Configure MACSec

This module describes how to configure Media Access Control Security (MACSec) encryption on the ASR 9000 Series Aggregation Services Routers. MACSec is a Layer 2 IEEE 802.1AE standard for encrypting packets between two MACSec-capable routers.

Feature History for Configure MACSec

Release	Modification
Release 5.3.2	This feature was introduced.
Release 6.0.1	This feature was modified to support VLAN sub-interfaces and bundles.
Release 6.1.2	This feature was modified to introduce MACsec as a service.
Release 6.3.3	Introduced the support for global MACsec shutdown.
Release 6.3.3	Introduced the support for MACsec SAK rekey interval.
Release 6.5.1	MACSec support was introduced on Cisco ASR 9901 Routers.
Release 6.6.1	A9K-MPA-32x1GE MPA card was introduced with MACSec support for Cisco IOS XR.
Release 6.6.2	MACSec support with A9K-MPA-32x1GE extended to IOS XR 64-bit.
Release 7.1.3	MACSec support was introduced on Cisco ASR 9000 5th generation line cards, Cisco ASR 9903 1.6T chassis and Cisco ASR 9903 2T port expansion card running Cisco IOS XR 64-bit.

Understanding MACsec Encryption

Security breaches can occur at any layer of the OSI model. At Layer 2, some of the common breaches at Layer 2 are MAC address spoofing, ARP spoofing, Denial of Service (DoS) attacks against a DHCP server, and VLAN hopping.

MACsec secures data on physical media, making it impossible for data to be compromised at higher layers. As a result, MACsec encryption takes priority over any other encryption method such as IPsec and SSL, at higher layers. MACsec is configured on Customer Edge (CE) router interfaces that connect to Provider Edge (PE) routers and on all the provider router interfaces.

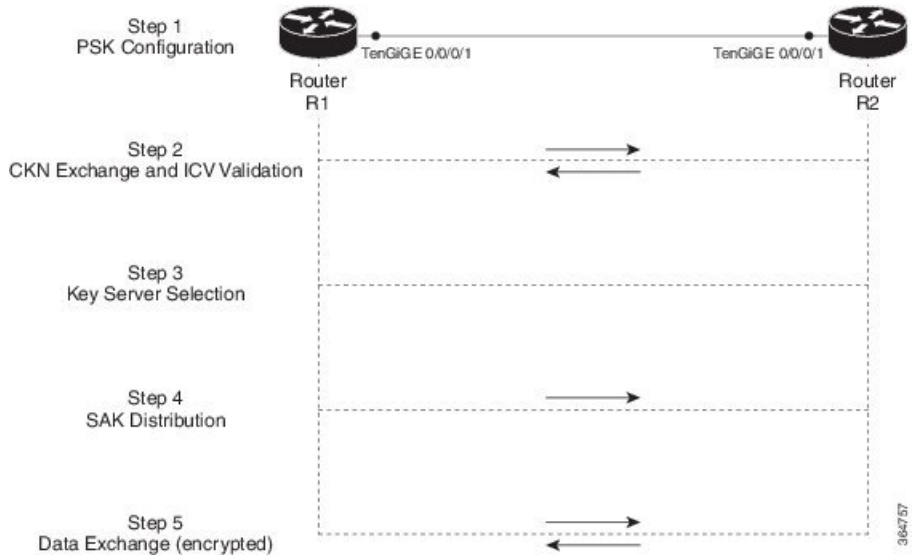
MACservice can be deployed in the network as a technology or as a service. For more information, see Types of MACsec Implementation, on page 3

MACsec Authentication Process

MACsec provides encryption using Advanced Encryption Standard (AES) algorithm at the Layer 2. MACsec uses the MACsec Key Agreement protocol (MKA) to exchange session keys, and manage encryption keys.

The MACsec encryption process is illustrated in the following figure and description.

Figure 1: MACsec Encryption Process



Step 1: When a link is first established between two routers, they become peers. Mutual peer authentication takes place by configuring a Pre-shared Key (PSK).

Step 2: On successful peer authentication, a connectivity association is formed between the peers, and a secure Connectivity Association Key Name (CKN) is exchanged. After the exchange, the MKA ICV is validated with a Connectivity Association Key (CAK), which is effectively a secret key.

Step 3: A key server is selected between the routers, based on the configured key server priority. Lower the priority value, higher the preference for the router to become the key server. If no value is configured, the default value of 16 is taken to be the key server priority value for the router. Lowest priority value configures that router as the key server, while the other router functions as a key client. The following rules apply to key server selection:

- Numerically lower values of key server priority and SCI are accorded the highest preference.
- Each router selects a peer advertising the highest preference as its key server provided that peer has not selected another router as its key server or is not willing to function as the key server.
- In the event of a tie for highest preferred key server, the router with the highest priority SCI is chosen as key server (KS).

Step 4: A security association is formed between the peers. The key server generates and distributes the Secure Association Key (SAK) to the key client (peer). SAKs are generated for every data exchange between the peers.

Step 5: Encrypted data is exchanged between the peers.

Advantages of Using MACsec Encryption

- **Client-Oriented Mode**: MACsec is used in setups where two routers that are peering with each other can alternate as a key server or a key client prior to exchanging keys. The key server generates and maintains the CAK between the two peers.
- **Data Integrity Check**: MACsec uses MKA to generate an Integrity Check Value (ICV) for the frame arriving on the port. If the generated ICV is the same as the ICV in the frame, then the frame is accepted; otherwise it is dropped.
- **Data Encryption**: MACsec provides port-level encryption on the line card of the router. This means that the frames sent out of the configured port are encrypted and frames received on the port are decrypted. MACsec also provides a mechanism where you can configure whether only encrypted frames or all frames (encrypted and plain) are accepted on the interface.
- **Replay Protection**: When frames are transmitted through the network, there is a strong possibility of frames getting out of the ordered sequence. MACsec provides a configurable window that accepts a specified number of out-of-sequence frames.
- **Support for Clear Traffic**: If configured accordingly, data that is not encrypted is allowed to transit through the port.

Types of MACsec Implementation

MACsec is implemented in the following ways:

- **MACsec** where it serves as an encryption method for all traffic on Ethernet links.

  For more information on configuring MACsec, see *Creating a MACsec Keychain* and *Creating a MACsec Policy*

- **MACsec as a service** where it serves as an encryption method for L2VPN and L3VPN traffic over a provider network. It provides a mechanism to provide encryption or decryption service for selected traffic across the WAN core. For example: aservice provider can charge encryption of voice calls at a premium. This solution supports both Point-to-Point as well as Multipoint service for all the traffic on the network.

  For more information on configuring MACsec as a service, see Configuring MACsec as a Service, on page 38

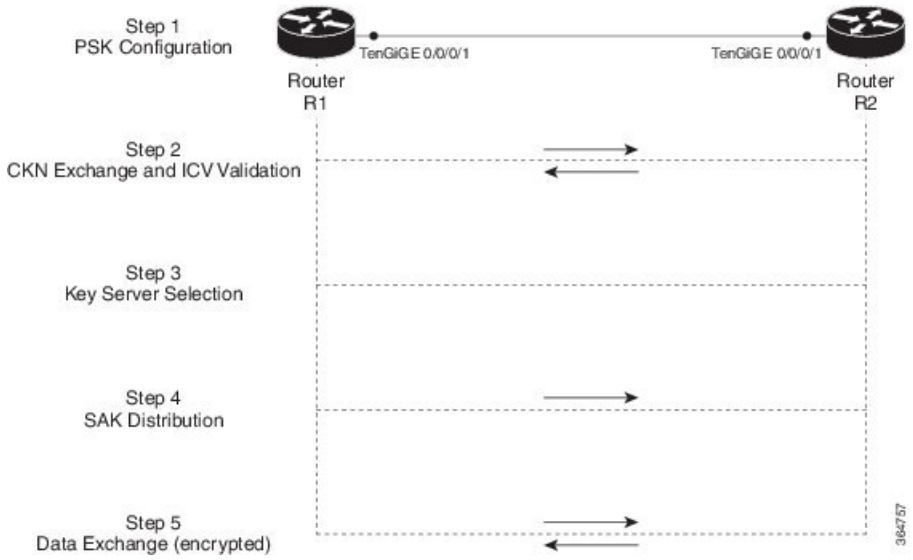
Both MACsec and MACsec service are mutually exclusive and can be deployed in the same network.

MKA Authentication Process

MACsec provides encryption at the Layer 2, which is provided by the Advanced Encryption Standard (AES) algorithm that replaces the DES algorithm. MACsec uses the MACsec Key Agreement protocol (MKA) to exchange session keys, and manage encryption keys.

The MACsec encryption process is illustrated in the following figure and description.

Figure 2: MKA Encryption Process



Step 1: When a link is first established between two routers, they become peers. Mutual peer authentication takes place by configuring a Pre-shared Key (PSK).

Step 2: On successful peer authentication, a connectivity association is formed between the peers, and a secure Connectivity Association Key Name (CKN) is exchanged. After the exchange, the MKA ICV is validated with a Connectivity Association Key (CAK), which is effectively a secret key.

Step 3: A key server is selected between the routers, based on the configured key server priority. Lower the priority value, higher the preference for the router to become the key server. If no value is configured, the default value of 16 is taken to be the key server priority value for the router. Lowest priority value configures that router as the key server, while the other router functions as a key client. The following rules apply to key server selection:

- Numerically lower values of key server priority and SCI are accorded the highest preference.
- Each router selects a peer advertising the highest preference as its key server provided that peer has not selected another router as its key server or is not willing to function as the key server.
- In the event of a tie for highest preferred key server, the router with the highest priority SCI is chosen as key server (KS).

Step 4: A security association is formed between the peers. The key server generates and distributes the Secure Association Key (SAK) to the key client (peer). Each secure channel is supported by an overlapped sequence of Security Associations(SA). Each SA uses a new Secure Association Key (SAK).

Step 5: Encrypted data is exchanged between the peers.

MACsec Frame Format

The MACsec header in a frame consists of three components as illustrated in the following figure.

- **Security tag**: The security tag is 8-16 bytes in length and identifies the SAK to be used for the frame. With Secure Channel Identifier (SCI) encoding, the security tag is 16 bytes in length, and without the encoding, 8 bytes in length (SCI encoding is optional).The security tag also provides replay protection when frames are received out of sequence.
- **Secure data**: This is the data in the frame that is encrypted using MACsec and can be 2 or more octets in length.
- **ICV**: The ICV provides the integrity check for the frame and is usually 8-16 bytes in length, depending on the cipher suite. Frames that do not match the expected ICV are dropped at the port.

Figure 3: MACsec Frame Format

Hardware Support for MACSec

The MACSec support on ASR 9000 Series Routers is compatible with the following chassis, line cards (LCs), and modular port adapters (MPAs).

Supported Chassis for MACSec

Table 1: Supported Chassis for MACSec

Chassis Type	Introduced Release for MACSec Support
Cisco ASR 9903 Router (1.6T Fixed Board only or with removable A9903-20HG-PEC card)	Release 7.1.3
Cisco ASR 9901 Router	Release 6.5.1

Supported Modular Port Adapters for MACSec

The MACSec technology is supported on modular line cards when used with the following MPAs:

Table 2: Supported MPAs for MACSec

Hardware PIDs	Hardware Description	Introduced Release for MACSec Support
A9K-MPA-32X1GE	32-port GE Modular Port Adapter	Release 6.6.1
A9K-MPA-20X10GE	20-port 10 Gigabit Modular Port Adapter	Release 6.1.2

Hardware PIDs	Hardware Description	Introduced Release for MACSec Support
A9K-MPA-1X100GE	1-port 100 Gigabit Modular Port Adapter	Release 6.1.2
A9K-MPA-2X100GE	2-port 100 Gigabit Modular Port Adapter	Release 6.1.2

Supported Line Cards and Port Expansion Cards for MACSec

Following line cards and port expansion cards support MACSec:

Table 3: Supported Line Cards for MACSec

Line Card	Introduced Release for MACSec Support
200G and 400G modular line cards with A9K-MPA-20X10GE, A9K-MPA-1X100GE and A9K-MPA-2X100GE	Release 6.1.2
200G and 400G modular line cards with A9K-MPA-32X1GE	Release 6.6.1
4X100 GE and 8X100 GE OTN Line Card	Release 6.1.2
Cisco ASR 9000 Series 400-Gbps IPoDWDM Line Card - A9K-400G-DWDM-TR	Release 6.2.1
ASR 9000 5th Generation Line Cards	*See the table below for the list of supported PIDs and release information*

Table 4: Supported Port Expansion Cards for MACSec

Hardware PID	Hardware Description	Introduced Release for MACSec Support (on main interface)	Introduced Release for MACSec Support (on sub-interface)
A9903-8HG-PEC	ASR 9903 800G Multirate Port Expansion Card	Release 7.4.1	Release 7.4.1
A9903-20HG-PEC	ASR 9903 2T Multirate Port Expansion Card	Release 7.1.3	Release 7.3.2

Table 5: Supported ASR 9000 5th Generation Line Cards for MACSec

Hardware PID	Hardware Description	Introduced Release for MACSec Support (on main interface)	Introduced Release for MACSec Support (on sub-interface)
A99-4HG-FLEX-SE	ASR 9900 400GE Combo Service Edge Line Card - 5th Generation	Release 7.4.1	Release 7.4.1
A99-4HG-FLEX-TR	ASR 9900 400GE Combo Packet Transport Line Card - 5th Generation	Release 7.4.1	Release 7.4.1
A99-10X400GE-X-SE	ASR 9000 4T Service Edge Line Card - 5th Generation	Release 7.3.1	Release 7.3.2
A99-10X400GE-X-TR	ASR 9000 4T Packet Transport Line Card - 5th Generation	Release 7.3.1	Release 7.3.2
A9K-20HG-FLEX-SE	ASR 9000 2T Service Edge Combo Line Card - 5th Generation	Release 7.1.3	Release 7.3.2
A9K-20HG-FLEX-TR	ASR 9000 2T Packet Transport Combo Line Card - 5th Generation	Release 7.1.3	Release 7.3.2
A9K-8HG-FLEX-SE	ASR 9000 800G Service Edge Combo Line Card - 5th Generation	Release 7.1.3	Release 7.3.2
A9K-8HG-FLEX-TR	ASR 9000 800G Packet Transport Combo Line Card - 5th Generation	Release 7.1.3	Release 7.3.2

Note

- MACSec is not supported on ASR9000 24-port dual-rate 10G/1G service edge–optimized line card (A9K-24X10GE-1G-SE).

MACSec Limitations for Cisco ASR 9901 Routers

The following MACSec limitations are applicable for Cisco ASR 9901 routers:

- 1 Gigabit Ethernet interface supports MACSec only for GCM-AES-128 cipher.
- 1 Gigabit Ethernet interfaces created from 24 multi-rate ports do not support MACSec.

- MACSec on VLAN is not supported.
- Point-to-Multipoint scenarios are not supported.
- MACSec as a service is not supported.

MACsec PSK

A pre-shared key includes a connectivity association key name (CKN) and a connectivity association key (CAK). A pre-shared key is exchanged between two devices at each end of a point-to-point (P2P) link to enable MACsec using static CAK security mode. The MACsec Key Agreement (MKA) protocol is enabled after the pre-shared keys are successfully verified and exchanged. The pre-shared keys, the CKN and CAK, must match on both ends of a link.

Fallback PSK

Fallback is a session recovery mechanism when primary PSK fails to bring up secured MKA session. It ensures that a PSK is always available to perform MACsec encryption and decryption.

- In CAK rollover of primary keys, if latest active keys are mismatched, system performs a hitless rollover from current active key to fallback key, provided the fallback keys match.
- If a session is up with fallback, and primary latest active key configuration mismatches are rectified between peers, system performs a hitless rollover from fallback to primary latest active key.

Note

- A valid Fallback PSK (CKN and CAK) must be configured with infinite lifetime. If the fallback PSK is configured with CAK mismatch, the only recovery mechanism is to push a new set of PSK configurations (both on fallback PSK keychain and primary PSK chain in that order) on all the association members.
- In P2P topologies, a rollover to the fallback PSK happens when either of the nodes in the Secure Association (SA) cannot peer up with the primary PSK. Whereas, in P2MP, the fallback happens only at the expiry or deletion of the primary key on all peers, not just on one of the peers. On deletion or expiry of the primary PSK on one of the nodes, say R1, a new key server is chosen among the peer nodes that does a SAK rekey for the remaining nodes. This ensures that R1 is no longer part of the SA, and the network drops all traffic to and from R1.

The following is a sample syslog for session secured with fallback PSK:

```
%L2-MKA-5-SESSION_SECURED_WITH_FALLBACK_PSK : (Hu0/1/0/0) MKA session secured, CKN:ABCD
```

For more information on MACsec fallback PSK configuration, see Applying MACsec Configuration on an Interface, on page 18.

Configuring and Verifying MACSec Encryption

MACSec can be configured on physical ethernet interfaces, VLAN sub-interfaces, or interface bundles (link bundles), as explained in this section.

Note MACSec on a VLAN sub-interface is configured in same way as on a physical interface. For a successful MKA session to be up on any VLAN sub-interface, it must have a valid tagging protocol encapsulation and VLAN identifier assigned. All Ethernet sub-interfaces always default to the 802.1Q VLAN encapsulation. However, the VLAN identifier must be explicitly defined. The sub-interfaces belonging to a physical interface can have the following encapsulation combinations:

- 802.1Q with a single tag
- 802.1Q with double tags
- 802.1ad with a single tag
- 802.1ad with double tags

Use Case 1: MACSec in a L2VPN

The following figure illustrates the use of MACSec in a L2VPN network. In this topology, MACSec is configured on the PE-facing interfaces of the CE routers. The interfaces can be physical ethernet interfaces or VLAN sub-interfaces.

In a L2VPN network that uses an Ethernet over MPLS (EoMPLS) pseudowire, the traffic between CE routers is encrypted by MACSec with VLAN tags in clear. The following figure illustrates the use of MACSec in a L2VPN cloud using an EoMPLS pseudowire. MACSec is configured on the PE-facing VLAN sub-interfaces of the CE router. The PE router encapsulates the MACSec frames with VLAN tags and MPLS labels in clear and sends the frames over the EoMPLS pseudowire.

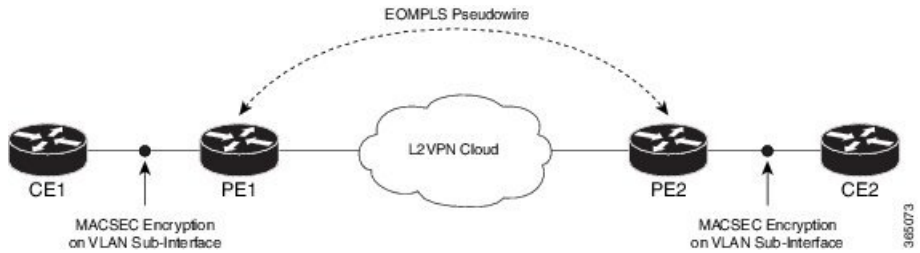
The following table lists the number of sub-interfaces with MACSec supported in a L2VPN.

Note To achieve scaling, sub-interfaces must be used.

Table 6: Supported MACSec Sessions on Sub-Interfaces

Interface Type	No. of Supported MACSec sessions (P2P)
10-GigE	5
40-GigE	21
100-GigE	42

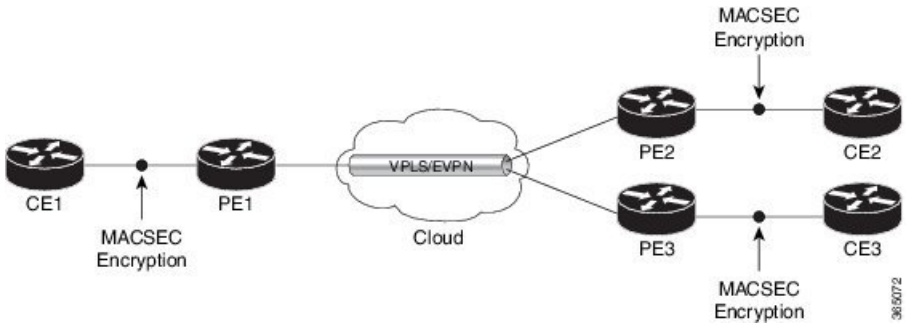
Figure 4: MACSec in a L2VPN Cloud



Use Case 2: MACSec in a VPLS/EVPN

A typical VPLS network often suffers the injection of labeled traffic from potential hackers. The following figure illustrates the use of MACSec in a VPLS/EVPN network for encrypting the data being exchanged over the VPLS cloud. In this topology MACSec is configured on the PE-facing interfaces of the CE routers. The interfaces can be physical ethernet interfaces or VLAN sub-interfaces.

Figure 5: MACSec in a VPLS/EVPN Cloud



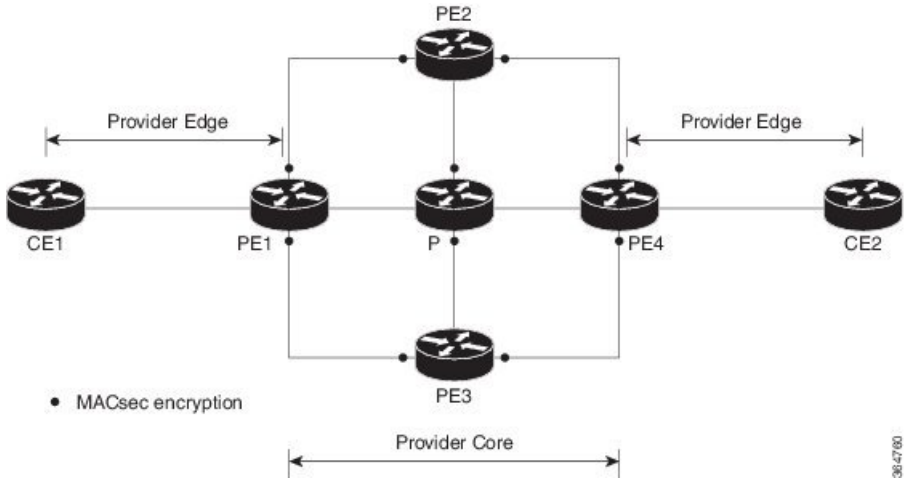
Use Case 3: MACSec in an MPLS Core Network

MACSec in an MPLS core network can be configured on physical interfaces, sub-interfaces or link bundles (Link Aggregation Group or LAG).

In the following topology, MACSec is configured on all router links in the MPLS core. This deployment is useful when the MPLS network spans data centers that are not co-located in the same geography. Each link is, therefore, a link between two data centers and all data exchanged is encrypted using MACSec.

The following figure illustrates the use of MACSec on physical interfaces in an MPLS core network.

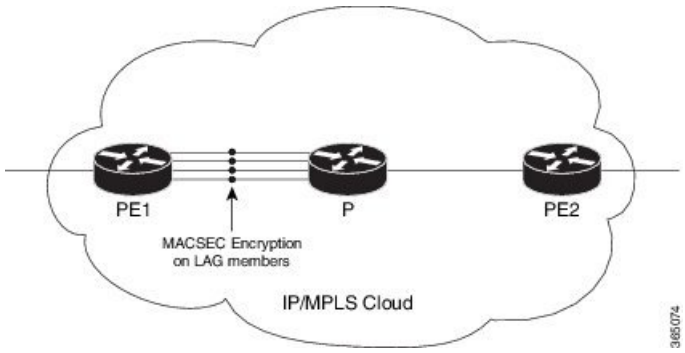
Figure 6: MACSec on Physical Interfaces in an MPLS Core Network



When MACSec is configured on the members of a LAG, an MKA session is set up for each member. SAK is exchanged for each LAG member and encryption/decryption takes place independently of other members in the group. MACSec can also be configured on VLAN sub-interfaces in these networks.

The following figure illustrates the use of MACSec on a link bundle in an MPLS core network.

Figure 7: MACSec on a Link Bundle in an MPLS Core Network



The following section describes procedures for configuring and verifying MACSec configuration in any of the described deployment modes.

Prior to configuring MACSec on a router interface, the MACSec key chain and MACSec policy must be defined. Configuring MACSec encryption involves the following steps:

1. Creating a MACSec Key Chain
2. Creating a MACSec Policy
3. Applying MACSec on a Physical Interface

Creating a MACsec Key Chain

A MACsec keychain is a collection of keys used to authenticate peers needing to exchange encrypted information. While creating a keychain, we define the key(s), key string with password, the cryptographic algorithm, and the key lifetime.

MACsec Keychain Keyword	Description
Key	The MACsec key or the CKN can be up to 64 characters in length. The key must be of an even number of characters. Entering an odd number of characters will exit the MACsec configuration mode.
Key-string	The MACsec key-string or the CAK can be either 32 characters or 64 characters in length (32 for AES-128, 64 for AES-256).
Lifetime	This field specifies the validity period of a key. It includes a start time, and an expiry time. We recommend you to set the value for expiry time as *infinite*.

Guidelines for Configuring MACsec Keychain

MACsec keychain management has the following configuration guidelines:

- To establish MKA session, ensure that the MACsec key (CKN) and key-string (CAK) match at both ends.

- MKA protocol uses the latest active key available in the Keychain. This key has the latest Start Time from the existing set of currently active keys. You can verify the values using the **show key chain** *keychain-name* command.
- Deletion or expiry of current active key brings down the MKA session resulting in traffic hit. We recommend you to configure the keys with infinite lifetime. If fallback is configured, traffic is safeguarded using fallback on expiry or deletion of primary-keychain active key.
- To achieve successful key rollover (CAK-rollover), the new key should be configured such that it is the latest active key, and kicks-in before the current key expires.
- We recommend an overlap of at least one minute for hitless CAK rollover from current key to new key.
- Start time and Expiry time can be configured with future time stamps, which allows bulk configuration for daily CAK rotation without any intervention of management agent.
- From Cisco IOS XR Software Release 6.7.2 and later, the MACsec key IDs (configured through CLI using the **macsec key** command under the key chain configuration mode) are considered to be case insensitive. These key IDs are stored as uppercase letters. For example, a key ID of value 'FF' and of value 'ff' are considered to be the same, and both these key IDs are now stored in uppercase as 'FF'. Whereas, prior to Release 7.1.2, both these values were treated as case sensitive, and hence considered as two separate key IDs. Hence it is recommended to have unique strings as key IDs for a MACsec key chain to avoid flapping of MACsec sessions. However, the support for this case insensitive IDs is applicable only for the configurations done through CLI, and not for configurations done through Netconf protocol.

  Also, it is recommended to do a prior check of the key IDs before upgrading to Release 6.7.2 or later.

  Consider a scenario where two MACsec key IDs with the same set of characters (say, ff and FF) are configured under the same key chain.

```
key chain 1
 macsec
  key ff
   lifetime 02:01:01 may 18 2020 infinite
  !
  key FF
   lifetime 01:01:01 may 18 2020 infinite
```

  When you upgrade to Release 6.7.2 or later, only one of these key IDs is retained. That is 'FF', the one that was applied second in this example.

SUMMARY STEPS

1. Enter the global configuration mode and provide a name for the MACsec keychain; for example, mac_chain.
2. Enter the MACsec mode.
3. Provide a name for the MACsec key.
4. Enter the key string and the cryptographic algorithm to be used for the key.
5. Enter the validity period for the MACsec key (CKN) also known as the lifetime period.
6. Commit your configuration.

DETAILED STEPS

Step 1 Enter the global configuration mode and provide a name for the MACsec keychain; for example, mac_chain.

Example:

```
RP/0/RSP0/CPU0:router(config)#key chain mac_chain
```

Step 2 Enter the MACsec mode.

Example:

```
RP/0/RSP0/CPU0:router(config-mac_chain)#macsec
```

Step 3 Provide a name for the MACsec key.

The key can be up to 64 characters in length. The key must be of an even number of characters. Entering an odd number of characters will exit the MACsec configuration mode.

Example:

```
RP/0/RSP0/CPU0:router(config-mac_chain-MacSec)#key 1234abcd5678
```

You can also configure a fall-back pre-shared key(PSK) to ensure that a PSK is always available to perform MACsec encryption and decryption. The fallback PSK along with the primary PSK ensures that the session remains active even if the primary PSK is mismatched or there is no active key for the primary PSK.

The configured key is the CKN that is exchanged between the peers.

See the guidelines section to know more about the need for a unique key ID for a MACsec key chain.

Note If you are configuring MACsec to inter-operate with a MACsec server that is running software prior to Cisco IOS XR Release 6.1.3, then ensure that the MACsec key length is of 64 characters. You can add extra zero characters to the MACsec key so that the length of 64-characters is achieved. If the key length is lesser than 64 characters, authentication will fail.

Step 4 Enter the key string and the cryptographic algorithm to be used for the key.

Example:

The key string is the CAK that is used for ICV validation by the MKA protocol.

```
! For AES 128-bit encryption

RP/0/RSP0/CPU0:router(config-mac_chain-MacSec-1234abcd5678)#key-string 12345678123456781234567812345678
 cryptographic-algorithm AES-128-CMAC

! For AES 256-bit encryption

RP/0/RSP0/CPU0:router(config-mac_chain-MacSec-1234abcd5678)#key-string
12345678123456781234567812345678123456781234567812345678123456781234567812345678 cryptographic
-algorithm AES-256-CMAC
```

Note In this example, we have used the AES 256-bit encryption algorithm, and therefore, the key string is 64 hexadecimal characters in length. A 256-bit encryption algorithm uses a larger key that requires more rounds of hacking to be cracked. 256-bit algorithms provide better security against large mass security attacks, and include the security provided by 128-bit algorithms.

Step 5 Enter the validity period for the MACsec key (CKN) also known as the lifetime period.

The lifetime period can be configured, with a duration in seconds, as a validity period between two dates (for example, Jan 01 2014 to Dec 31 2014), or with infinite validity.

The key is valid from the time you configure (in HH:MM:SS format). Duration is configured in seconds.

Example:

```
RP/0/RSP0/CPU0:router(config-mac_chain-MacSec-1234abcd5678)#lifetime 05:00:00 01
January 2015 duration 1800
```

An example of configuring the lifetime for a defined period:

```
RP/0/RSP0/CPU0:router(config-mac_chain-MacSec-1234abcd5678)#lifetime 05:00:00 20
february 2015 12:00:00 30 september 2015
```

An example of configuring the lifetime as infinite:

```
RP/0/RSP0/CPU0:router(config-mac_chain-MacSec-1234abcd5678)#lifetime
05:00:00 01 January 2015 infinite
```

Note When a key has expired, the MACsec session is torn down and running the **show macsec mka session** command does not display any information. If you run the **show macsec mka interface detail** command, the output displays ***** No Active Keys Present ***** in the PSK information.

Step 6 Commit your configuration.

Example:

```
RP/0/RSP0/CPU0:router(config-mac_chain-MacSec-1234abcd5678)#commit
```

This completes the configuration of the MACsec keychain.

Prerequisites for Configuring MACSec on Bundle Member Interfaces

To enable MACSec on bundle members, an user-defined policy must be configured with Should-Secure policy, or Must-Secure policy with **policy-exception LACP-in-clear** command.

Note By default, the system uses the Must-Secure security policy.

Example: Configuring MACSec on Bundle Member With Should-Secure Policy

```
(config)#macsec-policy should-secure
(config-macsec-policy)#security-policy should-secure
(config-macsec-policy)#commit


sh runn macsec-policy should-secure
  macsec-policy should-secure
  security-policy should-secure
!

router(config)# interface HundredGigE 0/1/1/1 # Applying the Should-Secure MACSec Policy
on Bundle Member Interface
  router(config-if)# bundle id 12 mode active
  router(config-if)# macsec psk-keychain kc1 policy should-secure
```

Example: Configuring MACSec on Bundle Member With Must-Secure Policy

```
(config)#macsec-policy must-secure
(config-macsec-policy)#security-policy must-secure
(config-macsec-policy)#policy-exception lacp-in-clear
(config-macsec-policy)#commit

#sh runn macsec-policy must-secure
macsec-policy must-secure
  security-policy must-secure
  policy-exception lacp-in-clear
!
router(config)# interface HundredGigE 0/1/1/2 #Applying the Must-Secure MACSec Policy on
Bundle Member Interface
  router(config-if)# bundle id 12 mode active
  router(config-if)# macsec psk-keychain kc1 policy must-secure
```

Creating a User-Defined MACsec Policy

SUMMARY STEPS

1. Enter the global configuration mode, and enter a name (mac_policy) for the MACsec policy.
2. Configure the cipher suite to be used for MACsec encryption.
3. Configure the confidentiality offset for MACsec encryption.
4. Enter the key server priority.
5. Configure the security policy parameters, either Must-Secure or Should-Secure.
6. Configure the replay protection window size.
7. Configure the ICV for the frame arriving on the port.
8. Commit your configuration and exit the global configuration mode.
9. Confirm the MACsec policy configuration.

DETAILED STEPS

Step 1 Enter the global configuration mode, and enter a name (mac_policy) for the MACsec policy.

Example:

```
RP/0/RSP0/CPU0:router# configure
RP/0/RSP0/CPU0:router(config)# macsec-policy mac_policy
```

Step 2 Configure the cipher suite to be used for MACsec encryption.

Example:

```
RP/0/RSP0/CPU0:router(config-mac_policy)# cipher-suite GCM-AES-XPN-256
RP/0/RSP0/CPU0:router(config-mac_policy)#GCM-AES-128
GCM-AES-256
GCM-AES-XPN-128
GCM-AES-XPN-256
```

Note In this example, we have used the GCM-AES-XPN-256 encryption algorithm. A 256-bit encryption algorithm uses a larger key that requires more rounds of hacking to be cracked. 256-bit algorithms provide better security against large mass security attacks, and include the security provided by 128-bit algorithms. Extended Packet Numbering (XPN) is used to reduce the number of key rollovers while data is sent over high speed links. It is therefore highly recommended to use GCM-AES-XPN-256 encryption algorithm for higher data ports.

Step 3 Configure the confidentiality offset for MACsec encryption.

Example:

```
RP/0/RSP0/CPU0:router(config-mac_policy)# conf-offset CONF-OFFSET-30
```

Note We recommend to change the offset value of the **conf-offset** <*offset_value*> command (MACsec encryption command) in the router only when the port is in **admin down** state (that is, when the interface is shut down). Changing the offset value otherwise may result in traffic loss.

Step 4 Enter the key server priority.

You can enter a value between 0-255. Lower the value, higher the preference to be selected as the key server.

In this example, a value of 0 configures the router as the key server, while the other router functions as a key client. The key server generates and maintains the SAK between the two routers. The default key server priority value is 16.

Example:

```
RP/0/RSP0/CPU0:router(config-mac_policy)# key-server-priority 0
```

Step 5 Configure the security policy parameters, either Must-Secure or Should-Secure.

Must-Secure: Must-Secure imposes only MACsec encrypted traffic to flow. Hence, until MKA session is not secured, traffic will be dropped.

Example:

```
RP/0/RSP0/CPU0:router(config-mac_policy)# security-policy must-secure
```

Should-Secure: Should-Secure allows unencrypted traffic to flow until MKA session is secured. After the MKA session is secured, Should-Secure policy imposes only encrypted traffic to flow.

Example:

```
RP/0/RSP0/CPU0:router(config-mac_policy)# security-policy should-secure
```

Table 7: MACsec Security Policies

MKA		Secured MKA Session	Unsecured MKA Session
Security Policy	Must-secure	Encrypted traffic	Traffic drop (no Tx and no Rx)
	Should-secure	Encrypted traffic	Plain text or unencrypted traffic

Step 6 Configure the replay protection window size.

Example:

```
RP/0/RSP0/CPU0:router(config-mac_policy)# window-size 64
```

This dictates the maximum out-of-sequence frames that are accepted. You can configure a value between 0 and 1024.

Step 7 Configure the ICV for the frame arriving on the port.

Example:

```
RP/0/RSP0/CPU0:router(config-mac_policy)# include-icv-indicator
```

This parameter configures inclusion of the optional ICV Indicator as part of the transmitted MACsec Key Agreement PDU (MKPDU). This configuration is necessary for MACsec to interoperate with routers that run software prior to IOS XR version 6.1.3. This configuration is also important in a service provider WAN setup where MACsec interoperates with other vendor MACsec implementations that expect ICV indicator to be present in the MKPDU.

Step 8 Commit your configuration and exit the global configuration mode.

Example:

```
RP/0/RSP0/CPU0:router(config-mac_policy)# exit
RP/0/RSP0/CPU0:router(config)# commit
RP/0/RSP0/CPU0:router(config)# exit
```

Step 9 Confirm the MACsec policy configuration.

Example:

```
RP/0/RSP0/CPU0:router# show running-config macsec-policy

macsec-policy mac_policy
conf-offset CONF-OFFSET-30
security-policy must-secure
window-size 64
cipher-suite GCM-AES-XPN-256
key-server-priority 0
include-icv-indicator
```

This completes the configuration of the MACsec policy.

Note

- Small packets might be dropped when Data Delay Protection (DDP) is enabled on many MACsec enabled interfaces of a scaled setup. To avoid this, enable DDP only on the interfaces which are absolutely necessary.
- For Cisco ASR 9000 Series Routers to interoperate with Cisco ASR9000 Series Routers that are older than Release 6.2.3, configure a user defined MACsec policy with the `policy-exception lacp-in-clear` command to bring up the MKA sessions over bundle interfaces running in LACP modes.

MACsec SAK Rekey Interval

From Cisco IOS XR Software Release 6.3.3 and later, you can set a timer value to rekey the MACsec secure association key (SAK) at a specified interval. This periodic refresh of SAK ensures that data encryption key is frequently updated. The configuration is effective on the node acting as a key server.

To set the rekey interval, use the **sak-rekey-interval** command in macsec-policy configuration mode. The timer ranges from 60 to 2,592,000 seconds, the default being OFF.

Configuration Example

```
Router#configure
Router(config)#macsec-policy test-policy
Router(config-macsec-policy)#sak-rekey-interval 120
Router(config-macsec-policy)#commit
```

Running Configuration

```
macsec-policy test-policy
 sak-rekey-interval 120
 !
```

Associated Command

sak-rekey-interval

Applying MACsec Configuration on an Interface

The MACsec service configuration is applied to the host-facing interface of a CE router.

Guidelines for MACsec Interface Configuration

- Configure different keychains for primary and fallback PSKs.
- We do not recommend to update both primary and fallback PSKs simultaneously, because fallback PSK is intended to recover MACsec session on primary key mismatch.

Note Under the IS-IS instance, use the **lsp-mtu** command to configure the maximum transmission unit (MTU) size of link-state packets (LSPs) on each router where MACsec is enabled. The LSP MTU should be set to 32 bytes less than the interface MTU, to account for MACsec overhead.

Tip You can programmatically view the MACsec configuration using the `openconfig-macsec.yang` OpenConfig data model. To get started with using data models, see *Programmability Configuration Guide for Cisco ASR 9000 Series Routers*.

MACsec PSK Configuration on an Interface

```
Router#configure terminal
Router(config)#interface Te0/3/0/1/4
Router(config-if)#macsec psk-keychain kc policy mac_policy
```

To apply MACsec configuration on a physical interface without the MACsec policy, use the following command:

```
Router(config-if)#macsec psk-keychain script_key_chain2
```

MACsec Fallback PSK Configuration on an Interface

It is optional to configure a fallback PSK. If a fallback PSK is configured, the fallback PSK along with the primary PSK ensures that the session remains active even if the primary PSK is mismatched, or there is no active key for the primary PSK.

```
Router(config-if)#macsec psk-keychain kc fallback-psk-keychain fallback_kc policy mac_policy
Router(config-if)#commit
```

MACsec Policy Exceptions

By default, the MACsec security policy uses **must-secure** option, that mandates data encryption. Hence, the packets cannot be sent in clear-text format. To optionally bypass the MACsec encryption or decryption for Link Aggregation Control Protocol (LACP) packets, and to send the packets in clear-text format, use the **policy-exception lacp-in-clear** command in macsec-policy configuration mode. This functionality is beneficial in scenarios such as, in a network topology with three nodes, where bundles are terminated at the middle node, whereas MACsec is terminated at the end nodes.

This MACsec policy exception is also beneficial in interoperability scenarios where the node at the other end expects the data packets to be in clear text.

How to Create MACsec Policy Exception

Configuration Example

Using the **policy-exception** command:

```
Router#configure
Router(config)#macsec-policy P1
Router(config-macsec-policy-P1)#policy-exception lacp-in-clear
Router(config-macsec-policy-P1)#commit
```

Running Configuration

With the **policy-exception** command:

```
Router#show run macsec-policy P1
macsec-policy P1
  policy-exception lacp-in-clear
  security-policy should-secure
  include-icv-indicator
  sak-rekey-interval seconds 120
!
```

Associated Commands

- **policy-exception lacp-in-clear**

Verifying MACsec Encryption on IOS XR

MACsec encryption on IOS XR can be verified by running relevant commands in the Privileged Executive Mode. The verification steps are the same for MACsec encryption on L2VPN or L3VPN network.

Note With the introduction of active fallback functionality in Cisco IOS XR Software Release 7.1.2 (Release 6.7.2 for 32-bit Cisco IOS XR platforms), the output of various MACsec show commands include the fallback PSK entry as well.

To verify if MACsec encryption has been correctly configured, follow these steps.

SUMMARY STEPS

1. Verify the MACsec policy configuration.
2. Verify the MACsec configuration on the respective interface.
3. Verify whether the interface of the router is peering with its neighbor after MACsec configuration
4. Verify whether the MKA session is secured with MACsec on the respective interface.
5. Verify the MACsec session counter statistics.

DETAILED STEPS

Step 1 Verify the MACsec policy configuration.

Example:

```
RP/0/RSP0/CPU0:router#show macsec policy mac_policy

================================================================================
Policy      Cipher         Key-Svr     Window  Conf
name        Suite          Priority    Size    Offset
================================================================================
mac_policy GCM-AES-XPN-256  0          64      30
```

If the values you see are different from the ones you configured, then check your configuration by running the **show run macsec-policy** command.

Step 2 Verify the MACsec configuration on the respective interface.

You can verify the MACsec encryption on the configured interface bundle (MPLS network), P2MP interface (VPLS network), or VLAN sub-interface (EoMPLS PW network).

Example:

Before the introduction of active fallback functionality:

```
RP/0/RSP0/CPU0:router#show macsec mka summary

NODE: node0_0_CPU0

================================================================
Interface     Status    Cipher Suite      KeyChain
================================================================

Fo0/0/0/1/0   Secured   GCM-AES-XPN-256   mac_chain

Total MACSec Sessions : 1
     Secured Sessions : 1
     Pending Sessions : 0

RP/0/RSP0/CPU0:router#show macsec mka session interface Fo0/0/0/1/0
=============================================================================
   Interface-Name        Local-TxSCI       #Peers   Status   Key-Server
=============================================================================
   Fo0/0/0/1/0        d46d.5023.3709/0001     1     Secured      YES


! If sub-interfaces are configured, the output would be as follows:

RP/0/RSP0/CPU0:router#show macsec mka session interface Fo0/0/0/1/1.8
=============================================================================
      Interface         Local-TxSCI       # Peers   Status  Key-Server
=============================================================================
  Fo0/0/0/1/1.8      e0ac.f172.4124/001d      1     Secured     Yes
```

With the introduction of active fallback functionality:

The following is a sample output that displays active fallback PSK entry as well:

```
RP/0/RSP0/CPU0:router#show macsec mka summary

NODE: node0_0_CPU0
=============================================================================================
   Interface-Name     Status     Cipher-Suite       KeyChain       PSK/EAP      CKN
=============================================================================================
     Fo0/0/0/1/0      Secured  GCM-AES-XPN-256      mac_chain      PRIMARY      5555
     Fo0/0/0/1/0      Active   GCM-AES-XPN-256      mac_chain_fb   FALLBACK     5556

Total MACSec Sessions : 2
     Secured Sessions : 1
     Pending Sessions : 0
      Active Sessions : 1

RP/0/RSP0/CPU0:router#show macsec mka session interface Fo0/0/0/1/0
```

```
=============================================================================================
   Interface-Name        Local-TxSCI       #Peers   Status   Key-Server   PSK/EAP      CKN
=============================================================================================
   Fo0/0/0/1/0        d46d.5023.3709/0001     1      Secured      YES       PRIMARY     5555
   Fo0/0/0/1/0        d46d.5023.3709/0001     1      Active       YES      FALLBACK     5556
```

The **Status** field in the output confirms that the respective interface is **Secured**. If MACsec encryption is not successfully configured, you will see a status such as **Pending** or **Init**.

Note In the VPLS network, because of the configuration on a multi-point interface, the number of live peers displayed is more than 1.

Run the **show run macsec-policy** command in the privileged executive mode to troubleshoot the configuration entered.

Step 3 Verify whether the interface of the router is peering with its neighbor after MACsec configuration

Example:

```
RP/0/RSP0/CPU0:router#show macsec mka session

NODE: node0_0_CPU0

=================================================================
Interface    Local-TxSCI           # Peers   Status  Key-Server
=================================================================

Fo0/0/0/1/0  001d.e5e9.aa39/0005      1      Secured  YES
```

The following is a sample output that displays active fallback PSK entry as well:

```
Router#show macsec mka session
Wed Apr 28 01:59:39.478 UTC

NODE: node0_1_CPU0
=============================================================================================
   Interface-Name        Local-TxSCI       #Peers   Status   Key-Server   PSK/EAP      CKN
=============================================================================================
     Fo0/0/0/1/0      001d.e5e9.aa39/0005     1      Secured      NO        PRIMARY     1234
     Fo0/0/0/1/0      001d.e5e9.aa39/0005     1      Active       NO        FALLBACK    1111
```

The **#Peers** field in the output confirms the presence of the peer you have configured on the physical interface, **Fo0/0/0/1/0**. If the number of peers is not reflected accurately in this output, run the **show run** command and verify the peer configuration on the interface.

Note If the MKA session status is shown as **Secured** with **0 (Zero)** peer count, this means that the link is locally secured (Tx). This is because of MKA peer loss caused by **No Rx Packets (MKA Packet)** from that peer.

Note In the VPLS network, because of the configuration on a multipoint interface, the number of live peers displayed is more than 1.

```
Router#show macsec mka session
Fri May 28 07:18:45.726 UTC

NODE: node0_0_CPU0
=============================================================================
Interface-Name        Local-TxSCI       #Peers   Status   Key-Server   PSK/EAP      CKN
=============================================================================
  Te0/0/0/1       6c8b.d34f.0635/0001     2      Secured      NO       FALLBACK     5556
```

Step 4 Verify whether the MKA session is secured with MACsec on the respective interface.

Example:

Before the introduction of active fallback functionality:

```
RP/0/RSP0/CPU0:router#show macsec mka session interface Fo0/0/0/1/0 detail
MKA Detailed Status for MKA Session
===================================
Status: SECURED - Secured MKA Session with MACsec
Local Tx-SCI            : 001d.e5e9.aa39/0005
Local Tx-SSCI           : 1
Interface MAC Address   : 001d.e5e9.aa39
MKA Port Identifier     : 1
Interface Name          : Fo0/0/0/1/0
CAK Name (CKN)          : 10200000000000000000000000000000000000000000000000000000000000000000
Member Identifier (MI)  : A880BB45B9CE01584535F239
Message Number (MN)     : 5382
Authenticator           : NO
Key Server              : YES
MKA Cipher Suite        : AES-128-CMAC
Latest SAK Status       : Rx & Tx
Latest SAK AN           : 0
Latest SAK KI (KN)      : A880BB45B9CE01584535F23900000001 (1)
Old SAK Status          : FIRST-SAK
Old SAK AN              : 0
Old SAK KI (KN)         : FIRST-SAK (0)
SAK Transmit Wait Time  : 0s (Not waiting for any peers to respond)
SAK Retire Time         : 0s (No Old SAK to retire)
MKA Policy Name         : scale-21
Key Server Priority     : 20
Replay Window Size      : 40
Confidentiality Offset  : 50
Algorithm Agility       : 80C201
SAK Cipher Suite        : 0080C20001000001 (GCM-AES-128)
MACsec Capability       : 3 (MACsec Integrity, Confidentiality, & Offset)
MACsec Desired          : YES
# of MACsec Capable Live Peers           : 1
# of MACsec Capable Live Peers Responded : 1
Live Peer List:
  MI                        MN          Rx-SCI (Peer)        SSCI KS-Priority
  ------------------------------------------------------------------------------
  4E33A276E7F79C04D80FE346       27114  d46d.5023.3704/0001     2         235
Potential Peer List:
  MI                        MN          Rx-SCI (Peer)        SSCI KS-Priority
  ------------------------------------------------------------------------------
```

! If sub-interfaces are configured, the output would be as follows:

```
RP/0/RSP0/CPU0:router# show macsec mka session interface Fo0/0/0/1/1.8 detail
MKA Detailed Status for MKA Session
===================================
Status: SECURED - Secured MKA Session with MACsec
Local Tx-SCI            : e0ac.f172.4124/001d
Local Tx-SSCI           : 1
Interface MAC Address   : e0ac.f172.4124
MKA Port Identifier     : 29
Interface Name          : Fo0/0/0/1/1.8
CAK Name (CKN)          : ABC10000000000000000000000000000000000000000000000000000000000000000
Member Identifier (MI)  : 1EC4A4D1B0D75D3D5C2F6393
Message Number (MN)     : 1915
Authenticator           : NO
Key Server              : NO
MKA Cipher Suite        : AES-128-CMAC
```

```
Latest SAK Status       : Rx & Tx
Latest SAK AN           : 3
Latest SAK KI (KN)      : EB1E04894327E4EFA283C66200000003 (3)
Old SAK Status          : No Rx, No Tx
Old SAK AN              : 0
Old SAK KI (KN)         : RETIRED (4)
SAK Transmit Wait Time  : 0s (Not waiting for any peers to respond)
SAK Retire Time         : 0s (No Old SAK to retire)
MKA Policy Name         : test12
Key Server Priority     : 0
Replay Window Size      : 1024
Confidentiality Offset  : 50
Algorithm Agility       : 80C201
SAK Cipher Suite        : 0080C20001000004 (GCM-AES-XPN-256)
MACsec Capability       : 3 (MACsec Integrity, Confidentiality, & Offset)
MACsec Desired          : YES
# of MACsec Capable Live Peers           : 1
# of MACsec Capable Live Peers Responded : 0
Live Peer List:
  MI                        MN          Rx-SCI (Peer)        SSCI KS-Priority
  ----------------------------------------------------------------------------
  EB1E04894327E4EFA283C662        1908  001d.e5e9.b1c0/0037     2           0
Potential Peer List:
  MI                        MN          Rx-SCI (Peer)        SSCI KS-Priority
  ----------------------------------------------------------------------------
RP/0/RSP0/CPU0:macsec-CE1#sh macsec mka  interface Fo0/0/0/1/1.8
============================================================
Interface-name          KeyChain-Name           Policy Name
============================================================
Fo0/0/0/1/1.8           kc3                     test12


! In a VPLS network with multipoint interface, the output would be as follows:

RP/0/RSP0/CPU0:router#show macsec mka session interface FortyGigE0/0/0/1/0.1 detail
MKA Detailed Status for MKA Session
===================================
Status: SECURED - Secured MKA Session with MACsec
Local Tx-SCI            : e0ac.f172.4123/0001
Local Tx-SSCI           : 1
Interface MAC Address   : e0ac.f172.4123
MKA Port Identifier     : 1
Interface Name          : Fo0/0/0/1/0.1
CAK Name (CKN)          : ABC10000000000000000000000000000000000000000000000000000000000000
Member Identifier (MI)  : A1DB3E42B4A543FBDBC281A6
Message Number (MN)     : 1589
Authenticator           : NO
Key Server              : NO
MKA Cipher Suite        : AES-128-CMAC
Latest SAK Status       : Rx & Tx
Latest SAK AN           : 1
Latest SAK KI (KN)      : AEC899297F5B0BDEF7C9FC6700000002 (2)
Old SAK Status          : No Rx, No Tx
Old SAK AN              : 0
Old SAK KI (KN)         : RETIRED (1)
SAK Transmit Wait Time  : 0s (Not waiting for any peers to respond)
SAK Retire Time         : 0s (No Old SAK to retire)
MKA Policy Name         : mk_xpn1
Key Server Priority     : 0
Replay Window Size      : 1024
Confidentiality Offset  : 50
Algorithm Agility       : 80C201
SAK Cipher Suite        : 0080C20001000004 (GCM-AES-XPN-256)
MACsec Capability       : 3 (MACsec Integrity, Confidentiality, & Offset)
```

```
MACsec Desired          : YES
# of MACsec Capable Live Peers           : 2
# of MACsec Capable Live Peers Responded : 0
Live Peer List:
  MI                        MN          Rx-SCI (Peer)        SSCI KS-Priority
  ------------------------------------------------------------------------------
  AEC899297F5B0BDEF7C9FC67         225  001d.e5e9.b1bf/0001     3           0
  0A4C49EE5B7401F1BECB7E22         147  001d.e5e9.f329/0001     2           0
Potential Peer List:
  MI                        MN          Rx-SCI (Peer)        SSCI KS-Priority
  ------------------------------------------------------------------------------
```

With the introduction of active fallback functionality:

The following show command output verifies that the primary and fallback keys (CAK) are matched on both peer ends.

```
RP/0/RSP0/CPU0:router#show macsec mka session interface Hu0/0/0/11 detail

MKA Detailed Status for MKA Session
===================================
Status: Secured - Secured MKA Session with MACsec

Local Tx-SCI                    : 7061.7bea.1df4/0001
Local Tx-SSCI                   : 1
Interface MAC Address           : 7061.7bea.1df4
MKA Port Identifier             : 1
Interface Name                  : Hu0/0/0/11
CAK Name (CKN)                  : 2111
CA Authentication Mode          : PRIMARY-PSK
Keychain                        : test1
Member Identifier (MI)          : 42A78BD6243539E917B8C6B2
Message Number (MN)             : 555
Authenticator                   : NO
Key Server                      : NO
MKA Cipher Suite                : AES-128-CMAC
Configured MACSec Cipher Suite  : GCM-AES-XPN-128

Latest SAK Status               : Rx & Tx
Latest SAK AN                   : 0
Latest SAK KI (KN)              : 69B39E87B3CBA673401E989100000001 (1)
Old SAK Status                  : FIRST-SAK
Old SAK AN                      : 0
Old SAK KI (KN)                 : FIRST-SAK (0)

SAK Transmit Wait Time          : 0s (Not waiting for any peers to respond)
SAK Retire Time                 : 0s (No Old SAK to retire)
Time to SAK Rekey               : NA
Time to exit suspension         : NA

MKA Policy Name                 : P12
Key Server Priority             : 20
Delay Protection                : TRUE
Replay Window Size              : 100
Include ICV Indicator           : TRUE
Confidentiality Offset          : 0
Algorithm Agility               : 80C201
SAK Cipher Suite                : 0080C20001000003 (GCM-AES-XPN-128)
MACsec Capability               : 3 (MACsec Integrity, Confidentiality, & Offset)
MACsec Desired                  : YES

# of MACsec Capable Live Peers           : 1
# of MACsec Capable Live Peers Responded : 0

Live Peer List:
```

```
------------------------------------------------------------------------------
           MI                  MN            Rx-SCI          SSCI  KS-Priority
------------------------------------------------------------------------------
69B39E87B3CBA673401E9891      617       008a.96d6.194c/0001    2        20

Potential Peer List:
------------------------------------------------------------------------------
           MI                  MN            Rx-SCI          SSCI  KS-Priority
------------------------------------------------------------------------------

Peers Status:
Last Tx MKPDU          : 2021 May 18 13:27:56.548
Peer Count             : 1

RxSCI                  : 008A96D6194C0001
  MI                    : 69B39E87B3CBA673401E9891
  Peer CAK              : Match
  Latest Rx MKPDU       : 2021 May 18 13:27:56.518

MKA Detailed Status for MKA Session
===================================
Status: Active - Marked Peer as Live (Waiting for SAK generation/distribution)

Local Tx-SCI                    : 7061.7bea.1df4/0001
Local Tx-SSCI                   : 1
Interface MAC Address           : 7061.7bea.1df4
MKA Port Identifier             : 1
Interface Name                  : Hu0/0/0/11
CAK Name (CKN)                  : 2000
CA Authentication Mode          : FALLBACK-PSK
Keychain                        : test1f
Member Identifier (MI)          : 1BB9428C721F6EE3E538C942
Message Number (MN)             : 553
Authenticator                   : NO
Key Server                      : NO
MKA Cipher Suite                : AES-128-CMAC
Configured MACSec Cipher Suite  : GCM-AES-XPN-128

Latest SAK Status               : Rx & Tx
Latest SAK AN                   : 0
Latest SAK KI (KN)              : 69B39E87B3CBA673401E989100000001 (1)
Old SAK Status                  : FIRST-SAK
Old SAK AN                      : 0
Old SAK KI (KN)                 : FIRST-SAK (0)

SAK Transmit Wait Time          : 0s (Not waiting for any peers to respond)
SAK Retire Time                 : 0s (No Old SAK to retire)
Time to SAK Rekey               : NA
Time to exit suspension         : NA

MKA Policy Name                 : P12
Key Server Priority             : 20
Delay Protection                : TRUE
Replay Window Size              : 100
Include ICV Indicator           : TRUE
Confidentiality Offset          : 0
Algorithm Agility               : 80C201
SAK Cipher Suite                : 0080C20001000003 (GCM-AES-XPN-128)
MACsec Capability               : 3 (MACsec Integrity, Confidentiality, & Offset)
MACsec Desired                  : YES

# of MACsec Capable Live Peers           : 1
# of MACsec Capable Live Peers Responded : 0
```

```
Live Peer List:
----------------------------------------------------------------------------
           MI                  MN             Rx-SCI          SSCI  KS-Priority
----------------------------------------------------------------------------
8F59AD6021FA3E2D5F9E6231      615       008a.96d6.194c/0001    2        20

Potential Peer List:
----------------------------------------------------------------------------
           MI                  MN             Rx-SCI          SSCI  KS-Priority
----------------------------------------------------------------------------

Peers Status:
Last Tx MKPDU          : 2021 May 18 13:27:56.547
Peer Count             : 1

RxSCI                  : 008A96D6194C0001
  MI                   : 8F59AD6021FA3E2D5F9E6231
  Peer CAK             : Match
  Latest Rx MKPDU      : 2021 May 18 13:27:56.518

RP/0/RSP0/CPU0:router#
```

If sub-interfaces are configured, the output would be as follows. In this example, the status of FALLBACK-PSK is *Secured*.

```
RP/0/RSP0/CPU0:router# show macsec mka session interface Hu0/0/0/0.6 detail
MKA Detailed Status for MKA Session
===================================
Status: Secured - Secured MKA Session with MACsec

Local Tx-SCI                    : 7061.7bea.1dc8/0006
Local Tx-SSCI                   : 1
Interface MAC Address           : 7061.7bea.1dc8
MKA Port Identifier             : 6
Interface Name                  : Hu0/0/0/0.6
CAK Name (CKN)                  : 9999
CA Authentication Mode          : FALLBACK-PSK
Keychain                        : D_tagf
Member Identifier (MI)          : 1DE18714A098B80964CC651E
Message Number (MN)             : 6203
Authenticator                   : NO
Key Server                      : YES
MKA Cipher Suite                : AES-128-CMAC
Configured MACSec Cipher Suite  : GCM-AES-XPN-256

Latest SAK Status               : Rx & Tx
Latest SAK AN                   : 0
Latest SAK KI (KN)              : 1DE18714A098B80964CC651E00000001 (1)
Old SAK Status                  : FIRST-SAK
Old SAK AN                      : 0
Old SAK KI (KN)                 : FIRST-SAK (0)

SAK Transmit Wait Time          : 0s (Not waiting for any peers to respond)
SAK Retire Time                 : 0s (No Old SAK to retire)
Time to SAK Rekey               : 23510s
Time to exit suspension         : NA

MKA Policy Name                 : D_tag1
Key Server Priority             : 1
Delay Protection                : FALSE
Replay Window Size              : 1000
Include ICV Indicator           : TRUE
```

```
Confidentiality Offset          : 50
Algorithm Agility               : 80C201
SAK Cipher Suite                : 0080C20001000004 (GCM-AES-XPN-256)
MACsec Capability               : 3 (MACsec Integrity, Confidentiality, & Offset)
MACsec Desired                  : YES

# of MACsec Capable Live Peers           : 1
# of MACsec Capable Live Peers Responded : 1

# of MACSec Suspended Peers              : 0

Live Peer List:
------------------------------------------------------------------------------
           MI                  MN             Rx-SCI          SSCI  KS-Priority
------------------------------------------------------------------------------
5C852D8F920306893D2BFB8F     10978      00c1.645f.2dd4/0006    2        11

Potential Peer List:
------------------------------------------------------------------------------
           MI                  MN             Rx-SCI          SSCI  KS-Priority
------------------------------------------------------------------------------

Suspended Peer List:
------------------------------------------------------------------------------
       Rx-SCI          SSCI
------------------------------------------------------------------------------

Peers Status:
Last Tx MKPDU          : 2021 May 18 13:29:15.687
Peer Count             : 1

RxSCI                  : 00C1645F2DD40006
  MI                    : 5C852D8F920306893D2BFB8F
  Peer CAK              : Match
  Latest Rx MKPDU       : 2021 May 18 13:29:15.769

RP/0/RSP0/CPU0:router#


! In a VPLS network with multipoint interface, the output would be as follows:

RP/0/RSP0/CPU0:router#show macsec mka session interface Hu0/0/1/7 detail
Fri May 28 07:19:11.362 UTC

MKA Detailed Status for MKA Session
===================================
Status: Secured - Secured MKA Session with MACsec

Local Tx-SCI                    : 6c8b.d34f.0635/0001
Local Tx-SSCI                   : 2
Interface MAC Address           : 6c8b.d34f.0635
MKA Port Identifier             : 1
Interface Name                  : Te0/0/0/1
CAK Name (CKN)                  : 5556
CA Authentication Mode          : FALLBACK-PSK
Keychain                        : test2f
Member Identifier (MI)          : 6D14ECCDFB70E7E0463BD509
Message Number (MN)             : 20455
Authenticator                   : NO
Key Server                      : NO
MKA Cipher Suite                : AES-256-CMAC
Configured MACSec Cipher Suite  : GCM-AES-XPN-256
```

```
Latest SAK Status               : Rx & Tx
Latest SAK AN                   : 2
Latest SAK KI (KN)              : 1BBDDC0520C797C26AB7F1BF00000002 (2)
Old SAK Status                  : No Rx, No Tx
Old SAK AN                      : 1
Old SAK KI (KN)                 : RETIRED (1)

SAK Transmit Wait Time          : 0s (Not waiting for any peers to respond)
SAK Retire Time                 : 0s (No Old SAK to retire)
Time to SAK Rekey               : NA
Time to exit suspension         : NA

MKA Policy Name                 : *DEFAULT POLICY*
Key Server Priority             : 16
Delay Protection                : FALSE
Replay Window Size              : 64
Include ICV Indicator           : FALSE
Confidentiality Offset          : 0
Algorithm Agility               : 80C201
SAK Cipher Suite                : 0080C20001000004 (GCM-AES-XPN-256)
MACsec Capability               : 3 (MACsec Integrity, Confidentiality, & Offset)
MACsec Desired                  : YES

# of MACsec Capable Live Peers           : 2
# of MACsec Capable Live Peers Responded : 0

Live Peer List:
--------------------------------------------------------------------------------
           MI                  MN             Rx-SCI          SSCI  KS-Priority
--------------------------------------------------------------------------------
1BBDDC0520C797C26AB7F1BF     19997      008a.96d6.194c/0001    3        16
B25B1000CC6FAE92D1F85738      139       dc77.4c3e.59c3/0001    1        16

Potential Peer List:
--------------------------------------------------------------------------------
           MI                  MN             Rx-SCI          SSCI  KS-Priority
--------------------------------------------------------------------------------

Peers Status:
 Last Tx MKPDU          : 2021 May 28 07:19:10.153
 Peer Count             : 2

 RxSCI                  : 008A96D6194C0001
  MI                    : 1BBDDC0520C797C26AB7F1BF
  Peer CAK              : Match
  Latest Rx MKPDU       : 2021 May 28 07:19:09.960

 RxSCI                  : DC774C3E59C30001
  MI                    : B25B1000CC6FAE92D1F85738
  Peer CAK              : Match
  Latest Rx MKPDU       : 2021 May 28 07:19:10.180

RP/0/RSP0/CPU0:router#


RP/0/RSP0/CPU0:router#show macsec mka session interface Hu0/0/1/7.1 detail

MKA Detailed Status for MKA Session
===================================
Status: Secured - Secured MKA Session with MACsec

Local Tx-SCI                    : 7061.7bff.e5e8/0001
Local Tx-SSCI                   : 2
Interface MAC Address           : 7061.7bff.e5e8
```

```
MKA Port Identifier             : 1
Interface Name                  : Hu0/0/1/7.1
CAK Name (CKN)                  : 5556
CA Authentication Mode          : FALLBACK-PSK
Keychain                        : test22f
Member Identifier (MI)          : 8FF3D1BBF09EA4AD6A0FC1B5
Message Number (MN)             : 81
Authenticator                   : NO
Key Server                      : YES
MKA Cipher Suite                : AES-256-CMAC
Configured MACSec Cipher Suite  : GCM-AES-XPN-256

Latest SAK Status               : Rx & Tx
Latest SAK AN                   : 3
Latest SAK KI (KN)              : 8FF3D1BBF09EA4AD6A0FC1B500000002 (2)
Old SAK Status                  : No Rx, No Tx
Old SAK AN                      : 2
Old SAK KI (KN)                 : RETIRED (1)

SAK Transmit Wait Time          : 0s (Not waiting for any peers to respond)
SAK Retire Time                 : 0s (No Old SAK to retire)
Time to SAK Rekey               : 17930s
Time to exit suspension         : NA

MKA Policy Name                 : P123
Key Server Priority             : 10
Delay Protection                : FALSE
Replay Window Size              : 64
Include ICV Indicator           : FALSE
Confidentiality Offset          : 30
Algorithm Agility               : 80C201
SAK Cipher Suite                : 0080C20001000004 (GCM-AES-XPN-256)
MACsec Capability               : 3 (MACsec Integrity, Confidentiality, & Offset)
MACsec Desired                  : YES

# of MACsec Capable Live Peers           : 2
# of MACsec Capable Live Peers Responded : 2

# of MACSec Suspended Peers              : 0

Live Peer List:
------------------------------------------------------------------------------
           MI                  MN             Rx-SCI          SSCI  KS-Priority
------------------------------------------------------------------------------
6BCF91135F807CB9F57DDAAA       61       dc77.4c3e.5b05/0001    1        24
D81CFE93D07E932DDC33666E       44       00a7.4250.56c2/0001    3        25

Potential Peer List:
------------------------------------------------------------------------------
           MI                  MN             Rx-SCI          SSCI  KS-Priority
------------------------------------------------------------------------------

Suspended Peer List:
------------------------------------------------------------------------------
       Rx-SCI          SSCI
------------------------------------------------------------------------------

Peers Status:
 Last Tx MKPDU          : 2021 May 28 13:16:50.992
 Peer Count             : 2

 RxSCI                  : DC774C3E5B050001
  MI                    : 6BCF91135F807CB9F57DDAAA
  Peer CAK              : Match
```

```
  Latest Rx MKPDU       : 2021 May 28 13:16:51.312

 RxSCI                  : 00A7425056C20001
  MI                    : D81CFE93D07E932DDC33666E
  Peer CAK              : Match
  Latest Rx MKPDU       : 2021 May 28 13:16:50.945
RP/0/RSP0/CPU0:router#
```

Step 5 Verify the MACsec session counter statistics.

Example:

```
RP/0/RSP0/CPU0:router# show macsec mka statistics interface Fo0/0/0/1/0


MKA Statistics for Session on interface (Fo0/0/0/1/0)
=====================================================
Reauthentication Attempts.. 0

CA Statistics
Pairwise CAKs Derived... 0
Pairwise CAK Rekeys..... 0
Group CAKs Generated.... 0
Group CAKs Received..... 0

SA Statistics
SAKs Generated.......... 3
SAKs Rekeyed............ 2
SAKs Received........... 0
SAK Responses Received.. 3

MKPDU Statistics
MKPDUs Transmitted...... 5425
"Distributed SAK".. 8
"Distributed CAK".. 0
MKPDUs Validated & Rx... 4932
"Distributed SAK".. 0
"Distributed CAK".. 0

MKA IDB Statistics
MKPDUs Tx Success.......... 5425
MKPDUs Tx Fail............. 0
MKPDUS Tx Pkt build fail... 0
MKPDUs Rx CA Not found..... 0
MKPDUs Rx Error............ 0
MKPDUs Rx Success.......... 4932

MKPDU Failures
   MKPDU Rx Validation (ICV)............... 0
   MKPDU Rx Bad Peer MN.................... 0
   MKPDU Rx Non-recent Peerlist MN........ 0
   MKPDU Rx Drop SAKUSE, KN mismatch...... 0
   MKPDU Rx Drop SAKUSE, Rx Not Set....... 0
   MKPDU Rx Drop SAKUSE, Key MI mismatch.. 0
   MKPDU Rx Drop SAKUSE, AN Not in Use.... 0
   MKPDU Rx Drop SAKUSE, KS Rx/Tx Not Set. 0

SAK Failures
   SAK Generation.................. 0
   Hash Key Generation............. 0
   SAK Encryption/Wrap............. 0
   SAK Decryption/Unwrap........... 0
```

```
! If sub-interfaces are configured, the output would be as follows:

RP/0/RSP0/CPU0:router# show macsec mka statistics interface Fo0/0/0/1/1.8

MKA Statistics for Session on interface (Fo0/0/0/1/1.8)
=======================================================
Reauthentication Attempts.. 0
CA Statistics
   Pairwise CAKs Derived... 0
   Pairwise CAK Rekeys..... 0
   Group CAKs Generated.... 0
   Group CAKs Received..... 0
SA Statistics
   SAKs Generated.......... 0
   SAKs Rekeyed............ 0
   SAKs Received........... 9
   SAK Responses Received.. 0
MKPDU Statistics
   MKPDUs Transmitted...... 1973
      "Distributed SAK".. 0
      "Distributed CAK".. 0
   MKPDUs Validated & Rx... 1965
      "Distributed SAK".. 9
      "Distributed CAK".. 0
MKA IDB Statistics
   MKPDUs Tx Success.......... 1973
   MKPDUs Tx Fail............. 0
   MKPDUS Tx Pkt build fail... 0
   MKPDUs Rx CA Not found..... 0
   MKPDUs Rx Error............ 0
   MKPDUs Rx Success.......... 1965

! In a VPLS network with a mulitpoint interface, the output would be as follows:

RP/0/RSP0/CPU0:router# show macsec mka statistics interface FortyGigE0/0/0/1/0.1

MKA Statistics for Session on interface (Fo0/0/0/1/0.1)
=======================================================
Reauthentication Attempts.. 0
CA Statistics
   Pairwise CAKs Derived... 0
   Pairwise CAK Rekeys..... 0
   Group CAKs Generated.... 0
   Group CAKs Received..... 0
SA Statistics
   SAKs Generated.......... 0
   SAKs Rekeyed............ 0
   SAKs Received........... 2
   SAK Responses Received.. 0
MKPDU Statistics
   MKPDUs Transmitted...... 1608
      "Distributed SAK".. 0
      "Distributed CAK".. 0
   MKPDUs Validated & Rx... 406
      "Distributed SAK".. 2
      "Distributed CAK".. 0
MKA IDB Statistics
   MKPDUs Tx Success.......... 1608
   MKPDUs Tx Fail............. 0
   MKPDUS Tx Pkt build fail... 0
   MKPDUs Rx CA Not found..... 0
   MKPDUs Rx Error............ 0
   MKPDUs Rx Success.......... 1802
```

The counters display the MACsec PDUs transmitted, validated, and received. The output also displays transmission errors, if any.

This completes the verification of MACsec encryption on the IOS-XR.

Verifying MACsec Encryption on ASR 9000

MACsec encryption on the router hardware can be verified by running relevant commands in the Privileged Executive Mode.

To verify if MACsec encryption has been correctly configured, follow these steps.

SUMMARY STEPS

1. Verify the MACsec encryption and hardware interface descriptor block (IDB) information on the interface.
2. Use the IDB handle retrieved from Step 1 to verify the platform hardware information.
3. Use the Transmitter SA retrieved from Step 2 to verify the MACsec SA information programmed in the hardware.
4. Verify the MACsec Secure Channel (SC) information programmed in the hardware.

DETAILED STEPS

Step 1 Verify the MACsec encryption and hardware interface descriptor block (IDB) information on the interface.

Example:

```
RP/0/RSP0/CPU0:router# show macsec ea idb interface Fo0/0/0/1/0


IDB Details:
if_sname : Fo0/0/0/1/0
if_handle : 0x3480
Replay window size : 64
Local MAC : 00:1d:e5:e9:aa:39
Rx SC Option(s) : Validate-Frames Replay-Protect
Tx SC Option(s) : Protect-Frames Always-Include-SCI
Security Policy : MUST SECURE
Sectag offset : 8
VLAN : Outer tag (etype=0x8100, id=1, priority=0, cfi=0): Inner tag (etype=0x8100, id=1, priority=0,
 cfi=0)
Rx SC 1
Rx SCI : 001de5e9b1bf0019
Peer MAC : 00:1d:e5:e9:b1:bf
Stale : NO
SAK Data
SAK[0] : ***
SAK Len : 32
HashKey[0] : ***
HashKey Len : 16
Conf offset : 30
Cipher Suite : GCM-AES-XPN-256
CtxSalt[0] : 83 c3 7b ad 7b 6f 63 16 09 8f f3 d2
Rx SA Program Req[0]: 2015 Oct 09 15:20:53.082
Rx SA Program Rsp[0]: 2015 Oct 09 15:20:53.092
```

```
Tx SC
Tx SCI : 001de5e9aa39001a
Active AN : 0
Old AN : 255
Next PN : 1, 0, 0, 0
SAK Data
SAK[0] : ***
SAK Len : 32
HashKey[0] : ***
HashKey Len : 16
Conf offset : 30
Cipher Suite : GCM-AES-XPN-256
CtxSalt[0] : 83 c3 7b ae 7b 6f 63 16 09 8f f3 d2
Tx SA Program Req[0]: 2015 Oct 09 15:20:55.053
Tx SA Program Rsp[0]: 2015 Oct 09 15:20:55.064
```

! When more than 1 RX SA is configured in P2MP networks, the output would be as follows:

```
RP/0/RSP0/CPU0:router# show macsec ea idb interface FortyGigE0/0/0/1/0.1
IDB Details:
  if_sname                : Fo0/0/0/1/0.1
  if_handle               : 0x2e40
  Replay window size      : 1024
  Local MAC               : e0:ac:f1:72:41:23
  Rx SC Option(s)         : Validate-Frames Replay-Protect
  Tx SC Option(s)         : Protect-Frames Always-Include-SCI
  Security Policy         : MUST SECURE
  Sectag offset           : 8
  VLAN                    : Outer tag (etype=0x8100, id=1, priority=0, cfi=0)
                          : Inner tag (etype=0x8100, id=1, priority=0, cfi=0)
  Rx SC 1
    Rx SCI                : 001de5e9f3290001
    Peer MAC              : 00:1d:e5:e9:f3:29
    Stale                 : NO
    SAK Data
      SAK[1]              : ***

      SAK Len             : 32
      HashKey[1]          : ***
      HashKey Len         : 16
      Conf offset         : 50
      Cipher Suite        : GCM-AES-XPN-256
      CtxSalt[1]          : ae ca 99 2b 7f 5b 0b de f7 c9 fc 67
  Rx SC 2
    Rx SCI                : 001de5e9b1bf0001
    Peer MAC              : 00:1d:e5:e9:b1:bf
    Stale                 : NO
    SAK Data
      SAK[1]              : ***

      SAK Len             : 32
      HashKey[1]          : ***
      HashKey Len         : 16
      Conf offset         : 50
      Cipher Suite        : GCM-AES-XPN-256
      CtxSalt[1]          : ae ca 99 2a 7f 5b 0b de f7 c9 fc 67
  Tx SC
    Tx SCI                : e0acf17241230001
    Active AN             : 1
    Old AN                : 0
    Next PN               : 1, 1, 0, 0
    SAK Data
      SAK[1]              : ***
```

```
SAK Len             : 32
HashKey[1]          : ***
HashKey Len         : 16
Conf offset         : 50
Cipher Suite        : GCM-AES-XPN-256
CtxSalt[1]          : ae ca 99 28 7f 5b 0b de f7 c9 fc 67
```

The **if_handle** field provides the IDB instance location.

The **Replay window size** field displays the configured window size.

The **Security Policy** field displays the configured security policy.

The **Local Mac** field displays the MAC address of the router.

The **Peer Mac** field displays the MAC address of the peer. This confirms that a peer relationship has been formed between the two routers.

Step 2 Use the IDB handle retrieved from Step 1 to verify the platform hardware information.

Example:

```
RP/0/RSP0/CPU0:router# show macsec ea platform hardware
idb location 0/0/CPU0 | b 3480

if_handle : 0x00003480
NPPort : 099 [0x063]
LdaPort : 016 [0x010] SerdesPort : 000 [0x000]
NetSoftPort : 061 [0x03d] SysSoftPort : 062 [0x03e]
Active AN : 0x00000000 Idle AN : 0x000000ff
Match-All Tx SA : 0x80010001 Match-All Rx SA : 0x00010001
Match-All Tx Flow : 0x80000003 Match-All Rx Flow : 0x00000003
Bypass Tx SA : 0x80000000 Bypass Rx SA : 0x00000000
Tx SA[0] : 0x80020002 Tx Flow[0] : 0x8000000c
Tx SA[1] : 0xffffffff Tx Flow[1] : 0xffffffff
Tx SA[2] : 0xffffffff Tx Flow[2] : 0xffffffff
Tx SA[3] : 0xffffffff Tx Flow[3] : 0xffffffff
Rx SA[0] : 0x00020002 Rx Flow[0] : 0x0000000c
Rx SA[1] : 0xffffffff Rx Flow[1] : 0xffffffff
Rx SA[2] : 0xffffffff Rx Flow[2] : 0xffffffff
Rx SA[3] : 0xffffffff Rx Flow[3] : 0xffffffff
```

Step 3 Use the Transmitter SA retrieved from Step 2 to verify the MACsec SA information programmed in the hardware.

Example:

```
RP/0/RSP0/CPU0:router# show macsec ea platform hardware sa
0x80020002 interface Fo0/0/0/1/0 location 0/0/CPU0

MACSEC HW SA Details:
Action Type : 0x00000003
Direction : Egress
Dest Port : 0x00000000
Conf Offset : 00000030
Drop Type : 0x00000002
Drop NonResvd : 0x00000000
SA In Use : YES
ConfProtect : YES
IncludeSCI : YES
ProtectFrame : YES
```

```
UseEs : NO
UseSCB : NO
SCI : 00 1d e5 e9 aa 39 00 05
Replay Window : 64 MacsecCryptoAlgo : 7
Direction : Egress AN : 0
AES Key Len : 256 X-Packet Number : 0x0000000000000000
CtxSalt : f8d88dc3e1c5e6a94ca2299
```

The output displays the details of the encryption, such as the AES key, the Auth key, and other parameters.

Step 4 Verify the MACsec Secure Channel (SC) information programmed in the hardware.

Example:

```
RP/0/RSP0/CPU0:router# show macsec ea platform hardware msc
interface Fo0/0/0/1/0 location 0/0/CPU0


MACSEC HW Cfg Details:
Mode : 0x5
Counter Clear on Read : 0x0
SA Fail Mask : 0xffff
VlanCounter Update : 0x1
Global SecFail Mask : 0xffffffff
Latency : 0xff
StaticBypass : 0x0
Should secure : 0x0
Global Frame Validation : 0x2
Ctrl Pkt CC Bypass : 0x1
NonCtrl Pkt CC Bypass : 0x1
Sequence Number Threshold : 0xbffffb8
Sequence Number Threshold 64bit : 0x000002fffffffffd
Non Matching Non Control Pkts Programming
      Untagged : Bypass: 0x0 DestPort : 0x2, DropType : 0x2
      Tagged : Bypass: 0x0 DestPort : 0x2, DropType : 0x2
      BadTagged : Bypass: 0x0 DestPort : 0x2, DropType : 0x2
      KayTagged : Bypass: 0x0 DestPort : 0x2, DropType : 0x2
Non Matching Control Pkts Programming
      Untagged : Bypass: 0x1 DestPort : 0x2, DropType : 0xffffffff
      Tagged : Bypass: 0x0 DestPort : 0x2, DropType : 0x2
      BadTagged : Bypass: 0x0 DestPort : 0x2, DropType : 0x2
      KayTagged : Bypass: 0x0 DestPort : 0x2, DropType : 0x2
```

This completes the verification of MACsec encryption on the router hardware.

This completes the configuration and verification of MACsec encryption.

Configuring and Verifying MACsec Encryption as a Service

This section describes how MACsec can be implemented as a service in a L2VPN or L3VPN setup.

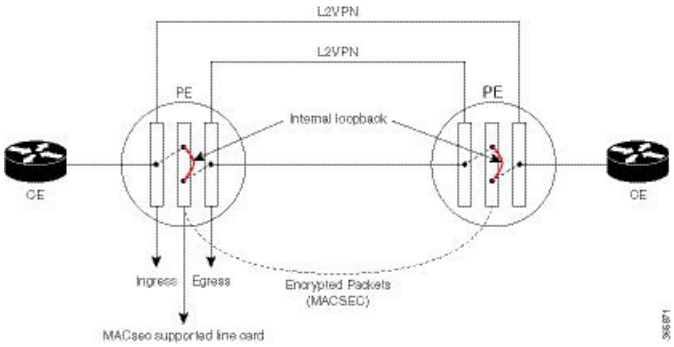
Note MACsec encryption is not supported on interface bundles, but is supported on member links .

Use Case 1: MACsec in an L2VPN Topology

In this topology, MACsec is configured on the PE router (with the interfaces facing the CE router) to provide crypto or encryption service on the PE router as a premium service for selected traffic on the WAN core. The interfaces can be physical ethernet interfaces or VLAN sub-interfaces. The customer can select the traffic that will be part of the encryption.

The following figure illustrates the use of MACsec as a service in an L2VPN network:

Figure 8: MACsec in an L2VPN topology



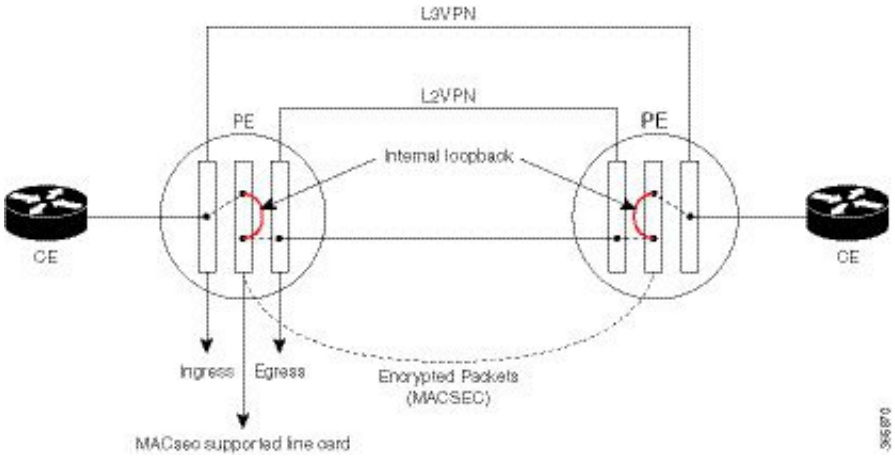
The data transferred between the CE router and the PE router are not encrypted. The data in clear format is sent to the access port of the PE router.

The PE router ports that receive traffic from CE routers divert the traffic using L2 local switching to the line card configured to perform encryption. The MACsec configuration creates internal loopback to the port configured for L2VPN to the opposite PE. After this, the packets are sent completely encrypted to the opposite PE router.

Use Case 2: MACsec in an L3VPN Topology

The following figure illustrates the use of MACsec as a service in an L3VPN environment. The topology is similar to an L2VPN set up where MACsec is configured on the PE router (where the interfaces facing the CE router) to provide crypto or encryption services on the PE router as a premium service for selected traffic on the WAN core.

Figure 9:



The data transferred between the CE router and the PE router is not encrypted. The data is sent in clear-text format to the PE router access port. The PE router for each sub-interface distinguishes whether the data is part of MACsec encrypted service.

The PE router ports that receive traffic from CE routers divert the traffic using L3 local switching to the line card port configured to do encryption. The MACsec configuration creates internal loopback to the port configured for L2VPN to the opposite PE router. After this, the packets are sent completely encrypted to the opposite PE.

Restrictions

Ports usage for encryption on the line card must meet the following criteria:

- The ports must be TenGigE interfaces.
- Both the ports must belong either to an A9K-MPA-20X10GE MPA, or they must be breakout interfaces from one of the A9K-8X100GE-SE, A9K-8X100GE-TR, A9K-4X100GE-SE, or A9K-4X100GE-TR line cards.
- If the interfaces belong to A9K-MPA-20x10GE line card, then both the interfaces must be either in port range 0-9, or in port range 10-19. One interface from range 0-9 and other from 10-19 must not be selected.
- If the interfaces are breakout interfaces, then both of them must belong to the same HundredGigE port.

Note These restrictions apply only to MACsec interfaces. These restrictions do not apply to the CE or core-facing interfaces.

Configuring MACsec as a Service

SUMMARY STEPS

1. Enter interface configuration mode.
2. Configure the MACsec service.
3. Commit your configuration and exit global configuration mode.
4. Confirm the MACsec policy configuration.

DETAILED STEPS

Step 1 Enter interface configuration mode.

Example:

```
RP/0/RSP/CPU0:router# interface <interface> 15.10 l2transport
RP/0/RSP0/CPU0:router(config-subif)# encapsulation dot1q 10
```

Step 2 Configure the MACsec service.

Example:

```
RP/0/RSP0/CPU0:router(config-subif)# macsec-service decrypt-port <intf>17.10 psk-keychain
<keychain_name> [policy <macsec_policy>]
```

Step 3 Commit your configuration and exit global configuration mode.

Example:

```
RP/0/RSP0/CPU0:router# commit
RP/0/RSP0/CPU0:router# exit
```

Step 4 Confirm the MACsec policy configuration.

Example:

```
RP/0/RSP0/CPU0:router#

show running-config interface <interface> 15.10

interface <interface> 15.10
 macsec-service decrypt-port <intf>17.10 psk-keychain <keychain_name> [policy <macsec_policy>]
 encapsulation dot1q 10
```

Configuring MACsec Service for L2VPN Network

Configuring the MACsec service for L2VPN network, involves the following steps:

SUMMARY STEPS

1. Enter global configuration mode.
2. Enter interface configuration mode and configure port facing the CE router.
3. Enable MACsec service.
4. Configure service port.
5. Configure the Xconnect group between ports.
6. Connect the ports.

DETAILED STEPS

Step 1 Enter global configuration mode.

Example:

```
RP/0/RSP0/CPU0:router# configure
```

Step 2 Enter interface configuration mode and configure port facing the CE router.

The interface can be a physical interface or a VLAN sub-interface.

Example:

```
RP/0/RSP0/CPU0:router(config)# interface  <interface>15.10  l2transport
 encapsulation dot1q 10
```

Step 3 Enable MACsec service.

Example:

```
RP/0/RSP0/CPU0:router(config-if)# interface  <interface>16.10  l2transport
 encapsulation dot1q 10
  macsec-service decrypt-port <intf>17.10 psk-keychain <keychain_name> [policy <macsec_policy>]
```

Step 4 Configure service port.

Example:

```
RP/0/RSP0/CPU0:router(config-if)# interface  <interface>17.10  l2transport
 encapsulation dot1q 10
```

Step 5 Configure the Xconnect group between ports.

Example:

```
RP/0/RSP0/CPU0:router(config-if)# l2vpn
xconnect group local_macsec
  p2p local_macsec
   interface  <interface>15.10
   interface  <interface>16.10
```

Step 6 Connect the ports.

Example:

```
RP/0/RSP0/CPU0:router(config-if)l2vpn
 xconnect group ext_macsec
  p2p ext_macsec
   interface  <interface>17.10
   neighbor  ipv4  <a.b.c.d>  pw-id  <num>
!
```

Configuring MACsec Service for L3VPN Network

Configuring the MACsec service for L3VPN network, involves the following steps:

SUMMARY STEPS

1. Enter global configuration mode.
2. Enter interface configuration mode and configure port facing the CE router
3. Configure the PE1 router with virtual routing details.
4. Enable MACsec service.
5. Configure service port.
6. Configure the Xconnect between ports.
7. Configure ports.
8. Configure OSPF on the core interface.
9. Configure MPLS on the core interface.

DETAILED STEPS

Step 1 Enter global configuration mode.

Example:

```
RP/0/RSP0/CPU0:router# configure
```

Step 2 Enter interface configuration mode and configure port facing the CE router

Example:

```
RP/0/RSP0/CPU0:router(config-if)# interface TenGigE0/4/0/0.1
ipv4 address 161.1.1.1 255.255.255.0
encapsulation dot1q 1
```

Step 3 Configure the PE1 router with virtual routing details.

Example:

```
RP/0/RSP0/CPU0:router(config-if)# interface TenGigE0/3/0/0/1.1
 vrf vrf_1
 ipv4 address 161.1.1.2 255.255.255.0
 encapsulation dot1q 1
```

Step 4 Enable MACsec service.

Example:

```
RP/0/RSP0/CPU0:router(config-if)# interface TenGigE0/3/0/0/2.1
 vrf vrf_1
 ipv4 address 181.1.1.1 255.255.255.0
 macsec-service decrypt-port TenGigE0/3/0/0/3.1 psk-keychain script_key_chain1
 encapsulation dot1q 1
```

Step 5 Configure service port.

Example:

```
RP/0/RSP0/CPU0:router(config-if)#interface TenGigE0/3/0/0/3.1 l2transport
 encapsulation dot1q 1
!
```

Step 6 Configure the Xconnect between ports.

Example:

```
RP/0/RSP0/CPU0:router#configure
RP/0/RSP0/CPU0:router(config)#l2vpn
 xconnect group l3serv_xc_gp_1
  p2p l3serv_xc_p2p_1
   interface TenGigE0/3/0/0/3.1
   neighbor ipv4 3.3.3.3 pw-id 1
   !
  !
```

Step 7 Configure ports.

Example:

```
RP/0/RSP0/CPU0:router#(config)
router bgp 100
 bgp router-id 2.2.2.2
 address-family ipv4 unicast
 !
 address-family vpnv4 unicast
 !
 neighbor 3.3.3.3
  remote-as 100
  update-source Loopback1
  address-family vpnv4 unicast
  !
 !
 vrf vrf_1
  rd 1234:1
  address-family ipv4 unicast
   redistribute connected
   redistribute static
  !
  neighbor 181.1.1.2
   remote-as 100
   address-family ipv4 unicast
   !
  !
 !
```

Step 8 Configure OSPF on the core interface.

Example:

```
RP/0/RSP0/CPU0:router#
macsec-PE1#sh run router ospf
router ospf core
 router-id 2.2.2.2
 redistribute connected
 redistribute static
 area 0
  interface Loopback1
  !
  interface TenGigE0/1/0/1
  !
 !
```

Step 9 Configure MPLS on the core interface.

Example:

```
RP/0/RSP0/CPU0:router#
mpls ldp
 graceful-restart
 router-id 2.2.2.2
 interface TenGigE0/1/0/1
 !
!
```

Applying MACsec Service Configuration on an Interface

The MACsec service configuration is applied to the host-facing interface of a CE router.

SUMMARY STEPS

1. Enter the global configuration mode.
2. Enter the interface configuration mode.
3. If you are configuring VLAN sub-interfaces, configure the encapsulation as shown.
4. Apply the MACsec service configuration on an interface.
5. Commit your configuration.

DETAILED STEPS

Step 1 Enter the global configuration mode.

Example:

```
RP/0/RSP0/CPU0:router# configure
```

Step 2 Enter the interface configuration mode.

The interface can be a physical interface or a VLAN sub-interface.

Example:

```
RP/0/RSP0/CPU0:router(config)# interface Te0/3/0/1/4
```

Step 3 If you are configuring VLAN sub-interfaces, configure the encapsulation as shown.

Example:

```
! For 802.1q encapsulation with a single tag
RP/0/RSP0/CPU0:router(config-if)# encapsulation dot1q 5

! For 802.1q encapsulation with double tags
RP/0/RSP0/CPU0:router(config-if)# encapsulation dot1q 3 second-dot1q 4

! For 802.1ad encapsulation with a single tag
RP/0/RSP0/CPU0:router(config-if)# encapsulation dot1ad 5

! For 802.1ad encapsulation with double tags
RP/0/RSP0/CPU0:router(config-if)# encapsulation dot1ad 3 dot1ad 4
```

Step 4 Apply the MACsec service configuration on an interface.

To apply MACsec service configuration on an interface, use the following configuration.

Example:

```
RP/0/RSP0/CPU0:router(config-if)# macsec-service decrypt-port TenGigE0/3/0/1/5 psk-keychain
script_key_chain1 policy mk_xpn_1tag
RP/0/RSP0/CPU0:router(config-if)# exit
```

Step 5 Commit your configuration.

Example:

```
RP/0/RSP0/CPU0:router(config)# commit
```

Verifying MACsec Encryption on IOS XR

MACsec encryption on IOS XR can be verified by running relevant commands in the Privileged Executive Mode. The verification steps are the same for MACsec encryption on L2VPN or L3VPN network.

Note With the introduction of active fallback functionality in Cisco IOS XR Software Release 7.1.2 (Release 6.7.2 for 32-bit Cisco IOS XR platforms), the output of various MACsec show commands include the fallback PSK entry as well.

To verify if MACsec encryption has been correctly configured, follow these steps.

SUMMARY STEPS

1. Verify the MACsec policy configuration.
2. Verify the MACsec configuration on the respective interface.
3. Verify whether the interface of the router is peering with its neighbor after MACsec configuration
4. Verify whether the MKA session is secured with MACsec on the respective interface.
5. Verify the MACsec session counter statistics.

DETAILED STEPS

Step 1 Verify the MACsec policy configuration.

Example:

```
RP/0/RSP0/CPU0:router#show macsec policy mac_policy

================================================================================
Policy      Cipher         Key-Svr     Window  Conf
name        Suite          Priority    Size    Offset
================================================================================
mac_policy GCM-AES-XPN-256  0          64      30
```

If the values you see are different from the ones you configured, then check your configuration by running the **show run macsec-policy** command.

Step 2 Verify the MACsec configuration on the respective interface.

You can verify the MACsec encryption on the configured interface bundle (MPLS network), P2MP interface (VPLS network), or VLAN sub-interface (EoMPLS PW network).

Example:

Before the introduction of active fallback functionality:

```
RP/0/RSP0/CPU0:router#show macsec mka summary

NODE: node0_0_CPU0

================================================================
Interface     Status    Cipher Suite      KeyChain
================================================================

Fo0/0/0/1/0   Secured   GCM-AES-XPN-256   mac_chain

Total MACSec Sessions : 1
     Secured Sessions : 1
     Pending Sessions : 0

RP/0/RSP0/CPU0:router#show macsec mka session interface Fo0/0/0/1/0
=============================================================================
   Interface-Name        Local-TxSCI       #Peers   Status   Key-Server
=============================================================================
   Fo0/0/0/1/0        d46d.5023.3709/0001     1     Secured      YES


! If sub-interfaces are configured, the output would be as follows:

RP/0/RSP0/CPU0:router#show macsec mka session interface Fo0/0/0/1/1.8
=============================================================================
      Interface         Local-TxSCI       # Peers   Status  Key-Server
=============================================================================
  Fo0/0/0/1/1.8      e0ac.f172.4124/001d      1     Secured     Yes
```

With the introduction of active fallback functionality:

The following is a sample output that displays active fallback PSK entry as well:

```
RP/0/RSP0/CPU0:router#show macsec mka summary

NODE: node0_0_CPU0
=============================================================================================
   Interface-Name     Status     Cipher-Suite       KeyChain       PSK/EAP      CKN
=============================================================================================
     Fo0/0/0/1/0      Secured  GCM-AES-XPN-256      mac_chain      PRIMARY      5555
     Fo0/0/0/1/0      Active   GCM-AES-XPN-256      mac_chain_fb   FALLBACK     5556

Total MACSec Sessions : 2
     Secured Sessions : 1
     Pending Sessions : 0
      Active Sessions : 1

RP/0/RSP0/CPU0:router#show macsec mka session interface Fo0/0/0/1/0
=============================================================================================
   Interface-Name        Local-TxSCI       #Peers   Status   Key-Server   PSK/EAP      CKN
=============================================================================================
   Fo0/0/0/1/0        d46d.5023.3709/0001     1      Secured      YES      PRIMARY     5555
   Fo0/0/0/1/0        d46d.5023.3709/0001     1      Active       YES     FALLBACK     5556
```

The **Status** field in the output confirms that the respective interface is **Secured**. If MACsec encryption is not successfully configured, you will see a status such as **Pending** or **Init**.

Note In the VPLS network, because of the configuration on a multi-point interface, the number of live peers displayed is more than 1.

Run the **show run macsec-policy** command in the privileged executive mode to troubleshoot the configuration entered.

Step 3 Verify whether the interface of the router is peering with its neighbor after MACsec configuration

Example:

```
RP/0/RSP0/CPU0:router#show macsec mka session

NODE: node0_0_CPU0

================================================================
Interface    Local-TxSCI           # Peers   Status  Key-Server
================================================================

Fo0/0/0/1/0  001d.e5e9.aa39/0005      1      Secured  YES
```

The following is a sample output that displays active fallback PSK entry as well:

```
Router#show macsec mka session
Wed Apr 28 01:59:39.478 UTC

NODE: node0_1_CPU0
=============================================================================================
   Interface-Name        Local-TxSCI       #Peers   Status   Key-Server   PSK/EAP      CKN
=============================================================================================
     Fo0/0/0/1/0      001d.e5e9.aa39/0005     1      Secured      NO       PRIMARY     1234
     Fo0/0/0/1/0      001d.e5e9.aa39/0005     1      Active       NO       FALLBACK    1111
```

The **#Peers** field in the output confirms the presence of the peer you have configured on the physical interface, **Fo0/0/0/1/0**. If the number of peers is not reflected accurately in this output, run the **show run** command and verify the peer configuration on the interface.

Note If the MKA session status is shown as **Secured** with **0 (Zero)** peer count, this means that the link is locally secured (Tx). This is because of MKA peer loss caused by **No Rx Packets (MKA Packet)** from that peer.

Note In the VPLS network, because of the configuration on a multipoint interface, the number of live peers displayed is more than 1.

```
Router#show macsec mka session
Fri May 28 07:18:45.726 UTC

NODE: node0_0_CPU0
=============================================================================================
Interface-Name        Local-TxSCI       #Peers   Status   Key-Server   PSK/EAP      CKN
=============================================================================================
  Te0/0/0/1       6c8b.d34f.0635/0001     2      Secured      NO      FALLBACK     5556
```

Step 4 Verify whether the MKA session is secured with MACsec on the respective interface.

Example:

Before the introduction of active fallback functionality:

```
RP/0/RSP0/CPU0:router#show macsec mka session interface Fo0/0/0/1/0 detail
MKA Detailed Status for MKA Session
===================================
Status: SECURED - Secured MKA Session with MACsec
Local Tx-SCI            : 001d.e5e9.aa39/0005
Local Tx-SSCI           : 1
Interface MAC Address   : 001d.e5e9.aa39
```

```
MKA Port Identifier     : 1
Interface Name          : Fo0/0/0/1/0
CAK Name (CKN)          : 1020000000000000000000000000000000000000000000000000000000000000
Member Identifier (MI)  : A880BB45B9CE01584535F239
Message Number (MN)     : 5382
Authenticator           : NO
Key Server              : YES
MKA Cipher Suite        : AES-128-CMAC
Latest SAK Status       : Rx & Tx
Latest SAK AN           : 0
Latest SAK KI (KN)      : A880BB45B9CE01584535F23900000001 (1)
Old SAK Status          : FIRST-SAK
Old SAK AN              : 0
Old SAK KI (KN)         : FIRST-SAK (0)
SAK Transmit Wait Time  : 0s (Not waiting for any peers to respond)
SAK Retire Time         : 0s (No Old SAK to retire)
MKA Policy Name         : scale-21
Key Server Priority     : 20
Replay Window Size      : 40
Confidentiality Offset  : 50
Algorithm Agility       : 80C201
SAK Cipher Suite        : 0080C20001000001 (GCM-AES-128)
MACsec Capability       : 3 (MACsec Integrity, Confidentiality, & Offset)
MACsec Desired          : YES
# of MACsec Capable Live Peers           : 1
# of MACsec Capable Live Peers Responded : 1
Live Peer List:
  MI                        MN          Rx-SCI (Peer)        SSCI KS-Priority
  ----------------------------------------------------------------------------
  4E33A276E7F79C04D80FE346       27114  d46d.5023.3704/0001     2         235
Potential Peer List:
  MI                        MN          Rx-SCI (Peer)        SSCI KS-Priority
  ----------------------------------------------------------------------------
```

! If sub-interfaces are configured, the output would be as follows:

```
RP/0/RSP0/CPU0:router# show macsec mka session interface Fo0/0/0/1/1.8 detail
MKA Detailed Status for MKA Session
===================================
Status: SECURED - Secured MKA Session with MACsec
Local Tx-SCI            : e0ac.f172.4124/001d
Local Tx-SSCI           : 1
Interface MAC Address   : e0ac.f172.4124
MKA Port Identifier     : 29
Interface Name          : Fo0/0/0/1/1.8
CAK Name (CKN)          : ABC1000000000000000000000000000000000000000000000000000000000000
Member Identifier (MI)  : 1EC4A4D1B0D75D3D5C2F6393
Message Number (MN)     : 1915
Authenticator           : NO
Key Server              : NO
MKA Cipher Suite        : AES-128-CMAC
Latest SAK Status       : Rx & Tx
Latest SAK AN           : 3
Latest SAK KI (KN)      : EB1E04894327E4EFA283C66200000003 (3)
Old SAK Status          : No Rx, No Tx
Old SAK AN              : 0
Old SAK KI (KN)         : RETIRED (4)
SAK Transmit Wait Time  : 0s (Not waiting for any peers to respond)
SAK Retire Time         : 0s (No Old SAK to retire)
MKA Policy Name         : test12
Key Server Priority     : 0
Replay Window Size      : 1024
Confidentiality Offset  : 50
Algorithm Agility       : 80C201
```

```
SAK Cipher Suite        : 0080C20001000004 (GCM-AES-XPN-256)
MACsec Capability       : 3 (MACsec Integrity, Confidentiality, & Offset)
MACsec Desired          : YES
# of MACsec Capable Live Peers           : 1
# of MACsec Capable Live Peers Responded : 0
Live Peer List:
  MI                        MN          Rx-SCI (Peer)        SSCI KS-Priority
  ------------------------------------------------------------------------------
  EB1E04894327E4EFA283C662        1908  001d.e5e9.b1c0/0037     2           0
Potential Peer List:
  MI                        MN          Rx-SCI (Peer)        SSCI KS-Priority
  ------------------------------------------------------------------------------
RP/0/RSP0/CPU0:macsec-CE1#sh macsec mka  interface Fo0/0/0/1/1.8
============================================================
Interface-name          KeyChain-Name           Policy Name
============================================================
Fo0/0/0/1/1.8           kc3                     test12


! In a VPLS network with multipoint interface, the output would be as follows:

RP/0/RSP0/CPU0:router#show macsec mka session interface FortyGigE0/0/0/1/0.1 detail
MKA Detailed Status for MKA Session
===================================
Status: SECURED - Secured MKA Session with MACsec
Local Tx-SCI            : e0ac.f172.4123/0001
Local Tx-SSCI           : 1
Interface MAC Address   : e0ac.f172.4123
MKA Port Identifier     : 1
Interface Name          : Fo0/0/0/1/0.1
CAK Name (CKN)          : ABC1000000000000000000000000000000000000000000000000000000000000
Member Identifier (MI)  : A1DB3E42B4A543FBDBC281A6
Message Number (MN)     : 1589
Authenticator           : NO
Key Server              : NO
MKA Cipher Suite        : AES-128-CMAC
Latest SAK Status       : Rx & Tx
Latest SAK AN           : 1
Latest SAK KI (KN)      : AEC899297F5B0BDEF7C9FC6700000002 (2)
Old SAK Status          : No Rx, No Tx
Old SAK AN              : 0
Old SAK KI (KN)         : RETIRED (1)
SAK Transmit Wait Time  : 0s (Not waiting for any peers to respond)
SAK Retire Time         : 0s (No Old SAK to retire)
MKA Policy Name         : mk_xpn1
Key Server Priority     : 0
Replay Window Size      : 1024
Confidentiality Offset  : 50
Algorithm Agility       : 80C201
SAK Cipher Suite        : 0080C20001000004 (GCM-AES-XPN-256)
MACsec Capability       : 3 (MACsec Integrity, Confidentiality, & Offset)
MACsec Desired          : YES
# of MACsec Capable Live Peers           : 2
# of MACsec Capable Live Peers Responded : 0
Live Peer List:
  MI                        MN          Rx-SCI (Peer)        SSCI KS-Priority
  ------------------------------------------------------------------------------
  AEC899297F5B0BDEF7C9FC67         225  001d.e5e9.b1bf/0001     3           0
  0A4C49EE5B7401F1BECB7E22         147  001d.e5e9.f329/0001     2           0
Potential Peer List:
  MI                        MN          Rx-SCI (Peer)        SSCI KS-Priority
  ------------------------------------------------------------------------------
```

With the introduction of active fallback functionality:

The following show command output verifies that the primary and fallback keys (CAK) are matched on both peer ends.

```
RP/0/RSP0/CPU0:router#show macsec mka session interface Hu0/0/0/11 detail

MKA Detailed Status for MKA Session
===================================
Status: Secured - Secured MKA Session with MACsec

Local Tx-SCI                    : 7061.7bea.1df4/0001
Local Tx-SSCI                   : 1
Interface MAC Address           : 7061.7bea.1df4
MKA Port Identifier             : 1
Interface Name                  : Hu0/0/0/11
CAK Name (CKN)                  : 2111
CA Authentication Mode          : PRIMARY-PSK
Keychain                        : test1
Member Identifier (MI)          : 42A78BD6243539E917B8C6B2
Message Number (MN)             : 555
Authenticator                   : NO
Key Server                      : NO
MKA Cipher Suite                : AES-128-CMAC
Configured MACSec Cipher Suite  : GCM-AES-XPN-128

Latest SAK Status               : Rx & Tx
Latest SAK AN                   : 0
Latest SAK KI (KN)              : 69B39E87B3CBA673401E989100000001 (1)
Old SAK Status                  : FIRST-SAK
Old SAK AN                      : 0
Old SAK KI (KN)                 : FIRST-SAK (0)

SAK Transmit Wait Time          : 0s (Not waiting for any peers to respond)
SAK Retire Time                 : 0s (No Old SAK to retire)
Time to SAK Rekey               : NA
Time to exit suspension         : NA

MKA Policy Name                 : P12
Key Server Priority             : 20
Delay Protection                : TRUE
Replay Window Size              : 100
Include ICV Indicator           : TRUE
Confidentiality Offset          : 0
Algorithm Agility               : 80C201
SAK Cipher Suite                : 0080C20001000003 (GCM-AES-XPN-128)
MACsec Capability               : 3 (MACsec Integrity, Confidentiality, & Offset)
MACsec Desired                  : YES

# of MACsec Capable Live Peers           : 1
# of MACsec Capable Live Peers Responded : 0

Live Peer List:
------------------------------------------------------------------------------
           MI                  MN             Rx-SCI          SSCI  KS-Priority
------------------------------------------------------------------------------
69B39E87B3CBA673401E9891      617       008a.96d6.194c/0001    2        20

Potential Peer List:
------------------------------------------------------------------------------
           MI                  MN             Rx-SCI          SSCI  KS-Priority
------------------------------------------------------------------------------

Peers Status:
Last Tx MKPDU          : 2021 May 18 13:27:56.548
```

```
Peer Count             : 1

RxSCI                  : 008A96D6194C0001
  MI                    : 69B39E87B3CBA673401E9891
  Peer CAK              : Match
  Latest Rx MKPDU       : 2021 May 18 13:27:56.518

MKA Detailed Status for MKA Session
===================================
Status: Active - Marked Peer as Live (Waiting for SAK generation/distribution)

Local Tx-SCI                    : 7061.7bea.1df4/0001
Local Tx-SSCI                   : 1
Interface MAC Address           : 7061.7bea.1df4
MKA Port Identifier             : 1
Interface Name                  : Hu0/0/0/11
CAK Name (CKN)                  : 2000
CA Authentication Mode          : FALLBACK-PSK
Keychain                        : test1f
Member Identifier (MI)          : 1BB9428C721F6EE3E538C942
Message Number (MN)             : 553
Authenticator                   : NO
Key Server                      : NO
MKA Cipher Suite                : AES-128-CMAC
Configured MACSec Cipher Suite  : GCM-AES-XPN-128

Latest SAK Status               : Rx & Tx
Latest SAK AN                   : 0
Latest SAK KI (KN)              : 69B39E87B3CBA673401E989100000001 (1)
Old SAK Status                  : FIRST-SAK
Old SAK AN                      : 0
Old SAK KI (KN)                 : FIRST-SAK (0)

SAK Transmit Wait Time          : 0s (Not waiting for any peers to respond)
SAK Retire Time                 : 0s (No Old SAK to retire)
Time to SAK Rekey               : NA
Time to exit suspension         : NA

MKA Policy Name                 : P12
Key Server Priority             : 20
Delay Protection                : TRUE
Replay Window Size              : 100
Include ICV Indicator           : TRUE
Confidentiality Offset          : 0
Algorithm Agility               : 80C201
SAK Cipher Suite                : 0080C20001000003 (GCM-AES-XPN-128)
MACsec Capability               : 3 (MACsec Integrity, Confidentiality, & Offset)
MACsec Desired                  : YES

# of MACsec Capable Live Peers           : 1
# of MACsec Capable Live Peers Responded : 0

Live Peer List:
------------------------------------------------------------------------------
           MI                  MN             Rx-SCI          SSCI  KS-Priority
------------------------------------------------------------------------------
8F59AD6021FA3E2D5F9E6231      615       008a.96d6.194c/0001    2        20

Potential Peer List:
------------------------------------------------------------------------------
           MI                  MN             Rx-SCI          SSCI  KS-Priority
------------------------------------------------------------------------------

Peers Status:
```

```
Last Tx MKPDU          : 2021 May 18 13:27:56.547
Peer Count             : 1

RxSCI                  : 008A96D6194C0001
  MI                   : 8F59AD6021FA3E2D5F9E6231
  Peer CAK             : Match
  Latest Rx MKPDU      : 2021 May 18 13:27:56.518

RP/0/RSP0/CPU0:router#
```

If sub-interfaces are configured, the output would be as follows. In this example, the status of FALLBACK-PSK is *Secured*.

```
RP/0/RSP0/CPU0:router# show macsec mka session interface Hu0/0/0/0.6 detail
MKA Detailed Status for MKA Session
===================================
Status: Secured - Secured MKA Session with MACsec

Local Tx-SCI                    : 7061.7bea.1dc8/0006
Local Tx-SSCI                   : 1
Interface MAC Address           : 7061.7bea.1dc8
MKA Port Identifier             : 6
Interface Name                  : Hu0/0/0/0.6
CAK Name (CKN)                  : 9999
CA Authentication Mode          : FALLBACK-PSK
Keychain                        : D_tagf
Member Identifier (MI)          : 1DE18714A098B80964CC651E
Message Number (MN)             : 6203
Authenticator                   : NO
Key Server                      : YES
MKA Cipher Suite                : AES-128-CMAC
Configured MACSec Cipher Suite  : GCM-AES-XPN-256

Latest SAK Status               : Rx & Tx
Latest SAK AN                   : 0
Latest SAK KI (KN)              : 1DE18714A098B80964CC651E00000001 (1)
Old SAK Status                  : FIRST-SAK
Old SAK AN                      : 0
Old SAK KI (KN)                 : FIRST-SAK (0)

SAK Transmit Wait Time          : 0s (Not waiting for any peers to respond)
SAK Retire Time                 : 0s (No Old SAK to retire)
Time to SAK Rekey               : 23510s
Time to exit suspension         : NA

MKA Policy Name                 : D_tag1
Key Server Priority             : 1
Delay Protection                : FALSE
Replay Window Size              : 1000
Include ICV Indicator           : TRUE
Confidentiality Offset          : 50
Algorithm Agility               : 80C201
SAK Cipher Suite                : 0080C20001000004 (GCM-AES-XPN-256)
MACsec Capability               : 3 (MACsec Integrity, Confidentiality, & Offset)
MACsec Desired                  : YES

# of MACsec Capable Live Peers           : 1
# of MACsec Capable Live Peers Responded : 1

# of MACSec Suspended Peers              : 0

Live Peer List:
```

```
-------------------------------------------------------------------------------
           MI                  MN             Rx-SCI          SSCI  KS-Priority
-------------------------------------------------------------------------------
5C852D8F920306893D2BFB8F     10978      00c1.645f.2dd4/0006    2        11

Potential Peer List:
-------------------------------------------------------------------------------
           MI                  MN             Rx-SCI          SSCI  KS-Priority
-------------------------------------------------------------------------------

Suspended Peer List:
-------------------------------------------------------------------------------
       Rx-SCI          SSCI
-------------------------------------------------------------------------------

Peers Status:
Last Tx MKPDU          : 2021 May 18 13:29:15.687
Peer Count             : 1

RxSCI                  : 00C1645F2DD40006
  MI                    : 5C852D8F920306893D2BFB8F
  Peer CAK              : Match
  Latest Rx MKPDU       : 2021 May 18 13:29:15.769

RP/0/RSP0/CPU0:router#


! In a VPLS network with multipoint interface, the output would be as follows:

RP/0/RSP0/CPU0:router#show macsec mka session interface Hu0/0/1/7 detail
Fri May 28 07:19:11.362 UTC

MKA Detailed Status for MKA Session
===================================
Status: Secured - Secured MKA Session with MACsec

Local Tx-SCI                    : 6c8b.d34f.0635/0001
Local Tx-SSCI                   : 2
Interface MAC Address           : 6c8b.d34f.0635
MKA Port Identifier             : 1
Interface Name                  : Te0/0/0/1
CAK Name (CKN)                  : 5556
CA Authentication Mode          : FALLBACK-PSK
Keychain                        : test2f
Member Identifier (MI)          : 6D14ECCDFB70E7E0463BD509
Message Number (MN)             : 20455
Authenticator                   : NO
Key Server                      : NO
MKA Cipher Suite                : AES-256-CMAC
Configured MACSec Cipher Suite  : GCM-AES-XPN-256

Latest SAK Status               : Rx & Tx
Latest SAK AN                   : 2
Latest SAK KI (KN)              : 1BBDDC0520C797C26AB7F1BF00000002 (2)
Old SAK Status                  : No Rx, No Tx
Old SAK AN                      : 1
Old SAK KI (KN)                 : RETIRED (1)

SAK Transmit Wait Time          : 0s (Not waiting for any peers to respond)
SAK Retire Time                 : 0s (No Old SAK to retire)
Time to SAK Rekey               : NA
Time to exit suspension         : NA
```

```
MKA Policy Name                 : *DEFAULT POLICY*
Key Server Priority             : 16
Delay Protection                : FALSE
Replay Window Size              : 64
Include ICV Indicator           : FALSE
Confidentiality Offset          : 0
Algorithm Agility               : 80C201
SAK Cipher Suite                : 0080C20001000004 (GCM-AES-XPN-256)
MACsec Capability               : 3 (MACsec Integrity, Confidentiality, & Offset)
MACsec Desired                  : YES

# of MACsec Capable Live Peers           : 2
# of MACsec Capable Live Peers Responded : 0

Live Peer List:
--------------------------------------------------------------------------------
           MI                   MN             Rx-SCI          SSCI  KS-Priority
--------------------------------------------------------------------------------
1BBDDC0520C797C26AB7F1BF     19997      008a.96d6.194c/0001    3        16
B25B1000CC6FAE92D1F85738      139       dc77.4c3e.59c3/0001    1        16

Potential Peer List:
--------------------------------------------------------------------------------
           MI                   MN             Rx-SCI          SSCI  KS-Priority
--------------------------------------------------------------------------------

Peers Status:
 Last Tx MKPDU          : 2021 May 28 07:19:10.153
 Peer Count             : 2

 RxSCI                  : 008A96D6194C0001
  MI                    : 1BBDDC0520C797C26AB7F1BF
  Peer CAK              : Match
  Latest Rx MKPDU       : 2021 May 28 07:19:09.960

 RxSCI                  : DC774C3E59C30001
  MI                    : B25B1000CC6FAE92D1F85738
  Peer CAK              : Match
  Latest Rx MKPDU       : 2021 May 28 07:19:10.180

RP/0/RSP0/CPU0:router#


RP/0/RSP0/CPU0:router#show macsec mka session interface Hu0/0/1/7.1 detail

MKA Detailed Status for MKA Session
===================================
Status: Secured - Secured MKA Session with MACsec

Local Tx-SCI                    : 7061.7bff.e5e8/0001
Local Tx-SSCI                   : 2
Interface MAC Address           : 7061.7bff.e5e8
MKA Port Identifier             : 1
Interface Name                  : Hu0/0/1/7.1
CAK Name (CKN)                  : 5556
CA Authentication Mode          : FALLBACK-PSK
Keychain                        : test22f
Member Identifier (MI)          : 8FF3D1BBF09EA4AD6A0FC1B5
Message Number (MN)             : 81
Authenticator                   : NO
Key Server                      : YES
MKA Cipher Suite                : AES-256-CMAC
Configured MACSec Cipher Suite  : GCM-AES-XPN-256
```

```
Latest SAK Status               : Rx & Tx
Latest SAK AN                   : 3
Latest SAK KI (KN)              : 8FF3D1BBF09EA4AD6A0FC1B500000002 (2)
Old SAK Status                  : No Rx, No Tx
Old SAK AN                      : 2
Old SAK KI (KN)                 : RETIRED (1)

SAK Transmit Wait Time          : 0s (Not waiting for any peers to respond)
SAK Retire Time                 : 0s (No Old SAK to retire)
Time to SAK Rekey               : 17930s
Time to exit suspension         : NA

MKA Policy Name                 : P123
Key Server Priority             : 10
Delay Protection                : FALSE
Replay Window Size              : 64
Include ICV Indicator           : FALSE
Confidentiality Offset          : 30
Algorithm Agility               : 80C201
SAK Cipher Suite                : 0080C20001000004 (GCM-AES-XPN-256)
MACsec Capability               : 3 (MACsec Integrity, Confidentiality, & Offset)
MACsec Desired                  : YES

# of MACsec Capable Live Peers           : 2
# of MACsec Capable Live Peers Responded : 2

# of MACSec Suspended Peers              : 0

Live Peer List:
------------------------------------------------------------------------------
           MI                  MN             Rx-SCI          SSCI  KS-Priority
------------------------------------------------------------------------------
6BCF91135F807CB9F57DDAAA       61       dc77.4c3e.5b05/0001    1        24
D81CFE93D07E932DDC33666E       44       00a7.4250.56c2/0001    3        25

Potential Peer List:
------------------------------------------------------------------------------
           MI                  MN             Rx-SCI          SSCI  KS-Priority
------------------------------------------------------------------------------

Suspended Peer List:
------------------------------------------------------------------------------
       Rx-SCI          SSCI
------------------------------------------------------------------------------

Peers Status:
 Last Tx MKPDU          : 2021 May 28 13:16:50.992
 Peer Count             : 2

 RxSCI                  : DC774C3E5B050001
  MI                    : 6BCF91135F807CB9F57DDAAA
  Peer CAK              : Match
  Latest Rx MKPDU       : 2021 May 28 13:16:51.312

 RxSCI                  : 00A7425056C20001
  MI                    : D81CFE93D07E932DDC33666E
  Peer CAK              : Match
  Latest Rx MKPDU       : 2021 May 28 13:16:50.945
RP/0/RSP0/CPU0:router#
```

Step 5 Verify the MACsec session counter statistics.

Example:

```
RP/0/RSP0/CPU0:router# show macsec mka statistics interface Fo0/0/0/1/0


MKA Statistics for Session on interface (Fo0/0/0/1/0)
=====================================================
Reauthentication Attempts.. 0

CA Statistics
Pairwise CAKs Derived... 0
Pairwise CAK Rekeys..... 0
Group CAKs Generated.... 0
Group CAKs Received..... 0

SA Statistics
SAKs Generated.......... 3
SAKs Rekeyed............ 2
SAKs Received........... 0
SAK Responses Received.. 3

MKPDU Statistics
MKPDUs Transmitted...... 5425
"Distributed SAK".. 8
"Distributed CAK".. 0
MKPDUs Validated & Rx... 4932
"Distributed SAK".. 0
"Distributed CAK".. 0

MKA IDB Statistics
MKPDUs Tx Success.......... 5425
MKPDUs Tx Fail............. 0
MKPDUS Tx Pkt build fail... 0
MKPDUs Rx CA Not found..... 0
MKPDUs Rx Error............ 0
MKPDUs Rx Success.......... 4932

MKPDU Failures
   MKPDU Rx Validation (ICV)............... 0
   MKPDU Rx Bad Peer MN.................... 0
   MKPDU Rx Non-recent Peerlist MN........ 0
   MKPDU Rx Drop SAKUSE, KN mismatch...... 0
   MKPDU Rx Drop SAKUSE, Rx Not Set....... 0
   MKPDU Rx Drop SAKUSE, Key MI mismatch.. 0
   MKPDU Rx Drop SAKUSE, AN Not in Use.... 0
   MKPDU Rx Drop SAKUSE, KS Rx/Tx Not Set. 0

SAK Failures
   SAK Generation................... 0
   Hash Key Generation.............. 0
   SAK Encryption/Wrap.............. 0
   SAK Decryption/Unwrap............ 0

! If sub-interfaces are configured, the output would be as follows:

RP/0/RSP0/CPU0:router# show macsec mka statistics interface Fo0/0/0/1/1.8

MKA Statistics for Session on interface (Fo0/0/0/1/1.8)
=======================================================
Reauthentication Attempts.. 0
CA Statistics
   Pairwise CAKs Derived... 0
   Pairwise CAK Rekeys..... 0
   Group CAKs Generated.... 0
```

```
   Group CAKs Received..... 0
SA Statistics
   SAKs Generated.......... 0
   SAKs Rekeyed............ 0
   SAKs Received........... 9
   SAK Responses Received.. 0
MKPDU Statistics
   MKPDUs Transmitted...... 1973
      "Distributed SAK".. 0
      "Distributed CAK".. 0
   MKPDUs Validated & Rx... 1965
      "Distributed SAK".. 9
      "Distributed CAK".. 0
MKA IDB Statistics
   MKPDUs Tx Success.......... 1973
   MKPDUs Tx Fail............. 0
   MKPDUS Tx Pkt build fail... 0
   MKPDUs Rx CA Not found..... 0
   MKPDUs Rx Error............ 0
   MKPDUs Rx Success.......... 1965

! In a VPLS network with a mulitpoint interface, the output would be as follows:

RP/0/RSP0/CPU0:router# show macsec mka statistics interface FortyGigE0/0/0/1/0.1

MKA Statistics for Session on interface (Fo0/0/0/1/0.1)
=======================================================
Reauthentication Attempts.. 0
CA Statistics
   Pairwise CAKs Derived... 0
   Pairwise CAK Rekeys..... 0
   Group CAKs Generated.... 0
   Group CAKs Received..... 0
SA Statistics
   SAKs Generated.......... 0
   SAKs Rekeyed............ 0
   SAKs Received........... 2
   SAK Responses Received.. 0
MKPDU Statistics
   MKPDUs Transmitted...... 1608
      "Distributed SAK".. 0
      "Distributed CAK".. 0
   MKPDUs Validated & Rx... 406
      "Distributed SAK".. 2
      "Distributed CAK".. 0
MKA IDB Statistics
   MKPDUs Tx Success.......... 1608
   MKPDUs Tx Fail............. 0
   MKPDUS Tx Pkt build fail... 0
   MKPDUs Rx CA Not found..... 0
   MKPDUs Rx Error............ 0
   MKPDUs Rx Success.......... 1802
```

The counters display the MACsec PDUs transmitted, validated, and received. The output also displays transmission errors, if any.

This completes the verification of MACsec encryption on the IOS-XR.

Verifying MACsec Encryption on ASR 9000

MACsec encryption on the router hardware can be verified by running relevant commands in the Privileged Executive Mode.

To verify if MACsec encryption has been correctly configured, follow these steps.

SUMMARY STEPS

1. Verify the MACsec encryption and hardware interface descriptor block (IDB) information on the interface.
2. Use the IDB handle retrieved from Step 1 to verify the platform hardware information.
3. Use the Transmitter SA retrieved from Step 2 to verify the MACsec SA information programmed in the hardware.
4. Verify the MACsec Secure Channel (SC) information programmed in the hardware.

DETAILED STEPS

Step 1 Verify the MACsec encryption and hardware interface descriptor block (IDB) information on the interface.

Example:

```
RP/0/RSP0/CPU0:router# show macsec ea idb interface Fo0/0/0/1/0


IDB Details:
if_sname : Fo0/0/0/1/0
if_handle : 0x3480
Replay window size : 64
Local MAC : 00:1d:e5:e9:aa:39
Rx SC Option(s) : Validate-Frames Replay-Protect
Tx SC Option(s) : Protect-Frames Always-Include-SCI
Security Policy : MUST SECURE
Sectag offset : 8
VLAN : Outer tag (etype=0x8100, id=1, priority=0, cfi=0): Inner tag (etype=0x8100, id=1, priority=0,
 cfi=0)
Rx SC 1
Rx SCI : 001de5e9b1bf0019
Peer MAC : 00:1d:e5:e9:b1:bf
Stale : NO
SAK Data
SAK[0] : ***
SAK Len : 32
HashKey[0] : ***
HashKey Len : 16
Conf offset : 30
Cipher Suite : GCM-AES-XPN-256
CtxSalt[0] : 83 c3 7b ad 7b 6f 63 16 09 8f f3 d2
Rx SA Program Req[0]: 2015 Oct 09 15:20:53.082
Rx SA Program Rsp[0]: 2015 Oct 09 15:20:53.092

Tx SC
Tx SCI : 001de5e9aa39001a
Active AN : 0
Old AN : 255
Next PN : 1, 0, 0, 0
SAK Data
SAK[0] : ***
SAK Len : 32
```

```
HashKey[0] : ***
HashKey Len : 16
Conf offset : 30
Cipher Suite : GCM-AES-XPN-256
CtxSalt[0] : 83 c3 7b ae 7b 6f 63 16 09 8f f3 d2
Tx SA Program Req[0]: 2015 Oct 09 15:20:55.053
Tx SA Program Rsp[0]: 2015 Oct 09 15:20:55.064
```

! When more than 1 RX SA is configured in P2MP networks, the output would be as follows:

```
RP/0/RSP0/CPU0:router# show macsec ea idb interface FortyGigE0/0/0/1/0.1
IDB Details:
  if_sname                : Fo0/0/0/1/0.1
  if_handle               : 0x2e40
  Replay window size      : 1024
  Local MAC               : e0:ac:f1:72:41:23
  Rx SC Option(s)         : Validate-Frames Replay-Protect
  Tx SC Option(s)         : Protect-Frames Always-Include-SCI
  Security Policy         : MUST SECURE
  Sectag offset           : 8
  VLAN                    : Outer tag (etype=0x8100, id=1, priority=0, cfi=0)
                          : Inner tag (etype=0x8100, id=1, priority=0, cfi=0)
  Rx SC 1
    Rx SCI                : 001de5e9f3290001
    Peer MAC              : 00:1d:e5:e9:f3:29
    Stale                 : NO
    SAK Data
      SAK[1]              : ***

      SAK Len             : 32
      HashKey[1]          : ***
      HashKey Len         : 16
      Conf offset         : 50
      Cipher Suite        : GCM-AES-XPN-256
      CtxSalt[1]          : ae ca 99 2b 7f 5b 0b de f7 c9 fc 67
  Rx SC 2
    Rx SCI                : 001de5e9b1bf0001
    Peer MAC              : 00:1d:e5:e9:b1:bf
    Stale                 : NO
    SAK Data
      SAK[1]              : ***

      SAK Len             : 32
      HashKey[1]          : ***
      HashKey Len         : 16
      Conf offset         : 50
      Cipher Suite        : GCM-AES-XPN-256
      CtxSalt[1]          : ae ca 99 2a 7f 5b 0b de f7 c9 fc 67
  Tx SC
    Tx SCI                : e0acf17241230001
    Active AN             : 1
    Old AN                : 0
    Next PN               : 1, 1, 0, 0
    SAK Data
      SAK[1]              : ***

      SAK Len             : 32
      HashKey[1]          : ***
      HashKey Len         : 16
      Conf offset         : 50
      Cipher Suite        : GCM-AES-XPN-256
      CtxSalt[1]          : ae ca 99 28 7f 5b 0b de f7 c9 fc 67
```

The **if_handle** field provides the IDB instance location.

The **Replay window size** field displays the configured window size.

The **Security Policy** field displays the configured security policy.

The **Local Mac** field displays the MAC address of the router.

The **Peer Mac** field displays the MAC address of the peer. This confirms that a peer relationship has been formed between the two routers.

Step 2 Use the IDB handle retrieved from Step 1 to verify the platform hardware information.

Example:

```
RP/0/RSP0/CPU0:router# show macsec ea platform hardware
idb location 0/0/CPU0 | b 3480

if_handle : 0x00003480
NPPort : 099 [0x063]
LdaPort : 016 [0x010] SerdesPort : 000 [0x000]
NetSoftPort : 061 [0x03d] SysSoftPort : 062 [0x03e]
Active AN : 0x00000000 Idle AN : 0x000000ff
Match-All Tx SA : 0x80010001 Match-All Rx SA : 0x00010001
Match-All Tx Flow : 0x80000003 Match-All Rx Flow : 0x00000003
Bypass Tx SA : 0x80000000 Bypass Rx SA : 0x00000000
Tx SA[0] : 0x80020002 Tx Flow[0] : 0x8000000c
Tx SA[1] : 0xffffffff Tx Flow[1] : 0xffffffff
Tx SA[2] : 0xffffffff Tx Flow[2] : 0xffffffff
Tx SA[3] : 0xffffffff Tx Flow[3] : 0xffffffff
Rx SA[0] : 0x00020002 Rx Flow[0] : 0x0000000c
Rx SA[1] : 0xffffffff Rx Flow[1] : 0xffffffff
Rx SA[2] : 0xffffffff Rx Flow[2] : 0xffffffff
Rx SA[3] : 0xffffffff Rx Flow[3] : 0xffffffff
```

Step 3 Use the Transmitter SA retrieved from Step 2 to verify the MACsec SA information programmed in the hardware.

Example:

```
RP/0/RSP0/CPU0:router# show macsec ea platform hardware sa
0x80020002 interface Fo0/0/0/1/0 location 0/0/CPU0

MACSEC HW SA Details:
Action Type : 0x00000003
Direction : Egress
Dest Port : 0x00000000
Conf Offset : 00000030
Drop Type : 0x00000002
Drop NonResvd : 0x00000000
SA In Use : YES
ConfProtect : YES
IncludeSCI : YES
ProtectFrame : YES
UseEs : NO
UseSCB : NO
SCI : 00 1d e5 e9 aa 39 00 05
Replay Window : 64 MacsecCryptoAlgo : 7
Direction : Egress AN : 0
AES Key Len : 256 X-Packet Number : 0x0000000000000000
CtxSalt : f8d88dc3e1c5e6a94ca2299
```

The output displays the details of the encryption, such as the AES key, the Auth key, and other parameters.

Step 4 Verify the MACsec Secure Channel (SC) information programmed in the hardware.

Example:

```
RP/0/RSP0/CPU0:router# show macsec ea platform hardware msc
interface Fo0/0/0/1/0 location 0/0/CPU0


MACSEC HW Cfg Details:
Mode : 0x5
Counter Clear on Read : 0x0
SA Fail Mask : 0xffff
VlanCounter Update : 0x1
Global SecFail Mask : 0xffffffff
Latency : 0xff
StaticBypass : 0x0
Should secure : 0x0
Global Frame Validation : 0x2
Ctrl Pkt CC Bypass : 0x1
NonCtrl Pkt CC Bypass : 0x1
Sequence Number Threshold : 0xbffffb8
Sequence Number Threshold 64bit : 0x000002fffffffffd
Non Matching Non Control Pkts Programming
      Untagged : Bypass: 0x0 DestPort : 0x2, DropType : 0x2
      Tagged : Bypass: 0x0 DestPort : 0x2, DropType : 0x2
      BadTagged : Bypass: 0x0 DestPort : 0x2, DropType : 0x2
      KayTagged : Bypass: 0x0 DestPort : 0x2, DropType : 0x2
Non Matching Control Pkts Programming
      Untagged : Bypass: 0x1 DestPort : 0x2, DropType : 0xffffffff
      Tagged : Bypass: 0x0 DestPort : 0x2, DropType : 0x2
      BadTagged : Bypass: 0x0 DestPort : 0x2, DropType : 0x2
      KayTagged : Bypass: 0x0 DestPort : 0x2, DropType : 0x2
```

This completes the verification of MACsec encryption on the router hardware.

This completes the configuration and verification of MACsec encryption.

Global MACsec Shutdown

The MACsec shutdown feature allows administrator to disable MACsec and re-enable it without modifying the existing MACsec configuration.

Enabling the **macsec shutdown** command, brings down all MACsec sessions on the MACsec-enabled interfaces and resets ports to non-macsec mode. The already existing MACsec configurations remain unaffected by enabling this feature.

Disabling the **macsec shutdown** command, brings up macsec sessions for the configured interfaces and enforces MACsec policy on the port. This feature is disabled by default.

Configure MACsec Shutdown

The following configuration enables the MACsec shutdown on a chassis:

```
RP/0/RP0/CPU0:router# configure terminal
RP/0/RP0/CPU0:router(config)# macsec shutdown
```

Warning Configuring **macsec shutdown** command disables MACsec on all data ports, system wide. Execute **clear** command to erase cached configuration or **commit** command to continue.

Verify MACsec Shutdown

The **show macsec mka session** command displays a shutdown banner indicating that the MACsec shutdown is enabled.

```
RP/0/RP0/CPU0:router# show macsec mka session
Fri Apr 13 11:56:57.409 IST

********** MACsec shutdown enabled **********
```

The **show macsec mka interface detail** command displays a shutdown banner and the interface-related information.

```
RP/0/RP0/CPU0:fretta-2#show macsec mka interface detail
Fri Apr 13 11:57:02.685 IST
********** MACsec shutdown enabled **********

Number of interfaces on node node0_3_CPU0 : 1
--------------------------------------------------

    Interface Name           : HundredGigE0/3/0/8
    Interface Namestring     : HundredGigE0/3/0/8
    Interface short name     : Hu0/3/0/8
    Interface handle         : 0x1800170
    Interface number         : 0x1800170
    Interface MAC            : 008a.9622.a9d0
    Ethertype                : 888E
    MACsec Shutdown          : TRUE
    Config Received          : TRUE
    IM notify Complete       : TRUE
    Interface CAPS Add       : FALSE
    RxSA CAPS Add            : FALSE
    TxSA CAPS Add            : FALSE
    MKA PSK Info
      Key Chain Name         : kc1
      MKA Cipher Suite       : AES-256-CMAC
      CKN                    : 12 34 56
    MKA fallback_PSK Info
      fallback keychain Name : fb1
      MKA Cipher Suite       : AES-256-CMAC
      CKN                    : ff ff ff
    Policy                   : *DEFAULT POLICY*
```

Syslog Messages for MACsec Shutdown

The following syslog messages are generated when MACsec shutdown is enabled.

```
%L2-MKA-5-MACSEC_SHUTDOWN_ENABLED : Shutdown ON, disable MACsec on all MACsec enabled ports
%L2-MKA-5-SESSION_STOP            : (Hu0/3/0/8) MKA session stopped,
CKN                               : 123456
```

```
%L2-MKA-4-SESSION_UNSECURED      : (Hu0/3/0/8) MKA Session was stopped and is not secured,

CKN                              :123456
%L2-MKA-5-MACSEC_DISABLED        : (Hu0/3/0/8), MACsec disabled (shutdown ON)
```

The following syslog messages are generated when MACsec shutdown is disabled.

```
%L2-MKA-5-MACSEC_SHUTDOWN_DISABLED : Shutdown OFF, resume MACsec on all MACsec enabled ports
%L2-MKA-5-MACSEC_ENABLED                    : (Hu0/3/0/8), MACsec enabled with MUST_SECURE
%L2-MKA-5-SESSION_START                      : (Hu0/3/0/8) MKA session started
CKN                                          :  123456
%L2-MKA-6-MKPDU_ICV_SUCCESS                  : (Hu0/3/0/8), ICV verification success for
RxSCI(008a.9600.60b0/0001), CKN(123456)
%L2-MKA-6-FALLBACK_PSK_MKPDU_ICV_SUCCESS     : (Hu0/3/0/8), ICV verification success for
RxSCI(008a.9600.60b0/0001), CKN(FFFFFF)
%L2-MKA-5-SESSION_SECURED                    : (Hu0/3/0/8) MKA session secured
 CKN                                         :  123456
```