Using Multi-Site Orchestrator to Configure L4-L7 Services in Infra Tenant for Cisco Cloud APIC

Revised: November 25, 2020,

New and Changed Information

The following table provides an overview of the significant changes to the organization and features in this guide from the release the guide was first published to the current release. The table does not provide an exhaustive list of all changes made to the guide or the new features of the Cisco Cloud APIC.

Table 1: New and Changed Information

Cloud APIC Release	Feature or Change Description
Release 5.0(2)	First release of this document.
Release 5.1(2)	Support for third-party load balancers.

Layer 4 to Layer 7 Services in Infra Tenant for Azure Sites

This document describes the workflow for Infra tenant configuration of multi-node service graphs with user defined routing (UDR).

Additional information about service graphs in cloud sites, such as specific features and use cases, is available in the *Cloud APIC Azure User Guide*. The information and procedures provided below are specific to deploying service graphs from Multi-Site Orchestrator.

Service Graphs

A service graph is used to represent a set of Layer 4 to Layer 7 service devices inserted between two or more Endpoint Groups (EPGs). EPGs can represent your applications running within a cloud (e.g. Cloud EPG), or internet (e.g. Cloud External EPG), or in other sites (e.g. on-premises or remote cloud sites).

A service graph in conjunction with contracts (and filters) is used to specify communication between two EPGs. The cloud APIC automatically derives security rules, such as network security groups (NSG) and application security groups (ASG), and forwarding routes using User Defined Routing (UDR) based on the policy specified in Contract and Service Graph.

By using a service graph, you can specify the policy once and deploy the service chain within regions or inter-regions. After the graph is configured, the Cloud APIC automatically configures the services according to the service function requirements that are specified in the service graph. The Cloud APIC also automatically configures the network according to the needs of the service function that is specified in the service graph, which does not require any change in the service device. For third-party firewalls, the configuration inside the device is not managed by cloud APIC.

Each time the graph is deployed, Cisco ACI takes care of changing the network configuration to enable the forwarding in the new logical topology.

Service Graph Devices

Multiple service graphs can be specified to represent different traffic flows or topologies. A service graph represents the network using the following elements:

- Service Graph Nodes—A node represents a device, such as a load balancer or a firewall. Each device within the service graph may require one or more parameters and have one or more connectors.
- Connectors—A connector enables input and output on a node.

Following combinations are possible with service graphs:

- Same device can be used in multiple service graphs.
- Same service graph can be used between multiple consumer and provider EPGs.

The following service graph devices are supported:

- Azure Application Load Balancers (ALB)
- Azure Network Load Balancers (NLB)
- Unmanaged third-party firewall devices
- Unmanaged third-party load balancers

Overlay-1 and Overlay-2 VRFs

The overlay-1 and overlay-2 VRFs are automatically created in the infra tenant for Cloud APIC. In the Azure portal, CIDRs and subnets from the overlay-1 and overlay-2 VRFs are deployed in the Azure cloud on the overlay-1 VNet. The overlay-2 VRF is used to hold additional CIDRs. You should not consider overlay-2 as a separate VNet.

Requirement for Separate VRFs in the Infra Hub

Prior to Release 5.0(2), the infra hub VNet was used to achieve transit routing functionality for inter-spoke communications within the site through CSRs in the hub, and to send VxLAN packets for EPG communication across sites.

There are situations where you might want to deploy a certain number of EPGs configured with shared services and layer 4 to layer 7 service graphs in a common hub that can be shared across spokes. In some situations, you might have multiple hub networks deployed separately (for example, for production, pre-production, and core services). You might want to deploy all of these hub networks in the same infra hub VNet (in the same infra cloud context profile), along with the existing cloud CSRs.

Thus, for these kind of requirements, you might need to split the hub VNet into multiple VRFs for network segmentation while keeping the security intact.

Infra Hub Services VRF (Overlay-2 VRF in the Infra VNet)

Beginning with Release 5.0(2), the overlay-2 VRF is now created in the infra tenant implicitly during the Cisco Cloud APIC bringup. In order to keep the network segmentation intact between the infra subnets used by the cloud site (for CSRs and network load balancers) and the user subnets deployed for shared services, different VRFs are used for infra subnets and user-deployed subnets:

- **Overlay-1**: Used for infra CIDRs for the cloud infra, along with Cisco Cloud Services Routers (CSRs), the infra network load balancer, and the Cisco Cloud APIC
- **Overlay-2**: Used for user CIDRs to deploy shared services, along with layer 4 to layer 7 service devices in the infra VNet (the overlay-1 VNet in the Azure cloud)

All the user-created EPGs in the infra tenant can only be mapped to the overlay-2 VRF in the infra VNet. You can add additional CIDRs and subnets to the existing infra VNet (the existing infra cloud context profile). They are implicitly mapped to overlay-2 VRF in the infra VNet, and are deployed in the overlay-1 VNet in the Azure cloud.

Prior to Release 5.0(2), any given cloud context profile would be mapped to a cloud resource of a specific VNet. All the subnets and associated route tables of the VNet would be have a one-to-one mapping with a single VRF. Beginning with Release 5.0(2), the cloud context profile of the infra VNet can be mapped to multiple VRFs (the overlay-1 and overlay-2 VRFs in the infra VNet).

In the cloud, the subnet's route table is the most granular entity for achieving network isolation. So all system-created cloud subnets of the overlay-1 VRF and the user-created subnets of the overlay-2 VRF will be mapped to separate route tables in the cloud for achieving the network segmentation.

Note On Azure cloud, you cannot add or delete CIDRs in a VNet when it has active peering with other VNets. Therefore, when you need to add more CIDRs to the infra VNet, you need to first disable VNet peering in it, which removes all the VNet peerings associated with the infra VNet and causes traffic disruption.

After adding new CIDRs to the infra VNet, you need to enable VNet peering again in the infra VNet.

You do not have to disable VNet peering if you are adding a new subnet in an existing CIDR in the hub VNet.

See *Configuring VNET Peering for Cloud APIC for Azure* for more information.

Redirect Programming

Redirect programming depends on the classification of the destination EPG (tag-based or subnet-based):

- For a subnet-based EPG, subnets of the destination EPGs are used to program redirects
- For a tag-based EPGs, CIDRs of the destination VNet are used to program redirects

  As a result of this, the redirect affects traffic from other EPGs going to the same destination in the redirect, even if the EPG is not part of the service graph with the redirect. Traffic from EPGs that are not part of the redirect will also get redirected to the service device.

The following table describes how redirect is programmed in different scenarios.

Consumer	Provider	Redirect on Consumer VNet	Redirect on Provider VNet
Tag-based	Tag-based	Redirect for the provider are the CIDRs of the provider's VNet	Redirect for the consumer are the CIDRs of the consumer's VNet
Tag-based	Subnet-based	Redirect for the provider are the subnets of the provider	Redirect for the consumer are the CIDRs of the consumer's VNet
Subnet-based	Tag-based	Redirect for the provider are the CIDRs of the provider's VNet	Redirect for the consumer are the subnets of the consumer
Subnet-based	Subnet-based	Redirect for the provider are the subnets of the provider	Redirect for the consumer are the subnets of the consumer

Redirect Policy

To support the Layer 4 to Layer 7 Service Redirect feature, a new redirect flag is now available for service device connectors. The following table provides information on the existing and new flags for the service device connectors.

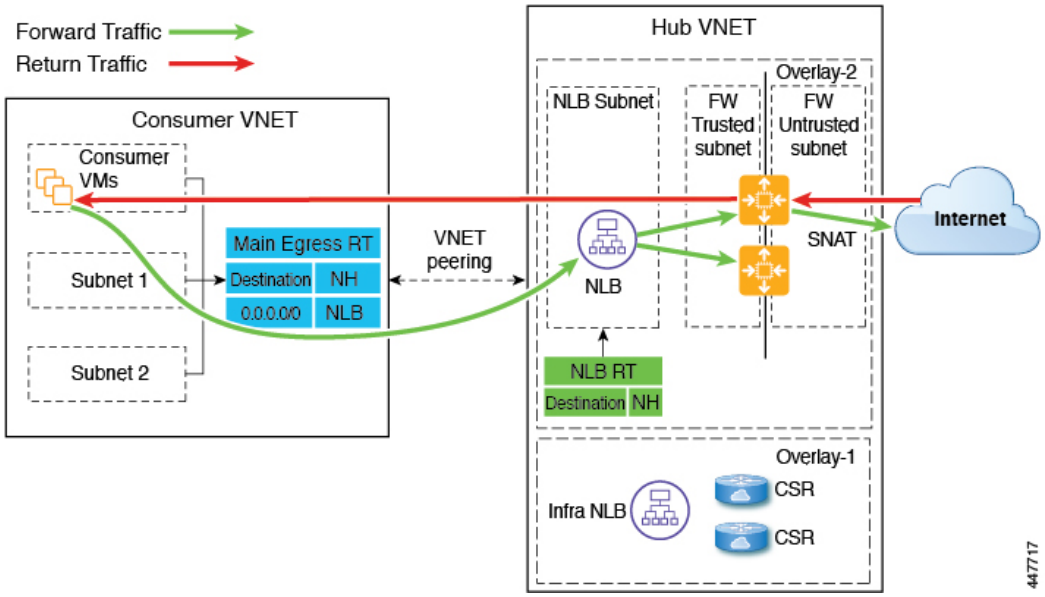
ConnType	Description
redir	This value means the service node is in redirect node for that connection. This value is only available or valid for third-party firewalls and Network Load Balancers.

ConnType	Description
snat	This value tells the service graph that the service node is performing source NAT on traffic. This value is only available or valid for the provider connector of third-party firewalls and only on the provider connector of a node.
snat_dnat	This value tells the service graph that the service node is performing both source NAT and destination NAT on traffic. This value is only available or valid for the provider connector of third-party firewalls and only on the provider connector of a node.
none	Default value.

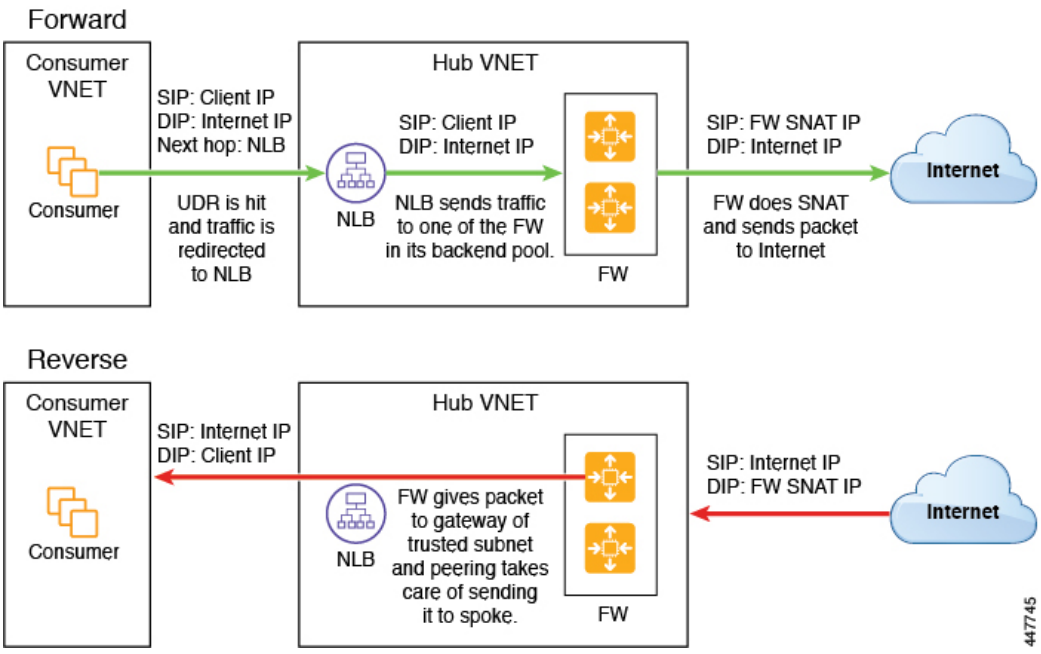
Spoke to Internet

In this use case, the consumer VNet (with consumer VMs) and the hub VNet are peered using VNet peering. A network load balancer is also deployed, fronting two firewalls for scaling. In this use case, the consumer VMs need access to the internet for a certain reason, such as patch updates. In the consumer VNet, the route table is modified to include a redirect for the internet in this case, and traffic is redirected to the NLB in front of firewalls in the hub VNet. Any traffic from this consumer that is part of the service graph that is going to the internet goes to the NLB as the next-hop. With VNet peering, traffic first goes to the NLB, then the NLB forwards the traffic to one of the firewalls in the back end. The firewalls also perform source network address translation (SNAT) when sending traffic to the internet.

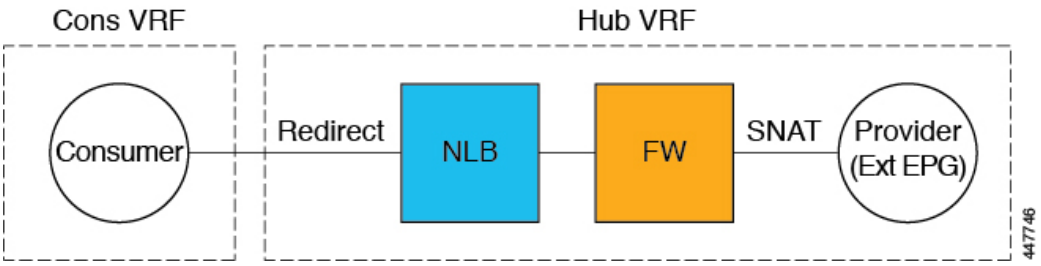
Ensure that all the Layer 4 - Layer 7 devices used in this use case have dedicated subnets.



The following figure shows the packet flow for this use case.



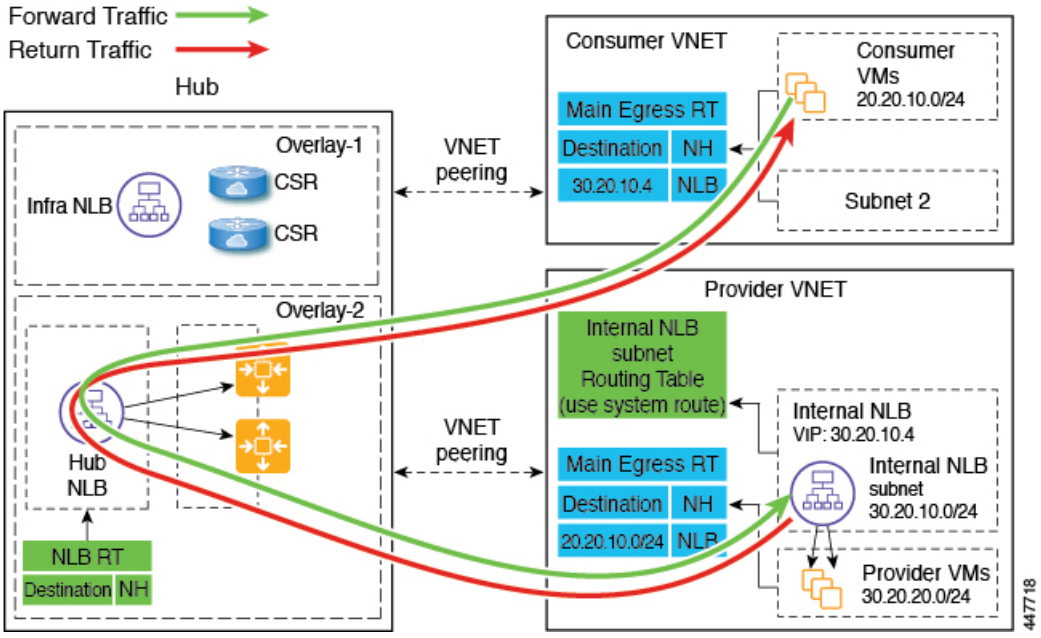
The following figure shows the service graph for this use case.



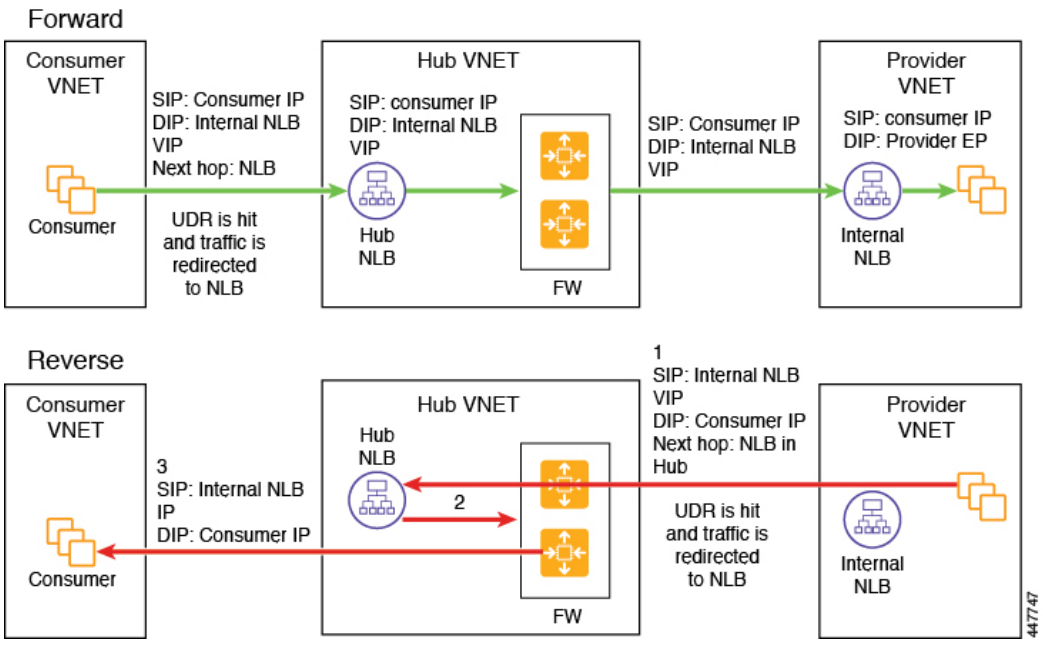
Spoke to Spoke

In this use case, traffic flows from spoke to spoke, through the hub firewall fronted by a hub NLB. Consumer endpoints are in the consumer VNet, and the provider VNet has VMs fronted by an internal NLB (or a third party load balancer). The egress route table is modified in the consumer and provider VNets so that traffic is redirected to the firewall device fronted by the NLB. Redirect is applied in both directions in this use case. The NLB must have a dedicated subnet in this case.

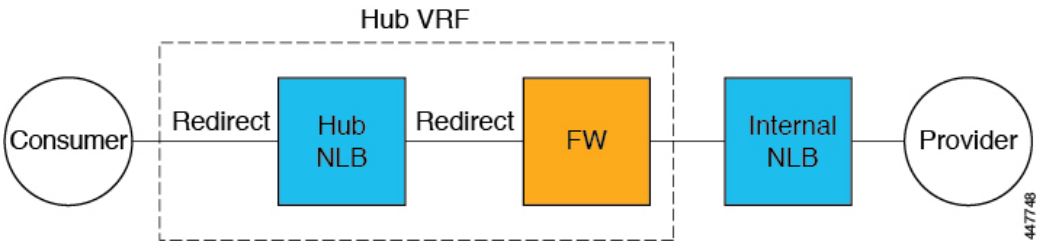
Ensure that all the Layer 4 - Layer 7 devices used in this use case have dedicated subnets.



The following figure shows the packet flow for this use case.



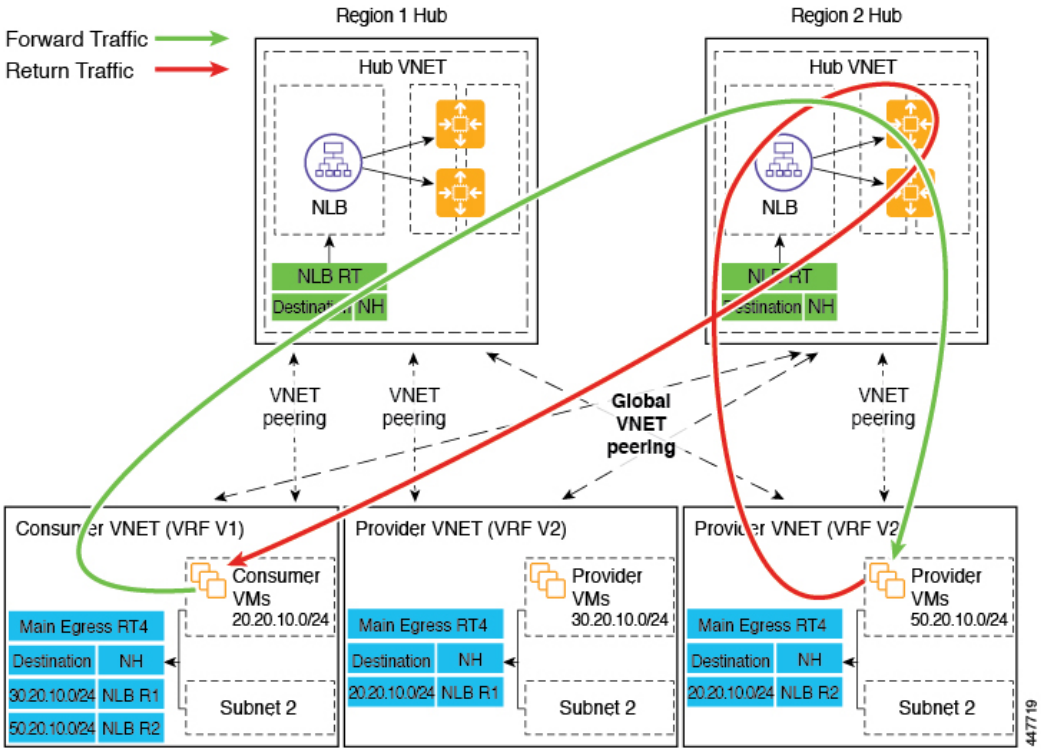
The following figure shows the service graph for this use case.



Inter-Region Spoke to Spoke

In this use case, both regions must have service devices,. The consumer VNet is in region 1, the provider is stretched across both regions (regions 1 and 2), and some endpoints are in region 1 and some endpoints are in region 2. Different redirects are programmed for local provider endpoints and for remote region endpoints. In this case, the firewall that is used will be the firewall that is closest to the provider endpoint side.

Ensure that all the Layer 4 - Layer 7 devices used in this use case have dedicated subnets.



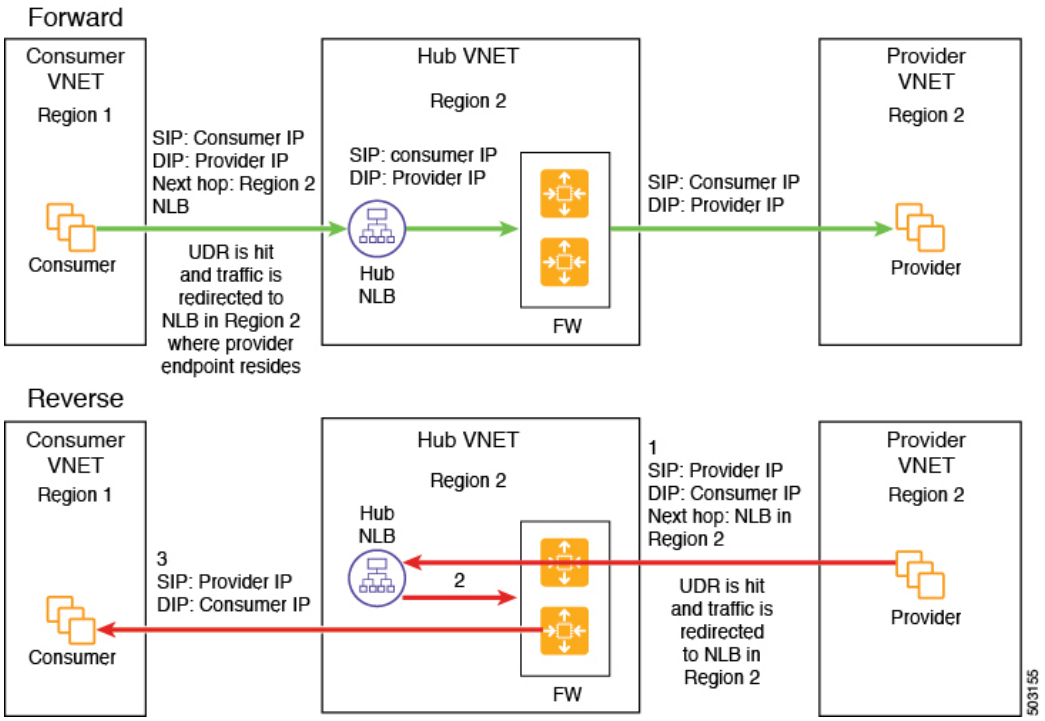
For example, consider the two subnets in the consumer VNet (VRF 1) egress route table (RT):

- 30.20.10.0/24 (NLB in region 1 [R1])
- 50.20.10.0/24 (NLB in region 2 [R2])

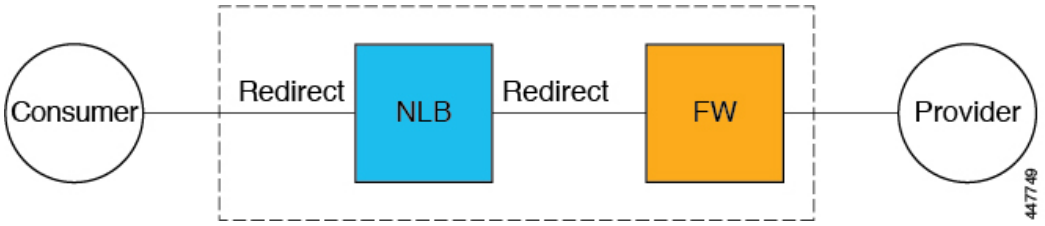
Assume the consumer wants to send traffic to the provider VMs 30.20.10.0/24, which are local to it. In that case, traffic will get redirected to the region 1 hub NLB and firewall, and will then go to the provider.

Now assume the consumer wants to send traffic to the provider VMs 50.20.10.0/24. In this case, the traffic will get redirected to the region 2 hub NLB and firewall, because that firewall is local to the provider endpoint.

The following figure shows the packet flow for this use case.



The following figure shows the service graph for this use case.



In the above use case, the provider VMs can also be front-ended by a cloud native or third party load balancer

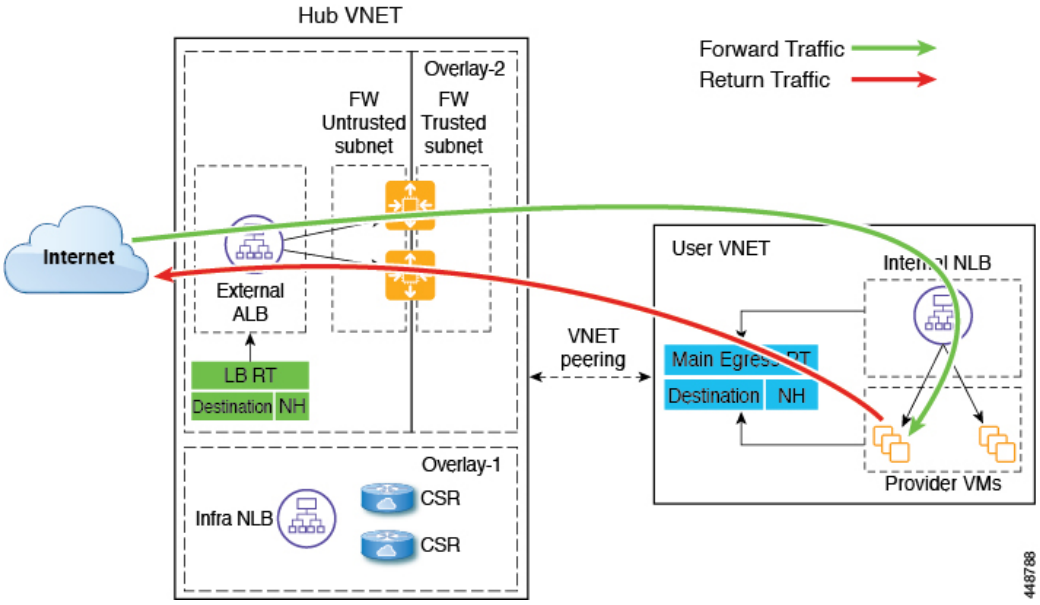
Internet to Spoke (Inter-VRF)

In this use case, traffic coming from the internet needs to go through the firewall before hitting the provider endpoints. Redirect is not used in this use case.

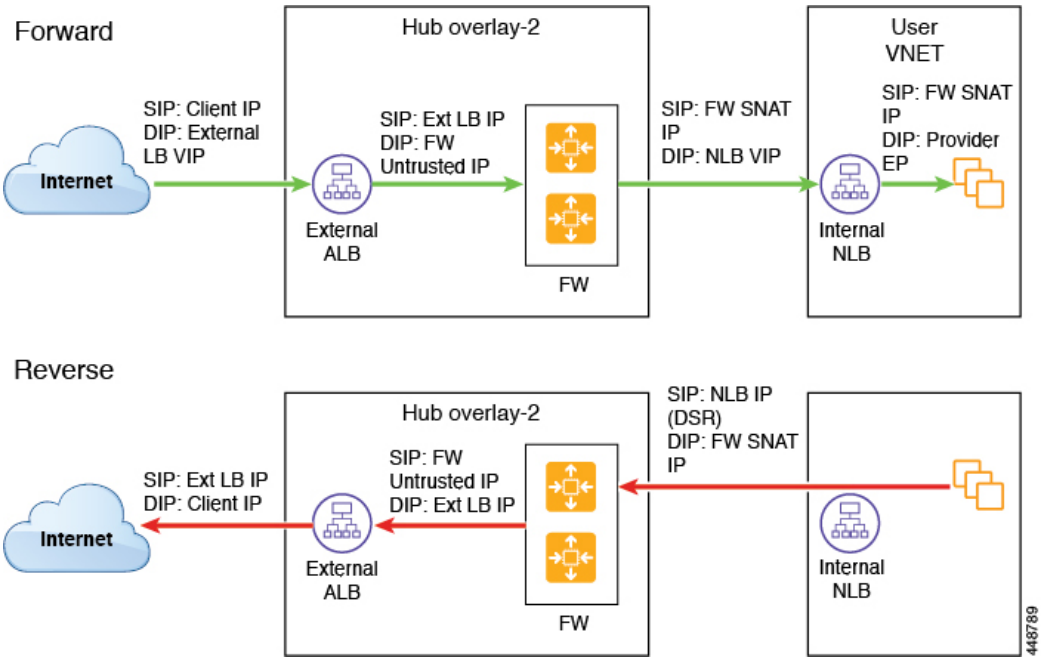
Note The general term "external load balancer" is used in this section because in this use case, the external load balancer could be either an NLB or an ALB or a third party load balancer. The following examples provide configurations using an ALB, but keep in mind that the external load balancer could be an NLB or a third party load balancer instead.

The external load balancer exposes the service through VIP. Internet traffic is directed to that VIP, then external load balancers direct traffic to the firewalls in the backend pool (the external load balancers have the firewall's untrusted interface as its backend pool). The firewall performs SNAT and DNAT, and the traffic goes to the internal NLB VIP. The internal NLB then sends traffic to one of the provider endpoints.

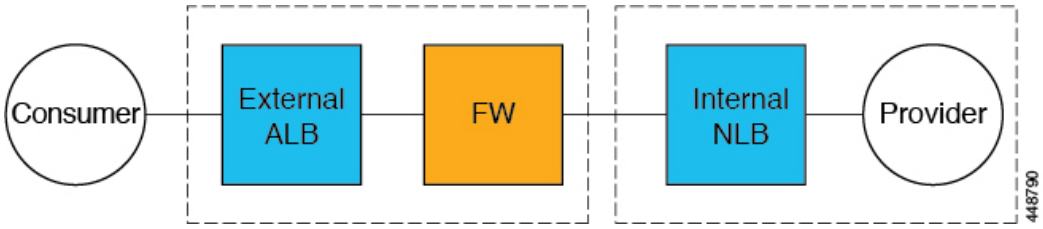
Ensure that all the Layer 4 - Layer 7 devices used in this use case have dedicated subnets.



The following figure shows the packet flow for this use case.



The following figure shows the service graph for this use case.

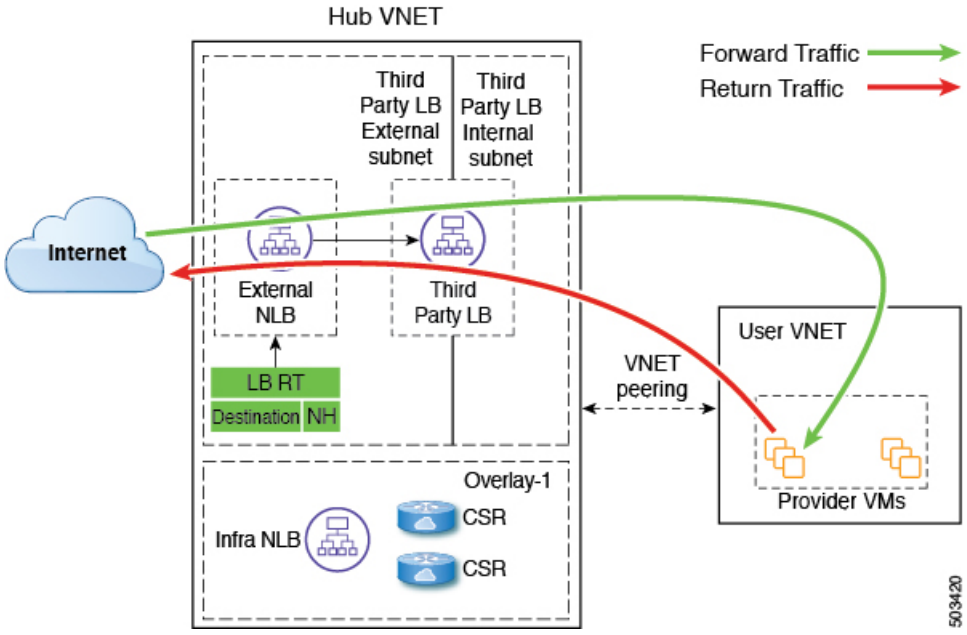


High Availability Support for Third Party Load Balancers

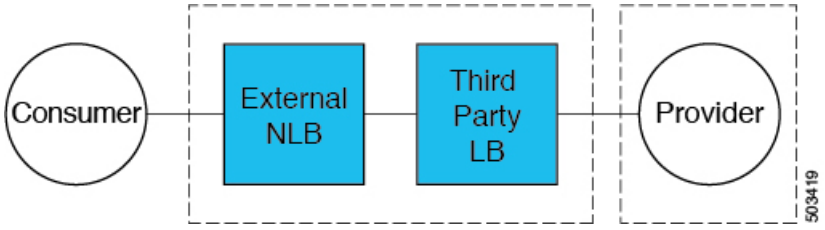
In this use case, traffic coming from the internet needs to go through the third party load balancer before hitting the provider endpoints. Redirect is not used in this use case.

The third party load balancer is configured as the backend pool of the NLB. Secondary IP addresses of the devices act as the target for the NLBs. You can choose to add either primary or secondary IP address (or both) as the target for the NLBs. The third party load balancer VMs are deployed in active-active mode only. Third party load balancers can not be used in active-standby high availability configuration.

Ensure that the third party load balancers and the network load balancers have dedicated subnets.



The following figure shows the service graph for this use case.



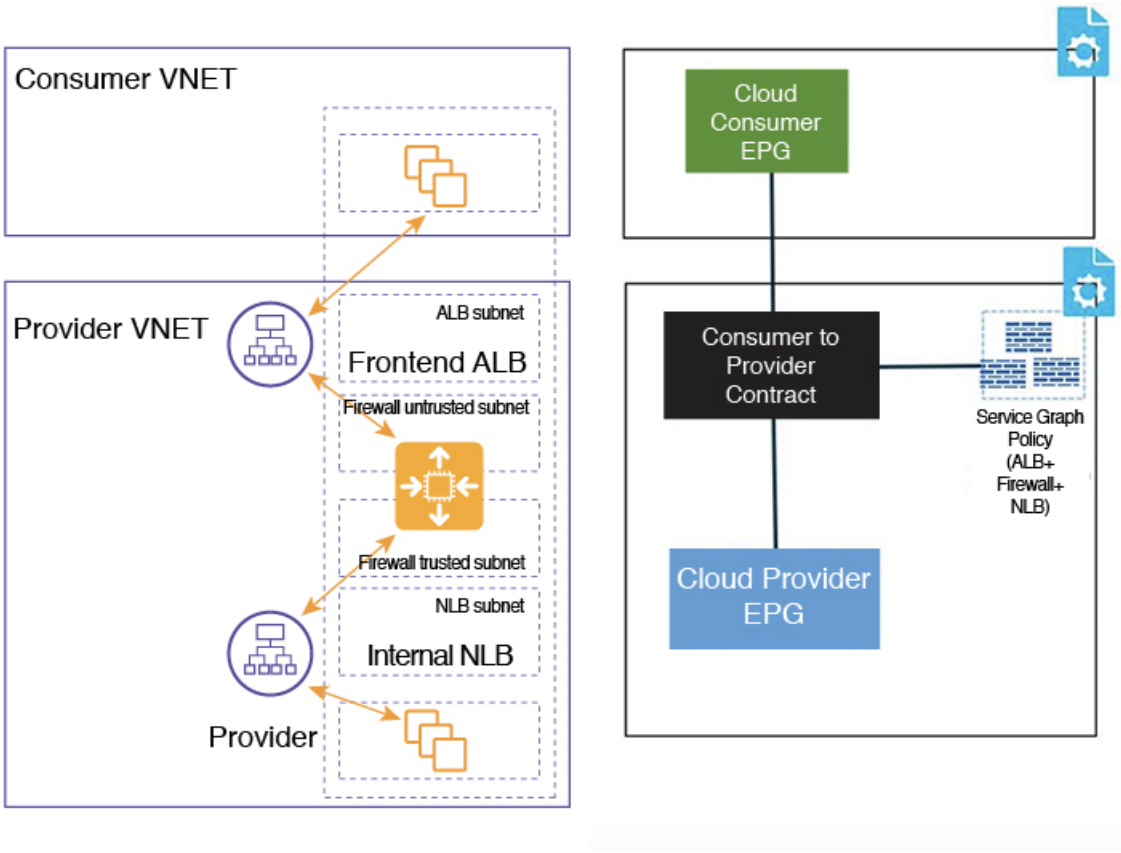
Consumer and Provider EPGs in Two Separate VNets

This use case is an example configuration with two VNets, with a consumer EPG and provider EPG in separate VNets.

- A frontend ALB, firewall, and internal NLB are inserted between the consumer and provider EPGs.
- A consumer endpoint sends traffic to the frontend ALB VIP and it is forwarded to the firewall.
- The firewall performs SNAT and DNAT, and the traffic flows to internal NLB VIP.
- The internal NLB load balances the traffic to the backend provider endpoints.

In this use case, a third party load balancer can be used in place of the frontend ALB or an internal NLB.

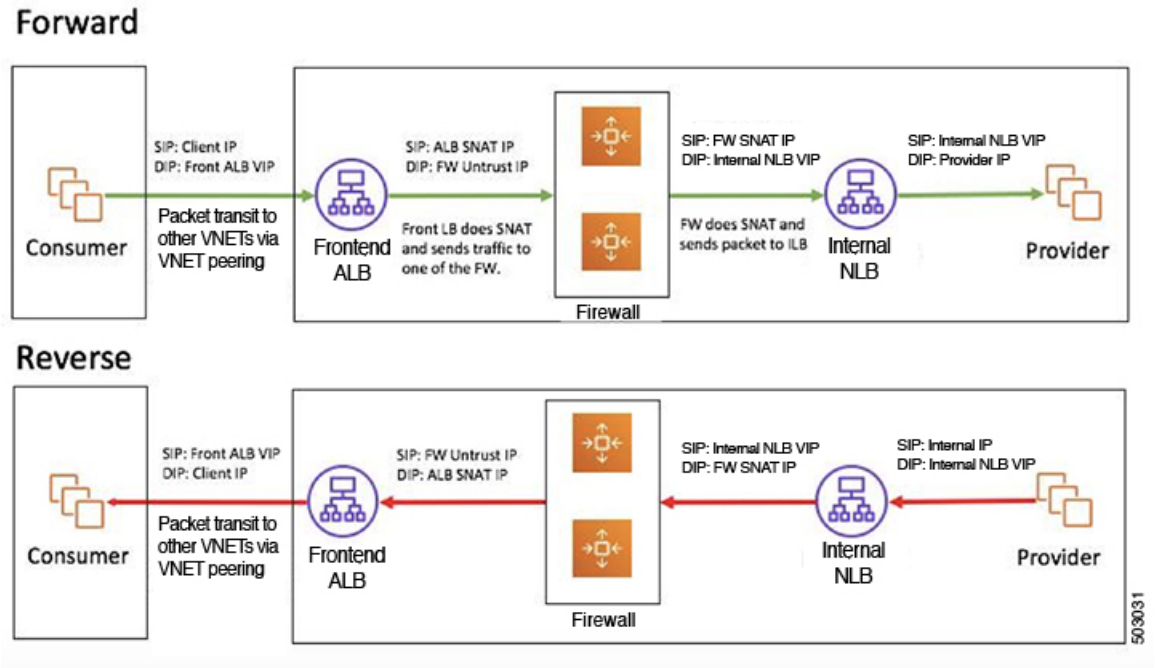
Ensure that all the Layer 4 - Layer 7 devices used in this use case have dedicated subnets.



In the figure:

- The consumer EPG is in a consumer VNet.
- The provider EPG and all the service devices are in the provider VNet.
- The application load balancer, network load balancer (or third party load balancer), and firewall need to have their own subnet in the VNet.

Packet flow for both the directions is shown in the following figure:



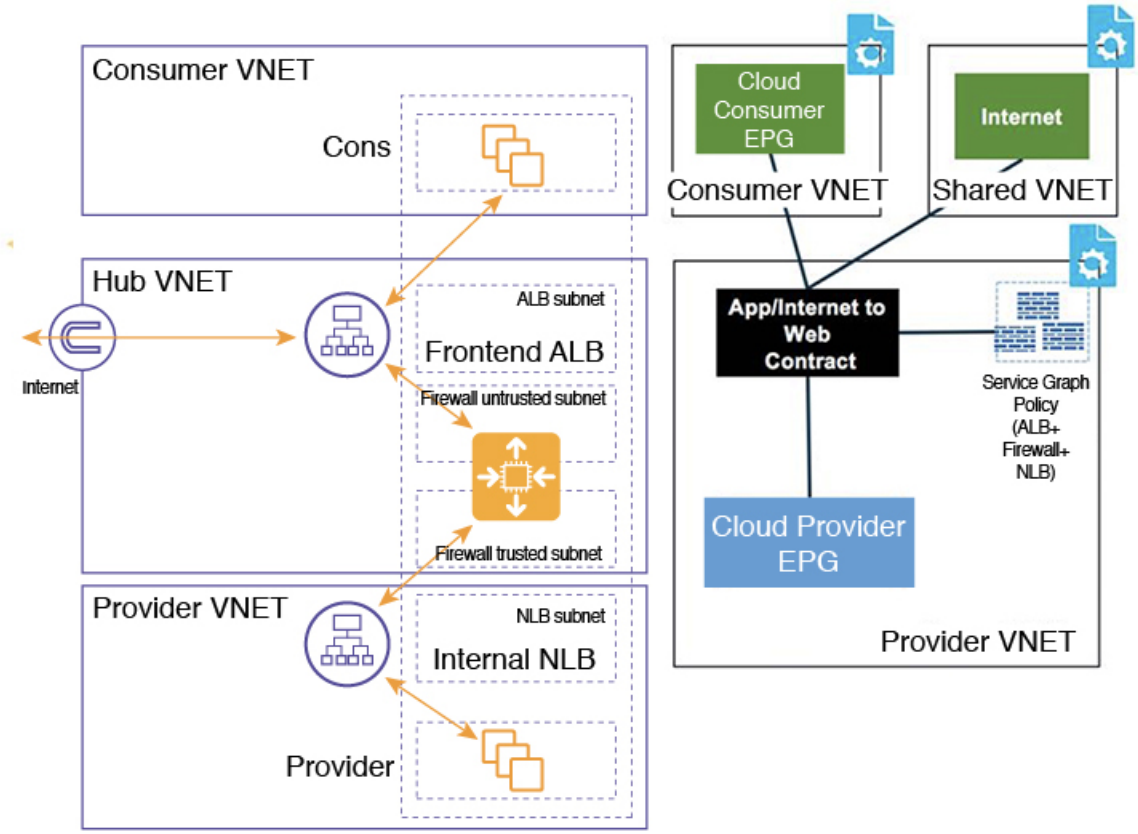
Hub VNet with Consumer and Provider EPGs in Two Separate VNets

This use case is an example configuration with three VNets: a hub VNet, and a consumer EPG and provider EPG in two separate VNets.

- A frontend ALB and firewall are inserted within the hub VNet, which is between the consumer and provider EPGs.
- An internal NLB is inserted in the provider EPG.
- A consumer endpoint sends traffic to the frontend ALB VIP and it is forwarded to the firewall.
- The firewall performs SNAT and DNAT, and the traffic flows to internal NLB VIP.
- The internal NLB load balances the traffic to the backend provider endpoints.

In this use case, a third party load balancer can be used in place of the frontend ALB or an internal NLB.

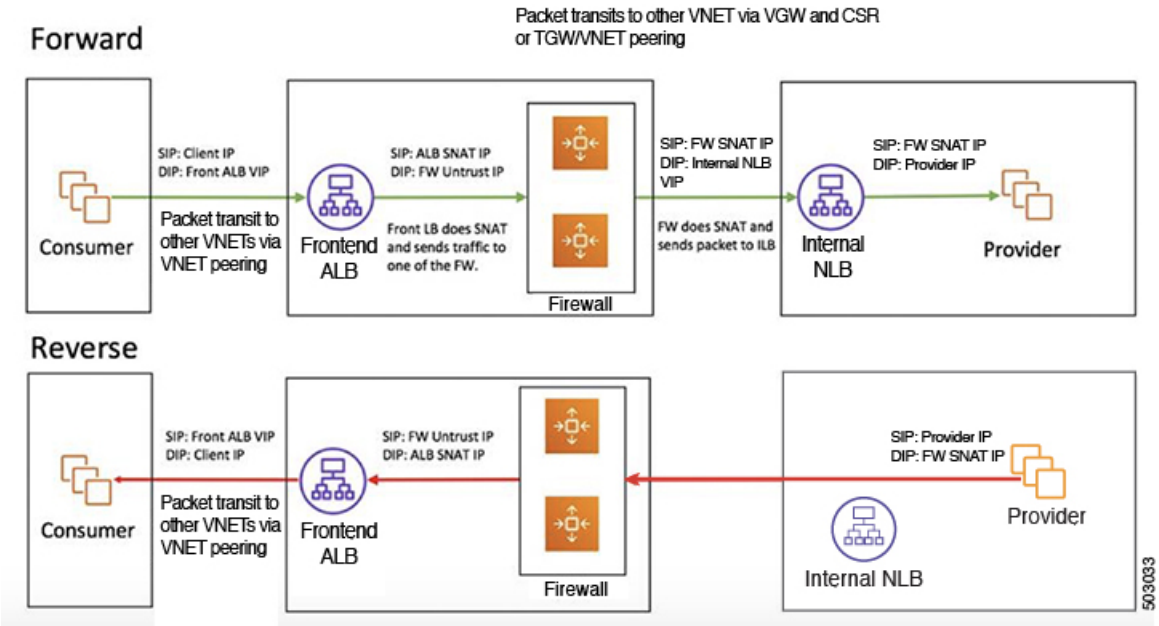
Ensure that all the Layer 4 - Layer 7 devices used in this use case have dedicated subnets.



In the figure:

- The consumer EPG is in a consumer VNet.
- The provider EPG and the internal NLB are in the provider VNet.
- The frontend ALB and firewall are in the hub VNet
- The application load balancer, network load balancer (or third party load balancer), and firewall need to have their own subnet in the VNet.

Packet flow for both the direction is shown in the following figure:



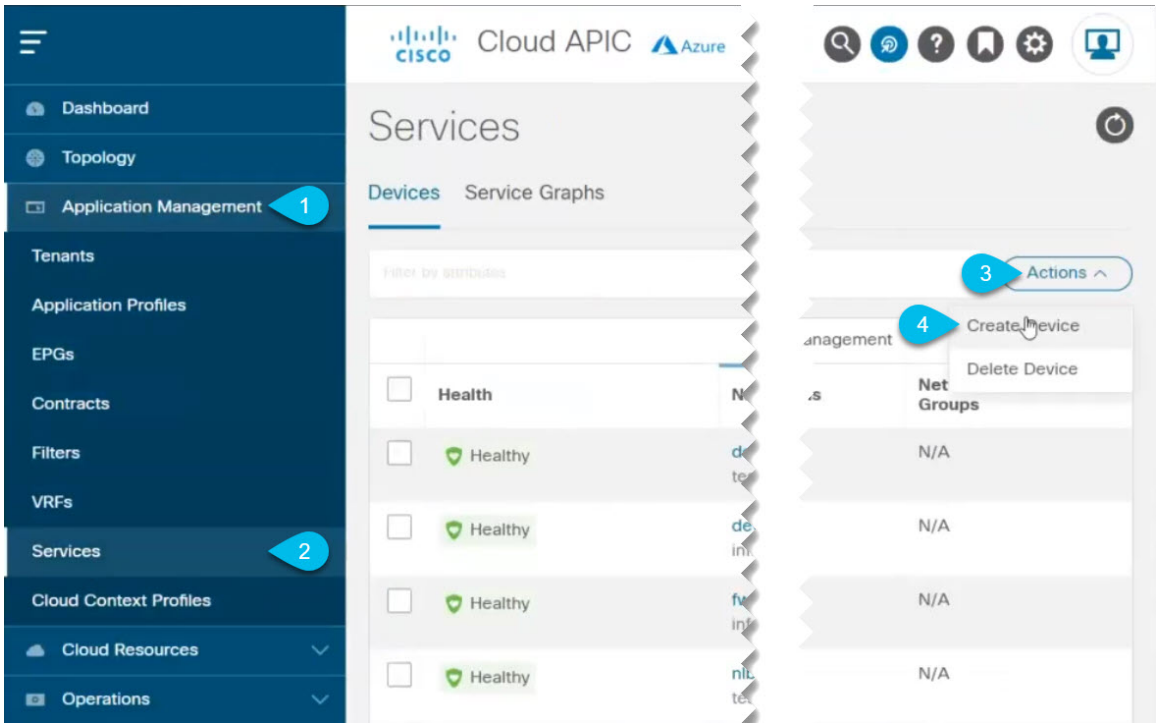
Creating Service Graph Devices

This release of Multi-Site Orchestrator does not support creating service graph devices, so you must first create them from the Cloud APIC UI. This section describes the GUI workflow to create the device; specific device configuration are described in the *Cloud APIC Azure User Guide*.

Procedure

Step 1 Log in to your Cloud APIC GUI.

Step 2 Create a new device



a) In the left navigation sidebar, expand the **Application Management** category.
b) Choose **Services**.
c) In the main pane, click the **Actions** menu.
d) Select **Create Device**.

Step 3 Create an Azure Application Load Balancers (ALB) device.

If you are not creating an ALB, skip this step.

a) Provide the **Name** for the device.
b) Click **Select Tenant** and select the Infra tenant.
c) From the **Service Type** dropdown, select `Application Load Balancer`.
d) Pick **Standard** or **Standard V2** for the type of ALB.
e) Click **Select Region** and choose the region where the device will be deployed.
f) Click **Select Cloud Content Profile** and choose the context profile for the device.
g) Click **Select Subnet** and choose the subnet.
h) In the **VM Instance Count** field, specify number of device instances.

   This is applicable only for the Application Gateway.

i) In the **VM Instance Size** selection, choose the size for each instance.

   This is applicable only for the Application Gateway.

j) In the **Schema** pick the scheme.

   - **Internet Facing**— This is used for configuring a public IP for the balancer. This is assigned by Azure.
   - **Internal**—Click to choose either **Dynamic** or **Static** under IP Address Assignment.
     - **Dynamic**—Dynamic IP addresses are assigned by Azure. Dynamic IP addresses change each time the VMs boot up.

- **Static**—Enter an IP address based on the CIDRs defined in Cloud Context Profile and check that the IP address is in the same subnet as the ALB.

  ALB SKU Standard supports static and dynamic IP addresses. ALB SKU Standard V2 support static IP addresses only.

k) Click **Save** to add the device.

Step 4 Create an Azure Network Load Balancers (NLB) device.

If you are not creating an NLB, skip this step.

a) Provide the **Name** for the device.
b) Click **Select Tenant** and select the Infra tenant.
c) From the **Service Type** dropdown, select `Network Load Balancer`.
d) In the **Schema** pick the scheme.

- **Internet Facing**— This is used for configuring a public IP for the balancer. This is assigned by Azure.
- **Internal**—Click to choose either **Dynamic** or **Static** under IP Address Assignment.
  - **Dynamic**—Dynamic IP addresses are assigned by Azure. Dynamic IP addresses change each time the VMs boot up.
  - **Static**—Enter an IP address based on the CIDRs defined in Cloud Context Profile and check that the IP address is in the same subnet as the NLB. Static IP addresses are associated to load balancers.

  Note Cloud APIC creates standard SKU NLBs only.

e) Click **Select Region** and choose the region where the device will be deployed.
f) Click **Select Cloud Content Profile** and choose the context profile for the device.
g) Click **Select Subnet** and choose the subnet.
h) Click **Save** to add the device.

Step 5 Create a Third-Party Firewall device.

If you are not creating a third-party unmanaged device, skip this step.

a) Provide the **Name** for the device.
b) Click **Select Tenant** and select the Infra tenant.
c) From the **Service Type** dropdown, select `Third-Party Firewall`.
d) Click **Select VRF** and choose the VRF.
e) Click **Add External Interface Selector**.

You will need to provide the name for the selector and the **Match Expression**. The match expression can contain the following:

- the **Key**: This can be IP, region or a custom based tag selector.
- **Operator**: This can be equal, not equals, in, not in, has key, or does not have key.
- **Value**: IP address of the app, web, internal network, management network, or external network.

f) Repeat the previous substep to **Add Internal Interface Selector**.
g) Click **Save** to add the device.

Step 6 Create a Third-Party load balancer device.

If you are not creating a third party load balancer, skip this step.

a) Provide the **Name** for the device.
b) Click **Select Tenant** and select the Infra tenant.
c) From the **Service Type** dropdown, select `Third-Party Load Balancer`.
d) Click **Select VRF** and choose the VRF.
e) Click **Add Interface** and enter a name for the external interface.
f) Click **Add Interface Selector**.

You will need to provide the name for the selector and the **Match Expression**. The match expression can contain the following:

- the **Key**: This can be IP, region or a custom based tag selector.
- **Operator**: This can be equal, not equals, in, not in, has key, or does not have key.
- **Value**: IP subnet or address or custom tag value to match.

g) Repeat steps (e) and (f) to add more internal interfaces and their interface selectors.
h) Click **Save** to add the device.

Note Third party load balancer interfaces should be configured with subnet-based selectors when deployed in a multi-node service graph.

Guidelines and Limitations

When configuring this use case, the following restrictions apply:

- ACI Multi-Site multi-cloud deployments support a combination of any two cloud sites (AWS, Azure, or both) and two on-premises sites for a total of four sites.
- Infra tenant configurations are supported only for Azure cloud sites.
- Infra tenant configurations are supported only for the two VRFs automatically created in the Cloud APIC.

  The Layer 4 to Layer 7 services in the `infra` tenant are configured on the `overlay-2` VRF which is implicitly created during the Cloud APIC setup. When configuring these use cases from the Multi-Site Orchestrator, you must import the existing `overlay-2` VRF from the Cloud APIC.
- The Layer 4 to Layer 7 services is not supported across multiple sites.

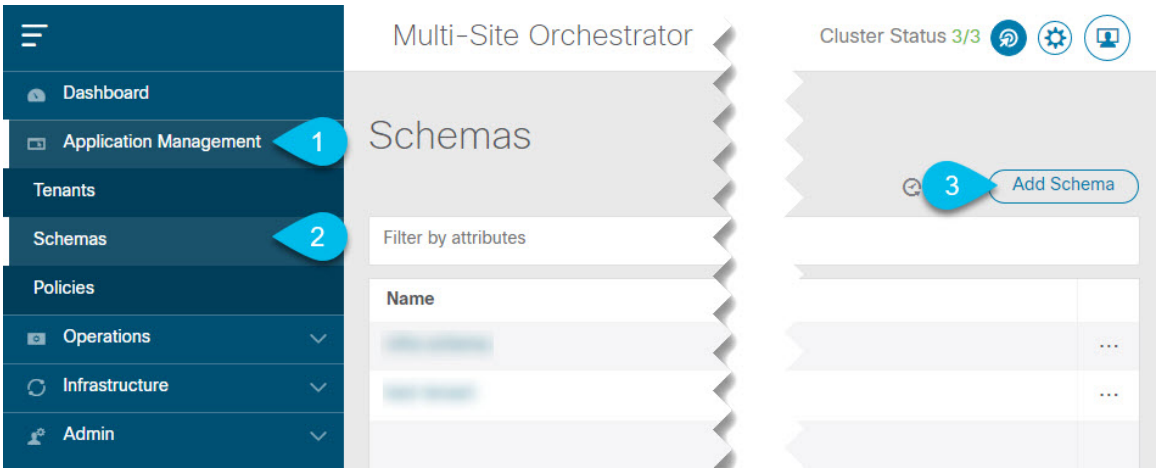
Creating Schema and Template

This section describes how to create a new schema for the Infra tenant. The process is the same as when creating a typical schema, with the exception that you can now choose the `infra` tenant.

Procedure

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

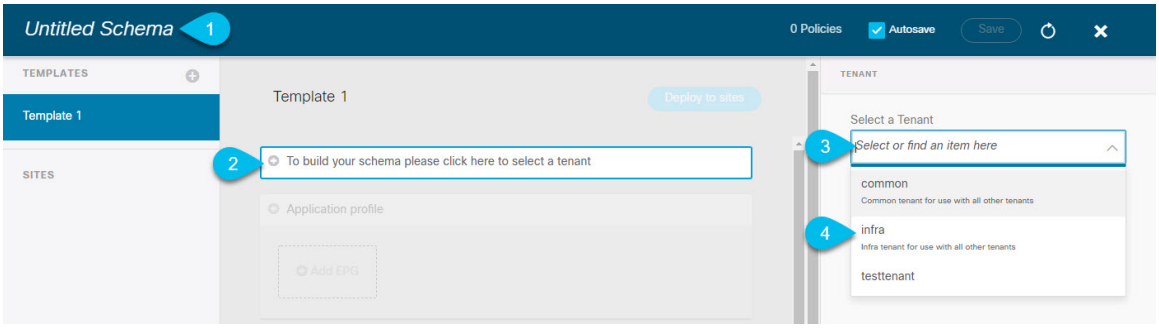
Step 2 Create a new Schema for the Infra Tenant.



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.



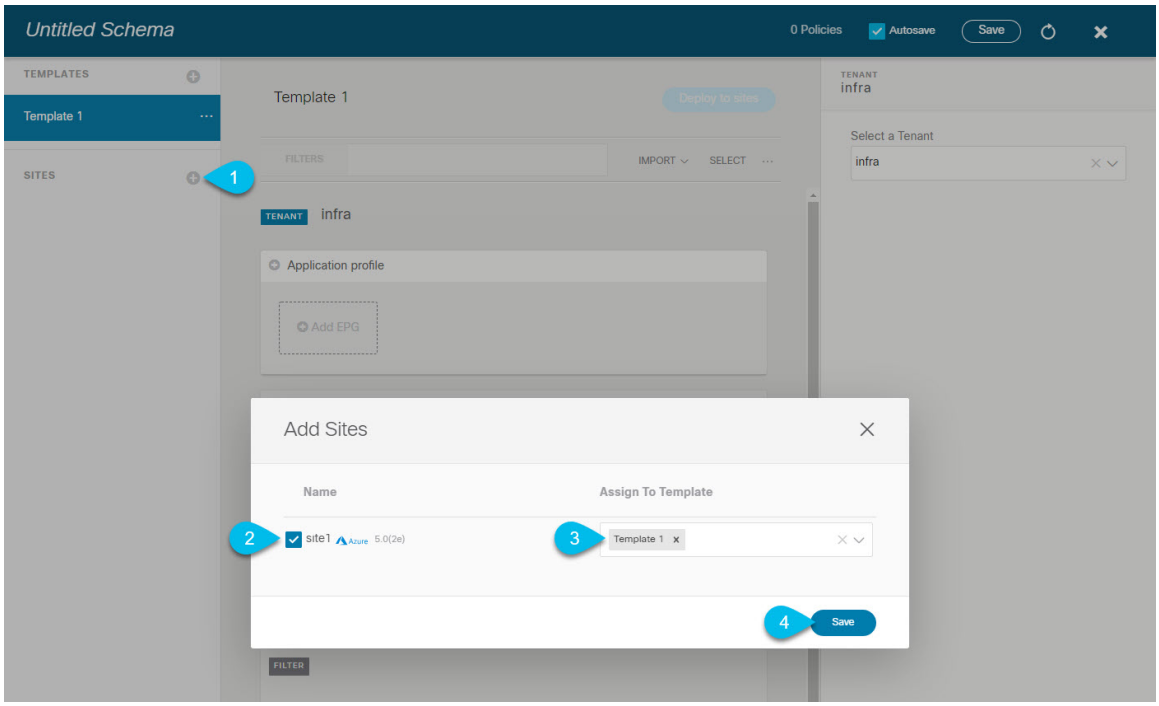
a) Replace **Untitled Schema** with the name for your schema.
b) In the main pane, click **To build your schema please click here to select a tenant**.
c) In the right sidebar, click **Select a Tenant**.
d) Select the `infra` tenant.

Associating Template with Sites

Use the following procedure to associate the template with the appropriate sites.

Procedure

Add the sites.



a) In the left pane, click the + icon next to **Sites**.
b) In the **Add Sites** window, check the checkbox next to the sites you want to add.
c) From the **Assign to Template** dropdown next to each site, select the template.
d) Click **Save**

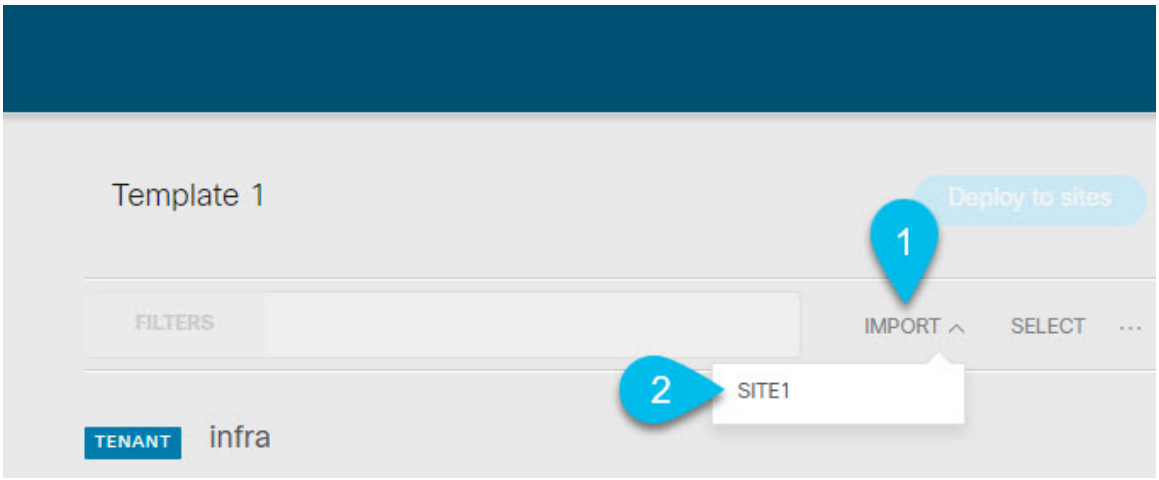
Importing overlay-2 VRF

When working with Infra tenant schemas, you cannot create new VRFs. This section describes how to import the `overlay-2` VRF from the cloud site.

Procedure

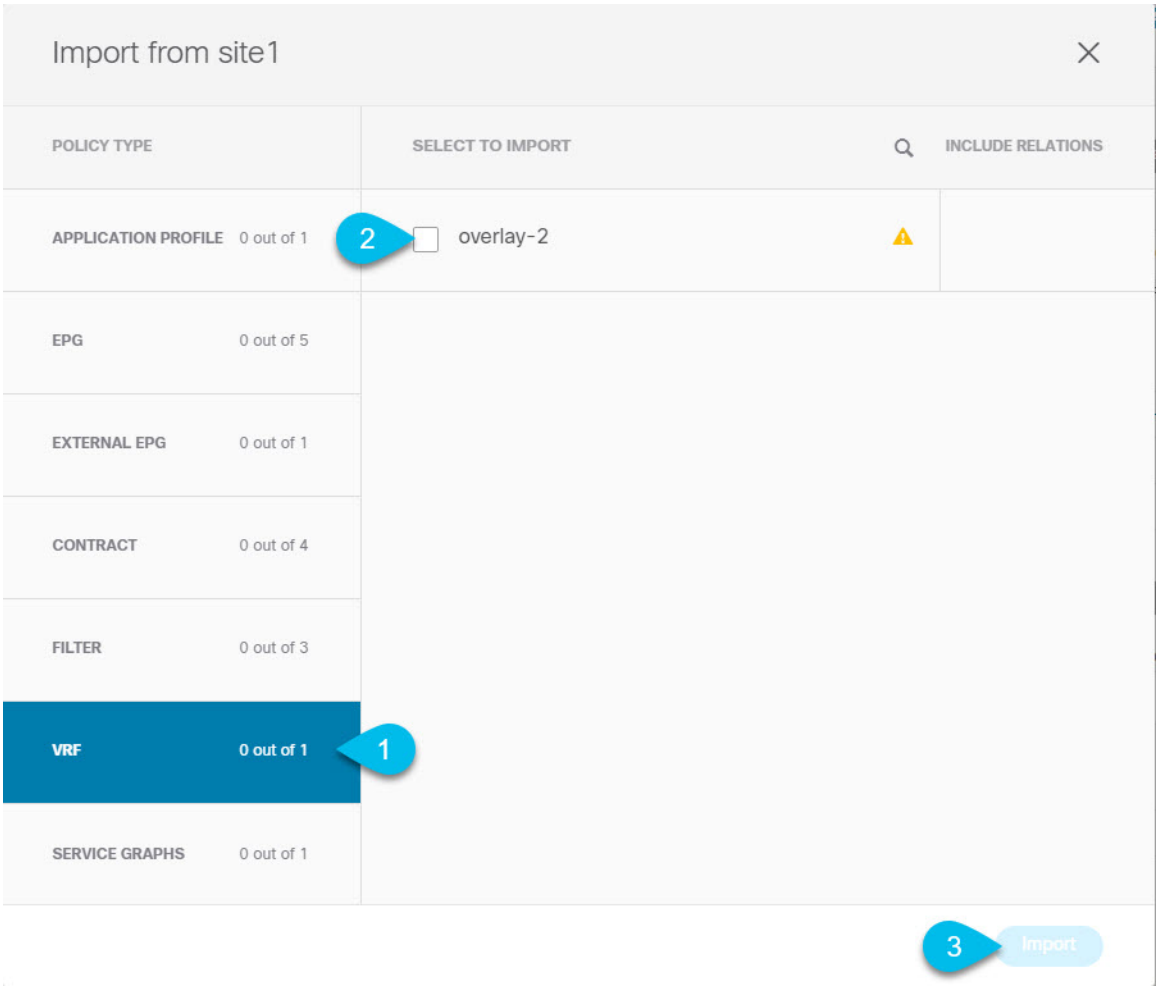
Step 1 Select the template and the `infra` tenant where you want to import the VRF.

Step 2 Choose to import from the Cloud site.



a) In the main pane, click **Import**.
b) Then select the site.

Step 3 Choose the `overlay-2` VRF and any other objects you want to import.



a) In the **Import from** window, select **VRF**.

You can choose to also import any other objects that have already been created on the cloud site.

b) Check `overlay-2`.
c) Click **Import**.

Step 4 Repeat these steps for all sites associated with the template.

If you plan to stretch the configuration between multiple Azure sites, you must import the `overlay-2` VRF from every site with which you associated the template.

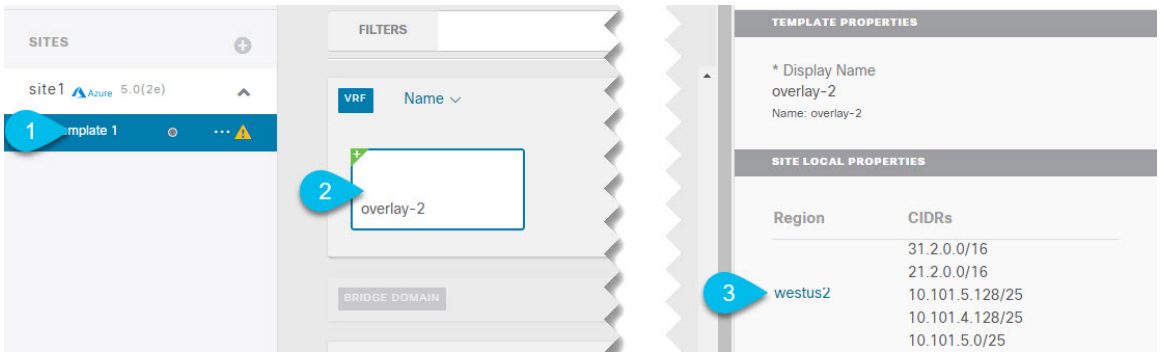
Adding or Updating Overlay-2 CIDRs

After you deploy your Cloud APIC, you will see `overlay-1` and `overlay-2` VRFs in the Cisco Cloud APIC. However, only the `overlay-1` will be created in the Azure portal. This is because `overlay-2` is a logical extension of `overlay-1` and is used to hold additional CIDRs that you may need when deploying firewalls or load balancers in the Infra VNet.

This section describes how to create new or modify existing CIDRs for the `overlay-2` VRF.

Procedure

Step 1 Navigate to the `overlay-2` VRF's site-local properties.



a) In the left sidebar, select the template under **Sites**.
b) In the main pane, scroll down to the **VRF** area and select `overlay-2`.
c) In the right sidebar, click the **Region** where you want to add a CIDR.

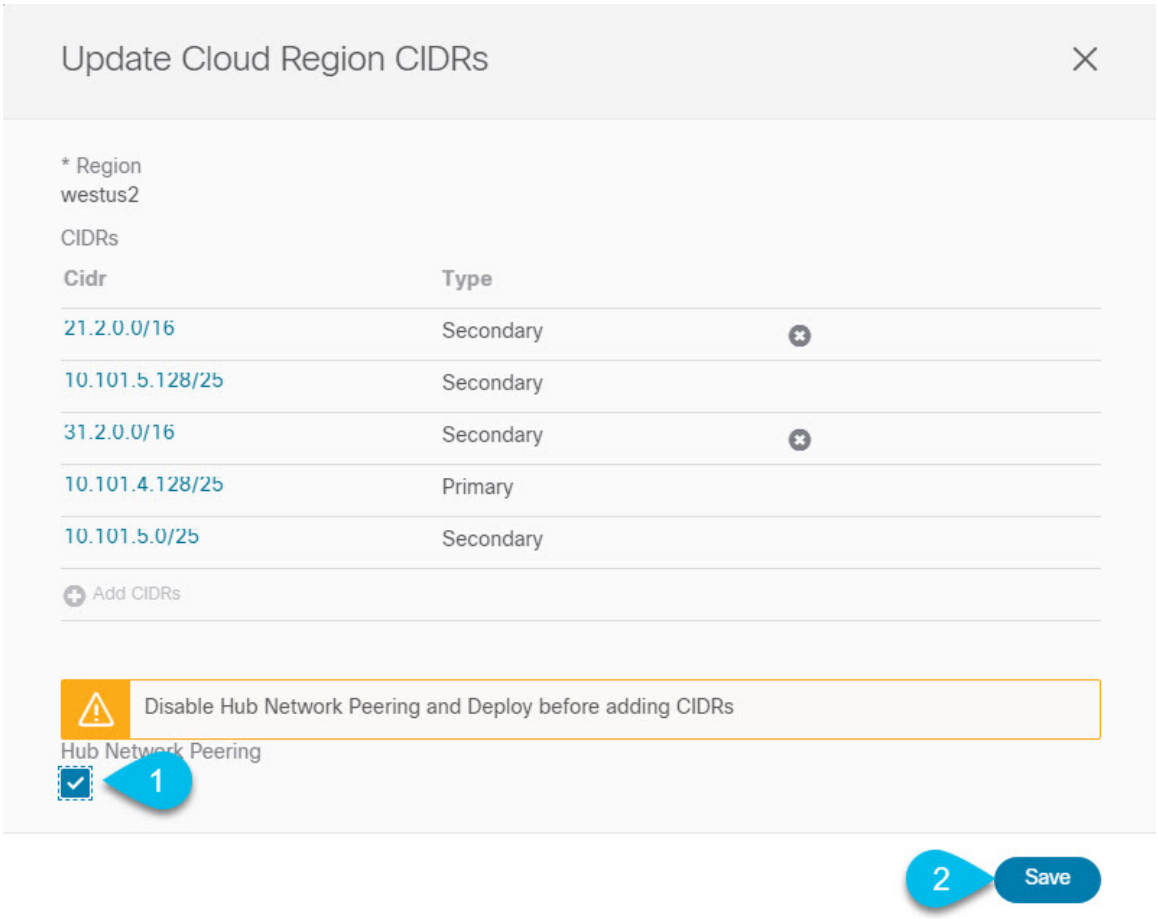
The **Update Cloud Region CIDRs** window will open.

Step 2 Disable Hub Network Peering.

If you simply need to add additional subnets to an existing CIDR or hub network peering is not enabled, skip this step.

You need to disable VNet peering before adding new CIDRs or editing existing CIDRs in `overlay-2`. This is due to a limitation in Azure, where you cannot update a CIDR on a VNet if it has active VNet peerings. To add the CIDRs, you first have to remove VNet peerings for that VNet in all regions, then you can update the CIDRs.

Once you have updated the CIDRs, you can then re-enable the VNet peerings.



a) Uncheck the **Hub Network Peering** checkbox.
b) Click **Save**.
c) Click **Deploy to sites** to re-deploy the configuration.

   You must re-deploy the configuration after changing hub network peering settings.

d) Navigate back to the **Update Cloud Region CIDRs** screen.

Step 3 In the **Update Cloud Region CIDRs** screen, click **Add CIDRs** and provide the new CIDR information.

You can add only secondary CIDRs.

Step 4 Re-enable Hub Network Peering.

If you did not disable the Hub Network Peering at the start of these steps, skip this step.

a) Navigate back to the **Update Cloud Region CIDRs** screen.
b) Check the **Hub Network Peering** checkbox.
c) Click **Save**.
d) Click **Deploy to sites** to re-deploy the configuration.

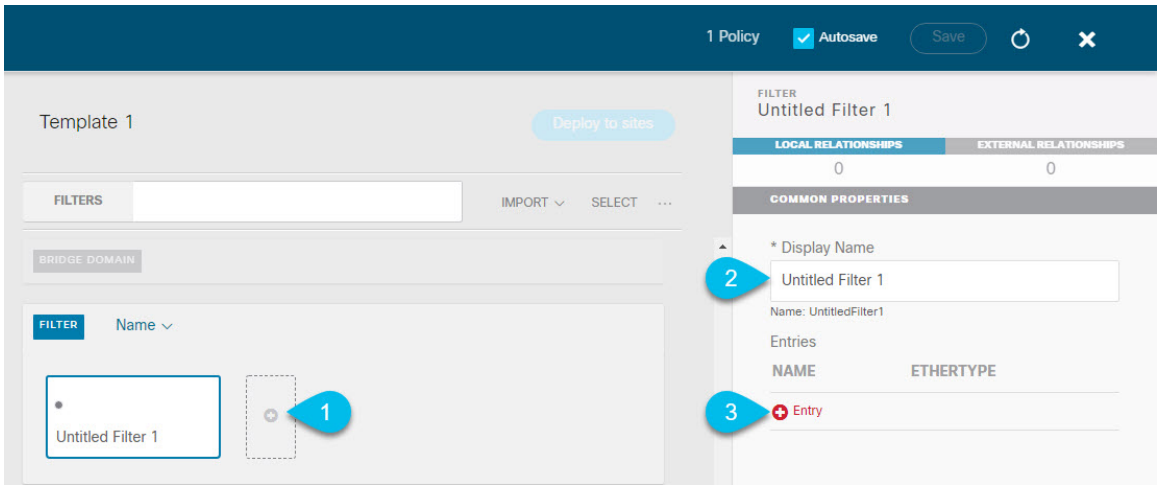
   You must re-deploy the configuration after changing hub network peering settings.

Creating Filter and Contract

This section describes how to create a contract and filters that will be used for the traffic going through the service graphs. If you plan to allow all traffic, you can skip this section.

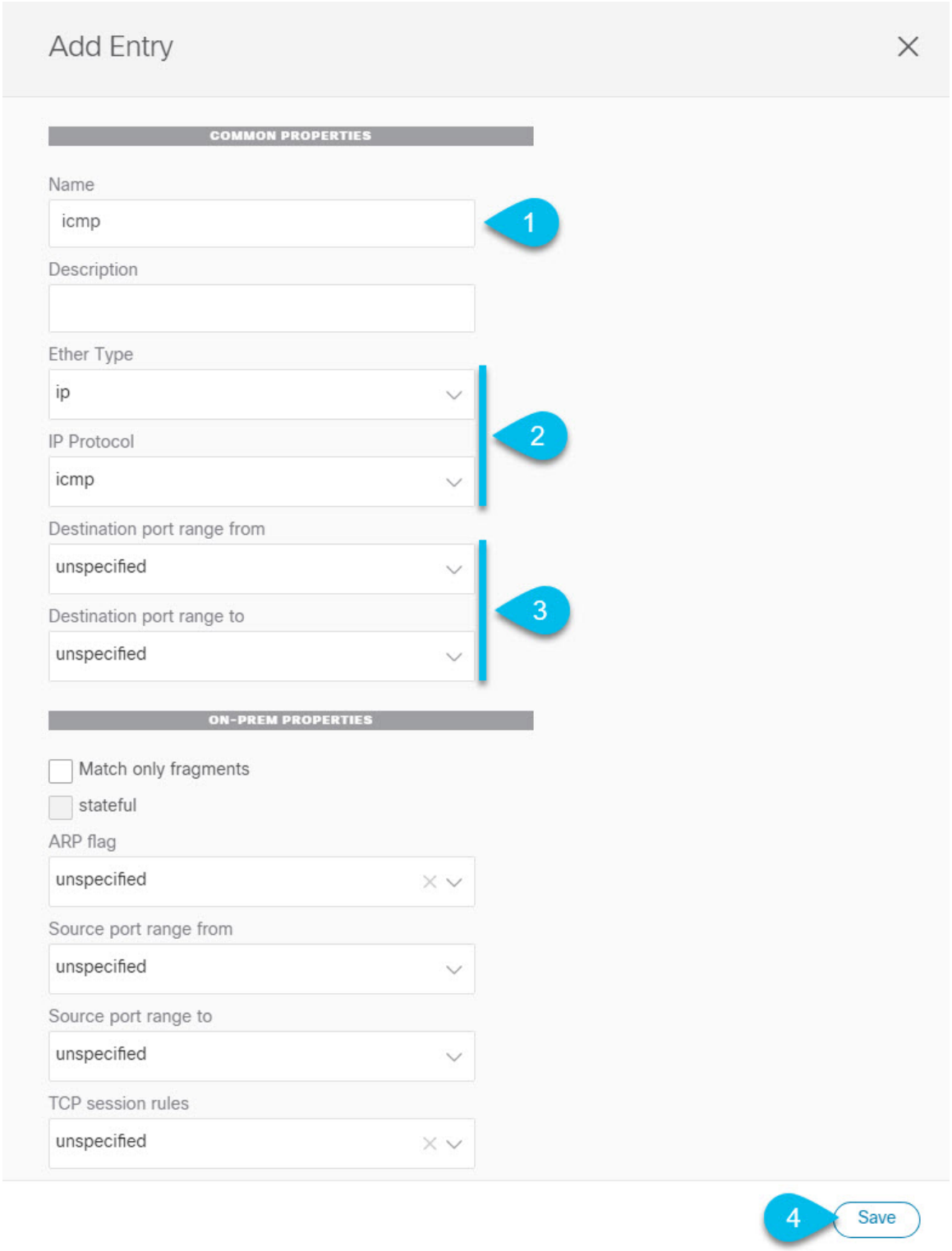
Procedure

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.



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 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, change the scope of the Contract 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 4 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 section from the **Name** dropdown menu.

Creating Consumer and Provider EPGs

This section describes how to create two cloud EPGs in the infra tenant. You will then establish a contract between them and attach the contract to a service graph so the traffic between the EPGs flows through the service graph nodes. If you have imported the EPGs from your cloud site, you can skip this section.

Procedure

Step 1 Create an application profile.

a) In the middle pane, click **+ Application Profile**.

b) In the right pane, provide the **Display Name** for the Application Profile.

Step 2 Create an EPG.

a) In the middle pane, click **+ Add EPG**.

b) In the right pane, provide the **Display Name** for the EPG.

c) In the right sidebar, scroll down to **Cloud Properites** area.

d) From the **Virtual Routing & Forwarding** dropdown, select the VRF for your EPG.

Step 3 Repeat the previous step to create the second EPG.

You will configure the two EPGs as the provider and consumer and the traffic between them will flow through the service graph.

Step 4 Establish the contract between the two EPGs.

a) Select one of the EPGs you have created.
b) In the right **Properties** sidebar, click **+Contract**.
c) Select the contract you have created for the EPG communication and choose its type based on whether this EPG will be the consumer or the provider.

Step 5 Repeat the previous step for the second EPG you created.

What to do next

After you created the cloud EPGs, you will need to add one or more endpoint selectors to it, as described in Adding Cloud EPG Endpoint Selectors, on page 27.

Adding Cloud EPG Endpoint Selectors

On the Cloud APIC, a cloud EPG is a collection of endpoints that share the same security policy. Cloud EPGs can have endpoints in one or more subnets and are tied to a CIDR.

You define the endpoints for a cloud EPG using an object called endpoint selector. The endpoint selector is essentially a set of rules run against the cloud instances assigned to either AWS VPC or Azure VNET managed by the Cloud APIC. Any endpoint selector rules that match endpoint instances will assign that endpoint to the Cloud EPG.

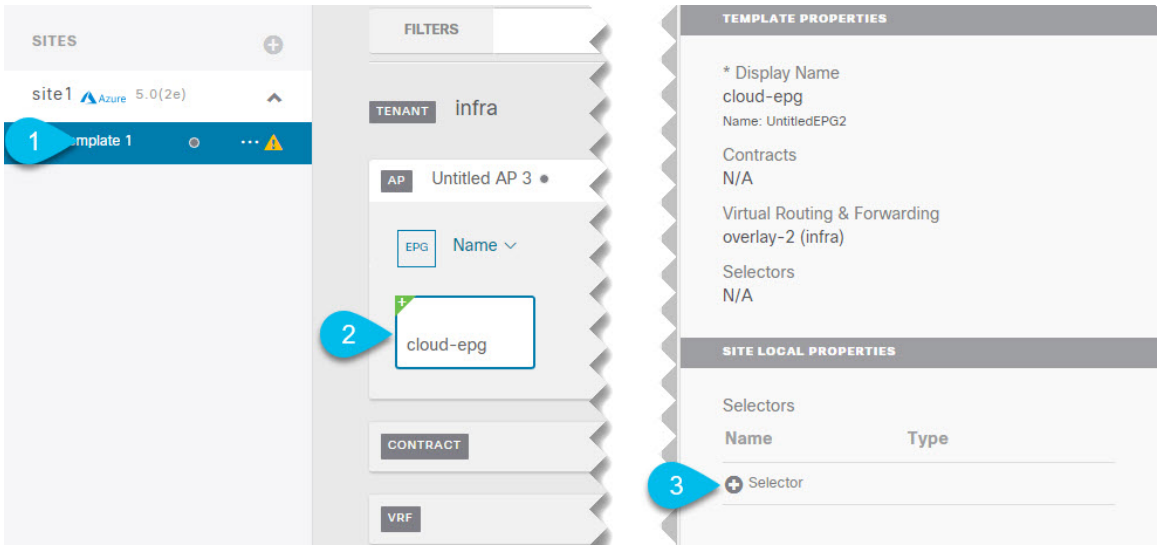
Unlike the traditional on-premises ACI fabrics where endpoints can only belong to a single EPG at any one time, it is possible to configure endpoint selectors to match multiple Cloud EPGs. This in turn would cause the same instance to belong to multiple Cloud EPGs. However, we recommend configuring endpoint selectors in such a way that each endpoint matches only a single EPG.

Before you begin

- You must have created a cloud EPG as described in Creating Consumer and Provider EPGs, on page 26.

Procedure

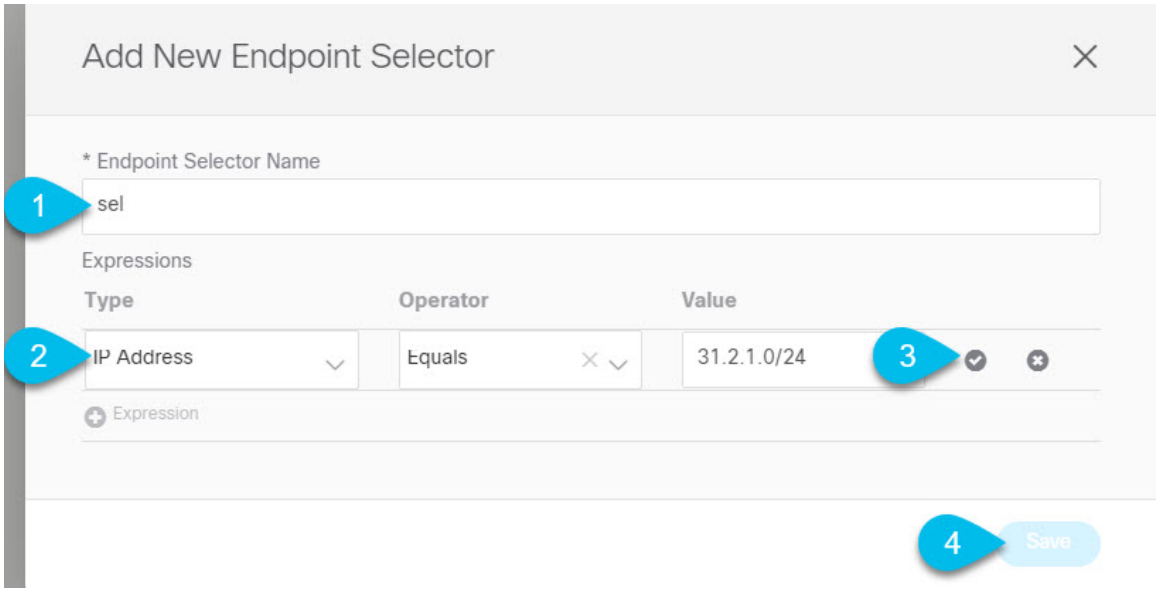
Step 1 Add an endpoint selector.



a) In the left sidebar, select template under **Sites**.
b) Select the cloud EPG you created.
c) In the right sidebar, click **+Selector**.

The **Add New Endpoint Selector** window opens.

Step 2 Define the endpoint selector rules.



a) Provide the **Endpoint Selector Name**.

For example, for an endpoint selector with the IP Subnet classification, you might use a name such as `IP-Subnet-EPSelector`.

b) Click **+Expression** to define a rule.
c) Select the **Type**, **Operator**, and the **Value** for the rule.

The **Type** field determines the expression that you want to use for the endpoint selector:

- Choose **IP Address** if you want to use an individual IP address or a subnet for the endpoint selector.

  Note If the endpoints are Azure scale sets and the selector is IP based, the selector must exactly match the subnet where the scale set is placed. For example, if you configured `10.1.0.0/16` CIDR, `10.1.0.0/24` subnet, and the scale set is in this subnet, then the IP selection must match `10.1.0.0/24` exactly and not a wider mask such as `10.1.0.1/32`.

- Choose **Region** if you want to use the cloud region for the endpoint selector, then choose the specific region that you want use.

  When you select `Region` for the endpoint selector, every instance within the tenant that is brought up in that region will be assigned to this cloud EPG.

- You can also type in a value and choose **Create key** to create a custom tag-based selector.

The **Operator** field determines the relation between the type and its value:

- **Equals**: Used when you have a single value in the Value field.
- **Not Equals**: Used when you have a single value in the Value field.
- **In**: Used when you have multiple comma-separated values in the Value field.
- **Not In**: Used when you have multiple comma-separated values in the Value field.
- **Has Key**: Used if the expression contains only a key.
- **Does Not Have Key**: Used if the expression contains only a key.

The **Value** field determines the collection of endpoints that you want to use for the endpoint selector, based on the choices that you made for the two previous fields.

d) Click the checkmark icon to save the rule.

You can choose to add multiple rules to the same endpoint selector.

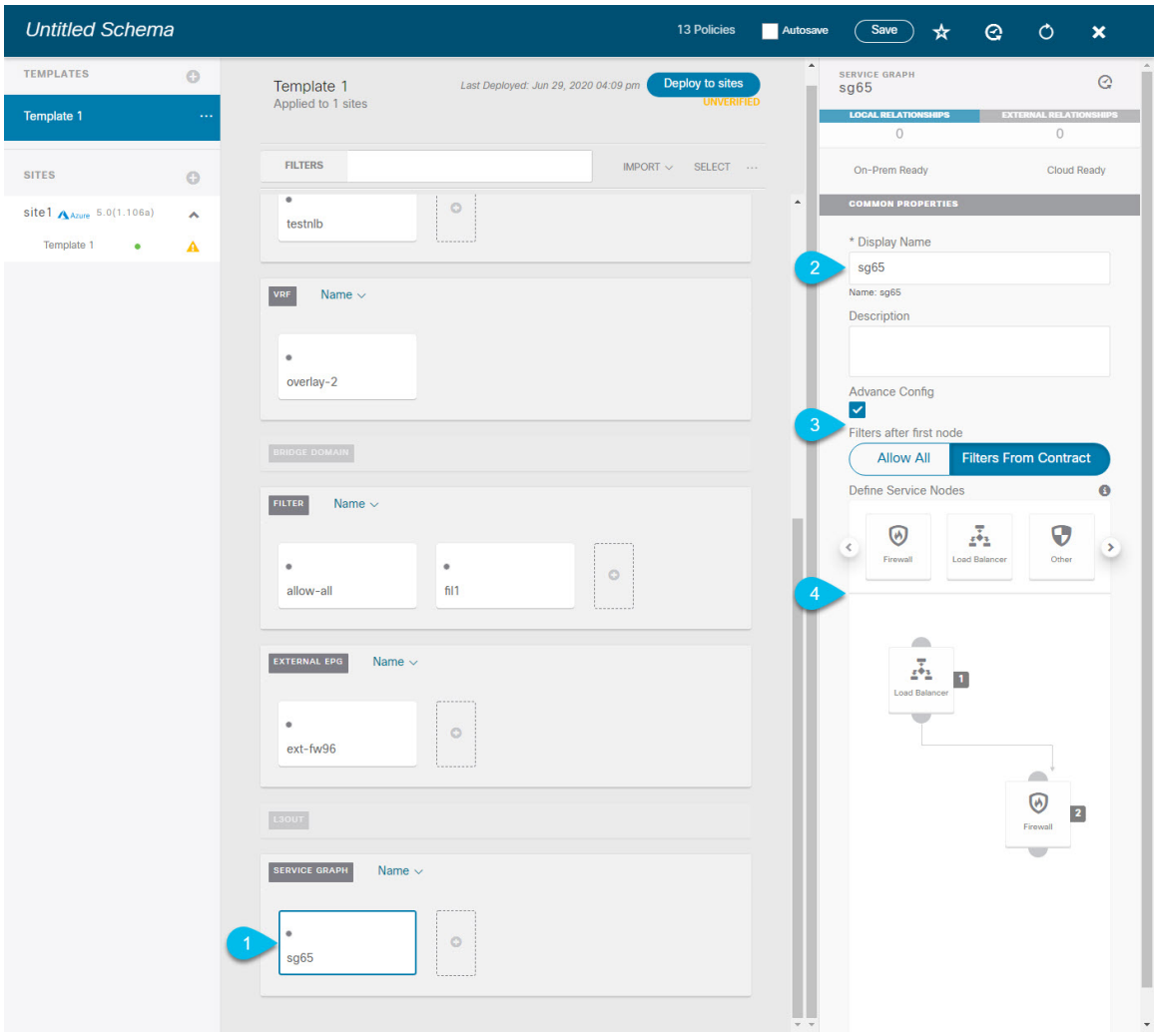
e) Click **Save** to save the endpoint selector.

Creating Service Graphs

This section describes how to configure one or more devices for a service graph and deploy it to an Azure cloud site.

Procedure

Add one or more Service Graph nodes.



a) In the main pane, scroll down to the **Service Graph** area and select a service graph or click the + sign to create a new one.

b) (Optional) Check the **Advanced Config** option.

By default, all traffic is allowed for the service graph node. If you want to restrict traffic using contracts, select **Filters From Contracts** after you enable the advanced config.

c) Provide the **Display Name** for the service graph.

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.

You can add up to 3 nodes to a single service graph.

What to do next

After you created the service graph, you will need to configure its site-local properties, as described in Configuring Service Graph's Site-Local Properties, on page 31.

Configuring Service Graph's Site-Local Properties

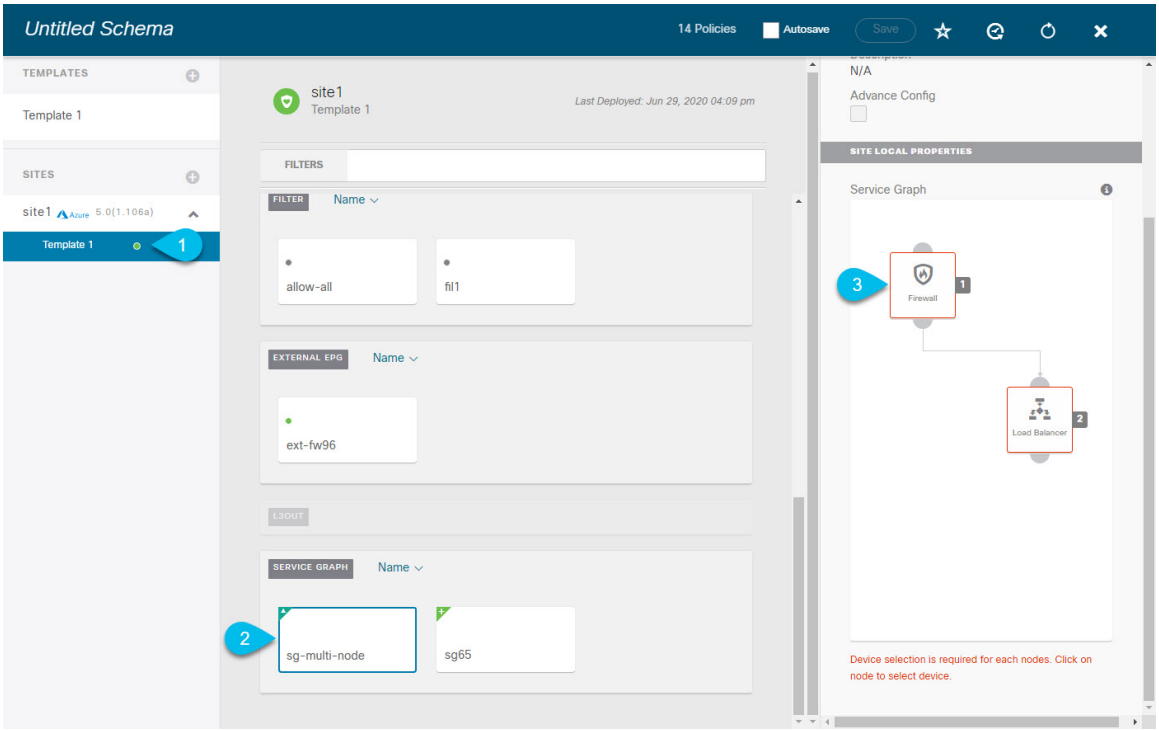
This section describes how to configure the service graph devices in an Azure cloud site.

Before you begin

- You must have created a service graph as described in Creating Service Graphs, on page 29.

Procedure

Step 1 Navigate to the service graph's site-local properties and select the first node.



a) In the left sidebar, select the template under **Sites**.
b) In the main pane, scroll down to the **Service Graph** area and select the service graph.
c) In the right sidebar, scroll down to the **Service Nodes** area and click the first node.

The **Select Device Details** window will open.

Step 2 Choose a load balancer device for the service graph node.

If you are not adding a load balancer device, skip this step.

Beginning with Cisco Cloud APIC Release 5.1(2), you can create a third party load balancer as a service device.

Note Redirection to a third party load balancer is not supported.

Figure 1: Device Type- Network Load Balancer

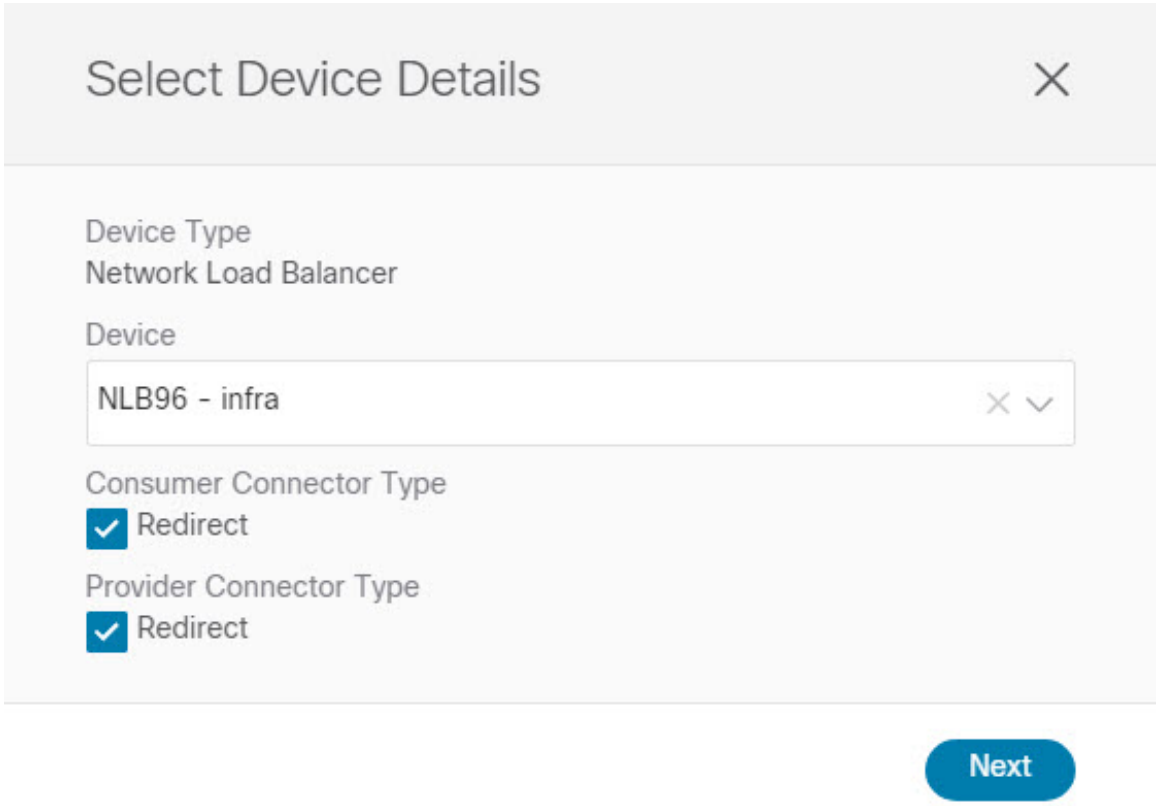
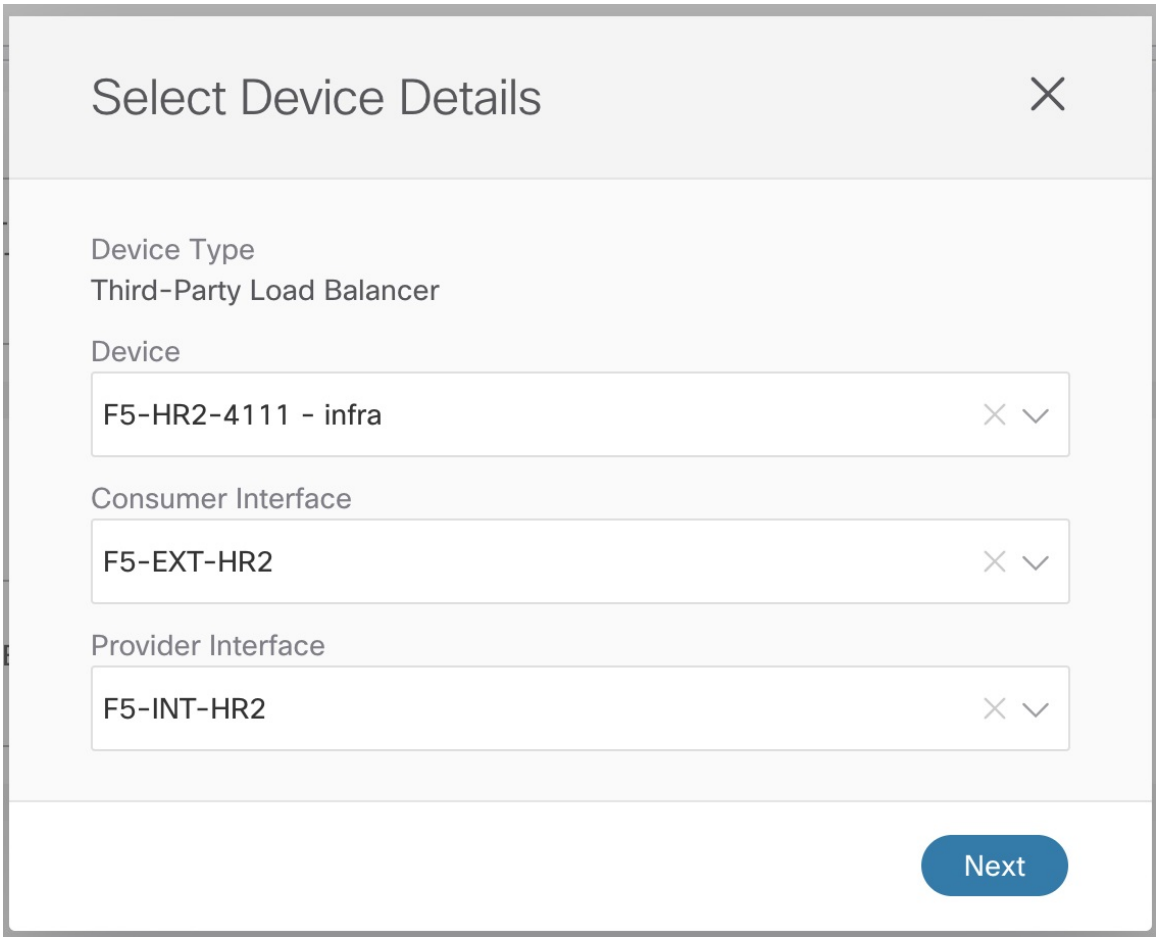


Figure 2: Device Type - Third-Party Load Balancer



a) From the **Device** dropdown, select the load balancer device you have created on the Cloud APIC for this node.

b) If you want to enable user-defined redirect (UDR), check the **Redirect** checkbox for the corresponding Connector Type.

You can choose to enable user-based redirect function on the `consumer`, `provider`, or both sides of the Third Party Firewall.

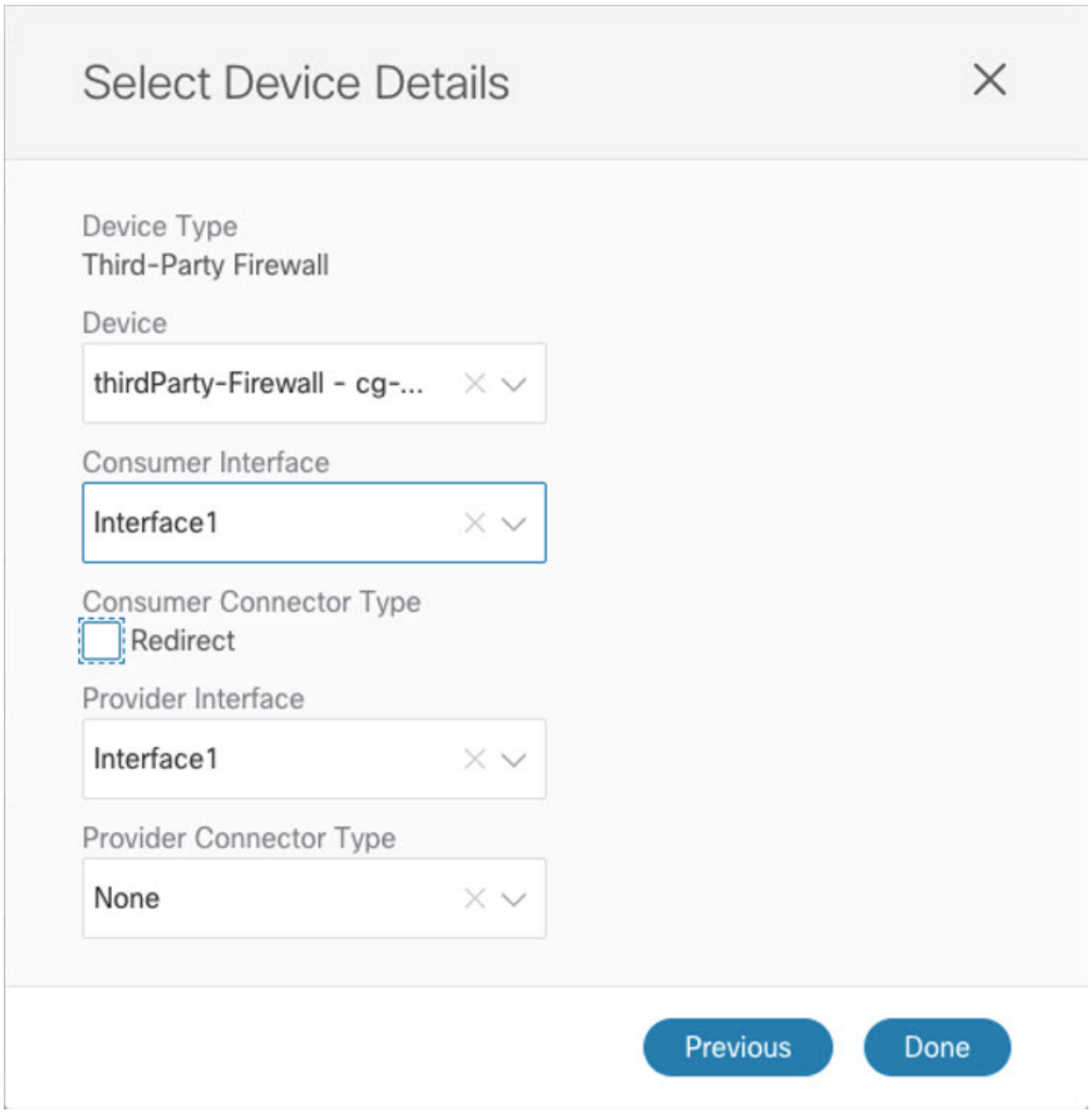
With redirect, policies are used to redirect traffic through specific service devices. This traffic isn't necessarily destined for the service device as part of the standard consumer-to-provider configuration; rather, you would configure the consumer-to-provider traffic as you normally would, and you would then configure service graphs to redirect that consumer-to-provider traffic to a specific service device.

When enabled, redirect rules from the contract are used. For more information on configuring listeners and redirects, see Configuring Listeners for Load Balancer Devices, on page 35.

c) Click **Next** to proceed to the next node in the service graph or **Done** if this is the last node you are configuring.

Step 3 Choose a firewall device for the service graph node.

If you are not adding a firewall device, skip this step.



a) From the **Device** dropdown, select the firewall device you have created on the Cloud APIC for this node.
b) From the **Consumer Interface** dropdown, select the consumer interface you have configured for this firewall device in the Cloud APIC.
c) If you want to enable user-defined redirect (UDR) for the consumer interface, check the **Redirect** checkbox for the corresponding Connector Type.

   With redirect, policies are used to redirect traffic through specific service devices. This traffic isn't necessarily destined for the service device as part of the standard consumer-to-provider configuration; rather, you would configure the consumer-to-provider traffic as you normally would, and you would then configure service graphs to redirect that consumer-to-provider traffic to a specific service device.

d) From the **Provider Interface** dropdown, select the provider interface you have configured for this firewall device in the Cloud APIC.
e) From the **Provider Connector Type** dropdown, select the type.

Connector types are described in the Redirect Policy, on page 4 section.

f) Click **Next** to proceed to the next node in the service graph or **Done** if this is the last node you are configuring.

Assigning Contract to Service Graph

This section describes how to associate a service graph with a contract.

Before you begin

- You must have created a contract as described in Creating Filter and Contract, on page 24.
- You must have created a service graph as described in Creating Service Graphs, on page 29.

Procedure

Step 1 In the main pane, select the contract you created.

Step 2 From the **Service Graph** dropdown in the right sidebar, select the service graph you created.

Configuring Listeners for Load Balancer Devices

This section describes how to add a listener to an ALB or NLB node of a service graph.

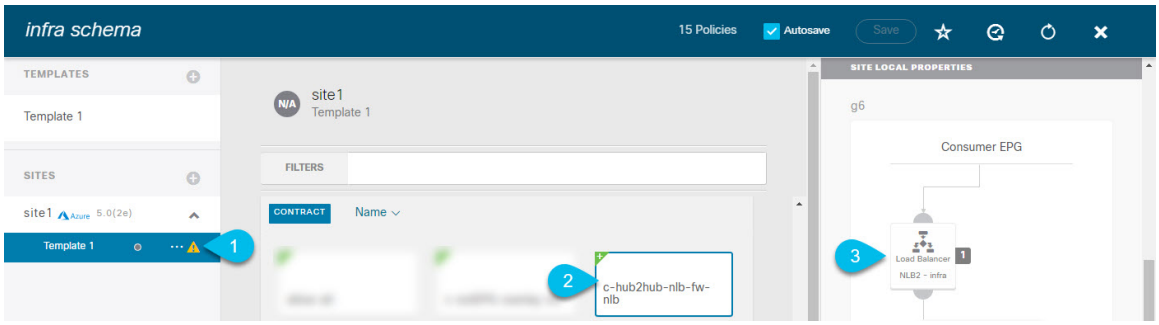
Listeners enable you to specify the ports and protocols that the load balancer accepts and forwards traffic on. All listeners require you to configure at least one rule (a default rule, which does not have a condition). Rules enable you to specify the action that the load balancer takes when a condition is met. Unlike application gateway, here a rule can only forward traffic to specific port of the backend pool. NLB should be in a separate subnet similar to ALB.

Before you begin

- You must have created a contract.
- You must have created a service graph as described in Creating Service Graphs, on page 29.
- You must have assigned the service graph to the contract.

Procedure

Step 1 Navigate to the contract's site—local properties and select the first service graph node.



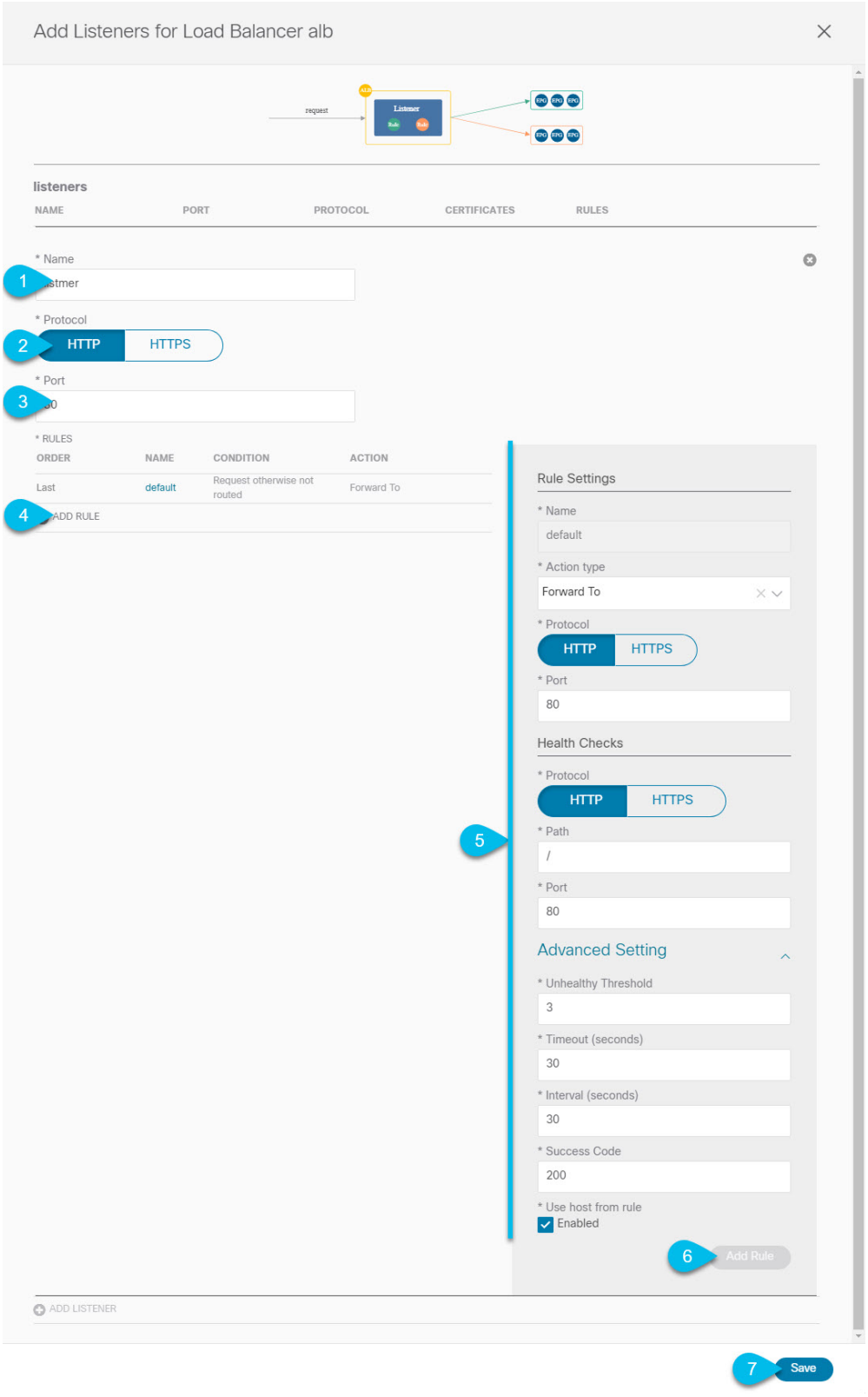
a) In the left sidebar, select the template under **Sites**.
b) In the main pane, scroll down to the **Contract** area and select the contract.
c) In the right sidebar, click a service graph node.

   The **Add Listeners** window will open.

Step 2 In the **Add Listeners for Load Balancer** window, click **Add Listener**.

Step 3 Configure a listener for an ALB device.

If you are not configuring any ALB devices, skip this step.



a) Provide the **Name** for the listener.

b) Choose the **Protocol**.

If you selected `HTTPS`, provide the **Security policy** and an **SSL Certificates**. You can provide multiple certificates.

Keep in mind, when enabling HTTPS, you must create the certificate store and the key ring in the Cloud APIC GUI, as described in Cisco Cloud APIC Security.

c) Provide the **Port** number that the device will accept traffic on.

d) Click on the **default** rule to modify it.

You can add multiple rules in addition to the default one. The following settings apply to any rule you add to an ALB listener.

- **Name**—Enter a name for the rule.

  The default rule's name cannot be changed.

- **Host**—Enter a hostname to create a host—based condition. When a request is made for this hostname, the action you specify is taken.

- **Path**—Enter a path to create a path—based condition. When a request is made for this path, the action you specify is taken.

- **Type**—The action type tells the device which action to take. The action type options:

  - **Return fixed response**—Returns a response using the following options:

    - **Fixed Response Body**—Enter a response message.

    - **Fixed Response Code**—Enter a response code.

    - **Fixed response Content—Type**—Choose a content type.

  - **Forward**—Forwards traffic using the following options:

    - **Port**—Enter the port that the device will accept traffic on.

    - **Protocol**—Click to choose **HTTP** or **HTTPS**.

    - **Provider EPG**—The EPG with the web server that handles the traffic.

    - **EPG**—To choose an EPG:

      1. Click **Select EPG**. The **Select EPG** dialog box appears.

      2. From the **Select EPG** dialog ox, click to choose an EPG in the left column then click **Select**. The **Select EPG** dialog box closes.

  - **Redirect**—Redirects requests to another location using the following options:

    - **Redirect Code**—Click the **Redirect Code** drop—down list and choose a code.

    - **Redirect Hostname**—Enter a hostname for the redirect.

    - **Redirect Path**—Enter a redirect path.

    - **Redirect Port**—Enter the port that the device will accept traffic on.

    - **Redirect Protocol**—Click to the **Redirect Protocol** drop—down list and choose **HTTP**, **HTTPS**, or **Inherit**.

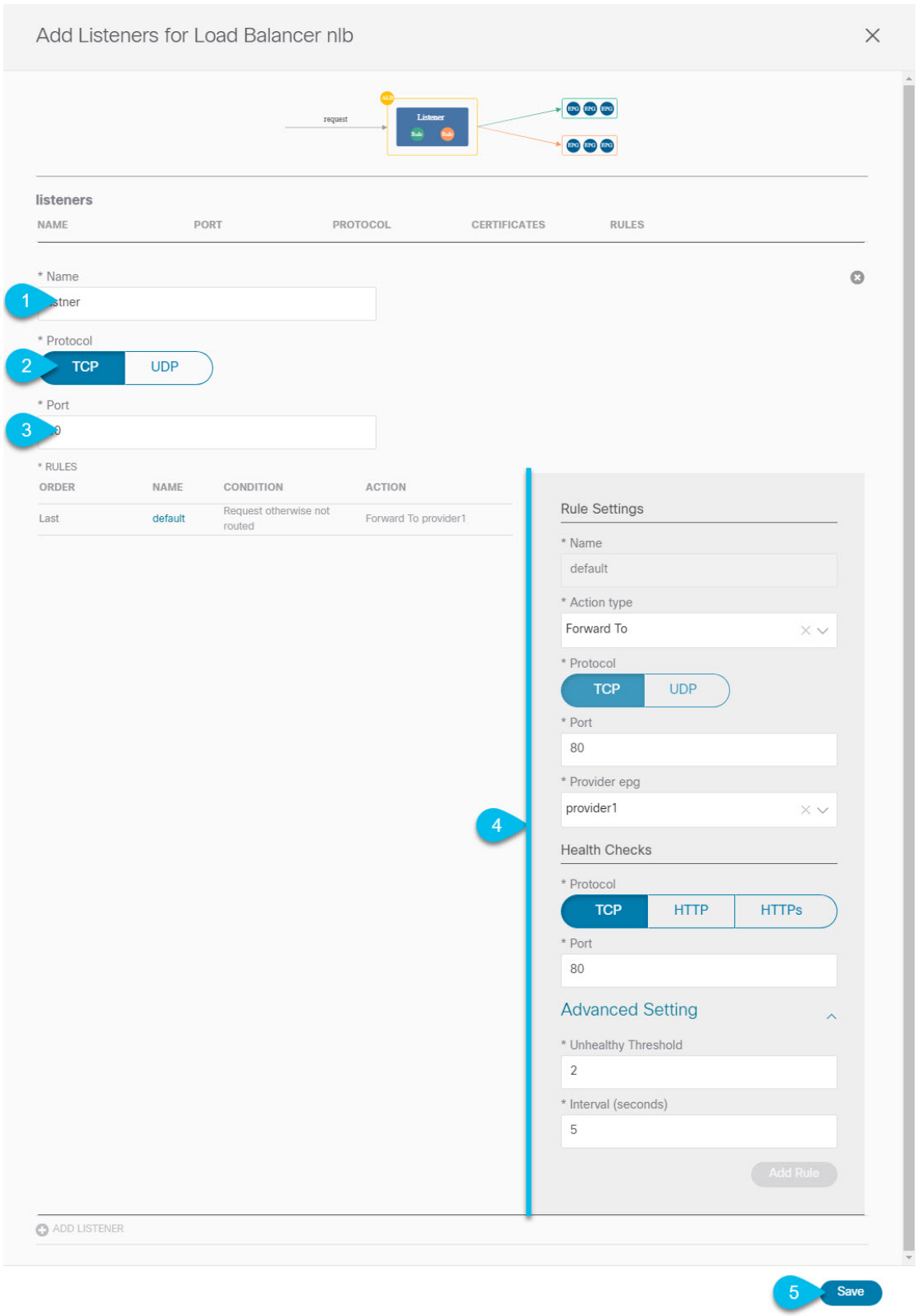
- **Redirect Query**—Enter a redirect query.

e) Provide the **Health checks** settings.
   - **Protocol**—Click to choose **TCP**, **HTTP** or **HTTPS**.
   - **Path** and **Port**—Enter the path and port on which health checks should be performed.
   - **Unhealthy Threshold**—Configure this threshold to determine when a backend target is advertised as unhealthy.
   - **Interval**—Enter a time in seconds to determine at what intervals checks should be performed.

f) Click **Add Rule** to save the rule.
g) (Optional) Click **Add Rule** to specify multiple rules for the same listener.
h) Click **Save** to save the listener.

Step 4 Configure a listener for an NLB device.

If you are not configuring any NLB devices, skip this step.



a) Provide the **Name** for the listener.

b) Choose the **Protocol**.
c) Provide the **Port** number that the device will accept traffic on.
d) Click on the **default** rule to modify it.

   You can have only a single `default` rule for NLB listeners, however you can add multiple listeners to the same NLB device.

   - **Protocol**—Choose **TCP** or **UDP**.
   - **Port**—Enter the port on which the backend pool servers will accept traffic from the load balancer.
   - **Provider EPG**—The EPG with the web servers handling traffic.

e) Provide the **Target IP Type** settings.

   This option is displayed only when the NLB is followed by a third-party load balancer in a service chain.

   Click the required radio button to select the target IP type. The options are:

   - **Primary IP** —Use the primary IP of the third party load balancer as the target IP.
   - **Secondary IP**—Use the secondary IP of the third party load balancer as the target IP.
   - **Both Primary and Secondary IPs**—Use both the primary and the secondary IP of the third party load balancer as the target IPs.

f) Provide the **Health checks** settings.

   - **Protocol**—Click to choose **TCP**, **HTTP** or **HTTPS**.
   - **Port**—Enter a port on which health checks should be performed.
   - **Unhealthy Threshold**—Configure this threshold to determine when a backend target is advertised as unhealthy.
   - **Interval**—Enter a time in seconds to determine at what intervals checks should be performed.

g) Click **Save** to save the listener.

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