Cisco ACI Multi-Site Configuration Guide, Release 3.0(x)

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CHAPTER 1

Multi-Site Orchestrator GUI

Overview

The Cisco ACI Multi-Site (Multi-Site) Orchestrator GUI is a browser-based graphical interface for configuring and monitoring your Cisco ACI, APIC, and Cloud APIC deployments.

The GUI is arranged according to function. For example, the **Dashboard** page contains an overview of your fabrics and their health, the **Sites** page provides information on each site and allows you to add sites, the **Schemas** page allows you to create and configure schemas, and so on. The functionality of each Multi-Site Orchestrator GUI page is described in the following sections

The top of each page shows the controller status indicating how many controllers are operational, the **Get Started** menu icon, the **Settings** icon, and the **User** icon.

The **Get Started** menu provides easy access to a number of common tasks you may want to perform, such as adding sites or schemas, configuring policies, or performing administrative tasks.

The **Settings** icon allows you to access overview information about your Multi-Site Orchestrator, such as the currently running version, what's new in the current release, system logs, and Swagger API documentation.

- Clicking the **About MSO** link displays information about the version of the Multi-Site Orchestrator currently installed.
- Clicking the **What's New in This Release** link displays a short summary of the new features in your release, as well as links to the rest of the Multi-Site documentation.
- Clicking the **API Docs** link gives you access to the set of Swagger API object and method references. Using the Swagger API is described in more detail in the *Cisco ACI Multi-Site REST API Configuration Guide*.

The **User** icon allows you to view information about the currently logged in user, such as password updates, preferences, and bookmarks. It also allows you to log out of the Orchestrator GUI.

- The **Reset Password** link allows you to update the currently logged in user's password
- The **Preferences** link allows you to change a few GUI options.
- The **Bookmarks** link opens the list of all the bookmarked schemas you save while using the Orchestrator. You can bookmark a schema by clicking the bookmark icon in the top right corner of the screen while viewing or editing the schema.

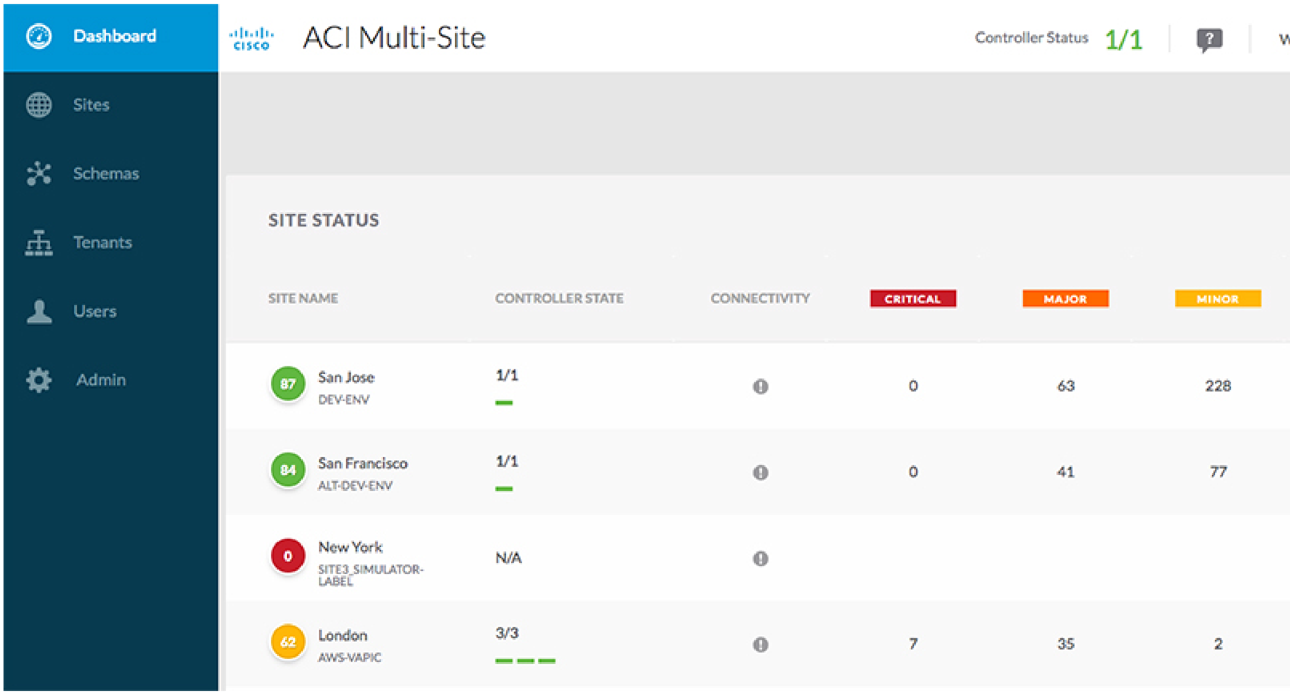
When working with fabric objects, a **Display Name** field is used throughout the Orchestrator's GUI whenever the objects are shown. You can specify a display name when creating the objects, however due to object naming requirements on the Cisco APIC, any invalid characters are removed and the resulting **Internal Name** is used when pushing the objects to sites. The **Internal Name** that will be used when creating the tenant is typically displayed below the **Display Name** textbox.

Dashboard

The Multi-Site dashboard displays the list of all of your site implementations in addition to their current functionality and health.

The following screen shot shows the Multi-Site Orchestrator dashboard display:

Figure 1: Multi-Site Orchestrator Dashboard



SITE STATUS

SITE NAME	CONTROLLER STATE	CONNECTIVITY	CRITICAL	MAJOR	MINOR
87 San Jose DEV-ENV	1/1	●	0	63	228
84 San Francisco ALT-DEV-ENV	1/1	●	0	41	77
0 New York SITE3_SIMULATOR-LABEL	N/A	●			
62 London AWS-VAPIC	3/3	●	7	35	2

The **Dashboard** has the following functional areas:

- **Site Status**: The site status table lists your sites according to name and location. The table also indicates the current health status for your implementation according to a descriptive color code.

    - The Controller State column indicates the number of controllers available and running. You can have a maximum number of 3 controllers in your Multi-Site implementation. For example, if one out of the 3 controller is down it is represented as 2/3.

    - The Connectivity column provides an operational status of the BGP sessions and the dataplane unicast and multicast tunnels that are connected to the peer sites for each site in the dashboard. This functionality is available starting with Cisco ACI Multi-Site, Release 1.0(2).

      When one or more BGP sessions or tunnels fail to establish, ACI Multi-Site provides the information about which exact local spines and remote spines failed to establish the BGP session or the tunnel. ACI Multi-Site should be enabled in the site in the infrastructure configuration, for the BGP sessions and the dataplane unicast and multicast tunnels to be established to the peer sites.

      BGP Sessions

        - When the BGP peering type is full-mesh in **Infra**-> **General Settings**, the spine node in a site with the BGP peering enabled will establish the BGP sessions to all the spine nodes with the BGP peering enabled in all the peer sites.

        - When the BGP peering type is route-reflector in **Infra**-> **General Settings**, the spine node in a site with both BGP peering enabled and route-reflector enabled, will establish the BGP sessions to all the spine nodes with the BGP peering enabled in all the peer sites. In the route-reflector mode, at least the local spine node or the remote spine node or both should have the route-reflector enabled. Otherwise, the BGP session is not established between them.

        - If the local and the remote ASNs are different, then it is eBGP. Therefore, the sessions between those sites are always full-mesh, irrespective of the BGP peering type and the route-reflector configuration.

      Unicast and Multicast Tunnels: A spine node in a site that is connected to ISN and has infrastructure configuration, will establish a tunnel to all the spine nodes that are connected to ISN in the peer sites.

  The color codes indicate the following conditions:

    - **Critical** (red)

    - **Major** (orange)

    - **Minor** (yellow)

    - **Warning** (green)

  The numbers in the color indicator columns indicate the number of faults per site.

- **+ Add Site:** enables you to add another site to our implementation. When you click **+ Add Site**, you must provide the following site details information on the **Connection Settings** page:

    - **Name**: the name of the site

    - **Labels**: the label identifier of the site. Multiple labels can be associated to a site.

    - **APIC Controller URL**: you can add more APIC controllers with a distinguishing URL of a cluster.

    - **Username** and **Password**: APIC login info with admin level privileges.

    - **Specify Domain For Site**: click the switch to on and provide the domain name if default authentication domain is configured in APIC.

After you have entered your details for your new site, click the **Save** button.

- **Schema Health**: provides a listing of your schemas with locales and health.
  - Click the magnifying glass icon and enter a schema name to search for a subject schema.
  - Click **+ Add Schema** to start the procedure for adding a new schema to your site.
  - Click the site locale in the **Schema Health** table to view the schema details and status for a template.

    The **Schema Health** table provides a heat map type of display; that is, the health of the subject schema is displayed according to color. Schemas that span two columns (i.e, locales) indicate a stretched condition.
    - Click the color highlighted table cell to further discover what policies are incorporated into the subject schema. On the schema details page, you can click the arrow to go into the schema builder and update the policy details in the subject schema.
    - The color coded slider enables you to select a range for identifying schemas whose health require further review. For example, you can adjust the slider value to between 80 and 100. Then all of your schema implementations that fall within that specific range are displayed on the accompanying Schema Health table.

Application Management > Tenants Page

The Multi-Site **Tenants** page lists all of the tenants that comprise your implementation.

The table on the **Tenants** page displays the following:

- **Tenant Name**
- **Assigned to Sites**
- **Assigned to Users**
- **Assigned to Schemas**
- **Actions**

The features and functionality on this page include the following:

- **Name**: click a tenant name to access the **Tenant Details** settings page. On the **Tenant Details** page you can edit or update the following sections:
  - **General Settings**: change the Display Name and Description as required.
  - **Associated Sites**: view the sites associated with the subject tenant.
  - **Associated Users**: view the users associated with the subject tenant - you can associate a user with the subject tenant by checking the empty box next to the user name.
- **Associated Schemas**: click the **Associated Schema** listing to view the schemas associated with the subject tenant.

- **Actions**: click the **Actions** listing to edit the subject tenant's details sites or to create a new network mapping.

> **Note** You can delete the Tenant object by selecting **Delete** on the **Actions** drop down menu.

- **Add Tenant:** click **Add Tenant** button to add an existing tenant to your implementation. On the proceeding Tenant Details page, you can add the tenant name, description, security domain, and associated users.

Audit Logs

Click the **Audit Log** icon next to the **Add Schema** tab to list the log details for the Schemas page. The **Audit Logs: Tenant List** page is displayed.

The table on the page displays the following details:

- **Date**
- **Action**
- **Details**
- **User**

Click the **Most Recent** tab to select the audit logs during a particular time period. For example, when you select the range from November 10, 2019 to February 14, 2020 and click **Apply**, the audit log details for this time period are displayed on the **Audit Logs** page.

Click the **Filter** icon next to the **Most Recent** tab to filter the log details using the following criteria:

- **User**: Select one username or all users and click **Apply** to filter the log details using the username.
- **Action**: Select the action, for example, created, updated, or deleted, and click **Apply** to filter the log details according to the action.

For more information, see the Managing Tenants, on page 17 chapter.

Application Management > Schemas Page

The **Schemas** page lists all schemas that are associated with your deployment.

Use the magnifying glass and associated field to search for a specific schema. Use schemas to configure or import tenant policies, including the VRF, application profile with EPGs, filters and contracts, bridge domains, and external EPGs.

The Schemas table shows the following information:

- **Name**: click the schema name to view or update the settings for the subject schema.
- **Templates**: displays the name of the template that is used for the schema. Templates are analogous to profiles in the ACI context, which group policies. You can create templates for stretched objects or site-specific objects.

- **Tenants**: displays the name of the tenant that is used for the subject schema.
- **Actions**: click the **Action** field with the associated schema to either edit or delete the subject schema.

You can use the **Add Schema** button to add a new schema, which is described in more details in Creating Schemas and Templates, on page 29.

Audit Logs

Click the **Audit Log** icon next to the **Add Schema** tab to list the log details for the Schemas page. The **Audit Logs: Schemas List** page is displayed.

The table on the page displays the following details:

- **Date**
- **Action**
- **Details**
- **User**

Click the **Most Recent** tab to select the audit logs during a particular time period. For example, when you select the range from November 10, 2019 to February 14, 2020 and click **Apply**, the audit log details for this time period are displayed on the **Audit Logs** page.

Click the **Filter** icon next to the **Most Recent** tab to filter the log details using the following criteria:

- **User**: Select one username or all users and click **Apply** to filter the log details using the username.
- **Action**: Select the action, for example, created, updated, or deleted, and click **Apply** to filter the log details according to the action.

Application Management > Policies Page

The Multi-Site Orchestrator **Policies** page displays all policies you have configured for your fabrics.

The **Policies** page contains a table of all policies along with the summary of their types, tenants they're associated with, descriptions, and usage. You can use this page to add new policies or edit existing ones.

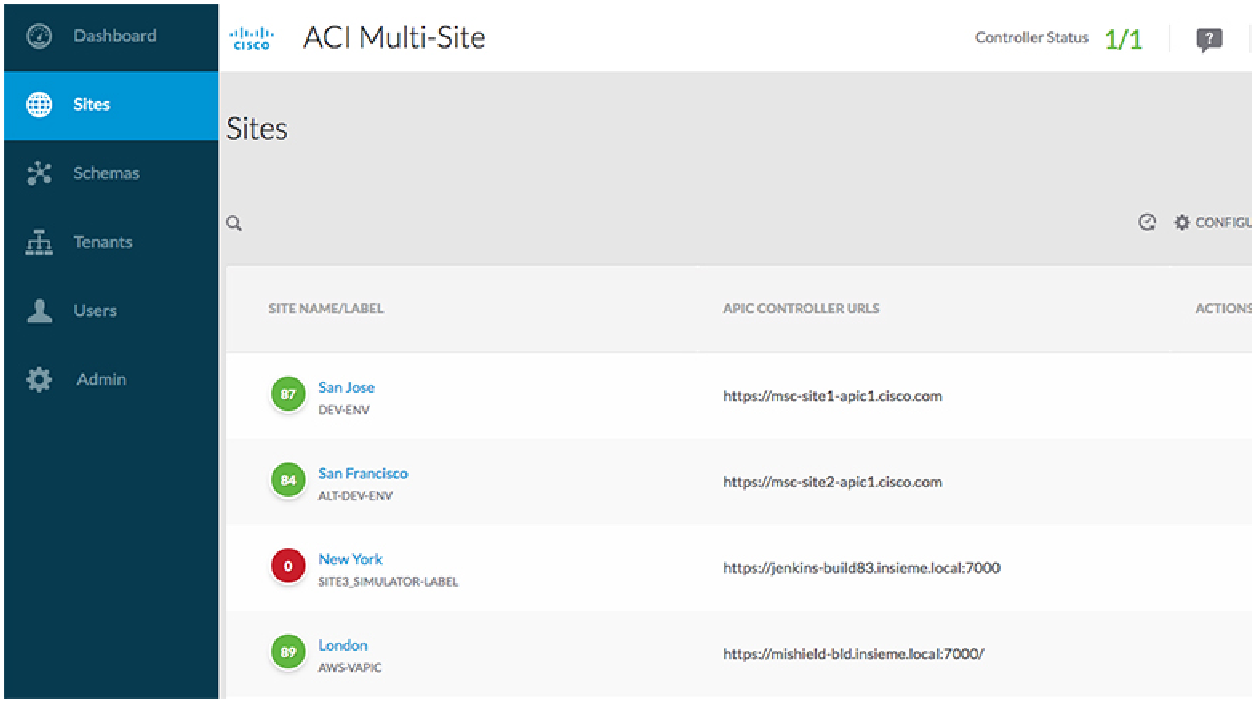
You can configure the following policies:

- DHCP Policy, as described in the DHCP Relay, on page 135 chapter
- MPLS QoS Policy, as described in the Sites Connected via SR-MPLS, on page 201 chapter.
- Route Map Policy, as described in the Sites Connected via SR-MPLS, on page 201 chapter.
- Multicast Route Map Policy, as described in the Layer 3 Multicast, on page 189 chapter.

Infrastructure > Sites Page

The Multi-Site **Sites** page displays all of the sites in your implementation. An example of the **Sites** page is shown in the following screen shot:

Figure 2: Multi-Site Sites Page



Controller Status 1/1

Sites

SITE NAME/LABEL	APIC CONTROLLER URLS	ACTIONS
87 San Jose DEV-ENV	https://msc-site1-apic1.cisco.com	
84 San Francisco ALT-DEV-ENV	https://msc-site2-apic1.cisco.com	
0 New York SITE3_SIMULATOR-LABEL	https://jenkins-build83.insieme.local:7000	
89 London AWS-VAPIC	https://mishield-bld.insieme.local:7000/	

The **Sites** page consists of the following two panes:

- **Site Name or Label**: the site status table lists your sites and then indicates the current health status for your implementation according to the following color coded identifiers:
  - **Critical** (red)
  - **Major** (orange)
  - **Minor** (yellow)
  - **Warning** (green)

  When you click a specific site, you can view or edit the site's details on the **Connection Settings** display:
  - **Name**
  - **Labels**
  - **APIC Controller URL**
  - **Username** and **Password**
  - **Specify Domain For Site**
  - **APIC Site ID**

    If you have made changes to the listed fields, click the **Save** button.

- **APIC Controller URLs**: the associated APIC URLs for your Multi-Site implementation

- **Configure Infra**: click this area to configure your Fabric infrastructure connectivity. For more information, refer to the Cisco Application Policy Infrastructure Controller (APIC) page.
- **Add Site**: click the **Add Site** button to add a site to your implementation. The following details are required for adding a site:
  - **Name:** the site name.
  - **Label:** select an existing or create a new label.
  - **APIC Controller URL**: the existing URL - click **+** to add a new APIC Controller URL.
  - **Username**: the site username.
  - **Password**: the unique site password for access.
  - **Specify Domain for Site**: click the selector to **On** to specify a domain for the site.
- **Actions**: drop down menu list option to edit, delete, or open a subject site in the APIC user interface.

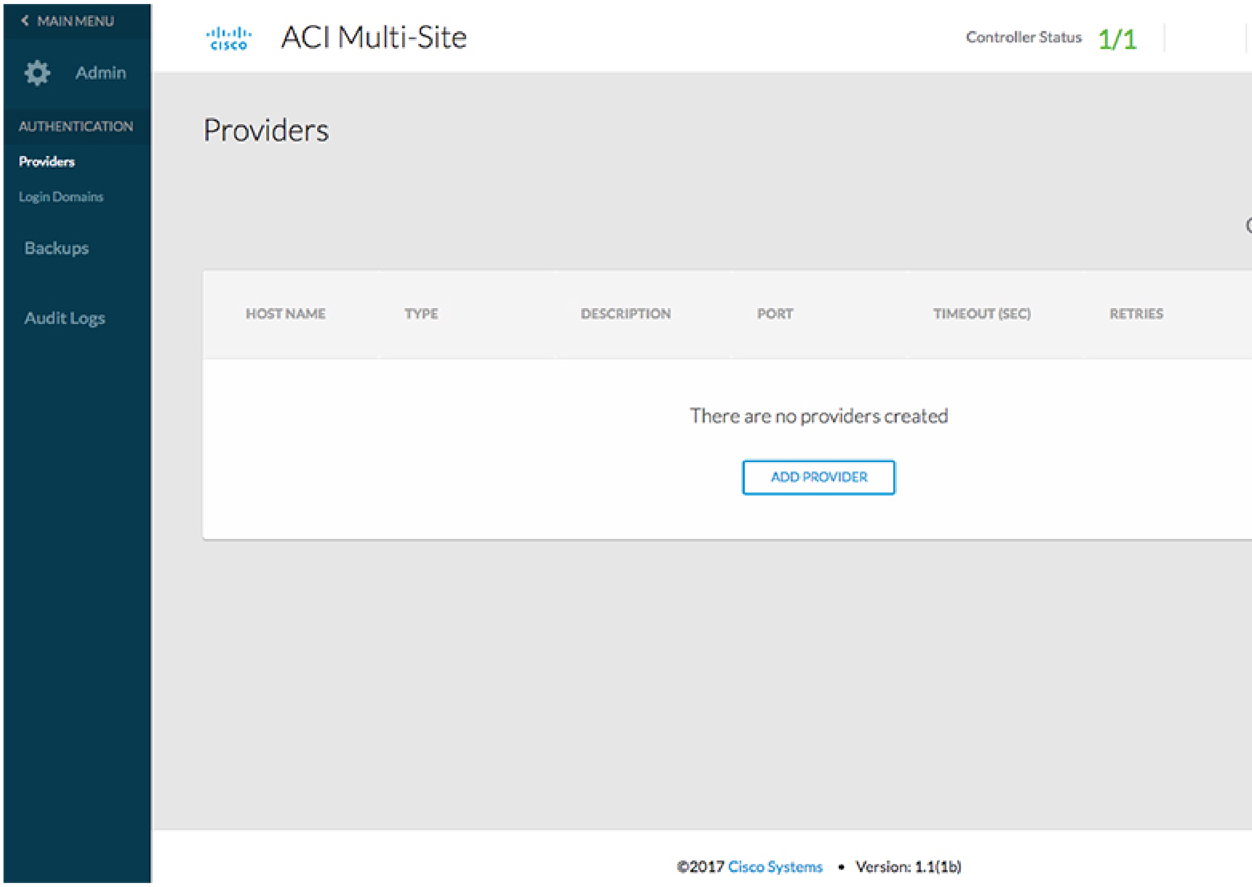
Admin Pages

When you select the Admin tab from the Cisco ACI Multi-Site Orchestrator navigation bar, it expands the following additional selection of administrative pages:

- **Providers**
- **Login Domains**
- **Backups**
- **Audit Logs**
- **Security**
- **Remote Locations**
- **System Configuration**

Providers

Figure 3: Cisco ACI Multi-Site Orchestrator Providers Page



HOST NAME	TYPE	DESCRIPTION	PORT	TIMEOUT (SEC)	RETRIES

There are no providers created

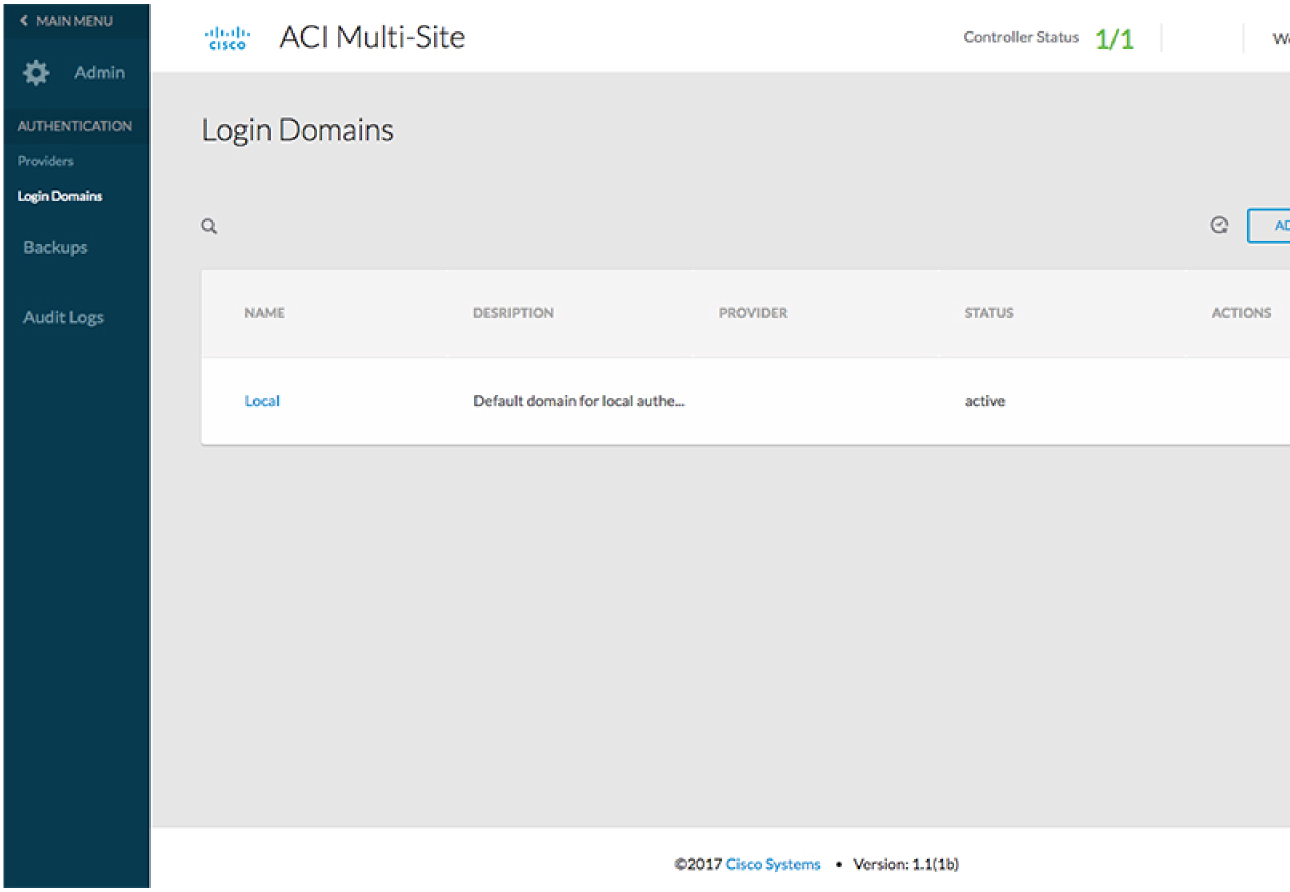
The **Providers** page under the **Admin** heading displays information about any configured external authentication providers. The following details are shown for each provider:

- **Host Name**
- **Type**
- **Description**
- **Port**
- **Timeout (Sec)**
- **Retries**

Working with external authentication providers is described in Audit Logs and Security, on page 125.

Login Domains

Figure 4: Cisco ACI Multi-Site Orchestrator Login Domains Page



NAME	DESRIPTION	PROVIDER	STATUS	ACTIONS
Local	Default domain for local authe...		active	

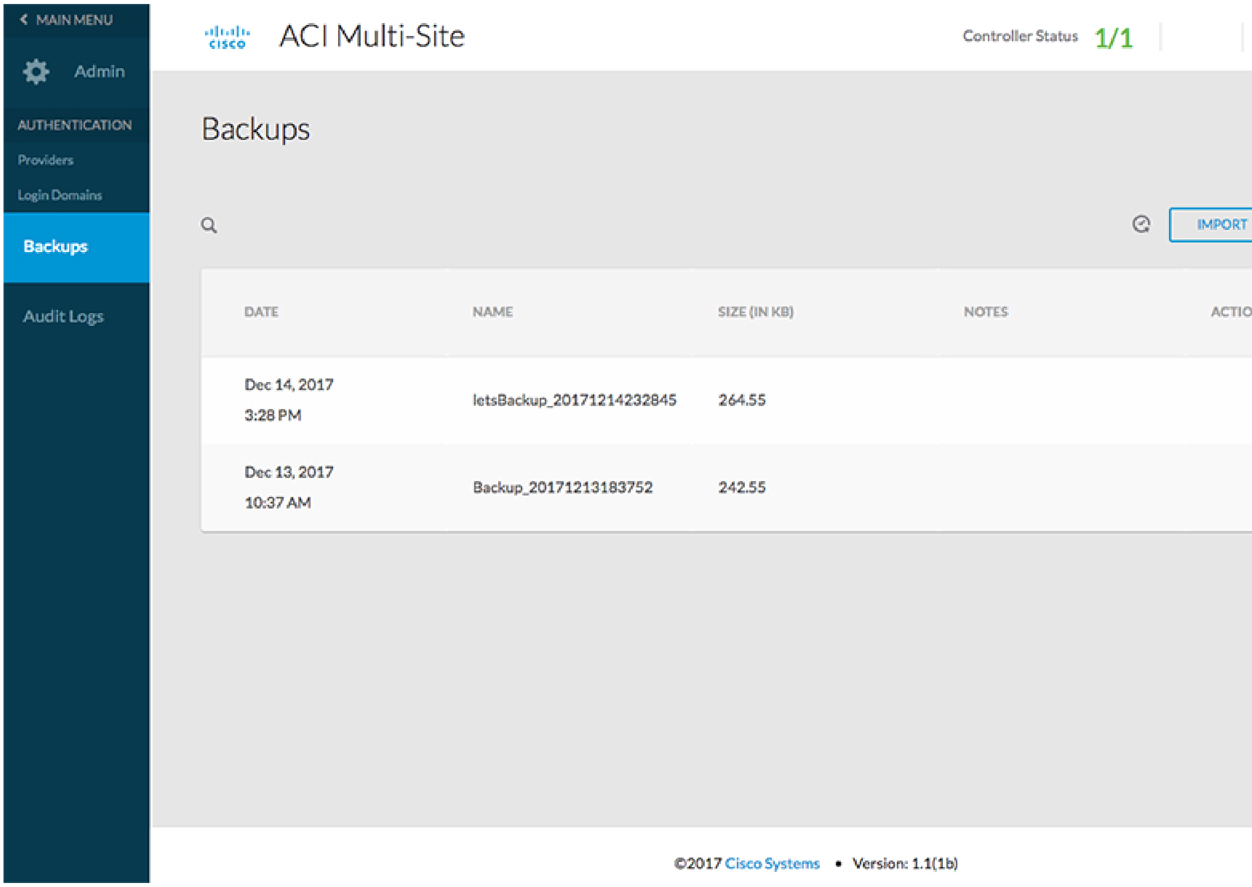
The **Login Domains** page under the **Admin** heading displays information about the available login domains. The following details are shown for each domain:

- **Name**
- **Description**
- **Provider**
- **Status**
- **Default**

Working with login domains is described in Audit Logs and Security, on page 125.

Backups

Figure 5: Cisco ACI Multi-Site Orchestrator Backups Page



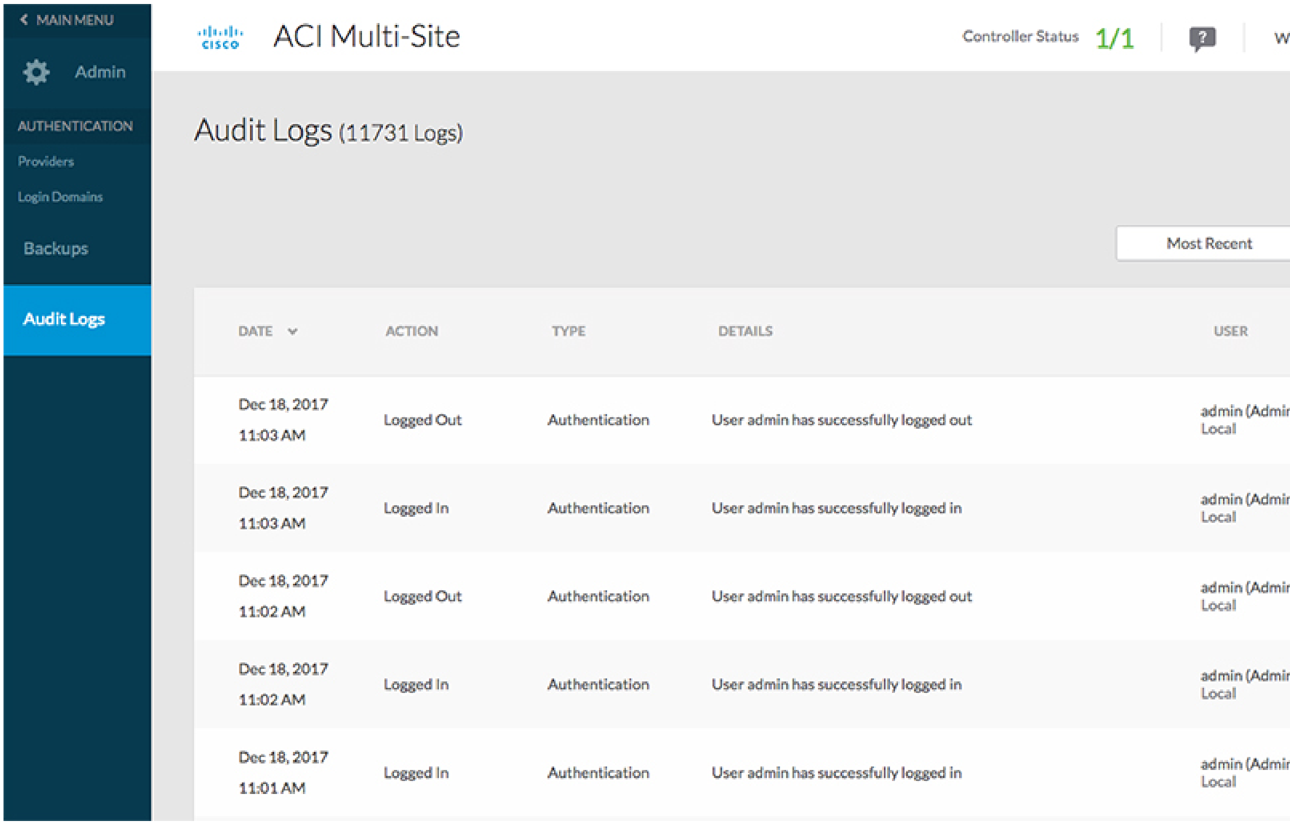
DATE	NAME	SIZE (IN KB)	NOTES	ACTIO
Dec 14, 2017 3:28 PM	letsBackup_20171214232845	264.55		
Dec 13, 2017 10:37 AM	Backup_20171213183752	242.55		

The **Backups** page under the **Admin** heading displays information about any backups that have been created. The following details are shown for each domain:

- **Date**
- **Name**
- **Size**
- **Notes**

Working with backups is described in Audit Logs and Security, on page 125.

Figure 6: Cisco ACI Multi-Site Orchestrator Audit Logs Page



Audit Logs (11731 Logs)

DATE	ACTION	TYPE	DETAILS	USER
Dec 18, 2017 11:03 AM	Logged Out	Authentication	User admin has successfully logged out	admin (Admi Local
Dec 18, 2017 11:03 AM	Logged In	Authentication	User admin has successfully logged in	admin (Admi Local
Dec 18, 2017 11:02 AM	Logged Out	Authentication	User admin has successfully logged out	admin (Admi Local
Dec 18, 2017 11:02 AM	Logged In	Authentication	User admin has successfully logged in	admin (Admi Local
Dec 18, 2017 11:01 AM	Logged In	Authentication	User admin has successfully logged in	admin (Admi Local

Audit Logs

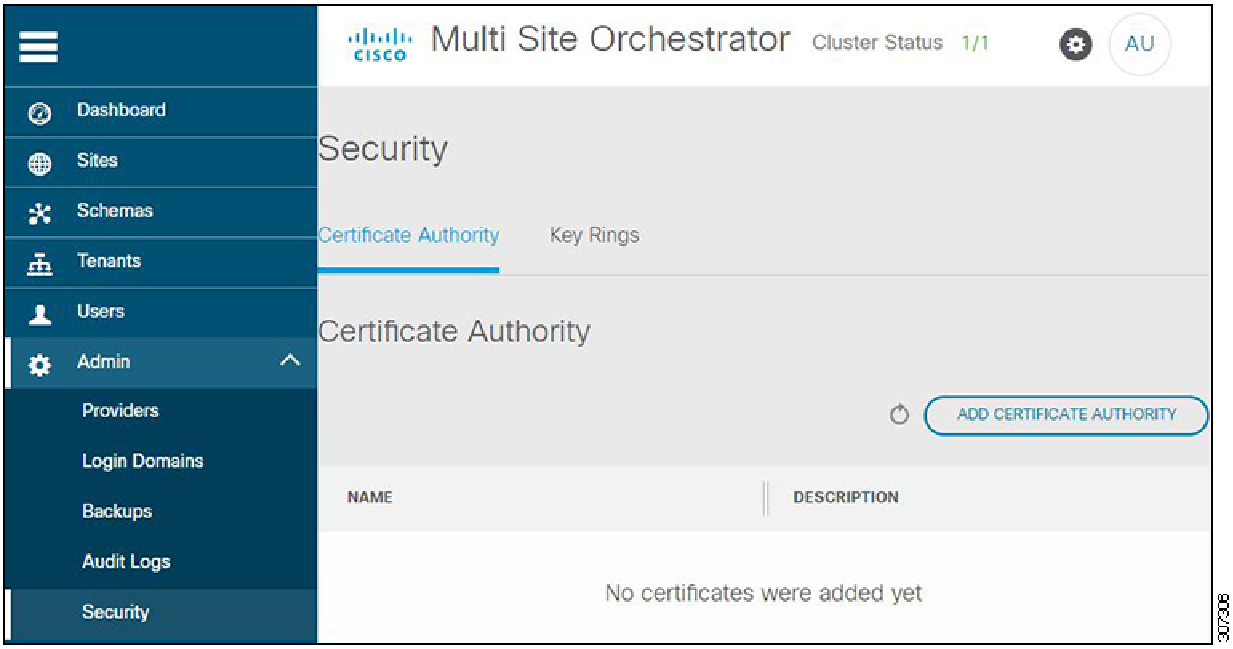
The **Audit Logs** page under the **Admin** heading displays information about the audit logs and records. The following details are shown:

- **Date**
- **Action**
- **Type**
- **Details**
- **User**

Working with logs is described in Audit Logs and Security, on page 125.

Security

Figure 7: Cisco ACI Multi-Site Orchestrator Security Page



The **Security** page under the **Admin** heading displays information about the custom certificates and key rings you have configured for use by the Orchestrator. The following details are shown:

- **Certificate Authority**
  - **Name**
  - **Description**
- **Key Rings**
  - **Name**
  - **Description**
  - **Trustpoint**
  - **State**

Working with certificates is described in Audit Logs and Security, on page 125.

Remote Locations

The **Remote Locations** page under the **Admin** heading displays information about any remote backup locations you have configured for use by the Orchestrator. The following details are shown:

- **Name**
- **Host**
- **Protocol**

- **Username**
- **Remote Path**

Working remote backups is described in Audit Logs and Security, on page 125.

System Configuration

The **System Configuration** page under the **Admin** heading allows you to configure a number of system settings that define how the Orchestrator GUI behaves. For example, you can change how failed login attempts are treated or if a warning banner should be displayed at the top of the GUI.

The available system settings are described in more detail in Audit Logs and Security, on page 125.

Admin > Users Page

The Multi-Site Orchestrator **Users** page displays all of the users.

The **Users** page features a table containing all of the identified users by username and associated email and current activity status. If you click a selected **Username**, you can access the **General Setting** page attributable to the subject user. On the **General Setting** page, you can edit the details associated with the subject user such as username, password, email, and switch-on user roles.

Click **Add User** to add a new user to your Multi-Site implementation. The **General Setting** page display enables you to assign username, password, email, and switch-on user roles associated with your Multi-Site implementation.

For specific tasks, see the User Management, on page 129 chapter.

PART I

Application Management

CHAPTER 2

Tenants

Managing Tenants

To manage tenants, you must have either `Power User` or `Site and Tenant Manager` read-write role.

You can create Tenants and their policies in one of two ways:

- Import a fully configured tenant from an APIC site.
- Create a tenant and configure the policies in the Multi-Site Orchestrator GUI.

The following tenant policies and their associations can be configured in the Multi-Site Orchestrator GUI:

- Application Profiles and EPGs
- VRFs
- Bridge Domains with subnets and stretched or site-local settings
- Contracts and Filters
- L3Outs
- External EPGs
- Physical or VMM domain association with EPGs
- Intra-EPG isolation
- Microsegmented EPGs
- EPGs deployed on a port, PC, or VPC

Adding Tenants

This section describes how to add tenants using the Multi-Site Orchestrator GUI.

Before you begin

You must have a user with either `Power User` or `Site Manager` read-write role to create and manage tenants.

Step 1 Log in to the Cisco ACI Multi-Site Orchestrator GUI.

Step 2 In the **Main menu**, select **Infrastructure** > **Tenants**.

Step 3 In the top right of the main pane, click **Add Tenant**.

Step 4 In the **Display Name** field, provide the tenant's name.

The tenant's **Display Name** is used throughout the Orchestrator's GUI whenever the tenant is shown. However, due to object naming requirements on the Cisco APIC, any invalid characters are removed and the resulting **Internal Name** is used when pushing the tenant to sites. The **Internal Name** that will be used when creating the tenant is displayed below the **Display Name** textbox.

You can change the **Display Name** of the tenant at any time, but the **Internal Name** cannot be changed after the tenant is created.

Step 5 (Optional) In the **Description** field, enter a description of the tenant.

Step 6 In the **Associated Sites** section, add the sites.

a) Check all sites where you plan to deploy templates that use this tenant.

Only the selected sites will be available for any templates using this tenant.

Note If you select a site that is connected via an MPLS network, you will

b) From the **Security Domains** drop-down list, choose the site's security domains.

Security domains are created using the Cisco APIC GUI and can be assigned to various Cisco APIC policies and user accounts to control their access. For more information, see the *Cisco APIC Basic Configuration Guide*.

Step 7 In the **Associated Users** section, add Orchestrator users.

Only the selected users will be able to use this tenant when creating templates.

Step 8 (Optional) Enable consistency checker scheduler.

You can choose to enable regular consistency checks. For more information about the consistency checker feature, see *Cisco ACI Multi-Site Troubleshooting Guide*.

Step 9 Click **SAVE** to finish adding the tenant.

Configuring Global Contracts Across Tenants or VRFs

This use case is for a data center that provides services to EPGs in other tenants or VRFs. It provides contracts that enable all the EPGs to consume the services.

For more information, see the *Shared Services with Stretched Provider EPG* use case in the *Cisco ACI Multi-Site Fundamentals Guide*.

Before you begin

Create a schema (for every site that provides and consumes the services) with Tenants, VRFs, bridge domains, application profiles, EPGs, and other contracts.

The tenants, VRFs, BDs, and EPGs do not have to be stretched across the sites.

Step 1 Open the provider schema.

Step 2 Create a filter (essentially an Access Control List) with the following steps:

a) Click the + icon to add a filter.
b) Enter the filter name.
c) Click the + icon to add an entry.
d) Enter the entry name.
e) Enter the rest of the data required for the filter and click **Save**.

Step 3 Create a contract with the following steps:

a) Click the + icon to add a contract.
b) Enter the contract name.
c) Change the contract scope to global.

   This enables the contract to be accessible to EPGs in multiple VRFs.

d) Click the + icon to add a filter and choose the filter you created.
e) Click **Save**.

Step 4 Associate the EPG that provides the services with the contract, with the following actions:

a) Click the EPG.
b) Click the + icon to add a contract.
c) Choose the global contract you previously created.
d) Set the type to **provider**.
e) Click **Save**.
f) Click **DEPLOY TO SITES.**Confirm the sites and click **DEPLOY**.

Step 5 Associate EPGs with the contract as consumers, with the following actions:

a) Open each consumer schema.
b) Click an EPG.
c) Click the + icon to add a contract.
d) In the **Contract** field, start typing the contract name. When the contract appears in the list, choose it.
e) Set the type to **consumer**.
f) Click **Save**.
g) Associate the contract to any other EPGs in the schema.
h) Click **DEPLOY TO SITES.**
i) Confirm the sites and click **DEPLOY**.

Configuring Intra-EPG Isolation

Intra-EPG isolation is allowed between endpoints in an EPG that is operating with isolation enforced. Isolation enforced EPGs reduce the number of EPG encapsulations required when many clients access a common service but are not allowed to communicate with each other. An EPG is isolation enforced for all ACI network domains or none. While the ACI fabric implements isolation directly to connected endpoints, switches connected to the fabric are made aware of isolation rules according to a primary VLAN (PVLAN) tag.

If an EPG is configured with intra-EPG endpoint isolation enforced, these restrictions apply:

- All Layer 2 endpoint communication across an isolation-enforced EPG is dropped within a bridge domain.
- All Layer 3 endpoint communication across an isolation-enforced EPG is dropped within the same subnet.
- Preserving QoS CoS priority settings is not supported when traffic is flowing from an EPG with isolation-enforced to an EPG without isolation enforced.
- In Multi-Site, intra-EPG isolation is not supported in AVS-VLAN mode and DVS-VXLAN mode. Setting Intra-EPG isolation to be enforced may cause the ports to go into a blocked state in these domains.
- Intra-EPG isolation is not supported if the Bridge Domain is configured as "legacy BD mode".

Before you begin

- Create the tenant associated with the EPGs.
- Import the tenant policies or configure a schema containing the tenant's VRF, bridge domain, and the Application Network Profile containing the EPGs that will be subject to intra-EPG isolation.

Step 1 Open the schema and template where the EPGs to be isolated are configured.

Step 2 Click an EPG.

Step 3 Choose **Enforced**, read the warning, and click **OK**.

Step 4 Optional. Configure other EPGs to be isolation-enforced.

Step 5 Push the template containing the EPGs (configured for intra-EPG isolation) to the site where they will be located.

Step 6 Click the deployed site and template and click an EPG.

Step 7 Click **ADD STATIC PORT**.

Step 8 Choose the **PATH TYPE** (Port, Direct Port Channel, or Virtual Port Channel).

Step 9 Choose the **LEAF**.

Step 10 Choose the **PATH**.

Step 11 In the **PORT ENCAP VLAN** field, enter the VLAN number to be used for traffic for the EPG.

Step 12 On the **DEPLOYMENT IMMEDIACY** field, choose **OnDemand** or **Immediate** deployment.

Step 13 On the **MODE** field, choose **Trunk**.

Step 14 Optional, repeat the steps for other EPGs that will have isolation enforced.

What to do next

Push the changes to the site where the EPGs are located.

Configuring Microsegmented EPGs

You can use Cisco ACI Multi-Site to configure microsegmentation to create an attribute-based EPG using a network-based attribute (IP, MAC, DNS) or VM-based attributes (VM ID, VM Name, VMM domain, and so forth). This enables you to isolate VMs or physical endpoints within a single base EPG or VMs or physical endpoints in different EPGs.

Only the basic options for microsegmented (uSeg) EPGs can be configured in Cisco ACI Multi-Site. For procedures for advanced options and for use cases and detailed information about Microsegmented EPGs, see the *Microsegmentation with Cisco ACI* chapter in *Cisco ACI Virtualization Guide*.

Note When creating an EPG, if you first create an application EPG and want to change it to a uSeg EPG, you must either assign the EPG a different name or remove the application EPG and add the uSeg EPG, with the following process:

1. Delete the application EPG from the schema.
2. Deploy the schema to the sites.
3. Create the uSeg EPG.
4. Redeploy the schema to the sites.

To configure a microsegmented EPG using Cisco ACI Multi-Site, perform the following steps:

Before you begin

- Create the tenant associated with the EPGs that will be microsegmented.
- Import the tenant policies or configure a schema containing the tenant's VRF, bridge domain, and the Application Network Profile containing the EPGs.
- Create at least one application EPG in the tenant.

Step 1 Open the schema where the EPGs are configured.

Step 2 Click an EPG.

Step 3 Click **USEG EPG.**

Step 4 Click **ADD USEG ATTRIBUTES**.

Step 5 On the DISPLAY NAME field, enter the name for the attribute.

Step 6 Choose the **ATTRIBUTE TYPE; it can be one of the following:**

- **IP**
- **Mac**
- **DNS**

- **VM Name**
- **VM Data Center**
- **VM Hypervisor Identifier**
- **VM Operating System**
- **VM Tag**
- **VM Identifier**
- **VM VMM Domain**
- **VM VNIC DN** (vNIC domain name

Step 7 Save your changes.

What to do next

Associate the USeg EPG with a domain using the Multi-Site GUI.

Associating EPGs with Domains

Before you begin

- Create the tenant associated with the EPGs in Cisco ACI Multi-Site.
- Create the domain profiles (VMM, L2, L3, or Fibre Channel) in APIC.
- Import the tenant policies from Cisco APIC or configure a schema (with template) in Multi-Site, that contains the tenant's VRF, bridge domain, and the Application Network Profile containing the EPGs that will be associated with a domain.

  Associate the template with a site.

Step 1 In the **Sites** list, click the site and template for the site where the EPG and domain are configured, and click the EPG.

Step 2 Click **ADD DOMAINS**.

Step 3 On the **DOMAIN ASSOCIATION TYPE** field, choose the type, which can be:

- **VMM**
- **Fibre Channel**
- **L2 External**
- **L3 External**
- **Physical**

Step 4 On the **DOMAIN PROFILE** field, choose a previously created profile or **phys**.

Step 5 On the **DEPLOYMENT IMMEDIACY** field, choose **OnDemand** or **Immediate**.

Step 6 On the **RESOLUTION IMMEDIACY** field, choose **OnDemand**, **Immediate**, or **Pre-Provision**.

Step 7 Save your changes.

What to do next

Push the template containing the changes to the site.

Displaying All the Tenants in an Aggregated View

Using the Multi-Site GUI **Tenants** tab, you can view the aggregated list of the tenants.

In the **Tenants** panel under the **Tenants** tab, the following fields are displayed in the GUI:

- NAME: Name of the tenant.
- DESCRIPTION: Description of each tenant.
- ASSIGNED TO SITES: The number of the sites that the tenant is assigned to.
- ASSIGNED TO USERS: The number of the users that the tenant is assigned to.
- ASSIGNED TO SCHEMAS: The number of the schemas that the tenant is assigned to.
- ACTIONS: Perform actions for each tenant, for example, **Edit**, **Delete**, or configure **Network Mappings** for the tenant.

Based on the **Tenants** chart, you can determine the resource utilization of the tenants.

CHAPTER 3

Schemas

Schema Design Considerations

A schema is a collection of templates, which are used for defining policies, with each template assigned to a specific tenant. There are multiple approaches you can take when it comes to creating schema and template configurations specific to your deployment use case. The following sections describe a few simple design directions you can take when deciding how to define the schemas, templates, and policies in your Multi-Site environment. Keep in mind that when designing schemas, you must consider the supported scalability limits for the number of schemas, number of templates, and number of objects per schema. Detailed information on verified scalability limits is available in the *Verified Scalability Guides for Cisco APIC, Cisco ACI Multi-Site, and Cisco Nexus 9000 Series ACI-Mode Switches* specific to your release.

Single Schema Deployment

The simplest schema design approach is a single schema, single template deployment. You can create a single schema with a single template within it and adds all VRFs, Bridge Domains, EPGs, Contracts and other elements to that template. You can then create a single application profile or multiple application profiles within the template and deploy it to one or more sites.

This simplest approach to Multi-Site schema creation is to create all objects within the same schema and template. However, the supported number of schemas or templates per schema scalability limit may make this approach unsuitable for large scale deployments, which could exceed those limits.

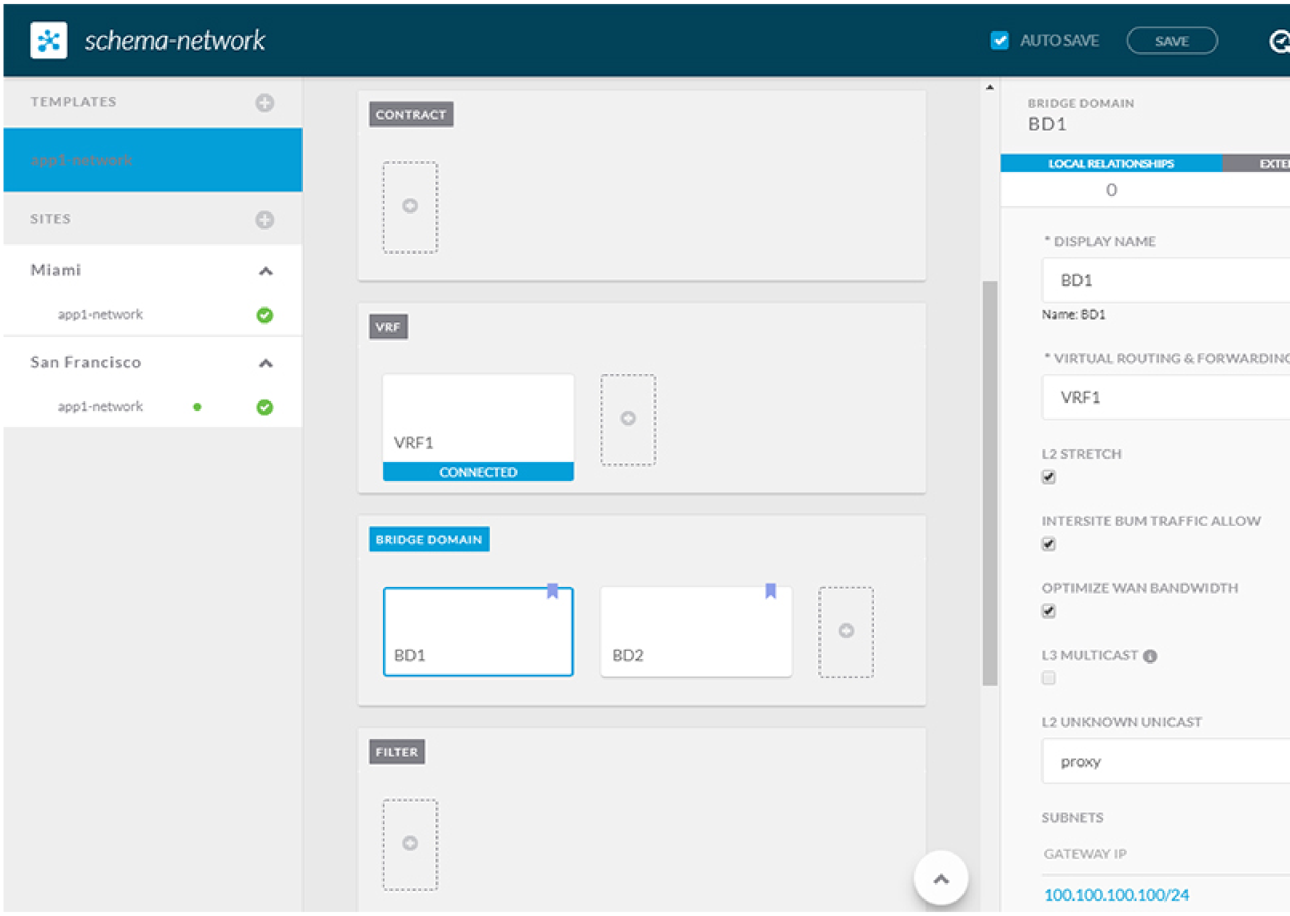
Multiple Schemas with Network Separation

Another approach to schema design is to separate the networking objects from the application policy configuration. Networking objects include VRFs, Bridge Domains, and subnets, while the application policy objects include EPGs, Contracts, Filters, External EPGs, and Service Graphs.

You begin by defining a schema that contains the network elements. You can choose to create a single schema that contains all the network elements or you can split them into multiple schemas based on which applications reference them or which sites the network is stretched to.

The following figure shows a single networking template configuration with VRF, BD, and subnets configured and deployed to two sites:

Figure 8: Network Schema



BRIDGE DOMAIN BD1

* DISPLAY NAME: BD1
Name: BD1

* VIRTUAL ROUTING & FORWARDINC: VRF1

L2 STRETCH ☑

INTERSITE BUM TRAFFIC ALLOW ☑

OPTIMIZE WAN BANDWIDTH ☑

L3 MULTICAST ☐

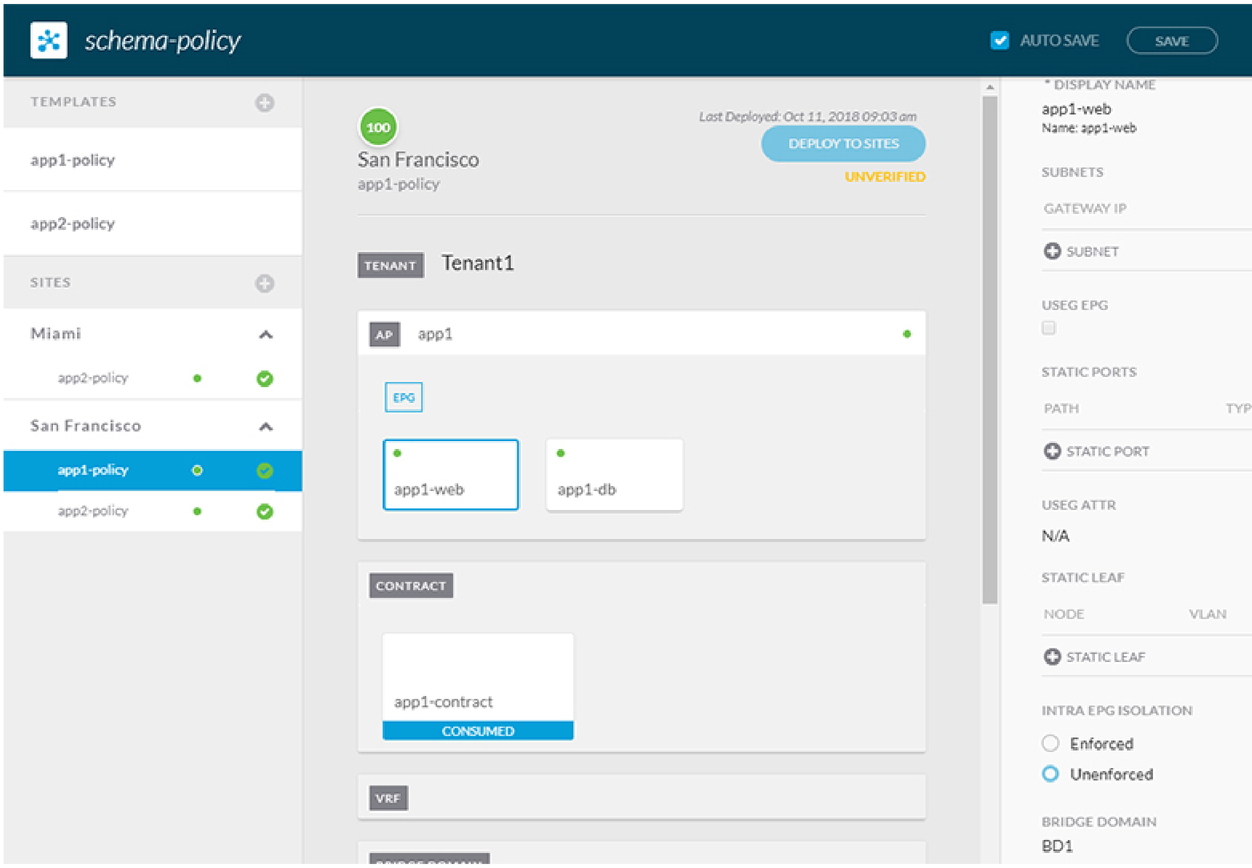
L2 UNKNOWN UNICAST: proxy

SUBNETS

GATEWAY IP: 100.100.100.100/24

You can then define one or more separate schemas which contain each application's policy objects. This new schema can reference the network elements, such as bridge domains, defined in the previous schema. The following figure shows a policy schema that contains two application templates both of which reference the networking elements in an external schema. One of the applications is local to one site while the other is stretched across two sites:

Figure 9: Policy Schema



* DISPLAY NAME
app1-web
Name: app1-web

INTRA EPG ISOLATION
○ Enforced
○ Unenforced

BRIDGE DOMAIN
BD1

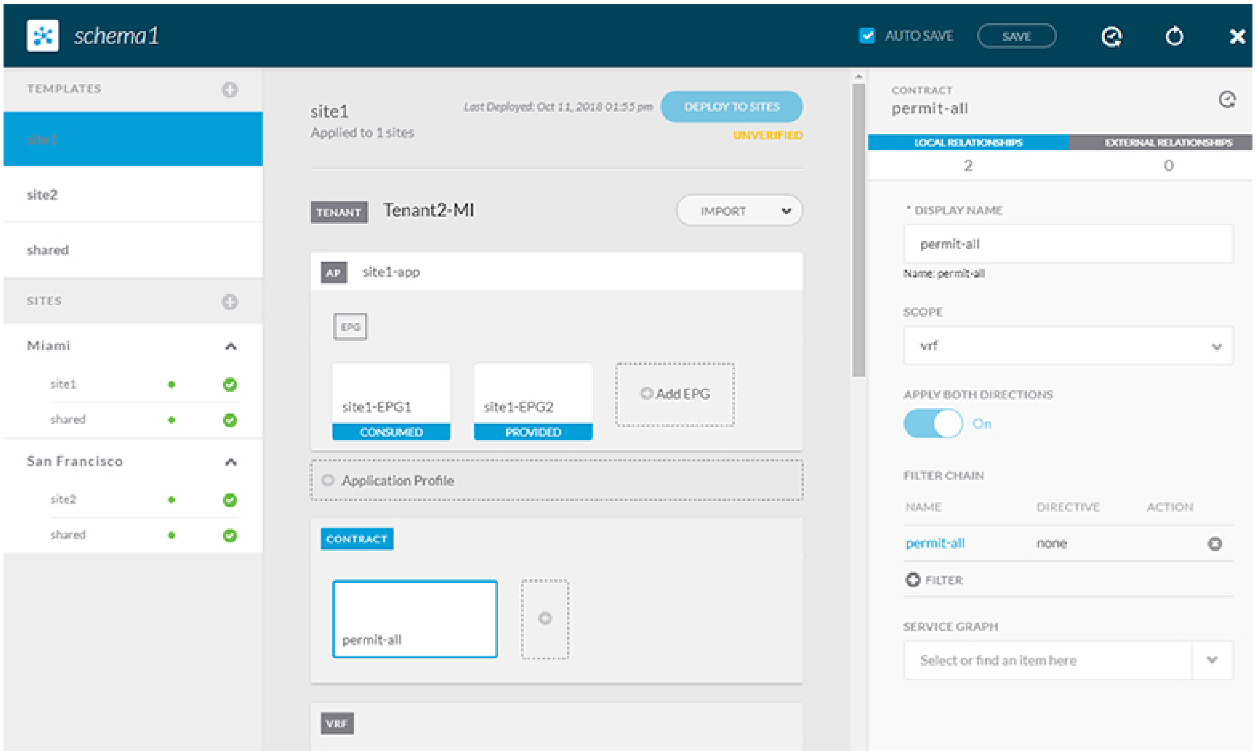
After creating and deploying the policy schemas and templates, the networking objects in the networking schema will display the number of external references by the policy schema elements. The object with external references will also be denoted by the ribbon icon as shown in the Network Schema figure above.

Schemas designed this way provide logical separation of networking objects from the policy objects. However, this creates additional complexity when it comes to keeping track of externally referenced objects in each schema.

Multiple Schemas Based On Object Relationships

When configuring multiple schemas with shared object references, it is important to be careful when making changes to those objects. For instance, making changes to or deleting a shared networking object can impact applications in one or more sites. Because of that, you may choose to create a template around each individual site that contains only the objects used by that site and its applications, including the VRFs, BDs, EPGs, Contracts, and Filters. And create different templates containing the shared objects.

Figure 10: One Template per Site



* DISPLAY NAME: permit-all

Name: permit-all

SCOPE: vrf

APPLY BOTH DIRECTIONS: On

FILTER CHAIN

NAME	DIRECTIVE	ACTION
permit-all	none	

SERVICE GRAPH

The **site1** template in the above figure contains only the objects that are local to Site1 and the template is deployed to only the Miami site. Similarly, the **site2** template contains only the object relevant to site2 and is deployed to the San Francisco site. Any change made to any object in either of these templates has no effect on the other one. The **shared** template contains any objects that are shared between the sites.

You can extend this scenario for an additional site with the following template layout:

- Site 1 template
- Site 2 template
- Site 3 template
- Site 1 and 2 shared template
- Site 1 and 3 shared template
- Site 2 and 3 shared template
- All shared template

Similarly, rather than separating objects based on which site they are deployed to, you can also choose to create schemas and templates based on individual applications instead. This would allow you to easily identify each application profile and map them to schemas and sites as well as easily configure each application as local or stretched across sites.

However, as this would exceed the 5 templates per schema limit, you would have to create additional schemas to accommodate the multiple combinations. While this creates additional complexity with multiple additional schemas and templates, it provides true separation of objects based on site or application.

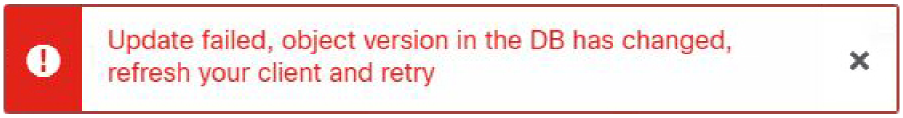
Schema Design for Cisco Cloud APIC Use-Cases

Cisco ACI Multi-Site supports Cisco Cloud APIC installed in the Amazon Web Services (AWS) starting with Release 2.1(1) and Microsoft Azure starting with Release 2.2(1). Each cloud deployment can be added to and managed by the Multi-Site Orchestrator as its own APIC site.

While the sections below outline generic steps required to create and manage schemas, specific use-case scenarios supported with Cloud APIC sites are detailed in the configuration examples available from the following Cloud APIC documentation landing page: https://www.cisco.com/c/en/us/support/cloud-systems-management/cloud-application-policy-infrastructure-controller/tsd-products-support-series-home.html.

Concurrent Configuration Updates

The Multi-Site Orchestrator GUI will ensure that any concurrent updates on the same site or schema object cannot unintentionally overwrite each other. If you attempt to make changes to a site or schema that was updated by another user since you opened it, the GUI will reject any subsequent changes you try to make and present a warning requesting you to refresh the object before making additional changes:



Update failed, object version in the DB has changed, refresh your client and retry

However, the default REST API functionality was left unchanged in order to preserve backward compatibility with existing applications. In other words, while the UI is always enabled for this protection, you must explicitly enable it for your API calls for MSO to keep track of configuration changes.

Note When enabling this feature, note the following:

- This release supports detection of conflicting configuration changes for Site and Schema objects only.
- Only `PUT` and `PATCH` API calls support the version check feature.
- If you do not explicitly enable the version check parameter in your API calls, MSO will not track any updates internally. And as a result, any configuration updates can be potentially overwritten by both subsequent API calls or GUI users.

To enable the configuration version check, you can pass the `enableVersionCheck=true` parameter to the API call by appending it to the end of the API endpoint you are using, for example:

```
https://<mso-ip-address>/mso/api/v1/schemas/<schema-id>?enableVersionCheck=true
```

Creating Schemas and Templates

Before you begin

- You must have an administrative user account with full read/write privileges.
- You must have a Cisco APIC tenant user account with read/write tenant policy privileges.

For more information, see the *User Access, Authentication, and Accounting* chapter in the *Cisco APIC Basic Configuration Guide*.

- You must have at least one available tenant that you want to incorporate into your site.

  For more information, refer to Adding Tenants, on page 18.

Step 1 Log in to your Cisco ACI Multi-Site Orchestrator.

Step 2 Create a new schema.

a) From the left navigation pane, choose **Application Management** > **Schemas**.

b) On the Schemas page, click **Add Schema**.

c) In the new schema screen, click **Untitled Schema** to provide a name for your new schema.

By default, the new schema is empty, so you need to add one or more templates.

Step 3 Create a template.

a) In the left sidebar under **Templates**, click the **+** sign to add a new template.

b) In the right sidebar, specify the **Display Name**.

c) If you are configuring an SR-MPLS template, enable the **SR-MPLS** knob.

For detailed information on SR-MPLS templates, see #unique_35.

d) From the **Select a Tenant** dropdown, select the Tenant for this template.

Keep in mind, the user account you're using to create a new schema must be associated with the tenant you are trying to add to it, otherwise the tenant will not be available in the drop-down menu. Associating a user account with a tenant is described in Adding Tenants, on page 18.

Importing Schema Elements From APIC Sites

You can create new objects and push them out to one or more sites or you can import existing site-local objects and manage them using the Multi-Site Orchestrator. This section describes how to import one or more existing objects, while creating new objects is described later on in this document.

Step 1 Open the **Schema** where you want to import objects.

Step 2 In the left sidebar, select the **Template** where you want to import objects.

Step 3 In the main pane click the **Import** button and select the **Site** from which you want to import.

Step 4 In the **Import from <*site-name*>** window that opens, select one or more objects.

Note The names of the objects imported into the Multi-Site Orchestrator must be unique across all sites. Importing different objects with duplicate names will cause a schema validation error and the import to fail. If you want to import objects that have the same name, you must first rename them.

Configuring Application Profiles and EPGs

This section describes how to configure an Application Profile and an EPG.

Before you begin

You must have the schema and template created and a tenant assigned to the template, as described in Creating Schemas and Templates, on page 29.

Step 1 Select the schema and template where you want to create the application profile.

Step 2 In the **Application Profile** tile, click the **+** sign.

Step 3 In the properties pane on the right, provide a name for the application profile.

Step 4 In the **AP <*name*>** area, click **+ Add EPG** to add an EPG.

Step 5 In the properties pane on the right, provide a name for the EPG.

Step 6 Add a contract for the EPG.

a) Click **+ Contract**.
b) On the **Add Contract** dialog, enter the contract name and type.
c) Click **SAVE**.

Step 7 From the **Bridge Domain** dropdown, select the bridge domain for this EPG.

If you are configuring an on-premises EPG, you must associate it with a bridge domain.

Step 8 (Optional) Click **+ Subnet** to add a subnet to your EPG.

You may choose to configure a subnet on the EPG level rather than the bridge domain level, for example for a VRF route-leaking use-case.

a) On the **Add Subnet** dialog, enter the **Gateway IP** address and a description for the subnet you plan to add.
b) In the **Scope** field select either **Private to VRF** or **Advertised Externally**.
c) Click the check box for **Shared Between VRFs** if appropriate.
d) Click the check box for **No Default SVI Gateway** if appropriate.
e) Click **OK**.

Step 9 (Optional) Enable microsegmentation.

If you are configuring a microsegmentation EPG (uSeg), you must provide one or more uSeg attributes for matching endpoints to the EPG.

a) Check the **uSeg EPG** checkbox.
b) Click **+uSeg Attribute**.
c) Provide the **Name** and **Type** for the uSeg attribute.
d) Based on the attribute type you have selected, provide the attribute details.

   For example, if you have selected `MAC` for the attribute type, provide the MAC address to identify an endpoint in this EPG.

e) Click **SAVE**.

Step 10 (Optional) Enable intra-EPG isolation.

By default, endpoints in EPG can freely communicate with each other. If you would like to isolate the endpoints from each other, set the isolation mode to **Enforced**.

Step 11 (Optional) Enable Layer 3 multicast for the EPG.

For additional information about Layer 3 multicast, see #unique_38

Step 12 (Optional) Enable preferred group membership for the EPG.

The Preferred Group feature allows you to include multiple EPGs within a single VRF to allow full communication between them with no need for contracts to be created. For additional information about EPG preferred group, see EPG Preferred Groups, on page 199

Configuring VRFs

This section describes how to configure a VRF.

Before you begin

You must have the schema and template created and a tenant assigned to the template, as described in Creating Schemas and Templates, on page 29.

Step 1 Select the schema and template where you want to create the application profile.

Step 2 In the template edit view, scroll down to the **VRF** area and click **+**.

Step 3 In the properties pane on the right, provide **Display Name** for the VRF.

Step 4 Configure the **On-Premises Properties** for the VRF.

a) (Optional) Enable **L3 Multicast** for the VRF.

For additional information, see Layer 3 Multicast, on page 189.

b) (Optional) Enable **vzAny** for the VRF.

For additional information, see #unique_42.

Configuring Bridge Domains

This section describes how to configure a Bridge Domain (BD).

Before you begin

- You must have the schema and template created and a tenant assigned to the template, as described in Creating Schemas and Templates, on page 29.
- You must have the VRF created as described in Configuring VRFs, on page 32

Step 1 Select the schema and template where you want to create the application profile.

Step 2 In the schema edit view, scroll down to the **Bridge Domain** area and click **+**.

Step 3 In the properties pane on the right, provide **Display Name** for the BD.

Step 4 From the **Virtual Routing & Forwarding** dropdown, select the VRF for this BD.

Step 5 Add one or more **Subnets** for the BD.

a) Click **+Add Subnet**.

An **Add New Subnet** window opens.

b) Enter the subnet's **Gateway IP** address and a description for the subnet you want to add.

c) Select the **Scope** for the subnet.

The network visibility of the subnet.

- `Private to VRF`—The subnet applies only within its tenant.
- `Advertised Externally`—The subnet can be exported to a routed connection.

d) (Optional) Enable **Shared Between VRFs**.

`Shared between VRFs`—The subnet can be shared with and exported to multiple contexts (VRFs) in the same tenant or across tenants as part of a shared service. An example of a shared service is a routed connection to an EPG present in another context (VRF) in a different tenant. This enables traffic to pass in both directions across contexts (VRFs). An EPG that provides a shared service must have its subnet configured under that EPG (not under a bridge domain), and its scope must be set to advertised externally, and shared between VRFs.

Shared subnets must be unique across the contexts (VRF) involved in the communication. When a subnet under an EPG provides a Layer 3 external network shared service, such a subnet must be globally unique within the entire ACI fabric.

e) (Optional) Enable **No Default SVI Gateway**.

When using Cisco ACI Multi-Site with this APIC fabric domain (site), indicates that the VRF, EPG, or BD using this subnet are mirrored from another site, which has a relationship to this site through a contract. Do not modify or delete the mirrored objects

f) (Optional) Enable **Querier**.

Enables IGMP Snooping on the subnet

g) Click **Save**.

Step 6 (Optional) Enable **DHCP Policy**.

For additional information, see #unique_44.

Configuring Contracts and Filters

This section describes how to configure a contract, a filter, and assign the filter to the contract. A filter is similar to an Access Control List (ACL), it is used to filter traffic through contracts associated to EPGs.

Step 1 Select the template where you want to create contract and filter.

You can create the contract in the same or different template as the objects (EPGs and external EPGs) to which you will apply it. If the objects that will use the contract are deployed to different sites, we recommend defining the contract in a template associated to multiple sites. However, this is not strictly required and even if the contract and filters are defined only as local objects in Site1, MSO will create those objects in a remote Site2 when a local EPG or external EPG in Site2 needs to consume or provide that contract.

Step 2 Create a filter.

a) In the middle pane, scroll down to the **Filter** area, then click + to create a filter.
b) In the right pane, provide the **Display Name** for the filter.
c) In the right pane, click **+ Entry**.

Step 3 Provide the filter details.

The filter entry is a combination of network traffic classification properties. You can specify one or more options as described in the following substeps.

a) Provide the **Name** for the filter.
b) Choose the **Ether Type**.

   For example, `ip`.

c) Choose the **IP Protocol**.

   For example, `icmp`.

d) Choose the **Destination Port Range From** and **Destination Port Range To**.

   The start and end of the destination ports range. You can define a single port by specifying the same value in both fields or you can define a range of ports from `0` to `65535`. You can also choose to specify one of the server types instead of specific port numbers, for example `http`.

e) Click **Save** to save the filter.

Step 4 Create a contract

a) In the middle pane, scroll down to the **Contract** area and click + to create a contract.
b) In the right pane, provide the **Display Name** for the contract
c) Select the appropriate **Scope** for the contract.

   Contract scope limits the contract's accessibility; the contract will not be applied to any consumer EPG outside the scope of the provider EPG:

   - `application-profile`
   - `vrf`
   - `tenant`
   - `global`

d) Toggle the **Apply both directions** knob if you want the same filter to apply for both consumer-to-provider and provider-to-consumer directions.

   If you enable this option, you will need to provide the filters only once and they will apply for traffic in both directions. If you leave this option disabled, you will need to provide two sets of filter chains, one for each direction.

e) (Optional) From the **Service Graph** dropdown, select a service graph for this contract.
f) (Optional) From the **QoS Level** dropdown, select a value for this contract.

   This value specifies the ACI QoS Level that will be assigned to the traffic using this contract. For more information, see #unique_46.

   If you leave this at `Unspecified`, the default QoS Level 3 is applied to the traffic.

Step 5 Assign the filters to the contract

a) In the right pane, scroll down to the **Filter Chain** area and click **+ Filter** to add a filter to the contract.

b) In the **Add Filter Chain** window that opens, select the filter you added in previous step from the **Name** dropdown menu.

c) Click **Save** to add the filter to the contract.

d) If you disabled the `Apply both directions` option on the contract, repeat this step for the other filter chain.

Configuring On-Premises External Connectivity

Cisco ACI allows you to establish connectivity to the networks outside your on-premises ACI fabric through the border leaf switches. This connectivity is defined using two constructs, L3Out and External EPG, which provide the configuration options necessary to define security and route maps.

This section describes how to create an L3Out and external EPG in the Multi-Site Orchestrator GUI. The Orchestrator then creates the objects on the APIC site where you deploy the template. Keep in mind that when creating an L3Out from the Orchestrator, only the L3Out container object is created in the APIC and you must still perform the full L3Out configuration (such as nodes, interfaces, routing protocols, and so on) directly in the site's APIC.

While in most cases the L3Out will be created directly at the APIC level and then associated to an external EPG that you create in the Orchestrator, it may be useful to create both here in order to directly associate the L3Out to a VRF which you have created from the Orchestrator.

Before you begin

- You must have the schema and template created and a tenant assigned to the template, as described in Creating Schemas and Templates, on page 29.

- You must have the VRF for the L3Out created as described in Configuring VRFs, on page 32

Step 1 Navigate to the Schema and Template you want to edit.

Step 2 Create an L3Out.

a) In the schema edit view, scroll down to the **L3Out** area and click **+** to add a new L3Out.

b) In the properties pane on the right, provide a display name for the L3Out.

c) From the **Virtual Routing & Forwarding** dropdown, select the VRF you created for this.

Step 3 Create an external EPG.

a) In the schema edit view, scroll down to the **External EPG** area and click **+** to add a new External EPG.

b) In the properties pane on the right, select **On-Prem** for the site type.

Step 4 Configure external EPG's basic properties.

a) In the right properties sidebar, provide a display name for the External EPG.

b) From the **Virtual Routing & Forwarding** dropdown, select the VRF you created.

This must be the same VRF that you associated with the L3Out.

c) Click **+Contract** to add a contract for the external EPG to communicate with other EPGs.

If you already have the contracts created, you can assign them now. Otherwise, you can come back to this screen to assign any Contracts you plan to create later.

When assigning Contracts:

- If you are associating a contract with the external EPG as provider, choose contracts only from the tenant associated with the external EPG. Do not choose contracts from other tenants.
- If you are associating the contract to the external EPG as consumer, you can choose any available contract.

Step 5 If configuring an external EPG for an on-premises fabric, set **Site Type** to `on-prem` and configure external EPG's on-premises properties.

a) From the **L3Out** dropdown, select the L3Out you created in a previous step.
b) Click **+Subnet** to add a classification subnet.
c) In the **Add Subnet** window, provide the subnet prefix.
d) Select the required **Route Control** options.

You can choose one or more for the following options:

- **Export Route Control** enables a route map that allows external prefixes to get advertised out of the L3Out. These are the prefixes learned from other L3Outs for transit routing use cases.

  If you are adding the `0.0.0.0/0` subnet and enable the export route control option, **Aggregate Export** option becomes available. This allows you to advertise all the external prefixes learned from other L3Outs. If you choose to leave this option disabled, only the default route learned from other L3Out will be advertised out of this L3Out.

- **Import Route Control** configures an ingress route map to give you control over what prefixes you want to import from your L3Out into the fabric. The **Import Route Control** is available only when using BGP as the routing protocol on the L3Out.

  If you are adding the `0.0.0.0/0` subnet and enable the import route control option,**Aggregate Import** option becomes available. This works similar to the export route control case except for ingress routes.

- **Shared Route Control** is used for shared L3Out use case and allows prefixes learned from the external router to be advertised to the other VRF that will use this L3Out.

  If you enable the shared route control option,**Aggregate Shared Routes** option becomes available. Again, this functions similar to previous two aggregate routes options but is available for non-`0.0.0.0/0` subnets.

e) Select the **External EPG Classification** options.

You can choose to enable the **External Subnets for External EPG** option to allow endpoints within the fabric to reach the external subnet.

If you enable the this option, **Shared Security Import** option becomes available, which allows access from the subnet to the endpoints within the fabric.

For both of these options, access is still subject to contract rules.

Step 6 If configuring an external EPG for a cloud fabric, set **Site Type** to `cloud` and configure external EPG's cloud properties.

a) From the **Application Profile** dropdown, select the application profile.
b) Click **+Add Selector** to add a cloud endpoint selector for the EPG.

Step 7 (Optional) If you want to include this external EPG in the preferred group, check the **Include in preferred group** checkbox.

For more info about EPG Preferred Group, see EPG Preferred Groups, on page 199.

Viewing Schemas

After you have created one or more schemas, they are displayed both on the Dashboard and the Schemas page.

You can use the functionality available on these two pages to monitor the usage and the health of your schemas when they are deployed. You can also access and edit specific areas of the implemented schema policies using the Multi-Site Orchestrator GUI.

For more information about the functionality of these Multi-Site Orchestrator GUI pages, refer to Overview, on page 1.

Migrating Objects Between Templates

This section describes how to move objects between templates or schemas. When moving one or more objects, the following restrictions apply:

- Only EPG and Bridge Domain (BD) objects can be moved between templates.
- Migrating objects to or from Cloud APIC sites is not supported.

  You can migrate objects between on-premises sites only.
- The source and destination templates can be in different templates and schemas, but the templates must be assigned to the same tenant.
- The destination template must have been created and assigned to at least one site.
- If the destination template is not deployed and has no other objects, the template will be automatically deployed after the objects are migrated.
- Once you initiate one object migration, you cannot perform another migration that involves the same source or target template. The migration is completed when the templates have been deployed to sites.

Step 1 Log in to your Multi-Site Orchestrator GUI.

Step 2 From the left navigation menu, select **Schemas**.

Step 3 Click the schema that contains the objects you want to migrate.

Step 4 In the Schema view, select the Template that contains the objects you want to migrate.

Step 5 In the top right of the main pane, click **Select**.

This allows you to select one or more objects to migrate.

Step 6 Click each object that you want to migrate.

Selected objects will display a check mark in their top right corner.

Step 7 In the top right of the main pane, click the actions (**...**) icon and choose **Migrate Objects**.

Step 8 In the **Migrate Objects** window, select the destination Schema and Template where you want to move the objects.

Only the templates with at least one site attached to them will appear in the list. If you don't see your target Template in the dropdown list, cancel the wizard and assign that template to at least one site.

Step 9 Click **OK** and then **YES** to confirm that you want to move the objects.

The objects will be migrated from the source template to the destination template that you selected. When you deploy your configuration, the objects will be removed from any site where the source Template is deployed and added to the site where the destination template is deployed.

Step 10 After the migration is completed, redeploy both, the source and the destination, templates.

If the destination template is not deployed and has no other objects, the template will be automatically deployed after the objects are migrated, so you can skip this step.

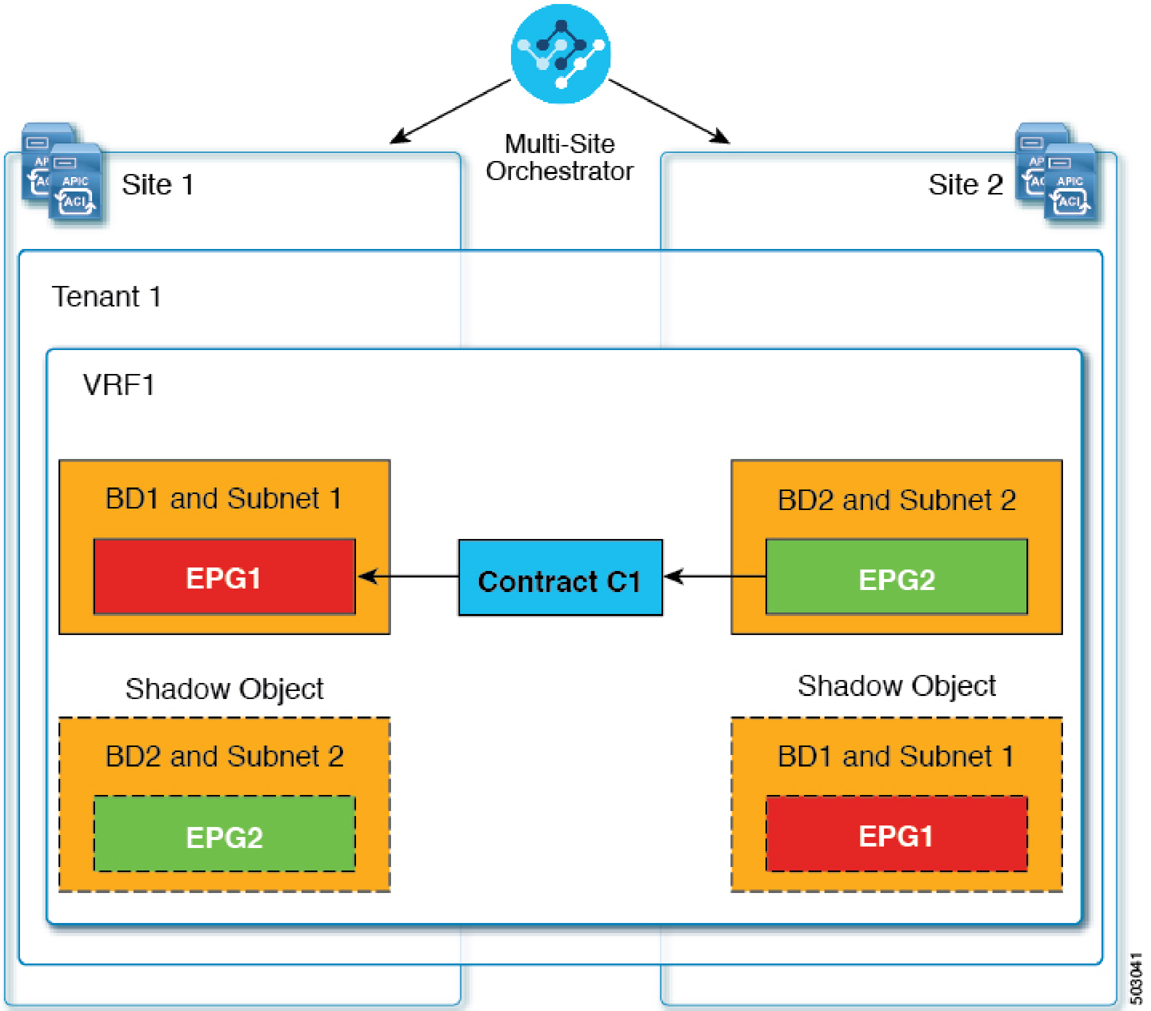
Shadow Objects

When a contract exists between site-local EPGs in stretched VRF or in Shared Services use-cases where provider and consumer are in different VRFs and communicate through Tenant contracts, the EPGs and bridge domains (BDs) are mirrored on the remote sites. The mirrored objects appear as if they are deployed in each of these sites' APICs, while only actually being deployed in one of the sites. These mirrored objects are called "shadow" objects.

Note Shadow objects should not be removed using the APIC GUI.

For example, if a tenant and VRF are stretched between Site1 and Site2, provider EPG and its bridge domain are deployed in Site2 only, and consumer EPG and its domain are deployed in Site1 only, then corresponding shadow bridge domains and EPGs will deployed as shown in the figure below. They appear with the same names as the ones that were deployed directly to each site.

Figure 11: Basic Shadow EPG



The following objects can be shadowed:

- VRFs
- Bridge Domains (BDs)
- L3Outs
- External EPGs
- Application Profiles
- Application EPGs
- Contracts (Hybrid Cloud deployments)

When you select a shadow object in the APIC GUI, you will see a `This is a shadow object pushed by MSC to support intersite policies. Do not make any changes or delete this object.` warning at the top of main GUI pane. In addition, shadow EPGs that are not part of a VMM domain will not have static ports, while shadow BDs will have **No Default SVI Gateway** option enabled in the APIC GUI. You can check for these options as described below:

Other Use Cases with Shadow Objects

Shadow objects are also create in a number of other use cases, such Preferred Group, vzAny, and Layer 3 Multicast, and hybrid cloud, as shown in the figures below.

Figure 12: Preferred Group

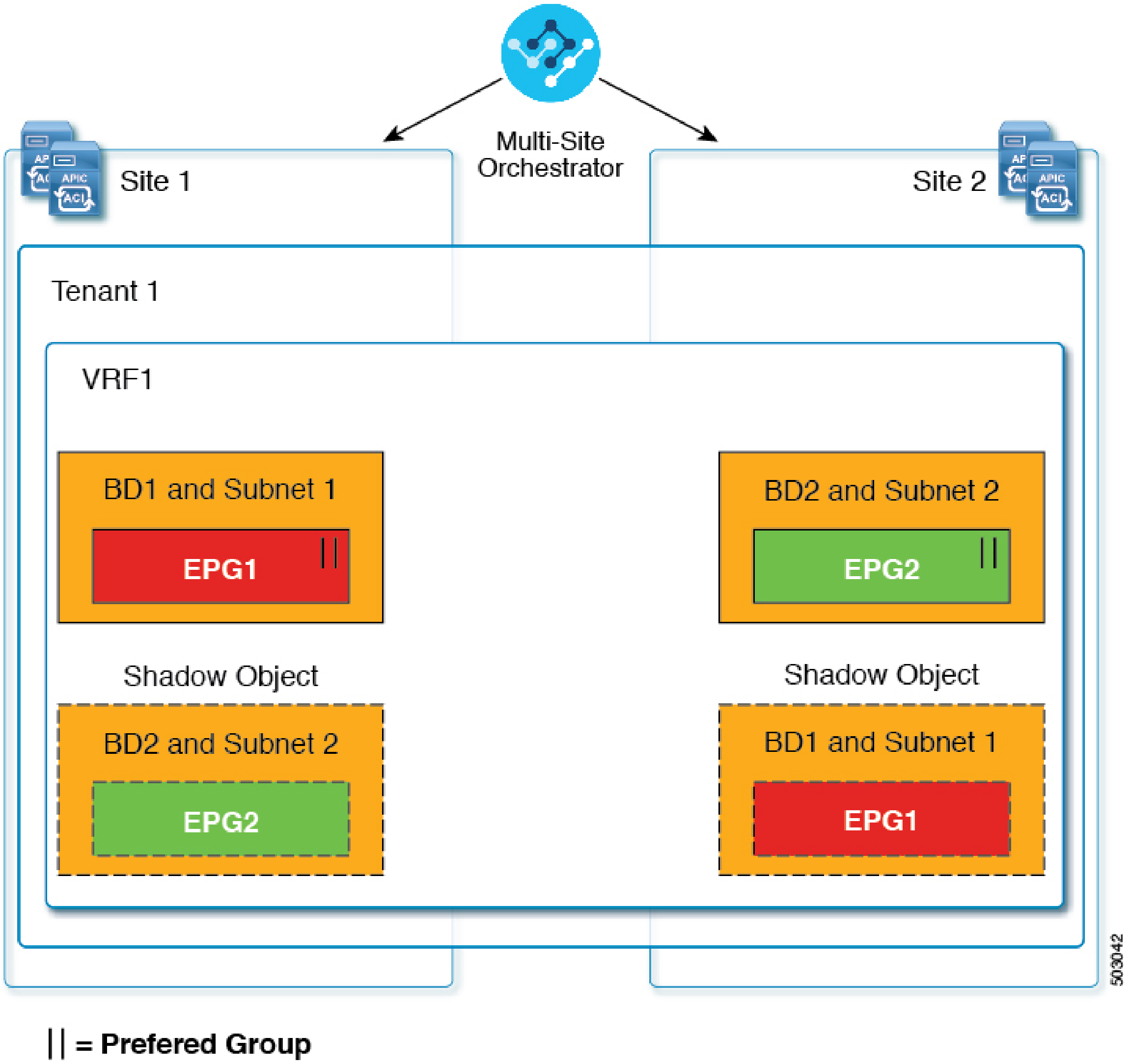
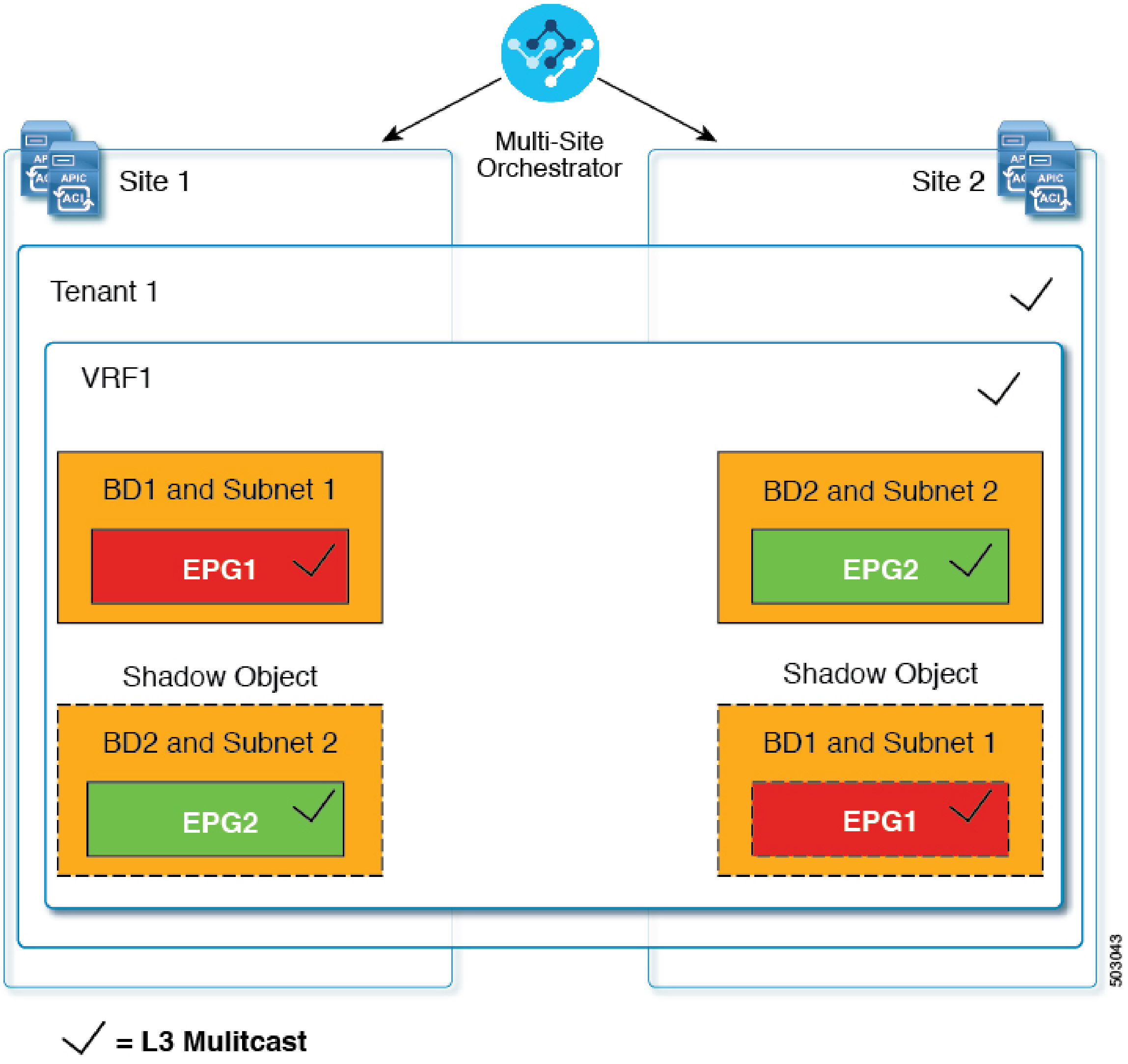
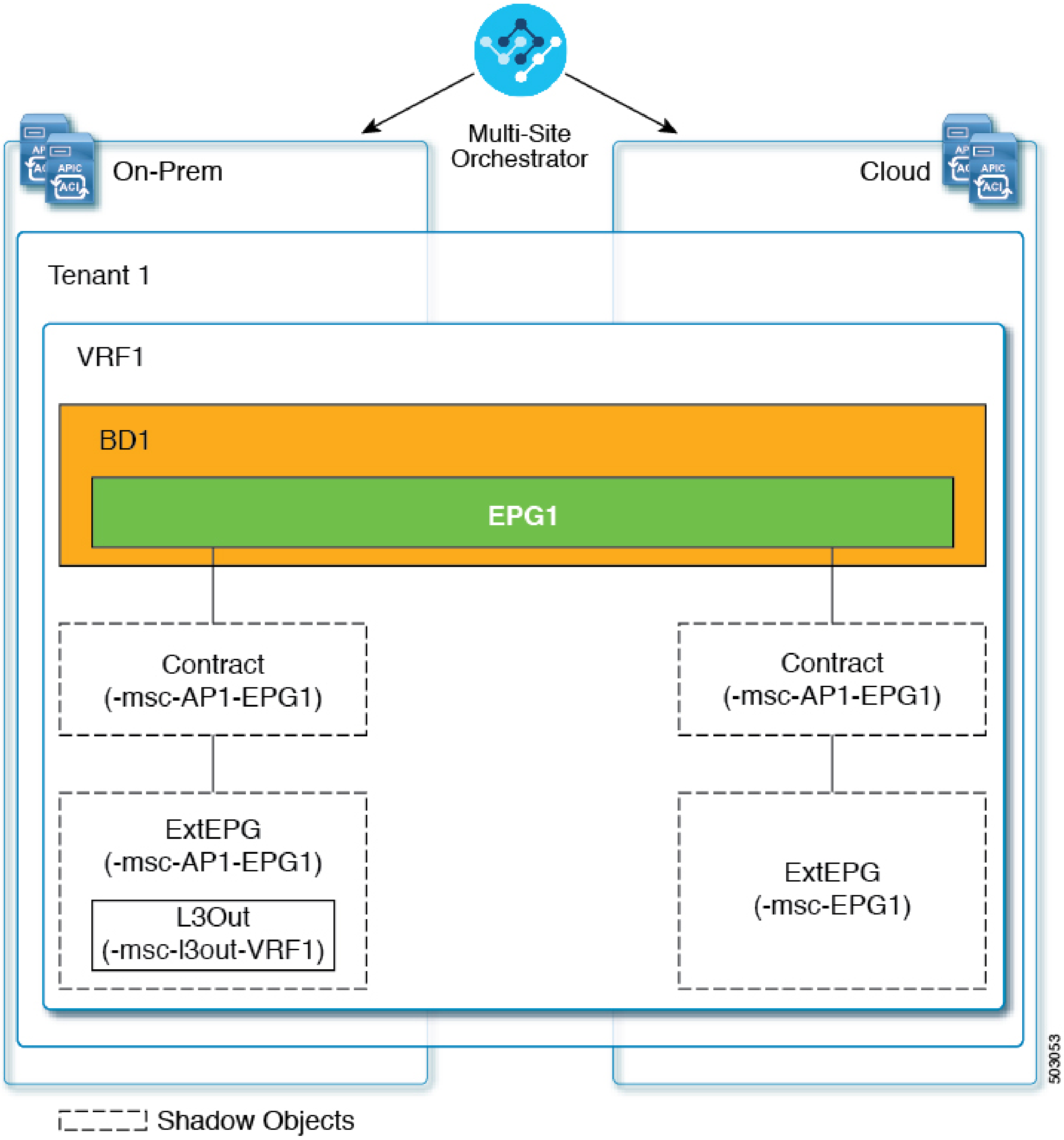


Figure 13: L3 Multicast



In case of hybrid cloud deployments, even stretched objects will create shadow objects where implicit contracts exist. For example in the following case where an EPG is stretched between an on-premises and cloud sites, shadow external EPGs are created in each site with implicit shadow contracts between the stretched EPG and the shadow external EPGs.

Figure 14: Hybrid Cloud



Hiding Shadow Objects in APIC GUI

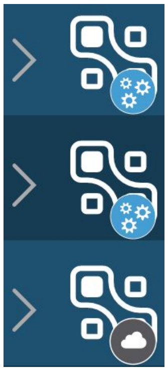
Starting with APIC Release 5.0(2), you can choose to show or hide the shadow objects created by the Multi-Site Orchestrator in the on-premises site's APIC GUI. Shadow objects in Cloud APIC are always hidden.

If you want to hide shadow objects from the GUI, keep the following in mind:

- This option cannot be set globally from the Orchestrator and must be set directly in each site's APIC as described in this section.

- The option to show shadow objects is turned off by default for all new APIC Release 5.0(2) installations and upgrades, so previously visible objects may become hidden.
- Hiding shadow objects relies on a flag set by the Multi-Site Orchestrator specifically for this feature, which is enabled from Orchestrator Release 3.0(2) and later:
    - If shadow objects are deployed by an earlier Orchestrator version, they will not have the required tag and will always be visible in the APIC GUI.
    - If shadow objects are deployed by Orchestrator version 3.0(2) or later, they will have the tag and can be hidden or shown using the APIC GUI setting.
    - We recommend upgrading each fabric to APIC Release 5.0(2) before upgrading the Multi-Site Orchestrator.
    - When the Multi-Site Orchestrator is upgraded to Release 3.0(2), any objects deployed to sites running APIC Release 5.0(2) or later will be tagged with appropriate tags and can be shown or hidden using the APIC GUI without having to re-deploy them.

      If you upgrade the Orchestrator before the fabric's APIC, the site's objects will not be tagged and you will need to manually re-deploy the configuration after the fabric is upgraded for the flag to be set.
- If you ever downgrade your fabric to a release prior to Release 5.0(2), the shadow objects will no longer be hidden and you may see a different icon for them in the APIC GUI.



Step 1 Log in to the site's APIC.

Step 2 In the top right corner, click the **Manage my profile** icon and choose **Settings**.

Step 3 In the **Application Settings** window, enable or disable the **Show Hidden Policies** checkbox.

The setting is stored in the user profile and is enable or disabled separately for each user.

Step 4 Repeat the process for any additional APIC sites.

PART II

Operations

CHAPTER 4

Backup and Restore

Configuration Backup and Restore

You can create backups of your Multi-Site Orchestrator configuration that can facilitate in recovery from Orchestrator failures or cluster restarts. We recommend creating a backup of the configuration before every upgrade or downgrade of your Orchestrator and after every configuration change or deployment. We also recommend exporting the backups to an external storage outside of the Orchestrator nodes' VMs.

Note Restoring a backup action restores the database on the Multi-Site Orchestrator, but it does not make any changes to the APIC databases on each site. Therefore, after you restore the Orchestrator database, you must also re-deploy any existing schemas to avoid potentially mismatching policies between the Orchestrator and APIC sites. For information on specific configuration mismatch scenarios and backup restore procedures related to each one, see Backup and Restore Guidelines, on page 47

Backup and Restore Guidelines

When saving and restoring configuration backups, the following guidelines apply:

- Importing and restoring backups created from later releases is not supported.

  For example, if you downgrade your Multi-Site Orchestrator to an earlier release, you cannot restore a backup of the configuration created on a later release.

- When saving a backup, the configuration is saved in the same state in which it was deployed. When restoring a backup, any policies that were deployed will show as "deployed", while any policies that were not deployed will remain in the "undeployed" state.

- Restoring a backup action restores the database on the Multi-Site Orchestrator, but it does not make any changes to the APIC databases on each site. As such, certain precautions and steps must be taken when restoring a previous configuration to avoid potentially mismatching policies between the Orchestrator and the APIC sites, as described below.

No Configuration Changes Since Backup

If there have been no policy changes between when the backup was created and when it is being restored, no additional considerations are required and you can simply restore the configuration as described in Restoring Backups, on page 52.

Objects or Policies Created, Modified, or Deleted Since Backup

If any configuration changes took place between the time when the configuration backup was created and the time it is being restored, consider the following:

- Restoring a backup will not modify any objects or policies on the APIC sites. Any new objects or policies created and deployed since the backup will remain deployed. You will need to manually remove these after restoring the backup to avoid any stale configurations.

  Alternatively, you can choose to undeploy all policies first, which will avoid any potential stale objects after the configuration is restored from backup. However, this would cause a disruption in traffic or services defined by those policies.

- The steps required to restore a configuration backup are described in Restoring Backups, on page 52.
- If the configuration backup you restored was saved before it was deployed to the APIC sites, it will be restored in the "undeployed" state and you can simply deploy it to the APIC sites as necessary.
- If the configuration backup you restored was saved when the configuration was already deployed, it will be restored in the "deployed" state, even though none of the policies will exist in the APIC sites yet. In this case, in order for the configuration to be properly pushed to each site, you will need to re-deploy it to sync the Orchestrator's configuration with the APIC sites.

Remote Backups

Cisco ACI Multi-Site is deployed as a 3-node cluster. When you first deploy the cluster, any backups you create are saved to a default location which is located on each node's local disk in the `/opt/cisco/msc/backups/` directory.

While the backups are available on any one node and can be viewed using the Orchestrator GUI, we recommend exporting all backups to a remote location outside the Orchestrator VMs. There are two approaches to configuring remote locations for all Orchestrator backups:

- Configuring a remote NFS share and mounting it to the default backups directory on each node, in which case the backup files are written directly to the remote NFS share bypassing the Orchestrator VMs' local drives.

  This approach is less flexible in that it allows only a single remote location to be used for all configuration backups created from the Orchestrator GUI.

- Configuring a remote SCP or SFTP location using the Orchestrator GUI and then exporting the backup files there.

Unlike the remote NFS share approach, configuring one or more remote locations in the Orchestrator GUI allows you to specify multiple destinations and provides additional flexibility for where the backup files can be stored.

Note When you create a configuration backup and export it to a remote server, the files are first created on the Orchestrators' local drives, then uploaded to the remote location, and finally deleted from the local storage. There is a limit on the local backups disk space usage, which if reached can prevent remote backups from being created.

Configuring a Remote Location for Backups

This section describes how to configure a remote location in Multi-Site Orchestrator to which you can then export your configuration backups.

Step 1 Log in to your Cisco ACI Multi-Site Orchestrator.

Step 2 From the left navigation pane, select **Operations** > **Remote Locations**.

Step 3 In the top right of the main window, click **Add Remote Location**.

An **Add New Remote Location** screen appears.

Step 4 Provide the name for the location and an optional description.

Two protocols are currently supported for remote export of configuration backups:

- `SCP`
- `SFTP`

Note `SCP` is supported for non-Windows servers only. If your remote location is a Windows server, you must use the `SFTP` protocol

Step 5 Specify the host name or IP address of the remote server.

Based on your **Protocol** selection, the server you specify must allow `SCP` or `SFTP` connections.

Step 6 Provide the full path to a directory on the remote server where you will save the backups.

The path must start with a slash (`/`) characters and must not contain periods (`.`) or backslashes (`\`). For example, *`/backups/multisite`*.

Note The directory must already exist on the remote server.

Step 7 Specify the port used to connect to the remote server.

By default, port is set to `22`.

Step 8 Specify the authentication type used when connecting to the remote server.

You can configure one of the following two authentication methods:

- `Password`—provide the username and password used to log in to the remote server.
- `SSH Private Files`—provide the username and the SSH Key/Passphrase pair used to log in to the remote server.

Step 9 Click **Save** to add the remote server.

Moving Existing Backups to a Remote Location

This section describes how to move an existing configuration backup you have created in the Multi-Site Orchestrator GUI from the nodes' local drives to a remote location.

Before you begin

You must have completed the following:

- Created a configuration backup as described in Creating Backups, on page 51.
- Added a remote location for exporting backups as described in Configuring a Remote Location for Backups, on page 49.

Step 1 Log in to your Cisco ACI Multi-Site Orchestrator.

Step 2 From the left navigation pane, select **Admin** > **Backups**.

Step 3 Locate the backup you want to export, then click the actions (⋮) icon next to it, then click **Move to remote location**.

A **Move Backup To Remote Location** window opens.

Step 4 From the **Remote Location** dropdown menu, select the remote location.

Step 5 (Optional) Update the remote location path.

The target directory on the remote server, which you configured when creating the remote backup location, will be displayed in the **Remote Path** field.

You can choose to append additional subdirectories to the path. However, the directories must be under the default configured path and must have been already created on the remote server.

Adding an NFS Share to Store Backups

This section describes how to add an NFS share to the Multi-Site Orchestrator VMs to store configuration backups.

Note While you can configure a single remote NFS share for your configuration backups, we recommend using the remote backup location feature available in the Orchestrator GUI and described in Configuring a Remote Location for Backups, on page 49 instead.

Step 1 Log in directly to your Multi-Site Orchestrator node's VM as the `root` user.

Step 2 Mount the NFS share.

The following command mounts the shared NFS directory to the default Orchestrator backups folder so all future backups are automatically stored to an external storage outside the Orchestrator VMs.

Note If you have any existing backups in this default directory that you want to save, you must manually move them to a different location before mounting the NFS share. After the share is mounted, any existing files in the mount directory will be hidden from view.

```
# mount <nfs-server-ip>:/<nfs-share-path> /opt/cisco/msc/backups/
```

Step 3 Repeat steps 1 through 2 on each Orchestrator VM.

Because each Orchestrator node can create and store its own backup files, you must mount the same NFS share on all nodes.

Step 4 Update the Docker backup services.

You must run the following Docker update command for the newly mounted file system to be usable by the Orchestrator services. However, since the command updates the services across the cluster, you only need to do this once after mounting the shares on each node.

```
# docker service update msc_backupservice --force
```

What to do next

If at any point you want to remove the NFS share and go back to storing the backups locally on each VM, simply unmount the directory on each node and run the `docker service update msc_backupservice --force` command again.

Creating Backups

This section describes how to create a new backup of your Multi-Site Orchestrator configuration.

Before you begin

If you want to create the backup using a remote location, you must first add the remote location as described in Configuring a Remote Location for Backups, on page 49.

Step 1 Log in to your Cisco ACI Multi-Site Orchestrator.

Step 2 Create a new backup.

a) From the left navigation pane, expand the **Operations** category.
b) Select **Backups & Restore**.
c) In the main window, click **New Backup**.

A **New Backup** window opens.

Step 3 Provide backup information.

a) Provide the **Name** and optional **Notes** for the backup.

The name can contain up to 10 alphanumeric characters, but no spaces or underscores (_).

b) Choose the **Backup Location**.

You can save the backup file locally on the Orchestrator nodes or export it to a remote location.

If you want to save the backup file locally, choose **Local**.

Otherwise, if you want to save the backup file to a remote location, choose **Remote** and provide the following:

- From the **Remote Location** dropdown menu, select the remote location.

  The remote location must be already created as described in Configuring a Remote Location for Backups, on page 49.

- In the **Remote Path**, either leave the default target directory or you can choose to append additional subdirectories to the path. However, the directories must be under the default configured path and must have been already created on the remote server.

c) Click **Save** to create the backup.

Restoring Backups

This section describes how to restore a Multi-Site Orchestrator configuration to a previous state.

Before you begin

Restoring a backup action restores the database on the Multi-Site Orchestrator, but it does not make any changes to the APIC databases on each site. Therefore, after you restore the Orchestrator database, you must also re-deploy any existing schemas to avoid potentially mismatching policies between the Orchestrator and APIC sites.

For information on specific configuration mismatch scenarios and recommended restore procedures related to each one, see Backup and Restore Guidelines, on page 47.

Step 1 Log in to your Multi-Site Orchestrator GUI.

Step 2 If necessary, undeploy existing policies.

We recommend you perform this step if new objects or policies were added to the configuration between when the backup was created and current configuration. Additional context is available in Backup and Restore Guidelines, on page 47.

Step 3 From the left navigation menu, select **Operations** > **Backups & Restore**.

Step 4 In the main window, click the actions (**...**) icon next to the backup you want to restore and select **Rollback to this backup**.

If the version of the selected backup is different from the running Multi-Site version, the rollback could cause a removal of the features that are not present in the backup version.

Step 5 Click **Yes** to confirm that you want to restore the backup you selected.

If you click **Yes**, the system terminates the current session and the user is logged out.

Note If your Multi-Site Orchestrator cluster is deployed in Application Services Engine, multiple services are restarted during the configuration restore process. As a result, you may notice an up to 5 minute delay before the restored configuration is properly reflected in the MSO GUI.

Step 6 If necessary, redeploy the configuration.

We recommend you perform this step to sync the restored configuration with the APIC sites. Additional context is available in Backup and Restore Guidelines, on page 47.

Downloading Backups

This section describes how to download you backup from the Multi-Site Orchestrator.

Before you begin

Step 1 Log in to your Multi-Site Orchestrator GUI.

Step 2 From the left navigation menu, select **Admin** > **Backups**.

Step 3 In the main window, click the actions (⋮) icon next to the backup you want to download and select **Download**.

This will download the backup file in `msc-backups-<timestamp>.tar.gz` format to your system. You can then extract the file to view its contents.

Importing Backups

This section describes how to import an existing backup into your Multi-Site Orchestrator.

Before you begin

Step 1 Log in to your Multi-Site Orchestrator GUI.

Step 2 From the left navigation menu, select **Admin** > **Backups**.

Step 3 In the main window, click **Import**.

Step 4 In the **Import from file** window that opens, click **Select File** and choose the backup file you want to import.

Importing a backup will add it to the list of the backups displayed the **Backups** page.

CHAPTER 5

Tech Support

Tech Support and System Logs

Multi-Site Orchestrator system logging is automatically enabled when you first deploy the Orchestrator cluster and captures the events and faults that occur in the environment.

You can choose to download the logs at any time or stream them to an external log analyzer, such as Splunk, if you want to use additional tools to quickly parse, view, and respond to important events without a delay.

Generating Troubleshooting Report and System Logs

This section describes how to generate a troubleshooting report and infrastructure logs file for all the schemas, sites, tenants, and users that are managed by Cisco ACI Multi-Site Orchestrator.

Step 1 Log in to your Multi-Site Orchestrator GUI.

Step 2 In the main menu, select **Operations** > **Tech Support**.

Step 3 In the top right corner of the **System Logs** frame, click the edit button.

A **System Logs** configuration window opens.

Step 4 In the **System Logs** window, check the logs you want to download.

Check the **Database Backup** to download a backup of the Orchestrator database.

Check the **Server Logs** to download the Orchestrator cluster logs.

Step 5 Click **Download**.

An archive of the selected items will be downloaded to your system. The report contains the following information:

- All schemas in JSON format
- All sites definitions in JSON format

- All tenants definitions in JSON format
- All users definitions in JSON format
- All logs of the containers in the `infra_logs.txt` file

Streaming System Logs to External Analyzer

Cisco ACI Multi-Site Orchestrator allows you to send the Orchestrator logs to an external log analyzer tool in real time. By streaming any events as they are generated, you can use the additional tools to quickly parse, view, and respond to important events without a delay.

This section describes how to enable Multi-Site Orchestrator to stream its logs to an external analyzer tool, such as Splunk or syslog.

Before you begin

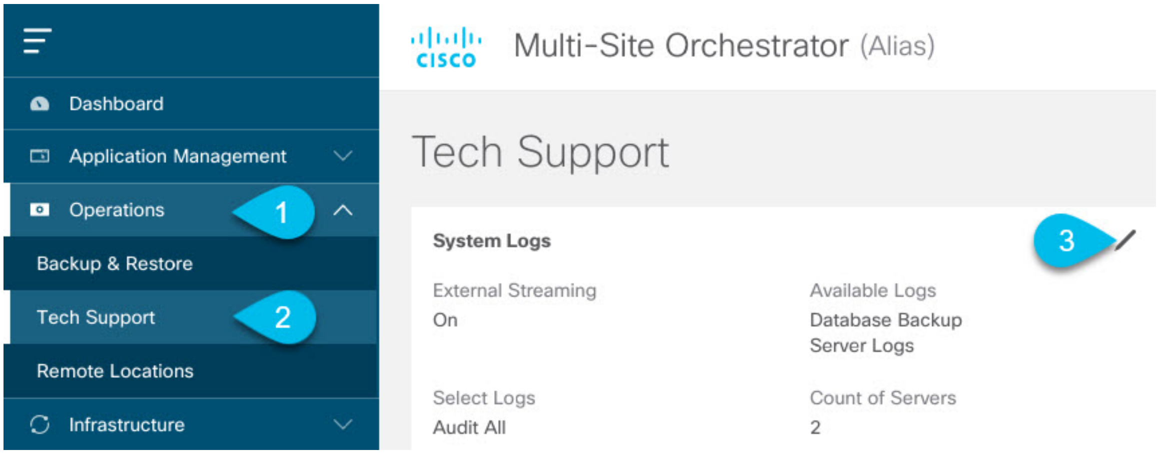
- This release supports only Splunk and `syslog` as external log analyzer.
- This release supports `syslog` only for Multi-Site Orchestrator in Application Services Engine deployments.
- This release supports up to 5 external servers.
- If using Splunk, set up and configure the log analyzer service provider.

  For detailed instructions on how to configure an external log analyzer, consult its documentation.
- If using Splunk, obtain an authentication token for the service provider.

  Obtaining an authentication token for Splunk service is detailed in the Splunk documentation, but in short, you can get the authentication token by logging into the Splunk server, selecting **Settings** > **Data Inputs** > **HTTP Event Collector**, and clicking **New Token**.

Step 1 Log in to your Multi-Site Orchestrator GUI.

Step 2 Open the **System Logs** screen.



External Streaming
On

Available Logs
Database Backup
Server Logs

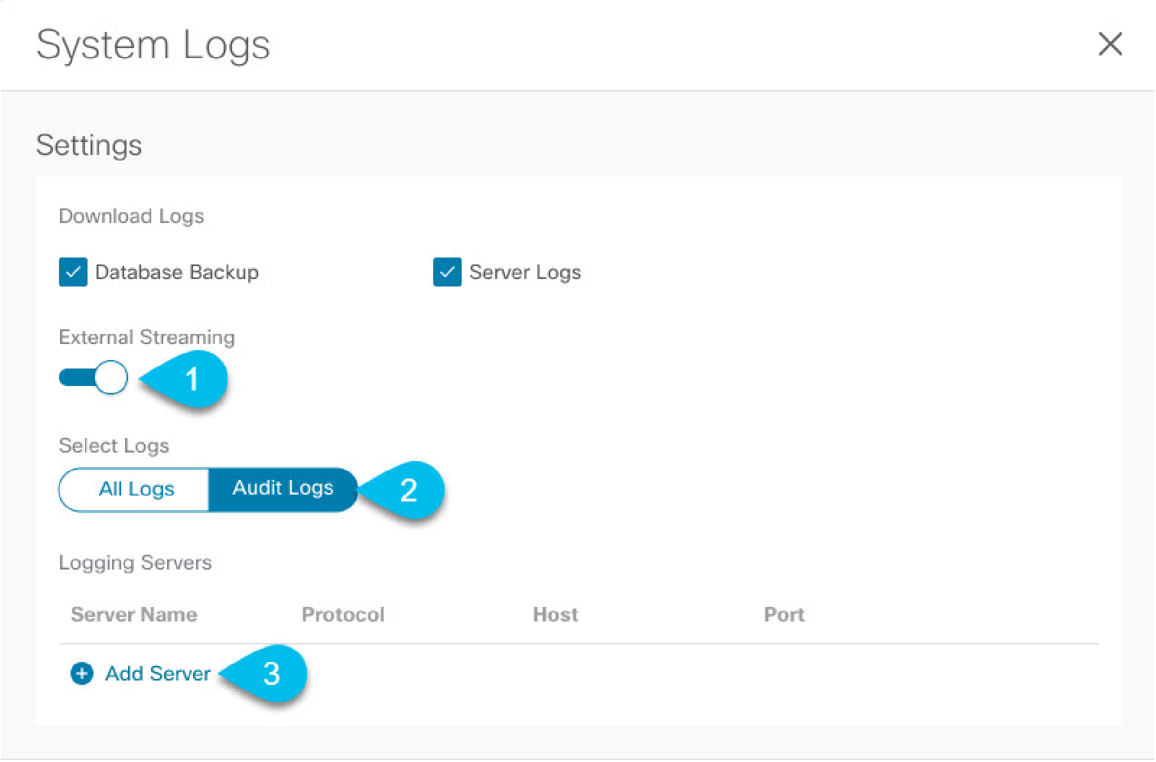
Select Logs
Audit All

Count of Servers
2

a) In the main menu, select **Operations** > **Tech Support**.

b) In the top right corner of the **System Logs** frame, click the edit button.

Step 3 In the **System Logs** window, enable external streaming and add a server.



System Logs

Settings

Download Logs

☑ Database Backup ☑ Server Logs

External Streaming

Select Logs

All Logs | Audit Logs

Logging Servers

Server Name	Protocol	Host	Port

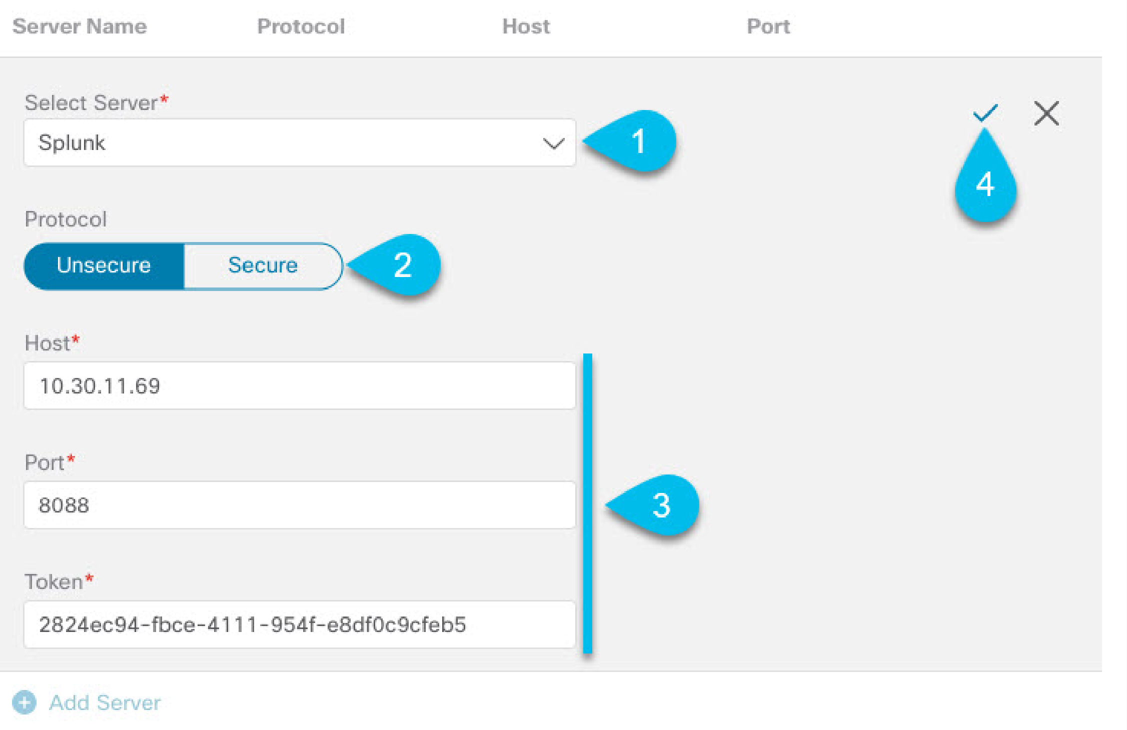
a) Enable the **External Streaming** knob.

b) Choose whether you want to stream **All Logs** or just the **Audit Logs**.

c) Click **Add Server** to add an external log analyzer server.

Step 4 Add a Splunk server.

If you do not plan to use Splunk service, skip this step.



Server Name | Protocol | Host | Port

Select Server*: Splunk

Protocol: Unsecure | Secure

Host*: 10.30.11.69

Port*: 8088

Token*: 2824ec94-fbce-4111-954f-e8df0c9cfeb5

a) Choose `Splunk` for the server type.

b) Choose the protocol.

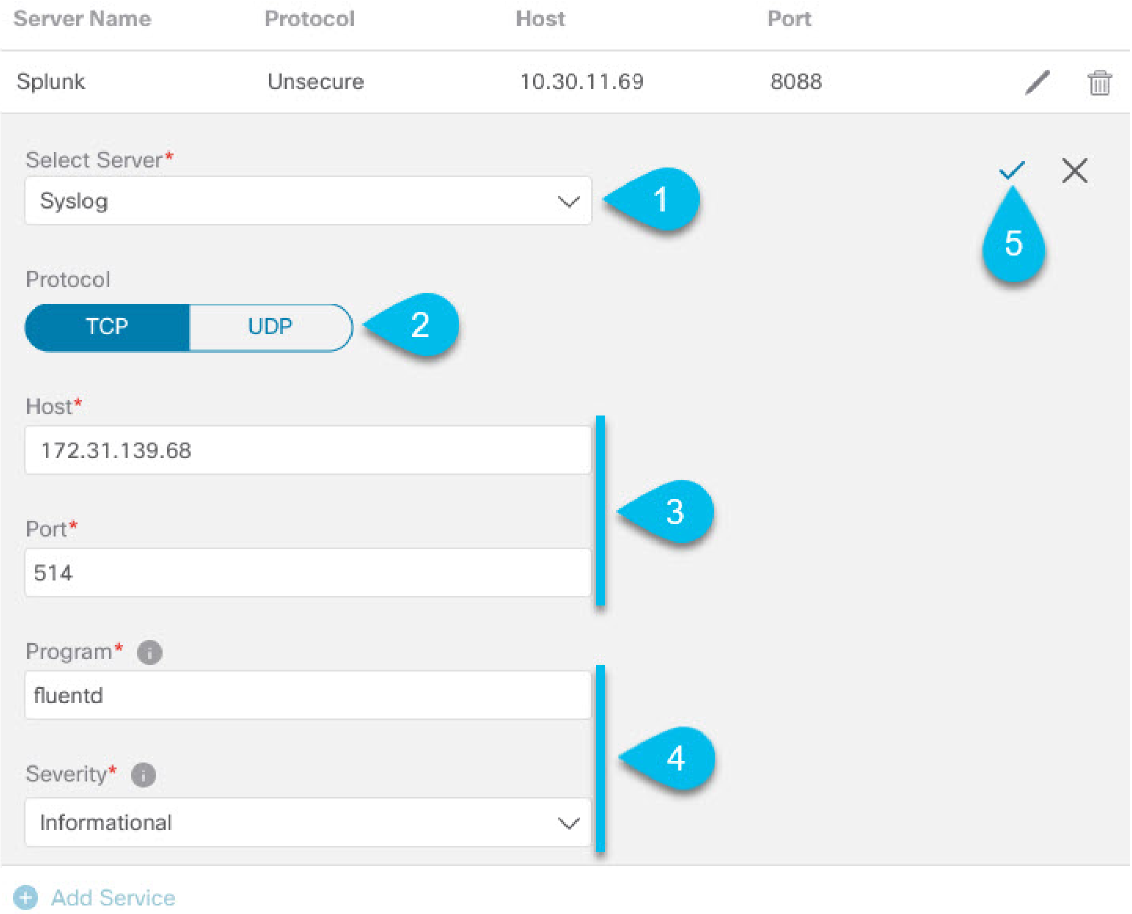
c) Provide the server name or IP address, port, and the authentication token you obtained from the Splunk service.

Obtaining an authentication token for Splunk service is detailed in the Splunk documentation, but in short, you can get the authentication token by logging into the Splunk server, selecting **Settings** > **Data Inputs** > **HTTP Event Collector**, and clicking **New Token**.

d) Click the checkmark icon to finish adding the server.

Step 5 Add a `syslog` server.

If you do not plan to use `syslog`, skip this step.



Server Name	Protocol	Host	Port
Splunk	Unsecure	10.30.11.69	8088

Select Server*: Syslog

Protocol: TCP UDP

Host*: 172.31.139.68

Port*: 514

Program*: fluentd

Severity*: Informational

a) Choose `syslog` for the server type.

b) Choose the protocol.

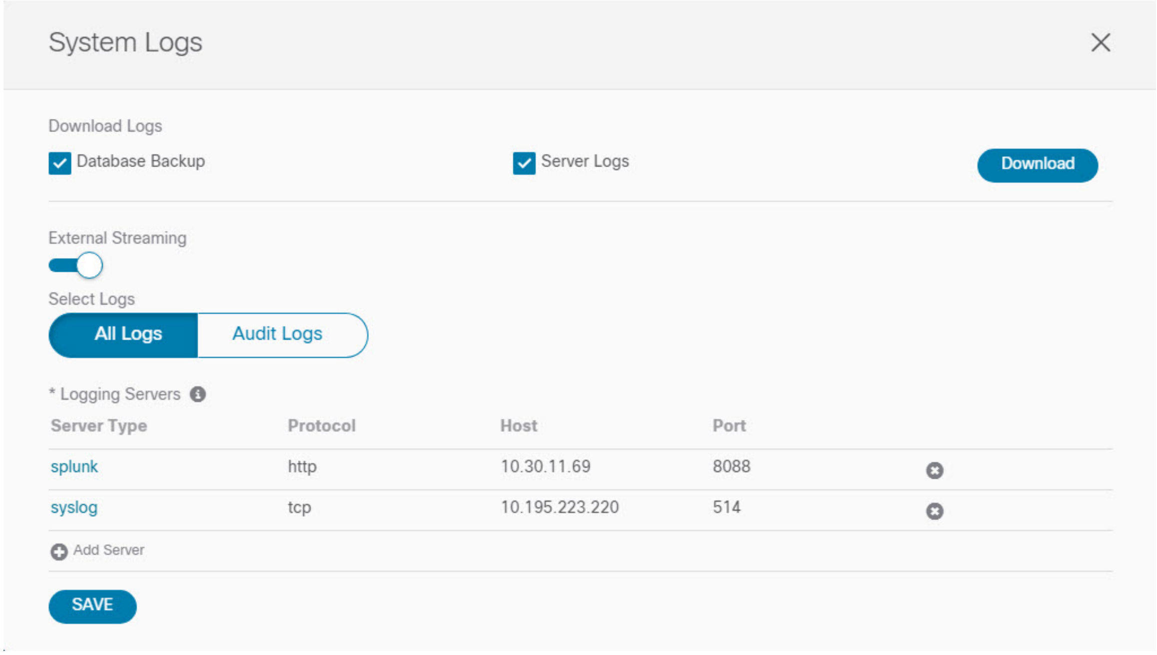
c) Provide the server name or IP address, port number, and the severity level of the log messages to stream.

d) Click the checkmark icon to finish adding the server.

Step 6 Repeat the steps if you want to add multiple servers.

This release supports up to 5 external servers.

Step 7 Click **Save** to save the changes.



System Logs

Download Logs

☑ Database Backup ☑ Server Logs

External Streaming: ●

Select Logs: [✓ All Logs] Audit Logs

* Logging Servers

Server Type	Protocol	Host	Port
splunk	http	10.30.11.69	8088
syslog	tcp	10.195.223.220	514

PART III

Infrastructure Management

CHAPTER 6

System Configuration

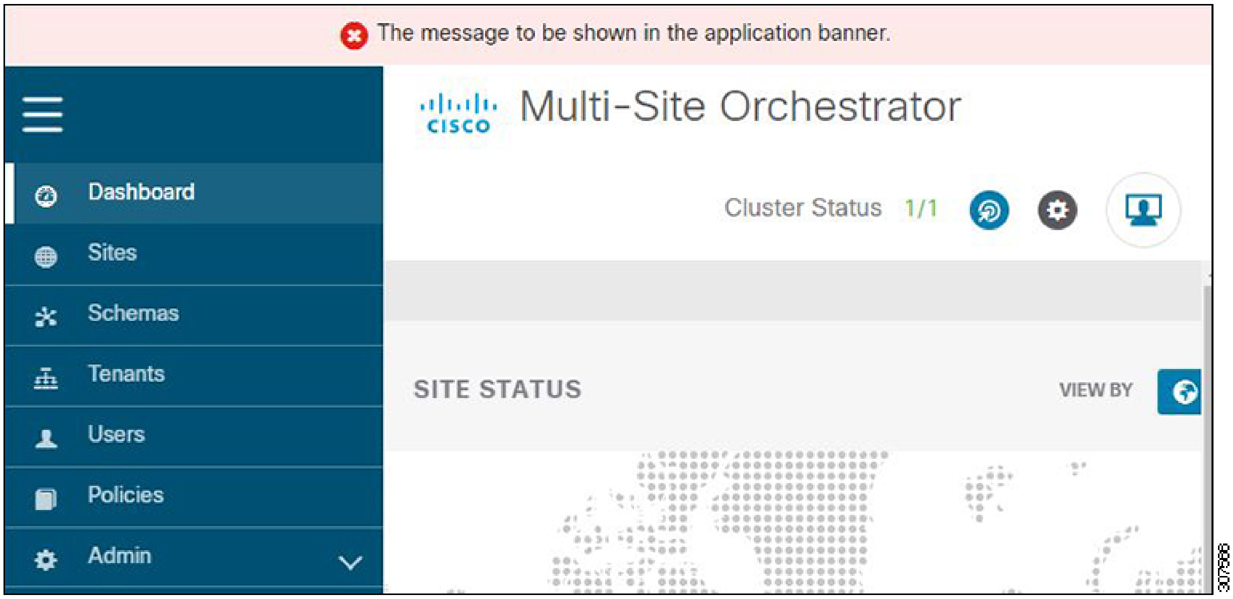
System Configuration Settings

There is a number of global system settings that are available under **Admin** > **System Configuration**, which you can configure for your Multi-Site Orchestrator as described in the following sections.

System Alias and Banner

This section describes how to configure an alias for your Multi-Site Orchestrator as well as enable a custom GUI-wide banner to be displayed at the top of your screen, as shown in the following figure.

Figure 15: System Banner Display



The message to be shown in the application banner.

Step 1 Log in to your Orchestrator.

Step 2 From the left navigation pane, select **Admin** > **System Configuration**.

Step 3 Click the **Edit** icon to the right of the **System Alias & Banners** area.

This opens the **System Alias & Banners** settings window.

Step 4 In the **Alias** field, specify the system alias.

Step 5 Choose whether you want to enable the GUI banner.

Step 6 If you enable the banner, you must provide the message that will be displayed on it.

Step 7 If you enable the banner, you must choose the severity, or color, for the banner.

Step 8 Click **Save** to save the changes.

Login Attempts and Lockout Time

When the Orchestrator detects a significant number of failed consecutive login attempts, the user is locked out of the system to prevent unauthorized access. You can configure how failed log in attempts are treated, for example the number of failed attempts before lockout and the length of the lockout.

Note This feature is enabled by default when you first install or upgrade to Release 2.2(1) or later.

Step 1 Log in to your Orchestrator.

Step 2 From the left navigation pane, select **Admin** > **System Configuration**.

Step 3 Click the **Edit** icon to the right of the **Fail Attempts & Lockout Time** area.

This opens the **Fail Attempts & Lockout Time** settings window.

Step 4 From the **Fail Attempt Settings** dropdown, select the number of attempts before the user is locked out.

Step 5 From the **Lockout Time (Minutes)** dropdown, select the length of the lockout.

This specifies the base lockout duration once it's triggered. The timer is extended up to three times exponentially with every additional consecutive login failure.

Step 6 Click **Save** to save the changes.

Proxy Server

The proxy server configuration is available only for Multi-Site Orchestrator deployments in Cisco Application Service Engine. If your cluster is deployed in a Docker swarm, this option will not be available in the GUI.

In certain deployment scenarios, such as with a combination of on-premises and cloud sites and the Orchestrator running inside a corporate network, the Orchestrator may have to access the internet and the cloud sites through a proxy. You can configure and enable proxy as described in this section.

When a proxy server is enabled, the Orchestrator will maintain a "no proxy" list of IP addresses and hostnames with which it will communicate directly bypassing the proxy. This list is a combination of user-specified hosts or domains plus all on-premises APIC sites currently added to the Orchestrator. Every time the list is updated with a new address, for example if you add a new site to the Orchestrator, the proxy service is restarted. You can minimize the service restarts by providing a complete list of your on-premises sites in advance, for example by adding an entire domain to the "no proxy" list, while configuring the proxy settings.

Step 1 Log in to your Orchestrator.

Step 2 From the left navigation pane, select **Infrastructure** > **System Configuration**.

Step 3 Click the **Edit** icon to the right of the **Proxy Server** area.

This opens the **Proxy Settings** window.

Step 4 Choose **Enable** to enable the proxy.

Step 5 In the **Proxy Server** field, specify the IP address or the hostname of your proxy server.

Step 6 In the **Proxy Server Port** field, specify the port number used to connect to the proxy server.

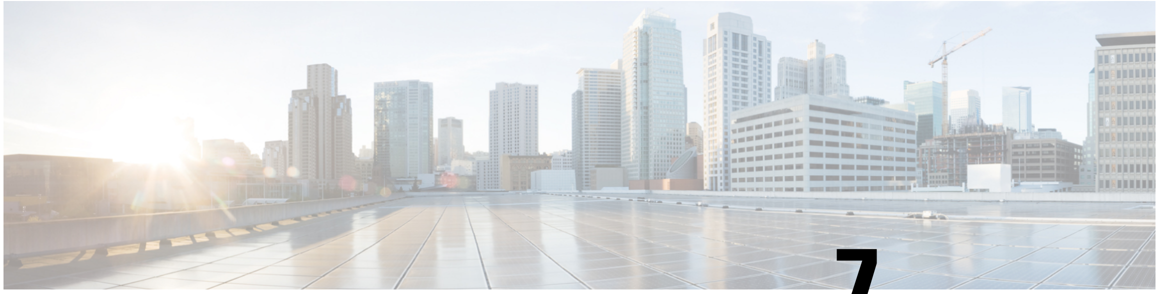
Step 7 In the **No Proxy List** field, provide a comma-separated list of hosts and domains that should bypass the proxy.

When specifying the list, you can provide exact IP addresses or hostnames, as well as entire domains using the wildcard (`*`) character. Wildcards cannot be used with IP addresses.

For example, `203.0.113.1, apic1.example.com, *.example.local`.

Step 8 Click **Save** to save the changes.

When you configure and enable proxy, the Orchestrator application will restart.



CHAPTER 7

Configuring and Managing Sites

Pod Profile and Policy Group

In each site's APIC, you must have one Pod profile with a Pod policy group. If you site does not have a Pod policy group you must create one.

To check if the POD profile contains a POD policy group:

- Navigate to the Cisco APIC GUI, **Fabric** > **Fabric Policies** > **Pods** > **Profiles** > **Pod Profile default**.

To create a POD policy group:

- Navigate to the Cisco APIC GUI, **Fabric** > **Fabric Policies** > **Pods** > **Policy Groups**, right-click **Policy Groups** and click **Create Pod Policy Group**. Enter the appropriate information and click **Submit**.

To assign the new pod policy group to the default POD profile:

- Navigate to the Cisco APIC GUI, **Fabric** > **Fabric Policies** > **Pods** > **Profiles** > **Pod Profile default**. Click on the default, choose the new pod policy group and click **Update**.

Configuring Fabric Access Policies for All APIC Sites

Before your APIC fabrics can be added to and managed by the Multi-Site Orchestrator, there is a number of fabric-specific access policies that you must configure on each site.

Configuring Fabric Access Global Policies

This section describes the global fabric access policy configurations that must be created for each APIC site before it can be added to and managed by the Multi-Site Orchestrator.

Step 1 Log in directly to the site's APIC GUI.

Step 2 From the main navigation menu, select **Fabric** > **Access Policies**.

You must configure a number of fabric policies before the site can be added to the Multi-Site Orchestrator. From the APIC's perspective, this is something you do just like you would if you were connecting a bare-metal host, where you would configure domains, AEPs, policy groups, and interface selectors; you must configure the same options for connecting the spine switch interfaces to the inter-site network for all the sites that will be part of the same Multi-Site domain.

Step 3 Specify the VLAN pool.

The first thing you configure is the VLAN pool. We use Layer 3 sub-interfaces tagging traffic with VLAN-4 to connect the spine switches to the inter-site network.

a) In the left navigation tree, browse to **Pools** > **VLAN**.
b) Right-click the **VLAN** category and choose **Create VLAN Pool**.

In the **Create VLAN Pool** window, specify the following:

- For the **Name** field, specify the name for the VLAN pool, for example `msite`.
- For **Allocation Mode**, specify `Static Allocation`.
- And for the **Encap Blocks**, specify just the single VLAN 4. You can specify a single VLAN by entering the same number in both **Range** fields.

Step 4 Configure Attachable Access Entity Profiles (AEP).

a) In the left navigation tree, browse to **Global Policies** > **Attachable Access Entity Profiles**.
b) Right-click the **Attachable Access Entity Profiles** category and choose **Create Attachable Access Entity Profiles**.

In the **Create Attachable Access Entity Profiles** window, specify the name for the AEP, for example `msite-aep`.

c) Click **Next** and **Submit**

No additional changes, such as interfaces, are required.

Step 5 Configure domain.

The domain you configure is what you will select from the Multi-Site Orchestrator when adding this site.

a) In the left navigation tree, browse to **Physical and External Domains** > **External Routed Domains**.
b) Right-click the **External Routed Domains** category and choose **Create Layer 3 Domain**.

In the **Create Layer 3 Domain** window, specify the following:

- For the **Name** field, specify the name the domain, for example `msite-l3`.
- For **Associated Attachable Entity Profile**, select the AEP you created in Step 4.
- For the **VLAN Pool**, select the VLAN pool you created in Step 3.

c) Click **Submit**.

No additional changes, such as security domains, are required.

What to do next

After you have configured the global access policies, you must still add interfaces policies as described in Configuring Fabric Access Interface Policies, on page 69.

Configuring Fabric Access Interface Policies

This section describes the fabric access interface configurations that must be done for the Multi-Site Orchestrator on each APIC site.

Before you begin

You must have configured the global fabric access policies, such as VLAN Pool, AEP, and domain, in the site's APIC, as described in Configuring Fabric Access Global Policies, on page 68.

Step 1 Log in directly to the site's APIC GUI.

Step 2 From the main navigation menu, select **Fabric** > **Access Policies**.

In addition to the VLAN, AEP, and domain you have configured in previous section, you must also create the interface policies for the fabric's spine switch interfaces that connect to the Inter-Site Network (ISN).

Step 3 Configure a spine policy group.

a) In the left navigation tree, browse to **Interface Policies** > **Policy Groups** > **Spine Policy Groups**.

This is similar to how you would add a bare-metal server, except instead of a Leaf Policy Group, you are creating a Spine Policy Group.

b) Right-click the **Spine Policy Groups** category and choose **Create Spine Access Port Policy Group**.

In the **Create Spine Access Port Policy Group** window, specify the following:

- For the **Name** field, specify the name for the policy group, for example `Spine1-PolGrp`.
- For the **Link Level Policy** field, specify the link policy used between your spine switch and the ISN.
- For **CDP Policy**, choose whether you want to enable CDP.
- For the **Attached Entity Profile**, select the AEP you have configured in previous section, for example `msite-aep`.

c) Click **Submit**.

No additional changes, such as security domains, are required.

Step 4 Configure a spine profile.

a) In the left navigation tree, browse to **Interface Policies** > **Profiles** > **Spine Profiles**.

b) Right-click the **Spine Profiles** category and choose **Create Spine Interface Profile**.

In the **Create Spine Interface Profile** window, specify the following:

- For the **Name** field, specify the name for the profile, for example `Spine1-ISN`.

- For **Interface Selectors**, click the **+** sign to add the port on the spine switch that connects to the ISN. Then in the **Create Spine Access Port Selector** window, provide the following:
    - For the **Name** field, specify the name for the port selector, for example `Spine1-ISN`.
    - For the **Interface IDs**, specify the switch port that connects to the ISN, for example `5/32`.
    - For the **Interface Policy Group**, choose the policy group you created in the previous step, for example `Spine1-PolGrp`.

  Then click **OK** to save the port selector.

c) Click **Submit** to save the spine interface profile.

Step 5 Configure a spine switch selector policy.

a) In the left navigation tree, browse to **Switch Policies** > **Profiles** > **Spine Profiles**.

b) Right-click the **Spine Profiles** category and choose **Create Spine Profile**.

In the **Create Spine Profile** window, specify the following:

- For the **Name** field, specify the name for the profile, for example `Spine1`.
- For **Spine Selectors**, click the **+**to add the spine and provide the following:
    - For the **Name** field, specify the name for the selector, for example `Spine1`.
    - For the **Blocks** field, specify the spine node, for example `201`.

c) Click **Update** to save the selector.

d) Click **Next** to proceed to the next screen.

e) Select the interface profile you have created in the previous step

For example `Spine1-ISN`.

f) Click **Finish** to save the spine profile.

Configuring Sites That Contain Remote Leaf Switches

Starting with Release 2.1(2), the Multi-Site architecture supports APIC sites with Remote Leaf switches. The following sections describe guidelines, limitations, and configuration steps required to allow Multi-Site Orchestrator to manage these sites.

Multi-Site and Remote Leaf Guidelines and Limitations

If you want to add an APIC site with a Remote Leaf to be managed by the Multi-Site Orchestrator, the following restrictions apply:

- You must upgrade your Cisco APIC to Release 4.1(2) or later.
- You must upgrade your Multi-Site Orchestrator to Release 2.1(2) or later.
- Only physical Remote Leaf switches are supported in this release

- Only -EX and -FX or later switches are supported as Remote Leaf switches for use with Multi-Site:
- Remote Leaf is not supported with back-to-back connected sites without IPN switches
- Remote Leaf switches in one site cannot use another site's L3out
- Stretching a bridge domain between one site and a Remote Leaf in another site is not supported

You must also perform the following tasks before the site can be added to and managed by the Multi-Site Orchestrator:

- You must enable Remote Leaf direct communication and configure routable subnets directly in the site's APIC, as described in the following sections.
- You must add the routable IP addresses of Cisco APIC nodes in the DHCP-Relay configuration applied on the interfaces of the Layer 3 routers connecting to the Remote Leaf switches.

  The routable IP address of each APIC node is listed in the **Routable IP** field of the **System** > **Controllers** > **<controller-name>** screen of the APIC GUI.

Configuring Routable Subnets for Remote Leaf Switches

Before you can add a site that contains one or more Remote Leaf switches to the Multi-Site Orchestrator, you must configure routable subnets for the pod with which the Remote Leaf nodes are associated.

Step 1 Log in directly to the site's APIC GUI.

Step 2 From the menu bar, select **Fabric** > **Inventory**.

Step 3 In the Navigation pane, click **Pod Fabric Setup Policy**.

Step 4 In the main pane, double-click the pod where you want to configure the subnets.

Step 5 In the **Routable Subnets** area, click the **+** sign to add a subnet.

Step 6 Enter the **IP** and **Reserve Address Count**, set the state to `Active` or `Inactive`, then click **Update** to save the subnet.

When configuring routable subnets, you must provide a netmask between `/22` and `/29`.

Step 7 Click **Submit** to save the configuration.

Enabling Direct Communication for Remote Leaf Switches

Before you can add a site that contains one or more Remote Leaf switches to the Multi-Site Orchestrator, you must configure direct remote leaf communication for that site. Additional information about remote leaf direct communication feature is available in the *Cisco APIC Layer 3 Networking Configuration Guide*. This section outlines the steps and guidelines specific to the integration with Multi-Site.

Note Once you enable Remote Leaf switch direct communication, the switches will function in the new mode only

Step 1 Log in directly to the site's APIC.

Step 2 Enable direct traffic forwarding for Remote Leaf switches.

a) From the menu bar, navigate to **System** > **System Settings**.
b) From the left side bar, select **Fabric Wide Setting**.
c) Check the **Enable Remote Leaf Direct Traffic Forwarding** checkbox.

Note You cannot disable this option after you enable it.

d) Click **Submit** to save the changes.

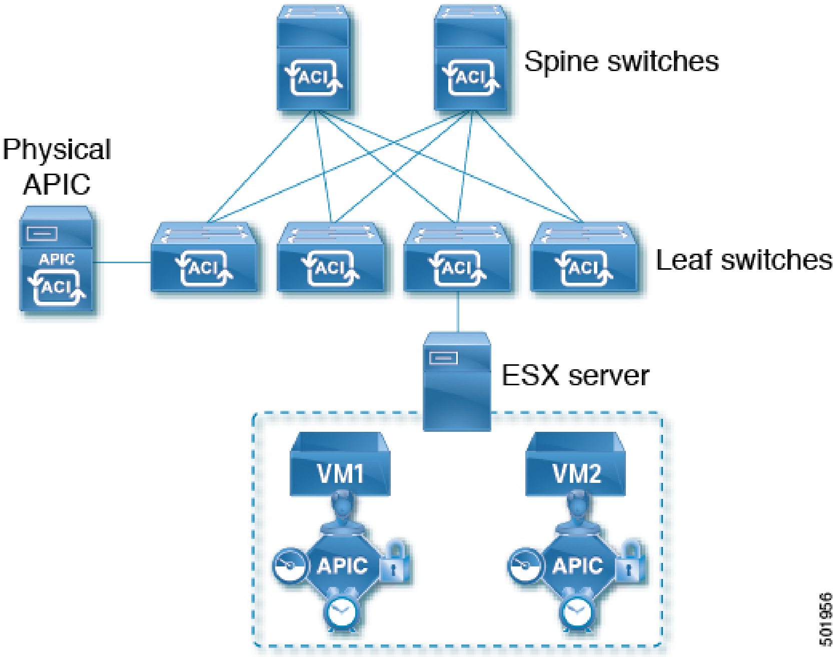
Cisco Mini ACI Fabrics

Cisco ACI Multi-Site supports Cisco Mini ACI fabrics as typical on-premises sites without requiring any additional configuration. This section provides brief overview of Mini ACI fabrics, detailed info on deploying and configuring this type of fabrics is available in *Cisco Mini ACI Fabric and Virtual APICs*.

Cisco ACI, Release 4.0(1) introduced Mini ACI Fabric for small scale deployment. Mini ACI fabric works with Cisco APIC cluster consisting of one physical APIC and two virtual APICs (vAPIC) running in virtual machines. This reduces the physical footprint and cost of the APIC cluster, allowing ACI fabric to be deployed in scenarios with limited rack space or initial budget, such as a colocation facility or a single-room data center, where a full-scale ACI installations may not be practical due to physical footprint or initial cost.

The following diagram shows an example of a mini Cisco ACI fabric with a physical APIC and two virtual APICs (vAPICs):

Figure 16: Cisco Mini ACI Fabric



Adding Sites

This section describes how to add sites using the Cisco ACI Multi-Site Orchestrator GUI.

Before you begin

You must have completed the site-specific configurations in each site's APIC, as decribed in previous sections in this chapter.

Step 1 Log in to the Multi-Site GUI, in the **Main menu**, click **Sites**.

If you are logging in for the first time, log in as the **admin** user with the default password **We1come2msc!**, you will then be prompted to change that default password. The new password requirements are:

- At least 12 characters
- At least 1 letter
- At least 1 number
- At least 1 special character apart from * and space

Step 2 In the **Main menu**, select **Infrastructure** > **Sites**.

Step 3 In the top right of the main pane, click **Add Site**.

Step 4 In the **Add Site** screen, provide the site's details.

a) In the **Name** field, enter the site name.

b) In the **Labels** field, choose or create a label.

You can choose to provide multiple labels for the site.

c) In the **APIC Controller URL** field, enter the Cisco APIC URL.

For the APIC URL, you can use the `http` or `https` protocol and the IP address or the DNS hostname, such as`https://<ip-address>` or `https://<dns-hostname>`.

d) If you have a cluster of APICs in the fabric, click **+APIC Controller URL** and provide the additional URLs.

e) In the **Username** field, enter the admin user's username for the site's APIC.

f) In the **Password** field, enter the user's password.

g) You can turn on the **Specify Login Domain for Site** switch, if you want to specify a domain to be used for authenticating the user you provided.

If you turn on this option, enter the domain name in the **Domain Name** field.

h) In the **APIC Site ID** field, enter a unique site ID.

The site ID must be a unique identifier of the Cisco APIC site, ranged between `1` and `127`. Once specified, the site ID cannot be changed without factory resetting Cisco APIC.

Step 5 Click **Save** to add the site.

Step 6 If prompted, confirm proxy configuration update.

If you have configured the Orchestrator to use a proxy server and are adding an on-premises site that is not already part of the "no proxy" list, the Orchestrator will inform you of the proxy settings update.

For additional information on proxy configuration, see the "Administrative Operations" chapter in *Cisco ACI Multi-Site Configuration Guide*.

Step 7 Repeat these steps to add any additional sites.

Deleting Sites Using Multi-Site Orchestrator GUI

This section describes how to delete sites using the Multi-Site GUI.

Step 1 Log in to the Multi-Site GUI.

Step 2 Ensure you unbind the site from any Schema's before trying to delete the site.

Step 3 In the **Main menu**, click **Sites**.

Step 4 In the **Sites List** page, hover over the site you want to delete and choose **Action** > **Delete** .

Step 5 Click **YES**.

Multi-Site Cross Launch to Cisco APIC

Multi-Site currently supports the basic parameters to choose when creating a Tenant and setting up a site. Multi-Site supports most of the Tenant policies, but in addition to that you can configure some advanced parameters.

Use the Multi-Site GUI to manage the basic properties to configure. If you want to configure advanced properties, the capability to cross launch into Cisco APIC GUI directly from the Multi-Site GUI is provided. You can also configure the additional properties directly in Cisco APIC.

There are three different access points in Multi-Site GUI from where you can cross launch into APIC. From these access points in Multi-Site, you can open a new browser tab with access into Cisco APIC. You will log in to Cisco APIC at that point for the first time, and the associated screen is displayed in the Cisco APIC GUI.

Cross-Launch to Cisco APIC from Sites

Before you begin

- At least one site must be configured in Multi-Site.
- The site must contain at least one tenant with entities such as VRF and bridge domain configured.

Step 1 From the left-hand sidebar, open the **Sites** view.

Step 2 From the **Sites** list, hover over the name of the appropriate site, click the **Actions** icon at the end of the row, and choose **Open in APIC User Interface** to access the Cisco APIC GUI.

The APIC GUI login screen is displayed for logging in with APIC GUI credentials.

Cross-Launch to Cisco APIC from Schemas

Before you begin

- At least one site based on a template must be configured in Multi-Site.
- The site must contain at least one tenant with entities such as VRF and bridge domain configured.

Step 1 From the left-hand sidebar, open the **Schemas** view.

Step 2 From the **Schemas** list, click the appropriate **<*schema-name*>**.

Step 3 From the left-hand sidebar **Sites** list, hover over the name of the appropriate site, click the **Actions** icon at the end of the row, and choose **Open in APIC User Interface** to access the Cisco APIC GUI.

The APIC GUI login screen is displayed for logging in with APIC GUI credentials.

Cross-Launch to Cisco APIC from the Property Pane

Before you begin

- At least one site must be configured in Multi-Site.
- The site must contain at least one tenant with entities such as VRF and bridge domain configured.

Step 1 From the left-hand sidebar, open the **Schemas** view.

Step 2 From the **Schemas** list, click the appropriate **<*schema-name*>**.

Step 3 From the left-hand sidebar **Sites** list, choose the appropriate site.

Step 4 In the **Canvas**, choose the name of a specific entity.

For example, choose an available VRF, Contract, Bridge Domain, or another entity as appropriate.

The details for the specific entity are displayed in the **Property Pane** on the right.

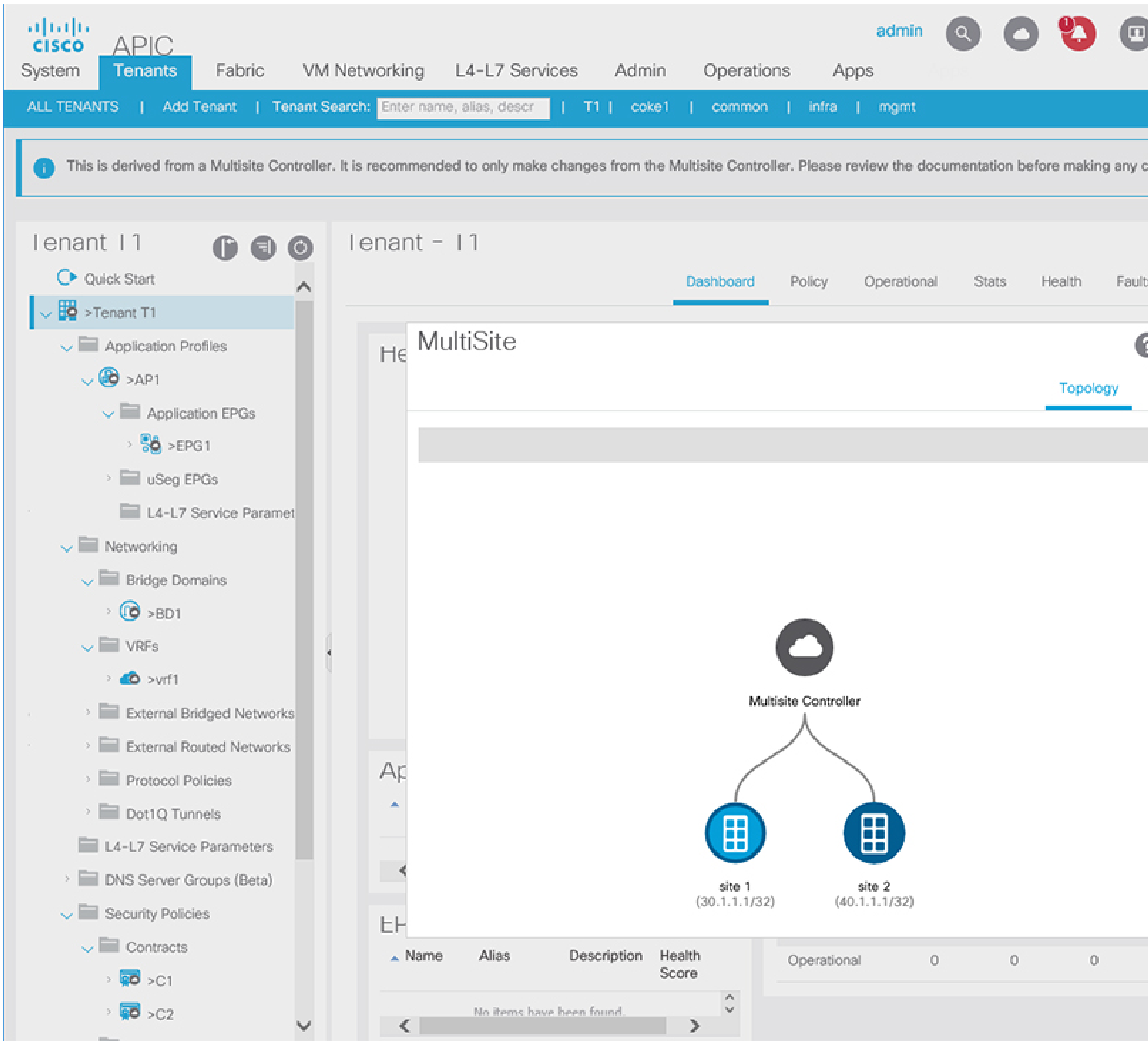
Step 5 In the top right of the **Property Pane**, click the **Open in APIC User Interface** icon to access the Cisco APIC GUI.

The APIC GUI login screen is displayed for logging in with APIC GUI credentials.

Viewing Cisco ACI Multi-Site-Managed Objects Using the Cisco APIC GUI

When an APIC cluster is managed by Multi-Site, cloud icons indicate the relationships with other sites.

Figure 17: Viewing Multi-Site-Managed Objects Using the APIC GUI



This is derived from a Multisite Controller. It is recommended to only make changes from the Multisite Controller. Please review the documentation before making any c

Before you begin

The APIC cluster/site must be set up to be managed by Cisco ACI Multi-Site.

Step 1 To view the relationship of the APIC site with other sites, click the cloud icon at the upper right, next to the settings icons.

In the diagram, hover over the light blue site icon to see the local site details, and hover over the dark blue icon to see the remote site details.

In the image, T1 and its Application Profile, EPG, BD, VRF, and contracts are marked with cloud icons. This indicates that they are managed by Multi-Site. We recommend that you only make changes to these objects in the Multi-Site GUI.

Step 2 To view the localized or stretched usage of a VRF, bridge domain, or other objects, where there is a **Show Usage** button on the information page, perform the following steps; for example for Bridge Domain and VRF:

a) On the menu bar, click **Tenants** and double-click on a tenant that is managed by Multi-Site.

b) Click **Networking** > **Bridge Domains** > ***BD-name*** or **Networking** > **VRFs** > ***vrf-name***.

Step 3 Click **Show Usage**.

Here you can view the nodes or policies using the object.

Note It is recommended to make changes to managed policies only in the Multi-Site GUI.

Step 4 To set the scope of deployment notification settings for this BD or VRF, click **Change Deployment Settings**. You can enable warnings to be sent for all deletions and modifications of the object on the **Policy** tab.

Step 5 To enable or disable Global warnings, check or uncheck the **(Global) Show Deployment Warning on Delete/Modify** check box.

Step 6 To enable or disable Local warnings, choose **Yes** or **No** on the **(Local) Show Deployment Warning on Delete/Modify** field.

Step 7 To view any past warnings, click the **History** tab **Events** or **Audit Logs**.

CHAPTER 8

Configuring Infra

This chapter contains the following sections:

Configuring Infra Prerequisites and Guidelines

The following sections describe the steps necessary to configure the general as well as site-specific fabric Infra settings.

Before you proceed with Infra configuration, you must have configured and added the sites as described in previous sections, which includes:

- Configuring each site's fabric access policies.
- Configuring direct communication and routable subnets for sites with remote leaf switches.

In addition, keep in mind the following:

- Any infrastructure changes such as adding and removing spine switches or spine node ID changes require a Multi-Site fabric connectivity information refresh described in the Refreshing Site Connectivity Information, on page 80 as part of the general Infra configuration procedures.
- The Overlay Unicast TEP, Overlay Multicast TEP, and BGP-EVPN Router-IDs IP addresses assigned on the Orchestrator should not be taken from the address space of the original fabric's `Infra` TEP pool or from the `0.x.x.x` range.

Configuring Infra: General Settings

This section describes how to configure general Infra settings for all the sites.

Step 1 Log in to the Cisco ACI Multi-Site Orchestrator GUI.

Step 2 In the **Main menu**, click **Sites**.

Step 3 In the **Sites** view, click **Configure Infra**.

Step 4 In the left pane, under **Settings**, click **General Settings**.

Step 5 From the **BGP Peering Type** dropdown, choose either `full-mesh` or `route-reflector`.

The `route-reflector` option is effective only when all sites are part of the same BGP Autonomous System (AS).

Step 6 In the **Keepalive Interval (Seconds)** field, enter the keep alive interval seconds.

We recommend keeping the default value.

Step 7 In the **Hold Interval (Seconds)** field, enter the hold interval seconds.

We recommend keeping the default value.

Step 8 In the **Stale Interval (Seconds)** field, enter stale interval seconds.

We recommend keeping the default value.

Step 9 Choose whether you want to turn on the **Graceful Helper** option.

Step 10 In the **Maximum AS Limit** field, enter the maximum AS limit.

Step 11 In the **BGP TTL Between Peers** field, enter the BGP TTL between peers.

Refreshing Site Connectivity Information

Any infrastructure changes, such as adding and removing spines or changing spine node IDs, require a Multi-Site fabric connectivity site refresh. This section describes how to pull up-to-date connectivity information directly from each site's APIC.

Step 1 Log in to the Cisco ACI Multi-Site Orchestrator GUI.

Step 2 In the **Main menu**, select **Infrastructure** > **Infra Configuration**.

Step 3 In the top right of the main **Infra Configuration** view, click the **Configure Infra** button.

Step 4 In the left pane, under **Sites**, select a specific site.

Step 5 In the main window, click the **Reload Site Data** button to pull fabric information from the APIC.

Step 6 (Optional) In the **Confirmation** dialog, check the box if you want to remove configuration for decommissioned spine switch nodes.

If you choose to enable this checkbox, all configuration info for any currently decommissioned spine switches will be removed from the database.

Step 7 Finally, click **Yes** to confirm and load the connectivity information.

This will discover any new or removed spines and all site-related fabric connectivity will be re-imported from the APIC.

Configuring Infra: On-Premises Site Settings

This section describes how to configure site-specific Infra settings for on-premises sites.

Step 1 Log in to the Cisco ACI Multi-Site Orchestrator GUI.

Step 2 In the **Main menu**, select **Infrastructure** > **Infra Configuration**.

Step 3 In the top right of the main pane, click **Configure Infra**.

Step 4 In the left pane, under **Sites**, select a specific on-premises site.

Step 5 In the right **<*Site*> Settings** pane, enable the **ACI Multi-Site** knob to manage the site from the Orchestrator.

Step 6 (Optional) Enable the **CloudSec Encryption** knob encryption for the site.

CloudSec Encryption provides inter-site traffic encryption. The "Infrastructure Management" chapter in the *Cisco ACI Multi-Site Configuration Guide* covers this feature in detail.

Step 7 Specify the **Overlay Multicast TEP**.

This address is used for the inter-site L2 BUM and L3 multicast traffic. This IP address is deployed on all spine switches that are part of the same fabric, regardless of whether it is a single pod or multi-pod fabric.

Step 8 Specify the **BGP Autonomous System Number**.

Step 9 Specify the **BGP Password**.

Step 10 Specify the **OSPF Area ID**.

When configuring the Multi-Site infra OSPF details, we recommend that you use OSPF Area `0`. If you use an Area ID other than `0`, in the next step configure it as a `regular` OSPF area type and not a `stub` area type.

Step 11 Select the **OSPF Area Type** from the dropdown menu.

The OSPF area type can be one of the following:

- `nssa`
- `regular`
- `stub`

Step 12 Select the external routed domain from the dropdown menu.

Choose an external router domain that you have created in the APIC GUI.

Step 13 Configure OSPF settings for the site.

You can either click an existing policy (for example, `msc-ospf-policy-default`) to modify it or click **+Add Policy** to add a new OSPF policy. Then in the **Add/Update Policy** window, specify the following:

- In the **Policy Name** field, enter the policy name.

- In the **Network Type** field, choose either `broadcast`, `point-to-point`, or `unspecified`.

  The default is `broadcast`.

- In the **Priority** field, enter the priority number.

  The default is `1`.

- In the **Cost of Interface** field, enter the cost of interface.

  The default is `0`.

- From the **Interface Controls** dropdown menu, choose one of the following:

  - **advertise-subnet**
  - **bfd**
  - **mtu-ignore**
  - **passive-participation**

- In the **Hello Interval (Seconds)** field, enter the hello interval in seconds.

  The default is `10`.

- In the **Dead Interval (Seconds)** field, enter the dead interval in seconds.

  The default is `40`.

- In the **Retransmit Interval (Seconds)** field, enter the retransmit interval in seconds.

  The default is `5`.

- In the **Transmit Delay (Seconds)** field, enter the transmit delay in seconds.

  The default is `1`.

Step 14 (Optional) Configure SR-MPLS settings for the site.

If the site is connected via an MPLS network, enable the **SR-MPLS Connectivity** knob and provide the Segment Routing global block (SRGB) range.

The Segment Routing Global Block (SRGB) is the range of label values reserved for Segment Routing (SR) in the Label Switching Database (LSD). These values are assigned as segment identifiers (SIDs) to SR-enabled nodes and have global significance throughout the domain.

The default range is `16000-23999`.

If you enable MPLS connectivity for the site, you will need to configure additional settings as described in Configuring Infra: MPLS L3Out Settings, on page 84.

Configuring Infra: Cloud Site Settings

This section describes how to configure site-specific Infra settings for Cloud APIC sites.

Step 1 Log in to the Cisco ACI Multi-Site Orchestrator GUI.

Step 2 In the **Main menu**, select **Infrastructure** > **Infra Configuration**.

Step 3 In the top right of the main pane, click **Configure Infra**.

Step 4 In the left pane, under **Sites**, select a specific cloud site.

Most of the information in the cloud site area is automatically populated and cannot be changed, with the exception of the BGP password field.

Step 5 In the right **<*Site*> Settings** pane, enable the **ACI Multi-Site** knob to manage the site from the Orchestrator.

Step 6 Specify the **BGP Password**.

Configuring Infra: Pod Settings

This section describes how to configure pod-specific settings in each site.

Step 1 Log in to the Cisco ACI Multi-Site Orchestrator GUI.

Step 2 In the **Main menu**, click **Sites**.

Step 3 In the **Sites** view, click **Configure Infra**.

Step 4 In the left pane, under **Sites**, select a specific site.

Step 5 In the main window, select a pod.

Step 6 In the right **POD Properties** pane, add the Overlay Unicast TEP for the POD.

This IP address is deployed on all spine switches that are part of the same pod and used for intersite known unicast traffic.

Step 7 Click **+Add TEP Pool** to add a routable TEP pool.

The routable TEP pools are used for public IP addresses for inter-site connectivity.

Step 8 Repeat the procedure for every pod in the site.

Configuring Infra: Spine Switches

This section describes how to configure spine switches in each site for Cisco ACI Multi-Site.

Step 1 Log in to the Cisco ACI Multi-Site Orchestrator GUI.

Step 2 In the **Main menu**, click **Sites**.

Step 3 In the **Sites** view, click **Configure Infra**.

Step 4 In the left pane, under **Sites**, select a specific site.

Step 5 In the main window, select a spine switch within a pod.

Step 6 In the right **<*Spine*> Settings** pane, click **+Add Port**.

Step 7 In the **Add Port** window, enter the following information:

- In the **Ethernet Port ID** field, enter the port ID, for example `1/29`.
- In the **IP Address** field, enter the IP address/netmask.

  The Orchestrator creates a sub-interface with VLAN 4 with the specified IP ADDRESS under the specified PORT.
- In the **MTU** field, enter the MTU. You can specify either `inherit` or a value between `576` and `9000`.

  MTU of the spine port should match MTU on IPN side.
- In the **OSPF Policy** field, choose the OSPF policy for the switch that you have configured in Configuring Infra: On-Premises Site Settings, on page 81.

  OSPF settings in the OSPF policy you choose should match on IPN side.
- For **OSPF Authentication**, you can pick either `none` or one of the following:
  - `MD5`
  - `Simple`

Step 8 Enable **BGP Peering** knob.

In a single Pod fabric with more than two spine switches, BGP peering should only be enabled on a pair (for redundancy) of spine switches called **BGP Speakers**. All other spine switches should have BGP peering disabled and will function as **BGP Forwarders**.

In a Multi-Pod fabric BGP peering should only be enabled on a couple of BGP speaker spine switches, each deployed in a different Pod. All other spines switches should have BGP peering disabled and function as BGP forwarders.

Step 9 In the **BGP-EVPN Router-ID** field, provide the IP address used for BGP-eVPN session between sites.

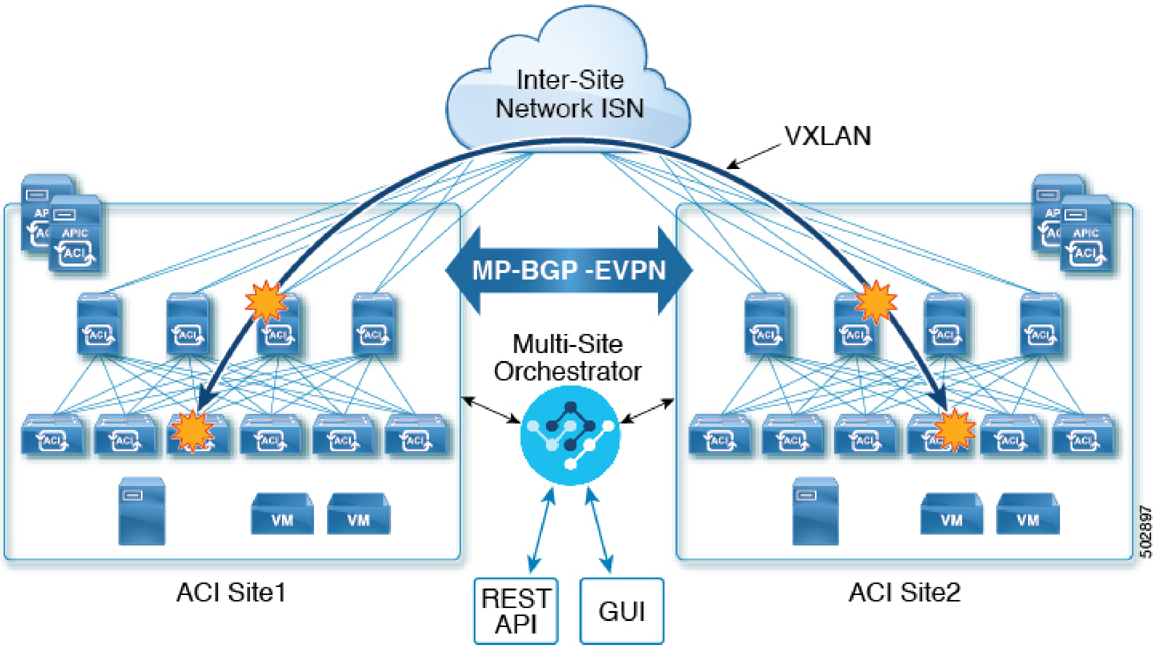
Step 10 Repeat the procedure for every spine switch.

Configuring Infra: MPLS L3Out Settings

Starting with Orchestrator Release 3.0(1) and APIC Release 5.0(1), the Multi-Site architecture supports APIC sites connected via MPLS networks.

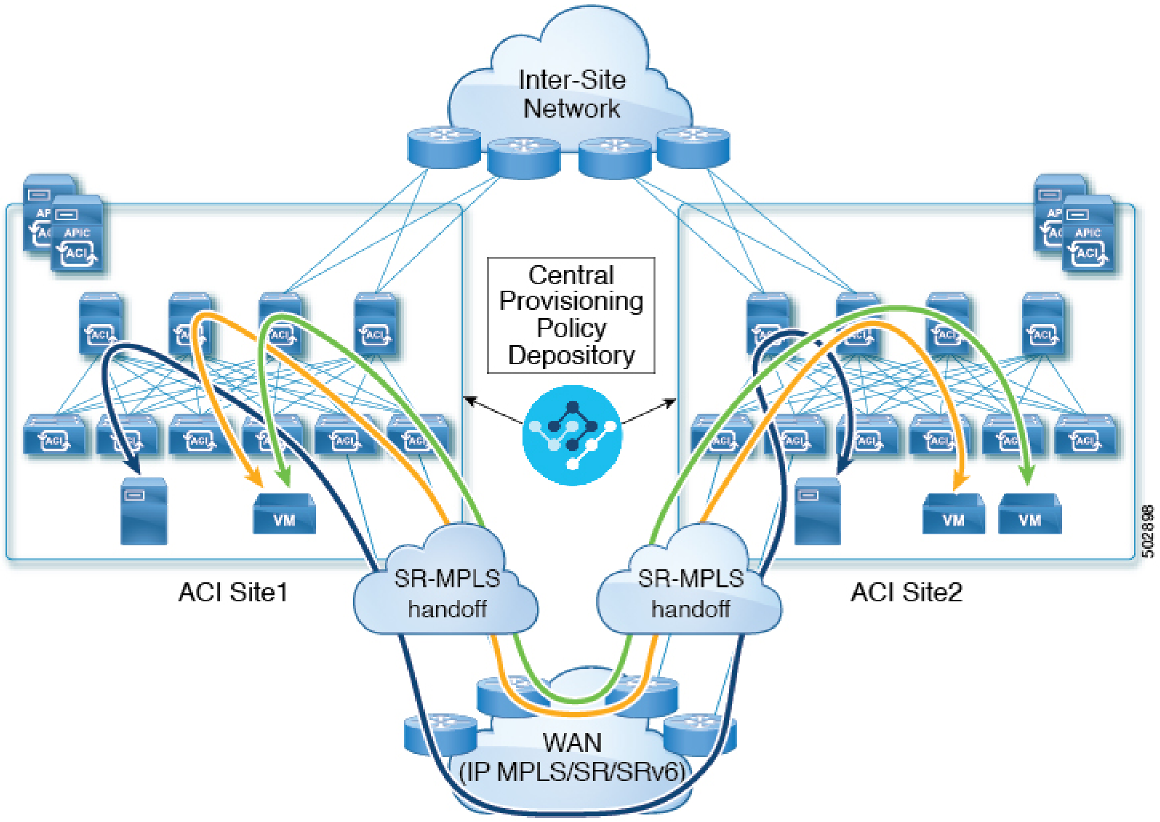
In a typical Multi-Site deployment, traffic between sites is forwarded over an intersite network (ISN) via VXLAN encapsulation:

Figure 18: Multi-Site and ISN



With Release 3.0(1), MPLS network can be used in addition to or instead of the ISN allowing inter-site L3Out communication via WAN:

Figure 19: Multi-Site and MPLS



The following sections describe guidelines, limitations, and configurations specific to managing Schemas that are deployed to these sites from the Multi-Site Orchestrator. Detailed information about MPLS hand off, supported individual site topologies (such as remote leaf support), and policy model is available in the *Cisco APIC Layer 3 Networking Configuration Guide*.

SR-MPLS Infra Guidelines and Limitations

If you want to add an APIC site that is connected to an SR-MPLS network to be managed by the Multi-Site Orchestrator, keep the following in mind:

- Any changes to the topology, such as node updates, are not reflected in the Orchestrator configuration until site configuration is refreshed, as described in Refreshing Site Connectivity Information, on page 80.

- Objects and policies deployed to a site that is connected to an SR-MPLS network cannot be stretched to other sites.

  When you create a template and specify a Tenant, you will need to enable the `SR-MPLS` option on the tenant. You will then be able to map that template only to a single ACI site.

- Tenants deployed to a site that is connected via an SR-MPLS network will have a set of unique configuration options specifically for SR-MPLS configuration. Tenant configuration is described in the "Tenants Management" chapter of the *Cisco ACI Multi-Site Configuration Guide, Release 3.0(x)*

Supported Hardware

The SR-MPLS connectivity is supported for the following platforms:

- **Leaf switches**: The "FX", "FX2", and "GX" switch models.
- **Spine switches**:
  - Modular spine switch models with "LC-EX", "LC-FX", and "GX" at the end of the linecard names.
  - The Cisco Nexus 9000 series N9K-C9332C and N9K-C9364C fixed spine switches.
- **For sites with remote leaf switch sites, DC-PE routers**:
  - Network Convergence System (NCS) 5500 Series
  - ASR 9000 Series
  - NCS 540 or 560 routers

SR-MPLS Infra L3Out

You will need to create an SR-MPLS Infra L3Out for the fabrics connected to SR-MPLS networks as described in the following sections. When creating an SR-MPLS Infra L3Out, the following restrictions apply:

- Each SR-MPLS Infra L3Out must have a unique name.
- You can have multiple SR-MPLS infra L3Outs connecting to different routing domains, where the same border leaf switch can be in more than one L3Out, and you can have different import and export routing policies for the VRFs toward each routing domain.
- Even though a border leaf switch can be in multiple SR-MPLS infra L3Outs, a border leaf switch/provider edge router combination can only be in one SR-MPLS infra L3Out as there can be only one routing policy for a user VRF/border leaf switch/DC-PE combination.
- If there is a requirement to have SR-MPLS connectivity from multiple pods and remote locations, ensure that you have a different SR-MPLS infra L3Out in each of those pods and remote leaf locations with SR-MPLS connectivity.
- If you have a multi-pod or remote leaf topology where one of the pods is not connected directly to the SR-MPLS network, that pod's traffic destined for the SR-MPLS network will use standard IPN path to another pod, which has an SR-MPLS L3Out. Then the traffic will use the other pod's SR-MPLS L3Out to reach its destination across SR-MPLS network.
- Routes from multiple VRFs can be advertised from one SR-MPLS Infra L3Out to provider edge (PE) routers connected to the nodes in this SR-MPLS Infra L3Out.

  PE routers can be connected to the border leaf directly or through other provider (P) routers.
- The underlay configuration can be different or can be the same across multiple SR-MPLS Infra L3Outs for one location.

  For example, assume the same border leaf switch connects to PE-1 in domain 1 and PE-2 in domain 2, with the underlay connected to another provider router for both. In this case, two SR-MPLS Infra L3Outs will be created: one for PE-1 and one for PE-2. But for the underlay, it’s the same BGP peer to the provider router. Import/export route-maps will be set for EVPN session to PE-1 and PE-2 based on the corresponding route profile configuration in the user VRF.

Guidelines and Limitations for MPLS Custom QoS Policies

Following is the default MPLS QoS behavior:

- All incoming MPLS traffic on the border leaf switch is classified into QoS Level 3 (the default QoS level).
- The border leaf switch will retain the original DSCP values for traffic coming from SR-MPLS without any remarking.
- The border leaf switch will forward packets with the default MPLS EXP (0) to the SR-MPLS network.

Following are the guidelines and limitations for configuring MPLS Custom QoS policies:

- Data Plane Policers (DPP) are not supported at the SR-MPLS L3Out.
- Layer 2 DPP works in the ingress direction on the MPLS interface.
- Layer 2 DPP works in the egress direction on the MPLS interface in the absence of an egress custom MPLS QoS policy.
- VRF level policing is not supported.

Creating SR-MPLS QoS Policy

This section describes how to configure SR-MPLS QoS policy for a site that is connected via an MPLS network. If you have no such sites, you can skip this section.

SR-MPLS Custom QoS policy defines the priority of the packets coming from an SR-MPLS network while they are inside the ACI fabric based on the incoming MPLS EXP values defined in the MPLS QoS ingress policy. It also marks the CoS and MPLS EXP values of the packets leaving the ACI fabric through an MPLS interface based on IPv4 DSCP values defined in MPLS QoS egress policy.

If no custom ingress policy is defined, the default QoS Level (`Level3`) is assigned to packets inside the fabric. If no custom egress policy is defined, the default EXP value of `0` will be marked on packets leaving the fabric.

Step 1 Log in to the Cisco ACI Multi-Site Orchestrator GUI.

Step 2 In the **Main menu**, select **Application Management** > **Policies**.

Step 3 In the main pane, select **Add Policy** > **Create QoS Policy**.

Step 4 In the **Add QoS Policy** screen, provide the name for the policy.

Step 5 Click **Add Ingress Rule** to add an ingress QoS translation rule.

These rules are applied for traffic that is ingressing the ACI fabric from an MPLS network and are used to map incoming packet's experimental bits (EXP) values to ACI QoS levels, as well as to set differentiated services code point (DSCP) values in the VXLAN header for the packet while it's inside the ACI fabric.

The values are derived at the border leaf using a custom QoS translation policy. The original DSCP values for traffic coming from SR-MPLS without any remarking. If a custom policy is not defined or not matched, default QoS Level (`Level3`) is assigned

a) In the **Match EXP From** and **Match EXP To** fields, specify the EXP range of the ingressing MPLS packet you want to match.

b) From the **Queuing Priority** dropdown, select the ACI QoS Level to map.

This is the QoS Level you want to assign for the traffic within ACI fabric, which ACI uses to prioritize the traffic within the fabric.. The options range from Level1 to Level6. The default value is `Level3`. If you do not make a selection in this field, the traffic will automatically be assigned a `Level3` priority.

c) From the **Set DSCP** dropdown, select the DSCP value to assign to the packet when it's inside the ACI fabric.

The DSCP value specified is set in the original traffic received from the external network, so it will be re-exposed only when the traffic is VXLAN decapsulated on the destination ACI leaf node.

If you set the value to `Unspecified`, the original DSCP value of the packet will be retained.

d) From the **Set CoS** dropdown, select the CoS value to assign to the packet when it's inside the ACI fabric.

The CoS value specified is set in the original traffic received from the external network, so it will be re-exposed only when the traffic is VXLAN decapsulated on the destination ACI leaf node.

If you set the value to `Unspecified`, the original CoS value of the packet will be retained, but only if the CoS preservation option is enabled in the fabric. For more information about CoS preservation, see *Cisco APIC and QoS*.

e) Click the checkmark icon to save the rule.
f) Repeat this step for any additional ingress QoS policy rules.

Step 6 Click **Add Egress Rule** to add an egress QoS translation rule.

These rules are applied for the traffic that is leaving the ACI fabric via an MPLS L3Out and are used to map the packet's IPv4 DSCP value to the MPLS packet's EXP value as well as the internal ethernet frame's CoS value.

Classification is done at the non-border leaf switch based on existing policies used for EPG and L3Out traffic. If a custom policy is not defined or not matched, the default EXP value of `0` is marked on all labels. EXP values are marked in both, default and custom policy scenarios, and are done on all MPLS labels in the packet.

Custom MPLS egress policy can override existing EPG, L3out, and Contract QoS policies

a) Using the **Match DSCP From** and **Match DSCP To** dropdowns, specify the DSCP range of the ACI fabric packet you want to match for assigning the egressing MPLS packet's priority.
b) From the **Set MPLS EXP** dropdown, select the EXP value you want to assign to the egressing MPLS packet.
c) From the **Set CoS** dropdown, select the CoS value you want to assign to the egressing MPLS packet.
d) Click the checkmark icon to save the rule.
e) Repeat this step for any additional egress QoS policy rules.

Step 7 Click **Save** to save the QoS policy.

What to do next

After you have created the QoS policy, enable MPLS connectivity and configure MPLS L3Out as described in Creating SR-MPLS Infra L3Out, on page 89.

Creating SR-MPLS Infra L3Out

This section describes how to configure SR-MPLS L3Out settings for a site that is connected to an SR-MPLS network.

- The SR-MPLS infra L3Out is configured on the border leaf switch, which is used to set up the underlay BGP-LU and overlay MP-BGP EVPN sessions that are needed for the SR-MPLS handoff.

- An SR-MPLS infra L3Out will be scoped to a pod or a remote leaf switch site.

- Border leaf switches or remote leaf switches in one SR-MPLS infra L3Out can connect to one or more provider edge (PE) routers in one or more routing domains.
- A pod or remote leaf switch site can have one or more SR-MPLS infra L3Outs.

Before you begin

You must have:

- Added a site that is connected via SR-MPLS network as described in Adding Sites, on page 73.
- If necessary, created SR-MPLS QoS policy as described in Creating SR-MPLS QoS Policy, on page 88.

Step 1 Log in to the Cisco ACI Multi-Site Orchestrator GUI.

Step 2 Ensure that SR-MPLS Connectivity is enabled for the site.

a) In the main navigation menu, select **Infrastructure** > **Infra Configuration**.
b) In the **Infra Configuration** view, click **Configure Infra**.
c) In the left pane, under **Sites**, select a specific site.
d) In the right ***<Site>* Settings** pane, enable the **SR-MPLS Connectivity** knob and provide the Segment Routing global block (SRGB) range

The SID index is configured on each node for the MPLS transport loopback. The SID index value is advertised using BGP-LU to the peer router, and the peer router uses the SID index to calculate the local label.

The Segment Routing Global Block (SRGB) is the range of label values reserved for Segment Routing (SR) in the Label Switching Database (LSD). The SID index is configured on each node for the MPLS transport loopback. The SID index value is advertised using BGP-LU to the peer router, and the peer router uses the SID index to calculate the local label.

The default range is `16000-23999`.

Step 3 In the main pane, click **+Add SR-MPLS L3Out** within a pod.

Step 4 In the right **Properties** pane, provide a name for the SR-MPLS L3Out.

Step 5 (Optional) From the **QoS Policy** dropdown, select a QoS Policy you created for SR-MPLS traffic.

Select the QoS policy you created in Creating SR-MPLS QoS Policy, on page 88.

Otherwise, if you do not assign a custom QoS policy, the following default values are assigned:

- All incoming MPLS traffic on the border leaf switch is classified into QoS Level 3 (the default QoS level).
- The border leaf switch does the following:
  - Retains the original DSCP values for traffic coming from SR-MPLS without any remarking.
  - Forwards packets to the MPLS network with the original CoS value of the tenant traffic if the CoS preservation is enabled.
  - Forwards packets with the default MPLS EXP value (`0`) to the SR-MPLS network.
- In addition, the border leaf switch does not change the original DSCP values of the tenant traffic coming from the application server while forwarding to the SR network.

Step 6 From the **L3 Domain** dropdown, select the Layer 3 domain.

Step 7 Configure BGP settings.

You must provide BGP connectivity details for the BGP EVPN connection between the site's border leaf (BL) switches and the provider edge (PE) router.

a) Click **+Add BGP Connectivity**.

b) In the **Add BGP Connectivity** window, provide the details.

For the **MPLS BGP-EVPN Peer IPv4 Address** field, provide the loopback IP address of the DC-PE router, which is not necessarily the device connected directly to the border leaf.

For the **Remote AS Number**, enter a number that uniquely identifies the neighbor autonomous system of the DC-PE. the Autonomous System Number can be in 4-byte as plain format from 1 to 4294967295. Keep in mind, ACI supports only `asplain` format and not `asdot` or `asdot+` format AS numbers. For more information on ASN formats, see Explaining 4-Byte Autonomous System (AS) ASPLAIN and ASDOT Notation for Cisco IOS document.

For the **TTL** field, specify a number large enough to account for multiple hops between the border leaf and the DC-PE router, for example `10`. The allowed range `2-255` hops.

(Optional) Choose to enable the additional BGP options based on your deployment.

c) Click **Save** to save BGP settings.

d) Repeat this step to for any additional BGP connections.

Typically, you would be connecting to two DC-PE routers, so provide BGP peer information for both connections.

Step 8 Configure settings for border leaf switches and ports connected to the SR-MPLS network.

You need to provide information about the border leaf switches as well as the interface ports which connect to the SR-MPLS network.

a) Click **+Add Leaf** to add a leaf switch.

b) In the **Add Leaf** window, select the leaf switch from the **Leaf Name** dropdown.

c) Provide a valid segment ID (SID) offset.

When configuring the interface ports later in this section, you will be able to choose whether you want to enable segment routing. The SID index is configured on each node for the MPLS transport loopback. The SID index value is advertised using BGP-LU to the peer router, and the peer router uses the SID index to calculate the local label. If you plan to enable segment routing, you must specify the segment ID for this border leaf.

- The value must be within the SRGB range you configured earlier.

- The value must be the same for the selected leaf switch across all SR-MPLS L3Outs in the site.

- The same value cannot be used for more than one leaf across all sites.

- If you need to update the value, you must first delete it from all SR-MPLS L3Outs in the leaf and re-deploy the configuration. Then you can update it with the new value, followed by re-deploying the new configuration.

d) Provide the local **Router ID**.

Unique router identifier within the fabric.

e) Provide the **BGP EVPN Loopback** address.

The BGP-EVPN loopback is used for the BGP-EVPN control plane session. Use this field to configure the MP-BGP EVPN session between the EVPN loopbacks of the border leaf switch and the DC-PE to advertise the overlay prefixes. The MP-BGP EVPN sessions are established between the BP-EVPN loopback and the BGP-EVPN remote peer address (configured in the **MPLS BGP-EVPN Peer IPv4 Address** field in the **BGP Connectivity** step before).

While you can use a different IP address for the BGP-EVPN loopback and the MPLS transport loopback, we recommend that you use the same loopback for the BGP-EVPN and the MPLS transport loopback on the ACI border leaf switch.

f) Provide the **MPLS Transport Loopback** address.

The MPLS transport loopback is used to build the data plane session between the ACI border leaf switch and the DC-PE, where the MPLS transport loopback becomes the next-hop for the prefixes advertised from the border leaf switches to the DC-PE routers.

While you can use a different IP address for the BGP-EVPN loopback and the MPLS transport loopback, we recommend that you use the same loopback for the BGP-EVPN and the MPLS transport loopback on the ACI border leaf switch.

g) Click **Add Interface** to provide switch interface details.

From the **Interface Type** dropdown, select whether it is a typical interface or a port channel. If you choose to use a port channel interface, it must have been already created on the APIC.

Then provide the interface, its IP address, and MTU size. If you want to use a subinterface, provide the **VLAN ID** for the sub-interface, otherwise leave the VLAN ID field blank.

In the **BGP-Label Unicast Peer IPv4 Address** and **BGP-Label Unicast Remote AS Number**, specify the BGP-LU peer information of the next hop device, which is the device connected directly to the interface. The next hop address must be part of the subnet configured for the interface.

Choose whether you want to enable segment routing (SR) MPLS.

(Optional) Choose to enable the additional BGP options based on your deployment.

Finally, click the checkmark to the right of the **Interface Type** dropdown to save interface port information.

h) Repeat the previous sub-step for all interfaces on the switch that connect to the MPLS network.
i) Click **Save** to save the leaf switch information.

Step 9 Repeat the previous step for all leaf switches connected to MPLS networks.

What to do next

After you have enabled and configured MPLS connectivity, you can create and manage Tenants, route maps, and schemas as described in the *Cisco ACI Multi-Site Configuration Guide, Release 3.0(x)*.

Deploying Infra Configuration

This section describes how to deploy the Infra configuration to each APIC site.

In the top right of the main pane, choose the appropriate **Deploy** option to deploy the configuration.

If you are configuring only on-premises or only cloud sites, simply click **Deploy** to deploy the Infra configuration.

However, if you have both, on-premises and cloud site, the following two additional options become available:

- **Deploy & Download IPN Device config files:** Pushes the configuration to both the on-premises APIC site and the cloud site and enables the end-to-end interconnect between the on-premises and the cloud sites.

In addition, this option downloads a zip file that contains configuration information that you will use to enable connectivity between the Cisco Cloud Services Router (CSR) deployed in your cloud sites and the on-premises IPsec termination device. A followup screen appears that allows you to select all or some of the configuration files to download.

- **Download IPN Device config files only:** Downloads a zip file that contains configuration information that you will use to enable connectivity between the Cisco Cloud Services Router (CSR) without deploying the configuration.

Enabling Connectivity Between On-Premises and Cloud Sites

If you have only on-premises or only cloud sites, you can skip this section.

This section describes how to enable connectivity between on-premises APIC sites and Cloud APIC sites.

By default, the Cisco Cloud APIC will deploy a pair of redundant Cisco Cloud Services Router 1000Vs. The procedures in this section creates two tunnels, one IPsec tunnel from the on-premises IPsec device to each of these Cisco Cloud Services Router 1000Vs.

The following information provides commands for Cisco Cloud Services Router 1000V as your on-premises IPsec termination device. Use similar commands if you are using a different device or platform.

Step 1 Gather the necessary information that you will need to enable connectivity between the CSRs deployed in the cloud site and the on-premises IPsec termination device.

You can get the required configuration details using either the **Deploy & Download IPN Device config files** or the **Download IPN Device config files only** option in ACI Multi-Site Orchestrator as part of the procedures provided in Deploying Infra Configuration, on page 92.

Step 2 Log into the on-premises IPsec device.

Step 3 Configure the tunnel for the *first* CSR.

Details for the first CSR are available in the configuration files for the ISN devices you downloaded from the Multi-Site Orchestrator.

In the following example, replace:

- <*first-CSR-tunnel-ID*> with a unique tunnel ID that you assign to this tunnel.
- <*first-CSR-elastic-IP-address*> with the elastic IP address of the third network interface of the first CSR.
- <*first-CSR-preshared-key*> with the preshared key of the first CSR.
- <*interface*> with the interface that is used for connecting to the Cisco Cloud Services Router 1000V deployed in Amazon Web Services.
- <*peer-tunnel-for-onprem-IPsec-to-first-CSR*> with the peer tunnel IP address for the on-premises IPsec device to the first cloud CSR.
- <*process-id*> with the OSPF process ID.
- <*area-id*> with the OSPF area ID.

```
crypto isakmp policy 1
    encryption  aes
    authentication pre-share
    group  2
    lifetime 86400
    hash sha
exit

crypto keyring infra:overlay-1-<first-CSR-tunnel-ID>
    pre-shared-key address <first-CSR-elastic-IP-address> key <first-CSR-preshared-key>
exit

crypto isakmp profile infra:overlay-1-<first-CSR-tunnel-ID>
    local-address <interface>
    match identity address <first-CSR-elastic-IP-address>
    keyring infra:overlay-1-<first-CSR-tunnel-ID>
exit

crypto ipsec transform-set infra:overlay-1-<first-CSR-tunnel-ID> esp-aes esp-sha-hmac
    mode tunnel
exit

crypto ipsec profile infra:overlay-1-<first-CSR-tunnel-ID>
    set pfs group2
    set security-association lifetime seconds 86400
exit

interface tunnel <first-CSR-tunnel-ID>
    ip address <peer-tunnel-for-onprem-IPsec-to-first-CSR> 255.255.255.252
    ip virtual-reassembly
    tunnel source <interface>
    tunnel destination <first-CSR-elastic-IP-address>
    tunnel mode ipsec ipv4
    tunnel protection ipsec profile infra:overlay-1-<first-CSR-tunnel-ID>
    ip mtu 1476
    ip tcp adjust-mss 1460
    ip ospf <process-id> area <area-id>
    no shut
exit
```

Example:

```
crypto isakmp policy 1
    encryption  aes
    authentication pre-share
    group  2
    lifetime 86400
    hash sha
exit

crypto keyring infra:overlay-1-1000
    pre-shared-key address 192.0.2.20 key 123456789009876543211234567890
exit

crypto isakmp profile infra:overlay-1-1000
    local-address GigabitEthernet1
    match identity address 192.0.2.20
    keyring infra:overlay-1-1000
exit

crypto ipsec transform-set infra:overlay-1-1000 esp-aes esp-sha-hmac
    mode tunnel
exit

crypto ipsec profile infra:overlay-1-1000
    set pfs group2
    set security-association lifetime seconds 86400
exit

interface tunnel 1000
    ip address 30.29.1.2 255.255.255.252
    ip virtual-reassembly
    tunnel source GigabitEthernet1
    tunnel destination 192.0.2.20
    tunnel mode ipsec ipv4
    tunnel protection ipsec profile infra:overlay-1-1000
    ip mtu 1476
    ip tcp adjust-mss 1460
    ip ospf 1 area 1
    no shut
exit
```

Step 4 Configure the tunnel for the *second* CSR.

Details for the second CSR are also available in the configuration files for the ISN devices you downloaded from the Multi-Site Orchestrator.

```
crypto isakmp policy 1
    encryption  aes
    authentication pre-share
    group  2
    lifetime 86400
    hash sha
exit

crypto keyring infra:overlay-1-<second-CSR-tunnel-ID>
    pre-shared-key address <second-CSR-elastic-IP-address> key <second-CSR-preshared-key>
exit

crypto isakmp profile infra:overlay-1-<second-CSR-tunnel-ID>
    local-address <interface>
    match identity address <second-CSR-elastic-IP-address>
    keyring infra:overlay-1-<second-CSR-tunnel-ID>
exit

crypto ipsec transform-set infra:overlay-1-<second-CSR-tunnel-ID> esp-aes esp-sha-hmac
    mode tunnel
exit

crypto ipsec profile infra:overlay-1-<second-CSR-tunnel-ID>
    set pfs group2
    set security-association lifetime seconds 86400
exit

interface tunnel <second-CSR-tunnel-ID>
    ip address <peer-tunnel-for-onprem-IPsec-to-second-CSR> 255.255.255.252
    ip virtual-reassembly
    tunnel source <interface>
    tunnel destination <second-CSR-elastic-IP-address>
    tunnel mode ipsec ipv4
    tunnel protection ipsec profile infra:overlay-1-<second-CSR-tunnel-ID>
    ip mtu 1476
    ip tcp adjust-mss 1460
    ip ospf <process-id> area <area-id>
    no shut
exit
```

Example:

```
crypto isakmp policy 1
    encryption  aes
    authentication pre-share
    group  2
    lifetime 86400
    hash sha
exit

crypto keyring infra:overlay-1-1001
    pre-shared-key address 192.0.2.21 key 123456789009876543211234567891
exit

crypto isakmp profile infra:overlay-1-1001
    local-address GigabitEthernet1
    match identity address 192.0.2.21
    keyring infra:overlay-1-1001
exit

crypto ipsec transform-set infra:overlay-1-1001 esp-aes esp-sha-hmac
    mode tunnel
exit

crypto ipsec profile infra:overlay-1-1001
    set pfs group2
    set security-association lifetime seconds 86400
exit

interface tunnel 1001
    ip address 30.29.1.6 255.255.255.252
    ip virtual-reassembly
    tunnel source GigabitEthernet1
    tunnel destination 192.0.2.21
    tunnel mode ipsec ipv4
    tunnel protection ipsec profile infra:overlay-1-1001
    ip mtu 1476
    ip tcp adjust-mss 1460
    ip ospf 1 area 1
    no shut
exit
```

Step 5 Repeat these steps for any additional CSRs that you need to configure.

Step 6 Verify that the tunnels are up on your on-premises IPsec device.

Use the following command to display the status. If you do not see that both tunnels are shown as up, verify the information that you entered in the steps in this section to determine where you might have an issue. Do not proceed to the next section until you see that both tunnels are shown as up.

```
ISN_CSR# show ip interface brief | include Tunnel
Interface              IP-Address      OK? Method Status                Protocol
Tunnel1000             30.29.1.2         YES manual up                    up
Tunnel1001             30.29.1.4         YES manual up                    up
```

CHAPTER 9

CloudSec Encryption

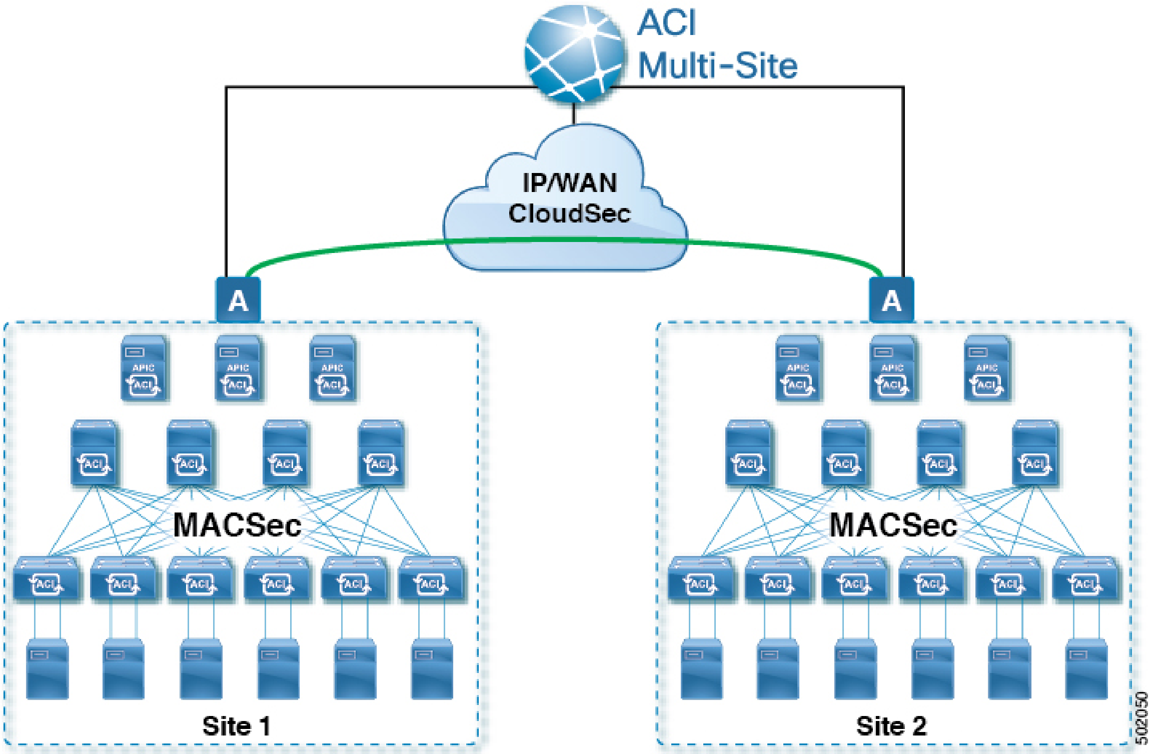
Cisco ACI CloudSec Encryption

As most Cisco ACI deployments are adopting the Cisco ACI Multi-Site architecture to address disaster recovery and scale, the current security implementation using MACsec encryption within local site is becoming insufficient to guarantee data security and integrity across multiple sites connected by insecure external IP networks interconnecting separate fabrics. Cisco ACI Multi-Site Orchestrator Release 2.0(1) introduces the CloudSec Encryption feature designed to provide inter-site encryption of traffic.

Cisco ACI Multi-Site topology uses three tunnel end-point (TEP) IP addresses to provide connectivity between sites. These TEP addresses are configured by the admin on Cisco ACI Multi-Site Orchestrator and pushed down to each site's Cisco APIC, which in turn configures them on the spine switches. These three addresses are used to determine when traffic is destined for a remote site, in which case an encrypted CloudSec tunnel is created between the two spine switches that provide physical connectivity between the two sites through the Inter-Site Network (ISN).

The following figure illustrates the overall encryption approach that combines MACsec for local site traffic and CloudSec for inter-site traffic encryption.

Figure 20: CloudSec Encryption



Requirements and Guidelines

When configuring CloudSec encryption, the following guidelines apply:

- CloudSec has been validated using a Nexus 9000 Inter-Site Network (ISN) infrastructure. If your ISN infrastructure is made up of different devices, or the devices are unknown (such as in the case of circuits purchased from a service provider), it is required that an ASR1K router is the first hop device directly connected to the ACI spine, or the Nexus 9000 ISN network. The ASR1K router with padding-fixup enabled allows the CloudSec traffic to traverse any IP network between the sites.
- If one or more spine switches are down when you attempt to disable CloudSec encryption, the disable process will not complete on those switches until the switches are up. This may result in packet drops on the switches when they come back up.

  We recommend you ensure that all spine switches in the fabric are up or completely decommissioned before enabling or disabling CloudSec encryption.
- The CloudSec Encryption feature is not supported with the following features:
  - Remote Leaf Direct
  - Virtual Pod (vPOD)
  - SDA
  - Intersite L3Out

- Other routable TEP configurations

Requirements

The CloudSec encryption capability requires the following:

- Cisco ACI spine-leaf architecture with a Cisco APIC cluster for each site
- Cisco ACI Multi-Site Orchestrator to manage each site
- One **Advantage** or **Premier** license per each device (leaf only) in the fabric
- An add-on license **ACI-SEC-XF** per device for encryption if the device is a fixed spine
- An add-on license **ACI-SEC-XM** per device for encryption if the device is a modular spine

The following table provides the hardware platforms and the port ranges that are capable of CloudSec encryption.

Hardware Platform	Port Range
N9K-C9364C spine switches	Ports 49-64
N9K-C9332C spine switches	Ports 25-32
N9K-X9736C-FX line cards	Ports 29-36

If CloudSec is enabled for a site, but the encryption is not supported by the ports, a fault is raised with `unsupported-interface` error message.

CloudSec encryption's packet encapsulation is supported if Cisco QSFP-to-SFP Adapters (QSA), such as CVR-QSFP-SFP10G, is used with a supported optic. The full list of supported optics is available from the following link: https://www.cisco.com/c/en/us/support/interfaces-modules/transceiver-modules/products-device-support-tables-list.html.

CloudSec Encryption Terminology

CloudSec Encryption feature provides a secure upstream symmetric key allocation and distribution method for initial key and rekey requirements between sites. The following terminology is used in this chapter:

- `Upstream device` – The device that adds the CloudSec Encryption header and does the encryption of the VXLAN packet payload on transmission to a remote site using a locally generated symmetric cryptography key.
- `Downstream device` – The device that interprets the CloudSec Encryption header and does the decryption of the VXLAN packet payload on reception using the cryptography key generated by the remote site.
- `Upstream site` – The datacenter fabric that originates the encrypted VXLAN packets.
- `Downstream site` – The datacenter fabric that receives the encrypted packets and decrypts them.
- `TX Key` – The cryptography key used to encrypt the clear VXLAN packet payload. In ACI only one TX key can be active for all the remote sites.

- RX Key – The cryptography key used to decrypt the encrypted VXLAN packet payload. In ACI two RX keys can be active per remote site.

  Two RX keys can be active at the same time because during the rekey process, the downstream sites will keep the old and the new RX keys after the new key deployment is finished for some duration to ensure that out of order packet deliveries with either key can be properly decrypted.

- Symmetric Keys – When the same cryptography key is used to encrypt (TX Key) and decrypt (RX Key) a packet stream by the upstream and downstream devices respectively.

- Rekey – The process initiated by the upstream site to replace its old key with a newer key for all downstream sites after the old key expires.

- Secure Channel Identifier (SCI) – A 64-bit identifier that represents a security association between the sites. It is transmitted in encrypted packet in CloudSec header and is used to derive the RX key on the downstream device for packet decryption.

- Association Number (AN) – A 2-bit number (0, 1, 2, 3) that is sent in the CloudSec header of the encrypted packet and is used to derive the key at the downstream device in conjunction with the SCI for decryption. This allows multiple keys to be active at the downstream device to handle out of order packet arrivals with different keys from the same upstream device following a rekey operation.

  In ACI only two association number values (0 and 1) are used for the two active RX keys and only one association number value (0 or 1) is used for the TX Key at any point in time.

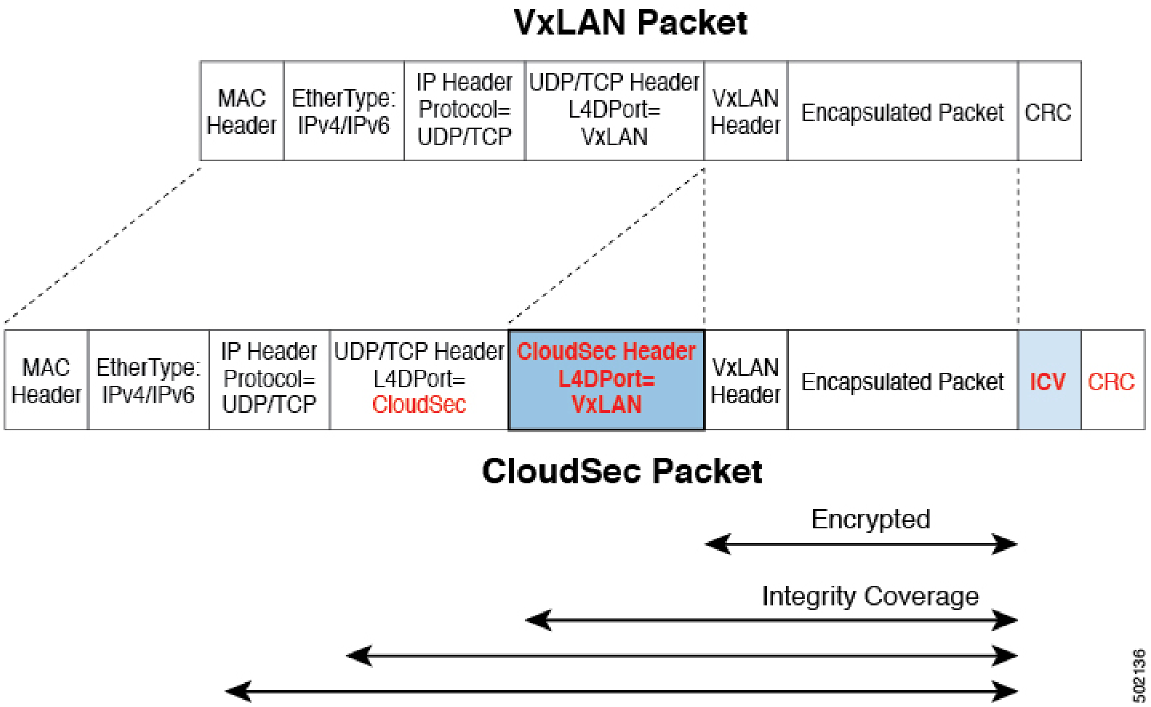
- Pre-shared key (PSK) – One ore more keys must be configured in the Cisco APIC GUI to be used as a random seed for generating the CloudSec TX and RX keys. If multiple PSK are configured, each rekey process will use the next PSK in order of their indexes; if no higher index PSK is available, a PSK with the lowest index will be used. Each PSK must be a hexadecimal string 64 characters long. Cisco APIC supports up to 256 pre-shared keys.

CloudSec Encryption and Decryption Handling

In order to provide a fully integrated, simple, and cost-effective solution that addresses both, data security and integrity, starting with Release 2.0(1), Cisco ACI Multi-Site provides a CloudSec Encryption feature that allows for complete source-to-destination packet encryption between Multi-Site fabrics.

The following figure shows packet diagram before and after CloudSec encapsulation, followed by descriptions of the encryption and decryption processes:

Figure 21: CloudSec Packet



Packet Encryption

The following is a high level overview of how CloudSec handles outgoing traffic packets:

- The packets are filtered using the outer IP header and Layer-4 destination port information and matching packets are marked for encryption.
- The offset to use for encryption is calculated according to the fields of the packet. For example, the offset may vary based on whether there is a 802.1q VLAN or if the packet is an IPv4 or IPv6 packet.
- The encryption keys are programmed in the hardware tables and are looked up from the table using the packet IP header.

Once the packet is marked for encryption, the encryption key is loaded, and the offset from the beginning of the packet where to start the encryption is known, the following additional steps are taken:

- The UDP destination port number is copied from the UDP header into a CloudSec field for recovery when the packet is decrypted.
- The UDP destination port number is overwritten with a Cisco proprietary Layer-4 port number (Port `9999`) indicating that it is a CloudSec packet.
- The UDP length field is updated to reflect the additional bytes that are being added.
- The CloudSec header is inserted directly after the UDP header.
- The Integrity Check Value (ICV) is inserted at the end of the packet, between the payload and the CRC.
- The ICV requires construction of a 128-bit initialization vector. For CloudSec, any use of the source MAC address for ICV purposes is replaced by a programmable value per SCI.

- CRC is updated to reflect the change in the contents of the packet.

Packet Decryption

The way CloudSec handles incoming packets is symmetric to the outgoing packets algorithm described above:

- If the received packet is a CloudSec packet, it is decrypted and the ICV is verified.

  If ICV verification passed, the extra fields are removed, the UDP destination port number is moved from the CloudSec header to the UDP header, the CRC is updated, and the packet is forwarded to destination after decryption and CloudSec header removal. Otherwise the packet is dropped.

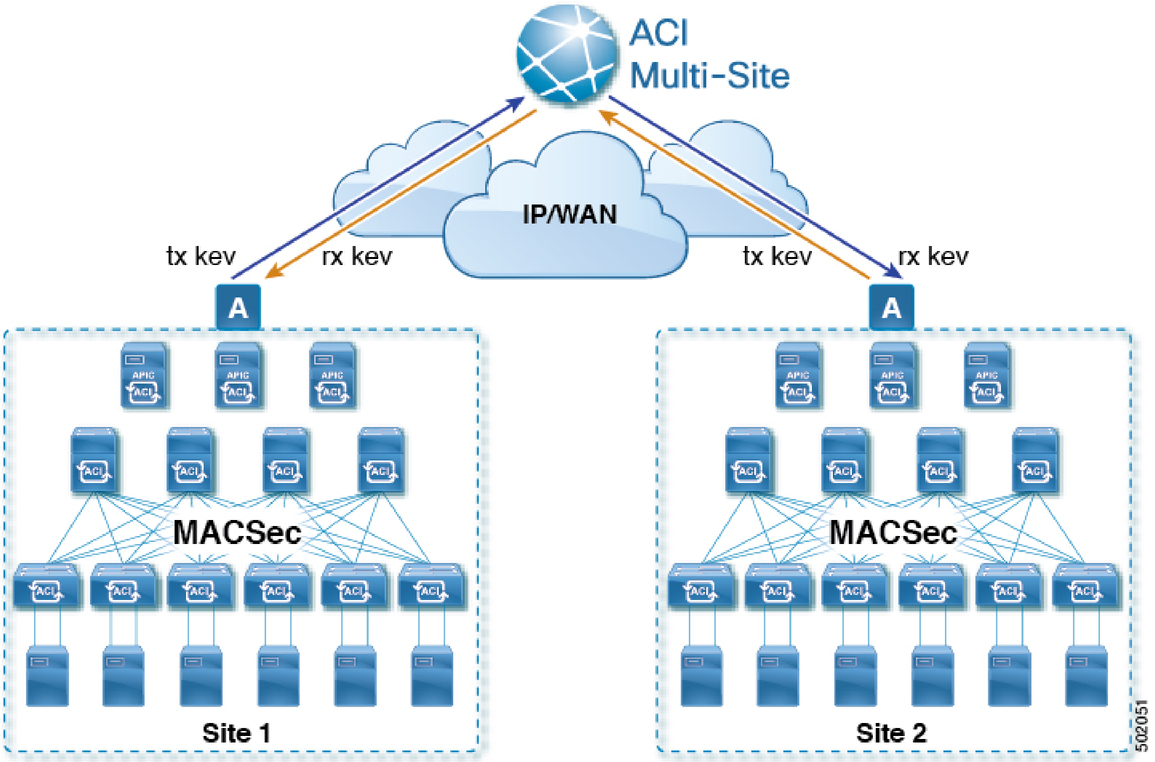
- If the key store returns two or more possible decryption keys, the Association Number (AN) field of the CloudSec header is used to select which key to use.

- If the packet is not a CloudSec packet, the packet is left unchanged.

CloudSec Encryption Key Allocation and Distribution

Initial Key Configuration

Figure 22: CloudSec Key Distribution



The following is a high level overview of the CloudSec encryption key initial allocation and distribution process illustrated by the figure above:

- The upstream site's Cisco APIC generates a local symmetric key intended to be used for data encryption of VXLAN packets transmitted from its site. The same key that is used by the upstream site for encryption is used for decryption of the packets on the downstream remote receiving sites.

  Every site is an upstream site for the traffic it transmits to other sites. If multiple sites exist, each site generates its own site-to-site key and use that key for encryption before transmitting to the remote site.

- The generated symmetric key is pushed to the Cisco ACI Multi-Site Orchestrator (MSO) by the upstream site's Cisco APIC for distribution to downstream remote sites.
- The MSO acts as a message broker and collects the generated symmetric key from the upstream site's Cisco APIC, then distributes it to downstream remote sites' Cisco APICs.
- Each downstream site's Cisco APIC configures the received key as RX key on the local spine switches which are intended to receive the traffic from the upstream site that generated the key.
- Each downstream site's Cisco APIC also collects the deployment status of the RX Key from the local spine switches and then pushes it to the MSO.
- The MSO relays the key deployment status from all downstream remote sites back to the upstream site's Cisco APIC.
- The upstream site's Cisco APIC checks if the key deployment status received from all downstream remote sites is successful.
  - If the deployment status received from a downstream device is successful, the upstream site deploys the local symmetric key as its TX key on the spine switches to enable encryption of the VXLAN packets that are sent to the downstream site.
  - If the deployment status received from a downstream device is failed, a fault is raised on the Cisco APIC site where it failed and it is handled based on the "secure mode" setting configured on the MSO. In "must secure" mode the packets are dropped and in the "should secure" mode the packets are sent clear (unencrypted) to the destination site.

Note In current release, the mode is always set to “should secure” and cannot be changed.

Rekey Process

Each generated TX/RX key expires after a set amount of time, by default key expiry time is set to 15 minutes. When the initial set of TX/RX keys expires, a rekey process takes place.

The same general key allocation and distribution flow applies for the rekey process. The rekey process follows the "make before break" rule, in other words all the RX keys on the downstream sites are deployed before the new TX key is deployed on the upstream site. To achieve that, the upstream site will wait for the new RX key deployment status from the downstream sites before it configures the new TX key on the local upstream site's devices.

If any downstream site reports a failure status in deploying the new RX key, the rekey process will be terminated and the old key will remain active. The downstream sites will also keep the old and the new RX keys after the new key deployment is finished for some duration to ensure that out of order packet deliveries with either key can be properly decrypted.

Note Special precautions must be taken in regards to rekey process during spine switch maintenance, see Rekey Process During Spine Switch Maintenance, on page 108 for details.

Rekey Process Failure

In case of any downstream site failing to deploy the new encryption key generated by the rekey process, the new key is discarded and the upstream device will continue to use the previous valid key as TX key. This approach keeps the upstream sites from having to maintain multiple TX keys per set of downstream sites. However, this approach may also result in the rekey process being delayed if the rekey deployment failures continue to occur with any one of the downstream sites. It is expected that the Multi-Site administrator will take action to fix the issue of the key deployment failure for the rekey to succeed.

Cisco APIC's Role in Key Management

The Cisco APIC is responsible for key allocation (both, initial key and rekey distribution), collection of the key deployment status messages from the spine switches, and notification of the Cisco ACI Multi-Site Orchestrator about each key's status for distribution to other sites.

Cisco ACI Multi-Site Orchestrator's Role in Key Management

The Cisco ACI Multi-Site Orchestrator is responsible for collecting the TX keys (both, initial key and subsequent rekeys) from the upstream site and distributing it to all downstream sites for deployment as RX keys. The MSO also collects the RX key deployment status information from the downstream sites and notifies the upstream site in order for it to update the TX key on successful RX key deployment status.

Upstream Model

In contrast to other technologies, such as MPLS, that use downstream key allocation, CloudSec's upstream model provides the following advantages:

- The model is simple and operationally easier to deploy in the networks.
- The model is preferred for Cisco ACI Multi-Site use cases.
- It provides advantages for multicast traffic as it can use the same key and CloudSec header for each copy of the replicated packet transmitted to multiple destination sites. In downstream model each copy would have to use a different security key for each site during encryption.
- It provides easier troubleshooting in case of failures and better traceability of packets from the source to destination consistently for both, unicast and multicast replicated packets.

Configuring Cisco APIC for CloudSec Encryption

You must configure one or more Pre-Shared Keys (PSK) to be used by the Cisco APIC for generating the CloudSec encryption and decryption keys. The PSK are used as a random seed during the re-key process. If multiple PSK are configured, each re-key process will use the next PSK in order of their indexes; if no higher index PSK is available, a PSK with the lowest index will be used.

Because PSK is used as a seed for encryption key generation, configuring multiple PSK provides additional security by lowering the over-time vulnerability of the generated encryption keys.

Note If no pre-shared key is configured on the Cisco APIC, CloudSec will not be enabled for that site. In that case, turning on CloudSec setting in Cisco ACI Multi-Site will raise a fault.

If at any time you wish to refresh a previously added PSK with a new one, simply repeat the procedure as if you were adding a new key, but specify an existing index.

You can configure one or more pre-shared keys in one of three ways:

- Using the Cisco APIC GUI, as described in Configuring Cisco APIC for CloudSec Encryption Using GUI, on page 105
- Using the Cisco APIC NX-OS Style CLI, as described in Configuring Cisco APIC for CloudSec Encryption Using NX-OS Style CLI, on page 105
- Using the Cisco APIC REST API, as described in Configuring Cisco APIC for CloudSec Encryption Using REST API, on page 106

Configuring Cisco APIC for CloudSec Encryption Using GUI

This section describes how to configure one or more pre-shared keys (PSK) using the Cisco APIC GUI.

Step 1 Log in to APIC.

Step 2 Navigate to **Tenants** > **infra** > **Policies** > **CloudSec Encryption**

Step 3 Specify the **SA Key Expiry Time**.

This option specifies how long each key is valid (in minutes). Each generated TX/RX key expires after the specified amount of time triggering a re-key process. The expiration time can be between 5 and 1440 minutes.

Step 4 Click the **+** icon in the **Pre-Shared Keys** table.

Step 5 Specify the **Index** of the pre-shared key you are adding and then the **Pre-Shared Key** itself.

The **Index** field specifies the order in which the pre-shared keys are used. After the last (highest index) key is used, the process will continue with the first (lowest index) key. Cisco APIC supports up to 256 pre-shared keys, so the PSK index value must be between 1 and 256.

Each **Pre-Shared Key** must be a hexadecimal string 64 characters long.

Configuring Cisco APIC for CloudSec Encryption Using NX-OS Style CLI

This section describes how to configure one or more pre-shared keys (PSK) using the Cisco APIC NX-OS Style CLI.

Step 1 Log in to the Cisco APIC NX-OS style CLI.

Step 2 Enter configuration mode.

Example:

```
apic1# configure
apic1 (config)#
```

Step 3 Enter configuration mode for the default CloudSec profile.

Example:

```
apic1(config)# template cloudsec default
apic1(config-cloudsec)#
```

Step 4 Specify the Pre-Shared Keys (PSK) expiration time.

This option specifies how long each key is valid (in minutes). Each generated TX/RX key expires after the specified amount of time triggering a re-key process. The expiration time can be between 5 and 1440 minutes.

Example:

```
apic1(config-cloudsec)# sakexpirytime <duration>
```

Step 5 Specify one or more Pre-Shared Keys.

In the following command, specify the index of the PSK you're configuring and the PSK string itself.

Example:

```
apic1(config-cloudsec)# pskindex <psk-index>
apic1(config-cloudsec)# pskstring <psk-string>
```

The *<psk-index>* parameter specifies the order in which the pre-shared keys are used. After the last (highest index) key is used, the process will continue with the first (lowest index) key. Cisco APIC supports up to 256 pre-shared keys, so the PSK index value must be between 1 and 256.

The *<psk-string>* parameter specifies the actual PSK, which must be a hexadecimal string 64 characters long.

Step 6 (Optional) View the current PSK configuration.

You can view how many PSK are currently configured and their duration using the following command:

Example:

```
apic1(config-cloudsec)# show cloudsec summary
```

Configuring Cisco APIC for CloudSec Encryption Using REST API

This section describes how to configure one or more pre-shared keys (PSK) using the Cisco APIC REST API.

Configure PSK expiration time, index, and string.

In the following XML POST, replace:

- The value of **`sakExpiryTime`** with the expiration time of each PSK.

  This **`sakExpiryTime`** parameter specifies how long each key is valid (in minutes). Each generated TX/RX key expires after the specified amount of time triggering a re-key process. The expiration time can be between 5 and 1440 minutes.

- The value of **`index`** with the index of the PSK you're configuring.

The **index** parameter specifies the order in which the pre-shared keys are used. After the last (highest index) key is used, the process will continue with the first (lowest index) key. Cisco APIC supports up to 256 pre-shared keys, so the PSK index value must be between 1 and 256.

- The value of **pskString** with the index of the PSK you're configuring.

  The **pskString** parameter specifies the actual PSK, which must be a hexadecimal string 64 characters long.

Example:

```
<fvTenant annotation="" descr="" dn="uni/tn-infra" name="infra" nameAlias="" ownerKey="" ownerTag="">

   <cloudsecIfPol descr="cloudsecifp" name="default" sakExpiryTime="10" stopRekey= "false" status=""
 >
        <cloudsecPreSharedKey index="1"
pskString="1234567812345678123456781234567812345678123456781234567812345678" status=""/>
    </cloudsecIfPol>
</fvTenant>
```

Enabling CloudSec Encryption Using Cisco ACI Multi-Site Orchestrator GUI

The CloudSec encryption can be enabled or disabled for each site individually. However, the communications between two sites will be encrypted only if the feature is enabled on both sites.

Before you begin

Before you enable the CloudSec encryption between two or more sites, you must have completed the following tasks:

- Installed and configured the Cisco APIC clusters in multiple sites, as described in *Cisco APIC Installation, Upgrade, and Downgrade Guide*
- Installed and configured Cisco ACI Multi-Site Orchestrator, as described in *Cisco ACI Multi-Site Orchestrator Installation and Upgrade Guide*.
- Added each Cisco APIC site to the Cisco ACI Multi-Site Orchestrator, as described in *Cisco ACI Multi-Site Configuration Guide*.

Step 1 Log in to the Cisco ACI Multi-Site Orchestrator.

Step 2 From the left-hand sidebar, select the **Sites** view.

Step 3 Click on the **Configure Infra** button in the top right of the main window.

Step 4 From the left-hand sidebar, select the site for which you want to change the CloudSec configuration.

Step 5 In the right-hand sidebar, toggle the **CloudSec Encryption** setting to enable or disable the CloudSec Encryption feature for the site.

Rekey Process During Spine Switch Maintenance

The following is a summary of the CloudSec rekey process during typical maintenance scenarios for the spine switches where the feature is enabled:

- **Normal Decommissioning** – CloudSec rekey process stops automatically whenever a CloudSec-enabled spine switch is decommissioned. Rekey process will not start again until the decommissioned node is commissioned back or the decommissioned node ID is removed from the Cisco APIC
- **Spine Switch Software Upgrade** – CloudSec rekey process stops automatically if a spine switch is reloaded due to software upgrade. Rekey process will resume after the spine switch comes out of reload.
- **Maintenance (GIR mode)** – CloudSec rekey process must be manually stopped using the instructions provided in Disabling and Re-Enabling Re-Key Process Using NX-OS Style CLI, on page 108. Rekey can be enabled back only after the node is ready to forward traffic again.
- **Decommissioning and Removal from Cisco APIC** – CloudSec rekey process must be manually stopped using the instructions provided in Disabling and Re-Enabling Re-Key Process Using NX-OS Style CLI, on page 108. Rekey can be enabled back only after the node is removed from Cisco APIC.

Disabling and Re-Enabling Re-Key Process Using NX-OS Style CLI

It is possible to manually stop and restart the re-key process. You may be required to manually control the re-key process in certain situations, such as switch decommissioning and maintenance. This section describes how to toggle the setting using Cisco APIC NX-OS Style CLI.

Step 1 Log in to the Cisco APIC NX-OS style CLI.

Step 2 Enter configuration mode.

Example:

```
apic1# configure
apic1(config)#
```

Step 3 Enter configuration mode for the default CloudSec profile.

Example:

```
apic1(config)# template cloudsec default
apic1(config-cloudsec)#
```

Step 4 Stop or restart the re-key process.

To stop the re-key process:

Example:

```
apic1(config-cloudsec)# stoprekey yes
```

To restart the re-key process:

Example:

```
apic1(config-cloudsec)# stoprekey no
```

Disabling and Re-Enabling Re-Key Process Using REST API

It is possible to manually stop and restart the re-key process. You may be required to manually control the re-key process in certain situations, such as switch decommissioning and maintenance. This section describes how to toggle the setting using Cisco APIC REST API.

Step 1 You can disable the rekey process using the following XML message.

Example:

```
<fvTenant annotation="" descr="" dn="uni/tn-infra" name="infra" nameAlias="" ownerKey="" ownerTag="">

    <cloudsecIfPol descr="cloudsecifp" name="default" sakExpiryTime="10" stopRekey= "true" status=""
 />
</fvTenant>
```

Step 2 You can enable the rekey process using the following XML message.

Example:

```
<fvTenant annotation="" descr="" dn="uni/tn-infra" name="infra" nameAlias="" ownerKey="" ownerTag="">

   <cloudsecIfPol descr="cloudsecifp" name="default" sakExpiryTime="10" stopRekey= "false" status=""
 />
</fvTenant>
```

CHAPTER 10

Adding Tenants and Schemas

This chapter contains the following sections:

Adding Tenants

This section describes how to add tenants using the Multi-Site Orchestrator GUI.

Before you begin

You must have a user with either `Power User` or `Site Manager` read-write role to create and manage tenants.

Step 1 Log in to the Cisco ACI Multi-Site Orchestrator GUI.

Step 2 In the **Main menu**, select **Infrastructure** > **Tenants**.

Step 3 In the top right of the main pane, click **Add Tenant**.

Step 4 In the **Display Name** field, provide the tenant's name.

The tenant's **Display Name** is used throughout the Orchestrator's GUI whenever the tenant is shown. However, due to object naming requirements on the Cisco APIC, any invalid characters are removed and the resulting **Internal Name** is used when pushing the tenant to sites. The **Internal Name** that will be used when creating the tenant is displayed below the **Display Name** textbox.

You can change the **Display Name** of the tenant at any time, but the **Internal Name** cannot be changed after the tenant is created.

Step 5 (Optional) In the **Description** field, enter a description of the tenant.

Step 6 In the **Associated Sites** section, add the sites.

a) Check all sites where you plan to deploy templates that use this tenant.

Only the selected sites will be available for any templates using this tenant.

Note If you select a site that is connected via an MPLS network, you will

b) From the **Security Domains** drop-down list, choose the site's security domains.

Security domains are created using the Cisco APIC GUI and can be assigned to various Cisco APIC policies and user accounts to control their access. For more information, see the *Cisco APIC Basic Configuration Guide*.

Step 7 In the **Associated Users** section, add Orchestrator users.

Only the selected users will be able to use this tenant when creating templates.

Step 8 (Optional) Enable consistency checker scheduler.

You can choose to enable regular consistency checks. For more information about the consistency checker feature, see *Cisco ACI Multi-Site Troubleshooting Guide*.

Step 9 Click **SAVE** to finish adding the tenant.

Adding Schemas

This section describes how to add schemas using the Cisco ACI Multi-Site Orchestrator GUI.

Step 1 Log in to the Cisco ACI Multi-Site Orchestrator GUI, in the **Main menu**, click **Schemas**.

Step 2 In the **Schemas List** area, click **ADD SCHEMA**.

Step 3 In the **Untitled Schema** field, enter the new schema's name.

Step 4 Select a tenant.

In the main window pane, click **To build your schema please click here to select a tenant** then select a tenant from the **SELECT A TENANT** drop-down list.

Step 5 (Optional) Import fabric elements.

You can create new objects and push them out to one or more sites or you can import existing site-local objects and manage them using the Multi-Site Orchestrator. To import existing objects:

a) Click **IMPORT** button.
b) Select the site from which you want to import objects
c) In the **Import** window that opens, select one or more objects you want to import.

Note The names of the objects imported into the Multi-Site Orchestrator must be unique across all sites. Importing different objects with duplicate names will cause a schema validation error and the import to fail. If you want to import objects that have the same name, you must first rename them.

Step 6 Add new fabric elements.

a) Click **+ Application profile**, in the **Master List**, enter the application profile name.
b) Click **+ Add EPG** field, in the **Master List**, perform the following actions:

1. In the **DISPLAY NAME** field, enter the EPG name.

2. Click **ADD SUBNET**, in the **Add Subnet** pane, perform the following actions:

    a. In the **GATEWAY IP** field, enter the gateway IP/netmask.

    b. In the **DESCRIPTION** field, enter a brief description.

c. In the **SCOPE** section, choose **Private to VRF** or **Advertised Externally** radio button.

d. In the **SHARED BETWEEN VRFS** section, place a check in the check box to share between VRFs.

e. In the **NO DEFAULT SVI GATEWAY** section, place a check in the check box to not have a default SVI gateway.

f. Click **SAVE**.

g. Repeat 3d to create another EPG. You should have two EPGs.

c) In the **BRIDGE DOMAIN** field, from the drop-down list, choose a bridge domain or enter a bridge domain name to create one.

d) Click **+ CONTRACT** field, perform the following actions:

1. In the **CONTRACT** field, from the drop-down list, choose a contract or enter a contract name to create one.
2. In the **TYPE** field, from the drop-down list, choose **consumer**.
3. Click **SAVE**.

e) Click **ADD CONTRACT** field to add a second contract, perform the following actions:

1. In the **CONTRACT** field, from the drop-down list, choose a contract or enter a contract name to create one.
2. In the **TYPE** field, from the drop-down list, choose **provider**.
3. Click **SAVE**.

f) Click **+ VRF**, in the **Master List**, perform the following actions:

1. In the **DISPLAY NAME** field, enter the VRF name.

g) Click **+ Add Bridge Domain**, in the **Master List**, perform the following actions:

1. In the **DISPLAY NAME** field, enter the bridge domain name.
2. In the **VIRTUAL ROUTING & FORWARDING** field, from the drop-down list, choose a VRF name or enter a VRF name to create one.
3. In the **L2STRETCH** section, place a check in the check box to enable Layer 2 stretch.
4. In the **INTERSITEBUMTRAFFICALLOW** section, place a check in the check box to allow intersite BUM traffic.
5. In the **L2UNKNOWNUNICAST** field, from the drop-down list, choose **proxy** or **flood**.
6. Click **[+] Add Subnet**, perform the following actions:

   a. In the **GATEWAY IP** field, enter the gateway IP address/netmask.

   b. In the **DESCRIPTION** field, enter a brief description of the subnet.

   c. In the **SCOPE** field, choose **Private to VRF** or **Advertised Externally**.

   d. In the **SHARED BETWEEN VRFS** section, place a check in the check box to share between VRFs.

   e. In the **NO DEFAULT SVI GATEWAY** section, place a check in the check box to not have a default SVI gateway.

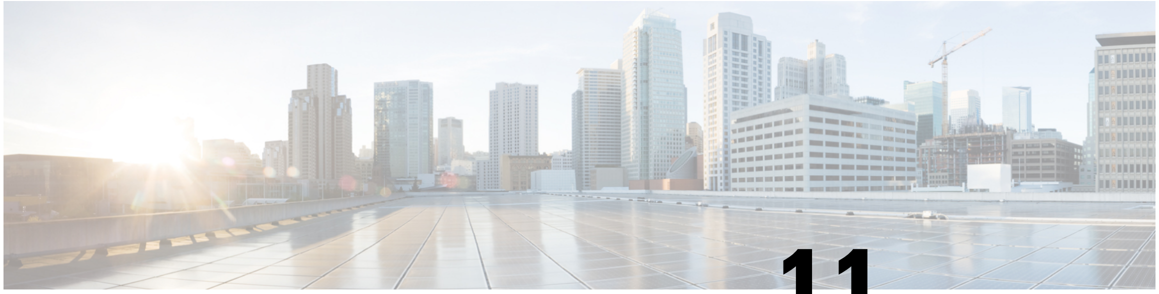
f. In the **QUERIER** section, place a check in the check box to querier.

g. Click **OK**.

h) Click **Sites +**, place a check in the check box for each site.
i) Click **SAVE**.
j) Click **Click DEPLOY TO SITES**.

PART IV

Admin Operations



CHAPTER 11

Authentication

External Authentication

You can configure external user authentication and authorization using RADIUS, TACACS+, and LDAP servers.

As a Multi-Site Orchestrator administrator, you can:

- Add one or more external authentication providers.

  It is recommended to set up at least 2 authentication providers for redundancy.

- Create login domains and associate them with providers.

  The default domain is the Local domain, for local authentication.

- Assign users to domains.

After you create domains, you can edit, deactivate, or delete them. You cannot delete the Local domain, but you can deactivate it.

Audit logs support external authentication and authorization.

External Authentication Guidelines and Limitations

When configuring external authentication servers for Multi-Site Orchestrator (MSO) user authentication:

- You must configure each user on the remote authentication servers.

  Each user role can be assigned in read-write or read-only mode. When read-only permissions are granted, the user can view any fabric objects available to that role just like before, but they cannot make any changes to those objects.

- For both local and external authentication, the username supports a maximum length of 20 characters.

- For each user, you must add a custom attribute-value (AV) pair, specifying the user roles assigned to that them.

General description of available MSO user roles is documented in Users, Roles, and Permissions, on page 129.

AV pair format and configuration is described in Configuring Remote Authentication Server for Orchestrator Users, on page 118.

- Starting with MSO Release 3.0(2) and APIC Release 5.0(2), single sign-on (SSO) is available between MSO and APIC users.

  SSO along with its limitations and usage is described in more detail in the Single Sign-On (SSO) Across APIC Sites, on page 123 section of this chapter.

- All LDAP configurations are case sensitive.

  For example, if you have `OU=`**`Cisco Users`** on the LDAP server and `OU=`**`cisco users`** on the Multi-Site Orchestrator, the authentication will not work.

- If you configure any read-only user roles and then downgrade your MSO to an earlier version, which does not support read-only permissions, those roles will be removed from all users. This also means that any user that has **only** the read-only roles will have no roles assigned to them and be deleted. A Power User or User Manager will need to recreate the users and re-assign them new read-write roles.

- For LDAP configurations, we recommend using **`CiscoAVPair`** as the attribute string. If, for any reason, you are unable to use an Object ID `1.3.6.1.4.1.9.22.1`, an additional Object IDs `1.3.6.1.4.1.9.2742.`*`1-5`* can also be used in the LDAP server.

Configuring Remote Authentication Server for Orchestrator Users

When configuring the remote authentication server for Multi-Site Orchestrator users, you must add a custom attribute-value (AV) pair, specifying the user roles assigned to them.

Detailed information about available user roles and their permissions is available in Users, Roles, and Permissions, on page 129. But in short, the following user role strings are supported in AV pairs: `powerUser`, `siteManager`, `schemaManager`, `schemaEditor`, and `userManager`.

The AV pair string format differs when configuring a read-write role, read-only role, or a combination of read-write and read-only roles for a specific user. A typical string includes the domain, followed by the read-write roles separated from the read-only roles using the slash (`/`) character; individual roles are separated by the pipe (`|`) character:

```
shell:domains=<domain>/<writeRole1>|<writeRole2>/<readRole1>|<readRole2>
```

Note In this release, only the `msoall` domain is supported and is required for consistency with the APIC AV pair format in order to support the single sign-on (SSO) feature. The `msoall` domain is the equivalent of the `all` domain on the APIC.

For example, the following string illustrates how to assign the Schema Manager and User Manager roles to a user, while still allowing them to see objects visible to the Site Manager users:

```
shell:domains=msoall/schemaManager|userManager/siteManager
```

If you want to use a single AV pair string for both MSO and APIC roles, you can combine them as follows:

```
shell:domains=all/admin/,msoall/schemaManager|userManager/siteManager
```

If you want to configure only the read-only or only read-write permissions for a user, you must still include the slash (`/`) character. The following examples show how to set just the read-write or read-only access to the objects available to Site Manager role:

- Read-only: `shell:domains=msoall//siteManager`
- Read-write: `shell:domains=msoall/siteManager/`

AV Pair String in Release 3.0(1) and Earlier

Starting with Release 3.0(2), the AV pair format was updated to match the format used by the Cisco APIC in order to support the single sing-on (SSO) feature.

Prior releases did not include the domain value but followed a similar format, for example:

```
shell:msc-roles=writeRole1|writeRole2/readRole1|readRole2
```

Note While Release 3.0(2) and later are backward compatible with the older AV pair formats, the SSO feature will not work until you update the AV pair string to the new format. If you ever downgrade to a release that does not support the new format, the users defined using the format will not be able to log in.

In addition, you cannot mix the old and the new format for the AV pairs them when configuring a single user. Mixed or incorrectly formatted AV strings are not parsed and the user roles are not configured.

Adding RADIUS or TACACS+ as Authentication Provider

This section describes how to add one or more RADIUS or TACACS+ servers as external authentication servers for authenticating Cisco ACI Multi-Site Orchestrator users.

Step 1 Log in to your Cisco ACI Multi-Site Orchestrator as the `admin` user using the Local domain.

Step 2 From the left-hand navigation pane, select **Admin** > **Providers**.

Step 3 In the main window, click **ADD PROVIDER**.

Step 4 Enter the host name or IP address of the external authentication server.

Step 5 (Optional) Enter a description for the provider you are adding.

Step 6 Select **RADIUS** or **TACACS+** for the provider type you are adding.

Step 7 Enter the **KEY** and confirm it in the **CONFIRM KEY** field.

Step 8 (Optional). Configure additional settings.

a) Expand **Additional Settings** for more settings.

b) You can specify the port used to connect to the authentication server.

The default port is `1812` for **RADIUS** and `49` for **TACACS+**.

c) You can specify the protocol used.

You can choose between **PAP** or **CHAP** protocols.

d) You can specify the timeout and number of attempts for connecting to the authentication server.

Adding LDAP as Authentication Provider

This section describes how to add one or more LDAP servers as external authentication servers for Cisco ACI Multi-Site Orchestrator users.

Step 1 Log in to your Cisco ACI Multi-Site Orchestrator as the `admin` user using the Local domain.

Step 2 From the left-hand navigation pane, select **Admin** > **Providers**.

Step 3 In the main window, click **Add Provider**.

Step 4 Enter the host name or IP address of the external authentication server.

Step 5 (Optional) Enter a description for the provider you are adding.

Step 6 Select **LDAP** for the provider type you are adding.

Step 7 Enter the **Base DN**, **Bind DN**, and the **Key** values for the LDAP server.

The Base DN and Bind DN depend on how your LDAP server is configured. You can get the Base DN and Bind DN values from the distinguished name of the user created on the LDAP server.

Base DN is the point from which the server will search for users. For example, `DC=mso,DC=local`.

Bind DN is the credentials used to authenticate against the server. For example, `CN=admin, CN=Users,DC=mso,DC=local`.

Bind DN comes with a key, which you can provide in the next field.

Step 8 (Optional) Enable SSL for LDAP communication.

a) Check the **Enable SSL** checkbox.
b) Select the certificate you want to use.
c) Select the validation level.

Permissive: Accept a certificate signed by any certificate authority (CA) and use it for encryption.

Restrictive: Verify the entire certificate chain before using it.

Step 9 (Optional). Configure additional settings.

a) Click **Additional Settings** to expand.
b) Specify the port used to connect to the LDAP server.

The default port for **LDAP** is `389`.

c) Specify the timeout and number of attempts for connecting to the authentication server.
d) Specify the filter used.

The filter value depends on the LDAP server configuration. The default LDAP filter is `(cn=username)`. However, if you're using a Microsoft LDAP server, set the filter to `(sAMAccountName={username})` instead.

e) Specify the authentication type.

The authentication type can be:

- **Cisco-AVPair** – uses an attribute-value (AV) pair to configure authorization based on individual user's role. When using this method, set the **Attribute** field to `ciscoAVPair`.

  You must also configure each user individually in your LDAP server using the AV pair string in the following format:

  - Release 2.1(2) and later:

```
cisco-av-pair=shell:msc-roles=writeRole1|writeRole2/readRole1|readRole2
```

- Release 2.1(1) and earlier:

```
cisco-av-pair=shell:msc-roles=role1,role2
```

For additional information, see External Authentication Guidelines and Limitations, on page 117.

- **LDAP Group Map Rules** - use an LDAP server group to configure authorization based on the users' group membership. When using this method, set the **Attribute** field to `memberOf`, then click **+LDAP Group Map Rules** to specify the group membership.

  In the **New Group Map Rule**, specify the group DN (for example, `CN=group1,OU=msc-ou,DC=msc,DC=local`) and the user roles to be assigned to that group. You can add multiple roles for the same group map rule. Detailed descriptions of each user role are available in Users, Roles, and Permissions, on page 129.

Creating Login Domains

A login domain defines the authentication domain for a user. Login domains can be set to the Local, RADIUS, TACACS+, or LDAP authentication mechanisms.

When you are logging in to the Cisco ACI Multi-Site Orchestrator using the GUI, the login screen offers a drop-down list of domains for the user to select from. If no domain is specified, the Local domain is used to look up the username.

When you are logging in to the Cisco ACI Multi-Site Orchestrator using the REST API, the login domain is provided along with the login information in the `POST` message, for example:

```
{
    "username":"bob",
    "password":"Welcome2msc!",
    "domainId":"59d5b5978d0000d000909f65"
}
```

To create a login domain using the Cisco ACI Multi-Site Orchestrator GUI:

Before you begin

You must have added one or more authentication providers as described in Adding RADIUS or TACACS+ as Authentication Provider, on page 119 or Adding LDAP as Authentication Provider, on page 120.

Step 1 Log in to your Cisco ACI Multi-Site Orchestrator.

Step 2 Navigate to **Admin** > **Authentication**.

Step 3 In the main window, select the **Login Domains** tab.

Step 4 Click **Add Login Domain**.

Step 5 Enter the domain's name.

Step 6 (Optional) Enter a description for the domain.

Step 7 In the **Realm** selection, specify the authentication provider.

You must have an external authentication provider added before creating a login domain.

Step 8 Assign providers to the login domain.

You can choose multiple providers for the domain to enable redundancy in case one of the providers experiences an issue.

If you select more than one provider, ensure that each provider has a unique **Priority** value. When multiple providers are available, they are used in order of priority when authenticating users.

What to do next

After you create one or more login domains, you can edit, delete, or deactivate them as described in Editing, Deleting, or Deactivating Login Domains, on page 122.

Editing, Deleting, or Deactivating Login Domains

After you have created one or more login domains, you can use the instruction described in this section to edit, delete, or deactivate them. You cannot delete the Local domain, but you can deactivate it.

Before you begin

You must have created one or more Login domains as described in Creating Login Domains, on page 121.

Step 1 Log in to your Cisco ACI Multi-Site Orchestrator.

Step 2 From the left-hand navigation pane, select **Admin** > **Login Domains**.

Step 3 Click the **...** menu next to the login domain you want to edit.

You can choose to **Edit** the domain information, **Deactivate** the domain so that it cannot be used, or **Set as default** so it is automatically selected when logging in using GUI.

Remote User Logon

When external authentication is enabled in Cisco ACI Multi-Site, you can log in to the Multi-Site Orchestrator as follows:

Step 1 Using a browser, navigate to the Multi-Site URL.

Step 2 Choose your assigned domain from the drop down list.

Step 3 Enter your username and password.

Step 4 Click **Submit**.
If you are authorized and pass authentication, the Multi-Site Orchestrator GUI is displayed and you have privileges according to the roles that are assigned to you. The first time you log on, you will be prompted to change your password.

Single Sign-On (SSO) Across APIC Sites

Beginning with Release 3.0(2), Cisco ACI Multi-Site supports single sign-on (SSO) capability between the Multi-Site Orchestrator and each site's Cisco APIC.

When you configure remote authentication for the MSO and APIC users, you can cross-launch into individual sites' APIC GUI directly from the MSO GUI without being prompted to log in at the APIC level.

SSO Guidelines and Limitations

When using the single sign-on feature, the following restriction apply:

- Your Multi-Site Orchestrator must be running Release 3.0(2) or later.
- Your Multi-Site Orchestrator must be deployed in Cisco Application Services Engine.

  Older Docker deployments using in vCenter or OVA do not support SSO.
- The APIC sites must be running Cisco APIC, Release 5.0(2) or later.

  If you cross-launch into an APIC running an earlier version, you will be prompted to log in.
- Your Multi-Site Orchestrator must be configured for remote user authentication.

  Remote authentication is described in External Authentication, on page 117.

Launching APIC GUI

This section describes how to cross-launch into an APIC GUI from your Multi-Site Orchestrator utilizing single sign-on.

Before you begin

You must have:

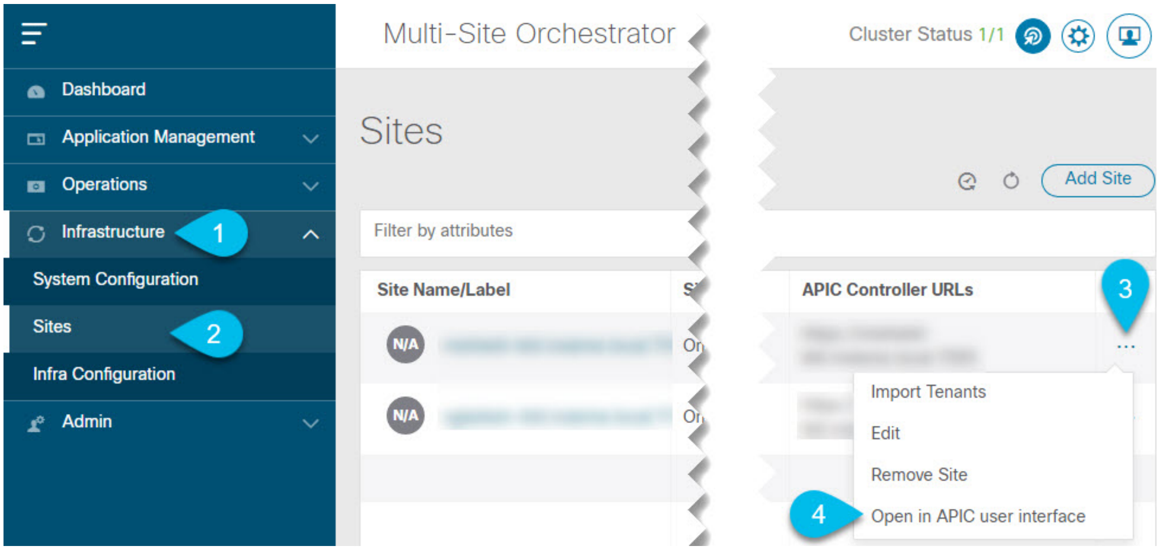
- Configured Cisco Multi-Site Orchestrator and Cisco APIC users and roles in your authentication provider server, as described in External Authentication, on page 117.

  In your AV pair string, you must include roles for both MSO and APIC.
- Added the remote authentication provider to your Multi-Site Orchestrator, as described in External Authentication, on page 117.

Step 1 Log in to your Cisco Multi-Site Orchestrator GUI as a remote user.

Single sign-on is not supported for local MSO users.

Step 2 Launch APIC GUI from the **Sites** page.



a) Navigate to **Infrastructure** > **Sites**.
b) Click the **Actions** menu next to the site you want to launch.

   You must select a site running APIC Release 5.0(2) or later.

c) Click **Open in APIC user interface**.

A new tab will open and you will be automatically logged in to the APIC GUI using the same user as you used to log in to the MSO.

Step 3 Alternatively, launch APIC GUI from a **Schema** page.

a) Navigate to **Application Management** > **Schemas**.
b) Select a schema.
c) In the left sidebar, select one of the sites in the schema.
d) Click the **Actions** menu next to the site you want to launch.

   You must select a site running APIC Release 5.0(2) or later.

e) Click **Open APIC**.

A new tab will open and you will be automatically logged in to the APIC GUI using the same user as you used to log in to the MSO.

Once the APIC GUI is loaded via cross-launch from Multi-Site Orchestrator, logging out of MSO will not logout from the APIC.

CHAPTER 12

Audit Logs and Security

Audit Logs

Multi-Site Orchestrator system logging is automatically enabled when you first deploy the Orchestrator cluster and captures the events and faults that occur in the environment.

You can view the Multi-Site Orchestrator logs directly in the GUI by selecting **Admin** > **Audit Logs** from the main navigation menu.

From the **Audit Logs** page, you can click the **Most Recent** field to select a specific time period for which you want to see the logs. For example, when you select the range from November 14, 2019 to November 17, 2019 and click **Apply**, the audit log details for this time period are displayed on the **Audit Logs** page.

You can also click the **Filter** icon to filter the log details using the following criteria:

- **User**: Select this option to filter the audit logs by the user type, then click **Apply** to apply the filter.
- **Type**: Select this option to filter the audit logs by the policy types, for example, site, user, template, application profile, bridge domain, EPG, external EPG, filter, VRF, BGP config, contract, OSPF policy, pod, node, port, domain, provider, RADIUS, TACACS+ and click **Apply**.
- **Action**: Select this option to filter the audit logs by an action. The available actions are Created, Updated, Deleted, Added, Removed, Associated, Disassociated, Deployed, Undeployed, Downloaded, Uploaded, Restored, Logged in, Logged Out, Login Failed. Select an action and click **Apply** to filter the log details according to the action.

Security

Cisco ACI Multi-Site Orchestrator OVA contains a self-signed SSL certificate that is stored in `/data/msc/secrets` directory on each node during the Orchestrator installation. By default, the Orchestrator GUI uses this certificate for its HTTPS connections.

While you could previously update these certificates by logging directly into an Orchestrator node server and changing its web server (`nginx`) configuration, starting with Cisco ACI Multi-Site Orchestrator Release 2.1(1), you can use the GUI to easily add or update custom certificates to be used for the Orchestrator's GUI connection.

When adding custom certificates, you can use one of the following two options:

- **Self-Signed Certificate** provide you with the ability to create your own public and private keys to be used by the Orchestrator's GUI.
- **CA-Issued Certificate** allows you to use a certificate provided by an existing Certificate Authority (CA) along with its keys.

You can add multiple CAs and Keyrings containing the public/private key combinations in the GUI, however only a single keyring can be active at any given time and used to secure the communication between the Orchestrator GUI and your browser.

Adding Custom Certificate Authority

You can add a custom Certificate Authority (CA) to be used for verifying the public key provided by the Orchestrator for HTTPS traffic encryption.

This section describes how to add and configure a custom CA in Multi-Site Orchestrator GUI. Configuring keyrings and keys is described in the next section.

Step 1 Log in to your Multi-Site Orchestrator GUI.

Step 2 From the left navigation menu, select **Admin** > **Security**.

Step 3 In the main window, select the **Certificate Authority** tab and click **Add Certificate Authority**.

Step 4 In the **Add Certificate Authority** window that opens, provide the CA details.

In the **Name** field, enter the CA name.

In the **Description** field, enter the CA description.

In the **Certificate Chain** field, enter the CA's certificate chain. You must include both, intermediate and root, certificates. The intermediate certificate must be entered first, followed by the root certificate.

Step 5 Click **SAVE** to save the changes.

Adding Custom Keyring

You can add a custom keyring containing a public and private encryption keys to be used for Orchestrator GUI HTTPS traffic encryption.

This section describes how to add a custom keyring. For instructions on adding a Certificate Authority (CA) that can be used to verify the public key in this keyring, see the previous section.

Step 1 Log in to your Multi-Site Orchestrator GUI.

Step 2 From the left-hand navigation menu, select **Admin** > **Security**.

Step 3 In the main window, select the **Key Rings** tab and click **ADD KEY RING**.

Step 4 In the **Create Key Ring** window that opens, provide the key ring details.

From the **SELECT CERTIFICATE AUTHORITY** dropdown menu, select the certificate authority that will contain the key ring.

In the **NAME** field, enter the key ring name.

In the **KEY RING DESCRIPTION** field, enter the key ring description.

In the **PUBLIC KEY** field, enter the ring's public key.

In the **PRIVATE KEY** field, enter the ring's private key

Step 5 Click **SAVE** to save the changes.

Activating Custom Keyring

After you add a keyring, as described in previous section, you need to activate it as the default keyring.

Step 1 Log in to your Multi-Site Orchestrator GUI.

Step 2 From the left-hand navigation menu, select **Admin** > **Security**.

Step 3 In the main window, select the **Key Rings** tab.

Step 4 In the main window, click the **...** icon next to the keyring you want to activate and choose **Make Keyring Active**.

Step 5 Click **ACTIVATE** to activate the keyring.

Activating a key will log you out of the Multi-Site Orchestrator GUI. When the login page is loaded, it will use the new certificate and key.

Custom Certificates Troubleshooting

The following sections describe how to resolve common issues when using custom SSL certificates with Multi-Site Orchestrator.

Unable to Load the Orchestrator GUI

If you are unable to load the Orchestrator GUI page after installing and activating a custom certificate, it is possible that the certificates were not copied correctly to each Orchestrator node. You can resolve this issue by recovering the default certificates and then repeating the new certificate installation procedure again.

To recover the default Orchestrator certificates:

1. Log in to each Orchestrator node directly.

2. Change into the certificates directory:

```
# cd /data/msc/secrets
```

3. Replace the msc.key and msc.cert files with msc.key_backup and msc.cert_backup files respectively.

```
# cp msc.key_backup msc.key
# cp msc.cert_backup msc.cert
```

4. Restart the Orchestrator GUI service

```
# docker service update msc_ui --force
```

5. Re-install and activate the new certificates as described in previous sections.

Adding a New Orchestrator Node to the Cluster

If you add a new node to you Multi-Site Orchestrator cluster:

1. Log in to the Orchestrator GUI.
2. Re-activate the key you are using as described in previous sections.

CHAPTER 13

User Management

Users, Roles, and Permissions

The Cisco ACI Multi-Site Orchestrator allows access according to a user’s role defined by role-based access control (RBAC). Roles are used in both local and external authentication. The following user roles are available in Cisco ACI Multi-Site Orchestrator.

- Power User—A role that allows the user to perform all the operations.
- Site Manager—A role that allows the user to manage sites, tenants, and associations between them.
- Schema Manager—A role that allows the user to manage all schemas regardless of their tenant associations.
- Schema Editor—A role that allows the user to manage schemas that contain at least one tenant to which the user is explicitly associated.
- User Manager—A role that allows the user to manage all the users, their roles, and passwords.

Each role above is associated with a set of permissions, which in turn are used to show relevant and hide irrelevant elements from the user's view of the Orchestrator GUI. For example, the User Manager role has only the user-related permissions associated with it and as such the user with that role will only see **Users** and **Admin** tabs in the GUI.

User Roles and Permissions

The following table lists the Cisco ACI Multi-Site permissions allowed with each available user role. The `Attribute-Value (AV)` column specifies the user configuration string required when configuring an external authentication server for use with the Multi-Site Orchestrator. External authentication is covered in more detail in the *Administrative Operations* chapter.

Table 1: User Roles

User Role	Permissions	Attribute-Value (AV) Pair
Power User	• Dashboard • Sites • Schemas • Tenants • Users • Troubleshooting Reports	`shell:msc-roles=powerUser`
Site Manager	• Dashboard—Sites • Sites • Tenants	`shell:msc-roles=siteManager`
Schema Manager	• Dashboard—Sites and Schema Health • Schemas	`shell:msc-roles=schemaManager`
Schema Editor	• Dashboard—Sites and Schema Health • Schemas	`shell:msc-roles=schemaEditor`
User Manager	• Users	`shell:msc-roles=userManager`

Admin User

In the initial configuration script, a default `admin` user account is configured and is the only user account available when the system starts. The initial password for the *admin* user is set by the system and you are prompted to change it after the first log in.

- The `admin` user's default password is `We1come2msc!`
- The `admin` user is assigned the Power User role.
- Use the `admin` user to creating other users and perform all other Day-0 configurations.
- The account status of the *admin* user cannot be set to **Inactive**.

Read-Only Access

Each of the user roles above can be assigned in read-only mode. When read-only permissions are granted, the user can view any fabric objects available to that role just like before, but they cannot make any changes to those objects.

Guidelines and Limitations

- Users authentication and authorization can be local or external. For external authentication, you can use RADIUS, TACACS+, or LDAP servers. For more information about external authentication, see External Authentication, on page 117 in the *Administrative Operations* chapter.
- For both local and external authentication, the username supports a maximum length of 20 characters.
- For both local and external authentication, you must associate at least one role with every user. A user may be associated with more than one role. Associating a user to multiple roles offers a combination of objects that the user may access.
- Users must be associated with tenants before they can use a tenant or a schema.
- Users can be assigned roles in read-only mode. When read-only permissions are granted, the user can view any fabric objects available to that role just like before, but they cannot make any changes to those objects.

  If you configure any read-only user roles and then downgrade your Multi-Site Orchestrator to an earlier version, which does not support read-only permissions, those roles will be removed from all users. This also means that any user that has **only** the read-only roles will have no roles assigned to them and be deleted. A Power User or User Manager will need to recreate the users and re-assign them new read-write roles.

Adding a User

This section describes how to create a Multi-Site Orchestrator user.

Step 1 Log in to Cisco ACI Multi-Site Orchestrator.

Step 2 From the main menu, select **Users**.

Step 3 In the top right of the main window pane, click **Add User**.

Step 4 In the **Add User** page, specify the following:

a) In the **Username** field, enter the new user's username.

b) In the **Password** and **Confirm Password** fields, provide the user's password.

   The password must:

   - Be at least 12 characters in length
   - Contain at least one letter
   - Contain at least one number
   - Contain at least one special character apart from `*` and spaces

c) In the **First Name** field, enter the first name of the user.

d) In the **Last Name** field, enter the last name of the user.

e) In the **Email Address** field, enter the email address of the user.

f) (Optional) In the **Phone Number** field, enter the phone number of the user.

g) In the **Account Status** field, choose the account status.

You can set users to either `Active` or `Inactive` status. Only active users can log in to the Multi-Site Orchestrator.

Step 5 In the **User Roles** list, assign one or more user roles for the new user you are adding.

You must associate at least one role with every user. A user may be associated with more than one role. Associating a user to multiple roles offers a combination of features that the user can access.

Each of the available roles can be configured in read-only mode. When a user is assigned a read-only role, they can view any fabric objects available to that role, but cannot make any changes to those objects

Step 6 Click **Save**.

Managing Users

This section describes how to edit or delete existing users.

Step 1 Log in to Cisco ACI Multi-Site Orchestrator.

Step 2 If you want to update your own password...

a) Click the **User** icon in the top right of the screen.
b) Select **Reset Password**

Step 3 If you want to delete a user...

a) From the main menu, select **Users**.
b) Click the actions icon next to the user's name and select **Delete**.

You cannot delete the default `admin` user.

Step 4 If you want to edit an existing user and their permissions...

a) From the main menu, select **Users**.
b) Click the actions icon next to the user's name and select **Edit**.

You cannot change the default `admin` user's name, account status, and roles.

The default `admin` user or a user associated with the **Power User** or **User Manager** roles can update the passwords for other users. On initial log in, the user will be prompted to update their own password.

PART V

Features and Use Cases

CHAPTER 14

DHCP Relay

DHCP Relay Policy

Typically, when your DHCP server is located under an EPG, all the endpoints in that EPG have access to it and can obtain the IP addresses via DHCP. However, in many deployment scenarios, the DHCP server may not exist in the same EPG, BD, or VRF as all the clients that require it. In these cases a DHCP relay can be configured to allow endpoints in one EPG to obtain IP addresses via DHCP from a server that is located in another EPG/BD deployed in a different site or even connected externally to the fabric and reachable via an L3Out connection.

You can create the DHCP `Relay` policy in the Orchestrator GUI to configure the relay. Additionally, you can choose to create a DHCP `Option` policy to configure additional options you can use with the relay policy to provide specific configuration details. For all available DHCP options refer to RFC 2132.

When creating a DHCP relay policy, you specify an EPG (for example, `epg1`) or external EPG (for example, `ext-epg1`) where the DHCP server resides. After you create the DHCP policy, you associate it with a bridge domain, which in turn is associated with another EPG (for example, `epg2`) allowing the endpoints in that EPG to reach the DHCP server. Finally, you create a contract between the relay EPG (`epg1` or `ext-epg1`) and application EPG (`epg2`) to allow communication. The DHCP policies you create are pushed to the APIC when the bridge domain to which the policy is associated is deployed to a site.

Guidelines and Limitations

The DHCP relay policies are supported with the following caveats:

- DHCP relay policies are supported for fabrics running Cisco APIC Release 4.2(1) or later.
- The DHCP servers must support DHCP Relay Agent Information Option (Option 82).

When an ACI fabric acts as a DHCP relay, it inserts the DHCP Relay Agent Information Option in DHCP requests that it proxies on behalf of clients. If a response (DHCP offer) comes back from a DHCP server without Option 82, it is silently dropped by the fabric.

- DHCP relay policies are supported in user tenants or the `common` tenant only. DHCP policies are not supported for the `infra` or `mgmt` tenants.

  When configuring shared resources and services in the ACI fabric, we recommend creating those resources in the `common` tenant, that way they can be used by any user tenant.

- DHCP relay server must be in the same user tenant as the DHCP clients or in the `common` tenant.

  The server and the clients cannot be in different user tenants.

- DHCP relay policies can be configured for the primary SVI interface only.

  If the bridge domain to which you assign a relay policy contains multiple subnets, the first subnet you add becomes the primary IP address on the SVI interface, while additional subnets are configured as secondary IP addresses. In certain scenarios, such as importing a configuration with a bridge domain with multiple subnets, the primary address on the SVI may change to one of the secondary addresses, which would break the DHCP relay for that bridge domain.

  You can use the `show ip interface vrf all` command to verify IP address assignments for the SVI interfaces.

- If you make changes to the DHCP policy after you have assigned it to a bridge domain and deployed the bridge domain to one or more sites, you will need to re-deploy the bridge domain for the DHCP policy changes to be updated on each site's APIC.

- For inter-VRF DHCP relay with the DHCP server reachable via an L3Out, DHCP relay packets must use site-local L3Out to reach the DHCP server. Packets using an L3Out in a different site (Intersite L3Out) to reach the DHCP server is not supported.

- The following DHCP relay configurations are not supported:

  - DHCP relay clients behind an L3Out.

  - Importing existing DHCP policies from APIC.

  - DHCP relay policy configuration in Global Fabric Access Policies is not supported

  - Multiple DHCP servers within the same DHCP relay policy and EPG.

    If you configure multiple providers under the same DHCP relay policy, they must be in different EPGs or external EPGs.

Creating DHCP Relay Policies

This section describes how to create a DHCP relay policy.

Note If you make changes to the DHCP policy after you have assigned it to a bridge domain and deployed the bridge domain to one or more sites, you will need to re-deploy the bridge domain for the DHCP policy changes to update on each site's APIC.

Before you begin

You must have the following:

- A DHCP server set up and configured in your environment.
- If the DHCP server is part of an application EPG, that EPG must be already created in the Multi-Site Orchestrator.
- If the DHCP server is external to the fabric, the external EPG associated to the L3Out that is used to access the DHCP server must be already created.

Step 1 Log in to your Multi-Site Orchestrator GUI.

Step 2 From the left navigation menu, select **Policies**.

Step 3 In the top right of the main pane, click **Add Policy** and select **DHCP**.

This opens an **Add DHCP** configuration screen.

Step 4 In the **Name** field, specify the name for the policy.

Step 5 From the **Select Tenant** dropdown, select the tenant that contains the DHCP server.

Step 6 (Optional) In the **Description** field, provide a description for the policy.

Step 7 Select `Relay` for the **Type**.

Step 8 Click **+Provider**.

Step 9 Select the provider type.

When adding a relay policy, you can choose one of the following two types:

- `Application EPG`—specifies a specific application EPG that includes the DHCP server you are adding as an endpoint.
- `L3 External Network`—specifies the External EPG associated to the L3Out that is used to access the DHCP server.

Note You can select any EPG or external EPG that has been created in the Orchestrator and assigned to the tenant you specified, even if you have not yet deployed it to sites. If you select an EPG that hasn't been deployed, you can still complete the DHCP relay configuration, but you will need to deploy the EPG before the relay is available for use.

Step 10 From the dropdown menu, pick the EPG or external EPG.

Step 11 In the **DHCP Server Address** field, provide the IP address of the DHCP server.

Step 12 Click **Save** to add the provider.

Step 13 (Optional) Add any additional providers.

Repeat steps 9 through 12 for each additional DHCP server.

Step 14 Click **Save** to save the DHCP relay policy.

Creating DHCP Option Policies

This section describes how to create a DHCP option policy. DHCP options are appended to the end of the messages that DHCP servers and clients exchange and can be used to provide additional configuration information to your DHCP server. Each DHCP option has a specific code that you must provide when adding the option policy. For a complete list of DHCP options and codes, see RFC 2132.

Before you begin

You must have the following already configured:

- A DHCP server set up and configured in your environment.
- An EPG that contains the DHCP server already created in the Multi-Site Orchestrator.
- A DHCP Relay policy created, as described in Creating DHCP Relay Policies, on page 136.

Step 1 Log in to your Multi-Site Orchestrator GUI.

Step 2 From the left navigation menu, select **Application Management** > **Policies**.

Step 3 In the top right of the main pane, click **Add Policy** and select **DHCP**.

This opens an **Add DHCP** configuration screen.

Step 4 In the **Name** field, specify the name for the policy.

This is a name for the policy you're creating, not a specific DHCP option name. Each policy can contain multiple DHCP options.

Step 5 From the **Select Tenant** dropdown, select the tenant that contains the DHCP server.

Step 6 (Optional) In the **Description** field, provide a description for the policy.

Step 7 Select `Option` for the **Type**.

Step 8 Click **+Option**.

Step 9 Specify a name of the option.

While not technically required, we recommend using the same name for the option as listed in RFC 2132.

For example, `Name Server`.

Step 10 Specify an ID for the option .

You must provide the option code as listed in RFC 2132.

For example, `5` for Name Server option.

Step 11 Specify the option's data.

Provide the value if the option requires one.

For example, a list of name servers available to the client for the Name Server option.

Step 12 Click the check mark next to the **Data** field to save the option.

Step 13 (Optional) Repeat the steps to add any additional options.

Step 14 Click **Save** to save the DHCP option policy.

Assigning DHCP Policies

This section describes how to assign a DHCP policy to a bridge domain.

Note If you make changes to the DHCP policy after you have assigned it to a bridge domain and deployed the bridge domain to one or more sites, you will need to re-deploy the bridge domain it for the DHCP policy changes to be updated on each site's APIC.

Before you begin

You must have the following already configured:

- A DHCP relay policy, as described in Creating DHCP Relay Policies, on page 136.
- (Optional) A DHCP option policy, as described in Creating DHCP Option Policies, on page 138.
- The bridge domain to which you will assign the DHCP policy, as described in the Creating Schemas and Templates, on page 29 chapter.

Step 1 Log in to your Multi-Site Orchestrator GUI.

Step 2 From the left navigation menu, select **Application Management** > **Schemas**.

Step 3 Select the schema where the bridge domain is defined.

Step 4 Scroll down to the **Bridge Domain** area and select the bridge domain.

Step 5 In the right sidebar, scroll down and check the **DHCP Policy** option checkbox.

Step 6 From the **DHCP Relay Policy** dropdown, select the DHCP policy you want to assign to this BD.

Step 7 (Optional) From the **DHCP Option Policy** dropdown, select the option policy.

A DHCP option policy provides additional options to be passed to the DHCP relay. For additional details see Creating DHCP Option Policies, on page 138.

Step 8 Assign the bridge domain to any EPG that needs access to the DHCP server via the relay.

Creating DHCP Relay Contract

DHCP packets are not filtered by contracts but contracts are required in many cases to propagate routing information within the VRF and across VRFs. Even though the DHCP packets are not filtered it is recommended to configure contracts between the client EPG and the EPG configured as the provider in the DHCP relay policy.

This section describes how to create a contract between the EPG that contains the DHCP server and the EPG that contains endpoints that need to use the relay. Even though you have already created and assigned the

DHCP policy to the bridge domain and the bridge domain to the clients' EPG, you must create and assign the contract to enable programming of routes to allow client to server communication.

Before you begin

You must have the following already configured:

- A DHCP relay policy, as described in Creating DHCP Relay Policies, on page 136.
- (Optional) A DHCP option policy, as described in Creating DHCP Option Policies, on page 138.
- The bridge domain to which you have assigned the DHCP policy, as described in Assigning DHCP Policies, on page 139.

Step 1 Log in to your Multi-Site Orchestrator GUI.

Step 2 From the left navigation menu, select **Schemas**.

Step 3 Select the schema where you want to create the contract.

Step 4 Create a contract.

DHCP packets are not filtered by the contract so no specific filter is required, but a valid contract should be created and assigned to ensure proper BD and routes deployment.

a) Scroll down to the **Contracts** area and click **+** to create a contract.
b) In the right sidebar, provide the **Display Name** for the contract.
c) From the **Scope** dropdown, select the appropriate scope.

   Because the DHCP server EPG and application EPG must be in the same tenant, you can select one of the following:

   - `vrf`, if both EPGs are in the same VRF
   - `tenant`, if the EPGs are in different VRFs

d) You can leave the **Apply Both Directions** knob on.

Step 5 Assign the contract to the DHCP relay EPG.

a) Browse to the template where the EPG is located.
b) Select the EPG or external EPG where the DHCP server resides.

   This is the same EPG you selected when creating the DHCP relay policy.

c) In the right sidebar, click **+Contract**.
d) Select the contract you created and `provider` for its type.

Step 6 Assign the contract to the application EPG whose endpoints require DHCP relay access.

a) Browse to the template where the application EPG is located.
b) Select the application EPG.
c) In the right sidebar, click **+Contract**.
d) Select the contract you created and `consumer` for its type.

Verifying DHCP Relay Policies in APIC

This section describes how to verify that the DHCP relay policies you have created and deployed using the Multi-Site Orchestrator are correctly pushed to each site's APIC. The DHCP policies you create are pushed to the APIC when the bridge domain to which the policy is associated is deployed to a site.

Step 1 Log in to the site's APIC GUI.

Step 2 From the top navigation bar, select **Tenants** > **<tenant-name>**.

Select the tenant where you deployed the DHCP policy.

Step 3 Verify that the DHCP relay policy is configured in APIC.

In the left tree view, navigate to **<tenant-name>** > **Policies** > **Protocol** > **DHCP** > **Relay Policies**. Then confirm that the DHCP relay policy you configured has been created.

Step 4 Verify that the DHCP option policy is configured in APIC.

If you have not configured any DHCP option policies, you can skip this step.

In the left tree view, navigate to **<tenant-name>** > **Policies** > **Protocol** > **DHCP** > **Option Policies**. Then confirm that the DHCP option policy you configured has been created.

Step 5 Verify that the DHCP policy is correctly associated with the bridge domain.

In the left tree view, navigate to **<tenant-name>** > **Networking** > **Bridge Domains** > **<bridge-domain-name>** > **DHCP Relay Labels**. Verify that the DHCP policy is also associated with the deployed bridge domain.

Editing or Deleting Existing DHCP Policies

This section describes how to edit or delete a DHCP relay or option policy.

Note

- If you make changes to the DHCP policy after you have assigned it to a bridge domain and deployed the bridge domain to one or more sites, you will need to re-deploy it for the DHCP policy changes to update on each site's APIC.
- You cannot deleted policies that are associated with one or more bridge domains, you must first unassign the policy from every bridge domain.

Step 1 Log in to your Multi-Site Orchestrator GUI.

Step 2 From the left navigation menu, select **Policies**.

Step 3 Click the actions menu next to the DHCP policy and select **Edit** or **Delete**.

CHAPTER 15

Intersite L3Out

Intersite L3Out Overview

Prior to Release 2.2(1), each site managed by the Multi-Site Orchestrator required its own local L3Out configured in order to route traffic out of the fabric, which often resulted in lack of communication between endpoints in one site and a service (such a firewall, server load balancer, or mainframe) connected to the L3Out of another site.

Release 2.2(1) adds a feature that enables a number of scenarios in which endpoints located in one site are able to establish connectivity with entities, such as external network, mainframe, or service nodes, reachable through a remote L3Out.

These include the following:

- L3Out across sites—endpoints in an application EPG in one site using an L3Out in another site (both part of the same VRF).
- Intersite transit routing—establishing communication between entities (such as endpoints, network devices, service nodes) connected behind L3Outs deployed in different sites (both L3Outs part of the same VRF).
- Shared services for intersite L3Out—application EPG to remote L3Out or intersite transit routing.

The following sections are divided into the generic GUI procedures you can follow to create the objects required to implement intersite L3Out use cases followed by overview and workflows specific to each supported use case scenario.

Note The term "intersite L3Out" refers to the functionality allowing communication to external resources reachable via the L3Out connection of a remote site. However, in this document, the term may also be used to indicate the specific remote L3Out object.

Intersite L3Out Guidelines and Limitations

When configuring intersite L3Out, you must consider the following:

- Intersite L3Out is supported for IPv4 and IPv6.
- With intersite L3Out, in addition to the BGP eVPN sessions that are always established between sites in Multi-Site topology, MP BGP VPNv4 (or VPNv6) sessions are created to support the intersite L3Out feature.
- If you are upgrading from a release prior to Release 2.2(1), any existing External EPG to L3Out association at the site-local level will be preserved. In addition, the Multi-Site Orchestrator will now support creation of an L3Out and associating it with an External EPG at the template level.

  When creating a new L3Out in a schema template and associating it to an existing External EPG:

  - If the L3Out has the **same name** as the L3Out already defined in the APIC, the Orchestrator will take ownership of that L3Out but will not manage the configuration of L3Out node profiles, interface profiles, protocol settings, or route control settings.

    Note If the L3Out already exists in APIC, we recommend importing it into Multi-Site Orchestrator along with any associated external EPG instead of creating a new L3Out with the same name from MSO.

    If you then choose to delete this L3Out from the Orchestrator, it will no longer be managed by the Orchestrator, but any previously existing L3Out configuration will be preserved in the APIC.

  - If the L3Out has a **different name** than the APIC defined L3Out the external EPG will be removed from the APIC defined L3Out and added to the L3Out defined in the Orchestrator. If this is the only external EPG under the APIC defined L3Out this can cause the configuration to be removed from the border leaves and can impact traffic.

- If you choose to downgrade to a release prior to Release 2.2(1), the L3Outs created in the Orchestrator MSO will no longer exist in the template so any template-level association between External EPG and L3Out will be removed. In this case, you will need to manually re-configure the External EPG to L3Out association at the site-local level. Any site-local associations will be preserved during the downgrade.
- You can now associate a bridge domain in one site with the L3Out in another site, however they must both be in the same tenant.

  This association is performed at the site-local level and is required to advertise the BD subnet out of the remote L3Out and ensure that inbound traffic to the BD can be maintained even if the local L3Out failed.

- The Policy Control Enforcement direction for the VRF associated to the intersite L3Out must be kept configured in the default ingress mode.

- The following scenarios are not supported with intersite L3Out and remote leaf (RL):
  - Transit routing between L3Outs deployed on RL pairs associated to separate sites
  - Endpoints connected to a RL pair associated to a site communicating with the L3Out deployed on the RL pair associated to a remote site
  - Endpoints connected to the local site communicating with the L3Out deployed on the RL pair associated to a remote site
  - Endpoints connected to a RL pair associated to a site communicating with the L3Out deployed on a remote site
- The following other features are not supported with intersite L3Out in ACI Multi-Site:
  - Multicast receivers in a site receiving multicast from an external source via another site L3Out. Multicast received in a site from an external source is never sent to other sites. When a receiver in a site receives multicast from an external source it must be received on a local L3Out.
  - An internal multicast source sending multicast to an external receiver with PIM-SM any source multicast (ASM). An internal multicast source must be able to reach an external Rendezvous Point (RP) from a local L3Out
  - GOLF
  - Preferred Groups for External EPG

Configuring External TEP Pool

Intersite L3Out requires a external TEP address for the border leaf switches in each pod. If you already have an external TEP pool configured, for example for another feature such as Remote Leaf, the same pool can be used. The existing TEP pool will be inherited by the Multi-Site Orchestrator and shown in the GUI as part of the infra configuration. Otherwise, you can add a TEP pool in the GUI, as described in this section.

Note Every pod must be assigned a unique TEP pool and it must not overlap with any other TEP pool in the fabric

Step 1 Log in to your Cisco ACI Multi-Site Orchestrator.

Step 2 From the left navigation pane, select **Infrastructure** > **Infra Configuration**.

Step 3 In the top right of the main pane, click **Configure Infra**.

Step 4 In the left sidebar, select the site you want to configure.

Step 5 In the main window, click a pod in the site.

Step 6 In the right sidebar, click **+Add TEP Pool**.

Step 7 In the **Add TEP Pool** window, specify the external TEP pool you want to configure for that site.

Note You must ensure that the TEP pool you are adding does not overlap with any other TEP pools or fabric addresses.

Step 8 Repeat the process for each site and pod where you plan to use intersite L3Outs.

Creating or Importing Intersite L3Out and VRF

This section describes how to create an L3Out and associate it to a VRF in the Orchestrator GUI, which will then be pushed out to the APIC site, or import an existing L3Out from one of your APIC sites. You will then associate this L3Out with an external EPG and use that external EPG to configure specific intersite L3Out use cases.

Note The VRF you assign to the L3Out can be in any template or schema, but it must be in the same tenant as the L3Out.

Step 1 Log in to your Cisco ACI Multi-Site Orchestrator.

Step 2 From the left navigation pane, select **Application Management** > **Schemas**.

Step 3 Select the schema and then the template where you want to create or import the VRF and L3Out.

We recommend creating the L3Out in a template that is associated with a single site, in which case the L3Out will be created in that site only.

Alternatively, you can choose to create the L3Out in a template that is associated to multiple sites. In this case the L3Out will be created with the same name across all sites, which may bring some functional restrictions, as explained later in this chapter

Step 4 Create a new VRF and L3Out.

If you want to import an existing L3Out, skip this step.

Note While you can create the L3Out object in the Orchestrator and push it out to the APIC, the physical configuration of the L3Out must be done in the APIC.

a) Scroll down to the **VRF** area and click the **+** icon to add a new VRF.

   If you already have the VRF you plan to use for the L3Out, skip this substep.

   In the right sidebar, provide the name for the VRF, for example `vrf-l3out`

b) Scroll down to the **L3Out** area and click the **+** icon to add a new L3Out.

   In the right sidebar, provide the required information.

c) Provide the name for the L3Out, for example `l3out-intersite`.

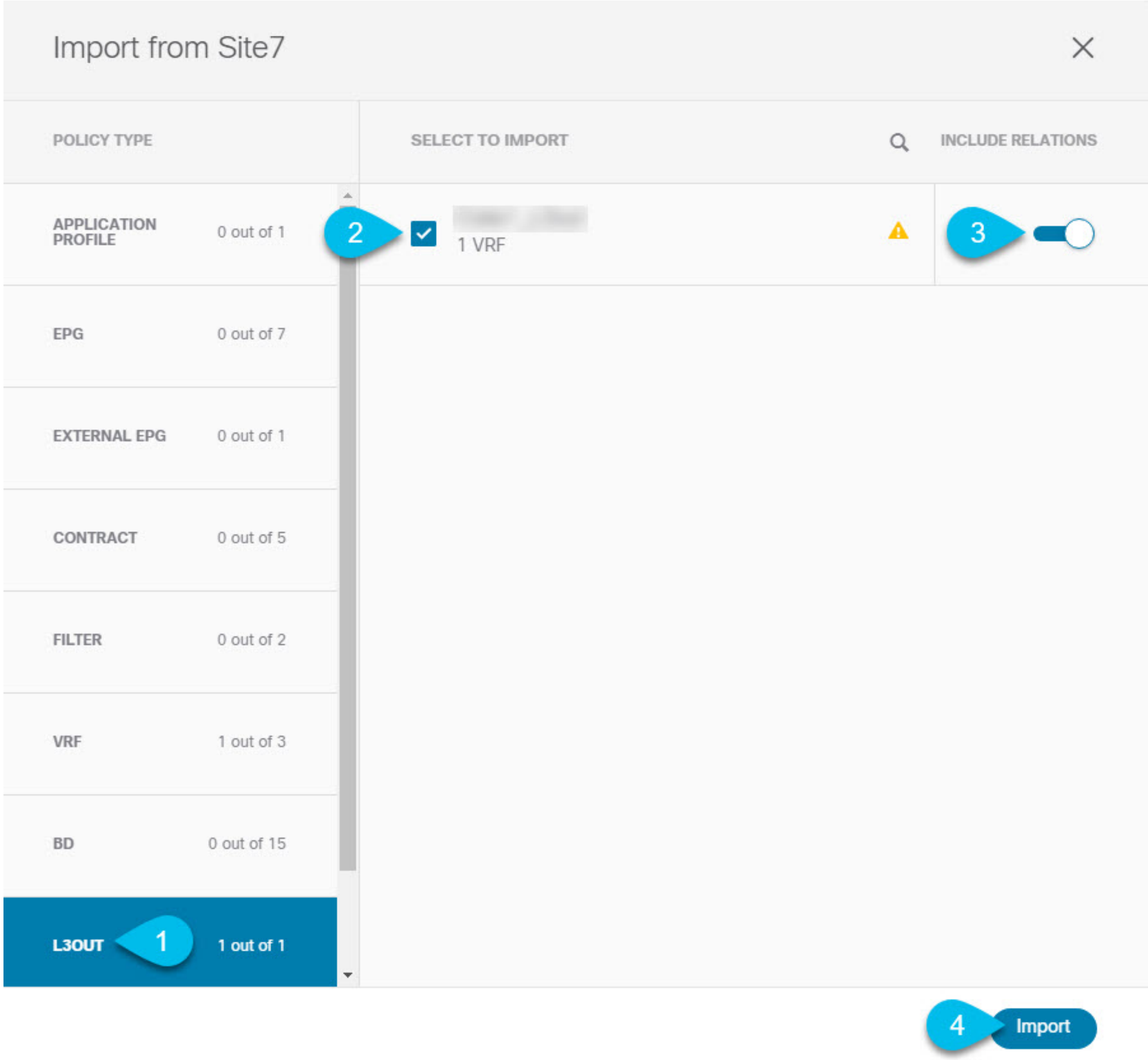
d) From the **Virtual Routing & Forwarding** dropdown, select the VRF.

   Select the VRF you created in the first substep or choose a previously existing VRF.

Step 5 Import an existing VRF and L3Out.

If you created a new L3Out in previous step, skip this step.

Click **Import** in the main window pane to open at the



a) At the top of the main template view, click **Import**.

b) Select the site from which you want to import the L3Out.

c) In the import window's **Policy Type** menu, select **L3Out**.

d) Check the L3Out you want to import.

By default, importing the L3Out will also import the corresponding VRF. This may not be desirable when importing the L3Out in a site specific template as you would typically define the VRF in a stretched template associated to multiple sites. In this case, disable the **Include Relations** option before importing the L3Out. In this case, you will also need to re-map the L3Out to the correct VRF after importing it.

e) Click **Import**.

f) If you imported only the L3Out, select it in the template view and associate it to the appropriate VRF.

Configuring External EPG to Use Intersite L3Out

This section describes how to create an external EPG that will be associated to the intersite L3Out. You can then use this external EPG and contracts to configure specific use cases for endpoints in one site to use an L3Out in another site.

Before you begin

Create the L3Out and associate it with a VRF as described in Creating or Importing Intersite L3Out and VRF, on page 146.

Step 1 Select the template where you want to create the external EPG.

If you create the external EPG in a template that is associated to multiple sites, the external EPG will be created on all of those sites. This is recommended when the external EPG's L3Outs provide access to a set of common external resources, for example the WAN.

If you create the external EPG in a template that is associated with a single site, the external EPG will be created in that site only. This is recommended when the external EPG's L3Out provides access to external resources accessible only from that site.

Step 2 Scroll down to the **External EPG** area and click the **+** icon to add an external EPG.

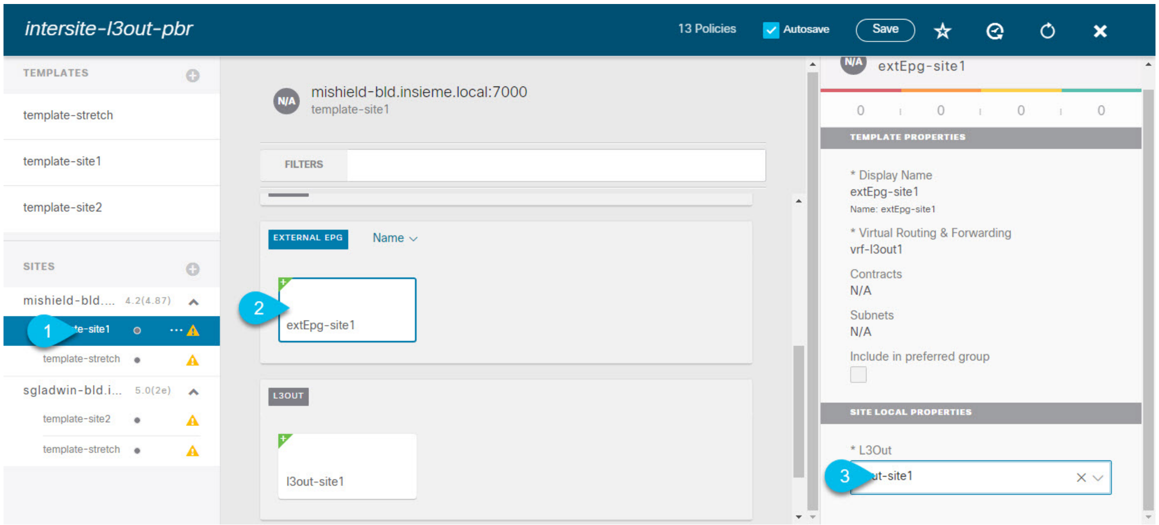
In the right sidebar, provide the required information.

a) Provide the name for the external EPG, for example `eepg-intersite-l3out`.
b) From the **Virtual Routing & Forwarding** dropdown, select the VRF you created and used for the L3Out.

Step 3 Map the external EPG to the L3Out.

You can map the external EPG to an L3Out at the site level or at the template level. We recommend creating the mapping at the site level because commonly each site defines a local L3Out with a unique name so the external EPG can be selectively mapped to each site specific L3Out independent of whether the external EPG itself is stretched.

To associate an L3Out with the external EPG at the site-local level:



intersite-l3out-pbr

mishield-bld.insieme.local:7000
template-site1

extEpg-site1

TEMPLATE PROPERTIES

* Display Name
extEpg-site1
Name: extEpg-site1

* Virtual Routing & Forwarding
vrf-l3out1

Contracts
N/A

Subnets
N/A

Include in preferred group
□

SITE LOCAL PROPERTIES

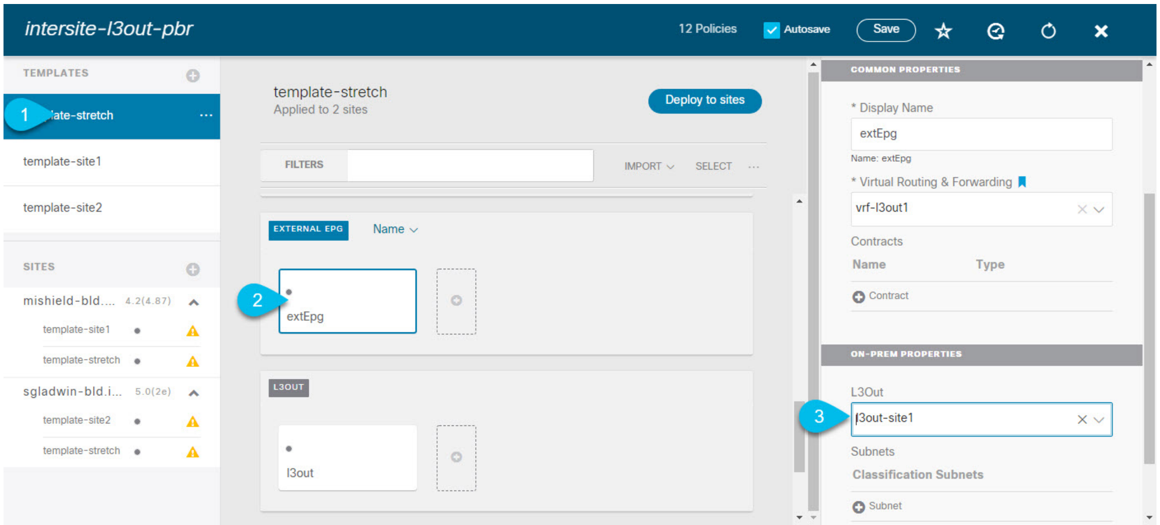
* L3Out
l3out-site1

a) In the left sidebar of the schema view, select the site where the external EPG is deployed.
b) Scroll down to the **External EPG** area and select the external EPG.
c) In the right sidebar, scroll down to the **L3Out** dropdown and choose the intersite L3Out you created.

   In this case, both the APIC-managed and the Orchestrator-managed L3Outs will be available for selection. You can select either the L3Out you have created in the previous section specifically for this or pick an L3Out that exists in the site's APIC.

Alternatively, you can map the external EPG to an L3Out at the template level. While this could ease the configuration in deployments where multiple sites have defined the same L3Out name, we do not recommend this approach as it allows less flexibility for the type of connectivity that can be established between the fabrics that are part of the Multi-Site domain and the external routed network. For example, it would not be possible to control where a specific BD's subnets are advertised because mapping the BD to the L3Out would cause the BD subnet to be advertised out of all the L3Outs in all the sites since all the L3Outs have the same name.

To associate an L3Out with the external EPG at the template level:



* Display Name: extEpg
Name: extEpg
* Virtual Routing & Forwarding: vrf-l3out1
L3Out: l3out-site1

a) In the left sidebar of the schema view, select the template where the external EPG is located
b) Scroll down to the **External EPG** area and select the external EPG.
c) In the right sidebar, scroll down to the **L3Out** dropdown and choose the intersite L3Out you created.

In addition, it is possible to migrate the configuration of an external EPG initially associated to the L3Out at the template level to a site-level mapping by removing the VRF association on the external EPG, re-associating the external EPG to the same VRF, then mapping the L3Outs at the site level. If this process is completed at once before deploying the template, there would be no traffic impact when pushing the new configuration as no changes are actually applied on the APIC side.

Step 4 Configure one or more subnets for the external EPG.

a) Select the external EPG.
b) In the right sidebar, click **+Add Subnet**.
c) In the **Add Subnet** window, provide the classification subnet and the required options.

   The prefixes and options you configure depend on the specific use cases:

   - To classify the inbound traffic as belonging to the external EPG, select the **External Subnets for External EPG** flag for the specified prefix. Depending on the specific use case, this allows you to apply a contract with an internal EPG or with the external network domain reachable via a remote L3Out.

- To advertise the external prefixes learned from another L3Out (in the same site or in a remote site) out of this L3Out, select the **Export Route Control** flag for the specified prefix. When specifying the `0.0.0.0/0` prefix, the **Aggregate Export** flag can be selected to advertise all prefixes out of the L3Out; if the **Aggregate Export** flag is not enabled, only the default route `0.0.0.0/0` would be advertised, if present in the routing table of the border leaf nodes.
- To filter out specific routes received from the external network, select the **Import Route Control** flag for the specified prefix. If specifying the `0.0.0.0/0`, you can also choose the **Aggregate Import** option.

  Note that this is possible only when peering BGP with the external routers.
- To leak routes to different VRFs, select the **Shared Route Control** and the associated **Aggregate Shared Routes** flags, as well as the **Shared Security Import** flag. These options are required for the specific use case of inter-VRF shared L3Out and inter-VRF intersite transit routing.

Creating a Contract for Intersite L3Out

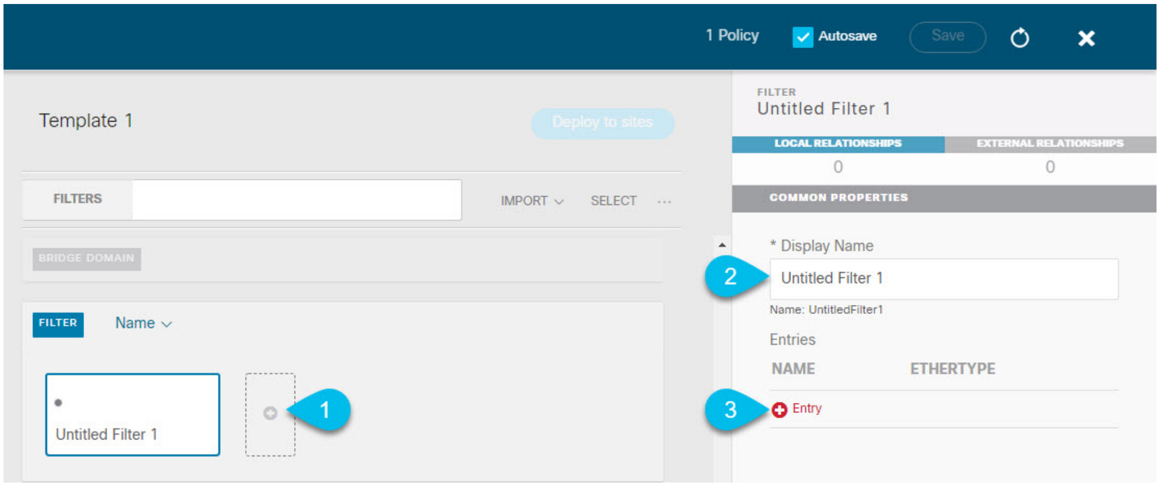
This section describes how to create a filter and a contract you will use to enable communication between an application EPG deployed in a site and the external EPG associated to an L3Out in a different site (intersite L3Out functionality).

Step 1 Select the template where you want to create contract and filter.

You can use the same schema and template where you created the L3Out, VRF, and the external EPG or you can choose a different schema and template.

Because the contract is applied to objects (EPGs and external EPGs) deployed in different sites, we recommend defining it in a template associated to multiple sites. However, this is not strictly required and even if the contract and filters are defined only as local objects in Site1, MSO will create the corresponding shadow objects in a remote Site2 when a local EPG or external EPG in Site2 needs to consume or provide that contract.

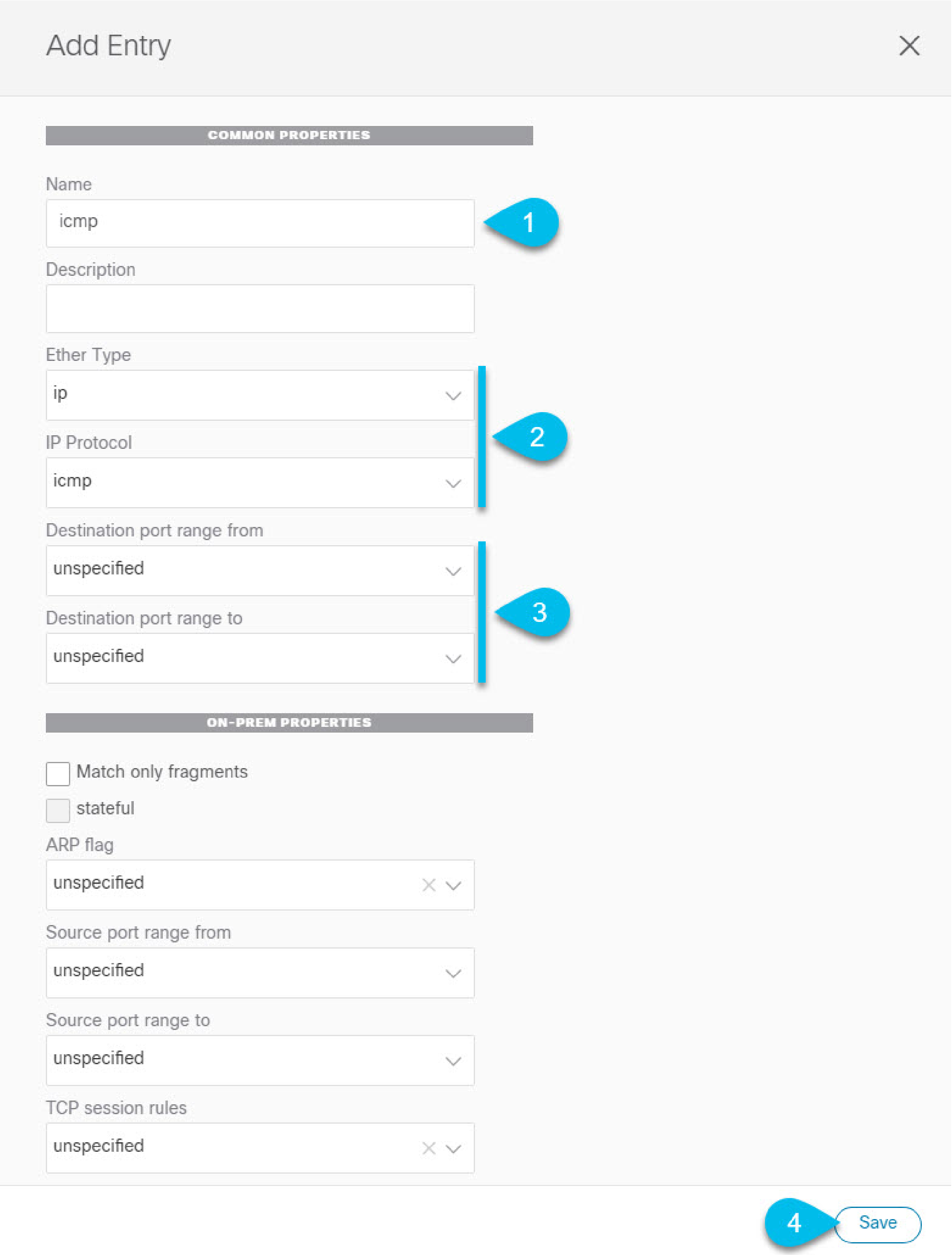
Step 2 Create a filter.



a) In the middle pane, scroll down to the **Filter** area, then click + to create a filter.

b) In the right pane, provide the **Display Name** for the filter.
c) In the right pane, click **+ Entry**.

Step 3 Provide the filter details.



Add Entry

COMMON PROPERTIES

Name: icmp

Description:

Ether Type: ip

IP Protocol: icmp

Destination port range from: unspecified

Destination port range to: unspecified

ON-PREM PROPERTIES

□ Match only fragments

□ stateful

ARP flag: unspecified

Source port range from: unspecified

Source port range to: unspecified

TCP session rules: unspecified

a) Provide the **Name** for the filter.

b) Choose the **Ether Type**.

For example, `ip`.

c) Choose the **IP Protocol**.

For example, `icmp`.

d) Leave other properties unspecified.
e) Click **Save** to save the filter.

Step 4 Create a contract

a) In the middle pane, scroll down to the **Contract** area and click **+** to create a contract.
b) In the right pane, provide the **Display Name** for the contract
c) Select the appropriate **Scope** for the contract.

If you plan to configure different VRFs for the intersite L3Out and application EPG, you must select `tenant` for the scope. Otherwise, if both are in the same VRF, you can set the scope to `vrf`.

d) Toggle the **Apply both directions** knob if you want the same filter to apply for both consumer-to-provider and provider-to-consumer directions.

If you enable this option, you will need to provide the filters only once and they will apply for traffic in both directions. If you leave this option disabled, you will need to provide two sets of filter chains, one for each direction.

Step 5 Assign the filters to the contract

a) In the right pane, scroll down to the **Filter Chain** area and click **+ Filter** to add a filter to the contract.

If you disabled the `Apply both directions` option, repeat this stem for the other filter chain.

b) In the **Add Filter Chain** window that opens, select the filter you added in previous step from the **Name** dropdown menu.
c) Click **Save** to add the filter to the contract.

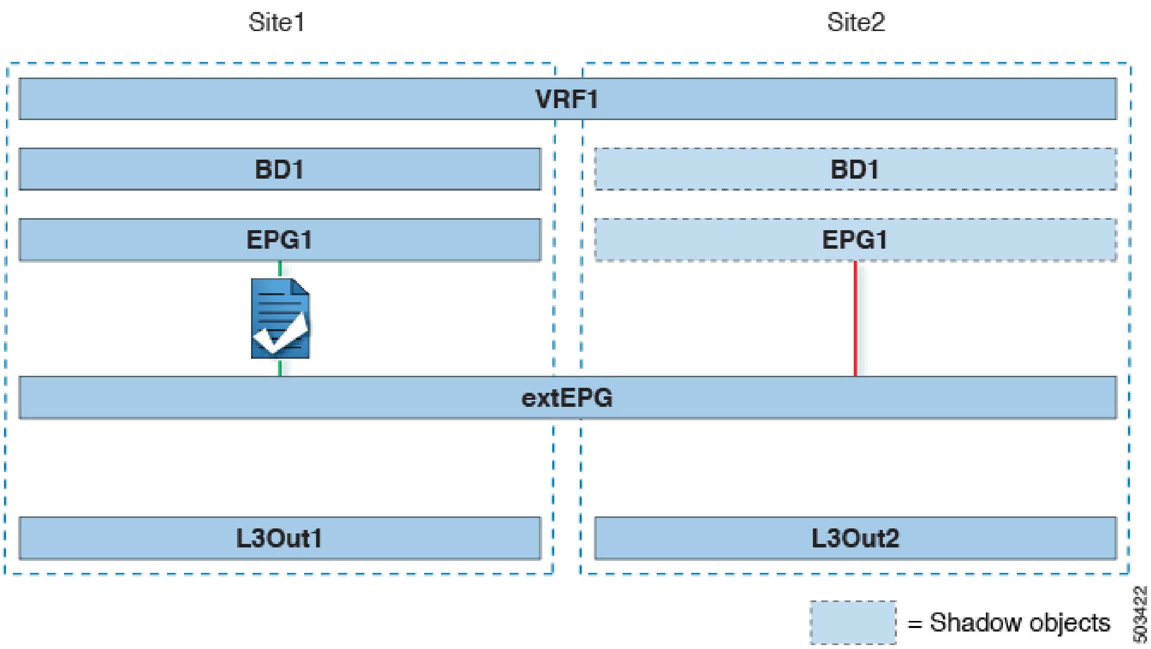
Use Cases

Intersite L3Out for Application EPGs (Intra-VRF)

This section describes the configuration required to allow endpoints that are part of an application EPG to communicate with the external network domain reachable through an L3Out deployed in another site but within the same VRF (intra-VRF).

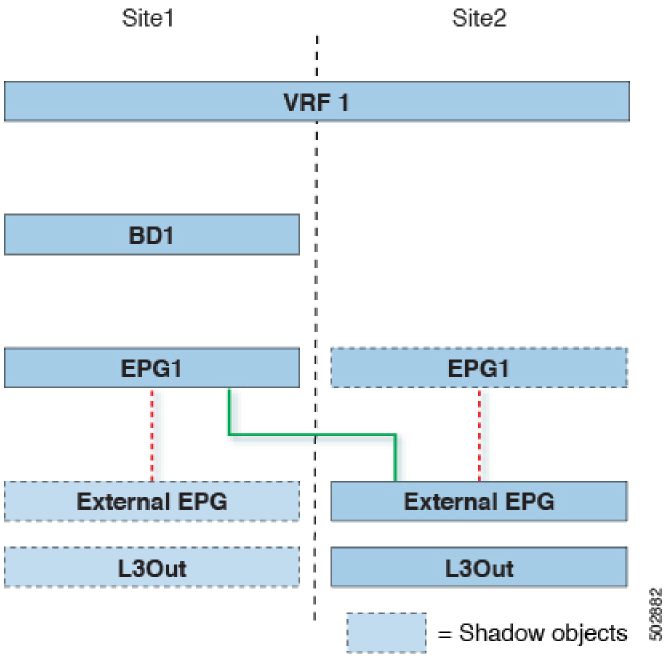
The first figure below shows a stretched external EPG and the associated L3Outs which will be created in both sites. An application EPG (`EPG1`) is created in Site 1 and has a contract with the external EPG. This use case is recommended when the L3Outs in the separate sites provide access to a common set of external resources. It simplifies the policy definition and external traffic classification, while still allowing you to apply route-map policies separately on each L3Out for the independent APIC domains.

Figure 23: Stretched External EPG



The second figure below shows a similar use case but with the external EPG being deployed to only the site where the physical L3Out is located. The application EPG and the contract are configured in the same exact way to allow the traffic flow between the EPG in one site and the physical L3Out in the other.

Figure 24: Non-Stretched (Site-Local) External EPG



The following steps describe the configuration required to implement the use case shown in Figure 1, which represents the most common scenario. If you want to deploy the use case shown in Figure 2, you can adapt the procedure with minor changes.

Before you begin

You need to have the following already configured:

- A schema with three templates.

  Create a template for each site (for example, `template-site1` and `template-site2`) where you will configure the objects unique to that site, such as the application EPG and the L3Outs. In addition, create a separate templates (for example, `template-stretched`) that you will use for the stretched objects, which in this case will be the external EPG.

- The L3Outs in each site, as described in the Creating or Importing Intersite L3Out and VRF, on page 146 section.

  In this use case, a separate L3Out will be imported or created in each site-specific template.

- The external EPG for the intersite L3Out, as described in Configuring External EPG to Use Intersite L3Out, on page 148.

  In this use case, the external EPG is configured as a stretched object that is defined in the stretched template (`template-stretched`). Assuming that the external EPG provides access to the entire external address space, we recommend configuring a `0.0.0.0/0` prefix for classification to avoid specifying a long list of more specific prefixes.

- The contract you will use between the application EPG and the L3Out external EPG, as described in Creating a Contract for Intersite L3Out, on page 150.

  We recommend creating the contract and the filter in the stretched template (`template-stretched`).

Step 1 Log in to your Cisco ACI Multi-Site Orchestrator.

Step 2 From the left navigation pane, select **Application Management** > **Schemas**.

Step 3 Select the schema and template for the application EPG and bridge domain.

In this use case, you will associate the template to Site1.

Step 4 Configure an application EPG and its bridge domain belonging to the same VRF as the L3Out.

If you already have an EPG that will use the intersite L3Out, you can skip this step.

You can create a new or import an existing EPG and bridge domain as you typically would.

Step 5 Assign the contract to the application EPG.

a) Select the EPG.
b) In the right sidebar, click **+Contract**.
c) Select the contract you created in previous section and its type.

   You can choose whether the application EPG is the `consumer` or the `provider`.

Step 6 Assign the contract to the external EPG mapped to the remote L3Out.

a) Select the `template-stretched` where the external EPG is located.
b) Select the external EPG.
c) In the right sidebar, click **+Contract**.
d) Select the contract you created in previous section and its type.

If you chose the application EPG to be the `consumer`, choose `provider` for the external EPG. Otherwise, choose `consumer` for the external EPG.

Step 7 Associate the application EPG's bridge domain with the L3Out.

This enables the BD subnet to be advertised out of the L3Out toward the external network domain. Note that the subnet(s) associated to the BD must be configured with the **Advertised Externally** option to be advertised out of the L3Out

a) In the left sidebar, under **Sites**, select the application EPG's template.
b) Select the bridge domain associated with the application EPG.
c) In the right sidebar, click **+L3Out**.
d) Select the intersite L3Out you created.

For the use case shown in Figure 1, associate the BD to both the L3Outs defined in Site1 and Site2 to ensure that the external network can have access to the EPG from both paths. Specific policies can be associated to the L3Out or to the external routers to ensure that a specific L3Out path is normally preferred for inbound traffic. We recommend this when the EPG and BD are local to a site (as in the specific example) to avoid suboptimal inbound traffic path via the remote site's L3Out.

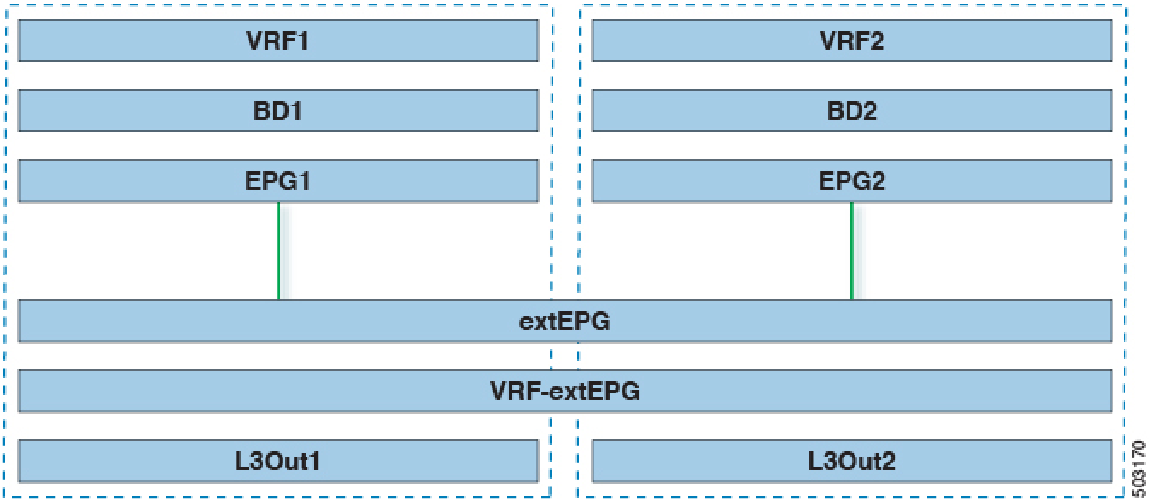
Step 8 Deploy the schema.

Shared Services with Intersite L3Out for Application EPGs (Inter-VRF)

This section describes the configuration required to allow endpoints that are part of an application EPG in one VRF to communicate with the external network domain reachable through an L3Out deployed in another site and different VRF, this is also known as "Shared Services".

This scenario is recommended when the L3Outs in separate sites provide access to a common set of external resources. It simplifies the policy definition and external traffic classification, while still allowing you to apply route-map policies separately on each L3Out for the independent APIC domains. In this case, the application EPGs can be

Figure 25: Stretched External EPG, Site-Local L3Outs and Application EPGs



The following steps describe the configuration required to implement the use case shown in Figure 1, which represents the most common scenario. If you want to deploy the use case shown in Figure 2, you can adapt the procedure with minor changes.

Before you begin

You need to have the following already configured:

- A schema with three templates.

  Create a template for each site (for example, `template-site1` and `template-site2`) where you will configure the objects unique to that site, such as the application EPGs and the L3Outs. In addition, create a separate templates (for example, `template-stretched`) that you will use for the stretched objects, which in this case will be the external EPG.

- The L3Outs in each site, as described in the Creating or Importing Intersite L3Out and VRF, on page 146 section.

  In this use case, a separate L3Out will be imported or created in each site-specific template.

- The external EPG for the intersite L3Out, as described in Configuring External EPG to Use Intersite L3Out, on page 148.

  In this use case, the external EPG is configured as a stretched object that is defined in the stretched template (`template-stretched`). Assuming that the external EPG provides access to the entire external address space, we recommend configuring a `0.0.0.0/0` prefix for classification to avoid specifying a long list of more specific prefixes.

  For this specific shared services use case, you are also required to enable the **Shared Route Control** and the **Shared Security Import** flags for the subnet(s) associated to the external EPG(s) of the remote L3Out. If you are using the `0.0.0.0/0` prefix for classification on the external EPG, in addition to the **Shared Route Control** flag, also enable the **Aggregate Shared Routes** flag.

- The contract you will use between the application EPG and the L3Out external EPG, as described in Creating a Contract for Intersite L3Out, on page 150.

  We recommend creating the contract and the filter in the stretched template (`template-stretched`).

Step 1 Log in to your Cisco ACI Multi-Site Orchestrator.

Step 2 From the left navigation pane, select **Application Management** > **Schemas**.

Step 3 Select the schema and template for the application EPG and bridge domain.

In this use case, you will associate the template to Site1.

Step 4 Configure an application EPG and its bridge domain belonging to a separate VRF from the L3Out's.

If you already have an EPG that will use the intersite L3Out, you can skip this step.

You can create a new or import an existing EPG and bridge domain as you typically would.

Step 5 Assign the contract to the application EPG.

a) Select the EPG.

b) In the right sidebar, click **+Contract**.

c) Select the contract you created in previous section and its type.

   You can choose whether the application EPG is the `consumer` or the `provider`.

Note If the application EPG is configured as `provider`, you need to configure the subnet already defined under the BD also under the EPG in order to leak that route into the L3Out VRF. The same flags used under the BD for the subnet should also be set under the EPG. In addition to that, for the subnet under the EPG the flag **No default SVI Gateway** should also be enabled, since the default gateway function is enabled at the BD level.

Step 6 Assign the contract to the external EPG mapped to the L3Outs.

a) Select the `template-stretched` where the external EPG is located.
b) Select the external EPG.
c) In the right sidebar, click **+Contract**.
d) Select the contract you created in previous section and its type.

If you chose the application EPG to be the `consumer`, choose `provider` for the external EPG. Otherwise, choose `consumer` for the external EPG.

Step 7 Associate the application EPG's bridge domain with the L3Out.

This enables the BD subnet to be advertised out of the L3Out toward the external network domain. Note that the subnet(s) associated to the BD must be configured with the **Advertised Externally** option to be advertised out of the L3Out

a) In the left sidebar, under **Sites**, select the application EPG's template.
b) Select the bridge domain associated with the application EPG.
c) In the right sidebar, click **+L3Out**.
d) Select the intersite L3Out you created.

For the use case shown in Figure 1, associate the BD to both the L3Outs defined in Site1 and Site2 to ensure that the external network can have access to the EPG from both paths. Specific policies can be associated to the L3Out or to the external routers to ensure that a specific L3Out path is normally preferred for inbound traffic. We recommend this when the EPG and BD are local to a site (as in the specific example) to avoid suboptimal inbound traffic path via the remote site's L3Out.

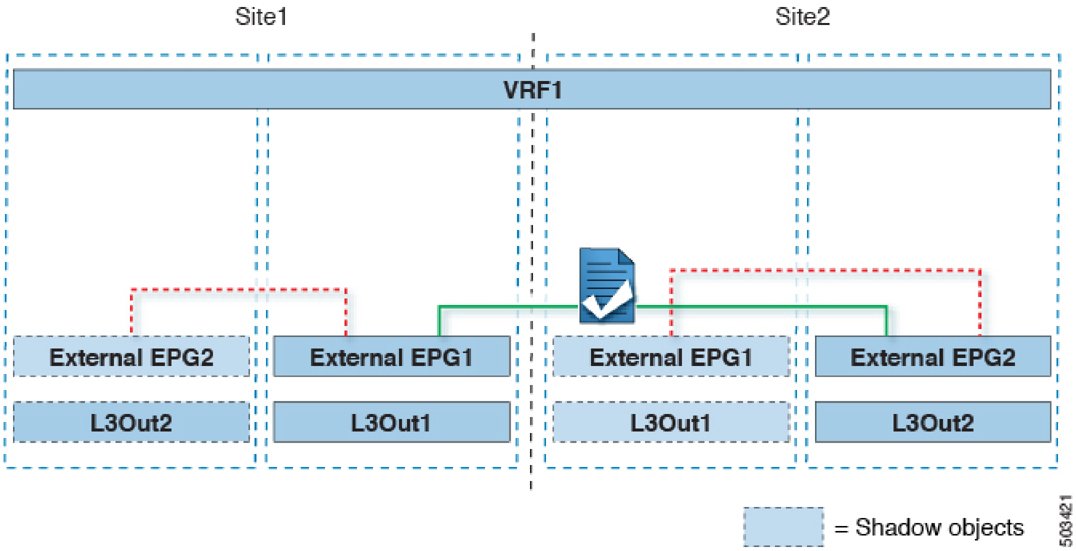
Step 8 Deploy the schema.

Intersite Transit Routing

This section describe the use cases where the ACI Multi-Site domain acts as a distributed router allowing communication between entities (endpoints, network devices, service nodes, etc.) connected behind L3Outs deployed in different sites, a functionality normally referred to as intersite transit routing. The intersite transit routing is supported for intra-VRF as well as inter-VRF use cases.

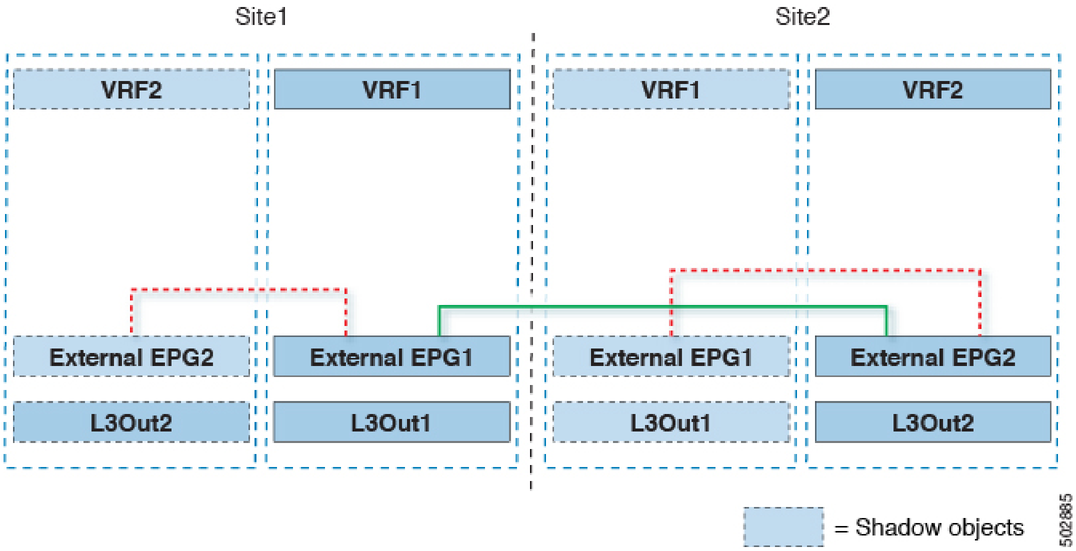
The figure below shows two L3Outs (`L3Out1` and `L3Out2`) configured in different sites. Each L3Out is associated with a respective external EPG (`External EPG1` and `External EPG2`). A contract between the two external EPGs allows communication between entities connected behind two different L3Outs in two different sites.

Figure 26: Intra-VRF Intersite Transit Routing



A similar configuration can be used when each site's L3Outs are in different VRFs.

Figure 27: Inter-VRF Intersite Transit Routing



The figures above show the two scenarios where the external EPGs and associated L3Outs are deployed as site-local objects; intersite transit routing can support all the combinations where neither external EPG is stretched, one of them is stretched, or both are stretched between sites.

When deploying intersite transit routing, the assumption is that the different external EPGs defined across sites are providing access to different external address spaces (obviously not overlapping). A couple of options are hence possible for the configuration of the prefix used for classification:

- Define the same `0.0.0.0/0` prefix on both external EPGs to ensure that inbound traffic received on the border leaf nodes of L3Out1 gets mapped to Ext-EPG1, whereas inbound traffic received on L3Out2 gets mapped to Ext-EPG2. Because the L3Outs are defined in separate fabrics, there are no conflict issues with this configuration.

The external prefixes received on `L3Out1` must be advertised out of `L3Out2` and vice versa. If you are using `0.0.0.0/0` as classification subnet on both external EPGs, it is sufficient to enable the **Export Route Control** and the **Aggregate Export** flags.

- Define specific prefixes for each external EPG. In this case, you must ensure that the prefixes are not overlapping to avoid a fault from being raised by the site's APIC when the shadow external EPG is created in that site for a contract between the local and remote external EPGs.

  When using specific prefixes, the same prefixes configured for classification on `External EPG1` must be configured with the **Export Route Control** flag set on `External EPG2` and vice versa.

Note No matter which of the two classification approaches you deploy, for the inter-VRF scenario you must also set the **Shared Route Control** (in addition to **Aggregate Shared Routes** if using `0.0.0.0/0`) and the **Shared Security Import** flags.

Before you begin

You need to have the following already configured:

- A schema with three templates.

  Create a template for each site (for example, `template-site1` and `template-site2`) where you will configure the objects unique to that site, such as the application EPGs and the L3Outs. In addition, create a separate templates (for example, `template-stretched`) that you will use for the stretched objects, which in this case will be the external EPG.

- The L3Outs in each site, as described in the Creating or Importing Intersite L3Out and VRF, on page 146 section.

  In this use case, a separate L3Out will be imported or created in each site-specific template.

- Two different external EPGs for two different L3Outs in different sites. You can use the same procedure to create both external EPGs, as described in Configuring External EPG to Use Intersite L3Out, on page 148.

- The contract you will use between the L3Out external EPGs defined in each site, as described in Creating a Contract for Intersite L3Out, on page 150.

  We recommend creating the contract and the filter in the stretched template (`template-stretched`).

Step 1 Log in to your Cisco ACI Multi-Site Orchestrator.

Step 2 From the left navigation pane, select **Application Management** > **Schemas**.

Step 3 Assign the contract to one of the external EPGs.

a) Select the schema and template where the external EPG is located.
b) Select the external EPG.
c) In the right sidebar, click **+Contract**.
d) Select the contract you created in previous section and its type.

   Choose `consumer` or `provider`.

Step 4 Assign the contract to the other external EPG.

a) Select the schema and template where the external EPG is located.
b) Browse to the template where the external EPG is located.
c) Select the external EPG.
d) In the right sidebar, click **+Contract**.
e) Select the contract you created in previous section and its type.

   Choose `provider` or `consumer`.

Step 5 Deploy the templates to appropriate sites.

CHAPTER 16

Intersite L3Out with PBR

Intersite L3Out with PBR

Cisco Application Centric Infrastructure (ACI) policy-based redirect (PBR) enables traffic redirection for service appliances, such as firewalls or load balancers, and intrusion prevention system (IPS). Typical use cases include provisioning service appliances that can be pooled, tailored to application profiles, scaled easily, and have reduced exposure to service outages. PBR simplifies the insertion of service appliances by using contract between the consumer and provider endpoint groups even if they are all in the same virtual routing and forwarding (VRF) instance.

PBR deployment consists of configuring a route redirect policy and a cluster redirect policy, and creating a service graph template that uses these policies. After the service graph template is deployed, you can attach it to a contract between EPGs so that all traffic following that contract is redirected to the service graph devices based on the PBR policies you have created. Effectively, this allows you to choose which type of traffic between the same two EPGs is redirected to the L4-L7 device, and which is allowed directly.

More in-depth information specific to services graphs and PBR is available in the *Cisco APIC Layer 4 to Layer 7 Services Deployment Guide*

PBR Support in ACI Multi-Site Deployments

Cisco ACI Multi-Site has supported EPG-to-EPG (east-west) and L3Out-to-EPG (north-south) contracts with PBR since Cisco APIC, Release 3.2(1). However, the L3Out-to-EPG across sites (traffic from an external endpoint in `site1` to an endpoint in `site2`) case was supported only if both sites had local L3Outs. The intersite L3Out use cases were limited to the examples and configurations described in the #unique_164 chapter. Similarly, the Service Graph integration with PBR but no intersite L3Out is described in great detail in the *Cisco ACI Multi-Site and Service Node Integration White Paper*.

Starting with Cisco APIC, Release 4.2(5), the L3Out-to-EPG with PBR across sites (intersite L3Out) use case has been extended to support cases where the application EPG has no local L3Out or the local L3Out is down.

Supported Use Cases

The following diagrams illustrate the traffic flows between the an ACI internal endpoint in application EPG and an external endpoint through the L3Out in another site in the supported intersite L3Out with PBR use cases.

The workflow to configure these examples is the same, with the only differences being whether you create the objects in the same or different VRFs (inter-VRF vs intra-VRF) and where you deploy the objects (stretched vs non-stretched):

1. Create the L4-L7 devices directly in the site's APIC, as described in Creating and Configuring L4-L7 Devices and PBR Policies, on page 169.

   You cannot create the devices and PBR policies from the Multi-Site Orchestrator, so you will need to log in to each site's APIC directly to configure those options.

2. Create the required templates, as described in Creating Templates, on page 172.

   We recommend creating a single stretched template that will contain all the objects deployed to all sites. Then an extra template for each site with the objects specific to that site only.

3. Create and configure the service graph, as described in Configuring Service Graph, on page 174.

4. Create the contract and filter you will use for all traffic between the application EPG and the external EPG containing the L3Out in another site, as described in Creating Filter and Contract, on page 176.

5. Create the application EPG with its VRF and bridge domain, as described in Creating Application Profile and EPG, on page 183.

   Depending on whether you plan to stretch the application EPG or not, you will create these objects in different templates. Similarly, you can choose to use the same or different VRFs for the application EPG and the L3Out.

6. Create the L3Out, as described in Creating or Importing Intersite L3Out and VRF, on page 184.

7. Create the external EPG for the L3Out, as described in Configuring External EPG to Use Intersite L3Out, on page 148.

Inter-VRF vs Intra-VRF

When creating and configuring the application EPG and the external EPG, you will need to provide a VRF for the application EPG's bridge domain and for the L3Out. You can choose to use the same VRF (intra-VRF) or different VRFs (inter-VRF).

When establishing a contract between the EPGs, you will need to designate one EPG as the provider and the other one as the consumer:

- When both EPGs are in the same VRF, either one can be the consumer or the provider.

- If the EPGs are in different VRFs, the external EPG must be the provider and the application EPG must be the consumer.

Stretched EPG

This use case illustrates a single application EPG that is stretched between two sites and a single L3Out created in only one of the sites. Regardless of whether the application EPG's endpoint is in the same site as the L3Out or the other site, traffic will go through the same L3Out. However, the traffic will always go through the service node that is local to the endpoint's site.

Note The same flow applies in cases when the external EPG is stretched and each site has its own L3Out, but the L3Out in the site where the traffic is originating or is destined to is down.

Figure 28: Inbound Traffic

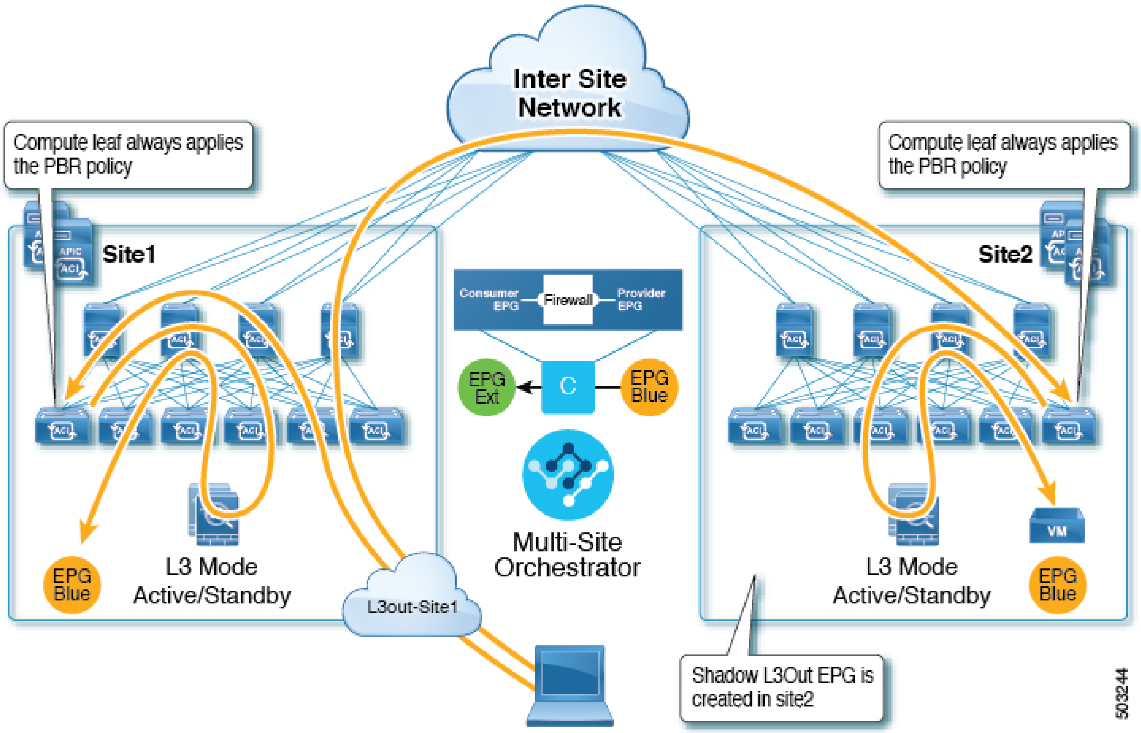
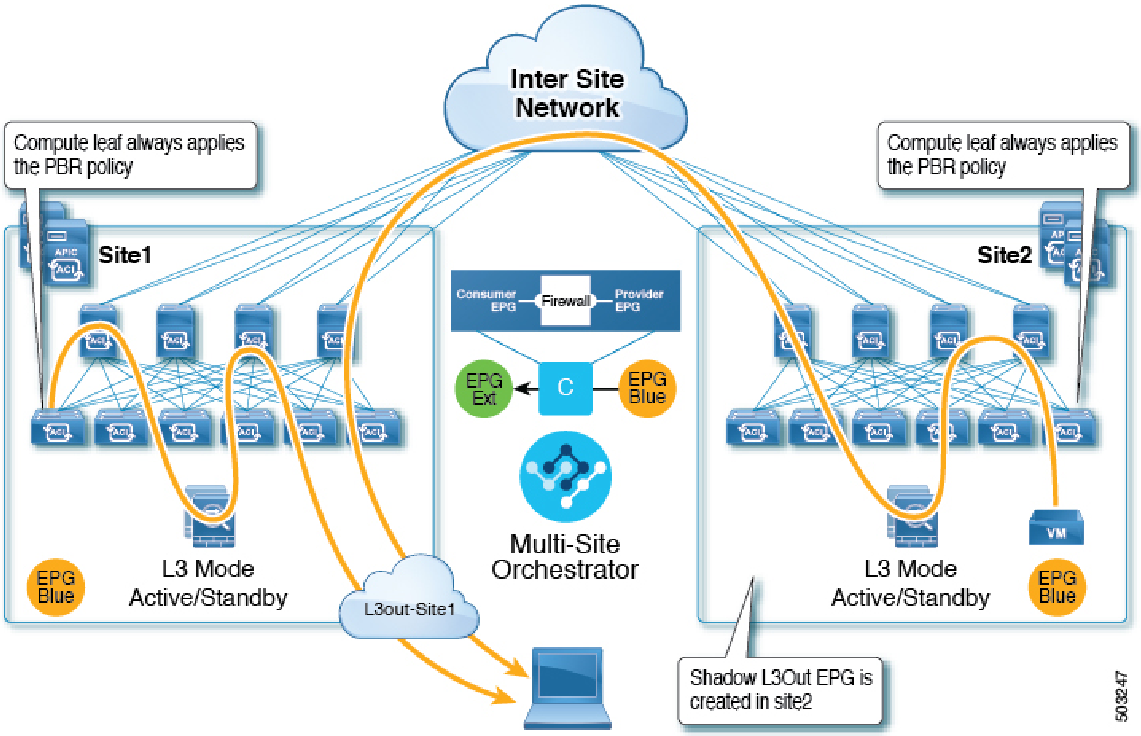


Figure 29: Outbound Traffic



Site-Local EPG

This use case illustrates a site-local application EPG that will use the L3Out in the other site for North-South traffic. Like in the previous example, all traffic will use the EPG's site-local service graph device.

Note The same flow applies in cases where the external EPG is stretched and each site has its own L3Out, but the EPG's local L3Out is down.

Figure 30: Inbound Traffic

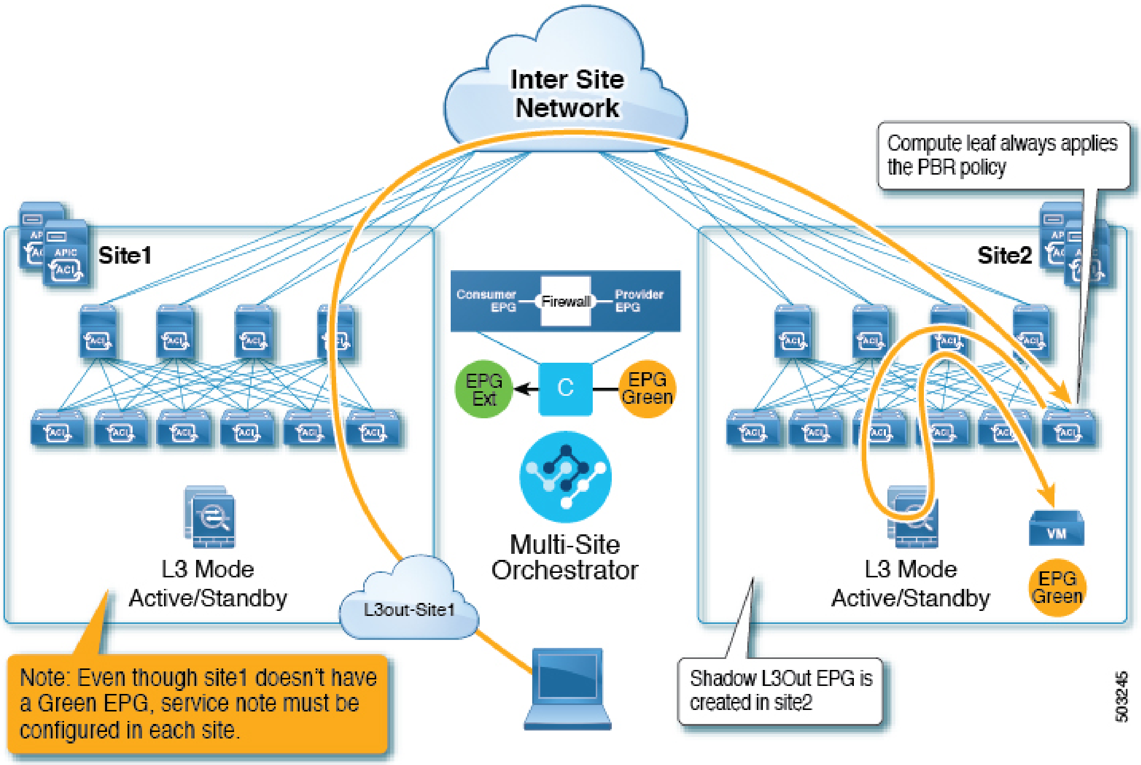
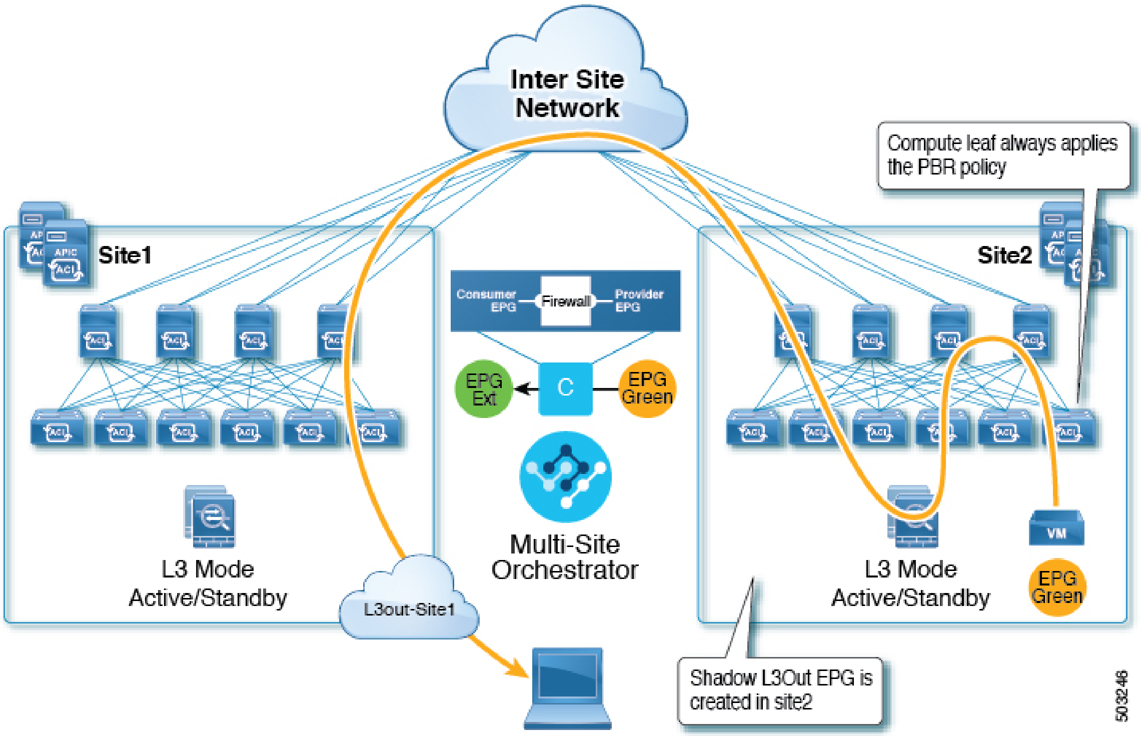

Inter Site Network
Compute leaf always applies the PBR policy
Site1
Site2
Consumer EPG
Firewall
Provider EPG
EPG Ext
C
EPG Green
Multi-Site Orchestrator
L3 Mode Active/Standby
L3 Mode Active/Standby
VM
EPG Green
L3out-Site1
Note: Even though site1 doesn't have a Green EPG, service note must be configured in each site.
Shadow L3Out EPG is created in site2
503245

Figure 31: Outbound Traffic



Guidelines and Limitations

When configuring an Intersite L3Out with PBR, the following restrictions apply:

- For intersite L3Out without PBR use cases, see #unique_164
- For intersite L3Out with PBR, the following use cases are supported:
  - Inter-VRF intersite L3Out with the application EPG as the `consumer`.

    For inter-VRF contracts, the L3Out must be the `provider`.
  - Intra-VRF intersite L3Out with the application EPG as either the `provider` or the `consumer`
  - Intersite transit routing (L3Out-to-L3Out) with PBR is not supported.
- The above use cases are supported for sites running Cisco APIC, Release 4.2(5) or Release 5.1(x). They are not supported for sites running Cisco APIC, Release 5.0(x).
- In all supported cases, the application EPG can be stretched or not stretched.
- Service graph devices must be defined in each site, including the sites that don't have an application EPG that has a PBR contract with an intersite L3Out external EPG.
- Both one-arm and two-arm deployment models are supported.

  In one-arm deployment, both the inside and outside interfaces of the service graph are connected to the same bridge domain. In two-arm deployments, the service graph interfaces are connected to separate BDs.
- When configuring a load balancer with PBR, the load balancer and the real servers for the virtual IP (VIP) must be in the same site. If PBR is disabled, the load balancer and the real servers can be in different sites.
- When configuring PBR, destination can be L1, L2, or L3.

Configuring APIC Sites

Configuring External TEP Pool

Intersite L3Out requires a external TEP address for the border leaf switches in each pod. If you already have an external TEP pool configured, for example for another feature such as Remote Leaf, the same pool can be used. The existing TEP pool will be inherited by the Multi-Site Orchestrator and shown in the GUI as part of the infra configuration. Otherwise, you can add a TEP pool in the GUI, as described in this section.

Note Every pod must be assigned a unique TEP pool and it must not overlap with any other TEP pool in the fabric

Step 1 Log in to your Cisco ACI Multi-Site Orchestrator.

Step 2 From the left navigation pane, select **Infrastructure** > **Infra Configuration**.

Step 3 In the top right of the main pane, click **Configure Infra**.

Step 4 In the left sidebar, select the site you want to configure.

Step 5 In the main window, click a pod in the site.

Step 6 In the right sidebar, click **+Add TEP Pool**.

Step 7 In the **Add TEP Pool** window, specify the external TEP pool you want to configure for that site.

Note You must ensure that the TEP pool you are adding does not overlap with any other TEP pools or fabric addresses.

Step 8 Repeat the process for each site and pod where you plan to use intersite L3Outs.

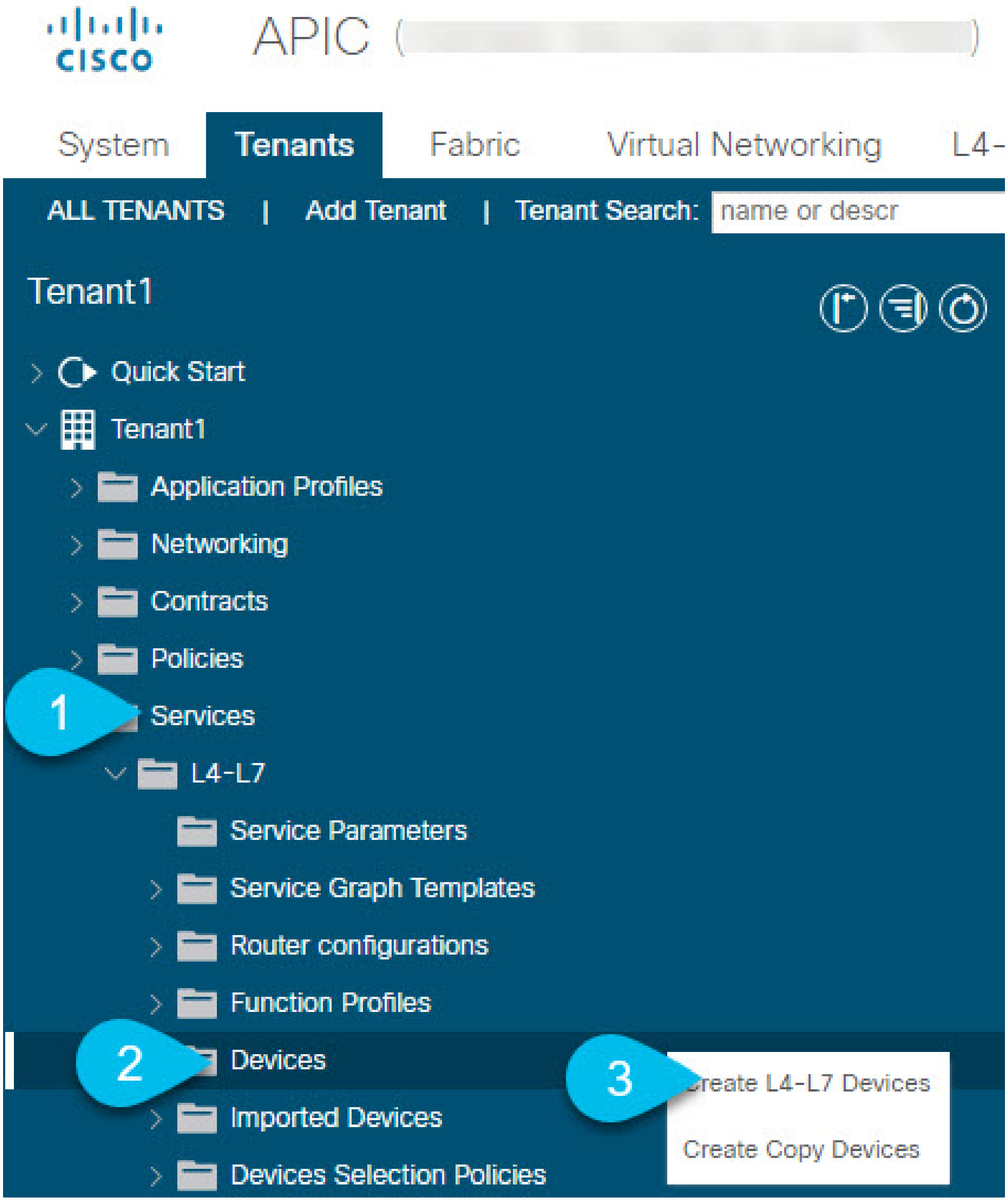
Creating and Configuring L4-L7 Devices and PBR Policies

You must create the service graph devices and define the PBR policies directly in each site's APIC.

Step 1 Log in to your Cisco APIC.

Step 2 In the top menu bar, click **Tenants**, then select the tenant where you want to create the device.

Step 3 Create an L4-L7 device.

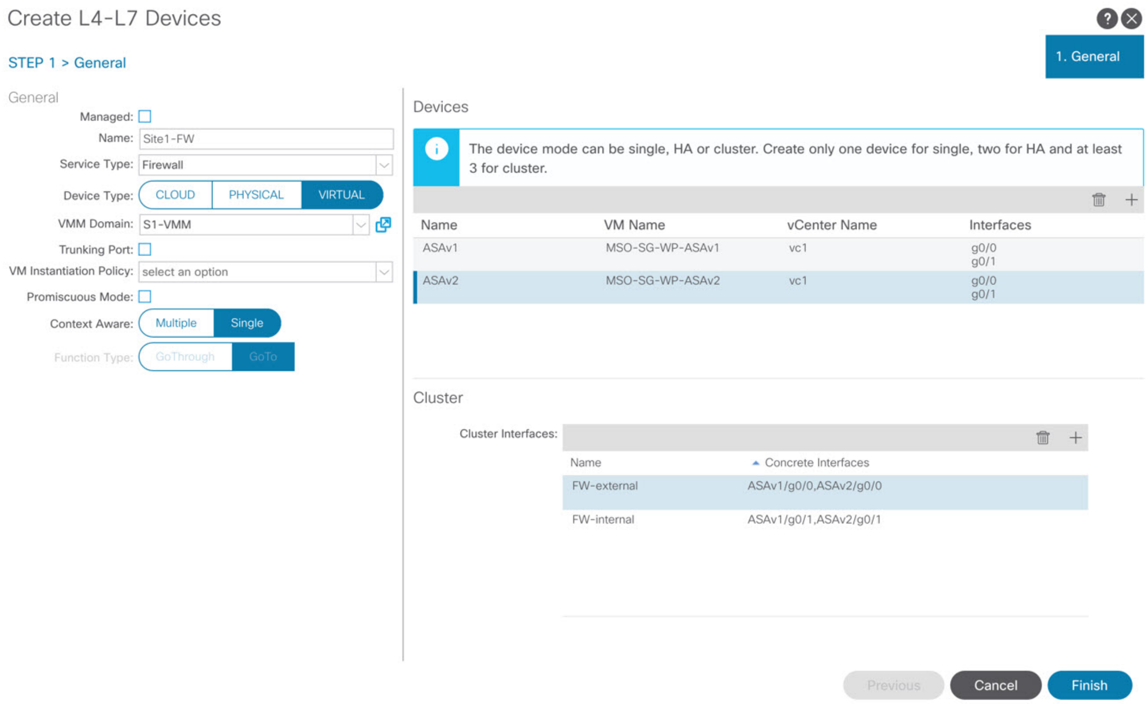


a) In the left sidebar, expand **<tenant-name>** > **Services** > **L4-L7** category.
b) Right-click **Devices** category.
c) Choose **Create L4-L7 Devices**.

The **Create L4-L7 Devices** configuration dialog opens.

Step 4 Configure the L4-L7 device.

The following image shows a sample device configuration. Your configuration settings will depend on the type and purpose of the device.



Create L4-L7 Devices

STEP 1 > General

General

Managed: □
Name: Site1-FW
Service Type: Firewall
Device Type: CLOUD PHYSICAL [✓ VIRTUAL]
VMM Domain: S1-VMM
Trunking Port: □
VM Instantiation Policy: select an option
Promiscuous Mode: □
Context Aware: Multiple [✓ Single]
Function Type: GoThrough [✓ GoTo]

Devices

The device mode can be single, HA or cluster. Create only one device for single, two for HA and at least 3 for cluster.

Name	VM Name	vCenter Name	Interfaces
ASAv1	MSO-SG-WP-ASAv1	vc1	g0/0 g0/1
ASAv2	MSO-SG-WP-ASAv2	vc1	g0/0 g0/1

Cluster

Cluster Interfaces:

Name	Concrete Interfaces
FW-external	ASAv1/g0/0,ASAv2/g0/0
FW-internal	ASAv1/g0/1,ASAv2/g0/1

Step 5 Create a PBR policy.

a) In the left sidebar, expand **<tenant-name>** > **Policies** > **Protocol** category.

b) Right-click **L4-L7 Policy-Based Redirect** category.

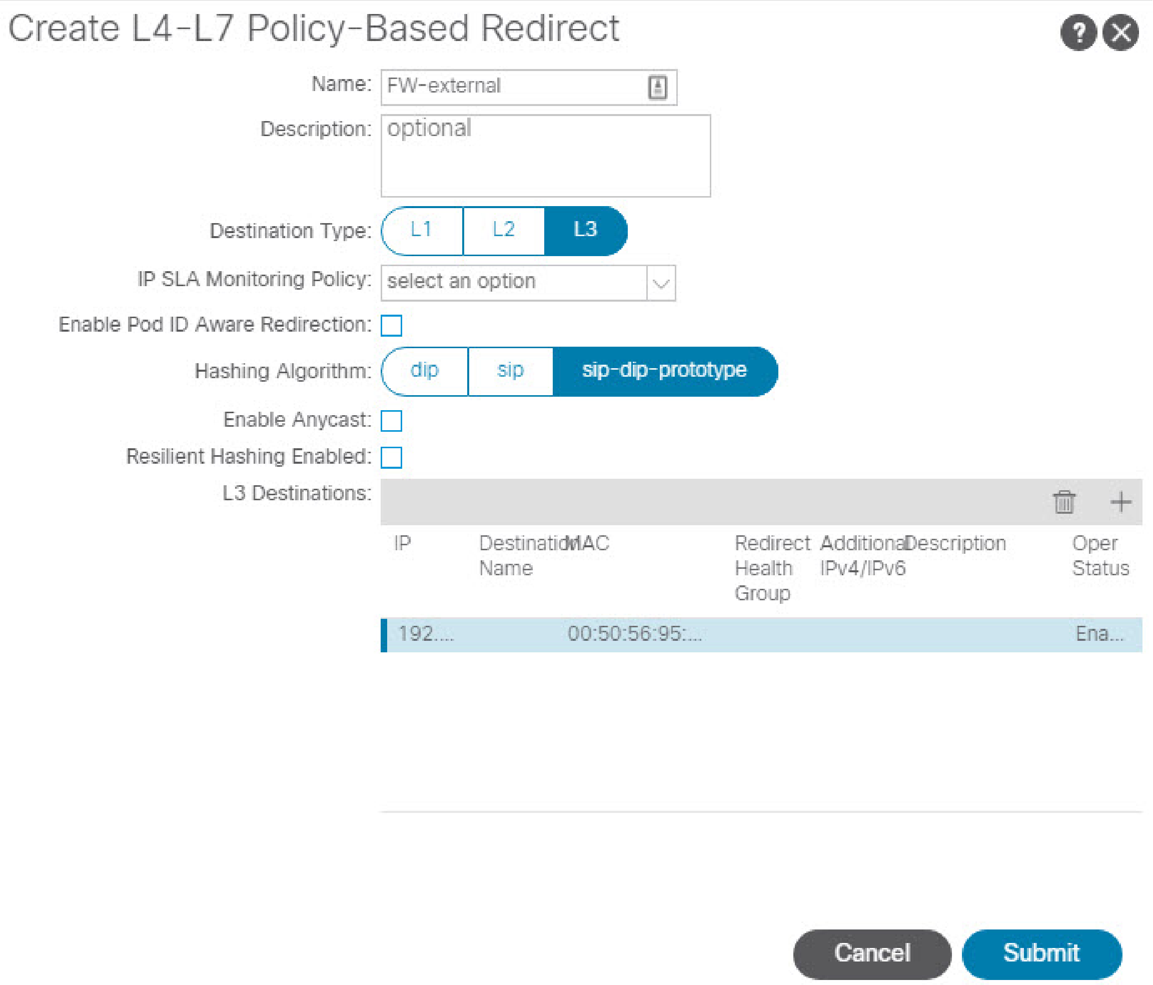
c) Choose **Create L4-L7 Policy-Based Redirect**.

The **Create L4-L7 Policy-Based Redirect** configuration dialog opens.

Step 6 Configure the PBR policy.

The following image shows a sample PBR policy configuration with destination IP and MAC added.

Your configuration settings will depend on the type and purpose of the device and policy you create. For example, you can configure additional options such as IP-SLA, hashing algorithm, resilient hashing, and so on in the PBR policy.



Create L4-L7 Policy-Based Redirect

Name: FW-external

Description: optional

Destination Type: L1 | L2 | [✓ L3]

IP SLA Monitoring Policy: select an option

Enable Pod ID Aware Redirection: □

Hashing Algorithm: dip | sip | [✓ sip-dip-prototype]

Enable Anycast: □

Resilient Hashing Enabled: □

L3 Destinations:

IP	Destination Name	MAC	Redirect Health Group	Additional IPv4/IPv6	Description	Oper Status
192....		00:50:56:95:...				Ena...

Step 7 Repeat the previous steps to create the required devices and PBR policies in the other site.

Creating Templates

When creating the schema and template, we recommend separating the templates in the following way:

- A single shared template that will contain all the objects that are stretched between all sites.
- One template per site that will contain the objects you will deploy to that site only.

In this example, we will work with two sites, so we will create a total of three templates: one for each site, plus one stretched.

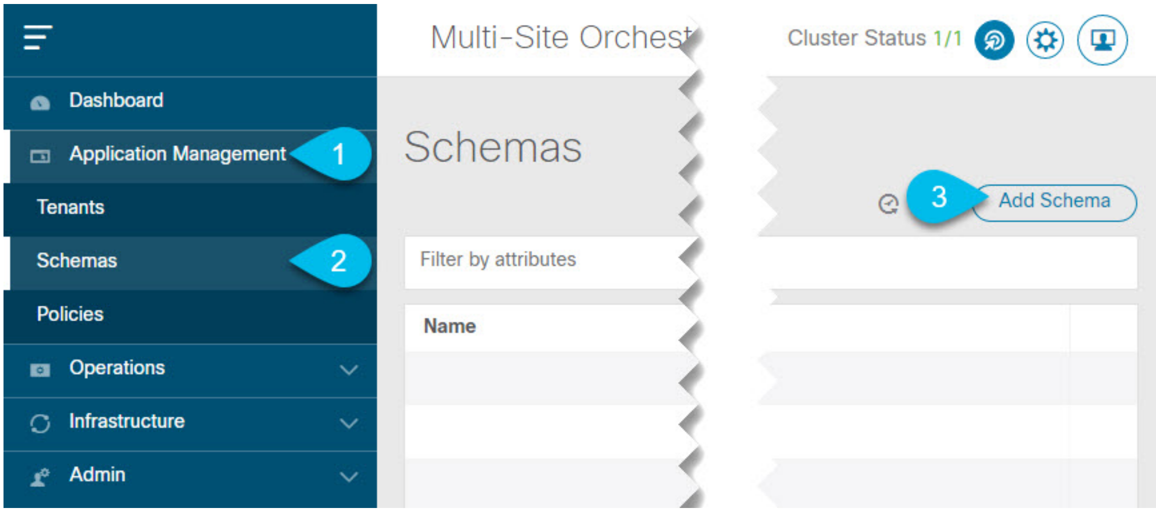
Before you begin

You must have:

- Reviewed the Guidelines and Limitations, on page 168 and completed any prerequisites listed there.
- Finished configuring the individual APIC sites as described in Configuring External TEP Pool, on page 145 and Creating and Configuring L4-L7 Devices and PBR Policies, on page 169.

Step 1 Log in to your Cisco Multi-Site Orchestrator GUI.

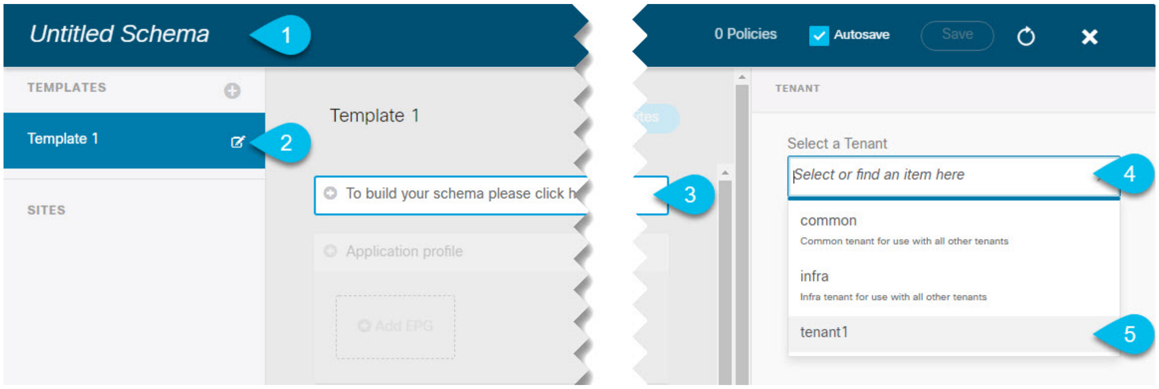
Step 2 Create a new Schema.



a) In the left navigation sidebar, expand the **Application Management** category.
b) Choose **Schemas**.
c) Click **Add Schema** to create a new schema.

The **Edit Schema** window will open.

Step 3 Name the Schema and pick the Tenant.


Untitled Schema
1
TEMPLATES
Template 1
2
SITES
Template 1
To build your schema please click h
3
Application profile
Add EPG
0 Policies
Autosave
Save
TENANT
Select a Tenant
Select or find an item here
4
common
Common tenant for use with all other tenants
infra
Infra tenant for use with all other tenants
tenant1
5

a) Replace **Untitled Schema** with the name for your schema.

Simply click on the `Untitled Schema` name to edit it.

b) Rename the template.

In the left sidebar, mouse over the template and click the **Edit** icon.

For example, `template-stretched`.

c) In the main pane, click **To build your schema please click here to select a tenant**.

d) In the right sidebar, click the **Select a Tenant** dropdown.

e) Select the tenant.

Step 4 Create any additional templates.

In the left sidebar, click the plus (+) icon next to **Templates** to add the site-specific templates. Then follow the same instructions described in the previous steps to name the templates and pick the tenant.

For example, `template-site1` and `template-site2`.

Configuring Service Graph

You must have:

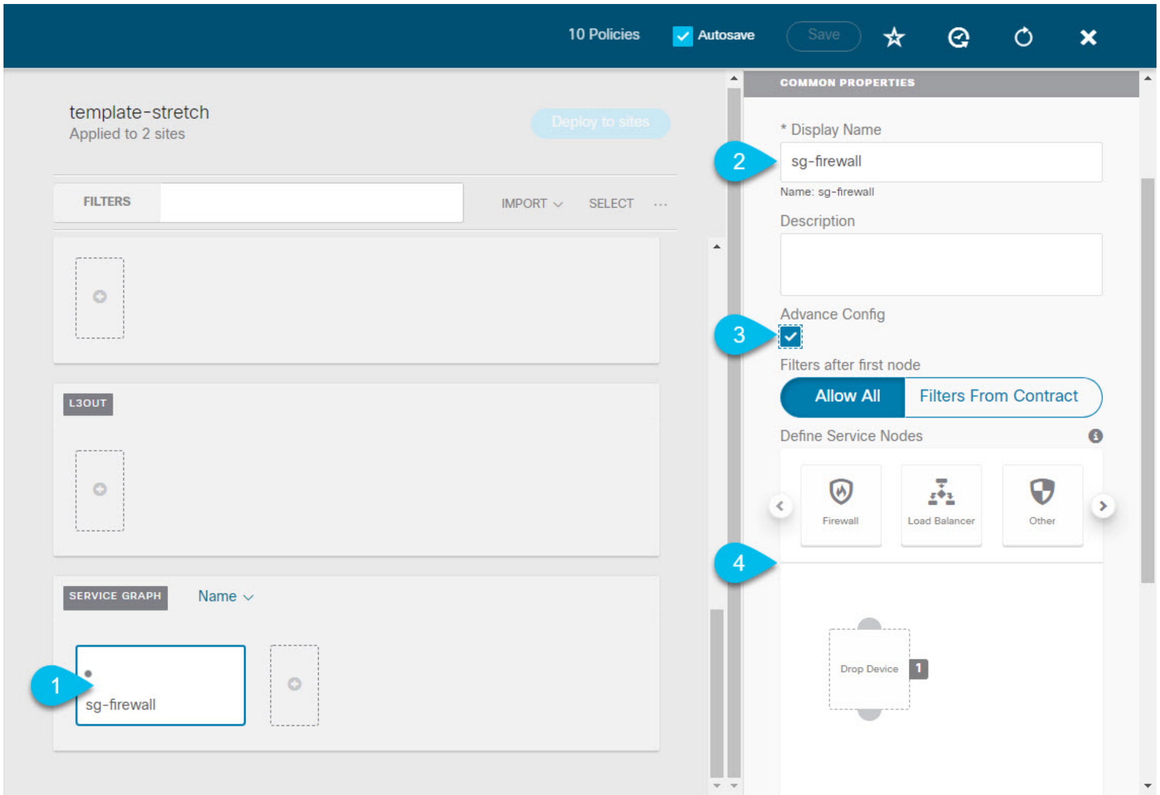
- Created the L4-L7 devices directly in each site's APIC, as described in Creating and Configuring L4-L7 Devices and PBR Policies, on page 169.
- Created the templates where you will create these objects, as described in Creating Templates, on page 172.

This section describes how to configure one or more devices for a service graph.

Step 1 Select the template where you will create the service graph.

You will create a single service graph in the `template-stretch` but configure site-local devices for it as described later in this procedure.

Step 2 Create the Service Graph.



* Display Name: sg-firewall

Name: sg-firewall

Description

Advance Config ☑

Filters after first node: Allow All | Filters From Contract

Define Service Nodes

a) In the main pane, scroll down to the **Service Graph** area and click the + sign to create a new one.

b) Provide the **Display Name** for the service graph.

c) (Optional) Check the **Advanced Config** option.

This option allows you to configure whether traffic is restricted or not after the first service graph node. If you do not enable this option, all traffic is allowed after the first service graph node by default.

If you choose to enable the **Advanced Config**, select one of the following two options:

- **Allow All**: Use default (`permit-all`) filter instead of specific filter from contract subject.

  This is the same behavior as with **Advanced Config** disabled.

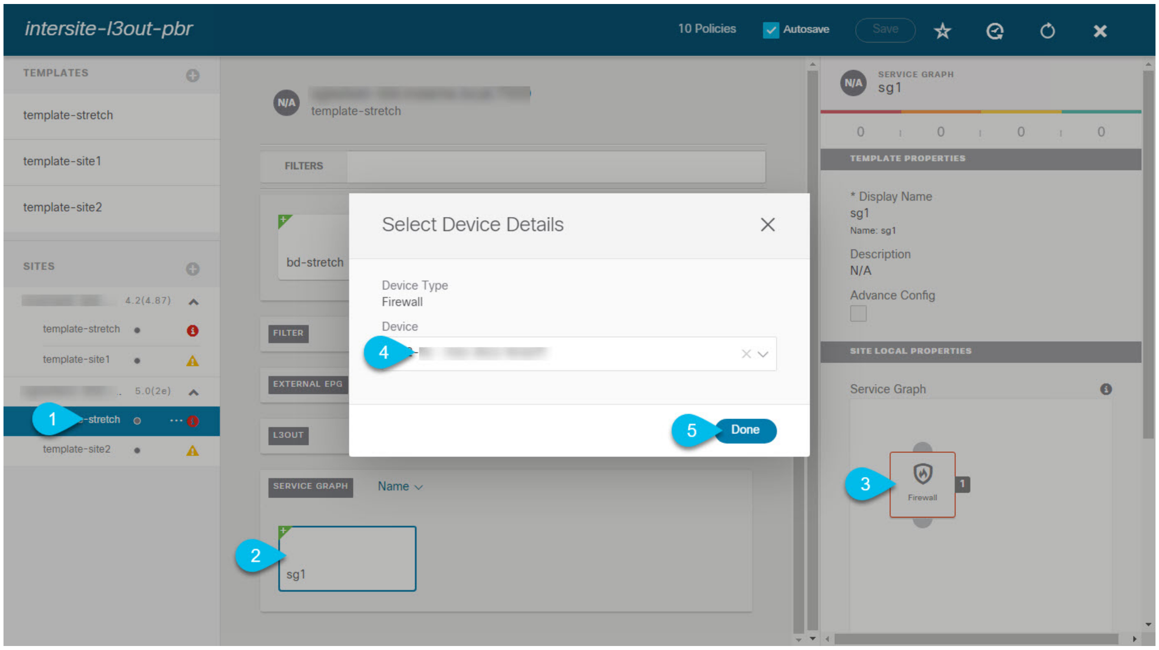
- **Filters From Contract**: Use specific filters from contract subject.

d) In the right sidebar, scroll down to the **Define Service Nodes** area and drag and drop one or more nodes into the **Drop Device** box.

Multi-Site supports up to two nodes per service graph.

Step 3 Configure service graph's site-local devices.

You must perform this step for every site that is part of the Multi-Site domain.



Select Device Details

Device Type
Firewall

Device

* Display Name
sg1
Name: sg1

Description
N/A

Advance Config

a) From the left sidebar, select one of the sites where you will deploy this service graph.
b) In the main pane, select the service graph you created.
c) In the right sidebar, click on the service graph node.
d) In the **Select Device Details** window, choose the device you have created in the site's APIC.

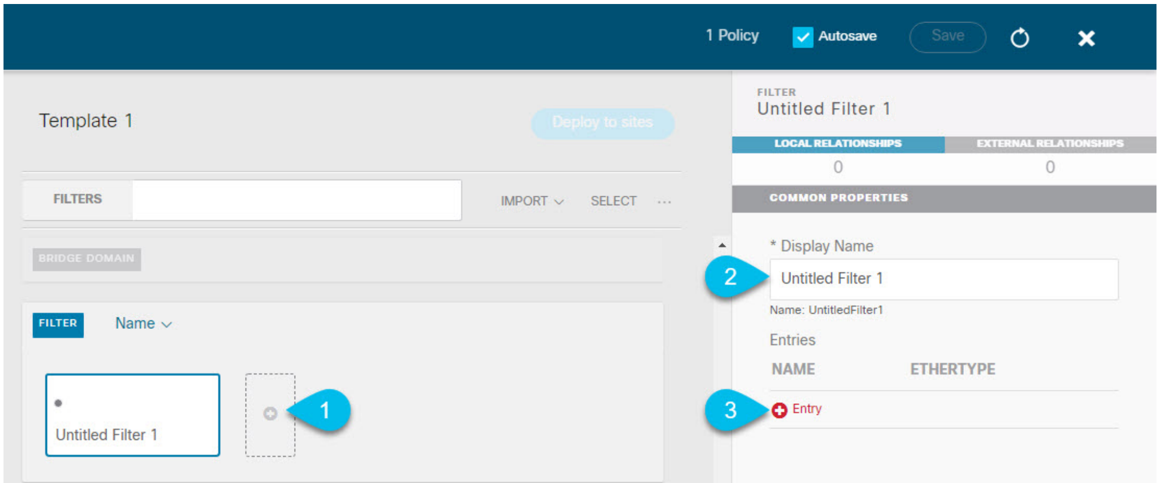
Creating Filter and Contract

You must have:

- Created the templates where you will create these objects, as described in Creating Templates, on page 172.

This section describes how to create a contract and filters that will be used for the traffic going between the application EPG and the L3Out through the service graph.

Step 1 Create a filter.

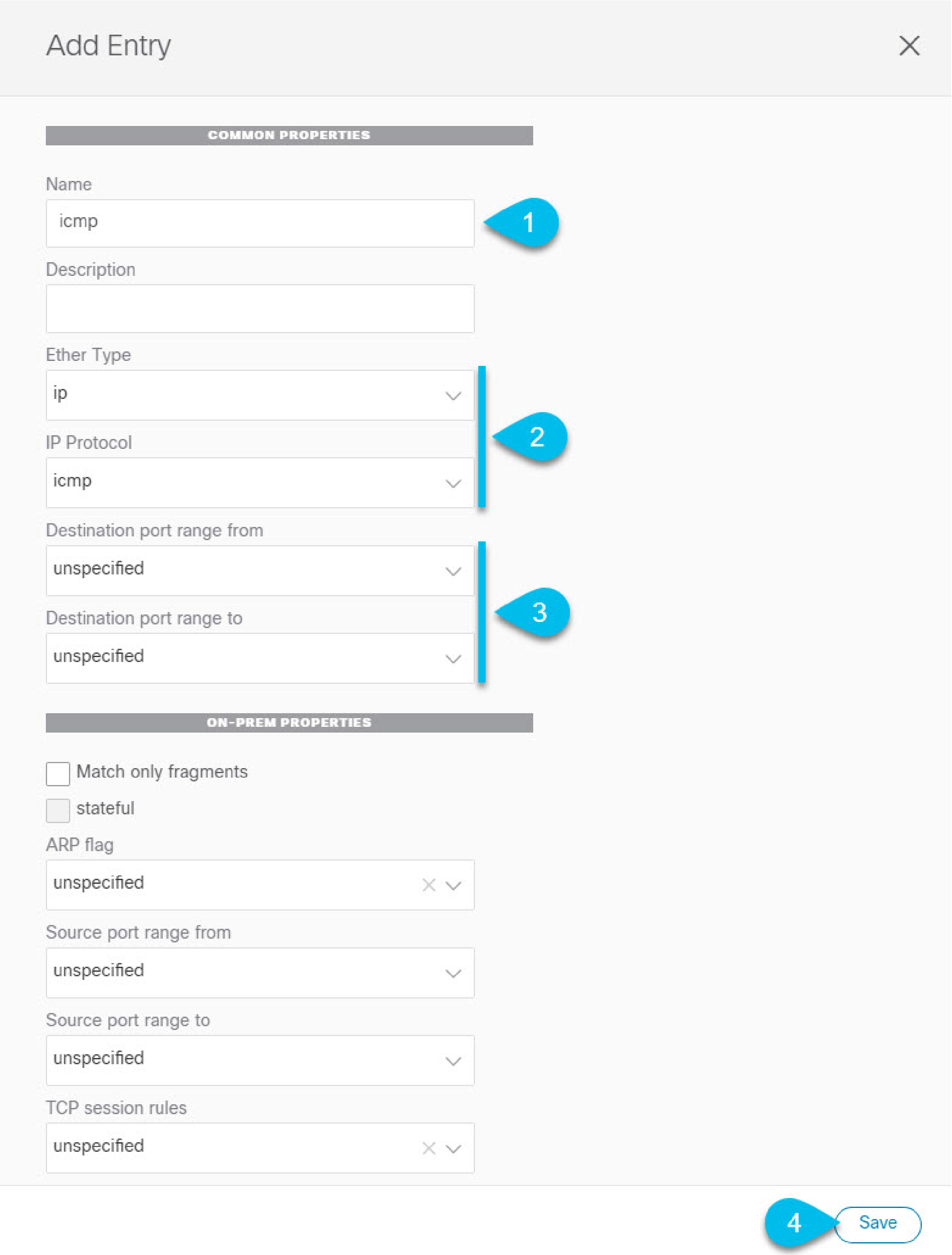


a) In the middle pane, scroll down to the **Filter** area, then click + to create a filter.

b) In the right pane, provide the **Display Name** for the filter.

c) In the right pane, click + **Entry**.

Step 2 Provide the filter details.



Add Entry

COMMON PROPERTIES

Name: icmp

Description:

Ether Type: ip

IP Protocol: icmp

Destination port range from: unspecified

Destination port range to: unspecified

ON-PREM PROPERTIES

□ Match only fragments

□ stateful

ARP flag: unspecified

Source port range from: unspecified

Source port range to: unspecified

TCP session rules: unspecified

a) Provide the **Name** for the filter.

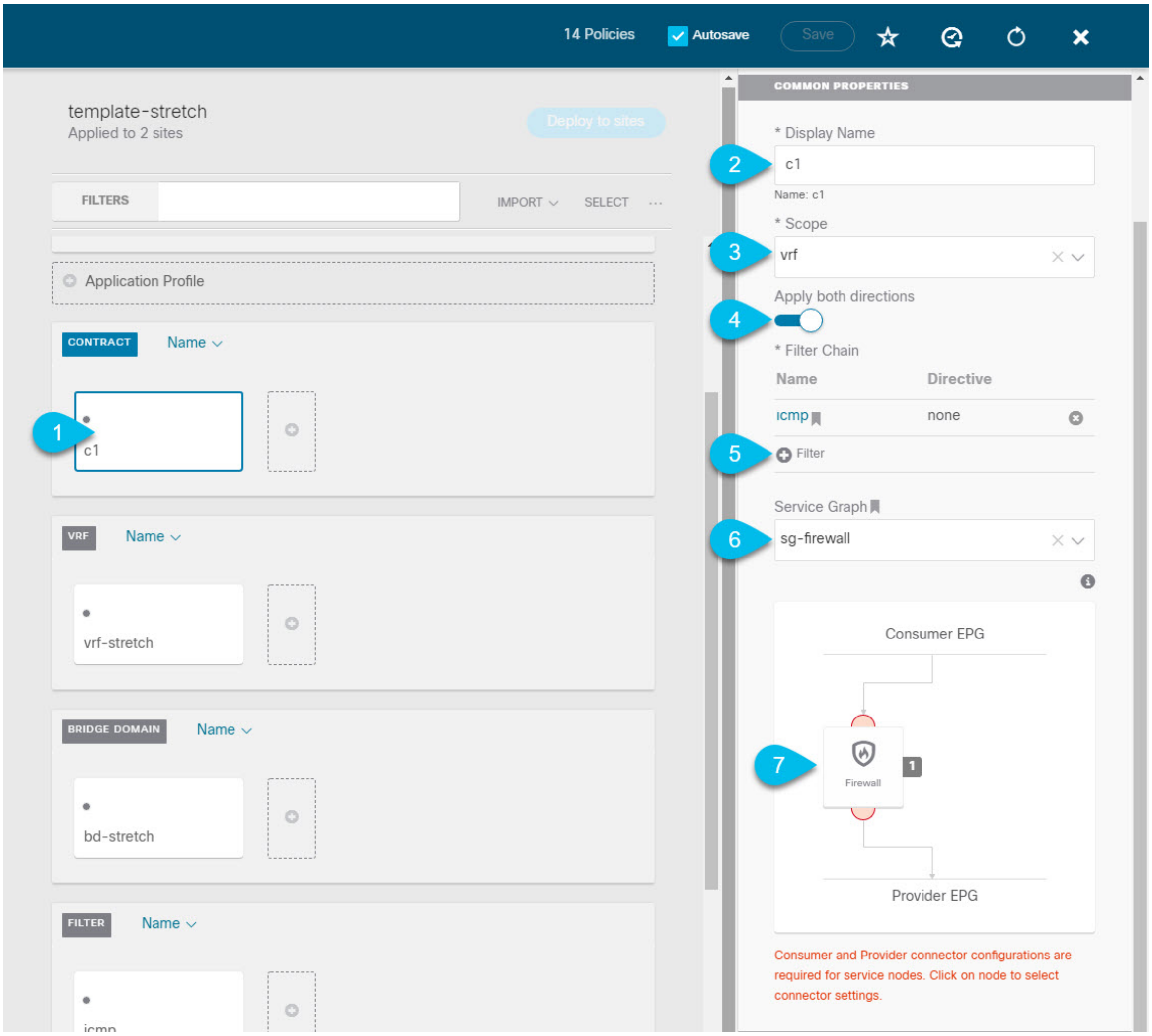
b) Choose the **Ether Type** and **IP Protocol**.

For example, `ip` and `icmp`.

c) Leave other properties `unspecified`.

d) Click **Save** to save the filter.

Step 3 Create a contract



a) In the middle pane, scroll down to the **Contract** area and click **+** to create a contract.

b) In the right pane, provide the **Display Name** for the contract

c) From the **Scope** dropdown menu, select the scope of the contract.

If your application EPG and L3Out are in the same VRF, choose `vrf`; otherwise, if you are configure inter-VRF use case, select `tenant`.

d) Ensure that **Apply both directions** is enabled.

This allows you to use the same filter to apply for both consumer-to-provider and provider-to-consumer directions.

e) In the right pane, scroll down to the **Filter Chain** area and click **+ Filter** to add a filter to the contract.

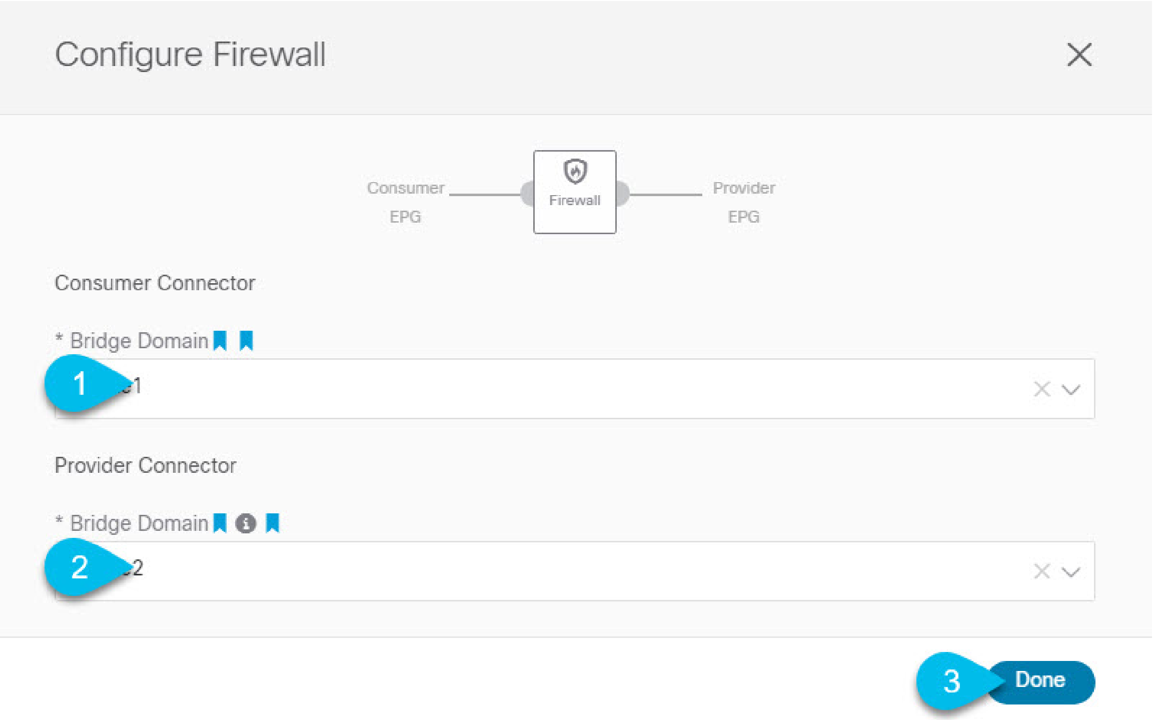
In the **Add Filter Chain** window that opens, select the filter you added in previous section from the **Name** dropdown menu.

If you disabled the `Apply both directions` option, repeat this stem for the other filter chain.

f) From the **Service Graph** dropdown, select the service graph you created in previous section.

g) Click the service graph node to configure its connectors.

Step 4 Select bridge domains for the service graph nodes' connectors.



Configure Firewall

Consumer Connector

* Bridge Domain

Provider Connector

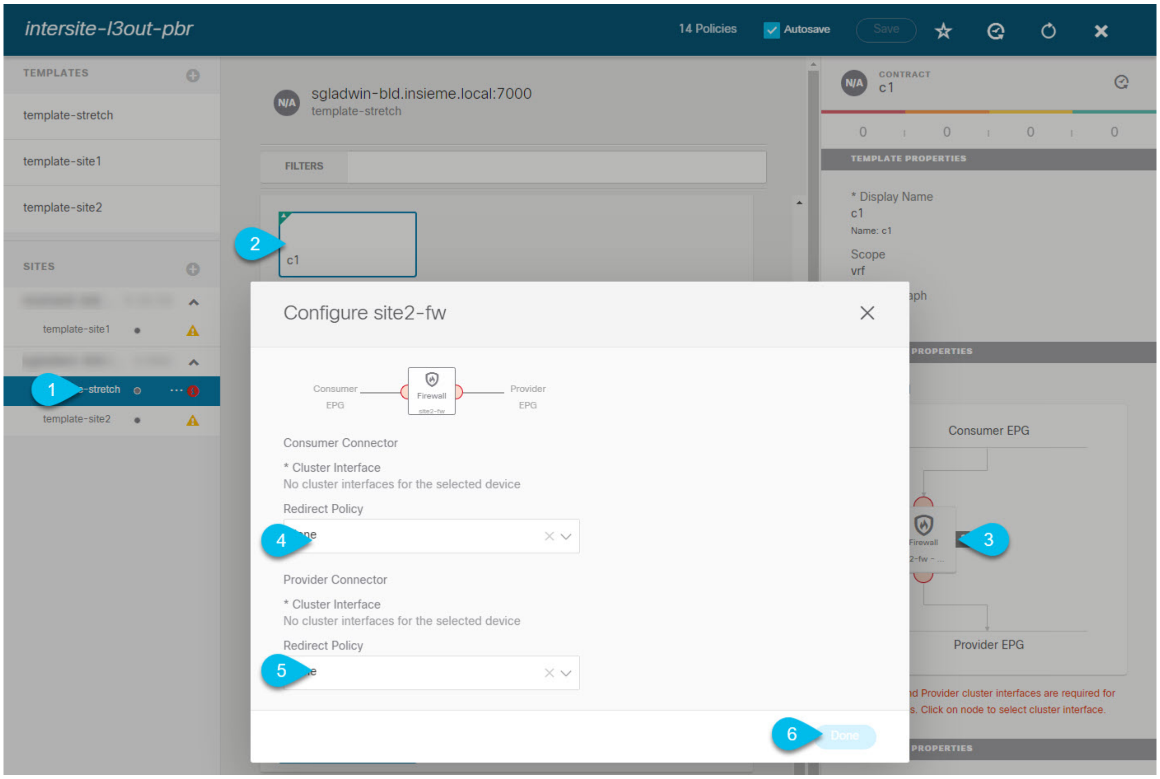
* Bridge Domain

a) Provide the **Consumer Connector** bridge domain.

b) Provide the **Provider Connector** bridge domain.

c) Click **Done** to save.

Step 5 Configure the contract's site-local properties.



a) In the left sidebar, select the template under a site to which it is assigned.
b) In the main pane, select the contract.
c) In the right sidebar, click a service graph node.
d) Select the **Cluster Interface** for the **Consumer Connector**.
e) Select the **Redirect Policy** for the **Consumer Connector**.
f) Select the **Cluster Interface** for the **Provider Connector**.
g) Select the **Redirect Policy** for the **Provider Connector**.
h) Click **Done** to save the changes.
i) Repeat this step for every site.

Creating Application EPG

Creating VRF and Bridge Domain for Application EPG

This section describes how to create the VRF and bridge domain (BD) for your application EPG.

Before you begin

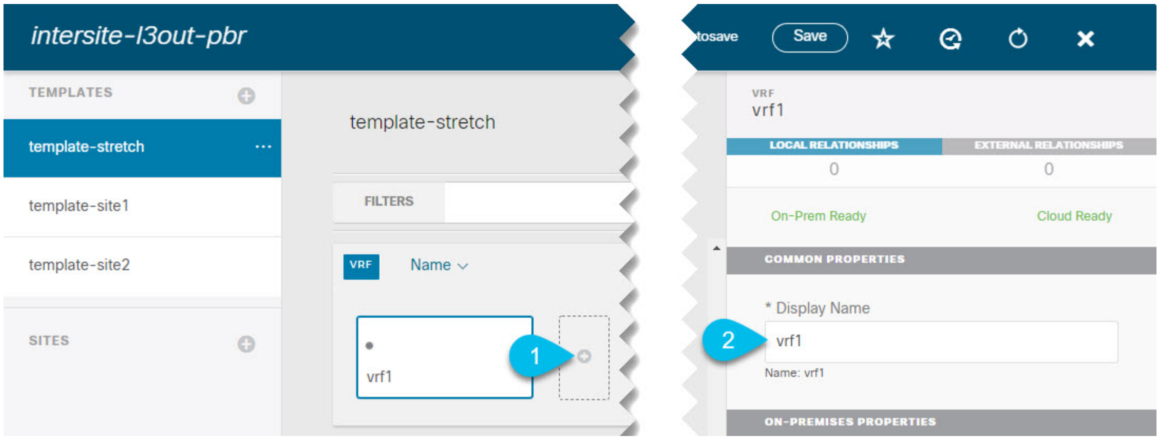
You must have:

- Created the templates where you will create these objects, as described in Creating Templates, on page 172.

Step 1 Select the template where you will create the VRF and BD.

If you are planning to stretch the VRF and BD, select the `template-stretch` template. Otherwise, choose one of the site-specific templates.

Step 2 Create VRF.

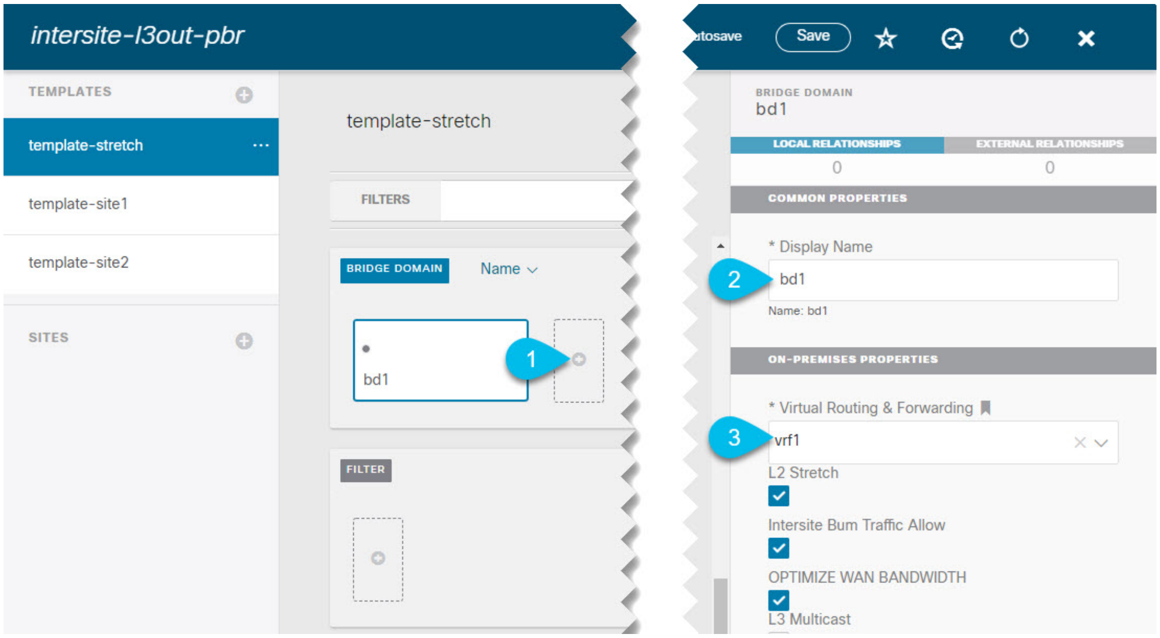


* Display Name: vrf1

Name: vrf1

a) In the main pane's **VRF** area, click the plus (+) sign to add a VRF.
b) In the right sidebar, provide the **Display Name** for the VRF.
c) Specify other VRF settings as appropriate for your deployment.

Step 3 Create BD.



* Display Name: bd1

Name: bd1

* Virtual Routing & Forwarding: vrf1

L2 Stretch ☑

Intersite Bum Traffic Allow ☑

OPTIMIZE WAN BANDWIDTH ☑

L3 Multicast

a) In the main pane's **BD** area, click the plus (+) sign to add a BD.
b) In the right sidebar, provide the **Display Name** for the BD.
c) From the **Virtual Routing & Forwarding** dropdown, select the VRF you created in the previous step.

d) Specify other BD settings as appropriate for your deployment.

Creating Application Profile and EPG

This section describes how to create the application EPG you will later configure to use the intersite L3Out with Service Graph.

Before you begin

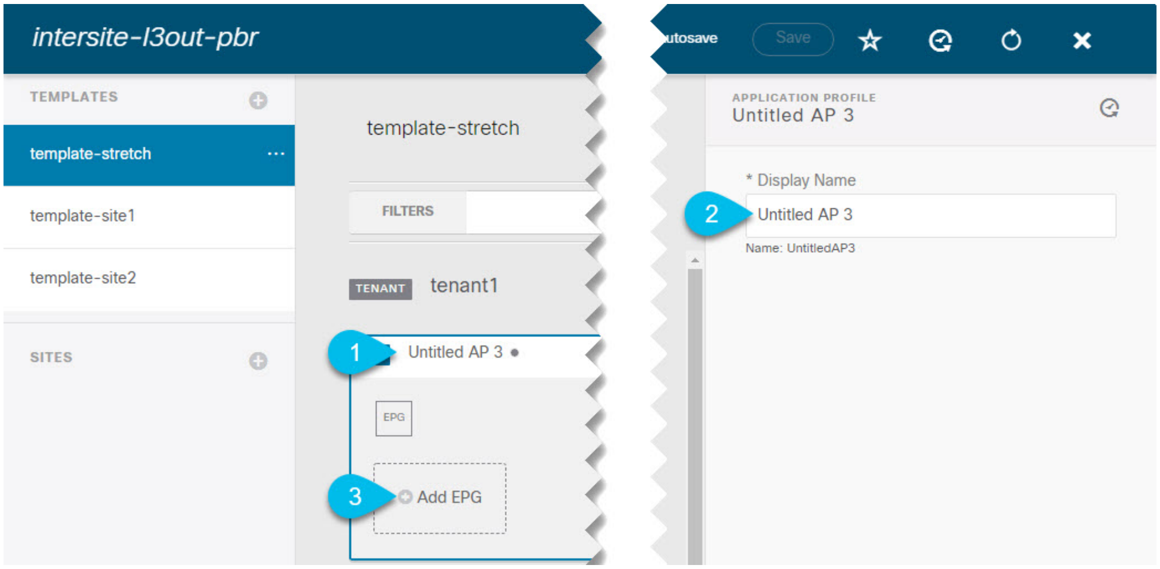
You must have:

- Created the templates where you will create these objects, as described in Creating Templates, on page 172.
- Created the contract you plan to use for communication between the application EPG and the external EPG, as described in Creating Filter and Contract, on page 176.
- Created the VRF and BD you plan to use for the EPG, as described in Creating VRF and Bridge Domain for Application EPG, on page 181.

Step 1 Select the template where you want to create the objects.

If you plan to stretch the application EPG, create it in the stretched template. If you application EPG is going to be site local, create it in the site-specific template.

Step 2 Create an application profile and EPG.

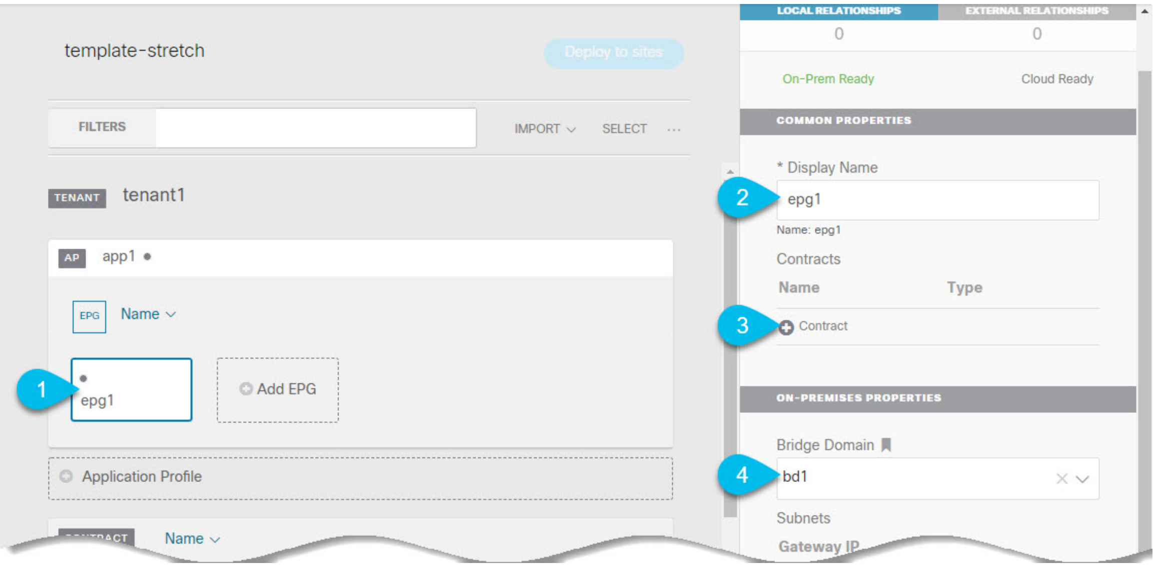


* Display Name: Untitled AP 3

Name: UntitledAP3

a) In the main pane, click + **Application profile**.
b) In the right sidebar, provide the **Display Name** for the profile.
c) In the main pane, click +**Add EPG**.

Step 3 Configure the EPG.



a) In the main pane, select the application EPG.
b) In the right sidebar, provide the **Display Name** for the EPG.
c) Click +**Contract** and select the contract.

   Select the contract you have created for the EPG communication and set its type.

   If you are using the same VRF for your application EPG and the L3Out external EPG, you can choose either one to be the `consumer` or the `provider`. However, if they are in different VRFs, you must select `consumer` for the application EPG's contract type.
d) From the **Bridge Domain** dropdown, select the BD.
e) Specify other EPG settings as appropriate for your deployment.

Creating L3Out External EPG

Creating or Importing Intersite L3Out and VRF

This section describes how to create an L3Out and associate it to a VRF in the Multi-Site Orchestrator (MSO) GUI, which will then be pushed out to the APIC site, or import an existing L3Out from one of your APIC sites. You will then associate this L3Out with an external EPG and use that external EPG to configure specific intersite L3Out use cases.

Note The VRF you assign to the L3Out can be in any template or schema, but it must be in the same tenant as the L3Out.

Before you begin

You must have:

- Created the templates where you will create these objects, as described in Creating Templates, on page 172.

Step 1 Log in to your Cisco ACI Multi-Site Orchestrator.

Step 2 From the left navigation pane, select **Application Management** > **Schemas**.

Step 3 Select the schema and then the template where you want to create or import the VRF and L3Out.

If you create the L3Out in a template that is associated to multiple sites, the L3Out will be created on all of those sites. If you create the L3Out in a template that is associated with a single site, the L3Out will be created in that site only.

Step 4 Create a new VRF and L3Out.

If you want to import an existing L3Out, skip this step.

Note While you can create the L3Out object in the MSO and push it out to the APIC, the physical configuration of the L3Out must be done in the APIC.

a) Scroll down to the **VRF** area and click the **+** icon to add a new VRF.

In the right sidebar, provide the name for the VRF, for example `vrf-l3out`

b) Scroll down to the **L3Out** area and click the **+** icon to add a new L3Out.

In the right sidebar, provide the required information.

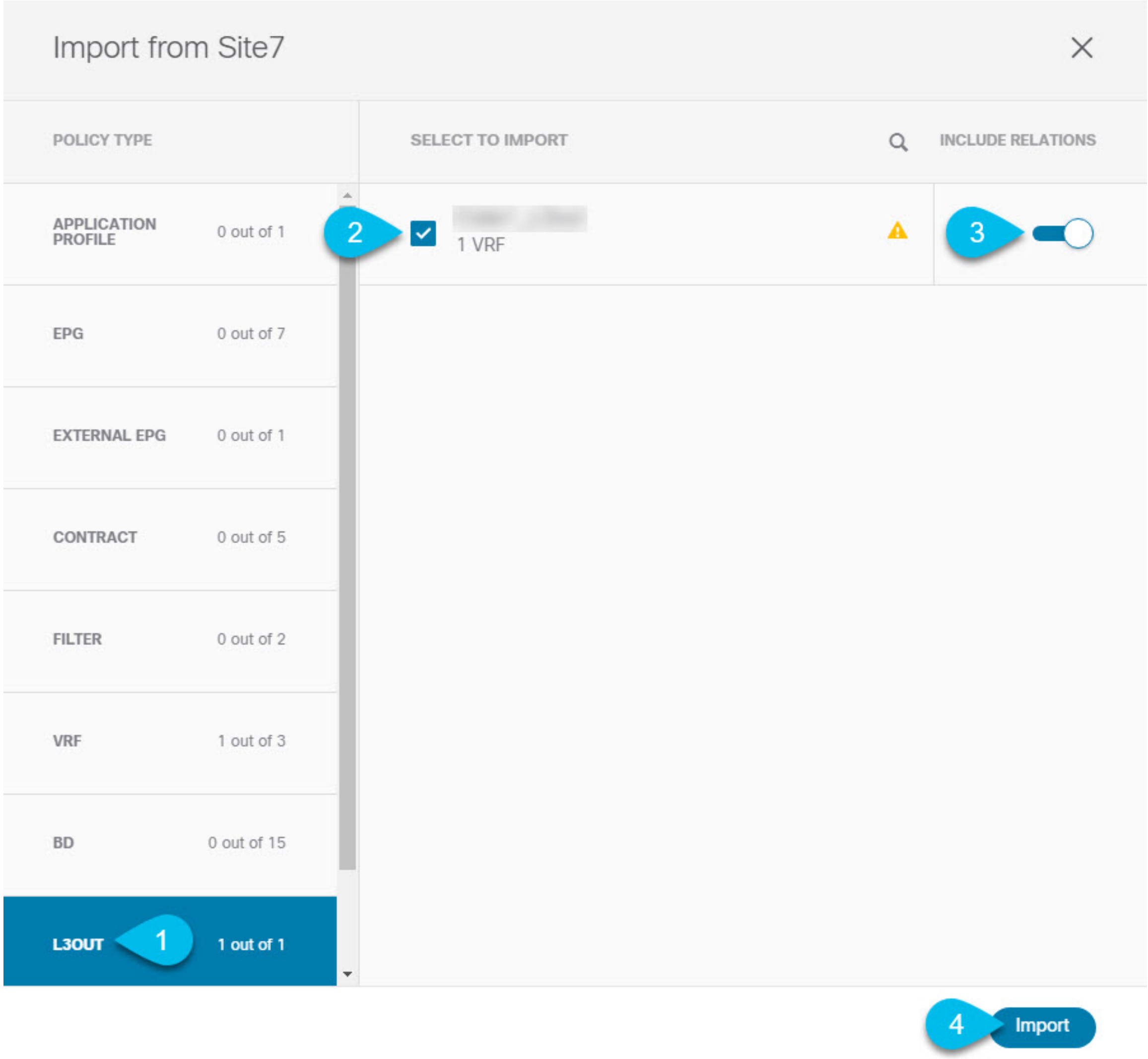
c) Provide the name for the L3Out, for example `l3out-intersite`.

d) From the **Virtual Routing & Forwarding** dropdown, select the VRF you created in the previous step.

Step 5 Import an existing L3Out.

If you created a new L3Out in previous step, skip this step.

At the top of the main template view, click **Import**, then select the site from which you want to import.



POLICY TYPE	
APPLICATION PROFILE	0 out of 1
EPG	0 out of 7
EXTERNAL EPG	0 out of 1
CONTRACT	0 out of 5
FILTER	0 out of 2
VRF	1 out of 3
BD	0 out of 15
L3OUT	1 out of 1

☑ 1 VRF

a) In the import window's **Policy Type** menu, select **L3Out**.
b) Check the L3Out you want to import.
c) (Optional) If you want to import all objects associated with the L3Out, enable the **Include Relations** knob.
d) Click **Import**.

Configuring External EPG

This section describes how to create an external EPG that will be associated to the intersite L3Out. You can then use this external EPG and contracts to configure specific use cases for endpoints in one site to use an L3Out in another site.

Before you begin

You must have:

- Created the templates where you will create these objects, as described in Creating Templates, on page 172.
- Created or imported the L3Out and VRF as described in Creating or Importing Intersite L3Out and VRF, on page 184.

Step 1 Select the template where you want to create the external EPG.

If you create the external EPG in a template that is associated to multiple sites, the external EPG will be created on all of those sites. If you create the external EPG in a template that is associated with a single site, the external EPG will be created in that site only.

Step 2 Scroll down to the **External EPG** area and click the + icon to add an external EPG.

In the right sidebar, provide the required information.

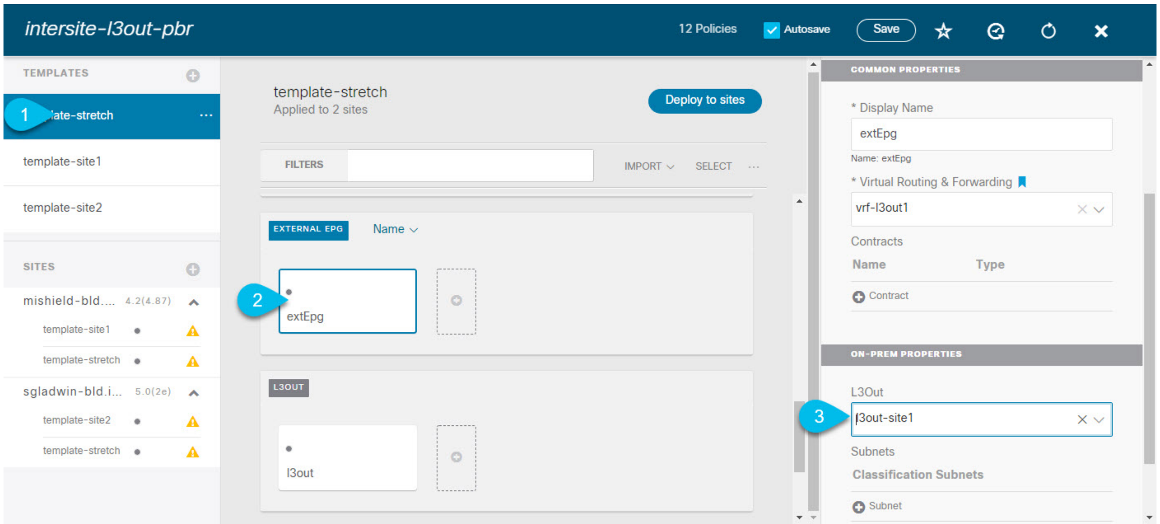
a) Provide the name for the external EPG, for example `extEpg`.
b) From the **Virtual Routing & Forwarding** dropdown, select the VRF you created and used for the L3Out.
c) Click **+Contract** and select the contract.

Select the contract you have created for the EPG communication and set its type.

If you are using the same VRF for your application EPG and the L3Out external EPG, you can choose either one to be the `consumer` or the `provider`. However, if they are in different VRFs, you must select `provider` for the external EPG's contract type.

Step 3 If you want to assign the L3Out at the template level...

You can choose to configure the L3Out for the external EPG at the template level, in which case, you will not be able to set the L3Outs at the site-local level.



* Display Name: extEpg

Name: extEpg

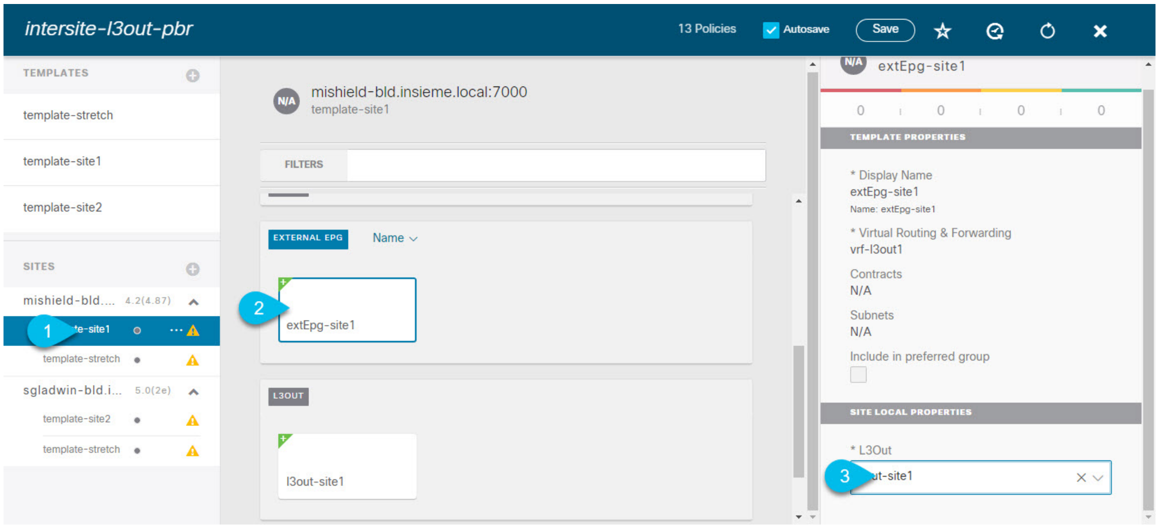
* Virtual Routing & Forwarding: vrf-l3out1

L3Out: l3out-site1

a) In the left sidebar of the schema view, select the template where the external EPG is located
b) Scroll down to the **External EPG** area and select the external EPG.
c) In the right sidebar, scroll down to the **L3Out** dropdown and choose the intersite L3Out you created.

Step 4 If you want to assign the L3Out at the site local level...

Alternatively, you can choose to associate an L3Out with the external EPG at the site-local level.



a) In the left sidebar of the schema view, select the site where the external EPG is deployed.
b) Scroll down to the **External EPG** area and select the external EPG.
c) In the right sidebar, scroll down to the **L3Out** dropdown and choose the intersite L3Out you created.

In this case, both the APIC-managed and the Orchestrator-managed L3Outs will be available for selection. You can select either the L3Out you have created in the previous section specifically for this or pick an L3Out that exists in the site's APIC.

CHAPTER 17

Layer 3 Multicast

Layer 3 Multicast

Cisco Multi-Site Layer 3 multicast is enabled or disabled at three levels, the VRF, the bridge domain (BD), and any EPGs that have multicast sources present.

At the top level, multicast routing must be enabled on the VRF that has any multicast-enabled BDs. On a multicast-enabled VRF, there can be a combination of multicast-enabled BDs and BDs where multicast routing is disabled. Enabling multicast routing on a VRF from the Cisco Multi-Site Orchestrator GUI enables it on the APIC sites where the VRF is stretched.

Once a VRF is enabled for multicast, the individual BDs under that VRF can be enabled for multicast routing. Configuring Layer 3 multicast on a BD enables protocol independent multicast (PIM) routing on that BD. By default, PIM is disabled in all BDs.

If a source belonging to a specific site-local EPG sends multicast traffic to a remote site, the Multi-Site Orchestrator must create a shadow EPG and program the corresponding subnet route(s) on the remote site for the source EPG. In order to limit the configuration changes applied to the remote Top-of-Rack (TOR) switches, you are required to explicitly enable Layer 3 multicast on the local EPGs that have multicast sources present, so that only the configuration necessary for those EPGs is pushed to the remote sites. EPGs with multicast receivers do not require enabling Layer 3 multicast.

Multi-Site supports all of the following Layer 3 multicast source and receiver combinations:

- Multicast sources and receivers inside ACI fabric
- Multicast sources and receivers outside ACI fabric
- Multicast sources inside ACI fabric with external receivers
- Multicast receivers inside ACI fabric with external sources

Layer 3 Multicast Routing

The following is a high level overview of the Layer 3 multicast routing across sites:

- When the multicast source is attached to the ACI fabric as an endpoint (EP) at one site and starts streaming a multicast flow, the specific site's spine switch that is elected as designated forwarder for the source VRF will forward the multicast traffic to all the remote sites where the source's VRF is stretched using Head End Replication (HREP). If there are no receivers in a specific remote site for that specific group. the traffic gets dropped on the receiving spine node. If there is at least a receiver, the traffic is forwarded into the site and reaches all the leaf nodes where the VRF is deployed and at that point is pruned/forwarded based on the group membership information.
- Prior to Cisco ACI Release 5.0(1), the multicast routing solution required external multicast routers to be the Rendezvous Points (RPs) for PIM-SM any-source multicast (ASM) deployments. Each site must point to the same RP address for a given stretched VRF. The RP must be reachable on each site via the site's local L3Out.
- When the source is outside and the receiver is within a fabric, the receiver will pull traffic via site's local L3Out as PIM joins toward RP and source are always sent via site local L3Out.
- Receivers in each site are expected to draw traffic from an external source via the site's local L3Out. As such, traffic received on the L3Out on one site should not be sent to other sites. This is achieved on the spine by pruning multicast traffic from being replicated into HREP tunnels.

  In order to be able to do so, all multicast traffic originated from an external source and received on a local L3Out is remarked with a special DSCP value in the outer VXLAN header. The spines can hence match that specific DSCP value preventing the traffic from being replicated toward the remote sites.
- Traffic originated from a source connected to a site can be sent toward external receivers via a local L3Out or via L3Outs deployed in remote sites. The specific L3Out that is used for this solely depends on which site received the PIM Join for that specific multicast group from the external network.
- When multicast is enabled on a BD and an EPG on the Multi-Site Orchestrator, all of the BD's subnets are programmed in the routing tables of all the leaf switches, including the border leaf nodes (BLs). This enables receivers attached to the leaf switches to determine the reachability of the multicast source in cases where the source BD is not present on the leaf switches. The subnet is advertised to the external network if there is a proper policy configured on the BLs. The `/32` host routes are advertised if host-based routing is configured on the BD.

For additional information about multicast routing, see the IP Multicast section of the *Cisco APIC Layer 3 Networking Configuration Guide*.

Rendezvous Points

Multicast traffic sources send packets to a multicast address group, with anyone joining that group able to receive the packets. Receivers that want to receive traffic from one or more groups can request to join the group, typically using Internet Group Management Protocol (IGMP). Whenever a receiver joins a group, a multicast distribution tree is created for that group. A Rendezvous Point (RP) is a router in a PIM-SM multicast domain that acts as a shared root for a multicast shared tree.

The typical way to provide a redundant RP function in a network consists in deploying a functionality called Anycast RP, which allows two or more RPs in the network to share the same anycast IP address. This provides for redundancy and load balancing. Should one RP device fails, the other RP can take over without service interruption. Multicast routers can also join the multicast shared tree by connecting to any of the anycast RPs in the network, with PIM `join` requests being forwarded to the closest RP.

Two types of RP configurations are supported from Multi-Site Orchestrator:

- **Static RP**—If your RP is outside the ACI fabric.
- **Fabric RP**—If the border leaf switches in the ACI fabric will function as the anycast RPs.

Any number of routers can be configured to work as RPs and they can be configured to cover different group ranges. When defining the RP inside the ACI fabric, you can configure which groups the RP covers by creating a route-map policy that contains the list of groups and attaching this policy to the RP when adding it to the VRF. Creating a route map is described in Creating Multicast Route Map Policy, on page 193, while VRF configuration is described in Enabling Any-Source Multicast (ASM) Multicast, on page 194.

Both static and fabric RPs require PIM-enabled border leaf switches in the VRF where multicast routing is enabled. L3Out configuration is currently configured locally from the APIC at each site including enabling PIM for the L3Out. Please refer to the *Cisco APIC Layer 3 Networking Configuration Guide* for details on configuration PIM on L3Outs

Multicast Filtering

Multicast filtering is a data plane filtering feature for multicast traffic available starting with Cisco APIC, Release 5.0(1) and Multi-Site Orchestrator, Release 3.0(1).

Cisco APIC supports control plane configurations that can be used to control who can receive multicast feeds and from which sources. In some deployments, it may be desirable to constrain the sending and/or receiving of multicast streams at the data plane level. For example, you may need to allow multicast senders in a LAN to be able to send only to specific multicast groups or to allow receivers to receive multicast from only specific sources.

To configure multicast filtering from the Multi-Site Orchestrator, you create source and destination multicast route maps, each of which contains one or more filter entries based on the multicast traffic's source IP and/or group with an action (`Permit` or `Deny`) attached to it. You then enable the filtering on a bridge domain by attaching the route maps to it.

When creating a multicast route map, you can define one or more filter entries. Some entries can be configured with a `Permit` action and other entries can be configured with a `Deny` action, all within the same route map. For each entry, you can provide a **Source IP** and a **Group IP** to define the traffic that will match the filter. You must provide at least one of these fields, but can choose to include both. If one of the fields is left blank, it will match all values.

You can enable both multicast source filtering and multicast receiver filtering on the same bridge domain. In this case one bridge domain can provide filtering for both, the source as well as the receivers.

If you do not provide a route map for a BD, the default action is to allow all multicast traffic on the bridge domain. However, if you do select a route map, the default action changes to deny any traffic not explicitly matched to a filter entry in the route map.

Source Filtering

For any multicast sources that are sending traffic on a bridge domain, you can configure a route map policy with one or more source and group IP filters defined. The traffic is then matched against every entry in the route map and one of the following actions takes place:

- If the traffic matches a filter entry with a `Permit` action in the route map, the bridge domain will allow traffic from that source to that group.
- If the traffic matches a filter entry with a `Deny` action in the route map, the bridge domain will block traffic from that source to that group.
- If the traffic does not match any entries in the route map, the default `Deny` action is applied.

Source filter is applied to the bridge domain on the First-Hop Router (FHR), represented by the ACI leaf node where the source is connected. The filter will prevent multicast from being received by receivers in different bridge domains, the same bridge domain, and external receivers.

Destination (Receiver) Filtering

Destination (receiver) filtering does not prevent receivers from joining a multicast group. The multicast traffic is instead allowed or dropped in the data plane based on the source IP and multicast group combination.

Similarly to the source filtering, when multicast traffic matches a destination filter, one of the following actions takes place:

- If the traffic matches a filter entry with a `Permit` action in the route map, the bridge domain will allow the traffic from the multicast group to the receiver.
- If the traffic matches a filter entry with a `Deny` action in the route map, the bridge domain will block the traffic from the multicast group to the receiver.
- If the traffic does not match any entries in the route map, the default `Deny` action is applied.

Destination filter is applied to the bridge domain on the Last-Hop Router (LHR), represented by the ACI leaf node where the receiver is connected, so other bridge domains can still receive the multicast traffic.

Layer 3 Multicast Guidelines and Limitations

Up to the current software release, Cisco ACI Multi-Site Orchestrator cannot be used to deploy specific multicast control plane filtering policies, such as IGMP or PIM related policies, on each site. As such you must configure any additional policies required for your use case on each APIC site individually for end-to-end solution to work. For specific information on how to configure those settings on each site, see the *Cisco APIC Layer 3 Networking Configuration Guide*.

You must also ensure that QoS DSCP translation policies in all fabrics are configured consistently. When you create custom QoS policies in ACI fabrics, you can create a mapping between the ACI QoS Levels and the packet header DSCP values for packets ingressing or egressing the fabric. The same ACI QoS Levels must be mapped to the same DSCP values on all sites for the multicast traffic to transit between those sites. For specific information on how to configure those settings on each site, see the *Cisco APIC and QoS*

Multicast Filtering

The following additional guidelines apply if you enable the multicast filtering:

- Multicast filtering is supported only for IPv4.
- You can enable either the multicast source filtering, or the receiver filtering, or both on the same bridge domain.
- If you do not want to have multicast filters on a bridge domain, do not configure a source filter or destination filter route maps on that bridge domain.

  By default, no route maps are associated with a bridge domain, which means that all multicast traffic is allowed. If a route map is associated with a bridge domain, only the permit entries in that route map will be allowed, while all other multicast traffic will be blocked.

  If you attach an empty route map to a bridge domain, route maps assume a `deny-all` by default, so all sources and groups will be blocked on that bridge domain.
- Multicast filtering is done at the BD level and apply to all EPGs within the BD. As such you cannot configure different filtering policies for different EPGs within the same BD. If you need to apply filtering more granularly at the EPG level, you must configure the EPGs in separate BDs.
- Multicast filtering is intended to be used for Any-Source Multicast (ASM) ranges only. Source-Specific Multicast (SSM) is not supported for source filtering and is supported only for receiver filtering.
- For both, source and receiver filtering, the route map entries are matched based on the specified `order` of the entry, with lowest number matched first. This means that lower order entries will match first, even if they are not the longest match in the list, and higher order entries will not be considered.

  For example, if you have the following route map for the `192.0.3.1/32` source:

Order	Source IP	Action
1	192.0.0.0/16	Permit
2	192.0.3.0/24	Deny

  Even though the second entry (`192.0.3.0/24`) is a longer match as a source IP, the first entry (`192.0.0.0/16`) will be matched because of the lower order number.

Creating Multicast Route Map Policy

This section describes how to create a multicast route map policy. You may want to create a route map for one of the following reasons:

- Define a set of filters for multicast source filtering.
- Define a set of filters for multicast destination filtering.
- Define a set of group IPs for a Rendezvous Point (RP).

  When configuring an RP for a VRF, if you do not provide a route map, the RP will be defined for the entire multicast group range (`224.0.0.0/4`). Alternatively, you can provide a route map with a group or group range defined to limit the RP to those groups only.

Step 1 Log in to the Cisco ACI Multi-Site Orchestrator GUI.

Step 2 In the **Main menu**, select **Application Management** > **Policies**.

Step 3 In the main pane, select **Add Policy** > **Create Multicast Route-Map Policy**.

Step 4 In the **Add Multicast Route-Map Policy** screen, select a Tenant and provide the name for the policy.

Step 5 Under **Route-Map Entry Order**, click **Add Route-Map Entry** to add an entry.

a) Provide the **Order** and **Action**.

Each entry is a rule that defines an action based on one or more matching criteria.

Order is used to determine the order in which the rules are evaluated.

Action defines the action to perform, either `Permit` or `Deny` the traffic, if a match is found.

b) Provide the **Group IP**, **Source IP**, and **RP IP** information as required.

As mentioned at the start of this section, you can use the same multicast route map policy UI for two different use cases—to configure a set of filters for multicast traffic or to restrict a rendezvous point configuration to a specific set of multicast groups. Depending on which use case you're configuring, you only need to fill some of the fields in this screen:

- For multicast filtering, you can use the **Source IP** and the **Group IP** fields to define the filter. You must provide at least one of these fields, but can choose to include both. If one of the fields is left blank, it will match all values.

  The Group IP range must be between `224.0.0.0` and `239.255.255.255` with a netmask between `/8` and `/32`. You must provide the subnet mask.

  The **RP IP** (Rendezvous Point IP) is not used for multicast filtering route maps, so leave this field blank.

- For Rendezvous Point configuration, you can use the **Group IP** field to define the multicast groups for the RP.

  The Group IP range must be between `224.0.0.0` and `239.255.255.255` with a netmask between `/8` and `/32`. You must provide the subnet mask.

  For Rendezvous Point configuration, the **RP IP** is configured as part of the RP configuration. If a route-map is used for group filtering it is not necessary to configure an RP IP address in the route-map. In this case, leave the **RP IP** and **Source IP** fields empty.

c) Click **Save** to save the entry.

Step 6 (Optional) Repeat the previous step if you want to add multiple entries to the same route policy.

Step 7 Click **Save** to save the route map policy.

Enabling Any-Source Multicast (ASM) Multicast

The following procedure describes how to enable ASM multicast on VRF, BD, and EPG using the Cisco ACI Multi-Site Orchestrator GUI. If you want to enable SSM multicast, follow the steps in Enabling Source-Specific Multicast (SSM), on page 196 instead.

Before you begin

- Ensure you have read and followed the information described in Layer 3 Multicast Guidelines and Limitations, on page 192.

- If you plan to enable multicast filtering, create the required multicast route maps, as described in Creating Multicast Route Map Policy, on page 193.
- Note that the site-local L3Outs must have PIM enabled in the VRF when fabric RP is enabled.

  This is described in Step 6 of the following procedure. Additional information about PIM configuration on an L3Out is available in the *Cisco APIC Layer 3 Networking Configuration Guide*.

Step 1 Log in to your Cisco ACI Multi-Site Orchestrator.

Step 2 From the left-hand sidebar, select the **Application Management** > **Schemas** view.

Step 3 Click on the Schema you want to change.

Step 4 Enable Layer 3 multicast on a VRF.

First, you enable Layer 3 multicast on a VRF that is stretched between sites.

a) Select the VRF for which you want to enable Layer 3 multicast.
b) In the right properties sidebar, check the **L3 Multicast** checkbox.

Step 5 Add one or more Rendezvous Points (RP).

a) Select the VRF.
b) In the right properties sidebar, click **Add Rendezvous Points**.
c) With the VRF still selected, click **Add Rendezvous Points** in the right sidebar.
d) In the **Add Rendezvous Points** window, provide the IP address of the RP.
e) Choose the type of the RP.

   - **Static RP**—If your RP is outside the ACI fabric.
   - **Fabric RP**—If your RP is inside the ACI fabric.

f) (Optional) From the **Multicast Route-Map Policy** dropdown, select the route-map policy you configured previously.

   By default, the RP IP you provide applies to all multicast groups in the fabric. If you want to restrict the RP to only a specific set of multicast groups, define those groups in a route map policy and select that policy here.

Step 6 Enable PIM on the L3Out.

Both static and fabric RPs require PIM-enabled border leaf switches where multicast routing is enabled. L3Out configuration currently cannot be done from the Multi-Site Orchestrator, so you must ensure that PIM is enabled directly in the site's APIC. Additional information about PIM configuration on an L3Out is available in the *Cisco APIC Layer 3 Networking Configuration Guide*.

a) Log in to your site's Cisco APIC.
b) In the top menu, click **Tenants** and select the tenant that contains the L3Out.
c) In the left navigation menu, select **Networking** > **L3Outs** > ***<l3out-name>***.
d) In the main pane, choose the **Policy** tab.
e) Check the **PIM** options.

   Multi-Site supports IPv4 multicast only.

Step 7 Enable Layer 3 multicast on a BD.

Once you have enabled L3 Multicast on a VRF, you can enable L3 multicast on a Bridge Domain (BD) level.

a) Select the BD for which you want to enable Layer 3 multicast.

b) In the right properties sidebar, check the **L3 Multicast** checkbox.

Step 8 (Optional) If you want to configure multicast filtering, provide the route-maps for source and destination filtering.

a) Select the BD.

b) In the right properties sidebar, select a **Route-Map Source Filter** and **Route-Map Destination Filter**.

You can choose to enable either the multicast source filtering, or the receiver filtering, or both.

Keep in mind, if you do not select a route map, the default action is to allow all multicast traffic on the bridge domain; however, if you select a route map the default action changes to deny any traffic not explicitly matched to a filter entry in the route map.

Step 9 If your multicast source is in one site and is not stretched to the other sites, enable intersite multicast source option on the EPG.

Once you have enabled L3 Multicast on the BD, you must also enable multicast on the EPGs (part of multicast-enabled BDs) where multicast sources are connected.

a) Select the EPG for which you want to enable Layer 3 multicast.

b) In the right-hand sidebar, check the **Intersite Multicast Source** checkbox.

Enabling Source-Specific Multicast (SSM)

The following procedure describes how to enable SSM multicast on VRF, BD, and EPG using the Cisco ACI Multi-Site Orchestrator GUI. If you want to enable ASM multicast, follow the steps in Enabling Any-Source Multicast (ASM) Multicast, on page 194 instead.

Before you begin

- Ensure you have read and followed the information described in Layer 3 Multicast Guidelines and Limitations, on page 192.

- If you plan to enable multicast filtering, create the required multicast route maps, as described in Creating Multicast Route Map Policy, on page 193.

- Note that you need to configure IGMPv3 interface policy for the multicast-enabled BDs at the site-local level.

  This is described in Step 8 of the following procedure. Additional information is available in the *Cisco APIC Layer 3 Networking Configuration Guide*.

Step 1 Log in to your Cisco ACI Multi-Site Orchestrator.

Step 2 From the left-hand sidebar, select the **Application Management** > **Schemas** view.

Step 3 Click on the Schema you want to change.

Step 4 Enable Layer 3 multicast on a VRF.

First, you enable Layer 3 multicast on a VRF that is stretched between sites.

a) Select the VRF for which you want to enable Layer 3 multicast.

b) In the right properties sidebar, check the **L3 Multicast** checkbox.

Step 5 (Optional) Configure a custom range for SSM listeners.

The default SSM range is `232.0.0.0/8`, which is automatically configured on the switches in your fabric. If you are using SSM, we recommend configuring your listeners to join groups in this range, in which case you can skip this step.

If for any reason you do not want to change your listener configuration, you can add additional SSM ranges under the VRF settings by creating a route-map with up to 4 additional ranges. Keep in mind that if you add a new range it will become an SSM range and cannot be used for ASM at the same time.

Custom SSM range configuration must be done directly in the site's APIC:

a) Log in to your site's Cisco APIC.
b) In the top menu, click **Tenants** and select the tenant that contains the VRF.
c) In the left navigation menu, select **Networking** > **VRFs** > ***<VRF-name>*** > **Multicast**.
d) In the main pane, choose the **Pattern Policy** tab.
e) From the **Route Map** dropdown in the **Source Specific Multicast (SSM)** area, choose an existing route map or click **Create Route Map Policy for Multicast** option to create a new one.

If you select an existing route map, click the icon next to the dropdown to view the route map's details.

In the route map details window or the **Create Route Map Policy for Multicast** window that opens, click **+** to add an entry. Then configure the Group IP; you need to provide only the group IP address to define the new range.

Step 6 (Optional) Enable PIM on the site's L3Out.

If you connect multicast sources and/or receivers to the external network domain, you must also enable PIM on the site's L3Out. L3Out configuration currently cannot be done from the Multi-Site Orchestrator, so you must ensure that PIM is enabled directly in the site's APIC. Additional information about PIM configuration on an L3Out is available in the *Cisco APIC Layer 3 Networking Configuration Guide*.

a) Log in to your site's Cisco APIC.
b) In the top menu, click **Tenants** and select the tenant that contains the L3Out.
c) In the left navigation menu, select **Networking** > **L3Outs** > ***<l3out-name>***.
d) In the main pane, choose the **Policy** tab.
e) Check the **PIM** options.

Multi-Site supports IPv4 multicast only.

Step 7 Enable Layer 3 multicast on a BD.

Once you have enabled L3 Multicast on a VRF, you can enable L3 multicast on a Bridge Domain (BD) level.

a) Select the BD for which you want to enable Layer 3 multicast.
b) In the right properties sidebar, check the **L3 Multicast** checkbox.

Step 8 Enabled IGMPv3 interface policy on the bridge domains where receivers are connected.

Because you are configuring SSM, you must also assign an IGMPv3 interface policy to the BD. By default, when PIM is enabled, IGMP is also automatically enabled on the SVI but the default version is set to IGMPv2. You must explicitly set the IGMP interface policy to IGMPv3. This must be done at the site-local level:

a) Log in to your site's Cisco APIC.
b) In the top menu, click **Tenants** and select the tenant that contains the BD.
c) In the left navigation menu, select **Networking** > **Bridge Domains** > ***<BD-name>***.
d) In the main pane, choose the **Policy** tab.
e) From the **IGMP Policy** dropdown, select the IGMP policy or click **Create IGMP Interface Policy** to create a new one.

If you select an existing policy, click the icon next to the dropdown to view the policy details.

In the policy details window or the **Create Route Map Policy for Multicast** window that opens, ensure that the **Version** field is set to `Version 3`.

Step 9 (Optional) If you want to configure multicast filtering, provide the route-maps for source and destination filtering.

a) Select the BD.

b) In the right properties sidebar, select a **Route-Map Source Filter** and **Route-Map Destination Filter**.

You can choose to enable either the multicast source filtering, or the receiver filtering, or both.

Keep in mind, if you do not select a route map, the default action is to allow all multicast traffic on the bridge domain; however, if you select a route map the default action changes to deny any traffic not explicitly matched to a filter entry in the route map.

Step 10 If your multicast source is in one site and is not stretched to the other sites, enable intersite multicast source option on the EPG.

Once you have enabled L3 Multicast on the BD, you must also enable multicast on the EPGs (part of multicast-enabled BDs) where multicast sources are connected.

a) Select the EPG for which you want to enable Layer 3 multicast.

b) In the right-hand sidebar, check the **Intersite Multicast Source** checkbox.

CHAPTER 18

EPG Preferred Group

EPG Preferred Groups

By default, Multi-Site architecture allows communication between EPGs only if a contract is configured between them. If there is no contract between the EPGs, any inter-EPG communication is explicitly disabled. The Preferred Group feature allows you to specify a set of EPGs that are part of the same VRF to allow full communication between them with no need for contracts to be created.

Preferred Group vs Contracts

There are two types of policy enforcements available for EPGs in a VRF which is stretched to multiple sites with a contract preferred group configured:

- **Included EPGs** – Any EPG that is a member of a preferred group can freely communicate with all other EPGs in the group without any contracts. The communication is based on the `source-any-destination-any-permit` default rule and appropriate Multi-Site translations.
- **Excluded EPGs** – EPGs that are not members of preferred groups continue to require contracts to communicate with each other. Otherwise, the default `source-any-destination-any-deny` rule applies.

The contract preferred group feature allows for greater control and ease of configuration of communication between EPGs across sites in a stretched VRF context. If two or more EPGs in the stretched VRF require open communication while others must have only limited communication, you can configure a combination of a contract preferred group and contracts with filters to control the inter-EPG communication. EPGs that are excluded from the preferred group can only communicate with other EPGs if there is a contract in place to override the `source-any-destination-any-deny` default rule.

Stretched vs Shadowed

If EPGs from multiple sites are configured to be part of the same contract preferred group, the Multi-Site Orchestrator creates shadows of each site's EPGs in the other sites in order to correctly translate and program the inter-site connectivity from the EPGs. Contract preferred group policy construct is then applied in each site between a real and shadow EPG for inter-EPG communication.

For example, consider a web-service EPG1 in Site1 and an app-service EPG2 in Site2 added to the contract preferred group. Then if EPG1 wants to access EPG2, it will first be translated to a shadow EPG1 in Site2 and then be able to communicate with EPG2 using the contract preferred group. Appropriate BDs are also stretched or shadowed if the EPG under it is part of a contract preferred group.

Limitations

Preferred Groups are not supported for intersite L3Out external EPGs.

Configuring EPGs for Preferred Group

Before you begin

You must have one or more EPGs added to a schema template.

Step 1 Log in to your Cisco ACI Multi-Site Orchestrator.

Step 2 From the left navigation pane, select the **Schemas** view.

Step 3 Click the Schema that you want to change.

Step 4 Configure one or more EPGs in the schema to be part of the preferred group.

Note If you have an existing preferred group in any of the APICs and are planning to import the EPGs from that preferred group into Multi-Site Orchestrator, you must import all EPGs in the group. You must not have a preferred group where some EPGs are managed by the Multi-Site Orchestrator and some are managed by the local APIC.

To add or remove a single EPG:

a) Select an EPG.
b) In the right properties bar, check or uncheck the **Include in Preferred Group** checkbox.
c) Click **SAVE** in the top right corner of the main window.

To add or remove multiple EPGs at once:

a) Click **SELECT** in the top-right corner of the **Application Profile** tab.
b) Select one or more EPGs by clicking on each one or click **Select All** to select all EPGs.
c) Click **...** in the top-right corner of the **Application Profile** tab and choose **Add EPGs to Preferred Group** or **Remove EPGs from Preferred Group**.
d) Click **SAVE** in the top right corner of the main window.

What to do next

You can view the full list of EPGs that are configured to be part of the preferred group by selecting a VRF and checking the **PREFERRED GROUP EPGS** list in the properties sidebar on the right.

CHAPTER 19

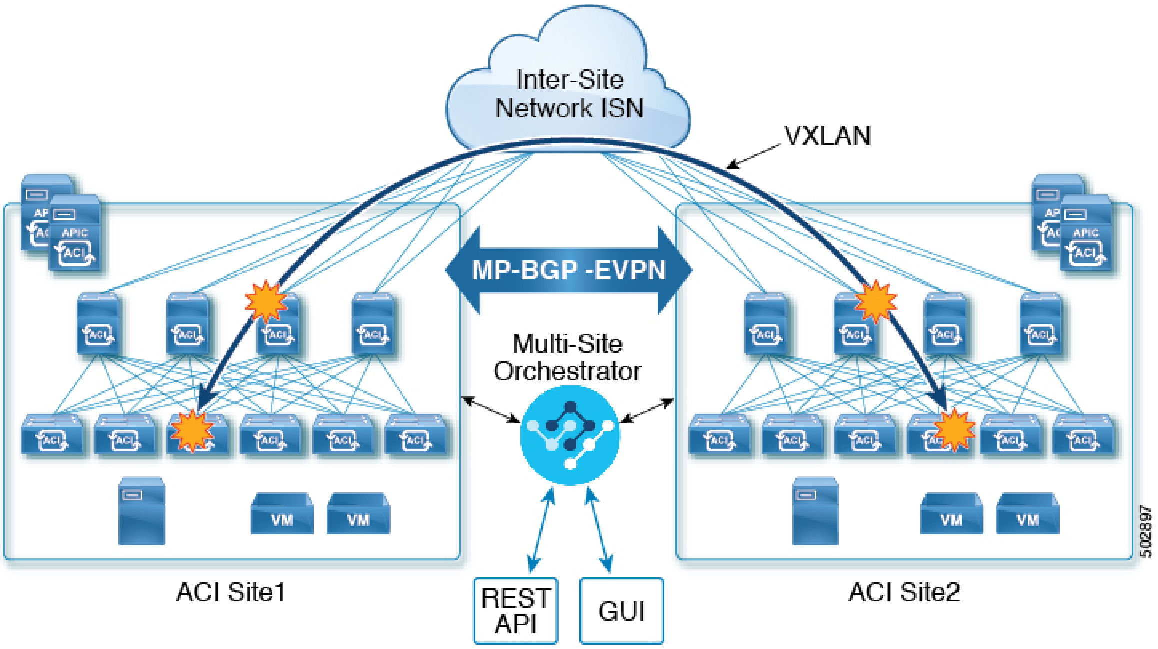
Sites Connected via SR-MPLS

SR-MPLS and Multi-Site

Starting with Orchestrator Release 3.0(1) and APIC Release 5.0(1), the Multi-Site architecture supports APIC sites connected via MPLS networks.

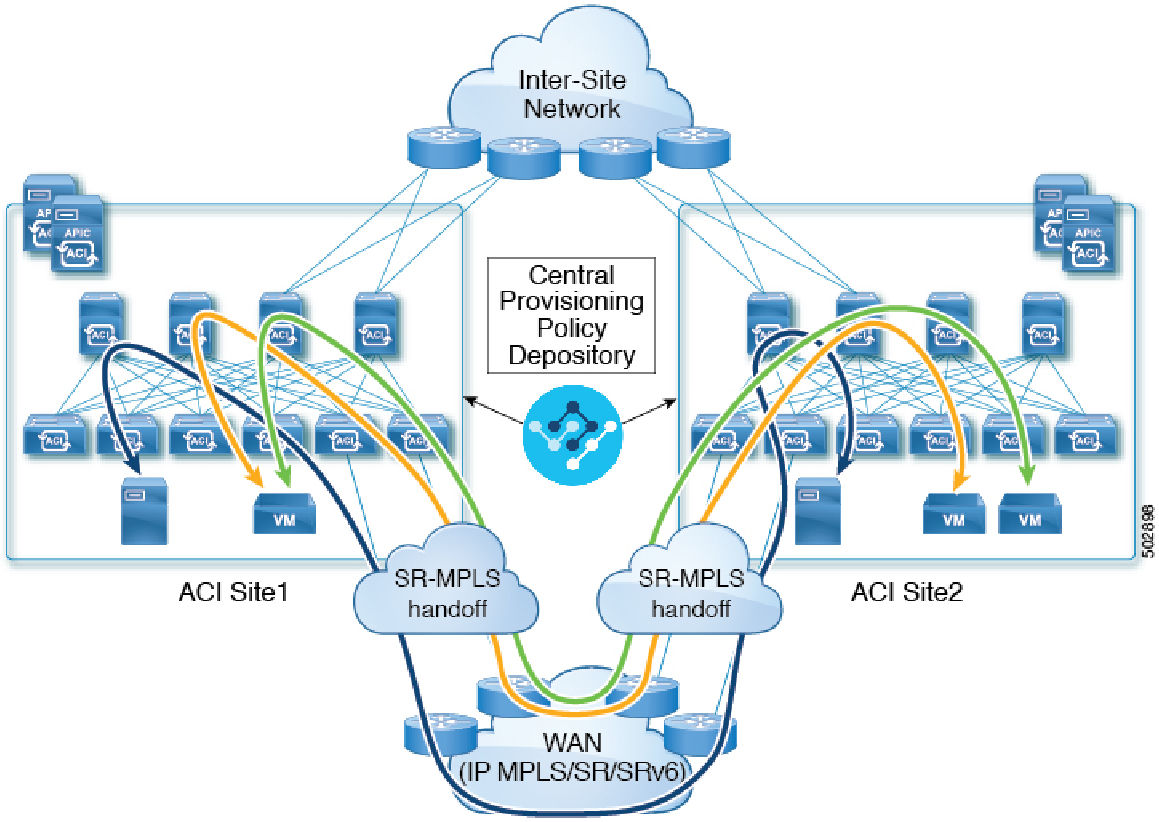
In a typical Multi-Site deployment, traffic between sites is forwarded over an intersite network (ISN) via VXLAN encapsulation:

Figure 32: Multi-Site and ISN



With Release 3.0(1), MPLS network can be used in addition to or instead of the ISN allowing inter-site communication via WAN:

Figure 33: Multi-Site and MPLS



The following sections describe guidelines, limitations, and configurations specific to managing Schemas that are deployed to these sites from the Multi-Site Orchestrator. Detailed information about MPLS hand off, supported individual site topologies (such as remote leaf support), and policy model is available in the *Cisco APIC Layer 3 Networking Configuration Guide*.

SR-MPLS Tenant Requirements and Guidelines

While the Infra MPLS configuration and requirements are described in the Day-0 operations chapter, the following restrictions apply for any user Tenants you will deploy to sites that are connected to SR-MPLS networks.

- You must have created and configured the SR-MPLS Infra L3Outs, including the QoS policies, as described in the Day-0 operations chapter.
- In case when traffic between two EPGs in the fabric needs to go through the SR-MPLS network:
  - Contracts must be assigned between each EPG and the external EPG defined on the local Tenant SR-MPLS L3Out.
  - If both EPGs are part of the same ACI fabric but separated by an SR-MPLS network (for example, in multi-pod or remote leaf cases), the EPGs must belong to different VRFs and not have a contract between them nor route-leaking configured.

- If EPGs are in different sites, they can be in the same VRF, but there must **not** be a contract configured directly between them.

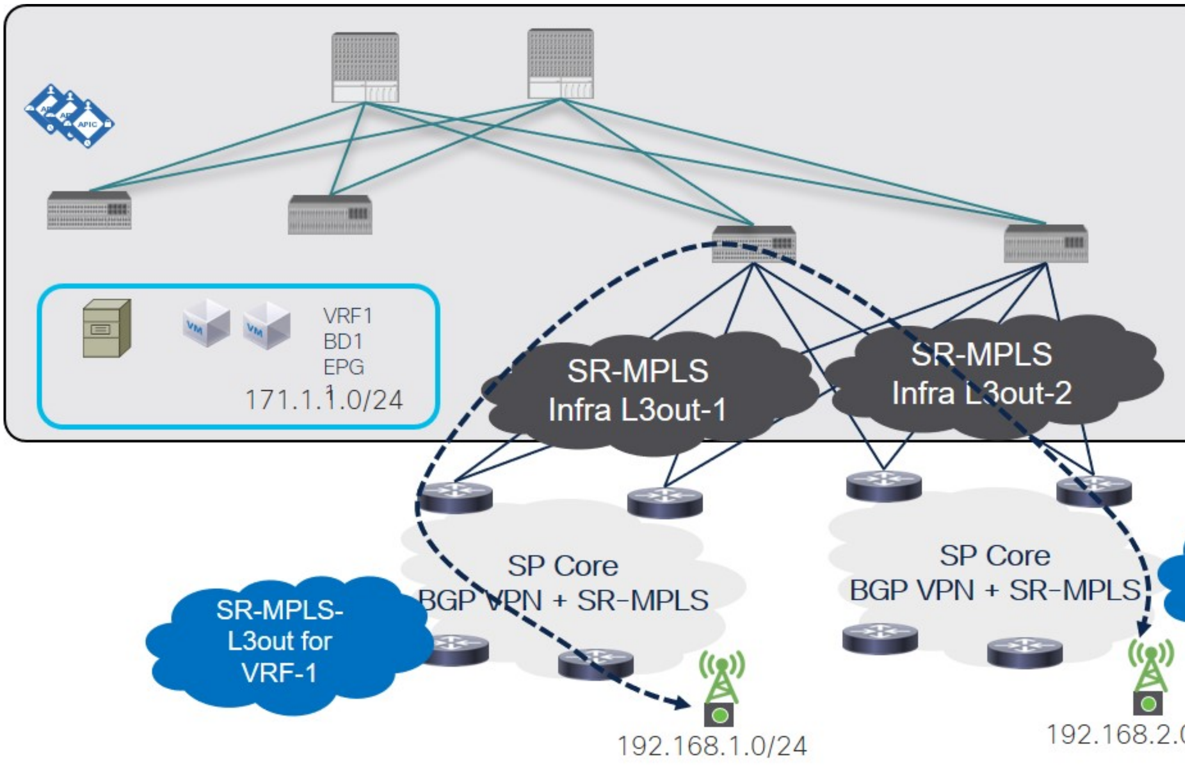
  Keep in mind, if the EPGs are in different sites, each EPG must be deployed to a single site only. Stretching EPGs between sites is not supported when using SR-MPLS L3Outs.

- When configuring a route map policy for the SR-MPLS L3Out:
  - Each L3Out must have a single export route map. Optionally, it can also have a single import route map.
  - Routing maps associated with any SR-MPLS L3Out must explicitly define all the routes, including bridge domain subnets, which must be advertised out of the SR-MPLS L3Out.
  - If you configure a `0.0.0.0/0` prefixe and choose to not aggregate the routes, it will allow the default route only.

    However, if you choose to aggregate routes `0` through `32` for the `0.0.0.0/0` prefix, it will allow all routes.
  - You can associate any routing policy with any tenant L3Out.

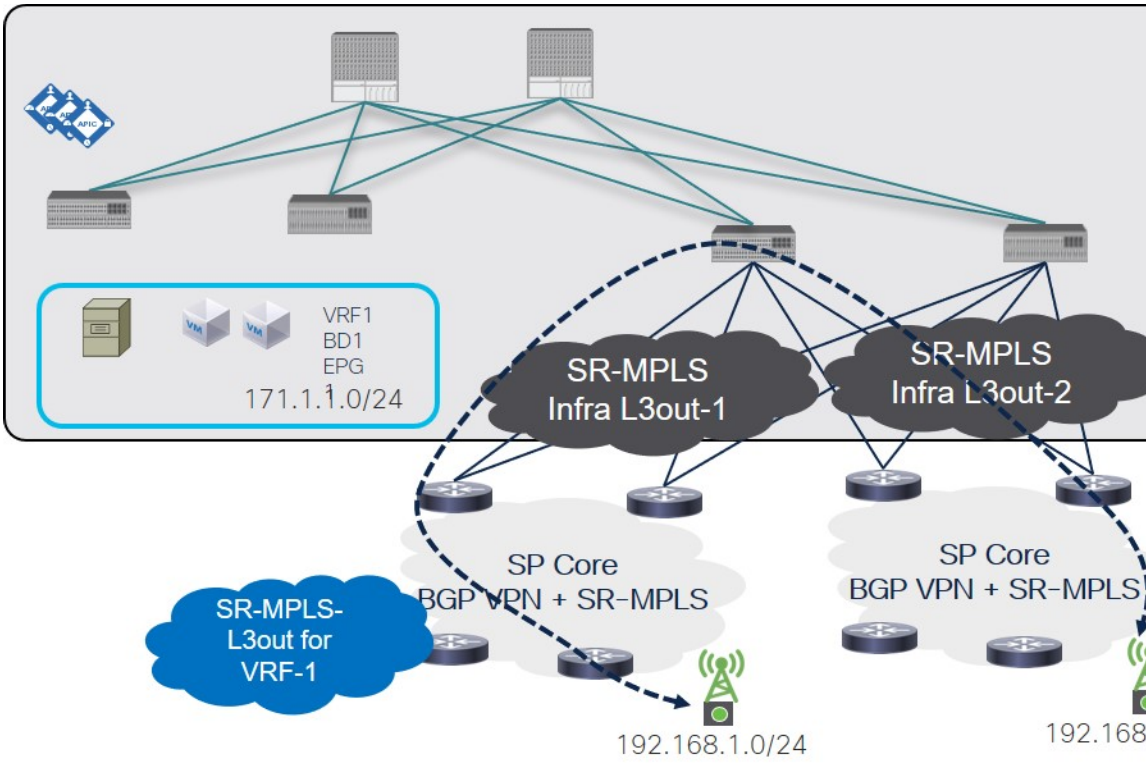
- Transit routing is supported, but with some restrictions:
  - Transit routing between two SR-MPLS networks **using the same VRF** is not supported. The following figure shows an example of this unsupported configuration.

Figure 34: Unsupported Transit Routing Configuration Using Single VRF



- Transit routing between two SR-MPLS networks **using different VRFs** is supported. The following figure shows an example of this supported configuration.

Figure 35: Supported Transit Routing Configuration Using Different VRFs



Creating SR-MPLS Route Map Policy

This section describes how to create a route map policy. Route maps are sets of `if-then` rules that enable you to specify which routes are advertised out of the Tenant SR-MPLS L3Out. Route maps also enable you to specify which routes received from the DC-PE routers will be injected into the BGP VPNv4 ACI control plane.

If you have no sites connected to MPLS networks, you can skip this section.

Step 1 Log in to the Cisco ACI Multi-Site Orchestrator GUI.

Step 2 In the **Main menu**, select **Application Management** > **Policies**.

Step 3 In the main pane, select **Add Policy** > **Create Route Map Policy**.

Step 4 In the **Add Route Map Policy** screen, select a Tenant and provide the name for the policy.

Step 5 Click **Add Entry** under **Route-Map Entry Order** to add a route map entry.

a) Provide the **Context Order** and **Context Action**.

Each context is a rule that defines an action based on one or more matching criteria.

Context order is used to determine the order in which contexts are evaluated. The value must be in the `0-9` range.

Action defines the action to perform (`permit` or `deny`) if a match is found.

b) If you want to match an action based on an IP addres or prefix, click **Add IP Address**.

In the **Prefix** field, provide the IP address prefix. Both IPv4 and IPv6 prefixes are supported, for example `2003:1:1a5:1a5::/64` or `205.205.0.0/16`.

If you want to aggregate IPs in a specific range, check the **Aggregate** checkbox and provide the range. For example, you can specify `0.0.0.0/0` prefix and choose to aggregate routes `0` through `32`.

c) If you want to match an action based on community lists, click **Add Community**.

In the **Community** field, provide the community string. For example, `regular:as2-nn2:200:300`.

Then choose the **Scope**.

d) Click **+Add Action** to specify the action that will be taken should the context match.

You can choose one of the following actions:

- `Set Community`
- `Set Route Tag`
- `Set Weight`
- `Set Next Hop`
- `Set Preference`
- `Set Metric`
- `Set Metric Type`

After you have configured the action, click the checkmark icon to save the action.

e) (Optional) You can repeat the previous substeps to specify multiple match criteria and actions within the same Context entry.

f) Click **Save** to save the Context entry.

Step 6 (Optional) Repeat the previous step if you want to add multiple entries to the same route policy.

Step 7 Click **Save** to save the route map policy.

Enabling Template for SR-MPLS

There is a number of template configuration settings that are unique when deploying them to sites connected via MPLS. Enabling SR-MPLS for a Tenant restricts and filters certain configurations that are not available for MPLS sites while bringing in additional configurations only available for such sites.

Before you can update MPLS-specific settings, you must enable the **SR-MPLS** knob in the template's Tenant properties.

Step 1 Log in to the Cisco ACI Multi-Site Orchestrator GUI.

Step 2 In the main navigation menu, select **Application Management** > **Schemas**.

Step 3 Create a new or select an existing Schema where you will configure SR-MPLS Tenant.

Step 4 Select the Tenant.

If you created a new Schema, choose a Tenant as you typically would. Otherwise click an existing Template in the left sidebar.

Step 5 In the right sidebar **Template** properties, enable **SR-MPLS** knob.

Creating VRF and SR-MPLS L3Out

This section describes how to create the VRF, tenant SR-MPLS L3Out, and External EPG you will use to configure communication between application EPGs separated by an MPLS network.

Before you begin

You must have:

- Created a template and enabled SR-MPLS for its tenant, as described in Enabling Template for SR-MPLS, on page 206.

Step 1 Select the template.

Step 2 Create a VRF.

a) In the main pane, scroll down to the **VRF** area and click the **+** sign to add a VRF.
b) In the right properties sidebar, provide the name for the VRF.

Step 3 Create an SR-MPLS L3Out.

a) In the main pane, scroll down to the **SR-MPLS L3Out** area and click the **+** sign to add an L3Out.
b) In the right properties sidebar, provide the name for the L3Out.
c) From the **Virtual Routing & Forwarding** dropdown, select the same VRF you selected for the external EPG in the previous step.

Step 4 Create an external EPG.

a) In the main pane, scroll down to the **External EPG** area and click the **+** sign to add an external EPG.
b) In the right properties sidebar, provide the name for the external EPG.
c) From the **Virtual Routing & Forwarding** dropdown, select the VRF you created in the previous step.

Configuring Site-Local VRF Settings

You must provide BGP route information for the VRF used by the SR-MPLS L3Out.

Before you begin

You must have:

- Created a template and enabled SR-MPLS for its tenant, as described in Enabling Template for SR-MPLS, on page 206.
- Created a VRF and SR-MPLS L3Out, as described in Creating VRF and SR-MPLS L3Out, on page 207.
- Added the template to an MPLS site.

Step 1 Select the schema that contains your template.

Step 2 In the left sidebar of the schema view under **Sites**, select the template to edit its site-local properties.

Step 3 In the main pane, scroll down to **VRF** area and select the VRF.

Step 4 In the right properties sidebar, click **+Add BGP Route Target Address**.

Step 5 Configure the BGP settings.

a) From the **Address Family** dropdown, select whether it is IPv4 or IPv6 address.

b) In the **Route Target** field, provide the route string.

For example, `route-target:ipv4-nn2:1.1.1.1:1901`.

c) From the **Type** dropdown, select whether to import or export the route.

d) Click **Save** to save the route information.

Step 6 (Optional) Repeat the previous step to add any additional BGP route targets.

Configuring Site-Local SR-MPLS L3Out Settings

Similar to how you configure site-local L3Out properties for typical external EPGs, you need to provide SR-MPLS L3Out details for external EPGs deployed to sites connected via MPLS.

Before you begin

You must have:

- Created a template and enabled SR-MPLS for its tenant, as described in Enabling Template for SR-MPLS, on page 206.
- Created a VRF and SR-MPLS L3Out, as described in Creating VRF and SR-MPLS L3Out, on page 207.
- Configured the VRF's site-local properties, as described in Configuring Site-Local VRF Settings, on page 207.
- Added the template to an MPLS site.

Step 1 Select the schema that contains your template.

Step 2 In the left sidebar of the schema view under **Sites**, select the template to edit its site-local properties.

Step 3 In the main pane, scroll down to **SR-MPLS L3Out** area and select the MPLS L3Out.

Step 4 In the right properties sidebar, click **+Add SR-MPLS Location**.

Step 5 Configure the SR-MPLS Location settings.

a) From the **SR-MPLS Location** dropdown, select the Infra SR-MPLS L3Out you created when configuring Infra for that site.

b) Under **External EPGs** section, select an external EPG from the dropdown and click the checkmark icon to add it.

   You can add multiple external EPGs.

c) Under **Route Map Policy** section, select a route map policy you created in previous section from the dropdown, specify whether you want to import or export the routes, then click the checkmark icon to add it.

   You must configure a single export route map policy. Optionally, you can configure an additional import route map policy.

d) Click **Save** to add the location to the MPLS L3Out.

Step 6 (Optional) Repeat the previous step to add any additional SR-MPLS Locations for your SR-MPLS L3Out.

Communication Between EPGs Separated by MPLS Network

Typically, if you wanted to establish communication between two EPGs, you would simply assign the same contract to both EPGs with one EPG being the provider and the other one a consumer.

However, if the two EPGs are separated by an MPLS network, the traffic has to go through each EPG's MPLS L3Out and you establish the contracts between each EPG and its MPLS L3Out instead. This behavior is the same whether the EPGs are deployed to different sites or within the same fabric but separated by an SR-MPLS network, such as in Multi-Pod or Remote Leaf cases.

Before you begin

You must have:

- Added one or more sites connected to MPLS network(s) to the Orchestrator.
- Configured Infra MPLS settings, as described in "Day-0 Operations" chapter.
- Created a schema, added a Tenant, and enabled the Tenant for SR-MPLS, as described in Enabling Template for SR-MPLS, on page 206.

Step 1 Log in to the Cisco ACI Multi-Site Orchestrator GUI.

Step 2 Create two application EPGs as you typically would.

For example, `epg1` and `epg2`.

Step 3 Create two separate external EPGs

These EPGs can be part of the same template or different templates depending on the specific deployment scenario.

For example, `mpls-extepg-1` and `mpls-extepg-2`

Step 4 Configure two separate Tenant SR-MPLS L3Outs.

For example, `mpls-l3out-1` and `mpls-l3out-2`

For each Tenant SR-MPLS, configure the VRF, route map policies, and external EPGs as described in Configuring Site-Local VRF Settings, on page 207 and Configuring Site-Local SR-MPLS L3Out Settings, on page 208.

Step 5 Create a contract you will use to allow traffic between the two application EPGs you created in Step 2.

You will need to create and define a filter for the contract just as you typically would.

Step 6 Assign the contracts to the appropriate EPGs.

In order to allow traffic between the two application EPGs you created, you will actually need to assign the contract twice: once between `epg1` and its `mpls-l3out-1` and then again between `epg2` and its `mpls-l3out-2`.

As an example, if you want `epg1` to provide a service to `epg2`, you would:

a) Assign the contract to `epg1` with type `provider`.
b) Assign the contract to `mpls-l3out-1` with type `consumer`.
c) Assign the contract to `epg2` with type `consumer`.
d) Assign the contract to `mpls-l3out-2` with type `provider`.

Deploying Configuration

You can deploy the configuration Template to an MPLS site as you typically would, with one exception: because you cannot stretch objects and policies between MPLS site and another site, you can only select a single site when deploying the template.

Step 1 Add the site to which you want to deploy the template.

a) In the left sidebar of the **Schema** view under **Sites**, click the **+** icon.
b) In the **Add Sites** window, select the site where you want to deploy the Template.

   You can only select a single site if your template is MPLS-enabled.

c) From the **Assign to Template** dropdown, select one or more Template you have created in this Schema.
d) Click **Save** to add the site.

Step 2 Deploy the configuration

a) In the main pain of the **Schemas** view, click **Deploy to Sites**.
b) In the **Deploy to Sites** window, verify the changes that will be pushed to the site and click **Deploy**.

CHAPTER 20

vzAny Contracts

vzAny and Multi-Site

The `vzAny` managed object provides a convenient way of associating all endpoint groups (EPGs) in a Virtual Routing and Forwarding (VRF) instance to one or more contracts, instead of creating a separate contract relation for each EPG.

In the Cisco ACI fabric, EPGs can only communicate with other EPGs according to contract rules. A relationship between an EPG and a contract specifies whether the EPG provides the communications defined by the contract rules, consumes them, or both. By dynamically applying contract rules to all EPGs in a VRF, vzAny automates the process of configuring EPG contract relationships. Whenever a new EPG is added to a VRF, vzAny contract rules automatically apply. The vzAny one-to-all EPG relationship is the most efficient way of applying contract rules to all EPGs in a VRF.

Advantages

Policy information in Cisco ACI is programmed in the fabric switches' TCAM tables. TCAM entries are typically specific to each pair of EPGs that are allowed to communicate with each other via a Contract. This means that even if the same contract is re-used, multiple TCAM entries are created for every pair of EPGs.

The size of the policy TCAM table depends on the generation of the switches that you are using. In certain large scale environments it is important to take policy TCAM usage into account and ensure that the limits are not exceeded.

vzAny allows you to combine all EPGs within the same VRF into a single "group" and create a contract relationship with that group rather than individual EPGs within it, while consuming only a single TCAM entry. This saves the time you would otherwise spend creating multiple contract relationships for individual EPGs in the VRF as well as the TCAM space.

Use Cases

There are two typical use cases for vzAny:

- Free communication between EPGs within the same VRF, as described in Free Intra-VRF Communication, on page 216.
- Many-to-one communication allowing all EPGs within the same VRF to consume a shared service from a single EPG, as described in more detail in Many-to-One Communication, on page 220.

vzAny and Multi-Site Guidelines and Limitations

The following guidelines and limitations apply when using vzAny:

- vzAny is not supported for VRFs used by shared service L3Out.
- vzAny is not supported with Preferred Group feature within the same VRF.

  vzAny and Preferred Group must not be concurrently enabled for the same VRF
- vzAny and Preferred Group is not supported in a shared services scenario.

  For example, if vzAny is enabled for VRF1 and VRF2 has EPGs in a Preferred Group, you must not establish contracts between the PG EPGs and vzAny.
- vzAny is not supported for Cloud Sites.
- vzAny is not supported with inter-VRF intersite L3Out configurations.
- vzAny must not consume or provide a contract that is associated with a Service-Graph with PBR.
- vzAny can be configured as provider, consumer or both of a contract for establishing intra-VRF communication.
- vzAny is supported only as a consumer of a shared service but not as a provider.
- We recommend stretching the vzAny VRF to all sites where you plan to deploy EPGs and BDs that use it.
- You can import existing vzAny configurations from an APIC.

  Note In certain cases due to an existing issue (CSCvt47568), if you make changes to the imported configuration before re-deploying it from the Multi-Site Orchestrator, some changes may not get correctly updated in the APICs. To avoid this, re-deploy the configuration immediately after importing but before making any changes to it. After you re-deploy the unchanged config, you will be able to update it as normal.
- vzAny providers and consumers include application EPGs, external EPGs associated to L3Outs, and endpoint groups for in-band or out-of-band access.
- vzAny implicitly creates a `0.0.0.0/0` classification for externally originating traffic, allowing all traffic originating from any external IP subnet. When vzAny is in use for a VRF, it also includes the external

EPGs associated to the L3Outs part of that VRF, hence it is equivalent to having created a L3external classification that includes the subnets specified in the VRF itself.

- If an EPG within a VRF is consuming a shared service contract from an EPG in a different VRF, the traffic from the EPG of the provider VRF is filtered within the consumer VRF. vzAny is equivalent to a wildcard for the source or destination EPG.

  Be careful when you configure a contract with a vzAny in the consumer VRF because the vzAny contracts may also apply to the traffic between the EPG of the provider VRF and the EPG of the consumer VRF. For example, if the provider EPG subnet is leaked into the consumer VRF, then the provider EPG will start communicating with the consumer EPG across VRFs, because the traffic is always allowed from a policy perspective. Failure to observe this guideline could allow unintended traffic between EPGs across VRFs.

- Configuring a VRF with vzAny as both provider and consumer of a contract using an "allow all" filter, is the same as configuring an unenforced VRF. This implies that all EPGs within that VRF are free to communicate to each other without a contract.

- If the contract scope is application-profile, the vzAny configuration is ignored and filter rules are expanded; CAM utilization is the same as if specific contracts were deployed between each pair of consumer and provider EPGs. In this case, there is no benefit in terms of TCAM space usage.

- In the case of shared services, you must define the provider EPG shared subnet under the EPG in order to properly derive the classification (`pcTag`) of the destination on the consumer (vzAny) side. If you are migrating from a BD-to-BD shared services configuration, where both the consumer and provider subnets are defined under bridge domains, to vzAny acting as a shared service consumer, you must take an extra configuration step where you add the provider subnet to the EPG with the shared flags at minimum. However, since the subnet under the EPG is not needed for connectivity, it is always recommended to check the `No default SVI gateway` flag.

  If you add the EPG subnet as a duplicate of the defined BD subnet, ensure that both definitions of the subnet always have the same flags defined. Failure to do so can result in unexpected fabric forwarding behavior.

Create Contract and Filters

When using vzAny, you are essentially creating a single point for a contract relationship, as such you must have a typical contract you will use for any such relationship as well as the filter for the contract.

This section describes how to create a new contract specifically for this purpose. Alternatively, you can choose to import any existing vzAny contracts you have configured on each APIC site.

Step 1 Log in to the Multi-Site Orchestrator GUI.

Step 2 From the left navigation pane, select **Schemas**.

Step 3 Select the Schema where you want to create your Contract.

If you have an existing Schema you want to update, simply click the Schema's name in the main window pane. Otherwise, if you want to create a new Schema, click the **Add Schema** button and provide the schema information, such as the name and tenant, as you typically would.

Step 4 Create a filter.

a) Scrolls down to the **Filter** area and click the + sign to add a new filter.
b) Provide the name for the Contract.
c) Click **+Entry** to add a filter entry.
d) In the **Add Entry** window, provide filter details.

   Provide the filter details as you typically would to define the kind of traffic you want to allow.

e) Click **SAVE** to add the entry.
f) (Optional) If required, create additional filter entries.

Step 5 Create the contract.

a) Scrolls down to the **Contract** area and click the + sign to add a new contract.
b) Provide the name for the Contract.

   For example, `contract-vzany`.

c) Choose the scope for the contract

   Choose the scope appropriate for your use-case. For example, if you want to enable cross-tenant shared services, you must set the scope to `Global`.

d) Choose whether the contract will apply in both directions
e) Click **+Filter** to add one or more contract filters.
f) In the **Add Filter Chain** window, choose the filter you created in the previous step.
g) Click **SAVE** to add the filter.
h) (Optional) If required, repeat the procedure to provide additional filters.
i) (Optional) If you disabled the **Apply Both Directions** option, provide filters for both, consumer and provider directions.

You have now created the contract you will use with vzAny in the next section.

Configure vzAny to Consume/Provide a Contract

This section describes how to create a vzAny VRF or enable an existing VRF for vzAny.

Before you begin

You must have:

- Created a Contract and one or more Filters to use with vzAny as described in Create Contract and Filters, on page 213.

Step 1 Log in to the Multi-Site Orchestrator GUI.

Step 2 From the left navigation pane, select **Schemas**.

Step 3 Select the Schema for the vzAny VRF.

If you have an existing Schema you want to update, simply click the Schema's name in the main window pane. Otherwise, if you want to create a new Schema, click the **Add Schema** button and provide the schema information, such as the name and tenant, as you typically would.

Step 4 Create or select a VRF.

If you have an existing VRF for which you want to configure vzAny to provide/consume a contract, simply click the VRF in the main window pane. Otherwise, if you want to create a new VRF, scroll down to the **VRF** area and click the + sign.

Step 5 Select vzAny.

In the right sidebar, check the **vzAny** checkbox.

Step 6 Select the vzAny contract.

The **+Contract** option becomes available after you enable the **vzAny** checkbox.

a) Click **+Contract** to add the contract

b) Select the contract.

Select the contract you created in Create Contract and Filters, on page 213.

c) Select the Contract type.

You can choose either `consumer` or `provider` for the contract based on your use case.

Create EPGs to Be Part of the vzAny VRF

You can choose to create new or use existing EPGs for your vzAny use cases. There are no explicit vzAny settings on the EPGs and free communication is allowed by default for any EPG that is part of the vzAny VRF. If you simply enabled vzAny for an existing VRF with all its EPGs already created and configured, you can skip this section.

Before you begin

You must have:

- Created a Contract and one or more Filters to use with vzAny as described in Create Contract and Filters, on page 213.
- Created the vzAny VRF and assigned the Contract to it as described niConfigure vzAny to Consume/Provide a Contract, on page 214.

Step 1 If you want to create an EPG to be part of the vzAny VRF

a) Create a BD you will use for your EPG.

b) In the BD configuration sidebar's **Virtual Routing & Forwarding** dropdown, select the vzAny VRF you created.

c) Create an EPG.

d) In the EPG configuration sidebar's **Bridge Domain** dropdown, select the BD you created.

Step 2 If you want to create an External EPG to be part of the vzAny VRF...

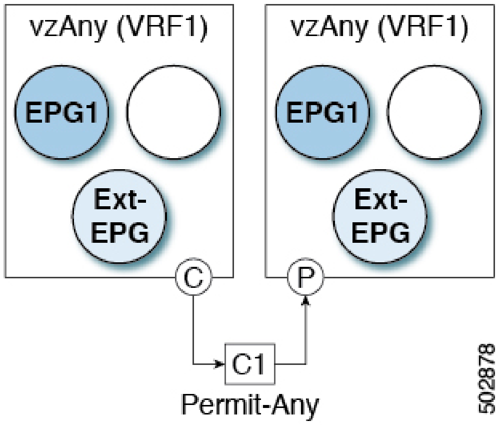
a) Create an external EPG.

b) In the External EPG configuration sidebar's **Virtual Routing & Forwarding** dropdown, select the vzAny VRF you created.

Free Intra-VRF Communication

This section shows a number of schema examples for unrestricted intra-VRF communication. In all shown scenarios vzAny provides and consumes a contract with a `permit-any` filter. This essentially uses the ACI fabrics for network connectivity only without any policy enforcement and is equivalent to the "VRF Unenforced" option.

Figure 36:



For all the following use cases, you will need to create the same objects and policies summarized below. However, the schema and template design will depend on the number of sites as well as which objects are going to be stretched. Specific sections contain recommendation on template layout.

Step 1 Create a Schema.

Step 2 Create a single common Template.

Step 3 Create any additional templates for every combination of sites where EPGs will be deployed .

If you will deploy a single template to all sites, you can skip this step. The use-case diagrams in the following sections provide template examples.

Step 4 Within the common Template, create the contract and filters to be consumed/provided by vzAny.

In this specific use case, the contract should have a single "permit-any" filter rule.

For specific steps, see Create Contract and Filters, on page 213.

Step 5 Within the common Template, create a VRF and configure vzAny to consume and provide the previously defined contract with the "permit-any" rule.

This ensures that free intra-VRF communication can be established.

For specific steps, see Configure vzAny to Consume/Provide a Contract, on page 214.

Step 6 Within each site's template, create and configure the EPGs that will be deployed to that site only.

If you will deploy a single template to all sites, create the EPGs within the same template as the VRF instead. The use-case diagrams in the following sections provide template examples.

This is described in Create EPGs to Be Part of the vzAny VRF, on page 215.

Step 7 Assign the common Template to every site.

Step 8 Assign each template to the appropriate sites.

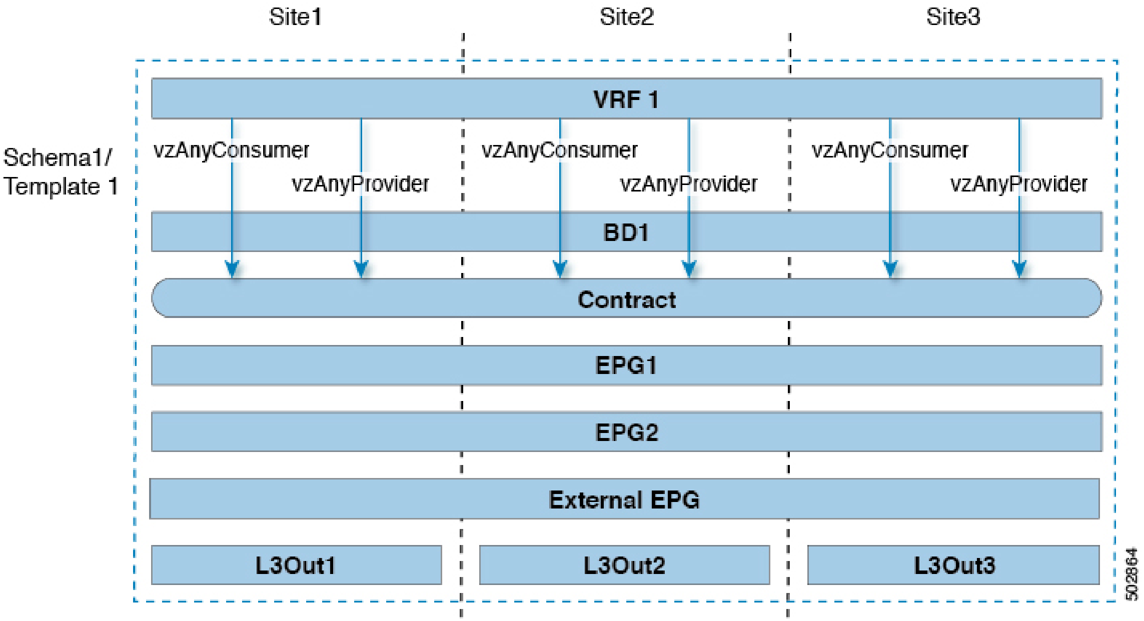
Step 9 Deploy the templates.

Stretched EPGs

The following example shows intra-VRF communication between EPGs or External EPGs all of which are stretched between sites. In this example EPG1 and EPG2 are mapped to the same BD1, but they could each be part of different BDs as long as both BDs are part of VRF1.

In this case you can create all objects within the same template and then deploy the template to all sites.

Figure 37:



Site-Local EPGs

The following example shows intra-VRF communication between EPGs or External EPGs where none of the EPGs are stretched but can still freely communicate with each other since vzAny consumes and provides the "permit-any" contract.

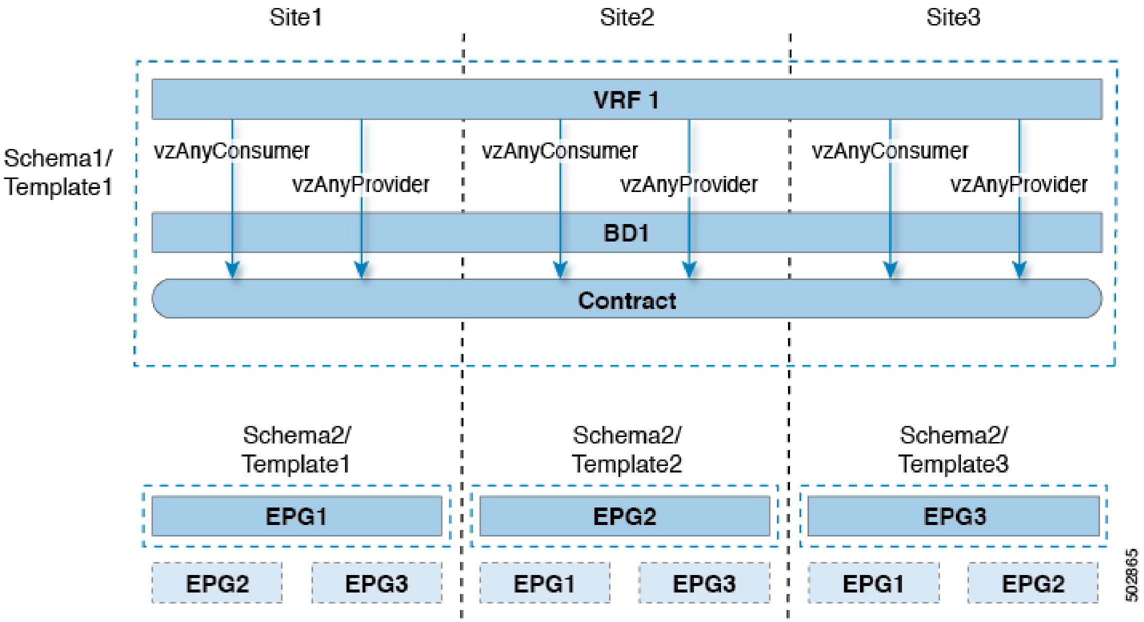
In this case you will need to create multiple templates:

- A single template for the shared objects (VRF, Contract) deployed to every site.

- And a separate template for every site containing the EPG and BD deployed that site.

For the objects that are not stretched, shadow objects are created in other sites.

Figure 38:



Combination of Site-Local and Stretched EPGs

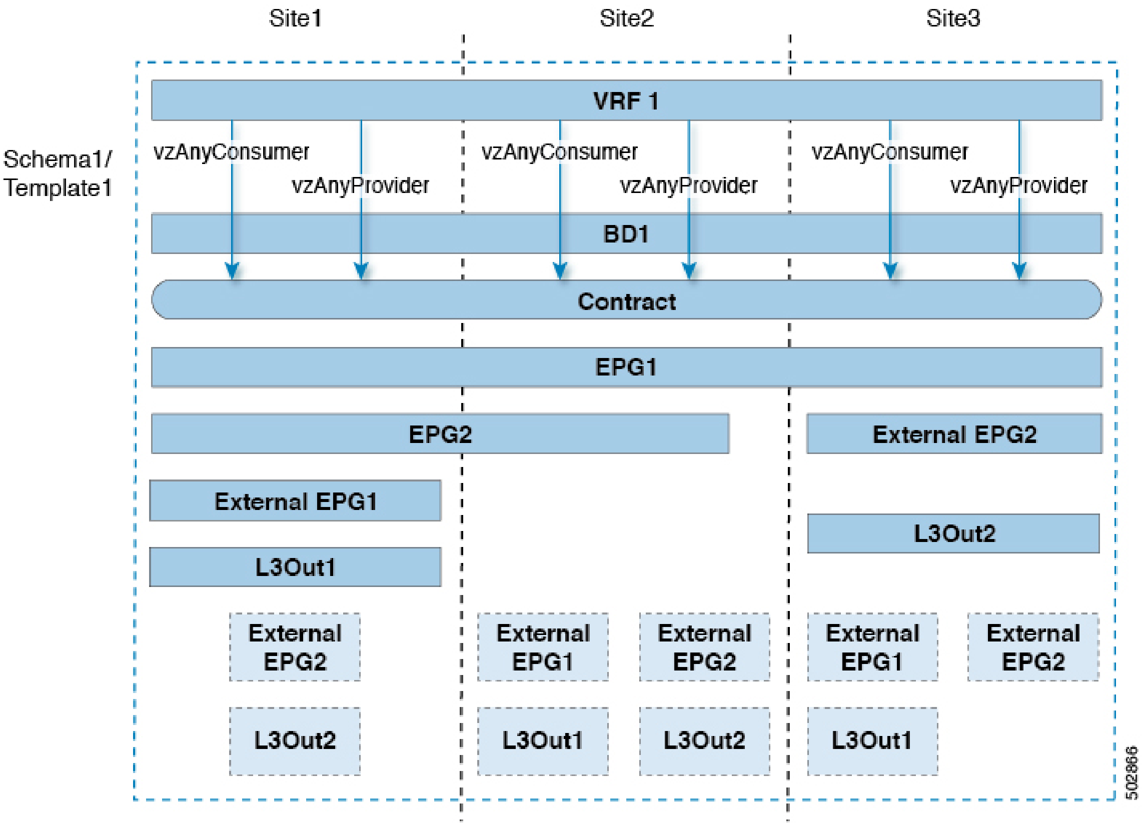
The following example shows intra-VRF communication between EPGs or External EPGs where some EPGs are stretched while others are deployed to a single site only. All EPGs can still freely communicate with each other since vzAny consumes and provides the "permit-any" contract.

In this case you will need to create multiple templates:

- A single template for the shared objects (VRF, Contract, BDs) deployed to every site.
- And a separate template for every site combination containing the objects deployed only to those sites.

For the objects that are not stretched, shadow objects are created in other sites.

Figure 39:



Intra-VRF Intersite L3Out

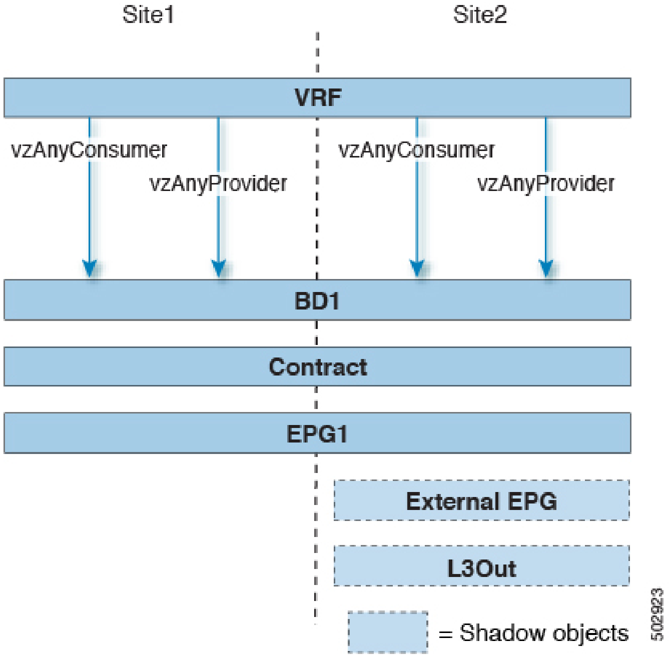
This use case allows you to configure an intersite L3Out for multiple EPGs within a vzAny VRF. When the L3Out's external EPG is in the same VRF, you do not need to explicitly add the provider contract to the external EPG.

Keep in mind, when configuring an intersite L3Oout, you must configure a routable TEP pool for each Pod. Additional intersite L3Out details and requirements are described in the Intersite L3Out Overview, on page 143 section.

In this case you will need to create multiple templates:

- A single template for the shared vzAny objects (VRF, Contract, BD) deployed to one or more sites.
- And a separate template for every site combination containing the objects deployed only to those sites.

Figure 40:

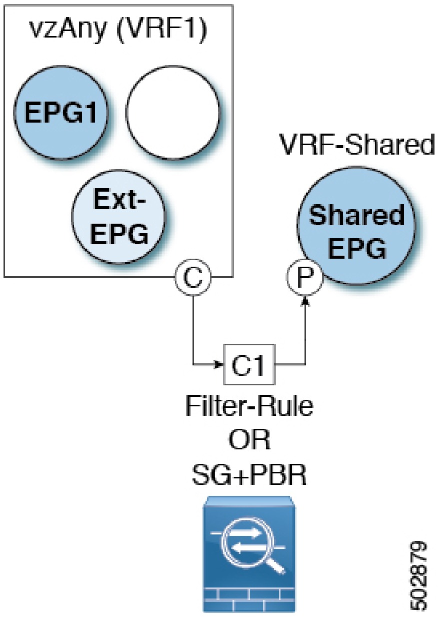


Many-to-One Communication

The following three sections provide schema examples of multiple EPGs that are part of the same vzAny VRF communicating with a single EPG that is providing a shared service. In this case, the contract can specify one or more filter rules.

The EPG providing shared services can be in a separate VRF (as shown in the figure below) or it can be part of the vzAny VRF.

Figure 41:



For all the following use cases, you will need to create the same objects and policies summarized below. However, the schema and template design will depend on the number of sites as well as which objects are going to be stretched. Specific sections contain recommendation on template layout.

Step 1 Create a Schema.

Step 2 Create a single common Template.

Step 3 Create any additional templates for every combination of sites where EPGs will be deployed .

Step 4 Within the common Template, create the contract and filters to be consumed by vzAny and provided by the EPG offering shared services.

This is described in Create Contract and Filters, on page 213.

Step 5 Within the common Template, create a VRF and configure vzAny to consume the previously defined contract.

This is described in Configure vzAny to Consume/Provide a Contract, on page 214.

Step 6 Within each site's template, create and configure the EPGs that are part of the vzAny VRF.

This is described in Create EPGs to Be Part of the vzAny VRF, on page 215.

Step 7 Create new or configure existing provider EPG or external EPG.

You create and configure the provider EPG or external EPG as you typically would.

Step 8 Assign the Contract to the provider EPG.

In addition to assigning the contract to be consumed by vzAny, you will also need to assign the same contract to the provider EPG.

Provider EPG Within vzAny VRF

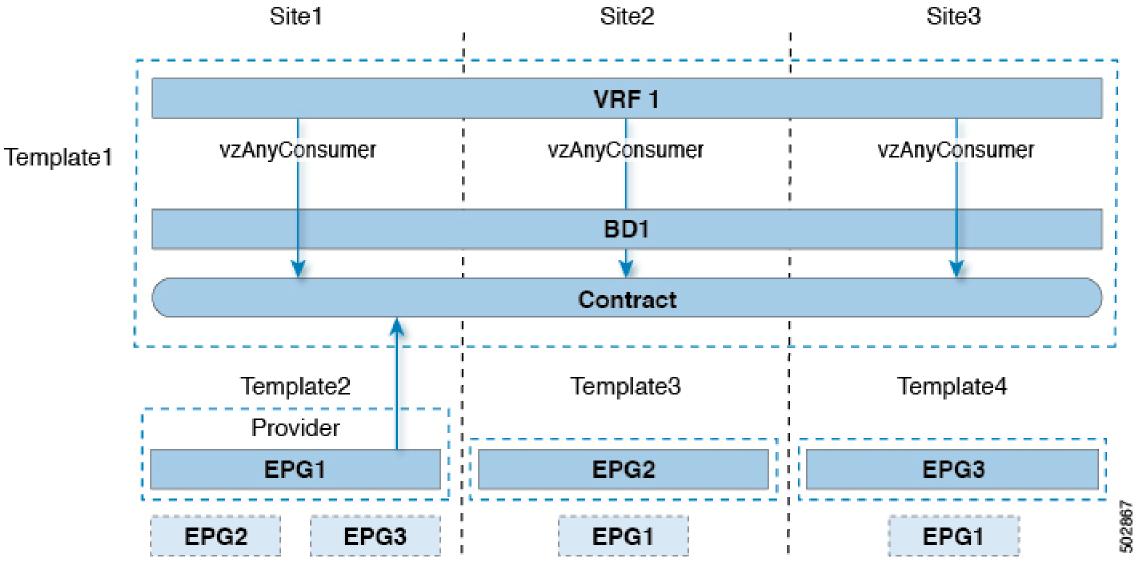
The following example shows intra-VRF communication between a single provider EPG (for example, shared service) and all other EPGs within the same VRF consuming the service.

In this case you will need to create multiple templates:

- A single template for the shared objects (VRF, Contract, BDs) deployed to every site.
- And a separate template for every site combination containing the objects deployed only to those sites.

The following figure shows a single stretched VRF/BD configuration. Alternatively, you can also configure and map a dedicated BD for each EPG, in which case shadow BDs would be deployed in the remote sites.

Figure 42:



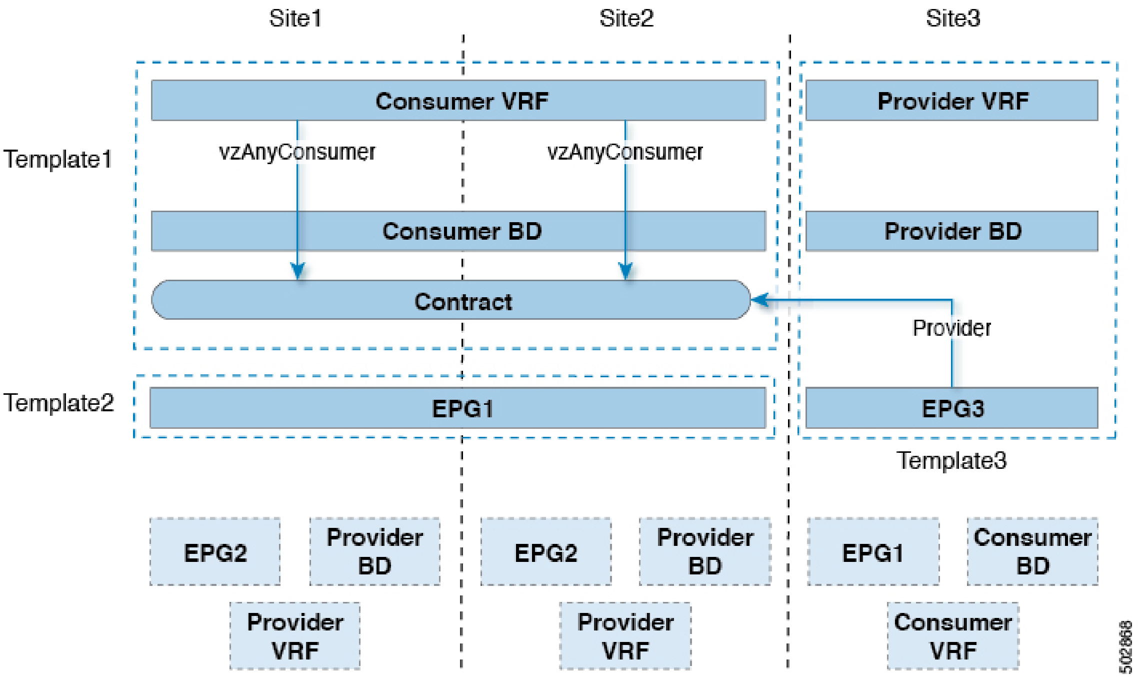
Provider EPG In Its Own VRF

The following example shows communication between a single EPG (for example, shared service provider) in its own VRF and all EPGs within a different, vzAny VRF. The provider EPG can be deployed to the same or a different site as the consumer EPGs in the vzAny VRF.

In this case you will need to create multiple templates:

- A single template for the shared vzAny objects (VRF, Contract, BD) deployed to one or more sites.
- And a separate template for every site combination containing the objects deployed only to those sites.

Figure 43:


Site1
Site2
Site3
Template1
Consumer VRF
vzAnyConsumer
vzAnyConsumer
Consumer BD
Contract
Provider VRF
Provider BD
Provider
EPG3
Template2
EPG1
Template3
EPG2
Provider BD
Provider VRF
EPG2
Provider BD
Provider VRF
EPG1
Consumer BD
Consumer VRF
502868

CHAPTER 21

QoS Preservation Across IPN

QoS and Global DSCP Policy

Cisco ACI Quality of Service (QoS) feature allows you to classify the network traffic in your fabric and then to prioritize and police the traffic flow to help avoid congestion in your network. When traffic is classified within the fabric, it is assigned a QoS Priority Level, which is then used throughout the fabric to provide the most desirable flow of packets through the network.

This release of Multi-Site Orchestrator supports configuration of QoS level based on source EPG or a specific Contract. Additional options are available in each fabric directly. You can find detailed information on ACI QoS in *Cisco APIC and QoS*.

When traffic is sent and received within the Cisco ACI fabric, the QoS Level is determined based on the CoS value of the VXLAN packet's outer header. In certain use cases, such as multi-pod or remote leaf topologies, the traffic must transit an intersite network, where devices that are not under Cisco APIC's management may modify the CoS values in the packets. In these cases you can preserve the ACI QoS Level between parts of the same fabric or different fabrics by creating a mapping between the Cisco ACI QoS level and the DSCP value within the packet.

DSCP Policy Guidelines and Limitations

When configuring the global DSCP translation policy, the following guidelines apply.

Note If you plan to use the global DSCP translation policy along with SD-WAN integration, skip this chapter and see the SD-WAN Integration, on page 231 chapter instead for all information including the full list of guidelines and limitations.

- Global DSCP policy is supported for on-premises sites only.
- When defining the global DSCP policy, you must pick a unique value for each QoS Level.

- When assigning QoS level, you can choose to assign it to a specific Contract or an entire EPG.

  If multiple QoS levels could apply for any given traffic, only one is applied using the following precedence:

  - Contract QoS level: If QoS is enabled in the Contract, the QoS level specified in the contract is used.
  - Source EPG QoS level: If QoS level is not specified for the Contract, the QoS level set for the source EPG is used.
  - Default QoS level: If no QoS level is specified, the traffic is assigned Level 3 QoS class by default.

Configuring Global DSCP Policy

When traffic is sent and received within a Cisco ACI fabric, it is prioritized based on the ACI QoS Level, which is determined based on the CoS value of the VXLAN packet's outer header. When traffic exits the ACI fabric towards an intersite network, for example in multi-pod and remote leaf topologies, the QoS level is translated into a DSCP value which is included in the outer header of the VXLAN-encapsulated packet.

This section describes how to define the DSCP translation policy for traffic entering or exiting ACI fabric. This is required when traffic must transit through non-ACI networks, where devices that are not under Cisco APIC's management may modify the CoS values in the transiting packets.

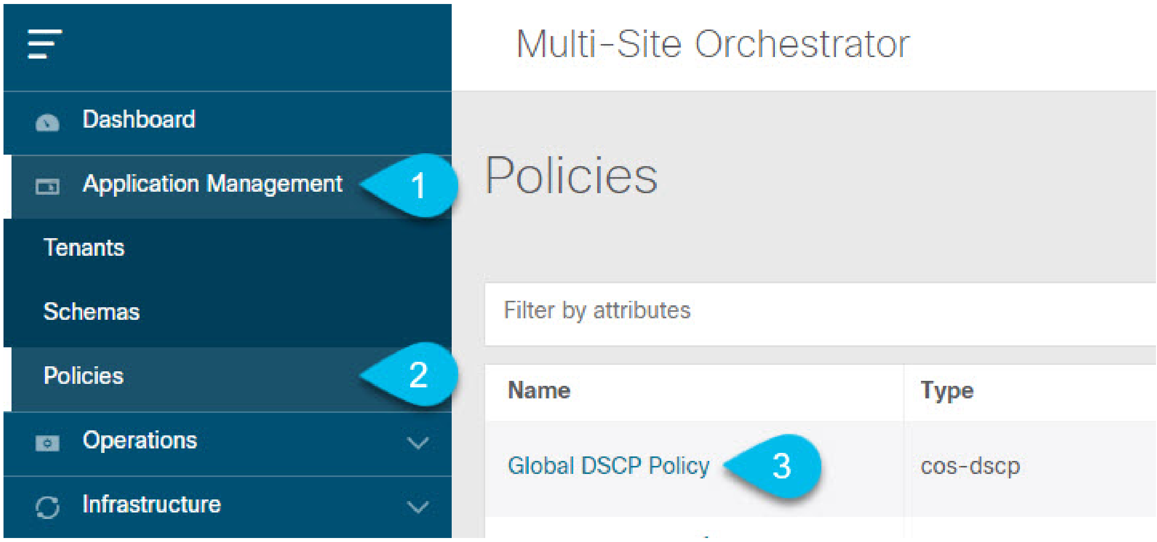
Before you begin

- You should be familiar with Quality of Service (QoS) functionality within ACI fabrics.

  QoS is described in more detail in *Cisco APIC and QoS*.

Step 1 Log in to your Cisco Multi-Site Orchestrator GUI.

Step 2 Open the global DSCP policy configuration screen.

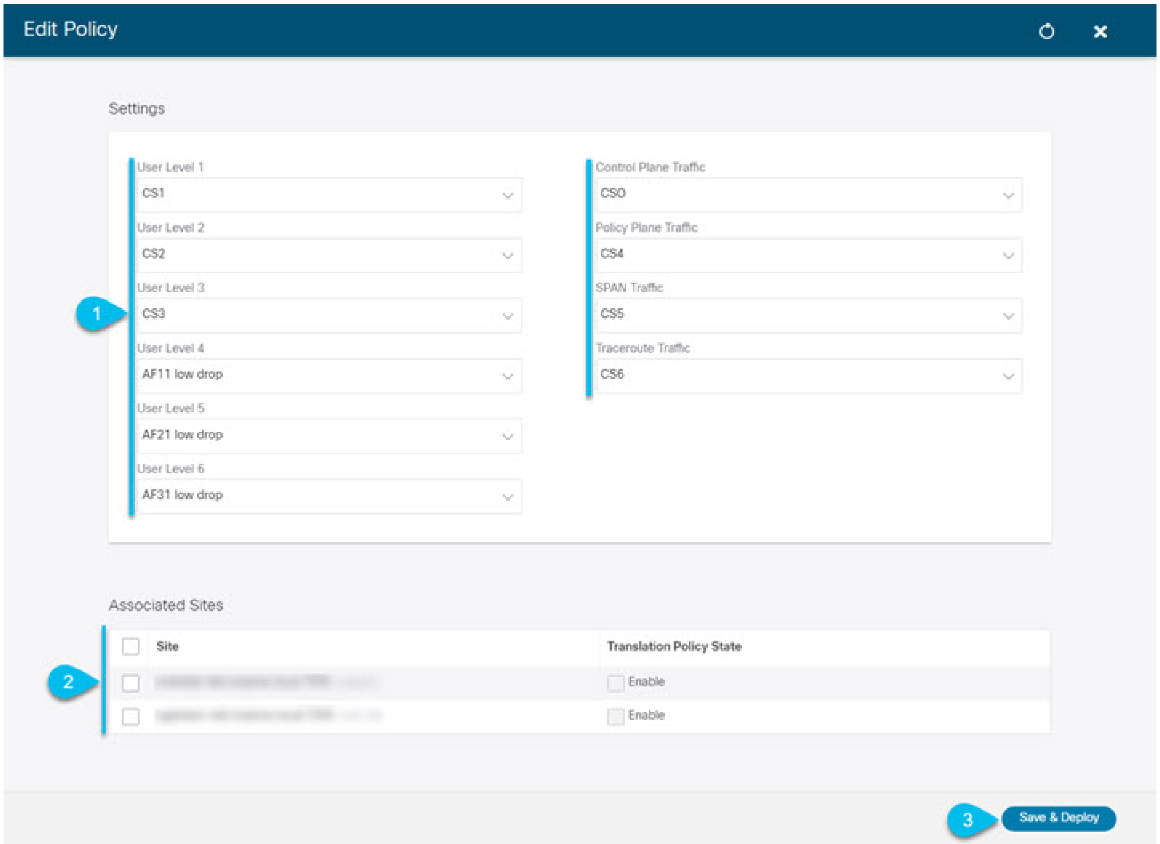


a) Navigate to **Application Management** > **Policies**.

b) Click **Global DSCP Policy** name.

The **Edit Policy** window will open.

Step 3 Update the global DSCP policy.



Edit Policy

Settings

User Level 1: CS1
User Level 2: CS2
User Level 3: CS3
User Level 4: AF11 low drop
User Level 5: AF21 low drop
User Level 6: AF31 low drop

Control Plane Traffic: CS0
Policy Plane Traffic: CS4
SPAN Traffic: CS5
Traceroute Traffic: CS6

Associated Sites

☐ Site	Translation Policy State
☐ [redacted]	☐ Enable
☐ [redacted]	☐ Enable

a) Choose the DSCP value for each ACI QoS level.

Each dropdown contains the default list of available DSCP values. You must choose a unique DSCP value for each level.

b) Choose the sites where you want to deploy the policy.

We recommend deploying the policy to all sites that are part of the Multi-Site domain in order to achieve a consistent end-to-end QoS behavior.

c) Choose whether you want to enable the policy on each site when it is deployed.

d) Click **Save & Deploy**.

After you save and deploy, the DSCP policy settings will be pushed to each site. You can verify the configuration by logging in to the site's APIC and navigating to **Tenants** > **infra** > **Policies** > **Protocol** > **DSCP class-CoS translation policy for L3 traffic**.

What to do next

After you have defined the global DSCP policy, you can assign the ACI QoS Levels to EPGs or Contracts as described in Set QoS Level for EPGs and Contracts, on page 228.

Set QoS Level for EPGs and Contracts

This section describes how to choose an ACI QoS level for traffic in your fabrics. You can choose to specify QoS for individual Contracts or entire EPGs.

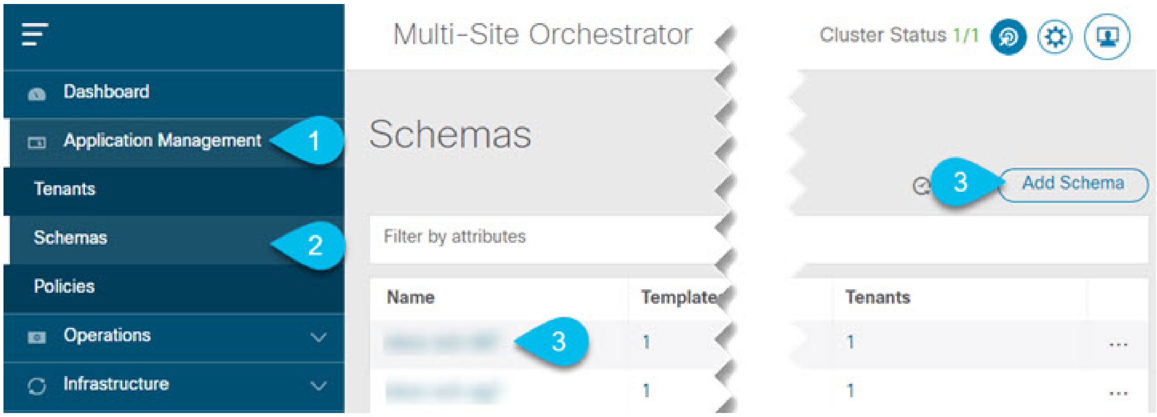
Before you begin

- You must have defined the global DSCP policy, as described in Configuring Global DSCP Policy, on page 226.
- You should be familiar with Quality of Service (QoS) functionality within ACI fabrics.

  QoS is described in more detail in *Cisco APIC and QoS*.

Step 1 Log in to your Cisco Multi-Site Orchestrator GUI.

Step 2 Choose the Schema you want to edit.

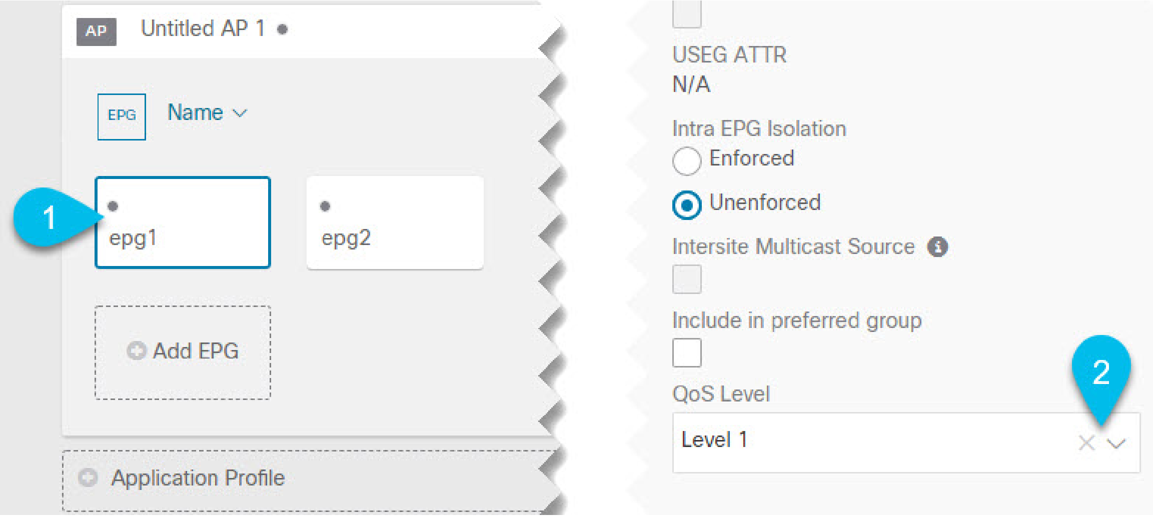


a) Navigate to **Application Management** > **Schemas** > **.**

b) Click the name of the schema you want to edit or **Add Schema** to create a new one.

The **Edit Policy** window will open.

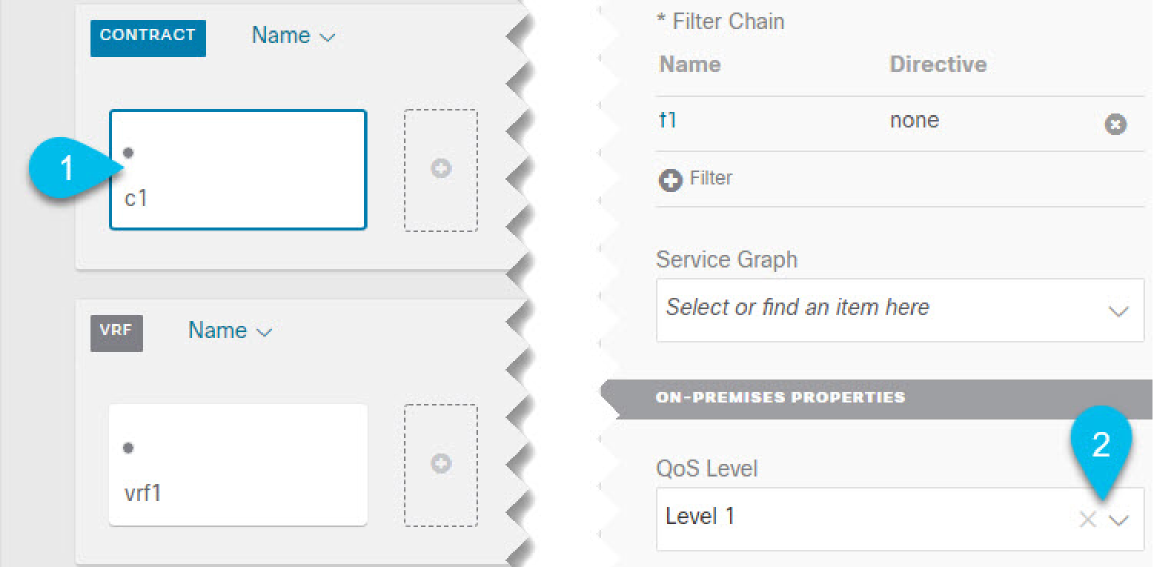
Step 3 Pick a QoS Level for an EPG



a) In the main pane, scroll down to the **EPG** area and select an EPG or click **Add EPG** to create a new one.

b) In the right sidebar, scroll down to the **QoS Level** dropdown and choose the QoS Level you want to assign to the EPG.

Step 4 Pick a QoS Level for an EPG



a) In the main pane, scroll down to the **Contract** area and select a Contract or click the + icon to create a new one.

b) In the right sidebar, scroll down to the **QoS Level** dropdown and choose the QoS Level you want to assign to the Contract.

CHAPTER 22

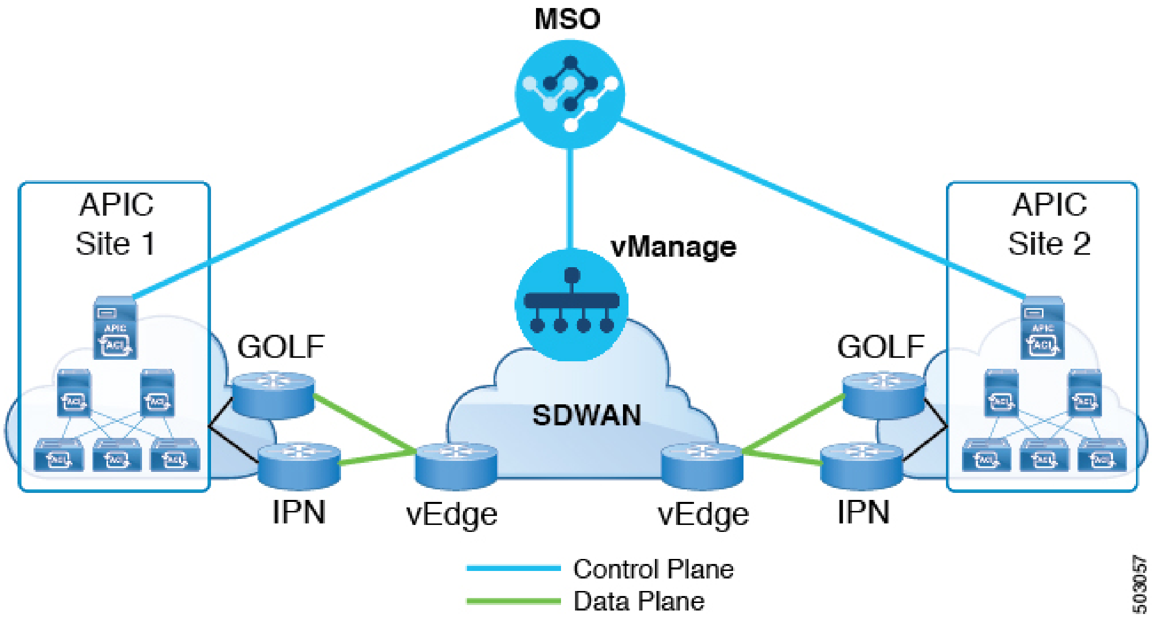
SD-WAN Integration

SD-WAN Integration

Cisco Software-Defined Wide Area Network (SD-WAN) is a cloud-delivered overlay WAN architecture connecting branches to datacenter and multicloud environments through a single fabric. Cisco SD-WAN ensures predictable user experience for applications, optimizes SaaS, IaaS and PaaS connections, and offers integrated security either on-premises or in the cloud. Analytics capabilities deliver the visibility and insights necessary for you to isolate and resolve issues promptly and deliver intelligent data analysis for planning and what-if scenarios.

On the dataplane side, SD-WAN deploys an ASR or ISR routers as edge devices (shown as cEdge in the following diagram) with each fabric's spine switches connecting to these edge devices. SD-WAN is managed by a separate controller called vManage, which allows you to define service-level agreement (SLA) policies to determine how each packet's path within SD-WAN is chosen based on its DSCP value.

Figure 44: ACI Multi-Site and SD-WAN Integration



Release 3.0(2) of Cisco ACI Multi-Site Orchestrator adds support for SD-WAN integration. You can configure the MSO to import SLA policies from a vManage controller, assign DSCP values to each SLA policy, and notify the vManage controller of the DSCP-to-SLA mapping. This enables you to apply preconfigured SLA policies to specify the levels of packet loss, jitter, and latency for intersite traffic over SD-WAN. The vManage controller, which is configured as an external device manager that provides SD-WAN capability, chooses the best possible WAN link that meets the loss, jitter, and latency parameters specified in the SLA policy.

ACI Multi-Site SD-WAN integration allows traffic between multiple fabrics to traverse the SD-WAN network while enabling returning traffic from a remote site to retain the ACI QoS level assigned to it. After you register your Cisco MSO to vManage, it imports the SLA policies allowing you to translating the ACI QoS levels to the appropriate DSCP values. MSO then applies DSCP translation policy for traffic transiting SD-WAN to enable quality of service on the returning traffic.

Release 3.0(2) also enables you to assign ACI QoS levels to Contracts and EPGs directly in the MSO GUI. Any time traffic leaves the fabric, its QoS level is translated into a DSCP value, which vManage uses to pick a path for the traffic through SD-WAN.

SD-WAN Integration Guidelines and Limitations

When enabling Multi-Site and SD-WAN integration, the following guidelines apply.

- To enable uniform user QoS Level and DSCP translation for east-west traffic across sites with Muilti-Site SD-WAN integration, the spine switches in each fabric must be connected to the SD-WAN edge devices, either directly or via multiple hops.

  This is in contrast with the existing implementation of APIC SD-WAN integration for north-south traffic where the leaf switches must be connected to the SD-WAN edge devices.

- Global DSCP policy is supported for on-premises sites only.

- SD-WAN integration is supported for Multi-Site Orchestrator deployments in Cisco Application Services Engine only.

  For more information, see the Deployment Overview chapter in the *Cisco ACI Multi-Site Orchestrator Installation and Upgrade Guide*.

- When defining the global DSCP policy, you must pick a unique value for each QoS Level.
- In addition to existing DSCP policy values, you can import up to four SLA policies from vManage with one of the following values: 41, 42, 43, 45, 47 and 49.
- SLA policies must be already defined in your Cisco vManage.
- When assigning QoS level, you can choose to assign it to a specific Contract or an entire EPG.

  If multiple QoS levels could apply for any given traffic, only one is applied using the following precedence:

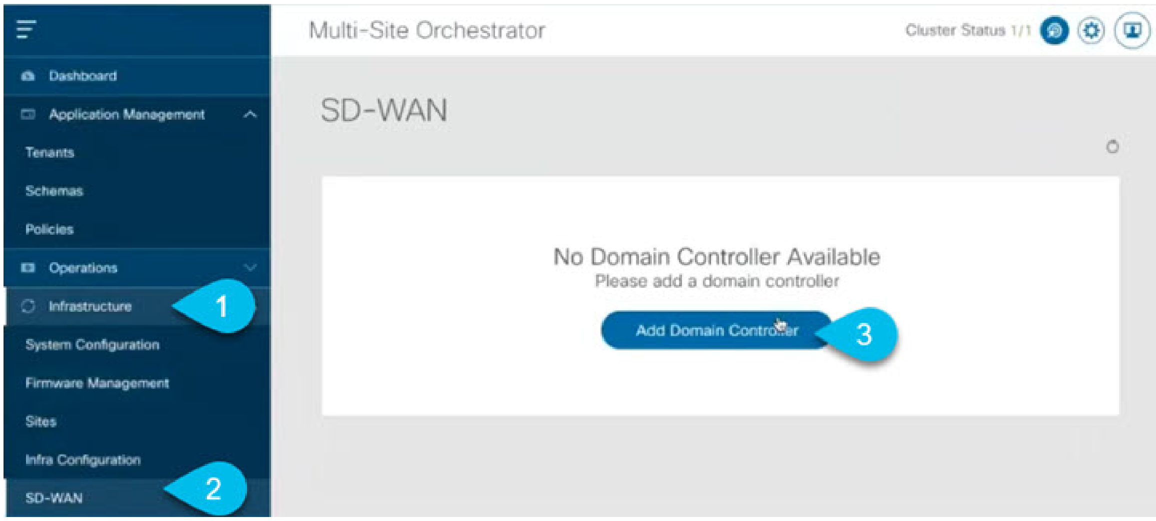
  - Contract QoS level: If QoS is enabled in the Contract, the QoS level specified in the contract is used.
  - Source EPG QoS level: If QoS level is not specified for the Contract, the QoS level set for the source EPG is used.
  - Default QoS level: If no QoS level is specified, the traffic is assigned Level 3 QoS class by default.

Adding a vManage Controller

This section describes how to add vManage controller to your Multi-Site Orchestrator in order to import any configured SLA policies.

Step 1 Log in to your Cisco Multi-Site Orchestrator GUI.

Step 2 Add a vManage Controller.



a) Navigate to **Infrastructure** > **SD-WAN**.

b) Click **Add Domain Controller** name.

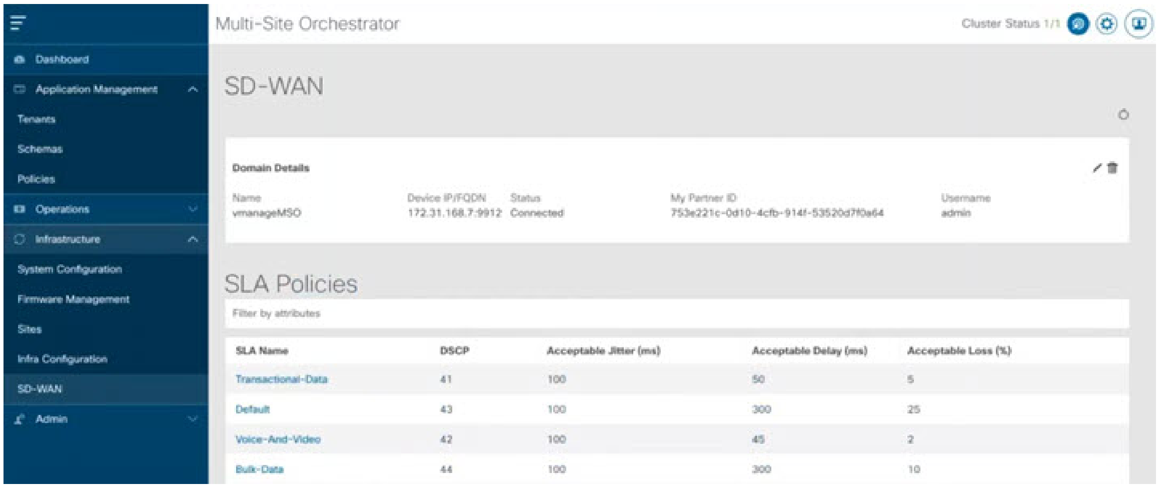
The **Add Domain** window will open.

Step 3 Provide the vManage controller information.

In the **Add Domain** window that opens, provide the following details:

- Name of the vManage domain to display in your MSO.
- The device's fully qualified domain name or IP address.
- Username and password used to log in to the vManage controller.

Then click **Add** to save the vManage domain. After the vManage controller information is entered, it can take up to one min before the list of existing SLA policies is displayed in the main pane:



SD-WAN

Domain Details

Name	Device IP/FQDN	Status	My Partner ID	Username
vmanageMSO	172.31.168.7:9912	Connected	753e221c-0d10-4cfb-914f-53520d7f0a64	admin

SLA Policies

Filter by attributes

SLA Name	DSCP	Acceptable Jitter (ms)	Acceptable Delay (ms)	Acceptable Loss (%)
Transactional-Data	41	100	50	5
Default	43	100	300	25
Voice-And-Video	42	100	45	2
Bulk-Data	44	100	300	10

What to do next

Define the global DSCP policy in your Multi-Site Orchestrator, as described in Configuring Global DSCP Policy, on page 234

Configuring Global DSCP Policy

When traffic is sent and received within a Cisco ACI fabric, it is prioritized based on the ACI QoS Level, which is determined based on the CoS value of the VXLAN packet's outer header. When traffic exits the ACI fabric from a spine switch towards an intersite network, the QoS level is translated into a DSCP value which is included in the outer header of the VXLAN-encapsulated packet.

This section describes how to define the DSCP translation policy for traffic entering or exiting ACI fabric. This is required when traffic must transit through non-ACI networks, such as between multiple fabrics separated by SD-WAN, where devices that are not under Cisco APIC's management may modify the CoS values in the transiting packets.

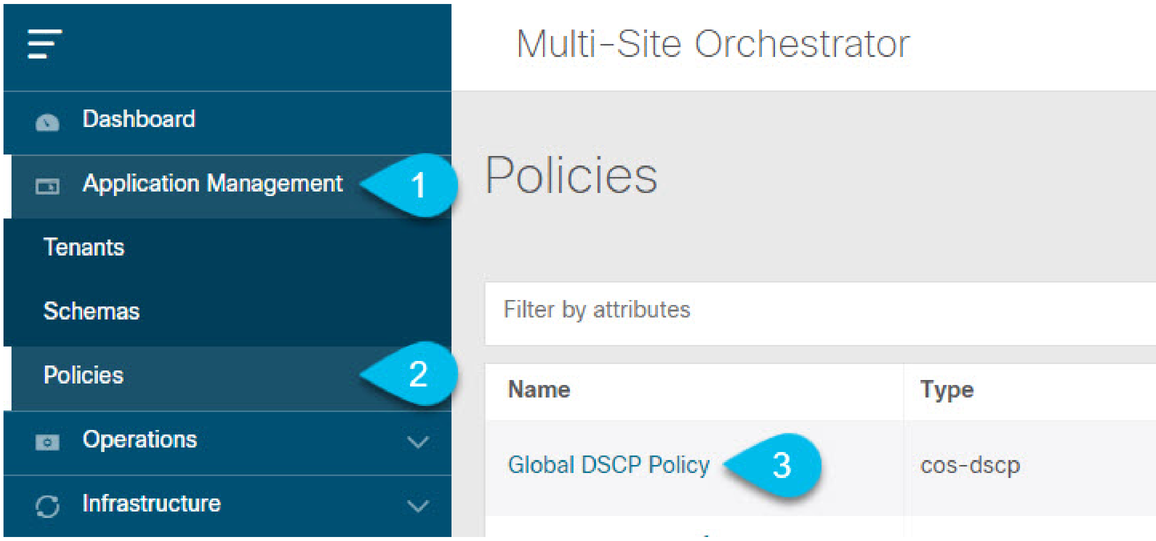
Before you begin

- You must have added a vManage controller to your MSO, as described in Adding a vManage Controller, on page 233.
- You should be familiar with Quality of Service (QoS) functionality within ACI fabrics.

  QoS is described in more detail in *Cisco APIC and QoS*.

Step 1 Log in to your Cisco Multi-Site Orchestrator GUI.

Step 2 Open the global DSCP policy configuration screen.

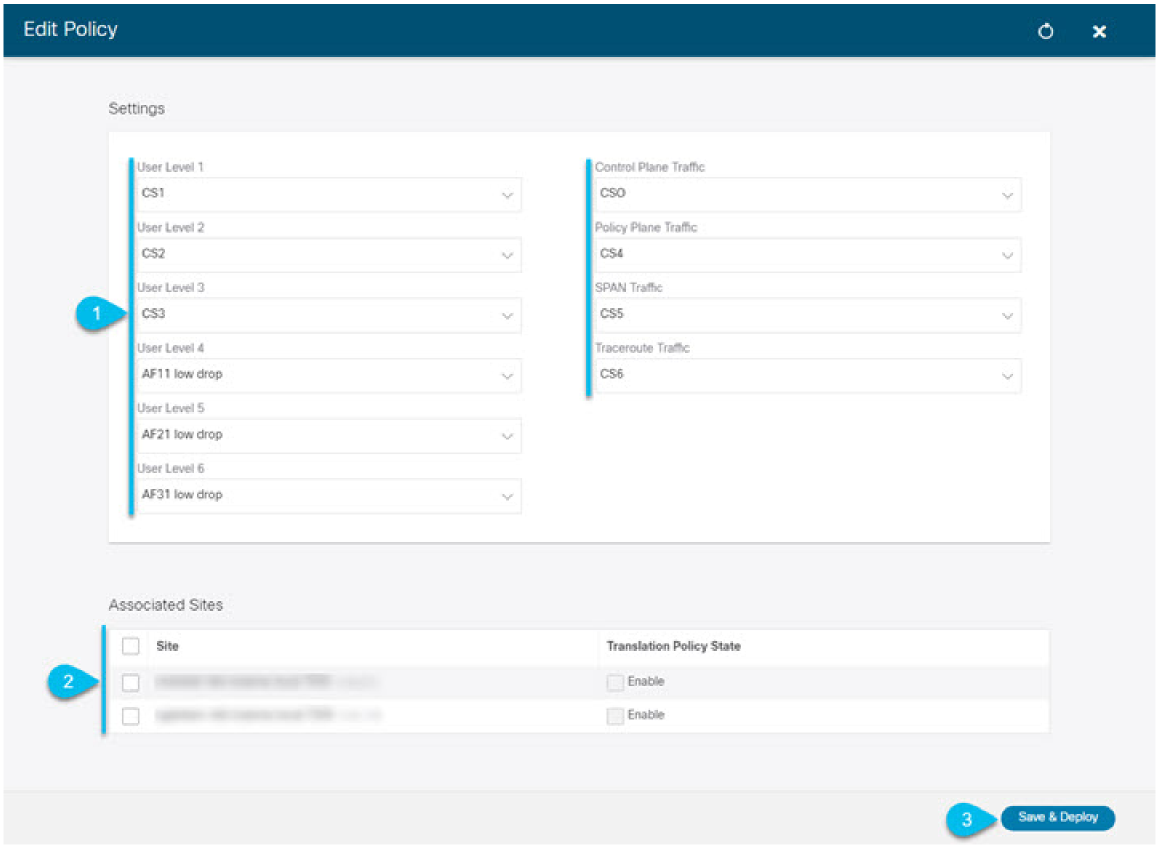


a) Navigate to **Application Management** > **Policies**.

b) Click **Global DSCP Policy** name.

The **Edit Policy** window will open.

Step 3 Update the global DSCP policy.



Edit Policy

Settings

User Level 1: CS1

User Level 2: CS2

User Level 3: CS3

User Level 4: AF11 low drop

User Level 5: AF21 low drop

User Level 6: AF31 low drop

Control Plane Traffic: CS0

Policy Plane Traffic: CS4

SPAN Traffic: CS5

Traceroute Traffic: CS6

Associated Sites

□	Site	Translation Policy State
□	[redacted]	□ Enable
□	[redacted]	□ Enable

a) Choose the DSCP value for each ACI QoS level.

Each dropdown contains the default list of available DSCP values as well as any values imported from the vManage SLA policies, for example `Voice-And-Video SLA (42)`.

b) Choose the sites where you want to deploy the policy.

We recommend deploying the policy to all sites that are part of the Multi-Site domain in order to achieve a consistent end-to-end QoS behavior.

c) Choose whether you want to enable the policy on each site when it is deployed.

d) Click **Save & Deploy**.

After you save and deploy, the DSCP policy settings will be pushed to each site. You can verify the configuration by logging in to the site's APIC and navigating to **Tenants** > **infra** > **Policies** > **Protocol** > **DSCP class-CoS translation policy for L3 traffic**.

What to do next

After you have defined the global DSCP policy, you can assign the ACI QoS Levels to EPGs or Contracts as described in Set QoS Level for EPGs and Contracts, on page 237

Set QoS Level for EPGs and Contracts

This section describes how to choose an ACI QoS level for traffic in your fabrics. You can choose to specify QoS for individual Contracts or entire EPGs.

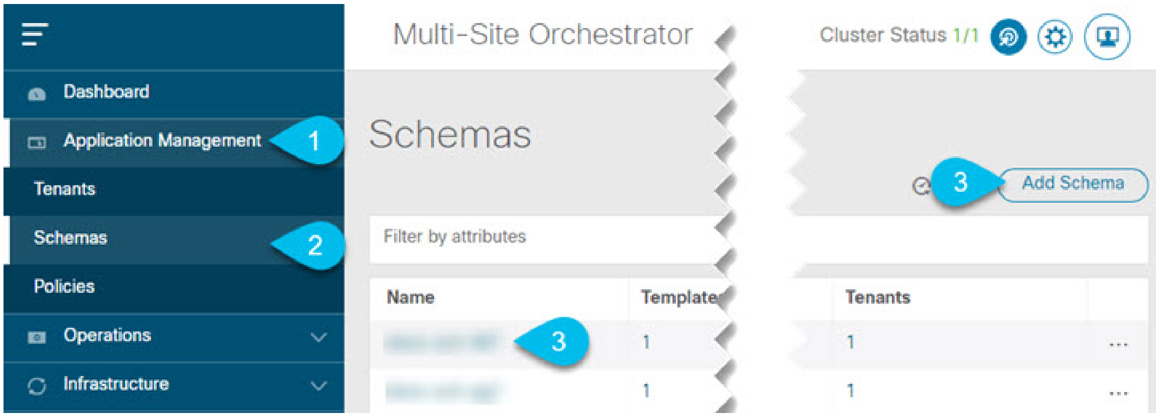
Before you begin

- You must have added a vManage controller to your MSO, as described in Adding a vManage Controller, on page 233.
- You must have defined the global DSCP policy, as described in Configuring Global DSCP Policy, on page 234.
- You should be familiar with Quality of Service (QoS) functionality within ACI fabrics.

  QoS is described in more detail in *Cisco APIC and QoS*.

Step 1 Log in to your Cisco Multi-Site Orchestrator GUI.

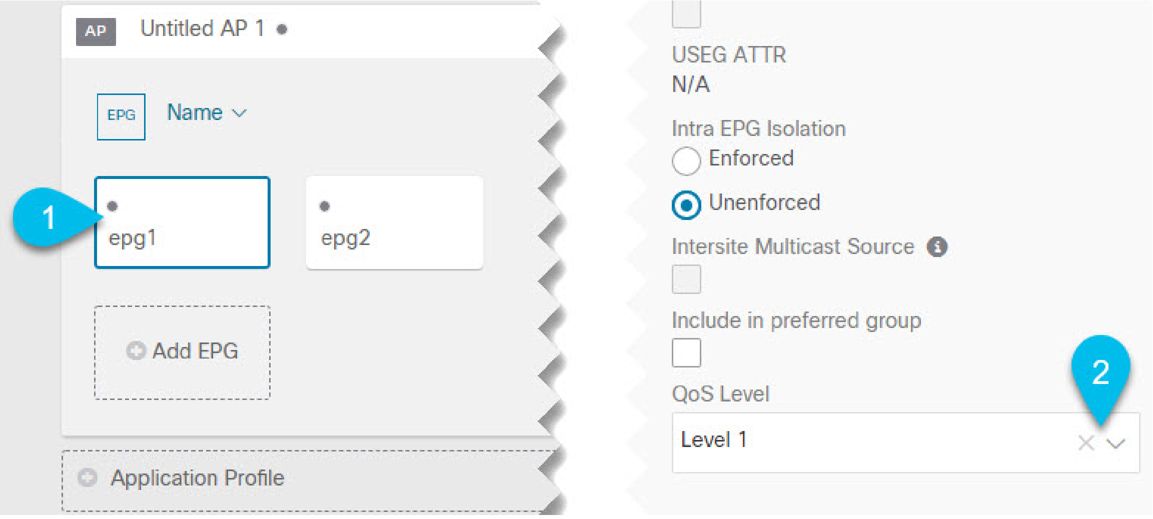
Step 2 Choose the Schema you want to edit.



a) Navigate to **Application Management** > **Schemas** > **.**
b) Click the name of the schema you want to edit or **Add Schema** to create a new one.

The **Edit Schema** window will open.

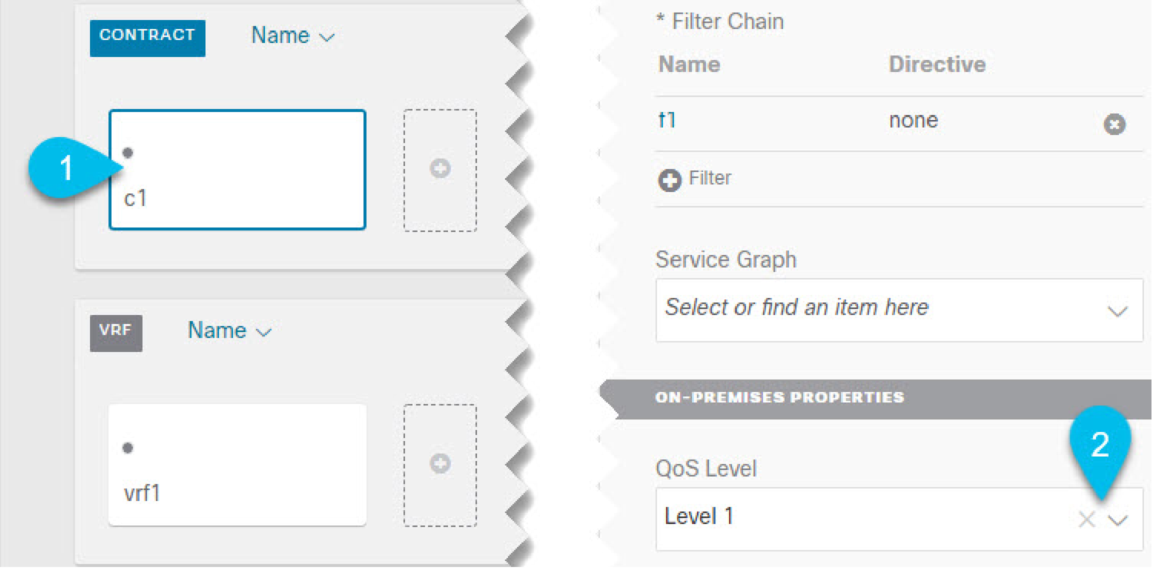
Step 3 Pick a QoS Level for an EPG



a) In the main pane, scroll down to the **EPG** area and select an EPG or click **Add EPG** to create a new one.
b) In the right sidebar, scroll down to the **QoS Level** dropdown and choose the QoS Level you want to assign to the EPG.

   You must choose the QoS level based on the previously configured Global DSCP policy to ensure that intersite traffic from the EPG is treated with the desired SLA across the SD-WAN network.

Step 4 Pick a QoS Level for an EPG



a) In the main pane, scroll down to the **Contract** area and select a Contract or click the **+** icon to create a new one.
b) In the right sidebar, scroll down to the **QoS Level** dropdown and choose the QoS Level you want to assign to the Contract.

   You must choose the QoS level based on the previously configured Global DSCP policy to ensure that intersite traffic between two EPGs is treated with the desired SLA across the SD-WAN network.