Simplified Cisco IoT FND Architecture

Tunnel management with a unique Pre-Shared Key (PSK) and the assignment of IP addresses using Cisco IoT FND IP Address Management (IPAM) aims to simplify the configuration process and reduce the number of components in Cisco IoT FND. In the simplified architecture, the PSK replaces existing security components such as CA, AAA, and RA, while the IPAM replaces the external DHCP server. This simplified architecture is supported only in greenfield deployments using VMs with a Postgres database, and is designed for router management only.

However, you have the discretion to use a unique PSK and the IPAM in the architecture. Cisco IoT FND continues to support existing PKI-based certificate communication between FAR and Cisco IoT FND, PKI-based certificates for tunnels between FAR and HER, and external DHCP servers for tunnel IP addressing.

Tunnel Management with Pre-Shared Key

A unique pre-shared key (PSK) solution is used for the tunnel management between FAR and HER, which significantly simplifies the authentication and authorization process in the headend infrastructure and allows the users to self-manage. The PSK is supported on all Cisco IOS and IOS-XE device types.

The table provides various scenarios where PSK can be used effectively in combination with either SUDI or a CA server in the greenfield deployment.

Deployment	Scenario	Recommendation
Greenfield deployment	Without CA server	• Use PSK for authentication and authorization of communication between FAR and HER. • Use SUDI for authentication and authorization of communication between FND and FAR.
	With CA server	Choose one of the following combinations: • Use PSK for authentication and authorization of communication between FAR and HER. • Use a custom CA certificate for authentication and authorization of communication between FND and FAR. (or) • Use a custom CA certificate for authentication and authorization of communication between both FAR and HER, FND and FAR.
Note In both scenarios, with or without CA server, it is mandatory to generate the IoT FND certificate from the CA server and install it on the IoT FND server (cgms_keystore).		

Note For the brownfield deployment, IoT FND continues to support CA, RA, and AAA for the FAR communication with FND and HER.

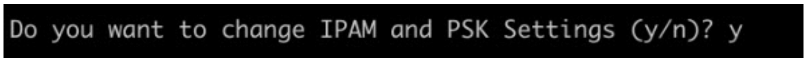
Configuring FND for Tunnel Management with PSK

Use the following steps to configure FND for managing tunnels with PSK.

Procedure

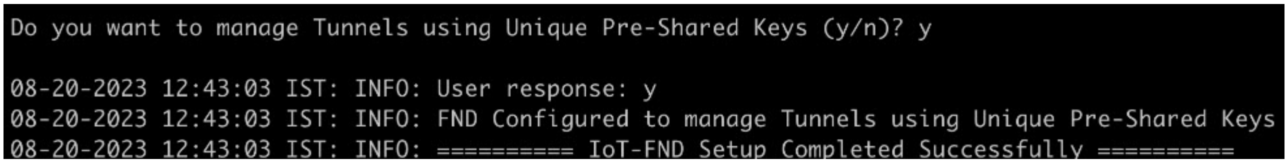
Step 1 Run the following script to configure FND with IPAM and PSK settings.

```
/opt/cgms/bin/setupCgms.sh
```



```
Do you want to change IPAM and PSK Settings (y/n)? y
```

Step 2 On entering **"y"**, you are provided with a new option to select PSK scheme for IPsec tunnel management.



```
Do you want to manage Tunnels using Unique Pre-Shared Keys (y/n)? y

08-20-2023 12:43:03 IST: INFO: User response: y
08-20-2023 12:43:03 IST: INFO: FND Configured to manage Tunnels using Unique Pre-Shared Keys
08-20-2023 12:43:03 IST: INFO: ========== IoT-FND Setup Completed Successfully ==========
```

Step 3 On entering **"y"**, FND is configured with PSK.

FND updates the Preferences table by setting the property `com.cisco.cgms.pnp.tunnelMgmtUsingPsk` as True. By default, this property is False.

Generating PSK

A unique pre-shared key is generated when you import a device through CSV or NB API. The pre-shared key is a 15-character alphanumeric string which is unique and generated randomly for each device. The generated key is encrypted and stored in the database for each router. For more information on tunnel management with PSK, see Workflow for Tunnel Management with PSK, on page 28.

Default templates

Templates are used for pushing the configuration commands and data to devices from Cisco IoT FND. Templates help in configuring many devices simultaneously with a single file. Numerous templates are available for tunnel management based on different device configurations.

These default templates are available for tunnel management:

- Router Tunnel Addition Template,
- HER Tunnel Addition Template,
- Router Bootstrap Configuration Template,
- HER Tunnel FlexVPN Configuration Template.

Table 1: Feature History

Release Information	Feature Name	Description
Cisco IoT FND Release 4.11.0	Tunnel Management with pre-shared key (PSK)	PSK is used during the tunnel provisioning to authenticate the communication between FAR and HER. This feature reduces the certificate dependency for tunnel formation. If PSK is enabled as part of Cisco IoT FND installation, then Cisco IoT FND generates a unique pre-shared key for each FAR in Cisco IoT FND. .

Router tunnel addition template

There are two default router addition templates available for authentication. Based on the configuration settings in `setupCgms.sh`, the default template is selected to manage tunnels using PSK.

A sample template for FlexVPN and DMVPN tunnel configuration is as given.

Note By default, the peer name is set to `her-tunnel` in `crypto ikev2 keyring FlexVPN_Keyring` and `Flexvpn_ikev2_profile`. You can configure the peer name to match the name that is given in `identity local key-id` in the HER configuration.

```
<#-- This template only supports FARs running IOS. -->
<#if !far.isRunningIos()>
  ${provisioningFailed("FAR is not running IOS")}
</#if>

<#--
  For FARs running IOS configure a FlexVPN client in order to establish secure
  communications to the HER. This template expects that the HER has been
  appropriately pre-configured as a FlexVPN server.
-->
<#if far.isRunningIos()>
  <#assign sublist=far.eid?split("+")[0..1]>
  <#assign sn=sublist[1]>
  <#--
    Configure a Loopback0 interface for the FAR.
  -->
  interface Loopback0
    <#--
      If the loopback interface IPv4 address property has been set on the CGR
      then configure the interface with that address. Otherwise obtain an
      address for the interface now using DHCP.
    -->
    <#if far.loopbackV4Address??>
      <#assign loopbackIpv4Address=far.loopbackV4Address>
    <#elseif far.isIPAMForLoopbackSelected()??>
```

```
      <#assign loopbackIpv4Address=far.IPAMForLoopbackIpv4()>
    <#else>
      <#--
        Obtain an IPv4 address that can be used to for this FAR's Loopback
        interface. The template API provides methods for requesting a lease from
        a DHCP server. The IPv4 address method requires a DHCP client ID and a link
        address to send in the DHCP request. The 3rd parameter is optional and
        defaults to "IoT-FND". This value is sent in the DHCP user class option.
        The API also provides the method "dhcpClientId". This method takes a DHCPv6
        Identity association identifier (IAID) and a DHCP Unique IDentifier (DUID)
        and generates a DHCPv4 client identifier as specified in RFC 4361. This
        provides some consistency in how network elements are identified by the
        DHCP server.
      -->
      <#assign
loopbackIpv4Address=far.ipv4Address(dhcpClientId(far.enDuid,0),far.dhcpV4LoopbackLink).address>

    </#if>
    ip address ${loopbackIpv4Address} 255.255.255.255
    <#--
      If the loopback interface IPv6 address property has been set on the CGR
      then configure the interface with that address. Otherwise obtain an
      address for the interface now using DHCP.
    -->
    <#if far.loopbackV6Address??>
      <#assign loopbackIpv6Address=far.loopbackV6Address>
    <#elseif far.isIPAMForLoopbackSelected()??>
      <#assign loopbackIpv6Address=far.IPAMForLoopbackIpv6()>
    <#else>
      <#--
        Obtain an IPv6 address that can be used to for this FAR's loopback
        interface. The method is similar to the one used for IPv4, except clients
        in DHCPv6 are directly identified by their DUID and IAID. IAIDs used for
        IPv4 are separate from IAIDs used for IPv6, so we can use zero for both
        requests.
      -->
      <#assign
loopbackIpv6Address=far.ipv6Address(far.enDuid,0,far.dhcpV6LoopbackLink).address>
    </#if>
    ipv6 address ${loopbackIpv6Address}/128
  exit

  <#--
    Default to using FlexVPN for the tunnel configuration of FARs running IOS.
  -->
 <#if (far.useFlexVPN!"true") = "true">
    <#--
      IPv4 ACL which specifies the route(s) FlexVPN will push to the HER.
      We want the HER to know the route to the CGR's loopback interface.
    -->
    ip access-list standard FlexVPN_Client_IPv4_LAN
      permit ${loopbackIpv4Address}
    exit

    <#--
      IPv6 ACL which specifies the route(s) FlexVPN will push to the HER.
      We want the HER to know the route to the CGR's loopback interface.
      If a mesh has been configured on this CGR we want the HER to know the route to the
mesh.
    -->
    ipv6 access-list FlexVPN_Client_IPv6_LAN
      <#if far.meshPrefix??>
        permit ipv6 ${far.meshPrefix}/64 any
      </#if>
      sequence 20 permit ipv6 host ${loopbackIpv6Address} any
    exit

    <#--
      FlexVPN authorization policy that configures FlexVPN to push the CGR LAN's
      specified in the ACLs to the HER during the FlexVPN handshake.
    -->
    crypto ikev2 authorization policy FlexVPN_Author_Policy
      route set access-list FlexVPN_Client_IPv4_LAN
      route set access-list ipv6 FlexVPN_Client_IPv6_LAN
      route set interface
    exit

    crypto ikev2 proposal FlexVPN_IKEv2_Proposal
      encryption aes-cbc-256
      group 14
      integrity sha256
    exit
    crypto ikev2 policy FLexVPN_IKEv2_Policy
      proposal FlexVPN_IKEv2_Proposal
    exit

    <#-- FlexVPN authorization policy is defined locally. -->
    aaa authorization network FlexVPN_Author local

    crypto ikev2 keyring FlexVPN_Keyring
      peer her-tunnel
        address ${far.ipsecTunnelDestAddr1}
        identity key-id her-tunnel
        pre-shared-key ${far.mgmtVpnPsk}
      exit
    exit

    crypto ikev2 profile FlexVPN_IKEv2_Profile
      match identity remote key-id her-tunnel
      identity local fqdn ${sn}.cisco.com
      authentication remote pre-share
      authentication local pre-share
      keyring local FlexVPN_Keyring
      dpd 120 3 periodic
      aaa authorization group psk list FlexVPN_Author FlexVPN_Author_Policy
    exit

    <#--
      If the headend router is an ASR then use a different configuration for the
      transform set as some ASR models are unable to support the set we'd prefer
      to use.
    -->
    <#if her.pid?contains("ASR")>
      crypto ipsec transform-set FlexVPN_IPsec_Transform_Set esp-aes esp-sha-hmac
        mode tunnel
      exit
    <#else>
      crypto ipsec transform-set FlexVPN_IPsec_Transform_Set esp-aes esp-sha256-hmac
        mode tunnel
      exit
    </#if>

    crypto ipsec profile FlexVPN_IPsec_Profile
      set ikev2-profile FlexVPN_IKEv2_Profile
      set pfs group14
      set transform-set FlexVPN_IPsec_Transform_Set
    exit
```

```
   <#assign wanInterface=far.interfaces(far.tunnelSrcInterface1!"Cellular")>
   interface Tunnel0
     description IPsec tunnel to ${her.eid}
     ip unnumbered loopback0
     ipv6 unnumbered loopback0
     tunnel destination dynamic
     tunnel protection ipsec profile FlexVPN_IPsec_Profile
     tunnel source ${wanInterface[0].name}
   exit

   <#if !(far.ipsecTunnelDestAddr1??)>
    ${provisioningFailed("FAR property ipsecTunnelDestAddr1 must be set to the destination
address to connect this FAR's FlexVPN tunnel to")}
   </#if>
   crypto ikev2 client flexvpn FlexVPN_Client
     peer 1 ${far.ipsecTunnelDestAddr1}
     client connect Tunnel0
   exit
   ip http secure-client-auth
   no ip http tls-version TLSv1.2
  <#else>
   <#--
     Configure the tunnel using DMVPN.
   -->
   router eigrp 1
     network ${loopbackIpv4Address}
   exit
   ipv6 router eigrp 2
     no shutdown
   exit
   interface Loopback0
     ipv6 eigrp 2
   exit
   crypto ikev2 proposal DMVPN_IKEv2_Proposal
     encryption aes-cbc-256
     group 14
     integrity sha256
   exit
   crypto ikev2 policy DMVPN_IKEv2_Policy
     proposal DMVPN_IKEv2_Proposal
   exit
   crypto ikev2 keyring DMVPN_Keyring
     peer her-tunnel
       address ${far.ipsecTunnelDestAddr1}
       identity key-id her-tunnel
       pre-shared-key ${far.mgmtVpnPsk}
     exit
   exit
   crypto ikev2 profile DMVPN_IKEv2_Profile
     match identity remote key-id her-tunnel
     identity local fqdn ${sn}.cisco.com
     authentication remote pre-share
     authentication local pre-share
     keyring local DMVPN_Keyring
     dpd 120 3 periodic
   exit
   <#--
     If the headend router is an ASR then use a different configuration for the
     transform set as some ASR models are unable to support the set we'd prefer
     to use.
   -->
   <#if her.pid?contains("ASR")>
     crypto ipsec transform-set DMVPN_IPsec_Transform_Set esp-aes esp-sha-hmac
       mode tunnel
```

```
      exit
    <#else>
      crypto ipsec transform-set DMVPN_IPsec_Transform_Set esp-aes 256 esp-sha256-hmac
        mode tunnel
      exit
    </#if>
    crypto ipsec profile DMVPN_IPsec_Profile
      set ikev2-profile DMVPN_IKEv2_Profile
      set pfs group14
      set transform-set DMVPN_IPsec_Transform_Set
    exit
    <#if !(far.nbmaNhsV4Address??)>
      ${provisioningFailed("FAR property nbmaNhsV4Address has not been set")}
    </#if>
    <#if !(far.nbmaNhsV6Address??)>
      ${provisioningFailed("FAR property nbmaNhsV6Address has not been set")}
    </#if>
    <#assign wanInterface=far.interfaces(far.tunnelSrcInterface1!"Cellular")>
    interface Tunnel0
      <#assign lease=far.ipv4Address(dhcpClientId(far.enDuid,1),far.dhcpV4TunnelLink)>
      ip address ${lease.address} ${lease.subnetMask}
      ip nhrp map ${far.nbmaNhsV4Address} ${far.ipsecTunnelDestAddr1}
      ip nhrp map multicast ${far.ipsecTunnelDestAddr1}
      ip nhrp network-id 1
      ip nhrp nhs ${her.interfaces("Tunnel0")[0].v4.addresses[0].address}
      ipv6 address ${far.ipv6Address(far.enDuid,1,far.dhcpV6TunnelLink).address}/128
      ipv6 eigrp 2
      ipv6 nhrp map ${far.nbmaNhsV6Address}/128 ${far.ipsecTunnelDestAddr1}
      ipv6 nhrp map multicast ${far.ipsecTunnelDestAddr1}
      ipv6 nhrp network-id 1
      ipv6 nhrp nhs ${far.nbmaNhsV6Address}
      tunnel mode gre multipoint
      tunnel protection ipsec profile DMVPN_IPsec_Profile
      tunnel source ${wanInterface[0].name}
    exit
    router eigrp 1
      network ${lease.address}
    exit
  </#if>
</#if>
```

Configure router tunnel addition using template

Use this task to configure the router tunnel addition using template.

Before you begin

Note By default, the peer name is set to `her-tunnel` in `crypto ikev2 keyring FlexVPN_Keyring` and `Flexvpn_ikev2_profile`. You can configure the peer name to match the name that is given in `identity local key-id` in the HER configuration.

Procedure

Step 1 Edit the template as given in the example to configure router tunnel addition.

Example:

```
<#-- This template only supports FARs running IOS. -->
<#if !far.isRunningIos()>
  ${provisioningFailed("FAR is not running IOS")}
</#if>

<#--
  For FARs running IOS configure a FlexVPN client in order to establish secure
  communications to the HER. This template expects that the HER has been
  appropriately pre-configured as a FlexVPN server.
-->
<#if far.isRunningIos()>
  <#assign sublist=far.eid?split("+")[0..1]>
  <#assign sn=sublist[1]>
  <#--
    Configure a Loopback0 interface for the FAR.
  -->
  interface Loopback0
    <#--
      If the loopback interface IPv4 address property has been set on the CGR
      then configure the interface with that address. Otherwise obtain an
      address for the interface now using DHCP.
    -->
    <#if far.loopbackV4Address??>
      <#assign loopbackIpv4Address=far.loopbackV4Address>
    <#elseif far.isIPAMForLoopbackSelected()??>
      <#assign loopbackIpv4Address=far.IPAMForLoopbackIpv4()>
    <#else>
      <#--
        Obtain an IPv4 address that can be used to for this FAR's Loopback
        interface. The template API provides methods for requesting a lease from
        a DHCP server. The IPv4 address method requires a DHCP client ID and a link
        address to send in the DHCP request. The 3rd parameter is optional and
        defaults to "IoT-FND". This value is sent in the DHCP user class option.
        The API also provides the method "dhcpClientId". This method takes a DHCPv6
        Identity association identifier (IAID) and a DHCP Unique IDentifier (DUID)
        and generates a DHCPv4 client identifier as specified in RFC 4361. This
        provides some consistency in how network elements are identified by the
        DHCP server.
      -->
      <#assign
loopbackIpv4Address=far.ipv4Address(dhcpClientId(far.enDuid,0),far.dhcpV4LoopbackLink).address>
    </#if>
    ip address ${loopbackIpv4Address} 255.255.255.255
    <#--
      If the loopback interface IPv6 address property has been set on the CGR
      then configure the interface with that address. Otherwise obtain an
      address for the interface now using DHCP.
    -->
    <#if far.loopbackV6Address??>
      <#assign loopbackIpv6Address=far.loopbackV6Address>
    <#elseif far.isIPAMForLoopbackSelected()??>
      <#assign loopbackIpv6Address=far.IPAMForLoopbackIpv6()>
    <#else>
      <#--
        Obtain an IPv6 address that can be used to for this FAR's loopback
        interface. The method is similar to the one used for IPv4, except clients
        in DHCPv6 are directly identified by their DUID and IAID. IAIDs used for
        IPv4 are separate from IAIDs used for IPv6, so we can use zero for both
        requests.
      -->
      <#assign loopbackIpv6Address=far.ipv6Address(far.enDuid,0,far.dhcpV6LoopbackLink).address>
    </#if>
    ipv6 address ${loopbackIpv6Address}/128
```

```
 exit

 <#--
   Default to using FlexVPN for the tunnel configuration of FARs running IOS.
 -->
<#if (far.useFlexVPN!"true") = "true">
   <#--
     IPv4 ACL which specifies the route(s) FlexVPN will push to the HER.
     We want the HER to know the route to the CGR's loopback interface.
   -->
   ip access-list standard FlexVPN_Client_IPv4_LAN
     permit ${loopbackIpv4Address}
   exit

   <#--
     IPv6 ACL which specifies the route(s) FlexVPN will push to the HER.
     We want the HER to know the route to the CGR's loopback interface.
     If a mesh has been configured on this CGR we want the HER to know the route to the mesh.
   -->
   ipv6 access-list FlexVPN_Client_IPv6_LAN
     <#if far.meshPrefix??>
       permit ipv6 ${far.meshPrefix}/64 any
     </#if>
     sequence 20 permit ipv6 host ${loopbackIpv6Address} any
   exit

   <#--
     FlexVPN authorization policy that configures FlexVPN to push the CGR LAN's
     specified in the ACLs to the HER during the FlexVPN handshake.
   -->
   crypto ikev2 authorization policy FlexVPN_Author_Policy
     route set access-list FlexVPN_Client_IPv4_LAN
     route set access-list ipv6 FlexVPN_Client_IPv6_LAN
     route set interface
   exit

   crypto ikev2 proposal FlexVPN_IKEv2_Proposal
     encryption aes-cbc-256
     group 14
     integrity sha256
   exit
   crypto ikev2 policy FLexVPN_IKEv2_Policy
     proposal FlexVPN_IKEv2_Proposal
   exit

   <#-- FlexVPN authorization policy is defined locally. -->
   aaa authorization network FlexVPN_Author local

   crypto ikev2 keyring FlexVPN_Keyring
     peer her-tunnel
       address ${far.ipsecTunnelDestAddr1}
       identity key-id her-tunnel
       pre-shared-key ${far.mgmtVpnPsk}
     exit
   exit

   crypto ikev2 profile FlexVPN_IKEv2_Profile
     match identity remote key-id her-tunnel
     identity local fqdn ${sn}.cisco.com
     authentication remote pre-share
     authentication local pre-share
     keyring local FlexVPN_Keyring
     dpd 120 3 periodic
     aaa authorization group psk list FlexVPN_Author FlexVPN_Author_Policy
   exit

   <#--
     If the headend router is an ASR then use a different configuration for the
     transform set as some ASR models are unable to support the set we'd prefer
     to use.
   -->
   <#if her.pid?contains("ASR")>
     crypto ipsec transform-set FlexVPN_IPsec_Transform_Set esp-aes esp-sha-hmac
       mode tunnel
     exit
   <#else>
     crypto ipsec transform-set FlexVPN_IPsec_Transform_Set esp-aes esp-sha256-hmac
       mode tunnel
     exit
   </#if>

   crypto ipsec profile FlexVPN_IPsec_Profile
     set ikev2-profile FlexVPN_IKEv2_Profile
     set pfs group14
     set transform-set FlexVPN_IPsec_Transform_Set
   exit

   <#assign wanInterface=far.interfaces(far.tunnelSrcInterface1!"Cellular")>
   interface Tunnel0
     description IPsec tunnel to ${her.eid}
     ip unnumbered loopback0
     ipv6 unnumbered loopback0
     tunnel destination dynamic
     tunnel protection ipsec profile FlexVPN_IPsec_Profile
     tunnel source ${wanInterface[0].name}
   exit

   <#if !(far.ipsecTunnelDestAddr1??)>
     ${provisioningFailed("FAR property ipsecTunnelDestAddr1 must be set to the destination address
to connect this FAR's FlexVPN tunnel to")}
   </#if>
   crypto ikev2 client flexvpn FlexVPN_Client
     peer 1 ${far.ipsecTunnelDestAddr1}
     client connect Tunnel0
   exit
   ip http secure-client-auth
   no ip http tls-version TLSv1.2
 <#else>
   <#--
     Configure the tunnel using DMVPN.
   -->
   router eigrp 1
     network ${loopbackIpv4Address}
   exit
   ipv6 router eigrp 2
     no shutdown
   exit
   interface Loopback0
     ipv6 eigrp 2
   exit
   crypto ikev2 proposal DMVPN_IKEv2_Proposal
     encryption aes-cbc-256
     group 14
     integrity sha256
   exit
   crypto ikev2 policy DMVPN_IKEv2_Policy
     proposal DMVPN_IKEv2_Proposal
   exit
```

```
        crypto ikev2 keyring DMVPN_Keyring
          peer her-tunnel
            address ${far.ipsecTunnelDestAddr1}
            identity key-id her-tunnel
            pre-shared-key ${far.mgmtVpnPsk}
          exit
        exit
        crypto ikev2 profile DMVPN_IKEv2_Profile
          match identity remote key-id her-tunnel
          identity local fqdn ${sn}.cisco.com
          authentication remote pre-share
          authentication local pre-share
          keyring local DMVPN_Keyring
          dpd 120 3 periodic
        exit
        <#--
          If the headend router is an ASR then use a different configuration for the
          transform set as some ASR models are unable to support the set we'd prefer
          to use.
        -->
        <#if her.pid?contains("ASR")>
          crypto ipsec transform-set DMVPN_IPsec_Transform_Set esp-aes esp-sha-hmac
            mode tunnel
          exit
        <#else>
          crypto ipsec transform-set DMVPN_IPsec_Transform_Set esp-aes 256 esp-sha256-hmac
            mode tunnel
          exit
        </#if>
        crypto ipsec profile DMVPN_IPsec_Profile
          set ikev2-profile DMVPN_IKEv2_Profile
          set pfs group14
          set transform-set DMVPN_IPsec_Transform_Set
        exit
        <#if !(far.nbmaNhsV4Address??)>
          ${provisioningFailed("FAR property nbmaNhsV4Address has not been set")}
        </#if>
        <#if !(far.nbmaNhsV6Address??)>
          ${provisioningFailed("FAR property nbmaNhsV6Address has not been set")}
        </#if>
        <#assign wanInterface=far.interfaces(far.tunnelSrcInterface1!"Cellular")>
        interface Tunnel0
          <#assign lease=far.ipv4Address(dhcpClientId(far.enDuid,1),far.dhcpV4TunnelLink)>
          ip address ${lease.address} ${lease.subnetMask}
          ip nhrp map ${far.nbmaNhsV4Address} ${far.ipsecTunnelDestAddr1}
          ip nhrp map multicast ${far.ipsecTunnelDestAddr1}
          ip nhrp network-id 1
          ip nhrp nhs ${her.interfaces("Tunnel0")[0].v4.addresses[0].address}
          ipv6 address ${far.ipv6Address(far.enDuid,1,far.dhcpV6TunnelLink).address}/128
          ipv6 eigrp 2
          ipv6 nhrp map ${far.nbmaNhsV6Address}/128 ${far.ipsecTunnelDestAddr1}
          ipv6 nhrp map multicast ${far.ipsecTunnelDestAddr1}
          ipv6 nhrp network-id 1
          ipv6 nhrp nhs ${far.nbmaNhsV6Address}
          tunnel mode gre multipoint
          tunnel protection ipsec profile DMVPN_IPsec_Profile
          tunnel source ${wanInterface[0].name}
        exit
        router eigrp 1
          network ${lease.address}
        exit
      </#if>
    </#if>
```

Step 2 Save the template.

HER tunnel addition template

Similar to Router Tunnel Addition templates, there are two default HER tunnel addition templates available. Based on the configuration settings in `setupCgms.sh`, the default template is selected to manage tunnels using PSK or not.

The following commands are pushed to HER for every router during device on-boarding (PnP). The configurations are added to a queue which are processed by a configurable number of threads and pushed to HER.

Note Ensure that the keyring name mentioned in `crypto ikev2 keyring FlexVPN_Keyring` and `FlexVPN_IKEv2_Profile` match the HER keyring name.

`per-Router HER Config`

```
<#-- This template only supports HERs running IOS or IOS XE. -->
<#if !her.isRunningIos() && !her.isRunningIosXe()>
  ${provisioningFailed("HER is not running IOS or IOS XE")}
</#if>

<#if far.isRunningIos()>
  <#assign sublist=far.eid?split("+")[0..1]>
  <#assign sn=sublist[1]>

  crypto ikev2 keyring FlexVPN_Keyring
    peer ${sn}
      identity fqdn ${sn}.cisco.com
      pre-shared-key ${far.mgmtVpnPsk}
   exit
  exit
</#if>
```

Configure HER tunnel addition template

Use this task to configure HER tunnel addition using template.

Before you begin

These commands are pushed to HER for every router during device on-boarding (PnP). The configurations are added to a queue which are processed by a configurable number of threads and pushed to HER.

Note Ensure that the keyring name mentioned in "crypto ikev2 keyring FlexVPN_Keyring" and "FlexVPN_IKEv2_Profile" match the HER keyring name.

Procedure

Step 1 Edit the template as given in the example to configure HER tunnel addition.

Example:

per-Router HER Config

```
<#-- This template only supports HERs running IOS or IOS XE. -->
<#if !her.isRunningIos() && !her.isRunningIosXe()>
  ${provisioningFailed("HER is not running IOS or IOS XE")}
</#if>

<#if far.isRunningIos()>
  <#assign sublist=far.eid?split("+")[0..1]>
  <#assign sn=sublist[1]>

  crypto ikev2 keyring FlexVPN_Keyring
    peer ${sn}
      identity fqdn ${sn}.cisco.com
      pre-shared-key ${far.mgmtVpnPsk}
   exit
  exit
</#if>
```

Step 2 Save the template.

Router bootstrap configuration template

Note For SUDI authentication, you must use `cgna initiator profile` as the tunnel profile.

Note Based on the device types, the following ports are used:

- For Cisco IOS-XE device types, use port 443.
- For Cisco IOS device types, use port 8443.

A sample router bootstrap configuration template:

```
<#assign sublist=far.eid?split("+")[0..1]>
<#assign pid=sublist[0]>
<#assign sn=sublist[1]>

hostname ${sn}
!
aaa new-model
!
!
aaa authentication login default local
aaa authorization exec default local
```

```
!
aaa session-id common
aaa password restriction
!
!
!
!
ip host fnd.iot.cisco.com <fnd ip address>
ip host tps.iot.cisco.com <tps ip address>
ip domain name cisco.com
!
password encryption aes
!
!
archive
  path bootflash:archive/
maximum 8
!
!
!
!
username admin privilege 15 password <router password>
!
!
no cdp run
!
!
!
!
interface Loopback999
 ip address <ip address for the interface> 255.255.255.255
!
!
ip forward-protocol nd
!
no ip http server
ip http tls-version TLSv1.2
ip http authentication aaa login-authentication default
ip http secure-server
ip http secure-port 443
ip http max-connections 5
ip http timeout-policy idle 600 life 86400 requests 3
ip http client connection timeout 5
ip http client connection retry 5
ip http client source-interface lo0
ip http client secure-trustpoint CISCO_IDEVID_SUDI

ip ssh time-out 60
ip ssh authentication-retries 2
crypto key generate rsa
ip ssh version 2
!
ipv6 unicast-routing
!
control-plane
!
!
line con 0
length 0
transport preferred none
escape-character 3
stopbits 1

!
```

```
line vty 6 15
session-timeout 10
exec-timeout 5 0
session-limit 2
transport input ssh
!
wsma agent exec
profile exec
!
wsma agent config
profile config
!
!wsma agent filesys
!
!wsma agent notify
!
!
wsma profile listener exec
transport https path /wsma/exec
!
wsma profile listener config
transport https path /wsma/config

event manager directory user policy "flash:/managed/scripts"
event manager policy no_config_replace.tcl type system authorization bypass
!
!
cgna gzip
!
!
cgna initiator-profile cg-nms-tunnel
 add-command show hosts | format flash:/managed/odm/cg-nms.odm
 add-command show interfaces | format flash:/managed/odm/cg-nms.odm
 add-command show version | format flash:/managed/odm/cg-nms.odm
 add-command show ipv6 dhcp | format flash:/managed/odm/cg-nms.odm
 add-command show ipv6 interface | format flash:/managed/odm/cg-nms.odm
 callhome-url https://tps.iot.cisco.com:9120/cgna/ios/config
 execution-url https://<ip address of Loopback999 interface>:443/wsma/config
 interval 10
 gzip
 post-commands
 active
```

Optional ACL Configuration

You can include ACL configuration in this template for additional security.

A sample ACL configuration:

```
access-list 10 permit <IP address of TPS>
access-list 10 deny any

interface gigabitEthernet 0/0/0
ip access-group 10 in
exit
```

Note In the above sample configuration, the communication with FAR is only through IP address of TPS until the tunnel is established.

After the tunnel is established, you can remove the ACL configuration.

To remove the ACL configuration, add the following commands in the Router Tunnel Addition Template:

```
no access-list 10
interface gigabitEthernet 0/0/0
no ip access-group 10 in
exit
```

Configure router bootstrap using template

Use this task to configure router bootstrap using template.

Procedure

Step 1 Edit the template as given in the example to configure router bootstrap.

Example:

```
<#assign sublist=far.eid?split("+")[0..1]>
<#assign pid=sublist[0]>
<#assign sn=sublist[1]>

hostname ${sn}
!
aaa new-model
!
aaa authentication login default local
aaa authorization exec default local
!
aaa session-id common
aaa password restriction
!
ip host fnd.iot.cisco.com <fnd ip address>
ip domain name cisco.com
!
password encryption aes
!
!
archive
  path bootflash:archive/
maximum 8
!
username admin privilege 15 password <router password>
!
!
no cdp run
!
!
interface Loopback999
 ip address <ip address for the interface> 255.255.255.255
!
ip forward-protocol nd
!
no ip http server
ip http tls-version TLSv1.2
ip http authentication aaa login-authentication default
ip http secure-server
ip http secure-port 443
ip http client source-interface lo0
ip http client secure-trustpoint CISCO_IDEVID_SUDI

ip ssh time-out 60
ip ssh authentication-retries 2
crypto key generate rsa
ip ssh version 2
!
ipv6 unicast-routing
!
control-plane
!
line con 0
length 0
transport preferred none
escape-character 3
stopbits 1

!

line vty 6 15
session-timeout 10
exec-timeout 5 0
session-limit 2
transport input ssh
!
wsma agent exec
profile exec
!
wsma agent config
profile config
!
!wsma agent filesys
!
!wsma agent notify
!
!
wsma profile listener exec
transport https path /wsma/exec
!
wsma profile listener config
transport https path /wsma/config

event manager directory user policy "flash:/managed/scripts"
event manager policy no_config_replace.tcl type system authorization bypass
!
!
cgna gzip
!
!
cgna initiator-profile cg-nms-tunnel
 add-command show hosts | format flash:/managed/odm/cg-nms.odm
 add-command show interfaces | format flash:/managed/odm/cg-nms.odm
 add-command show version | format flash:/managed/odm/cg-nms.odm
 add-command show ipv6 dhcp | format flash:/managed/odm/cg-nms.odm
 add-command show ipv6 interface | format flash:/managed/odm/cg-nms.odm
 callhome-url https://tps.iot.cisco.com:9120/cgna/ios/config
 execution-url https://<ip address of Loopback999 interface>:443/wsma/config
 interval 10
 gzip
 post-commands
 active
```

Step 2 Edit the template as given in the example to configure ACL optionally as an additional security step.

Example:

```
access-list 10 permit <IP address of TPS>
access-list 10 deny any
```

```
interface gigabitEthernet 0/0/0
ip access-group 10 in
exit
```

Note

- In the above sample configuration, the communication with FAR is only through IP address of TPS until the tunnel is established.
- You can also remove the ACL configuration using the command as given in the example, in the router tunnel addition template.

  ```
  no access-list 10
  interface gigabitEthernet 0/0/0
  no ip access-group 10 in
  exit
  ```

Step 3 Save the template.

HER tunnel FlexVPN configuration template

A sample HER tunnel FlexVPN configuration template:

```
version 17.12
service timestamps debug datetime msec
service timestamps log datetime msec
platform qfp utilization monitor load 80
platform punt-keepalive disable-kernel-core
platform sslvpn use-pd
platform console virtual
!
hostname xxxxxxx
!
boot-start-marker
boot-end-marker
!
!
aaa new-model
!
!
aaa authentication login default local
aaa authentication login AUTH local
aaa authorization exec default local
aaa authorization network FlexVPN_Author local
aaa authorization network NET local !
!
aaa session-id common
clock timezone IST 0 0
!
!

ip domain name cisco.com
!
!
!
login on-success log
!
!
subscriber templating
```

```
vtp version 1
!
!
!
!
!
!
multilink bundle-name authenticated
!
!
!
!
!
!
!
!
crypto pki trustpoint TP-self-signed-141726200
 enrollment selfsigned
 subject-name cn=IOS-Self-Signed-Certificate-141726200
 revocation-check none
 rsakeypair TP-self-signed-141726200
 hash sha256
!
crypto pki trustpoint SLA-TrustPoint
 enrollment pkcs12
 revocation-check crl
 hash sha256
!
!
crypto pki certificate chain TP-self-signed-141726200
 certificate self-signed 01
  xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
  xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
  xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
  xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
  xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
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  xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
  xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
  xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
  xxxxxxxxxxxxxx
        quit
crypto pki certificate chain SLA-TrustPoint
 certificate ca 01
  xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
  xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
  xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
  xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
  xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
  xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
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  xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
  xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
  xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
  xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
  xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
  xxxxxxxxxxxxxx
        quit
!
!
!
!
!
!
!
!
!
license udi pid C8000V sn 9OA9SRYYZVZ
license boot level network-advantage addon dna-advantage
memory free low-watermark processor 203066
diagnostic bootup level minimal
!
!
spanning-tree extend system-id
!
!
!
username xxxxxx privilege 15 password 0 xxxxxxxxxx
!
redundancy
!
crypto ikev2 authorization policy FlexVPN_Author_Policy
 route set interface
 route set access-list FlexVPN_Client_Default_IPv4_Route
!
crypto ikev2 redirect client
crypto ikev2 proposal FlexVPN_IKEv2_Proposal
 encryption aes-cbc-256
 integrity sha256
 group 14
!
crypto ikev2 policy FLexVPN_IKEv2_Policy
 proposal FlexVPN_IKEv2_Proposal
!
crypto ikev2 keyring FlexVPN_Keyring
 peer far1_sn
  identity fqdn far1_sn.cisco.com
  pre-shared-key GE39jy3Qe8Uo1Ro
!
 peer far2_sn
  identity fqdn far2_sn.cisco.com
  pre-shared-key LE73pj2Pk8Jh8Ui
!
 peer far3_sn
  identity fqdn far3_sn.cisco.com
  pre-shared-key FB86gn4Ns1Fm1Dj
!
!
!
crypto ikev2 profile FlexVPN_IKEv2_Profile
 match identity remote fqdn domain cisco.com
 identity local key-id CLUSTER-2
 authentication remote pre-share
 authentication local pre-share
 keyring local FlexVPN_Keyring
 dpd 120 3 periodic
 aaa authorization group psk list FlexVPN_Author FlexVPN_Author_Policy
 virtual-template 1 !
!
!
!
!
!
!
!
!
!
!
crypto isakmp invalid-spi-recovery
!
!
crypto ipsec transform-set FlexVPN_IPsec_Transform_Set esp-aes esp-sha256-hmac
 mode transport
!
crypto ipsec profile FlexVPN_IPsec_Profile
 set transform-set FlexVPN_IPsec_Transform_Set
 set pfs group14
 set ikev2-profile FlexVPN_IKEv2_Profile
 responder-only !
!
!
!
!
!
!
!
!
!
interface Loopback0
 ip address xx.xx.xx.xx 255.255.255.255
!
interface GigabitEthernet1
 ip address xx.xx.xx.xx 255.255.255.128
 negotiation auto
 no mop enabled
 no mop sysid
!
interface GigabitEthernet2
 ip address xx.xx.xx.xx 255.255.255.0
 negotiation auto
 no mop enabled
 no mop sysid
!
interface GigabitEthernet3
 no ip address
 shutdown
 negotiation auto
 no mop enabled
 no mop sysid
!
interface Virtual-Template1 type tunnel
 ip unnumbered Loopback0
 ip mtu 1200
 ip tcp adjust-mss 1240
 tunnel source GigabitEthernet2
 tunnel protection ipsec profile FlexVPN_IPsec_Profile
!
ip default-gateway xx.xx.xx.xx
ip forward-protocol nd
!
ip http server
ip http authentication local
ip http secure-server
ip http secure-active-session-modules none
ip http active-session-modules none
ip dns server
ip ssh bulk-mode 131072 !
!
ip access-list standard FlexVPN_Client_Default_IPv4_Route
 10 permit any
!
!
!
!
!
!
!
control-plane
!
!
mgcp behavior rsip-range tgcp-only
mgcp behavior comedia-role none
mgcp behavior comedia-check-media-src disable
mgcp behavior comedia-sdp-force disable !
mgcp profile default
!
!
!
!
!
!
line con 0
 stopbits 1
line aux 0
line vty 0 4
 password cisco123
 transport input ssh
!
!
netconf legacy
netconf ssh
!
!
!
!
!
End
```

Configure HER tunnel FlexVPN using template

Use this task to configure the HER tunnel FlexVPN using template.

Procedure

Step 1 Edit the template as given in the example to configure HER tunnel FlexVPN.

Example:

```
version 17.12
service timestamps debug datetime msec
service timestamps log datetime msec
platform qfp utilization monitor load 80
platform punt-keepalive disable-kernel-core
platform sslvpn use-pd
platform console virtual
!
hostname xxxxxxx
!
boot-start-marker
boot-end-marker
!
!
aaa new-model
!
!
aaa authentication login default local
aaa authentication login AUTH local
!......
........
crypto pki trustpoint SLA-TrustPoint
 enrollment pkcs12
 revocation-check crl
 hash sha256
!
!
crypto pki certificate chain TP-self-signed-141726200
 certificate self-signed 01
  xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
  xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
  xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
.......
  xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
  xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
  xxxxxxxxxxxxxx
        quit
crypto pki certificate chain SLA-TrustPoint
 certificate ca 01
  xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
  xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
.....
  xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
  xxxxxxxxxxxxxx
        quit
!
!
!
license udi pid C8000V sn 9OA9SRYYZVZ
license boot level network-advantage addon dna-advantage
memory free low-watermark processor 203066
diagnostic bootup level minimal
!
!
spanning-tree extend system-id
!
username xxxxxx privilege 15 password 0 xxxxxxxxxx
!
redundancy
!
crypto ikev2 authorization policy FlexVPN_Author_Policy
 route set interface
 route set access-list FlexVPN_Client_Default_IPv4_Route
```

```
!
crypto ikev2 redirect client
crypto ikev2 proposal FlexVPN_IKEv2_Proposal
crypto ikev2 profile FlexVPN_IKEv2_Profile
 match identity remote fqdn domain cisco.com
 identity local key-id CLUSTER-2
 authentication remote pre-share
 authentication local pre-share
 keyring local FlexVPN_Keyring
 dpd 120 3 periodic
 aaa authorization group psk list FlexVPN_Author FlexVPN_Author_Policy
 virtual-template 1 !
!......
........
!
crypto isakmp invalid-spi-recovery
!
!
crypto ipsec transform-set FlexVPN_IPsec_Transform_Set esp-aes esp-sha256-hmac
 mode transport
!
crypto ipsec profile FlexVPN_IPsec_Profile
 set transform-set FlexVPN_IPsec_Transform_Set
 set pfs group14
!.....
......
!
interface Loopback0
 ip address xx.xx.xx.xx 255.255.255.255
!
interface GigabitEthernet1
 ip address xx.xx.xx.xx 255.255.255.128
 negotiation auto
 no mop enabled
 no mop sysid
!
interface GigabitEthernet2
 ip address xx.xx.xx.xx 255.255.255.0
...
....
mgcp behavior rsip-range tgcp-only
mgcp behavior comedia-role none
mgcp behavior comedia-check-media-src disable
mgcp behavior comedia-sdp-force disable !
mgcp profile default
!
line con 0
 stopbits 1
line aux 0
line vty 0 4
 password cisco123
 transport input ssh
!
!
netconf legacy
netconf ssh
!
!
End
```

Step 2 Save the template.

HER tunnel deletion template

Note Ensure that the keyring name mentioned in "crypto ikev2 keyring FlexVPN_Keyring" and "FlexVPN_IKEv2_Profile" match the HER keyring name.

A sample HER tunnel deletion template for HERs on Cisco IOS and Cisco IOS-XE.

```
Remove Router PSK config from HER
<#-- This template only supports HERs running IOS or IOS XE. -->
<#if !her.isRunningIos() && !her.isRunningIosXe()>
  ${provisioningFailed("HER is not running IOS or IOS XE")}
</#if>

<#if far.isRunningIos()>
  <#assign sublist=far.eid?split("+")[0..1]>
  <#assign sn=sublist[1]>

  crypto ikev2 keyring FlexVPN_Keyring
    no peer ${sn}
  exit
</#if>
```

Configure HER tunnel deletion using template

Use this task to configure HER tunnel deletion using template.

Procedure

Step 1 Edit the template as given in the example to configure HER tunnel deletion for HERs on Cisco IOS and Cisco IOS-XE.

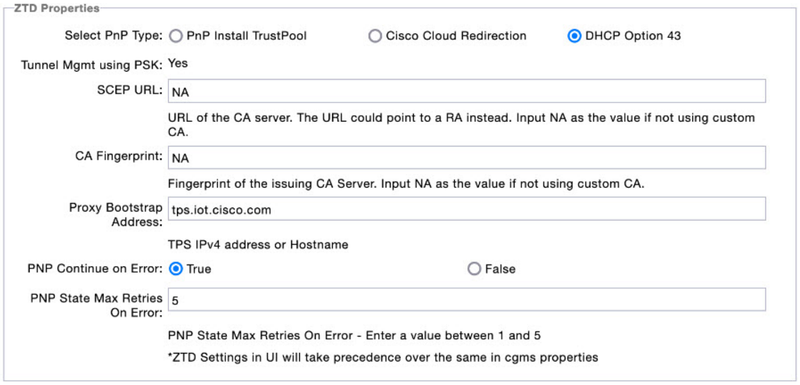
Example:

```
Remove Router PSK config from HER
<#-- This template only supports HERs running IOS or IOS XE. -->
<#if !her.isRunningIos() && !her.isRunningIosXe()>
  ${provisioningFailed("HER is not running IOS or IOS XE")}
</#if>

<#if far.isRunningIos()>
  <#assign sublist=far.eid?split("+")[0..1]>
  <#assign sn=sublist[1]>

  crypto ikev2 keyring FlexVPN_Keyring
    no peer ${sn}
  exit
</#if>
```

Step 2 Save the template.

Configuring ZTD Properties

The ZTD Properties section allows you to manage the device certificates with either SUDI or a CA server. On configuring FND with PSK for tunnel management, by default, the devices use SUDI certificate for the communication with FND. However, if you want to manage using a CA server, provide details in the **SCEP URL** and **CA Fingerprint** fields (**ADMIN** > **SYSTEM MANAGEMENT** > **PROVISIONING SETTINGS**).



ZTD Properties

Select PnP Type: ○ PnP Install TrustPool ○ Cisco Cloud Redirection ● DHCP Option 43

Tunnel Mgmt using PSK: Yes

SCEP URL: NA

URL of the CA server. The URL could point to a RA instead. Input NA as the value if not using custom CA.

CA Fingerprint: NA

Fingerprint of the issuing CA Server. Input NA as the value if not using custom CA.

Proxy Bootstrap Address: tps.iot.cisco.com

TPS IPv4 address or Hostname

PNP Continue on Error: ● True ○ False

PNP State Max Retries On Error: 5

PNP State Max Retries On Error - Enter a value between 1 and 5

*ZTD Settings in UI will take precedence over the same in cgms properties

Changes To TCL Script

This section explains about the two different versions of a TCL script used for configuring a trustpoint in a network device managed using Cisco IoT FND. The trustpoint is part of the device Public Key Infrastructure (PKI), which handles certificates and cryptographic keys.

TCL Script For Cisco IOS XE Release 17.4.x And Lower Releases

Here's the original TCL script version released in Cisco IOS XE Release 17.4.x and lower releases:

```
set clist [ list "config terminal" \
                    "crypto pki trustpoint $tp_name" \
                    "serial-number none" \
                    "ip-address none" \
                    "password" \
                    "no subject-name" \
                    "subject-name $subject_name" \
                    "enrollment retry count $ZTD_SCEP_enrollment_retry_count" \
                    "enrollment retry period $ZTD_SCEP_enrollment_retry_period" \
                    "crypto pki enroll $tp_name" \
                    "end"]
```

Updated Script For Cisco IOS XE Release 17.9.x And Later Releases

Here's the updated TCL script starting from Cisco IOS XE Release 17.9.x and later releases:

```
set clist [ list "config terminal" \
                    "crypto pki trustpoint $tp_name" \
                    "serial-number none" \
                    "ip-address none" \
                    "no subject-name" \
                    "subject-name $subject_name" \
                    "enrollment retry count $ZTD_SCEP_enrollment_retry_count" \
                    "enrollment retry period $ZTD_SCEP_enrollment_retry_period" \
                    "end"]
```

Reason For The Changes

The script is modified to no longer use an empty password, aligning with the new PKI policy that recommends to migrate to strong type-6 encryption.

Note Starting from Cisco IOS XE Release 17.9.x and later releases, the Subject Alternative Name (SAN) is included with the Certificate Signing Request (CSR). For more information see, CSCsk85992.

Workflow for Tunnel Management with PSK

This section provides the workflow for tunnel management with PSK.

Staging

To stage the router with Cisco IoT FND TPS URL:

Procedure

Step 1 Configuring Cisco IoT FND for PSK-based tunnels differ for each deployment as given below.

For **VM deployment with Postgres DB**, as the cgms service will already be running on OVA installation, the cgms service is restarted using the steps below while executing `setupCgms.sh` script. In this deployment, user creates a new Tunnel Provisioning group for PSK based tunnel management configuration.

a) Stop the cgms service.

```
./fnd-container.sh stop
```

b) Run the following script to configure FND to create IPsec tunnels for management with PSK.

```
/opt/cgms/bin/setupCgms.sh
```

c) Start the cgms service.

```
./fnd-container.sh start
```

d) Create new groups in the tunnel provisioning to on board devices that use PSK tunnels.

Step 2 Generate a public CA signed server certificate for TPS and Cisco IoT FND using the existing CSR generation workflow.

Step 3 Configure FlexVPN on HER. For more information on the configuration, see HER tunnel FlexVPN configuration template, on page 19.

Step 4 Import the device to Cisco IoT FND through CSV or NB API.

a) During the device import, set the **tunnelHerEid** property on FAR to know the associated HERs. Ensure to set this property for the PnP to continue, else, the PnP cannot proceed.

Cisco IoT FND generates a unique pre-shared key for each device and adds the generated key to the device property while storing in the database.

Step 5 Stage the router with Cisco IoT FND TPS URL using DHCP option 43 or PnP Install Trustpool / Cloud Redirection for PnP.

What to do next

Pnp Bootstrapping

PnP Bootstrapping

To bootstrap a device:

Before you begin

Staging.

Procedure

Step 1 Field area router (PnP agent) calls FND (through FND TPS).

Step 2 FND pushes the Trust Anchor (root certificate) to the device.

Step 3 To push the FAR PSK to the associated HER, a new state `CONFIGURING_HEADEND` is added in PnP.

Note
This state is executed only if IPsec tunnels are configured for management with PSK.

a) FND pushes the PSK to HER associated with the device in a separate batch process.

- On successful PSK configuration push on HER, an event is generated on FAR with the following message.

  ```
  PSK Tunnel configuration pushed successfully to HER
  ```

- On failure to push the PSK configuration on HER, an event is generated on FAR with the following message.

  ```
  PSK Tunnel configuration failed on HER
  ```

  Note
  FND keeps retrying (no limit) to push the configuration to HER until it succeeds as long as PnP requests come in.

Step 4 FND pushes the Bootstrap template to the device, which includes a tunnel creation profile and loopback IP configuration. For more information on the default templates, see Default templates, on page 3.

a) Set the following commands in the bootstrap template for SUDI-based authentication.

```
no ip http secure-client-auth
ip http tls-version TLSv1.2
ip http client secure-trustpoint CISCO_IDEVID_SUDI
```

Use the `cgna initiator` profile as a tunnel creation profile. This is due to a platform limitation for Cisco IOS-XE device types, which does not support SUDI when the device is acting as a server in the TLS communication.

Step 5 On successful completion of PnP, the device status is marked as `Bootstrapped` in FND.

What to do next

Tunnel Provisioning, on page 30

Tunnel Provisioning

To push the PSK configuration to the router:

Before you begin

- Staging, on page 28
- PnP Bootstrapping, on page 29

Procedure

Step 1 Field area router calls FND (through FND TPS).

Authentication based on mTLS:

a) Validate the FND server based on the FND trust anchor.
b) Validate the field area router based on SUDI.

Step 2 FND pushes the PSK along with other tunnel configurations present in the Router Tunnel Addition template to the router and activates the registration profile.

a) Ensure that the following command is added in the Router Tunnel Addition template for the registration to work.

```
ip http secure-client-auth

no ip http tls-version TLSv1.2
```

What to do next

Device Configuration, on page 30

Device Configuration

To push device configuration to the router:

Before you begin

Complete the following workflows:

- Staging, on page 28
- PnP Bootstrapping, on page 29
- Tunnel Provisioning, on page 30

Procedure

Step 1 Field area router calls FND (through IPsec).

Authentication based on mTLS:

- Validate the FND server based on FND trust anchor.
- Validate the field area router based on SUDI.

Step 2 FND pushes the device configuration present in the Configuration Template to the router.

Step 3 On successful completion, the device is marked as `UP` in FND.

Pushing PSK Configuration to HER Cluster

This section explains the steps that are required to push the PSK configuration to HER in the cluster.

Pushing PSK Configuration to Existing HERs in the Cluster

Use the following steps to push the PSK configuration to the existing HERs in the cluster, which are added to the cluster before the tunnel establishment.

Procedure

Step 1 Import all HERs in the cluster to FND and have them managed with the device status as UP.

Step 2 For FND to be aware of the list of HERs in a cluster, add the list of HER eids separated by comma in the `tunnelhereid` property.

Step 3 On receiving a PnP request from a FAR, the `tunnelhereid` property is checked to get the list of HERs in the cluster.

Step 4 PSK configuration is pushed to each HER in the cluster.

- PnP continues if at least one of the HERs in the cluster receives the PSK configuration successfully.
- If the PSK configuration push fails on HERs, then correct the HER or replace it with a new HER by updating the `tunnelHerEid` property of the FAR.

The following events are generated for the PSK configuration push to HER in a cluster.

- If the PSK configuration push to HER is successful, then an event is generated for the router with the following message.

  ```
  "PSK Tunnel configuration pushed successfully to HER [**eid**]"
  ```

- If the PSK configuration push to HER fails, then an event is generated for the router with the following message.

  ```
  "PSK Tunnel configuration failed on HER [**eid**]".
  ```

Pushing PSK Configuration to New HER in the Cluster

Use the following steps to push the PSK configuration to a new HER, which is added to the cluster after the tunnel is established.

Note The addition or removal of HERs from the `tunnelHerEid` list is added to a table named `pending_tunnel_her_in_cluster` in the DB. FND has a separate thread that runs every five minutes to pick up the entries from the table and based on the `add_peer` flag, it either pushes the PSK configuration or removes the PSK configuration to or from the HER.

Procedure

Step 1 Import the new HER to FND and have it managed with the device status as UP.

Step 2 Update the FAR using **Change Device Properties** to add the new HER to the `tunnelhereid` property list.

Note
HER must be managed by FND before updating FAR using **Change Device Properties**.

Step 3 The PSK configuration is pushed to the new HER added to the `tunnelHerEid` property list and an associated event (success or failure) is generated on the FAR.

If any HER is removed from the `tunnelHerEid` property, then the PSK configuration of that HER is removed and an event is generated for successful configuration removal on the HER.

Viewing Events

This section provides information on the events generated on FAR and HER when pushing and removing PSK tunnel configuration.

- Viewing FAR Events
- Viewing HER Events

Viewing FAR Events

Use the following steps to view the events generated when pushing PSK tunnel configuration on HER during FAR onboarding.

1. Choose **DEVICES** > **FIELD DEVICES**.
2. Select the device on the right pane. The Device Info page appears.
3. Click the **Events** tab to view the following events.

Event Name	Severity Level	Description
PSK Tunnel Configuration Pushed to HER	INFO	On successful completion of pushing PSK tunnel configuration on HER.
PSK Tunnel Configuration on HER Failed	Major	On failure to push the PSK tunnel configuration on HER.

Viewing HER Events

Use the following steps to view the events generated when removing the PSK tunnel configuration from HER and FAR during FAR decommissioning.

1. Choose **DEVICES** > **HEAD-END ROUTERS**.
2. Select the HER on the right pane. The Device Info page appears.
3. Click the **Events** tab to view the following events.

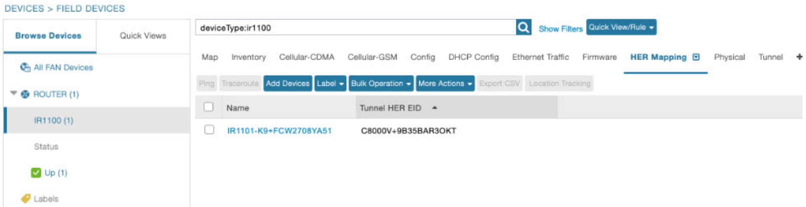
Event Name	Severity Level	Description
HER PSK Tunnel Configuration Removed for FAR	INFO	On successful removal of PSK configuration from HER.
HER PSK Tunnel Configuration Removal Failure for FAR	Major	On failure to remove the PSK configuration from HER. **Note** In this case, you should remove the PSK configuration from HER manually.

HER Mapping with FAR

Use the following steps to view the HERs associated with the FAR.

1. Choose **DEVICES** > **FIELD DEVICES**.
2. Select the device on the left pane.
3. Click the **HER Mapping** tab on the right pane.
4. The HER associated with the device appears under the **Tunnel HER EID** column.

   Use the filter option to search for HERs based on HER EID.



deviceType:ir1100

Name	Tunnel HER EID
IR1101-K9+FCW2708YA51	C8000V+9B35BAR3OKT

Decommissioning a Device

Whenever there is a device decommissioning, FND automatically removes the PSK configuration from HER using the HER deletion template which is available by default. If the HER is in a cluster, FND removes the PSK configuration from all HERs.

For information on HER deletion template, see HER tunnel deletion template, on page 26.

For information on events generated during PSK configuration removal from HER, see Viewing HER Events, on page 33.

List of Ports used in Simplified IoT FND Architecture for Router only Deployments

The table provides the list of standard ports used in simplified IoT FND architecture.

Service	Port
GUI	443
Tunnel Provisioning	9120
TPS	9122
PostGreSql DB Server	5432
Influx	8086
Kapacitor	9092
WSMA (for IOS-XE)	443
WSMA (for Classic IOS)	8443
Registration + Periodic	9121
Bandwidth Op Mode	9124
PnP — HTTP	9125
Web Sockets — Device Communication	9121
DB Replication for HA	1622
SSH	22
NTP Server	123
SNMP (for polling)	161
SNMP (for notifications)	162
SSM Server	8445
FND Demo Mode	80
Syslog service	514

PSK Challenge String Support

The pre-shared key challenge string is supported to enhance the security between FND and FAR in the SUDI+PSK based tunnel management. In this process, FND generates the challenge string during its first communication with the device. The generated nonce is pushed to the device and signed using the SUDI certificate. The signed response is validated against the SUDI certificate and the hash of the nonce is verified against the nonce sent by FND. The nonce is verified only for the first time when a device communicates with FND.

Only Cisco IOS-XE devices support the challenge string using the SUDI certificate.

Note By default, the challenge string validation is enabled for PSK-based tunnels. However, you can skip the device validation using the challenge string by setting the cgms.properties to false. After disabling the property, you have to restart the cgms service.

```
enable-challenge-string-auth=false
```

Device Validation Using a Challenge String

FND validates the device during onboarding by sending a challenge string using the following command.

```
sh platform sudi certificate sign nonce <generated number>
```

- On successful verification, FND authenticates the device for further communications.
- If the verification fails, an error message is logged in the server.log file, and the device is not onboarded.

PSK Rotation

To protect against pre-shared key (PSK) vulnerabilities and hacks, PSK rotation is utilized in Cisco IoT FND, which provides an additional layer of security for the device communication. This involves running the script either manually or schedule using a cron. The script is bundled with the cgms tools package of Cisco IoT FND. The cgms tools package is installed on a Cisco IoT FND Postgres VM. However, you can also install the cgms tools package on a separate VM (It is not necessary to have Cisco IoT FND installed in this VM). For information on installing cgms tools on a separate VM, see Installing CGMS Tools RPM on a Separate VM, on page 38.

When the script is run, it rotates the pre-shared key at both HER and FAR and flaps the tunnels for a secure network. The PSK rotation feature is available only to customers who use PSK for tunnel management with FlexVPN.

- Manual PSK Rotation
- Schedule PSK Rotation Using Cron

Prerequisites

Ensure that all prerequisites are met before running the PSK rotation script for every fresh install or upgrade.

- Run the script during the maintenance window.

- Ensure that the Cisco IoT FND service is not active when executing the script.
- Ensure that there are no active operations (like configuration push, firmware upgrade) running in Cisco IoT FND.
- Copy the following files from cgms rpm package (`/opt/cgms`) to cgms-tools package (`/opt/cgms-tools`).

Filename	Copy From (cgms package)	Copy To (cgms-tools package)
fnd_psk_enc	/opt/cgms/server/cgms/conf/.fnd_psk_enc	/opt/cgms-tools/conf
fnd_psk.keystore	/opt/cgms/server/cgms/conf/fnd_keystore	/opt/cgms-tools/conf
jdbc.properties	/opt/cgms/tools/conf/jdbc.properties	/opt/cgms-tools/conf/jdbc.properties
cgms_keystore	/opt/cgms/server/cgms/conf/cgms_keystore	/opt/cgms-tools/conf
cgms.properties	/opt/cgms/server/cgms/conf/cgms.properties	/opt/cgms-tools/conf

Manual PSK Rotation

Run the following script (location: `/opt/cgms-tools/bin`) to rotate the PSK.

```
$ ./rotate-psk <csv-file>
```

The `<csv-file>` refers to the CSV file location, which contains the list of HER name or FAR name (with HER peer name).

- If the CSV file contains the name of the HER, then the HER PSK of all the FARs and the FAR PSK are rotated.
- If the CSV file contains the name of the FAR, then the PSK of the specified FAR and the HER associated with the FAR are rotated.

Sample CSV file with HER NAME:

```
HER_NAME,  HER_PEER_NAME, KEYRING_NAME
C8000V+9B35BAR3OKT, CLUSTER-2, FlexVPN_Keyring
C8000V+9OA9SRYYZVZ, CLUSTER-1, FlexVPN_Keyring1
```

Note HER_PEER_NAME is the `identity local key-id name` configured on the HER.

Sample CSV file with FAR NAME:

```
FAR_NAME,     HER_PEER_NAME , KEYRING_NAME
IR1835-K9+FCW2730Y1UZ, CLUSTER-1, FlexVPN_Keyring
IR1101-K9+FCW2710ZA25, CLUSTER-2, FlexVPN_Keyring1
IR1101-K9+FCW2708YA53, CLUSTER-2, FlexVPN_Keyring2
```

The status of the device PSK rotation, for both success or a failure, is available in the CSV file (`rotate-psk-timestamp.csv`).

Log Location:

- The output status log of PSK rotation for each device is stored at: `/opt/cgms-tools/log/rotate-psk-<timestamp>.csv`.

  Sample CSV output:

  ```
  ROUTER,MESSAGE,STATUS
  IR1835-K9+FCW2730Y1UZ,PSK update for FAR IR1835-K9+FCW2730Y1UZ was failure as FAR is
  down ,FAILURE
  IR1835-K9+FCW2730Y2UZ,PSK update success for FAR IR1835-K9+FCW2730Y1UZ connected to HER
   C8000V+9B35BAR3OKT,SUCCESS
  ```

- Debug logs are stored at: `/opt/cgms-tools/log/rotate-psk.log`.

Schedule PSK Rotation Using Cron

Alternatively, cron is used to run the script automatically at a specific time and day of a month. You can schedule PSK rotation for the following deployments:

- Postgres OVA

The following prerequisites are must:

- Ensure that the script is scheduled to run during the monthly maintenance window to avoid conflict with other active operations in Cisco IoT FND.
- For a successful PSK rotation, it is recommended to allow a 24-hour gap between each script execution.

Note After each successful PSK rotation, the tunnel is toggled. As a result, the tunnel between HER and FAR comes up with a new PSK value.

Postgres OVA Deployment

Follow the steps to schedule PSK rotation for Postgres OVA.

Procedure

Step 1 Install the tools `rpm` in VM.

Step 2 Enable the db connection in `pg_hba.conf` with the following entry.

```
host all all <IP of the VM to be entered here>/32 md5
```

Step 3 Restart `postgresql`.

```
service postgresql-12 stop
 service postgresql-12 start
```

Step 4 Copy the following files from docker container to cgms-tools package.

a) `docker cp fnd-container:/opt/cgms/server/cgms/conf/.fnd_psk_enc /opt/cgms-tools/conf`

b) `docker cp fnd-container:/opt/cgms/server/cgms/conf/fnd_psk.keystore /opt/cgms-tools/conf`

c) `docker cp fnd-container:/opt/cgms/tools/conf/jdbc.properties /opt/cgms-tools/conf/jdbc.properties`

d) `docker cp fnd-container:/opt/cgms/server/cgms/conf/cgms_keystore /opt/cgms-tools/conf`

e) `docker cp fnd-container:/opt/cgms/server/cgms/conf/cgms.properties /opt/cgms-tools/conf`

Installing CGMS Tools RPM on a Separate VM

Follow the steps to install CGMS tools rpm on a separate VM.

Procedure

Step 1 Install the `cgms-tools` rpm.

- For the Postgres deployment, extract the cgms tools file (CISCO-IOTFND-VPI-K9-CGMS-TOOLS-<release>-<build>.zip) from the upgrade script (CISCO-IOTFND-VPI-K9-UPGRADE-SCRIPTS-<release>-<build number>.zip) and install the cgms tools in the server. For more information, see Postgres Installation Guide.

Step 2 Copy the prerequisite files from the Cisco IoT FND server to the path where the `cgms-tools` package is installed.

- `copy .fnd_psk_enc from /opt/cgms/server/cgms/conf/.fnd_psk_enc to /opt/cgms-tools/conf`
- `copy fnd_psk.keystore from /opt/cgms/server/cgms/conf/fnd_psk.keystore to /opt/cgms-tools/conf`
- `copy jdbc.properties from /opt/cgms/tools/conf/jdbc.properties to /opt/cgms-tools/conf/jdbc.properties`
- `copy cgms_keystore from /opt/cgms/server/cgms/conf/cgms_keystore to /opt/cgms-tools/conf`
- `copy cgms.properties from /opt/cgms/server/cgms/conf/cgms.properties to /opt/cgms-tools/conf`

Step 3 Provide Postgres IP in the `jdbc.properties` as below.

```
jdbc.url=jdbc:postgresql://<Postgres IP>:5432/cgms
```

Step 4 Add the route in the server for the device reachability.

On successful cgms tools installation, the PSK rotation script is executed.

IPAM for Loopback

Loopback IP addresses for FAR devices forming tunnels was assigned by an external DHCP Server with FND acting as the DHCP client. IoT FND now generates the IPv4 and IPv6 addresses for the provided subnet while forming the tunnels without relying on the third-party DHCP Server. The consumption of internal IP addresses applies only for first-time IoT FND installation and the users with administrative privileges only can access. This is supported only in root domain.

Procedure

Step 1 While setting up IoT FND, run the setupCgms.sh script on the IoT FND server and choose your preferred IP allocation method for loopback IPs in the user prompt. For more information about running the setupCgms.sh script, see Setting Up IoT FND.

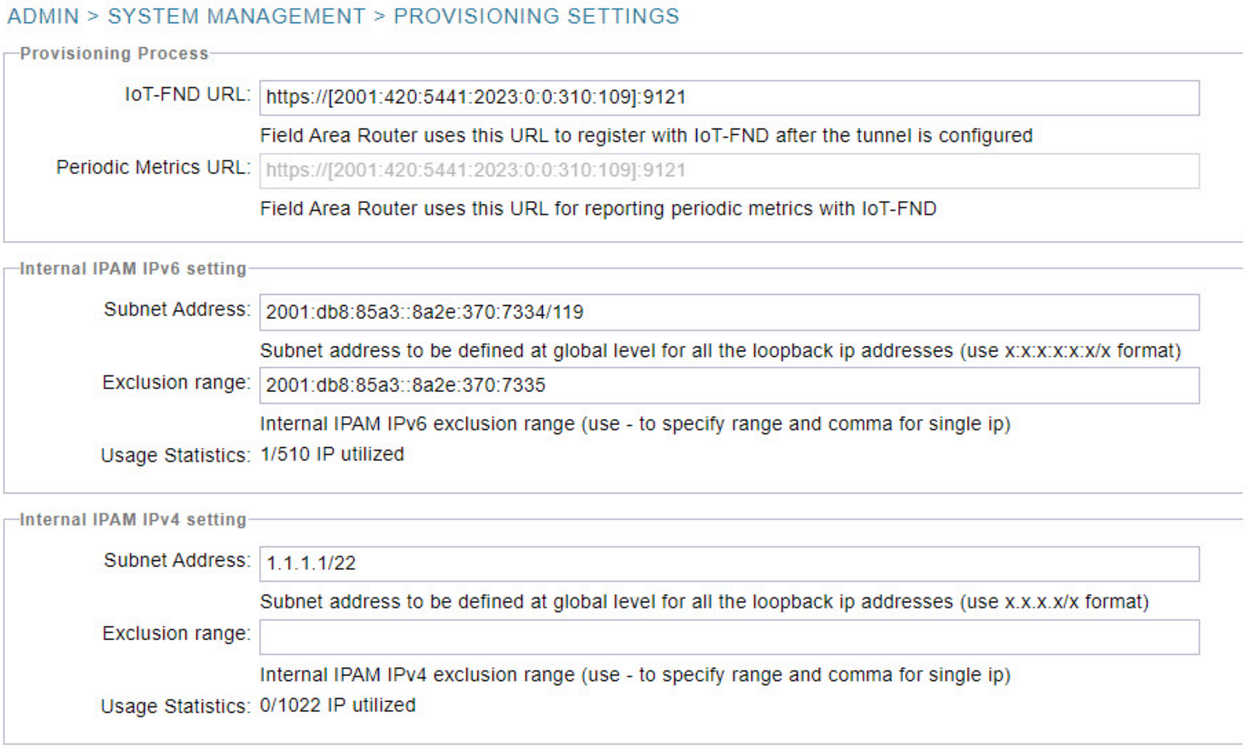
Step 2 If you choose IPAM, configure the subnet in the **Admin** > **System Management** > **Provisioning Settings** page.

Note
To configure the subnet range, set the limit in **ipam-ipv6-subnet-limit** or **ipam-ipv4-subnet-limit** property in cgms.properties file. The default values for the properties are 108 (generates around 1,048,576 IPv6) and 12 (generates around 1,048,576 IPv4) respectively.

Caution
Do not decrease the subnet size. If you intend to utilize more than 1 million IP addresses, we recommend consulting with Cisco for expert guidance and support.

Step 3 Provide the exclusion range as a single IP address, a range, or a list of multiple IP addresses separated by commas. The Usage Statistics is a label that shows the IP addresses utilized for the provided subnet.

Note
Provide values in either or both of the IPAM IPv6 and IPAM IPv4 setting.



ADMIN > SYSTEM MANAGEMENT > PROVISIONING SETTINGS

Provisioning Process

IoT-FND URL: https://[2001:420:5441:2023:0:0:310:109]:9121
Field Area Router uses this URL to register with IoT-FND after the tunnel is configured

Periodic Metrics URL: https://[2001:420:5441:2023:0:0:310:109]:9121
Field Area Router uses this URL for reporting periodic metrics with IoT-FND

Internal IPAM IPv6 setting

Subnet Address: 2001:db8:85a3::8a2e:370:7334/119
Subnet address to be defined at global level for all the loopback ip addresses (use x:x:x:x:x:x/x format)

Exclusion range: 2001:db8:85a3::8a2e:370:7335
Internal IPAM IPv6 exclusion range (use - to specify range and comma for single ip)

Usage Statistics: 1/510 IP utilized

Internal IPAM IPv4 setting

Subnet Address: 1.1.1.1/22
Subnet address to be defined at global level for all the loopback ip addresses (use x.x.x.x/x format)

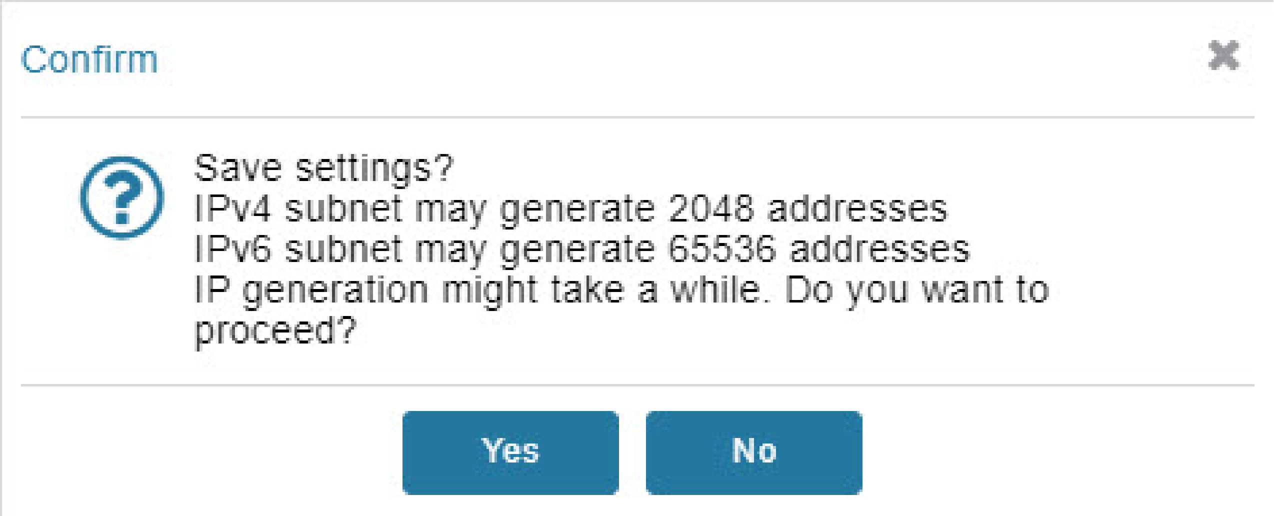
Exclusion range:
Internal IPAM IPv4 exclusion range (use - to specify range and comma for single ip)

Usage Statistics: 0/1022 IP utilized

Step 4 Click the Disk icon to save changes. The following window pops up to show the probable IP addresses that will be generated.

Note

If you choose to modify the subnet after the warning, then IoT FND deletes all the existing ip addresses created under previous subnet except the one being used and generates fresh ip addreses for new subnet.

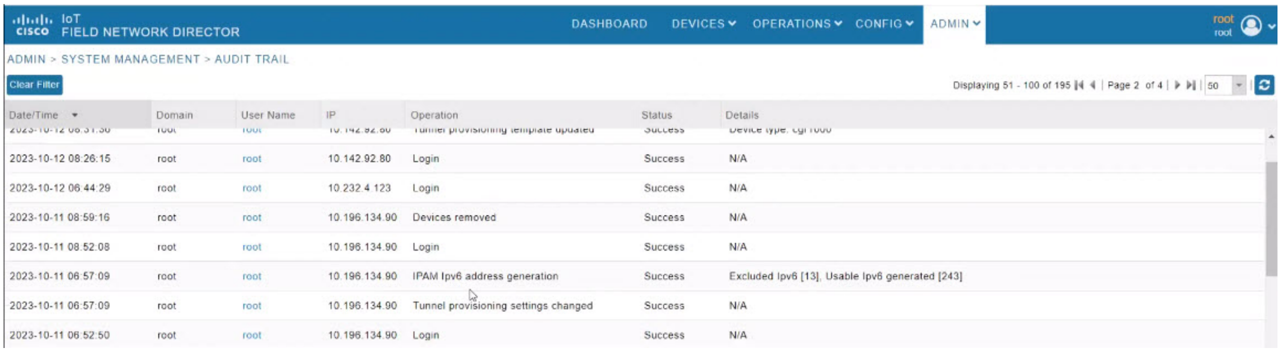


Confirm

Save settings?
IPv4 subnet may generate 2048 addresses
IPv6 subnet may generate 65536 addresses
IP generation might take a while. Do you want to proceed?

Step 5 Click **Yes**.

Step 6 Navigate to **ADMIN** > **SYSTEM MANAGEMENT** > **AUDIT TRAIL** page to check for the number of excluded IPs and the generated usable IPs.



IoT FIELD NETWORK DIRECTOR
DASHBOARD
DEVICES
OPERATIONS
CONFIG
ADMIN
root
root
ADMIN > SYSTEM MANAGEMENT > AUDIT TRAIL
Clear Filter
Displaying 51 - 100 of 195
Page 2 of 4
50

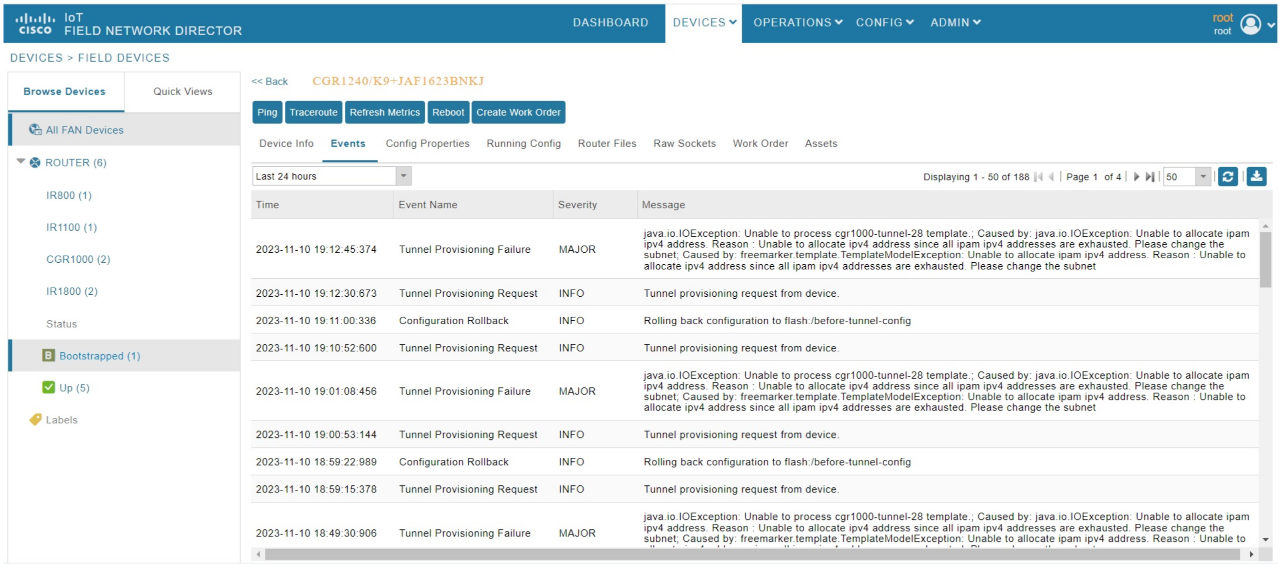
Date/Time	Domain	User Name	IP	Operation	Status	Details
2023-10-12 08:31:30	root	root	10.142.92.80	Tunnel provisioning template updated	Success	Device type: cgr1000
2023-10-12 08:26:15	root	root	10.142.92.80	Login	Success	N/A
2023-10-12 06:44:29	root	root	10.232.4.123	Login	Success	N/A
2023-10-11 08:59:16	root	root	10.196.134.90	Devices removed	Success	N/A
2023-10-11 08:52:08	root	root	10.196.134.90	Login	Success	N/A
2023-10-11 06:57:09	root	root	10.196.134.90	IPAM Ipv6 address generation	Success	Excluded Ipv6 [13], Usable Ipv6 generated [243]
2023-10-11 06:57:09	root	root	10.196.134.90	Tunnel provisioning settings changed	Success	N/A
2023-10-11 06:52:50	root	root	10.196.134.90	Login	Success	N/A

After configuring subnet settings and generating IP addresses, initiate the tunnel provisioning process.

Note

During tunnel provisioning, if the IP address is provided in the CSV in the `loopbackv4address` and `loopbackv6address` property when adding routers, it is utilized as the loopback IP address. In case the IP address is not provided in the CSV, then internal IP address is fetched.

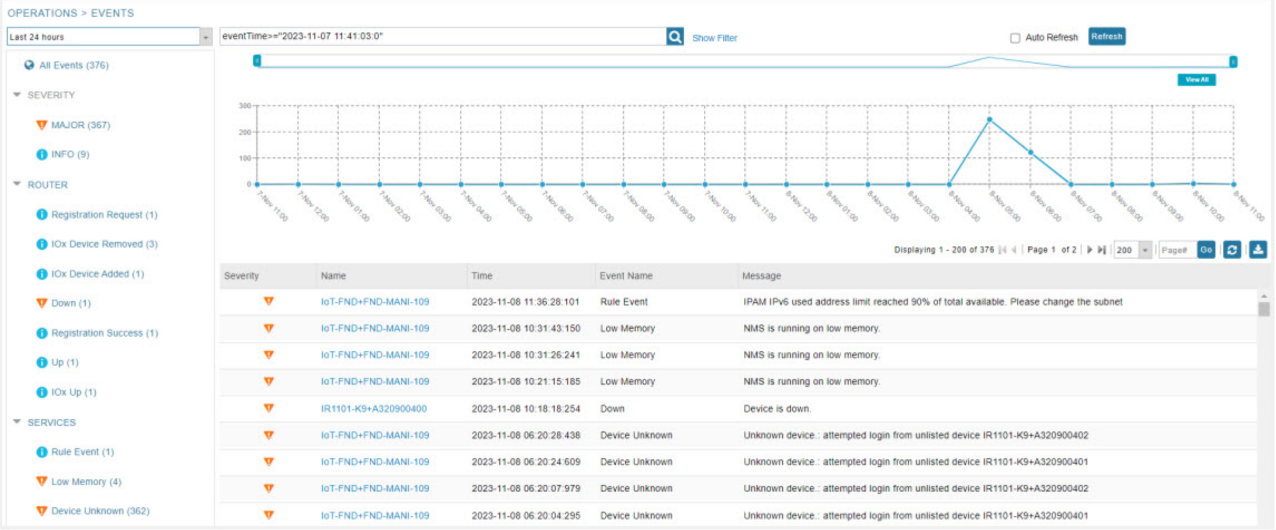
If the tunnel provisioning fails as IP address lease exceeds, then the error message is seen in the **DEVICES** > **FIELD DEVICES** page under Events tab.



Time	Event Name	Severity	Message
2023-11-10 19:12:45:374	Tunnel Provisioning Failure	MAJOR	java.io.IOException: Unable to process cgr1000-tunnel-28 template.; Caused by: java.io.IOException: Unable to allocate ipam ipv4 address. Reason : Unable to allocate ipv4 address since all ipam ipv4 addresses are exhausted. Please change the subnet; Caused by: freemarker.template.TemplateModelException: Unable to allocate ipam ipv4 address. Reason : Unable to allocate ipv4 address since all ipam ipv4 addresses are exhausted. Please change the subnet
2023-11-10 19:12:30:673	Tunnel Provisioning Request	INFO	Tunnel provisioning request from device.
2023-11-10 19:11:00:336	Configuration Rollback	INFO	Rolling back configuration to flash:/before-tunnel-config
2023-11-10 19:10:52:600	Tunnel Provisioning Request	INFO	Tunnel provisioning request from device.
2023-11-10 19:01:08:456	Tunnel Provisioning Failure	MAJOR	java.io.IOException: Unable to process cgr1000-tunnel-28 template.; Caused by: java.io.IOException: Unable to allocate ipam ipv4 address. Reason : Unable to allocate ipv4 address since all ipam ipv4 addresses are exhausted. Please change the subnet; Caused by: freemarker.template.TemplateModelException: Unable to allocate ipam ipv4 address. Reason : Unable to allocate ipv4 address since all ipam ipv4 addresses are exhausted. Please change the subnet
2023-11-10 19:00:53:144	Tunnel Provisioning Request	INFO	Tunnel provisioning request from device.
2023-11-10 18:59:22:989	Configuration Rollback	INFO	Rolling back configuration to flash:/before-tunnel-config
2023-11-10 18:59:15:378	Tunnel Provisioning Request	INFO	Tunnel provisioning request from device.
2023-11-10 18:49:30:906	Tunnel Provisioning Failure	MAJOR	java.io.IOException: Unable to process cgr1000-tunnel-28 template.; Caused by: java.io.IOException: Unable to allocate ipam ipv4 address. Reason : Unable to allocate ipv4 address since all ipam ipv4 addresses are exhausted. Please change the subnet; Caused by: freemarker.template.TemplateModelException: Unable to allocate ipam ipv4 address. Reason : Unable to

Note

In the **Operations** > **Events** page, check the event generated. A minor event is generated if the percentage of utilization crosses 80% of total generated IP. Similarly, a major event is generated if the percentage of utilization crosses 90% of total generated IP. You can configure the limit for major threshold in **ipam-ipAddress-pool-thresold-limit** property in cgms.properties file. The default value is set to 90, if not configured.



Severity	Name	Time	Event Name	Message
▼	IoT-FND+FND-MANI-109	2023-11-08 11:36:28:101	Rule Event	IPAM IPv6 used address limit reached 90% of total available. Please change the subnet
▼	IoT-FND+FND-MANI-109	2023-11-08 10:31:43:150	Low Memory	NMS is running on low memory.
▼	IoT-FND+FND-MANI-109	2023-11-08 10:31:26:241	Low Memory	NMS is running on low memory.
▼	IoT-FND+FND-MANI-109	2023-11-08 10:21:15:185	Low Memory	NMS is running on low memory.
▼	IR1101-K9+A320900400	2023-11-08 10:18:18:254	Down	Device is down.
▼	IoT-FND+FND-MANI-109	2023-11-08 06:20:28:438	Device Unknown	Unknown device.: attempted login from unlisted device IR1101-K9+A320900402
▼	IoT-FND+FND-MANI-109	2023-11-08 06:20:24:609	Device Unknown	Unknown device.: attempted login from unlisted device IR1101-K9+A320900401
▼	IoT-FND+FND-MANI-109	2023-11-08 06:20:07:979	Device Unknown	Unknown device.: attempted login from unlisted device IR1101-K9+A320900402
▼	IoT-FND+FND-MANI-109	2023-11-08 06:20:04:295	Device Unknown	Unknown device.: attempted login from unlisted device IR1101-K9+A320900401

Once tunnels are assigned an IP address, the DB is also updated.

For tunnel reprovisioning, the router uses the same IP address.

IPAM for All Interfaces

The IP addresses for FAR devices forming tunnels was assigned by an external DHCP server with IoT FND acting as the DHCP client. IoT FND now generates the IPv4 and IPv6 addresses for the provided subnet while forming the tunnels without relying on the third-party DHCP server. The consumption of internal IP addresses applies only for first-time IoT FND installation and the users with administrative privileges only can access. This is supported only in root domain.

Starting from IoT FND release 4:12 onwards, IoT FND supports IPAM for all interfaces. You can define multiple subnets and IoT FND manages those subnets.

Note When you upgrade to IoT FND release 4:12, one subnet is migrated, subnet id is created and listed under the respective tabs in the Provisioning settings page.

Procedure

Step 1 To enable IPAM, run the setupCgms.sh script on the IoT FND server while setting up IoT FND. Choose IPAM in the user prompt. IPAM takes precedence over DHCP server for IP address management. For more information about running the setupCgms.sh script, see Setting Up IoT FND.

Step 2 If you choose IPAM, configure the subnet in the **Admin** > **System Management** > **Provisioning Settings** page.

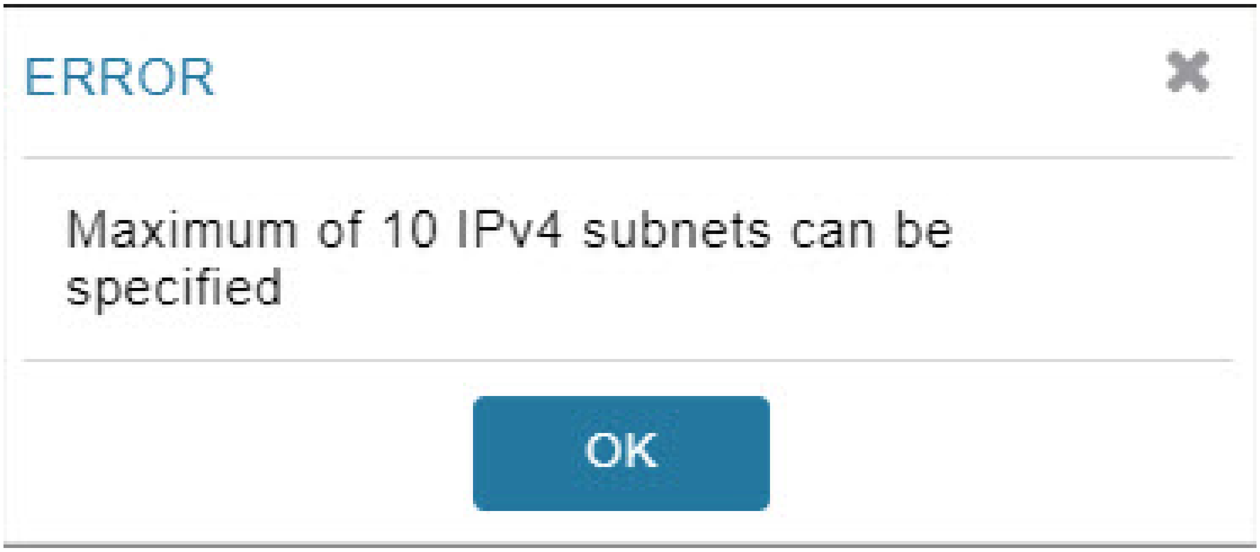
Step 3 Click the IPAM-IPv4 and IPAM-IPv6 tabs to define the IPv4 and IPv6 subnets.

Note
To configure the subnet range, set the limit in **ipam-ipv6-subnet-limit** or **ipam-ipv4-subnet-limit** property in cgms.properties file. The default values for IPv6 and IPv4 properties are 108 (generates around 1,048,576 IPv6) and 12 (generates around 1,048,576 IPv4) respectively.

Caution
Do not decrease the subnet size. If you intend to utilize more than 1 million IP addresses, we recommend consulting with Cisco for expert guidance and support.

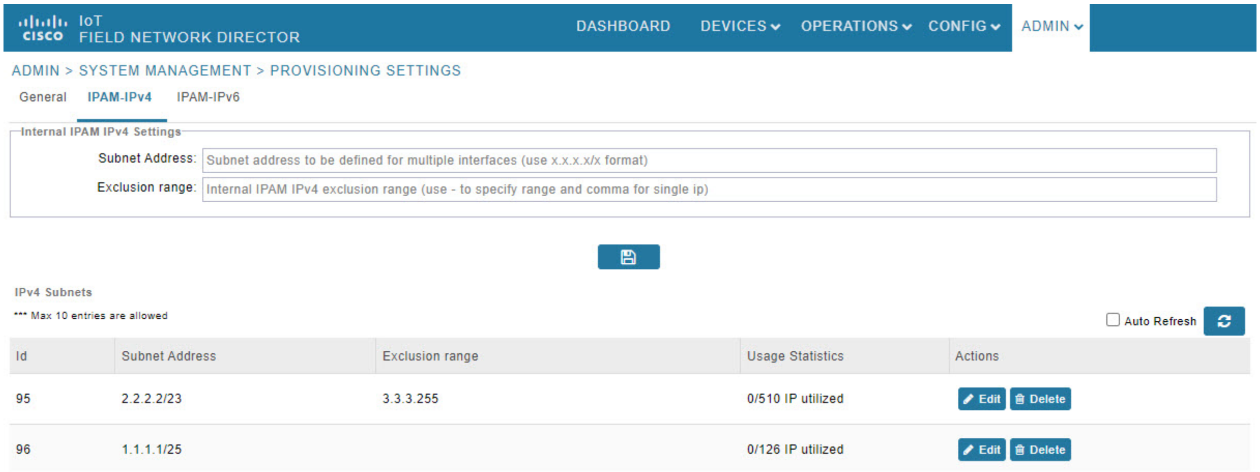
Step 4 Enter the Subnet Address and Exclusion range. The Exclusion range can be provided as a single IP address, range, or list of multiple IP addresses separated by commas.

Note
You cannot define more than 10 subnets. The following error message appears when you try to define additional subnets. This is applicable for IPv6 subnets as well.



ERROR

Maximum of 10 IPv4 subnets can be specified



ADMIN > SYSTEM MANAGEMENT > PROVISIONING SETTINGS

Internal IPAM IPv4 Settings

Subnet Address: Subnet address to be defined for multiple interfaces (use x.x.x.x/x format)

Exclusion range: Internal IPAM IPv4 exclusion range (use - to specify range and comma for single ip)

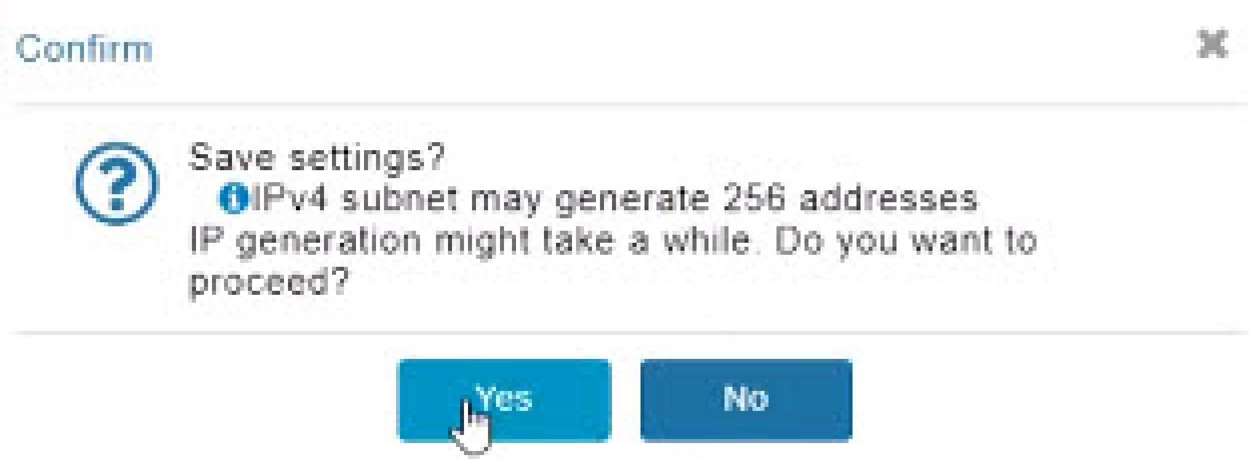
IPv4 Subnets

*** Max 10 entries are allowed

□ Auto Refresh

Id	Subnet Address	Exclusion range	Usage Statistics	Actions
95	2.2.2.2/23	3.3.3.255	0/510 IP utilized	Edit Delete
96	1.1.1.1/25		0/126 IP utilized	Edit Delete

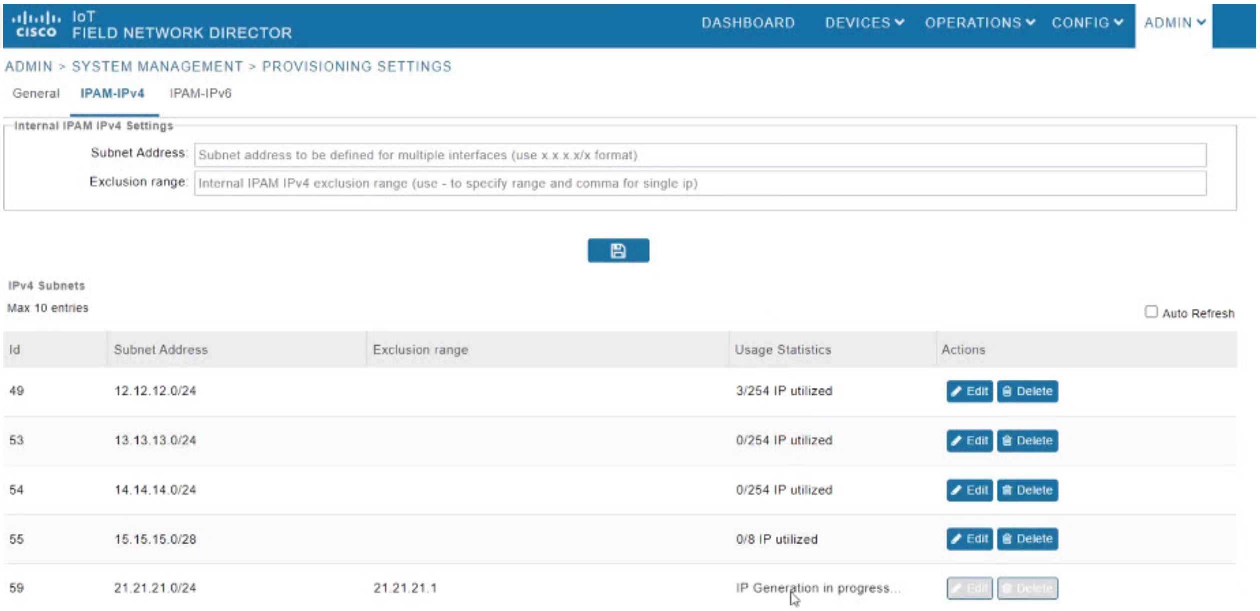
Step 5 Click the Disk icon to save changes. The following window pops up to show the probable IP addresses that will be generated.



Confirm

Save settings?
IPv4 subnet may generate 256 addresses
IP generation might take a while. Do you want to proceed?

Step 6 Click **Yes**. The IP address generation is in progress.



Internal IPAM IPv4 Settings

Subnet Address: Subnet address to be defined for multiple interfaces (use x.x.x.x/x format)

Exclusion range: Internal IPAM IPv4 exclusion range (use - to specify range and comma for single ip)

IPv4 Subnets

Max 10 entries

Id	Subnet Address	Exclusion range	Usage Statistics	Actions
49	12.12.12.0/24		3/254 IP utilized	Edit Delete
53	13.13.13.0/24		0/254 IP utilized	Edit Delete
54	14.14.14.0/24		0/254 IP utilized	Edit Delete
55	15.15.15.0/28		0/8 IP utilized	Edit Delete
59	21.21.21.0/24	21.21.21.1	IP Generation in progress...	Edit Delete

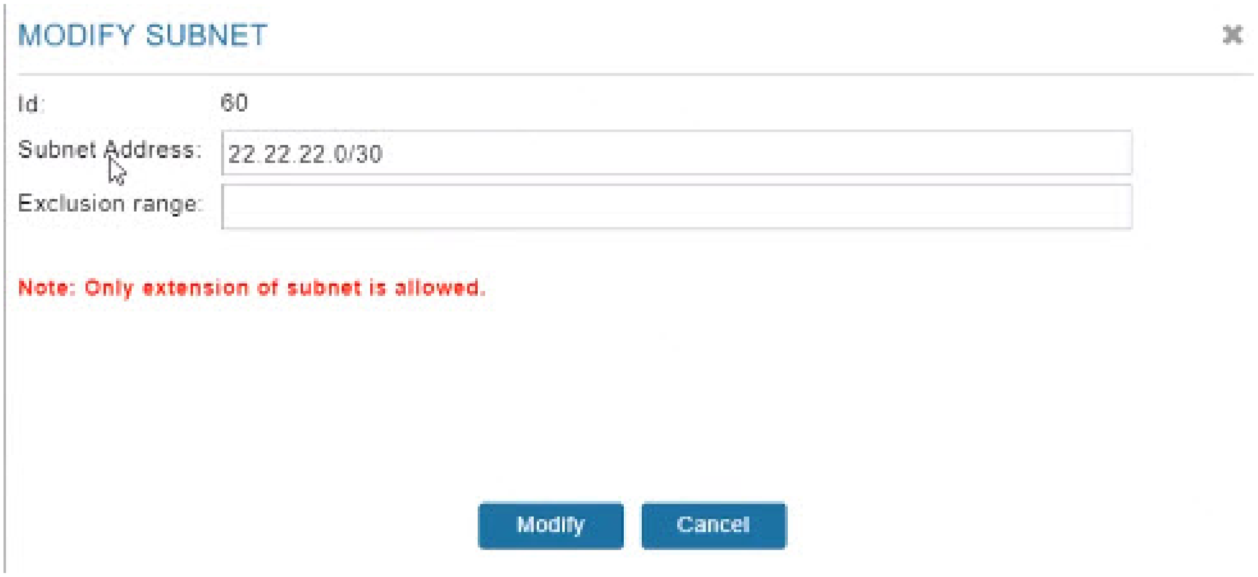
The following table describes the fields in the IPv4 Subnets tab.

Field	Description
Id	Indicates the subnet id allocated for the defined subnet.
Subnet Address	Indicates the defined subnet address.
Exclusion range	Indicates the range of IP addresses within a subnet that are excluded from being assigned to devices.
Usage Statistics	Indicates the IP addresses utilized for the provided subnet.
Actions	You can either modify or delete the subnets.

Step 7 To edit the subnet details:

- Click Edit to modify the subnet.
- Edit the Subnet Address and Exclusion range and click **Modify**.

Important
You can only extend the subnet while editing and shrinking the subnet is not allowed.



MODIFY SUBNET

Id: 60

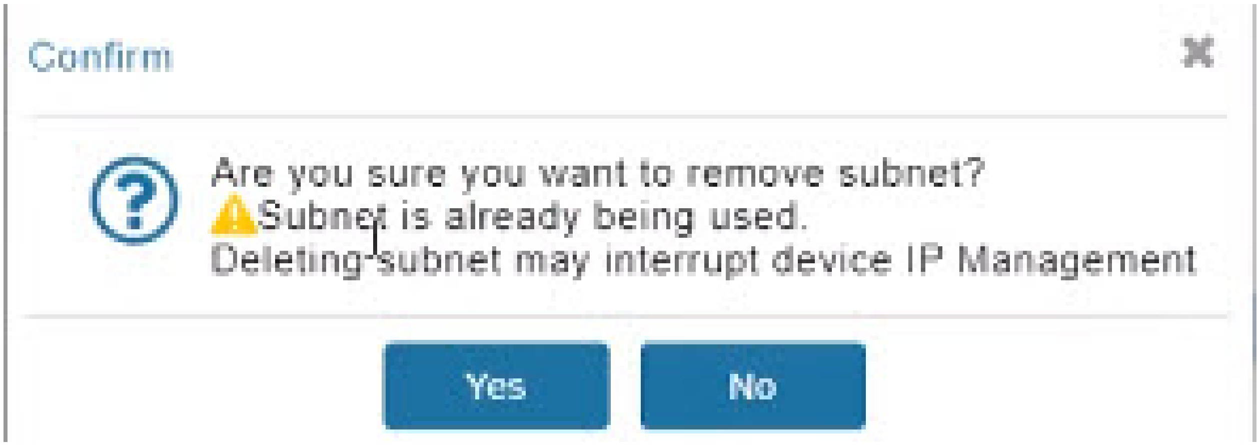
Subnet Address: 22.22.22.0/30

Exclusion range:

Note: Only extension of subnet is allowed.

You can also delete the subnet by clicking the delete icon. In case you delete the subnet where some of the IPs are utilized, the following warning pops up. Click **Yes** to proceed.

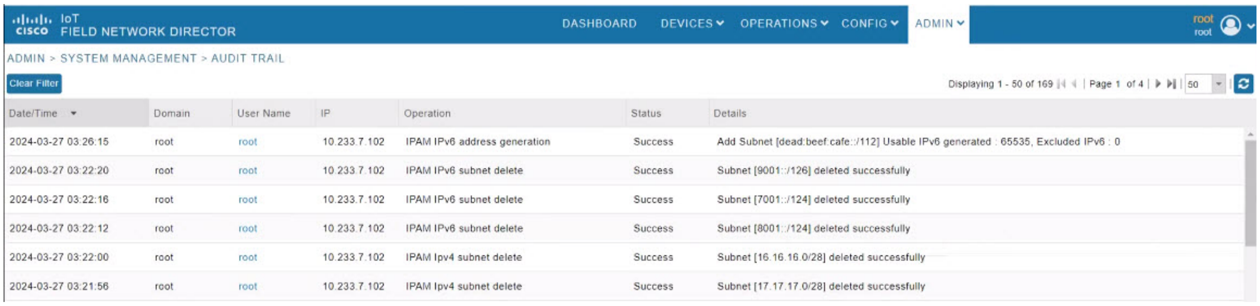
Note
It is recommended to recheck before proceeding as there are no restrictions in deletion.



Confirm

Are you sure you want to remove subnet?
⚠Subnet is already being used.
Deleting subnet may interrupt device IP Management

Step 8 Navigate to **ADMIN** > **SYSTEM MANAGEMENT** > **AUDIT TRAIL** page to see the addition, modification, and deletion of the subnets.



IoT FIELD NETWORK DIRECTOR
DASHBOARD
DEVICES
OPERATIONS
CONFIG
ADMIN
root
root
ADMIN > SYSTEM MANAGEMENT > AUDIT TRAIL
Clear Filter
Displaying 1 - 50 of 169 | Page 1 of 4 | 50

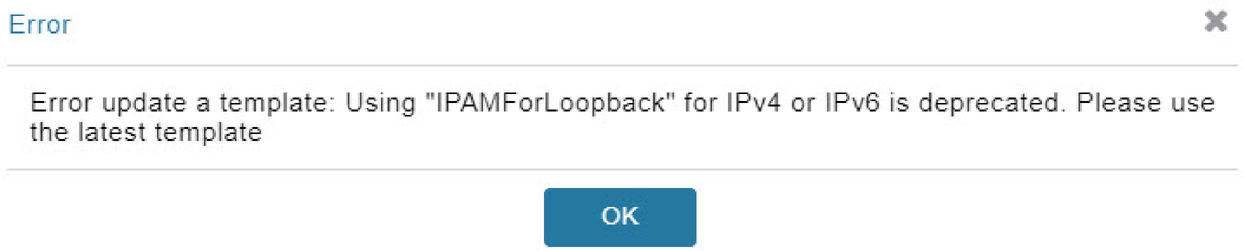
Date/Time	Domain	User Name	IP	Operation	Status	Details
2024-03-27 03:26:15	root	root	10.233.7.102	IPAM IPv6 address generation	Success	Add Subnet [dead:beef:cafe::/112] Usable IPv6 generated : 65535, Excluded IPv6 : 0
2024-03-27 03:22:20	root	root	10.233.7.102	IPAM IPv6 subnet delete	Success	Subnet [9001::/126] deleted successfully
2024-03-27 03:22:16	root	root	10.233.7.102	IPAM IPv6 subnet delete	Success	Subnet [7001::/124] deleted successfully
2024-03-27 03:22:12	root	root	10.233.7.102	IPAM IPv6 subnet delete	Success	Subnet [8001::/124] deleted successfully
2024-03-27 03:22:00	root	root	10.233.7.102	IPAM Ipv4 subnet delete	Success	Subnet [16.16.16.0/28] deleted successfully
2024-03-27 03:21:56	root	root	10.233.7.102	IPAM Ipv4 subnet delete	Success	Subnet [17.17.17.0/28] deleted successfully

Step 9 Go to **CONFIG** > **TUNNEL PROVISIONING** and click Router Tunnel Addition. Enter the Subnet ID in the Router Tunnel Addition template and click Save.

```
interface Loopback0
    <#--
      If the loopback interface IPv4 address property has been set on the CGR
      then configure the interface with that address. Otherwise obtain an
      address for the interface now using DHCP.
    -->
    <#if far.loopbackV4Address??>
      <#assign loopbackIpv4Address=far.loopbackV4Address>
    <#elseif far.isIPAMSelected()??>
      <#assign loopbackIpv4Address=far.IPAMIpv4address(1)>
    <#else>
      <#--
        Obtain an IPv4 address that can be used to for this FAR's Loopback
        interface. The template API provides methods for requesting a lease from
        a DHCP server. The IPv4 address method requires a DHCP client ID and a link
        address to send in the DHCP request. The 3rd parameter is optional and
        defaults to "IoT-FND". This value is sent in the DHCP user class option.
        The API also provides the method "dhcpClientId". This method takes a DHCPv6
        Identity association identifier (IAID) and a DHCP Unique IDentifier (DUID)
        and generates a DHCPv4 client identifier as specified in RFC 4361. This
        provides some consistency in how network elements are identified by the
        DHCP server.
      -->
      <#assign
loopbackIpv4Address=far.ipv4Address(dhcpClientId(far.enDuid,0),far.dhcpV4LoopbackLink).address>
    </#if>
    ip address ${loopbackIpv4Address} 255.255.255.255
    <#--
      If the loopback interface IPv6 address property has been set on the CGR
      then configure the interface with that address. Otherwise obtain an
      address for the interface now using DHCP.
    -->
    <#if far.loopbackV6Address??>
      <#assign loopbackIpv6Address=far.loopbackV6Address>
    <#elseif far.isIPAMSelected()??>
      <#assign loopbackIpv6Address=far.IPAMIpv6address(21)>
    <#else>
```

Note

IoT FND throws the following error while processing the template during tunnel provisioning if the template contains obsolete methods.



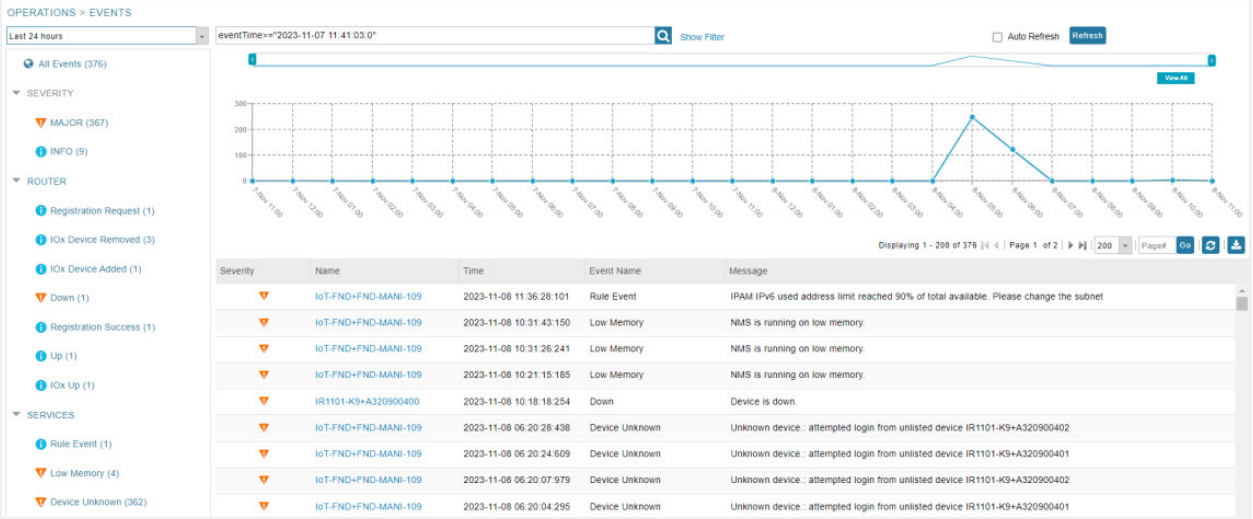
Error update a template: Using "IPAMForLoopback" for IPv4 or IPv6 is deprecated. Please use the latest template

Step 10 After configuring subnet settings and generating IP addresses, initiate the tunnel provisioning process. Once the PNP is complete, the IP addresses are allocated to the respective interfaces which can be seen under the IPv4 and IPv6 tabs in the **Admin** > **System Management** > **Provisioning Settings** page.

Note

During tunnel provisioning, if the IP address is defined in the CSV in `loopbackv4address` and `loopbackv6address` property while adding routers, it is utilized as the loopback IP address. In case the IP address is not provided in the CSV, then internal IP address is fetched. This is applicable for loopback interface only.

Step 11 In the **Operations** > **Events** page, an event is generated if the percentage of utilization crosses 90% of total generated IP.You can configure the limit for major threshold in **ipam-ipAddress-pool-thresold-limit** property in cgms.properties file. The default value is set to 90, if not configured.



Last 24 hours

eventTime>="2023-11-07 11:41:03:0"

All Events (376)

SEVERITY
- MAJOR (367)
- INFO (9)

ROUTER
- Registration Request (1)
- IOx Device Removed (3)
- IOx Device Added (1)
- Down (1)
- Registration Success (1)
- Up (1)
- IOx Up (1)

SERVICES
- Rule Event (1)
- Low Memory (4)
- Device Unknown (362)

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Severity	Name	Time	Event Name	Message
▼	IoT-FND+FND-MANI-109	2023-11-08 11:36:28:101	Rule Event	IPAM IPv6 used address limit reached 90% of total available. Please change the subnet
▼	IoT-FND+FND-MANI-109	2023-11-08 10:31:43:150	Low Memory	NMS is running on low memory.
▼	IoT-FND+FND-MANI-109	2023-11-08 10:31:26:241	Low Memory	NMS is running on low memory.
▼	IoT-FND+FND-MANI-109	2023-11-08 10:21:15:185	Low Memory	NMS is running on low memory.
▼	IR1101-K9+A320900400	2023-11-08 10:18:18:254	Down	Device is down.
▼	IoT-FND+FND-MANI-109	2023-11-08 06:20:28:438	Device Unknown	Unknown device.: attempted login from unlisted device IR1101-K9+A320900402
▼	IoT-FND+FND-MANI-109	2023-11-08 06:20:24:609	Device Unknown	Unknown device.: attempted login from unlisted device IR1101-K9+A320900401
▼	IoT-FND+FND-MANI-109	2023-11-08 06:20:07:979	Device Unknown	Unknown device.: attempted login from unlisted device IR1101-K9+A320900402
▼	IoT-FND+FND-MANI-109	2023-11-08 06:20:04:295	Device Unknown	Unknown device.: attempted login from unlisted device IR1101-K9+A320900401

Once tunnels are assigned an IP address, the DB is also updated.

During decommissioning of the device or subnet, IPAM IP address is marked unused. Click Refresh and the IP addresses is released.