



## **Cisco Cloud Network Controller for AWS User Guide, Release 25.0(5)**

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# CHAPTER 1

## New and Changed Information

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- [New and Changed Information](#), on page 1

### New and Changed Information

The following table provides an overview of the significant changes to the organization and features in this guide up to this current release. The table does not provide an exhaustive list of all changes made to the guide or of the new features up to this release.

*Table 1: New Features and Changed Behavior in Cisco Cloud Network Controller for Release 25.0(5)*

Feature or Change	Description	Where Documented
Change in name of Cisco Cloud APIC	Beginning with release 25.0(5), Cisco Cloud APIC is renamed as Cisco Cloud Network Controller.	Entire document





## CHAPTER 2

# About Cisco Cloud Network Controller

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- [Overview, on page 3](#)
- [External Network Connectivity, on page 4](#)
- [Understanding Supported Routing and Security Policies, on page 5](#)
- [Source Interface Selection for Tunnels, on page 9](#)
- [General Guidelines and Limitations for Cisco Cloud Network Controller, on page 9](#)
- [About the Cisco Cloud Network Controller GUI, on page 12](#)

## Overview

Cisco Cloud Network Controller is a software deployment of Cisco APIC that you deploy on a cloud-based virtual machine (VM). Amazon Web Services (AWS), Azure, and Google Cloud are the cloud providers supported with the Cisco Cloud Network Controller.

When deployed, the Cisco Cloud Network Controller:

- Provides an interface that is similar to the existing Cisco APIC to interact with the AWS public cloud
- Automates the deployment and configuration of cloud constructs
- Configures the cloud router control plane
- Configures the data path between the on-premises Cisco ACI fabric and the cloud site
- Translates Cisco ACI policies to cloud native construct
- Discovers endpoints
- Provides a consistent policy, security, and analytics for workloads deployed either on or across on-premises data centers and the public cloud



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**Note**

- Cisco Nexus Dashboard Orchestrator pushes the MP-BGP EVPN configuration to the on-premises spine switches
  - On-premises VPN routers require a manual configuration for IPsec
- 
- Provides an automated connection between on-premises data centers and the public cloud with easy provisioning and monitoring

- Policies are pushed by Cisco Nexus Dashboard Orchestrator to the on-premises and cloud sites, and Cisco Cloud Network Controller translates the policies to the cloud to keep the policies consistent with the on-premises site

For more information about extending Cisco ACI to the public cloud, see the *Cisco Cloud Network Controller Installation Guide*.

When the Cisco Cloud Network Controller is up and running, you can begin adding and configuring Cisco Cloud Network Controller components. This document describes the Cisco Cloud Network Controller policy model and explains how to manage (add, configure, view, and delete) the Cisco Cloud Network Controller components using the GUI and the REST API.

## External Network Connectivity

External network connectivity for Cisco Cloud Network Controller with AWS is available by using EVPN connectivity from the CCRs in the infra VPC. Support is also available for IPv4 connectivity from the infra VPC CCRs to any external device with IPsec/BGP. This IPsec/BGP external connectivity allows Cisco Cloud Network Controller to connect to branch offices.

The following sections provide more information on the components that allow for external network connectivity.

### External VRF

An **external VRF** is a unique VRF that does not have any presence in the cloud but is associated with one or more external networks. As opposed to an internal VRF, which is a VRF that is used to host the VPCs and is associated with a cloud context profile, an external VRF is not referred to in any cloud context profile used by Cisco Cloud Network Controller.

An external VRF represents an external network that is connected to other cloud sites or to on-premises branch offices. Multiple cloud VRFs can leak routes to an external VRF or can get the routes from an external VRF. When an external network is created on an external VRF, inter-VRF routing is set up so that routes received and advertised on the external network are received or advertised on the external VRF.

### Connections to Non-ACI External Devices

Support is also available for connectivity from AWS CCRs to any non-ACI external device. IPv4 sessions are created on an external VRF from the infra VPC CCRs to these non-ACI external devices, and inter-VRF routing is set up between the external VRF and the site local VRFs.

Following are the guidelines and limitations for this type of connectivity:

- You cannot use both EVPN and IPv4 IPsec/BGP to connect from the cloud to the same remote site.

### Guidelines and Limitations

Instead of manually selecting all the regions, you have to set `allRegion` to true for the external network connectivity.

# Understanding Supported Routing and Security Policies

Routing and security policies are handled differently, depending on the release that is running on your Cisco Cloud Network Controller.

## Routing and Security Policies: Releases Prior to 25.0(1)

Prior to release 25.0(1), routing and security policies are tightly coupled together. To allow communication between two endpoints that are across EPGs, you must configure contracts. These contracts are used for the following:

- **Routing policies:** Policies used to define routes to establish traffic flow.
- **Security policies:** Rules used for security purposes, such as security group rules or network security group rules.

In other words, contracts inherently serve the dual purpose of configuring both security policies and routing policies. This means that tearing down contracts not only tears down the security policies that govern which traffic to allow and which to deny, it also tears down any policies used to route that traffic. Prior to release 25.0(1), there is no way to configure routing policies without also configuring security policies, and vice versa.

## Routing and Security Policies: Release 25.0(1)

Beginning with release 25.0(1), support is now available for configuring routing separately, independent of the security policies.



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**Note** The routing and security policies described in this section are specifically for the 25.0(1) release and apply only between internal and external VRFs. For changes in the routing and security policies in the 25.0(2) release, see [Routing Policies: Release 25.0\(2\), on page 7](#).

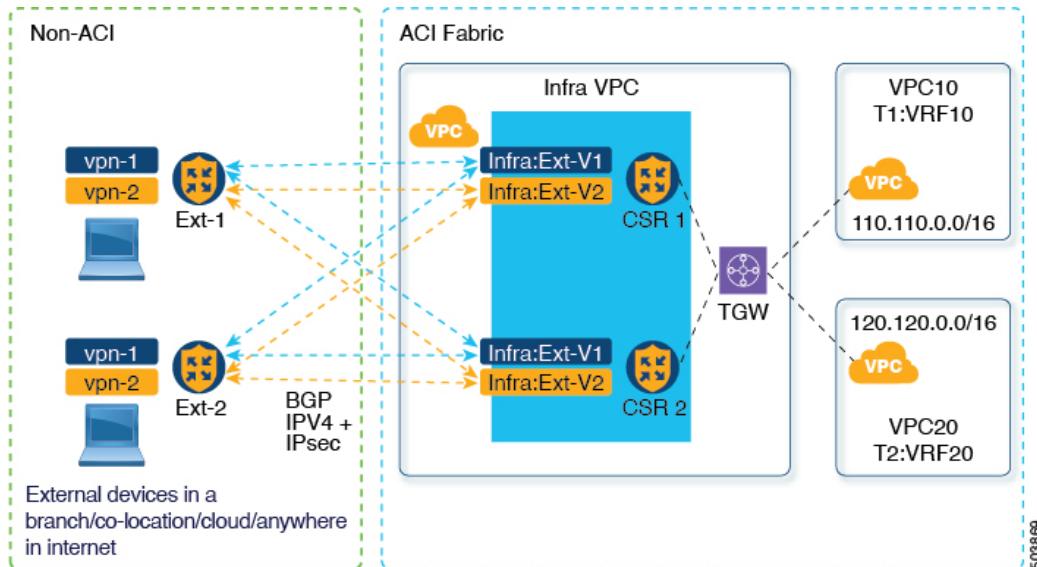
---

The procedures for configuring the routing and security policies are here:

- **Routing policy:** You will use the inter-VRF routing feature introduced in release 25.0(1) to configure the routing policy separately. See [Configuring Inter-VRF Route Leaking Using the Cisco Cloud Network Controller GUI, on page 58](#) for those procedures.
- **Security policy:** After you have configured the routing policy, you will continue to use contracts as you did previously to configure the security policy separately:
  - First create an external EPG. See [Creating an EPG Using the Cisco Cloud Network Controller GUI, on page 67](#) for those procedures.
  - Then create a contract between the external EPG and the cloud EPG. See [Creating a Contract Using the Cisco Cloud Network Controller GUI, on page 72](#) for those procedures.

Using inter-VRF routing, you can configure an independent routing policy to specify which routes to leak between a pair of internal and external VRFs when you are setting up routing between a cloud site and a non-ACI site.

The following figure shows an example topology of this sort of configuration. This example topology shows how you can connect to a remote endpoint (vpn-1) behind an external device (Ext-1) which might be located in a non-ACI site. This non-ACI site could be a branch office, co-located or cloud site, or anywhere in the internet that has the capability of BGP IPv4 and IPsec.



In this example, the infra:Ext-V1 is the external VRF on the CCRs in the infra VPC, with BGP IPv4 sessions over IPsec tunnels to the remote devices. The remote endpoint routes are received over these sessions in the infra:Ext-V1 VRF, which are then leaked into the internal VRFs displayed on the right side of the graphic (for example, the T1:VRF10 in VPC10). The reverse leaking routes are also configured.

Route leaking occurs between internal and external VRFs using route maps. Cisco Cloud Network Controller supports using route maps to configure routing policies independent of security policies only from internal VRFs to external VRFs, and from external VRF to internal VRFs. You will continue to use contracts when configuring routing between a pair of internal VRFs, so routing and security policies are tied together in the configuration process when routing between internal VRFs.

The following list provides more information on situations when you can use **route maps** to configure routing policies independent of security policies, and when you have to use **contracts** where the routing and security policies are tied together.

- Routing situations that use contracts-based routing:
  - Intra-site routing (within and across regions)
  - Inter-site routing (cloud-to-ACI on-premises using EVPN)
  - Cloud-to-cloud routing
  - Route leaking between internal VRFs
- Routing situations that use route map-based routing:
  - Cloud-to-non-ACI on-premises site using L3Out external VRF (no EVPN)
  - Leak specific or all routes from an internal VRF to an external VRF
  - Leak specific or all routes from an external VRF to an internal VRF



### Guidelines and Restrictions for Security and Routing Policies in Release 25.0(1)

The following guidelines apply when using inter-VRF routing to leak routes between a pair of VRFs using route maps:

- Routes are always leaked bi-directionally between an internal VRF and the external VRF.  
For example, assume there is a user tenant (t1) with an internal VRF (V1) and external VRF (Ext-V1). The route leak must be configured for both of these VRFs bi-directionally.
- You cannot configure "smaller" prefixes to be leaked while a "larger" prefix is already being leaked. For example, configuring the 10.10.10.0/24 prefix will be rejected if you already have the 10.10.0.0/16 prefix configured to be leaked. Similarly, if you configure the 0.0.0.0/0 (leak all) prefix, no other prefix will be allowed to be configured.
- Contracts are not allowed between cloud external EPGs (cloudExtEpgs).
- An external VRF cannot be used for creating cloud EPGs.
- An external VRF always belongs to the infra tenant.
- Leak routing is not supported between external VRFs.

## Routing Policies: Release 25.0(2)



**Note** The routing and security policies described in this section are specifically for the 25.0(2) release. For changes in the routing and security policies in the previous release, see [Routing and Security Policies: Release 25.0\(1\), on page 5](#).

For release 25.0(2), the routing and security policies continue to be split as described in [Routing and Security Policies: Release 25.0\(1\), on page 5](#), but with these additional changes specifically for the routing policies:

- [Route Leaking Between Internal VRFs, on page 7](#)
- [Global Inter-VRF Route Leak Policy, on page 8](#)
- [Guidelines and Limitations, on page 9](#)

### Route Leaking Between Internal VRFs

In the previous 25.0(1) release, the inter-VRF route map-based routing feature was introduced, where you can configure an independent routing policy to specify which routes to leak between a pair of internal and external VRFs. This route map-based routing feature applied specifically between internal and external VRFs; when configuring routing between a pair of internal VRFs, you could only use contract-based routing in that situation, as described in [Routing and Security Policies: Release 25.0\(1\), on page 5](#).

Beginning with release 25.0(2), support is now available for route map-based route leaking between a pair of internal VRFs. You will specify how routes are leaked using one of the following options:

- Leak all CIDRS or specific subnet IP addresses associated with the VRF by using:
  - **Leak All** option through the GUI
  - `leakInternalPrefix` field through the REST API

- Leak between a pair of VRFs by using:
  - **Subnet IP** option through the GUI
  - `leakInternalSubnet` field through the REST API

### Global Inter-VRF Route Leak Policy

In addition to the support that is now available for route map-based route leaking between a pair of internal VRFs, the internal VRF route leak policy also allows you to choose whether you want to use contract-based routing or route map-based routing between a pair of internal VRFs. This is a global mode configuration available in the First Time Setup to allow a contract-based or route map-based model. Note that when you enable contract-based routing in this global mode, the routes between a pair of internal VRFs can be leaked using contracts only in the absence of route maps.

This policy has the following characteristics:

- This policy is associated with every internal VRF.
- This is a Cisco Cloud Network Controller-created policy.
- Contract-based routing is disabled by default (turned off) for greenfield cases (when you are configuring a Cisco Cloud Network Controller for the first time). For upgrades, where you have a Cisco Cloud Network Controller that was already configured prior to release 25.0(2), contract-based routing is enabled (turned on).

The internal VRF route leak policy is a global policy that is configured in the First Time Setup screen under the infra tenant, where a Boolean flag is used to indicate whether contracts can drive routes in the absence of route maps:

- **Off**: Default setting. Routes are not leaked based on contracts, and are leaked based on route maps instead.
- **On**: Routes are leaked based on contracts in the absence of route maps. When enabled, contracts drive routing when route maps are not configured. When route maps exist, route maps always drives routing.

You can toggle this Boolean flag back and forth. Following are the general recommended steps for toggling this global VRF route leak policy, with more detailed instructions provided in [Configuring Leak Routes for Internal VRFs Using the Cisco Cloud Network Controller GUI](#), on page 61.

- You should enable contract-based routing in Cisco Cloud Network Controller for multi-cloud and hybrid-cloud deployments with EVPN.
- For multi-cloud and hybrid-cloud deployments without EVPN, routing is driven through route maps only and not through contracts.
- If you want to disable contract-based routing by toggling from contract-based routing to route map-based routing (toggling to the **Off** setting), this action can be disruptive if route map-based routing is not configured before you've toggled this setting to **Off**.

You should make the following configuration changes before toggling to route map-based routing:

1. Enable route map-based route leaking between all pairs of VRFs that have existing contracts.
2. Disable contract-based routing policy in the global policy.

At that point, you can change the routing policy to route map-based routing, and you can then change the routing to reflect any granularity that is required with the new route map-based routing.

- If you want to enable contract-based routing by toggling from route map-based routing to contract-based routing (toggling to the **On** setting), you do not have to make any configuration changes before toggling to contract-based routing. That's because this setting is an additive operation. In other words, both contract-based and route map-based routing can be enabled between a pair of VRFs. Route maps take precedence over contracts when enabling routing. With route map-based routing enabled, adding contract-based routing should be non-disruptive.

### Guidelines and Limitations

The following guidelines and limitations apply for release 25.0(2):

- Routing between external and internal VRFs continues to use route map-based routing only.
- The `leakExternalPrefix` should not overlap with the route to the internet gateway (the external endpoint selector configured for external EPG to perform SSH), otherwise SSH will be broken.

## Source Interface Selection for Tunnels

Support is available for having more than one tunnel across different external networks to the same destination. This is done in the GUI by using different source interfaces (2,3, or 4) or through the REST API using `cloudtemplateIpsecTunnelSourceInterface`.

The following example shows a situation where only interface 3 is used as the originating interface:

```
<cloudtemplateIpsecTunnel peeraddr="173.36.19.2" preSharedKey="def" poolname="pool1">
  <cloudtemplateIpsecTunnelSourceInterface sourceInterfaceId="3" />
</cloudtemplateIpsecTunnel>
```

The following example shows a situation where both interfaces 2 and 3 are used as the originating interfaces:

```
<cloudtemplateIpsecTunnel peeraddr="173.36.19.2" preSharedKey="def" poolname="pool1">
  <cloudtemplateIpsecTunnelSourceInterface sourceInterfaceId="2" />
  <cloudtemplateIpsecTunnelSourceInterface sourceInterfaceId="3" />
</cloudtemplateIpsecTunnel>
```

### Guidelines and Limitations

- Increasing the number of interfaces increases the demand of tunnel inner local IP addresses.
- The IPsec tunnel source interfaces feature is supported only with the IKEv2 configuration.

## General Guidelines and Limitations for Cisco Cloud Network Controller

This section contains the guidelines and limitations for Cisco Cloud Network Controller.

- Inter-site (VRF-to-VRF) traffic is not supported if one of the VRFs is present as an attachment in a different VRF group (hub network). For example, consider the following scenario:

- VRF-1 is stretched across different sites (Azure and AWS). In the AWS site, VRF-1 is in VRF group 1.
- VRF-2 is present in a different VRF group (VRF group 2).

In this scenario, traffic from VRF-2 to VRF-1 across sites is not supported, since the contracts between the VRFs will be implicitly allowing traffic between different VRF groups as well. Traffic across different VRF groups (hub networks) is not supported.

- You cannot stretch more than one VRF between on-prem and the cloud while using inter-VRF route leaking in the CCRs (cloud routers). For example, in a situation where VRF1 with EPG1 is stretched and VRF2 with EPG2 is also stretched, EPG1 cannot have a contract with EPG2. However, you can have multiple VRFs in the cloud, sharing one or more contracts with one on-premises VRF.
- Set the BD subnet for on-premises sites as advertised externally to advertise to the CSR1kv on the cloud.
- The default AWS security group (SG) rules limit only permits 2 CCRs per region and only 2 regions can deploy CCRs (a total maximum of 4 CCRs). To deploy more CCRs, increase the AWS SG rule limit to 120 or more. We recommend increasing the rule limit to 500.
- When configuring an object for a tenant, first check for any stale cloud resources in AWS. A stale configuration might be present if it was not cleaned properly from the previous Cisco Cloud Network Controller instances that managed the account.




---

**Note** It takes some time for Cisco Cloud Network Controller to detect the stale cloud resources after adding the tenant account ID.

---

To check for and clean up stale cloud resources:

1. Click the **Navigation menu** > **Application Management** > **Tenants**. The **Tenants** summary table appears in the work pane with a list of tenants as rows in a summary table.
2. Double click the tenant you are creating objects for. The **Overview**, **Cloud Resources**, **Application Management**, **Statistics**, and **Event Analytics** tabs appear.
3. Click the **Cloud Resources** > **Actions** > **View Stale Cloud Objects**. The **Stale Cloud Objects** dialog box appears.
4. If you see any stale objects, click to place a check mark in the **Automatically Clean Up Stale Cloud Objects** check box.
5. Click **Save**. The Cisco Cloud Network Controller automatically cleans up stale cloud objects.




---

**Note** To disable the automatic cleanup, follow steps 1 - 4 and click the **Automatically Clean Up Stale Cloud Objects** check box to remove the check mark.

---

- Cisco Cloud Network Controller tries to manage the AWS resources that it created. It does not attempt to manage resources created by other applications, other than listing existing resources as inventory. At the same time, it is also expected that AWS IAM users in the AWS infra tenant account, and the other tenant accounts, do not disturb the resources that Cisco Cloud Network Controller creates. For this

purpose, all resources Cisco Cloud Network Controller creates on AWS has at least one of these two tags:

- AciDnTag
- AciOwnerTag

Cisco Cloud Network Controller must prevent AWS IAM users who have access to create, delete, or update EC2, or any other resources, from accessing or modifying the resources that Cisco Cloud Network Controller created and manages. Such restrictions should apply on both the infra tenant and other user tenant accounts. AWS account administrators should utilize the above two tags to prevent their unintentional access and modifications. For example, you can have an access policy like the following to prevent access to resources managed by Cisco Cloud Network Controller:

```
{
  "Effect": "Deny",
  "Action": [
    "ec2:*"
  ],
  "Resource": "*",
  "Condition": {
    "StringLike": {"ec2:ResourceTag/AciDnTag": "*"}
  }
}
```

- When configuring shared L3Out:
  - An on-premises L3Out and cloud EPGs cannot be in tenant common.
  - If an on-premises L3Out and a cloud EPG are in different tenants, define a contract in tenant common. The contract cannot be in the on-premises site or the cloud tenant.
  - Specify the CIDR for the cloud EPG in the on-premises L3Out external EPGs (l3extInstP).
  - When an on-premises L3Out has a contract with a cloud EPG in a different VRF, the VRF in which the cloud EPG resides cannot be stretched to the on-premises site and cannot have a contract with any other VRF in the on-premises site.
  - When configuring an external subnet in an on-premises external EPG:
    - Specify the external subnet as a non-zero subnet.
    - The external subnet cannot overlap with another external subnet.
    - Mark the external subnet with a shared route-control flag to have a contract with a cloud EPG.
  - The external subnet that is marked in the on-premises external EPG should have been learned through the routing protocol in the L3Out or created as a static route.
- When mapping availability zones, choose only a or b in Cisco Cloud Network Controller. Internally, the zone-mapping function maps this to actual availability zones in AWS.




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**Note** The mapping works in alphabetical order. The availability zones are sorted alphabetically and then the function picks the first two and associates them to a zone a and b in Cisco Cloud Network Controller.

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- Configuring ASN 64512 for cloud routers causes BGP sessions to not work between cloud routers and AWS virtual private gateways.
- For the total supported scale, see the following *Scale Supported* table:



**Note** With the scale that is specified in the *Scale Supported* table:

- You can have only 4 total managed regions.
- You can have only CCRs in 2 regions, 2 \* 2 CCRs. This is irrespective of AWS SG rule limit.

**Table 2: Scale Supported**

Component	Number Supported
Tenants	20
Applications	500
EPGs	500
Cloud Endpoints	1000
VRFs	20
Cloud Context Profiles	40
Contracts	1000
Service Graphs	200
Service Devices	100

## About the Cisco Cloud Network Controller GUI

The Cisco Cloud Network Controller GUI is categorized into groups of related windows. Each window enables you to access and manage a particular component. You move between the windows using the **Navigation** menu that is located on the left side of the GUI. When you hover your mouse over any part of the menu, the following list of tab names appear: **Dashboard**, **Topology**, **Application Management**, **Cloud Resources**, **Operations**, **Infrastructure**, and **Administrative**.

Each tab contains a different list of subtabs, and each subtab provides access to a different component-specific window. For example, to view the tenant-specific window, hover your mouse over the **Navigation** menu and click **Application Management > Tenants**. From there, you can use the **Navigation** menu to view the details of another component. For example, you can navigate to the **Availability Zones** window from **Tenants** by clicking **Cloud Resources > Availability Zones**.

The **Intent** menu bar icon enables you to create a component from anywhere in the GUI. For example, to create a tenant while viewing the **Availability Zones** window, click the **Intent** icon. A dialog appears with

a search box and a drop-down list. When you click the drop-down list and choose **Application Management**, a list of options, including the **Tenant** option, appears. When you click the **Tenant** option, the **Create Tenant** dialog appears displaying a group of fields that are required for creating the tenant.

For more information about configuring Cisco Cloud Network Controller components, see [Configuring Cisco Cloud Network Controller Components, on page 41](#)







## CHAPTER 3

# Cisco Cloud Network Controller Policy Model

- [About the ACI Policy Model, on page 15](#)
- [Policy Model Key Characteristics, on page 15](#)
- [Logical Constructs, on page 16](#)
- [The Cisco ACI Policy Management Information Model, on page 17](#)
- [Tenants, on page 19](#)
- [Cloud Context Profile, on page 20](#)
- [VRFs, on page 29](#)
- [Cloud Application Profiles, on page 30](#)
- [Cloud Endpoint Groups, on page 30](#)
- [Contracts, on page 32](#)
- [About the Cloud Template, on page 34](#)
- [Managed Object Relations and Policy Resolution, on page 37](#)
- [Default Policies, on page 38](#)
- [Shared Services, on page 39](#)

## About the ACI Policy Model

The ACI policy model enables the specification of application requirements policies. The Cisco Cloud Network Controller automatically renders policies in the cloud infrastructure. When you or a process initiates an administrative change to an object in the cloud infrastructure, the Cisco Cloud Network Controller first applies that change to the policy model. This policy model change then triggers a change to the actual managed item. This approach is called a model-driven framework.

## Policy Model Key Characteristics

Key characteristics of the policy model include the following:

- As a model-driven architecture, the software maintains a complete representation of the administrative and operational state of the system (the model). The model applies uniformly to cloud infrastructure, cloud infrastructure, services, system behaviors, and virtual devices attached to the network.
- The logical and concrete domains are separated; the logical configurations are rendered into concrete configurations by applying the policies in relation to the available resources. No configuration is carried

out against concrete entities. Concrete entities are configured implicitly as a side effect of the changes to the Cisco Cloud policy model.

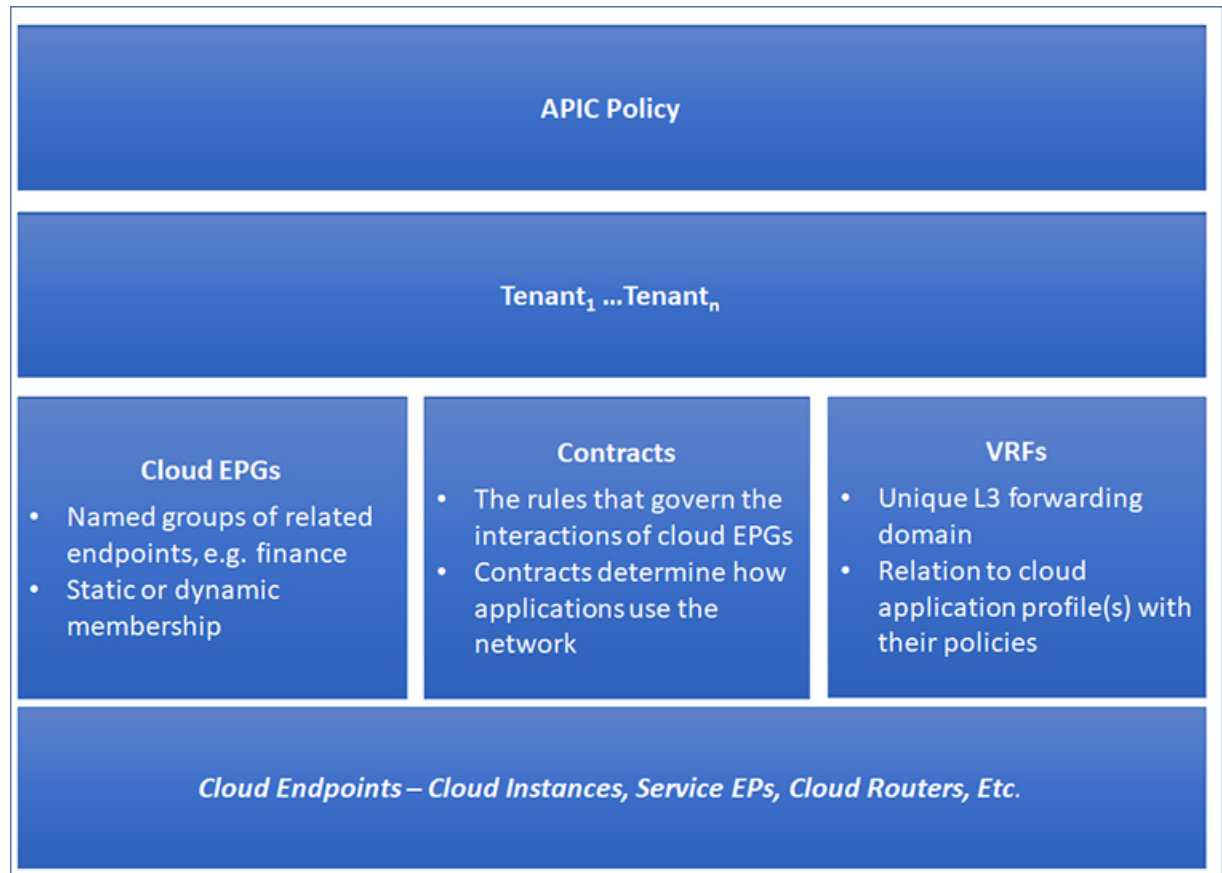
- The system prohibits communications with newly connected endpoints until the policy model is updated to include the new endpoint.
- Network administrators do not configure logical system resources directly. Instead, they define logical (hardware-independent) configurations and the Cisco Cloud Network Controller policies that control different aspects of the system behavior.

Managed object manipulation in the model relieves engineers from the task of administering isolated, individual component configurations. These characteristics enable automation and flexible workload provisioning that can locate any workload anywhere in the infrastructure. Network-attached services can be easily deployed, and the Cisco Cloud Network Controller provides an automation framework to manage the lifecycle of those network-attached services.

## Logical Constructs

The policy model manages the entire cloud infrastructure, including the infrastructure, authentication, security, services, applications, cloud infrastructure, and diagnostics. Logical constructs in the policy model define how the cloud infrastructure meets the needs of any of the functions of the cloud infrastructure. The following figure provides an overview of the ACI policy model logical constructs.

Figure 1: ACI Policy Model Logical Constructs Overview



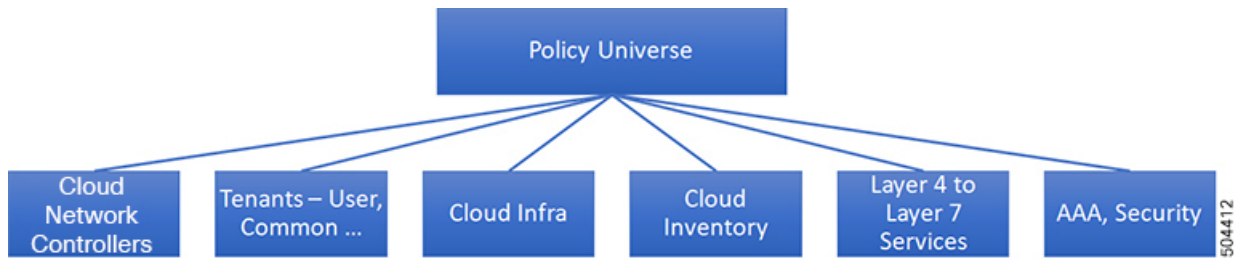
cloud infrastructure-wide or tenant administrators create predefined policies that contain application or shared resource requirements. These policies automate the provisioning of applications, network-attached services, security policies, and tenant subnets, which puts administrators in the position of approaching the resource pool in terms of applications rather than infrastructure building blocks. The application needs to drive the networking behavior, not the other way around.

## The Cisco ACI Policy Management Information Model

The cloud infrastructure comprises the logical components as recorded in the Management Information Model (MIM), which can be represented in a hierarchical management information tree (MIT). The Cisco Cloud Network Controller runs processes that store and manage the information model. Similar to the OSI Common Management Information Protocol (CMIP) and other X.500 variants, the Cisco Cloud Network Controller enables the control of managed resources by presenting their manageable characteristics as object properties that can be inherited according to the location of the object within the hierarchical structure of the MIT.

Each node in the tree represents a managed object (MO) or group of objects. MOs are abstractions of cloud infrastructure resources. An MO can represent a concrete object, such as a cloud router, adapter, or a logical object, such as an application profile, cloud endpoint group, or fault. The following figure provides an overview of the MIT.

Figure 2: Cisco ACI Policy Management Information Model Overview



The hierarchical structure starts with the policy universe at the top (Root) and contains parent and child nodes. Each node in the tree is an MO and each object in the cloud infrastructure has a unique distinguished name (DN) that describes the object and locates its place in the tree.

The following managed objects contain the policies that govern the operation of the system:

- A tenant is a container for policies that enable an administrator to exercise role-based access control. The system provides the following four kinds of tenants:
  - The administrator defines user tenants according to the needs of users. They contain policies that govern the operation of resources such as applications, databases, web servers, network-attached storage, virtual machines, and so on.
  - Although the system provides the common tenant, it can be configured by the cloud infrastructure administrator. It contains policies that govern the operation of resources accessible to all tenants, such as firewalls, load balancers, Layer 4 to Layer 7 services, intrusion detection appliances, and so on.




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**Note** The Cisco Cloud Network Controller only supports load balancers as a Layer 4 to Layer 7 service.

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- The infrastructure tenant is provided by the system but can be configured by the cloud infrastructure administrator. It contains policies that govern the operation of infrastructure resources. It also enables a cloud infrastructure provider to selectively deploy resources to one or more user tenants. Infrastructure tenant policies are configurable by the cloud infrastructure administrator.
- The cloud infra policies enable you to manage on-premises and inter-region connectivity when setting up the Cisco Cloud Network Controller. For more information, see the *Cisco Cloud Network Controller Installation Guide*.
- Cloud inventory is a service that enables you to view different aspects of the system using the GUI. For example, you can view the regions that are deployed from the aspect of an application or the applications that are deployed from the aspect of a region. You can use this information for cloud resource planning and troubleshooting.
- Layer 4 to Layer 7 service integration lifecycle automation framework enables the system to dynamically respond when a service comes online or goes offline. For more information, see [Deploying Layer 4 to Layer 7 Services, on page 131](#)

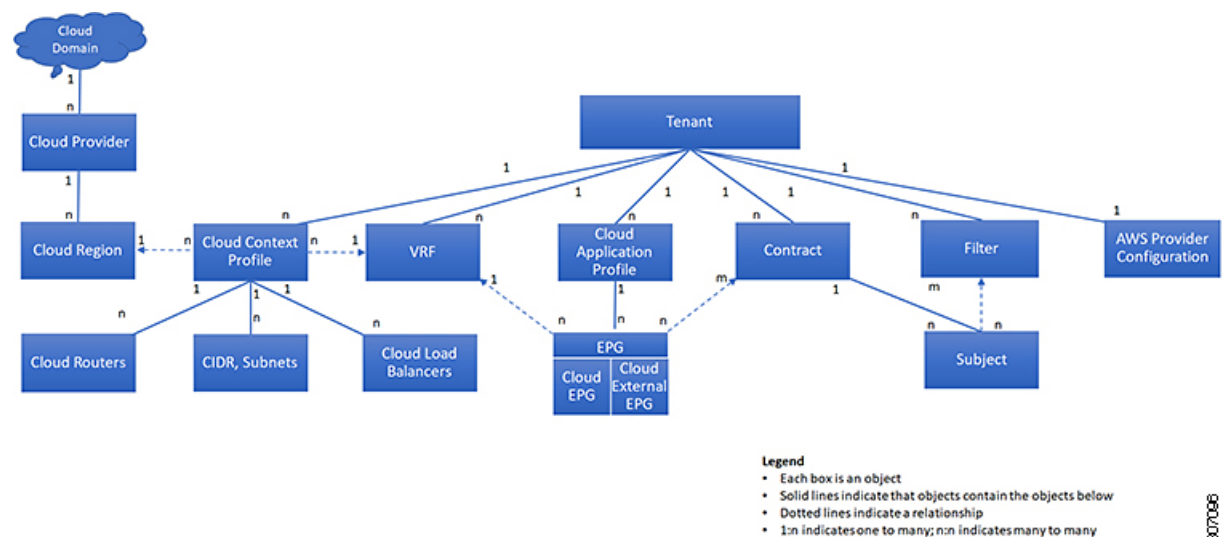
- Access, authentication, and accounting (AAA) policies govern user privileges, roles, and security domains of the Cisco Cloud Network Controller cloud infrastructure. For more information, see [Cisco Cloud Network Controller Security, on page 159](#)

The hierarchical policy model fits well with the REST API interface. When invoked, the API reads from or writes to objects in the MIT. URLs map directly into distinguished names that identify objects in the MIT. Any data in the MIT can be described as a self-contained structured tree text document encoded in XML or JSON.

## Tenants

A tenant (`fvTenant`) is a logical container for application policies that enable an administrator to exercise domain-based access control. A tenant represents a unit of isolation from a policy perspective, but it does not represent a private network. Tenants can represent a customer in a service provider setting, an organization or domain in an enterprise setting, or just a convenient grouping of policies. The following figure provides an overview of the tenant portion of the management information tree (MIT).

**Figure 3: Tenants**



Tenants can be isolated from one another or can share resources. The primary elements that the tenant contains are filters, contracts, Virtual Routing and Forwarding (VRF) instances, cloud context profiles, AWS provider configurations, and cloud application profiles that contain cloud endpoint groups (cloud EPGs). Entities in the tenant inherit its policies. VRFs are also known as contexts; each VRF can be associated with multiple cloud context profiles. A cloud context profile in conjunction with a VRF and a region represents the AWS VPC in that region.

Tenants are logical containers for application policies. The cloud infrastructure can contain multiple tenants. You must configure a tenant before you can deploy any Layer 4 to Layer 7 services. The ACI cloud infrastructure supports IPv4 and dual-stack configurations for tenant networking.

# Cloud Context Profile

The cloud context profile contains information on the following Cisco Cloud Network Controller components:

- Availability zones and regions
- CIDRs
- CCRs
- Endpoints
- EPGs
- Virtual Networks
- VRFs

The following sections provide additional information on some of the components that are part of the cloud context profile.

## CCR

The CCR is a virtual router that delivers comprehensive WAN gateway and network services into virtual and cloud environments. The CCR enables enterprises to extend their WANs into provider-hosted clouds. Two CCRs are required for Cisco Cloud Network Controller solution.

The **Cisco Catalyst 8000V** is used with the Cisco Cloud Network Controller. For more information on this type of CCR, see the [Cisco Catalyst 8000V Edge software documentation](#).

## About the Cisco Catalyst 8000V

Following are the updates for the Cisco Catalyst 8000V.

- [Licensing, on page 20](#)
- [Throughput, on page 21](#)

### Licensing

The Cisco Catalyst 8000V on Cisco Cloud Network Controller supports the following licensing models:

1. **Bring Your Own License (BYOL)** Licensing Model
2. **Pay As You Go (PAYG)** Licensing Model

### BYOL Licensing Model

The BYOL licensing model on Cisco Catalyst 8000V which requires you to purchase your Catalyst 8000V Cisco DNA license from Cisco and deploy it in the cloud.

- For instructions on subscribing to one of the tier-based Cisco Catalyst 8000V licenses, see [Cisco Catalyst 8000V Edge Software](#).
- For more information on different throughputs based on the tiers, see [Throughput, on page 21](#).

Cisco Cloud Network Controller makes use of the “Cisco DNA Advantage” subscription. For features supported by the “Cisco DNA Advantage” subscription, see [Cisco DNA Software SD-WAN and Routing Matrices](#).

### PAYG Licensing Model

Beginning with the 25.0(4) release, Cisco Cloud Network Controller supports Pay-As-You-Go (PAYG) Licensing Model on Cisco Catalyst 8000V which allows users to deploy a Catalyst 8000V instance in the cloud based on the VM size and purchase the usage on an hourly basis.

As you completely depend on the VM size to get the throughput, the PAYG licensing model can be enabled only by first un-deploying the current Cisco Catalyst 8000V and then re-deploying it using the First Time Set Up with the new VM size. For more information, see the chapter "Configuring Cisco Cloud Network Controller Using the Setup Wizard" in the [Cisco Cloud Network Controller for AWS Installation Guide](#)



**Note** The procedure for switching between licenses can also be used if you would like to switch between the two licensing types available.



**Note** There are two PAYG options for consuming licenses in the AWS marketplace: **Catalyst 8000V Cisco DNA Essentials** and **Catalyst 8000V Cisco DNA Advantage**. Cisco Cloud Network Controller will make use of **Catalyst 8000V Cisco DNA Advantage**. For features supported by the “Cisco DNA Advantage” subscription, see [Cisco DNA Software SD-WAN and Routing Matrices](#)

### Throughput

The Cisco Catalyst 8000V on Cisco Cloud Network Controller supports the following licensing models:

1. **Bring Your Own License (BYOL)** Licensing Model
2. **Pay As You Go (PAYG)** Licensing Model

#### 1. Bring Your Own License (BYOL)

For this model, the Cisco Catalyst 8000V supports tier-based (T0/T1/T2/T3) throughput options. The following table lists what AWS EC2 instance is used for different router throughput settings for the Cisco Catalyst 8000V:

CCR Throughput	AWS EC2 Instance
T0 (up to 15M throughput)	c5.xlarge
T1 (up to 100M throughput)	c5.xlarge
T2 (up to 1G throughput)	c5.xlarge
T3 (up to 10G throughput)	c5.9xlarge

Tier2 (T2) is the default throughput supported by Cisco Cloud Network Controller.

#### 2. Pay-As-You-Go Licensing Model

For this model, Cisco Cloud Network Controller supports a range of AWS EC2 instances for cloud networking needs powered by Cisco’s Catalyst 8000V virtual router.

The table below shows the cloud instance type supported by Cisco Cloud Network Controller on AWS. -

AWS EC2 Instance	CCR Throughput	vCPUs	Memory
c5.xlarge	up to 5 Gigabit throughput	4	8 GiB
c5.2xlarge	up to 10 Gigabit throughput	8	16 GiB
c5.4xlarge	up to 10 Gigabit throughput	16	32 GiB
c5.9xlarge	up to 10 Gigabit throughput	36	72 GiB
c5n.xlarge	up to 25 Gigabit throughput	4	10.5 GiB
c5n.2xlarge	up to 25Gigabit throughput	8	21 GiB
c5n.4xlarge	up to 25 Gigabit throughput	16	42 GiB
c5n.9xlarge	up to 50 Gigabit throughput	36	96 GiB

## Private IP Address Support for Cisco Cloud Network Controller and CCR in AWS

By default, CCR interfaces are assigned private IP addresses only and assignment of public IP addresses to CCR interfaces is optional. Private IP addresses are always assigned to all the interfaces of a CCR. The private IP address of GigabitEthernet1 of a CCR is used as BGP and OSPF router IDs.

To enable CCR private IP addresses for inter-site connectivity, where you are disabling public IP addresses for the CCR interfaces, see the [Managing Regions \(Configuring a Cloud Template\) Using the Cisco Cloud Network Controller GUI, on page 107](#) procedure.

By default, a private IP address is assigned to the management interface of the Cisco Cloud Network Controller and assigning a public IP address is optional. To disable public IP to the Cisco Cloud Network Controller so that a private IP address is used for connectivity, see the *Deploying the Cisco Cloud Network Controller in AWS* procedure in the *Cisco Cloud Network Controller for AWS Installation Guide*.

### Restrictions for CCR with Private IP Address

When public IP is disabled, the underlay inter-site connectivity cannot be Public internet because Public Internet requires a public IP address. The underlay inter-site connectivity can only be one of the following:

- Private connection for connecting to an on-premise ACI site, which is through AWS Direct Connect or Azure Express Route
- Cloud backbone for connecting to a Cisco Cloud Network Controller site of the same cloud provider, which is through AWS VPC Peering or Azure Vnet Peering



## Communicating to External Sites From Regions Without a CCR

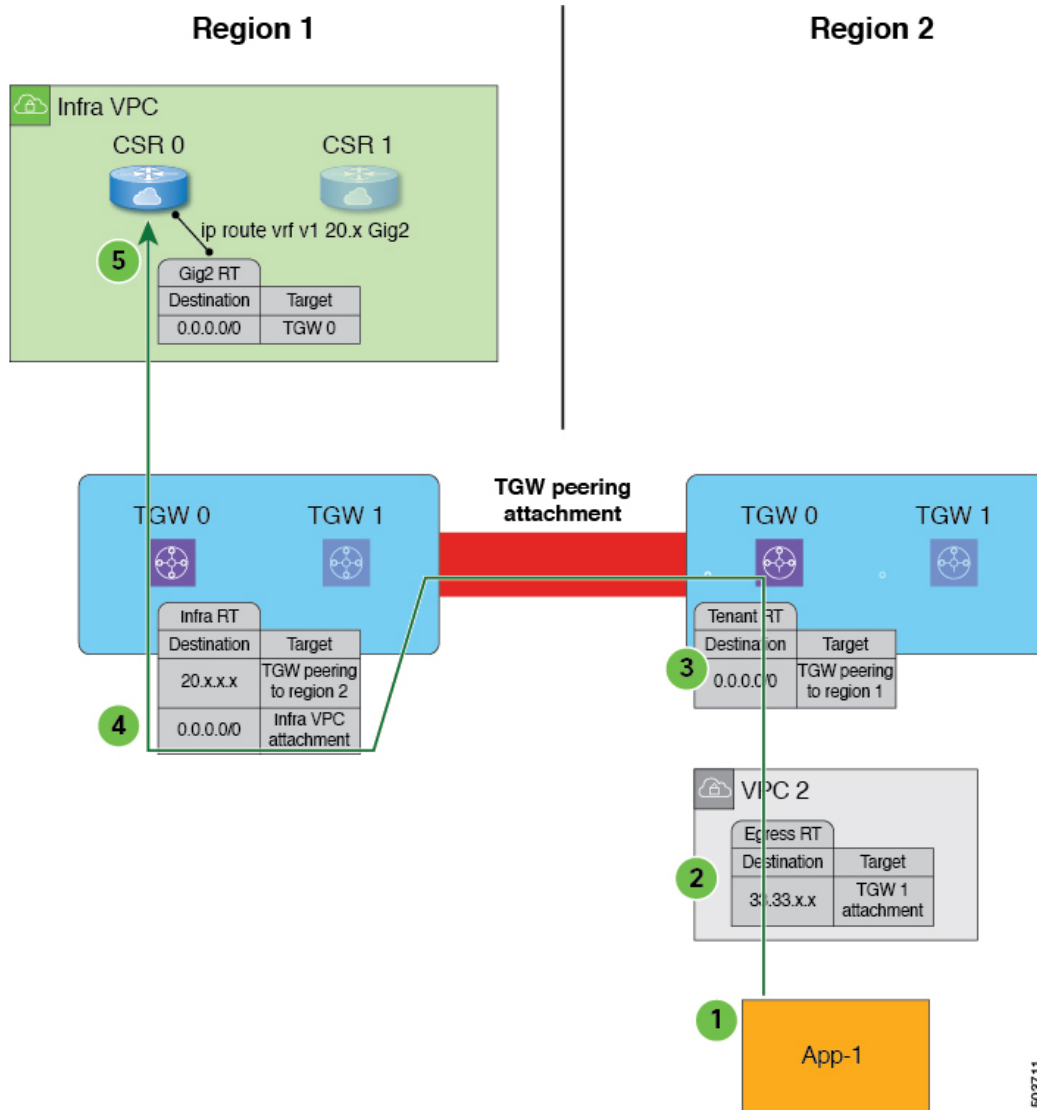
Support is available for communication with an external site from regions without a CCR. This is accomplished by making use of the AWS Transit Gateway feature. When you enable the AWS Transit Gateway feature on Cisco Cloud Network Controller, you also enable peering between all managed regions on AWS. In this way, the AWS Transit Gateway peering feature allows the Cisco Cloud Network Controller to address the issue of communicating with external sites from regions without a CCR. It addresses this issue by having traffic rerouted to a region with a CCR.

Using the AWS Transit Gateway feature, when traffic from a region without a CCR tries to egress out of a site, this traffic will be routed to the infra VPC for the closest region with a CCR. After the traffic is rerouted to that region's infra VPC, that CCR is used to egress out the packet. For ingress traffic, packets coming from an external site can reach any region's CCR and then be routed to the destination region using the AWS Transit Gateway peering in the ingress data path.

In these situations, traffic is rerouted automatically when the system recognizes that external traffic is egressing or ingressing through a region without a CCR. However, you must have the following components configured in order for the system to automatically perform this rerouting task:

- AWS Transit Gateway must be configured. If AWS Transit Gateway is not already configured, see [Increasing Bandwidth Between VPCs by Using AWS Transit Gateway](#) for those instructions.
- CCRs must be deployed in at least one region. Even though this enhancement allows you to communicate with an external site from a region that *does not* contain a CCR, in order to do this, you must have another separate region that *does* contain a CCR so that traffic can be rerouted from the region without a CCR to the region with a CCR.

The following figure shows an example scenario where traffic is rerouted automatically when the system recognizes that external traffic is egressing from a region without a CCR.



The following occurs when the Cisco Cloud Network Controller recognizes that Region 2 does not have a CCR, but traffic is egressing out to an external site (shown with the green arrow and circles):

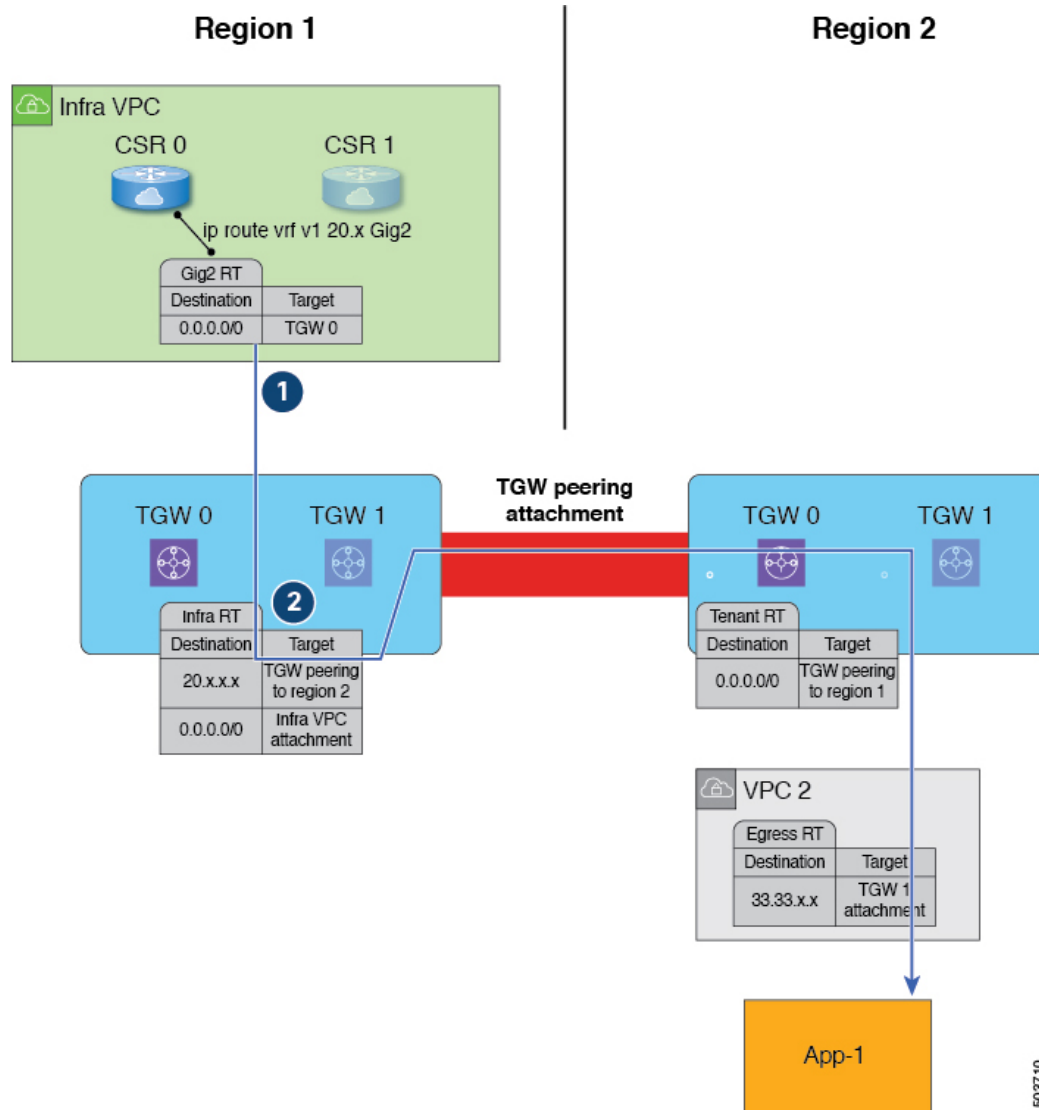
1. Traffic flow begins egressing out from the CIDR in App-1 in Region 2 to a remote site. Note that the endpoint is configured with the appropriate outbound rule to allow the remote site CIDR.
2. The VPC 2 egress route table has the remote site CIDR, which then has the AWS Transit Gateway as the next hop. The AWS Transit Gateway information is programmed automatically based on the configured contracts.
3. A 0.0.0.0/0 route is inserted in the AWS Transit Gateway route table, which essentially tells the system to take the AWS Transit Gateway peering attachment if traffic is egressing out to an external site but there is no CCR in this region. In this situation, the AWS Transit Gateway peering attachment goes to another region that does have a CCR (Region 1 in the example scenario). The region with a CCR that will be used is chosen based on geographical proximity to the region that does not have a CCR.

4. The packet is first forwarded to the infra VPC in the region with the CCR (Region 1), and is then forwarded to the gigabit ethernet network interface on the CCR that is associated with the appropriate VRF group.
5. The gigabit 2 inbound security group on the CCR in Region 1 is configured to allow traffic from the remote region VPC.

It's useful to note that in the egress example shown above:

- For steps 1 and 2, there is no change from pre-release 5.2(1) behavior.
- Step 3 is behavior that is new and unique to this feature in release 5.2(1), where the redirect occurs to the TGW peering attachment from the region without a CCR to the region with a CCR. In addition, step 3 occurs on the AWS cloud.
- Steps 4 and 5 would normally occur in Region 2 before release 5.2(1), but only if Region 2 had a CCR. However, because Region 2 does not have a CCR, with this feature in release 5.2(1), these steps are taking place in Region 1 where a CCR is present.

The following figure shows an example scenario where traffic is rerouted automatically when the system recognizes that external traffic is ingressing to a region without a CCR.



The following occurs when the Cisco Cloud Network Controller recognizes that Region 2 does not have a CCR, but traffic is ingressing in from an external site to a CIDR in App-1 in Region 2 (shown with the blue arrow and circles):

1. Normally, the CCR in Region 1 would only advertise the CIDRs that are local to that region. However, with this enhancement that is part of release 5.2(1), all CCRs in all regions now advertise CIDRs from all remote regions. Therefore, in this example, the CCR in Region 1 will also advertise the CIDRs that are in Region 2 (assuming AWS Transit Gateway peering is configured between both regions and the contracts are configured correctly). In this situation, the traffic ingresses in from an external site to the CCR in Region 1, where the CCR in Region 1 advertises the static route for the remote region VPC CIDRs.
2. The infra route table (the AWS Transit Gateway route table in Region 1) has the next hop to the AWS Transit Gateway peering attachment to Region 2.

It's useful to note that in the ingress example shown above:

- Both steps (steps 1 and 2) in the ingress example shown above are new and unique to this feature in release 5.2(1).
- Step 1 in the ingress example shows configurations programmed on the CCR.
- Step 2 in the ingress example occurs on the AWS cloud.

## Support for ECMP Forwarding from Remote Sites for CCRs

Support is available for ECMP with CCRs, where traffic from CCRs will be forwarded to all ECMP paths received from a destination site. This support is automatically enabled and requires no manual configuration to enable.

## Preference For Routes to CCRs in Regions with Local CIDRs

Every CIDR that is configured is local to a specific region. With multiple regions in a cloud, CCRs from all regions advertise the CIDRs for redundancy. However, rather than have CCRs from all regions advertise the CIDRs with the same preference, support is available for having CCRs advertise with a higher preference from the region where the CIDR is local. This causes the on-premises site or the remote cloud site to direct traffic directly to the region where the CIDR is local. If the CCRs in the local region fail, the paths from the other regions can be used for data forwarding.

## Availability Zones

Two types of availability zones are supported for Cisco Cloud Network Controller:

- **Virtual availability zones:** Cisco Cloud Network Controller supports only two virtual availability zones per region in AWS, where Cisco Cloud Network Controller creates two virtual availability zones for each region using the format <region-name>a and <region-name>b. For example, under the `us-west-1` region, Cisco Cloud Network Controller creates the two virtual availability zones `us-west-1a` and `us-west-1b`.
- **Cloud availability zones:** This type of availability zone allows for multiple availability zones in each AWS region with Cisco Cloud Network Controller.
- To view the **virtual** availability zones for your Cisco Cloud Network Controller, navigate to **Cloud Resources > Availability Zones**, then click the **Virtual Availability Zones** tab.

Name	Cloud Availability Zone	Tenants	Application Management		Cloud Resources		
			App. Profiles	EPGs	VPCs	Routers	Endpoints
af-south-1-1a region-af-south-1		N/A	N/A	N/A	N/A	0	N/A
af-south-1-1b region-af-south-1		N/A	N/A	N/A	N/A	0	N/A
ap-east-1-1a region-ap-east-1		N/A	N/A	N/A	N/A	0	N/A

- To view the **cloud** availability zones for your Cisco Cloud Network Controller, navigate to **Cloud Resources > Availability Zones**, then click the **Cloud Availability Zones** tab.


Name	Tenants	Application Management			Cloud Resources	
		App. Profiles	EPGs	VPCs	Routers	Endpoints
us-east-1a AWS > infra > us-east-1	N/A	N/A	N/A	N/A	0	N/A
us-east-1b AWS > infra > us-east-1	N/A	N/A	N/A	N/A	0	N/A
us-east-1c AWS > infra > us-east-1	N/A	N/A	N/A	N/A	0	N/A

## Migrating from Virtual Availability Zones to Cloud Availability Zones

If you have deployments where you have virtual availability zones configured, we recommend that you migrate from the virtual availability zones to the cloud availability zones.

- You can migrate individual subnets or all of the subnets in a CIDR block range as part of the availability zone migration.
- Migrating from older virtual availability zones to the newer cloud availability zones will not cause have any functional impact, such as a traffic drop, in the cloud resources in AWS.



**Note** The following steps describe how to migrate from virtual availability zones to cloud availability zones through the cloud context profile, but you can also migrate availability zones by clicking the Intent icon (  ) and selecting **Availability Zone Configuration Migration**.

To migrate from virtual availability zones to cloud availability zones:

1. Navigate to the cloud context profile that was configured previously with the older virtual availability zones.
 

In the left nav pane, navigate to **Application Management > Cloud Context Profiles**, then locate the cloud context profile that was configured previously with the older virtual availability zones.
2. Double-click on that cloud context profile.
 

The details panel for that cloud context profile appears with the **Overview** tab selected automatically. View the entries in the **Availability Zone** column in the **Overview** tab to determine if you have virtual availability zones in this cloud context profile that you can migrate to cloud availability zones.
3. Click **Actions > Migrate Subnet Configuration**.
 

The **Availability Zone Configuration Migration** window appears.
4. Select the subnets associated with the virtual availability zones that you want to migrate to cloud availability zones.
  - All of the subnets listed in this window that are associated with virtual availability zones will be selected by default. Manually deselect any subnets associated with virtual availability zones that you do not want to migrate to cloud availability zones.
  - For each virtual availability zone that will be migrated over to cloud availability zones, make a note of the entry in the Cloud Availability Zones column to determine the new availability zone value for that subnet, if necessary.

5. Click **Migrate Subnet Configuration**.

The selected virtual availability zones are migrated to cloud availability zones.

**Guidelines and Limitations**

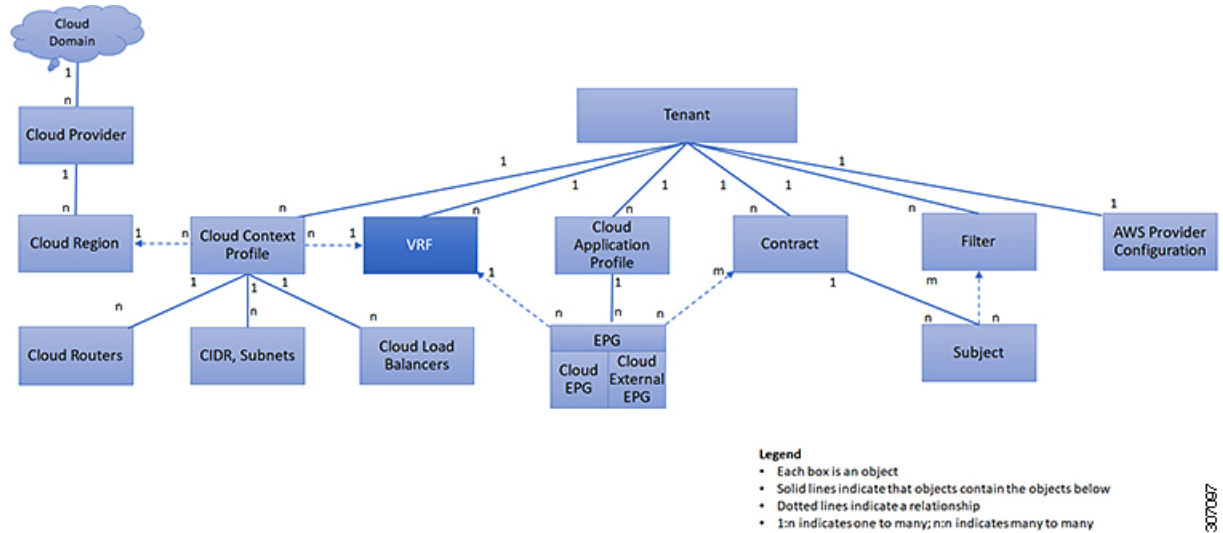
Following are the guidelines and limitations for support of multiple availability zones:

- Support for cloud availability zones, where you can have more than two availability zones, is available for user tenants only. Infra tenants will continue to use virtual availability zones which have a limit of two availability zones.

**VRFs**

A Virtual Routing and Forwarding (VRF) object (`fvCtx`) or context is a tenant network (called a private network in the Cisco Cloud Network Controller GUI). A tenant can have multiple VRFs. A VRF is a unique Layer 3 forwarding and application policy domain. The following figure shows the location of VRFs in the management information tree (MIT) and their relation to other objects in the tenant.

**Figure 4: VRFs**

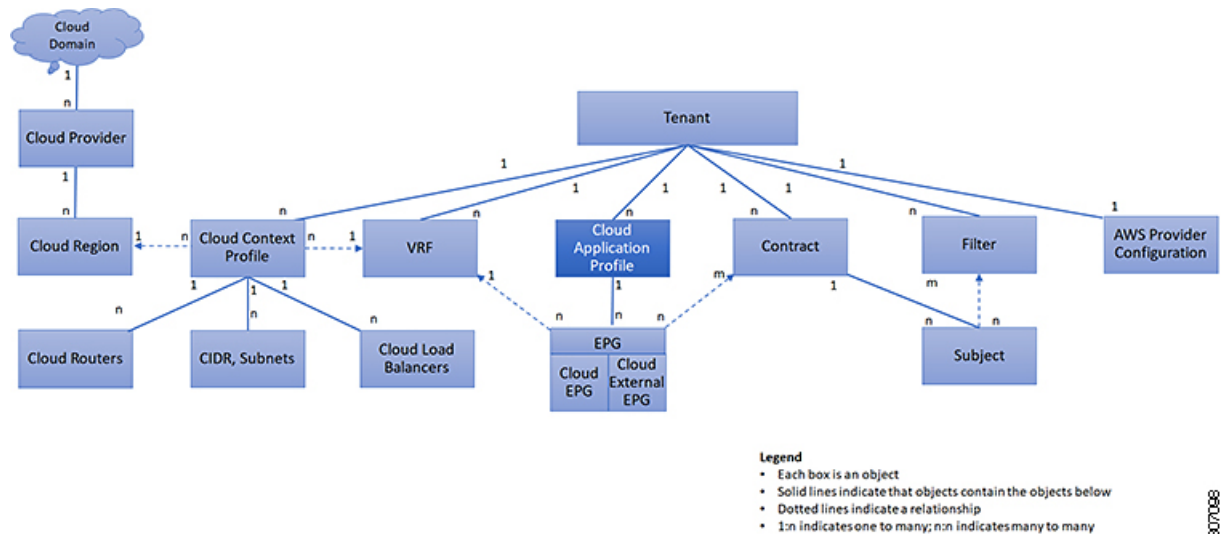


A VRF defines a Layer 3 address domain. One or more cloud context profiles are associated with a VRF. You can only associate one cloud context profile with a VRF in a given region. All the endpoints within the Layer 3 domain must have unique IP addresses because it is possible to forward packets directly between these devices if the policy allows it. A tenant can contain multiple VRFs. After an administrator creates a logical device, the administrator can create a VRF for the logical device, which provides a selection criteria policy for a device cluster. A logical device can be selected based on a contract name, a graph name, or the function node name inside the graph.

# Cloud Application Profiles

A cloud application profile (`cloudAp`) defines the policies, services and relationships between cloud EPGs. The following figure shows the location of cloud application profiles in the management information tree (MIT) and their relation to other objects in the tenant.

**Figure 5: Cloud Application Profiles**



Cloud application profiles contain one or more cloud EPGs. Modern applications contain multiple components. For example, an e-commerce application could require a web server, a database server, data located in a storage service, and access to outside resources that enable financial transactions. The cloud application profile contains as many (or as few) cloud EPGs as necessary that are logically related to providing the capabilities of an application.

Cloud EPGs can be organized according to one of the following:

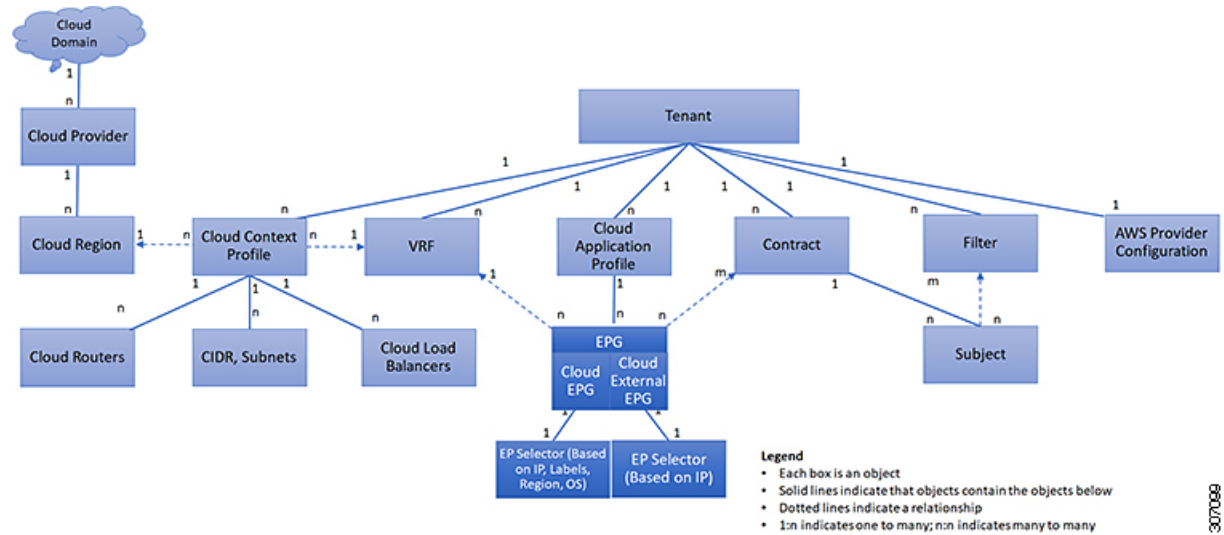
- The application they provide, such as a DNS server or SAP application (see *Tenant Policy Example* in *Cisco APIC REST API Configuration Guide*).
- The function they provide (such as infrastructure)
- Where they are in the structure of the data center (such as DMZ)
- Whatever organizing principle that a cloud infrastructure or tenant administrator chooses to use

## Cloud Endpoint Groups

The cloud endpoint group (cloud EPG) is the most important object in the policy model. The following figure shows where application cloud EPGs are located in the management information tree (MIT) and their relation to other objects in the tenant.



Figure 6: Cloud Endpoint Groups



A cloud EPG is a managed object that is a named logical entity that contains a collection of endpoints. Endpoints are devices that are connected to the network directly or indirectly. They have an address (identity), a location, attributes (such as version or patch level), and are virtual. Knowing the address of an endpoint also enables access to all its other identity details. Cloud EPGs are fully decoupled from the physical and logical topology. Endpoint examples include servers, virtual machines, storage services, or clients on the Internet. Endpoint membership in a cloud EPG can be dynamic or static.

The ACI cloud infrastructure can contain the following types of cloud EPGs:

- Cloud endpoint group (`cloudEPg`)
- Cloud external endpoint group (`cloudExtEPg`)

Cloud EPGs contain endpoints that have common policy requirements such as security or Layer 4 to Layer 7 services. Rather than configure and manage endpoints individually, they are placed in a cloud EPG and are managed as a group.

Policies apply to cloud EPGs, never to individual endpoints.

Regardless of how a cloud EPG is configured, cloud EPG policies are applied to the endpoints they contain.

WAN router connectivity to the cloud infrastructure is an example of a configuration that uses a static cloud EPG. To configure WAN router connectivity to the cloud infrastructure, an administrator configures a `cloudExtEPg` cloud EPG that includes any endpoints within an associated WAN subnet. The cloud infrastructure learns of the cloud EPG endpoints through a discovery process as the endpoints progress through their connectivity life cycle. Upon learning of the endpoint, the cloud infrastructure applies the `cloudExtEPg` cloud EPG policies accordingly. For example, when a WAN connected client initiates a TCP session with a server within an application (`cloudEPg`) cloud EPG, the `cloudExtEPg` cloud EPG applies its policies to that client endpoint before the communication with the (`cloudExtEPg`) cloud EPG web server begins. When the client server TCP session ends, and communication between the client and server terminates, the WAN endpoint no longer exists in the cloud infrastructure.

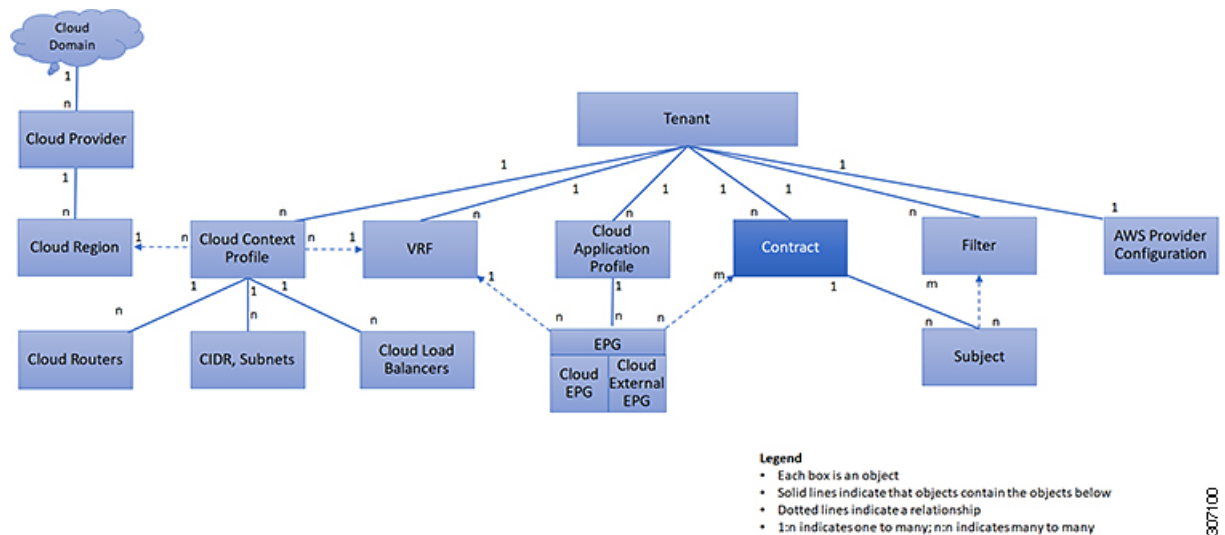
The Cisco Cloud Network Controller uses endpoint selectors to assign endpoints to Cloud EPGs. The endpoint selector is essentially a set of rules that are run against the cloud instances that are assigned to the AWS VPC

managed by Cisco ACI. Any endpoint selector rules that match endpoint instances assign that endpoint to the Cloud EPG. The endpoint selector is similar to the attribute-based microsegmentation available in Cisco ACI.

## Contracts

In addition to cloud EPGs, contracts (vzBrCP) are key objects in the policy model. Cloud EPGs can only communicate with other cloud EPGs according to contract rules. The following figure shows the location of contracts in the management information tree (MIT) and their relation to other objects in the tenant.

**Figure 7: Contracts**



An administrator uses a contract to select one or more types of traffic that can pass between cloud EPGs, including the protocols and ports allowed. If there is no contract, inter-EPG communication is disabled by default. There is no contract required for intra-EPG communication; intra-EPG communication is always implicitly allowed.

Contracts govern the following types of cloud EPG communications:

- Between cloud EPGs (cloudEPG), both intra-tenant and inter-tenant



**Note** In the case of a shared service mode, a contract is required for inter-tenant communication. A contract is used to specify static routes across VRFs, although the tenant VRF does not enforce a policy.

- Between cloud EPGs and cloud external EPGs (cloudExtEPG)

Contracts govern the communication between cloud EPGs that are labeled providers, consumers, or both. The relationship between a cloud EPG and a contract can be either a provider or consumer. When a cloud EPG provides a contract, communication with that cloud EPG can be initiated from other cloud EPGs as long as the communication complies with the provided contract. When a cloud EPG consumes a contract, the cloud endpoints in the consuming cloud EPG may initiate communication with any cloud endpoint in a cloud EPG that is providing that contract.

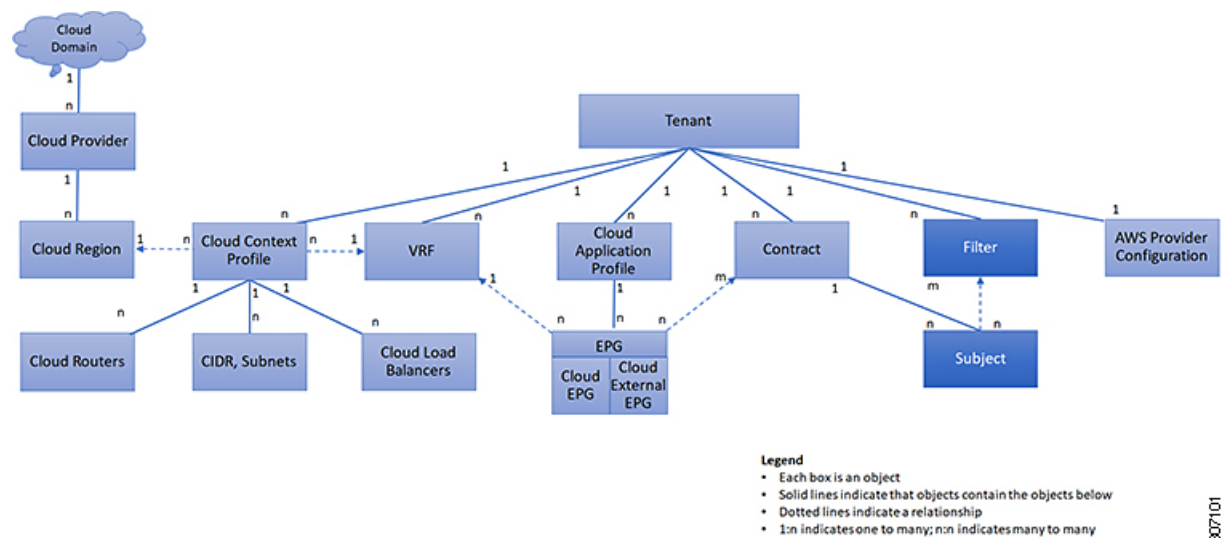


**Note** A cloud EPG can both provide and consume the same contract. A cloud EPG can also provide and consume multiple contracts simultaneously.

## Filters and Subjects Govern Cloud EPG Communications

Subject and filter managed-objects enable mixing and matching among cloud EPGs and contracts so as to satisfy various applications or service delivery requirements. The following figure shows the location of application subjects and filters in the management information tree (MIT) and their relation to other objects in the tenant.

**Figure 8: Subjects and Filters**



Contracts can contain multiple communication rules and multiple cloud EPGs can both consume and provide multiple contracts. A policy designer can compactly represent complex communication policies and re-use these policies across multiple instances of an application.



**Note** Subjects are hidden in Cisco Cloud Network Controller and not configurable. For rules installed in AWS, source port provided in the filter entry s not taken into account.

Subjects and filters define cloud EPG communications according to the following options:

- Filters are Layer 2 to Layer 4 fields, TCP/IP header fields such as Layer 3 protocol type, Layer 4 ports, and so forth. According to its related contract, a cloud EPG provider dictates the protocols and ports in both the in and out directions. Contract subjects contain associations to the filters (and their directions) that are applied between cloud EPGs that produce and consume the contract.




---

**Note** When a contract filter match type is `All`, best practice is to use the VRF unenforced mode. Under certain circumstances, failure to follow these guidelines results in the contract not allowing traffic among cloud EPGs in the VRF.

---

- Subjects are contained in contracts. One or more subjects within a contract use filters to specify the type of traffic that can be communicated and how it occurs. For example, for HTTPS messages, the subject specifies the direction and the filters that specify the IP address type (for example, IPv4), the HTTP protocol, and the ports allowed. Subjects determine if filters are unidirectional or bidirectional. A unidirectional filter is used in one direction. Unidirectional filters define in or out communications but not the same for both. Bidirectional filters are the same for both; they define both in and out communications.




---

**Note** For rules that are installed in AWS, the source port provided in the filter entry is not taken into account.

---

- ACI contracts rendered in AWS constructs are always stateful, allowing return traffic.

## About the Cloud Template

The cloud template provides a template that configures and manages the Cisco Cloud Network Controller infra network. The template requires only the most essential elements for the configuration. From these elements, the cloud template generates a detailed configuration necessary for setting up the Cisco Cloud Network Controller infra network. However, it is not a one-time configuration generation—it is possible to add, modify, or remove elements of the template input. The cloud template updates the resulting configuration accordingly.

One of the central things in the AWS network configuration is the Virtual Private Cloud (VPC). AWS supports many regions worldwide and one VPC is specific to one region.

The cloud template accepts one or more region names and generates the entire configuration for the infra VPCs in those regions. They are the infra VPCs. The Cisco Cloud Network Controller-managed object (MO) corresponding to the AWS VPC is `cloudCtxProfile`. For every region specified in the cloud template, it generates the `cloudCtxProfile` configuration. A `cloudCtxProfile` is the topmost MO for all the configuration corresponding to a region. Underneath, it has many of other MOs organized as a tree to capture a specific configuration. A `cloudCtxProfile` MO generated by the cloud template carries `ctxProfileOwner == SYSTEM`. For the non-infra network, it is possible to configure `cloudCtxProfile` directly; in this case, `cloudCtxProfile` carries `ctxProfileOwner == USER`.

A primary property of an AWS VPC is the CIDR. Every region needs a unique CIDR. In Cisco Cloud Network Controller, you can provide the CIDRs for the infra VPCs. The CIDRs for the first two regions come from the Cloud Formation Template (CFT) that deploys the Cisco Cloud Network Controller AMI on the AWS. The `cloudApicSubnetPool` MO provides CIDRs for the additional regions directly to the Cisco Cloud Network Controller. In the Cisco Cloud Network Controller configuration, the `cloudCidr` MO, which is a child of `cloudCtxProfile`, models the CIDR.

The cloud template generates and manages a huge number of MOs in the `cloudCtxProfile` subtree including, but not limited to, the following:

- Subnets
- Association of subnets to AWS availability zones
- Cloud routers
- IP address allocation for the cloud router interfaces
- IP address allocation and configuration for tunnels
- IP address allocation and configuration for loopbacks

Without the cloud template, you would be responsible for configuring and managing these.

The *Cisco Cloud Template MO* table contains a brief summary of the inputs (MOs) to the cloud template.

**Table 3: Cloud Template MOs**

MO	Purpose
<code>cloudtemplateInfraNetwork</code>	The root of the cloud template configuration. Attributes include:  <code>numRoutersPerRegion</code> —The number of cloud routers for each <code>cloudRegionName</code> specified under <code>cloudtemplateIntNetwork</code> .
<code>cloudtemplateProfile</code>	Configuration profile for all the cloud routers. Attributes include: <ul style="list-style-type: none"> <li>• <code>routerUsername</code></li> <li>• <code>routerPassword</code></li> <li>• <code>routerThroughput</code></li> <li>• <code>routerLicenseToken</code></li> <li>• <code>routeDataInterfacePublicIP</code></li> <li>• <code>routerMgmtInterfacePublicIP</code></li> </ul>
<code>cloudtemplateIntNetwork</code>	Contains a list of regions, which specify where you deploy the cloud routers. Each region is captured through a <code>cloudRegionName</code> child MO
<code>cloudtemplateExtNetwork</code>	Contains infra network configuration input that is external of the cloud.  Contains a list of regions where cloud routers are configured for external networking.  Each region is captured through a <code>cloudRegionName</code> child MO

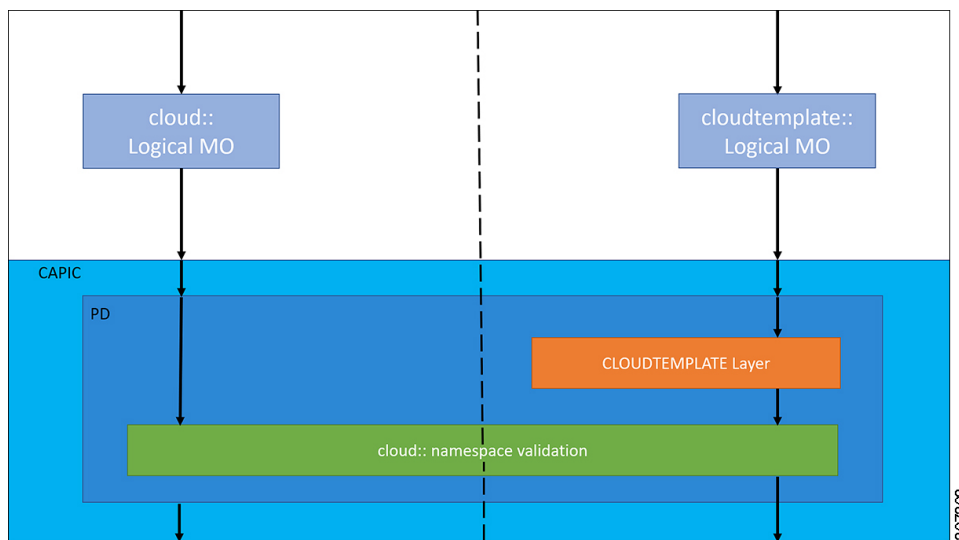
MO	Purpose
cloudtemplateVpnNetwork	Contains information for setting up a VPN with an ACI on-premises site or another Cisco Cloud Network Controller site.
cloudtemplateIpSecTunnel	Captures the IP address of the IPsec peer in the ACI on-premises site.
cloudtemplateOspf	Captures the OSPF area to be used for the VPN connections.
cloudtemplateBgpEvpn	Captures the peer IP address, ASN, and so forth, for setting up the BGP session with the on-premises site.

In Cisco Cloud Network Controller, the layering of MOs is slightly different from a regular Cisco APIC due to the cloud template. In a regular Cisco APIC, you post logical MOs that go through two layers of translation:

1. Logical MO to resolved MO
2. Resolved MO to concrete MO

In Cisco Cloud Network Controller, there is an additional layer of translation for the infra network. This additional layer is where the cloud template translates logical MOs in the `cloudtemplate` namespace to logical MOs in the cloud namespace. For configurations outside of the infra network, you post logical MOs in the cloud namespace. In this case, the MOs go through the usual two-layer translation as in the regular Cisco APIC.

**Figure 9: Cloud and Cloud Template MO Conversion**



**Note** For information about configuring the cloud template, see [Configuring Cisco Cloud Network Controller Components, on page 41](#)

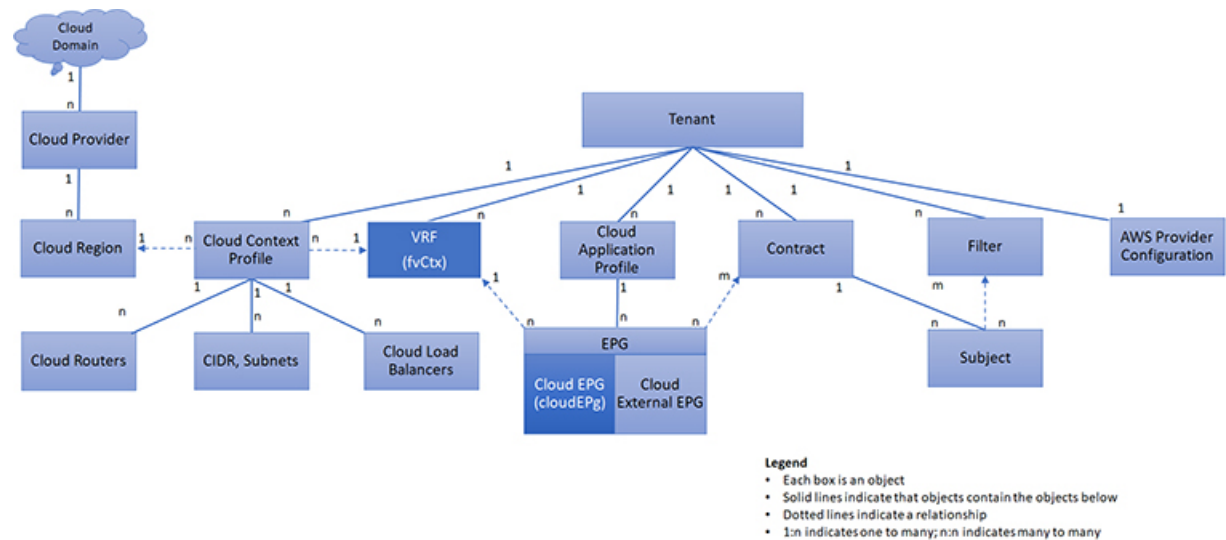
# Managed Object Relations and Policy Resolution

Relationship-managed objects express the relation between managed object instances that do not share containment (parent-child) relations. MO relations are established between the source MO and a target MO in one of the following two ways:

- An explicit relation, such as with `cloudRsZoneAttach` and `cloudRsCloudEPgCtx`, defines a relationship that is based on the target MO distinguished name (DN).
- A named relation defines a relationship that is based on the target MO name.

The dotted lines in the following figure show several common MO relations.

**Figure 10: MO Relations**



For example, the dotted line between the cloud EPG and the VRF defines the relation between those two MOs. In this figure, the cloud EPG (`cloudEPg`) contains a relationship MO (`cloudRsCloudEPgCtx`) that is named with the name of the target VRF MO (`fvCtx`). For example, if production is the VRF name (`fvCtx.name=production`), then the relation name is production (`cloudRsCloudEPgCtx.tnFvCtxName=production`).

In the case of policy resolution based on named relations, if a target MO with a matching name is not found in the current tenant, the ACI cloud infrastructure tries to resolve in the common tenant. For example, if the user tenant cloud EPG contained a relationship MO targeted to a VRF that did not exist in the tenant, the system tries to resolve the relationship in the common tenant. If a named relation cannot be resolved in either the current tenant or the common tenant, the ACI cloud infrastructure attempts to resolve to a default policy. If a default policy exists in the current tenant, it is used. If it does not exist, the ACI cloud infrastructure looks for a default policy in the common tenant. Cloud context profile, VRF, and contract (security policy) named relations do not resolve to a default.

# Default Policies



---

**Warning** Default policies can be modified or deleted. Deleting a default policy can result in a policy resolution process to complete abnormally.

---

The ACI cloud infrastructure includes default policies for many of its core functions. Examples of default policies include the following:

- Cloud AWS provider (for the infra tenant)
- Monitoring and statistics



---

**Note** To avoid confusion when implementing configurations that use default policies, document changes made to default policies. Be sure that there are no current or future configurations that rely on a default policy before deleting a default policy. For example, deleting a default firmware update policy could result in a problematic future firmware update.

---

A default policy serves multiple purposes:

- Allows a cloud infrastructure administrator to override the default values in the model.
- If an administrator does not provide an explicit policy, the Cisco Cloud Network Controller applies the default policy. An administrator can create a default policy and the Cisco Cloud Network Controller uses that unless the administrator provides any explicit policy.

The following scenarios describe common policy resolution behavior:

- A configuration explicitly refers to the default policy: if a default policy exists in the current tenant, it is used. Otherwise, the default policy in tenant **common** is used.
- A configuration refers to a named policy (not default) that does not exist in the current tenant or in tenant **common**: if the current tenant has a default policy, it is used. Otherwise, the default policy in tenant **common** is used.



---

**Note** The scenario above does not apply to a VRF in a tenant.

---

- A configuration does not refer to any policy name: if a default policy exists in the current tenant, it is used. Otherwise, the default policy in tenant **common** is used.

The policy model specifies that an object is using another policy by having a relation-managed object (MO) under that object and that relation MO refers to the target policy by name. If this relation does not explicitly refer to a policy by name, then the system tries to resolve a policy that is called default. Cloud context profiles and VRFs are exceptions to this rule.



# Shared Services

Cloud EPGs in one tenant can communicate with cloud EPGs in another tenant through a contract interface that is contained in a shared tenant. Within the same tenant, a cloud EPG in one VRF can communicate with another cloud EPG in another VRF through a contract defined in the tenant. The contract interface is an MO that can be used as a contract consumption interface by the cloud EPGs that are contained in different tenants. By associating to an interface, a cloud EPG consumes the subjects that are represented by the interface to a contract contained in the shared tenant. Tenants can participate in a single contract, which is defined at some third place. More strict security requirements can be satisfied by defining the tenants, contract, subjects, and filter directions so that tenants remain isolated from one another.

Follow these guidelines when configuring shared services contracts:

- A shared service is supported only with non-overlapping and non-duplicate CIDR subnets. When configuring CIDR subnets for shared services, follow these guidelines:
  - CIDR subnets leaked from one VRF to another must be disjointed and must not overlap.
  - CIDR subnets advertised from multiple consumer networks into a VRF or vice versa must be disjointed and must not overlap.





## CHAPTER 4

# Configuring Cisco Cloud Network Controller Components

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- [About Configuring the Cisco Cloud Network Controller, on page 41](#)
- [Configuring the Cisco Cloud Network Controller Using the GUI, on page 41](#)
- [Configuring Cisco Cloud Network Controller Using the REST API, on page 109](#)

## About Configuring the Cisco Cloud Network Controller

You create the Cisco Cloud Network Controller components using either the Cisco Cloud Network Controller GUI or the REST API. This section explains how to create configuration, application management, operations, and administrative components.



### Note

- For information about configuring a load balancer and service graph, see [Deploying Layer 4 to Layer 7 Services, on page 131](#).
  - For information about the GUI, such as navigation and a list of configurable components, see [About the Cisco Cloud Network Controller GUI, on page 12](#).
- 

## Configuring the Cisco Cloud Network Controller Using the GUI

### Creating a Tenant Using the Cisco Cloud Network Controller GUI

This section explains how to create a tenant using the Cisco Cloud Network Controller GUI.

---

**Step 1** Click the **Intent** icon. The **Intent** menu appears.

**Step 2** Click the drop-down arrow below the **Intent** search box and choose **Application Management**.

A list of **Application Management** options appear in the **Intent** menu.

**Step 3** From the **Application Management** list in the **Intent** menu, click **Create Tenant**. The **Create Tenant** dialog box appears.

**Step 4** Enter the appropriate values in each field as listed in the following *Create Tenant Dialog Box Fields* table then continue.

**Table 4: Create Tenant Dialog Box Fields**

Properties	Description
<b>Name</b>	Enter the name of the tenant.
<b>Description</b>	Enter a description of the tenant.
<b>Settings</b>	
<b>Add Security Domain</b>	To add a security domain: <ol style="list-style-type: none"> <li>a. Click <b>Add Security Domain</b>. The <b>Select Security Domains</b> dialog appears with a list of security domains in the left pane.</li> <li>b. Click to choose a security domain.</li> <li>c. Click <b>Select</b> to add the security domain to the tenant.</li> </ol>
<b>AWS Account ID</b>	Enter the cloud account ID.
<b>Access Type</b>	Click to enable the tenant type: <ul style="list-style-type: none"> <li>• <b>Untrusted</b></li> <li>• <b>Trusted</b></li> <li>• <b>Organization</b></li> </ul>

**Step 5** Click **Save** when finished.

## Configure a Tenant AWS Provider For Release 4.2(2) and Earlier

### Before you begin

- AWS Provider is auto-configured for Infra tenant. You do not need to do anything to configure the AWS provider for the infra tenant.
- For all non-infra tenants, the AWS provider is configured either as a trusted tenant or as untrusted tenant. Our recommendation is to use trusted tenants because managing credentials is not easy. Also, each tenant must be in a separate AWS account. Sharing the same AWS account for multiple tenants is not allowed.

For a trusted tenant, establish the trust relationship first with the account in which Cisco Cloud Network Controller is deployed (the account for the infra tenant). To establish the trust relation and give all the required permissions to the Cisco Cloud Network Controller for accessing the tenant account, run the tenant role cloud-formation template in the tenant account. This template is available as a tenant-cft.json object in the S3 bucket that is named capic-common-[capicAccountId]-data in the infra tenant's AWS

account. For security reasons, public access to this S3 bucket is not allowed, so the S3 bucket owner needs to download this file and use it in the tenant account.

- Untrusted tenants - use the account access and secret keys. The access and secret keys being used must be for an IAM user having these permissions at a minimum. The IAM role created must be named `ApicTenantRole`.



**Note** Cisco Cloud Network Controller does not disturb AWS resources created by other applications or users. It only manages the AWS resources created by itself.

```
{
  "Version": "2012-10-17",
  "Statement": [
    {
      "Action": [
        "ec2:*"
      ],
      "Resource": "*",
      "Effect": "Allow"
    }, {
      "Action": [
        "s3:*"
      ],
      "Resource": "*",
      "Effect": "Allow"
    }, {
      "Action": [
        "events:*"
      ],
      "Resource": "*",
      "Effect": "Allow"
    }, {
      "Action": [
        "logs:*"
      ],
      "Resource": "*",
      "Effect": "Allow"
    }, {
      "Action": [
        "cloudtrail:*"
      ],
      "Resource": "*",
      "Effect": "Allow"
    }, {
      "Action": [
        "cloudwatch:*"
      ],
      "Resource": "*",
      "Effect": "Allow"
    }, {
      "Action": [
        "resource-groups:*"
      ],
      "Resource": "*",
      "Effect": "Allow"
    }, {
      "Action": [
        "sqs:*"
      ],

```

```

        "Resource": "*",
        "Effect": "Allow"
    }, {
        "Action": "elasticloadbalancing:*",
        "Resource": "*",
        "Effect": "Allow"
    }, {
        "Action": [
            "config:*"
        ],
        "Resource": "*",
        "Effect": "Allow"
    }, {
        "Action": "iam:PassRole",
        "Resource": "arn:aws:iam::<account-id>:role/ApicTenantRole",
        "Effect": "Allow"
    }
]
}

```

- Add trust relationship:

```

{
  "Version": "2012-10-17",
  "Statement": [
    {
      "Effect": "Allow",
      "Principal": {
        "Service": "vpc-flow-logs.amazonaws.com",
        "AWS": "arn:aws:iam::<account-d>:root"
      },
      "Action": "sts:AssumeRole"
    }
  ]
}

```

- Cisco Cloud Network Controller enforces ownership checks to prevent deployment of policies in the same tenant-region combination done either intentionally or by mistake. For example, assume that Cisco Cloud Network Controller is deployed in AWS account IA1 in region R1. Now you want to deploy a tenant TA1 in region R2. This tenant deployment i.e. account-region combination TA1-R2 is now owned by IA1-R1. If another Cisco Cloud Network Controller attempts to manage the same tenant-region combination later (say Capic2 in AWS account IA2 deployed in region R3), this will not be allowed because the current owner for the deployment TA1-R2 is IA1-R1. In other words, only one account in one region can be managed by one Cisco Cloud Network Controller. Example below shows some valid and wrong deployment combinations.

```

Capic1:
IA1-R1: TA1-R1 - ok
        TA1-R2 - ok

Capic2:
IA1-R2: TA1-R1 - not allowed
        TA1-R3 - ok

Capic3:
IA2-R1: TA1-R1 - not allowed
        TA1-R4 - ok
        TA2-R4 - ok

```

- Ownership enforcement is done using AWS Resource Groups. When a new tenant in account TA1 in region R2 is managed by Cisco Cloud Network Controller, a Resource Group CAPIC\_TA1\_R2 (e.g. CAPIC\_123456789012\_us-east-2) is created in the tenant account. This Resource Group has a resource

tag AciOwnerTag with value IA1\_R1\_TA1\_R2, assuming it was managed by Cisco Cloud Network Controller in account IA1 and deployed in region R1. If the AciOwnerTag mismatch happens, tenant-region management is aborted.

Here is a summary of AciOwnerTag mismatch cases:

- Initially Cisco Cloud Network Controller is installed in an account, and then taken down and Cisco Cloud Network Controller is installed in a different account. All existing tenant-region deployment will fail.
- Another Cisco Cloud Network Controller is managing the same tenant-region.

In ownership mismatch cases, **retry** (to setup tenant-region again) is not currently supported. As a workaround, if you are certain that no other Cisco Cloud Network Controller is managing the same tenant-region combination, logon to the tenant's AWS account and manually remove the affected Resource Group (e.g. CAPIC\_123456789012\_us-east-2). Next, reload Cisco Cloud Network Controller or delete and add the tenant again.

---

**Step 1** In the Cisco Cloud Network Controller, configure the AWS Provider.

- a) On the **Intent** menu, choose **Tenants** > *tenant\_name* from the drop-down.
- b) In the **Intent** pane, choose **Application Management** > *tenant\_name* .

**Step 2** Perform the following actions:

- a) Confirm there is a check in the **Trusted** Tenant checkbox.

The AWS account must be a Trusted account for the user tenant using the cloud.

- b) In the **Cloud Account ID** field, provide the Cloud account ID.
- c) Run the tenant role cloud-formation template available at the URL [https://capic-common-\*<infraAccountId>\*-data.s3.amazonaws.com/tenant-cft.json](https://capic-common-<i><infraAccountId></i>-data.s3.amazonaws.com/tenant-cft.json) which is in a s3 bucket in the infra tenant's AWS account.

**Note** Alternatively, keep the trusted flag unchecked and provide the access and secret keys as done normally for any tenant.

**Step 3** Click **Save**.

---

## Configuring a Tenant AWS Provider

### Before you begin

- AWS Provider is auto-configured for Infra tenant. You do not need to do anything to configure the AWS provider for the infra tenant.
- For all non-infra tenants, the AWS provider is configured either as a trusted tenant, untrusted tenant, or organization tenant. Our recommendation is to use trusted tenants because managing credentials is not easy. Also, each tenant must be in a separate AWS account. Sharing the same AWS account for multiple tenants is not allowed.

For a trusted tenant, establish the trust relationship first with the account in which Cisco Cloud Network Controller is deployed (the account for the infra tenant). To establish the trust relation and give all the required permissions to the Cisco Cloud Network Controller for accessing the tenant account, first create a tenant and assign the Trusted tag to that tenant as the Access Type. Then, bring up that new trusted tenant again by clicking on the tenant name in the Tenants page, and in the AWS Account area in the tenant window, click the Run the CloudFormation template link.

- Organization tenants are for adding tenant accounts that are part of the organization. This requires deploying the Cisco Cloud Network Controller in the master account of the organization.
- Untrusted tenants use the account access and secret keys. The access and secret keys being used must be for an IAM user having these permissions at a minimum. The IAM role created must be named `ApicTenantRole`.



**Note** Cisco Cloud Network Controller does not disturb AWS resources created by other applications or users. It only manages the AWS resources created by itself.

```
{
  "Version": "2012-10-17",
  "Statement": [
    {
      "Action": [
        "ec2:*"
      ],
      "Resource": "*",
      "Effect": "Allow"
    }, {
      "Action": [
        "s3:*"
      ],
      "Resource": "*",
      "Effect": "Allow"
    }, {
      "Action": [
        "events:*"
      ],
      "Resource": "*",
      "Effect": "Allow"
    }, {
      "Action": [
        "logs:*"
      ],
      "Resource": "*",
      "Effect": "Allow"
    }, {
      "Action": [
        "cloudtrail:*"
      ],
      "Resource": "*",
      "Effect": "Allow"
    }, {
      "Action": [
        "cloudwatch:*"
      ],
      "Resource": "*",
      "Effect": "Allow"
    }, {
```



```

        "Action": [
            "resource-groups:*"
        ],
        "Resource": "*",
        "Effect": "Allow"
    }, {
        "Action": [
            "sqs:*"
        ],
        "Resource": "*",
        "Effect": "Allow"
    }, {
        "Action": "elasticloadbalancing:*",
        "Resource": "*",
        "Effect": "Allow"
    }, {
        "Action": [
            "config:*"
        ],
        "Resource": "*",
        "Effect": "Allow"
    }, {
        "Action": "iam:PassRole",
        "Resource": "arn:aws:iam::<account-id>:role/ApicTenantRole",
        "Effect": "Allow"
    }
}
]
}

```

- Add trust relationship:

```

{
  "Version": "2012-10-17",
  "Statement": [
    {
      "Effect": "Allow",
      "Principal": {
        "Service": "vpc-flow-logs.amazonaws.com",
        "AWS": "arn:aws:iam::<infra-account-id>:root"
      },
      "Action": "sts:AssumeRole"
    }
  ]
}

```

- The Cisco Cloud Network Controller uses the OrganizationAccountAccessRole IAM role to manage policies for AWS Organization tenants.
  - If you created an AWS account within the existing organization in the master account, the OrganizationAccountAccessRole IAM role is automatically assigned to that created AWS account. You do not have to manually configure the OrganizationAccountAccessRole IAM role in AWS in this case.
  - If the master account invited an existing AWS account to join the organization, then you must manually configure the OrganizationAccountAccessRole IAM role in AWS. Configure the OrganizationAccountAccessRole IAM role in AWS for the organization tenant and verify that it has Cisco Cloud Network Controller-related permissions available.

The OrganizationAccountAccessRole IAM role, together with the SCP (Service Control Policy) used for the organization or the account, must have the minimum permissions that are required by the Cisco Cloud Network Controller to manage policies for the tenants. The access policy requirement is the same as the requirement for the trusted or untrusted tenants.

```

{
  "Version": "2012-10-17",
  "Statement": [
    {
      "Action": [
        "ec2:*"
      ],
      "Resource": "*",
      "Effect": "Allow"
    }, {
      "Action": [
        "s3:*"
      ],
      "Resource": "*",
      "Effect": "Allow"
    }, {
      "Action": [
        "events:*"
      ],
      "Resource": "*",
      "Effect": "Allow"
    }, {
      "Action": [
        "logs:*"
      ],
      "Resource": "*",
      "Effect": "Allow"
    }, {
      "Action": [
        "cloudtrail:*"
      ],
      "Resource": "*",
      "Effect": "Allow"
    }, {
      "Action": [
        "cloudwatch:*"
      ],
      "Resource": "*",
      "Effect": "Allow"
    }, {
      "Action": [
        "resource-groups:*"
      ],
      "Resource": "*",
      "Effect": "Allow"
    }, {
      "Action": [
        "sqs:*"
      ],
      "Resource": "*",
      "Effect": "Allow"
    }, {
      "Action": "elasticloadbalancing:*",
      "Resource": "*",
      "Effect": "Allow"
    }, {
      "Action": [
        "config:*"
      ],
      "Resource": "*",
      "Effect": "Allow"
    }, {
      "Action": "iam:PassRole",
      "Resource": "*"
    }
  ]
}

```

```

        "Effect": "Allow"
    }
]
}

```

To add a trust relationship for an Organization tenant:

```

{
  "Version": "2012-10-17",
  "Statement": [
    {
      "Effect": "Allow",
      "Principal": {
        "Service": "vpc-flow-logs.amazonaws.com",
        "AWS": "arn:aws:iam::<infra-account-id>:root"
      },
      "Action": "sts:AssumeRole"
    }
  ]
}

```

- Cisco Cloud Network Controller enforces ownership checks to prevent deployment of policies in the same tenant-region combination done either intentionally or by mistake. For example, assume that Cisco Cloud Network Controller is deployed in AWS account IA1 in region R1. Now you want to deploy a tenant TA1 in region R2. This tenant deployment i.e. account-region combination TA1-R2 is now owned by IA1-R1. If another Cisco Cloud Network Controller attempts to manage the same tenant-region combination later (say CNC2 in AWS account IA2 deployed in region R3), this will not be allowed because the current owner for the deployment TA1-R2 is IA1-R1. In other words, only one account in one region can be managed by one Cisco Cloud Network Controller. Example below shows some valid and wrong deployment combinations.

```

CNC1:
IA1-R1: TA1-R1 - ok
        TA1-R2 - ok

CNC2:
IA1-R2: TA1-R1 - not allowed
        TA1-R3 - ok

CNC3:
IA2-R1: TA1-R1 - not allowed
        TA1-R4 - ok
        TA2-R4 - ok

```

- Ownership enforcement is done using AWS Resource Groups. When a new tenant in account TA1 in region R2 is managed by Cisco Cloud Network Controller, a Resource Group CNC\_TA1\_R2 (e.g. CNC\_123456789012\_us-east-2) is created in the tenant account. This Resource Group has a resource tag AciOwnerTag with value IA1\_R1\_TA1\_R2, assuming it was managed by Cisco Cloud Network Controller in account IA1 and deployed in region R1. If the AciOwnerTag mismatch happens, tenant-region management is aborted.

Here is a summary of AciOwnerTag mismatch cases:

- Initially Cisco Cloud Network Controller is installed in an account, and then taken down and Cisco Cloud Network Controller is installed in a different account. All existing tenant-region deployment will fail.
- Another Cisco Cloud Network Controller is managing the same tenant-region.

In ownership mismatch cases, **retry** (to setup tenant-region again) is not currently supported. As a workaround, if you are certain that no other Cisco Cloud Network Controller is managing the same tenant-region combination, logon to the tenant's AWS account and manually remove the affected Resource Group (e.g. CAPIC\_123456789012\_us-east-2). Next, reload Cisco Cloud Network Controller or delete and add the tenant again.

---

**Step 1** In the Cisco Cloud Network Controller, configure the AWS Provider.

- a) On the **Intent** menu, choose **Tenants** > *tenant\_name* from the drop-down.
- b) In the **Intent** pane, choose **Application Management** > *tenant\_name* .

**Step 2** Perform the following actions:

- a) In the **AWS Account ID** field, provide the cloud account ID.
- b) In the **Access Type** area, choose **Trusted**.

The AWS account must be a Trusted account for the user tenant that is using the cloud.

- c) Click **Save**.
- d) Bring up the new trusted tenant again by clicking on the tenant name in the **Tenants** page.

In the **AWS Account** area in the tenant **Overview** page, you will see the following message: "In order to deploy any configuration from this tenant, you must create a trusted role in the tenant AWS account which will establish trust with the AWS infra account. To do so, open the link below to run the CloudFormation template."

- e) Click the **Run the CloudFormation** template link.

This returns you to the AWS sign in page, which should be pre-populated with the necessary AWS account information that you entered earlier in these procedures in the Cisco Cloud Network Controller GUI.

- f) Click **Next** in the AWS sign in page after verifying that the sign-in information is correct.
- g) Run the tenant role cloud-formation template in the tenant account.

**Note** Alternatively, keep the trusted flag unchecked and provide the access and secret keys as done normally for any tenant.

**Step 3** Click **Save**.

---

## Creating an Application Profile Using the Cisco Cloud Network Controller GUI

This section explains how to create an application profile using the Cisco Cloud Network Controller GUI.

### Before you begin

Create a tenant.

---

**Step 1** Click the **Intent** icon. The **Intent** menu appears.

**Step 2** Click the drop-down arrow below the **Intent** search box and choose **Application Management**.

A list of **Application Management** options appear in the **Intent** menu.

- Step 3** From the **Application Management** list in the **Intent** menu, click **Create Application Profile**. The **Create Application Profile** dialog box appears.
- Step 4** Enter a name in the **Name** field.
- Step 5** Choose a tenant:
- Click **Select Tenant**.  
The **Select Tenant** dialog box appears.
  - From the **Select Tenant** dialog, click to choose a tenant in the left column then click **Select**.  
You return to the **Create Application Profile** dialog box.
- Step 6** Enter a description in the **Description** field.
- Step 7** Click **Save** when finished.

## Creating a VRF Using the Cisco Cloud Network Controller GUI

This section explains how to create a VRF using the Cisco Cloud Network Controller GUI.

### Before you begin

Create a tenant.

- Step 1** Click the **Intent** icon. The **Intent** menu appears.
- Step 2** Click the drop-down arrow below the **Intent** search box and choose **Application Management**.  
A list of **Application Management** options appear in the **Intent** menu.
- Step 3** From the **Application Management** list in the **Intent** menu, click **Create VRF**. The **Create VRF** dialog box appears.
- Step 4** Enter the appropriate values in each field as listed in the following *Create VRF Dialog Box Fields* table then continue.

**Table 5: Create VRF Dialog Box Fields**

Properties	Description
<b>General</b>	
<b>Name</b>	<p>Enter a name for the VRF in the <b>Name</b> field.</p> <p>All VRFs are assigned a <i>vrfEncoded</i> value. If the Tenant and VRF name combination has more than 32 characters, then, a VRF name (which also contains the tenant name) is identified in the cloud router using the <i>vrfEncoded</i> value. To see the <i>vrfEncoded</i> value, navigate to <b>Application Management &gt; VRFs</b> subtab. Click a VRF on the right hand pane and look for <i>Encoded VRF Name in Cloud Router</i>.</p>

Properties	Description
<b>Tenant</b>	To choose a tenant: <ol style="list-style-type: none"> <li>a. Click <b>Select Tenant</b>. The <b>Select Tenant</b> dialog box appears.</li> <li>b. From the <b>Select Tenant</b> dialog, click to choose a tenant in the left column then click <b>Select</b>. You return to the <b>Create VRF</b> dialog box.</li> </ol>
<b>Description</b>	Enter a description of the VRF.
<b>Settings &gt; IPv4 unicast address family BGP targets</b>	
<b>Add Filter</b>	<ol style="list-style-type: none"> <li>a. Click the <b>Add Route Target</b> option for the unicast address family BGP target you want to configure.</li> <li>b. Click to choose the following options for the <b>Type</b> field:               <ul style="list-style-type: none"> <li>• <b>Export</b>—The route target can be exported to other VRFs</li> <li>• <b>Import</b>—The route target is imported from other VRFs</li> <li>• Enter the route target that can be exported from the current VRF or imported into the current VRF in the <b>Route Target</b> text box.</li> </ul> </li> </ol>

**Step 5** When finished, click **Save**.

## Creating an External Network Using the Cisco Cloud Network Controller GUI

This procedure describes how to create an external network. You can have a single external network that can connect to multiple routers on the on-premises site, or you can have multiple external networks with multiple VRFs that you can use to connect to CCRs.

### Before you begin

You must have a hub network created before you can create an external network.

- Step 1** In the left navigation bar, navigate to **Application Management > External Networks**. The configured external networks are displayed.
- Step 2** Click **Actions**, then choose **Create External Network**. The **Create External Network** window appears.
- Step 3** Enter the appropriate values in each field as listed in the following *Create External Network Dialog Box Fields* table then continue.

Table 6: Create External Network Dialog Box Fields

Properties	Description
<b>General</b>	
<b>Name</b>	Enter the name for the external network.
<b>VRF</b>	<p>This external VRF will be used for external connectivity with external non-ACI devices. You can create multiple external VRFs for this purpose.</p> <p>This VRF will be identified as an external VRF if the VRF has all three of the following characteristics:</p> <ul style="list-style-type: none"> <li>• Configured under the infra tenant</li> <li>• Associated with an external network</li> <li>• Not associated with a cloud context profile</li> </ul> <p>Any VRF that is associated with an external network becomes an external VRF. The external VRF is not allowed to be associated with a cloud context profile or subnet.</p> <p>To choose an external VRF:</p> <ol style="list-style-type: none"> <li>a. Click <b>Select VRF</b>. The <b>Select VRF</b> dialog box appears.</li> <li>b. From the <b>Select VRF</b> dialog, click to choose a VRF in the left column. You can also create a VRF using the + <b>Create VRF</b> option.</li> <li>c. Click <b>Select</b>. You return to the <b>Create External Network</b> dialog box.</li> </ol>
<b>Router Type</b>	<p>Choose the router type:</p> <ul style="list-style-type: none"> <li>• <b>CCR</b>: <ul style="list-style-type: none"> <li>• Cisco Catalyst 8000V</li> </ul> </li> <li>• <b>TGW</b>: An AWS transit gateway router</li> </ul>
<b>Host Router Name</b>	<p>This field appears if you select <b>CCR</b> as the <b>Router Type</b>.</p> <p>This field is not editable. The default host router is automatically selected.</p>
<b>Hub Network</b>	<p>This field appears if you select <b>TGW</b> as the <b>Router Type</b>.</p> <p>To choose a hub network:</p> <ol style="list-style-type: none"> <li>a. Click <b>Select Hub Network</b>. The <b>Select Hub Network</b> dialog box appears.</li> <li>b. In the <b>Select Hub Network</b> dialog box, click the desired hub network from the list and then click <b>Select</b>. You are returned to the <b>Create External Network</b> page.</li> </ol>

Properties	Description
<b>Settings</b>	
<b>Regions</b>	<p>To choose a region:</p> <ol style="list-style-type: none"><li data-bbox="380 394 1487 520"><b>a.</b> Click <b>Add Regions</b>. The <b>Select Regions</b> dialog box appears. The regions that you selected as part of the First Time Setup are displayed here.</li><li data-bbox="380 541 1487 621"><b>b.</b> From the <b>Select Regions</b> dialog, click to choose a region in the left column then click <b>Select</b>. You return to the <b>Create External Network</b> dialog box.</li></ol>



Properties	Description
VPN Networks	

Properties	Description
	<p>The VPN networks entries are used for external connectivity. All configured VPN networks will be applied to all the selected regions.</p> <p>To add a VPN network:</p> <ol style="list-style-type: none"> <li>a. Click <b>Add VPN Network</b>. The <b>Add VPN Network</b> dialog box appears.</li> <li>b. In the <b>Name</b> field, enter a name for the VPN network.</li> <li>c. Click <b>+ Add IPsec Peer</b>. The <b>Add IPsec Tunnel Destination</b> window appears.</li> <li>d. Enter values for the following fields for the IPsec tunnel destination that you want to add: <ul style="list-style-type: none"> <li>• <b>Public IP of IPsec Tunnel Peer</b></li> <li>• <b>Pre-Shared Key</b></li> <li>• <b>IKE Version</b>: Select <b>ikev1</b> or <b>ikev2</b> for IPsec tunnel connectivity</li> <li>• <b>BGP Peer ASN</b></li> <li>• <b>Subnet Pool Name</b>: Click <b>Select Subnet Pool Name</b>. The <b>Select Subnet Pool Name</b> dialog box appears. Select one of the available subnet pools that are listed, then click <b>Select</b>.</li> </ul> <p><b>Note</b> Additional IPsec tunnel subnet pools can be added in the <b>External Networks</b> page, or through the Cloud Network Controller First Time Set Up, if necessary. For more information on adding additional subnet pools through the Cloud Network Controller First Time Set Up, see the chapter "Configuring Cisco Cloud Network Controller Using the Setup Wizard" in the <i>Cisco Cloud Network Controller for AWS Installation Guide</i>, Release 25.0(5). The subnet pool size should be large enough to accommodate the number of IPsec tunnels that will get created.</p> <ul style="list-style-type: none"> <li>• <b>IPsec Tunnel Source Interfaces</b>: Using the entries in this field, the Cisco Cloud Network Controller creates one IPsec tunnel from each selected source interface to the destination IP address.</li> </ul> <p><b>Note</b> <b>ikev2</b> is the default option in this field. The IPsec tunnel source interfaces feature is supported only with the IKEv2 configuration.</p> <p><b>gig3</b> is selected by default. Choose one or more from the following interfaces:</p> <ul style="list-style-type: none"> <li>• <b>gig2</b>: The GigabitEthernet2 interface</li> <li>• <b>gig3</b>: The GigabitEthernet3 interface</li> <li>• <b>gig4</b>: The GigabitEthernet4 interface</li> </ul> <p><b>Note</b> After you have configured the IPsec tunnel source interfaces in this external network, you can then configure IPsec tunnel source interfaces in additional networks where tunnels to the same destination can be formed, as described in <a href="#">Routing Policies: Release 25.0(2), on page 7</a>.</p> </li> </ol>

Properties	Description
	<p>e. Click <b>Add</b> to add this IPsec tunnel destination.</p> <p>You return to the <b>Add VPN Network</b> window.</p> <p>Click + <b>Add IPsec Peer</b> if you want to add another IPsec tunnel destination.</p> <p>f. Click <b>Add</b> in the <b>Add VPN Network</b> dialog box.</p> <p>You return to the <b>Create External Network</b> dialog box.</p>

- Step 4** When you have finished creating the external network, click **Save**.  
After you click **Save** in the **Create External Network** window, cloud routers are then configured in AWS.

## Configuring the Global Inter-VRF Route Leak Policy

The global inter-VRF route leak policy feature is introduced in release 25.0(2).

### Before you begin

Review the information provided in [Global Inter-VRF Route Leak Policy, on page 8](#) before making any changes in the **Contract Based Routing** area in the **Cisco Cloud Network Controller Setup** window.

- Step 1** Click the **Intent** icon. The **Intent** menu appears.

- Step 2** Click the drop-down arrow below the **Intent** search box and choose **Configuration**.

A list of options appear in the **Intent** menu.

- Step 3** From the **Configuration** list in the **Intent** menu, click **Cisco Cloud Network Controller Setup**.  
The **Set up - Overview** dialog box appears.

- Step 4** In the **Contract Based Routing** area, note the current setting for the **Contract Based Routing** field.

The **Contract Based Routing** setting reflects the current internal VRF route leak policy, which is a global policy under the infra tenant where a Boolean flag is used to indicate whether contracts can drive routes in the absence of route maps:

- **Off**: Default setting. Indicates that routes are not leaked based on contracts, and are leaked based on route maps instead.
- **On**: Indicates that routes are leaked based on contracts in the absence of route maps. When enabled, contracts drive routing when route maps are not configured. When route maps exist, route maps always drives routing.

- Step 5** Determine if you want to change the current setting for the **Contract Based Routing** field.

Follow these procedures if you toggle from one setting to another:

- **Toggle from On setting to Off (disabling contract-based routing)**: In this situation, the assumption is that you have contract-based routing configured currently and you want to toggle over to route map-based routing. This can be disruptive if the route map-based routing is not configured before you toggle from contract-based routing to route map-based routing.

Before toggling from the **On** setting to the **Off** setting in this situation, make the following changes:

- a. Between all pairs of VRFs that have existing contracts, enable route map-based route leaking.

Follow the procedures provided in [Configuring Leak Routes Using the Cisco Cloud Network Controller GUI, on page 58](#).

- b. Disable the contract-based route policy in the global policy.

Toggle the switch in the **Contract Based Routing** field from the **On** setting to the **Off** setting to toggle from contract-based routing to route map-based routing.

- c. Change the routing to reflect any granularity that is required based on the new route map-based routing that you enabled.

- **Toggling from Off setting to On (enabling contract-based routing):** In this situation, the assumption is that you have route map-based routing configured currently and you want to toggle over to contract-based routing. This is not a disruptive operation, but rather is an additive operation, since both contracts and route maps can be enabled between a pair of VRFs. In that situation, route maps take precedence over contracts when enabling routing. With route map-based routing enabled, adding contract-based routing should be non-disruptive.

For that reason, you do not have to make any changes before toggling from the **Off** setting to the **On** setting in this situation. However, if you do not want to have both contracts and route maps enabled between a pair of VRFs, and you want to move completely to contract-based routing, you should completely set up contracts between the VRFs and delete the route maps between the VRFs before toggling to the **On** setting in the **Contract Based Routing** field.

**Step 6** If you want to change the current setting for the **Contract Based Routing** area, toggle the setting based on the type of routing that you want.

**Step 7** Click **Done** when you have finished the **Cisco Cloud Network Controller Setup** configurations.

## Configuring Leak Routes Using the Cisco Cloud Network Controller GUI

The procedures for configuring leak routes using the Cisco Cloud Network Controller GUI will vary slightly, depending on the release:

- For releases prior to 25.0(2), you can configure an independent routing policy to specify which routes to leak between internal and external VRFs when you are setting up routing between an ACI cloud site and an external destination using the external connectivity feature. See [Configuring Inter-VRF Route Leaking Using the Cisco Cloud Network Controller GUI, on page 58](#) for those procedures.
- For releases 25.0(2) and later, support is available for route maps-based route leaking between a pair of internal VRFs. See [Configuring Leak Routes for Internal VRFs Using the Cisco Cloud Network Controller GUI, on page 61](#) for those procedures.

## Configuring Inter-VRF Route Leaking Using the Cisco Cloud Network Controller GUI

Configuring leak routes is part of the release 25.0(1) update where routing and security policies are configured separately. Using inter-VRF routing, you can configure an independent routing policy to specify which routes to leak between internal and external VRFs when you are setting up routing between an ACI cloud site and an external destination using the external connectivity feature. See [Understanding Supported Routing and Security Policies, on page 5](#) for more information.

The external destination must be configured manually using the [Enabling Connectivity From the AWS Site to External Devices, on page 63](#) procedures. The external destination could be another cloud site, an ACI on-premises site or a branch office.

**Note**

- Use these procedures to configure routing policies independent of security policies only between internal and external VRFs, based on updates provided in release 25.0(1).
- Do not use these procedures to configure routing between a pair of internal VRFs; use contracts as you normally would prior to release 25.0(1) in that case.

- Step 1** In the left navigation bar, navigate to **Application Management > VRFs**.  
The configured VRFs are displayed.
- Step 2** Click the **Leak Routes** tab.  
Any already-configured leak routes are displayed.
- Step 3** Click **Actions**, then choose **Create Leak Route**.  
The **Create Leak Route** window appears.
- Step 4** Enter the appropriate values in each field as listed in the following *Create Leak Routes Dialog Box Fields* table then continue.

**Table 7: Create Leak Routes Dialog Box Fields**

Properties	Description
<b>Source VRF</b>	<p>To choose a source VRF:</p> <ol style="list-style-type: none"> <li>Click <b>Select a Source VRF</b>. The <b>Select a VRF</b> dialog box appears.</li> <li>From the <b>Select a VRF</b> dialog, click to choose a VRF in the left column to use for the source VRF. Note that the source VRF can be an internal or an external VRF.</li> <li>Click <b>Select</b> to select this source VRF. You return to the <b>Create Leak Route</b> dialog box.</li> </ol>
<b>Destination VRF</b>	<p>To choose a destination VRF:</p> <ol style="list-style-type: none"> <li>Click <b>Select a Destination VRF</b>. The <b>Select a VRF</b> dialog box appears.</li> <li>From the <b>Select a VRF</b> dialog, click to choose a VRF in the left column to use for the destination VRF. Note that the destination VRF cannot be an internal VRF if the source VRF is also internal VRF.</li> <li>Click <b>Select</b> to select this destination VRF. You return to the <b>Create Leak Route</b> dialog box.</li> </ol>

Properties	Description
Type	<p>Choose the type of leaked route that you want to configure:</p> <ul style="list-style-type: none"> <li>• <b>Leak All:</b> Select to configure all routes to leak from the source VRF to the destination VRF. The entry <code>0.0.0.0/0</code> is entered automatically in the subnet IP area by default in this case.</li> <li>• <b>Subnet IP:</b> Select to configure a specific subnet IP address as the route to leak from the source VRF to the destination VRF. The <b>Subnet IP</b> box appears. In the <b>Subnet IP</b> box, enter a subnet IP address as the route to leak between VRFs.</li> </ul>

**Step 5** When finished, click **Save**.  
The **Success** window appears.

**Step 6** Determine if you want to configure additional inter-VRF route leaking.

- If you want to add another route to leak between a pair of VRFs, click the **Add Another Leak Route** option in the **Success** window.

You are returned to the **Add Leak Route** window. Repeat [Step 4, on page 59](#) through [Step 5, on page 60](#) to configure another route to leak between a pair of VRFs.

- If you want to add a reverse route, where:

- The destination VRF from the previous configuration now becomes the source VRF, and
- The source VRF from the previous configuration now becomes the destination VRF

Then click the **Add Reverse Leak Route** option in the **Success** window.

You are returned to the **Add Leak Route** window. Repeat [Step 4, on page 59](#) through [Step 5, on page 60](#) to configure another route, but this time:

- In the **Source VRF** field, select the VRF that you had selected as a destination VRF in the previous configuration.
- In the **Destination VRF** field, select the VRF that you had selected as a source VRF in the previous configuration.

**Step 7** When you have finished configuring leak routes, click **Done**.

The **Leak Routes** tab in the main **VRFs** page is displayed again, with the newly configured leak route displayed.

**Step 8** To get more information on a source or destination VRF, or to make changes to a configured leak route, double-click the VRF in the **Leak Routes** tab in the main **VRFs** page.  
The **Overview** page for that VRF is displayed.

**Step 9** Click the **Application Management** tab at the top of the VRF page, then click the **Leak Routes** tab in the left nav bar. The leak routes associated with this particular VRF are displayed.

**Step 10** Configure additional leak routes associated with this VRF, if necessary.

- To add a leak route from this VRF, click **Actions**, then choose **Add Leak Route from <VRF\_name>**.

The **Add Leak Route** window appears. Enter the necessary information as you did previously using the information in [Step 4, on page 59](#). Note that the entry in the **Source VRF** is pre-selected and cannot be changed in this situation.

- To add a leak route to this VRF, click **Actions**, then choose **Add Leak Route to <VRF\_name>**.

The **Add Leak Route** window appears. Enter the necessary information as you did previously using the information in [Step 4, on page 59](#). Note that the entry in the **Destination VRF** is pre-selected and cannot be changed in this situation.

### What to do next

You have now configured the routing policy. Since the routing and security policies are separate, you now need to configure the security policy separately:

- [Creating an EPG Using the Cisco Cloud Network Controller GUI, on page 67](#): Use these procedures to create an external EPG.
- [Creating a Contract Using the Cisco Cloud Network Controller GUI, on page 72](#): Use these procedures to create a contract between the external EPG and the cloud EPG.

## Configuring Leak Routes for Internal VRFs Using the Cisco Cloud Network Controller GUI

Beginning with release 25.0(2), support is available for route maps-based route leaking between a pair of internal VRFs, as described in [Route Leaking Between Internal VRFs, on page 7](#). This feature is an extension of the routing and security split update provided in release 25.0(1), where routing and security policies are configured separately.

- Step 1** In the left navigation bar, navigate to **Application Management > VRFs**.  
The configured VRFs are displayed.
- Step 2** Click the **Leak Routes** tab.  
Any already-configured leak routes are displayed.
- Step 3** Click **Actions**, then choose **Create Leak Route**.  
The **Create Leak Route** window appears.
- Step 4** Enter the appropriate values in each field as listed in the following *Create Leak Routes Dialog Box Fields* table then continue.

**Table 8: Create Leak Routes Dialog Box Fields**

Properties	Description
Source VRF	<p>To choose a source VRF:</p> <ol style="list-style-type: none"> <li>Click <b>Select a Source VRF</b>. The <b>Select a VRF</b> dialog box appears.</li> <li>From the <b>Select a VRF</b> dialog, click to choose a VRF in the left column to use for the source VRF. Because this procedure is for route maps-based route leaking between a pair of internal VRFs, choose an internal VRF for the source VRF.</li> <li>Click <b>Select</b> to select this source VRF. You return to the <b>Create Leak Route</b> dialog box.</li> </ol>

Properties	Description
<b>Destination VRF</b>	<p>To choose a destination VRF:</p> <ol style="list-style-type: none"> <li>Click <b>Select a Destination VRF</b>. The <b>Select a VRF</b> dialog box appears.</li> <li>From the <b>Select a VRF</b> dialog, click to choose a VRF in the left column to use for the destination VRF. Because this procedure is for route maps-based route leaking between a pair of internal VRFs, choose an internal VRF for the destination VRF.</li> <li>Click <b>Select</b> to select this destination VRF. You return to the <b>Create Leak Route</b> dialog box.</li> </ol>
<b>Type</b>	<p>Choose the type of leaked route that you want to configure:</p> <ul style="list-style-type: none"> <li><b>Leak All:</b> Select to configure all routes to leak from the source VRF to the destination VRF. The entry <code>0.0.0.0/0</code> is entered automatically in the subnet IP area by default in this case.</li> <li><b>Subnet IP:</b> Select to configure a specific subnet IP address as the route to leak from the source VRF to the destination VRF. The <b>Subnet IP</b> box appears. In the <b>Subnet IP</b> box, enter a subnet IP address as the route to leak between VRFs.</li> </ul>

**Step 5** When finished, click **Save**.

The **Success** window appears.

**Step 6** Determine if you want to configure additional inter-VRF route leaking.

- If you want to add another route to leak between a pair of VRFs, click the **Add Another Leak Route** option in the **Success** window.

You are returned to the **Add Leak Route** window. Repeat [Step 4, on page 61](#) through [Step 5, on page 62](#) to configure another route to leak between a pair of VRFs.

- If you want to add a reverse route, where:
  - The destination VRF from the previous configuration now becomes the source VRF, and
  - The source VRF from the previous configuration now becomes the destination VRF

Then click the **Add Reverse Leak Route** option in the **Success** window.

You are returned to the **Add Leak Route** window. Repeat [Step 4, on page 61](#) through [Step 5, on page 62](#) to configure another route, but this time:

- In the **Source VRF** field, select the VRF that you had selected as a destination VRF in the previous configuration.
- In the **Destination VRF** field, select the VRF that you had selected as a source VRF in the previous configuration.

**Step 7** When you have finished configuring leak routes, click **Done**.



The **Leak Routes** tab in the main **VRFs** page is displayed again, with the newly configured leak route displayed.

- Step 8** To get more information on a source or destination VRF, or to make changes to a configured leak route, double-click the VRF in the **Leak Routes** tab in the main **VRFs** page. The **Overview** page for that VRF is displayed.
- Step 9** Click the **Application Management** tab at the top of the VRF page, then click the **Leak Routes** tab in the left nav bar. The leak routes associated with this particular VRF are displayed.
- Step 10** Configure additional leak routes associated with this VRF, if necessary.
- To add a leak route from this VRF, click **Actions**, then choose **Add Leak Route from <VRF\_name>**.  
The **Add Leak Route** window appears. Enter the necessary information as you did previously using the information in [Step 4, on page 61](#). Note that the entry in the **Source VRF** is pre-selected and cannot be changed in this situation.
  - To add a leak route to this VRF, click **Actions**, then choose **Add Leak Route to <VRF\_name>**.  
The **Add Leak Route** window appears. Enter the necessary information as you did previously using the information in [Step 4, on page 61](#). Note that the entry in the **Destination VRF** is pre-selected and cannot be changed in this situation.

---

## Enabling Connectivity From the AWS Site to External Devices

Follow these procedures to manually enable IPv4 connectivity from the infra VPC CCRs to any external device with IPsec/BGP.

### Downloading the External Device Configuration Files

- Step 1** In the Cisco Cloud Network Controller GUI, click on **Dashboard**. The **Dashboard** view for the Cisco Cloud Network Controller appears.
- Step 2** Navigate to **Infrastructure > External Connectivity**. The **External Connectivity** window appears.
- Step 3** Click **Actions > Download External Device Configuration Files**. The **Download External Device Configuration Files** pop-up appears.
- Step 4** Select the external device configuration files to download and click **Download**. This action downloads a zip file that contains configuration information that you will use to manually configure the external device for IPv4 connectivity to the CCRs.

---

### Enabling Connectivity From the AWS Site to External Devices

- Step 1** Gather the necessary information that you will need to manually enable IPv4 connectivity from the infra VPC CCRs to any external device without EVPN.
- Step 2** Log into the external device.
- Step 3** Enter the configuration information to connect an external networking device.

If you downloaded the external device configuration files using the instructions in [Downloading the External Device Configuration Files, on page 63](#), locate the configuration information for the first tunnel and enter that configuration information.

Following is an example of what the external device configuration file might look like for the first tunnel:

```
! The following file contains configuration recommendation to connect an external networking device
with the cloud ACI Fabric
! The configurations here are provided for an IOS-XE based device. The user is expected to understand
the configs and make any necessary amends before using them
! on the external device. Cisco does not assume any responsibility for the correctness of the config.

! Tunnel to 128.107.72.122 1.100 [ikev2] for
hctunnIf.acct-[infra]/region-[westus]/context-[overlay-1]-addr-[10.115.9.128/25]/csr-[ct_routerp_westus_0:0]/tunn-34
! USER-DEFINED: please define gig-gateway: GIG-GATEWAY
! USER-DEFINED: please define GigabitEthernet2 if required
! USER-DEFINED: please define tunnel-id: 100 if required
! USER-DEFINED: please define vrf-name: infra:externalvrf1 if required
! USER-DEFINED: please define gig3-public-ip: 13.88.168.176 if 0.0.0.0 ip still not provided by AWS.
! Device:          128.107.72.122
! Tunnel ID:       100
! Tunnel counter:  1
! Tunnel address:  5.16.1.9
! Tunnel Dn:
acct-[infra]/region-[westus]/context-[overlay-1]-addr-[10.115.9.128/25]/csr-[ct_routerp_westus_0:0]/tunn-34
! VRF name:        infra:externalvrf1
! ikev:            ikev2
! Bgp Peer addr:   5.16.1.10
! Bgp Peer asn:    65015
! Gig3 Public ip:  13.88.168.176
! PreShared key:   devicelazure
! ikev profile name: ikev2-100

vrf definition infra:externalvrf1
  rd 1:1

  address-family ipv4
    route-target export 64550:1
    route-target import 64550:1
  exit-address-family
exit

crypto ikev2 proposal ikev2-infra:externalvrf1
  encryption aes-cbc-256 aes-cbc-192 aes-cbc-128
  integrity sha512 sha384 sha256 sha1
  group 24 21 20 19 16 15 14 2
exit

crypto ikev2 policy ikev2-infra:externalvrf1
  proposal ikev2-infra:externalvrf1
exit

crypto ikev2 keyring keyring-ikev2-100
  peer peer-ikev2-keyring
  address 13.88.168.176
  pre-shared-key devicelazure
  exit
exit

crypto ikev2 profile ikev2-100
  match address local interface GigabitEthernet2
  match identity remote address 13.88.168.176 255.255.255.255
  identity local address 128.107.72.122
```

```
authentication remote pre-share
authentication local pre-share
keyring local keyring-ikev2-100
lifetime 3600
dpd 10 5 on-demand
exit

crypto ipsec transform-set ikev2-100 esp-gcm 256
mode tunnel
exit

crypto ipsec profile ikev2-100
set transform-set ikev2-100
set pfs group14
set ikev2-profile ikev2-100
exit

interface Tunnel100
vrf forwarding infra:externalvrf1
ip address 5.16.1.10 255.255.255.252
ip mtu 1400
ip tcp adjust-mss 1400
tunnel source GigabitEthernet2
tunnel mode ipsec ipv4
tunnel destination 13.88.168.176
tunnel protection ipsec profile ikev2-100
exit

ip route 13.88.168.176 255.255.255.255 GigabitEthernet2 GIG-GATEWAY

router bgp 65015

address-family ipv4 vrf infra:externalvrf1
redistribute connected
maximum-paths eibgp 32

neighbor 5.16.1.9 remote-as 65008
neighbor 5.16.1.9 ebgp-multihop 255
neighbor 5.16.1.9 activate
neighbor 5.16.1.9 send-community both

distance bgp 20 200 20
exit-address-family
```

The following figures provide more information on what each set of fields is used for in the external device configuration file:

- The fields shown in the following figure are used to configure these areas:
  - VRF definition
  - IPSec global configurations

```

vrf definition Ext-V1
rd 1:10
!
address-family ipv4
  route-target export 64550:10
  route-target import 64550:10
!
crypto isakmp policy 10
encryption aes
authentication pre-share
group 2
lifetime 28800
!
crypto isakmp keepalive 10 10 periodic
crypto isakmp aggressive-mode disable
!

```

VRF Definition

IPSec Global Configurations

- The fields shown in the following figure are used to configure these areas:

- IPSec and ikev1 per tunnel configurations
- BGP configurations for the VRF neighbor

```

!
crypto keyring Ext-V1-1000-ike
  pre-shared-key address <50.18.55.126>[cAPIC CSR Gig3 Public IP] key <abodef12345>
!
crypto isakmp profile Ext-V1-1000-ike
  keyring Ext-V1-1000-ike
  match identity address <50.18.55.126>[cAPIC CSR1 gig3 Public IP] 255.255.255.255
!
crypto ipsec transform-set Ext-V1-1000-ike esp-aes esp-sha-hmac
mode tunnel
!
crypto ipsec profile Ext-V1-1000-ike
set security-association lifetime kilobytes disable
set security-association replay window-size 512
set transform-set Ext-V1-1000-ike
set pfs group14
!
interface Tunnel1000
vrf forwarding Ext-V1
ip address 50.50.0.2[cAPIC CSR BGP Peer Addr] 255.255.255.252
ip mtu 1400
ip tcp adjust-mss 1400
tunnel source GigabitEthernet2
tunnel mode ipsec ipv4
tunnel destination <50.18.55.126>[cAPIC CSR1 gig3 Public IP]
tunnel protection ipsec profile Ext-V1-1000-ike
!
router bgp 64550
!
address-family ipv4 vrf Ext-V1
  redistribute connected
  neighbor <50.50.0.1>[cAPIC CSR1 Tunnel Inner IP Addr] remote-as 1234
  neighbor 50.50.0.1 ebgp-multihop 255
  neighbor 50.50.0.1 activate
  neighbor 50.50.0.1 send-community both
  neighbor <50.50.0.5>[cAPIC CSR1 Tunnel Inner IP Addr] remote-as 1234
  neighbor 50.50.0.5 ebgp-multihop 255
  neighbor 50.50.0.5 activate
  neighbor 50.50.0.5 send-community both
  distance bgp 20 200 20
!
ip route 50.18.55.126[cAPIC CSR1 gig3 Public IP] 255.255.255.255 GigabitEthernet2 10.10.0.103
!

```

IPSec and Ikev1 Per Tunnel Configurations

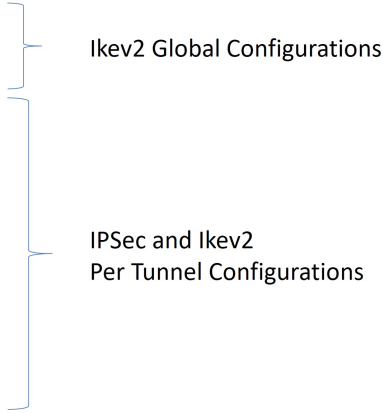
BGP Configurations for VRF Neighbor

- The fields shown in the following figure are used to configure these areas:

- Ikev2 global configurations
- IPSec and ikev2 per tunnel configurations

```

crypto ikev2 proposal ikev2-1
  encryption aes-cbc-256 aes-cbc-192 aes-cbc-128
  integrity sha512 sha384 sha256 sha1
  group 24 21 20 19 16 15 14 2
  !
crypto ikev2 policy ikev2-1
  proposal ikev2-1
  !
crypto ikev2 keyring ikev2-2000
  peer peer-ikev2-keyring
  address 35.81.94.248 [cAPIC CSR1 gig3 Public IP]
  pre-shared-key abcdefg12345
  !
crypto ikev2 profile ikev2-2000
  match address local interface GigabitEthernet3
  match identity remote address 35.81.94.248[cAPIC CSR1 gig3 Public IP] 255.255.255.255
  identity local address 52.53.49.193 [Local Device tunnel source interface Public IP (Gig3 public IP)]
  authentication remote pre-share
  authentication local pre-share
  keyring local keyring-ikev2-2000
  lifetime 3600
  dpd 10 5 on-demand
  !
crypto ipsec transform-set ikev2-2000 esp-gcm 256
  mode tunnel
  !
crypto ipsec profile ikev2-2000
  set transform-set ikev2-2000
  set pfs group14
  set ikev2-profile ikev2-2000
  !
interface Tunnel2000
  vrf forwarding Ext-V1
  ip address 50.50.0.14 [cAPIC CSR1 BGP Peer Addr] 255.255.255.252
  ip mtu 1400
  ip tcp adjust-mss 1400
  tunnel source GigabitEthernet3
  tunnel mode ipsec ipv4
  tunnel destination 35.81.94.248[cAPIC CSR1 gig3 Public IP]
  tunnel protection ipsec profile ikev2-2000
  
```



**Step 4** Repeat the previous step to configure additional tunnels.

## Creating an EPG Using the Cisco Cloud Network Controller GUI

This section explains how to create an EPG using the Cisco Cloud Network Controller GUI. Each service needs at least one consumer EPG and one provider EPG.

### Before you begin

Create an application profile and a VRF.

**Step 1** Click the **Intent** icon. The **Intent** menu appears.

**Step 2** Click the drop-down arrow below the **Intent** search box and choose **Application Management**.

A list of **Application Management** options appear in the **Intent** menu.

**Step 3** From the **Application Management** list in the **Intent** menu, click **Create EPG**. The **Create EPG** dialog box appears.

**Step 4** Enter the appropriate values in each field as listed in the following *Create EPG Dialog Box Fields* table then continue.

**Table 9: Create EPG Dialog Box Fields**

Properties	Description
Name	Enter the name of the EPG.

Properties	Description
<b>Tenant</b>	To choose a tenant: <ol style="list-style-type: none"> <li>a. Click <b>Select Tenant</b>. The <b>Select Tenant</b> dialog box appears.</li> <li>b. From the <b>Select Tenant</b> dialog, click to choose a tenant in the left column then click <b>Select</b>. You return to the <b>Create EPG</b> dialog box.</li> </ol>
<b>Application Profile</b>	To choose an application profile: <ol style="list-style-type: none"> <li>a. Click <b>Select Application Profile</b>. The <b>Select Application Profile</b> dialog box appears.</li> <li>b. From the <b>Select Application Profile</b> dialog, click to choose an application profile in the left column then click <b>Select</b>. You return to the <b>Create EPG</b> dialog box.</li> </ol>
<b>Description</b>	Enter a description of the EPG.
<b>Settings</b>	
<b>Type</b>	Choose the EPG type: <ul style="list-style-type: none"> <li>• <b>Cloud</b> - Click to create the EPG in the cloud.</li> <li>• <b>External</b> - Click to create an external EPG.</li> </ul>
<b>Route Reachability</b>	(Visible when creating an external EPG) Click the <b>Route Reachability</b> drop-down list and choose: <ul style="list-style-type: none"> <li>• <b>On Premises</b></li> <li>• <b>Internet</b></li> <li>• <b>Unspecified</b></li> </ul>
<b>VRF</b>	To choose a VRF: <ol style="list-style-type: none"> <li>a. Click <b>Select VRF</b>. The <b>Select VRF</b> dialog box appears.</li> <li>b. From the <b>Select VRF</b> dialog, click to choose a VRF in the left column then click <b>Select</b>. You return to the <b>Create EPG</b> dialog box.</li> </ol>

Properties	Description
Endpoint Selectors	

Properties	Description
	<p><b>Note</b> See <a href="#">Configuring Instances in AWS, on page 78</a> for instructions on configuring instances in AWS as part of the endpoint selector configuration process.</p> <p>To add an endpoint selector:</p> <ol style="list-style-type: none"> <li>a. Click <b>Add Endpoint Selector</b> to open the <b>Add Endpoint Selector</b> dialog.</li> <li>b. In the <b>Add Endpoint Selector</b> dialog, enter a name in the <b>Name</b> field.</li> <li>c. Click <b>Selector Expression</b>. The <b>Key</b>, <b>Operator</b>, and <b>Value</b> fields are enabled.</li> <li>d. Click the <b>Key</b> drop-down list to choose a key. The options are: <ul style="list-style-type: none"> <li>• Choose <b>IP</b> if you want to use an IP address or subnet for the endpoint selector.</li> <li>• Choose <b>Zone</b> if you want to use an availability zone for the endpoint selector.</li> <li>• Choose <b>Region</b> if you want to use the Amazon Web Services region for the endpoint selector.</li> <li>• Choose <b>Custom</b> if you want to create a custom key for the endpoint selector. <p><b>Note</b> When choosing the <b>Custom</b> option, the drop-down list becomes a text box. You need to enter a name for the key in the spaces after <b>custom:</b> (for example, <b>custom: Location</b>).</p> </li> </ul> </li> <li>e. Click the <b>Operator</b> drop-down list to choose an operator. The options are: <ul style="list-style-type: none"> <li>• <b>equals</b>: Used when you have a single value in the Value field.</li> <li>• <b>not equals</b>: Used when you have a single value in the Value field.</li> <li>• <b>in</b>: Used when you have multiple comma-separated values in the Value field.</li> <li>• <b>not in</b>: Used when you have multiple comma-separated values in the Value field.</li> <li>• <b>has key</b>: Used if the expression contains only a key.</li> </ul> </li> </ol>



Properties	Description
	<ul style="list-style-type: none"> <li>• <b>does not have key</b>: Used if the expression contains only a key.</li> </ul> <p><b>f.</b> Enter a value in the <b>Value</b> field then click the check mark to validate the entries. The value you enter depends on the choices you made for the <b>Key</b> and <b>Operator</b> fields. For example, if the <b>Key</b> field is set to <b>IP</b> and the <b>Operator</b> field is set to <b>equals</b>, the <b>Value</b> field must be an IP address or subnet. However, if the <b>Operator</b> field is set to <b>has key</b>, the <b>Value</b> field is disabled.</p> <p><b>g.</b> When finished, click the check mark to validate the selector expression.</p> <p><b>h.</b> Determine if you want to create additional endpoint selector expressions to the endpoint selector. If you create more than one expression under a single endpoint selector, a logical AND exists between those expressions.</p> <p>For example, assume you created two sets of expressions under a single endpoint selector:</p> <ul style="list-style-type: none"> <li>• Endpoint selector 1, expression 1: <ul style="list-style-type: none"> <li>• <b>Key</b>: Zone</li> <li>• <b>Operator</b>: equals</li> <li>• <b>Value</b>: us-west-1a</li> </ul> </li> <li>• Endpoint selector 1, expression 2: <ul style="list-style-type: none"> <li>• <b>Key</b>: IP</li> <li>• <b>Operator</b>: equals</li> <li>• <b>Value</b>: 192.0.2.1/24</li> </ul> </li> </ul> <p>In this case, if <i>both</i> of these expressions are true (if the availability zone is us-west-1a AND if the IP address belongs to subnet 192.0.2.1/24), then that endpoint is assigned to the Cloud EPG.</p>

Properties	Description
	<p>i. Click the check mark after every additional expression that you want to create under this endpoint selector then click <b>Add</b> when finished.</p> <p>If you create more than one endpoint selector under an EPG, a logical OR exists between those endpoint selectors. For example, assume you had created endpoint selector 1 as described in the previous step, and then you created a second endpoint selector as described below:</p> <ul style="list-style-type: none"> <li>• Endpoint selector 2, expression 1: <ul style="list-style-type: none"> <li>• <b>Key:</b> Region</li> <li>• <b>Operator:</b> in</li> <li>• <b>Value:</b> us-east-1, us-east-2</li> </ul> </li> </ul> <p>In this case:</p> <ul style="list-style-type: none"> <li>• If the availability zone is us-west-1a AND the IP address belongs to the 192.0.2.1/24 subnet (endpoint selector 1 expressions)</li> </ul> <p>OR</p> <ul style="list-style-type: none"> <li>• If the region is either us-east-1 or us-east-2 (endpoint selector 2 expression)</li> </ul> <p>Then that end point is assigned to the Cloud EPG.</p>

**Step 5** Click **Save** when finished.

## Creating a Contract Using the Cisco Cloud Network Controller GUI

This section explains how to create a contract using the Cisco Cloud Network Controller GUI.

### Before you begin

Create filters.

**Step 1** Click the **Intent** icon. The **Intent** menu appears.

**Step 2** Click the drop-down arrow below the **Intent** search box and choose **Application Management**.

A list of **Application Management** options appear in the **Intent** menu.

**Step 3** From the **Application Management** list in the **Intent** menu, click **Create Contract**. The **Create Contract** dialog box appears.

**Step 4** Enter the appropriate values in each field as listed in the following *Create Contract Dialog Box Fields* table then continue.

**Table 10: Create Contract Dialog Box Fields**

Properties	Description
<b>Name</b>	Enter the name of the contract.
<b>Tenant</b>	To choose a tenant: <ol style="list-style-type: none"> <li><b>a.</b> Click <b>Select Tenant</b>. The <b>Select Tenant</b> dialog box appears.</li> <li><b>b.</b> From the <b>Select Tenant</b> dialog, click to choose a tenant in the left column then click <b>Select</b>. You return to the <b>Create Contract</b> dialog box.</li> </ol>
<b>Description</b>	Enter a description of the contract.
<b>Settings</b>	
<b>Scope</b>	The scope limits the contract to any endpoint groups within the same application profile, within the same VRF instance, throughout the fabric (globally), or within the same tenant. <p><b>Note</b> Shared services enables communication between EPGs in different tenants and between EPGs in different VRFs.</p> <p>To enable EPGs in one tenant to communicate with EPGs in another tenant, choose <b>Global</b> scope.</p> <p>To enable an EPG in one VRF to communicate with another EPG in a different VRF, choose <b>Global</b> or <b>Tenant</b> scope.</p> <p>For more information about shared services, see <a href="#">Shared Services, on page 39</a></p> <p>Click the drop-down arrow to choose from the following scope options:</p> <ul style="list-style-type: none"> <li>• <b>Application Profile</b></li> <li>• <b>VRF</b></li> <li>• <b>Global</b></li> <li>• <b>Tenant</b></li> </ul>
<b>Apply Filter in Both Directions</b>	Put a check in the box to apply the same filters to traffic from consumer-to-provider and provider-to-consumer. Do not put a check in the box if you want to apply different filters for each direction of traffic. <p>The check box is enabled by default.</p>

Properties	Description
<b>Add Filter</b>	<p>To choose a filter:</p> <ol style="list-style-type: none"> <li>Click <b>Add Filter</b>. The filter row appears with a <b>Select Filter</b> option.</li> <li>Click <b>Select Filter</b>. The <b>Select Filter</b> dialog box appears.</li> <li>From the <b>Select Filter</b> dialog, click to choose a filter in the left column then click <b>Select</b>. You return to the <b>Create Contract</b> dialog box.</li> </ol>

**Step 5** Click **Save** when finished.

## Specifying Consumer and Provider EPGs Using the Cisco Cloud Network Controller

This section explains how to specify an EPG as a consumer or a provider.

### Before you begin

- You have configured a contract.
- You have configured an EPG.

**Step 1** Click the **Intent** icon. The **Intent** menu appears.

**Step 2** Click the drop-down arrow below the **Intent** search box and choose **Configuration**.

A list of **Configuration** options appears in the **Intent** menu.

**Step 3** From the **Configuration** list in the **Intent** menu, click **EPG Communication**. The **EPG Communication** dialog box appears with the **Consumer EPGs**, **Contract**, and **Provider EPGs** information.

**Step 4** To choose a contract:

- Click **Select Contract**. The **Select Contract** dialog appears.
- In the pane on the left side of the **Select Contract** dialog, click to choose a contract then click **Select**. The **Select Contract** dialog box closes.

**Step 5** To add a consumer EPG:

- Click **Add Consumer EPGs**. The **Select Consumer EPGs** dialog appears.
- In the pane on the left side of the **Select Consumer EPGs** dialog, click to place a check in a check box to choose an EPG.

**Step 6** To add a provider EPG:

- Click **Add Provider EPGs**. The **Select Provider EPGs** dialog appears.
- In the pane on the left side of the **Select Provider EPGs** dialog, click to place a check in a check box to choose a provider EPG.

- c) When finished, click **Select**. The **Select Provider EPGs** dialog box closes.

## Creating a Filter Using the Cisco Cloud Network Controller GUI

This section explains how to create a filter using the Cisco Cloud Network Controller GUI.

**Step 1** Click the **Intent** icon. The **Intent** menu appears.

**Step 2** Click the drop-down arrow below the **Intent** search box and choose **Application Management**.

A list of **Application Management** options appear in the **Intent** menu.

**Step 3** From the **Application Management** list in the **Intent** menu, click **Create Filter**. The **Create Filter** dialog box appears.

**Step 4** Enter the appropriate values in each field as listed in the following *Create Filter Dialog Box Fields* table then continue.

**Table 11: Create Filter Dialog Box Fields**

Properties	Description
<b>Name</b>	Enter a name for the filter in the <b>Name</b> field.
<b>Tenant</b>	To choose a tenant: <ol style="list-style-type: none"> <li>a. Click <b>Select Tenant</b>. The <b>Select Tenant</b> dialog box appears.</li> <li>b. From the <b>Select Tenant</b> dialog, click to choose a tenant in the left column then click <b>Select</b>. You return to the <b>Create Filter</b> dialog box.</li> </ol>
<b>Description</b>	Enter a description of the filter.

Properties	Description
<b>Add Filter</b>	<p>To add a filter:</p> <ol style="list-style-type: none"> <li>a. Click <b>Add Filter Entry</b>. The <b>Create Filter Entry</b> dialog box appears.</li> <li>b. Enter a name for the filter entry in the <b>Name</b> field.</li> <li>c. From the <b>Select Filter</b> dialog, click to choose a filter in the left column then click <b>Select</b>. You return to the <b>Create Contract</b> dialog box.</li> <li>d. Click the <b>Ethernet Type</b> drop-down list to choose an ethernet type. The options are: <ul style="list-style-type: none"> <li>• <b>IP</b></li> <li>• <b>Unspecified</b></li> </ul> <p><b>Note</b> When <b>Unspecified</b> is chosen, the remaining fields are disabled.</p> </li> <li>e. Click the <b>IP Protocol</b> drop-down menu to choose a protocol. The options are: <ul style="list-style-type: none"> <li>• <b>icmp</b></li> <li>• <b>tcp</b></li> <li>• <b>udp</b></li> <li>• <b>Unspecified</b></li> </ul> <p><b>Note</b> The remaining fields are enabled only when <b>tcp</b> or <b>udp</b> is chosen.</p> </li> <li>f. Enter the appropriate port information in the <b>Origin Port from</b> and <b>to</b> fields.</li> <li>g. Enter the appropriate port information in the <b>Destination Port from</b> and <b>to</b> fields.</li> <li>h. When finished entering filter entry information, click <b>Add</b>. You return to the <b>Create Filter</b> dialog box where you can repeat the steps to add another filter entry.</li> </ol>

**Step 5** When finished, click **Save**.

# Creating a Cloud Context Profile Using the Cisco Cloud Network Controller GUI

This section explains how to create a cloud context profile using the Cisco Cloud Network Controller GUI.

## Before you begin

Create a VRF.

- 
- Step 1** Navigate to **Application Management > Cloud Context Profiles**.  
The list of configure cloud context profiles appears.
- Step 2** Click **Actions > Create Cloud Context Profile**.  
The **Create Cloud Context Profile** dialog box appears.
- Step 3** Enter the appropriate values in each field as listed in the following *Cloud Context Profile Dialog Box Fields* table then continue.

**Table 12: Create Cloud Context Profile Dialog Box Fields**

Properties	Description
<b>Name</b>	Enter the name of the cloud context profile.
<b>Tenant</b>	To choose a tenant: <ol style="list-style-type: none"> <li>a. Click <b>Select Tenant</b>. The <b>Select Tenant</b> dialog box appears.</li> <li>b. From the <b>Select Tenant</b> dialog, click to choose a tenant in the left column then click <b>Select</b>. You return to the <b>Create Cloud Context Profile</b> dialog box.</li> </ol>
<b>Description</b>	(Optional) Enter a description of the cloud context profile.
<b>Settings</b>	
<b>Select Region</b>	To choose a region: <ol style="list-style-type: none"> <li>a. Click <b>Select Region</b>. The <b>Select Region</b> dialog box appears.</li> <li>b. From the <b>Select Region</b> dialog, click to choose a region in the left column then click <b>Select</b>. You return to the <b>Create Cloud Context Profile</b> dialog box.</li> </ol>
<b>Select VRF</b>	To choose a VRF: <ol style="list-style-type: none"> <li>a. Click <b>Select VRF</b>. The <b>Select VRF</b> dialog box appears.</li> <li>b. From the <b>Select VRF</b> dialog box, click to choose a VRF in the left column then click <b>Select</b>. You return to the <b>Create Cloud Context Profile</b> dialog box.</li> </ol>

Properties	Description
<b>Add CIDR</b>	<p><b>Note</b> The following subnets are reserved and should not be used in this <b>Add CIDR</b> field:</p> <ul style="list-style-type: none"> <li>• 169.254.0.0/16 (reserved for VPN tunnel to the transit gateway)</li> <li>• 192.168.100.0/24 (reserved by the CCR for the bridge domain interface)</li> </ul> <p>To add a CIDR:</p> <ol style="list-style-type: none"> <li>a. Click <b>Add CIDR</b>. The <b>Add CIDR</b> dialog box appears.</li> <li>b. Enter the address in the <b>Address</b> field.</li> <li>c. Click <b>Add Subnet</b> and enter the subnet address in the <b>Address</b> field.</li> <li>d. To add availability zones: <ol style="list-style-type: none"> <li>1. Click <b>Select Availability Zone</b>. The <b>Select Availability Zone</b> dialog box appears.</li> <li>2. From the <b>Select Availability Zone</b> dialog box, click to choose an availability zone in the left column.</li> </ol> <p>The type of availability zone shown in this window varies depending on the type of tenant that you selected for this cloud context profile.</p> <p><b>Note</b> If you are creating a cloud context profile in a <b>user</b> tenant, you are restricted to only <b>cloud</b> availability zones in this window.</p> <p>See <a href="#">Availability Zones, on page 27</a> for more information.</p> <ol style="list-style-type: none"> <li>3. Click <b>Select</b></li> </ol> <p>You return to the <b>Create Cloud Context Profile</b> dialog box.</p> </li> <li>e. Click to check (enabled) or uncheck (disabled) the <b>Primary</b> check box.</li> <li>f. When finished, click <b>Add</b>.</li> </ol>
<b>VPN Gateway Router</b>	(Optional) Click to check (enabled) or uncheck (disabled) in the <b>VPN Gateway Router</b> check box.
<b>TGW Attachment</b>	(Optional) Click to check (enabled) or uncheck (disabled) in the <b>TGW Attachment</b> check box.

**Step 4** Click **Save** when finished.

## Configuring Instances in AWS

When you configure endpoint selectors for Cisco Cloud Network Controller, you will also need to configure the instances that you will need in AWS that will correspond with the endpoint selectors that you configure for Cisco Cloud Network Controller.



This topic provides the instructions for configuring the instances in AWS. You can use these procedures to configure the instances in AWS either before you configure the endpoint selectors for Cisco Cloud Network Controller or afterward. For example, you might go to your account in AWS and create a custom tag or label in AWS first, then create an endpoint selector using a custom tag or label in Cisco Cloud Network Controller afterward. Or you might create an endpoint selector using a custom tag or label in Cisco Cloud Network Controller first, then go to your account in AWS and create a custom tag or label in AWS afterward.

- 
- Step 1** Review your cloud context profile configuration settings and determine which settings you will use with your AWS instance.
- You must configure a cloud context profile as part of the AWS instance configuration process. When you configure a cloud context profile, the configurations, such as the VRF and region settings, are pushed out to AWS afterward.
- From the **Navigation** menu, choose the **Application Management** tab.  
When the **Application Management** tab expands, a list of subtab options appear.
  - Choose the **Cloud Context Profiles** subtab option.  
A list of the cloud context profiles that you have created for your Cisco Cloud Network Controller are displayed.
  - Select the cloud context profile that you will use as part of this AWS instance configuration process.  
Various configuration parameters are displayed for this cloud context profile, such as the region, VRF, IP address and subnets. Use the information displayed in this window when you configure the AWS instance.
- Step 2** Log in to the Amazon Web Services account for the Cisco Cloud Network Controller user tenant, if you are not logged in already.
- Step 3** Go to **Services > EC2 > Instances > Launch Instance**.
- Step 4** In the **Choose an Amazon Machine Image (AMI)** page, select an Amazon Machine Image (AMI).
- Step 5** In the **Choose an Instance Type** page, select an instance type, then click **Configure Instance Details**.
- Step 6** In the **Configure Instance Details** page, enter the necessary information in the appropriate fields.
- In the **Network** field, select your Cisco Cloud Network Controller VRF.  
This would be the VRF that is associated with the cloud context profile that you are using as part of this AWS instance configuration process.
  - In the **Subnet** field, select the subnet.
  - In the **Auto-assign Public IP** field, if you want to have a public IP, select **Enable** from the scroll-down menu.
- Step 7** When you have finished entering the necessary information into the **Configure Instance Details** page, click **Add Storage**.
- Step 8** In the **Add Storage** page, accept the default values or configure the storage in this page, if necessary, and click **Add Tags**.
- Step 9** In the **Add Tags** page, click **Add Tag** and enter the necessary information in the appropriate fields in this page.
- Note** If you will be using IP Address, Region or Zone for the type of endpoint selector later in these procedures, you do not have to enter any information in this page. In those situations, when you start the instance in AWS, the IP address, region or zone will be discovered by the Cisco Cloud Network Controller and the endpoint will be assigned to the EPG.

- **Key:** Enter the key that you will use when you create a custom tag for the type of endpoint selector that you are adding later in these procedures.
- **Value:** Enter the value that you will be using for this key.
- **Instances:** Check the box for this field.
- **Volumes:** Check the box for this field.

For example, if you are planning on creating a custom tag for a specific building for your endpoint selector later in these procedures (such as building6), you might enter the following values in these fields on this page:

- **Key:** Location
- **Value:** building6

**Step 10** Click **Review and Launch**.

The **Select an existing key pair or create a new key pair** page appears. Use the information in this page if you want to ssh to the instance later on.

## Creating a Backup Configuration Using the Cisco Cloud Network Controller GUI

This section explains how to create a backup configuration.

### Before you begin

Create a remote location and a scheduler, if needed.

**Step 1** Click the **Intent** icon. The **Intent** menu appears.

**Step 2** Click the drop-down arrow below the **Intent** search box and choose **Operations**.

A list of **Operations** options appear in the **Intent** menu.

**Step 3** From the **Operations** list in the **Intent** menu, click **Create Backup Configuration**. The **Create Backup Configuration** dialog box appears.

**Step 4** Enter the appropriate values in each field as listed in the following *Create Backup Configuration Dialog Box Fields* table then continue.

**Table 13: Create Backup Configuration Dialog Box Fields**

Properties	Description
<b>General</b>	
<b>Name</b>	Enter the name of the backup configuration.
<b>Description</b>	Enter a description of the backup configuration.
<b>Settings</b>	

Properties	Description
<b>Backup Destination</b>	Choose a backup destination. <ul style="list-style-type: none"><li>• <b>Local</b></li><li>• <b>Remote</b></li></ul>

Properties	Description
Backup Object	

Properties	Description
	<p>Choose the root hierarchical content to consider for the backup</p> <ul style="list-style-type: none"> <li>• <b>Policy Universe</b></li> <li>• <b>Selector Object</b>—When chosen, this option adds the <b>Object Type</b> drop-down list and <b>Object DN</b> field.             <ol style="list-style-type: none"> <li>a. From the <b>Object Type</b> drop-down list, choose from the following options:                 <ul style="list-style-type: none"> <li>• <b>Tenant</b>—When chosen the <b>Select Tenant</b> option appears.</li> <li>• <b>Application Profile</b>—When chosen the <b>Select Application Profile</b> option appears.</li> <li>• <b>EPG</b>—When chosen the <b>Select EPG</b> option appears.</li> <li>• <b>Contract</b>—When chosen the <b>Select Contract</b> option appears.</li> <li>• <b>Filter</b>—When chosen the <b>Select Filter</b> option appears.</li> <li>• <b>VRF</b>—When chosen the <b>Select VRF</b> option appears.</li> <li>• <b>Device</b>—When chosen the <b>Select fvcloudLBCTX</b> option appears.</li> <li>• <b>Service Graph</b>—When chosen the <b>Select Service Graph</b> option appears.</li> <li>• <b>Cloud Context Profile</b>—When chosen the <b>Select Cloud Context Profile</b> option appears.</li> </ul> </li> <li>b. Click the <b>Select &lt;object_name&gt;</b>. The <b>Select &lt;object_name&gt;</b> dialog appears.</li> <li>c. From the <b>Select &lt;object_name&gt;</b> dialog, click to choose from the options in the left column then click <b>Select</b>. You return to the <b>Create Backup Configuration</b> dialog box.                 <p><b>Note</b> The <b>Object DN</b> field is automatically populated with the DN of the object it will use as root of the object tree to backup</p> </li> </ol> </li> <li>• <b>Enter DN</b>—When chosen, this option displays the <b>Object DN</b> field.             <ol style="list-style-type: none"> <li>a. From the <b>Object DN</b> field, enter the DN of a</li> </ol> </li> </ul>

Properties	Description
	specific object to use as the root of the object tree to backup.
<b>Scheduler</b>	<ol style="list-style-type: none"> <li>Click <b>Select Scheduler</b> to open the <b>Select Scheduler</b> dialog and choose a scheduler from the left-side column.</li> <li>Click the <b>Select</b> button at the bottom-right corner when finished.</li> </ol>
<b>Trigger Backup After Creation</b>	Choose one of the following: <ul style="list-style-type: none"> <li><b>Yes</b>—(Default) Trigger a backup after creating the backup configuration.</li> <li><b>No</b>—Do not trigger a backup after creating the backup configuration.</li> </ul>

**Step 5** Click **Save** when finished.

## Creating a Tech Support Policy Using the Cisco Cloud Network Controller GUI

This section explains how to create a tech support policy.

### Before you begin

When creating a tech support policy for a remote location, you must first create the remote location.

**Step 1** Click the **Intent** icon. The **Intent** menu appears.

**Step 2** Click the drop-down arrow below the **Intent** search box and choose **Operations**.

A list of **Operations** options appear in the **Intent** menu.

**Step 3** From the **Operations** list in the **Intent** menu, click **Create Tech Support**. The **Create Tech Support** dialog box appears.

**Step 4** Enter the appropriate values in each field as listed in the following *Create Tech Support Dialog Box Fields* table then continue.

**Table 14: Create Tech Support Dialog Box Fields**

Properties	Description
<b>General</b>	
<b>Name</b>	Enter the name of the tech support policy.
<b>Description</b>	Enter a description of the tech support.
<b>Settings</b>	

Properties	Description
<b>Export Destination</b>	Choose an export destination. <ul style="list-style-type: none"> <li>• <b>Controller</b></li> <li>• <b>Remote Location</b>—When chosen the <b>Select Remote Location</b> option appears. <ol style="list-style-type: none"> <li>Click <b>Select Remote Location</b>. The <b>Select Remote Location</b> dialog box appears.</li> <li>From the <b>Select Remote Location</b> dialog, click to choose a remote location in the left column then click <b>Select</b>. You return to the <b>Create Tech Support</b> dialog box.</li> </ol> </li> </ul>
<b>Include Pre-Upgrade Logs</b>	Click to place a check in the <b>Enabled</b> check box if you want to include pre-upgrade logs in the tech support policy.
<b>Trigger After Creation</b>	Click to place a check in the <b>Enabled</b> (the default) check box if you want to create the tech support policy after the policy creation. To disable, click the check box to uncheck.

**Step 5** Click **Save** when finished.

## Creating a Trigger Scheduler Using the Cisco Cloud Network Controller GUI

This section explains how to create a trigger scheduler.

**Step 1** Click the **Intent** icon. The **Intent** menu appears.

**Step 2** Click the drop-down arrow below the **Intent** search box and choose **Operations**.

A list of **Operations** options appear in the **Intent** menu.

**Step 3** From the **Operations** list in the **Intent** menu, click **Create Scheduler**. The **Create Trigger Scheduler** dialog box appears.

**Step 4** Enter the appropriate values in each field as listed in the following *Create Trigger Scheduler Dialog Box Fields* table then continue.

**Table 15: Create Trigger Scheduler Dialog Box Fields**

Properties	Description
<b>General</b>	
<b>Name</b>	Enter the name of the trigger scheduler policy.
<b>Description</b>	Enter a description of the trigger scheduler.
<b>Settings</b>	

Properties	Description
<b>Recurring Windows</b>	<p>Click <b>Add Recurring Window</b>. The <b>Add Recurring Window</b> dialog appears.</p> <ol style="list-style-type: none"> <li>a. From the <b>Schedule</b> drop-down list, choose from the following. <ul style="list-style-type: none"> <li>• <b>every-day</b></li> <li>• <b>Monday</b></li> <li>• <b>Tuesday</b></li> <li>• <b>Wednesday</b></li> <li>• <b>Thursday</b></li> <li>• <b>Friday</b></li> <li>• <b>Saturday</b></li> <li>• <b>Sunday</b></li> <li>• <b>odd-day</b></li> <li>• <b>even-day</b></li> </ul> </li> <li>b. From the <b>Start Time</b> field, enter a time.</li> <li>c. From the <b>Maximum Concurrent Tasks</b> field, enter a number or leave the field empty to specify unlimited.</li> <li>d. From the <b>Maximum Running Time</b>, click to choose <b>Unlimited</b> or <b>Custom</b>.</li> <li>e. Click <b>Add</b> when finished.</li> </ol>
<b>Add One Time Window</b>	<p>Click <b>Add One Time Window</b>. The <b>Add One Time Window</b> dialog appears.</p> <ol style="list-style-type: none"> <li>a. From the <b>Start Time</b> field, enter a date and time.</li> <li>b. From the <b>Maximum Concurrent Tasks</b> field, enter a number or leave the field blank to specify unlimited.</li> <li>c. From the <b>Maximum Running Time</b>, click to choose <b>Unlimited</b> or <b>Custom</b>.</li> <li>d. Click <b>Add</b> when finished.</li> </ol>

**Step 5** Click **Save** when finished.



## Creating a Remote Location Using the Cisco Cloud Network Controller GUI

This section explains how to create a remote location using the Cisco Cloud Network Controller.

- Step 1** Click the **Intent** icon. The **Intent** menu appears.
- Step 2** Click the drop-down arrow below the **Intent** search box and choose **Operations**.  
A list of **Operations** options appear in the **Intent** menu.
- Step 3** From the **Operations** list in the **Intent** menu, click **Create Remote Location**. The **Create Remote Location** dialog box appears.
- Step 4** Enter the appropriate values in each field as listed in the following *Create Remote Location Dialog Box Fields* table then continue.

**Table 16: Create Remote Location Dialog Box Fields**

Properties	Description
<b>General</b>	
<b>Name</b>	Enter the name of the remote location policy.
<b>Description</b>	Enter a description of the remote location policy.
<b>Settings</b>	
<b>Hostname/IP Address</b>	Enter the hostname or IP address of the remote location
<b>Protocol</b>	Choose a protocol: <ul style="list-style-type: none"> <li>• <b>FTP</b></li> <li>• <b>SFTP</b></li> <li>• <b>SCP</b></li> </ul>
<b>Path</b>	Enter the path for the remote location.
<b>Port</b>	Enter the port for the remote location.
<b>Username</b>	Enter a username for the remote location.
<b>Authentication Type</b>	When using SFTP or SCP, choose the authentication type: <ul style="list-style-type: none"> <li>• <b>Password</b></li> <li>• <b>SSH Key</b></li> </ul>
<b>SSH Key Content</b>	Enter the SSH key content.
<b>SSH Key Passphrase</b>	SSH key passphrase.
<b>Password</b>	Enter a password for accessing the remote location.
<b>Confirm Password</b>	Reenter the password for accessing the remote location.

Properties	Description
Management EPG	<ol style="list-style-type: none"> <li>a. Click <b>Select Management EPG</b>. The <b>Select Management EPG</b> dialog appears.</li> <li>b. From the column on the left, click to choose a management EPG.</li> <li>c. Click <b>Select</b>.</li> </ol>

**Step 5** Click **Save** when finished.

## Creating a Login Domain Using the Cisco Cloud Network Controller GUI

This section explains how to create a login domain using the Cisco Cloud Network Controller GUI.

### Before you begin

Create a provider before creating a non-local domain.

**Step 1** Click the **Intent** icon. The **Intent** menu appears.

**Step 2** Click the drop-down arrow below the **Intent** search box and choose **Administrative**.

A list of **Administrative** options appear in the **Intent** menu.

**Step 3** From the **Administrative** list in the **Intent** menu, click **Create Login Domain**. The **Create Login Domain** dialog box appears.

**Step 4** Enter the appropriate values in each field as listed in the following *Create Login Domain Dialog Box Fields* table then continue.

**Table 17: Create Login Domain Dialog Box Fields**

Properties	Description
Name	Enter the name of the login domain.
Description	Enter a description of the login domain.
Realm	Choose a realm: <ul style="list-style-type: none"> <li>• <b>Local</b></li> <li>• <b>LDAP</b>—Requires adding providers and choosing an authentication type.</li> <li>• <b>RADIUS</b>—Requires adding providers.</li> <li>• <b>TACACS+</b>—Requires adding providers.</li> <li>• <b>SAML</b>—Requires adding providers.</li> </ul>

Properties	Description
<b>Providers</b>	To add a provider: <ol style="list-style-type: none"><li>Click <b>Add Providers</b>. The <b>Select Providers</b> dialog appears with a list of providers in the left pane.</li><li>Click to choose a provider.</li><li>Click <b>Select</b> to add the provider.</li></ol>
<b>Advanced Settings</b>	Displays the <b>Authentication Type</b> and <b>LDAP Group Map Rules</b> fields.
<b>Authentication Type</b>	When LDAP is chosen for realm option, choose one of the following authentication types: <ul style="list-style-type: none"><li>• <b>Cisco AV Pairs</b>—(Default)</li><li>• <b>LDAP Group Map Rules</b>—Requires adding LDAP group map rules.</li></ul>

Properties	Description
<b>LDAP Group Map Rules</b>	<p>To add an LDAP group map rule:</p> <ol style="list-style-type: none"> <li>a. Click <b>Add LDAP Group Map Rule</b>. The <b>Add LDAP Group Map Rule</b> dialog appears with a list of providers in the left pane.</li> <li>b. Enter a name for the rule in the <b>Name</b> field.</li> <li>c. Enter a description for the rule in the <b>Description</b> field.</li> <li>d. Enter a group DN for the rule in the <b>Group DN</b> field.</li> <li>e. Add security domains: <ol style="list-style-type: none"> <li>1. Click <b>Add Security Domain</b>. The <b>Add Security Domain</b> dialog box appears.</li> <li>2. Click <b>Select Security Domain</b>. The <b>Select Security Domain</b> dialog box appears with a list of security domains in the left pane.</li> <li>3. Click to choose a security domain.</li> <li>4. Click <b>Select</b> to add the security domain. You return to the <b>Add Security Domain</b> dialog box.</li> </ol> </li> <li>5. Add a user role: <ol style="list-style-type: none"> <li>a. From the <b>Add Security Domain</b> dialog box, click <b>Select Role</b>. The <b>Select Role</b> dialog box appears with a list of roles in the left pane.</li> <li>b. Click to choose a role.</li> <li>c. Click <b>Select</b> to add the role. You return to the <b>Add Security Domain</b> dialog box.</li> <li>d. From the <b>Add Security Domain</b> dialog box, click the <b>Privilege Type</b> drop-down list and choose <b>Read Privilege</b> or <b>Write Privilege</b>.</li> <li>e. Click the check mark on the right side of the <b>Privilege Type</b> drop-down list to confirm.</li> <li>f. Click <b>Add</b> when finished. You return to the <b>Add LDAP Group Map Rule</b> dialog box where you can add another security domain.</li> </ol> </li> </ol>

**Step 5** Click **Save** when finished.

## Creating a Provider Using the Cisco Cloud Network Controller GUI

This section explains how to create a provider using the Cisco Cloud Network Controller GUI.

**Step 1** Click the **Intent** icon. The **Intent** menu appears.

**Step 2** Click the drop-down arrow below the **Intent** search box and choose **Administrative**.

A list of **Administrative** options appear in the **Intent** menu.

**Step 3** From the **Administrative** list in the **Intent** menu, click **Create Provider**. The **Create Provider** dialog box appears.

**Step 4** Enter the appropriate values in each field as listed in the following *Create Provider Dialog Box Fields* table then continue.

**Table 18: Create Provider Dialog Box Fields**

Properties	Description
Hostname/IP Address	Enter the hostname or IP address of the provider.
Description	Enter a description of the provider.
Type	Click the <b>Type</b> drop-down list and choose one of the following types: <ul style="list-style-type: none"> <li>• LDAP</li> <li>• RADIUS</li> <li>• TACACS+</li> <li>• SAML</li> </ul> <p><b>Note</b> A set of fields will appear based on the type that you choose.</p>
<b>[LDAP] Settings</b>	
Bind DN	Enter the LDAP bind DN.
Base DN	Enter the LDAP base DN.
Password	Enter a password for the LDAP settings.
Confirm Password	Reenter the password for the LDAP settings.
Port	Enter the port number for the provider type.
Advanced Settings	Displays additional fields in the <b>Settings</b> section of the provider dialog box.
Timeout (sec)	Enter the number of seconds allowed before a timeout occurs. The default is 30.
Retries	Enter the number of allowed retries. The default is 1.

Properties	Description
<b>SSL</b>	To enable SSL, click to place a check in the <b>SSL</b> check box. To disable SSL, click to remove the check from the <b>SSL</b> check box. The default is enabled.
<b>SSL Certificate Validation Level</b>	Choose one of the following: <ul style="list-style-type: none"> <li>• <b>Permissive</b></li> <li>• <b>Strict</b></li> </ul>
<b>Attribute</b>	Enter an LDAP attribute in the <b>Attribute</b> text box.
<b>Filter Type</b>	Choose a filter type: <ul style="list-style-type: none"> <li>• <b>Default</b></li> <li>• <b>Microsoft AD</b></li> <li>• <b>Custom</b></li> </ul>
<b>Filter</b>	Enter an LDAP filter in the text box. This option only appears when the <b>Custom</b> filter type is chosen.
<b>Select Management EPG</b>	To add a management EPG: <ol style="list-style-type: none"> <li>Click <b>Select Management EPG</b>. The <b>Select Management EPG</b> dialog appears with a list of EPGs in the left pane.</li> <li>Click to choose an EPG.</li> <li>Click <b>Select</b> to add the management EPG to the LDAP.</li> </ol>
<b>Server Monitoring</b>	To enable server monitoring, click to place a check in the <b>Enabled</b> check box. To disable server monitoring, click to remove the check from the <b>Enabled</b> check box. The default is disabled.
<b>[RADIUS] Settings</b>	
<b>Key</b>	Enter the RADIUS key.
<b>Confirm Key</b>	Reenter the RADIUS key.
<b>Advanced Settings</b>	Displays additional fields in the <b>Settings</b> section of the provider dialog box.
<b>Port</b>	Enter the port number for the RADIUS settings. The default is 1812.

Properties	Description
<b>Authentication Protocol</b>	Choose from the following: <ul style="list-style-type: none"> <li>• <b>PAP</b>—(Default)</li> <li>• <b>CHAP</b></li> <li>• <b>MS-CHAP</b></li> </ul>
<b>Timeout (sec)</b>	Enter the number of seconds allowed before a timeout occurs. The default is 5.
<b>Retries</b>	Enter the number of allowed retries. The default is 1.
<b>Select Management EPG</b>	To add a management EPG: <ol style="list-style-type: none"> <li>Click <b>Select Management EPG</b>. The <b>Select Management EPG</b> dialog appears with a list of EPGs in the left pane.</li> <li>Click to choose an EPG.</li> <li>Click <b>Select</b> to add the management EPG to the RADIUS.</li> </ol>
<b>Server Monitoring</b>	To enable server monitoring, click to place a check in the <b>Enabled</b> check box. To disable server monitoring, click to remove the check from the <b>Enabled</b> check box. The default is disabled.
<b>[TACACS+] Settings</b>	
<b>Key</b>	Enter the TACACS+ key.
<b>Confirm Key</b>	Reenter the TACACS+ key.
<b>Advanced Settings</b>	Displays additional fields in the <b>Settings</b> section of the provider dialog box.
<b>Port</b>	Enter the port number for the TACACS+ settings. The default is 1812.
<b>Authentication Protocol</b>	Choose from the following: <ul style="list-style-type: none"> <li>• <b>CHAP</b></li> <li>• <b>MS-CHAP</b></li> <li>• <b>PAP</b>—(Default)</li> </ul>
<b>Timeout (sec)</b>	Enter the number of seconds allowed before a timeout occurs. The default is 5.
<b>Retries</b>	Enter the number of allowed retries. The default is 1.

Properties	Description
Select Management EPG	To add a management EPG: <ol style="list-style-type: none"> <li>Click <b>Select Management EPG</b>. The <b>Select Management EPG</b> dialog appears with a list of EPGs in the left pane.</li> <li>Click to choose an EPG.</li> <li>Click <b>Select</b> to add the management EPG to the TACACS+.</li> </ol>
Server Monitoring	To enable server monitoring, click to place a check in the <b>Enabled</b> check box. To disable server monitoring, click to remove the check from the <b>Enabled</b> check box. The default is disabled.
<b>[SAML] Settings</b>	
Identity Provider	Choose from the following identity providers: <ul style="list-style-type: none"> <li>• <b>ADFS</b>—(default)</li> <li>• <b>OKTA</b></li> <li>• <b>PING IDENTITY</b></li> </ul>
Identity Provider Metadata URL	Enter the metadata URL provided by the identity provider.
Entity ID	Enter a unique ID as the SAML entity identifier.
HTTPS Proxy for Metadata URL	Enter the HTTPS proxy used to reach the identity provider's metadata URL.
Advanced Settings	Displays additional fields in the <b>Settings</b> section of the provider dialog box.
GUI Redirect Banner Message (URL)	Enter the GUI redirect banner message.
Certificate Authority	To choose a certificate authority: <ol style="list-style-type: none"> <li>Click <b>Select Certificate Authority</b>. The <b>Select Certificate Authority</b> dialog appears with a list of certificates in the left pane.</li> <li>Click to choose a certificate.</li> <li>Click <b>Select</b> to add the certificate. You return to the <b>Create Provider</b> dialog box.</li> </ol>
Timeout (sec)	Enter the number of seconds allowed before a timeout occurs. The default is 5.
Retries	Enter the number of allowed retries. The default is 1.



Properties	Description
<b>Signature Algorithm Authentication User Requests*</b>	Click the <b>Signature Algorithm for Requests</b> drop-down list and choose one of the following: <ul style="list-style-type: none"> <li>• <b>RSA SHA1</b></li> <li>• <b>RSA SHA224</b></li> <li>• <b>RSA SHA256</b> (Default)</li> <li>• <b>RSA SHA384</b></li> <li>• <b>RSA SHA512</b></li> </ul>
<b>Sign SAML Authentication Requests</b>	To enable, click to place a check in the check box. To disable, click to remove the check from the check box. The default is enabled.
<b>Sign SAML Response Message</b>	To enable, click to place a check in the check box. To disable, click to remove the check from the check box. The default is enabled.
<b>Sign Assertions in SAML Response</b>	To enable, click to place a check in the check box. To disable, click to remove the check from the check box. The default is enabled.
<b>Encrypt SAML Assertions</b>	To enable, click to place a check in the check box. To disable, click to remove the check from the check box. The default is enabled.

**Step 5** Click **Save** when finished.

## Creating a Security Domain Using the Cisco Cloud Network Controller GUI

A security domain restricts the tenant to the security domains that you add. If you do not add a security domain, all security domains will have access to this tenant. This section explains how to create a security domain using the GUI.

**Step 1** Click the **Intent** icon. The **Intent** menu appears.

**Step 2** Click the drop-down arrow below the **Intent** search box and choose **Administrative**.

A list of **Administrative** options appear in the **Intent** menu.

**Step 3** From the **Administrative** list in the **Intent** menu, click **Create Security Domain**. The **Create Security Domain** dialog box appears.

**Step 4** In the **Name** field, enter the name of the security domain.

**Step 5** In the **Description** field, enter a description of the security domain.

**Step 6** Click **Save** when finished.

## Creating a Role Using the Cisco Cloud Network Controller GUI

This section explains how to create a role using the Cisco Cloud Network Controller GUI.

**Step 1** Click the **Intent** icon. The **Intent** menu appears.

**Step 2** Click the drop-down arrow below the **Intent** search box and choose **Administrative**.

A list of **Administrative** options appear in the **Intent** menu.

**Step 3** From the **Administrative** list in the **Intent** menu, click **Create Role**. The **Create Role** dialog box appears.

**Step 4** Enter the appropriate values in each field as listed in the following *Create Role Dialog Box Fields* table then continue.

**Table 19: Create Role Dialog Box Fields**

Properties	Description
<b>General</b>	
<b>Name</b>	Enter a name for the role in the <b>Name</b> field.
<b>Description</b>	Enter a description of the role.
<b>Settings</b>	

Properties	Description
Privilege	

Properties	Description
	<p>Click to place a check mark in the check boxes of the privileges you want to assign the user. The privileges are:</p> <ul style="list-style-type: none"> <li>• <b>aaa</b>—Used for configuring authentication, authorization, accounting and import/export policies.</li> <li>• <b>access-connectivity-11</b>—Used for Layer 1 configuration under infra. Example: selectors and port Layer 1 policy configurations.</li> <li>• <b>access-connectivity-12</b>—Used for Layer 2 configuration under infra. Example: Encap configurations on selectors, and attachable entity.</li> <li>• <b>access-connectivity-13</b>—Used for Layer 3 configuration under infra and static route configurations under a tenant's L3Out.</li> <li>• <b>access-connectivity-mgmt</b>—Used for management infra policies.</li> <li>• <b>access-connectivity-util</b>—Used for tenant ERSPAN policies.</li> <li>• <b>access-equipment</b>—Used for access port configuration.</li> <li>• <b>access-protocol-11</b>—Used for Layer 1 protocol configurations under infra.</li> <li>• <b>access-protocol-12</b>—Used for Layer 2 protocol configurations under infra.</li> <li>• <b>access-protocol-13</b>—Used for Layer 3 protocol configurations under infra.</li> <li>• <b>access-protocol-mgmt</b>—Used for fabric-wide policies for NTP, SNMP, DNS, and image management.</li> <li>• <b>access-protocol-ops</b>—Used for operations-related access policies such as cluster policy and firmware policies.</li> <li>• <b>access-protocol-util</b>—Used for tenant ERSPAN policies.</li> <li>• <b>access-qos</b>—Used for changing CoPP and QoS-related policies.</li> <li>• <b>admin</b>—Complete access to everything (combine ALL roles)</li> <li>• <b>fabric-connectivity-11</b>—Used for Layer 1 configuration under the fabric. Example: selectors and port Layer 1 policy and vPC protection.</li> </ul>

Properties	Description
	<ul style="list-style-type: none"> <li>• <b>fabric-connectivity-l2</b>—Used in firmware and deployment policies for raising warnings for estimating policy deployment impact.</li> <li>• <b>fabric-connectivity-l3</b>—Used for Layer 3 configuration under the fabric. Example: Fabric IPv4 and MAC protection groups.</li> <li>• <b>fabric-connectivity-mgmt</b>—Used for atomic counter and diagnostic policies on leaf switches and spine switches.</li> <li>• <b>fabric-connectivity-util</b>—Used for atomic counter, diagnostic, and image management policies on leaf switches and spine switches.</li> <li>• <b>fabric-equipment</b>—Used for atomic counter, diagnostic, and image management policies on leaf switches and spine switches.</li> <li>• <b>fabric-protocol-l1</b>—Used for Layer 1 protocol configurations under the fabric.</li> <li>• <b>fabric-protocol-l2</b>—Used for Layer 2 protocol configurations under the fabric.</li> <li>• <b>fabric-protocol-l3</b>—Used for Layer 3 protocol configurations under the fabric.</li> <li>• <b>fabric-protocol-mgmt</b>—Used for fabric-wide policies for NTP, SNMP, DNS, and image management.</li> <li>• <b>fabric-protocol-ops</b>—Used for ERSPAN and health score policies.</li> <li>• <b>fabric-protocol-util</b>—Used for firmware management traceroute and endpoint tracking policies.</li> <li>• <b>none</b>—No privilege.</li> <li>• <b>nw-svc-device</b>—Used for managing Layer 4 to Layer 7 service devices.</li> <li>• <b>nw-svc-devshare</b>—Used for managing shared Layer 4 to Layer 7 service devices.</li> <li>• <b>nw-svc-params</b>—Used for managing Layer 4 to Layer 7 service policies.</li> <li>• <b>nw-svc-policy</b>—Used for managing Layer 4 to Layer 7 network service orchestration.</li> </ul>

Properties	Description
	<ul style="list-style-type: none"> <li>• <b>ops</b>—Used for operational policies including monitoring and troubleshooting policies such as atomic counter, SPAN, TSW, tech support, traceroute, analytics, and core policies.</li> <li>• <b>tenant-connectivity-11</b>—Used for Layer 1 connectivity changes, including bridge domains and subnets.</li> <li>• <b>tenant-connectivity-12</b>—Used for Layer 2 connectivity changes, including bridge domains and subnets.</li> <li>• <b>tenant-connectivity-13</b>—Used for Layer 3 connectivity changes, including VRFs.</li> <li>• <b>tenant-connectivity-mgmt</b>—Used for tenant in-band and out-of-band management connectivity configurations and for debugging/monitoring policies such as atomic counters and health score.</li> <li>• <b>tenant-connectivity-util</b>—Used for atomic counter, diagnostic, and image management policies on leaf switches and spine switches.</li> <li>• <b>tenant-epg</b>—Used for managing tenant configurations such as deleting/creating endpoint groups, VRFs, and bridge domains.</li> <li>• <b>tenant-ext-connectivity-12</b>—Used for managing tenant L2Out configurations.</li> <li>• <b>tenant-ext-connectivity-13</b>—Used for managing tenant L3Out configurations.</li> <li>• <b>tenant-ext-connectivity-mgmt</b>—Used as write access for firmware policies.</li> <li>• <b>tenant-ext-connectivity-util</b>—Used for debugging/monitoring/observer policies such as traceroute, ping, oam, and eptrk.</li> <li>• <b>tenant-ext-protocol-11</b>—Used for managing tenant external Layer 1 protocols. Generally only used for write access for firmware policies.</li> <li>• <b>tenant-ext-protocol-12</b>—Used for managing tenant external Layer 2 protocols. Generally only used for write access for firmware policies.</li> <li>• <b>tenant-ext-protocol-13</b>—Used for managing tenant external Layer 3 protocols such as BGP, OSPF, PIM, and IGMP.</li> <li>• <b>tenant-ext-protocol-mgmt</b>—Used as write access for firmware policies.</li> </ul>

Properties	Description
	<ul style="list-style-type: none"> <li>• <b>tenant-ext-protocol-util</b>—Used for debugging/monitoring/observer policies such as traceroute, ping, oam, and eptrk.</li> <li>• <b>tenant-network-profile</b>—Used for managing tenant configurations, such as deleting and creating network profiles, and deleting and creating endpoint groups.</li> <li>• <b>tenant-protocol-l1</b>—Used for managing configurations for Layer 1 protocols under a tenant.</li> <li>• <b>tenant-protocol-l2</b>—Used for managing configurations for Layer 2 protocols under a tenant.</li> <li>• <b>tenant-protocol-l3</b>—Used for managing configurations for Layer 3 protocols under a tenant.</li> <li>• <b>tenant-protocol-mgmt</b>—Only used as write access for firmware policies.</li> <li>• <b>tenant-protocol-ops</b>—Used for tenant traceroute policies.</li> <li>• <b>tenant-protocol-util</b>—Used for debugging/monitoring/observer policies such as traceroute, ping, oam, and eptrk.</li> <li>• <b>tenant-qos</b>—Only used as Write access for firmware policies.</li> <li>• <b>tenant-security</b>—Used for Contract related configurations for a tenant.</li> <li>• <b>vmm-connectivity</b>—Used to read all the objects in APIC's VMM inventory required for VM connectivity.</li> <li>• <b>vmm-ep</b>—Used to read VM and Hypervisor endpoints in the APIC's VMM inventory.</li> <li>• <b>vmm-policy</b>—Used for managing policies for VM networking.</li> <li>• <b>vmm-protocol-ops</b>—Not used by VMM policies.</li> <li>• <b>vmm-security</b>—Used for Contract related configurations for a tenant.</li> </ul>

**Step 5** Click **Save** when finished.

## Creating an RBAC Rule Using the Cisco Cloud Network Controller GUI

This section explains how to create an RBAC rule using the GUI.

**Before you begin**

Create a security domain.

- 
- Step 1** Click the **Intent** icon. The **Intent** menu appears.
- Step 2** Click the drop-down arrow below the **Intent** search box and choose **Administrative**.  
A list of **Administrative** options appears in the **Intent** menu.
- Step 3** From the **Administrative** list in the **Intent** menu, click **Create RBAC Rule**. The **Create RBAC Rule** dialog box appears.
- Step 4** In the **DN** field, enter the DN for the rule.
- Step 5** Choose a security domain:  
a) Click **Select Security Domain**. The **Select Security Domain** dialog box appears.  
b) From the **Select Security Domain** dialog box, click to choose a security domain from the column on the left then click **Select**. You return to the **Create RBAC Rule** dialog box.
- Step 6** From the **Allow Writes** field, click **Yes** to allow writes or **No** to not allow writes.
- Step 7** Click **Save** when finished.
- 

## Creating a Certificate Authority Using the Cisco Cloud Network Controller GUI

This section explains how to create a certificate authority using the GUI.

**Before you begin**

- Have the certificate chain.
- If the certificate authority is for a tenant, create the tenant.

- 
- Step 1** Click the **Intent** icon. The **Intent** menu appears.
- Step 2** Click the drop-down arrow below the **Intent** search box and choose **Administrative**.  
A list of **Administrative** options appears in the **Intent** menu.
- Step 3** From the **Administrative** list in the **Intent** menu, click **Create Certificate Authority**. The **Create Certificate Authority** dialog box appears.
- Step 4** Enter the appropriate values in each field as listed in the following *Create Certificate Authority Dialog Box Fields* table then continue.

**Table 20: Create Certificate Authority Dialog Box Fields**

Properties	Description
<b>Name</b>	Enter the name of the certificate authority.
<b>Description</b>	Enter a description of the certificate authority.



Properties	Description
Used for	<p>Choose from the following options:</p> <ul style="list-style-type: none"> <li>• <b>Tenant</b>—Choose if the certificate authority is for a specific tenant. When chosen, the <b>Select Tenant</b> option appears in the GUI.</li> <li>• <b>System</b>—Choose if the certificate authority is for the system.</li> </ul>
Select Tenant	<p>To choose a tenant:</p> <ol style="list-style-type: none"> <li>Click <b>Select Tenant</b>. The <b>Select Tenant</b> dialog box appears.</li> <li>From the <b>Select Tenant</b> dialog, click to choose a tenant in the left column then click <b>Select</b>. You return to the <b>Create Certificate Authority</b> dialog box.</li> </ol>
Certificate Chain	<p>Enter the certificate chain in the <b>Certificate Chain</b> text box.</p> <p><b>Note</b> Add the certificates for a chain in the following order:</p> <ol style="list-style-type: none"> <li>CA</li> <li>Sub-CA</li> <li>Subsub-CA</li> <li>Server</li> </ol>

**Step 5** Click **Save** when finished.

## Creating a Key Ring Using the Cisco Cloud Network Controller GUI

This section explains how to create a key ring using the Cisco Cloud Network Controller GUI.

### Before you begin

- Create a certificate authority.
- Have a certificate.
- If the key ring is for a specific tenant, create the tenant.

**Step 1** Click the **Intent** icon. The **Intent** menu appears.

**Step 2** Click the drop-down arrow below the **Intent** search box and choose **Administrative**.

A list of **Administrative** options appear in the **Intent** menu.

- Step 3** From the **Administrative** list in the **Intent** menu, click **Create Key Ring**. The **Create Key Ring** dialog box appears.
- Step 4** Enter the appropriate values in each field as listed in the following *Create Key Ring Dialog Box Fields* table then continue.

**Table 21: Create Key Ring Dialog Box Fields**

Properties	Description
<b>Name</b>	Enter the name of the key ring.
<b>Description</b>	Enter a description of the key ring.
<b>Used for</b>	<ul style="list-style-type: none"> <li>• <b>System</b>—The key ring is for the system.</li> <li>• <b>Tenant</b>—The key ring is for a specific tenant. Displays a <b>Tenant</b> field for specifying the tenant.</li> </ul>
<b>Select Tenant</b>	<p>To choose a tenant:</p> <ol style="list-style-type: none"> <li>a. Click <b>Select Tenant</b>. The <b>Select Tenant</b> dialog box appears.</li> <li>b. From the <b>Select Tenant</b> dialog, click to choose a tenant in the left column then click <b>Select</b>. You return to the <b>Create Key Ring</b> dialog box.</li> </ol>
<b>Settings</b>	
<b>Certificate Authority</b>	<p>To choose a certificate authority:</p> <ol style="list-style-type: none"> <li>a. Click <b>Select Certificate Authority</b>. The <b>Select Certificate Authority</b> dialog appears.</li> <li>b. Click to choose a certificate authority in the column on the left.</li> <li>c. Click <b>Select</b>. You return to the <b>Create Key Ring</b> dialog box.</li> </ol>
<b>Private Key</b>	<p>Choose one of the following:</p> <ul style="list-style-type: none"> <li>• <b>Generate New Key</b>—Generates a new key.</li> <li>• <b>Import Existing Key</b>—Displays the <b>Private Key</b> text box and enables you to use an existing key.</li> </ul>
<b>Private Key</b>	Enter an existing key in the <b>Private Key</b> text box (for the <b>Import Existing Key</b> option).

Properties	Description
<b>Modulus</b>	Click the <b>Modulus</b> drop-down list to choose from the following: <ul style="list-style-type: none"> <li>• <b>MOD 512</b></li> <li>• <b>MOD 1024</b></li> <li>• <b>MOD 1536</b></li> <li>• <b>MOD 2048</b>—(Default)</li> </ul>
<b>Certificate</b>	Enter the certificate information in the <b>Certificate</b> text box.

**Step 5** Click **Save** when finished.

## Creating a Local User Using the Cisco Cloud Network Controller GUI

This section explains how to create a local user using the Cisco Cloud Network Controller GUI.

**Step 1** Click the **Intent** icon. The **Intent** menu appears.

**Step 2** Click the drop-down arrow below the **Intent** search box and choose **Administrative**.

A list of **Administrative** options appear in the **Intent** menu.

**Step 3** From the **Administrative** list in the **Intent** menu, click **Create Local User**. The **Create Local User** dialog box appears.

**Step 4** Enter the appropriate values in each field as listed in the following *Create Local User Dialog Box Fields* table then continue.

**Table 22: Create Local User Dialog Box Fields**

Properties	Description
<b>Name</b>	Enter the username of the local user.
<b>Password</b>	Enter the password for the local user.
<b>Confirm Password</b>	Reenter the password for the local user.
<b>Description</b>	Enter a description of the local user.
<b>Settings</b>	
<b>Account Status</b>	To choose the account status: <ul style="list-style-type: none"> <li>• <b>Active</b>—Activates the local user account.</li> <li>• <b>Inactive</b>—Deactivates the local user account.</li> </ul>
<b>First Name</b>	Enter the first name of the local user.

Properties	Description
Last Name	Enter the last name of the local user.
Email Address	Enter the email address of the local user.
Phone Number	Enter the phone number of the local user.
Security Domains	<p>To add a security domain:</p> <ol style="list-style-type: none"> <li>a. Click <b>Add Security Domain</b>. The <b>Add Security Domain</b> dialog box appears.</li> <li>b. Click <b>Select Security Domain</b>. The <b>Select Security Domain</b> dialog box appears with a list of security domains in the left pane.</li> <li>c. Click to choose a security domain.</li> <li>d. Click <b>Select</b> to add the security domain. You return to the <b>Add Security Domain</b> dialog box.</li> <li>e. Add a user role: <ol style="list-style-type: none"> <li>1. From the <b>Add Security Domain</b> dialog box, click <b>Select Role</b>. The <b>Select Role</b> dialog box appears with a list of roles in the left pane.</li> <li>2. Click to choose a role.</li> <li>3. Click <b>Select</b> to add the the role. You return to the <b>Add Security Domain</b> dialog box.</li> <li>4. From the <b>Add Security Domain</b> dialog box, click the <b>Privilege Type</b> drop-down list and choose <b>Read Privilege</b> or <b>Write Privilege</b>.</li> <li>5. Click the check mark on the right side of the <b>Privilege Type</b> drop-down list to confirm.</li> <li>6. Click <b>Add</b> when finished. You return to the <b>Create Local User</b> dialog box where you can add another security domain.</li> </ol> </li> </ol>

**Step 5** Click **Advanced Settings** and enter the appropriate values in each field as listed in the following *Create Local User Dialog Box Fields: Advanced Settings* table then continue.

**Table 23: Create Local User Dialog Box Fields: Advanced Settings**

Property	Description
Account Expires	If you choose <b>Yes</b> , the account is set to expire at the time that you choose.
Password Update Required	If you choose <b>Yes</b> , the user must change the password upon the next login.

Property	Description
OTP	Put a check in the box to enable the one-time password feature for the user.
User Certificates	To add a user certificate: <ol style="list-style-type: none"> <li>a. Click <b>Add X509 Certificate</b>. The <b>Add X509 Certificate</b> dialog box appears.</li> <li>b. Enter a name in the <b>Name</b> field.</li> <li>c. Enter the X509 certificate in the <b>User X509 Certificate</b> text box.</li> <li>d. Click <b>Add</b>. The <b>X509 certificate in the User X509 Certificate</b> dialog box closes. You return to the <b>Local User</b> dialog box.</li> </ol>
SSH Keys	To add a an SSH key: <ol style="list-style-type: none"> <li>a. Click <b>Add SSH Key</b>. The <b>Add SSH Key</b> dialog box appears.</li> <li>b. Enter a name in the <b>Name</b> field.</li> <li>c. Enter the SSH key in the <b>Key</b> text box.</li> <li>d. Click <b>Add</b>. The <b>Add SSH Key</b> dialog box closes. You return to the <b>Local User</b> dialog box.</li> </ol>

**Step 6** Click **Save** when finished.

## Managing Regions (Configuring a Cloud Template) Using the Cisco Cloud Network Controller GUI

Regions are configured during the first-time setup. When configured, you specify the regions that are managed by Cisco Cloud Network Controller and the region's inter-site and inter-region connectivity. This section explains how to manage regions with the cloud template using the Cisco Cloud Network Controller GUI after the initial installation.

For more information about cloud templates, see [About the Cloud Template, on page 34](#).

**Step 1** Click the **Intent** icon. The **Intent** menu appears.

**Step 2** Click the drop-down arrow below the **Intent** search box and choose **Configuration**.

A list of options appear in the **Intent** menu.

**Step 3** From the **Configuration** list in the **Intent** menu, click **Cisco Cloud Network Controller Setup**. The **Set up - Overview** dialog box appears.

- Step 4** In the **Region Management** area, click **Edit Configuration**.  
The **Setup - Region Management** dialog box appears, and the first step in the **Setup - Region Management** series of steps appears, **Regions to Manage**, with a list of managed regions.
- Step 5** If you want inter-site connectivity, click to place a check mark in the **Enabled** box in the **Inter-Site Connectivity** area. The **Inter-Site Connectivity** step is added in the **Setup - Region Management** steps at the top of the page.
- Step 6** To choose a region that you want to be managed by the Cisco Cloud Network Controller, click to place a check mark in check box of that region.
- Step 7** To deploy cloud routers locally to this region, click to place a check mark in the **Cloud Routers** check box for that region.
- Step 8** To configure the fabric infra connectivity for the cloud site, click **Next**.  
The next step in the **Setup - Region Management** series of steps appears, **General Connectivity**
- Step 9** To add a subnet pool for the CCRs, click **Add Subnet Pool for Cloud Router** and enter the subnet in the text box.
- Note** The /24 subnet provided during the Cisco Cloud Network Controller deployment would be sufficient for up to two cloud sites. If you need to manage more than two cloud sites, you need to add more subnets.
- Step 10** Enter a value in the **BGP Autonomous System Number for CCRs** field.  
The BGP ASN can be in the range of 1 - 65534.
- Step 11** In the **Assign Public IP to CCR Interface** field, determine if you want to assign public IP addresses to the Catalyst 8000V interfaces.  
Private IP addresses are assigned to the Catalyst 8000V interfaces by default. The **Assign Public IP to CCR Interface** option determines whether public IP addresses will also be assigned to the Catalyst 8000V interfaces or not.  
By default, the **Enabled** check box is checked. This means that public IP addresses can be assigned to the Catalyst 8000Vs.
- If you want *public* IP addresses assigned to the Catalyst 8000Vs in addition to the private IP addresses, leave the check in the box next to **Enabled**.
  - If you want only *private* IP addresses assigned to the Catalyst 8000Vs, remove the check in the box next to **Enabled** to disable this option.
- Note that changing the Catalyst 8000V connectivity from private to public, or vice versa, may cause disruption in your network.
- Note** Both the public and private IP addresses assigned to a CCR are displayed with the other details of the router in the **Cloud Resources** area. If public IP addresses are not assigned to a CCR, only the private IP addresses are displayed.
- Step 12** To choose the number of routers per region, click the **Number of Routers Per Region** drop-down list and click **2**, **3**, or **4**.
- Step 13** Enter a username in the **Username** text box.
- Step 14** Enter a password in the **Password** and **Confirm Password** text boxes.
- Step 15** To choose the throughput value, click the **Throughput of the routers** drop-down list.
- Note**
- Cloud routers should be undeployed from all regions before changing the throughput or login credentials.
  - For information on the throughput values for the Cisco Catalyst 8000V, see [About the Cisco Catalyst 8000V, on page 20](#).

- Step 16** (Optional) To specify the license token, enter the product instance registration token in the **License Token** text box.
- Note**
- For licensing information for the Cisco Catalyst 8000V, see [About the Cisco Catalyst 8000V, on page 20](#).
  - If no token is entered, the CCR will be in EVAL mode.
  - If the public IP addresses are disabled to the CCRs in [Step 11, on page 108](#), the only supported option is **AWS Direct Connect or Azure Express Route to Cisco Smart Software Manager (CSSM)** when registering smart licensing for CCRs with private IP addresses (available by navigating to **Administrative > Smart Licensing**). You must provide reachability to the CSSM through AWS Direct Connect or Azure Express Route in this case. When the public IP addresses are disabled, public internet cannot be used because private IP addresses are being used. The connectivity should therefore use Private Connection, which is AWS Direct Connect or Azure Express Route.
- Step 17** Click **Next**.
- If you placed a check mark in the **Enabled** box in the **Inter-Site Connectivity** area earlier in these procedures, **Inter-Site Connectivity** appears as the next step in the **Setup - Region Management** series of steps. Go to [Step 18, on page 109](#).
  - If you did not place a check mark in the **Enabled** box in the **Inter-Site Connectivity** area earlier in these procedures, go to [Step 22, on page 109](#).
- Step 18** To enter a peer public IP address of the IPsec Tunnel peer on-premises in the text box, click **Add Public IP of IPsec Tunnel Peer**.
- Step 19** Enter the OSPF area ID in the **OSPF Area Id** text box.
- Step 20** To add an external subnet pool, click **Add External Subnet** and enter a subnet pool in the text box.
- Step 21** When you have configured all the connectivity options, click **Next** at the bottom of the page.
- Step 22** Click **Save and Continue** when finished.
- 

# Configuring Cisco Cloud Network Controller Using the REST API

## Creating a Tenant Using the REST API

This section demonstrates how to create a tenant and assigns using the REST API.

---

To create a tenant:

```
<polUni>
  <fvTenant name="infra">
    <cloudAwsProvider region="us-east-1" accessKeyId="123" secretAccessKey="ABCDE" providerId="admin"
      status=""/>
  </fvTenant>
</polUni>
```

```
</fvTenant>
</polUni>
```

---

## Creating a Contract Using the REST API

This example demonstrates how to create a contract for the Cisco Cloud Network Controller using the REST API.

### Before you begin

Create filters.

---

To create a contract:

### Example:

```
<polUni>
  <fvTenant name="t2" status="">
    <vzFilter descr="" name="http-family-destination" ownerKey="" ownerTag="">
      <vzEntry name="http" prot="tcp" etherT="ip" dFromPort="http" dToPort="http"/>
      <vzEntry name="https" prot="tcp" etherT="ip" dFromPort="https" dToPort="https"/>
    </vzFilter>
    <vzBrCP name="httpFamily">
      <vzSubj name="default" revFltPorts="yes" targetDscp="unspecified">
        <vzRsSubjFiltAtt action="permit" directives="" tnVzFilterName="http-family-destination"/>
      </vzSubj>
    </vzBrCP>
  </fvTenant>
</polUni>
```

---

## Creating a Cloud Context Profile Using the REST API

This section demonstrates how to create a cloud context profile.

### Before you begin

Create a VRF.

---

To create a cloud context profile using the cloud availability zones, enter a post such as the following example.

If you are creating a cloud context profile in a **user** tenant, you are restricted to only **cloud** availability zones. The cloud availability zones are created through the `zone` field highlighted below. For more information on the cloud availability zones, see [Availability Zones, on page 27](#).

### Example:

```
<polUni>
<fvTenant name="Corp1" status="">
  <cloudAwsProvider accessKeyId="" secretAccessKey="" providerId="aws" status="" accountId=""/>

  <fvCtx name="prod-1" status="">
```



```

    <bgpRtTargetP af="ipv4-ucast">
      <bgpRtTarget rt="route-target:as4-nn2:400:400" type="export"/>
      <bgpRtTarget rt="route-target:as4-nn2:400:400" type="import"/>
    </bgpRtTargetP>
  </fvCtx>

  <fvCtx name="prod-2" status="">
    <bgpRtTargetP af="ipv4-ucast">
      <bgpRtTarget rt="route-target:as4-nn2:500:500" type="export"/>
      <bgpRtTarget rt="route-target:as4-nn2:500:500" type="import"/>
    </bgpRtTargetP>
  </fvCtx>

  <cloudVpnGwPol name="VgwPol" status=""/>

  <cloudApp name="payment" status="">
    <cloudEPg name="web" status="">
      <cloudRsCloudEPgCtx tnFvCtxName="prod-1" />
    </cloudEPg>
  </cloudApp>
  <cloudApp name="billing">
    <cloudEPg name="app">
      <cloudRsCloudEPgCtx tnFvCtxName="prod-2" />
    </cloudEPg>
  </cloudApp>

  <cloudCtxProfile name="prod-web-east-1">
    <cloudRsCtxProfileToRegion tDn="uni/clouddomp/provp-aws/region-us-east-1"/>
    <cloudRsToCtx tnFvCtxName="prod-1"/>
    <cloudRouterP name="RouterP1" type="vpn-gw">
      <cloudRsToVpnGwPol tnCloudVpnGwPolName="VgwPol"/>
      <cloudIntNetworkP name="IntNetworkP1"/>
    </cloudRouterP>
    <cloudCidr addr="10.10.0.0/16" primary="yes">
      <cloudSubnet ip="10.10.1.0/24" usage="gateway" scope="public" zone="us-west-1a"/>
      <cloudSubnet ip="10.10.2.0/24" scope="public" zone="us-west-1b"/>
    </cloudCidr>
  </cloudCtxProfile>

  <cloudCtxProfile name="prod-payment-east-1" status="">
    <cloudRsCtxProfileToRegion tDn="uni/clouddomp/provp-aws/region-us-east-1"/>
    <cloudRsToCtx tnFvCtxName="prod-2" status=""/>
    <cloudRouterP name="RouterP1" type="vpn-gw">
      <cloudRsToVpnGwPol tnCloudVpnGwPolName="VgwPol"/>
      <cloudIntNetworkP name="IntNetworkP1" status=""/>
    </cloudRouterP>
    <cloudCidr addr="20.10.0.0/16" primary="yes">
      <cloudSubnet ip="20.10.1.0/24" scope="public" zone="us-west-1a"/>
    </cloudCidr>
  </cloudCtxProfile>

</fvTenant>
</polUni>

```

## Managing a Cloud Region Using the REST API

This section demonstrates how to manage a cloud region using the REST API.

---

To create a cloud region:

```
<polUni>
  <cloudDomP name="dom-us-east-2">
    <cloudBgpAsP asn="64513"/>
    <cloudProvP vendor="aws">
      <cloudRegion name="us-east-2" adminSt="managed">
        <cloudZone name="us-east-2a"/>
        <cloudZone name="us-east-2b"/>
      </cloudRegion>
    </cloudProvP>
  </cloudDomP>
</polUni>
```

---

## Creating a Filter Using the REST API

This section demonstrates how to create a filter using the REST API.

---

To create a filter:

```
https://<IP_Address>/api/node/mo/.xml
<polUni>
<fvTenant name="intervpc" >
<fvCtx name="VRF1"/>
  <cloudApp name="CloudAPI" >
    <cloudEPg name="CloudEPG1" >
      <cloudRsCloudEPgCtx tnFvCtxName="VRF1"/>
      <fvRsProv tnVzBrCPName="Contract2" > </fvRsProv>
      <cloudEPSelector name="sell" matchExpression="custom:epgtag=='cloudepg1'" />
    </cloudEPg>
  </cloudApp>

  <vzFilter name="http" annotation="orchestrator:msc" >
    <vzEntry name="Entry3" prot="tcp" etherT="ipv4" arpOpc="unspecified" stateful="no"
applyToFrag="no" sFromPort="unspecified" sToPort="unspecified" dFromPort="80" dToPort="80" > </vzEntry>

  </vzFilter>

  <vzBrCP name="Contract2" scope="global">
    <vzSubj name="test-subj" >

      <vzRsSubjFiltAtt action="permit" tnVzFilterName="http" directives="none" />

    </vzSubj>
  </vzBrCP>
</fvTenant>
</polUni>
```

---

## Creating an Application Profile Using the REST API

This section demonstrates how to create an application profile using the REST API.

### Before you begin

Create a tenant.

To create an application profile:

```
https://<IP_Address>/api/node/mo/.xml
<polUni>
<fvTenant name="intervpc" >
<fvCtx name="VRF1"/>
  <cloudApp name="CloudAP1" >

    <cloudEPg name="CloudEPG1" >
      <cloudRsCloudEPgCtx tnFvCtxName="VRF1"/>
      <fvRsProv tnVzBrCPName="Contract2" > </fvRsProv>
      <cloudEPSelector name="sell" matchExpression="custom:epgtag=='cloudepg1'" />
    </cloudEPg>

  </cloudApp>

  <vzFilter name="http" annotation="orchestrator:msc" >
    <vzEntry name="Entry3" prot="tcp" etherT="ipv4" arpOpc="unspecified" stateful="no"
applyToFrag="no" sFromPort="unspecified" sToPort="unspecified" dFromPort="80" dToPort="80" > </vzEntry>

  </vzFilter>
  <vzBrCP name="Contract2" scope="global">
    <vzSubj name="test-subj" >
      <vzRsSubjFiltAtt action="permit" tnVzFilterName="http" directives="none" />
    </vzSubj>
  </vzBrCP>
</fvTenant>
</polUni>
```

## Creating a Cloud EPG Using the REST API

This example demonstrates how to create a cloud EPG using the REST API.

### Before you begin

Create an application profile and a VRF.

To create a cloud EPG:

#### Example:

```
<polUni>
  <fvTenant name="t2" status="">
    <!-- Tenant provide AWS credentials -->
    <cloudAwsProvider region="us-east-2" accessKeyId="123" secretAccessKey="ABCDE" providerId="admin"/>
  </fvTenant>
</polUni>
```

```

<fvCtx name="v1" status=""/>
<cloudApp name="ap">
  <cloudEPg name="provEPG" status="">
    <cloudRsCloudEPgCtx tnFvCtxName="v1"/>
    <cloudEPSelector name="1" matchExpression="custom:tag=='provfoo'"/>
    <cloudEPSelector name="2" matchExpression="custom:tag=='provbaz'"/>
    <fvRsProv tnVzBrCPName="httpFamily"/>
  </cloudEPg>
  <cloudEPg name="consEPG">
    <cloudRsCloudEPgCtx tnFvCtxName="v1"/>
    <cloudEPSelector name="1" matchExpression="custom:tag=='consfoo'"/>
    <cloudEPSelector name="2" matchExpression="custom:tag=='consbaz'"/>
    <fvRsCons tnVzBrCPName="httpFamily"/>
  </cloudEPg>
</cloudApp>
</fvTenant>
</polUni>

```

## Creating an External Cloud EPG Using the REST API

This example demonstrates how to create an external cloud EPG using the REST API.

### Before you begin

Create an application profile and a VRF.

To create an external cloud EPG:

### Example:

```

<polUni>
  <fvTenant name="t2" status="">
    <!-- Tenant provide AWS credentials -->
    <cloudAwsProvider region="us-east-2" accessKeyId="123" secretAccessKey="ABCDE" providerId="admin"/>

    <fvCtx name="v1" status=""/>
    <cloudApp name="ap">
      <cloudEPg name="provEPGInternet" status="">
        <cloudRsCloudEPgCtx tnFvCtxName="v1"/>
        <cloudEPSelector name="1" matchExpression="custom:tag=='provfoo'"/>
        <cloudEPSelector name="2" matchExpression="custom:tag=='provbaz'"/>
        <fvRsProv tnVzBrCPName="httpFamily"/>
      </cloudEPg>
      <cloudExtEPg name="consInternetEPG">
        <cloudRsCloudEPgCtx tnFvCtxName="v1"/>
        <cloudExtEPSelector name="1" subnet="0.0.0.0/0"/>
        <fvRsCons tnVzBrCPName="httpFamily"/>
      </cloudExtEPg>
    </cloudApp>
  </fvTenant>
</polUni>

```

## Creating a Cloud Template Using the REST API

This section demonstrates how to create a cloud template using the REST API. For more information about cloud templates, see [About the Cloud Template, on page 34](#).

The REST API will change depending on the type of Licensing model selected. The license type of the Cisco Catalyst 8000V is captured by the property `routerThroughput` in the `cloudtemplateProfile` managed object .

If the `routerThroughput` value belongs to **T0/T1/T2/T3** then **BYOL** Cisco Catalyst 8000V is deployed on Cisco Cloud Network Controller. If `routerThroughput` value is **PAYG** then **PAYG** Cisco Catalyst 8000V is deployed on Cisco Cloud Network Controller.

**Step 1** To create a cloud template for the **BYOL Licensing Model** Cisco Catalyst 8000V:

```
<polUni>
  <fvTenant name="infra">
    <cloudtemplateInfraNetwork name="default" vrfName="overlay-1">
      <cloudtemplateProfile name="default" routerUsername="admin" routerPassword="rtppsw"
routerThroughput="15"
          routerLicenseToken="hYjZhYjItYTg0mrtrLl5ocStS%0AUzRSZz0%3"
routerMgmtInterfacePublicIp="yes" routerDataInterfacePublicIp="yes"/>

      <cloudtemplateExtSubnetPool subnetpool="10.20.0.0/16"/>

      <cloudtemplateIntNetwork name="default">
        <cloudRegionName provider="aws" region="us-west-1"/>
        <cloudRegionName provider="aws" region="us-west-2"/>
      </cloudtemplateIntNetwork>

      <cloudtemplateExtNetwork name="default">
        <cloudRegionName provider="aws" region="us-west-2"/>

        <cloudtemplateVpnNetwork name="default">

          <cloudtemplateIpSecTunnel peeraddr="23.2.1.1/32" />
          <cloudtemplateIpSecTunnel peeraddr="23.0.1.1/32" />
          <cloudtemplateIpSecTunnel peeraddr="23.1.1.1/32" />

          <cloudtemplateOspf area="0.0.0.1"/>

        </cloudtemplateVpnNetwork>

        <cloudtemplateBgpEvpn peeraddr="34.1.1.1/32" asn="63000" siteId="123" password="abcd1234" />

      </cloudtemplateExtNetwork>
    </cloudtemplateInfraNetwork>
  </fvTenant>
</polUni>
```

**Note** Tier2 (T2) is the default throughput supported by Cisco Cloud Network Controller, which is indicated by the property `routerThroughput` in the `cloudtemplateProfile` managed object above.

**Step 2** To create a cloud template for the **PAYG Licensing Model** Cisco Catalyst 8000V:

```
<polUni>
  <fvTenant name="infra">
    <cloudtemplateInfraNetwork name="default" vrfName="overlay-1">
      <cloudtemplateProfile name="default" routerUsername="admin" routerPassword="rtppsw"
```

```

routerThroughput="PAYG"
  vmName="c5.4xlarge" routerMgmtInterfacePublicIp="yes" routerDataInterfacePublicIp="yes"/>

  <cloudtemplateExtSubnetPool subnetpool="10.20.0.0/16"/>

  <cloudtemplateIntNetwork name="default">
    <cloudRegionName provider="aws" region="us-west-1"/>
    <cloudRegionName provider="aws" region="us-west-2"/>
  </cloudtemplateIntNetwork>

  <cloudtemplateExtNetwork name="default">
    <cloudRegionName provider="aws" region="us-west-2"/>

    <cloudtemplateVpnNetwork name="default">

      <cloudtemplateIpSecTunnel peeraddr="23.2.1.1/32" />
      <cloudtemplateIpSecTunnel peeraddr="23.0.1.1/32" />
      <cloudtemplateIpSecTunnel peeraddr="23.1.1.1/32" />

      <cloudtemplateOspf area="0.0.0.1"/>

    </cloudtemplateVpnNetwork>

    <cloudtemplateBgpEvpn peeraddr="34.1.1.1/32" asn="63000" siteId="123" password="abcd1234" />

  </cloudtemplateExtNetwork>
</cloudtemplateInfraNetwork>
</fvTenant>
</polUni>

```

On selecting PAYG throughput user must also select the **vmName** from a list of vmName which is already created by Cisco Cloud Network Controller, and is represented by a managed object `cloudProvVmType`.

The following table lists the vmNamesTypes that are indicated by the property `vmName` in the `cloudtemplateProfile`

AWS EC2 Instance	CCR Throughput	vCPUs	Memory
c5.xlarge	up to 5 Gigabit throughput	4	8 GiB
c5.2xlarge	up to 10 Gigabit throughput	8	16 GiB
c5.4xlarge	up to 10 Gigabit throughput	16	32 GiB
c5.9xlarge	up to 10 Gigabit throughput	36	72 GiB
c5n.xlarge	up to 25 Gigabit throughput	4	10.5 GiB
c5n.2xlarge	up to 25Gigabit throughput	8	21 GiB
c5n.4xlarge	up to 25 Gigabit throughput	16	42 GiB
c5n.9xlarge	up to 50 Gigabit throughput	36	96 GiB

## Configuring VRF Leak Routes Using the REST API

### Before you begin

Review the information provided in [Route Leaking Between Internal VRFs, on page 7](#) and [Global Inter-VRF Route Leak Policy, on page 8](#) before proceeding with the instructions in this section.

**Step 1** Enter a post similar to the following to enable or disable contract-based routing.

```
<fvTenant name="infra">
  <cloudVrfRouteLeakPol name="default" allowContractBasedRouting="true"/>
</fvTenant>
```

Where the `allowContractBasedRouting` field has either of the following settings:

- **true:** Indicates that routes are leaked based on contracts in the absence of route maps. When enabled, contracts drive routing when route maps are not configured. When route maps exist, route maps always drives routing.
- **false:** Default setting. Indicates that routes are not leaked based on contracts, and are leaked based on route maps instead.

**Step 2** Enter a post similar to the following to use the `leakInternalPrefix` field to configure route leaking for all cloud CIDRs associated with the VRFs.

```
<fvTenant name="t1">
  <fvCtx name="v1">
    <leakRoutes>
      <leakInternalPrefix ip="0.0.0.0/0" le="32">
        <leakTo tenantName="t2" ctxName="v2" scope="public"/>
      </leakInternalPrefix>
    </leakRoutes>
  </fvCtx>
</fvTenant>

<fvTenant name="t2">
  <fvCtx name="v2">
    <leakRoutes>
      <leakInternalPrefix ip="0.0.0.0/0" le="32">
        <leakTo tenantName="t1" ctxName="v1" scope="public"/>
      </leakInternalPrefix>
    </leakRoutes>
  </fvCtx>
</fvTenant>
```

**Step 3** Enter a post similar to the following to use the `leakInternalSubnet` field to leak specific routes between a pair of VRFs.

```
<fvTenant name="anyTenant" status="">
  <fvCtx name="VRF1" >
    <leakRoutes status="">
      <leakInternalSubnet ip="110.110.1.0/24" >
        <leakTo ctxName="VRF2" scope="public" tenantName=" anyTenant " />
      </leakInternalSubnet>
    </leakRoutes>
  </fvCtx>
  <fvCtx name="VRF2" status="" >
    <leakRoutes status="">
      <leakInternalSubnet ip="110.110.2.0/24" >
```

```

        <leakTo ctxName="VRF1" scope="public" tenantName=" anyTenant " />
    </leakInternalSubnet>
</leakRoutes>
</fvCtx>
</fvTenant>

```

## Configuring the Source Interface Selection for Tunnels Using the REST API

### Before you begin

Review the information provided in [Source Interface Selection for Tunnels, on page 9](#) before proceeding with these instructions.

Enter a post similar to the following to configure the source interface selection for tunnels.

```

<cloudtemplateInfraNetwork name="default" vrfName="overlay-1">
  <cloudtemplateProfile name="defaultxyz" routerUsername="james" routerPassword="bond@7" />

  <cloudtemplateIpSecTunnelSubnetPool subnetpool="10.20.0.0/16" poolname="pool1" />

  <cloudtemplateIntNetwork name="default">
    <cloudRegionName provider="aws" region="us-west-1"/>
    <cloudRegionName provider="aws" region="us-west-2"/>
  </cloudtemplateIntNetwork>

  <cloudtemplateExtNetwork name="something" vrfName="xyz" >
    <cloudRegionName provider="aws" region="us-west-2"/>
    <cloudtemplateVpnNetwork name="default">
      <cloudtemplateIpSecTunnel peeraddr="23.2.1.1/32" poolname="" presharedkey="abcd"
ikeVersion="v1|v2">
        <cloudtemplateIpSecTunnelSourceInterface sourceInterfaceId="2" />
      </cloudtemplateIpSecTunnel>
    </cloudtemplateVpnNetwork>
  </cloudtemplateExtNetwork>
</cloudtemplateInfraNetwork>

```





## CHAPTER 5

# Viewing System Details

---

- [Monitoring VM Host Metrics, on page 119](#)
- [Viewing Application Management Details, on page 122](#)
- [Viewing Cloud Resource Details, on page 123](#)
- [Viewing Operations Details, on page 124](#)
- [Viewing Infrastructure Details, on page 126](#)
- [Viewing Administrative Details, on page 126](#)
- [Viewing Health Details Using the Cisco Cloud Network Controller GUI, on page 128](#)

## Monitoring VM Host Metrics

Support is available for monitoring metrics for the VM host where the Cisco Cloud Network Controller is deployed using the Prometheus Node Exporter. The Prometheus Node Exporter provides visibility to a wide variety of hardware and kernel-related metrics, where it collects technical information from Linux nodes, such as CPU, disk, and memory statistics. For overview information on the Prometheus Node Exporter, see:

<https://prometheus.io/docs/introduction/overview/>

If your Cisco Cloud Network Controller is running on release 25.0(1) or later, the Prometheus Node Exporter is automatically available by default.

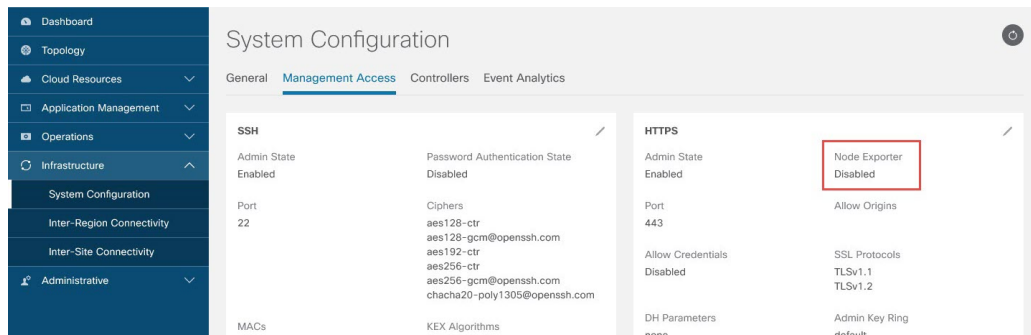
### Guidelines and Limitations

HTTP is not supported for monitoring metrics using the Prometheus Node Exporter. Only HTTPS is supported for monitoring metrics using the Prometheus Node Exporter.

## Monitoring VM Host Metrics Using the GUI

These procedures describe how to enable the Prometheus Node Exporter to monitor VM host metrics using the GUI.

- 
- Step 1** In the Cisco Cloud Network Controller GUI, navigate to **Infrastructure > System Configuration**, then click on the **Management Access** tab.
- Step 2** In the **HTTPS** area to the right of the window, note the entry in the **Node Exporter** field.

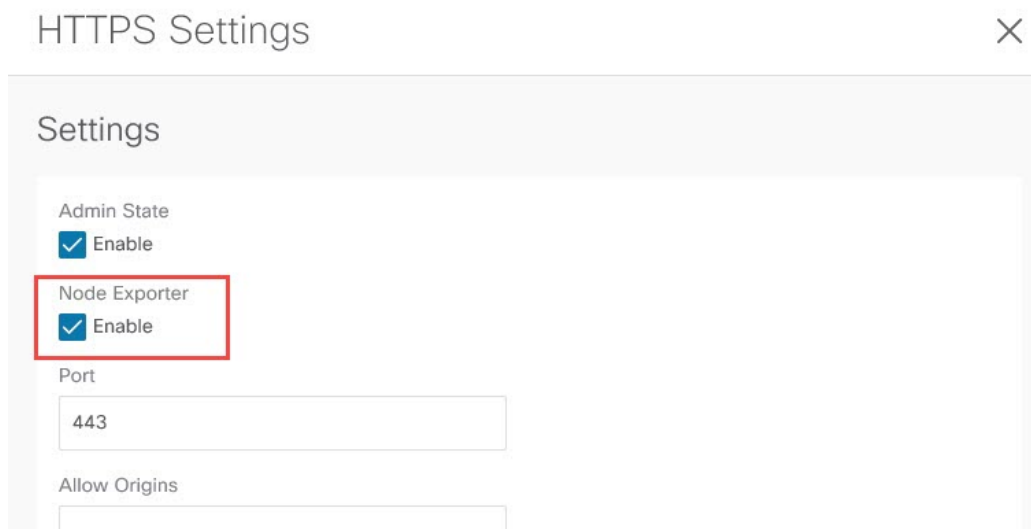


- **Enabled:** The Prometheus Node Exporter has already been enabled. You do not have to continue with these instructions in that case.
- **Disabled:** The Prometheus Node Exporter is not enabled yet. Proceed with these instructions to enable the Prometheus Node Exporter.

**Step 3** Click the pencil icon in the **HTTPS** area to edit the HTTPS settings.

The **HTTPS Settings** window appears.

**Step 4** Locate the **Node Exporter** field and click **Enable**.



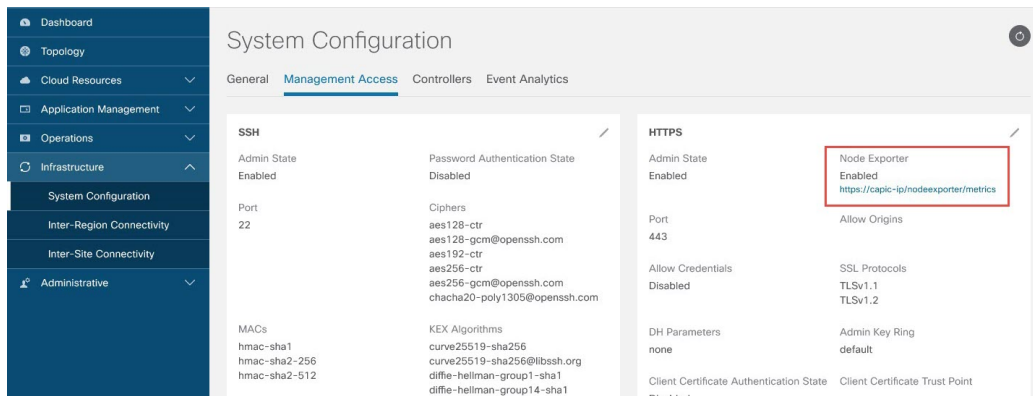
A warning message appears, telling you that saving these settings will restart the web service, and that it will take a moment for it to resume responding to requests. Click **OK** to confirm these changes.

**Step 5** At the bottom of the window, click **Save**.

You are returned to the **System Configuration/Management Access** window. The web service reboots and comes back online in a few seconds.

**Step 6** In the **HTTPS** area to the right of the window, verify that the entry in the **Node Exporter** field is set to **Enabled**.

This verifies that the Prometheus Node Exporter is enabled.



**Step 7** Click the link under the **Enabled** text in the **Node Exporter** area.

Another tab in your browser appears, showing the metrics for the VM host where the Cisco Cloud Network Controller is deployed.

## Monitoring VM Host Metrics Using the REST API

These procedures describe how to enable the Prometheus Node Exporter to monitor VM host metrics using the REST API.

**Step 1** To determine if the Prometheus Node Exporter is enabled or not, send the following GET call:

```
GET https://<cloud-network-controller-ip-address>/api/mo/uni/fabric/comm-default/https.xml
```

Locate the `nodeExporter` field to determine if it is set to `enabled` or `disabled`.

**Step 2** To monitor VM host metrics, send the following post to enable the Prometheus Node Exporter:

```
POST https://<cloud-network-controller-ip-address>/api/mo/uni/fabric/comm-default/https.xml
<commHttps nodeExporter="enabled" />
```

The metrics are displayed for the VM host where the Cisco Cloud Network Controller is deployed.

**Step 3** To view the metrics using REST API, send the following GET call:

```
GET https://<cloud-network-controller-ip-address>/nodeexporter/metrics
```

**Step 4** To disable the Prometheus Node Exporter, send the following post:

```
POST https://<cloud-network-controller-ip-address>/api/mo/uni/fabric/comm-default/https.xml
<commHttps nodeExporter="disabled" />
```

# Viewing Application Management Details

This section explains how to view application management details using the Cisco Cloud Network Controller GUI. The application management details include the information of a specific tenant, application profile, EPG, contract, filter, VRF, service, or cloud context profile.

**Step 1** From the **Navigation** menu, choose the **Application Management** tab.

When the **Application Management** tab expands, a list of subtab options appear. See the *Application Management Options* table for more information.

**Table 24: Application Management Subtabs**

Subtab Name	Description
<b>Tenants</b>	Displays tenants as rows in a summary table.
<b>Application Profiles</b>	Displays application profiles as rows in a summary table.
<b>EPGs</b>	Displays an EPGs as rows in a summary table.
<b>Contracts</b>	Displays a contracts as rows in a summary table.
<b>Filters</b>	Displays filters as rows in a summary table.
<b>VRFs</b>	Displays VRFs as rows in a summary table.
<b>Services</b>	Contains the following two subtabs and information: <ul style="list-style-type: none"> <li>• <b>Devices</b>—Displays the devices as rows in a summary table.</li> <li>• <b>Service Graphs</b>—Displays service graphs as rows in a summary table.</li> </ul>
<b>Cloud Context Profiles</b>	Displays cloud context profiles as rows in a summary table.

**Step 2** Click the tab that represents the component with the details you want to view.

A summary table appears with items as rows in the table. For example, if you chose the **Tenants** subtab, a list of tenants appear as rows in a summary table

You can filter the rows by clicking the Filter by Attributes bar. Choose the attribute, operator and filter-value. For example, for filtering based on a tenant, choose Tenant == T1 (where T1 is the name of a tenant).

**Step 3** To view a summary pane, click the row that represents the specific component you want to view.

**Step 4** For more information, double-click the summary table row that represents the specific component you want to view.

A new dialog box appears over the **work** pane with any of the following tabs:

**Note** The tabs that appear differ between components and configurations.

- **Overview**—Provides a general overview of cloud resources, configuration relationships, and settings of the component.

- **Cloud Resources**—Contains a list of subtabs that display the cloud resource information related to the component.
- **Configuration**—Contains one or more subtabs that display the configuration information related to the component.
- **Statistics**—Enables you to view statistics based on a chosen sampling interval and statistics type. The **Statistics** tab may contain subtabs, depending on the component you are viewing.
- **Event Analytics**—Contains a list of subtabs that display faults, events, and audit logs.

**Note** The dialog box that appears over the **work** pane contains an **edit** button in the top-right corner between the **refresh** button and the **Actions** button. When clicked, the **edit** button enables you to edit the chosen component.

## Viewing Cloud Resource Details

This section explains how to view cloud resource details using the Cisco Cloud Network Controller GUI. The cloud resource details include the information about a specific region, availability zone, VPC, router, security group, endpoint, instance, and cloud service.

**Step 1** From the **Navigation** menu, choose the **Cloud Resources** tab.

When the **Cloud Resources** tab expands, a list of subtab options appear. See the *Cloud Resource Options* table for more information.

**Table 25: Cloud Resource Subtabs**

Subtab Name	Description
<b>Regions</b>	Displays regions as rows in a summary table.
<b>Availability Zones</b>	Displays the availability zones as rows in a summary table.
<b>VPCs</b>	Displays VPCs as rows in a summary table.
<b>Routers</b>	Displays routers as rows in a summary table.
<b>Security Groups</b>	Displays security groups as rows in a summary table.
<b>Endpoints</b>	Displays endpoints as rows in a summary table.
<b>Instances</b>	Displays the instances as rows in a summary table.
<b>Cloud Services</b>	Contains the following subtabs: <ul style="list-style-type: none"> <li>• <b>Cloud Services</b> Tab—Displays cloud services as rows in a summary table.</li> <li>• <b>Target Groups</b> Tab—Displays target groups as rows in a summary table.</li> </ul>

**Step 2** Click the tab that represents the component with the details you want to view.

A summary table appears with items as rows in the table. For example, if you chose the **Endpoints** subtab, a list of endpoints appear as rows in a summary table

You can filter the rows by selecting an attribute from the drop-down menu when you click the *Filter by attributes* bar. The attributes displayed in the drop-down menu depend on the selected subtab.

**Step 3** To view a summary pane, click the row that represents the specific component you want to view.

**Step 4** For more information, double-click the summary table row that represents the specific component you want to view.

A new dialog box appears over the **work** pane with any of the following tabs:

**Note** The tabs that appear differ between components and configurations.

- **Overview**—Provides a general overview of cloud resources, configuration relationships, and settings of the component.
- **Cloud Resources**—Contains a list of subtabs that display the cloud resource information related to the component.
- **Application Management**—Contains a list of subtabs that display the ACI relation information related to the component.
- **Statistics**—Enables you to view statistics based on a chosen sampling interval and statistics type. The **Statistics** tab may contain subtabs, depending on the component you are viewing.
- **Event Analytics**—Contains a list of subtabs that display faults, events, and audit logs.

## Viewing Operations Details

This section explains how to view operations details using the Cisco Cloud Network Controller GUI. The operations details include the information of a specific fault, event, audit log, active sessions, backup and restore policies, tech support policies, firmware management, scheduler policies, and remote locations.

**Step 1** From the **Navigation** menu, choose the **Operations** tab.

When the **Operations** tab expands, a list of subtab options appear. See the *Operations Options* table for more information.

**Table 26: Operations Subtabs**

Subtab Name	Description
<b>Event Analytics</b>	Contains the following subtabs: <ul style="list-style-type: none"> <li>• <b>Faults</b> Tab—Displays faults as rows in a summary table.</li> <li>• <b>Events</b> Tab—Displays events as rows in a summary table.</li> <li>• <b>Audit Logs</b> Tab—Displays audit logs as rows in a summary table.</li> </ul>
<b>Active Sessions</b>	Displays a list of active users as rows in a summary table.

Subtab Name	Description
<b>Backup &amp; Restore</b>	Contains the following subtabs: <ul style="list-style-type: none"> <li>• <b>Backups</b> Tab—Displays backups as rows in a summary table.</li> <li>• <b>Backup Policies</b> Tab—Displays backup policies as rows in a summary table.</li> <li>• <b>Job Status</b> Tab—Displays the job status as rows in a summary table.</li> <li>• <b>Event Analytics</b> Tab—Contains the following subtabs:               <ul style="list-style-type: none"> <li>• <b>Faults</b> Tab—Displays faults as rows in a summary table.</li> <li>• <b>Events</b> Tab—Displays events as rows in a summary table.</li> <li>• <b>Audit Logs</b> Tab—Displays audit logs as rows in a summary table.</li> </ul> </li> </ul>
<b>Tech Support</b>	Contains the following subtabs: <ul style="list-style-type: none"> <li>• <b>Tech Support</b> Tab—Displays tech support policies as rows in a summary table.</li> <li>• <b>Core Logs</b> Tab—Displays core logs as rows in a summary table.</li> <li>• <b>Per-Feature Containers</b> Tab—Displays the per-feature containers as rows in a summary table.</li> </ul>
<b>Firmware Management</b>	Contains the following subtabs: <ul style="list-style-type: none"> <li>• <b>General</b> Tab—Displays general firmware management information.</li> <li>• <b>Images</b> Tab—Displays a list of images.</li> <li>• <b>Event Analytics</b> Tab—Contains the following subtabs:               <ul style="list-style-type: none"> <li>• <b>Faults</b> Tab—Displays faults as rows in a summary table.</li> <li>• <b>Events</b> Tab—Displays events as rows in a summary table.</li> <li>• <b>Audit Logs</b> Tab—Displays audit logs as rows in a summary table.</li> </ul> </li> </ul>
<b>Schedulers</b>	Displays scheduler policies as rows in a summary table.
<b>Remote Locations</b>	Displays remote locations as rows in a summary table.

**Step 2** Click the tab that represents the component you want to view.

A summary table appears with items as rows in the table. For example, if you chose the **Active Sessions** subtab, a list of active sessions appear as rows in a summary table.

You can filter the rows by clicking the *Filter by Attributes* bar. Choose the attribute, operator and filter-value. For example, for filtering based on a username, choose username == user1 (where user1 is a user logged into Cisco Cloud Network Controller).

**Step 3** To view a summary pane, click the row that represents the specific component you want to view.

**Step 4** For more information, double-click the summary table row that represents the specific item you want to view.

A new dialog box appears over the **work** pane that displays additional information about the item you chose from the summary table.

## Viewing Infrastructure Details

This section explains how to view infrastructure details using the Cisco Cloud Network Controller GUI. The infrastructure details include information about system configuration, inter-region connectivity, and external connectivity.

**Step 1** From the **Navigation** menu, choose the **Infrastructure** tab.

When the **Infrastructure** tab expands, a list of subtab options appear. See the *Infrastructure Options* table for more information.

**Table 27: Infrastructure Subtabs**

Subtab Name	Description
<b>System Configuration</b>	Displays <b>General</b> system configuration information, <b>Management Access</b> information, <b>Controllers</b> , and <b>Event Analytics</b> .
<b>Inter-Region Connectivity</b>	Displays one pane with a map that contains the inter-region connectivity view and additional panes for each region.
<b>Inter-Site Connectivity</b>	Displays one pane with a map that contains the inter-site connectivity view and additional panes for each region.

**Step 2** Click the tab that represents the component with the details you want to view.

## Viewing Administrative Details

This section explains how to view administrative details using the Cisco Cloud Network Controller GUI. The administrative details include the information about authentication, security, users, and smart licensing..



**Step 1** From the **Navigation** menu, choose the **Administrative** tab.

When the **Administrative** tab expands, a list of subtab options appear. See the *Administrative Options* table for more information.

**Table 28: Administrative Subtabs**

Subtab Name	Description
<b>Authentication</b>	<p>Displays the <b>Authentication Default Settings</b>, <b>Login Domains</b>, and <b>Providers</b> subtabs, which contain the information described below:</p> <ul style="list-style-type: none"> <li>• <b>Authentication Default Settings</b> Tab—Displays settings information.</li> <li>• <b>Login Domains</b> Tab—Displays the login domains as rows in a summary table.</li> <li>• <b>Providers</b> Tab—Displays the providers as rows in a summary table.</li> <li>• <b>Event Analytics</b> Tab—Displays the <b>Faults</b>, <b>Events</b>, and <b>Audit Logs</b> subtabs, each with the corresponding information displayed as rows in a summary table.</li> </ul>
<b>Security</b>	<p>Contains the following list of subtabs:</p> <ul style="list-style-type: none"> <li>• <b>Security Default Settings</b> Tab—Enables you to view the default security settings information.</li> <li>• <b>Security Domains</b> Tab—Enables you to view security domain information in a summary table.</li> <li>• <b>Roles</b> Tab—Enables you to view the role information in a summary table.</li> <li>• <b>RBAC Rules</b> Tab—Enables you to view RBAC rule information in a summary table.</li> <li>• <b>Certificate Authorities</b> Tab—Enables you to view the certificate authority information in a summary table.</li> <li>• <b>Key Ring</b> Tab—Enables you to view key ring information in a summary table.</li> </ul>
<b>Users</b>	<p>Contains the following subtabs:</p> <ul style="list-style-type: none"> <li>• <b>Local</b> Tab—Displays local users as rows in a summary table.</li> <li>• <b>Remote</b> Tab—Displays remote users as rows in a summary table.</li> </ul>

Subtab Name	Description
Smart Licensing	<p>Contains the following subtabs:</p> <ul style="list-style-type: none"> <li>• <b>General</b> Tab—Displays the licenses as rows in a summary table.</li> <li>• <b>Faults</b> Tab—Displays faults as rows in a summary table.</li> </ul>

**Step 2** Click the tab that represents the component you want to view.

For some options, a summary table appears with items as rows in the table (For example, if you choose the **Users** tab, a list of users appear as rows in a summary table). To view a summary pane, click the row that represents the specific component you want to view. To view more information, double-click the summary table row that represents the specific item you want to view. A new dialog box appears over the **work** pane that displays additional information about the item you chose from the summary table.

**Note** You can filter the rows by entering an attribute in the *Filter by Attributes* bar.

## Viewing Health Details Using the Cisco Cloud Network Controller GUI

This section explains how to view health details using the Cisco Cloud Network Controller GUI. You can view health details for any object that you can see in the Cloud Resources area in the Cisco Cloud Network Controller GUI, such as the following:

- Regions
- Availability Zones (for AWS cloud sites)
- VPCs (for AWS cloud sites)
- VNETs (for Azure cloud sites)
- Routers
- Security Groups
- Endpoints
- Instances
- Cloud Services

**Step 1** From the **Navigation** menu, choose the **Dashboard** tab.

The **Dashboard** window for the Cisco Cloud Network Controller system appears. From this window, you can view the overall health status of your system.

The screenshot shows the Dashboard window with the following sections:

- Health Summary:** Major (indicated by a yellow warning icon).
- Fault Summary:** A bar chart showing fault counts by severity: Critical (2), Major (14), Minor (4), and Warning (2).
- Inter-Site Connectivity Status:** 4 CSRs, 4 IPsec Tunnels, 4 OSPF, and 0 BGP Sessions.
- Inter-Region Connectivity Status:** 4 CSRs, 0 Virtual Networks, 0 IPsec Tunnels, and 0 BGP Sessions.
- Smart License Registration State:** Unregistered (indicated by a yellow warning icon).
- Smart License Authorization Status:** Evaluation (76 days remaining).
- Cloud Resources Summary (Azure):**
  - Regions: 0 Total
  - Virtual Networks: 2 Total
  - Routers: 4 Total
  - Endpoints: 0
  - Virtual Machines: 0

**Step 2** Click within the Fault Summary area in the **Dashboard** window.

The **Event Analytics** window appears, showing more detailed information for the specific fault level that you clicked. The following screen shows an example **Event Analytics** window for the faults listed with critical severity.

The screenshot shows the Event Analytics window with the following details:

- Severity Filter:** Critical (indicated by a red 'X' icon).
- Table of Faults:**

Acked	Severity	Code	Affected object	Description	Lifecycle	Creation Time
<input type="checkbox"/>	Critical	F0104	topology/pod-1/node-1/sys/caggr-[po1.1]	Bond Interface po1.1 on node 1 of fabric mininet with hostname capic1 is now down	raised	Sep 11 2019 05:22:33pm
<input type="checkbox"/>	Critical	F0104	topology/pod-1/node-1/sys/caggr-[po1]	Bond Interface po1 on node 1 of fabric mininet with hostname capic1 is now down	raised	Sep 11 2019 05:22:33pm
- Page Information:** 10 Rows, Page 1 of 1.

**Step 3** Click the **X** next to the Severity level to display Event Analytics information for all faults.

The information provided in the **Event Analytics** window changes to show the events with critical, major, and warning levels of severity.

## Viewing Health Details Using the Cisco Cloud Network Controller GUI

Acked	Severity	Code	Affected object	Description	Lifecycle	Creation Time
No	Critical	F0104	topology/pod-1/node-1/ryu/capqr-[po1.1]	Bond interface po1.1 on node 1 of fabric mininet with hostname capic1 is now down	raised	Sep 11 2019 05:22:33pm
No	Critical	F0104	topology/pod-1/node-1/ryu/capqr-[po1]	Bond interface po1 on node 1 of fabric mininet with hostname capic1 is now down	raised	Sep 11 2019 05:22:33pm
No	Major	F3442	acct-{infra}/region-{eastus}/context-{eventy-1}-addr-[10.10.0.128/20]/csr-[c_routerp_eastus_1_0]/instoper	Operational State of the hcloudInstanceOper is down with [computeVirtualMachinesClientCreateOrUpdate: Failure sending request: StatusCode=404 -- Original Error: Code= "ResourceGroupNotFound" Message="Resource group 'APFC-infra-mininet-fchazei-centralus' could not be found."]	raised	Sep 11 2019 07:38:27pm
No	Major	F3442	acct-{infra}/region-{centralus}/context-{eventy-1}-addr-[10.10.0.0/25]/csr-[c_routerp_centralus_1_0]/instoper	Operational State of the hcloudInstanceOper is down with [computeVirtualMachinesClientCreateOrUpdate: Failure sending request: StatusCode=404 -- Original Error: Code= "ResourceGroupNotFound" Message="Resource group 'APFC-infra-mininet-fchazei-centralus' could not be found."]	raised	Sep 11 2019 07:38:27pm
No	Major	F3442	acct-{infra}/region-{eastus}/context-{eventy-1}-addr-[10.10.0.0/25]/csr-[c_routerp_eastus_0_0]/instoper	Operational State of the hcloudInstanceOper is down with [computeVirtualMachinesClientCreateOrUpdate: Failure sending request: StatusCode=404 -- Original Error: Code= "ResourceGroupNotFound" Message="Resource group 'APFC-infra-mininet-fchazei-centralus' could not be found."]	raised	Sep 11 2019 07:39:27pm
No	Major	F3442	acct-{infra}/region-{centralus}/context-{eventy-1}-addr-[10.10.0.0/25]/csr-[c_routerp_centralus_0_0]/instoper	Operational State of the hcloudInstanceOper is down with [computeVirtualMachinesClientCreateOrUpdate: Failure sending request: StatusCode=404 -- Original Error: Code= "ResourceGroupNotFound" Message="Resource group 'APFC-infra-mininet-fchazei-centralus' could not be found."]	raised	Sep 11 2019 07:45:10pm
No	Major	F3527	acct-{infra}/region-{eastus}/context-{eventy-1}-addr-[10.10.0.128/20]/csr-[c_routerp_eastus_0_0]/license/oper	Operational State of the HcpPlatformLicense is down with administrative-down	raised	Sep 11 2019 05:21:24pm
No	Major	F3527	acct-{infra}/region-{centralus}/context-{eventy-1}-addr-[10.10.0.0/25]/csr-[c_routerp_centralus_1_0]/license/oper	Operational State of the HcpPlatformLicense is down with administrative-down	raised	Sep 11 2019 05:21:35pm
No	Major	F0101	topology/pod-1/node-1/ryu/chp-[jdev/vcb]-[jdev/vcb]	Storage unit rdw/vcb on node 1 with hostname capic1 has failed.	raised	Sep 11 2019 05:22:33pm

**Step 4** From the **Navigation** menu, choose the **Cloud Resources** tab.

When the **Cloud Resources** tab expands, a list of subtab options appear. See the *Administrative Options* table for more information.

**Step 5** Choose any item under the **Cloud Resources** tab to display health information for that component.

For example, the following figure shows health information that might be displayed when you click on **Cloud Resources > Regions**, then you select a specific region.

Name	Admin State	Tenants	EPGs	AZs	Virtual Networks
eastus	managed	N/A	N/A	N/A	N/A
eastus2	managed	N/A	N/A	N/A	N/A
westus	managed	N/A	N/A	N/A	N/A
centralus	managed	N/A	N/A	N/A	N/A
koreasouth	unmanaged	N/A	N/A	N/A	N/A
francecentral	unmanaged	N/A	N/A	N/A	N/A
eastasia	unmanaged	N/A	N/A	N/A	N/A
canadeast	unmanaged	N/A	N/A	N/A	N/A
brazilouth	unmanaged	N/A	N/A	N/A	N/A
australeast	unmanaged	N/A	N/A	N/A	N/A
australacentral2	unmanaged	N/A	N/A	N/A	N/A
koreacentral	unmanaged	N/A	N/A	N/A	N/A
ukwest	unmanaged	N/A	N/A	N/A	N/A
southindia	unmanaged	N/A	N/A	N/A	N/A
southeastasia	unmanaged	N/A	N/A	N/A	N/A



## CHAPTER 6

# Deploying Layer 4 to Layer 7 Services

- [Overview, on page 131](#)
- [Deploying a Service Graph, on page 135](#)

## Overview

The Cisco Cloud Network Controller enables you to deploy Layer 4 to Layer 7 service devices to the public cloud. This initial release supports application load balancer (ALB) deployments in Amazon Web Services (AWS).

## About Application Load Balancers

An application load balancer (ALB) is a Layer 7 load balancer that inspects packets and creates access points to HTTP and HTTPS headers. It also identifies the load and spreads it out to the targets with higher efficiency. You deploy an ALB using a service graph, which enables you to define how you want traffic to come into the network, the devices that the traffic passes through, and how the traffic leaves the network. You specify these actions by configuring one or more listeners.

Listeners enable you to specify the ports and protocols (HTTP or HTTPS) that the ALB accepts traffic on. When specifying HTTPS, you also choose a security policy and an SSL certificate.



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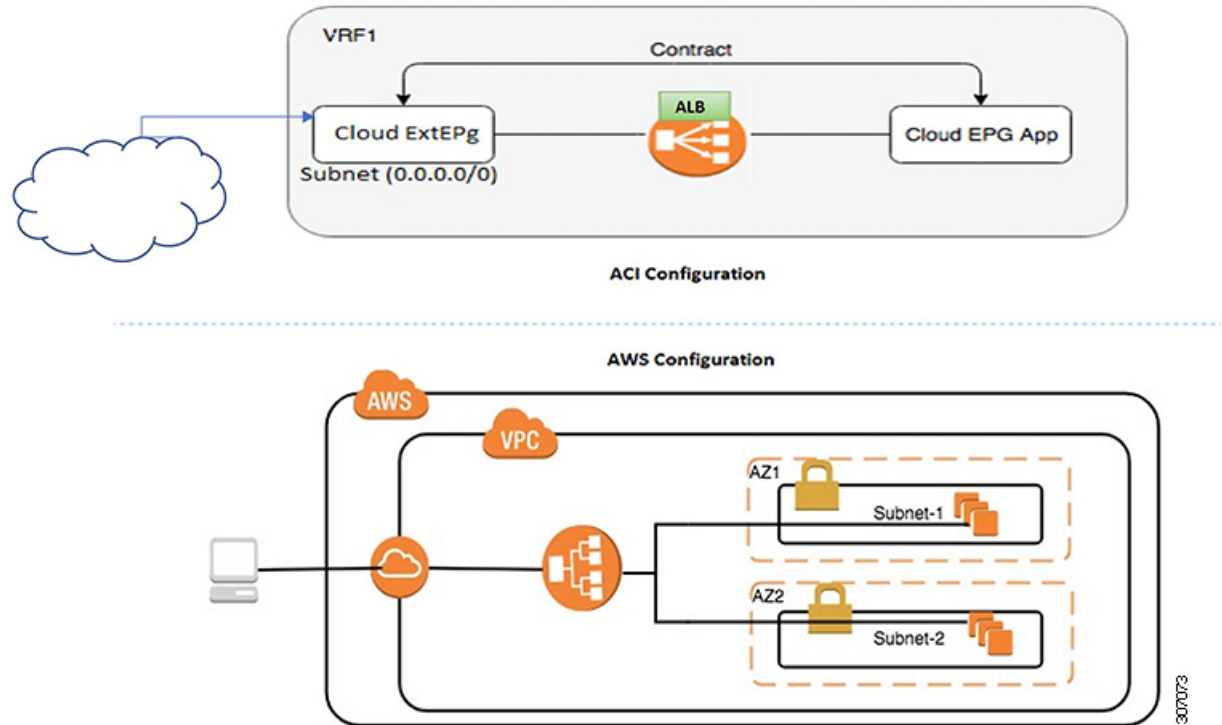
**Note** A listener can have multiple certificates.

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All listeners require you to configure at least one rule (a default rule, which does not have a condition). Rules enable you to specify the action that the load balancer takes when a condition is met. For example, you can create a rule that redirects traffic to a specified URL when a request is made to a specified hostname or path.

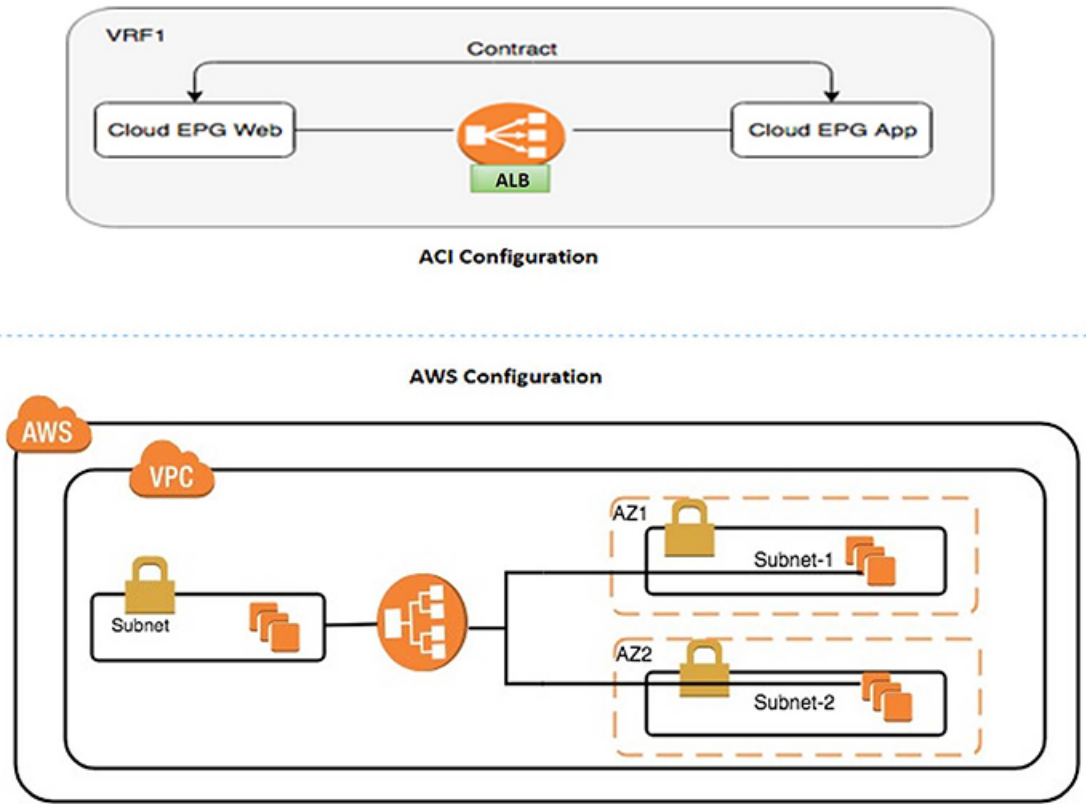
There are two deployment types: internet-facing and internal-facing. An internet-facing deployment inserts the ALB as a service between the consumer external EPG and the provider cloud EPG. The following figure shows the contract configuration within the VRF and the ALB as a service inserted between the consumer external EPG and the provider cloud EPG.

Figure 11: Internet-Facing Deployment



An internal-facing deployment inserts the ALB as a service between the consumer cloud EPG and the provider cloud EPG. The following figure shows the contract configuration within the VRF and the ALB as a service inserted between the consumer cloud EPG and provider cloud EPG.

Figure 12: Internal-Facing Deployment



**Note** You can find more information about ALBs in the documentation on the AWS website.

## Dynamic Server Attachment to Server Pool

Servers in the server pool or target group are dynamically added. You do not need to specify the IP addresses or instance Ids for the targets. The relation from a listener rule to a provider cloud EPG is used for the dynamic selection of endpoints. The relation is also used for adding the endpoints to the target group. By default, the endpoints are registered with the port number 80.

Based on the target group-to-security group association that is provided in the ALB, and the EPG (security group) of the endpoint, the EC2 instance (server) is associated to the target group dynamically on the target group's default port. Alternatively, instead of registering the EC2 instance on the target group port, you can attach the custom port by specifying the ports in the following table:

Table 29: Custom Port-Based Attachment

Provider EPG	Ports
EPGMap:<Epg1DN>	9090

Provider EPG	Ports
EPGMap:<Epg2DN>	9091, 9099

You can specify EPGMap:<EpgDN> as the tag and the list of ports to be registered on the target group as a list separated by commas.

## About Service Graphs

The Cisco Application Centric Infrastructure (ACI) treats services as a part of an application. Any services that are required are treated as a service graph that is instantiated on the Cisco ACI fabric from the Cisco APIC. You define the service for the application while service graphs identify the set of network or service functions that the application needs.

A service graph represents the network using the following elements:

- **Function node**—A function node represents a function that is applied to the traffic, such as a load balancer. A function within the service graph might require one or more parameters and have one or more connectors.
- **Terminal node**—A terminal node enables input and output from the service graph.
- **Connector**—A connector enables input and output from a node.

After the graph is configured, the Cisco APIC automatically configures the services according to the service function requirements that are specified in the service graph. The Cisco APIC also automatically configures the network according to the needs of the service function that is specified in the service graph, which does not require any change in the service device.

A service graph is represented as two or more tiers of an application with the appropriate service function inserted between them.

A service appliance (device) performs a service function within the graph. One or more service appliances might be required to render the services required by a graph. A single-service device can perform one or more service functions.

Service graphs and service functions have the following characteristics:

- Traffic sent from specific endpoint groups can be redirected based on a policy.
- Service graph redirection is directional. In other words, redirection can be applied to both traffic directions or either one of them.
- Logical functions can be rendered on the appropriate device, based on the policy.
- The service graph supports splits and joins of edges, and it does not restrict the administrator to linear service chains.
- Traffic can be reclassified again in the network after a service appliance emits it.

By using a service graph, you can install a service, a load balancer, once and deploy it multiple times in different logical topologies. Each time the graph is deployed, Cisco ACI takes care of changing the configuration on the service device to enable the forwarding in the new logical topology.



## About Function Nodes

A function node represents a single service function. A function node has function node connectors, which represent the network requirement of a service function.

A function node within a service graph requires the following parameters:

- A tenant
- A cloud context profile with subnets in two availability zones

Function parameters can be specified when the service graph is rendered. For example, if the function node is a load balancer, the listener and its rule can be specified for the function node at the time the graph is rendered.

## About Terminal Nodes

Terminal nodes connect a service graph with the contracts. You can insert a service graph for the traffic between two application cloud EPGs by connecting the terminal node to a contract. Once connected, traffic between the consumer cloud EPG and provider cloud EPG of the contract is redirected to the service graph.

## Deploying a Service Graph

The service graph enables you to define how traffic flows between devices, how the traffic comes into the network, which devices the traffic passes through, and how the traffic leaves the network.

Before you can configure a service graph, you must first configure the following:

1. A tenant
2. A cloud context profile
3. Subnets
4. An application profile
5. A consumer EPG
6. A provider EPG
7. A contract

## Deploying the Service Graph Using the Cisco Cloud Network Controller GUI

### Creating a Load Balancer Using the Cisco Cloud Network Controller GUI

This section explains how to create a load balancer using the Cisco Cloud Network Controller GUI.

- 
- Step 1** Click **Application Management > Services**.  
The **Services** page appears.

**Step 2** Click the Devices tab, then click **Actions > Create Device**.

The **Create Device** page appears.

**Step 3** Enter the appropriate values in each field as listed in the following *Create Device Dialog Box Fields* table then continue.

**Table 30: Create Device Dialog Box Fields**

Properties	Description
<b>General</b>	
<b>Name</b>	Enter the name of the load balancer.
<b>Tenant</b>	To choose a tenant: <ol style="list-style-type: none"> <li>Click <b>Select Tenant</b>. The <b>Select Tenant</b> dialog appears.</li> <li>From the column on the left, click to choose a tenant.</li> <li>Click <b>Select</b>. You return to the <b>Create Device</b> dialog box.</li> </ol>
<b>Settings</b>	
<b>Service Type</b>	Choose <b>Application Load Balancer</b> .
<b>Scheme</b>	Choose <b>Internal</b> or <b>Internet Facing</b> .
<b>Subnets</b>	You can specify only one subnet per availability zone. You must specify subnets from at least two availability zones to increase the availability of your load balancer. <ol style="list-style-type: none"> <li>Click <b>Add Subnet</b>. The <b>Add Subnet</b> dialog box appears.</li> <li>In the <b>Add Subnet</b> dialog box, click <b>Select Cloud Context Profile</b>. The <b>Select Cloud Context Profile</b> dialog box appears.</li> <li>In the <b>Select Cloud Context Profile</b> dialog box, select a cloud context profile, then click <b>Select</b>. You are returned to the <b>Add Subnet</b> dialog box.</li> <li>In the <b>Add Subnet</b> dialog box, click <b>Select Subnet</b>. The <b>Select Subnet</b> dialog box appears.</li> <li>In the <b>Select Subnet</b> dialog box, select a subnet, then click <b>Select</b>. You are returned to the <b>Add Subnet</b> dialog box.</li> <li>In the <b>Add Subnet</b> dialog box, click <b>Add</b>. You are returned to the <b>Create Device</b> page.</li> </ol>

**Step 4** Click **Save** when finished.

## Creating a Service Graph Template Using the Cisco Cloud Network Controller GUI

This section explains how to configure a service graph template using the Cisco Cloud Network Controller GUI.

### Before you begin

You have already created a device.

**Step 1** Click **Application Management > Services**.

The **Services** page appears.

**Step 2** Click the **Service Graphs** tab, then click **Actions > Create Service Graph**.

The **Create Service Graph** page appears.

**Step 3** Enter the appropriate values in each field as listed in the following *Create Service Graph Dialog Box Fields* table then continue.

**Table 31: Create Service Graph Dialog Box Fields**

Properties	Description
<b>General</b>	
<b>Name</b>	Enter the name of service graph template.
<b>Tenant</b>	To choose a tenant: <ol style="list-style-type: none"> <li>a. Click <b>Select Tenant</b>. The <b>Select Tenant</b> dialog appears.</li> <li>b. From the column on the left, click to choose a tenant.</li> <li>c. Click <b>Select</b>. You return to the <b>Create Service Graph</b> dialog box.</li> </ol>
<b>Description</b>	Enter a description of the service graph template.
<b>Settings</b>	

Properties	Description
Select a Device	<p>To choose a device:</p> <ol style="list-style-type: none"> <li>Drag and drop the Application Load Balancer icon to the <b>Drop Device</b> area in the service graph. The <b>Service Node</b> dialog box appears.</li> <li>Click <b>Select Application Load Balancer</b>. The <b>Select Application Load Balancer</b> dialog appears.</li> <li>From the column on the left, click to choose a device.</li> <li>Click <b>Select</b>. You return to the <b>Service Node</b> dialog box.</li> <li>Click <b>Add</b>. You return to the <b>Create Service Graph</b> window.</li> </ol>

**Step 4** Click **Save** when finished.

## Deploying Layer 4 to Layer 7 Services Using the Cisco Cloud Network Controller GUI

This section explains how to deploy Layer 4 to Layer 7 services.

### Before you begin

- You have configured a device.
- You have configured a service graph.

**Step 1** Click the **Intent** icon. The **Intent** menu appears.

**Step 2** Click the drop-down arrow below the **Intent** search box and choose **Configuration**.

A list of **Configuration** options appear in the **Intent** menu.

**Step 3** From the **Configuration** list in the **Intent** menu, click **EPG Communication**. The **EPG Communication** dialog box appears with the **Consumer EPGs**, **Contract**, and **Provider EPGs** information.

**Step 4** To choose a contract:

- Click **Select Contract**. The **Select Contract** dialog appears.
- In the pane on the left side of the **Select Contract** dialog, click to choose a contract then click **Select**. The **Select Contract** dialog box closes.

**Step 5** To add a consumer EPG:

- Click **Add Consumer EPGs**. The **Select Consumer EPGs** dialog appears.
- In the pane on the left side of the **Select Consumer EPGs** dialog, click to place a check in a check box to choose a cloud EPG (for an internal facing load balancer) or a cloud external EPG (for an internet facing load balancer) then click **Select**. The **Select Consumer EPGs** dialog box closes.

- Step 6** To add a provider EPG:
- Click **Add Provider EPGs**. The **Select Provider EPGs** dialog appears.
  - In the pane on the left side of the **Select Provider EPGs** dialog, click to place a check in a check box to choose a provider EPG then click **Select**. The **Select Provider EPGs** dialog box closes.

- Step 7** To choose a service graph:
- From the **EPG Communication Configuration** dialog, click **Select Service Graph**. The **Select Service Graph** dialog box appears.
  - In the pane on the left side of the **Select Service Graph** dialog, click to choose a service graph then click **Select**. The **Select Service Graph** dialog box closes.

- Step 8** Under **Service Graph Preview**, click **Add Cloud Load Balancer Listener**. The **Add Cloud Load Balancer Listener** dialog appears that enables you to add listeners.

Listeners are the ports and protocols that the device will work on.

- Step 9** Enter the appropriate values in each field as listed in the following *Add Cloud Load Balancer Listener Dialog Box Fields* table then continue.

**Table 32: Add Cloud Load Balancer Listener Dialog Box Fields**

Properties	Description
<b>Name</b>	Enter the name of the listener.
<b>Port</b>	Enter the port that the device will accept traffic on.
<b>Protocol</b>	Click to choose <b>HTTP</b> or <b>HTTPS</b> .
<b>Security Policy</b>	Click the drop-down list and choose a security policy (only available when <b>HTTPS</b> is chosen).
<b>SSL Certificate</b>	<p>To choose an SSL certificate(only available when <b>HTTPS</b> is chosen):</p> <ol style="list-style-type: none"> <li>Click <b>Add SSL Certificates</b>.</li> <li>Click to place a check mark in the check box of the certificates you want to add.</li> <li>Choose a key ring: <ol style="list-style-type: none"> <li>Click <b>Select Key Ring</b>. The <b>Select Key Ring</b> dialog appears.</li> <li>From the <b>Select Key Ring</b> dialog, click to choose a key ring in the left column then click <b>Select</b>. The <b>Select Key Ring</b> dialog box closes.</li> </ol> </li> <li>Click the <b>Certificate Store</b> drop-down list and choose a certificate.</li> </ol> <p><b>Note</b> A listener can have multiple certificates.</p>

Properties	Description
<b>Add Rule</b>	To add rule settings to the device listener, click <b>Add Rule</b> . A new row appears in the <b>Rules</b> list and the <b>Rules Settings</b> fields are enabled.

Properties	Description
Rule Settings	

Properties	Description
	<p>The <b>Rule Settings</b> pane contains the following options:</p> <ul style="list-style-type: none"> <li>• <b>Name</b>—Enter a name for the rule.</li> <li>• <b>Host</b>—Enter a hostname to create a host-based condition. When a request is made for this hostname, the action you specify is taken.</li> <li>• <b>Path</b>—Enter a path to create a path-based condition. When a request is made for this path, the action you specify is taken.</li> <li>• <b>Type</b>—The action type tells the device which action to take. The action type options: <ul style="list-style-type: none"> <li>• <b>Return fixed response</b>—Returns a response using the following options: <ul style="list-style-type: none"> <li>• <b>Fixed Response Body</b>—Enter a response message.</li> <li>• <b>Fixed Response Code</b>—Enter a response code.</li> <li>• <b>Fixed response Content-Type</b>—Choose a content type.</li> </ul> </li> <li>• <b>Forward</b>—Forwards traffic using the following options: <ul style="list-style-type: none"> <li>• <b>Port</b>—Enter the port that the device will accept traffic on.</li> <li>• <b>Protocol</b>—Click to choose <b>HTTP</b> or <b>HTTPS</b>.</li> <li>• <b>Provider EPG</b>—The EPG with the web server that handles the traffic.</li> <li>• <b>EPG</b>—To choose an EPG: <ol style="list-style-type: none"> <li>a. Click <b>Select EPG</b>. The <b>Select EPG</b> dialog box appears.</li> <li>b. From the <b>Select EPG</b> dialog ox, click to choose an EPG in the left column then click <b>Select</b>. The <b>Select EPG</b> dialog box closes.</li> </ol> </li> </ul> </li> <li>• <b>Redirect</b>—Redirects requests to another location using the following options: <ul style="list-style-type: none"> <li>• <b>Redirect Code</b>—Click the <b>Redirect Code</b> drop-down list and choose a code.</li> </ul> </li> </ul> </li> </ul>



Properties	Description
	<ul style="list-style-type: none"> <li>• <b>Redirect Hostname</b>—Enter a hostname for the redirect.</li> <li>• <b>Redirect Path</b>—Enter a redirect path.</li> <li>• <b>Redirect Port</b>—Enter the port that the device will accept traffic on.</li> <li>• <b>Redirect Protocol</b>—Click to the <b>Redirect Protocol</b> drop-down list and choose <b>HTTP</b>, <b>HTTPS</b>, or <b>Inherit</b>.</li> <li>• <b>Redirect Query</b>—Enter a redirect query.</li> </ul> <p>Click <b>Add Rule</b> when finished.</p>

**Step 10** Click **Add** when finished.  
The service graph is deployed.

## Deploying a Service Graph Using the REST API

### Creating an Internal-Facing Load Balancer Using the REST API

This example demonstrates how to create an internal-facing load balancer using the REST API.

To create an internal-facing load balancer:

**Example:**

```
<polUni>
  <fvTenant name="t2" status="">
    <cloudLB name="ALB1" type="application" scheme="internal" status="">
      <cloudRsLDevToCloudSubnet tDn="uni/tn-t2/ctxprofile-cl/cidr-[10.33.0.0/16]/subnet-[10.33.7.0/24]"
status=""/>
      <cloudRsLDevToCloudSubnet tDn="uni/tn-t2/ctxprofile-cl/cidr-[10.33.0.0/16]/subnet-[10.33.8.0/24]"
status=""/>
    </cloudLB>
  </fvTenant>
</polUni>
```

### Configuring an Internet-Facing Load Balancer Using the REST API

This example demonstrates how to create an internet-facing load balancer using the REST API.

To create an internet-facing load balancer:

**Example:**

```
<polUni>
  <fvTenant name="t2" status="">
    <cloudLB name="ALB1" type="application" scheme="internet" status="">
      <cloudRsLDevToCloudSubnet tDn="uni/tn-t2/ctxprofile-c1/cidr-[10.33.0.0/16]/subnet-[10.33.5.0/24]"
status=""/>
      <cloudRsLDevToCloudSubnet tDn="uni/tn-t2/ctxprofile-c1/cidr-[10.33.0.0/16]/subnet-[10.33.6.0/24]"
status=""/>
    </cloudLB>
  </fvTenant>
</polUni>
```

**Creating a Service Graph Using the REST API**

This example demonstrates how to create a service graph using the REST API.

To create a service graph:

```
<polUni>
  <fvTenant name="t2">
    <vnsAbsGraph name="CloudGraph" type="cloud" status="">
      <vnsAbsTermNodeProv name="Input1">
        <vnsAbsTermConn name="C1"/>
      </vnsAbsTermNodeProv>
      <vnsAbsTermNodeCon name="Output1">
        <vnsAbsTermConn name="C2"/>
      </vnsAbsTermNodeCon>
      <vnsAbsNode funcType="GoTo" name="N1" managed="yes">
        <vnsRsNodeToCloudLDev tDn="uni/tn-t2/clb-ALB1" status=""/>
        <vnsAbsFuncConn name="provider"/>
        <vnsAbsFuncConn name="consumer"/>
      </vnsAbsNode>
      <vnsAbsConnection connDir="consumer" connType="external" name="CON2">
        <vnsRsAbsConnectionConns tDn="uni/tn-t2/AbsGraph-CloudGraph/AbsTermNodeCon-Output1/AbsTConn"/>

        <vnsRsAbsConnectionConns tDn="uni/tn-t2/AbsGraph-CloudGraph/AbsNode-N1/AbsFConn-consumer"/>
      </vnsAbsConnection>
      <vnsAbsConnection connDir="provider" connType="internal" name="CON1">
        <vnsRsAbsConnectionConns tDn="uni/tn-t2/AbsGraph-CloudGraph/AbsTermNodeProv-Input1/AbsTConn"/>

        <vnsRsAbsConnectionConns tDn="uni/tn-t2/AbsGraph-CloudGraph/AbsNode-N1/AbsFConn-provider"/>
      </vnsAbsConnection>
    </vnsAbsGraph>
  </fvTenant>
</polUni>
```

**Attaching a Service Graph Using the REST API**

This example demonstrates how to attach a service graph using the REST API.

To attach a service graph:

```

<polUni>
  <fvTenant name="t2">
    <vzBrCP name="httpFamily">
      <vzSubj name="default" revFltPorts="yes" targetDscp="unspecified">
        <vzRsSubjGraphAtt tnVnsAbsGraphName="CloudGraph"/>
      </vzSubj>
    </vzBrCP>
  </fvTenant>
</polUni>

```

## Configuring an HTTP Service Policy Using the REST API

This example demonstrates how to create an HTTP service policy using the REST API.

To create an HTTP service policy:

```

<polUni>
  <fvTenant name="t2">
    <vnsAbsGraph name="CloudGraph" type="cloud" status="">
      <vnsAbsNode funcType="GoTo" name="N1" managed="yes">
        <cloudSvcPolicy tenantName="t2" contractName="httpFamily" subjectName="consubj">
          <cloudListener name="http_listener1" port="80" protocol="http" status="">
            <cloudListenerRule name="rule1" priority="10" default="yes" status="">
              <cloudRuleAction type="forward" port="80" protocol="http"
epgdn="uni/tn-t2/cloudapp-ap/cloudepg-provEPG"/>
            </cloudListenerRule>
            <cloudListenerRule name="redirectRule" priority="20">
              <cloudRuleCondition type="path" value="/img/*"/>
              <cloudRuleAction type="redirect" RedirectPort="8080"/>
            </cloudListenerRule>
            <cloudListenerRule name="FixedRspRule" priority="30">
              <cloudRuleCondition type="host" value="example.com"/>
              <cloudRuleAction type="fixedResponse" FixedResponseCode="200"/>
            </cloudListenerRule>
            <cloudListenerRule name="redirectHPRule" priority="40" status="">
              <cloudRuleCondition type="host" value="example.com"/>
              <cloudRuleCondition type="path" value="/img/*"/>
              <cloudRuleAction type="forward" port="80" protocol="http"
epgdn="uni/tn-t2/cloudapp-ap/cloudepg-provEPG"/>
            </cloudListenerRule>
          </cloudListener>
        </cloudSvcPolicy>
      </vnsAbsNode>
    </vnsAbsGraph>
  </fvTenant>
</polUni>

```

## Configuring a Key Ring Using the REST API

This example demonstrates how to configure a key ring using the REST API. For more information about key ring configuration, see the *Cisco APIC Basic Configuration Guide*.

To configure a key ring:

```
<polUni>
  <fvTenant name="t2">
    <cloudCertStore>
      <pkiKeyRing status="" name="lbCert" tp="lbTP" key="-----BEGIN RSA PRIVATE KEY-----
MIIEpQIBAAKCAQEAA4DGxaK+RHv/nToHLnmDBq2BfLimgX/zNJQC9bGuzr8Mj7dm0
XuHfQYGV0h1PtL4Pdx5qjB0NbHjAVB1Gw8cDiErEgAXy9Km27ySo2foKryNqCRe
Ginn/CgF75QPied568eScNDZPt/eMeHAuRX/PykKUatWWncGanJvHqc+SOLPF6TD
gQ5nwOHFFvyM2DY8bfdYWRWmGsO7JqZzbPMptA2QWblLsSoIrdkI Igf6ZfYy/EN
bH+nYN2rJT8lZysxz0YmR0oRQHTiN2NiDY/ZV63yxCXfLg9qpNZCuD8KOfdCZPEq
8takiWBxiR5/HRPscWAdWQsoiKgG1k4NEbFA9QIDAQABAoIBAQQDQQA9Is1YrdtqN
q6mZ3s2BNfF/4kgb7gn0Dws+9EJJLCJNZVhFEo2ZxyfPp6HRnjYS50W83/E1and
+GD1bSucTuxqFWIQvH7r1ebYZIWK+NYSjr5yNVxux8U2hCNNV8WWVqkJjKcUqICB
Bm47FKj53LV46ze0yqCaibFrYxZJ9+farGneyBdnoV+3thmez7534KCioT3J3Eri
lgSY3ql6hPXB2ZXP4jdAoLgWDU4I1M6OqOiWopZM/QYIE/WtPYyJ0QzNCXObtc5
FboDcvedsgd4x5Glfv2A4xTBQMCTZUZJ9fyAcFogTZXD+UVqxorh47tf/mz+1fjq
f1XphEDLAoGBAPV1vkfGW46qqRnYovfryxxz4OM1sVsgcJpQTQtBQi2koJ8OwEzJ
2s+CX0r+oDqWp23go/QEVYVkcic9RGkJBNGel+dm/bTjzgmQYtqSCNtecTszD5JN
yljkciiizznDkjcyjReS22kh3dGXIBriYk7ezp2z7EKfDrHe5x5ouGMgCnAoGBAOnh
buDeohv8KJaB+DiUfhtoa3aKNPBO+zWPCHP0HFGjPXshJcIYZc1GcycmuDKVnNdd
MxhE/yOnQHowi4T9FMLpZ5yh5zuCUVqOBgB1P6MzbC5t5MtLrEYr/AqFN11CqyXQ
cVt6iCW1OAFJRw3c/OiEswLMzchsl8RnbwOi6kDAoGBANV1zmPb07zB3eGTCUOt
KgiqwFLncUkVaDZYRZYppNwiRkoe73j9brkNbgCqXW+NLp5UjoeFry0N6y106q/
ZA4I7FnXryLBw2HYuw41Vixl+XOZ/HeO3RmFN1z717dGmaGbv43aKIB9x+X5n8wF
6z1NtBHmBk7yNwomlIRaglsbAoGAX0p4cJ/tJNXSe7AswHDQCL68uimJdDfz5nKG
k83nE+Qc0qQozDJAmCiSfmuSNRnSep3FiafjBFXK0X4h+mdbJcC7bagRnI92Mh0X
mOwsp4P2GdywzWdbuHQ6UBp1Ferf9aztzt+n+as6xKOUATEezy9DK9zMWzQhhtAY
m9yZTp0CgYEALUtcpwJAzQbXODJGmxGdAAakPpeiKw/Da3MccrTdGJt88ezM10eJ
PdoabOG2PcFgJZoTSGk7N4KArVkeq7pgZ0kwCYAshO6A2Hal+D1z/bGoZP+kmD/x
Ny82phxYOXcnEc5Vv921U59+j7e067UFLAYJe6fu+oFImvofRnP4DIQ= -----END RSA PRIVATE KEY-----" cert="-----BEGIN
CERTIFICATE-----
MIIElTCCA32gAwIBAgIJAKWNjp//arBsMA0GCSqGSIb3DQEBCwUAMIGNMQswCQYD
VQQGEwJVUzELMAkGA1UECBMCQ0ExETAPBgNVBAcTCFhbiBk3N1MRiWEAYDVQQK
Ew1NeUNvbXBhbnkxDjAMBGNVBAStBU15T3JnMRgwFgYDVQQDFA8qLmFtYXpvb2F3
cy5jb20xIDAEBgkqhkiG9w0BCQEWEWEXJhbXNoYWhAY21zY28uY29tMB4XDTE4MTAw
MjIwNTMwNV0XDTE5MTAwMjIwNTMwNV0wY0xzcjAjBgNVBAYTAlVTMQswCQYDVQQI
EwJkQTERMA8GA1UEBxMIU2F1IEpvc2UxEjAQBGNVBAoTCU15Q29tcGFueTEOMAwG
A1UECXMFTX1PcmcxGDAWBgNVBAMUDyouYW1hem9uYXZzLmNvbTEgMB4GCSqGSIb3
DQEJARYRcmFtc2hhaEBjaXNjby5jb20wggEiMA0GCSqGSIb3DQEBAQUAA4IBDwAw
ggEKAoIBAQQDgMbfFor5Ee/+dOgcueYMGryF8uKaBf/M01AL1sa7OvwyPt2bRe4d9E
ga/SHU+0vg93F/mqMHQ1seMBUHUBDxwOISsSABfL0qbbvJKjZ+gqvI2oJF4aKef8
KAXv1A8h53nrx5Jw0Nk+394x4cC5Ff8/KQpRq1ZadwZqe08epz5I4s8XpMOBDMfA
4ccW/IzYnJxt91hataYaw7smpnNs8ym0DZBZuUguxKgIt2QgiB/pl9jL8Q1sf6dg
3as1PyXNizHPRiZHSFAdoi3Y2INj9lXrflEJd8ud2qk1kK4Pwo590Jk8Sry1qSj
YHGJHn8dE+xxYB1ZCyilqAbWTg0RsUD1AgMBAAGjgFwWgFIwHQYDVR0OBBYEFBYq
K3b39+1oOr4IBSsePwOpML7MIHCBGNVHSMegbowgbeAFBYqK3b39+1oOr4IBSse
PwOpML7oYGTpIGQMIGNMQswCQYDVQQGEwJVUzELMAkGA1UECBMCQ0ExETAPBgNV
BACTCFhbiBk3N1MRiWEAYDVQQKEw1NeUNvbXBhbnkxDjAMBGNVBAStBU15T3Jn
MRgwFgYDVQQDFA8qLmFtYXpvb2F3cy5jb20xIDAEBgkqhkiG9w0BCQEWEWEXJhbXNo
YWhAY21zY28uY29tggkAP2On/9qsGwwDAYDVR0TBAUwAwEB/zANBgkqhkiG9w0B
AQsFAAOCAQEAE/RuzCheLibHbrurGet6eaVx9DPYydNiKVBSAKO+5iuR84mqZhoT
nx5CN109xu5ml5baCYZzSnn6D7usC092bPA/kRCGxt29gkjpWA74tJHqIhVWgBM
mOrLiSHoelew+wR1oOVRCh1tFkTXO68Tuk6vrrqpw76hKfOHIa7b2h1IIMdq6VA/
+A5FQ0xqYfKdVd2RaInpzI8mqZiszqw+7E6j1PL5k4tftWEaYpfGF1VesFEyJEL
gHBUIPt8TIbaMYI8gUQmB/emnLXeKQ5PRxdRnleA3h8jfq3D1CQRTLjMDL3tpFwg qopM6et5ZKqShX4T87BsgZIoiquzXqsuHg==
-----END CERTIFICATE-----"
    </pkiKeyRing>
  </fvTenant>
</polUni>
```

```

MjIwNTMwNVoXDTExMTAwMjIwNTMwNVowgY0xCzAJBgNVBAYTA1VTMQswCQYDVQQLI
EwJDRTERMA8GA1UEBxMIU2FuIEpvc2UxEjAQBGNVBAOTCU15Q29tcGFueTEOMAwG
A1UECmFTXlPcmcxGDAWBGNVBAUDyouYw1hem9uYXdzLmNvbTEgMB4GCSqGSIb3
DQEJARYRcmFtc2hhaEBjaXNjby5jb20wggEiMA0GCSqGSIb3DQEBBAQUAA4IBDwAw
ggEKAoIBAQQdMgFor5Ee/+dOgcueYMGryF8uKaBf/M0lAL1sa7OvwyPt2bRe4d9B
ga/SHU+0vg93F/mqMHQ1seMBUHUBDxwOISsSABfL0qbbvJKjZ+gqvI2oJF4aKef8
KAXv1A8h53nrX5Jw0Nk+394x4cC5Ff8/KQpRq1ZadwZqeO8epz5I4s8XpMOBDMfA
4ccW/IzYNjxt9lhataYaw7smpnNs8ym0DZBZuUguxKgit2QgiB/pl9jL8Q1sf6dg
3aslPyXNizHPRIzHSHFadOI3Y2INj9lXrfLEJd8uD2qk1kK4Pwo590Jk8Sry1qSJ
YHGJHn8de+xxYBlZCyIqAbWTg0RsUD1AgMBAAGjgfUwgfIwHQYDVR0OBBYEFBYq
K3b39+1oOr4IBSsePwcOpML7MIHCBGNVHSMegbowgbeAFBYqK3b39+1oOr4IBSse
PwcOpML7oYGTpIGQMIGNMQswCQYDVQQGEwJVUzELMAkGA1UECBMCQ0ExETAPBgNV
BACTFNhbIBKb3NlMRIwEAYDVQQKEw1NeUNvbXBhbnkxKjJAMBgNVBAStBU15T3Jn
MRgwFgYDVQQDFA8qLmFtYXNjaXNjby5jb20xIDAeBgkqhkiG9w0BCQEWEXJhbXNo
YWhAY21zY28uY292ggkApY2On/9qsGwwDAYDVR0TBAAUwAwEB/zANBgkqhkiG9w0B
AQsFAAOCAQEAE/RuzCheLIbHbrurGet6eaVx9DPYydNiKVBSAKO+5iuR84mQzhoT
nx5CN109xu5ml5baCYZsSnn6D7usC092bPA/kRCGxt29gkjpWA74tJHqIhVWgbM
mOrLiSHoelewv+wRl0oVRChlTfKtXO68TUK6vrqpw76hKfOHIA7b2h1IIMdq6VA/
+A5FQ0xqYfGKdVd2RaINpzI8mqZiszqw+7E6j1PL5k4tftWEaYpfGPLVesFEyJEL
gHBUiPt8TIbaMYI8qUQmB/emnLXeKQ5PRxdRnleA3h8jfq3D1CQRTLjmdL3tpFwg
qopM6et5ZKqShX4T87BsgZIoiquzXqsuHg==
-----END CERTIFICATE-----"
  </pkITP>
  </cloudCertStore>
</fvTenant>
</polUni>

```

## Creating an HTTPS Service Policy Using the REST API

This section demonstrates how to create an HTTPS service policy using the REST API.



**Note** A listener can have multiple certificates. The certificate options are:

- ELBSecurityPolicy-2016-08 – The default when no security policy is chosen.
- ELBSecurityPolicy-FS-2018-06
- ELBSecurityPolicy-TLS-1-2-2017-01
- ELBSecurityPolicy-TLS-1-2-Ext-2018-06
- ELBSecurityPolicy-TLS-1-1-2017-01
- ELBSecurityPolicy-2015-05
- ELBSecurityPolicy-TLS-1-0-2015-04

If you use multiple certificates, you must specify the default certificate. The default is specified using the **defaultCert** property in **cloudRsListenerToCert**.

### Before you begin

You have already configured a key ring certificate.

To create an HTTPS service policy:

```

<polUni>
  <fvTenant name="t2">
    <vnsAbsGraph name="CloudGraph" type="cloud" status="">
      <vnsAbsNode funcType="GoTo" name="N1" managed="yes">
        <cloudSvcPolicy tenantName="t2" contractName="httpFamily" subjectName="consubj">
          <cloudListener name="https_listener" port="443" protocol="https"
secPolicy="eLBSecurityPolicy-2016-08" status="">
            <cloudRsListenerToCert defaultCert="yes" certStore="iam"
tDn="uni/tn-t2/certstore/keyring-lbCert" status=""/>
              <cloudListenerRule name="defaultRule" default="yes" priority="100" status="">
                <cloudRuleAction type="forward" port="80" protocol="http"
epgdn="uni/tn-t1/cloudapp-ap/cloudepg-ep1">
                  </cloudRuleAction>
                </cloudListenerRule>
              </cloudListenerRule>
            </cloudListener>
          </cloudSvcPolicy>
        </vnsAbsNode>
      </vnsAbsGraph>
    </fvTenant>
  </polUni>

```

---



## CHAPTER 7

# Cisco Cloud Network Controller Statistics

- [About Cisco Cloud Network Controller Statistics, on page 149](#)
- [AWS Networking Interface Statistics Collection, on page 149](#)
- [Cisco Cloud Network Controller Endpoints and cloudEPg Statistics Processing, on page 150](#)
- [Cisco Cloud Network Controller Statistics Filters, on page 150](#)
- [AWS Transit Gateway Statistics, on page 151](#)
- [Enabling VPC Flow Logs, on page 152](#)
- [Cloud Router Statistics, on page 155](#)

## About Cisco Cloud Network Controller Statistics

Cisco Cloud Network Controller supports statistics that are collected from the cloud routers. Additionally, it supports statistics that are derived by processing Amazon Web Services (AWS) flow logs. Because AWS flow logs is not a free service, the Cisco Cloud Network Controller provides a policy that allows you to control this feature. This feature is not enabled by default.

For more information about CloudWatch and flow logs, see "VPC Flow Logs" for Amazon Virtual Private Cloud on the AWS website.

Beginning in Cisco Cloud Network Controller Release 5.0(1), you can do the following:

- You can use filters to see specific information from the AWS flow logs. You can define up to eight filters for a given flow log policy (or VPC) at the same time. You can filter for a combination of source or destination IP address, port and protocol. See [Cisco Cloud Network Controller Statistics Filters, on page 150](#) for more information.
- You can collect statistics for traffic to and from AWS Transit Gateways. See the section [AWS Transit Gateway Statistics, on page 151](#) in this guide.

## AWS Networking Interface Statistics Collection

AWS provides the nonreal-time IP traffic information per network interface through flow logs. Cisco Cloud Network Controller provides a policy for enabling flow logs per `cloudCtxProfile`. Because the `cloudCtxProfile` maps to a VPC in AWS, enabling flow logs per `cloudCtxProfile` or VPC means that you enabled flow logs for each interface belonging to that VPC. Once flow logs are enabled, flow records are periodically pushed to AWS Cloudwatch. The Cisco Cloud Network Controller then periodically polls AWS

CloudWatch for these flow records and parses these records to extract statistics. Because it can take up to 15 minutes to publish flow records to CloudWatch, the Cisco Cloud Network Controller delays its flow logs query to CloudWatch by 15 minutes too. This means that there is a lag between the flow logs being present in CloudWatch and the corresponding statistics showing up on the Cisco Cloud Network Controller. Cisco Cloud Network Controller does not process flow records that take longer than 15 minutes to publish to CloudWatch.

## Cisco Cloud Network Controller Endpoints and cloudEPg Statistics Processing

The Cisco Cloud Network Controller extracts the following statistics for each AWS networking endpoint that has flow logs present in CloudWatch:

- Number of bytes or packets sent (egress)
- Number of bytes or packets received (ingress)
- Number of bytes or packets rejected (egress drop)
- Number of bytes or packets dropped (ingress drop)

These statistics are associated with the `cloudEpInfoHolder` observable.

Also, the Cisco Cloud Network Controller maps the flow log records to one or more per region `cloudEPg` objects. This is because a `cloudEPg` can be present in multiple regions. These statistics are associated with the `cloudRgInfoHolder` observable. This observable is a child of `cloudEPg` and the accumulation of statistics for the `cloudRgInfoHolder` children results in statistics for `cloudEPg`. The `cloudEPg` supports the following statistics:

- Number of bytes or packets sent (egress)
- Number of bytes or packets received (ingress)
- Number of bytes or packets rejected (egress drop)
- Number of bytes or packets dropped (ingress drop)

The `cloudEPg` statistics are aggregated up `fvApp` and then up `fvTenant`.

## Cisco Cloud Network Controller Statistics Filters

Beginning in Cisco Cloud Network Controller Release 5.0(1), you can use filters to see specific information from the Amazon Web Services (AWS) flow logs.

Statistics are collected for each endpoint on which the filter is deployed. The filters enable you to see information about a flow, filtered by a combination of source or destination IP address, port, and protocol. You can define up to eight filters for a given AWS log group at the same time.

A statistics filter has the following three attributes:

- **PeerIP:** The IPv4 address to filter
- **PeerPort:** The port number to listen to



- **Protocol:** The protocol number to listen to



---

**Note** We recommend that you configure statistics filters using the Cisco Cloud Network Controller GUI. You can alternatively use REST API; however, if you do and then switch to the GUI, the feature will appear incomplete. You should stick to the method that you choose.

---

Use of statistics filters depend on enabling Virtual Private Cloud (VPC) flow log; you must enable the logs before you configure the statistics filters.

Flow logs, which are stored in AWS CloudWatch, consist of flow log records. Cisco Cloud Network Controller extracts statistics by parsing the flow log records.

It can take up to 15 minutes from the occurrence of a particular flow record to its being present in AWS CloudWatch. Cisco Cloud Network Controller polls for flow records that occurred 15 minutes or more in the past. It does not process flow records that take longer than 15 minutes to appear in AWS CloudWatch.

## AWS Transit Gateway Statistics

You can collect statistics for traffic going through Amazon Web Services (AWS) Transit Gateways on both the infra tenant and the user tenant. Statistics reported for user tenant represent the traffic of an attachment between an user VPC and an AWS Transit Gateway. Statistics reported from infra tenant represents the traffic of an attachment between an infra VPC and a Transit Gateway.

The following statistics are collected for AWS Transit Gateway:

- Ingress packets
- Ingress packet bytes
- Ingress packet drops
- Ingress packet drop bytes
- Egress packets
- Egress packet bytes
- Egress packet drops
- Egress packet drop bytes

You can enable infra tenant Transit Gateway statistics collection from the Cisco Cloud Network Controller **Setup - Region Management** page. See the section "Set Up the Cloud Site to Use AWS Transit Gateway" in [Increasing Bandwidth Between VPCs by Using AWS Transit Gateway](#).

You can enable user tenant Transit Gateway statistics collection by enabling flow logs on the user VPC. See the sections [Enabling VPC Flow Logs, on page 152](#) and [Enabling VPC Flow Logs Using the Cisco Cloud Network Controller GUI, on page 152](#) in this guide.

To view AWS Transit Gateway statistics, in the Cisco Cloud Network Controller GUI, click the **Statistics** tab and then click **AWS Transit Gateway** in the left navigation pane. The central pane displays the information.

## Enabling VPC Flow Logs

Steps to enable VPC Flow Logs:

1. Define a log group policy.
2. Define a flow log policy and associate the log group that you defined in the first step.
3. Associate the flow log policy to one or more `cloudCtxProfile`.

Log group properties:

- **name**—The location in CloudWatch where flow logs are sent.




---

**Note** The actual log group name that is programmed in AWS is the concatenation of `<tenant name><cloudCtxProfile name><log group name>`.

---

- **retention**—The length of duration for storing the logs in CloudWatch. The default is 5-days.

Flow log properties:

- **trafficType**—The type of traffic to collect. Supported types are **all**, **accepted only**, and **rejected only**. The default is **all**.

## Enabling VPC Flow Logs Using the Cisco Cloud Network Controller GUI

This section explains how to enable VPC flow logs using the Cisco Cloud Network Controller GUI.




---

**Note** If you want to use filters to see specific information from AWS flow logs, perform the optional steps in this procedure.

---

**Step 1** Click the **Navigation** menu and choose **Application Management > Tenants**.

The **Tenants** window appears with the tenants listed as rows in a summary table.

**Step 2** Double-click on a tenant.

The tenant dialog box appears over the Work pane. The tenant dialog box displays the **Overview**, **Cloud Resources**, **Application Management**, **Statistics**, and **Event Analytics** tabs.

**Step 3** Click the **Statistics** tab.

The **EPGs**, **CCRs**, and **Flow Log Collection** subtabs appear.

**Step 4** Click **Flow Log Collection**.

The **Flow Log Collection Settings** information appears at the top of the dialog box with the **edit** icon in the top-right corner.

**Step 5** Click the **edit** icon.

The **Flow Log Collection Settings** dialog box appears.

**Step 6** Enter the appropriate values in each field as listed in the following *Flow Log Collection Settings Dialog Box Fields* table then continue.

**Table 33: Flow Log Collection Settings Dialog Box Fields**

Properties	Description
<b>Type of Traffic to be Logged</b>	Click the <b>Type of Traffic to be Logged</b> drop-down list and choose one of the following options: <ul style="list-style-type: none"> <li>• <b>All Traffic</b> (default)</li> <li>• <b>Accepted Only Traffic</b></li> <li>• <b>Rejected Only Traffic</b></li> </ul>
<b>Destination</b>	Click the <b>Destination</b> drop-down list and choose <b>CloudWatch</b> (default).
<b>Retention</b>	Click the <b>Retention</b> drop-down list and chose from the following options: <ul style="list-style-type: none"> <li>• <b>1 day</b></li> <li>• <b>3 days</b></li> <li>• <b>5 days</b> (default)</li> <li>• <b>1 month</b></li> <li>• <b>13 months</b></li> <li>• <b>18 months</b></li> <li>• <b>2 months</b></li> <li>• <b>3 months</b></li> <li>• <b>4 months</b></li> <li>• <b>5 months</b></li> <li>• <b>6 months</b></li> <li>• <b>1 week</b></li> <li>• <b>2 weeks</b></li> <li>• <b>1 year</b></li> <li>• <b>10 years</b></li> <li>• <b>2 years</b></li> <li>• <b>5 years</b></li> </ul>

**Step 7** (Optional) Add flow filters to get information about source and destination IP addresses, ports, or protocols by completing the following tasks:

For information about statistics filters, see the section [Cisco Cloud Network Controller Statistics Filters, on page 150](#).

a) Click **Add Flow Filters** at the bottom of the **Flow Log Collection Settings** dialog box.

Fields for the filter attributes appear.

After you click on the **Add Flow Filters** button, you will see a new filter being created; fill out the attributes.

b) In the **Peer IP** field, enter the IPv4 IP address of the peer.

The address needs to be in the format x.x.x.x/x. It tells the filter which network to monitor. An address of 0.0.0.0/0 will match all.

c) (Optional) From the **Protocol** drop-down list, choose a protocol to listen to.

The choices are integers from 0 to 255. Entering 255 will match any protocol. Well-known protocols are translated when text format is given:

<ul style="list-style-type: none"> <li>• "icmp": 1</li> <li>• "igmp": 2</li> <li>• "tcp": 6</li> <li>• "egp": 8</li> </ul>	<ul style="list-style-type: none"> <li>• "igp": 9</li> <li>• "l2tp": 115</li> <li>• "udp": 17</li> <li>• "icmpv6": 58</li> </ul>	<ul style="list-style-type: none"> <li>• "eigrp": 88</li> <li>• "ospfigp": 89</li> <li>• "pim": 103</li> </ul>
----------------------------------------------------------------------------------------------------------------------------	----------------------------------------------------------------------------------------------------------------------------------	----------------------------------------------------------------------------------------------------------------

d) (Optional) In the **Peer Port** field, enter the port number to listen to.

This number must be an integer from 0 to 65535 or text input for a well-known port number. Entering 0 will match any port. Well-known protocols are translated when text format is given:

<ul style="list-style-type: none"> <li>• "dns": 53</li> <li>• "ftpData": 20</li> <li>• "smtp": 25</li> </ul>	<ul style="list-style-type: none"> <li>• "http": 80</li> <li>• "https": 443</li> </ul>	<ul style="list-style-type: none"> <li>• "rtsp": 554</li> <li>• "pop3": 110</li> </ul>
--------------------------------------------------------------------------------------------------------------	----------------------------------------------------------------------------------------	----------------------------------------------------------------------------------------

e) (Optional) Check the **Active** check box and then click the check icon.

**Step 8** Click **Save**.

## Enabling VPC Flow Logs Using the REST API

This section demonstrates how to enable VPC flow logs using the REST API.

**Step 1** Create a log group:

```
<cloudAwsLogGroup name="lg1" retention="days-3" status="">
  </cloudAwsLogGroup>
```

**Step 2** Create a flow log policy:

```
<cloudAwsFlowLogPol name="flowLog1" trafficType="ALL" status="">
  <cloudRsToLogGrp tDn="uni/tn-t20/loggrp-lg1" status=""/>
</cloudAwsFlowLogPol>
```

**Step 3** Create a relationship from a CtxProfile to a flow log policy:

```
<cloudCtxProfile name=" vrf1" status="">
  <cloudRsCtxToFlowLog tnCloudAwsFlowLogPolName="flowLog1" status=""/>
</cloudCtxProfile>
```

## Cloud Router Statistics

These statistics are available for the cloud router:

- Ingress packets
- Egress packets
- Ingress bytes
- Egress bytes

The Cisco Cloud Network Controller collects and stores the cloud router statistics by the following granularities:

- 15-minutes
- 1-hour
- 1-month
- 1-year

### Collection Mechanism

Each cloud router instance captures and stores the previously mentioned 4-stat values for each physical and tunnel interface.

The Cisco Cloud Network Controller queries the cloud routers for these statistics and maps the response to cloud router statistics on the Cisco Cloud Network Controller. The statistics query repeats every 5 minutes for as long as the tunnel is up and operational.

### Raw Statistics

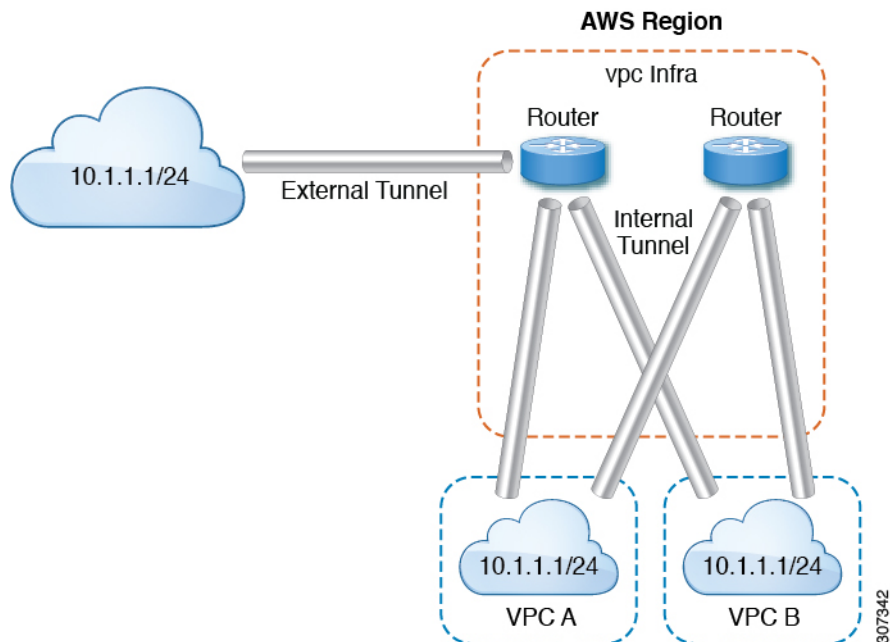
The raw statistics are stored under 2 Dns:

- uni/tn-*<infraTenant>*/ctx-*<infraCtx>*/region-*<infraRegion>*/router-*<csrname>*/to-*<ip or user-region>*/tunn-*<tunnel-id>*
- uni/tn-*<userTenant>*/ctx-*<userCtx>*/region-*<userRegion>*/region-*<infraRegion>*/router-*<csrname>*/tunn-*<tunnel-id>*

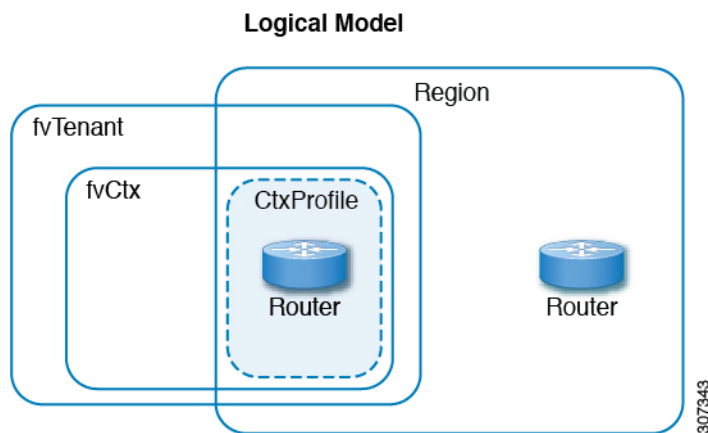
**Note**

- The second Dn holder is the statistics as seen from the user endpoints connected to the cloud router. These statistics are hence flipped (Ingress on the CCR becomes egress on the user region)
- Not all tunnels have a corresponding user dn. This is only applicable to internal tunnels. External tunnels statistics are only available on the 1st Dn.

In the following figure, internal tunnels are between the user VPC and infra VPC. The infra VPC contains the CCR router. The user VPC can contain the CCR or VGW router. Cisco Cloud Network Controller creates these tunnels. As a result, statistics are available for both the infra side and the user side. External tunnels are between infra VPC and an external IP address. Statistics are only available on the infra side (Dn-1).



In the logical model diagram, a tenant can be infra or a user tenant. You configure a VRF (or `fvCtx`) to be inside a tenant (per tenant). A VRF can be within one region or span across multiple regions.



### Aggregated Statistics

Statistics are aggregated at each parent level of the DN. For the preceding case, statistics on tunnel, statistics are aggregated on to the destination IP, cloud router, region, vrf (ctx), and tenant.

For example, if you want to find the egress packets from the infra cloud router to a user region, it is available under `uni/tn-<infraTenant>/ctx-<infraCtx>/region-<infraRegion>/router-<csrname>/to-<ip or user-region>/`

If you want to get all the packets between user region1 and infra region2, it is available under `uni/tn-<userTenant>/ctx-<userCtx>/region-<userRegion>/region-<infraRegion>/`

Also, if you want to find statistics per `cloudCtxProfile`, it is available under `uni/tn-<userTenant>/ctx-<userCtx>/region-<userRegion>/` OR `uni/tn-<infraTenant>/ctx-<infraCtx>/region-<infraRegion>/`.

### Cloud Router GUI Statistics

In the Cisco Cloud Network Controller GUI, statistics are visible available under the tenant, VRF, infra region, and cloud context profile.

For Amazon Web Services (AWS) Transit Gateway stats, in the **Cloud Context Profile** work pane, click **AWS Transit Gateway** For all other stats, in the **Cloud Context Profile** work pane, click **Endpoints**.







## CHAPTER 8

# Cisco Cloud Network Controller Security

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This chapter contains the following sections:

- [Access, Authentication, and Accounting, on page 159](#)
- [Configuring TACACS+, RADIUS, LDAP and SAML Access, on page 160](#)
- [Configuring HTTPS Access, on page 167](#)

## Access, Authentication, and Accounting

Cisco Cloud Network Controller policies manage the authentication, authorization, and accounting (AAA) functions. The combination of user privileges, roles, and domains with access rights inheritance enables administrators to configure AAA functions at the managed object level in a granular fashion. These configurations can be implemented using the REST API or the GUI.



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**Note** There is a known limitation where you cannot have more than 32 characters for the login domain name. In addition, the combined number of characters for the login domain name and the user name cannot exceed 64 characters.

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For more access, authentication, and accounting configuration information, see [Cisco Cloud Network Controller Security Configuration Guide](#).

## Configuration

The admin account is configured in the initial configuration script, and the admin is the only user when the system starts.

### Configuring a Local User

Refer to [Creating a Local User Using the Cisco Cloud Network Controller GUI, on page 105](#) to configure a Local User and associate it to the OTP, SSH Public Key, and X.509 User Certificate using the Cisco Cloud Network Controller GUI.

# Configuring TACACS+, RADIUS, LDAP and SAML Access

The following topics describe how to configure TACACS+, RADIUS, LDAP and SAML access for the Cisco Cloud Network Controller.

## Overview

This topic provides step-by-step instructions on how to enable access to the Cisco Cloud Network Controller for RADIUS, TACACS+, LDAP, and SAML users, including ADFS, Okta, and PingID.

For additional TACACS+, RADIUS, LDAP, and SAML information, see [Cisco Cloud Network Controller Security Configuration Guide](#).

## Configuring Cisco Cloud Network Controller for TACACS+ Access

### Before you begin

- The Cisco Cloud Network Controller is online.
- The TACACS+ server host name or IP address, port, and key are available.
- The Cisco Cloud Network Controller management endpoint group is available.

---

**Step 1** In the Cisco Cloud Network Controller, create the **TACACS+ Provider**.

a) Click the **Global Create** icon.

The **Global Create** menu appears.

b) Scroll down until you see the **Administrative** area, then click **Create Provider** under the **Administrative** area.

The **Create Provider** dialog box appears.

c) In the **Host Name/IP Address** field, enter the Host Name/IP Address of the provider.

d) In the **Description** field, enter a description of the provider.

e) Click the **Type** drop-down list and choose **TACACS+**.

f) In **Settings** section, specify the **Key**, **Port**, **Authentication Protocol**, **Timeout**, **Retries**, **Management EPG**. Select either **Enabled** or **Disabled** for **Server Monitoring**.

**Step 2** Create the **Login Domain** for TACACS+.

a) Click the **Global Create** icon.

The **Global Create** menu appears.

b) Click the drop-down arrow below the **Global Create** search box and choose **Administrative**.

A list of **Administrative** options appear in the **Global Create** menu.

c) From the **Administrative** list in the **Global Create** menu, click **Create Login Domain**.

The **Create Login Domain** dialog box appears.

- d) Enter the appropriate values in each field as listed in the following *Create Login Domain Dialog Box Fields* table then continue.

Properties	Description
<b>General</b>	
<b>Name</b>	Enter the name of the Login Domain
Description	Enter the description of the Login Domain.
<b>Settings</b>	
Realm	Choose <b>TACACS+</b> from the dropdown menu
Providers	To choose a Provider(s): <ol style="list-style-type: none"> <li>1. Click <b>Add Providers</b>. The <b>Select Providers</b> dialog appears.</li> <li>2. Click to choose a provider(s) in the column on the left.</li> <li>3. Click <b>Select</b>. You return to the <b>Create Login Domain</b> dialog box.</li> </ol>

- e) Click **Save** to save the configuration.

### What to do next

This completes the APIC TACACS+ configuration steps. Next, if a RADIUS server will also be used, configure the APIC for RADIUS.

## Configuring Cisco Cloud Network Controller for RADIUS Access

### Before you begin

- The Cisco Cloud Network Controller is online.
- The RADIUS server host name or IP address, port, and key are available.
- The Cisco Cloud Network Controller management endpoint group is available.

### Step 1

In the Cisco Cloud Network Controller, create the **RADIUS Provider**.

- a) Click the **Global Create** icon.

The **Global Create** menu appears.

- b) Scroll down until you see the **Administrative** area, then click **Create Provider** under the **Administrative** area.

The **Create Provider** dialog box appears.

- c) In the **Host Name/IP Address** field, enter the Host Name/IP Address of the provider.
- d) In the **Description** field, enter a description of the provider.
- e) Click the **Type** drop-down list and choose **RADIUS**.
- f) In the **Settings** section, specify the **Key, Port, Authentication Protocol, Timeout, Retries, Management EPG**. Select either **Enabled** or **Disabled** for **Server Monitoring**.

**Step 2** Create the **Login Domain** for **RADIUS**.

- a) Click the **Global Create** icon.

The **Global Create** menu appears.

- b) Click the drop-down arrow below the **Global Create** search box and choose **Administrative**

A list of **Administrative** options appear in the **Global Create** menu.

- c) From the **Administrative** list in the **Global Create** menu, click **Create Login Domain**.

The **Create Login Domain** dialog box appears.

- d) Enter the appropriate values in each field as listed in the following *Create Login Domain Dialog Box Fields* table then continue.

Properties	Description
<b>General</b>	
<b>Name</b>	Enter the name of the Login Domain
Description	Enter the description of the Login Domain.
<b>Settings</b>	
Realm	Choose <b>RADIUS</b> from the dropdown menu
Providers	To choose a Provider(s): <ol style="list-style-type: none"> <li>1. Click <b>Add Providers</b>. The <b>Select Providers</b> dialog appears.</li> <li>2. Click to choose a provider(s) in the column on the left.</li> <li>3. Click <b>Select</b>. You return to the <b>Create Login Domain</b> dialog box.</li> </ol>

- e) Click **Save** to save the configuration.

### What to do next

This completes the Cisco Cloud Network Controller RADIUS configuration steps. Next, configure the RADIUS server.

# Configuring a Cisco Secure Access Control Server for RADIUS and TACACS+ Access to the Cisco Cloud Network Controller

Refer to the section *Configuring a Cisco Secure Access Control Server for RADIUS and TACACS+ Access to the APIC* in the [Cisco Cloud Network Controller Security Configuration Guide](#).

## Configuring LDAP Access

There are two options for LDAP configurations:

- Configure a Cisco AVPair
- Configure LDAP group maps in the Cisco Cloud Network Controller

The following sections contain instructions for both configuration options.

### Configuring Windows Server 2008 LDAP for APIC Access with Cisco AVPair

Refer to the section *Configuring Windows Server 2008 LDAP for APIC Access with Cisco AVPair* in the [Cisco Cloud Network Controller Security Configuration Guide](#).

## Configuring Cisco Cloud Network Controller for LDAP Access

### Before you begin

- The Cisco Cloud Network Controller is online.
- The LDAP server host name or IP address, port, bind DN, Base DN, and password are available.
- The Cisco Cloud Network Controller management endpoint group is available.

### Step 1

In the Cisco Cloud Network Controller, create the **LDAP Provider**.

- a) On the menu bar, choose **Administrative > Authentication**.
- b) In the Work pane, click on **Providers** tab and then click on the **Actions** drop-down and select **Create Provider**.
- c) In the **Host Name/IP Address** field, enter the Host Name/IP Address of the provider.
- d) In the **Description** field, enter a description of the provider.
- e) Click the **Type** drop-down list and choose **LDAP**.
- f) Specify the **Bind DN**, **Base DN**, **Password**, **Port**, **Attribute**, **Filter Type** and **Management EPG**.

- Note**
- The bind DN is the string that the Cisco Cloud Network Controller uses to log in to the LDAP server. The Cisco Cloud Network Controller uses this account to validate the remote user attempting to log in. The base DN is the container name and path in the LDAP server where the Cisco Cloud Network Controller searches for the remote user account. This is where the password is validated. Filter is used to locate the attribute that the Cisco Cloud Network Controller requests to use for the *cisco-av-pair*. This contains the user authorization and assigned RBAC roles for use on the Cisco Cloud Network Controller. The Cisco Cloud Network Controller requests the attribute from the LDAP server.
  - **Attribute** field—Enter one of the following:
    - For LDAP server configurations with a Cisco AVPair, enter **CiscoAVPair**.
    - For LDAP server configurations with an LDAP group map, enter **memberOf**.

**Step 2** Create the **Login Domain** for LDAP.

- a) On the menu bar, choose **Administrative > Authentication**.
- b) In the Work pane, click on **Login Domains** tab and then click on the **Actions** drop-down and select **Create Login Domain**.
- c) Enter the appropriate values in each field as listed in the following *Create Login Domain Dialog Box Fields* table then continue.

Properties	Description
<b>General</b>	
<b>Name</b>	Enter the name of the Login Domain
Description	Enter the description of the Login Domain.
<b>Settings</b>	
Realm	Choose <b>LDAP</b> from the dropdown menu
Providers	<p>To choose a Provider(s):</p> <ol style="list-style-type: none"> <li><b>1.</b> Click <b>Add Providers</b>. The <b>Select Providers</b> dialog appears.</li> <li><b>2.</b> Click to choose a provider(s) in the column on the left.</li> <li><b>3.</b> Click <b>Select</b>. You return to the <b>Create Login Domain</b> dialog box.</li> </ol>

Properties	Description
Authentication Type	<ol style="list-style-type: none"> <li>1. Select <b>Cisco AV Pairs</b>, if provider(s) was configured with <b>CiscoAVPair</b> as the <b>Attribute</b>.</li> <li>2. Select <b>LDAP Group Map Rules</b>, if provider(s) was configured with <b>memberOf</b> as the <b>Attribute</b>. <ol style="list-style-type: none"> <li>a. Click <b>Add LDAP Group Map Rule</b>. The dialog box appears.</li> <li>b. Specify the map rule <b>Name</b>, <b>Description</b> (optional), and <b>Group DN</b>.</li> <li>c. Click the + next to <b>Add Security Domain</b>. The dialog box appears.</li> <li>d. Click the + to access the <b>Role</b> name and <b>Role Privilege</b> Type (<b>Read</b> or <b>Write</b>) fields. Click check mark.</li> <li>e. Repeat step 4 to add more roles. Then click <b>Add</b>.</li> <li>f. Repeat step 3 to add more security domains. Then click <b>Add</b>.</li> </ol> </li> </ol>

d) Click **Save** on Create Login Domain dialog box.

## Configuring Cisco Cloud Network Controller for SAML Access

The following sections provide detailed information on configuring Cisco Cloud Network Controller for SAML access.

### About SAML

Refer to the section *About SAML* in the [Cisco Cloud Network Controller Security Configuration Guide](#).

#### Basic Elements of SAML

Refer to the section *Basic Elements of SAML* in the [Cisco Cloud Network Controller Security Configuration Guide](#).

#### Supported IdPs and SAML Components

Refer to the section *Supported IdPs and SAML Components* in the [Cisco Cloud Network Controller Security Configuration Guide](#).

## Configuring Cisco Cloud Network Controller for SAML Access



**Note** SAML based Authentication is only for Cisco Cloud Network Controller GUI and not for REST.

### Before you begin

- The SAML server host name or IP address, and the IdP's metadata URL are available.
- The Cisco Cloud Network Controller management endpoint group is available.
- Set up the following:
  - Time Synchronization and NTP
  - Configuring a DNS Provider Using the GUI
  - Configuring a Custom Certificate for Cisco ACI HTTPS Access Using the GUI

**Step 1** In the Cisco Cloud Network Controller, create the **SAML Provider**.

- a) On the menu bar, choose **Administrative > Authentication**.
- b) In the **Work** pane, click on **Providers** tab and then click on the **Actions** drop-down and select **Create Provider**.
- c) In the **Host Name/IP Address** field, enter the Host Name/IP Address of the provider.
- d) In the **Description** field, enter a description of the provider.
- e) Click the **Type** drop-down list and choose **SAML**.
- f) In **Settings** pane, perform following:
  - Specify the IdP metadata URL:
    - In case of AD FS, IdP Metadata URL is of the format *https://<FQDN ofADFS>/FederationMetadata/2007-06/FederationMetadata.xml*.
    - In case of Okta, to get the IdP Metadata URL, copy the link for **Identity Provider Metadata** in the **Sign On** section of the corresponding SAML Application from the Okta server.
  - Specify the **Entity ID** for the SAML-based service.
  - Configure the **HTTPS Proxy for Metadata URL** if it is needed to access the IdP metadata URL.
  - Select the **Certificate Authority** if IdP is signed by a Private CA.
  - Select the **Signature Algorithm Authentication User Requests** from the drop-down.
  - Select checkbox to enable **Sign SAML Authentication Requests**, **Sign SAML Response Message**, **Sign Assertions in SAML Response**, **Encrypt SAML Assertions**.
- g) Click **Save** to save the configuration.

**Step 2** Create the login domain for SAML.

- a) On the menu bar, choose **Administrative > Authentication**.
- b) In the **Work** pane, click on the **Login Domains** tab and then click on the **Actions** drop-down and select **Create Login Domain**.



- c) Enter the appropriate values in each field as listed in the following Create Login Domain Dialog Box Fields table then continue.

Properties	Description
<b>General</b>	
<b>Name</b>	Enter the name of the Login Domain
Description	Enter the description of the Login Domain.
<b>Settings</b>	
Realm	Choose <b>SAML</b> from the dropdown menu
Providers	<p>To choose a Provider(s):</p> <ol style="list-style-type: none"> <li>1. Click <b>Add Providers</b>. The <b>Select Providers</b> dialog appears.</li> <li>2. Click to choose a provider(s) in the column on the left.</li> <li>3. Click <b>Select</b>. You return to the <b>Create Login Domain</b> dialog box.</li> </ol>

- d) Click **Save** to save the configuration.

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## Setting Up a SAML Application in Okta

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Refer to the section *Setting Up a SAML Application in Okta* of [Cisco Cloud Network Controller Security Configuration Guide](#).

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## Setting Up a Relying Party Trust in AD FS

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Refer to the section *Setting Up a Relying Party Trust in AD FS* in the [Cisco Cloud Network Controller Security Configuration Guide](#).

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## Configuring HTTPS Access

The following sections describe how to configure HTTPS access.

## About HTTPS Access

This article provides an example of how to configure a custom certificate for HTTPS access when using Cisco ACI.

For more information, see the section *HTTPS Access* in the [Cisco Cloud Network Controller Security Configuration Guide](#).

## Guidelines for Configuring Custom Certificates

- Wild card certificates (such as \*.cisco.com, which is used across multiple devices) and its associated private key generated elsewhere are not supported on the Cisco Cloud Network Controller as there is no support to input the private key or password in the Cisco Cloud Network Controller. Also, exporting private keys for any certificates, including wild card certificates, is not supported.
- You must download and install the public intermediate and root CA certificates before generating a Certificate Signing Request (CSR). Although a root CA Certificate is not technically required to generate a CSR, Cisco requires the root CA certificate before generating the CSR to prevent mismatches between the intended CA authority and the actual one used to sign the CSR. The Cisco Cloud Network Controller verifies that the certificate submitted is signed by the configured CA.
- To use the same public and private keys for a renewed certificate generation, you must satisfy the following guidelines:
  - You must preserve the originating CSR as it contains the public key that pairs with the private key in the key ring.
  - The same CSR used for the originating certificate must be resubmitted for the renewed certificate if you want to re-use the public and private keys on the Cisco Cloud Network Controller.
  - Do not delete the original key ring when using the same public and private keys for the renewed certificate. Deleting the key ring will automatically delete the associated private key used with CSRs.
- Only one Certificate Based Root can be active per pod.
- Client Certificate based authentication is not supported for this release.

## Configuring a Custom Certificate for Cisco ACI HTTPS Access Using the GUI

Determine from which authority you will obtain the trusted certification so that you can create the appropriate Certificate Authority.

### Before you begin

**CAUTION:** PERFORM THIS TASK ONLY DURING A MAINTENANCE WINDOW AS THERE IS A POTENTIAL FOR DOWNTIME. Expect a restart of all web servers on Cisco Cloud Network Controller during this operation.

---

**Step 1** On the menu bar, choose **Administrative > Security**.

- Step 2** In the Work pane, click on **Certificate Authorities** tab and then click on the **Actions** drop-down and select **Create Certificate Authority**.
- Step 3** In the **Create Certificate Authority** dialog box, in the **Name** field, enter a name for the certificate authority and in the **Description** field, enter a description.
- Step 4** Select **System** in the **Used for** field.
- Step 5** In the **Certificate Chain** field, copy the intermediate and root certificates for the certificate authority that will sign the Certificate Signing Request (CSR) for the Cloud Network Controller. The certificate should be in Base64 encoded X.509 (CER) format. The intermediate certificate is placed before the root CA certificate. It should look similar to the following example:
- ```
-----BEGIN CERTIFICATE-----  
<Intermediate Certificate>  
-----END CERTIFICATE-----  
-----BEGIN CERTIFICATE-----  
<Root CA Certificate>  
-----END CERTIFICATE-----
```
- Step 6** Click **Save**.
- Step 7** On the menu bar, choose **Administrative > Security**.
- Step 8** In the Work pane, click on the **Key Rings** tab, then click on the **Actions** drop-down and select **Create Key Ring**.
- Step 9** In the **Create Key Ring** dialog box, in the **Name** field, enter a name for the certificate authority and in **Description** enter description.
- Step 10** Select **System** in the **Used for** field.
- Step 11** For the **Certificate Authority** field, click on **Select Certificate Authority** and select the Certificate Authority that you created earlier.
- Step 12** Select either **Generate New Key** or **Import Existing Key** for the field **Private Key**. If you select **Import Existing Key**, enter a private key in the **Private Key** text box.
- Step 13** Select modulus from the **Modulus** drop-down. menu
- Step 14** In the **Certificate** field, do not add any content.
- Step 15** Click **Save**.
- In the **Work** pane, in the **Key Rings** area, the **Admin State** for the key ring created displays **Started**.
- Step 16** Double-click on the created Key Ring to open **Key Ring** *key\_ring\_name* dialog box from the **Work** pane.
- Step 17** In the **Work** pane, click on **Create Certificate Request**.
- Step 18** In the **Subject** field, enter the fully qualified domain name (FQDN) of the Cisco Cloud Network Controller.
- Step 19** Fill in the remaining fields as appropriate.
- Step 20** Click **Save**.
- The **Key Ring** *key\_ring\_name* dialog box appears.
- Step 21** Copy the contents from the field Request to submit to the **Certificate Authority** for signing.
- Step 22** From the **Key Ring** *key\_ring\_name* dialog box, click on edit icon to display the **Key Ring** *key\_ring\_name* dialog box.
- Step 23** In the **Certificate** field, paste the signed certificate that you received from the certificate authority.
- Step 24** Click **Save** to return to the **Key Rings** work pane.
- The key is verified, and in the **Work** pane, the **Admin State** changes to **Completed** and is now ready for use in the HTTPS policy.
- Step 25** Navigate to **Infrastructure > System Configuration**, then click the **Management Access** tab.

**Step 26** Click the edit icon on the **HTTPS** work pane to display the **HTTPS Settings** dialog box.

**Step 27** Click on **Admin Key Ring** and associate the Key Ring that you created earlier.

**Step 28** Click **Save**.

All web servers restart. The certificate is activated, and the non-default key ring is associated with HTTPS access.

---

### What to do next

You must remain aware of the expiration date of the certificate and take action before it expires. To preserve the same key pair for the renewed certificate, you must preserve the CSR, as it contains the public key that pairs with the private key in the key ring. Before the certificate expires, the same CSR must be resubmitted. Do not delete or create a new key ring, as deleting the key ring will delete the private key stored internally on the Cisco Cloud Network Controller.



# CHAPTER 9

## Configuration Drifts

- [Configuration Drift Notifications and Faults, on page 171](#)
- [Accessing the Main Configuration Drift Page, on page 172](#)
- [Checking for Missing Contracts Configuration, on page 174](#)
- [Checking for Missing EPGs Configuration, on page 176](#)
- [Checking for Missing VRFs Configuration, on page 177](#)
- [Configuration Drift Troubleshooting, on page 179](#)

## Configuration Drift Notifications and Faults

When you deploy Cisco ACI in a public cloud, you will perform most of the fabric configuration from the Cloud Network Controller. However, there may be cases where you or another cloud administrator changes the deployed configuration directly in the cloud provider's GUI using the tools provided by AWS or Azure. In these cases, the intended configuration you deployed from the Cloud Network Controller and the actual configuration in the cloud site may become out of sync, we call this a configuration drift.

Cloud Network Controller provides visibility into any security policy (contracts) configuration discrepancy between what you deploy from the Cloud Network Controller and what is actually configured in the cloud site. Configuration drift is enabled by default, and configuration drift information is available for EPGs, VRFs, and contracts with or without Layer 4 to Layer 7 service graphs attached.

Configuration drift information is consolidated under a single page, located at **Cloud Resources > Drifts**.

The screenshot shows the 'Drifts' page in the Cisco Cloud Network Controller. The left sidebar contains a navigation menu with 'Drifts' selected. The main content area shows a 'Detection Summary' table and a list of drifts.

| Object                                                                                                                                                                                            | Status    | Drift Type   | Last Configuration Update     |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|--------------|-------------------------------|
| /subscriptions/630daf13-e0e6-40bf-bb7e-17844309af73/resourceGroups/CAPIC_int_vrf1_eastus/providers/Microsoft.Network/networkSecurityGroups/ALB2-subnet/securityRules/AzureIntraBackendHealthPorts | Unmanaged | Extra Object | Jul 08 2022 01:43:56am -07:00 |
| /subscriptions/630daf13-e0e6-40bf-bb7e-17844309af73/resourceGroups/CAPIC_int_vrf1_eastus/providers/Microsoft.Network/networkSecurityGroups/ALB2-subnet/securityRules/AzureLoadBalancer            | Unmanaged | Extra Object | Jul 08 2022 01:43:56am -07:00 |
| /subscriptions/630daf13-e0e6-40bf-bb7e-17844309af73/resourceGroups/CAPIC_int_vrf1_eastus/providers/Microsoft.Network/networkSecurityGroups/vrf1-east-VM1-rsg/securityRules/SSH                    | Unmanaged | Extra Object | Jul 08 2022 01:32:32am -07:00 |
| /subscriptions/630daf13-e0e6-40bf-bb7e-17844309af73/resourceGroups/CAPIC_int_vrf1_eastus/providers/Microsoft.Network/networkSecurityGroups/ALB2-subnet/securityRules/AzureIntraBackendHealthPorts | Unmanaged | Extra Object | Jul 08 2022 01:32:32am -07:00 |

See [Accessing the Main Configuration Drift Page, on page 172](#) for more information.

There are two aspects to analyzing configuration drift:

- Have all the fabric elements configured in the Cloud Network Controller and intended to be deployed in the cloud fabric been properly deployed?

This scenario can occur due to user configuration errors in Cloud Network Controller that could not be deployed in the cloud, connection or API issues on the cloud provider end, or if a cloud administrator manually deletes or modifies security rules directly in the cloud provider's UI. Any intended but missing configurations may present an issue for the Cloud Network Controller fabric.

- Are there any additional configurations that exist in the cloud but were not intended to be deployed from the Cloud Network Controller?

Similarly to the previous scenario, this can occur if there are connection or API issues or if a cloud administrator manually creates additional security rules directly in the cloud provider's UI. Any existing but not intended configuration may present issues.

## Accessing the Main Configuration Drift Page

Configuration drift information is consolidated under a single **Drifts** page.

The **Drifts** page is used to provide the following pieces of information:

- To identify if something has been deleted
- To ensure that anything that should be present is correctly shown as present

**Step 1** Log in to your Cisco Cloud Network Controller GUI.

**Step 2** Navigate to the main configuration drift page:

**Cloud Resources > Drifts**

The consolidated **Drifts** page appears.

The screenshot shows the Cisco Cloud Network Controller GUI. On the left is a navigation menu with options like Dashboard, Topology, Cloud Resources, Regions, Virtual Networks, Routers, Security Groups, Endpoints, Virtual Machines, Network Services, Kubernetes Clusters, Native Services, Drifts (highlighted), Application Management, Operations, Infrastructure, and Administrative. The main content area is titled 'Drifts' and includes a 'Detection Summary' section with the following data:

| Unmanaged Objects | Objects with Drifts | Last Drift Check              |
|-------------------|---------------------|-------------------------------|
| 32                | 0                   | Jul 08 2022 08:37:26am -07:00 |

Below the summary is a table of drifts:

| Object                                                                                                                                                                                              | Status    | Drift Type   | Last Configuration Update     |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|--------------|-------------------------------|
| /subscriptions/630daf13-e0e6-40bf-b87e-17844309af73/resourceGroups/CAPIC_int_vr f1_eastus/providers/Microsoft.Network/netwo rkSecurityGroups/ALB2-subnet/securityRules/AzureInfraBackendHealthPorts | Unmanaged | Extra Object | Jul 08 2022 01:43:56am -07:00 |
| /subscriptions/630daf13-e0e6-40bf-b87e-17844309af73/resourceGroups/CAPIC_int_vr f1_eastus/providers/Microsoft.Network/netwo rkSecurityGroups/ALB2-subnet/securityRules/AzureLoadBalancer            | Unmanaged | Extra Object | Jul 08 2022 01:32:32am -07:00 |
| /subscriptions/630daf13-e0e6-40bf-b87e-17844309af73/resourceGroups/CAPIC_int_vr f1_eastus/providers/Microsoft.Network/netwo rkSecurityGroups/vrf1-east-VM1-nsg/securityRules/SSH                    | Unmanaged | Extra Object | Jul 08 2022 01:32:32am -07:00 |

In the **Drifts** page, you can see a summary of any configuration issues in your fabric.

The **Detection Summary** area provides an overview of how many configuration drifts were detected with managed or unmanaged objects, and the time when this information was last updated. If the inventory update timestamp is out of date, you can refresh the information by clicking the **Refresh** icon in the top right corner of this screen.

**Step 3** Use the information in the table below the **Detection Summary** area to find any configuration drifts.

- **Object:** Provides information on the object associated with the configuration drift.
- **Status:** Following are the different values that might appear in the **Status** column:
  - **Transient (low):** Drifts that are likely due to recent configuration changes. We recommend waiting for the fabric to stabilize and the drift will likely resolve on its own after the next configuration refresh.
  - **Presumed (medium):** Drifts that may or may not be transient. We recommend monitoring the status and troubleshoot the configuration should the drift persist.
  - **Raised (high):** Critical drifts. We recommend verifying the configuration on Cloud Network Controller and checking for any associated faults. Redeploying the configuration may help resolve communication issues between the Cloud Network Controller and cloud services. If the issue persists, check the tech-support logs.
  - **Unmanaged:** Configuration drifts related to extra inventory objects not created through the Cisco Cloud Network Controller.
- **Drift Type:** Following are the different values that might appear in the **Drift Type** column:
  - **Configuration:** External changes on the cloud providers site that could result in the intended configuration and the actual configuration being out of sync. Used for configuration drifts related to *EPGs* or *VRFs*.
  - **Rule:** External changes on the cloud providers site that could result in the intended security rules and the expected rules that are established through a contract being out of sync. Used for configuration drifts related to *contracts*.
  - **Extra Object:** Used to show extra inventory objects that were not created through the Cisco Cloud Network Controller. Cisco Cloud Network Controller does not perform drift detection on these objects.
- **Last Configuration Update:** Provides information on when the last configuration update occurred.

**Step 4** Enter information in the filter line to filter the configuration drifts provided in the table, if necessary.

a) Click in the filter line below the **Detection Summary** area. The following filter types appear:

- Object
- Status
- Drift Type
- Last Configuration Update
- Parent Path

Select the appropriate type for your filter.

b) Click the necessary operator.

The options are:

- **==:** The equal-to operator


- !=: The not-equal-to operator

c) Click the necessary drift type.

The options are `Extra Object`, `Rule`, and `Configuration`. See the explanations for the **Drift Type** field above for more information.

The entries in the table are filtered based on your selections above.

**Step 5** View additional information on a specific configuration drift, if necessary.

For any object listed in this page, you can bring up additional configuration drift information by clicking the appropriate line in the **Configuration Drifts** table. A side panel appears with additional information on this particular configuration drift; clicking the Details icon () automatically brings you to the appropriate **Cloud Mapping** page for this particular object.

Refer to the following sections for additional configuration drift information for specific objects:

- [Checking for Missing Contracts Configuration, on page 174](#)
- [Checking for Missing EPGs Configuration, on page 176](#)
- [Checking for Missing VRFs Configuration, on page 177](#)

---

## Checking for Missing Contracts Configuration

This section describes how to check for any contract settings you have configured from the Cisco Cloud Network Controller, but which have not been properly deployed to the cloud fabric.

**Step 1** Log in to your Cloud Network Controller GUI.

**Step 2** Click **Application Management > Contracts**.

**Step 3** Double-click the appropriate contract to bring up the **Overview** page for that contract.

**Step 4** Note the service graph information provided in the **Service Graph** area, if applicable.


Contract drift information is available for contracts with or without Layer 4 to Layer 7 service graphs attached. See [Deploying Layer 4 to Layer 7 Services, on page 131](#) for more information.

**Step 5** Click the **Cloud Mapping** tab.

The **Cloud Mapping** view displays all the information about the contract and the cloud resources it uses.



The screenshot displays the 'Contract NFA\_contract' page in the Cisco Cloud Network Controller for AWS. The interface includes a navigation bar with tabs for Overview, Topology, Cloud Resources, Application Management, Cloud Mapping (selected), and Event Analytics. A notification banner at the top states 'Detection of configuration drifts is still in beta.' Below this, the 'Detection Summary' section provides a high-level overview: Configuration Drift Status (0 Drifts Found), Configured Cloud Resources (87), Expected Cloud Resources (87), and Last Drift Check (Jul 08 2022 08:37:26am -07:00). The 'Related Objects' section lists 1 Consumer EPG, 1 Provider EPG, and 1 Filter. The 'Configuration Drifts' section features a table with columns for Status, Type, Protocol, From Port, To Port, Source, Destination, Network Security Group, NSG Cloud Provider ID, Consumer EPGs, Provider EPGs, Drift Type, Description, and Recommended Action. The table currently shows 'No rows found'. At the bottom, there is a pagination control showing 'Page 1 of 1' and a 'Rows' dropdown set to 15.

**Note** You can also navigate to this page by navigating to **Cloud Resources > Drifts**, then clicking the appropriate line in the **Configuration Drifts** table. A side panel appears with additional information on this particular configuration drift; clicking the Details icon () automatically brings you to the appropriate **Cloud Mapping** page for this particular object. See [Accessing the Main Configuration Drift Page, on page 172](#) for more information.

The screen is divided into four sections: **Detection Summary**, **Related Objects**, **Configuration Drifts**, and **Presented Cloud Resources**. Each section contains a table that lists the respective information about the contract you selected.

- The **Detection Summary** area provides an overview of how many configuration drifts were detected, number of intended and actual cloud resources configured, and the time when this information was last updated. If the inventory update timestamp is out of date, you can refresh the information by clicking the **Refresh** icon in the top right corner of this screen.
- The **Related Objects** area shows any other objects that have a relation to the contract, such as consumer and provider EPGs, and filters.
- The **Configuration Drifts** table lists all the issues with the contract rules. Specifically, all the contract rules that were intended to be deployed but are missing in the actual fabric configuration.

The table contains detailed information, such as the protocol used, port ranges, source and destination IP or group, consumer and provider EPGs, description of the issue, and the recommended action to resolve it. For each configuration drift, the **Status** field will indicate the severity and recommended action:

- **Transient (low)**: Drifts that are likely due to recent configuration changes. We recommend waiting for the fabric to stabilize and the drift will likely resolve on its own after the next configuration refresh.
- **Presumed (medium)**: Drifts that may or may not be transient. We recommend monitoring the status and troubleshoot the configuration should the drift persist.
- **Raised (high)**: Critical drifts. We recommend verifying the configuration on Cloud Network Controller and checking for any associated faults. Redeploying the configuration may help resolve communication issues between the Cloud Network Controller and cloud services. If the issue persists, check the tech-support logs.

- The **Presented Cloud Resources** table shows the information about all the resources that were properly configured in your cloud. This table is designed to provide you with better visibility into what rules are configured in your cloud for a specific contract.

## Checking for Missing EPGs Configuration

This section describes how to check for any EPG settings you have configured from the Cloud Network Controller, but which have not been properly deployed to the cloud fabric.

- Step 1** Log in to your Cloud Network Controller GUI.
- Step 2** Click **Application Management > EPGs**.
- Step 3** Double-click the appropriate EPG to bring up the **Overview** page for that EPG.
- Step 4** Click the **Cloud Mapping** tab.

The **Cloud Mapping** view displays all the information about the EPG and the cloud resources it uses.

**Note** You can also navigate to this page by navigating to **Cloud Resources > Drifts**, then clicking the appropriate line in the **Configuration Drifts** table. A side panel appears with additional information on this particular configuration drift; clicking the Details icon (🔍) automatically brings you to the appropriate **Cloud Mapping** page for this particular object. See [Accessing the Main Configuration Drift Page, on page 172](#) for more information.

The screen is divided into four sections: **Detection Summary**, **Related Objects**, **Configuration Drifts**, and **Presented Cloud Resources**. Each section contains a table that lists the respective information about the EPG you selected.

- The **Detection Summary** area provides an overview of how many configuration drifts were detected, number of intended and actual cloud resources configured, and the time when this information was last updated. If the inventory update timestamp is out of date, you can refresh the information by clicking the **Refresh** icon in the top right corner of this screen.

- The **Related Objects** area shows any other objects that have a relation to the EPG, such as security groups and contracts.
- The **Configuration Drifts** table lists all the issues with the security groups associated with the EPG. Specifically, all the security groups that were intended to be deployed but are missing in the actual fabric configuration.

The table contains detailed information, such as the logical DN, cloud provider ID, drift type, description of the issue, and the recommended action to resolve it. For each configuration drift, the **Status** field will indicate the severity and recommended action:

- **Transient (low)**: Drifts that are likely due to recent configuration changes. We recommend waiting for the fabric to stabilize and the drift will likely resolve on its own after the next configuration refresh.
  - **Presumed (medium)**: Drifts that may or may not be transient. We recommend monitoring the status and troubleshoot the configuration should the drift persist.
  - **Raised (high)**: Critical drifts. We recommend verifying the configuration on Cloud Network Controller and checking for any associated faults. Redeploying the configuration may help resolve communication issues between the Cloud Network Controller and cloud services. If the issue persists, check the tech-support logs.
- The **Presented Cloud Resources** table shows the information about all the resources that were properly configured in your cloud. This table is designed to provide you with better visibility into what security groups are associated with a specific EPG in your cloud.

---

## Checking for Missing VRFs Configuration

This section describes how to check for any VRF settings you have configured from the Cloud Network Controller, but which have not been properly deployed to the cloud fabric.

- 
- Step 1** Log in to your Cloud Network Controller GUI.
  - Step 2** Click **Application Management > VRFs**.
  - Step 3** Double-click the appropriate VRF to bring up the **Overview** page for that VRF.
  - Step 4** Click the **Cloud Mapping** tab.

The **Cloud Mapping** view displays all the information about the VRF and the cloud resources it uses.

The screenshot displays the 'VRF vrf1' configuration page in the Cisco Cloud Network Controller for AWS. The interface includes a navigation bar with tabs for Overview, Topology, Cloud Resources, Application Management, Cloud Mapping (selected), Statistics, and Event Analytics. A notification banner at the top states 'Detection of configuration drifts is still in beta.' Below this, the 'Detection Summary' section provides a high-level overview: Configuration Drift Status shows 0 drifts found, Configured Cloud Resources are 13, Expected Cloud Resources are 13, and the Last Drift Check was on Jul 08 2022 08:46:00am -07:00. The 'Related Objects' section lists 8 Application Security Groups, 7 Network Security Groups, 4 CIDRs, and 7 Subnets. The 'Configuration Drifts' section features a table with columns for Status, Logical DN, Region, Primary CIDR, Drift Type, Description, and Recommendation. The table is currently empty, displaying 'No rows found'. A side panel on the left allows filtering by Virtual Networks, CIDRs, or Subnets.

**Note** You can also navigate to this page by navigating to **Cloud Resources > Drifts**, then clicking the appropriate line in the **Configuration Drifts** table. A side panel appears with additional information on this particular configuration drift; clicking the Details icon (🔍) automatically brings you to the appropriate **Cloud Mapping** page for this particular object. See [Accessing the Main Configuration Drift Page, on page 172](#) for more information.

The screen is divided into four sections: **Detection Summary**, **Related Objects**, **Configuration Drifts**, and **Presented Cloud Resources**. Each section contains a table that lists the respective information about the VRF you selected.

- The **Detection Summary** area provides an overview of how many configuration drifts were detected, number of intended and actual cloud resources configured, and the time when this information was last updated. If the inventory update timestamp is out of date, you can refresh the information by clicking the **Refresh** icon in the top right corner of this screen.
- The **Related Objects** area shows any other objects that have a relation to the VRF, such as security groups, CIDRs, and subnets.
- The **Configuration Drifts** table lists all the issues with the virtual networks, the CIDRs that are associated with the virtual networks, and the subnets within those CIDRs. Specifically, all the virtual networks, CIDRs, and subnets that were intended to be deployed but are missing in the actual fabric configuration.

Note that if there are configuration drifts at any one level, the table will show the configuration drift at that level and not any configuration drifts at the levels below it. For example, if a configuration drift occurs at a CIDR level and the corresponding subnets within that CIDR, the table will display the configuration drifts in the CIDR area but not the configuration drifts for the corresponding subnets within that CIDR.

The table contains detailed information in these areas:

- **Virtual Networks:** Provides information on logical DN, region, primary CIDR, drift type, description of the issue, and the recommended action to resolve it.
- **CIDRs:** Provides information on logical DN, region, CIDR block range, whether it is a primary CIDR or not, the subnets within the CIDR, drift type, description of the issue, and the recommended action to resolve it.
- **Subnets:** Provides information on logical DN, region, IP address, drift type, description of the issue, and the recommended action to resolve it.

For each configuration drift, the **Status** field will indicate the severity and recommended action:

- **Transient (low)**: Drifts that are likely due to recent configuration changes. We recommend waiting for the fabric to stabilize and the drift will likely resolve on its own after the next configuration refresh.
  - **Presumed (medium)**: Drifts that may or may not be transient. We recommend monitoring the status and troubleshoot the configuration should the drift persist.
  - **Raised (high)**: Critical drifts. We recommend verifying the configuration on Cloud Network Controller and checking for any associated faults. Redeploying the configuration may help resolve communication issues between the Cloud Network Controller and cloud services. If the issue persists, check the tech-support logs.
- The **Presented Cloud Resources** table shows the information about all the resources that were properly configured in your cloud, split into the same hierarchies that is shown in the **Configuration Drifts** table (Virtual Networks, CIDRs, and Subnets). This table is designed to provide you with better visibility into what virtual networks, CIDRs, and subnets are associated with a specific VRF in your cloud.

## Configuration Drift Troubleshooting

This section provides a few useful command to verify that the configuration drift processes are up and running on your Cloud Network Controller, check the application logs, and if necessary generate tech support information.

**Step 1** Log in to the Cisco Cloud Network Controller via console as a `root` user.

**Step 2** Check the status of the configuration drift application.

```
ACI-Cloud-Fabric-1# moquery -d pluginContr/plugin-Cisco_CApicDrift | egrep "dn |pluginSt |operSt |version"
dn: pluginContr/plugin-Cisco_CApicDrift
operSt: active
pluginSt: active
Version: 5.1.0
```

**Step 3** Check the status of the application container.

```
ACI-Cloud-Fabric-1# docker ps | grep drift
CONTAINER ID        IMAGE                               COMMAND                  CREATED             STATUS
NAMES
649af6feb72c      a5ea08bbf541    "/opt/bin/conit.bi..." 13 hours ago       Up 13
hours              drift-api-b703e569-0aa6-859f-c538-a5fecbc5708f
```

**Step 4** Check memory consumed by all Docker containers.

Total amount of memory consumed must be under 12GB.

```
ACI-Cloud-Fabric-1# systemctl status ifc-scheduler_allocations.slice | grep Memory
```

**Step 5** If necessary, collect the tech support logs.

Logs will be saved in the `/data/techsupport` directory on the controller.

```
ACI-Cloud-Fabric-1# trigger techsupport controllers application CApicDrift
ACI-Cloud-Fabric-1# trigger techsupport controllers application CApicDrift vendorName Cisco
```

**Step 6** Check the application logs.

The logs for configuration drift process are stored in the `/data2/logs/Cisco_CApicDrift` directory.

The `runhist.log` file provides information about each time the application was started, for example:

```
# cat runhist.log
1 - Thu Jun 11 23:55:59 UTC 2020
2 - Fri Jun 12 01:19:41 UTC 2020
```

The `drift.log` file is the application log file and can be used to view the number of times configuration drift was updated and how long each update took.

```
# cat drift.log | grep ITER
{"file":"online_snapshot.go:178","func":"Wait","level":"info","msg":"ITER# 109
ENDED === RDFGEN TIME: 1m40.383751649s, MODEL UPLOAD TIME 5m54.245550374s; TOTAL
TIME:: 7m34.629447083s","time":"2020-06-12T19:53:13Z"}
```

---



## CHAPTER 10

# AWS Transit Gateway on Cisco Cloud Network Controller

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- [AWS Transit Gateway on Cisco Cloud Network Controller, on page 181](#)

## AWS Transit Gateway on Cisco Cloud Network Controller

You can use Amazon Web Services (AWS) Transit Gateway with Cisco Cloud Network Controller. AWS Transit Gateway is a service that functions as an internal router to automate connectivity between virtual private clouds (VPCs). The VPCs can be in different AWS regions in a cloud site.

Virtual private clouds (VPC) can't communicate with each other without additional configuration. Without using AWS Transit Gateway, you can configure inter-VPC communication by configuring VPC peering. Alternatively, you can use VPN tunnels and CCRs.

However, when you use AWS Transit Gateway with Cisco Cloud Network Controller, you connect VPCs or VRFs in the cloud site simply by associating the VPCs or VRFs to the same AWS Transit Gateways.

Using AWS Transit Gateway with Cisco Cloud Network Controller provides several benefits: higher performance, simplicity, scalability and potential lower cost.



---

**Note** You can attach a Cisco Cloud Network Controller user tenant's VPC (CtxProfile) to an AWS Transit Gateway (hub network) only if you have administrator privileges and the user is part of security domain "all". Without such access, you cannot attach the user tenant's VPC to an AWS Transit Gateway.

---

For detailed information about using AWS Transit Gateway with Cisco Cloud Network Controller, see [Increasing Bandwidth Between VPCs by Using AWS Transit Gateway](#).







# APPENDIX **A**

## Cisco Cloud Network Controller Error Codes

- [Cisco Cloud Network Controller Error Codes, on page 183](#)

### Cisco Cloud Network Controller Error Codes

This section describes the Cisco Cloud Network Controller error codes.

**Table 34: Cisco Cloud Network Controller Error Codes**

| Component      | Error Code                                  | Constraint                                                                                                 |
|----------------|---------------------------------------------|------------------------------------------------------------------------------------------------------------|
| cloud-template | CT_INFRANETWORK_COUNT                       | The count of the cloudtemplateInfraNetwork MO is at most 1                                                 |
| cloud-template | CT_INFRANETWORK_COUNT                       | The count of the cloudtemplateInfraNetwork MO is at most 1                                                 |
| cloud-template | CT_INFRANETWORK_VRF                         | In the cloudtemplateInfraNetwork MO, the vrfName must be overlay-1                                         |
| cloud-template | CT_INFRANETWORK_PARENT                      | For the cloudtemplateInfraNetwork MO, the parent MO must be uni/tn-infra                                   |
| cloud-template | CT_INFRANETWORK_NUMROUTERSPERREGION_MINIMUM | In the cloudtemplateInfraNetwork MO, for the attribute numRoutersPerRegion, the minimum allowed value is 2 |

| Component      | Error Code                                      | Constraint                                                                                                                                                                                                    |
|----------------|-------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| cloud-template | CT_INFRANETWORK_NUMROUTERSPERREGION_MAXIMUM     | In the <code>cloudtemplateInfraNetwork</code> MO, for the attribute <code>numRoutersPerRegion</code> , the maximum allowed value is 4                                                                         |
| cloud-template | CT_INFRANETWORK_NUMREMOTESITESUBNETPOOL_MINIMUM | In the <code>cloudtemplateInfraNetwork</code> MO, for the attribute <code>numRemoteSiteSubnetPool</code> , the minimum allowed value is 2                                                                     |
| cloud-template | CT_INFRANETWORK_NUMREMOTESITESUBNETPOOL_MAXIMUM | In the <code>cloudtemplateInfraNetwork</code> MO, for the attribute <code>numRemoteSiteSubnetPool</code> , the maximum allowed value is 2                                                                     |
| cloud-template | CT_INTNETWORK_COUNT                             | The count of the <code>cloudtemplateIntNetwork</code> MO is at most 1                                                                                                                                         |
| cloud-template | CT_EXTNETWORK_COUNT                             | The count of the <code>cloudtemplateExtNetwork</code> MO is at most 1                                                                                                                                         |
| cloud-template | CT_VPNNETWORK_COUNT                             | The count of the <code>cloudtemplateVpnNetwork</code> MO is at most 1                                                                                                                                         |
| cloud-template | CT_OSPF_COUNT                                   | The count of the <code>cloudtemplateOspf</code> MO is at most 1                                                                                                                                               |
| cloud-template | CT_INTNETWORK_REGION_MATCH                      | The regions specified by <code>cloudRegionName</code> under <code>cloudtemplateIntNetwork</code> must have a corresponding <code>cloudRegion</code> under <code>cloudProvP</code>                             |
| cloud-template | CT_INTNETWORK_REGION_MANAGED                    | The regions specified by the <code>cloudRegionName</code> children of <code>cloudtemplateIntNetwork</code> must have corresponding <code>cloudRegion</code> with <code>adminSt</code> as <code>managed</code> |

| Component      | Error Code                               | Constraint                                                                                                                                                                                                                     |
|----------------|------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| cloud-template | CT_INTNETWORK_REGION_MAXIMUM             | The maximum number of regions ( <code>cloudRegionName</code> ) specified under <code>cloudtemplateIntNetwork</code> is 4                                                                                                       |
| cloud-template | CT_EXTNETWORK_REGION_SUBSET              | The regions that are specified by the <code>cloudRegionName</code> children of <code>cloudtemplateExtNetwork</code> must also be specified by <code>cloudRegionName</code> children under <code>cloudtemplateIntNetwork</code> |
| cloud-template | CT_EXTSUBNETPOOL_COUNT                   | The count of the <code>cloudtemplateExtSubnetPool</code> is at most 1                                                                                                                                                          |
| cloud-template | CT_EXTSUBNETPOOL_SUBNETPOOL_ADDRESS      | In <code>cloudtemplateExtSubnetPool</code> , the subnetpool must contain a network address                                                                                                                                     |
| cloud-template | CT_EXTSUBNETPOOL_SUBNETPOOL_IP_VERSION   | In <code>cloudtemplateExtSubnetPool</code> , the subnetpool must contain a IPv4 address                                                                                                                                        |
| cloud-template | CT_EXTSUBNETPOOL_SUBNETPOOL_ADDRESS_TYPE | In <code>cloudtemplateExtSubnetPool</code> , the subnetpool IP address must not from multicast or loopback address space                                                                                                       |
| cloud-template | CT_EXTSUBNETPOOL_SUBNETPOOL_MINIMUM_SIZE | In <code>cloudtemplateExtSubnetPool</code> , the subnetpool must be at least /22 (the netmask must be 22 or less)                                                                                                              |

| Component      | Error Code                           | Constraint                                                                                                                                                                                                                                                                                                                                                                                                               |
|----------------|--------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| cloud-template | CT_INTNETWORK_MISSING_HOME           | If there are any <code>cloudRegionName</code> under <code>cloudtemplateIntNetwork</code> , then one of the <code>cloudRegonName</code> must be associated to a region that is the home region of the Cisco Cloud Network Controller ( <code>capicDeployed</code> )                                                                                                                                                       |
| cloud-template | CT_CLOUD_APICSUBNETPOOL_INSUFFICIENT | There must be enough <code>cloudApicSubnetPool</code> MOs to generate <code>cloudApicSubnet</code> MOs so that all the <code>cloudRegionName</code> MOs specified under <code>cloudtemplateIntNetwork</code> can be associated to a unique <code>cloudApicSubnet</code> MO. The subnets from the <code>cloudApicSubnet</code> MOs are used as the CIDRs in the <code>cloudCtxProfile</code> of the corresponding region. |
| cloud-template | CT_IPSECTUNNEL_PEERADDR_IP_VERSION   | In <code>cloudtemplateIpSecTunnel</code> , the <code>peeraddr</code> must contain a IPv4 address                                                                                                                                                                                                                                                                                                                         |
| cloud-template | CT_IPSECTUNNEL_PEERADDR_IS_HOST      | In <code>cloudtemplateIpSecTunnel</code> , the <code>peeraddr</code> must be host address (i.e. /32)                                                                                                                                                                                                                                                                                                                     |
| cloud-template | CT_PROFILE_COUNT                     | The count of the <code>cloudtemplateProfile</code> MO is at most 1                                                                                                                                                                                                                                                                                                                                                       |
| cloud-template | CT_PROFILE_DELETE                    | The <code>cloudtemplateProfile</code> MO cannot be deleted unless its parent <code>cloudtemplateInfraNetwork</code> is also deleted                                                                                                                                                                                                                                                                                      |
| cloud-template | CT_PROFILE_ROUTERUSERNAME_NONEMPTY   | In <code>cloudtemplateProfile</code> , the <code>routerUsername</code> must be non-empty                                                                                                                                                                                                                                                                                                                                 |

| Component      | Error Code                         | Constraint                                                                                                                                                                                                                                              |
|----------------|------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| cloud-template | CT_PROFILE_ROUTERPASSWORD_NONEMPTY | In cloudtemplateProfile, the routerPassword must be non-empty                                                                                                                                                                                           |
| cloud-template | CT_PROFILE_ROUTERUSERNAME_MODIFY   | In cloudtemplateProfile, the routerUsername cannot be modified when there are routers deployed in any region, i.e. any cloudRegionName under cloudtemplateIntNetwork (The modification is allowed when there are no router deployments in any region)   |
| cloud-template | CT_PROFILE_ROUTERPASSWORD_MODIFY   | In cloudtemplateProfile, the routerPassword cannot be modified when there are routers deployed in any region, i.e. any cloudRegionName under cloudtemplateIntNetwork (The modification is allowed when there are no router deployments in any region)   |
| cloud-template | CT_PROFILE_ROUTERTHROUGHPUT_MODIFY | In cloudtemplateProfile, the routerThroughput cannot be modified when there are routers deployed in any region, i.e. any cloudRegionName under cloudtemplateIntNetwork (The modification is allowed when there are no router deployments in any region) |
| cloud          | CT_APICSUBNET_INVALID_HOME_REGION  | In a cloudApicSubnet MO, the region marked for capicDeployed must be a valid region                                                                                                                                                                     |

| Component | Error Code                             | Constraint                                                                                                                           |
|-----------|----------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------|
| cloud     | CT_APICSUBNET_REPEATED_REGION          | In a <code>cloudApicSubnet</code> MO, a region can be associated with at most 1 subnet                                               |
| cloud     | CT_APICSUBNET_MULTIPLE_HOME_REGION     | In <code>cloudApicSubnet</code> MOs, at most, 1 region may have <code>capicDeployed</code> as true                                   |
| cloud     | CLOUD_APICSUBNETPOOL_CREATEDBY_USER    | In <code>cloudApicSubnetPool</code> , the <code>createdBy</code> attribute must be USER                                              |
| cloud     | CLOUD_APICSUBNETPOOL_SUBNET_IP_VERSION | In <code>cloudApicSubnetPool</code> , the subnet must contain a IPv4 address                                                         |
| cloud     | CLOUD_APICSUBNETPOOL_SUBNET_SIZE       | In <code>cloudApicSubnetPool</code> , the subnet must be /24                                                                         |
| cloud     | CLOUD_APICSUBNETPOOL_DELETE_USAGE      | A <code>cloudApicSubnetPool</code> cannot be deleted if at least one of its <code>cloudApicSubnet</code> child is in use by a region |
| cloud     | CLOUD_APICSUBNETPOOL_DELETE_CREATEDBY  | A <code>cloudApicSubnetPool</code> whose <code>createdBy</code> attribute is not USER cannot be deleted                              |