Quick Integration Guide for Cisco IoT FND in Pre-Shared Key Based Deployments

Quick bringup and integration of Cisco IoT FND, IPAM, HER, TPS

PnP and ZTD with validated templates (bootstrap, tunnel, and config)

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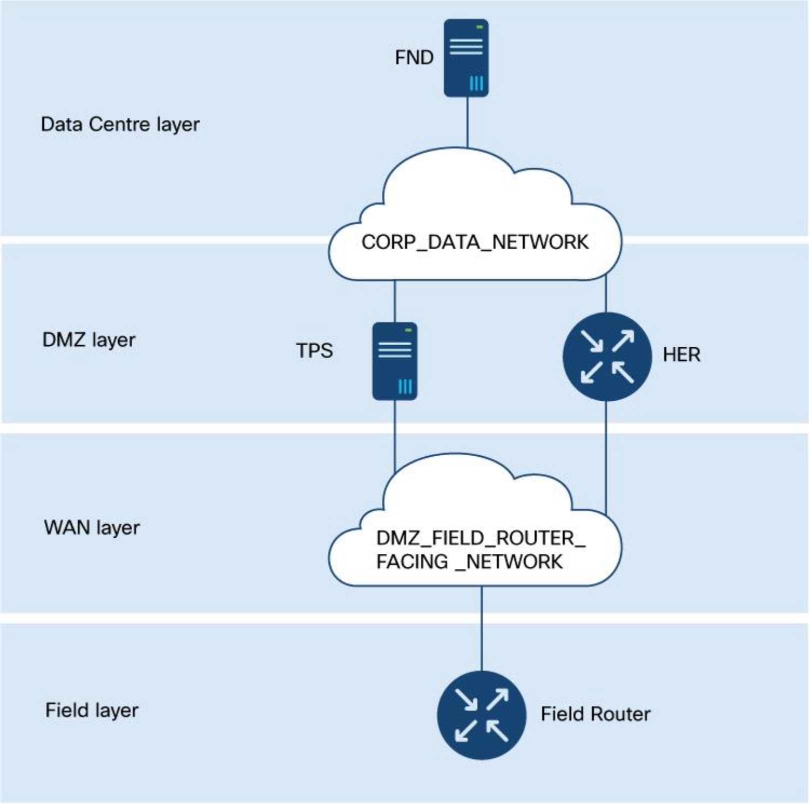
Introduction

The objective of this document is to provide quick integration steps to onboard Cisco IoT Field Network Director (FND) and to integrate it with other components like tunnel provisioning servers (TPS) and head-end routers (HER). It also covers steps required to configure and make use of the IP Address Management (IPAM) functionality (in-built DHCP Server) in Cisco IoT FND.

Note: This guide only applies to greenfield deployments.

The integration tunnel between a field router and the head-end router is secured with IPSec tunnels using pre-shared keys (PSK). This document also covers the templates that are essential for PnP bootstrapping,and Zero Touch Deployment (ZTD) of field routers.

Figure 1. Deployment topology for the examples in this guide



Supported component versions

Table 1. Minimum version for the integration

Component	Description	Minimum version required	Version used in the documented examples
ESXi	Hypervisor	6.5	7.0U3
FND	Field Network Director / NMS	5.0	5.0
TPS	Tunnel Proxy Server	5.0	5.0
Cisco Catalyst 8000 platform	Head-end router	17.9.5	17.12.4b
IR1101	Field router	17.9.5b	17.15.3

For the most recent version compatibility information, see Release Notes for Director, Release 5.0.x.Essential configuration items

Tech tip: Print out the Essential configuration items

table (Table 11), and fill out the values for the configuration items for reference as you carry out the tasks in this guide.

Cisco IoT FND deployment using OVA on ESXi

This section provides an overview of deploying Cisco IoT FND using an Open Virtual Appliance (OVA) file on VMware ESXi. It covers the prerequisites, installation steps, and configurations necessary to set up the Cisco IoT FND environment effectively.

Table 2. Essential configuration items for Cisco IoT FND OVA deployment on ESXi

Configuration Item	Description
ESXI_HOST_URL	IP Address of the ESXi host (version 6.5 and above) where the Cisco IoT FND VM will be deployed.
ESXI_HOST_USERNAME	Username to access the ESXi host.
ESXI_HOST_PASSWORD	Password to access the ESXi host.
FND_OVA_IMAGE	Cisco IoT FND OVA image.
ADMIN_NETWORK_PORTGROUP	ESXi port group that will be used for Admin Network SSH and GUI access.
CORP_DATA_NETWORK_PORTGROUP	ESXi port group that will be used for Corporate Data Network for the communication of Cisco IoT FND with HER, TPS, and field routers (via TPS or HER).

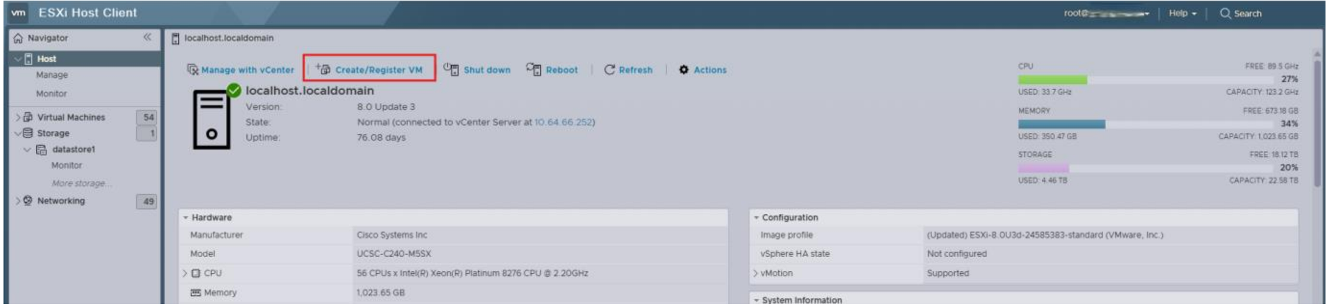
Import Cisco IoT FND OVA file into an ESXi host

Step 1. Log into the VMware ESXi server using a web browser, using the configuration items ESXI_HOST_URL, ESXI_HOST_USERNAME, and ESXI_HOST_PASSWORD.

Step 2. From the main menu of the ESXi host client, choose **Host**.

Step 3. Click **Create/ Register VM** to initiate the wizard to create a new virtual machine.

Figure 2. **Select Create/ Register VM on ESXi host**



localhost.localdomain

Version: 8.0 Update 3
State: Normal (connected to vCenter Server at 10.64.66.252)
Uptime: 76.08 days

CPU: FREE: 89.5 GHz, 27%, USED: 33.7 GHz, CAPACITY: 123.2 GHz
MEMORY: FREE: 673.18 GB, 34%, USED: 350.47 GB, CAPACITY: 1,023.65 GB
STORAGE: FREE: 18.12 TB, 20%, USED: 4.46 TB, CAPACITY: 22.58 TB

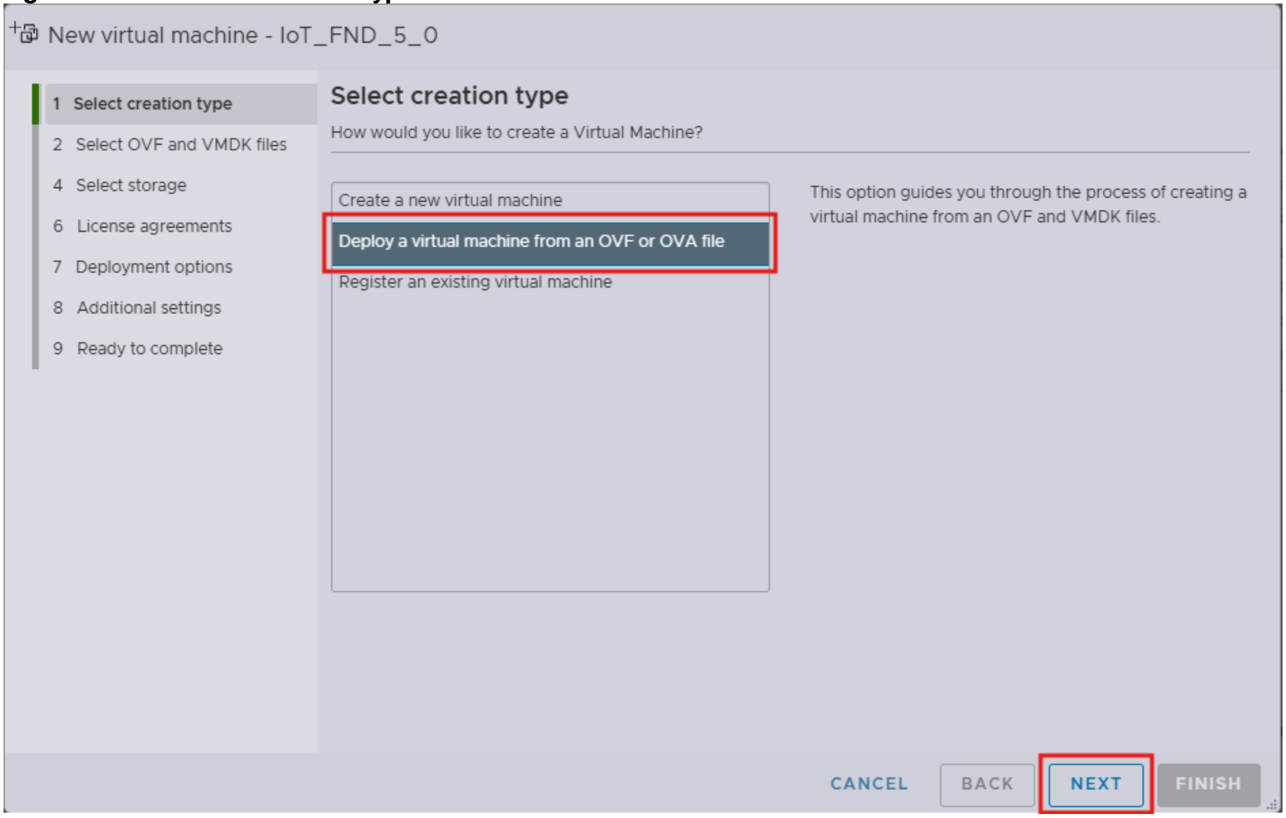
Hardware	
Manufacturer	Cisco Systems Inc
Model	UCSC-C240-M5SX
CPU	56 CPUs x Intel(R) Xeon(R) Platinum 8276 CPU @ 2.20GHz
Memory	1,023.65 GB

Configuration	
Image profile	(Updated) ESXi-8.0U3d-24585383-standard (VMware, Inc.)
vSphere HA state	Not configured
vMotion	Supported

System Information

Step 4. In the step **Select creation type**, click **Deploy a virtual machine from an OVF or OVA file.**

Figure 3. **Select VM creation type in ESXi**



New virtual machine - IoT_FND_5_0

1 Select creation type
2 Select OVF and VMDK files
4 Select storage
6 License agreements
7 Deployment options
8 Additional settings
9 Ready to complete

Select creation type

How would you like to create a Virtual Machine?

Create a new virtual machine
Deploy a virtual machine from an OVF or OVA file
Register an existing virtual machine

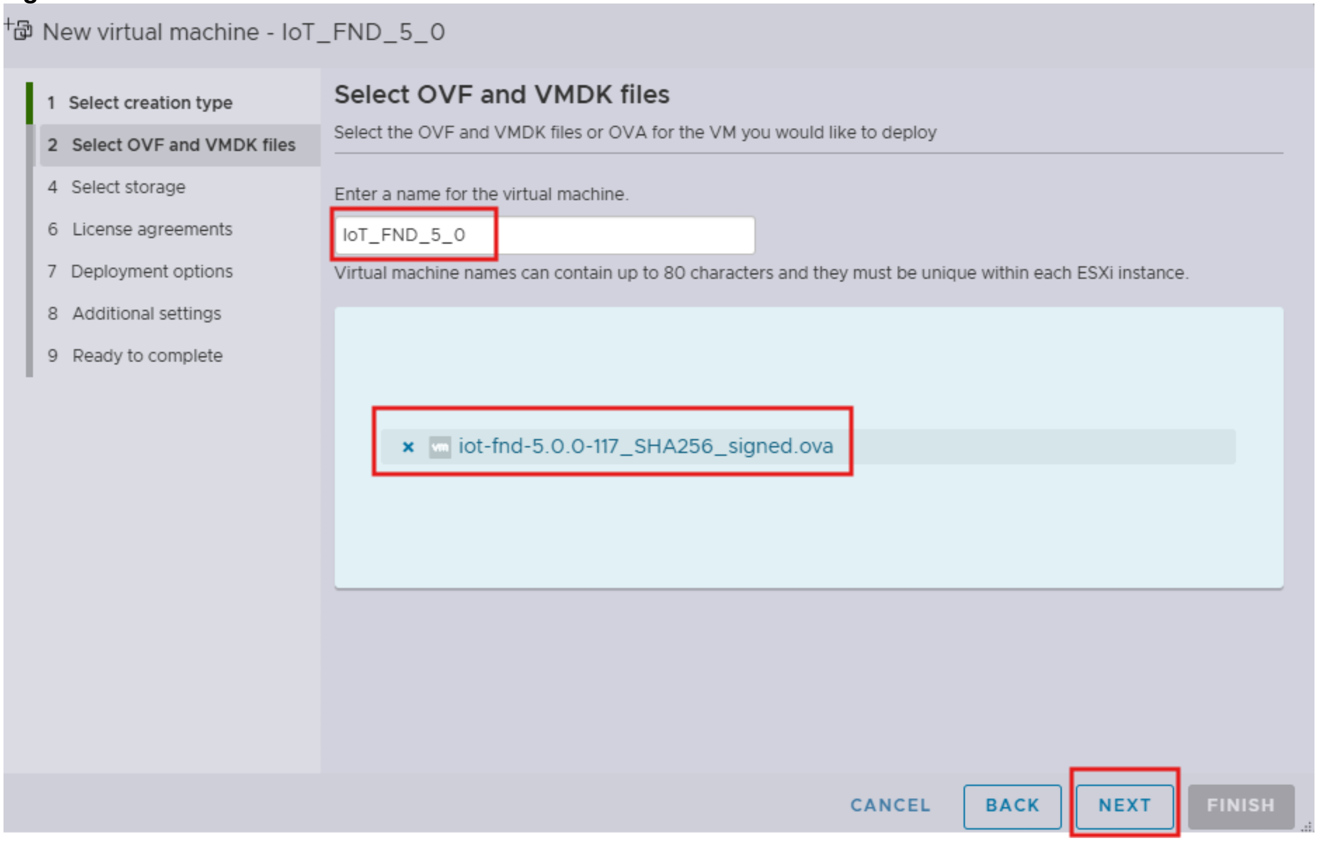
This option guides you through the process of creating a virtual machine from an OVF and VMDK files.

Step 5. In the step **Select OVF and VMDK files**:

i. Enter a name for the virtual machine.

ii. Attach the Cisco IoT FND OVA file.

Figure 4. **Select OVA file**



New virtual machine - IoT_FND_5_0

1 Select creation type
2 Select OVF and VMDK files
4 Select storage
6 License agreements
7 Deployment options
8 Additional settings
9 Ready to complete

Select OVF and VMDK files

Select the OVF and VMDK files or OVA for the VM you would like to deploy

Enter a name for the virtual machine.

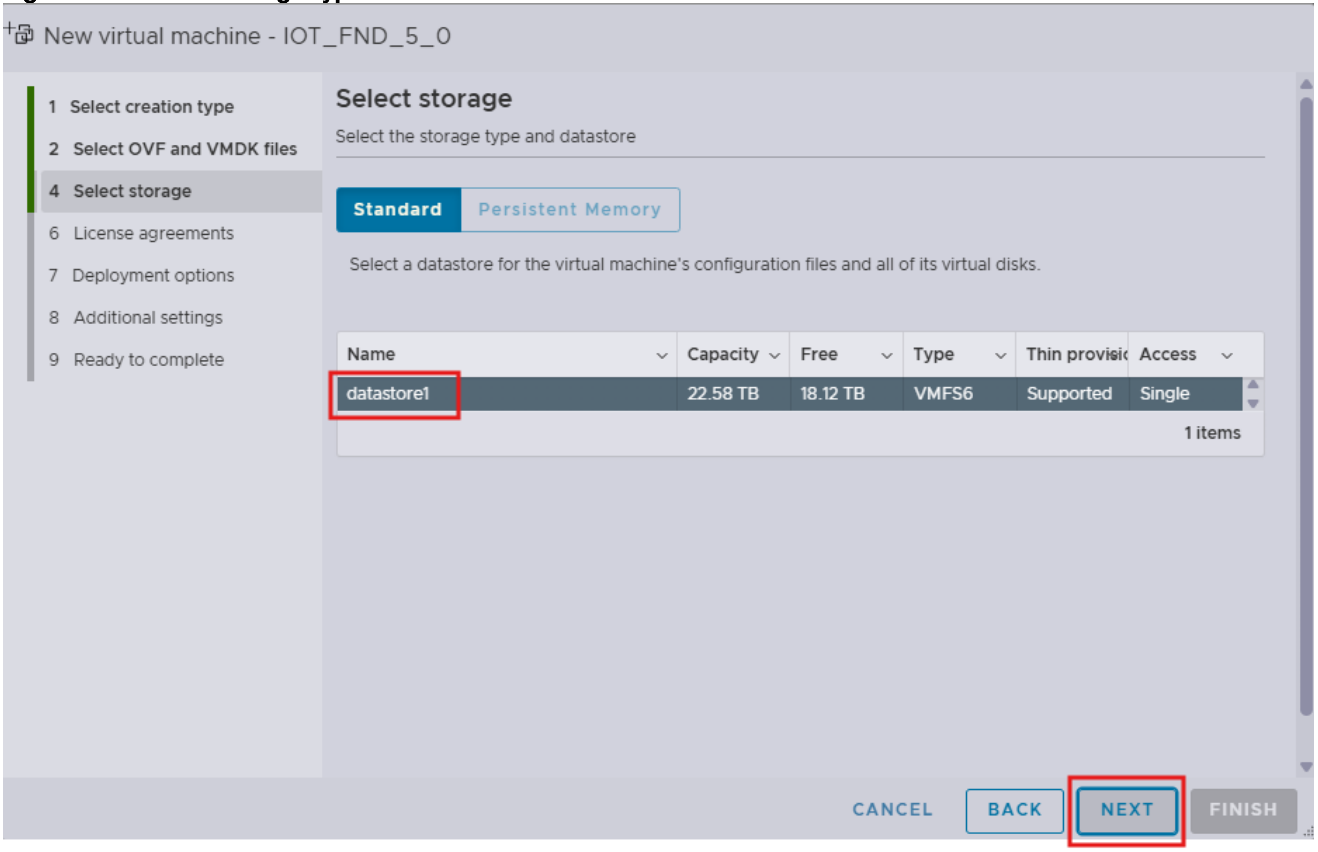
IoT_FND_5_0

Virtual machine names can contain up to 80 characters and they must be unique within each ESXi instance.

iot-fnd-5.0.0-117_SHA256_signed.ova

Step 6. In the step **Select storage**, choose a storage location for the virtual machine.

Figure 5. Select storage type and datastore



New virtual machine - IOT_FND_5_0

Select storage

Select the storage type and datastore

Select a datastore for the virtual machine's configuration files and all of its virtual disks.

Name	Capacity	Free	Type	Thin provisio	Access
datastore1	22.58 TB	18.12 TB	VMFS6	Supported	Single

1 items

Step 7. In the step **Deployment options**:

i. In the **Network mappings** field, enter the port group that must be used for Admin Network SSH and GUI access (configuration item ADMIN_NETWORK_PORTGROUP).

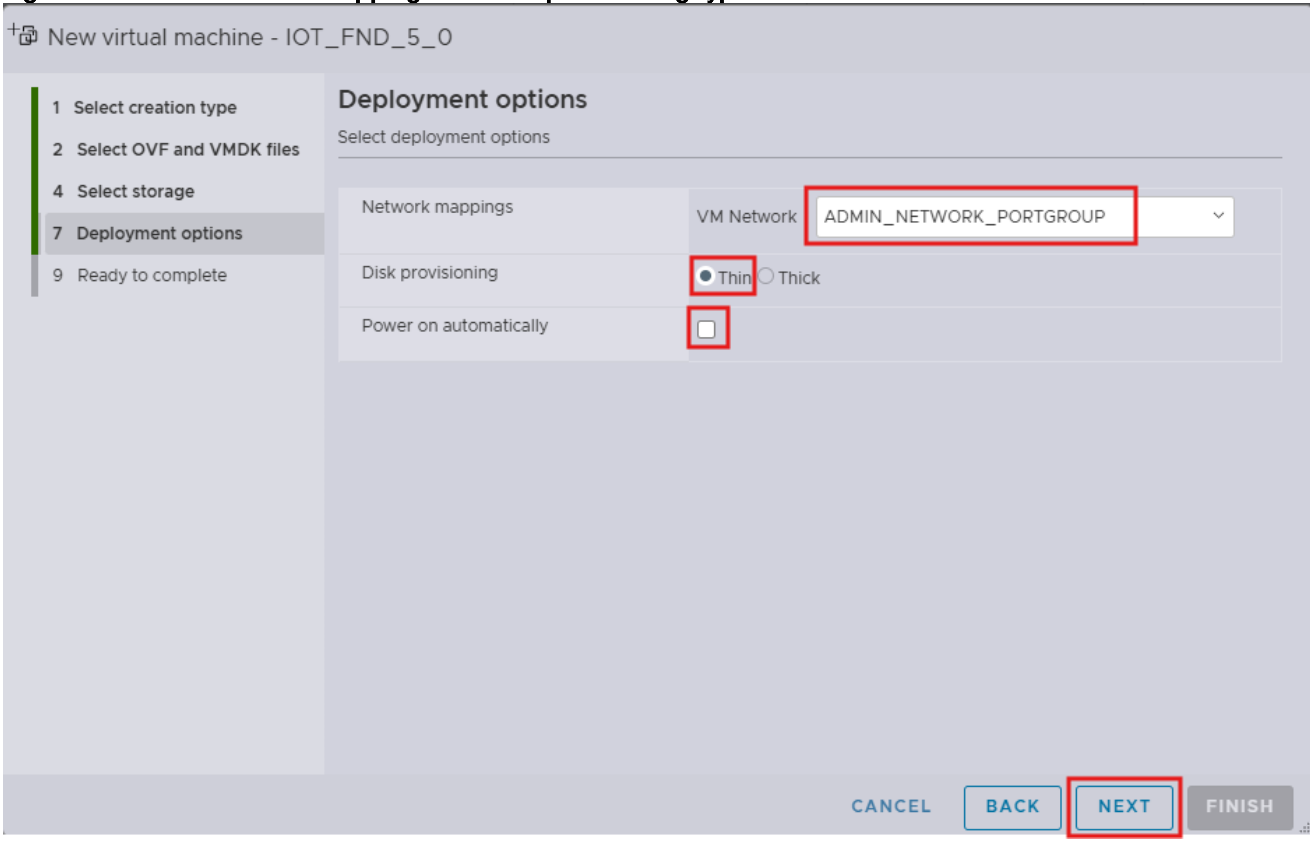
ii. In the **Data provisioning** field, select **Thin** provisioning type.

iii. Unselect the **Power on automatically** option to avoid the VM from being powered on automatically after deployment.

Note: Thin Provisioning allows the VM disk to grow as needed.

Note: If the selected storage location does not have sufficient storage for the largest file installation option, a message displays noting insufficient storage. If the warning message appears, select another storage resource with greater capacity and click Next.

Figure 6. Select network mappings and disk provisioning type



New virtual machine - IOT_FND_5_0

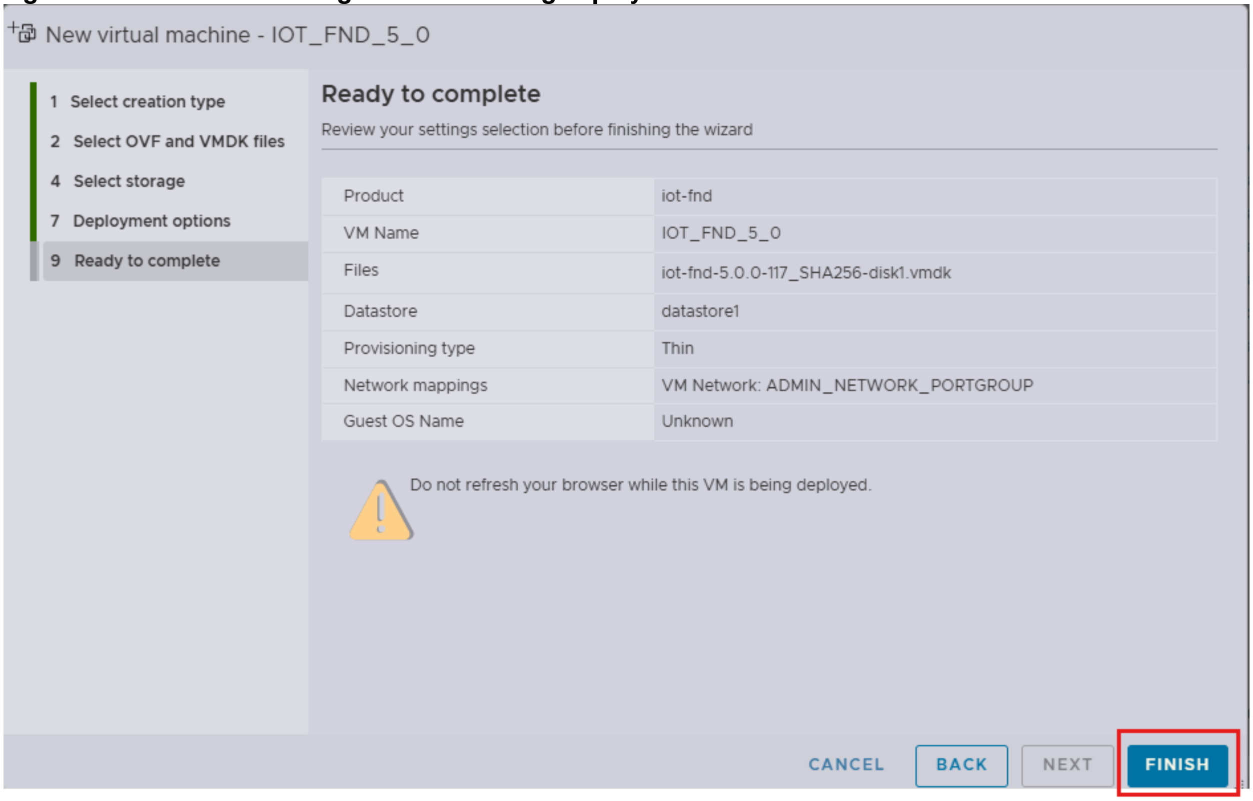
Deployment options

Select deployment options

Network mappings	VM Network ADMIN_NETWORK_PORTGROUP
Disk provisioning	● Thin ○ Thick
Power on automatically	□

Step 8. Review the settings in step **Ready to complete** and click **Finish.**

Figure 7. Review VM settings before initiating deployment



New virtual machine - IOT_FND_5_0

Ready to complete

Review your settings selection before finishing the wizard

Product	iot-fnd
VM Name	IOT_FND_5_0
Files	iot-fnd-5.0.0-117_SHA256-disk1.vmdk
Datastore	datastore1
Provisioning type	Thin
Network mappings	VM Network: ADMIN_NETWORK_PORTGROUP
Guest OS Name	Unknown

Do not refresh your browser while this VM is being deployed.

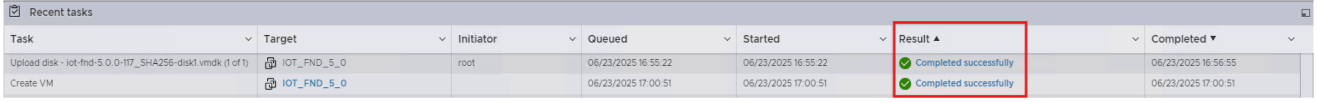
This completes the OVA deployment on ESXi, setting the foundation for further configuration and management of Cisco IoT FND, enabling robust network management capabilities.

Additional Changes to Cisco IoT FND VM before Power On

Before powering on the Cisco IoT FND virtual machine, certain configurations and adjustments are required to optimize performance and ensure compatibility with your network environment.

Step 1. Confirm that the deployment of the FND VM is fully complete. When the VM creation is complete, in the **Recent** tasks table, the **Result** column for the OVA deployment entry contains the value **Completed Successfully**.

Figure 8. **Verify deployment completion**



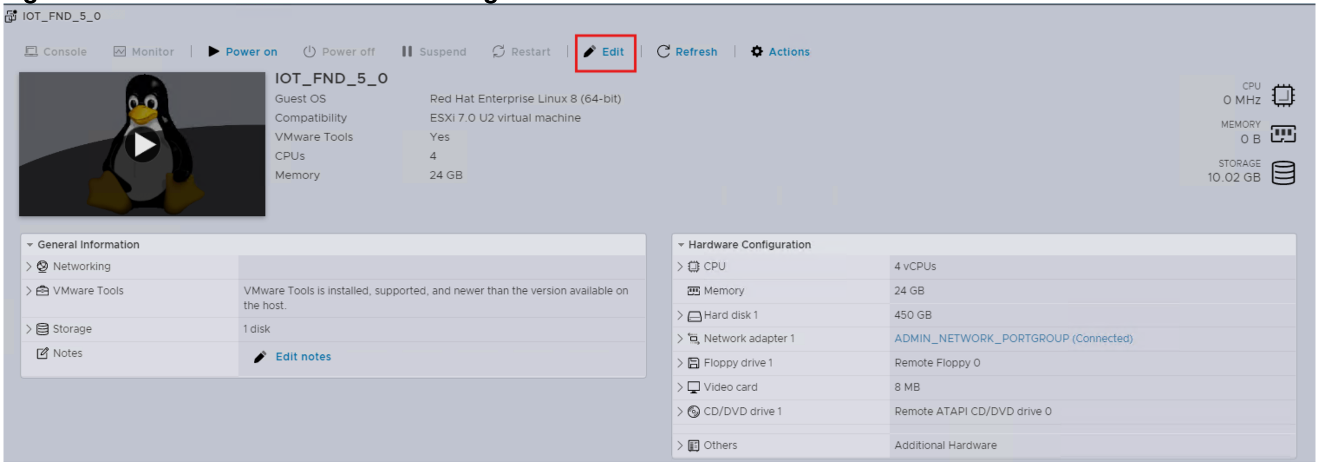
Recent tasks

Task	Target	Initiator	Queued	Started	Result ▲	Completed ▼
Upload disk - iot-fnd-5.0.0-117_SHA256-disk1.vmdk (1 of 1)	IOT_FND_5_0	root	06/23/2025 16:55:22	06/23/2025 16:55:22	✓ Completed successfully	06/23/2025 16:56:55
Create VM	IOT_FND_5_0		06/23/2025 17:00:51	06/23/2025 17:00:51	✓ Completed successfully	06/23/2025 17:00:51

Step 2. Check that the VM is currently powered off.

Step 3. To edit hardware configuration, in the EXSi host, select the Cisco IoT FND virtual machine and click **Edit**.

Figure 9. **Select Edit for hardware configuration**



IOT_FND_5_0

Guest OS	Red Hat Enterprise Linux 8 (64-bit)
Compatibility	ESXi 7.0 U2 virtual machine
VMware Tools	Yes
CPUs	4
Memory	24 GB

General Information

Networking	
VMware Tools	VMware Tools is installed, supported, and newer than the version available on the host.
Storage	1 disk
Notes	Edit notes

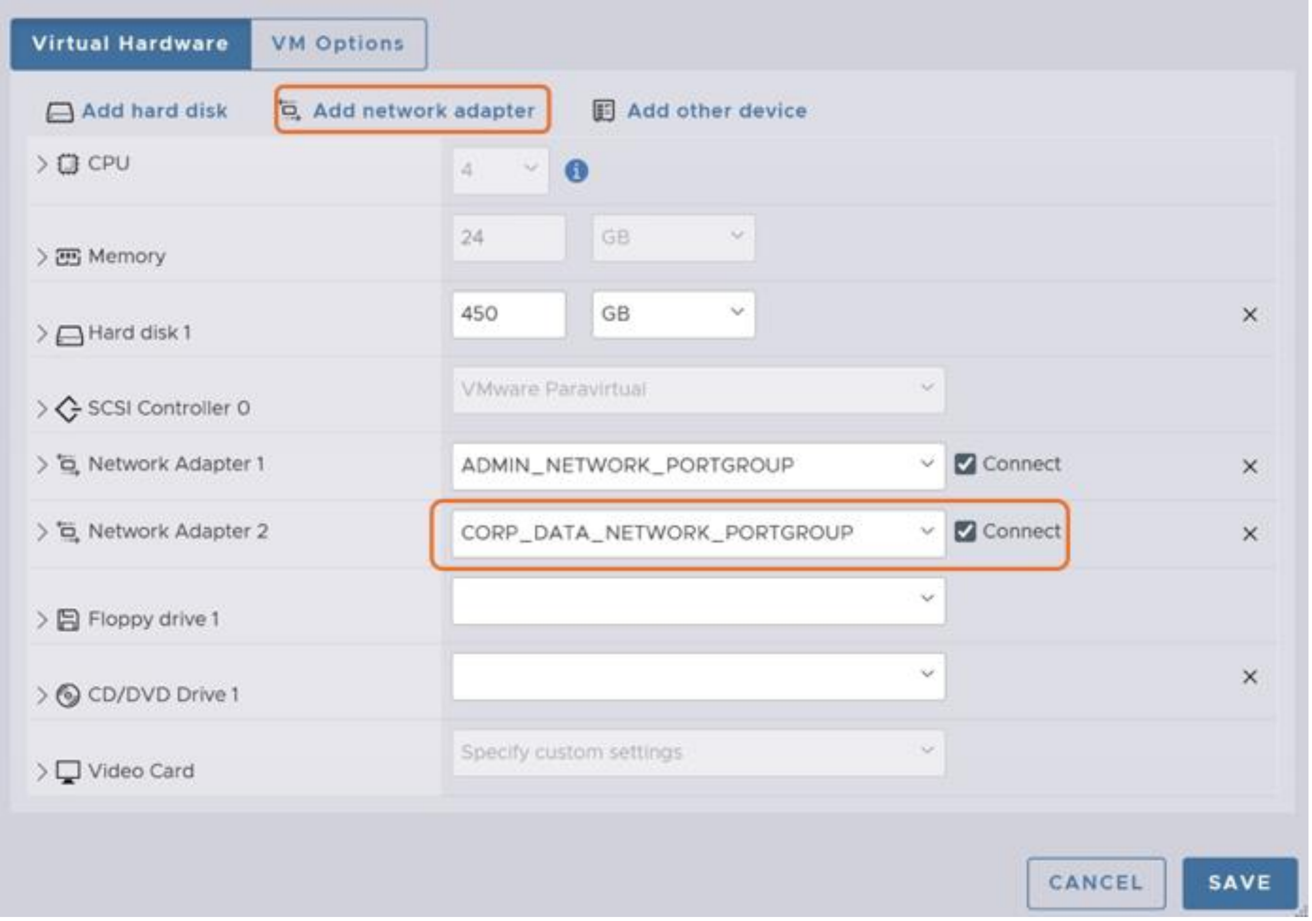
Hardware Configuration

CPU	4 vCPUs
Memory	24 GB
Hard disk 1	450 GB
Network adapter 1	ADMIN_NETWORK_PORTGROUP (Connected)
Floppy drive 1	Remote Floppy 0
Video card	8 MB
CD/DVD drive 1	Remote ATAPI CD/DVD drive 0
Others	Additional Hardware

Step 4. In the **Virtual Hardware** tab, choose **Add network adaptor**.

Step 5. In the **Network Adaptor 2** field, enter the port group that must be used for Corporate Data Network communications (configuration item CORP_DATA_NETWORK_PORTGROUP).

Figure 10. Add additional network adaptor



CPU 4

Memory 24 GB

Hard disk 1 450 GB

SCSI Controller 0 VMware Paravirtual

Network Adapter 1 ADMIN_NETWORK_PORTGROUP ☑ Connect

Network Adapter 2 CORP_DATA_NETWORK_PORTGROUP ☑ Connect

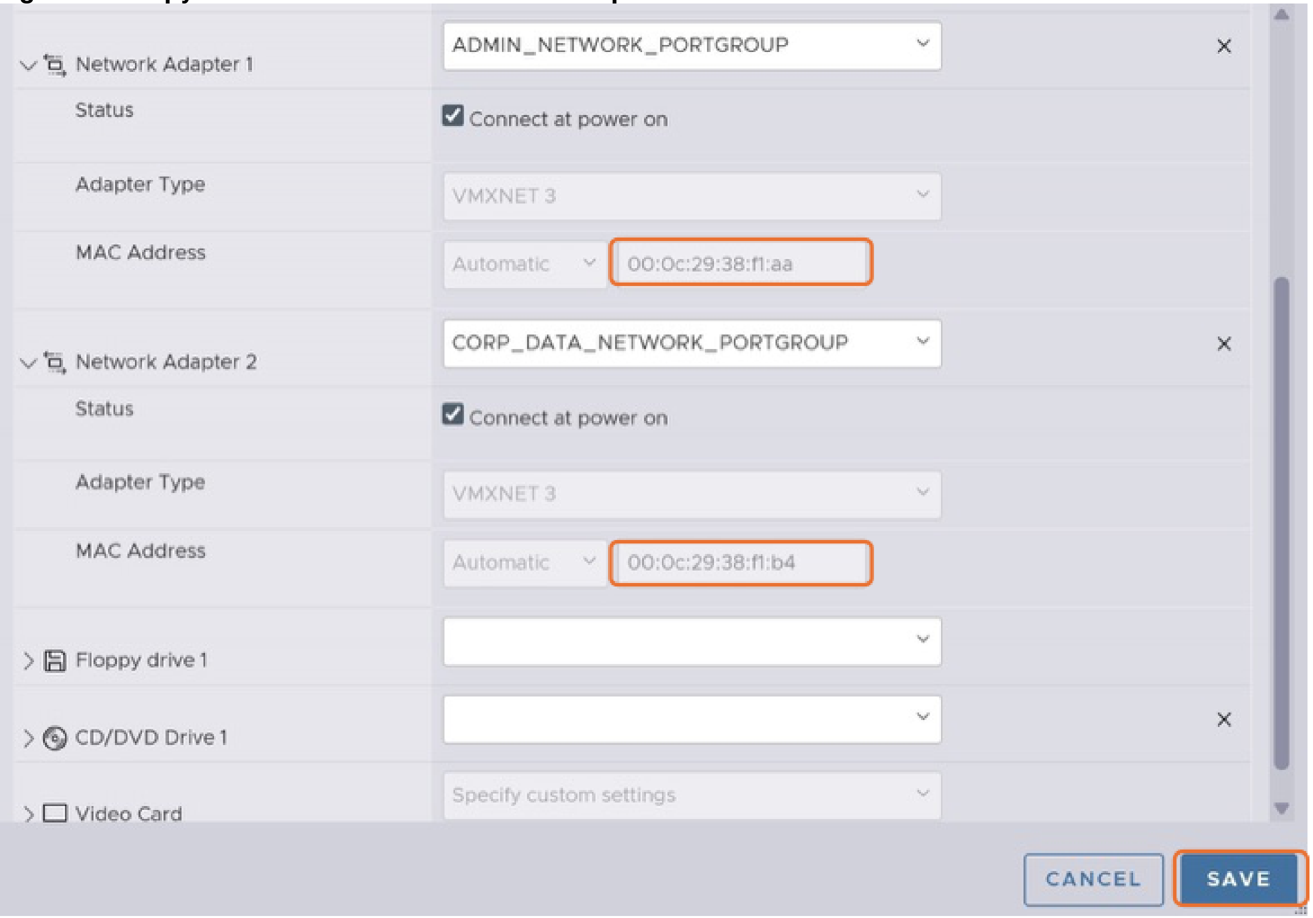
Floppy drive 1

CD/DVD Drive 1

Video Card Specify custom settings

Step 6. Copy the MAC addresses for **Network adaptor 1** and **Network adaptor 2.** Expand each section and note down the values in the **MAC Address** fields.

Figure 11. **Copy the MAC addresses of network adapters in ESXi**



Network Adapter 1: ADMIN_NETWORK_PORTGROUP

Status: ☑ Connect at power on

Adapter Type: VMXNET 3

MAC Address: Automatic 00:0c:29:38:f1:aa

Network Adapter 2: CORP_DATA_NETWORK_PORTGROUP

Status: ☑ Connect at power on

Adapter Type: VMXNET 3

MAC Address: Automatic 00:0c:29:38:f1:b4

Floppy drive 1

CD/DVD Drive 1

Video Card: Specify custom settings

Step 7. Click **Save**.

Step 8. Power on the VM.

This completes verification of successful deployment of FND OVA image and other additional hardware changes required before powering on.

Access FND Shell

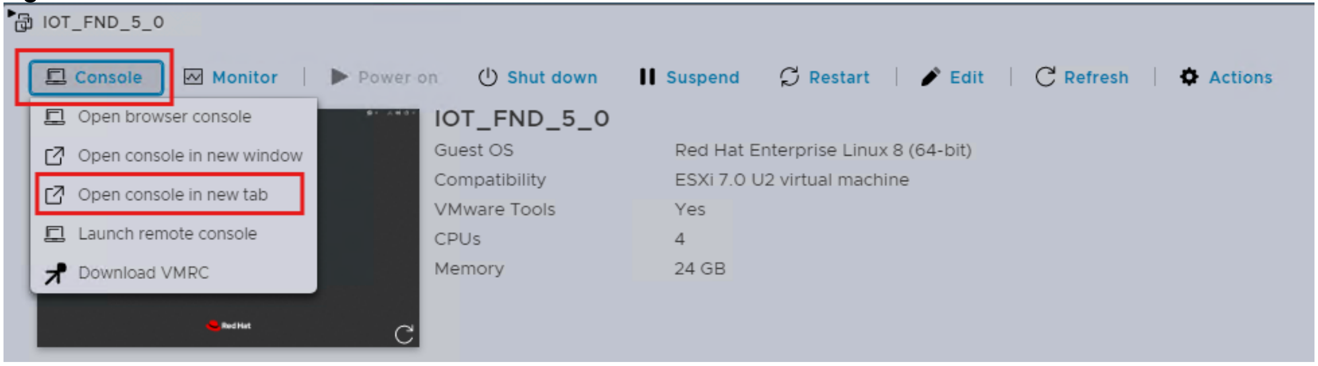
Map the NIC connection names that are required for Cisco IoT FND bringup and for integration with other necessary components.

Step 1. Log into the ESXi host and select the Cisco IoT FND VM.

Step 2. Click **Console** and select **Open Console in new tab.**

The RHEL server launches. At first log in, the default credentials to use are:
Username: fnduser
Password: C!sco123

Figure 12. Access VM console from ESXi



IOT_FND_5_0

Guest OS: Red Hat Enterprise Linux 8 (64-bit)

Compatibility: ESXi 7.0 U2 virtual machine

VMware Tools: Yes

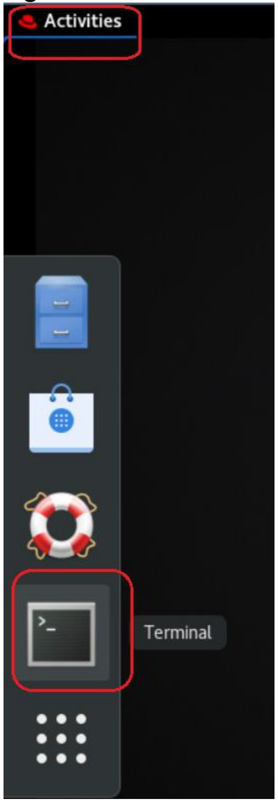
CPUs: 4

Memory: 24 GB

Step 3. After you log in, you are immediately prompted to change the default password.

Step 4. To access the terminal, click Activities and click the Terminal icon.

Figure 13. Access Terminal

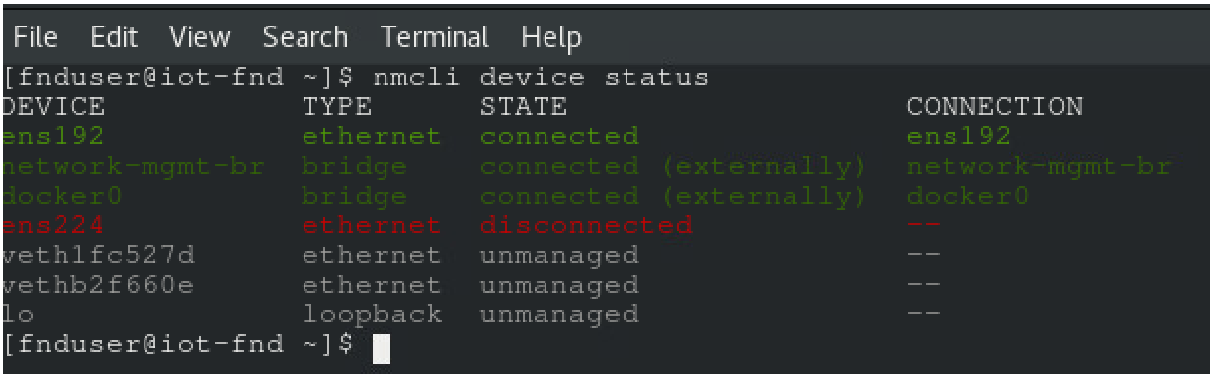


Step 5. Check and note down Network Connection names: Check existing NIC Devices using **nmcli device status** and **ifconfig** commands.

Note: Note down the device and connection name for the NICs to be configured. (`ens192` and `ens224` as per the example shown below)

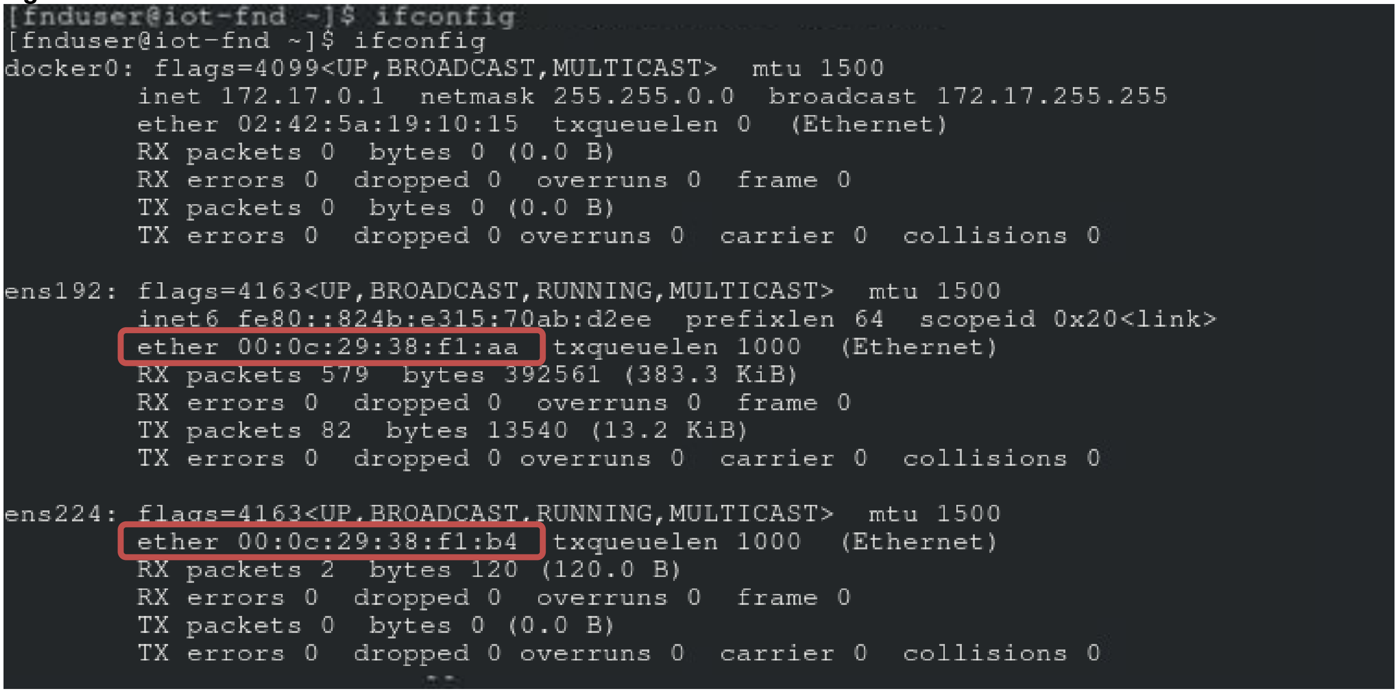
Note: Check the MAC address of device using the **ifconfig** command and map the connection-names accordingly by referring to MAC Addresses noted down in ESXi in Step 6 of task Additional Changes to Cisco IoT FND VM before Power On.

Figure 14. Check nmcli device and connection names



```
[fnduser@iot-fnd ~]$ nmcli device status
DEVICE              TYPE      STATE                    CONNECTION
ens192              ethernet  connected                ens192
etwork-mgmt-br      bridge    connected (externally)   network-mgmt-br
docker0             bridge    connected (externally)   docker0
ens224              ethernet  disconnected             --
veth1fc527d         ethernet  unmanaged                --
vethb2f660e         ethernet  unmanaged                --
lo                  loopback  unmanaged                --
[fnduser@iot-fnd ~]$ 
```

Figure 15. Check MAC addresses of network devices from shell



```
[fnduser@iot-fnd ~]$ ifconfig
[fnduser@iot-fnd ~]$ ifconfig
docker0: flags=4099<UP,BROADCAST,MULTICAST>  mtu 1500
        inet 172.17.0.1  netmask 255.255.0.0  broadcast 172.17.255.255
        ether 02:42:5a:19:10:15  txqueuelen 0  (Ethernet)
        RX packets 0  bytes 0 (0.0 B)
        RX errors 0  dropped 0  overruns 0  frame 0
        TX packets 0  bytes 0 (0.0 B)
        TX errors 0  dropped 0 overruns 0  carrier 0  collisions 0

ens192: flags=4163<UP,BROADCAST,RUNNING,MULTICAST>  mtu 1500
        inet6 fe80::824b:e315:70ab:d2ee  prefixlen 64  scopeid 0x20<link>
        ether 00:0c:29:38:f1:aa  txqueuelen 1000  (Ethernet)
        RX packets 579  bytes 392561 (383.3 KiB)
        RX errors 0  dropped 0  overruns 0  frame 0
        TX packets 82  bytes 13540 (13.2 KiB)
        TX errors 0  dropped 0 overruns 0  carrier 0  collisions 0

ens224: flags=4163<UP,BROADCAST,RUNNING,MULTICAST>  mtu 1500
        ether 00:0c:29:38:f1:b4  txqueuelen 1000  (Ethernet)
        RX packets 2  bytes 120 (120.0 B)
        RX errors 0  dropped 0  overruns 0  frame 0
        TX packets 0  bytes 0 (0.0 B)
        TX errors 0  dropped 0 overruns 0  carrier 0  collisions 0
```

Step 6. For reference in later tasks, collect the details in a table. Here's an example table based on the examples in this task.

Table 3. Cisco IoT FND device port mapping

ESXi Portgroup Name	MAC Address	NMCLI Device Name	NMCLI Connection Name
ADMIN_NETWORK_PORTGROUP	00:0c:29:38:f1:aa	ens192	ens192 (ADMIN_NETWORK_NMCLI_CONNECTION_NAME)
CORP_DATA_NETWORK_PORTGROUP	00:0c:29:38:f1:b4	ens224	ens224 (CORP_DATA_NETWORK_PORTGROUP_CONNECTION_NAME)

Bring up of FND using Shell configurations

This section explains the configurations required in Cisco IoT FND Shell after Power On for its bringup.

Network and system configurations

This section guides in basic setup like configuring Admin and Data Networks, hostname, NTP, and so on.

Table 4. Essential configuration items for network and system configurations

Configuration Item	Description
ADMIN_NETWORK_NMCLI_CONNECTION_NAME	Admin Network connection name. Keep it same as the device name for simplicity. For example, eth0, ens192 etc.
CORP_DATA_NETWORK_NMCLI_CONNECTION_NAME	Corporate Network Connection name . Keep it same as the device name for simplicity. For example, eth0, ens192 etc.
FND_ADMIN_NETWORK_IP	IP Address for Cisco IoT FND Admin Network which is used for SSH and GUI access
FND_NMCLI_CONNECTION_NAME_TO_REACH_NTP	Network Connection name to reach NTP. You can use ADMIN_NETWORK_NMCLI_CONNECTION_NAME or CORP_DATA_NETWORK_NMCLI_CONNECTION_NAME.
FND_CORP_DATA_NETWORK_IP	IP Address of Cisco IoT FND in Corporate Data Network which is used for communication with HER, TPS, and field routers (via TPS or HER).
FND_HOST_NAME_FQDN	Hostname of Cisco IoT FND, including domain name.
HER_CORP_DATA_NETWORK_IP	IP Address of HER in Corporate Data Network which is used for communication with Cisco IoT FND.
NEXTHOP_TO_REACH_NTP_FROM_FND	Nexthop IP address to reach NTP from Cisco IoT FND .
NTP_SERVER_1	Primary NTP server used for time synchronization.
NTP_SERVER_2	Backup NTP server used for time synchronization.
TPS_HOST_NAME_FQDN	Hostname of TPS including domain name.
TPS_CORP_DATA_NETWORK_IP	IP address of TPS in Corporate Data Network which is used to communicate with Cisco IoT FND.

Configure hostname

Step 1. Access the terminal of the Cisco IoT FND Shell.

Step 2. Start an interactive root shell session using the following command.

```
Example:
[fnduser@iot-fnd ~]# sudo -i

[sudo] password for fnduser: <Enter FND Shell Password>

[root@iot-fnd ~]#
```

Step 3. Network Adaptor connected to <ADMIN_NETWORK_PORTGROUP> (as noted down in Table 3) would already have connection-name. Use the following configuration to:

i. Set IPv4 method to manual

ii. Configure IPv4 address

iii. Bringup the interface by applying the changes

```
nmcli connection modify <ADMIN_NETWORK_NMCLI_CONNECTION_NAME> ipv4.addresses <FND_ADMIN_NETWORK_IP>/<subnet>
ipv4.method manual

nmcli connection up <ADMIN_NETWORK_NMCLI_CONNECTION_NAME>


Example:
```

```
[root@iot-fnd ~]# nmcli connection modify ens192 ipv4.addresses 192.168.254.161/24 ipv4.method manual

[root@iot-fnd ~]# nmcli connection up ens192
```

Step 4. NIC with <CORP_DATA_NETWORK_PORTGROUP> (as noted down in Table 3) would not have connection-name. Add the connection and IP addresses using the following commands.

Note: This configuration assumes that <HER_CORP_DATA_NETWORK_IP> as the default gateway. It is recommended to have only one default gateway in the system. Consider adapting the gateway configurations based on your network environment.

```
nmcli nmcli connection add type ethernet ifname <CORP_DATA_NETWORK_NMCLI_CONNECTION_NAME> con-name
<CORP_DATA_NETWORK_NMCLI_CONNECTION_NAME> ip4 <FND_CORP_DATA_NETWORK_IP>/<subnet> gw4
<HER_CORP_DATA_NETWORK_IP>

nmcli connection up <CORP_DATA_NETWORK_NMCLI_CONNECTION_NAME>


Example:

[root@iot-fnd ~]# nmcli connection add type ethernet ifname ens224 con-name ens224 ip4 192.168.103.100/24
gw4 192.168.103.102

[root@iot-fnd ~]# nmcli connection up ens224
```

Step 5. With the configured <FND_ADMIN_NETWORK_IP> IP address, SSH access can now be established from the servers in same subnet. Add appropriate static routes if SSH has to be done from servers that are not in the same subnet.

Configure hostname

Step 1. Use the **nmcli general hostname** command to add the hostname.

```
[root@iot-fnd ~]# nmcli general hostname <FND_HOST_NAME_FQDN>
```

Step 2. Use the **hostnamectl** command to verify the configuration.

```
[root@iot-fnd ~]# hostnamectl
```

Configure NTP

Step 1. To ensure primary and backup NTP servers are reachable, add the routes to reach them. Verify the added routes using **ip route** command.

```
[nmcli connection modify <FND_NMCLI_CONNECTION_NAME_TO_REACH_NTP> +ipv4.routes "<NTP_SERVER_1>/32
<NEXTHOP_TO_REACH_NTP_FROM_FND>"

nmcli connection modify <FND_NMCLI_CONNECTION_NAME_TO_REACH_NTP> +ipv4.routes "<NTP_SERVER_2>/32
<NEXTHOP_TO_REACH_NTP_FROM_FND>"

nmcli connection up <FND_NMCLI_CONNECTION_NAME_TO_REACH_NTP>


Example:

nmcli connection modify ens192 +ipv4.routes "1.0.0.101/32 192.168.1.1"

nmcli connection modify ens192 +ipv4.routes "1.0.0.102/32 192.168.1.1"

nmcli connection up ens192

ip route
```

Step 2. Backup the existing **/etc/chrony.conf** file before modifications.

```
[root@iot-fnd ~]# sudo cp /etc/chrony.conf /etc/chrony.conf.bak
```

Step 3. Comment existing default pool in the **/etc/chrony.conf** file.

```
[root@iot-fnd ~]# sudo sed -i '/^pool/s/^/#/' /etc/chrony.conf
```

Step 4. Add the primary and backup NTP Servers in the **/etc/chrony.conf** file.

```
[root@iot-fnd ~]# sudo sed -i '1i\server <NTP_SERVER_2> iburst' /etc/chrony.conf
[root@iot-fnd ~]# sudo sed -i '1i\server <NTP_SERVER_1> iburst' /etc/chrony.conf

Example:
[root@iot-fnd ~]# sudo sed -i '1i\server 1.0.0.102 iburst' /etc/chrony.conf
[root@iot-fnd ~]# sudo sed -i '1i\server 1.0.0.101 iburst' /etc/chrony.conf
```

Step 5. Verify the contents of the configuration file to check that both the NTP servers are added.

```
[root@iot-fnd ~]# cat /etc/chrony.conf | grep server
```

Step 6. Restart the chronyd service.

```
[fnduser@iot-fnd ~]# systemctl restart chronyd.service
[root@iot-fnd ~]# systemctl status chronyd.service
● chronyd.service - NTP client/server
   Loaded: loaded (/usr/lib/systemd/system/chronyd.service; enabled; vendor preset: enabled)
   Active: active (running) since Thu 2024-10-17 01:19:42 EDT; 29s ago
     Docs: man:chronyd(8)
           man:chrony.conf(5)
  Process: 197485 ExecStopPost=/usr/libexec/chrony-helper remove-daemon-state (code=exited, 
status=0/SUCCESS)
  Process: 200554 ExecStartPost=/usr/libexec/chrony-helper update-daemon (code=exited, status=0/SUCCESS)
  Process: 200550 ExecStart=/usr/sbin/chronyd $OPTIONS (code=exited, status=0/SUCCESS)
 Main PID: 200552 (chronyd)
    Tasks: 1 (limit: 203710)
   Memory: 1.0M
   CGroup: /system.slice/chronyd.service
           └─200552 /usr/sbin/chronyd
```

Step 7. It may take some time for NTP to synchronize. Wait for a while and then confirm if NTP synchronization is complete using the following commands.

```
[root@iot-fnd ~]# chronyc tracking
[root@iot-fnd ~]# chronyc sources
[root@iot-fnd ~]# timedatectl
               Local time: Thu 2024-10-17 02:59:08 EDT
           Universal time: Thu 2024-10-17 06:59:08 UTC
                 RTC time: Thu 2024-10-17 06:59:08
                Time zone: America/New_York (EDT, -0400)
System clock synchronized: yes
              NTP service: active
          RTC in local TZ: no
[root@iot-fnd ~]#
```

Static name resolution for TPS domain name

Step 1. Map FQDN of TPS with its IP address in the **/etc/hosts** file.

```
[root@iot-fnd ~]$ sudo cp /etc/hosts /etc/hosts.bak
[root@iot-fnd ~]$ sudo sed -i '$a <TPS_CORP_DATA_NETWORK_IP> <TPS_HOST_NAME_FQDN>' /etc/hosts
[root@iot-fnd ~]$ cat /etc/hosts
127.0.0.1   iot-fnd  localhost localhost.localdomain localhost4 localhost4.localdomain4
::1         iot-fnd  localhost localhost.localdomain localhost6 localhost6.localdomain6
<TPS_CORP_DATA_NETWORK_IP> <TPS_HOST_NAME_FQDN>
```

Configure PSK and IPAM in Cisco IoT FND Shell

Table 5. Essential configuration items for PSK and IPAM configurations

Configuration Item	Description
FND_CGMS_KEYSTORE	CGMS keystore to be used for CISCO IoT FND
FND_KEYSTORE_PASSWORD	Password of Cisco IoT FND CGMS Keystore

Step 1. Log into the Cisco IoT FND VM shell and carry out this task as a root user.

Step 2. Copy the CGMS keystore file. Use root user privileges to upload the cgms_keystore (FND_CGMS_KEYSTORE) file to the **/opt/fnd/data/** directory. Backup existing cgms_keystore before upload.

```
[root@iot-fnd ~]$ cp /opt/fnd/data/cgms_keystore /opt/fnd/data/cgms_keystore.bak


[root@iot-fnd ~]# ls -lrt /opt/fnd/data/
[root@iot-fnd ~]$ scp <scp_user>@<scp_server>://<cgms_keystore_file_path> /opt/cgms-
tpsproxy/conf/cgms_keystore


[root@iot-fnd ~]# ls -lrt /opt/fnd/data/
total 40
-rw-r--r-- 1 root root 1258 May  7 12:44 userPropertyTypes.xml
-rw-r--r-- 1 root root 1529 May  7 12:44 cisco-sudi-ca.pem
-rw-r--r-- 1 root root 4315 May  7 12:44 cgms_keystore.selfsigned
-rw------- 1 root root  518 May  8 06:03 fnd_psk.keystore
-rw-r--r-- 1 root root 9064 Oct  9 07:00 cgms_keystore
-rw------- 1 root root  270 Oct  9 07:02 cgms_backup.properties
-rw------- 1 root root  944 Oct 17 10:17 cgms.properties
```

Step 3. Check the status of the Cisco IoT FND container on the Linux host. The response should contain the value **fnd-image: active**.

```
[root@iot-fnd ~]# /opt/fnd/scripts/fnd-container.sh status
fnd-container is running, pid=2509

*** WARNING : deprecated key derivation used.

Using -iter or -pbkdf2 would be better.

CONTAINER ID        NAME                CPU %               MEM USAGE / LIMIT   MEM %               NET I/O
BLOCK I/O           PIDS
```

```
e3d151c0c9ef        fnd-container       2.61%               1.7GiB / 31.14GiB   5.46%               634MB /
599MB       1.2GB / 721kB       650

[root@iot-fnd ~]#


[root@iot-fnd ~]# docker container ls

CONTAINER ID        IMAGE               COMMAND                  CREATED             STATUS
PORTS
NAMES

06fc10399064        fogd-image:active   "/bin/sh -c /usr/loc…"   5 months ago        Up 4 days
443/tcp

fogd-container

e3d151c0c9ef        fnd-image:active    "/bin/sh -c /opt/fnd…"   5 months ago        Up 4 days
0.0.0.0:80->80/tcp, 0.0.0.0:162->162/udp, 0.0.0.0:443->443/tcp, 0.0.0.0:9120-9121->9120-9121/tcp,
0.0.0.0:5683->5683/udp, 0.0.0.0:61624-61626->61624-61626/udp, 0.0.0.0:9124-9125->9124-9125/tcp,
0.0.0.0:61628->61628/udp   fnd-container
```

Tech tip: If the Cisco IoT FND container is not running, start the container using the **/opt/fnd/scripts/fnd-container.sh start** command.

Step 4. Encrypt the CGMS keystore password (FND_KEYSTORE_PASSWORD) in the Cisco IoT FND docker container. Copy the password value displayed.

```
[root@iot-fnd ~]# docker container exec fnd-container /opt/cgms/bin/encryption_util.sh encrypt
<FND_KEYSTORE_PASSWORD>

7jlXPniVpMvat+TrDWqh1w==
```

Step 5. Update these parameters in the **cgms.properties** file.

Parameters	Value to add
cgms-keystore-password-hidden	The encrypted password displayed in Step 4 of this task.
• cgdm-tpsproxy-addr • cgdm-tpsproxy-subject=CN • proxy-bootstrap-ip	*<TPS_HOST_NAME_FQDN>*

```
[root@iot-fnd ~]# cp /opt/fnd/data/cgms.properties /opt/fnd/data/cgms.properties.bak

[root@iot-fnd ~]# nano /opt/fnd/data/cgms.properties

[root@iot-fnd ~]# cat /opt/fnd/data/cgms.properties

cgms-keystore-password-hidden=7jlXPniVpMvat+TrDWqh1w==


fogd-ip=192.68.5.3

enable-reverse-dns-lookup=false

enableApiAuth=false

enable-bootstrap-service=true

cgdm-tpsproxy-addr=<TPS_HOST_NAME_FQDN>

cgdm-tpsproxy-subject=CN=<TPS_HOST_NAME_FQDN>

enable-bootstrap-service=true

pnp-server-port=9125
```

```
proxy-bootstrap-ip=<TPS_HOST_NAME_FQDN>

reload-during-bootstrap=false

optimizeTunnelProv=true

reprovision-timeout-minutes=30

#DEBUG_SSL=true

firmware-update-bootstrap=true

trust-device-server=true
```

Step 6. Restart the Cisco IoT FND container.

```
[root@iot-fnd ~]# /opt/fnd/scripts/fnd-container.sh restart
[root@iot-fnd ~]# /opt/fnd/scripts/fnd-container.sh status

fnd-container is running, pid=1237121

*** WARNING : deprecated key derivation used.

Using -iter or -pbkdf2 would be better.

CONTAINER ID        NAME                CPU %               MEM USAGE / LIMIT     MEM %               NET
I/O             BLOCK I/O           PIDS

e3d151c0c9ef        fnd-container       3.17%               2.929GiB / 31.14GiB   9.40%               18.6MB
/ 13.7MB     8.19kB / 745kB      644

[root@iot-fnd ~]#
```

Step 7. Stop the Cisco IoT FND container and all its services. Check the status of the container, and if fnd-container is still active, stop the fnd service to make sure no processes are running.

```
[root@iot-fnd ~]# docker container exec fnd-container /opt/cgms/bin/cgms_status.sh

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10-14-2024 06:14:03 EDT: INFO: IoT-FND database server: 192.68.5.1

10-14-2024 06:14:04 EDT: INFO: IoT-FND database connection verified.

10-14-2024 06:14:04 EDT: INFO: IoT FND timeseries database server: 192.68.5.1

10-14-2024 06:14:04 EDT: INFO: IoT FND kapacitor server: 192.68.5.1

10-14-2024 06:14:05 EDT: INFO: IoT-FND timeseries database/kapacitor connection verified.

10-14-2024 06:14:07 EDT: INFO: IoT-FND application server is up and running.

10-13-2024 22:58:21 EDT: INFO: IoT-FND is up and running.


[root@iot-fnd ~]# docker container exec fnd-container /opt/cgms/bin/cgms_stop.sh

./jboss-cli.sh: line 59: setDefaultModularJvmOptions: command not found

[root@iot-fnd ~]# docker container exec fnd-container /opt/cgms/bin/cgms_status.sh

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10-13-2024 22:59:58 EDT: INFO: IoT-FND database server: 192.68.5.1

10-13-2024 22:59:58 EDT: INFO: IoT-FND database connection verified.

10-13-2024 22:59:58 EDT: INFO: IoT FND timeseries database server: 192.68.5.1

10-13-2024 22:59:58 EDT: INFO: IoT FND kapacitor server: 192.68.5.1

10-13-2024 22:59:59 EDT: INFO: IoT-FND timeseries database/kapacitor connection verified.

10-13-2024 23:00:01 EDT: ERROR: IoT-FND application server is not running.

[root@iot-fnd ~]#
```

Step 8. Run the **setupCgms.sh** script to configure IPAM and PSK settings.

Choose **y** for the following prompts:

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

ii. Do you want to use Internal IP Address Management (IPAM) (y/n)?

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

Choose **n** for all other prompts.

Note: The default database password is **Cgms123**.

```
[root@iot-fnd ~]# docker container exec -it fnd-container /opt/cgms/bin/setupCgms.sh
10-13-2024 23:09:48 EDT: INFO: ========== IoT-FND Setup Started - 2024-10-13-23-09-48 ==========
10-13-2024 23:09:48 EDT: INFO: Log file: /opt/cgms/bin/../server/cgms/log/cgms_setup.log

Are you sure you want to setup IoT-FND (y/n)? y
10-13-2024 23:10:01 EDT: INFO: User response: y

Do you want to change the database settings (y/n)? n
10-13-2024 23:10:08 EDT: INFO: User response: n

Do you want to change the database password (y/n)? n
10-13-2024 23:10:10 EDT: INFO: User response: n

Do you want to change the keystore password (y/n)? n
10-13-2024 23:10:13 EDT: INFO: User response: n

Do you want to change the web application 'root' user password (y/n)? n
10-13-2024 23:10:21 EDT: INFO: User response: n

Do you want to change IPAM and PSK Settings (y/n)? y
10-13-2024 23:10:41 EDT: INFO: User response: y
10-13-2024 23:10:41 EDT: INFO: Checking database connection. This may take a while. Please wait ...
10-13-2024 23:10:42 EDT: INFO: Database connection verification completed successfully
10-13-2024 23:10:42 EDT: INFO: Migrating IoT-FND database ...

Enter database password:Cgms123
10-13-2024 23:10:50 EDT: INFO: Log file: /opt/cgms/bin/../server/cgms/log/cgms_setup.log
10-13-2024 23:10:50 EDT: INFO: Performing migration. This may take a while. Please wait ...
10-13-2024 23:10:52 EDT: INFO: Migration completed.
10-13-2024 23:10:52 EDT: INFO: Performing post migration. This may take a while. Please wait ...
10-13-2024 23:10:57 EDT: INFO: Post migration completed.
10-13-2024 23:10:57 EDT: INFO: IoT-FND database migration completed successfully

Do you want to use Internal IP Address Management (IPAM) (y/n)? y
10-13-2024 23:11:05 EDT: INFO: User response: y
10-13-2024 23:11:05 EDT: INFO: Configuring Preferences settings for IPAM. This may take a while. Please
wait...
10-13-2024 23:11:09 EDT: INFO: Preferences Settings for IPAM completed successfully
```

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

10-13-2024 23:11:18 EDT: INFO: User response: y

10-13-2024 23:11:18 EDT: INFO: Configuring Preferences settings for Tunnel Mgmt. This may take a while.
Please wait...

10-13-2024 23:11:23 EDT: INFO: Preferences Settings for Tunnel Mgmt completed successfully


Do you want to change the FTP settings (y/n)? n

10-13-2024 23:11:28 EDT: INFO: User response: n


Do you want to change router CGDM protocol settings (y/n)? n

10-13-2024 23:11:50 EDT: INFO: User response: n


Do you want to change router management mode [Demo, Bandwidth Optimized, Default] (y/n)? n

10-13-2024 23:12:56 EDT: INFO: User response: n


Do you want to configure timeseries database (y/n)? n

10-13-2024 23:13:12 EDT: INFO: User response: n

10-13-2024 23:13:12 EDT: INFO: Configuring timeseries flag  none in system properties. This may take a
while. Please wait...

10-13-2024 23:13:12 EDT: INFO: timeseries flag none


Do you want to change log file settings)? (y/n)? n

10-13-2024 23:13:22 EDT: INFO: User response: n

10-13-2024 23:13:22 EDT: INFO: ========== IoT-FND Setup Completed Successfully ==========
```

Step 9. Restart the Cisco IoT FND container and check its status to confirm that the container is up and running for the configuration changes to take effect.

```
[root@iot-fnd ~]# /opt/fnd/scripts/fnd-container.sh restart

[root@iot-fnd ~]# /opt/fnd/scripts/fnd-container.sh status

fnd-container is running, pid=1237121

*** WARNING : deprecated key derivation used.

Using -iter or -pbkdf2 would be better.

CONTAINER ID        NAME                CPU %               MEM USAGE / LIMIT     MEM %               NET
I/O             BLOCK I/O           PIDS

e3d151c0c9ef        fnd-container       3.17%               2.929GiB / 31.14GiB   9.40%               18.6MB
/ 13.7MB      8.19kB / 745kB      644

[root@iot-fnd ~]#


[root@iot-fnd ~]# docker container ls

CONTAINER ID        IMAGE               COMMAND                   CREATED             STATUS
PORTS
NAMES

06fc10399064        fogd-image:active   "/bin/sh -c /usr/loc…"   5 months ago        Up 4 days
443/tcp
fogd-container

e3d151c0c9ef        fnd-image:active    "/bin/sh -c /opt/fnd…"   5 months ago        Up 6 minutes
0.0.0.0:80->80/tcp, 0.0.0.0:162->162/udp, 0.0.0.0:443->443/tcp, 0.0.0.0:9120-9121->9120-9121/tcp,
0.0.0.0:5683->5683/udp, 0.0.0.0:61624-61626->61624-61626/udp, 0.0.0.0:9124-9125->9124-9125/tcp,
0.0.0.0:61628->61628/udp   fnd-container

[root@iot-fnd ~]#


[root@iot-fnd ~]# docker container exec fnd-container /opt/cgms/bin/cgms_status.sh

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10-14-2024 06:14:03 EDT: INFO: IoT-FND database server: 192.68.5.1

10-14-2024 06:14:04 EDT: INFO: IoT-FND database connection verified.

10-14-2024 06:14:04 EDT: INFO: IoT FND timeseries database server: 192.68.5.1

10-14-2024 06:14:04 EDT: INFO: IoT FND kapacitor server: 192.68.5.1

10-14-2024 06:14:05 EDT: INFO: IoT-FND timeseries database/kapacitor connection verified. 10-14-2024
06:14:05 EDT: INFO: IoT-FND application server is up and running.
```

Access Cisco IoT FND GUI

After the Cisco IoT FND container and the service are up and running, you can access the Cisco IoT FND GUI.

Step 1. In a web browser, enter one of the following URLs:

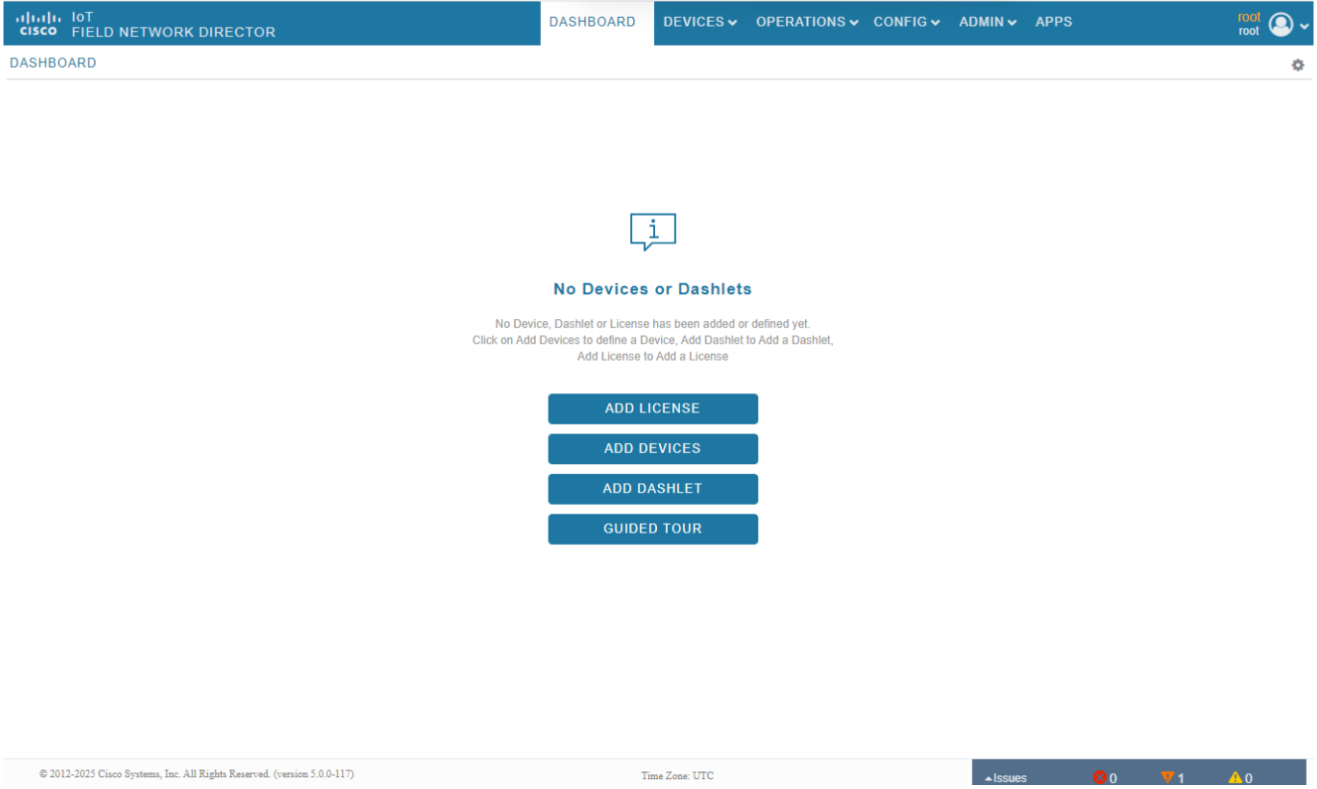
- https://<FND_ADMIN_NETWORK_IP>
- https://<FND_CORP_DATA_NETWORK_IP>

Step 2. At first login, use the following credentials:

Username: root
Password: root123

Step 3. After the first login, change your password immediately.

Figure 16. Cisco IoT FND dashboard



No Devices or Dashlets

No Device, Dashlet or License has been added or defined yet.
Click on Add Devices to define a Device, Add Dashlet to Add a Dashlet,
Add License to Add a License

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Time Zone: UTC

At this stage, the network and essential system configurations, including NTP, hostname, and static name resolution, are finalized. Additionally, configurations for tunnel management using a unique Pre-Shared Key (PSK) and IPAM are complete. The Cisco IoT FND GUI should now be accessible. The subsequent sections guide you through integrating additional components that are necessary for successful PnP and ZTD.

Integrate TPS with Cisco IoT FND

A TPS (also referred as TPS Proxy) takes in the communication from the untrusted part of the network and proxies the communication to Cisco IoT FND which is located in a trusted part of the network.

Table 6. Configuration items for TPS VM creation

Configuration item	Description
ADMIN_NETWORK_PORTGROUP	ESXi Port group that will be used for Admin Network for SSH and GUI access.
CORP_DATA_NETWORK_PORTGROUP	ESXi Port group that will be used for Corporate Data Network for the communication of Cisco IoT FND with HER, TPS and field router (via TPS or HER).
DMZ_FIELD_ROUTER_FACING_NETWORK_PORTGROUP	ESXi Port group that will be used for communication with field router over DMZ.
DMZ_FIELD_ROUTER_FACING_NETWORK_NMCLI_CONNECTION_NAME	DMZ field-router-facing network’s connection name. Keep it same as the device name for simplicity. For example, eth0, ens192, and so on.
ESXI_HOST_PASSWORD	Password to access the ESXi host.
ESXI_HOST_URL	IP Address of the ESXi host (version 6.5 and above) where the Cisco IoT FND VM is deployed.
ESXI_HOST_USERNAME	Username to access the ESXi host.
FND_HOST_NAME_FQDN	Hostname of Cisco IoT FND including domain name.
FND_CORP_DATA_NETWORK_IP	IP Address for Cisco IoT FND Corporate Data Network which is used for communication with HER and TPS.
NEXTHOP_TO_REACH_NTP_FROM_TPS	Nexthop IP to reach NTP from TPS.
NTP_SERVER_1	Primary NTP server used for Time synchronization.
NTP_SERVER_2	Backup NTP server used for time synchronization.
TPS_HOST_NAME_FQDN	Hostname of TPS including domain name.
TPS_ADMIN_NETWORK_IP	IP address for TPS Admin Network which is used for SSH and GUI access.
TPS_CGMS_KEYSTORE	TPS CGMS keystore file.
TPS_NMCLI_CONNECTION_NAME_TO_REACH_NTP	Network Connection name to reach NTP. The value could be ADMIN_NETWORK_NMCLI_CONNECTION_NAME or CORP_DATA_NETWORK_NMCLI_CONNECTION_NAME
TPS_CORP_DATA_NETWORK_IP	IP address for TPS data network which is used to communicate over Corporate Data Network with Cisco IoT FND.
TPS_DMZ_FIELD_ROUTER_FACING _NETWORK _GATEWAY	Gateway of field-router-facing network.
TPS_DMZ_FIELD_ROUTER_FACING_NETWORK _IP	IP Address for TPS field-router-facing network used for communication with field router.
TPS_KEYSTORE_PASSWORD	Password protecting the TPS keystore.
TPS_OVA_IMAGE	TPS OVA image.

Set up TPS VM

Step 1. Upload the TPS OVA file using the steps detailed in the task Import Cisco IoT FND OVA file into an ESXi host

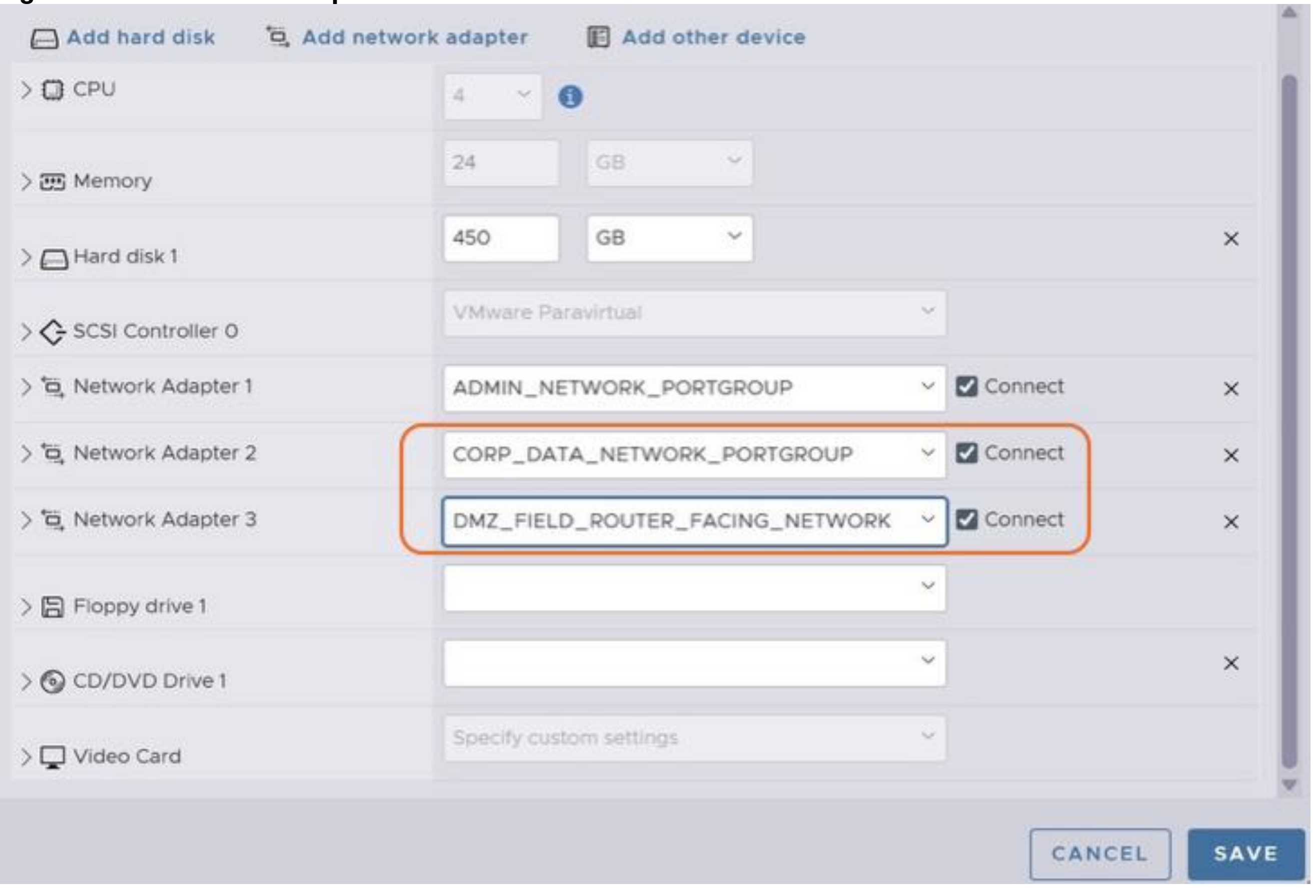
Step 2. In the EXSi host, select the TPS virtual machine.

Step 3. Click **Edit.**

Step 4. In the **Virtual Hardware** tab, choose **Add network adaptor**.

Step 5. Add three network adaptors: *<ADMIN_NETWORK_PORTGROUP>*, *<CORP_DATA_NETWORK_PORTGROUP>*, and *<DMZ_FIELD_ROUTER_FACING_NETWORK_PORTGROUP>*.

Figure 17. Add network adapors for TPS in ESXi



- CPU: 4
- Memory: 24 GB
- Hard disk 1: 450 GB
- SCSI Controller 0: VMware Paravirtual
- Network Adapter 1: ADMIN_NETWORK_PORTGROUP ☑ Connect
- Network Adapter 2: CORP_DATA_NETWORK_PORTGROUP ☑ Connect
- Network Adapter 3: DMZ_FIELD_ROUTER_FACING_NETWORK ☑ Connect
- Floppy drive 1
- CD/DVD Drive 1
- Video Card: Specify custom settings

Step 6. Power on the TPS VM.

To map the NICs and their connection names, for the TPS VM, carry out the steps detailed in the task **Error! Reference source not found.**Here's an example table for you to fill out.

Table 7. TPS device port mappings

ESXi Portgroup Name	MAC Address	NMCLI Device Name	NMCLI Connection Name
ADMIN_NETWORK_PORTGROUP	*<Enter the IP address>*	*<Enter device name>*	*<Enter connection name>* (ADMIN_NETWORK_NMCLI_CONNECTION_NAME)
CORP_DATA_NETWORK_PORTGROUP	*<Enter the IP address>*	*<Enter device name>*	*<Enter connection name>* (CORP_DATA_NETWORK_PORTGROUP_CONNECTION_NAME)
DMZ_FIELD_ROUTER_FACING_NETWORK_PORTGROUP	*<Enter the IP address>*	*<Enter device name>*	*<Enter connection name>* (DMZ_FIELD_ROUTER_FACING_NETWORK_NMCLI_CONNECTION_NAME)

Configure TPS network settings

Step 1. In the ESXi client, click **Console.**

Step 2. Select **Open Console in new tab.**

Step 3. Log into the TPS VM console using the following default credentials:

Username: root
Password: C!sco123

Step 4. Change the password after the first login.

Step 5. Click **Applications**, and choose **System Tools > Terminal**.

Step 6. Check existing NIC Devices using the **nmcli device status** and **ifconfig** commands.

Step 7. NIC with <ADMIN_NETWORK_PORTGROUP> would already have connection-name. Modify the connection using the **nmcli connection modify** command.

```
nmcli connection modify <ADMIN_NETWORK_NMCLI_CONNECTION_NAME> ipv4.addresses <TPS_ADMIN_NETWORK_IP>/<subnet>
ipv4.method manual

nmcli connection up <ADMIN_NETWORK_NMCLI_CONNECTION_NAME>
```

Step 8. With the configured <TPS_ADMIN_NETWORK_IP> IP address, you can now establish SSH access from the local subnet. For SSH access from other subnets, enable static routes for reachability.

Step 9. For the NICs CORP_DATA_NETWORK_PORTGROUP and DMZ_FIELD_ROUTER_FACING_NETWORK_PORTGROUP, add the connections and IP addresses.

Note: This configuration assumes that <TPS_DMZ_FIELD_ROUTER_FACING_NETWORK_GATEWAY> as the default gateway. It is recommended to have only one default gateway in the system. Consider adapting the gateway configurations based on your network environment.

```
nmcli connection add type ethernet ifname <CORP_DATA_NETWORK_NMCLI_CONNECTION_NAME> con-name
<CORP_DATA_NETWORK_NMCLI_CONNECTION_NAME> ip4 <TPS_CORP_DATA_NETWORK_IP>/<subnet>


nmcli connection add type ethernet ifname <DMZ_FIELD_ROUTER_FACING_NETWORK_NMCLI_CONNECTION_NAME> con-name
<DMZ_FIELD_ROUTER_FACING_NETWORK_NMCLI_CONNECTION_NAME> ip4
<TPS_DMZ_FIELD_ROUTER_FACING_NETWORK_IP>/<subnet> gw4 <TPS_DMZ_FIELD_ROUTER_FACING_NETWORK_GATEWAY>


nmcli connection up <CORP_DATA_NETWORK_NMCLI_CONNECTION_NAME>

nmcli connection up <DMZ_FIELD_ROUTER_FACING_NETWORK_NMCLI_CONNECTION_NAME>
```

Step 10. Use the **nmcli general hostname <>** command to configure the hostname and the **hostnamectl** command to verify that the configured hostname is saved.

```
[root@iot-tps ~]# nmcli general hostname <TPS_HOST_NAME_FQDN>
[root@iot-tps ~]# hostnamectl
```

Configure NTP

Step 1. Use the following commands to add the routes to primary and backup NTP servers.

```
[root@iot-tps ~]# nmcli connection modify <TPS_NMCLI_CONNECTION_NAME_TO_REACH_NTP> +ipv4.routes
"<NTP_SERVER_1>/32 <NEXTHOP_TO_REACH_NTP_FROM_TPS>"

[root@iot-tps ~]# nmcli connection modify <TPS_NMCLI_CONNECTION_NAME_TO_REACH_NTP> +ipv4.routes
"<NTP_SERVER_2>/32 <NEXTHOP_TO_REACH_NTP_FROM_TPS>"

[root@iot-tps ~]# nmcli connection up <TPS_NMCLI_CONNECTION_NAME_TO_REACH_NTP>


Example:

nmcli connection modify ens192 +ipv4.routes "1.0.0.101/32 192.168.1.1"

nmcli connection modify ens192 +ipv4.routes "1.0.0.102/32 192.168.1.1"

nmcli connection up ens192

ip route
```

Step 2. Backup the existing **/etc/chrony.conf** file.

```
[root@iot-tps ~]# cp /etc/chrony.conf /etc/chrony.conf.bak
```

Step 3. Comment the existing default pool in the configuration file.

```
[root@iot-tps ~]# sed -i '/^pool/s/^/#/' /etc/chrony.conf
```

Step 4. Add the primary and backup NTP servers in the configuration file.

```
[root@iot-tps ~]# sed -i '1i\server <NTP_SERVER_2> iburst' /etc/chrony.conf

[root@iot-tps ~]# sed -i '1i\server <NTP_SERVER_1> iburst' /etc/chrony.conf

Example:

[root@iot-tps ~]# sed -i '1i\server 1.0.0.102 iburst' /etc/chrony.conf

[root@iot-tps ~]# sed -i '1i\server 1.0.0.101 iburst' /etc/chrony.conf
```

Step 5. Verify the contents of the file to ensure that the changes are saved.

```
[root@iot-tps ~]# more /etc/chrony.conf
```

Step 6. Restart **chronyd** service.

```
[root@iot-tps ~]# systemctl restart chronyd.service

[root@iot-tps ~]# systemctl status chronyd.service

● chronyd.service - NTP client/server

   Loaded: loaded (/usr/lib/systemd/system/chronyd.service; enabled; vendor preset: enabled)

   Active: active (running) since Thu 2024-10-17 01:19:42 EDT; 29s ago

     Docs: man:chronyd(8)

           man:chrony.conf(5)

  Process: 197485 ExecStopPost=/usr/libexec/chrony-helper remove-daemon-state (code=exited,
status=0/SUCCESS)

  Process: 200554 ExecStartPost=/usr/libexec/chrony-helper update-daemon (code=exited, status=0/SUCCESS)

  Process: 200550 ExecStart=/usr/sbin/chronyd $OPTIONS (code=exited, status=0/SUCCESS)

 Main PID: 200552 (chronyd)

    Tasks: 1 (limit: 203710)

   Memory: 1.0M

   CGroup: /system.slice/chronyd.service

           └─200552 /usr/sbin/chronyd
```

Step 7. To verify NTP synchronization, use the following commands. Note that it may take some time for the synchronization to complete. The value **System clock synchronized: yes** in the response confirms that the NTP synchronization is complete.

```
[root@iot-tps ~]# chronyc tracking

[root@iot-tps ~]# chronyc sources

[root@iot-tps ~]# timedatectl

               Local time: Thu 2024-10-17 02:59:08 EDT

           Universal time: Thu 2024-10-17 06:59:08 UTC

                 RTC time: Thu 2024-10-17 06:59:08

                Time zone: America/New_York (EDT, -0400)

System clock synchronized: yes
```

```
               NTP service: active
           RTC in local TZ: no
[root@iot-tps ~]#
```

Configure static name resolution

Step 1. Map FQDN of FND with its IP in the **/etc/hosts** file.

```
[root@iot-tps ~]$ cp /etc/hosts /etc/hosts.bak

[root@iot-tps ~]$ sed -i '$a <FND_CORP_DATA_NETWORK_IP> <FND_HOST_NAME_FQDN>' /etc/hosts


[root@iot-tps ~]$ cat /etc/hosts

127.0.0.1   iot-tps   localhost localhost.localdomain localhost4 localhost4.localdomain4

::1         iot-tps   localhost localhost.localdomain localhost6 localhost6.localdomain6

<FND_CORP_DATA_NETWORK_IP> <FND_HOST_NAME_FQDN>
```

Update CGMS keystore and TPS proxy properties

Step 1. Use root user privileges to upload cgms_keystore (<TPS_CGMS_KEYSTORE>) file to the **/opt/cgms-tpsproxy/conf/** directory. Backup existing cgms_keystore before upload.

```
[root@iot-tps ~]$ cp /opt/cgms-tpsproxy/conf/cgms_keystore /opt/cgms-tpsproxy/conf/cgms_keystore.bak


[root@iot-tps ~]$ scp <scp_user>@<scp_server>://<cgms_keystore_file_path> /opt/cgms-
tpsproxy/conf/cgms_keystore
```

Step 2. Encrypt the CGMS keystore password and copy the displayed encrypted password.

```
[root@iot-tps bin]# /opt/cgms-tpsproxy/bin/encryption_util.sh encrypt <TPS_KEYSTORE_PASSWORD>
yJ7v/eijrPT9a3B/otHDoffVfMmz6at5JBDtFrb4EtMif+mo
```

Step 3. In the **/opt/cgms-tpsproxy/conf/tpsproxy.properties** file, update the following properties

Property	Value
• Inbound proxy destination • Outbound proxy allowed addresses • Inbound bsproxy destination	<FND_HOST_NAME_FQDN>
CGMS keystore encrypted password	The encrypted password from step 3

```
root@iot-tps ~]# nano /opt/cgms-tpsproxy/conf/tpsproxy.properties

[root@iot-tps ~]# more /opt/cgms-tpsproxy/conf/tpsproxy.properties

inbound-proxy-destination=https://<FND_HOST_NAME_FQDN>:9120

outbound-proxy-allowed-addresses=<FND_HOST_NAME_FQDN>

cgms-keystore-password-hidden=yJ7v/eijrPT9a3B/otHDoffVfMmz6at5JBDtFrb4EtMif+mo


inbound-bsproxy-destination=http://<FND_HOST_NAME_FQDN>:9125
```

```
enable-bootstrap-service=true
bootstrap-proxy-listen-port=9125
enable-reverse-dns-lookup=false
```

Step 4. Start the TPS proxy service.

```
[root@iot-tps conf]# systemctl start tpsproxy.service
```

Step 5. Verify that the TPS proxy service is running. The value **Active: active (running)** in the response confirms that the service is running.

```
[root@iot-tps bin]# systemctl status tpsproxy.service
● tpsproxy.service - SYSV: CGMS Tunnel Provisioning proxy server
   Loaded: loaded (/etc/rc.d/init.d/tpsproxy; generated)
   Active: active (running) since Thu 2025-03-06 06:19:57 EST; 1min 31s ago
     Docs: man:systemd-sysv-generator(8)
  Process: 4278 ExecStart=/etc/rc.d/init.d/tpsproxy start (code=exited, status=0/SUCCESS)
    Tasks: 39 (limit: 152110)
   Memory: 68.2M
   CGroup: /system.slice/tpsproxy.service
           └─4296 java -server -Xms128m -Xmx2g -XX:MaxPermSize=256m -server -XX:+HeapDumpOnOutOfMemoryError
-XX:HeapDumpPath=/opt/cgms-tpsproxy/log -XX:-OmitStackTraceInFastThrow -XX:-UseP>

Mar 06 06:19:56 tps-san.ipg.cisco.com systemd[1]: Starting SYSV: CGMS Tunnel Provisioning proxy server...
Mar 06 06:19:56 tps-san.ipg.cisco.com runuser[4294]: pam_unix(runuser:session): session opened for user root
by (uid=0)
Mar 06 06:19:56 tps-san.ipg.cisco.com runuser[4294]: pam_unix(runuser:session): session closed for user root
Mar 06 06:19:57 tps-san.ipg.cisco.com tpsproxy[4278]: [36B blob data]
Mar 06 06:19:57 tps-san.ipg.cisco.com systemd[1]: Started SYSV: CGMS Tunnel Provisioning proxy server.

[root@iot-tps ~]# ss -tulwn | grep LISTEN
tcp   LISTEN 0      128          0.0.0.0:22         0.0.0.0:*
tcp   LISTEN 0      5          127.0.0.1:631        0.0.0.0:*
tcp   LISTEN 0      128             [::]:22            [::]:*
tcp   LISTEN 0      5              [::1]:631           [::]:*
tcp   LISTEN 0      50                 *:9120             *:*
tcp   LISTEN 0      50                 *:9122             *:*
tcp   LISTEN 0      50                 *:9125             *:*
```

By following the steps outlined in the previous sections, the TPS OVA deployment completes successfully, and the TPS shell is accessible. All necessary configurations within TPS are finalized, ensuring successful integration with Cisco IoT FND.

Integrate HER with Cisco IoT FND

After the field router is bootstrapped successfully, to ensure secure communication of field routers with Cisco IoT FND, OT applications like SCADA and so on, IPSec tunnels (based on pre-shared key) are established between field router and HER. The HER can be positioned in Network Operation Centre or Control Centre/DSO.

This section provides a guide on the steps necessary to configure HER using the Cisco Catalyst 8000 platform.

Table 8. Essential configuration items for HER integration

Configuration item	Description
DOMAIN_NAME	Domain name used across the network.
HER_ADMIN_NETWORK_IP	IP Address for HER Admin Network which is used for SSH access.
HER_CORP_DATA_NETWORK_IP	IP Address configured on the Corporate Data Network interface which is used for communication with Cisco IoT FND.
HER_DMZ_FIELD_ROUTER_FACING_NETWORK_IP	IP Address configured on the field-router-facing interface.
HER_DMZ_FIELD_ROUTER_FACING_NETWORK_GATEWAY	Nexthop IP address on HER in DMZ_FIELD_ROUTER_FACING_NETWORK.
HER_HOST_NAME	Hostname of HER, also used as local key-id on HER and remote key-id on field router for PSK based key-rings in this guide.
HER_LOOPBACK_IP	IP Address of HER's loopback interface.
HER_PASSWORD	Password for accessing HER.
HER_USERNAME	Username for accessing HER.
NEXTHOP_TO_REACH_NTP_FROM_HER	Nexthop IP to reach NTP server from HER.
IPSEC_TRANSFORM_SET_MODE	IPSec Transform-set mode can be either transport or tunnel. Configure it based on the network design.
IP_MTU	Maximum IPv4 MTU supported between field router and DMZ Network through the Provider network. See the Appendix section for calculation reference.
TCP_MSS	Maximum IPv4 segment size supported between field router and DMZ Network through the provider network. See the Appendix section for calculation reference.

Note: We assume that the HER router is up and running, and can be accessed.

Step 1. Connect to the HER console.

Step 2. To enable device SSH access, configure the Admin Network interface, user credentials, and AAA configuration.

```
conf t
interface GigabitEthernet1
 description ADMIN Network
 ip address <HER_ADMIN_NETWORK_IP> <subnet>
 no shut
!
username <HER_USERNAME> privilege 15 secret <HER_PASSWORD>
enable password <HER_PASSWORD>
!
aaa new-model
```

```
!
end
write
```

Step 3. Configure IP address on the interfaces that are part of Corporate Data and DMZ field-router-facing networks.

```
conf t
interface GigabitEthernet2
 description FND_TPS_HER_Network
 ip address <HER_CORP_DATA_NETWORK_IP> <subnet_mask>
 no shutdown
!
!Field Router Facing Interface used as Tunnel Source
interface GigabitEthernet3
 description Field Router Facing Network
 ip address <HER_DMZ_FIELD_ROUTER_FACING_NETWORK_IP> <subnet_mask>
 no shutdown
!
ip route 0.0.0.0 0.0.0.0 <HER_DMZ_FIELD_ROUTER_FACING_NETWORK _GATEWAY>
end
write
```

Step 4. Verify the changes using the **ip interface brief** command.

```
Router#show ip interface brief
Interface              IP-Address                                        OK? Method Status
Protocol
GigabitEthernet1       <HER_ADMIN_NETWORK_IP>                    YES NVRAM  up                     up
GigabitEthernet2       <HER_CORP_DATA_NETWORK_IP>                YES NVRAM  up                     up
GigabitEthernet3       <HER_DMZ_FIELD_ROUTER_FACING_NETWORK_IP>  YES NVRAM  up                     up
```

Step 5. Use the **ping** command to verify that Cisco IoT FND is reachable over Corporate Data Network.

```
Router#ping <FND_CORP_DATA_NETWORK_IP>
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to <FND_CORP_DATA_NETWORK_IP>, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms
```

Step 6. Enable the Network Advantage license and reload.

```
conf t
license accept end user agreement
license boot level network-advantage addon dna-advantage
end
write
reload
```

Add NTP configurations

Step 1. Use the following commands to add NTP configurations.

```
conf t
!
ip route <NTP_SERVER_1> 255.255.255.255 <NEXTHOP_TO_REACH_NTP_FROM_HER>
ip route <NTP_SERVER_2> 255.255.255.255 <NEXTHOP_TO_REACH_NTP_FROM_HER>
!
ntp server <NTP_SERVER_1> prefer
ntp server <NTP_SERVER_2>
!
end
write
```

Step 2. Use the **show ntp associations** command to verify the status of NTP peers.

```
Router#show ntp associations


  address         ref clock       st   when   poll reach  delay  offset   disp
*~<NTP_SERVER_1>     .GNSS.           1    140   1024   377  1.620  -2.905  1.030
 ~<NTP_SERVER_2>     .TIME.          16     61     64     0  0.000   0.000 15937.
 * sys.peer, # selected, + candidate, - outlyer, x falseticker, ~ configured
```

Step 3. Use the **show ntp status command** to verify synchronization status. The value **Clock is synchronized** in the response verifies that the process is complete.

```
Router#show ntp status
Clock is synchronized, stratum 2, reference is <NTP_SERVER_1>
nominal freq is 250.0000 Hz, actual freq is 249.9967 Hz, precision is 2**10
ntp uptime is 48501300 (1/100 of seconds), resolution is 4016
reference time is EB7B82A3.E7EFA030 (09:18:51.906 IST Wed Mar 12 2025)
clock offset is -2.9053 msec, root delay is 1.62 msec
root dispersion is 7.07 msec, peer dispersion is 1.03 msec
loopfilter state is 'CTRL' (Normal Controlled Loop), drift is 0.000013263 s/s
system poll interval is 1024, last update was 145 sec ago.
```

Add general configurations

Step 1. Add general configurations.

```
conf t
!Hostname
hostname <HER_HOST_NAME>
!AAA Configurations
aaa group server radius FARAuthList
 server name fanheradius
aaa authentication login default local
aaa authorization console
aaa authorization exec default local
aaa authorization network FARAuthList group radius
aaa authorization network FlexVPN-Config local
aaa authorization network FlexVPN_Author local
!
aaa session-id common
!Domain Configurations
no ip domain lookup
ip domain name <DOMAIN_NAME>
!
!Other General Settings
ip forward-protocol nd
ip tcp mss <TCP_MSS>
ip tcp synwait-time 5
ip tcp path-mtu-discovery
no ip http server
ip http authentication local
no ip http secure-server
ip http secure-active-session-modules none
ip http active-session-modules none
!
ip ssh version 2
!
netconf max-sessions 16
netconf ssh
!
end
write
```

Step 2. Configure IKEv2 and tunnel-related settings to bringup a PSK-based tunnel with the field router.

```
conf t
!Loopback Configurations
interface Loopback0
 ip address <HER_LOOPBACK_IP> 255.255.255.255
!
!Access-List for FND prefix advertisement to Field Router
ip access-list standard ADVERTISE_TO_FAR_ACL
 10 permit <FND_CORP_DATA_NETWORK_IP> <wild_card_mask>
!
!IKEv2 Author Policy configs
crypto ikev2 authorization policy FlexVPN_Author_Policy
 route set interface Loopback0
 route set access-list ADVERTISE_TO_FAR_ACL
!
```

```
!IKEv2 Proposal configs
crypto ikev2 redirect client
crypto ikev2 proposal FlexVPN_IKEv2_Proposal
 encryption aes-cbc-256
 integrity sha256
 group 14
!
!IKEv2 Policy configs
crypto ikev2 policy FlexVPN_IKEv2_Policy
 proposal FlexVPN_IKEv2_Proposal
!
!IKEv2 keyring configuration (peer configs and corresponding keys) is updated by FND
crypto ikev2 keyring FlexVPN_Keyring
!
crypto ikev2 profile FlexVPN_IKEv2_Profile
 match identity remote fqdn domain <DOMAIN_NAME>
 !Use local key-id as per your requirement, make sure to update the same in FND Router Tunnel Addition Template
 identity local key-id <HER_HOST_NAME>
 authentication remote pre-share
 authentication local pre-share
 keyring local FlexVPN_Keyring
 dpd 30 3 periodic
 aaa authorization group psk list FlexVPN_Author FlexVPN_Author_Policy
 virtual-template 1
!
!IPSec Policy configs
crypto isakmp invalid-spi-recovery
!
crypto ipsec transform-set FlexVPN_IPsec_Transform_Set esp-aes esp-sha256-hmac
 mode <IPSEC_TRANSFORM_SET_MODE>
!
crypto ipsec profile FlexVPN_IPsec_Profile
 set transform-set FlexVPN_IPsec_Transform_Set
 set pfs group14
 set ikev2-profile FlexVPN_IKEv2_Profile
 responder-only
!
!Virtual-Template configs
interface Virtual-Template1 type tunnel
 ip unnumbered Loopback0
 ip mtu <IP_MTU>
 ip tcp adjust-mss <TCP_MSS>
 tunnel source GigabitEthernet3    !Field Router Facing Interface used as Tunnel Source
 tunnel protection ipsec profile FlexVPN_IPsec_Profile
```

```
!
end
write
```

Cisco IoT FND configurations

Carry out the following tasks in the Cisco IoT FND GUI :

1. Add HER and field routers to Cisco IoT FND using CSV files
2. Configure Cisco IoT FND provisioning settings for bootstrapping and ZTD
3. Add subnets used for IPAM

Table 9. Configuration items for adding HER and field routers to Cisco IoT FND

Configuration item	Description
FIELD_ROUTER_PASSWORD	Password used by Cisco IoT FND for accessing the field router.
FIELD_ROUTER_SERIAL_NUMBER	Serial number of field router.
FIELD_ROUTER_TUNNEL_SOURCE_INTERFACE	Source interface of tunnel from field router to HER.
FIELD_ROUTER_USERNAME	Username of rield router.
FIELD_ROUTER_V4_LOOPBACK_IP	Loopback IP to be used for field router, if IPAM feature is not used.
FND_HOST_NAME_FQDN	Hostname of Cisco IoT FND including domain name.
HER_DMZ_FIELD_ROUTER_FACING_NETWORK_IP	IP address configured on HER for field-router-facing network interface.
HER_HOST_NAME	Hostname of HER, also used as local key-id on HER and remote key-id on field router for PSK-based key rings.
HER_LOOPBACK_IP	IP Address of HER’s loopback interface for accessing from Cisco IoT FND.
HER_EID	EID of HER to be added using CSV. It is recommended to use <Platform>+<SerialNumber> which can be fetched using the show license udi command. For example, C8000V+ 9Z2CEK3YBQ9.
HER_PASSWORD	Password for accessing HER from Cisco IoT FND.
HER_USERNAME	Username for accessing HER from Cisco IoT FND.
TPS_HOST_NAME_FQDN	Hostname of TPS including domain name.

Add HER to Cisco IoT FND

Step 1. Create a CSV file with the necessary parameters for the HER.

```
eid,deviceType,ip,netconfUsername,netconfPassword
<HER_EID>,c8000,<HER_CORP_DATA_NETWORK_IP>,<HER_USERNAME>,<HER_PASSWORD>
```

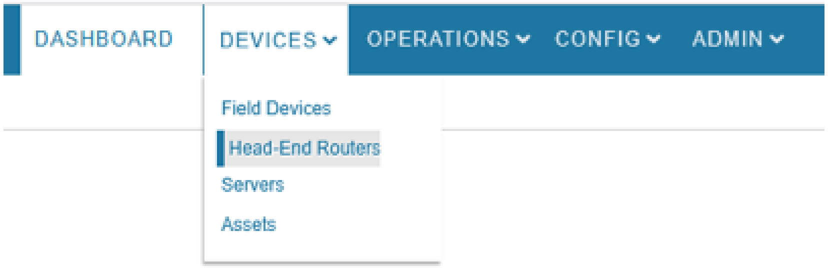
For example:

```
eid,deviceType,ip,netconfUsername,netconfPassword
C8000V+9Z2CEK3YBQ9,c8000,192.168.103.102,her-admin,her-password
C8000V+9Z2CEK3YBJ8,c8000,192.168.103.103,her-admin,her-password
C8000V+9Z2CEK3YBI7,c8000,192.168.103.104,her-admin,her-password
```

Step 2. Log into Cisco IoT FND.

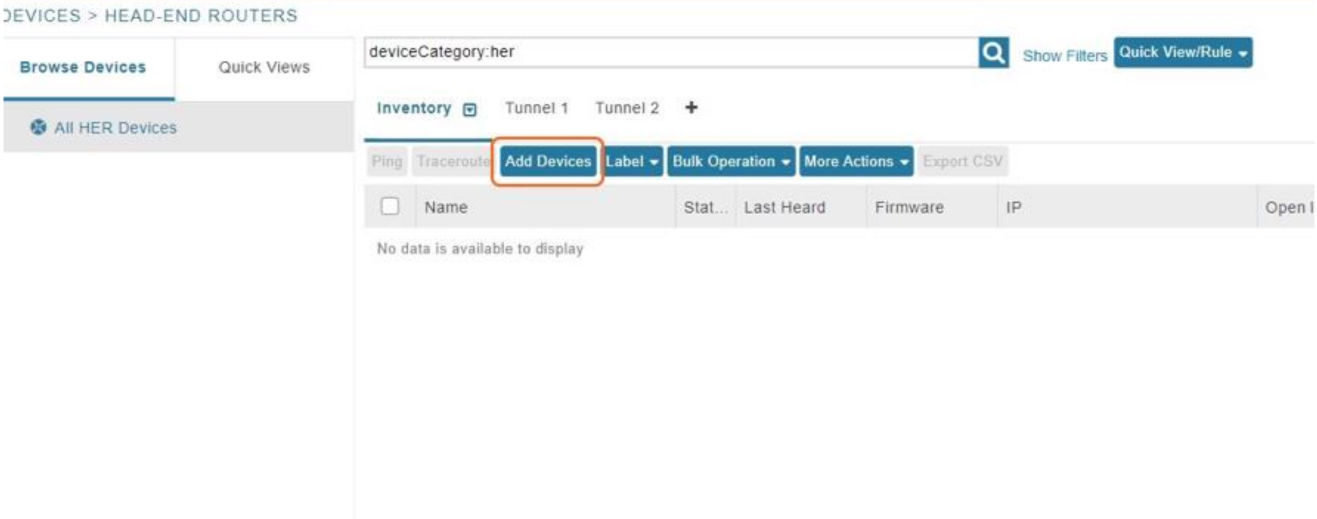
Step 3. From the main menu, choose **Devices > Head-End Routers**.

Figure 18. Navigate to head-end routers page



Step 4. Click **Add Devices**.

Figure 19. Navigate to Add HER device page

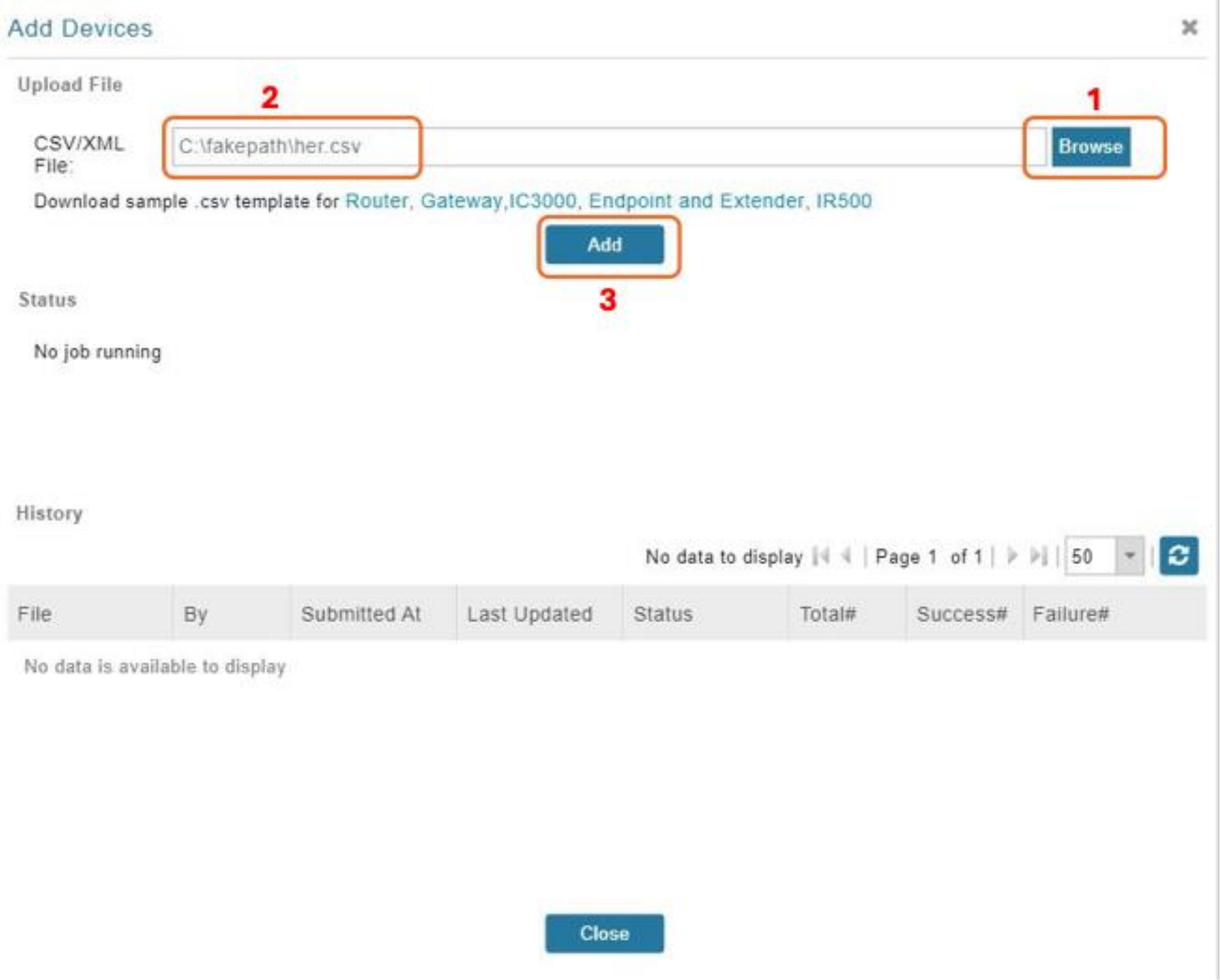


deviceCategory:her

No data is available to display

Step 5. In the **CSV/XML file** field, upload the CSV file you created.

Figure 20. Add HER device CSV



Add Devices

Upload File

CSV/XML File: C:\fakepath\her.csv

Download sample .csv template for Router, Gateway,IC3000, Endpoint and Extender, IR500

Status

No job running

History

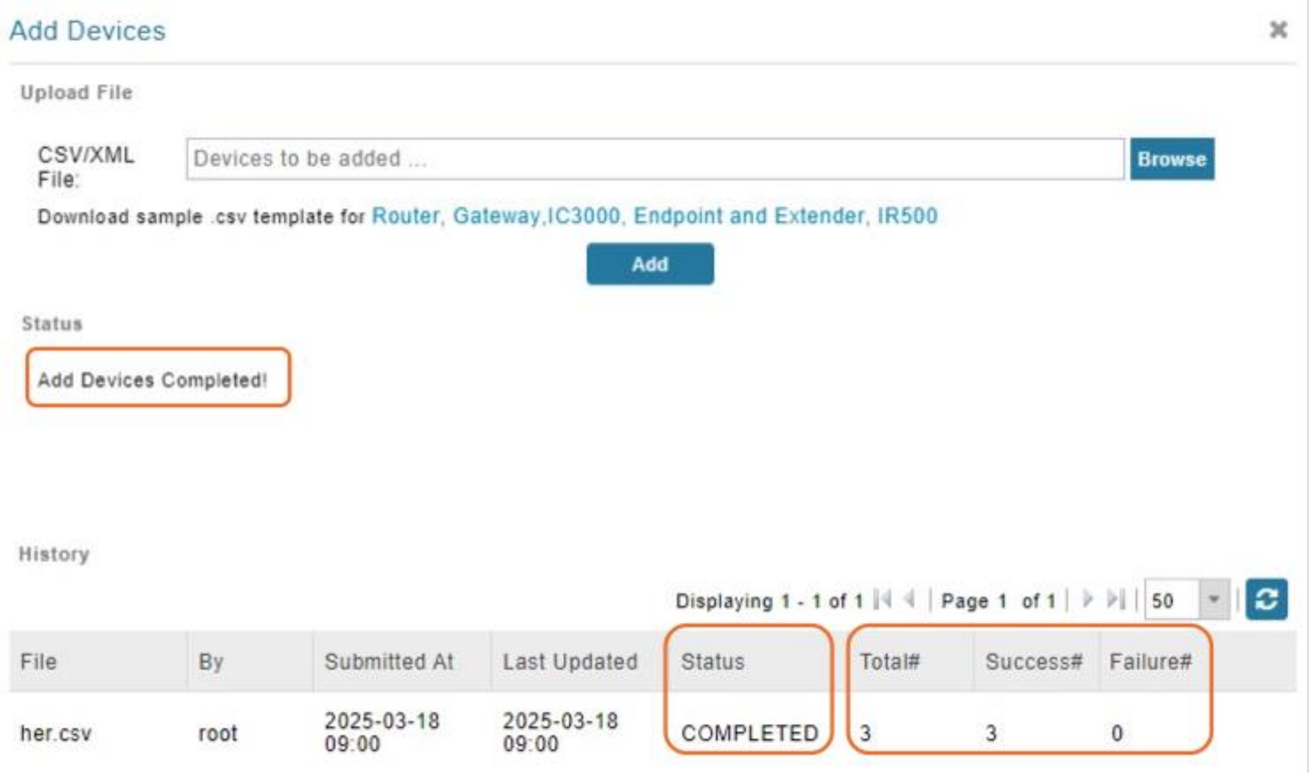
No data to display | Page 1 of 1 | 50

File	By	Submitted At	Last Updated	Status	Total#	Success#	Failure#

No data is available to display

When the upload is complete, in the **Add Devices** page, the **History** table displays the status of the file upload as **Completed.** The table entry also displays the total number of routers in the CSV, and the number of successful and failed uploads.

Figure 21. Verify successful addition of HER CSV



Add Devices

Upload File

CSV/XML File: Devices to be added ...

Download sample .csv template for Router, Gateway,IC3000, Endpoint and Extender, IR500

Status

Add Devices Completed!

History

Displaying 1 - 1 of 1 | Page 1 of 1 | 50

File	By	Submitted At	Last Updated	Status	Total#	Success#	Failure#
her.csv	root	2025-03-18 09:00	2025-03-18 09:00	COMPLETED	3	3	0

Add field routers to Cisco IoT FND

Step 1. Create a CSV file with the required parameters for the field area routers, using the following examples.

a. If you do not use the IPAM feature, to use a specific loopback address (assigned manually), use the loopbackv4Address or loopbackv6Address columns in the CSV file.

```
deviceType,eid,loopbackv4Address,tunnelSrcInterface1,ipsecTunnelDestAddr1,tunnelHerEid,adminUsername,adminPassword

ir1100,IR1101-K9+<FIELD_ROUTER_SERIAL_NUMBER>,<FIELD_ROUTER_V4_LOOPBACK_IP>,<FIELD_ROUTER_TUNNEL_SOURCE_INTERFACE>,<HER_DMZ_FIELD_ROUTER_FACING_NETWORK_IP>,<HER_EID>,<FIELD_ROUTER_USERNAME>,<FIELD_ROUTER_PASSWORD>


Example:
deviceType,eid,loopbackv4Address,tunnelSrcInterface1,ipsecTunnelDestAddr1,tunnelHerEid,adminUsername,adminPassword

ir1100,IR1101-K9+FCW2712Y9V1,192.168.221.2,Cellular0/1/0,10.10.143.101, C8000V+9Z2CEK3YBQ9,username,password

ir1100,IR1101-K9+FCW2712Y9V2,192.168.221.3,Cellular0/1/0,10.10.143.101, C8000V+9Z2CEK3YBQ9,username,password

ir1100,IR1101-K9+FCW2712Y9V3,192.168.221.4,Cellular0/1/0,10.10.143.101, C8000V+9Z2CEK3YBQ9,username,password
```

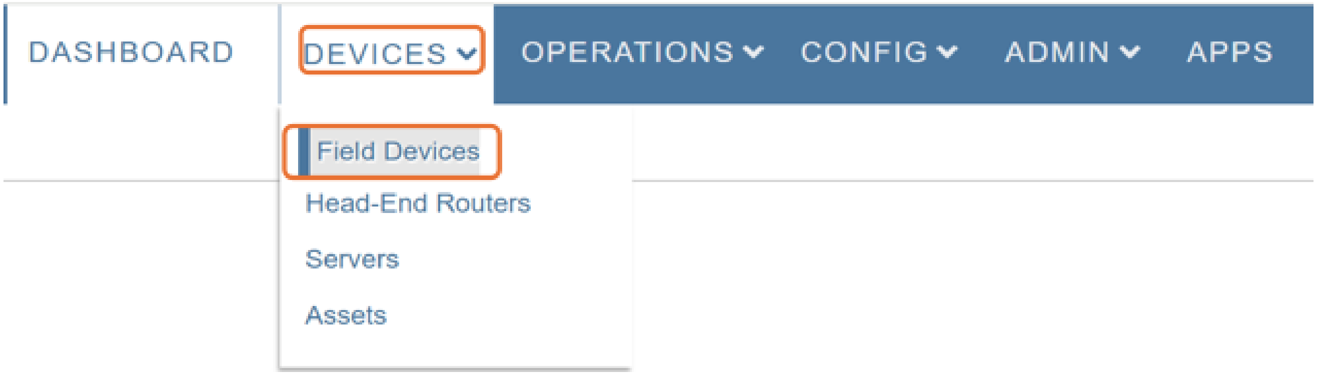
b. If you intend to use the IPAM feature, where the Cisco IoT FND's in-built DHCP server assigns loopback addresses, remove the loopbackv4Address and loopbackv6Address columns from the CSV file.

```
deviceType,eid,tunnelSrcInterface1,ipsecTunnelDestAddr1,tunnelHerEid,adminUsername,adminPassword

ir1100,IR1101-K9+<FIELD_ROUTER_SERIAL_NUMBER>,<FIELD_ROUTER_TUNNEL_SOURCE_INTERFACE>,<HER_DMZ_FIELD_ROUTER_FACING_NETWORK_IP>,<HER_HOST_NAME>,<FIELD_ROUTER_USERNAME>,<FIELD_ROUTER_PASSWORD>


Example:
deviceType,eid,tunnelSrcInterface1,ipsecTunnelDestAddr1,tunnelHerEid,adminUsername,adminPassword

ir1100,IR1101-K9+FCW2712Y9V1,Cellular0/1/0,10.10.143.101,C8000V+9Z2CEK3YBQ9,username,password
```

```
ir1100,IR1101-K9+FCW2712Y9V2,Cellular0/1/0,10.10.143.101,C8000V+9Z2CEK3YBQ9,username,password
ir1100,IR1101-K9+FCW2712Y9V3,Cellular0/1/0,10.10.143.101,C8000V+9Z2CEK3YBQ9,username,password
```

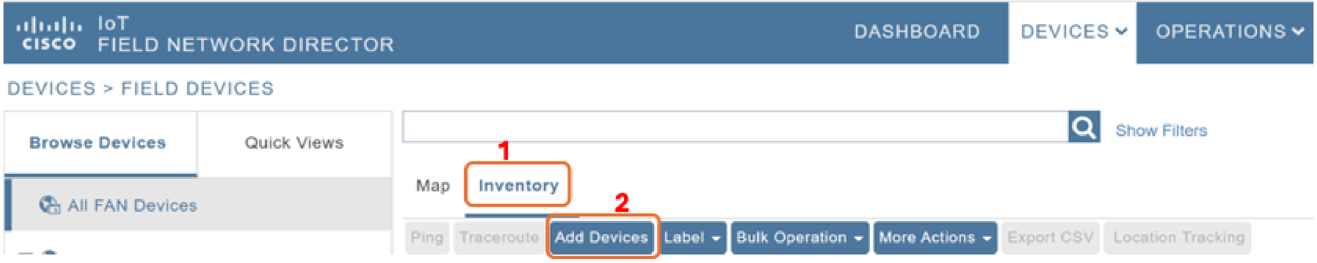
Step 2. From the Cisco IoT FND main menu, choose **Devices > Field Devices**.

Figure 22. Navigate to Field Devices page



Step 3. Choose **Inventory**, and click **Add Devices**.

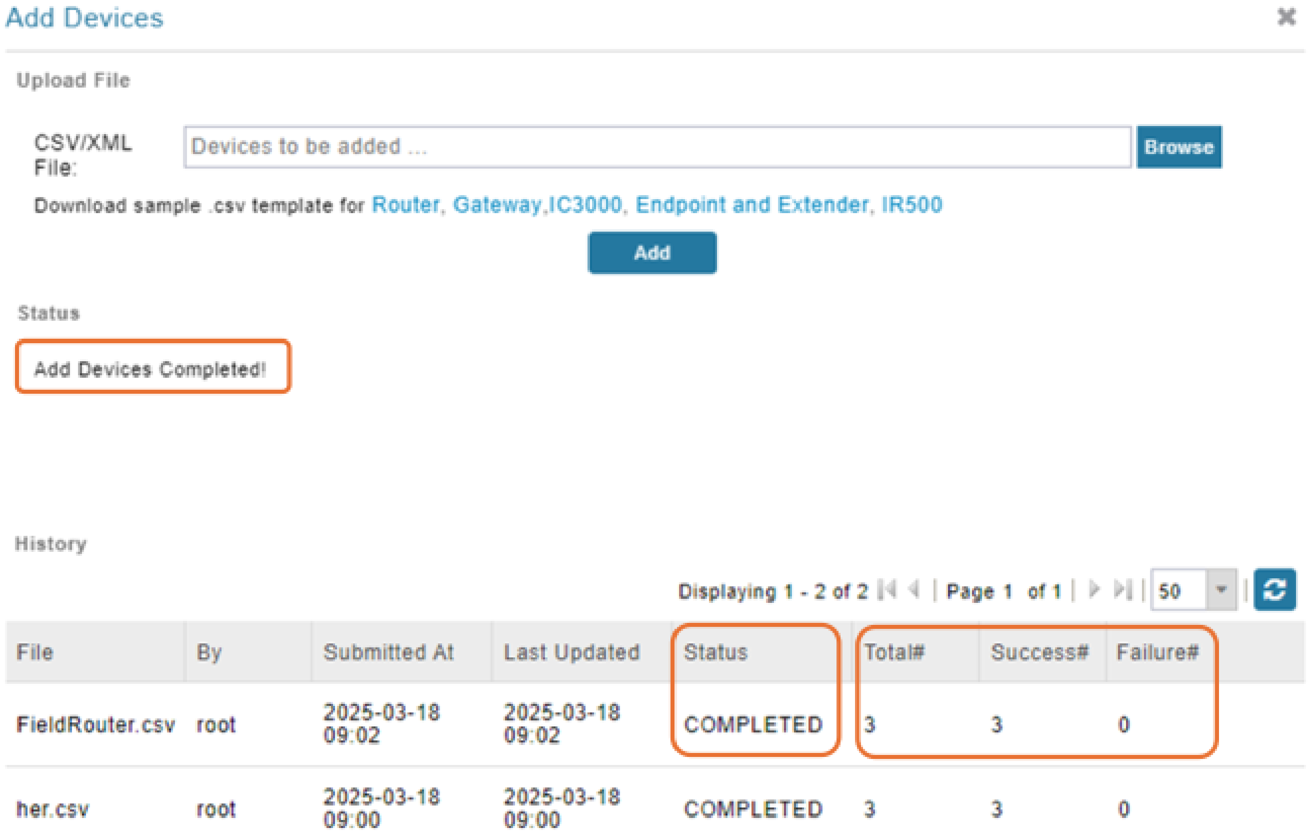
Figure 23. Navigate to Add Field Device page



Step 4. In the **CSV/XML file** field, click **Browse** and then **Add** to upload the CSV file you created.

When the upload is complete, in the **Add Devices** page, the **History** table displays the status of the file upload as **Completed.** The table entry also displays the total number of routers in the CSV, and the number of successful and failed uploads.

Figure 24. Verify successful field router CSV addition



Upload File

CSV/XML File: Devices to be added ...

Download sample .csv template for Router, Gateway,IC3000, Endpoint and Extender, IR500

Status

Add Devices Completed!

History

Displaying 1 - 2 of 2 | Page 1 of 1 | 50

File	By	Submitted At	Last Updated	Status	Total#	Success#	Failure#
FieldRouter.csv	root	2025-03-18 09:02	2025-03-18 09:02	COMPLETED	3	3	0
her.csv	root	2025-03-18 09:00	2025-03-18 09:00	COMPLETED	3	3	0

Configure Cisco IoT FND provisioning settings

Step 1. In the Cisco IoT FND GUI, from the menu, choose **Admin > System Management > Provisioning Settings**.

Step 2. In the **General** tab:

i. In the IoT-FND URL field, enter https://*<FND_HOST_NAME_FQDN>*:9121.

ii. In the Select PnP Type field, select DHCP Option 43.

iii. In the **SCEP URL** field, enter **NA.**

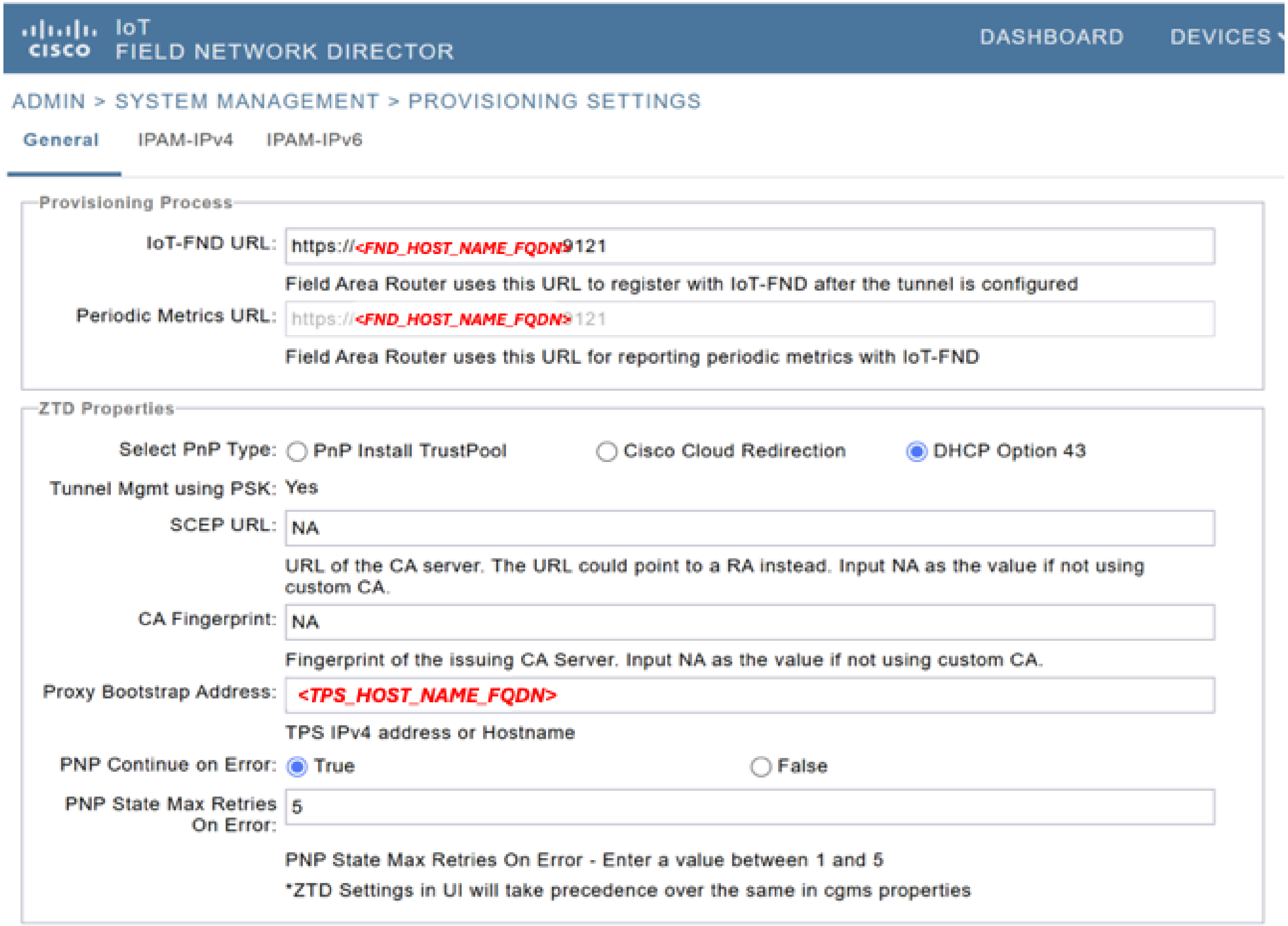
iv. In the **CA Fingerprint** field, enter **NA.**

v. In the **Proxy Bootstrap Address** field, the TPS_HOST_NAME_FQDN value is displayed by default.

vi. In the **PNP Continue on Error** field, select **True.**

vii. In the **PNP State Max Retries On Error** field, enter **5.**

Figure 25. Configure provisioning settings


IoT FIELD NETWORK DIRECTOR
DASHBOARD
DEVICES
ADMIN > SYSTEM MANAGEMENT > PROVISIONING SETTINGS
General
IPAM-IPv4
IPAM-IPv6

Provisioning Process

IoT-FND URL:	https://<FND_HOST_NAME_FQDN>9121
	Field Area Router uses this URL to register with IoT-FND after the tunnel is configured
Periodic Metrics URL:	https://<FND_HOST_NAME_FQDN>9121
	Field Area Router uses this URL for reporting periodic metrics with IoT-FND

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_HOST_NAME_FQDN>
	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

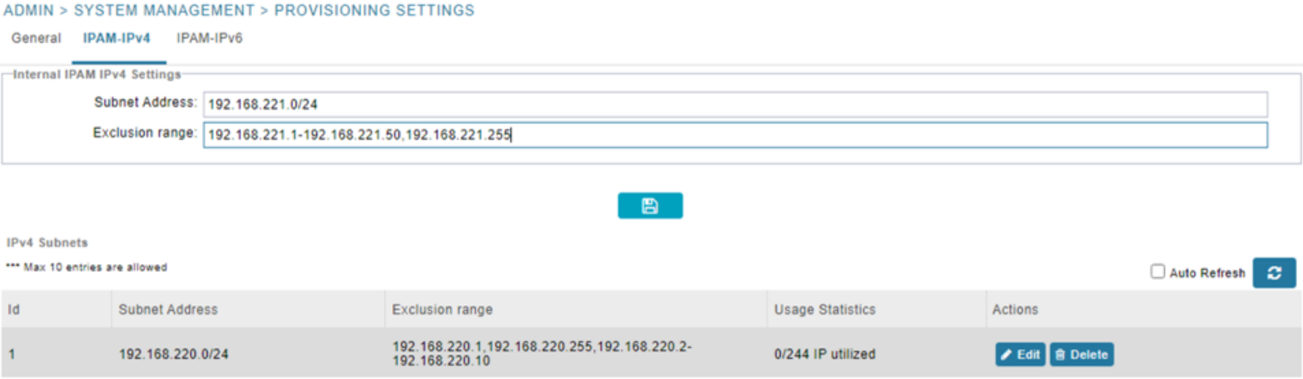
Step 3. Configure IPAM subnets to help Cisco IoT FND dynamically allocate IP address to the loopback interface of field routers. In the **IPAM-IPv4** tab:

i. Enter the subnet address

ii. Enter the exclusion range of IP addresses within a subnet to exclude from being assigned to devices

iii. Click the disk icon to save the settings

Figure 26. IPAM-IPv4 settings



Internal IPAM IPv4 Settings

Subnet Address:	192.168.221.0/24
Exclusion range:	192.168.221.1-192.168.221.50,192.168.221.255

IPv4 Subnets

*** Max 10 entries are allowed

□ Auto Refresh

Id	Subnet Address	Exclusion range	Usage Statistics	Actions
1	192.168.220.0/24	192.168.220.1,192.168.220.255,192.168.220.2-192.168.220.10	0/244 IP utilized	Edit Delete

Step 4. A list of porbable IP addresses that may be generated is displayed. Click **Yes** to initiate IP address generation.

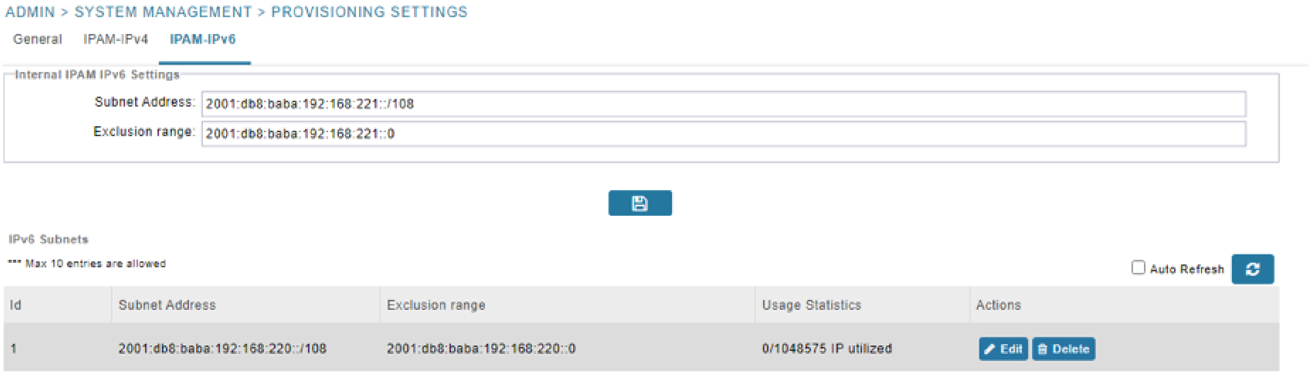
Step 5. (Optional) In the **IPAM-IPv6** tab;

i. Enter the subnet address

ii. Enter the exclusion range of IP addresses within a subnet to exclude from being assigned to devices

iii. Click the disk icon to save the settings

Figure 27. IPAM-IPv6 settings



Internal IPAM IPv6 Settings

Subnet Address: 2001:db8:baba:192:168:221::/108

Exclusion range: 2001:db8:baba:192:168:221::0

IPv6 Subnets

*** Max 10 entries are allowed

□ Auto Refresh

Id	Subnet Address	Exclusion range	Usage Statistics	Actions
1	2001:db8:baba:192:168:220::/108	2001:db8:baba:192:168:220::0	0/1048575 IP utilized	Edit Delete

Step 6. A list of porbable IP addresses that may be generated is displayed. Click **Yes** to initiate IP address generation.

Following the steps outlined above, the addition of HER and field devices is complete. The necessary settings for Plug and Play (PnP) and Zero Touch Deployment (ZTD), as well as the addition of subnets for IP Address Management (IPAM), have also been configured. The next section contains instructions on initiating PnP and ZTD.

Set up PnP and ZTD

Note: This guide demonstrates PnP bootstrapping using manual PnP profile configuration. For automatic PnP Server discovery methods, see the **Cisco Network PnP - Available Discovery Methods** section of Distribution Automation-Secondary Substation Design Guide.

To configure PnP and ZTD, you must add the following tunnel provisioning templates to field routers:

- Router Bootstrap configuration template
- Router Tunnel Addition Template
- HER Tunnel Addition Template
- HER Tunnel Deletion Template

Table 10. Configuration items for PnP and ZTP configurations

Configuration item	Description
NTP_SERVER_1	Primary NTP server used for time synchronization.
NTP_SERVER_2	Backup NTP server used for time synchronization.
DOMAIN_NAME	Domain name used across the network.
HER_HOST_NAME	Hostname of HER, also used as local key-id on HER and remote key-id on field router for PSK-based key rings.
FND_HOST_NAME_FQDN	Hostname of Cisco IoT FND including domain name.
FND_CORP_DATA_NETWORK_IP	IP Address for Cisco IoT FND Corporate Data Network which is used for communication with HER and TPS.
TPS_HOST_NAME_FQDN	Hostname of TPS including domain name.
TPS_DMZ_FIELD_ROUTER_FACING _NETWORK _GATEWAY	Gateway of field-router-facing network.
TPS_DMZ_FIELD_ROUTER_FACING_NETWORK_IP	IP address for TPS field-router-facing network used for communication with field router.
IPSEC_TRANSFORM_SET_MODE	IPSec transform set mode can be either transport or tunnel. Configure it based on the network design.
NEXTHOP_IP_TO_REACH_TPS_FROM_FIELD_ROUTER	Nexthop IP address to reach TPS from field router for PnP.
IP_MTU	Maximum IPv4 MTU supported between field router and DMZ Network through the provider network. See the Appendix section for calculation reference.
TCP_MSS	Maximum IPv4 Segment Size supported between field router and DMZ Network through the provider network. See the Appendix section for calculation reference.

Add tunnel provisioning templates

Create a tunnel group and add field routers

Step 1. In Cisco IoT FND GUI, from the main menu, choose **Config > Tunnel Provisioning**.

Step 2. Click the add icon.

Step 3. Enter a group name.

Step 4. Click **Add**.

Step 5. Select **Default-Ir1100**.

Step 6. From **Group Members** drop-down list, choose **Router**.

Step 7. Select the field router.

Step 8. Click **Change Tunnel Group**.

Step 9. From the drop-down list, choose the newly added tunnel group and click **Change Tunnel Group**.

Navigate to the new tunnel group and verify if the field router is present in the **Group Members** tab.

Add router bootstrap template

The router bootstrap template content is also available on Github.

Step 1. In the **Router Bootstrap configuration** tab, replace the existing template with a custom template.

The following sample template must be edited to add domain names and NTP server configurations. You can uncomment any section by removing the lines **[COMMENT-START]** and **[COMMENT-END]**

```
<#-- This is a sample template can be used for router bootstrapping with minimal configs.

Please go through the template carefully and find the section to uncomment and add Domain name and NTP
Server configurations.

NOTE: To uncomment any section, remove the lines containing [COMMENT-START] and [COMMENT-END]


-->

<#if far.isRunningIos()>

  <#-- New section to support Day 0 operation -->

  <#if isBootstrapping??>

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

    <#assign sn=sublist[1]>

    file prompt quiet

    do mkdir flash:Archive

    !

    service timestamps debug datetime msec

    no service password-encryption

    !

    <#-- the following license commands are listed here as those are not config replace friendly and might
be automatically added at a later stage. -->

    license smart reservation

    license smart transport off

    no ip http client source-interface ${far.tunnelSrcInterface1}

    !

    hostname FR${sn}

    !

    username ${far.adminUsername} privilege 15 algorithm-type sha256 secret ${far.adminPassword}

    aaa new-model

    aaa authentication login default local

    aaa authorization exec default local

    !


    <#-- [MANDATORY] Uncomment and update Domain Configs given below -->

    <#-- [COMMENT-START]
```

```
ip domain name <DOMAIN_NAME>
[COMMENT-END] -->

<#-- [MANDATORY] Uncomment and update Static Route to TPS Configs given below -->
<#-- [COMMENT-START]
ip route <TPS_DMZ_FIELD_ROUTER_FACING_NETWORK_IP> 255.255.255.255 ${far.tunnelSrcInterface1}
[COMMENT-END] -->

service timestamps log datetime localtime
!
<#-- [MANDATORY] Uncomment and update NTP Configs given below -->
<#-- [COMMENT-START]
clock timezone IST +5 30
ntp server <NTP_SERVER_1> prefer
ntp server <NTP_SERVER_2>
ip route <NTP_SERVER_1> 255.255.255.255 ${far.tunnelSrcInterface1}
ip route <NTP_SERVER_2> 255.255.255.255 ${far.tunnelSrcInterface1}
[COMMENT-END] -->
!

crypto key generate rsa general-keys label SSH modulus 2048
ip ssh rsa keypair-name SSH
ip ssh version 2
!
<#-- Adjust TCP MSS values as per your network -->
ip tcp mss <TCP_MSS>
!
interface loopback999
  description workaround for CSCvb49055
  ip address 169.254.1.2 255.255.255.255
!
cgna initiator-profile cg-nms-tunnel
  execution-url https://169.254.1.2:443/wsma/config
!
cgna initiator-profile cg-nms-tunnel
  callhome-url https://<TPS_HOST_NAME_FQDN>:9120/cgna/ios/config
  execution-url https://169.254.1.2:443/wsma/config
  post-commands
  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
  add-command dir flash:/before-tunnel-config | format flash:/managed/odm/cg-nms.odm
  interval 10
  gzip
!

 cgna gzip
 no ip http server
 ip http authentication aaa login-authentication default

 ip http tls-version TLSv1.2
 ip http secure-server
 ip http timeout-policy idle 600 life 86400 requests 3
 ip http client connection timeout 5
 ip http client connection retry 5
!
 wsma agent exec
  profile exec
!
 wsma agent config
  profile config
!
 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
!
 event manager applet post_pnp
  event timer watchdog  time 30
  action 10.0 cli command "enable"
  action 11.0 cli command "show pnp profile | inc Active:0"
  action 12.0 regexp "Active:0.*" "$_cli_result" pnpStatus
  action 13.0 if $_regexp_result eq 1
  action 14.0 cli command "config t"
  action 15.0 cli command "no key config-key password-encrypt" pattern ".*"
  action 16.0 cli command "yes"
  action 17.0 cli command "key config-key password-encrypt ${far.adminPassword}"
  action 18.0 cli command "password encryption aes"
  action 19.0 cli command "archive"
  action 20.0 cli command "path flash:/Archive/"
  action 21.0 cli command "maximum 8"
  action 22.0 cli command "ip http client secure-trustpoint CISCO_IDEVID_SUDI"
```

```
      action 25.0 cli command "no event manager applet post_pnp"
      action 80.0 cli command "do delete /force flash:express-setup-config"
      action 81.0 cli command "do copy running-config flash:express-setup-config"
      action 82.0 cli command "no file prompt quiet"
      action 89.1 cli command "cgna initiator-profile cg-nms-tunnel"
      action 89.2 cli command "active"
      action 90.0 end
      action 99.0 cli command "end"
  </#if>
<#else>
  ${provisioningFailed("Field Router is not running IOS")}
</#if>
```

Step 2. Click the disk icon to save the changes.

Add router tunnel addition template

The router tunnel addition template content is also available on Github.

Step 1. In the **Router Tunnel Addition** tab, replace the existing template with a custom template.

You must edit the following sample template. You can uncomment any section by removing the lines [COMMENT-START] and [COMMENT-END].

```
<#-- This is a sample template can be used for router tunnel addition with minimal configs.
Please go through the template carefully and find the section to uncomment and update highlighted configurations.
NOTE: To uncomment any section, remove the lines containing [COMMENT-START] and [COMMENT-END]


-->
<#-- This template only supports Field Router’s running IOS. -->
<#if !far.isRunningIos()>
  ${provisioningFailed("Field Router is not running IOS")}
<#else>
  <#--
  For Field Routers 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.
  -->
  <#assign sublist=far.eid?split("+")[0..1]>
  <#assign sn=sublist[1]>
  <#--
    Configure a Loopback0 interface for the Field Router.
  -->
  interface Loopback0
    <#--
      If the loopback interface IPv4 address property has been set on the Field Router CSV
      then configure the interface with that address. Otherwise obtain an
      address for the interface using IPAM.
    -->
    <#if far.loopbackV4Address??>
      <#assign loopbackIpv4Address=far.loopbackV4Address>
    <#elseif far.isIPAMSelected()??>
      <#assign loopbackIpv4Address=far.IPAMIpv4address(1)>
    <#else>
      ${provisioningFailed("Neither loopbackIpv4Address is populated in CSV, nor IPAM is selected")}
    </#if>
    ip address ${loopbackIpv4Address} 255.255.255.255
  exit
  !
  ip http client source-interface Loopback0
  <#--
    Configure the Field Router's FQDN.
  -->
  <#-- [COMMENT-START]
  ip host <FND_HOST_NAME_FQDN> <FND_CORP_DATA_NETWORK_IP>
  [COMMENT-END]-->

  <#--
    Default to using FlexVPN for the tunnel configuration of Field Router’s running IOS.
  -->
  <#if (far.useFlexVPN!"true") = "true">
    <#--
      Defining ACL to advertise Field Router’s Loopback IPv4 address to HER.
      It can also be used to advertise other LAN prefixes connected to Field Router
      Example 10.10.10.0 with sequence 20
    -->
    ip access-list standard FlexVPN_Client_IPv4_LAN
      10 permit ${loopbackIpv4Address}

  <#-- [COMMENT-START]
      20 permit 10.10.10.0
  [COMMENT-END]-->
    exit

    <#--
      Advertise IPv4 LAN prefixes to HER using IKEv2 prefix injection
    -->
    crypto ikev2 authorization policy FlexVPN_Author_Policy
      route set access-list FlexVPN_Client_IPv4_LAN
      route set interface
    exit

    !
```

```
 crypto ikev2 fragmentation mtu 1000
 !
 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

<#-- [COMMENT-START]
 crypto ikev2 keyring FlexVPN_Keyring
  peer <HER_HOST_NAME>
   address ${far.ipsecTunnelDestAddr1}
   identity key-id <HER_HOST_NAME>
   pre-shared-key ${far.mgmtVpnPsk}
  exit
 exit

 crypto ikev2 profile FlexVPN_IKEv2_Profile
  match identity remote key-id <HER_HOST_NAME>
  identity local fqdn FR${sn}.<DOMAIN_NAME>
  authentication remote pre-share
  authentication local pre-share
  keyring local FlexVPN_Keyring
  dpd 30 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 <IPSEC_TRANSFORM_SET_MODE>
  exit
 <#else>
```

```
      crypto ipsec transform-set FlexVPN_IPsec_Transform_Set esp-aes esp-sha256-hmac
        mode <IPSEC_TRANSFORM_SET_MODE>
      exit
    </#if>
  [COMMENT-END]-->

    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 Tunnel11
      description IPsec tunnel to ${her.eid}
      ip unnumbered loopback0
      tunnel destination ${far.ipsecTunnelDestAddr1}
      tunnel protection ipsec profile FlexVPN_IPsec_Profile
      tunnel source ${far.tunnelSrcInterface1}
      ip mtu <IP_MTU>
      ip tcp adjust-mss <TCP_MSS>
    exit

    <#if !(far.ipsecTunnelDestAddr1??)>
      ${provisioningFailed("Field Router property ipsecTunnelDestAddr1 must be set to the address of the HER for FlexVPN tunnel destination")}
    </#if>
    crypto ikev2 client flexvpn FlexVPN_Client
    exit
    ip http secure-client-auth
    no ip http tls-version TLSv1.2
  </#if>
</#if>
```

Step 2. Click the disk icon to save the changes.

Add HER tunnel addition template

The HER tunnel addition template content is also available on Github.

Step 1. In the **HER Tunnel Addition** tab, replace the existing template with the following content.

```
<#-- 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 FR${sn}
      identity fqdn FR${sn}.<DOMAIN_NAME>
      pre-shared-key ${far.mgmtVpnPsk}
   exit
  exit
</#if>
```

Step 2. Click the disk icon to save the changes.

Add HER tunnel deletion template

The HER tunnel deletion template content is also available on Github.

Step 3. In the **HER Tunnel Deletion** tab, replace the existing template with the following content.

```
<#-- This template only supports HERs running IOS or IOS XE. -->
<#if !her.isRunningIos() && !her.isRunningIosXe()>
  ${provisioningFailed("HER is not running IOS or IOS XE")}
</#if>
<#if far.isRunningIos()>
  <#assign sublist=far.eid?split("+")[0..1]>
  <#assign sn=sublist[1]>
  crypto ikev2 keyring FlexVPN_Keyring
    no peer FR${sn}
  exit
</#if>
```

Step 4. Click the disk icon to save the changes.

Configuration templates

Create field router configuration group

Step 1. In Cisco IoT FND GUI, from the main menu, choose **Config > Device Configuration**.

Step 2. Click the add icon.

Step 3. Enter a group name and click **Add**.

Step 4. Select the group **Default-Ir1100**.

Step 5. In the **Group Members** tab, from the drop-down list, choose **Router**.

Step 6. Select the field router.

Step 7. Click **Change Configuration Group**.

Step 8. From the drop-down list, choose the newly added configuration group

Step 9. Click **Change Configuration Group** to move the selected field router to the new group.

Navigate to the new configuration group and verify if the field router is present in the **Group Members** tab.

Add configuration template

The device configuration template content is also available on Github.

Step 1. In the **Edit Configuration** tab, replace the existing template with the following content.

```
<#if far.isRunningIos()>
  <#--
    If a Loopback0 interface is present on the device (normally configured
    during tunnel provisioning) then use that as the source interface for
    the HTTP client and SNMP traps. The source for the HTTP client is not
    changed during tunnel provisioning because usually the addresses assigned
    to the loopback interface are only accessible through the tunnels.
    Waiting ensures the tunnel is configured correctly and comes up.
  -->
  <#if far.interfaces("Loopback0")?size != 0>
    ip http client source-interface Loopback0
    snmp-server trap-source Loopback0
  </#if>
!
  <#-- Enable periodic inventory notification every 1 hour to report metrics. -->
    cgna profile cg-nms-periodic
      interval 60
    exit
</#if>
```

Step 2. Click the disk icon to save the changes.

Staging and verification

Note: If this is a fresh installation and you have not carried out PnP or ZTD for the router, start with Step 3.

Step 1. Access the IR1101 console and delete the before configuration files.

Note: Skip this step if this is a fresh installation and router has not already gone through PnP/ZTD.

```
Router#dir bootflash:before*
Directory of bootflash:/before*

Directory of bootflash:/


134031  -rw-       11423   Mar 7 2025 20:22:11 +05:30  before-tunnel-config
134032  -rw-       14049   Mar 7 2025 20:23:24 +05:30  before-registration-config
2788687872 bytes total (424030208 bytes free)

Router#delete bootflash:before*
Delete filename [before*]?
Delete bootflash:/before-tunnel-config? [confirm]
Delete bootflash:/before-registration-config? [confirm]

Router#
```

Step 2. The field router must be in unheard state. If the router is not reported as unheard in the Cisco IoT FND GUI, carry out the following steps in the GUI:

Note: Skip this step if this is a fresh installation and router has not already gone through PnP/ZTD.

i. From the main menu choose **Devices > Field Devices**.

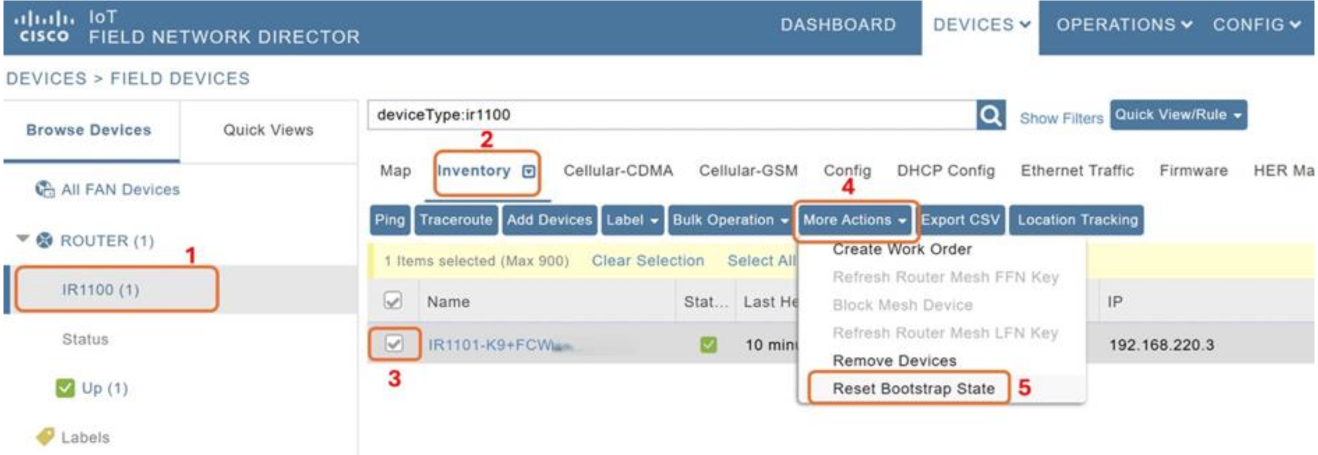
ii. From the **Browse Devices** menu, from the **Router** list, choose **IR1101**.

iii. Click Inventory.

iv. Select the device that you want to bootstrap.

v. From the **More Actions** drop-down list, choose **Reset Bootstrap State** to update the device to unheard state.

Figure 28. Reset bootstrap mode



Step 3. Bringup IR1101 and verify that TPS and HER IP addresses are reachable from the field router over GigabitEthernet or Cellular interface.

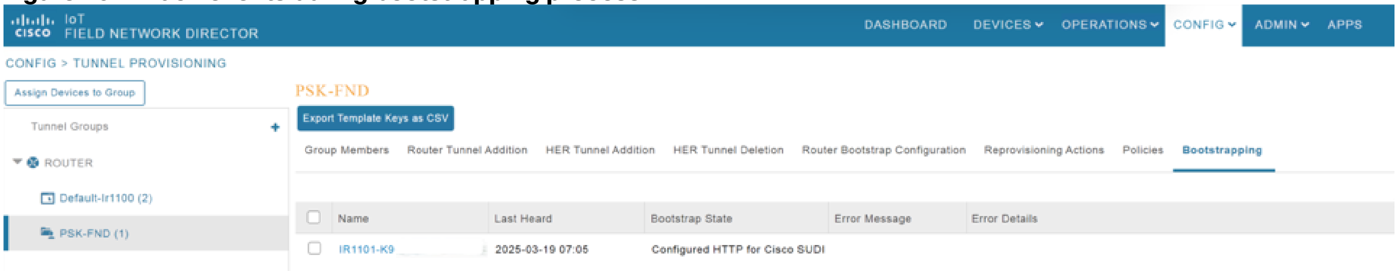
Step 4. After reachability is established, enter the following commands in the field router console.

```
ip host <TPS_HOST_NAME_FQDN> <TPS_DMZ_FIELD_ROUTER_FACING_NETWORK_IP>

pnp profile custom_pnp

  transport http host <TPS_HOST_NAME_FQDN> port 9125

!
```

Step 5. In the Cisco IoT FND GUI, from the main menu, choose **Config > Tunnel Provisioning**.

Step 6. Select the newly created group and click the **Bootstrapping** tab to view the events during the bootstrapping process.

Figure 29. Track events during bootstrapping process

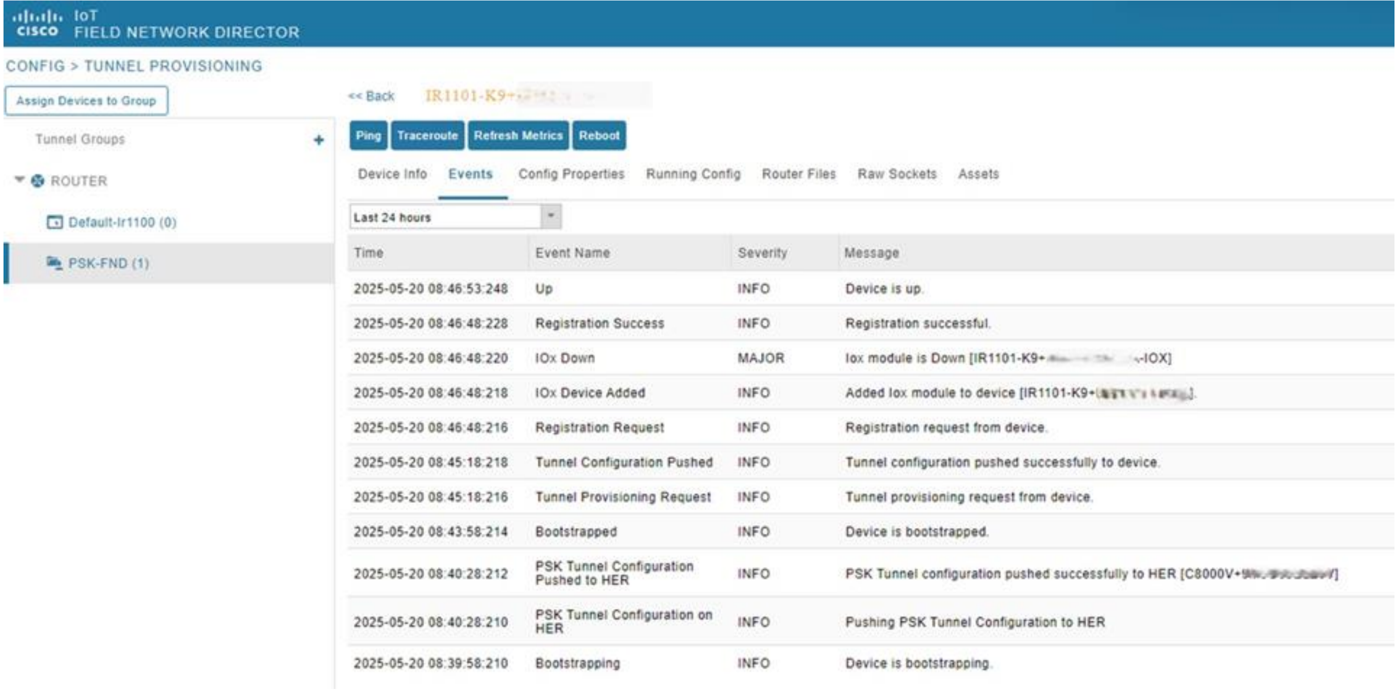


Name	Last Heard	Bootstrap State	Error Message	Error Details
IR1101-K9[redacted]	2025-03-19 07:05	Configured HTTP for Cisco SUDI		

Step 7. Click the EID.

Step 8. In the **Events** tab, view the overall events at the device level.

Figure 30. Check events at device level



Time	Event Name	Severity	Message
2025-05-20 08:46:53:248	Up	INFO	Device is up.
2025-05-20 08:46:48:228	Registration Success	INFO	Registration successful.
2025-05-20 08:46:48:220	IOx Down	MAJOR	Iox module is Down [IR1101-K9+[redacted]-IOX]
2025-05-20 08:46:48:218	IOx Device Added	INFO	Added Iox module to device [IR1101-K9+[redacted]].
2025-05-20 08:46:48:216	Registration Request	INFO	Registration request from device.
2025-05-20 08:45:18:218	Tunnel Configuration Pushed	INFO	Tunnel configuration pushed successfully to device.
2025-05-20 08:45:18:216	Tunnel Provisioning Request	INFO	Tunnel provisioning request from device.
2025-05-20 08:43:58:214	Bootstrapped	INFO	Device is bootstrapped.
2025-05-20 08:40:28:212	PSK Tunnel Configuration Pushed to HER	INFO	PSK Tunnel configuration pushed successfully to HER [C8000V+[redacted]]
2025-05-20 08:40:28:210	PSK Tunnel Configuration on HER	INFO	Pushing PSK Tunnel Configuration to HER
2025-05-20 08:39:58:210	Bootstrapping	INFO	Device is bootstrapping.

Appendix

Essential configuration items

Table 11. Configuration items used in the guide

Configuration item	Description	Value
ESXI_HOST_URL	IP Address of the ESXi host (version 6.5 and above) where the Cisco IoT FND VM will be deployed.	
ESXI_HOST_USERNAME	Username to access the ESXi host.	
ESXI_HOST_PASSWORD	Password to access the ESXi host.	
FND_OVA_IMAGE	Cisco IoT FND OVA Image	
TPS_OVA_IMAGE	TPS OVA Image	
ADMIN_NETWORK_PORTGROUP	ESXi Port group that will be used for Admin Network for SSH and GUI access.	
CORP_DATA_NETWORK_PORTGROUP	ESXi Port group that will be used for Corporate Data Network for the communication of Cisco IoT FND with HER, TPS and Field Router(via TPS or HER)	
DMZ_FIELD_ROUTER_FACING_NETWORK_PORTGROUP	ESXi Port group that will be used for communication with Field Router over DMZ	
ADMIN_NETWORK_NMCLI_CONNECTION_NAME	Admin Network Connection name ; Keep it same as device-name for simplicity. Ex: eth0, ens192 etc.,	
CORP_DATA_NETWORK_NMCLI_CONNECTION_NAME	Corporate Network Connection name ; Keep it same as device-name for simplicity. Ex: eth0, ens192 etc.,	
DMZ_FIELD_ROUTER_FACING_NETWORK_NMCLI_CONNECTION_NAME	DMZ Field Router Facing Network Connection Name; Keep it same as device-name for simplicity. Ex: eth0, ens192 etc.,	
NTP_SERVER_1	Primary NTP server used for Time synchronization	
NTP_SERVER_2	Backup NTP server used for Time synchronization	
DOMAIN_NAME	Domain name used across the Network	
FND_ADMIN_NETWORK_IP	IP Address for Cisco IoT FND Admin Network which is used for SSH and GUI access	
FND_NMCLI_CONNECTION_NAME_TO_REACH_NTP	Network Connection name to reach NTP; Could be one of <ADMIN_NETWORK_NMCLI_CONNECTION_NAME> or <CORP_DATA_NETWORK_NMCLI_CONNECTION_NAME>	
FND_CORP_DATA_NETWORK_IP	IP Address for Cisco IoT FND Corporate Data Network which is used for communication with HER and TPS	
FND_HOST_NAME_FQDN	Hostname of Cisco IoT FND including domain	
NEXTHOP_TO_REACH_NTP_FROM_FND	Nexthop IP address to reach NTP from Cisco IoT FND	
FND_CGMS_KEYSTORE	cgms_keystore to be used for Cisco IoT FND	
FND_KEYSTORE_PASSWORD	Password of Cisco IoT FND CGMS Keystore	
FND_GUI_URL	URL to Access Cisco IoT FND	
TPS_HOST_NAME_FQDN	Hostname of TPS including domain name	
TPS_ADMIN_NETWORK_IP	IP Address for TPS Admin Network which is used for SSH and GUI access	
TPS_CGMS_KEYSTORE	TPS CGMS Keystore File	
TPS_NMCLI_CONNECTION_NAME_TO_REACH_NTP	Network Connection name to reach NTP; Could be one of <ADMIN_NETWORK_NMCLI_CONNECTION_NAM	

Configuration item	Description	Value
	E> or <CORP_DATA_NETWORK_NMCLI_CONNECTION_NAME>	
TPS_CORP_DATA_NETWORK_IP	IP Address for TPS Data Network which is used to communicate over Corporate Data Network with Cisco IoT FND.	
TPS_DMZ_FIELD_ROUTER_FACING _NETWORK_GATEWAY	Gateway of Field Router Facing Network in TPS	
TPS_DMZ_FIELD_ROUTER_FACING_NETWORK_IP	IP Address for TPS Field Router Facing Network used for communication with Field Router	
TPS_KEYSTORE_PASSWORD	Password Protecting Keystore in TPS	
HER_ADMIN_NETWORK_IP	IP Address for HER Admin Network which is used for SSH and GUI access	
HER_CORP_DATA_NETWORK_IP	IP Address for HER Corporate Data Network which is used for communication with Cisco IoT FND	
HER_DMZ_FIELD_ROUTER_FACING_NETWORK_GATEWAY	Nexthop IP address on HER in DMZ Field Router facing network	
HER_DMZ_FIELD_ROUTER_FACING_NETWORK_IP	IP Address for HER Field router Facing Network used for communication with Field router	
HER_HOST_NAME	Hostname of HER	
HER_LOOPBACK_IP	IP Address of HER's Loopback Interface	
HER_PASSWORD	Password for accessing HER	
HER_USERNAME	Username for accessing HER	
NEXTHOP_TO_REACH_NTP_FROM_HER	Nexthop IP to reach NTP from HER	
IPSEC_TRANSFORM_SET_MODE	IPSec Transform-set mode can be either transport or tunnel. Configure it based on the network design.	
IP_MTU	Maximum IPv4 MTU supported between Field-Router to DMZ Network through the Provider network. Refer Appendix 7.4 for steps on calculation if required.	
TCP_MSS	Maximum IPv4 Segment Size supported between Field-Router to DMZ Network through the Provider network. Refer Appendix 7.5 for steps on calculation if required.	
FIELD_ROUTER_PASSWORD	Password for accessing Field Router	
FIELD_ROUTER_SERIAL_NUMBER	Serial Number of Field Router	
FIELD_ROUTER_TUNNEL_SOURCE_INTERFACE	Source Interface of Tunnel from Field Router to HER	
FIELD_ROUTER_USERNAME	Username of Field Router	
FIELD_ROUTER_V4_LOOPBACK_IP	[OPTIONAL] Loopback IP intended to be used for Field Router (If IPAM Feature is not used)	

Acronyms and glossary

Acronym	Definition
FND	Field Network Director
HER	Head-End Router
PSK	Pre-Shared Key
IPAM	IP Address Management

Acronym	Definition
TPS	Tunnel Provisioning Server
PnP	Plug and Play
ZTD	Zero Touch Deployment
DHCP	Dynamic Host Configuration Protocol
IPSec	Internet Protocol Security
OVA	Open Virtual Appliance
GUI	Graphical User Interface
SSH	Secure Shell
VM	Virtual Machine
OVF	Open Virtualization Format
NTP	Network Time Protocol
NIC	Network Interface Card
FQDN	Fully Qualified Domain Name
CGMS	Connected Grid Management System (Old name of CISCO IOT FND)
URL	Uniform Resource Locator
CORP	Corporate
DSO	Distribution System Operator
NTP_SERVER_1	Primary NTP server used for Time synchronization

References

- Distribution Automation-Secondary Substation Design Guide
- Cisco IoT FND 5.0 Release Notes
- Tunnel management with PSK and IPAM
- Cisco IoT FND 5.0 User Guide
- Achieve Scale Beyond 25,000 Routers

Identify Maximum IPv4 MTU supported by network provider using sweep ping

Note: Carry out this task only after you configure <HER_DMZ_FIELD_ROUTER_FACING_NETWORK_IP> and <TPS_DMZ_FIELD_ROUTER_FACING_NETWORK_IP>.

Step 1. Access the console of any field router

Step 2. Enter the **ping** command.

Step 3. When prompted, enter the target IP address *<HER_DMZ_FIELD_ROUTER_FACING_NETWORK_IP>.*

Step 4. Choose to use extended commands.

Step 5. Specify the minimum and maximum packet sizes to test the MTU range (For example, minimum size 1401 and maximum size 1600).

Step 6. Set the sweep interval (usually 1-byte increments).

Step 7. Send the sweep ping and observe the results.

Response	Definition
!	Packet traversed to the destination successfully
.	Network could not deliver the packet of that size

Step 8. Identify the largest packet size that consistently succeeds without loss. This size approximates the MTU supported by the network provider path.

Step 9. Optionally, narrow the sweep range around the size where failures begin to pinpoint the exact MTU.

```
Router#ping
Protocol [ip]:
Target IP address: <HER_DMZ_FIELD_ROUTER_FACING_NETWORK_IP>
Repeat count [5]: 1
Datagram size [100]:
Timeout in seconds [2]:
Extended commands [n]: y
Ingress ping [n]:
Source address or interface:
DSCP Value [0]:
Type of service [0]:
Set DF bit in IP header? [no]:
Validate reply data? [no]:
Data pattern [0x0000ABCD]:
Loose, Strict, Record, Timestamp, Verbose[none]:
Sweep range of sizes [n]: y
Sweep min size [36]: 1491
Sweep max size [18024]: 1510
Sweep interval [1]:
Type escape sequence to abort.
Sending 20, [1491..1510]-byte ICMP Echos to <HER_DMZ_FIELD_ROUTER_FACING_NETWORK_IP>, timeout is 2 seconds:
!!!!!!!!!!......!...
Success rate is 55 percent (11/20), round-trip min/avg/max = 52/85/124 ms
```

As you see in above example, Ping is consistently working till packet size of 1500 and is inconsistent above that size. This could vary from network to network, choose the value according to your network.

Note: Repeat this task for <TPS_DMZ_FIELD_ROUTER_FACING_NETWORK_IP> as well.

Identify the Maximum TCP Maximum Segment Size (MSS) supported by Network Provider

To calculate the TCP MSS, use the formula:

TCP MSS = MTU – (IP Headers + TCP Header size)

The standard header sizes are:

- IP header: 20 bytes
- TCP header: 20 bytes

So, for a standard configuration: TCP MSS = MTU – 40 bytes

Note: Some networks may include additional headers such as VLAN tags, GRE, or IPsec encapsulations that increase the total header size. In such cases, adjust the MSS calculation to account for the additional overhead specific to your network setup.