tunnel mode is decided by VPN traffic IP type. Configure IPv4 and IPv6 addresses accordingly.

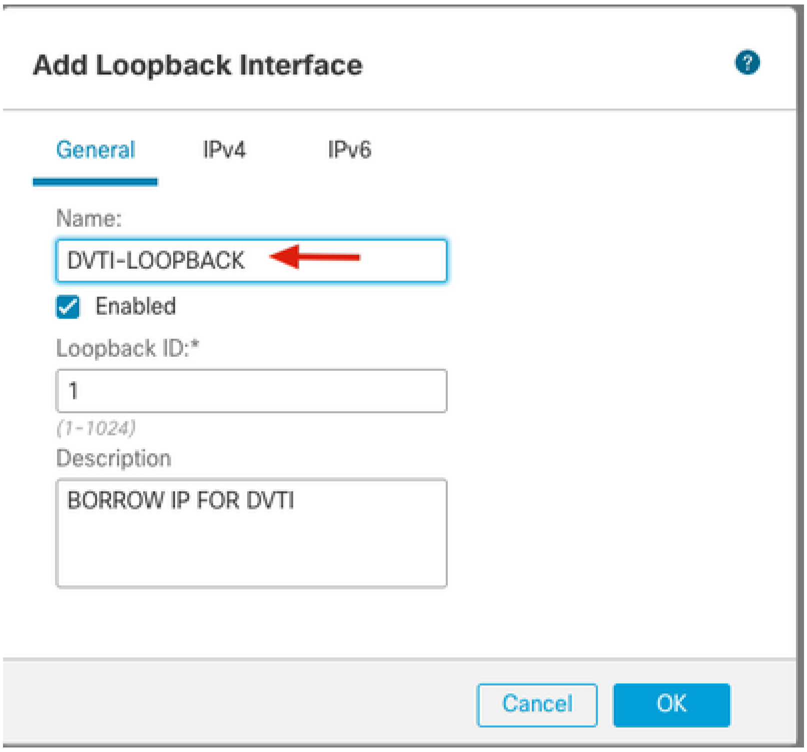
IPsec Tunnel Mode:* ● IPv4 ○ IPv6

IP Address:*

○ Configure IP 169.254.2.1/30

● Borrow IP (IP unnumbered) Select Interface +

7. From the **Add Loopback Interface** window, specify the name of the interface with its ID and go to **IPv4** tab.



Add Loopback Interface

Name: DVTI-LOOPBACK

☑ Enabled

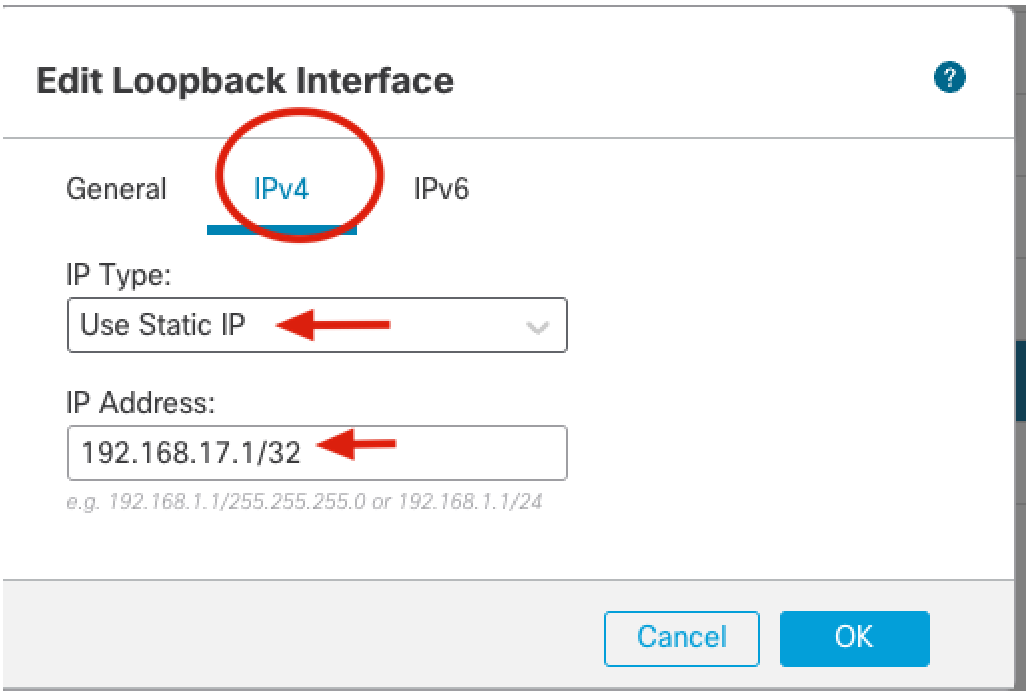
Loopback ID:* 1

(1-1024)

Description: BORROW IP FOR DVTI

8. From the **IPv4** tab select **Use Static IP** under the **IP Type** option from the dropdown menu and specify the IP Address that belongs to the DVTI and click **OK**.

Note: Hub DVTI has an IP Address of 192.168.17.1/32.



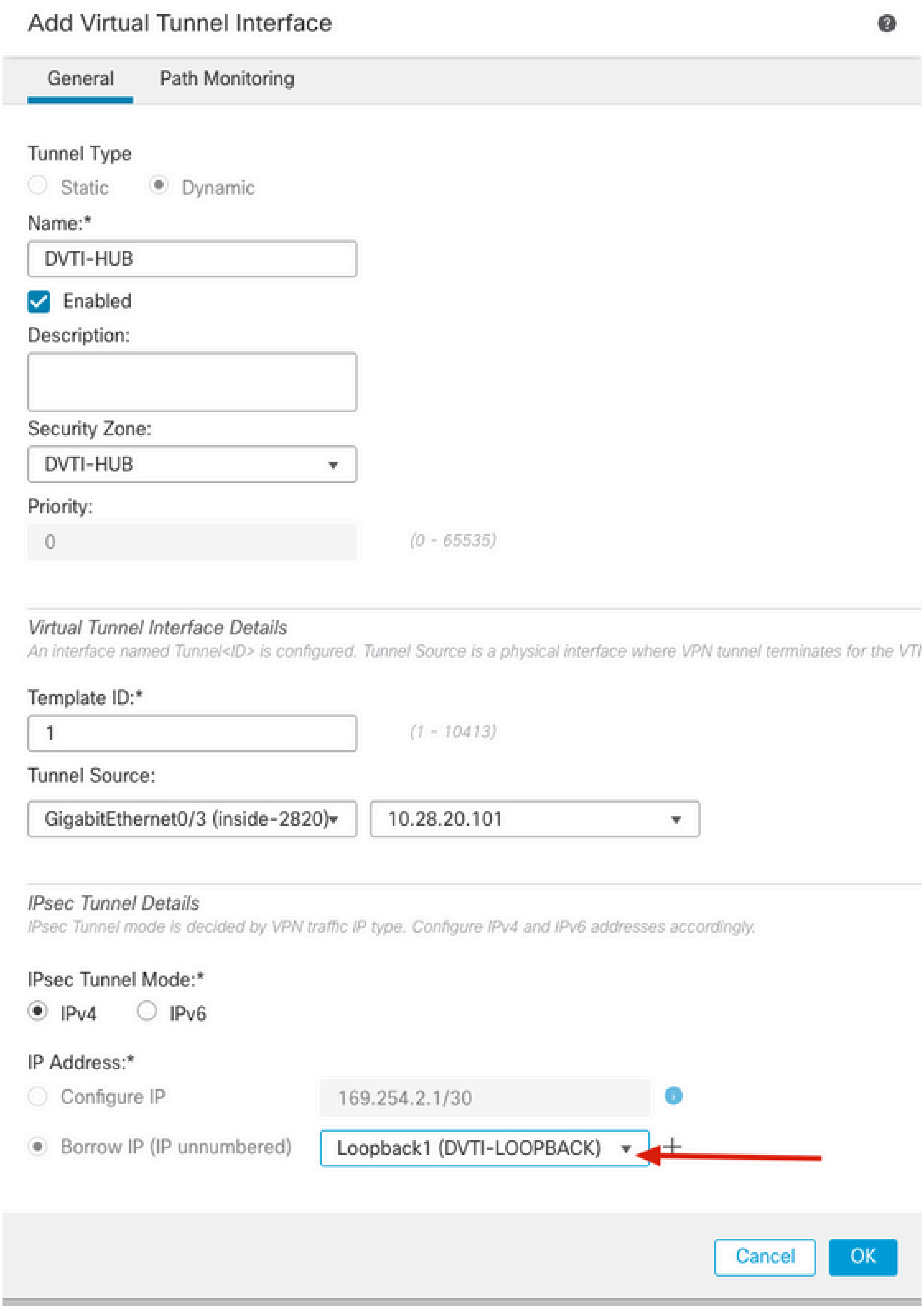
Edit Loopback Interface

IP Type: Use Static IP

IP Address: 192.168.17.1/32

e.g. 192.168.1.1/255.255.255.0 or 192.168.1.1/24

9. From the **Add Virtual Tunnel Interface** menu, new Loobpack is displayed under the dropdown menu, select it and click **OK**.



Add Virtual Tunnel Interface

Tunnel Type

○ Static ● Dynamic

Name:* DVTI-HUB

☑ Enabled

Description:

Security Zone: DVTI-HUB

Priority: 0 (0 - 65535)

Virtual Tunnel Interface Details

An interface named Tunnel<ID> is configured. Tunnel Source is a physical interface where VPN tunnel terminates for the VTI

Template ID:* 1 (1 - 10413)

Tunnel Source: GigabitEthernet0/3 (inside-2820) 10.28.20.101

IPsec Tunnel Details

IPsec Tunnel mode is decided by VPN traffic IP type. Configure IPv4 and IPv6 addresses accordingly.

IPsec Tunnel Mode:*

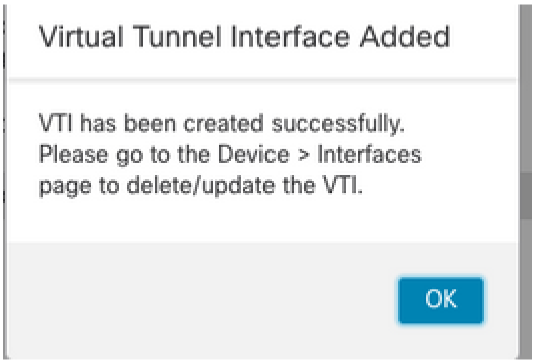
● IPv4 ○ IPv6

IP Address:*

○ Configure IP 169.254.2.1/30

● Borrow IP (IP unnumbered) Loopback1 (DVTI-LOOPBACK)

10. A **Virtual Tunnel Interface Added** window is prompted that indicates the new DVTI has been created, click **Ok** and continue.

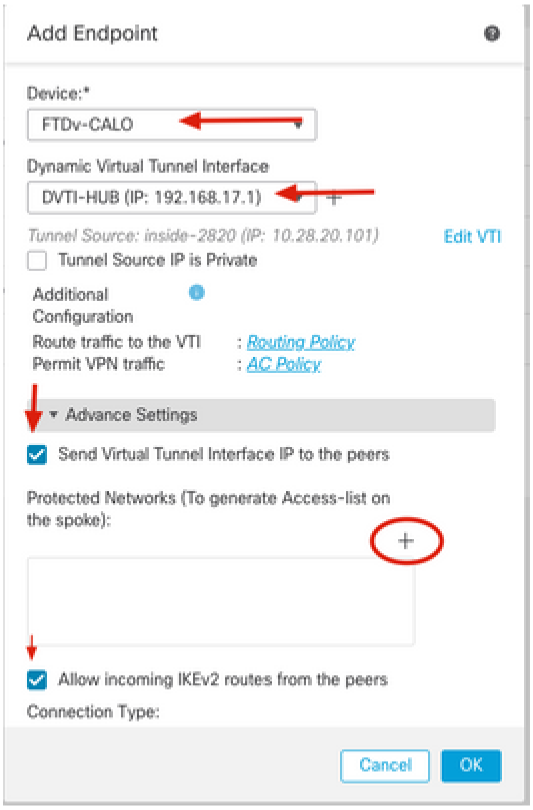


Virtual Tunnel Interface Added

VTI has been created successfully. Please go to the Device > Interfaces page to delete/update the VTI.

11. From the **Add Endpoint** window, new DVTI is displayed under **Dynamic Virtual Tunnel Interface** dropdown bar, select it, check the **Send Virtual Tunnel Interface IP to peers** box option along with the **Allow incoming IKEv2 routes from the peers** option and click on the **+** next to the **Protected Networks** settings in order to specify the networks behind the hub device.

> **Note**: In this example, a second loopback interface on the hub simulates a host in the local OnPREM subnet as part of the protected network with an IP Address of 192.168.5.1/24.



Add Endpoint

Device:* FTDv-CALO

Dynamic Virtual Tunnel Interface: DVTI-HUB (IP: 192.168.17.1)

Tunnel Source: inside-2820 (IP: 10.28.20.101)

□ Tunnel Source IP is Private

Additional Configuration

Route traffic to the VTI : Routing Policy

Permit VPN traffic : AC Policy

☑ Send Virtual Tunnel Interface IP to the peers

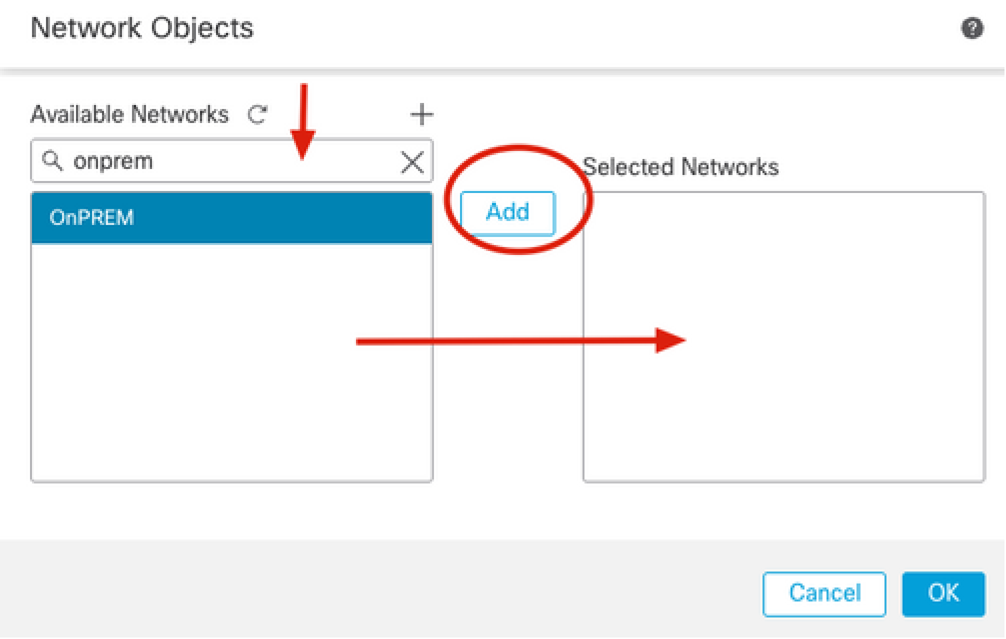
Protected Networks (To generate Access-list on the spoke):

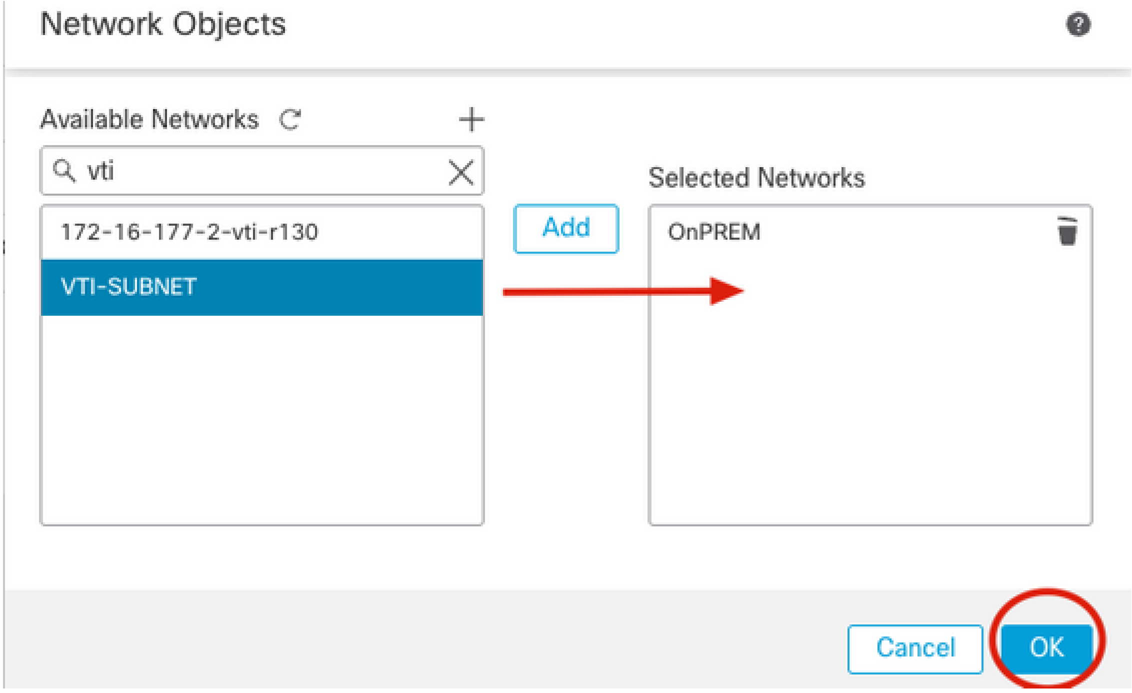
☑ Allow incoming IKEv2 routes from the peers

Connection Type:

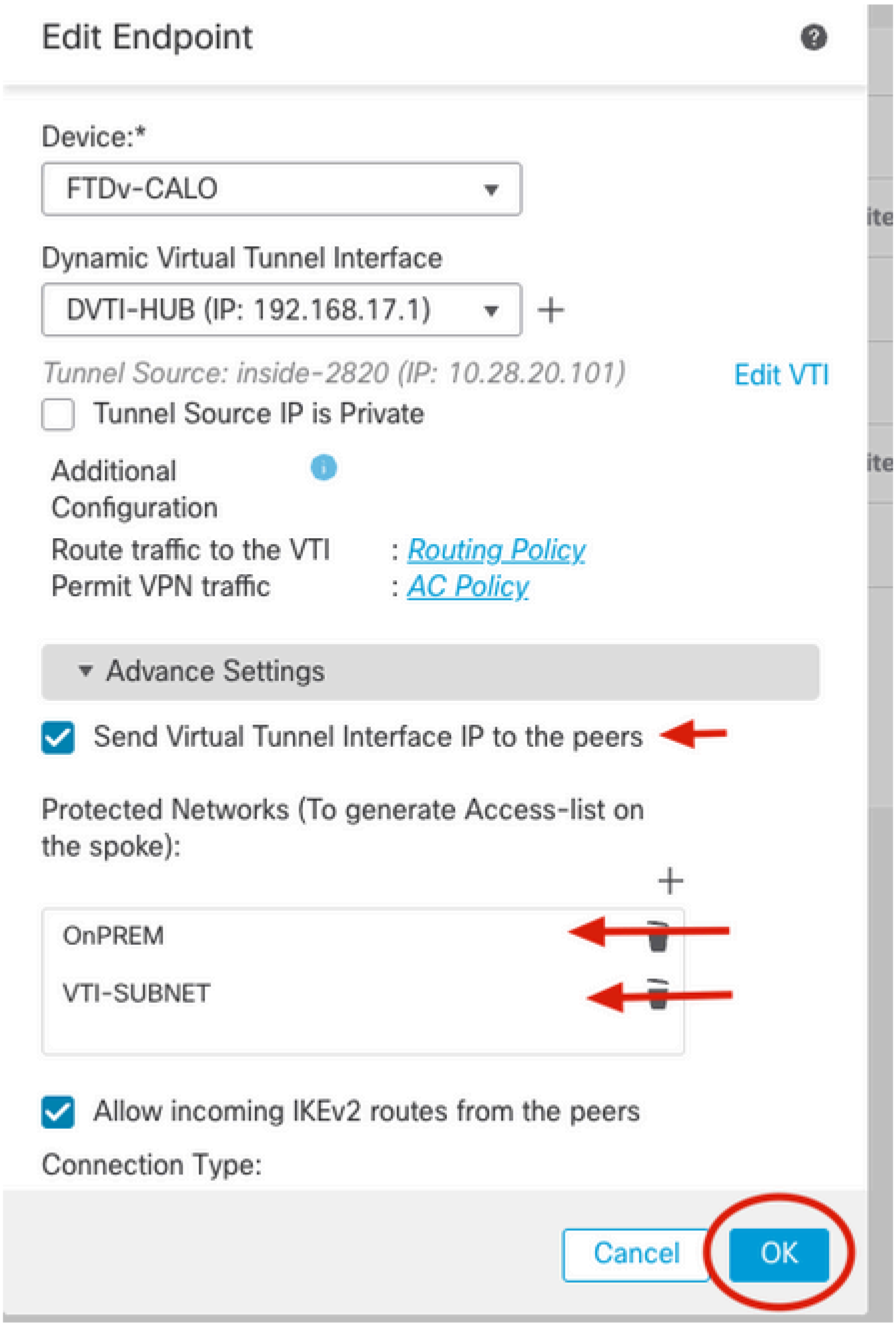
12. On the **Available Networks** section, identify the subnet that simulates the local protected network as well as the DVTI subnet (192.168.17.0/24) and click on **Add** and then **OK** to apply the change.

> **Note**: In this article a network object has been preconfigured as **OnPREM** with the 192.168.17.0/24 network. DVTI subnet needs to be added in order to protect traffic that is sourced from the tunnel interfaces.





13. Confirm the new protected network object has been added and click **OK**.



Edit Endpoint

Device:* FTDv-CALO

Dynamic Virtual Tunnel Interface: DVTI-HUB (IP: 192.168.17.1)

Tunnel Source: inside-2820 (IP: 10.28.20.101)

☐ Tunnel Source IP is Private

Additional Configuration

Route traffic to the VTI : Routing Policy

Permit VPN traffic : AC Policy

Advance Settings

☑ Send Virtual Tunnel Interface IP to the peers

Protected Networks (To generate Access-list on the spoke):

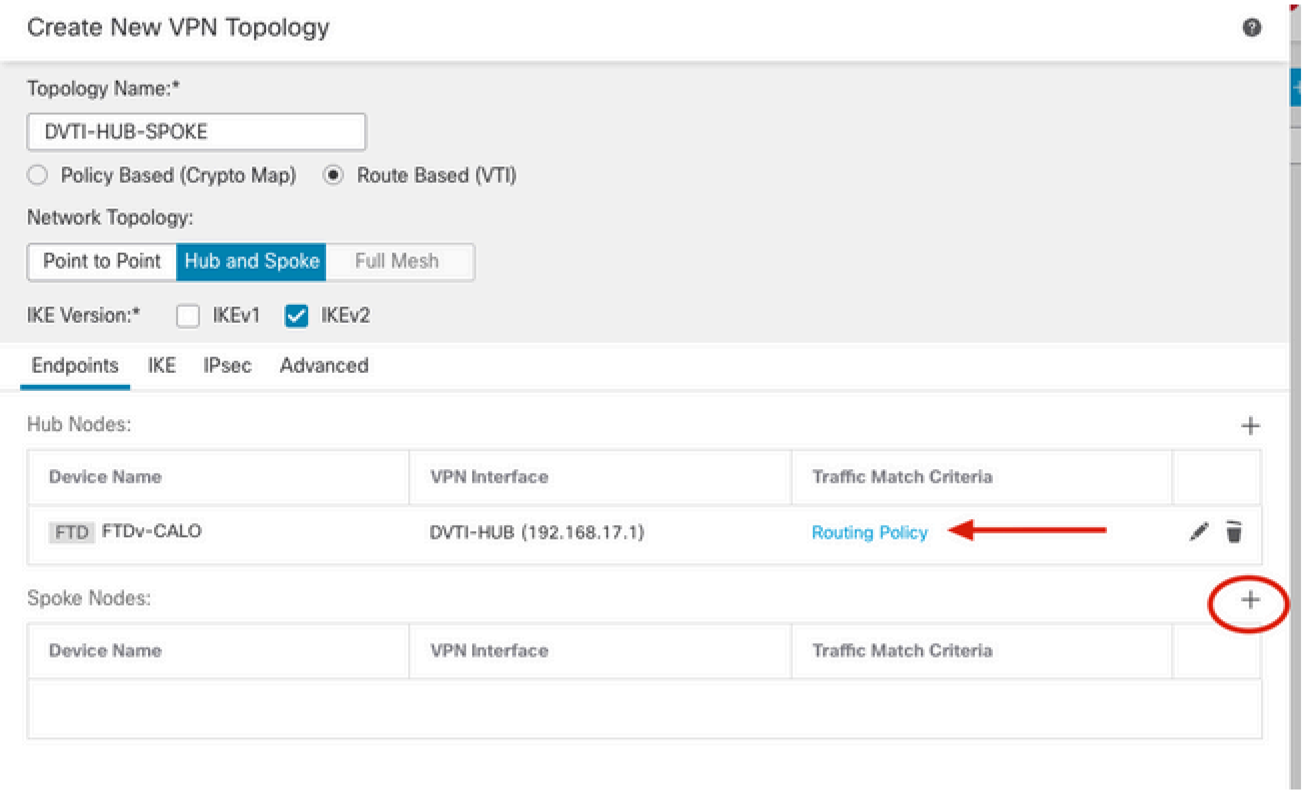
OnPREM

VTI-SUBNET

☑ Allow incoming IKEv2 routes from the peers

Connection Type:

14. Confirm the new hub device has been added under the **Hub Nodes** section and click on the **+** next to the **Spoke Nodes** section to add a new endpoint as a remote spoke-1.



Create New VPN Topology

Topology Name:*

DVTI-HUB-SPOKE

○ Policy Based (Crypto Map) ● Route Based (VTI)

Network Topology:

Point to Point | Hub and Spoke | Full Mesh

IKE Version:* ☐ IKEv1 ☑ IKEv2

Endpoints | IKE | IPsec | Advanced

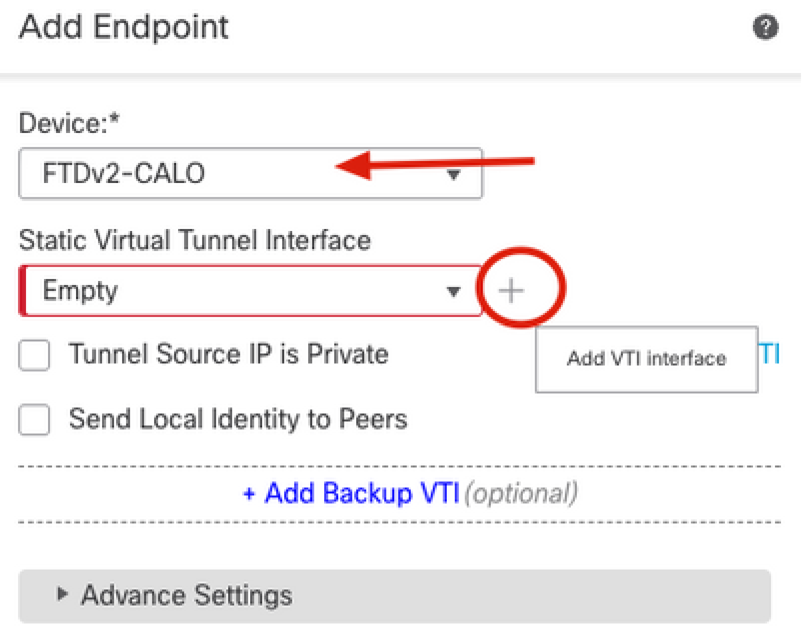
Hub Nodes:

Device Name	VPN Interface	Traffic Match Criteria
FTD FTDv-CALO	DVTI-HUB (192.168.17.1)	Routing Policy

Spoke Nodes:

Device Name	VPN Interface	Traffic Match Criteria

15. From the **Add Endpoint** window, select the device that runs as the spoke-1 and click on the **+** icon next to **Static Virtual Tunnel Interface** dropdown menu to create a new SVTI.



Add Endpoint

Device:*

FTDv2-CALO

Static Virtual Tunnel Interface

Empty

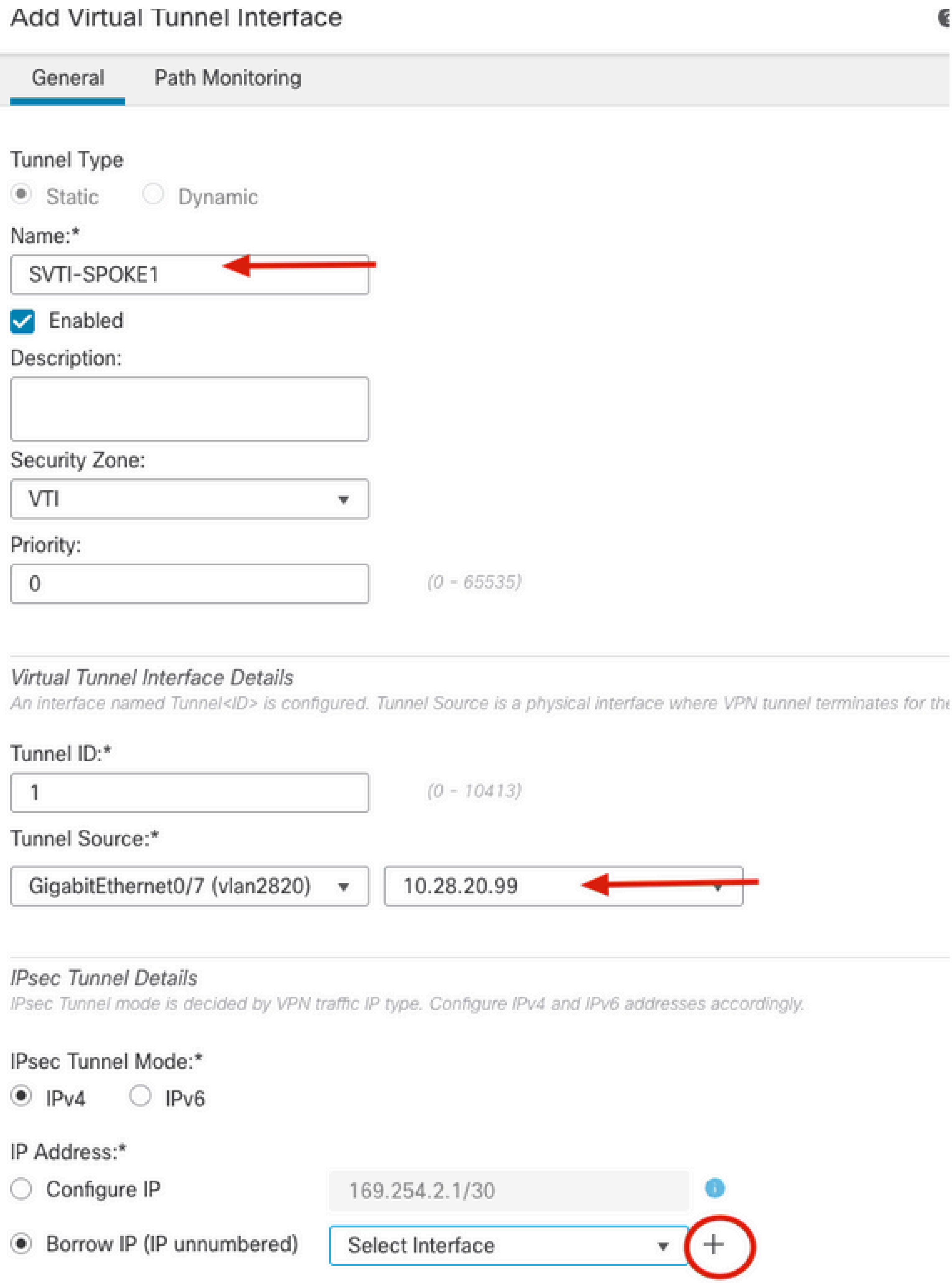
☐ Tunnel Source IP is Private

☐ Send Local Identity to Peers

+ Add Backup VTI *(optional)*

▸ Advance Settings

16. From the **Add Virtual Tunnel Interface** menu, specify the name of the new Tunnel interface, assign it to the desired **Security Zone**, select the **Tunnel Source** with its IP and click on the "+" icon under the **IP Address** configuration in order to create a new Loopback interface next to the **Borrow IP** option.



Add Virtual Tunnel Interface

General | Path Monitoring

Tunnel Type

● Static ○ Dynamic

Name:*

SVTI-SPOKE1

☑ Enabled

Description:

Security Zone:

VTI

Priority:

0 (0 - 65535)

Virtual Tunnel Interface Details

An interface named Tunnel<ID> is configured. Tunnel Source is a physical interface where VPN tunnel terminates for the

Tunnel ID:*

1 (0 - 10413)

Tunnel Source:*

GigabitEthernet0/7 (vlan2820) | 10.28.20.99

IPsec Tunnel Details

IPsec Tunnel mode is decided by VPN traffic IP type. Configure IPv4 and IPv6 addresses accordingly.

IPsec Tunnel Mode:*

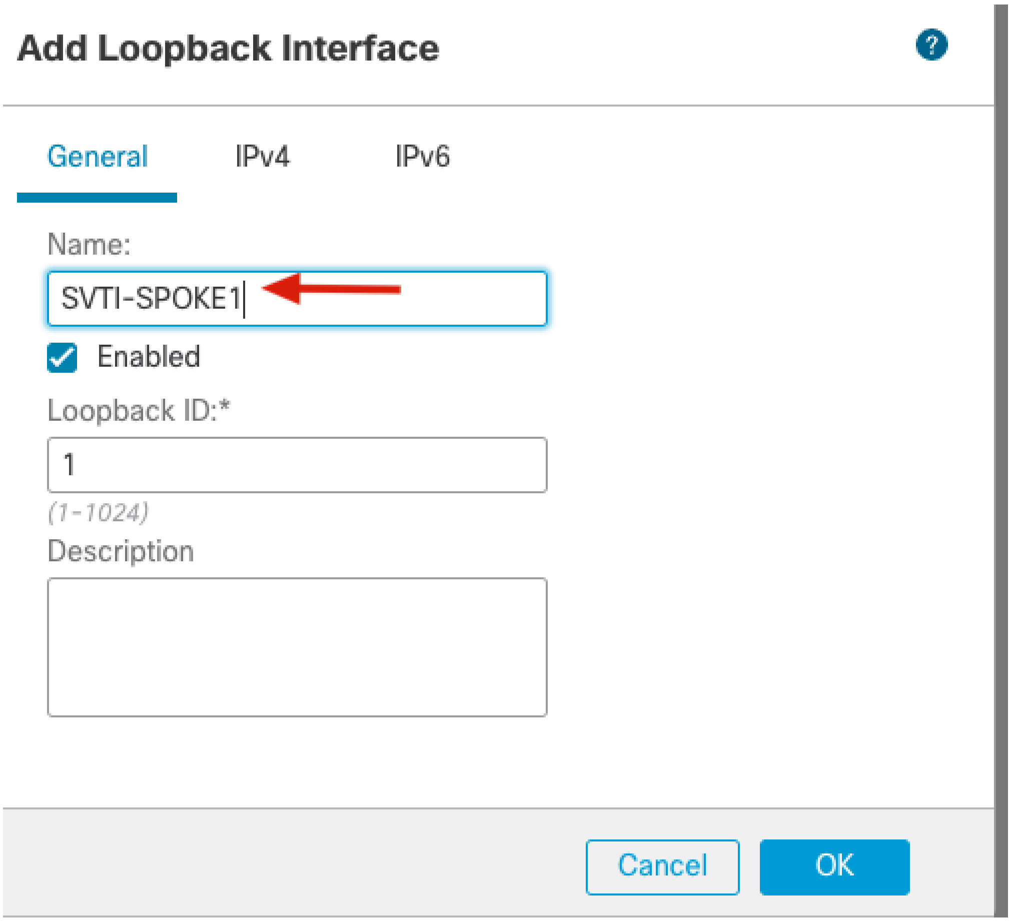
● IPv4 ○ IPv6

IP Address:*

○ Configure IP 169.254.2.1/30

● Borrow IP (IP unnumbered) Select Interface +

17. From the **Add Loopback Interface** window, specify the name of the interface with its ID and go to **IPv4** tab.



Name: SVTI-SPOKE1

☑ Enabled

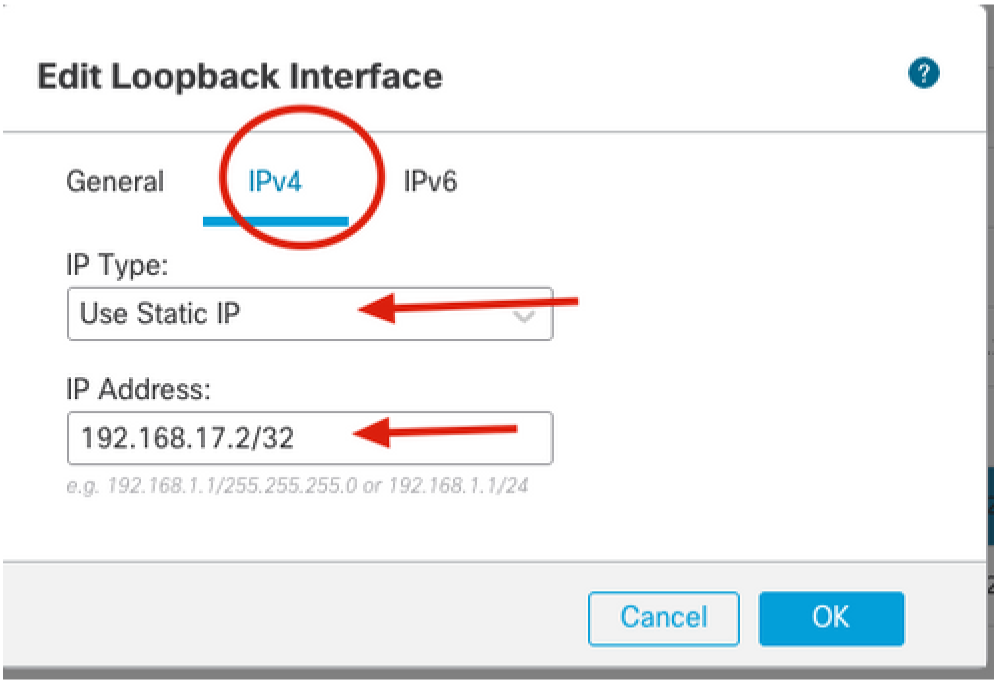
Loopback ID:* 1

(1-1024)

Description

18. From the **IPv4** tab select **Use Static IP** under the IP Type option from the dropdown menu and specify the IP Address that belongs to the SVTI and click **OK**.

Note: Spoke-1 SVTI has an IP Address of 192.168.17.2/32.

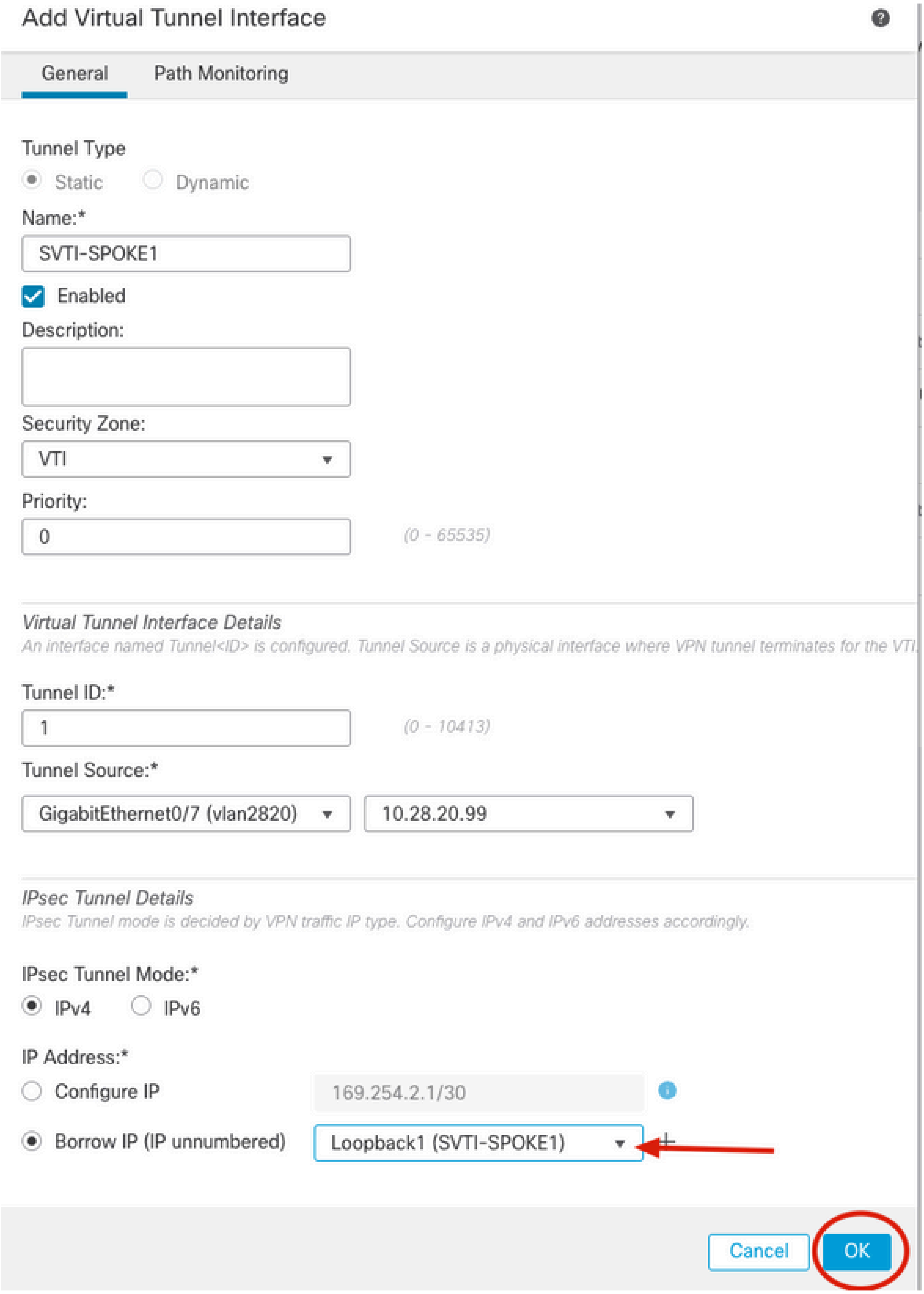


IP Type: Use Static IP

IP Address: 192.168.17.2/32

e.g. 192.168.1.1/255.255.255.0 or 192.168.1.1/24

19. From the **Add Virtual Tunnel Interface** menu, new Loopback is displayed under the dropdown menu, select it and click **OK**.



Add Virtual Tunnel Interface

Tunnel Type

● Static ○ Dynamic

Name:* SVTI-SPOKE1

☑ Enabled

Description:

Security Zone: VTI

Priority: 0 (0 - 65535)

Virtual Tunnel Interface Details

An interface named Tunnel<ID> is configured. Tunnel Source is a physical interface where VPN tunnel terminates for the VTI.

Tunnel ID:* 1 (0 - 10413)

Tunnel Source:* GigabitEthernet0/7 (vlan2820) 10.28.20.99

IPsec Tunnel Details

IPsec Tunnel mode is decided by VPN traffic IP type. Configure IPv4 and IPv6 addresses accordingly.

IPsec Tunnel Mode:*

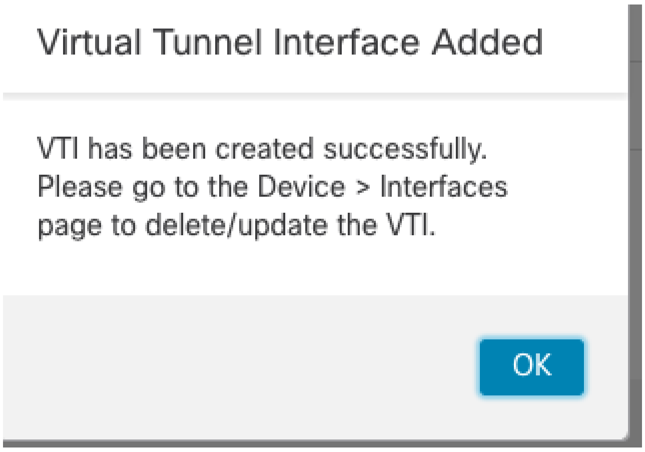
● IPv4 ○ IPv6

IP Address:*

○ Configure IP 169.254.2.1/30

● Borrow IP (IP unnumbered) Loopback1 (SVTI-SPOKE1)

20. A **Virtual Tunnel Interface Added** window is prompted that indicates the new DVTI has been created, click **Ok** and continue.

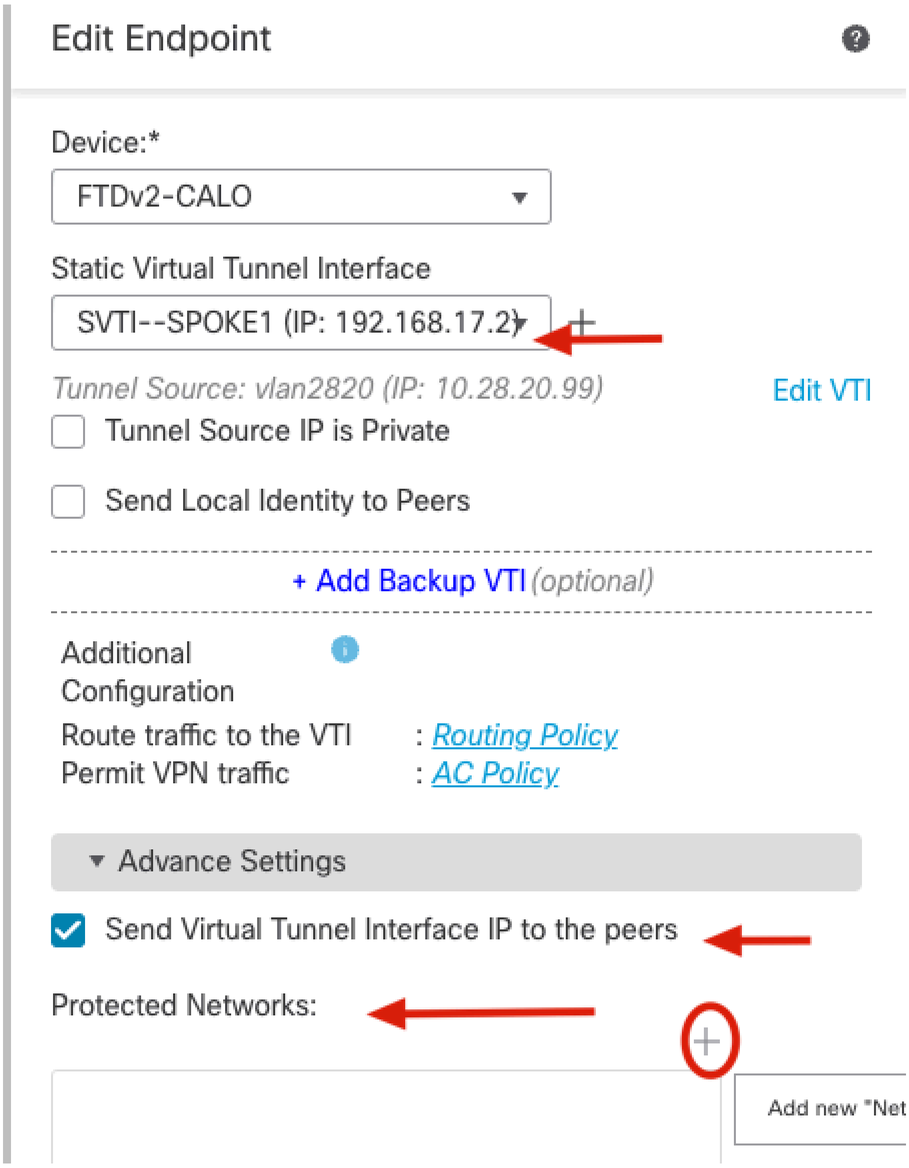


Virtual Tunnel Interface Added

VTI has been created successfully. Please go to the Device > Interfaces page to delete/update the VTI.

21. From the **Add Endpoint** window, new SVTI is displayed under **StaticVirtual Tunnel Interface** dropdown bar, select it, check the **Send Virtual Tunnel Interface IP to peers** option along with the **Allow incoming IKEv2 routes from the peers** option and click on the "+" next to the **Protected Networks** settings in order to specify the networks behind the spoke device.

> **Note**: In this example, a second Loopback interface on the spoke-1 simulates a host in the remote network of 192.168.6.1/24.



Edit Endpoint

Device:*

FTDv2-CALO

Static Virtual Tunnel Interface

SVTI--SPOKE1 (IP: 192.168.17.2)

Tunnel Source: vlan2820 (IP: 10.28.20.99) Edit VTI

□ Tunnel Source IP is Private

□ Send Local Identity to Peers

+ Add Backup VTI *(optional)*

Additional Configuration

Route traffic to the VTI : *Routing Policy*

Permit VPN traffic : *AC Policy*

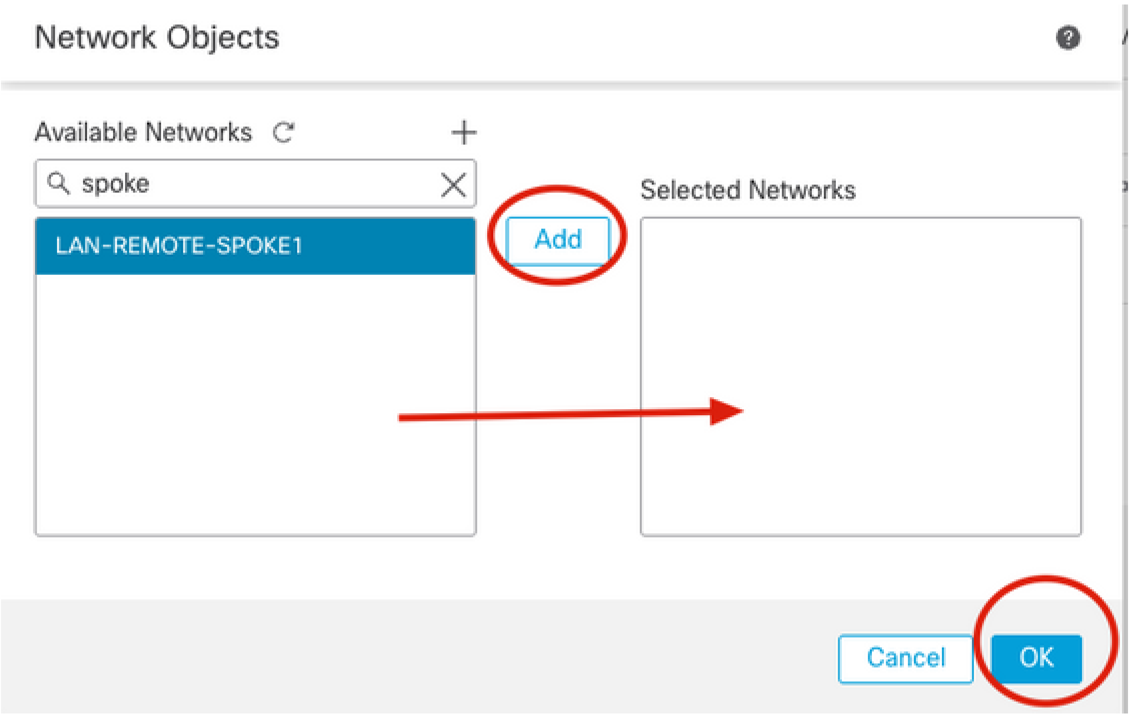
▼ Advance Settings

☑ Send Virtual Tunnel Interface IP to the peers

Protected Networks:

22. On the **Available Networks** section, identify the remote protected network as well as the VTI subnet (192.168.17.0/24) and click on **Add** and then **OK** to apply the change.

> **Note**: SVTI subnets needs to be added in order to protect, traffic that is sourced with tunnel interfaces.



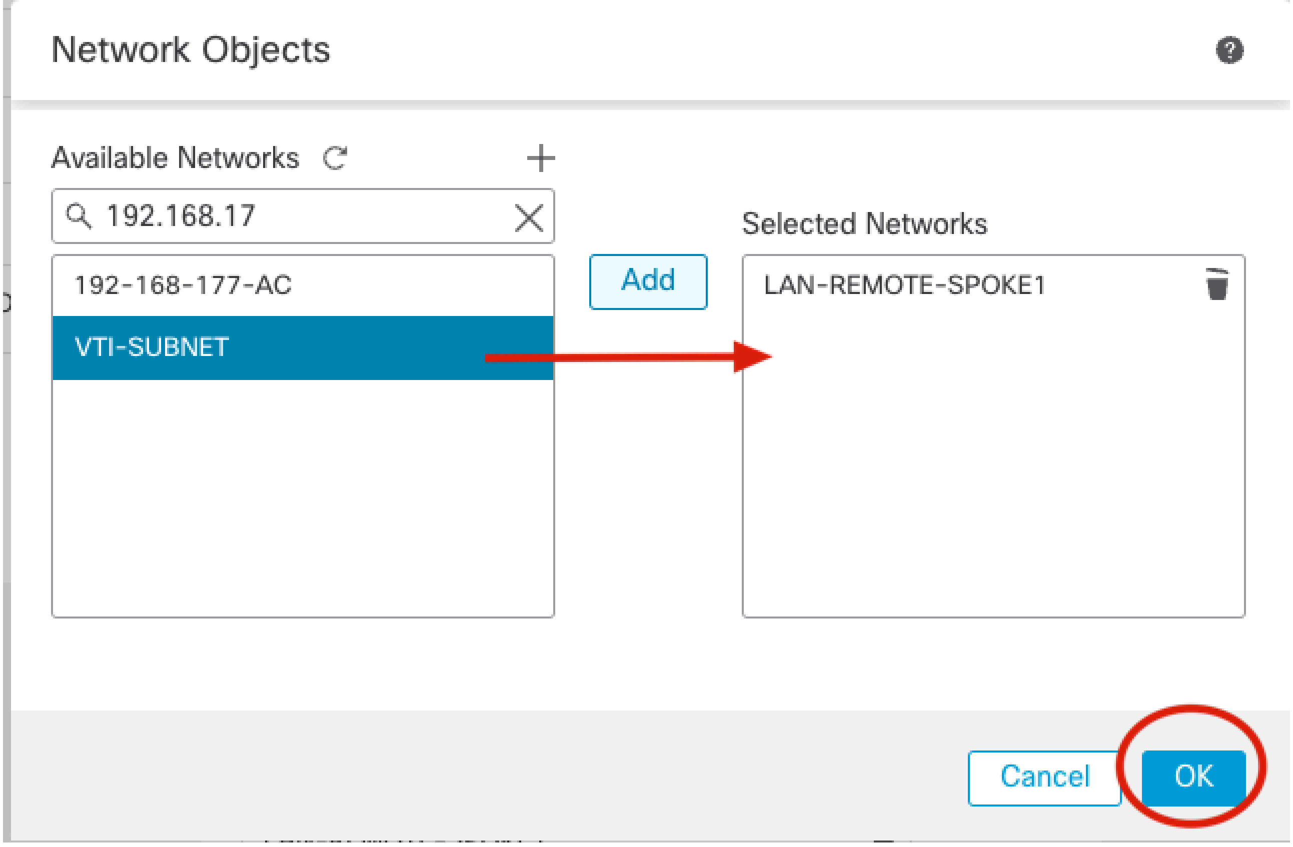
Network Objects

Available Networks

spoke

LAN-REMOTE-SPOKE1

Selected Networks



Network Objects

Available Networks

192.168.17

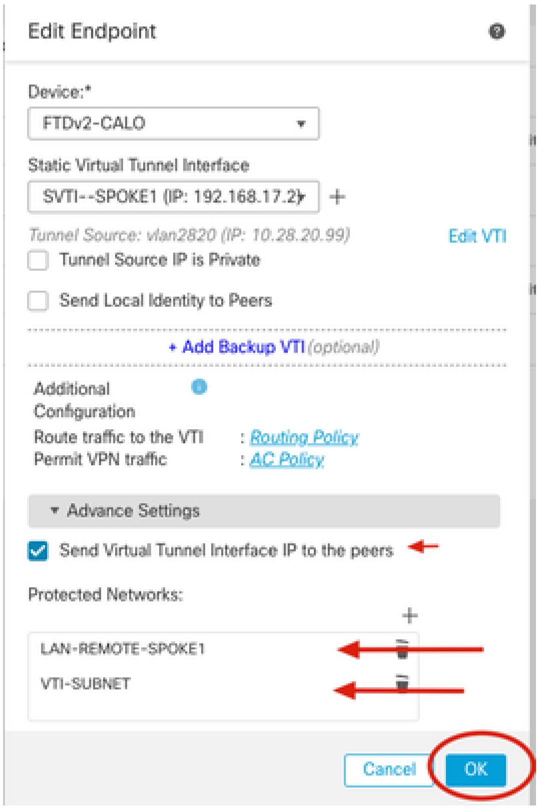
192-168-177-AC

VTI-SUBNET

Selected Networks

LAN-REMOTE-SPOKE1

23. Confirm the new protected network object has been added and click **OK**.



Edit Endpoint

Device:*

FTDv2-CALO

Static Virtual Tunnel Interface

SVTI--SPOKE1 (IP: 192.168.17.2)

Tunnel Source: vlan2820 (IP: 10.28.20.99) Edit VTI

□ Tunnel Source IP is Private

□ Send Local Identity to Peers

+ Add Backup VTI *(optional)*

Additional Configuration

Route traffic to the VTI : Routing Policy

Permit VPN traffic : AC Policy

▾ Advance Settings

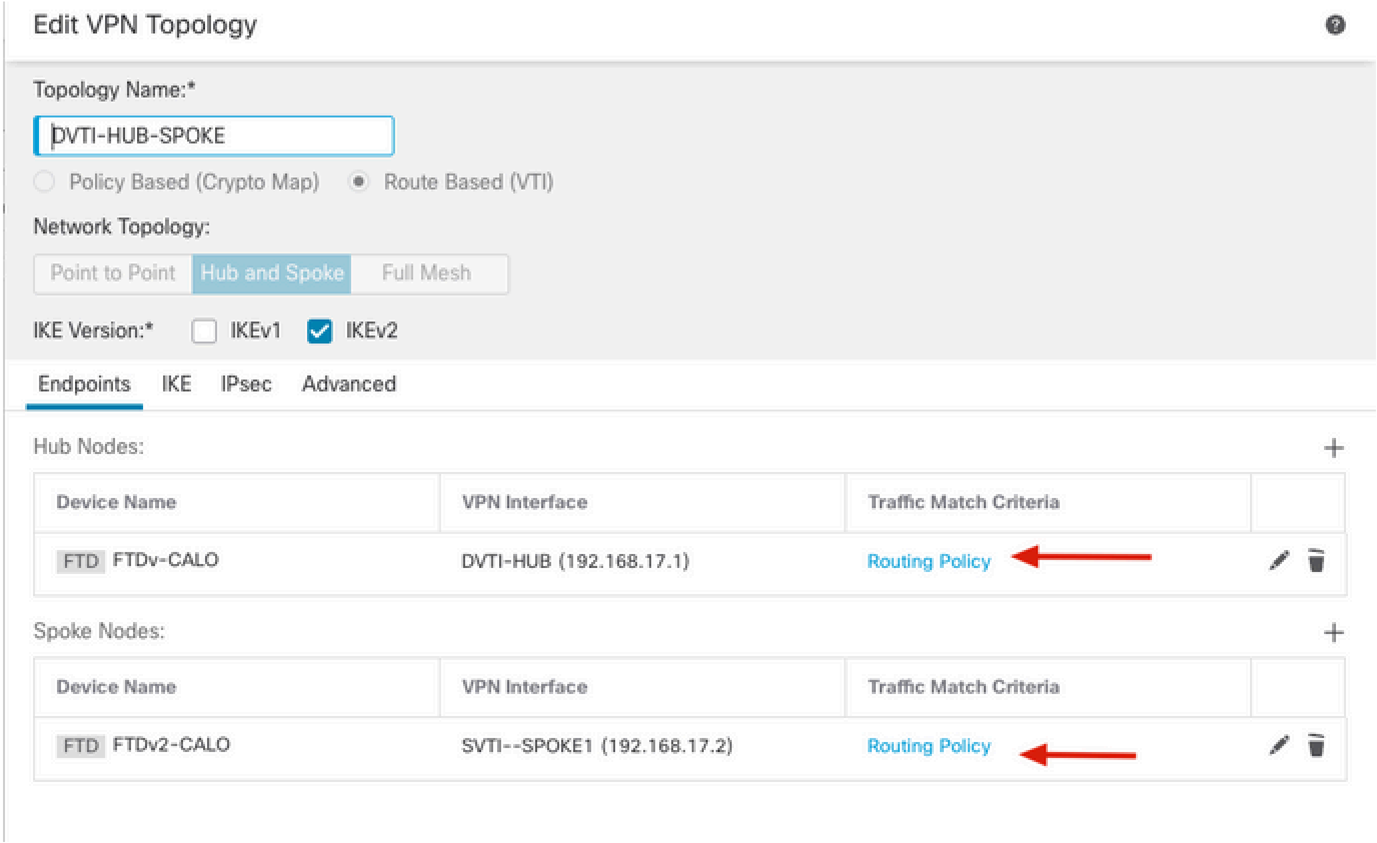
☑ Send Virtual Tunnel Interface IP to the peers

Protected Networks:

LAN-REMOTE-SPOKE1

VTI-SUBNET

24. Confirm both hub and spoke nodes have been added to the new topology.



Edit VPN Topology

Topology Name:*

DVTI-HUB-SPOKE

○ Policy Based (Crypto Map) ● Route Based (VTI)

Network Topology:

Point to Point | Hub and Spoke | Full Mesh

IKE Version:* □ IKEv1 ☑ IKEv2

Hub Nodes:

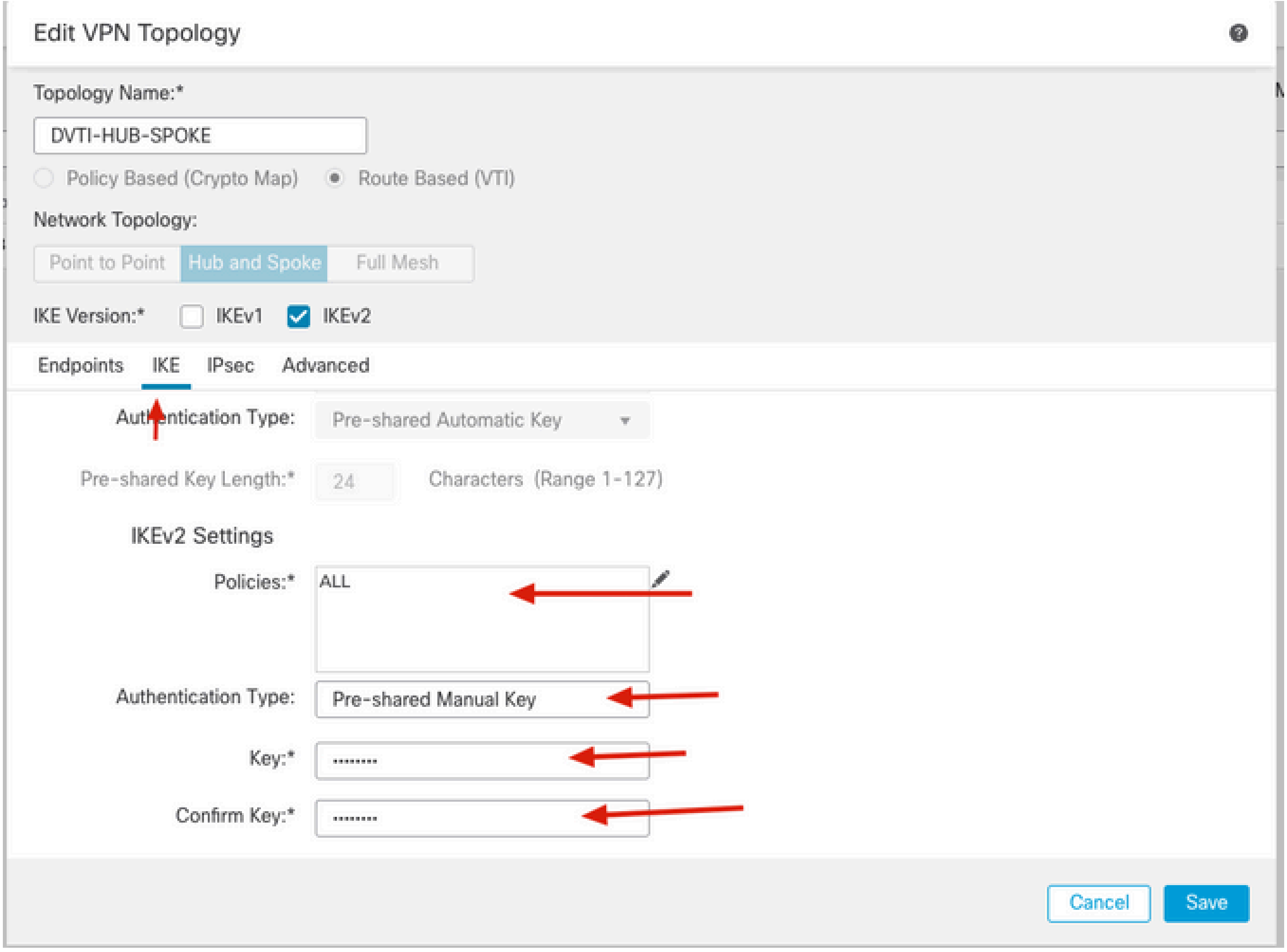
Device Name	VPN Interface	Traffic Match Criteria	
FTD FTDv-CALO	DVTI-HUB (192.168.17.1)	Routing Policy	

Spoke Nodes:

Device Name	VPN Interface	Traffic Match Criteria	
FTD FTDv2-CALO	SVTI--SPOKE1 (192.168.17.2)	Routing Policy	

25. Go to **IKE** tab and specify the desired algorithms under "**KEv2 Settings**, select the **Authentication Type** with its attributes.

Note: In this article manual pre-shared key is used for authentication.



Edit VPN Topology

Topology Name:* DVTI-HUB-SPOKE

○ Policy Based (Crypto Map) ● Route Based (VTI)

Network Topology: Point to Point | Hub and Spoke | Full Mesh

IKE Version:* □ IKEv1 ☑ IKEv2

Authentication Type: Pre-shared Automatic Key

Pre-shared Key Length:* 24 Characters (Range 1-127)

IKEv2 Settings

Policies:* ALL

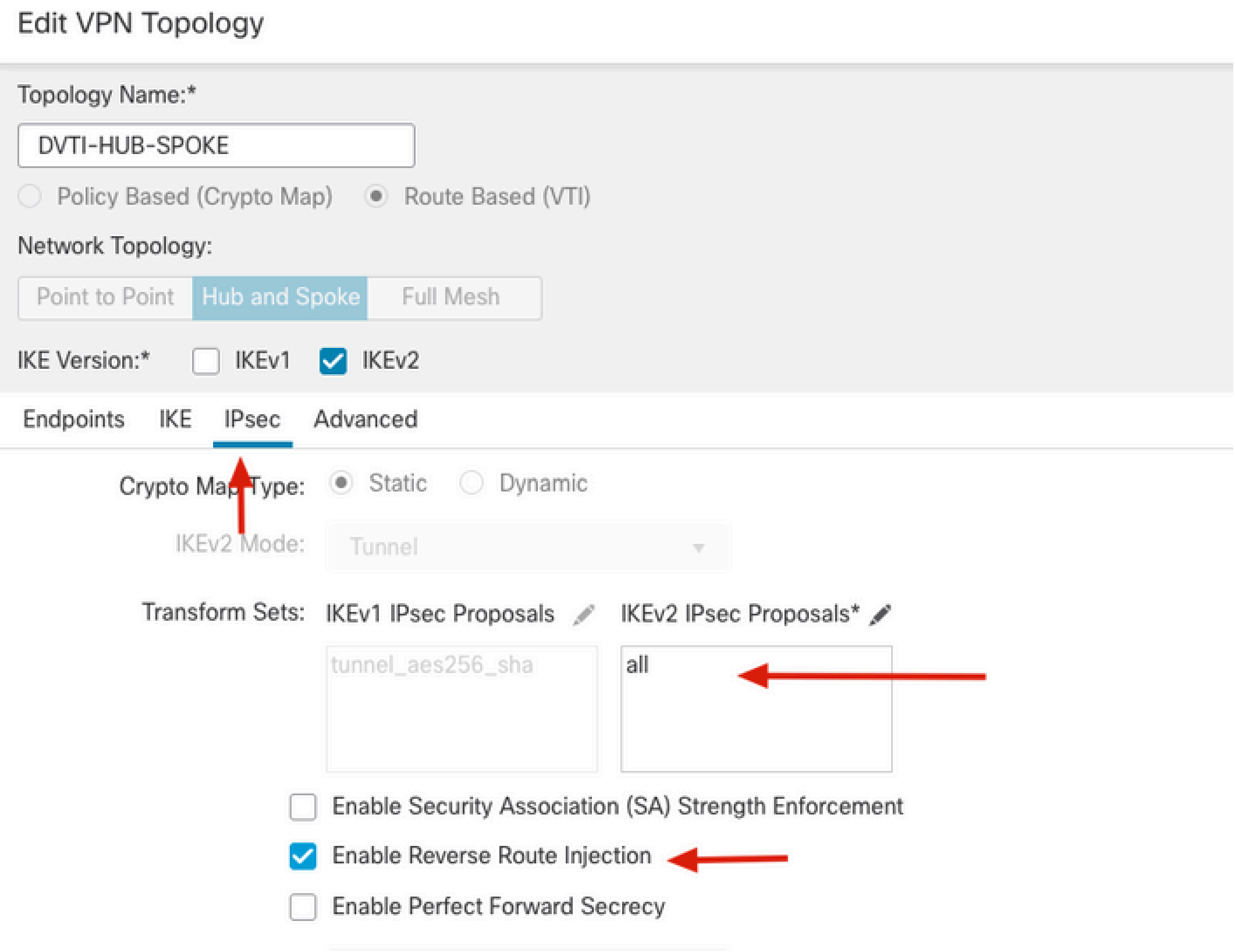
Authentication Type: Pre-shared Manual Key

Key:* ••••••••

Confirm Key:* ••••••••

26. Go to **IPsec** tab, specify the desired algorithms under **IKEv2 IPsec Proposals** settings and check the **Enable Reverse Route Injection** option and go back to **Endpoints** tab.

> **Note**: When no dynamic routing protocol is used Reverse Route Injection needs to be enabled in order to advertise OnPREM and remote protected networks across the tunnel between hub and all spokes.



Edit VPN Topology

Topology Name:* DVTI-HUB-SPOKE

○ Policy Based (Crypto Map) ● Route Based (VTI)

Network Topology: Point to Point | Hub and Spoke | Full Mesh

IKE Version:* □ IKEv1 ☑ IKEv2

Crypto Map Type: ● Static ○ Dynamic

IKEv2 Mode: Tunnel

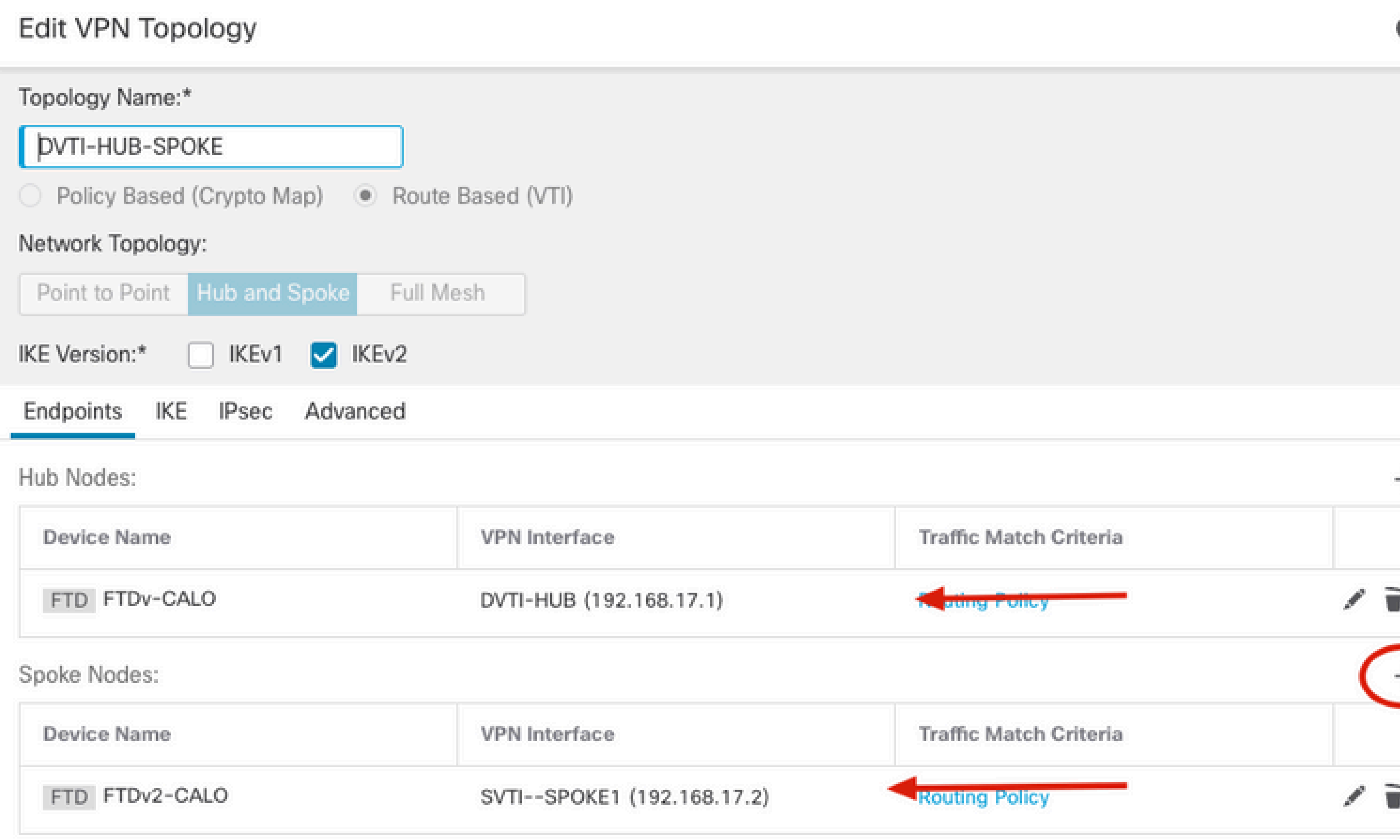
Transform Sets: IKEv1 IPsec Proposals: tunnel_aes256_sha; IKEv2 IPsec Proposals*: all

□ Enable Security Association (SA) Strength Enforcement

☑ Enable Reverse Route Injection

□ Enable Perfect Forward Secrecy

27. Add one more extranet spoke-2, click on the + icon from the **Endpoints** tab.



Edit VPN Topology

Topology Name:*

DVTI-HUB-SPOKE

○ Policy Based (Crypto Map) ● Route Based (VTI)

Network Topology:

IKE Version:* □ IKEv1 ☑ IKEv2

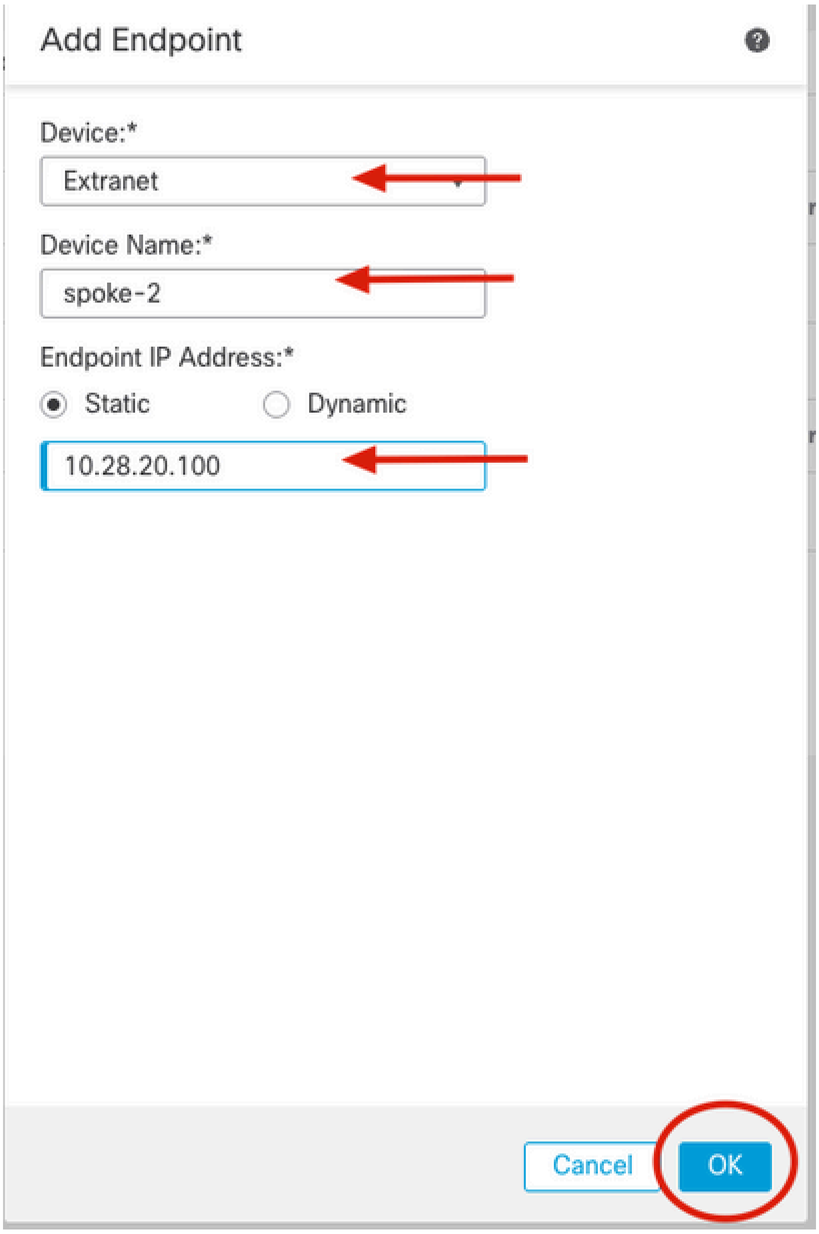
Hub Nodes:

Device Name	VPN Interface	Traffic Match Criteria
FTD FTDv-CALO	DVTI-HUB (192.168.17.1)	Routing Policy

Spoke Nodes:

Device Name	VPN Interface	Traffic Match Criteria
FTD FTDv2-CALO	SVTI--SPOKE1 (192.168.17.2)	Routing Policy

28. From the **Add Endpoint** window Select **Extranet** from the dropdown menu under **Device**, specify the device name from spoke-2 and its peer IP Address and click **OK**.



Add Endpoint

Device:* Extranet

Device Name:* spoke-2

Endpoint IP Address:*

● Static ○ Dynamic

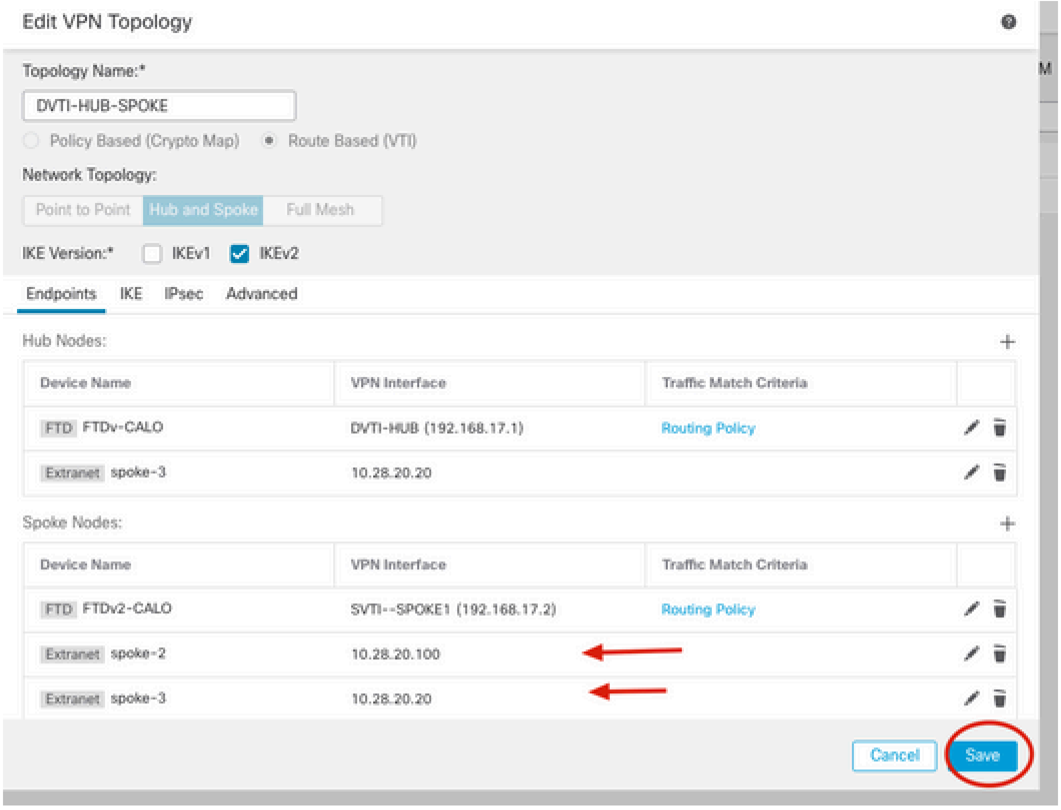
10.28.20.100

29. Repeat steps 27 and 28 to add a new spoke-3 from the extranet.

Note: In this article CSRv1000 device is be used as the spoke-3.

---

30. Confirm new extrane spokes have been added to the topology and click on **Save**.



Edit VPN Topology

Topology Name:* DVTI-HUB-SPOKE

○ Policy Based (Crypto Map) ● Route Based (VTI)

Network Topology: Point to Point | Hub and Spoke | Full Mesh

IKE Version:* □ IKEv1 ☑ IKEv2

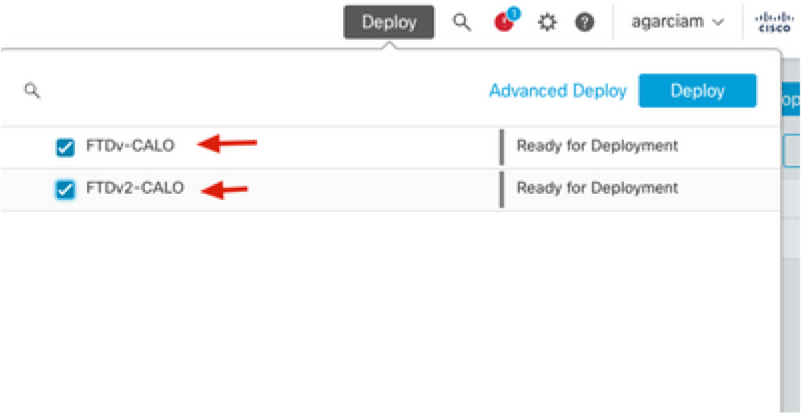
Hub Nodes:

Device Name	VPN Interface	Traffic Match Criteria
FTD FTDv-CALO	DVTI-HUB (192.168.17.1)	Routing Policy
Extranet spoke-3	10.28.20.20	

Spoke Nodes:

Device Name	VPN Interface	Traffic Match Criteria
FTD FTDv2-CALO	SVTI--SPOKE1 (192.168.17.2)	Routing Policy
Extranet spoke-2	10.28.20.100	
Extranet spoke-3	10.28.20.20	

31. Deploy configuration on both Cisco Secure Firewall devices.



☑ FTDv-CALO	Ready for Deployment
☑ FTDv2-CALO	Ready for Deployment

Final configurations

Cisco Secure Firewall Hub configuration

```
crypto ikev2 policy 100
 encryption aes-256 aes
 integrity sha512 sha384 sha256 sha
 group 21 20 19 14
 prf sha512 sha384 sha256 sha
 lifetime seconds 86400

crypto ikev2 enable inside-2820

crypto ipsec ikev2 ipsec-proposal CSM_IP_1
 protocol esp encryption aes-256 aes
 protocol esp integrity sha-512 sha-384 sha-256 sha-1
```

```
crypto ipsec profile FMC_IPSEC_PROFILE_2
 set ikev2 ipsec-proposal CSM_IP_1

interface Virtual-Template1 type tunnel
 nameif DVTI-HUB
 ip unnumbered DVTI-LOOPBACK
 tunnel source interface inside-2820
 tunnel mode ipsec ipv4
 tunnel protection ipsec profile FMC_IPSEC_PROFILE_2

tunnel-group 10.28.20.99 type ipsec-l2l
tunnel-group 10.28.20.99 general-attributes
 default-group-policy .DefaultS2SGroupPolicy
tunnel-group 10.28.20.99 ipsec-attributes
 virtual-template 1
 ikev2 remote-authentication pre-shared-key *****
 ikev2 local-authentication pre-shared-key *****
 ikev2 route set interface
tunnel-group 10.28.20.100 type ipsec-l2l
tunnel-group 10.28.20.100 general-attributes
 default-group-policy .DefaultS2SGroupPolicy
tunnel-group 10.28.20.100 ipsec-attributes
 virtual-template 1
 ikev2 remote-authentication pre-shared-key *****
 ikev2 local-authentication pre-shared-key *****
 ikev2 route set interface
tunnel-group 10.28.20.20 type ipsec-l2l
tunnel-group 10.28.20.20 general-attributes
 default-group-policy .DefaultS2SGroupPolicy
tunnel-group 10.28.20.20 ipsec-attributes
 virtual-template 1
 ikev2 remote-authentication pre-shared-key *****
 ikev2 local-authentication pre-shared-key *****
 ikev2 route set interface
```

Cisco Secure Firewall Spoke-1 configuration

```
crypto ikev2 policy 10
 encryption aes-256 aes
 integrity sha512 sha384 sha256 sha
 group 21 20 19 14
 prf sha512 sha384 sha256 sha
 lifetime seconds 86400
crypto ikev2 enable vlan2820

crypto ipsec ikev2 ipsec-proposal CSM_IP_2
 protocol esp encryption aes-256 aes
 protocol esp integrity sha-512 sha-384 sha-256 sha-1
crypto ipsec profile FMC_IPSEC_PROFILE_2
 set ikev2 ipsec-proposal CSM_IP_2
 set reverse-route

access-list CSM_IPSEC_ACL_2 extended permit ip 192.168.6.0 255.255.255.0 192.168.5.0 255.255.255.0
access-list CSM_IPSEC_ACL_2 extended permit ip 192.168.6.0 255.255.255.0 192.168.17.0 255.255.255.0
access-list CSM_IPSEC_ACL_2 extended permit ip 192.168.17.0 255.255.255.0 192.168.5.0 255.255.255.0
access-list CSM_IPSEC_ACL_2 extended permit ip 192.168.17.0 255.255.255.0 192.168.17.0 255.255.255.0

interface Tunnel1
```

```
 nameif SVTI--SPOKE1
 ip unnumbered SVTI-SPOKE1
 tunnel source interface vlan2820
 tunnel destination 10.28.20.101
 tunnel mode ipsec ipv4
 tunnel protection ipsec profile FMC_IPSEC_PROFILE_2
 tunnel protection ipsec policy CSM_IPSEC_ACL_2
tunnel-group 10.28.20.101 type ipsec-l2l
tunnel-group 10.28.20.101 ipsec-attributes
 ikev2 remote-authentication pre-shared-key *****
 ikev2 local-authentication pre-shared-key *****
 ikev2 route set interface
```

Note: Cisco ASAv spoke-2 configuration omited as it is the same as configuration for spoke-1

Cisco CSRv1000 spoke-3 configuration

```
crypto ikev2 proposal all
 encryption aes-cbc-256 aes-cbc-128 aes-cbc-192
 integrity sha256 sha1 sha384 sha512
 group 20 14 15 21 24
crypto ikev2 policy test
 match address local 10.28.20.20
 proposal all
crypto ikev2 authorization policy default
 route set interface Tunnel100
 route set remote ipv4 192.168.8.0 255.255.255.255

crypto ikev2 profile vti
 match identity remote any
 identity local address 10.28.20.20
 authentication remote pre-share key cisco123
 authentication local pre-share key cisco123
 no config-exchange request
aaa authorization group psk list default default

crypto ipsec transform-set aes256sha256 esp-aes 256 esp-sha256-hmac
 mode tunnel
crypto ipsec profile vti
 set security-association lifetime seconds 120
 set transform-set aes256sha256
 set ikev2-profile vti
 reverse-route

interface Tunnel100
 ip address 192.168.17.4 255.255.255.0
 tunnel source GigabitEthernet1
 tunnel mode ipsec ipv4
 tunnel destination 10.28.20.101
 tunnel protection ipsec policy ipv4 ipsec-policy
 tunnel protection ipsec profile vti
ip access-list extended ipsec-policy
 10 permit ip 192.168.8.0 0.0.0.255 192.168.5.0 0.0.0.255
 20 permit ip 192.168.8.0 0.0.0.255 192.168.17.0 0.0.0.255
 30 permit ip 192.168.17.0 0.0.0.255 192.168.5.0 0.0.0.255
 40 permit ip 192.168.17.0 0.0.0.255 192.168.17.0 0.0.0.255
```

Verify

From **Hub** routing table, we see the routes from all spokes received over the virtual templates as soon as IKEv2 tunnels come up.

```
firepower# show route


C        192.168.5.0 255.255.255.0 is directly connected, OnPrem-Network
L        192.168.5.1 255.255.255.255 is directly connected, OnPrem-Network
V        192.168.6.0 255.255.255.0
           connected by VPN (advertised), DVTI-HUB_va146
V        192.168.7.0 255.255.255.0
           connected by VPN (advertised), DVTI-HUB_va105
V        192.168.8.0 255.255.255.0
           connected by VPN (advertised), DVTI-HUB_va155
V        192.168.17.0 255.255.255.0
           connected by VPN (advertised), DVTI-HUB_va146
C        192.168.17.1 255.255.255.255 is directly connected, DVTI-LOOPBACK
V        192.168.17.2 255.255.255.255
           connected by VPN (advertised), DVTI-HUB_va146
V        192.168.17.3 255.255.255.255
           connected by VPN (advertised), DVTI-HUB_va105
V        192.168.17.4 255.255.255.255
           connected by VPN (advertised), DVTI-HUB_va155
S        192.168.19.100 255.255.255.255 [1/0] via 10.28.20.20, inside-2820
```

Hub is now able to ping all SVTI spoke interface sourced from DVTI.

> **Note**: "show crypto ipsec" sa command displays the multiple IPSec SA created when Reverse Route Injection with protected networks is applied.

```
firepower# ping 192.168.17.2
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.17.2, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/4/10 ms
firepower#   ping 192.168.17.3
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.17.3, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/2/10 ms
firepower#   ping 192.168.17.4
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.17.4, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms
firepower# show crypto ipsec sa | i cap|iden
local ident (addr/mask/prot/port): (192.168.17.0/255.255.255.0/0/0)
      remote ident (addr/mask/prot/port): (192.168.17.0/255.255.255.0/0/0)
      #pkts encaps: 15, #pkts encrypt: 15, #pkts digest: 15
      #pkts decaps: 15, #pkts decrypt: 15, #pkts verify: 15
     #PMTUs sent: 0, #PMTUs rcvd: 0, #decapsulated frgs needing reassembly: 0
      current outbound spi: 5A68524C
      current inbound spi : DDF6D48F
      spi: 0xDDF6D48F (3723941007)
      spi: 0x5A68524C (1516786252)
```

Hub is now able to ping REMOTE-LAN networks behind all spokes sourced from OnPREM host.

> **Note**: "show crypto ipsec" sa command displays the multiple IPSec SA created when Reverse Route Injection with protected networks is applied.

```
firepower# ping OnPrem-Network 192.168.6.1
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.6.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/4/10 ms
firepower# ping OnPrem-Network 192.168.7.1
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.7.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/2/10 ms
firepower# ping OnPrem-Network 192.168.8.1
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.8.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms

firepower# show crypto ipsec sa | i cap|iden
local ident (addr/mask/prot/port): (192.168.5.0/255.255.255.0/0/0)
      remote ident (addr/mask/prot/port): (192.168.6.0/255.255.255.0/0/0)
      #pkts encaps: 5, #pkts encrypt: 5, #pkts digest: 5
      #pkts decaps: 5, #pkts decrypt: 5, #pkts verify: 5
local ident (addr/mask/prot/port): (192.168.5.0/255.255.255.0/0/0)
      remote ident (addr/mask/prot/port): (192.168.7.0/255.255.255.0/0/0)
      #pkts encaps: 5, #pkts encrypt: 5, #pkts digest: 5
      #pkts decaps: 5, #pkts decrypt: 5, #pkts verify: 5
local ident (addr/mask/prot/port): (192.168.5.0/255.255.255.0/0/0)
      remote ident (addr/mask/prot/port): (192.168.8.0/255.255.255.0/0/0)
      #pkts encaps: 5, #pkts encrypt: 5, #pkts digest: 5
      #pkts decaps: 5, #pkts decrypt: 5, #pkts verify: 5
```

Troubleshoot

To troubleshoot IKEv2 and IPSEC process use the debug commands below:

```
ASA/Cisco Secure Firewall

debug crypto ikev2 protocol 255
debug crypto ikev2 platform 255
debug crypto ipsec
```

CSR

```
debug crypto ikev2
debug crypto ipsec
```