# Fabric Management

## Tenants

A tenant is a logical container for application policies that enable an administrator to exercise domain-based access control. A tenant represents a unit of isolation from a policy perspective, but it does not represent a private network. Tenants can represent a customer in a service provider setting, an organization or domain in an enterprise setting, or just a convenient grouping of policies.

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

Three tenants are pre-configured for you:

- `common`—A special tenant with the purpose of providing "common" services to other tenants in ACI fabrics. Global reuse is a core principle in the common tenant. Some examples of common services include shared L3Outs, DNS, DHCP, Active Directory, and shared private networks or bridge domains.
- `dcnm-default-tn`—A special tenant with the purpose of providing configuration for Cisco DCNM fabrics.
- `infra`—The Infrastructure tenant that is used for all internal fabric communications, such as tunnels and policy deployment. This includes switch to switch and switch to APIC communications. The `infra` tenant does not get exposed to the user space (tenants) and it has its own private network space and bridge domains. Fabric discovery, image management, and DHCP for fabric functions are all handled within this tenant.

When using Multi-Site Orchestrator to manage Cisco DCNM fabrics, you will use the default `dcnm-default-tn` that is preconfigured for you and allows you to create and manage the following objects:

- VRFs
- Networks

# Schemas and Templates

A schema is a collection of templates, which are used for defining networking configuration, with each template assigned to a specific tenant. A template is a set of configuration objects and their properties that you deploy all at once to one or more sites. 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, templates, and objects per schema. Detailed information on verified scalability limits is available in the *Cisco Multi-Site Verified Scalability Guides* for your release.

## Single Schema Deployment

The simplest schema design approach is a single schema deployment. You can create a single schema with all VRFs and Networks in that schema. You can then create a single application profile or multiple application profiles within the templates 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 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. And create different templates containing the shared objects.

For example, you can use the following templates for a configuration that you plan to deploy to 3 different sites:

- 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 could quickly exceed the templates per schema limit (listed in the Verified Scalability Guide for your release), 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.

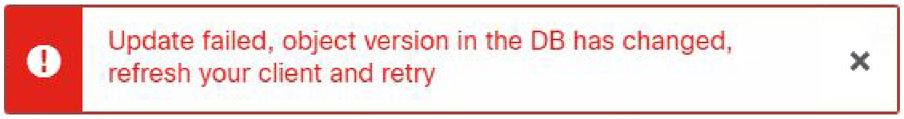
### Template Design

In this release, we recommend creating separate templates for VRFs and Networks within each schema and then deploying the VRF templates first, followed by the templates that contain Networks. This way any VRFs required by the networks will be already created when you push Network configuration to the sites.

Similarly, when undeploying multiple networks and VRFs, we recommend undeploying the Networks template first, followed by the VRF templates. This will ensure that when VRFs are undeployed, there will be no conflicts with any existing Networks still using them.

## 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
```

### Example

We will use a simple example of updating the display name of a template in a schema to show how to use the version check attribute with `PUT` or `PATCH` calls.

First, you would `GET` the schema you want to modify, which will return the current latest version of the schema in the call's response:

```
{
    "id": "601acfed38000070a4ee9ec0",
    "displayName": "Schema1",
    "description": "",
    "templates": [
        {
            "name": "Template1",
            "displayName": "current name",
            [...]
        }
    ],
    "_updateVersion": 12,
    "sites": [...]
}
```

Then you can modify the schema in one of two ways appending `enableVersionCheck=true` to the request URL:

**Note** You must ensure that the value of the `"_updateVersion"` field in the payload is the same as the value you got in the original schema.

- Using the `PUT` API with the entire updated schema as payload:

  ```
  PUT /v1/schemas/601acfed38000070a4ee9ec0?enableVersionCheck=true
  ```

  ```
  {
      "id": "601acfed38000070a4ee9ec0",
      "displayName": "Schema1",
      "description": "",
      "templates": [
          {
              "name": "Template1",
              "displayName": "new name",
              [...]
          }
      ],
      "_updateVersion": 12,
      "sites": [...]
  }
  ```

- Using any of the `PATCH` API operations to make a specific change to one of the objects in the schema:

  ```
  PATCH /v1/schemas/601acfed38000070a4ee9ec0?enableVersionCheck=true
  ```

  ```
  [
      {
          "op": "replace",
          "path": "/templates/Template1/displayName",
          "value": "new name",
          "_updateVersion": 12
      }
  ]
  ```

When the request is made, the API will increment the current schema version by 1 (from `12` to `13`) and attempt to create the new version of the schema. If the new version does not yet exist, the operation will succeed and the schema will be updated; if another API call (with `enableVersionCheck` enabled) or the UI have modified the schema in the meantime, the operation fails and the API call will return the following response:

```
{
    "code": 400,
    "message": "Update failed, object version in the DB has changed, refresh your client
```

```
and retry"
}
```

## Creating Schemas and Templates

### Before you begin

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

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

**Step 2** Create a new schema.

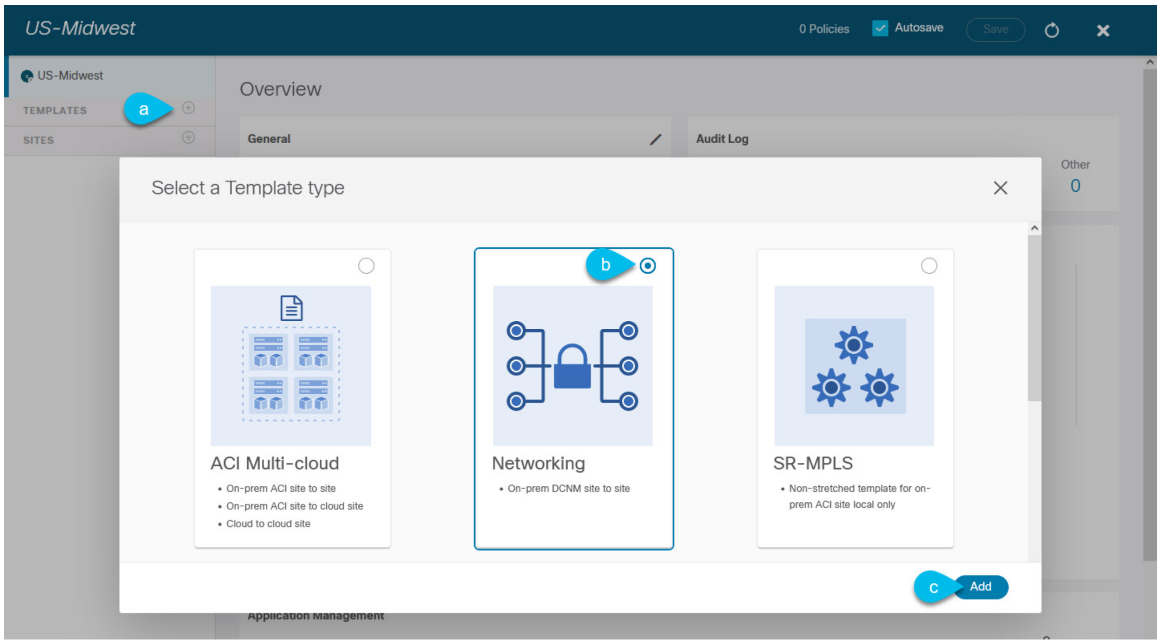
a) From the left navigation pane, choose **Application Management** > **Schemas**.

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

c) In the schema creation dialog, provide the **Name** and optional description for the schema.

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

**Step 3** Create a template.

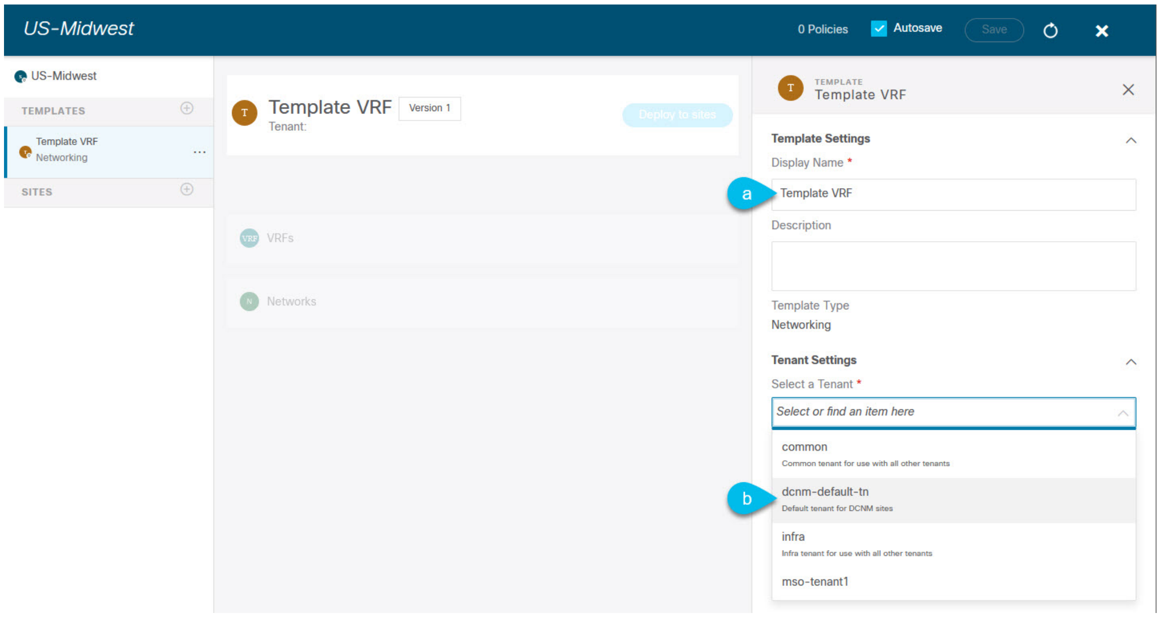


a) In the left sidebar under **Templates**, click the + sign to add a new template.

b) In the **Select a Template type** window, choose **Networking** for the template type.

c) Click **Add** to create the template.

**Step 4** Provide the name and the tenant for the template.



a) In the right sidebar, specify the **Display Name** for the template.
b) From the **Select a Tenant** dropdown, select the `dcnm-default-tn` tenant.

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.

**Step 5** Assign the templates to sites.

You deploy one template at a time, so you need to associate the template with at least one site where you want to deploy the configuration.

a) In the left pane, click the + icon next to Sites
b) In the **Add Sites** window, check the checkbox next to the sites where you want to deploy the template.
c) From the **Assign to Template** dropdown next to each site, select one or more templates.

While you deploy one template at a time to every site with which it is associated, you can associate multiple templates to a site at once.

d) Click **Save**.

## Importing Schema Elements From DCNM 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.

## Creating VRFs

This section describes how to create 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 5.

**Step 1** Select the schema and template where you want to create VRF.

**Step 2** In the schema edit view, choose **Create Object** > **VRF**.

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

**Step 4** Configure the **DCNM Properties** for the VRF.

a) (Optional) Provide the **VRF ID**.

You can choose to specify the VNI of the VRF or leave the field empty and the VNI will be automatically allocated by the MSO from the ranges you specified in Configuring Infra: General Settings.

b) From the **VRF Profile** dropdown, select the VRF profile.

You can assign the `Default_VRF_Universal` profile or choose any available VRF Profile that had been previously created in DCNM. Any profiles created in DCNM are automatically imported into the MSO and are available for selection here.

c) From the **VRF Extension Profile** dropdown, select the extension profile.

You can assign the `Default_VRF_Extension_Universal` profile or choose any available VRF Extension Profile that had been previously created in the DCNM. Any profiles created in DCNM are automatically imported into the MSO and are available for selection here.

d) Provide the **Loopback Routing Tag**.

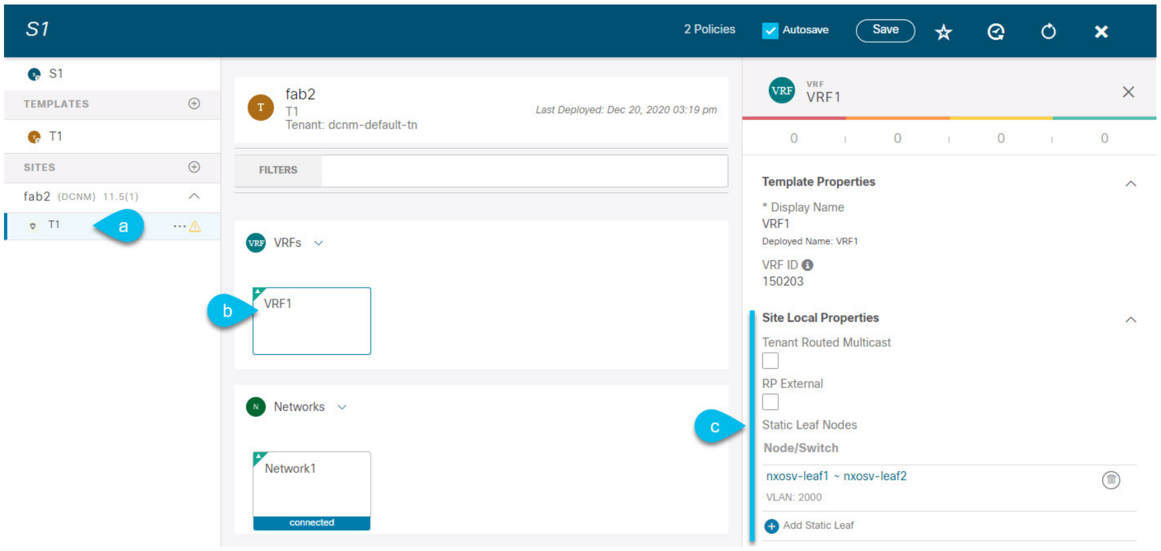
If a VLAN is associated with multiple subnets, then this tag is associated with the IP prefix of each subnet. Note that this routing tag is associated with overlay network creation too.

e) Provide the **Redistribute Direct Route Map**.

Specifies the route map name for redistribution of routes in the VRF.

**Step 5** Configure the VRF's site-local properties.

In addition to the network's general properties that apply to every site where the VRF is deployed, you can configure site-specific properties for this VRF individually for each site.



a) In the left sidebar under **SITES**, select the template where the network is defined.
b) In the main pane, select the network.
c) In the right **Properties** sidebar, provide the site-specific settings.

You can configure the following site-local properties:

- Enable **Tenant Routed Multicast**—Tenant Routed Multicast (TRM) enables multicast forwarding on the VXLAN fabric that uses a BGP-based EVPN control plane. TRM provides multi-tenancy aware multicast forwarding between senders and receivers within the same or different subnets local or across VTEPs.

  If you enable TRM, you must also provide the **RP Address** and **Overlay Multicast Group**.

- Enable **RP External** if the Rendezvous Point (RP) is external to the fabric.

- Click **Add Static Leaf** to select one or more leaf switches where the VRF will be configured.

  In the **Add Static Leaf** window that opens, choose the leaf node and provide the VLAN ID for the VRF.

# Creating Networks

This section describes how to configure a DCNM network from Multi-Site 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 5.
- You must have the VRF created as described in Creating VRFs, on page 7

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

**Step 2** In the schema edit view, choose **Create Object** > **Network**.

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

**Step 4** (Optional) Provide the **Network ID**.

You can choose to specify the network ID or leave the field empty and the ID will be automatically allocated by the MSO when you save the schema.

**Step 5** Choose whether or not this is a **Layer2 Only** network.

**Step 6** From the **Virtual Routing & Forwarding** dropdown, select the VRF you created for this network.

This option will be unavailable if you enabled **Layer2 Only**.

**Step 7** From the **Network Profile** dropdown, select the network profile.

You can assign the `Default_Network_Universal` profile or choose any available Network Profile that had been previously created in DCNM. Any profiles created in DCNM are automatically imported into the MSO and are available for selection here.

**Step 8** From the **Network Extension Profile** dropdown, select the network extension profile.

You can assign the `Default_Network_Extension_Universal` profile or choose any available Network Extension Profile that had been previously created in the DCNM. Any profiles created in DCNM are automatically imported into the MSO and are available for selection here.

**Step 9** Provide the **VLAN ID** for the network.

**Step 10** Provide the **VLAN Name**.

**Step 11** Add one or more **Subnets**.

This option will be unavailable if you enabled **Layer2 Only**.

a) Click **+Add Subnet**.

   An **Add Subnet** window opens.

b) Click **+Add Gateway IP** and enter the subnet's **Gateway IP** address.

   You can configure up to four gateway IPs.

c) Choose `Primary` for the first gateway you add.
d) Click the checkmark to save the gateway information.
e) Repeat the previous substeps to provide additional gateways.
f) Click **Add** to finish adding the subnet.

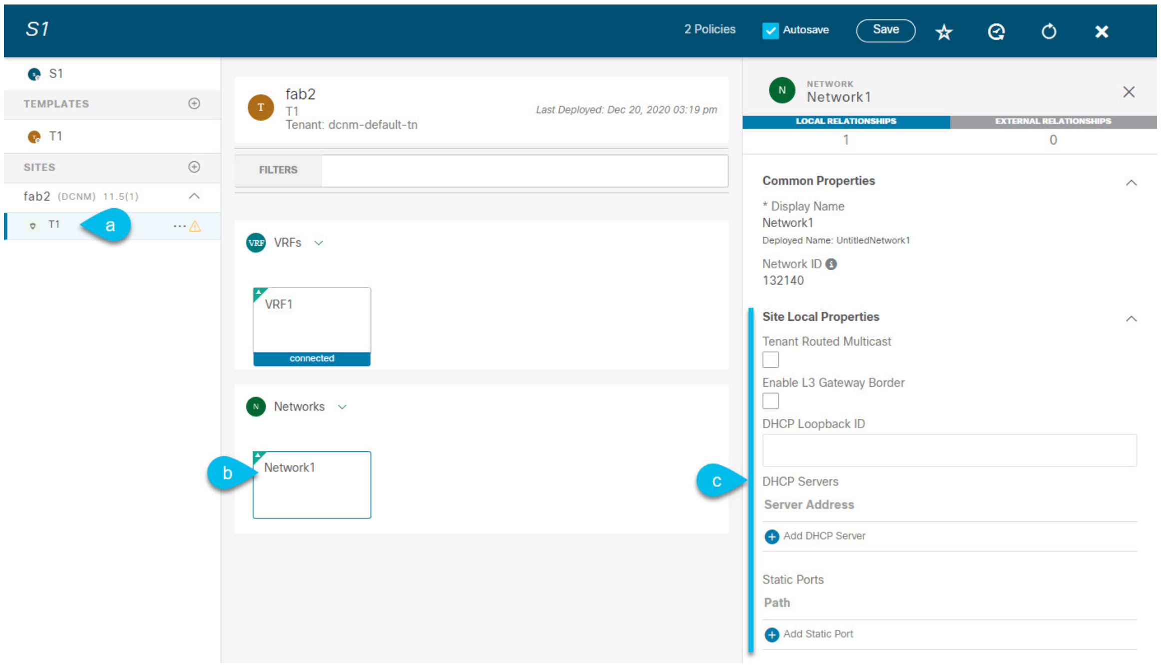
**Step 12** Choose whether you want to **Suppress ARP**.

**Step 13** Provide the **MTU** for this network.

**Step 14** Provide the **Routing Tag**.

**Step 15** Configure the network's site-local properties.

In addition to the network's general properties that apply to every site where the network is deployed, you can configure site-specific properties for this network individually for each site.



fab2
T1
Tenant: dcnm-default-tn
Last Deployed: Dec 20, 2020 03:19 pm

NETWORK
Network1
LOCAL RELATIONSHIPS 1
EXTERNAL RELATIONSHIPS 0

Common Properties
* Display Name
Network1
Deployed Name: UntitledNetwork1
Network ID
132140

Site Local Properties
Tenant Routed Multicast
Enable L3 Gateway Border
DHCP Loopback ID
DHCP Servers
Server Address
Static Ports
Path

a) In the left sidebar under **SITES**, select the template where the VRF is defined.
b) In the main pane, select the VRF.
c) In the right **Properties** sidebar, provide the site-specific settings.

You can configure the following site-local properties:

- Enable **Tenant Routed Multicast**—Tenant Routed Multicast (TRM) enables multicast forwarding on the VXLAN fabric that uses a BGP-based EVPN control plane. TRM provides multi-tenancy aware multicast forwarding between senders and receivers within the same or different subnets local or across VTEPs.
- Check **Enable L3 Gateway Border** to enable Layer 3 SVI on the border gateways to allow connecting dual-attached hosts to it.
- Provide the **DHCP Loopback ID**.

  The value must be in the `0-1023` range.
- Click **+Add DHCP Server** to add one or more DHCP relay servers.

  In the **Add DHCP Server** window that opens, provide the IP address of the DHCP relay and the VRF to which it belongs.
- Click **+Add Static Port** to add one or more ports to which the network's VLAN will be attached.

  In the **Add Static Port** window that opens, select the leaf switch that contains the port, provide the VLAN ID, and finally click **Add Port** to specify one or more ports for the network.

  Note that if you want to add multiple static ports from different leaf switches, you will need to repeat the process for each leaf switch separately.

## Deploying Templates

This section describes how to deploy new or updated configuration to DCNM fabrics.

**Before you begin**

You must have the schema, template, and any objects you want to deploy to sites already created, as described in previous sections of this document.

**Step 1** Navigate to the schema that contains one or more templates that you want to deploy.

**Step 2** Assign the templates to sites.

If you have already assigned the templates to sites, skip this step.

You deploy one template at a time, so you need to associate the template with at least one site where you want to deploy the configuration.

a) In the left pane, click the **+** icon next to Sites
b) In the **Add Sites** window, check the checkbox next to the sites where you want to deploy the template.
c) From the **Assign to Template** dropdown next to each site, select one or more templates.

   While you deploy one template at a time to every site with which it is associated, you can associate multiple templates to a site at once.

d) Click **Save**.

**Step 3** In the left sidebar, select the template you want to deploy.

**Step 4** In the top right of the template edit view, click **Deploy to sites**.

The **Deploy to Sites** window opens that shows the summary of the objects to be deployed.

**Step 5** Click **Deploy** to deploy the template.

- If this is the first time you are deploying this template or you have made changes to a previously deployed template, the **Deploy to Sites** summary will show the configuration difference that will be deployed to sites.

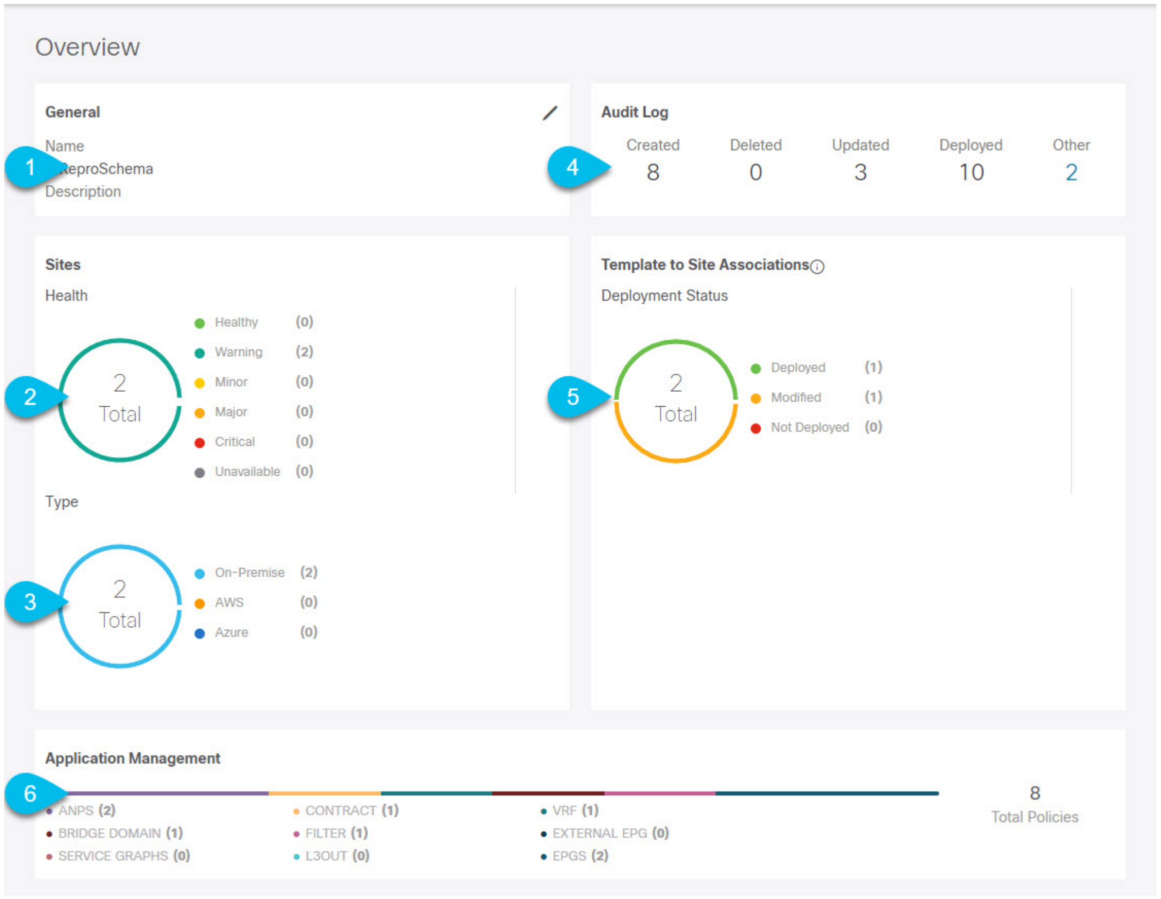
  **Note** You can filter the view using the `Created`, `Modified`, and `Deleted` checkboxes for informational purposes, but keep in mind that all of the changes are still deployed when you click **Deploy**.

- If you have previously deployed this template but made no changes to it since, the **Deploy to Sites** summary will allow you to re-deploy the entire template only the `Full Template` option and you can simply click **Deploy** to re-deploy the entire template.

## Schema Overview and Deployment Visualizer

When you open a schema with one or more objects defined and deployed to one or more fabrics, the schema **Overview** page will provide you with a summary of the deployment.

*Figure 1: Schema Overview*

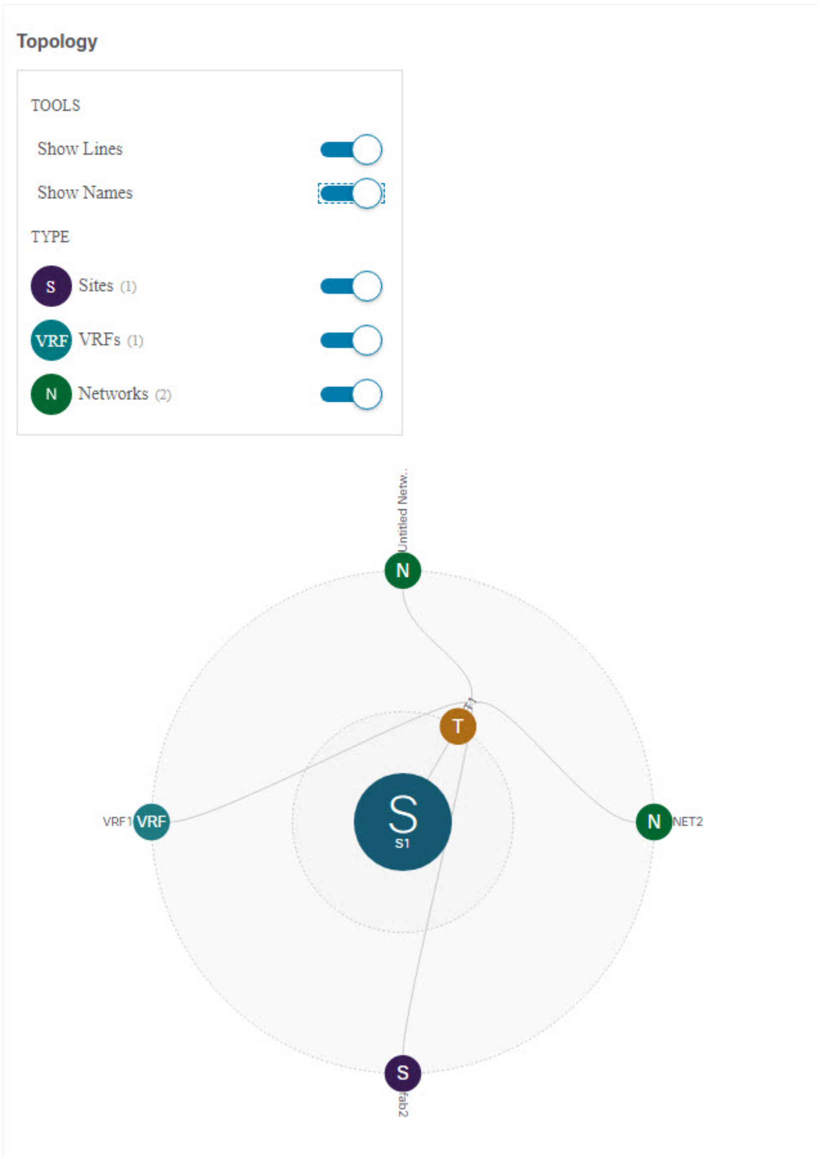


The following details are provided on this page:

1. **General**—Provides general information of the schema, such the name and description.
2. **Audit Log**—Provides audit log summary of the actions performed on the schema.
3. **Sites** > **Health**—Provides the number of sites associated with the templates in this schema sorted by the site's health status.
4. **Sites** > **Type**—Provides the number of sites associated with the templates in this schema sorted by the site's type.
5. **Template to Site Associations** > **Deployment Status**—Provides the number of templates in this schema that are associated with one or more sites and their deployment status.
6. **Application Management**—Provides a summary of individual objects contained by the templates in this schema.

The **Topology** tile allows you to create a topology visualizer by selecting one or more objects to be displayed by the diagram as shown in the following figure.

*Figure 2: Deployment Visualizer*



1. **Configuration Options**—Allows you to choose which policy objects to display in the topology diagram below.

2. **Topology Diagram**—Provides visual representation of the policies configured in all of the Schema's templates that are assigned to sites.

   You can choose which objects you want to display using the **Configuration Options** above.

   You can also mouse over an objects to highlight all of its dependencies.