Cisco Wireless MACsec On-Prem Deployment Guide

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Introduction

MACsec (IEEE 802.1AE) allows to secure the link between AP and the access switch using hop-by-hop link encryption to mitigate attacks such as denial of service, intrusion, eavesdropping and man-in-the-middle attacks.

In this release support is added for MACsec with a Pre-Shared Key (PSK) and with 802.1X. The link is treated as a switch-to-switch link.

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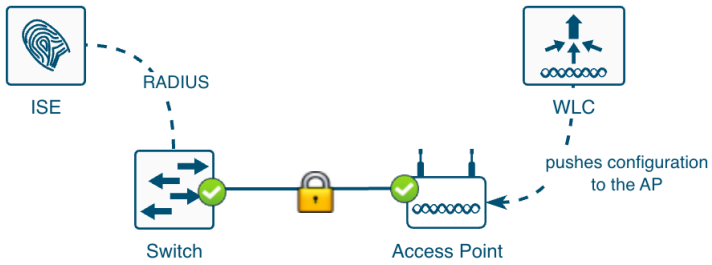


Figure 1. MACsec 802.1X architecture overview

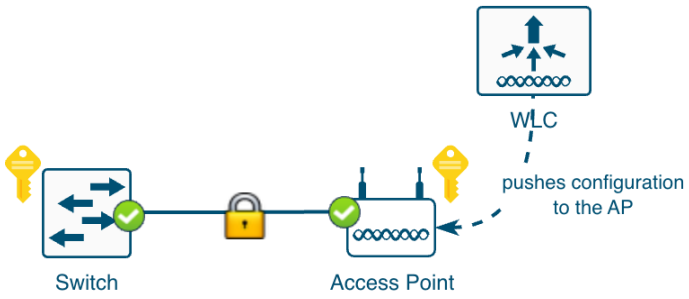


Figure 2. MACsec PSK architecture overview

This document describes the configuration of MACsec between a Cisco Catalyst 9000 Series Switch and a Cisco Wireless Access Point. The guide is divided in two general sections: PSK and 802.1X.

Requirements

- One or more compatible **Cisco Wireless Access Points**, to find the compatible models check the Feature Matrix for Cisco Wireless Access Points section Security Feature Matrix (IOS XE)
- **Cisco Wireless 9800 Wireless LAN Controller** running Cisco IOS® XE 26.1.1 or later
- **One Cisco Wireless Essentials license** per Access Point
- **Cisco Catalyst 9000 Series Switch** (or a MACsec compatible switch)
- **ISE** (or any RADIUS server): required only if MACsec using 802.1X is desired

MACsec concepts

The following concepts are provided for educational purposes.

- **MKA:** MACsec Key Agreement, the protocol that creates, distributes, and manages the encryption keys used by MACsec. It is defined in **IEEE 802.1X-2010** and works on top of EAPOL (Extensible Authentication Protocol over LAN).
- **MSK:** Master Session Key, generated during **EAP exchange**. Supplicant and authentication server use the MSK to **generate** the **CAK**.
- **CAK:** Connectivity Association Key, it is derived from **MSK**. CAK is a long-lived master key used to **generate all other keys** used for MACsec.
- **CKN**: Connectivity Association Key Name, identifies the **CAK**.
- **SAK:** Secure Association Key, it is derived from the CAK and is the key used by supplicant and switch to **encrypt traffic** for a given session.

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- **KS:** Key Server, it is:
  - responsible for selecting and advertising a cipher suite
  - responsible for generating the Secure Association Key (SAK) from the Connectivity Association Key (CAK).
- **Key server priority**: value used by **MKA** (MACsec Key Agreement) to determine **which device becomes the Key Server** in a MACsec session.
- **Key chain:** in the context of IOS-XE it is a configuration structure used to store and manage cryptographic keys, mainly for protocols that require authentication or key exchange. For **MACsec**, the key chain holds the **CAK** (Connectivity Association Key) and **CKN** (Connectivity Key Name) used by **MKA** (MACsec Key Agreement).
- **Control-plane vs data-plane:** the control-plane is MKA as described above, it has integrity verification to authenticate both sides. The data-plane (traffic) uses a different set of algorithms to encrypt the data.
- **Replay Protection Window Size:** it is a security parameter that defines **how many sequence numbers (packets) can arrive out of order and still be accepted** before the device starts treating them as *replay attacks* and drops them.

Note: Replay Protection Window Size won't be supported at launch in 26.1.1, support will be added later.

Supported modes

Supported MACsec modes:

- PSK
- 802.1X:
  - EAP-TLS
  - EAP-FAST

Supported MKA (control-plane) authentication ciphers:

- AES-128-CMAC
- AES-256-CMAC

Supported data encryption ciphers:

- AES-128-GCM
- AES-256-GCM

Supported Access Point modes:

- Local
- FlexConnect
- Fabric

Limitations

- For dual-port APs using the Link Aggregation Protocol (LAG) is not possible. However, for failover scenarios both ports can support MACsec independently.
- It is not possible to enable MACsec in the SFP ports of APs.

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- The AP cannot act as a key server (KS), the switch is expected act as KS.

Configuration for PSK

As explained above, PSK stands for Pre-Shared Key. This mode requires to configure MACsec with the same password in both ends, the switch and the AP (which implies the WLC).

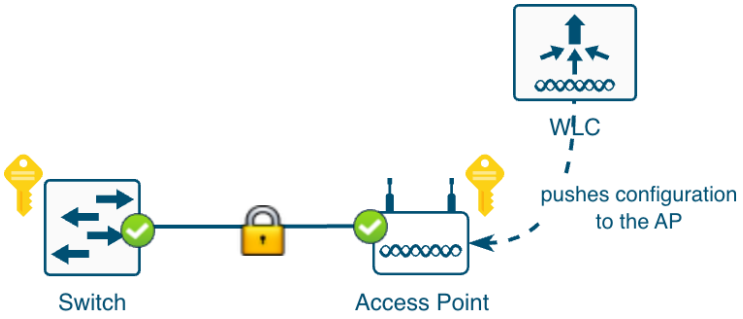


Figure 3. MACsec PSK diagram

Once MACsec is enabled in the switch, the AP will lose connectivity. Therefore, it is important to configure things in the right order:

Step 1. Configure the WLC (and AP) enabling MACsec

Step 2. Configure the switch enabling MACsec (this will power cycle the switch port)

The configuration has the following elements:

- WLC
  - Key chain
  - AP Join Profile configuration
- Switch
  - Key chain
  - MKA policy
  - Interface configuration

When using PSK to derive the encryption keys the following diagram depicts how the keys are derived. In this PSK scenario, the CAK=PSK and the CKN must be manually entered.

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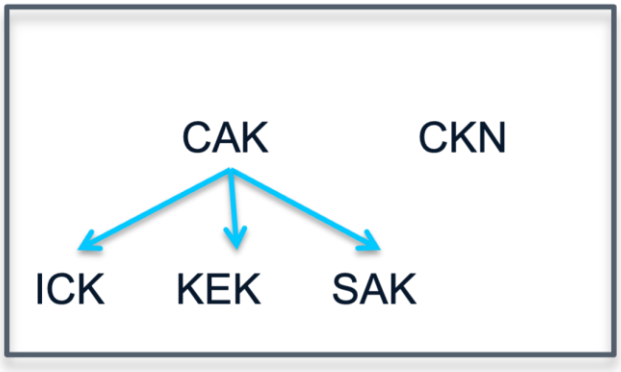


Figure 4. Encryption key deriving with PSK

PSK - Configuring the Controller

First configure the key chain. To do that navigate to **Configuration > Security > MACsec** and add a new Key Chain:

- Give it a name
- Add a key:
  - Enter a key identifier: should be a hex string with even number of digits. This is the Connectivity Association Key name (CKN) and must match in both sides.
  - Select the crypto algorithm for the control-plane authentication
  - Select the Key String Type
  - Enter the Key String: should be a hex string with 32 digits. This is the Pre-Shared Key (PSK) which in this scenario is equivalent to the Connectivity Association Key (CAK). This must match in both sides.

Important: save the key before applying to device

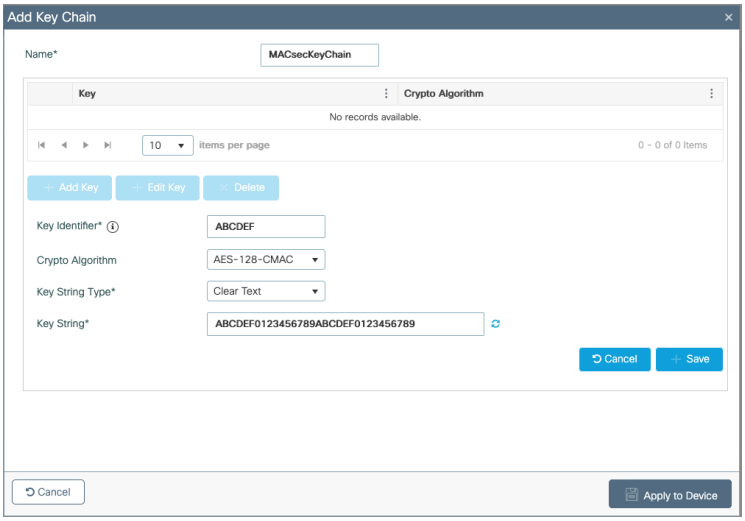


Figure 5. MACsec keychain configuration

Using CLI in the WLC:

```
key chain MACsecKeyChain macsec
```

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```
key ABCDEF
  cryptographic-algorithm aes-128-cmac
  key-string ABCDEF0123456789ABCDEF0123456789
```

Second, configure the AP Join Profile. Navigate to **Configuration > Tags & Profiles > AP Join**. Edit or create a new AP Join Profile, inside, go to **AP > General > AP MACsec Configuration** section.

- Enable MACsec
- Select the previously configured Key Chain

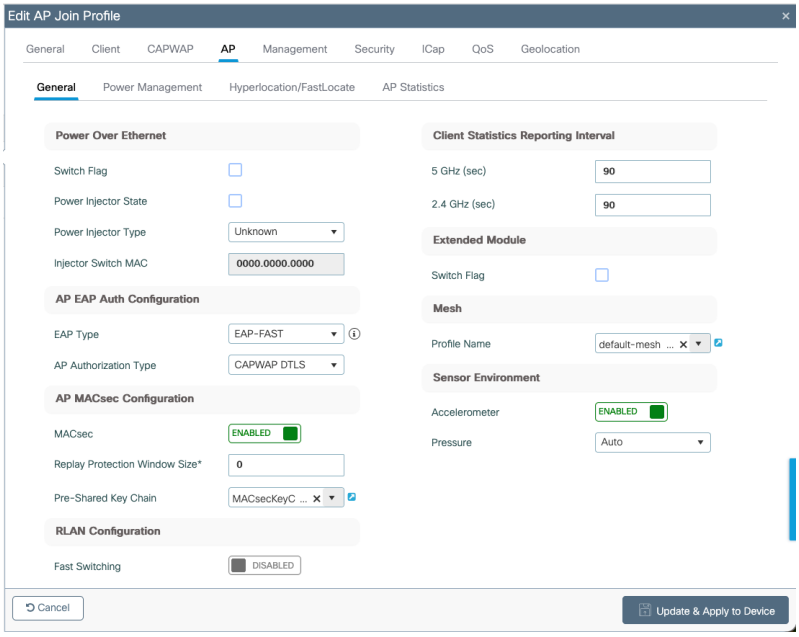


Figure 6. AP Join profile configuration for PSK MACsec

Using CLI in the WLC:

```
ap profile macsec-ap-profile
 macsec
 macsec psk-chain MACsecKeyChain
 macsec replay-protection window-size 0
```

PSK - Configuring the Switch

Since MACsec is a standard any switch that supports it should work. In this document a sample of Cisco Catalyst 9300 series will be covered.

You can find more details on MACsec configuration in the following guide: https://www.cisco.com/c/en/us/td/docs/switches/lan/catalyst9300/software/release/17-15/configuration_guide/sec/b_1715_sec_9300_cg/macsec_encryption.html

Currently it is not possible in switching to have MACsec PSK and MAC Authentication Bypass (MAB) with or without Dynamic VLAN assignment. Therefore, the port must be open and VLAN assignment done statically.

Like the WLC, first a key chain must be configured in the switch in config mode. Here's the CLI:

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```
key chain macsec macsec
 key ABCDEF
  cryptographic-algorithm aes-128-cmac
  key-string ABCDEF0123456789ABCDEF0123456789
```

Now, the MKA policy. It is important to set the key-server priority to a value lower than 255.

CLI:

```
mka policy macsec-policy
 key-server priority 200
 mka policy macsec-policy
```

Optionally, if you want to use a stronger data encryption cipher (for traffic) add this command to the previous section:

```
macsec-cipher-suite gcm-aes-256
```

Finally, configure the interface to use MACsec PSK. Config mode CLI:

```
interface GigabitEthernetx/y/z
 mka policy macsec-policy
 mka pre-shared-key key-chain macsec
 macsec network-link
```

Note: Applying the command “macsec network-link” will power cycle the port.

Verification for PSK

Legend:

- [WLC] indicates this command works on the WLC.
- [AP] indicates this command works on the AP.
- [SW] indicates this command works on the switch.

[WLC] AP Profile

```
show ap profile name <ap-profile-name> detailed
AP Profile Name               :<ap-profile-name>
[…]
Macsec :
  Enabled                      : True
  Auth Method                  : PSK
  PSK chain name               : MACsecKeyChain
  Replay protection window size: 0
```

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[WLC] AP MACsec summary

```
show ap macsec summary
AP Name                          AP Mac                           Capable     Port 0
Port 1
-------------------------------------------------------------------------------------------
----------
AP11AA.22BB.33CC                 99ff.88ee.77dd                   Yes    SUCCESS
UNKNOWN
```

[AP] MACsec status (there are some changes depending on the AP model)

```
show macsec status
------------------------
wired0: Phy Address 0
------------------------
MACsec 100M: Enabled
      1000M: Enabled
      2500M: Enabled
      5000M: Enabled
Capabilities:
    Ciphers supported: GCM-AES-128
                       GCM-AES-256
Egress SC:
    AN Roll Over: Disabled
    Egress Protect Frames: True
    Egress Cipher: GCM-AES-128
Ingress SC:
    Replay Protect: False
    Replay Window: 0
    AN Roll Over: Disabled
    Validate Frames: Strict
```

[AP] MACsec statistics (there are some changes depending on the AP model)

```
show macsec statistics
------------------------
wired0: Phy Address 0
------------------------
Egress SC:
    Protected Not Encrypted Packets: 0
    Protected and Encrypted Packets: 1185
    Plain Text Octets Protected Not Encrypted: 0
```

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```
    Plain Text Octets Protected and Encrypted: 567830
Egress SA:
    Dropped Packets: 0
    Protected Not Encrypted Packets: 0
    Protected and Encrypted Packets: 1185
Egress Common:
    Control Packets: 445
    Unknown Packets: 2
    Untagged Packets: 0
    Too Long Packets: 0
    ECC Error Packets: 0
    Dropped Packets: 0
------------------------
Ingress SA:
    Untagged Packets: 0
    Dropped Packets: 0
    Not Using Packets: 0
    UnUsed Packets: 0
    Not Valid Packets: 0
    Invalid Packets: 0
    Validated Packets: 2149
    Late Packets: 0
    Delayed Packets: 0
    Unchecked Packets: 0
    Octets of Plaintext Not Encrypted: 0
    Octets of Plaintext Encrypted: 359574
Ingress Common:
    Control Packets: 445
    Tagged but Miss Match Packets: 0
    Untagged and Miss Match Packets: 1
    Untagged and Match that Validate is Strict Packets: 1
    Untagged and Match that Validate is Not Strict Packets: 0
    Invalid Packets: 0
    Unknown SCI and Match that Validate is Strict Packets: 0
    Unknown SCI and Match that Validate is Not Strict Packets: 0
    Controlled Port Pass the Check Packets: 2149
    Uncontrolled Port Pass the Check Packets: 1
    Controlled Port Failed the Check Packets: 0
    UnControlled Port Failed the Check Packets: 0
    Too Long Packets: 0
    Control Packets by Post-MACSec Filter: 0
    ECC Error Packets: 0
```

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```
    Uncontrolled Port Dropped Packets: 0
```

[AP] AP Authentication status, includes MACsec

```
show ap authentication status
Wired Link Status:
wired0 link: Up

Wired 0 Session:
key_mgmt=NONE
wpa_state=COMPLETED
address=99:ff:88:ee:77:dd
PAE KaY status=Active
Authenticated=No
Secured=Yes [Indicates that MACsec is in place]
Failed=No [Indicates if MACsec establishment failed]
Actor Priority=255
Key Server Priority=200
Is Key Server=No
Number of Keys Distributed=0
Number of Keys Received=1
MKA Hello Time=2000
actor_sci=8c:88:81:54:6e:70@1
key_server_sci=aa:11:22:bb:33:dd@27
participant_idx=0
ckn=abcdef
mi=a1d1eb46248ea1b53a883f3c
mn=525
active=Yes
participant=No
retain=No
live_peers=1
potential_peers=0
is_key_server=No
is_elected=Yes
```

[AP] Possible debugs

```
debug macsec phy
wpa_supplicant logs:
debug ap authentication {error | events | information | packet}
```

[SW] Sample syslogs when session is started and secured:

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```
064427: Dec 12 11:51:34.116: %MKA-5-SESSION_START: (Gi1/0/20 : 27) MKA Session started for
RxSCI aa11.22bb.33dd/0000, AuditSessionID , AuthMgr-Handle B0000163
064435: Dec 12 11:52:18.244: %MKA-5-SESSION_SECURED: (Gi1/0/20 : 27) MKA Session was secured
for RxSCI 99ff.88ee.77dd/0001, AuditSessionID , CKN ABCDEF
```

[SW] Check MKA session

```
show mka sessions

Total MKA Sessions....... 1
      Secured Sessions... 1
      Pending Sessions... 0

================================================================================================
========
Interface       Local-TxSCI          Policy-Name       Inherited          Key-Server
Port-ID         Peer-RxSCI           MACsec-Peers      Status             CKN
================================================================================================
========
Gi1/0/20        aa11.22bb.33dd/001b  macsec-policy     NO                 YES
27              99ff.88ee.77dd/0001  1                 Secured            ABCDEF
```

[SW] MACsec summary (1 indicates success)

```
show macsec summary
Interface                     Transmit SC          Receive SC
Gi1/0/20                            1                    1
```

Configuration for 802.1X

MACsec can also be configured with 802.1X. The following diagrams explain this scenario.

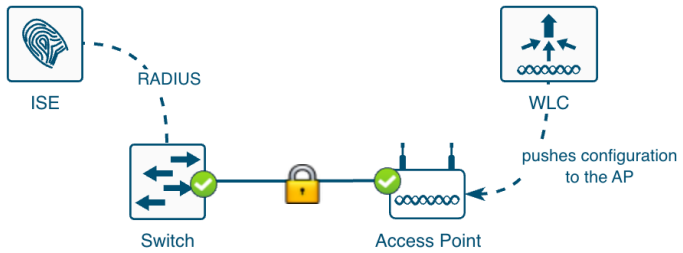


Figure 7. MACsec 802.1X diagram

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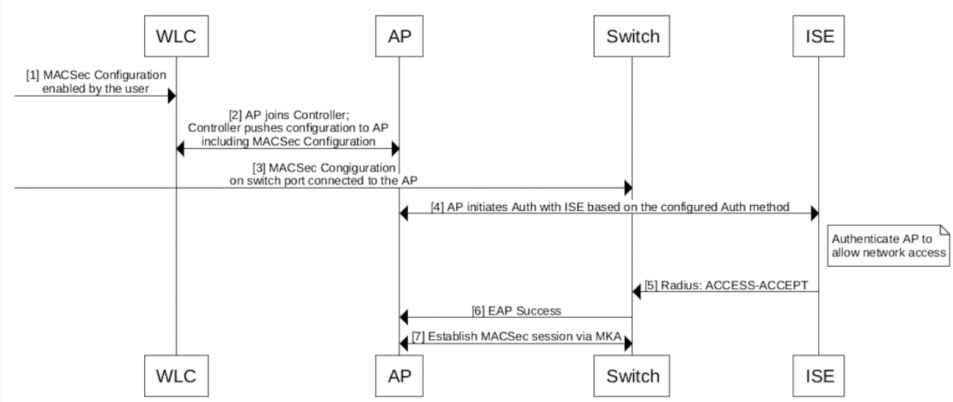


Figure 8. MACsec 802.1X flow chart

Like the PSK scenario, once MACsec is enabled in the switch, the AP will lose connectivity. However, since 802.1X is introduced, it is **recommended** to have a **working 802.1X setup before attempting MACsec**, some references for that are shown below. Recommended order:

1. Configure 802.1X in the switch, WLC (and AP) and RADIUS
2. Verify 802.1X is working
3. Configure the WLC (and APs) enabling MACsec
4. Configure the switch enabling MACsec

The configuration has the following elements:

- WLC
  - [Not covered in detail] 802.1X
  - Key chain
  - AP Join Profile configuration
- Switch
  - [Not covered in detail] 802.1X
  - Key chain
  - MKA policy
  - Interface configuration
- RADIUS (like ISE)
  - Not covered in detail

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802.1X has several flavors, only the following two are supported, here are the basic differences:

Table 1. EAP types

EAP Type	Client Certificate	Server Certificate	Username
EAP-TLS	Yes	Yes	No
EAP-FAST	No	No	Yes

Here are some documents that explains how to configure 802.1X:

Configure 802.1X Supplicant for Access Points with 9800 Controller

Configure 802.1X on APs for PEAP or EAP-TLS with LSC

EAP-FAST Authentication with Wireless LAN Controllers and Identity Services Engine

When using 802.1X to derive the encryption keys the following diagrams depicts how the keys are derived.

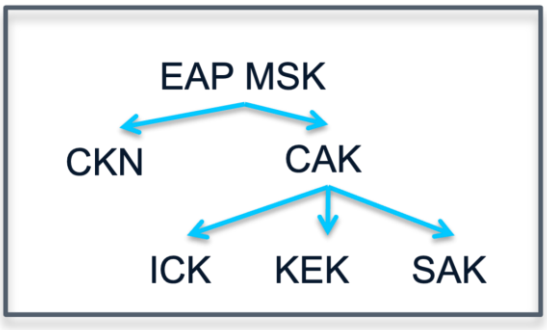


Figure 9. Encryption key deriving with 802.1X

Should Secure and Must Secure

As part of the 802.1X negotiation, the switch port needs to receive an instruction telling it to how to secure the port.

There are two options:

- **Should Secure:** the switch attempts to establish a MACsec session. If the peer supports it, the link is encrypted. If the peer doesn't support it, the link is not encrypted.
- **Must Secure:** the switch requires a successful MACsec session to pass traffic. This provides stricter security but in case of failure no communication is allowed.

This can be achieved in 2 different ways:

1. Directly on the switch using a policy map that includes the service template *DEFAULT_LINKSEC_POLICY_SHOULD_SECURE*. An example of this is shown later in the section Sample 802.1X switch configuration.

2. Sending from ISE the following attribute: *cisco-av-pair = linksec-policy=should-secure*. (or must-secure). See the following screenshot.

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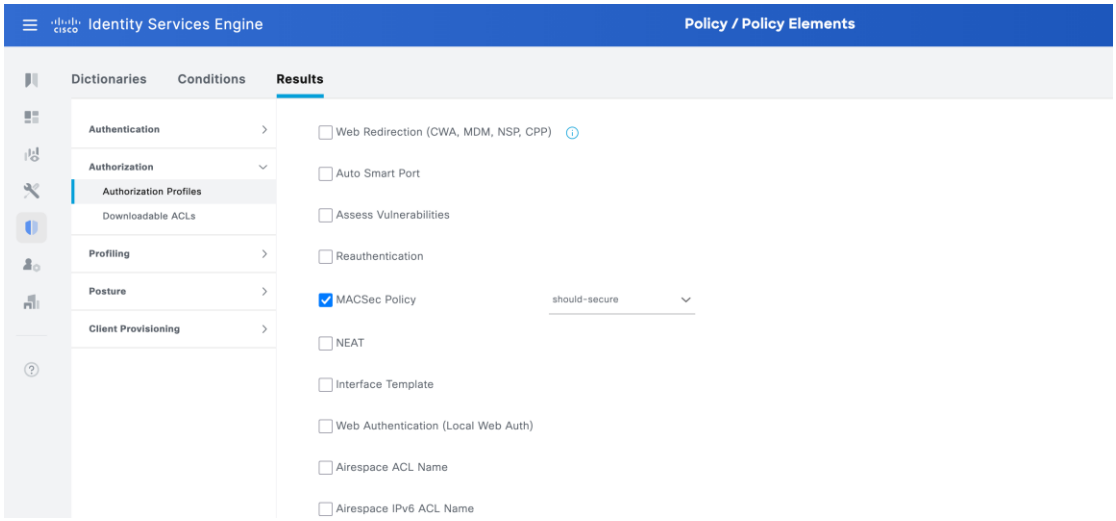


Figure 10. ISE should-secure example

Access versus Trunk

For simplicity, the samples in this section are with interfaces in access mode. However, for FlexConnect local switching a trunk is required. Details on how to configure 802.1X for that use case can be found later in section Switching considerations for FlexConnect with local switching.

Sample 802.1X Switch Configuration

The following section only covers 802.1X, without MACsec, later in the document MACsec is explained.

Policy Map:

```
policy-map type control subscriber PMAP_DefaultWiredDot1xClosedAuth_1X_MAB
 event session-started match-all
  10 class always do-until-failure
   10 authenticate using dot1x retries 2 retry-time 0 priority 10
 event authentication-failure match-first
  5 class DOT1X_FAILED do-until-failure
   10 terminate dot1x
   20 authenticate using mab priority 20
  10 class AAA_SVR_DOWN_UNAUTHD_HOST do-until-failure
   30 authorize
   40 pause reauthentication
  20 class AAA_SVR_DOWN_AUTHD_HOST do-until-failure
   10 pause reauthentication
   20 authorize
  30 class DOT1X_NO_RESP do-until-failure
   10 terminate dot1x
   20 authenticate using mab priority 20
  40 class MAB_FAILED do-until-failure
   10 terminate mab
   20 authentication-restart 60
```

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```
  50 class DOT1X_TIMEOUT do-until-failure
   10 terminate dot1x
   20 authenticate using mab priority 20
  60 class always do-until-failure
   10 terminate dot1x
   20 terminate mab
   30 authentication-restart 60
 event aaa-available match-all
  10 class IN_CRITICAL_AUTH_CLOSED_MODE do-until-failure
   10 clear-session
  20 class NOT_IN_CRITICAL_AUTH_CLOSED_MODE do-until-failure
   10 resume reauthentication
 event agent-found match-all
  10 class always do-until-failure
   10 terminate mab
   20 authenticate using dot1x retries 2 retry-time 0 priority 10
 event inactivity-timeout match-all
  10 class always do-until-failure
   10 clear-session
 event authentication-success match-all
! If the should-secure wants to be configured in the policy map, uncomment the following
!  10 class always do-until-failure
!   10 activate service-template DEFAULT_LINKSEC_POLICY_SHOULD_SECURE
 event violation match-all
  10 class always do-until-failure
   10 restrict
 event authorization-failure match-all
  10 class AUTHC_SUCCESS-AUTHZ_FAIL do-until-failure
   10 authentication-restart 60
```

Interface configuration

```
interface GigabitEthernet1/0/19
 description BASE CONFIG
 switchport mode access
 switchport access vlan 72
 switchport port-security maximum 3
 switchport port-security
 device-tracking attach-policy IPDT_POLICY
 authentication periodic
 authentication timer reauthenticate server
 access-session host-mode multi-host
```

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```
access-session closed
access-session port-control auto
mab
snmp trap mac-notification change added
snmp trap mac-notification change removed
dot1x pae authenticator
dot1x timeout tx-period 4
dot1x timeout supp-timeout 3
dot1x max-req 3
spanning-tree portfast
spanning-tree bpduguard enable
service-policy type control subscriber PMAP_DefaultWiredDot1xClosedAuth_1X_MAB
```

Note: The “access-session host-mode multi-host” is required for MACsec to work.

Sample 802.1X EAP-FAST WLC configuration

```
ap profile macsec-ap-profile
 dot1x username ap password 8 [I]P^MXBVUeAJiO]EZPRJZR`VH]PUfERD
 ntp ip 173.38.201.115
```

Note: The first EAP-FAST negotiation always fails; this is expected. This happens because the first time the AP establishes EAP-FAST, the AP needs to download/import the correct PAC (Protected Access Credentials) file generated by ISE.

Sample 802.1X EAP-TLS WLC configuration

EAP-TLS requires setting up the LSC so the APs can be primed with a certificate. Please see the following doc: Configure 802.1X on APs for PEAP or EAP-TLS with LSC.

This section includes a sample configuration but **please follow the previous doc** as a SCEP server is required and **configurations** must **follow** a certain **order**.

LSC Configuration Section

```
ap lsc-provision join-attempt 3
ap lsc-provision provision-list
ap lsc-provision subject-name-parameter country ES state Madrid city Madrid domain
labwirelessmadrid.cisco.com org Cisco email-address madlab@cisco.com
ap lsc-provision trustpoint APs-MSCA
ap lsc-provision mac-address aabb.ccdd.eeff
```

AP Profile

```
ap profile macsec-ap-profile
 dot1x eap-type eap-tls
 dot1x lsc-ap-auth-state dot1x-port-auth
 dot1x username ap password 8 [I]P^MXBVUeAJiO]EZPRJZR`VH]PUfERD
```

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```
syslog host 0.0.0.0
macsec
macsec replay-protection window-size 0
```

Note: Even though EAP-TLS doesn't require a username and password, it is needed for the configuration to work in the WLC.

Note: When using LSC, one must be careful with the certificates. Depending on how the WLC is configured the AP might try to join using the provisioned LSC and if the WLC trustpoint hasn't been changed to also use the LSC this won't work. There are several possible combinations to only use LSC everywhere or to have the AP join using the SUDI and keep the WLC trustpoint with the self-signed cert.

802.1X - Configuring the WLC

Let's configure the AP Join Profile. Navigate to **Configuration > Tags & Profiles > AP Join**. Edit or create a new AP Join Profile, inside, go to **AP > General > AP MACsec Configuration** section.

- Enable MACsec
- Do **not set any Pre-Shared Key Chain** since it is not needed

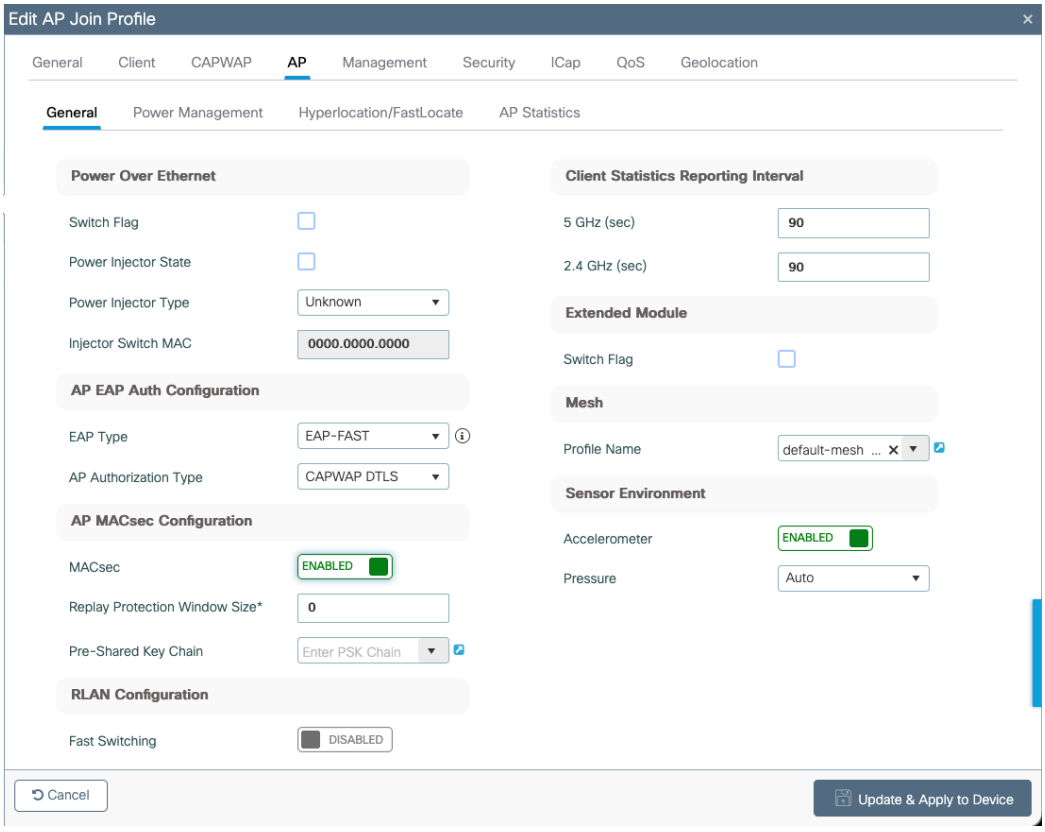


Figure 11. AP Join profile configuration for 802.1X MACsec

Using CLI in the WLC:

```
ap profile macsec-ap-profile
 macsec
```

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802.1X - Configuring the Switch

Since MACsec is a standard, any switch that supports it should work. In this document a sample of Cisco Catalyst 9300 series will be covered.

You can find more details on MACsec configuration in the following guide: https://www.cisco.com/c/en/us/td/docs/switches/lan/catalyst9300/software/release/17-15/configuration_guide/sec/b_1715_sec_9300_cg/macsec_encryption.html

Create the MKA policy. It is important to set the key-server priority to a value lower than 255. CLI:

```
mka policy macsec-policy
 key-server priority 200
 mka policy macsec-policy
```

Optionally, if you want to use a stronger data encryption cipher (for traffic) add this command to the previous section:

```
macsec-cipher-suite gcm-aes-256
```

CLI:

```
interface GigabitEthernetx/y/z
 mka policy macsec-policy
 macsec network-link
```

Note: please be aware that applying the 'macsec network-link' command will result in a power cycle of the port. Additionally, dynamic VLAN assignment is currently not supported as well as switchport-to-trunk conversion using an interface template.

Tech tip: if for some reason you need to re-trigger the 802.1X negotiation you might do so by changing the interface speed, this will flap the port (without a power cycle) and the AP will retry 802.1X and MACsec.

802.1X - Configuring ISE

As discussed previously, Should Secure and Must Secure might be sent by ISE. This is configured in the Authorization Profiles.

Navigate to **Policy > Policy Elements > Results** then in the left navigation bar select **Authorization > Authorization Profiles**. Create a new one or edit an existing one that is used for APs.

Search for MACsec Policy and enable it, select should-secure or must-secure.

Note: to toggle from should-secure to must-secure or viceversa, first choose the right one in the dropdown, then disable MACsec Policy and reenable it. You can check the results at the bottom in the Attributes Details section

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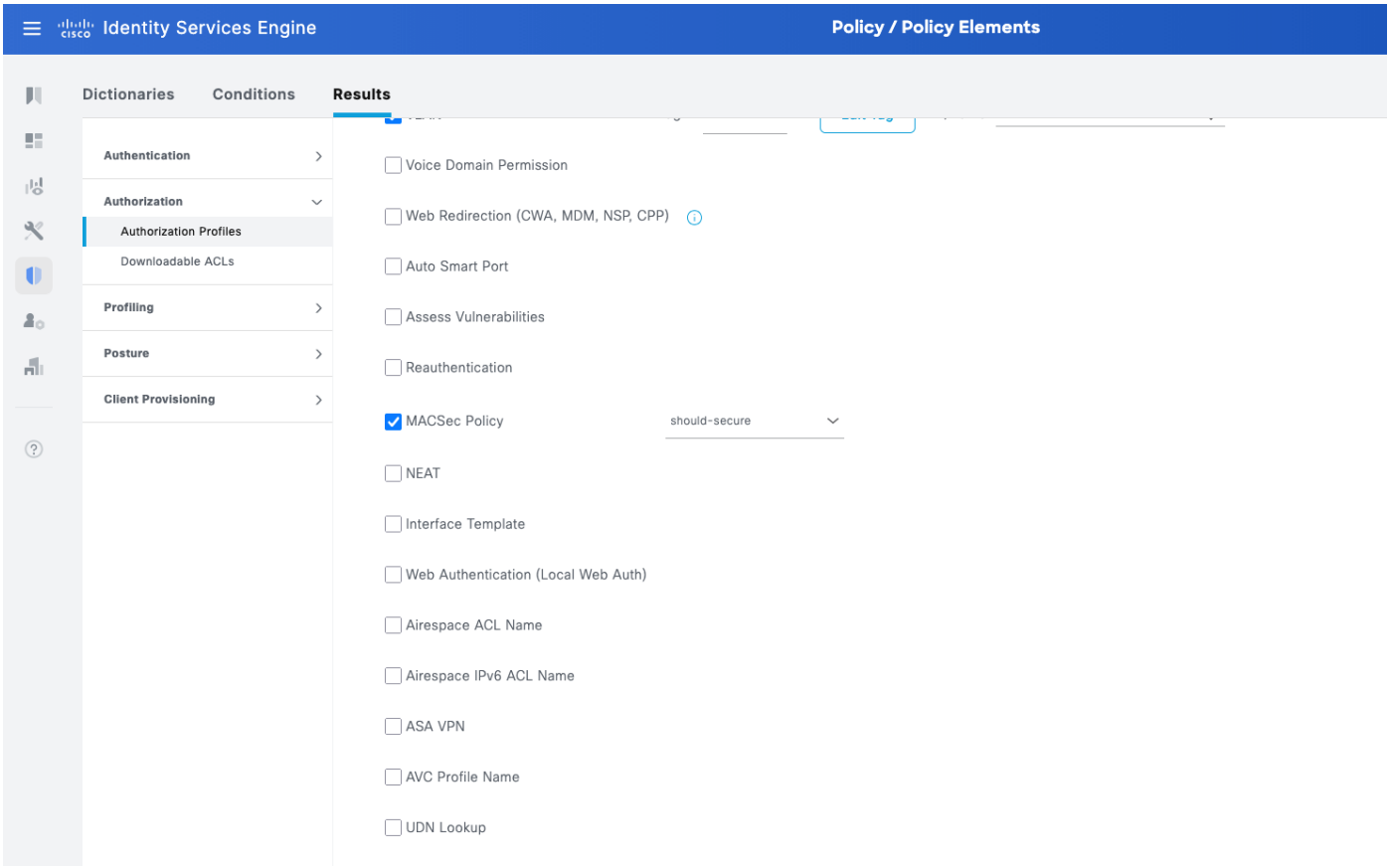


Figure 12. MACsec configuration in ISE Authorization Profile

Verification for 802.1X

Legend:

- [WLC] indicates this command works on the WLC.
- [AP] indicates this command works on the AP.
- [SW] indicates this command works on the switch.

[WLC] AP Profile

```
show ap profile name <ap-profile-name> detailed
[…]
Macsec :
  Enabled                        : True
  Replay protection window size: 0
```

[WLC] AP MACsec summary

```
show ap macsec summary
AP Name                          AP Mac                          Capable      Port 0
Port 1
```

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```
-------------------------------------------------------------------------------------------
----------
AP11AA.22BB.33CC                  99ff.88ee.77dd                    Yes   SUCCESS
UNKNOWN
```

[AP] MACsec status (there are some changes depending on the AP model)

```
show macsec status
------------------------
wired0: Phy Address 16
------------------------
MACsec: Enabled
Capabilities:
        Max. Egress SecY: 32
        Egress FlowIDTcam Table Size: 32
        Egress SecyPolicy Table Size: 32
        Egress SaPolicy Table Size: 64
        Egress SecyToSaMap Table Size: 32
        Ciphers supported: GCM-AES-128
                           GCM-AES-256
        Max. Ingress SecY: 32
        Ingress FlowIDTcam Table Size: 32
        Ingress SecyPolicy Table Size: 32
        Ingress ScCamLookupKey Table Size: 32
        Ingress AnPerSc: 4
        Ingress ScAnToSaMap Table Size: 128
        Ingress SaPolicy Table Size: 64
Port Configuration:
        MACsec Port Count: 1
        MACsec Ingress pnThreshold: 0xffffffff
        MACsec Egress pnThreshold: 0xffffffff
SecY Configuration:
        Egress Controlled Port Enable: True
        Egress Protect Frames: True
        Egress Cipher: GCM-AES-256
        Ingress Replay Protect: False
        Ingress Replay Window: 3
        Ingress Validate Frames: Strict
        Ingress Cipher: GCM-AES-256
SC Configuration:
        Ingress SecY: 0, SCI: 0xecce13c791130002, enable: 1
```

[AP] MACsec statistics (there are some changes depending on the AP model)

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```
show macsec statistics
------------------------
wired0: Phy Address 16
------------------------
Egress SecY:
        Ifoutcommonoctets: 247290
        Ifoutunctloctets: 19856
        Ifoutctloctets: 227434
        Ifoutunctlucpkts: 0
        Ifoutunctlmcpkts: 136
        Ifoutunctlbcpkts: 0
        Ifoutctlucpkts: 378
        Ifoutctlmcpkts: 18
        Ifoutctlbcpkts: 0
        Outpktssecyuntagged: 0
        Outpktssecytoolong: 0
        Outpktssecynoactivesa: 0
        Outpktsctrlportdisabled: 0
Egress SC:
        Outoctetsscprotected: 0
        Outoctetsscencrypted: 222682
Egress SA:
        Outoctetssaprotected: 0
        Outoctetssaencrypted: 396
Egress Port:
        Outpktsflowidtcammiss: 0
        Outpktsparseerr: 0
        Outpktssectaginsertionerr: 0
        Outpktsearlypreempterr: 0
Egress Flow:
        Outpktsflowidtcamhit: 532
------------------------
Ingress SecY:
        Ifinunctloctets: 176021
        Ifinctloctets: 130341
        Ifinunctlucpkts: 133
        Ifinunctlmcpkts: 352
        Ifinunctlbcpkts: 441
        Ifinctlucpkts: 133
        Ifinctlmcpkts: 216
        Ifinctlbcpkts: 441
        Inpktssecyuntaggedornotag: 136
```

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```
        Inpktssecybadtag: 0
        Inpktssecyctl: 136
        Inpktssecytaggedctl: 0
        Inpktssecyunknownsci: 0
        Inpktssecynosci: 0
        Inpktsctrlportdisabled: 0
Ingress SC:
        Inoctetsscvalidate: 0
        Inoctetsscdecrypted: 120861
        Inpktsscunchecked: 0
        Inpktssclateordelayed: 0
        Inpktssccamhit: 790
Ingress SA:
        Inpktssaok: 790
        Inpktssainvalid: 0
        Inpktssanotvalid: 0
        Inpktssaunusedsa: 0
        Inpktssanotusingsaerror: 0
Ingress Port:
        Inpktsflowidtcammiss: 0
        Inpktsparseerr: 0
        Inpktsearlypreempterr: 0
Ingress Flow:
        Inpktsflowidtcamhit: 926
```

[AP] AP Authentication status, includes MACsec

```
show ap authentication status
Wired Link Status:
wired0 link: Up

Wired 0 Session:
key_mgmt=IEEE 802.1X (no WPA)
wpa_state=COMPLETED
address=99:ff:88:ee:77:dd
Supplicant PAE state=AUTHENTICATED
suppPortStatus=Authorized
EAP state=SUCCESS
selectedMethod=43 (EAP-FAST)
eap_tls_version=TLSv1.2
EAP TLS cipher=ECDHE-RSA-AES256-GCM-SHA384
tls_session_reused=1
```

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```
EAP-FAST Phase2 method=MSCHAPV2
PAE KaY status=Active
Authenticated=No
Secured=Yes
Failed=No
Actor Priority=255
Key Server Priority=200
Is Key Server=No
Number of Keys Distributed=0
Number of Keys Received=1
MKA Hello Time=2000
actor_sci=8c:88:81:54:6e:70@1
key_server_sci=aa:11:22:bb:33:dd@2
participant_idx=0
ckn=ba1bdfa89c6457f4a5adfa16e83558b8
mi=3e2a531f2f77275ed068b430
mn=1003
active=Yes
participant=No
retain=No
live_peers=1
potential_peers=0
is_key_server=No
is_elected=Yes
eap_session_id=2b494af2bd8152a44d14966d26f4dc47be2f9ee6be68f4809912bd52f21543bf9
5000c202595dbb5045eea99283f30a2ec6be0583a237422daa87413a793eb8207
```

[AP] Possible debugs

```
debug macsec phy
wpa_supplicant logs:
debug ap authentication {error | events | information | packet}
```

[SW] Sample syslogs when session is started and secured:

```
000296: Dec 15 09:45:27.646: %MKA-5-SESSION_START: (Gi1/0/19 : 2) MKA Session started for
RxSCI 99ff.88ee.77dd/0000, AuditSessionID 0801070A0000000B21668C31, AuthMgr-Handle 32000001
000312: Dec 15 09:45:31.672: %MKA-5-SESSION_SECURED: (Gi1/0/19 : 2) MKA Session was secured
for RxSCI 99ff.88ee.77dd/0001, AuditSessionID 0801070A0000000B21668C31, CKN
CE95AC2F38461CF085796E8924ADA77F
```

[SW] Check MKA session

```
show mka sessions
```

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```
Total MKA Sessions....... 1
      Secured Sessions... 1
      Pending Sessions... 0

================================================================================================
========
Interface       Local-TxSCI          Policy-Name       Inherited          Key-Server
Port-ID         Peer-RxSCI           MACsec-Peers      Status             CKN
================================================================================================
========
Gi1/0/19        aa11.22bb.33dd/001b  macsec-policy     NO                 YES
2               99ff.88ee.77dd/0001  1                 Secured
BA1BDFA89C6457F4A5ADFA16E83558B8
```

[SW] MACsec summary (1 indicates success)

```
show macsec summary
Interface                     Transmit SC         Receive SC
Gi1/0/19                           1                   1
```

Switching considerations for FlexConnect local switching

If you are thinking about deploying MACsec 802.1X with FlexConnect local switching which requires a trunk, this is possible.

The way to do this is configuring the switch port as a **trunk port**, with the right native VLAN assigned and enable 802.1X.

Note: It is not possible to convert an interface from access to trunk using an interface template along with MACsec.

Sample Switch Configuration

```
interface GigabitEthernet1/0/19
 switchport trunk native vlan 72
 switchport mode trunk
 device-tracking attach-policy IPDT_POLICY
 macsec network-link
 authentication periodic
 authentication timer reauthenticate server
 access-session host-mode multi-host
 access-session closed
 access-session port-control auto
 mab
 snmp trap mac-notification change added
 snmp trap mac-notification change removed
 dot1x pae authenticator
 dot1x timeout tx-period 4
 dot1x timeout supp-timeout 3
```

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```
 dot1x max-req 3
 mka policy macsec-policy
 spanning-tree portfast trunk
 spanning-tree bpduguard enable
 service-policy type control subscriber PMAP_DefaultWiredDot1xClosedAuth_1X_MAB
end
```

A key command in this configuration is access-session host-mode multi-host, which allows more than one MAC address in the port, which is necessary for FlexConnect local switching.

Sample ISE Authorization Profile

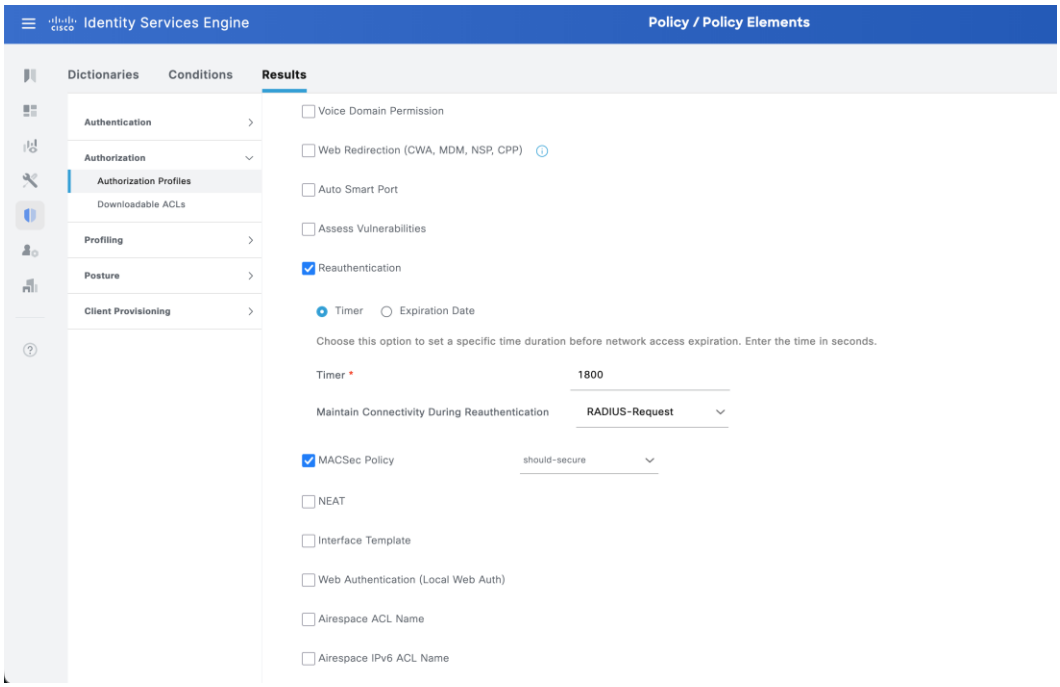


Figure 13. ISE Authorization Profile detail 1

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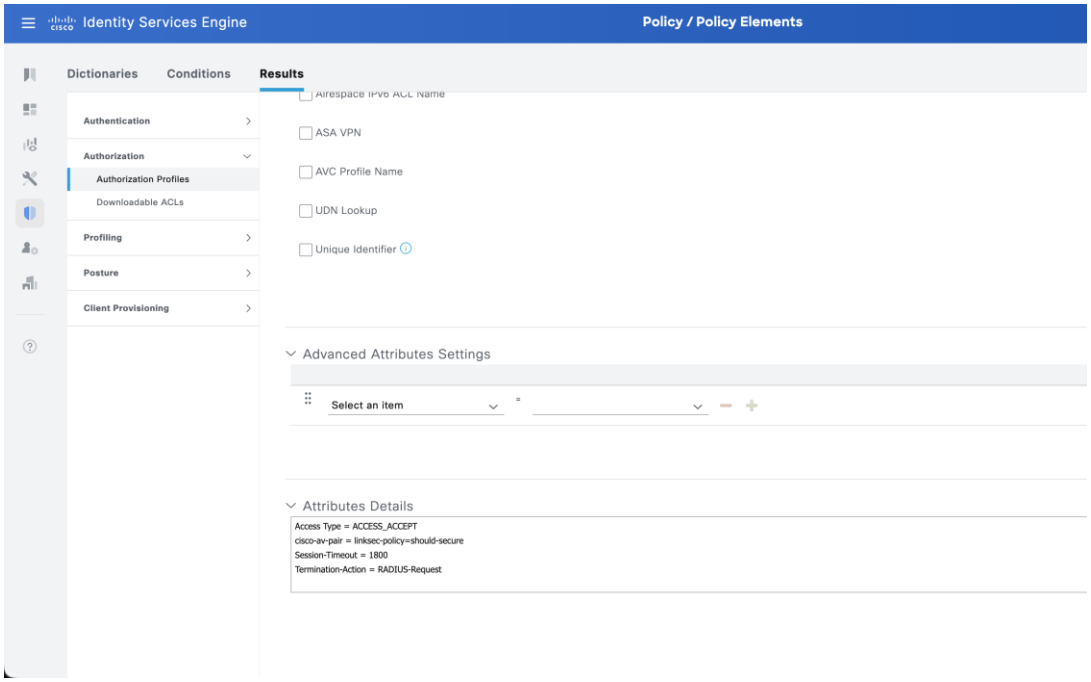


Figure 14. ISE Authorization Profile detail 2

Failover Mechanism

If MACsec is enabled on the AP but the connected switch port does not support it or it is not configured for MACsec, the AP may be unable to establish a secure wired session. To prevent the AP from remaining offline, the AP monitors MACsec peer availability and automatically falls back after a 5 minute timeout if no valid MACsec peer is detected.

For APs with more than one wired uplink, fallback is triggered only when all applicable uplinks fail to establish MACsec. If any uplink successfully establishes a MACsec session, the AP continues operating securely on that uplink. When fallback is triggered, the AP reports the MACsec failure to the controller. MACsec fallback is recovered after AP reboot, or after the AP rejoins the controller and then detects a wired port flap. The AP keeps blocking MACsec restart while the no-peer failure is pending, and clears the block only after controller rejoin plus link recovery.

Note: This behavior was introduced in IOS-XE 26.1.2 and 26.2.1.

Here's a diagram if the described behavior:

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