Configure Security Parameters

This section describes how to change security parameters for the control plane and the data plane in the Cisco SD-WAN overlay network.

Configure Control Plane Security Parameters

By default, the control plane uses DTLS as the protocol that provides privacy on all its tunnels. DTLS runs over UDP.

You can change the control plane security protocol to TLS, which runs over TCP. The primary reason to use TLS is that, if you consider the vSmart controller to be a server, firewalls protect TCP servers better than UDP servers.

You configure the control plane tunnel protocol on a vSmart controller:

```
vSmart(config)# security control protocol tls
```

With this change, all control plane tunnels between the vSmart controller and the routers and between the controller and vManage use TLS. Control plane tunnels to vBond orchestrators always use DTLS, because these connections must be handled by UDP.

In a domain with multiple vSmart controllers, when you configure TLS on one of the vSmart controllers, all control plane tunnels from that controller to the other controllers use TLS. Said another way, TLS always takes precedence over DTLS. However, from the perspective of the other vSmart controllers, if you have not configured TLS on them, they use TLS on the control plane tunnel only to that one vSmart controller, and they use DTLS tunnels to all the other vSmart controllers and to all their connected routers. To have all vSmart controllers use TLS, configure it on all of them.

By default, the vSmart controller listens on port 23456 for TLS requests. To change this:

```
vSmart(config)# security control tls-port number
```

The port can be a number from 1025 through 65535.

To display control plane security information, use the **show control connections** command on the vSmart controller. For example:

```
vSmart-2# show control connections
```

```
                                                                                                  PEER                    PEER
PEER    PEER     PEER            SITE   DOMAIN  PEER          PEER           PEER           PEER
TYPE    PROTOCOL SYSTEM IP       ID     ID      PRIVATE IP    PRIVATE  PEER  PUBLIC IP      PUBLIC
REMOTE COLOR  STATE  UPTIME                                                  PORT           PORT
-------------------------------------------------------------------------------------------------------------------
vedge   dtls     172.16.255.11  100    1       10.0.5.11     12346    10.0.5.11      12346
lte            up    0:07:48:58
vedge   dtls     172.16.255.21  100    1       10.0.5.21     12346    10.0.5.21      12346
lte            up    0:07:48:51
vedge   dtls     172.16.255.14  400    1       10.1.14.14    12360    10.1.14.14     12360
lte            up    0:07:49:02
vedge   dtls     172.16.255.15  500    1       10.1.15.15    12346    10.1.15.15     12346
default        up    0:07:47:18
vedge   dtls     172.16.255.16  600    1       10.1.16.16    12346    10.1.16.16     12346
default        up    0:07:41:52
vsmart  tls      172.16.255.19  100    1       10.0.5.19     12345    10.0.5.19      12345
default        up    0:00:01:44
vbond   dtls     -              0      0       10.1.14.14    12346    10.1.14.14     12346
default        up    0:07:49:08

vSmart-2# control connections

                                                                                                  PEER                    PEER
PEER     PEER     PEER            SITE   DOMAIN  PEER          PEER           PEER           PEER
TYPE     PROTOCOL SYSTEM IP       ID     ID      PRIVATE IP    PRIVATE  PEER  PUBLIC IP      PUBLIC
 REMOTE COLOR  STATE   UPTIME                                                  PORT           PORT
-------------------------------------------------------------------------------------------------------------------
vedge    tls      172.16.255.11  100    1       10.0.5.11     12345    10.0.5.11      12345
 lte            up     0:00:01:18
vedge    tls      172.16.255.21  100    1       10.0.5.21     12345    10.0.5.21      12345
 lte            up     0:00:01:18
vedge    tls      172.16.255.14  400    1       10.1.14.14    12345    10.1.14.14     12345
 lte            up     0:00:01:18
vedge    tls      172.16.255.15  500    1       10.1.15.15    12345    10.1.15.15     12345
 default        up     0:00:01:18
vedge    tls      172.16.255.16  600    1       10.1.16.16    12345    10.1.16.16     12345
 default        up     0:00:01:18
vsmart   tls      172.16.255.20  200    1       10.0.12.20    23456    10.0.12.20     23456
 default        up     0:00:01:32
vbond    dtls     -              0      0       10.1.14.14    12346    10.1.14.14     12346
 default        up     0:00:01:33
```

Configure DTLS on vManage

If you configure the vManage to use TLS as the control plane security protocol, you must enable port forwarding on your NAT. If you are using DTLS as the control plane security protocol, you do not need to do anything.

The number of ports forwarded depends on the number of vdaemon processes running on the vManage. To display information about these processes and about and the number of ports that are being forwarded, use the **show control summary** command shows that four vdaemon processes are running:

```
vManage# show control summary
          VBOND     VMANAGE    VSMART    VEDGE
INSTANCE  COUNTS    COUNTS     COUNTS    COUNTS
-------------------------------------------------
0           2          0          2        7
1           2          0          0        5
2           2          0          0        5
3           2          0          0        4
```

To see the listening ports, use the **show control local-properties** command:

```
vManage# show control local-properties

organization-name            Cisco SD-WAN Inc Test
certificate-status           Installed
root-ca-chain-status         Installed

certificate-validity         Valid
certificate-not-valid-before May 20 00:00:00 2015 GMT
certificate-not-valid-after  May 20 23:59:59 2016 GMT

dns-name                     vbond.cisco.com
site-id                      5000
domain-id                    0
protocol                     dtls
tls-port                     23456
...
...
...
number-active-wan-interfaces 1

                PUBLIC       PUBLIC PRIVATE       PRIVATE
  ADMIN  OPERATION LAST
INDEX INTERFACE IP           PORT   IP            PORT    VSMARTS  VMANAGES COLOR  CARRIER
  STATE  STATE     CONNECTION
-------------------------------------------------------------------------------------------------------------
0     eth0      72.28.108.37 12361  172.16.98.150 12361   2        0        silver default
  up     up       0:00:00:08
```

This output shows that the listening TCP port is 23456. If you are running vManage behind a NAT, you should open the following ports on the NAT device:

- 23456 (base - instance 0 port)
- 23456 + 100 (base + 100)
- 23456 + 200 (base + 200)
- 23456 + 300 (base + 300)

Note that the number of instances is the same as the number of cores you have assigned for the vManage, up to a maximum of 8.

Configure Data Plane Security Parameters

In the data plane, IPsec is enabled by default on all routers, and by default IPsec tunnel connections use a modified version of the Encapsulating Security Payload (ESP) protocol for authentication on IPsec tunnels. On the routers, you can change the type of authentication, the IPsec rekeying timer, and the size of the IPsec anti-replay window.

Configure Allowed Authentication Types

By default, IPsec tunnel connections use a modified version of the Encapsulating Security Payload (ESP) protocol for authentication. To modify the negotiated authentication types, use the following command:

```
Device(config)# security ipsec authentication-type (ah-sha1-hmac | ah-no-id | sha1-hmac |
)
```

By default, IPsec tunnel connections use AES-GCM-256, which provides both encryption and authentication.

Configure each authentication type with a separate **security ipsec authentication-type** command. The command options map to the following authentication types, which are listed in order from most strong to least strong:

Note The `sha1` in the configuration options is used for historical reasons. The authentication options indicate over how much of the packet integrity checking is done. They do not specify the algorithm that checks the integrity. The authentication algorithms supported by Cisco SD-WAN do not use SHA1.

- **ah-sha1-hmac** enables encryption and encapsulation using ESP. However, in addition to the integrity checks on the ESP header and payload, the checks also include the outer IP and UDP headers. Hence, this option supports an integrity check of the packet similar to the Authentication Header (AH) protocol. All integrity and encryption is performed using AES-256-GCM.
- **ah-no-id** enables a mode that is similar to **ah-sha1-hmac**, however the ID field of the outer IP header is ignored. This option accommodates some non-Cisco SD-WAN devices, including the Apple AirPort Express NAT, that have a bug that causes the ID field in the IP header, a non-mutable field, to be modified. Configure the **ah-no-id** option in the list of authentication types to have the Cisco SD-WAN AH software ignore the ID field in the IP header so that the Cisco SD-WAN software can work in conjunction with these devices.
- **sha1-hmac** enables ESP encryption and integrity checking.

For information about which data packet fields are affected by these authentication types, see Data Plane Integrity.

Cisco IOS XE SD-WAN devices and Cisco vEdge devices advertise their configured authentication types in their TLOC properties. The two routers on either side of an IPsec tunnel connection negotiate the authentication to use on the connection between them, using the strongest authentication type that is configured on both of the routers. For example, if one router advertises the `ah-sha1-hmac` and `ah-no-id` types, and a second router advertises the `ah-no-id` type, the two routers negotiate to use `ah-no-id` on the IPsec tunnel connection between them. If no common authentication types are configured on the two peers, no IPsec tunnel is established between them.

The encryption algorithm on IPsec tunnel connections is AES-256-GCM.

When the IPsec authentication type is changed, the AES key for the data path is changed.

Change the Rekeying Timer

Before Cisco IOS XE SD-WAN devices and Cisco vEdge devices can exchange data traffic, they set up a secure authenticated communications channel between them. The routers use IPSec tunnels between them as the channel, and the AES-256 cipher to perform encryption. Each router generates a new AES key for its data path periodically.

By default, a key is valid for 86400 seconds (24 hours), and the timer range is 10 seconds through 1209600 seconds (14 days). To change the rekey timer value:

```
Device(config)# security ipsec
rekey seconds
```

The configuration looks like this:

```
security
    ipsec
      rekey seconds
    !
```

If you want to generate new IPsec keys immediately, you can do so without modifying the configuration of the router. To do this, issue the **request platform software sdwan security ipsec-rekey** command on the compromised router.

For example, the following output shows that the local SA has a Security Parameter Index (SPI) of 256:

```
Device# show sdwan ipsec local-sa

                                          SOURCE           SOURCE
TLOC ADDRESS     TLOC COLOR       SPI     IP               PORT    KEY HASH
-------------------------------------------------------------------------------
172.16.255.15    lte              256     10.1.15.15       12346   *****b93a
```

A unique key is associated with each SPI. If this key is compromised, use the **request platform software sdwan security ipsec-rekey** command to generate a new key immediately. This command increments the SPI. In our example, the SPI changes to 257 and the key associated with it is now used:

```
Device# request platform software sdwan security ipsec-rekey
Device# show sdwan ipsec local-sa
                                          SOURCE           SOURCE
TLOC ADDRESS     TLOC COLOR       SPI     IP               PORT    KEY HASH
-------------------------------------------------------------------------------
172.16.255.15    lte              257     10.1.15.15       12346   *****b93a
```

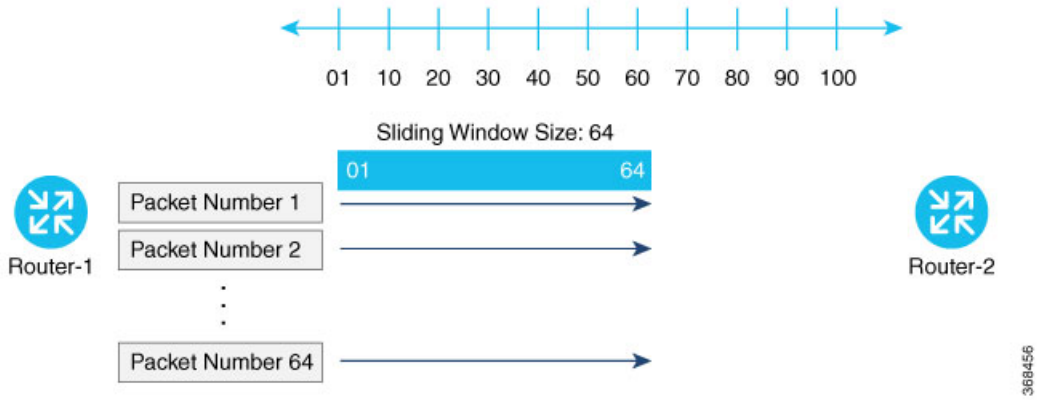
After the new key is generated, the router sends it immediately to the vSmart(s) using DTLS or TLS. The vSmart(s) send the key to the peer routers. The routers begin using it as soon as they receive it. Note that the key associated with the old SPI (256) will continue to be used for a short period of time, until it times out.

To stop using the old key immediately, issue the **request platform software sdwan security ipsec-rekey** command twice, in quick succession. This sequence of commands removes both SPI 256 and 257 and sets the SPI to 258. The router then uses the associated key of SPI 258. Note, however, that some packets will be dropped for a short period of time, until all the remote routers learn the new key.

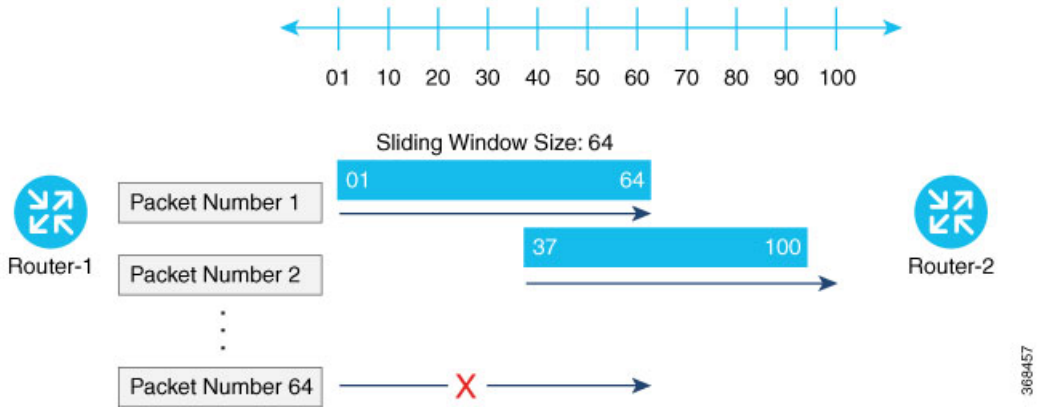
```
Device# request platform software sdwan security ipsec-rekey
Device# request platform software sdwan security ipsec-rekey
Device# show sdwan ipsec local-sa
                                          SOURCE           SOURCE
TLOC ADDRESS     TLOC COLOR       SPI     IP               PORT    KEY HASH
-------------------------------------------------------------------------------
172.16.255.15    lte              258     10.1.15.15       12346   *****b93a
```

Change the Size of the Anti-Replay Window

IPsec authentication provides anti-replay protection by assigning a unique sequence number to each packet in a data stream. This sequence numbering protects against an attacker duplicating data packets. With anti-replay protection, the sender assigns monotonically increasing sequence numbers, and the destination checks these sequence numbers to detect duplicates. Because packets often do not arrive in order, the destination maintains a sliding window of sequence numbers that it will accept.



Packets with sequence numbers that fall to the left of the sliding window range are considered old or duplicates, and the destination drops them. The destination tracks the highest sequence number it has received, and adjusts the sliding window when it receives a packet with a higher value.



By default, the sliding window is set to 512 packets. It can be set to any value between 64 and 4096 that is a power of 2 (that is, 64, 128, 256, 512, 1024, 2048, or 4096). To modify the anti-replay window size, use the **replay-window** command, specifying the size of the window:

```
Device(config)# security ipsec replay-window
number
```

The configuration looks like this:

```
security
   ipsec
     replay-window number
   !
!
```

To help with QoS, separate replay windows are maintained for each of the first eight traffic channels. The configured replay window size is divided by eight for each channel.

If QoS is configured on a router, that router might experience a larger than expected number of packet drops as a result of the IPsec anti-replay mechanism, and many of the packets that are dropped are legitimate ones. This occurs because QoS reorders packets, giving higher-priority packets preferential treatment and delaying lower-priority packets. To minimize or prevent this situation, you can do the following:

- Increase the size of the anti-replay window.
- Engineer traffic onto the first eight traffic channels to ensure that traffic within a channel is not reordered.

VPN Interface IPsec

Use the VPN Interface IPsec feature template to configure IPsec tunnels on Cisco IOS XE service VPNs that are being used for Internet Key Exchange (IKE) sessions. You can configure IPsec on tunnels for VPN 1 through 65530, except for 512.

Cisco Cisco IOS XE SD-WAN devices use VRFs in place of VPNs. However, the following steps still apply to configure Cisco IOS XE SD-WAN devices through Cisco vManage. In Cisco vManage, the system automatically maps the VPN configurations to VRF configurations.

Create VPN IPsec Interface Template

Step 1 From the Cisco vManage menu, select **Configuration** > **Templates**.

Step 2 Click **Feature**.

Step 3 Click **Add Template**.

Step 4 Select a Cisco IOS XE SD-WAN device from the list.

Step 5 From the VPN section, click **VPN Interface IPsec**. The Cisco VPN Interface IPsec template displays.

Step 6 In the **Template Name** field, enter a name for the template. The name can be up to 128 characters and can contain only alphanumeric characters.

Step 7 In the **Template Description** field, enter a description of the template. The description can be up to 2048 characters and can contain only alphanumeric characters.

Changing the Scope for a Parameter Value

When you first open a feature template, for each parameter that has a default value, the scope is set to Default (a), and the default setting or value is shown. To change the default or to enter a value, click the **scope** drop-down to the left of the parameter field and select one of the following:

Parameter Name	Description
Device Specific	Use a device-specific value for the parameter. For device-specific parameters, you cannot enter a value in the feature template. You enter the value when you attach a device to a device template. When you click Device Specific, the Enter Key box opens. This box displays a key, which is a unique string that identifies the parameter in a CSV file that you create. This file is an Excel spreadsheet that contains one column for each key. The header row contains the key names (one key per column), and each row after that corresponds to a device and defines the values of the keys for that device. Upload the CSV file when you attach a device to a device template. To change the default key, type a new string and move the cursor out of the Enter Key box. Examples of device-specific parameters are system IP address, hostname, GPS location, and site ID.
Global	Enter a value for the parameter, and apply that value to all devices. Examples of parameters that you might apply globally to a group of devices are DNS server, syslog server, and interface MTUs.

Once you have created and named the template, enter the following values. Parameters marked with an asterisk are required.

Configure IPsec Tunnel Parameters

To configure the IPsec tunnel that carries IKE traffic, select the IPsec tab and configure the following parameters:

Parameter Name	Options	Description
IPsec Rekey Interval	3600 - 1209600 seconds	Specify the interval for refreshing IKE keys. Range: 1 hour through 14 days Default: 3600 seconds
IKE Replay Window	64, 128, 256, 512, 1024, 2048, 4096, 8192	Specify the replay window size for the IPsec tunnel. Default: 512
IPsec Cipher Suite	aes256-cbc-sha1 aes256-gcm null-sha1	Specify the authentication and encryption to use on the IPsec tunnel Default: aes256-gcm

Parameter Name	Options	Description
Perfect Forward Secrecy	**2** 1024-bit modulus **14** 2048-bit modulus **15** 3072-bit modulus **16** 4096-bit modulus **none**	Specify the PFS settings to use on the IPsec tunnel. Select one of the following Diffie-Hellman prime modulus groups: 1024-bit – group-2 2048-bit – group-14 3072-bit – group-15 4096-bit – group-16 none –disable PFS. *Default*: group-16

To save the feature template, click **Save**.

CLI Equivalent

```
crypto
   ipsec
      profile ipsec_profile_name
         set ikev2-profile ikev2_profile_name
         set security-association
            lifetime {seconds 120-2592000 | kilobytes disable}
            replay {disable | window-size {64 | 128 | 256 | 512 | 1024 | 4096 | 8192}
         set pfs group {2 | 14 | 15 | 16 | none}
         set transform-set transform_set_name
```

Release Information

Introduced in Cisco vManage for Cisco IOS XE SD-WAN Release 16.11.x.

Configure Dead-Peer Detection

To configure Internet key exchange (IKE) dead-peer detection (DPD) to determine whether the connection to an IKE peer is functional and reachable, select the DPD tab and configure the following parameters:

Parameter Name	Description
DPD Interval	Specify the interval for IKE to send Hello packets on the connection. Range: 10 through 3600 seconds Default: Disabled
DPD Retries	Specify how many unacknowledged packets to accept before declaring an IKE peer to be dead and then tearing down the tunnel to the peer. Range: 2 through 60 Default: 3

To save the feature template, click **Save**.

CLI Equivalent

```
crypto
   ikev2
      profile ikev2_profile_name
         dpd 10-3600 2-60 {on-demand | periodic}
```

Configure IKE

Table 1: Feature History

Feature Name	Release Information	Description
SHA256 Support for IPSec Tunnels	Cisco IOS XE Release 17.2.1r	This feature adds support for `HMAC_SHA256` algorithms for enhanced security.

To configure IKE, click **IKE** and configure the following parameters:

Note When you create an IPsec tunnel on a Cisco IOS XE SD-WAN device, IKE Version 1 is enabled by default on the tunnel interface.

IKE Version 1 and IKE Version 2

To configure the IPsec tunnel that carries IKEv1 and IKEv2 traffic, click **IPSEC** and configure the following parameters:

Parameter Name	Options	Description
IKE Version	**1** IKEv1 **2** IKEv2	Enter **1** to choose IKEv1. Enter **2** to choose IKEv2. *Default*: IKEv1

Parameter Name	Options	Description
IKE Mode	**Aggressive mode** **Main mode**	For IKEv1 only, specify one of the following modes: • Aggressive mode - Negotiation is quicker, and the initiator and responder ID pass in the clear. • Establishes an IKE SA session before starting IPsec negotiations. **Note** For IKEv2, there is no mode. **Note** IKE aggressive mode with pre-shared keys should be avoided where possible. Otherwise a strong pre-shared key should be chosen. *Default*: Main mode
IPsec Rekey Interval	3600 - 1209600 seconds	Specify the interval for refreshing IKE keys. *Range*: 1 hour through 14 days *Default*: 14400 seconds (4 hours)
IKE Cipher Suite	**3DES** **192-AES** **256-AES** **AES** **DES**	Specify the type of authentication and encryption to use during IKE key exchange. *Default*: 256-AES
IKE Diffie-Hellman Group	**2** **14** **15** **16**	Specify the Diffie-Hellman group to use in IKE key exchange, whether IKEv1 or IKEv2. • 1024-bit modulus • 2048-bit modulus • 3072-bit modulus • 4096-bit modulus *Default*: 4096-bit modulus

Parameter Name	Options	Description
IKE Authentication	Configure IKE authentication.	
	Preshared Key	Enter the password to use with the preshared key.
	IKE ID for Local End Point	If the remote IKE peer requires a local end point identifier, specify it. *Range*: 1 through 64 characters *Default*: Tunnel's source IP address
	IKE ID for Remote End Point	If the remote IKE peer requires a remote end point identifier, specify it. *Range*: 1 through 64 characters *Default*: Tunnel's destination IP address

To save the feature template, click **Save**.

Change the IKE Version from IKEv1 to IKEv2

To change the IKE version, do the following:

1. From the Cisco vManage menu, choose **Configuration** > **Templates**.
2. Click **Feature**, and then click **Add Template**.
3. Choose the device for which you are creating the template.
4. Click **Basic Configuration**.
5. Use the **shutdown** parameter with the **yes** option (**yes shutdown**) to shut down the tunnel.
6. Remove the ISAKMP profile from the IPsec profile.
7. Attach the IKEv2 profile with the IPsec profile.

Note Perform this step if you already have an IKEv2 profile. Otherwise, create an IKEv2 profile first.

8. Use the **shutdown** parameter with the **no** option (**no shutdown**) to start up the tunnel.

Note You must issue the **shutdown** operations in two separate operations.

Note There is no single CLI for changing the IKE version. You need to follow the sequence of steps listed in the Change the IKE Version from IKEv1 to IKEv2 section.

CLI Equivalents for IKEv1

ISAKMP CLI Configuration for IKEv1

```
crypto
   isakmp
      keepalive 60-86400 2-60 {on-demand | periodic}
      policy policy_num
         encryption {AES128-CBC-SHA1 | AES256-CBC-SHA1}
         hash {sha384 | sha256 | sha}
         authentication pre-share
         group {2 | 14 | 16 | 19 | 20 | 21}
         lifetime 60-86400
      profile ikev1_profile_name
         match identity address ip_address [mask]
         keyring keyring_name
```

IPsec CLI Configuration for IKEv1

```
profile ipsec_profile_name
         set transform-set transform_set_name
         set isakmp-profile ikev1_profile_name
         set security-association
            lifetime {kilobytes disable | seconds 120-2592000}
            replay {disable | window-size [64 | 128 | 256 | 512 | 1024]}
         set pfs group {14 | 16 | 19 | 20 | 21}
   keyring keyring_name
      pre-shared-key address ip_address [mask] key key_string
   ipsec transform-set transform_set_name {esp-gcm 256 | esp-aes 256 [esp-sha384-hmac |
esp-sha256-hmac] mode tunnel
```

Summary Steps

1. enable
2. configure terminal
3. crypto isakmp policy *priority*
4. encryption {des | 3des | aes | aes 192 | aes 256 }
5. hash {sha | sha256 | sha384 | md5 }
6. authentication {rsa-sig | rsa-encr | pre-share }
7. group {1 | 2 | 5 | 14 | 15 | 16 | 19 | 20 | 24 }
8. lifetime *seconds*
9. exit
10. exit

CLI Equivalent for IKE2

```
crypto
   ikev2
      proposal proposal_name
         encryption {3des | aes-cbc-128 | aes-cbc-192 | aes-cbc-256 | des}
         integrity {sha256 | sha384 | sha512}
         group {2 | 14 | 15 | 16}
      keyring idev2_keyring_name
```

```
    peer peer_name
    address tunnel_dest_ip [mask]
    pre-shared-key key_string
 profile ikev2_profile_name
    match identity remote address ip_address
    authentication {remote | local} pre-share
    keyring local ikev2_keyring_name
    lifetime 120-86400
```