

Security Features

Note To achieve simplification and consistency, the Cisco SD-WAN solution has been rebranded as Cisco Catalyst SD-WAN. In addition, from Cisco IOS XE SD-WAN Release 17.12.1a and Cisco Catalyst SD-WAN Release 20.12.1, the following component changes are applicable: **Cisco vManage** to **Cisco Catalyst SD-WAN Manager**, **Cisco vAnalytics** to **Cisco Catalyst SD-WAN Analytics**, **Cisco vBond** to **Cisco Catalyst SD-WAN Validator**, **Cisco vSmart** to **Cisco Catalyst SD-WAN Controller**, and **Cisco Controllers** to **Cisco Catalyst SD-WAN Control Components**. See the latest Release Notes for a comprehensive list of all the component brand name changes. While we transition to the new names, some inconsistencies might be present in the documentation set because of a phased approach to the user interface updates of the software product.

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Encrypt Communications

The U.S. federal government requires that all data at rest and in transit be encrypted.

To satisfy this requirement, Cisco uses the following forms of encryption:

- Transport Layer Security (TLS) 1.2 encryption.
- FIPS Object Module - a FIPS validated model that meets the FIPS 140-2 requirements, performs the FIPS-approved cryptographic functions, and is designed for use in conjunction with Cisco SSL distributions. FIPS mode is enabled by default in Cisco Catalyst SD-WAN for government.

  For more information, see Cisco FIPS Object Module.
- Cisco SSL is a Cisco-enhanced version of OpenSSL, which enables products to achieve FIPS compliance.

  For more information, see Cryptographic Module Validation Program CMVP.

Note All the virtual machines within the Cisco Catalyst SD-WAN for government boundary use the 7.x version of the Cisco SSL library, which runs in FIPS mode, thereby ensuring that all the data at rest and in transit are encrypted.

IPsec Pairwise Keys

Table 1: Feature History

Feature Name	Release Information	Description
Secure Communication Using Pairwise IPsec Keys	Cisco IOS XE Catalyst SD-WAN Release 16.12.1b	This feature allows you to create and install private pairwise IPsec session keys for secure communication between an IPsec device and its peers.

The IPsec pairwise keys feature implements controller-based key exchange protocol between a device and controller.

Controller-based key exchange protocol is used to create a Gateway-to-Gateway VPN (RFC7018) in either a full-mesh topology or dynamic full-mesh topology.

The network devices set up a protected control-plane connection to the controller. The controller distributes policies to network devices. The network devices, in turn, communicate with each other through a secure data plane.

A pair of IPsec session keys (one encryption key and one decryption key) are configured for each pair of local and remote transport locations (TLOC).

Pairwise Keys

Key exchange method combined with authentication policies facilitate pairwise key creation between two network devices. You use a controller to distribute keying material and policies between network devices. The devices generate private pairwise keys with each other.

IPsec devices share public keys from the Diffie-Hellman (DH) algorithm with the controllers. The controllers relay the DH public keys to authorized peers of the IPsec device as defined by the centralized policy.

Network devices create and install private pairwise IPsec session keys to secure communication with their peers.

IPsec Security Association Rekey

Every rekeying IPsec device generates a new Diffie-Hellman (DH) pair and new IPsec security association pairs for each peer with which it is communicating. The new security association pairs are generated as a combination of the new DH private key and the DH public key of each peer. The IPsec device distributes the new DH public value to the controller, which forwards it to its authorized peers. Each peer continues to transmit to the existing security association, and subsequently, to new security associations.

During a simultaneous rekey, up to four pairs of IPsec Security Associations (SAs) can be temporarily created. These four pairs converge on a single rekey of a device.

An IPsec device can initiate a rekey due to reasons such as the local time or a volume-based policy, or the counter result of a cipher counter mode initialization vector nearing completion.

When you configure a rekey on a local inbound security association, it triggers a peer outbound and inbound security association rekey. The local outbound security association rekey is initiated after the IPsec device receives the first packet with the new Security Parameter Index (SPI) from a peer.

Note

- A pairwise-key device can form IPsec sessions with both pairwise and nonpairwise devices.
- The rekeying process requires higher control plane CPU usage, resulting in lower session scaling.

Configure IPsec Pairwise Keys Using Cisco Catalyst SD-WAN Manager

1. From the Cisco SD-WAN Manager menu, choose **Configuration** > **Templates**.
2. Click **Feature Templates** and then click **Add Template**.

Note In Cisco vManage Release 20.7.1 and earlier releases, **Feature Templates** is called **Feature**.

3. From the **Device Model** drop-down menu, choose the type of device for which you are creating the template.
4. From **Basic Information**, click **Cisco Security** feature template.
5. From **Basic Configuration**, click **On** or **Off** from the **IPsec pairwise-keying** field.
6. Alternatively, enter the pairwise key specific to the device in the **Enter Key** field.
7. Click **Save**.

Configure Pairwise Keys and Enable Rekeying on the CLI

A pair of IPsec session keys is configured for each pair of local and remote transport locations.

The keys use AES-GCM-256 (AES_256_CBC for multicast) cipher to perform encryption. By default, a key is valid for 3600 seconds.

Configure Pairwise Keys

Use the following command to configure pairwise keys:

```
Device(config)# security ipsec pairwise-keying
```

Note You must reboot the Cisco IOS XE Catalyst SD-WAN device for the private-key configuration to take effect.

Configure Rekeying for IPsec Pairwise Keys

Use the following command to configure rekeying for pairwise keys:

```
Device(config)# security ipsec pwk-sym-rekey
```

Verify IPsec Pairwise Keys on a Cisco IOS XE Catalyst SD-WAN Device

Use the following command to verify the outbound connections for pairwise keys:

```
Device# show sdwan ipsec pwk outbound-connections

                                        REMOTE                    SA    PKEY  NONCE   PKEY
SS   E-KEY   AH
 SOURCE IP    Source Port  SOURCE IP   DEST Port LOCAL TLOC ADDRESS  REMOTE TLOC COLOR
REMOTE TLOC ADDRESS   REMOTE TLOC COLOR     PWK-SPI  INDEX      ID      HASH   HASH   HASH
   HASH  AUTH
-------------------+----+-------------------+----+-------+-------+-------+-------+----+----+----+----+----+----
10.168.11.3   12346    192.168.90.3      12346    10.1.0.2                lte
  10.1.0.1          private1          000000   202    0       6668          17B0   F5A5
true
10.168.11.3   12346    192.168.92.6      12346    10.1.0.2                lte
  10.1.0.6          default           00A001   52     10      0ED6   AF12   0A09   8030
true
10.168.12.3   12346    192.168.90.3      12346    10.1.0.2                blue
  10.1.0.1          private1          000000   205    0       6668          17B0   F5A5
true
10.168.12.3   12346    192.168.92.6      12346    10.1.0.2                blue
  10.1.0.6          default           00A001   55     10      0ED6   AF12   B9B7   BE29
true
```

Use the following command to verify the inbound connections on IPsec pairwise keys:

```
Device# show sdwan ipsec pwk inbound-connections

                                        SOURCE
   DEST        LOCAL            LOCAL            REMOTE           REMOTE
SA    PKEY  NONCE   PKEY    SS   D-KEY   AH
               SOURCE IP                  PORT                  DEST IP
   PORT     TLOC ADDRESS      TLOC COLOR      TLOC ADDRESS      TLOC COLOR     PWK-SPI
INDEX    ID    HASH   HASH   HASH   HASH  AUTH
-------------------+----+-------------------+----+-------+-------+-------+----+----+----+----+----+----
192.168.90.3                            12346    10.168.11.3
 12346    10.1.0.2          lte             10.1.0.1          private1          000000
2      1       5605   70C7   17B0   F5A5  true
192.168.92.6                            12346    10.168.11.3
 12346    10.1.0.2          lte             10.1.0.6          default           00100B
52     1       5605   70C7   CCC2   C9E1  true
192.168.90.3                            12346    10.168.12.3
 12346    10.1.0.2          blue            10.1.0.1          private1          000000
5      1       B9F9   5C75   17B0   F5A5  true
192.168.92.6                            12346    10.168.12.3
 12346    10.1.0.2          blue            10.1.0.6          default           00100B
55     1       B9F9   5C75   A0F8   7B6B  true


Device# show sdwan ipsec pwk local-sa

                                                                                    SA
PKEY  NONCE PKEY
TLOC-ADDRESS     TLOC-COLOR     SOURCE-IP   SOURCE PORT     SPI   INDEX  ID
-------------+-------------+-------------------------------------+------+------+-----+-----+-----
10.1.0.2         lte             10.168.11.3    12346           257     6     1     5605
70C7
10.1.0.2         blue            10.168.12.3    12346           257     3     1     B9F9
5C75

Device# show platform hardware qfp active feature ipsec da spi

g_hash_idx  Flow id  QFP SA hdl  source IP                              sport  dest IP
                                 dport  SA ptr      spi/old               crypto_hdl/old
```

```
--------+-----+------+-------------------+---+-------------------------------+----+------+---------------+-----------------------
1541        3       11          192.168.90.3                                12346  192.168.92.6
                                12346  0x312b84f0  0x00000115/0x00000114
0x0000000031fbfa80/0x0000000031fbd520
6661        131     36          10.168.12.3                                 12346  192.168.92.6
                                12346  0x312b9990  0x0000b001/0x0000a001
0x0000000031fbe380/0x0000000031fbc9a0
7429        117     6           10.168.11.3                                 12346  192.168.92.6
                                12346  0x312b9300  0x0000b001/0x0000a001
0x0000000031fbd970/0x0000000031fbb580


           System id    Wan int Wan ip
Yubei-cedge     5102    Gi2.xxx Sub 10.168.xxx
Yubei-tsn       5108    Gi0/0/1 192.168.92.8
Yubei-ovld      5106    Gi0/0/0 192.168.92.6
Yubei-lng       5107    Gi0/0/0 192.168.92.7
Yubei-utah      5104    Gi0/0/0 192.168.92.4
Yubei-vedge     5101    ge0/0   192.168.90.3
```

Use the following command to display IPsec pairwise keys information on a Cisco IOS XE Catalyst SD-WAN device:

```
Device# show sdwan security-info

security-info authentication-type "AH_SHA1_HMAC SHA1_HMAC"
security-info rekey 86400
security-info replay-window 512
security-info encryption-supported "AES_GCM_256 (and AES_256_CBC for multicast)"
security-info fips-mode Enabled
security-info pairwise-keying Enabled
```

Debug Commands on Cisco IOS XE Catalyst SD-WAN Devices

Use the following **debug** commands for debugging issues related to IPsec pairwise keys:

```
debug plat soft sdwan ftm pwk [dump | log]
debug plat soft sdwan ttm pwk [dump | log]
debug plat soft sdwan vdaemon pwk [dump | log]
```