Cloud OnRamp Configuration Guide for vEdge Routers, Cisco SD-WAN Release 20.x

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Americas Headquarters

Cisco Systems, Inc.
170 West Tasman Drive
San Jose, CA 95134-1706
USA
http://www.cisco.com
Tel: 408 526-4000
800 553-NETS (6387)
Fax: 408 527-0883

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Related References

- Release Notes
- Cisco SD-WAN Controller Compatibility Matrix and Server Recommendations

User Documentation

- Cisco SD-WAN (Cisco vEdge Devices)
- User Documentation for Cisco vEdge Devices

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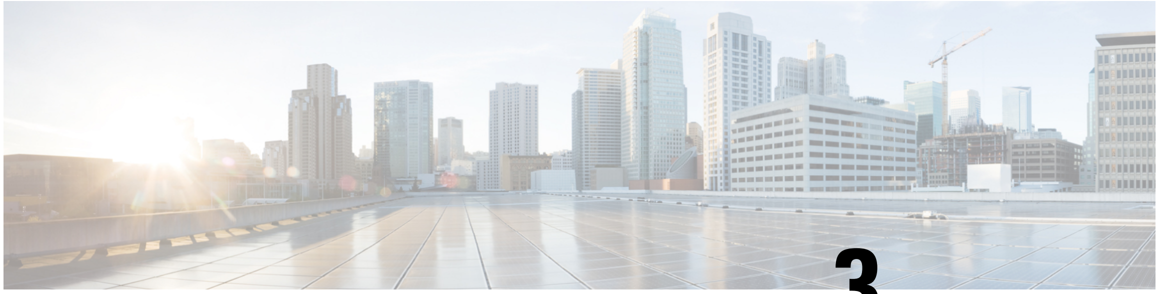
CHAPTER 2

What's New in Cisco SD-WAN

Cisco is constantly enhancing the SD-WAN solution with every release and we try and keep the content in line with the latest enhancements. The following table lists new and modified features we documented in the Configuration, Command Reference, and Hardware Installation guides. For information on additional features and fixes that were committed to the Cisco SD-WAN solution, see the *Resolved and Open Bugs* section in the Release Notes.

What's New in Cisco SD-WAN (vEdge) Release 20.x



CHAPTER 3

Cloud onRamp for IaaS

Cisco SD-WAN Cloud OnRamp for IaaS

Note Beginning with Cisco vManage Release 20.9.1, we recommend setting up your cloud infrastructure using Cloud OnRamp for Multicloud. Cloud OnRamp for IaaS will be phased out in a future release.

Cisco SD-WAN Cloud onRamp for Infrastructure as a Service (IaaS) extends the fabric of Cisco SD-WAN overlay network to public cloud instances. Cisco SD-WAN Cloud OnRamp for IaaS allows branches with vEdge Cloud routers to connect directly to public-cloud application providers. By eliminating the need for a physical data center, Cisco SD-WAN Cloud OnRamp for IaaS improves the performance of SaaS applications.

The connection between the overlay network and a public-cloud application is provided by one to four pairs of redundant Cisco SD-WAN cloud devices. These devices act together as a transit between the overlay network and an application. By using redundant devices to form the transit, Cisco SD-WAN Cloud OnRamp for IaaS offers path resiliency to the public cloud. In addition, having redundant routers helps in brownout protection to improve the availability of public-cloud applications. Together, the two routers can remediate link degradation that might occur during brownouts. You can configure these devices as part of the Cisco SD-WAN Cloud OnRamp for IaaS workflow.

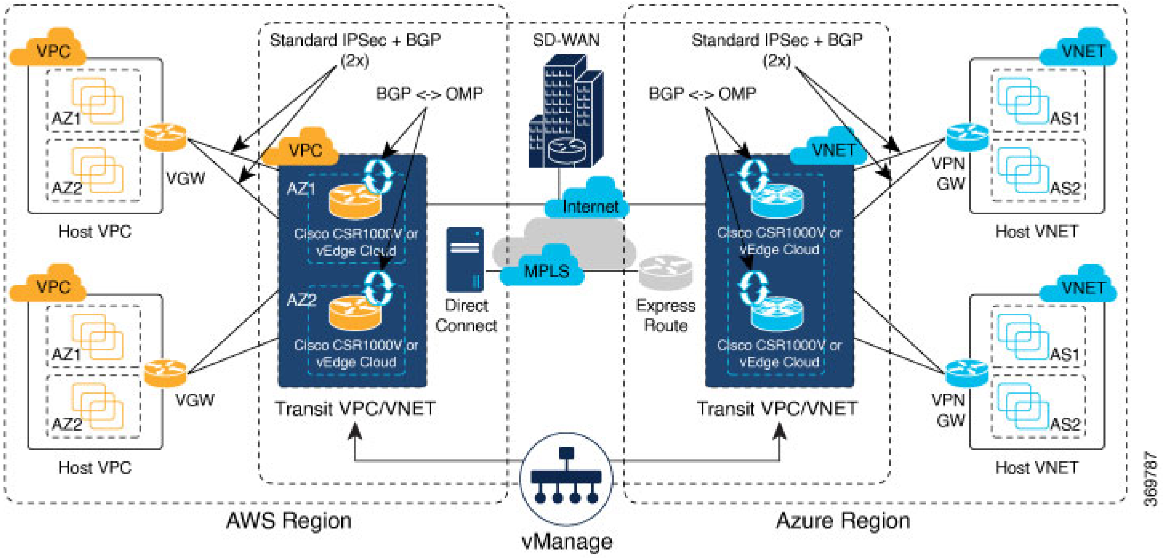
The Cisco SD-WAN Cloud OnRamp for IaaS works along with AWS Virtual Private Cloud (VPC) and Azure Virtual Network (VNet).

The key steps to deploy a Cisco SD-WAN Cloud OnRamp for IaaS solution are:

1. Identify one to four pairs of unused Cisco SD-WAN cloud devices in Cisco vManage that you can use forCisco SD-WAN Cloud OnRamp for IaaS.
2. Configure and attach a basic device template to both the Cisco SD-WAN cloud devices.
3. Enter AWS or Azure API credentials (access key and secret key) when configuring using Cisco vManage.
4. Add the transit Virtual Private Cloud (VPC) or transit Virtual Network (VNet) configuration.
5. Discover and map host VPCs or host VNets to the transit VPC or transit VNet.

The following image shows the topology of Cisco SD-WAN Cloud OnRamp for IaaSwith AWS and Microsoft Azure integrated. You can apply the same policy, security, and other Cisco SD-WAN policies everywhere with Cisco vManage as a single server for all the Cisco SD-WAN devices, which are on-premises and on multiple clouds. The infrastructure on AWS and Microsoft Azure can be seamlessly integrated into the Cisco SD-WAN fabric. The Cisco SD-WAN Cloud OnRamp for IaaS workflow automates all steps, and the Cisco vManage server builds the whole solution within minutes.

Figure 1: Cisco SD-WAN Cloud OnRamp for IaaS Topology



Supported Cisco Cloud Service Providers and Supported Cisco SD-WAN Cloud Devices

The following IaaS public cloud providers are supported with Cisco SD-WAN Cloud OnRamp for IaaS:

- Amazon AWS
- Microsoft Azure

The following devices are supported:

- Cisco vEdge Cloud Router

In this document, the supported devices are collectively referred to as Cisco SD-WAN cloud devices.

Prerequisites of Cisco SD-WAN Cloud Devices

Before you can configure Cisco SD-WAN Cloud OnRamp for IaaS, ensure that the following device requirements are met.

- Verify you have available tokens or licenses for at least two Cisco vEdge Cloud Routers in Cisco vManage. See Verify Presence of Cisco SD-WAN Cloud Devices in Cisco vManage, on page 8.
- Configure feature and device templates for the Cisco vEdge Cloud Routers that you'll use within the transit VPCs or VNets during configuration. See Configure Device Template for Cisco SD-WAN Cloud Devices, on page 8.
- Attach the device template to the software tokens representing the Cisco vEdge Cloud Routers that you'll use within the transit VPCs or VNets. See Attach a Device Template to Cisco SD-WAN Cloud Devices, on page 8.

Provision Cisco vManage Server

Before you can configure Cisco SD-WAN Cloud OnRamp for IaaS, provision the Cisco vManage server.

1. Ensure that your Cisco vManage server can access the Internet, and you configure the DNS server so that it can reach AWS or Microsoft Azure. To configure a DNS server, in the Cisco vManage VPN feature configuration template, enter the IP address of a DNS server. Next, reattach the configuration template to the VPN feature using Cisco vManage.
2. Ensure that you add at least two Cisco SD-WAN cloud devices to the Cisco vManage server to bring up Cisco SD-WAN Cloud OnRamp for IaaS. Attach these two Cisco SD-WAN cloud devices to the appropriate configuration template. Ensure that the configuration for these devices include the following attributes:
   - Hostname
   - IP address of Cisco vBond Orchestrator
   - Site ID
   - Organization name
   - Tunnel interface configuration on the eth1 interface

     In vEdge Cloud routers, the tunnel interface is on the ge0/0 interface.
3. Ensure that you synchronize the Cisco vManage server with the current time. To check the current time, click the **Help (?)** icon at the top bar of the Cisco vManage screen. The **Timestamp** field shows the current time. If the time isn’t correct, configure the Cisco vManage server time to point to an NTP time server, such as the Google NTP server. To configure the server time, in the Cisco vManage NTP feature configuration template, enter the hostname of an NTP server. Next, reattach the configuration template to the NTP feature using Cisco vManage. The Google NTP servers are time.google.com, time2.google.com, time3.google.com, and time4.google.com, and so on.

Verify Presence of Cisco SD-WAN Cloud Devices in Cisco vManage

Step 1 From the Cisco vManage menu, choose **Configuration** > **Devices**.

Step 2 On the Device listing page, verify that there are at least two valid Cisco vEdge Cloud routers, which aren't used already.

The valid unused devices are:

- The devices that have the word, "valid"under the **Validity** column.
- The devices that have the **Assigned Template**, **Device Status**, **Hostname**, **System IP**, and **Site ID** columns blank.

Go to software.cisco.com, and use the Plug and Play Connect portal to add tokens or licenses if you have insufficient Cisco vEdge Cloud routers.

Configure Device Template for Cisco SD-WAN Cloud Devices

Ensure that you have at least a minimal device template assigned within Cisco vManage to the two Cisco vEdge Cloud routers. A minimal device template is the one that uses factory default feature templates within the device template. You need at least one service VPN and the management (VPN 512) interface configured within the device template. However, we recommend that you configure a fully functional device template that includes settings specific to your deployment within custom feature templates. See Configure the Cisco SD-WAN Routers for step-by-step instructions on how to create individual feature templates and device templates using Cisco vManage.

Ensure that you don't modify the feature templates after these templates have been attached to the device templates and configured using the Cloud onRamp for IaaS. The Cloud onRamp for IaaS configuration overwrites these feature templates configuration that is modified.

A sample device template, and the various feature templates which make up the device template, is available in Sample Feature Template Settings topic that you can use for Cisco vEdge Cloud routers.

Attach a Device Template to Cisco SD-WAN Cloud Devices

When you attach a device template to the Cisco vEdge Cloud routers, Cisco vManage builds the configurations based on the feature templates and then saves the configurations to the designated Cisco vEdge Cloud routers. Before you can build and save the configurations, define all variables within the feature templates attached to the device template.

To enter values of the variables manually using Cisco vManage, instead of uploading a .csv file:

Step 1 From the Cisco vManage menu, choose **Configuration** > **Templates** > **Device Templates**.

Note In Cisco vManage Release 20.7.x and earlier releases, **Device Templates** is titled **Device**.

Step 2 For the desired device template, click **…** and choose **Attach Devices**.

A pop-up window listing the available devices to be attached to this configuration appear. The list of available devices contains either:

- The hostname and IP address of a device if it’s known using Cisco vManage.

- The chassis serial number of the devices that aren't available on the network and aren't known to Cisco vManage.

Cisco vEdge Cloud routers are assigned a chassis serial number although there's no physical chassis. The list contains only the device model that was defined when the device template was created.

Step 3 To apply the configuration template, choose one or more devices from **Available Devices** and move them to **Selected Devices**.

Note In this document, we're using two Cisco SD-WAN cloud devices on which you apply the configurations.

Step 4 Click **Attach**.

The window that appears, lists the Cisco SD-WAN cloud devices that you had chosen.

Step 5 For the first Cisco vEdge Cloud router, click **…** and choose **Edit Device Template**.

A pop-up window appears with a list of variables and empty text boxes. There can be variables with check boxes to check and uncheck for on and off values. Make sure that you fill all text boxes. You can use the sample information available in the Sample Device Template Variable Values, on page 36 topic to fill in the variable values.

Step 6 Click **Update**.

Step 7 Repeat Steps 5–6 for the second Cisco vEdge Cloud router.

You can download the variable values into the .csv file for future use.

Step 8 Click **Next**.

The window indicates that the configure action is applied to the two devices, which are attached to one device template.

You can select a device from the left pane to view the configuration that is saved on the Cisco SD-WAN cloud device.

Step 9 Click **Configure Devices**.

Step 10 In the pop-up window that appears, check **Confirm configuration changes on 2 devices**.

Step 11 Click **OK**.

The **Task View** window appears.

After some time, the status of the two Cisco vEdge Cloud routers appears as **Done – Scheduled** with a message indicating that the device is offline and that the template will be attached to the device when it's online.

What to do next

You can now deploy the two Cisco vEdge Cloud routers within the AWS transit VPC or Azure transit VNet using Cisco SD-WAN Cloud OnRamp for IaaS.

AWS Prerequisite

Step 1 Have a valid AWS account.

Step 2 Subscribe to the Cisco vEdge Cloud router Amazon machine image (AMI) in your account within the AWS Marketplace. To subscribe to Amazon machine image (AMI) in your account within the AWS Marketplace:

a) Log in to Amazon Web Services Marketplace.

b) Search AWS Marketplace for: “Cisco vEdge Cloud router”.

A list of AMIs appears.

c) From the list, click the Cisco vEdge Cloud router link that you’re planning to deploy.

The subscription screen appears where you can subscribe to the Cisco vEdge Cloud Router AMI.

d) Click **Continue to Subscribe**.

e) Click **Accept Terms**.

After a few moments, a message appears that you’re subscribed to use the Cisco vEdge Cloud Router AMI.

Note Don’t click **Continue to Configuration**, because Cisco SD-WAN Cloud OnRamp for IaaS automatically configures the Cisco SD-WAN cloud devices when it creates the transit VPC.

f) Log out of from the AWS Marketplace.

Configure Cisco SD-WAN Cloud OnRamp for IaaS on AWS

Points to Consider

- Transit VPCs provide the connection between the Cisco overlay network and the cloud-based applications running on host VPCs. You can provision up to four pairs of redundant Cisco SD-WAN cloud devices within each VPC dedicated to function as a transit point for traffic from the branch to host VPCs. The individual Cisco SD-WAN devices of each redundant pair are deployed within a different availability zone in the AWS region of the transit VPC. Multiple Cisco SD-WAN devices provide redundancy for the connection between the overlay network and cloud-based applications. On each of these two Cisco SD-WAN cloud devices, the transport VPN (VPN 0) connects to a branch router, and the service-side VPNs (any VPN except for VPN 0 and VPN 512) connect to applications and application providers in the public cloud.

- The Cisco SD-WAN Cloud OnRamp for IaaS workflow uses a public IP address of the second WAN interface to set up the Customer Gateway for mapping (ipsec tunnels) the host VPCs to a transit VPC. To add the public IP address of the WAN interface, configure the VPN interface ethernet template with ge0/0 interface for the devices used in Cisco SD-WAN Cloud OnRamp for IaaS. In vEdge Cloud routers, the tunnel interface is on the ge0/0 interface. See sample VPN interface ethernet template configuration in VPN0 Interface Feature Template, on page 34.

- Cisco SD-WAN Cloud OnRamp for IaaS supports autoscale for AWS. To use the AWS autoscale feature, ensure that you associate one to four pairs of Cisco SD-WAN cloud devices with a transit VPC.

- Host VPCs are virtual private clouds in which your cloud-based applications reside. When a transit VPC connects to an application or application provider, it’s simply connecting to a host VPC.

- All host VPCs can belong to the same AWS account, or each host VPC can belong to a different account. You can map a host that belongs to one AWS account to a transit VPC that belongs to a different account. You configure cloud instances or cloud accounts by using the Cloud OnRamp configuration wizard.

Step 1 From the Cisco vManage menu, choose **Configuration** > **Cloud onRamp for IaaS**.

If you're configuring Cisco SD-WAN Cloud OnRamp for IaaS the first time, no cloud instances appear in the screen. A cloud instance corresponds to an AWS account with one or more transit VPCs created within an AWS region.

Step 2 Click **Add New Cloud Instance**.

Step 3 Click the **Amazon Web Services (AWS)** radio button.

Step 4 In the next pop-up window, perform the following:

a) To log in to the cloud server, click **IAM Role** or **Key**. We recommend that you use IAM Role.

b) If you click **IAM Role**, then create an IAM role with Cisco vManage provided **External ID**. Note the displayed external Id from the window and provide the **Role ARN** value that is available when creating an IAM role.

Starting from Cisco SD-WAN Release 20.4.1, to create an IAM role, you must enter the Cisco vManage provided External Id into a policy by using the AWS Management Console. Do the following:

1. Attach an IAM Role to an existing Cisco vManage EC2 instance.

   a. See the Creating an IAM role (console) topic of AWS documentation to create a policy. In the AWS **Create policy** wizard, click **JSON** and enter the following JSON policy document.

```
{

"Version": "2012-10-17",

  "Statement": [{

    "Sid": "VisualEditor0",

"Effect": "Allow",

    "Action": "sts:AssumeRole",

"Resource": "*"

    }
]

}
```

   b. See the Easily Replace or Attach an IAM Role to an Existing EC2 Instance by Using the EC2 Console blog of AWS Security Blog for information about creating an IAM role and attaching it to the Cisco vManage EC2 instance based on the policy created in Step 1.

   Note On the **Attach permissions policy** window, choose the AWS-managed policy that you created in Step 1.

2. Create an IAM role on an AWS account that you want to use for Cisco SD-WAN Cloud OnRamp for IaaS.

   a. See the Creating an IAM role (console) topic of AWS Documentation and create an IAM role by checking **Require external ID** and pasting the external Id that you noted in Step 4(b).

   b. See the Modifying a role trust policy (console) topic of AWS Documentation to change who can assume a role.

   In the **IAM Roles** window, scroll down and click the role you created in the previous step.

   In the **Summary** window, note the **Role ARN**.

   Note You can enter this role ARN value when you choose the IAM role in Step 4(b).

c. After modifying the trust relationship, click **JSON** and enter the following JSON document. Save the changes.

Note The account Id in the following JSON document is the Cisco vManage EC2 instance.

```
{
  "Version": "2012-10-17",
  "Statement": [
    {
      "Effect": "Allow",
      "Principal": {
        "AWS": "arn:aws:iam::[Account ID from Part 1]:root"
      },
      "Action": "sts:AssumeRole",
      "Condition": {
        "StringEquals": {
          "sts:ExternalId": "[vManage provided External ID]"
       }
      }
    }
  ]
}
```

c) If you click the **Key** radio button:

1. In the **API Key** field, enter your Amazon API key.
2. In the **Secret Key** field, enter the password associated with the API key.
3. From the **Environment** drop-down list, choose **commercial** or **govcloud**.

   By default, commercial environment is selected. You can choose the geographical regions based on the environment specifications.

   Note AWS Government Cloud isn't supported for vEdge Cloud routers. Therefore, ensure that you don't choose **govcloud**.

Step 5 Click **Login** to log in to the cloud server.

The cloud instance configuration wizard appears. This wizard consists of three screens that you use to select a region, add a transit VPC, discover host VPCs, and map host VPCs to transit the VPC. A graphic on each wizard screen illustrates the steps in the cloud instance configuration process. The steps that aren't yet completed are shown in light gray. The current step is highlighted within a blue box. Completed steps are indicated with a green checkmark and are shown in light orange.

Step 6 Select a region:

From the **Choose Region** drop-down list, choose a region where you want to create the transit VPC.

Step 7 Add a transit VPC:

a) In the **Transit VPC Name** field, enter the transit VPC name.

The name can contain 128 alphanumeric characters, hyphens (–), and underscores (_). It can't contain spaces or any other characters.

b) Under **Device Information**, enter information about the transit VPC:

1. In the **WAN Edge Version** drop-down list, choose the software version of the Cisco SD-WAN cloud device to run on the transit VPC.

2. In the **Size of Transit WAN Edge** drop-down list, choose an option to determine the memory and CPUs you can use for each of the Cisco SD-WAN cloud devices that run on the transit VPC. See the Supported Instance Types topic of Cisco Cloud vEdge Routers in the *Cisco SD-WAN Getting Started Guide*.

   Note We recommend that you choose the following size:

   For Cisco Cloud vEdge Routers, choose c4 instance type with four vCPUs, such as c4.xlarge (4 vCPU).

3. In the **Max. Host VPCs per Device Pair** field, select the maximum number of host VPCs that can be mapped to each device pair for the transit VPC. Valid values are 1–32.

4. To set up the transit VPC devices for Direct Internet Access (DIA), click one of the following:

   - **Disabled**: No Internet access.
   - **Enabled via Transport**: Configure or enable NAT for the WAN interface on a device.
   - **Enabled via Umbrella SIG**: Configure Cisco Umbrella to enable secure DIA on a device.

5. In the **Device Pair 1#** field, choose the serial numbers of each device in the pair. To remove a device serial number, click **X** that appears in the field.

   The serial numbers of the devices that appear are associated with a configuration template and supports the Cisco SD-WAN WAN edge version that you selected in Step 1.

6. To add more device pairs, click ⊕.

   To remove a device pair, click ⊖.

   A transit VPC can be associated with one to four device pairs. To enable the autoscale feature on AWS, associate at least two device pairs with the transit VPC.

7. Click **Advanced**, if you wish to enter more specific configuration options:

   a. In the **Transit VPC CIDR** field, enter a custom CIDR that has a network mask in the range of 16–25. If you choose to leave this field empty, the Transit VPC is created with a default CIDR of 10.0.0.0/16. There must be sufficient address space to create six subnets within the CIDR block.

   b. (Optional) In the **SSH PEM Key** drop-down list, choose a PEM key pair to log into an instance. The key pairs are region-specific. See the AWS Documentation for instructions about creating key pairs.

8. To complete the transit VPC configuration, click **Save and Finish**, or optionally to continue with the wizard, click **Proceed to Discovery and Mapping**.

   With this cloud instance, a single transit VPC with two Cisco SD-WAN cloud devices has been created. You can configure multiple transit VPCs within a single cloud instance (AWS account within a region). When multiple transit VPCs exist within a cloud instance, you can map host VPCs to any one of the transit VPCs.

9. Discover host VPCs:

   a. In the **Select an account to discover** field, choose the AWS account from which you wish to discover host VPCs.

   Alternatively, to add a new AWS account from which you wish to discover host VPCs, click **New Account**.

   b. Click **Discover Host VPCs**.

A table appears that display the VPCs, which are available to be mapped to a transit VPC. Only the host VPCs in the selected AWS account and within the same AWS region as the transit VPC appears.

c. In the table that appears, check one or more hosts to map to the transit VPC.

   To filter the search results, use the Filter option in the search bar and display only host VPCs that match specific search criteria.

   Click the **Refresh** icon to update the table with current information.

   Click the **Show Table Columns** icon to specify which columns to be displayed in the table.

10. Map the host VPCs to a transit VPC:

    a. In the table with all host VPCs, choose the desired host VPCs.

    b. Click **Map VPCs**. The Map Host VPCs pop-up opens.

    c. In the **Transit VPC** drop-down list, choose the transit VPC to map to the host VPCs.

    d. In the **VPN** drop-down list, choose a service VPN in the overlay network in which to place the mapping.

    e. Enable the **Route Propagation** option if Cisco vManage automatically propagates route to the host VPC routes table.

       By default, **Route Propagation** is disabled.

    f. Click **Map VPCs**.

After a few minutes, the **Task View** screen appears, confirming that the host VPC has been mapped to the transit VPC.

Note When configuring the VPN feature template for VPN 0 for the two Cisco SD-WAN cloud devices that form the transit VPC, ensure that the color you assign to the tunnel interface is a public color, and not a private color. The following are the public colors:

- **3g**
- **biz-internet**
- **blue**
- **bronze**
- **custom1**
- **custom2**
- **custom3**
- **default**
- **gold**
- **green**
- **lte**
- **metro-ethernet**
- **mpls**
- **public-internet**
- **red**
- **silver**

Manage Host and Transit VPCs

Display Host VPCs

Step 1 From the Cisco vManage menu, choose **Configuration** > **Cloud onRamp for IaaS**. Click the desired VPC. The **Host VPCs/Transit VPCs** window opens.

By default, the **Mapped Host VPCs** field is selected, and the table under mapped host VPCs list the mapped host and transit VPCs, the state of the transit VPC, and the VPN ID.

Step 2 To list unmapped host VPCs, click **Un-Mapped Host VPCs**. Then, click **Discover Host VPCs**.

Step 3 To display the transit VPCs, click **Transit VPCs**.

Map Host VPCs to a Transit VPC

Step 1 From the Cisco vManage menu, choose **Configuration** > **Cloud onRamp for IaaS**. Click the desired VPC. The **Host VPCs/Transit VPCs** window opens.

Step 2 Click **Un-Mapped Host VPCs**.

Step 3 In the **Select an account to discover** field, choose the AWS account from which you wish to discover host VPCs.

Step 4 Click **Discover Host VPCs**.

Step 5 From the list of discovered host VPCs, choose the desired host VPCs.

Step 6 Click **Map VPCs**. The **Map Host VPCs** pop-up opens.

Step 7 From the **Transit VPC** drop-down list, choose the desired transit VPC.

Step 8 From the **VPN** drop-down list, choose the VPN in the overlay network in which to place the mapping.

Step 9 Click **Map VPCs**.

Unmap Host VPCs

Step 1 From the Cisco vManage menu, choose **Configuration** > **Cloud onRamp for IaaS**. Click the desired VPC. The **Host VPCs/Transit VPCs** window opens.

Step 2 Click **Mapped Host VPCs**.

Step 3 From the list of VPCs, choose the desired host VPC that you wish to unmap.

Step 4 Click **Un-Map VPCs**.

Step 5 Click **OK** to confirm the unmapping.

Unmapping host VPCs deletes all VPN connections to the VPN gateway in the host VPC, and then deletes the VPN gateway. When you make more VPN connections to a mapped host VPC, these connections are terminated as part of the unmapping process.

Display Transit VPCs

Step 1 From the Cisco vManage menu, choose **Configuration** > **Cloud onRamp for IaaS**. Click the desired VPC. The **Host VPCs/Transit VPCs** window opens.

Step 2 Click **Transit VPCs**.

Add Transit VPC

Step 1 From the Cisco vManage menu, choose **Configuration** > **Cloud onRamp for IaaS**. Click the desired VPC. The **Host VPCs/Transit VPCs** window opens.

Step 2 Click **Transit VPCs**.

Step 3 Click **Add Transit VPC**.

To add a transit VPC, follow the instructions in Step 7 of Configure Cisco SD-WAN Cloud OnRamp for IaaS on AWS, on page 10.

Delete Device Pair

Note To delete the last pair of online device pairs, ensure to delete a transit VPC.

Before you begin

The device pair to be deleted should be offline.

Step 1 From the Cisco vManage menu, choose **Configuration** > **Cloud onRamp for IaaS**.

Step 2 Click a device pair ID.

Step 3 Verify that the status of the device pair is offline.

Step 4 To descale the device pairs, click the trash can icon under the **Action** column, or click **Trigger Autoscale**.

Delete Transit VPC

Note To delete the last pair of online device pairs, you should delete a transit VPC.

Before you begin

Delete the device pairs that are associated with the transit VPC.

Step 1 From the Cisco vManage menu, choose **Configuration** > **Cloud onRamp for IaaS**. Click the desired VPC. The **Host VPCs/Transit VPCs** window opens.

Step 2 Click **Host VPCs**.

Step 3 Choose all host VPCs, and click **Un-Map VPCs**.

Ensure that all host VPCs mapped with the transit VPCs are unmapped.

Step 4 Click **OK** to confirm the unmapping.

Step 5 Click **Transit VPCs**.

Step 6 For the desired transit VPC to be deleted, click the trash icon.

Note The trash icon isn’t available for the last device pair of transit VPC. Therefore, to delete the last device pair, click the **Delete Transit** drop-down list item. The trash icon is only available from the second device pair onwards.

Step 7 Click **OK** to confirm.

Add Device Pairs

Step 1 From the Cisco vManage menu, choose **Configuration** > **Cloud onRamp for IaaS**. Click the desired VPC. The **Host VPCs/Transit VPCs** window opens.

Step 2 Click **Transit VPCs**.

A table with the list of transit VPCs appears.

Step 3 For the desired transit VPC, click **...** and choose **Add Device Pair**.

Step 4 In the **Add Device Pairs** dialog box, click **Add** to add more device pairs.

Note Ensure that the devices you’re adding are already associated with a device template.

You can add up to a total of four device pairs to the transit VPC.

Step 5 Click **Save**.

History of Device Pairs for Transit VPCs

Step 1 From the Cisco vManage menu, choose **Configuration** > **Cloud onRamp for IaaS**. Click the desired VPC. The **Host VPCs/Transit VPCs** window opens.

Step 2 Click **Transit VPCs**.

A table with the list of transit VPCs appears.

Step 3 For the desired transit VPC, click **...** and choose **History for a device pair**.

This displays the Transit VPC Connection History page with all the corresponding events.

Step 4 View a histogram of events that occurred in the previous one hour and a table of all events for the transit VPC that you've chosen. The table lists all the events generated in the transit VPC. The events can be one of the following:

- Device Pair Added
- Device Pair Spun Up
- Device Pair Spun Down
- Device Pair Removed
- Host Vpc Mapped
- Host Vpc Unmapped

- Host Vpc Moved
- Transit Vpc Created
- Transit Vpc Removed

Edit Transit VPC

Step 1 From the Cisco vManage menu, choose **Configuration** > **Cloud onRamp for IaaS**. Click the desired VPC. The **Host VPCs/Transit VPCs** window opens.

Step 2 Click **Transit VPCs**.

A table with the list of transit VPCs appears.

Step 3 For the desired transit VPC, click **...** and choose, and click **Edit Transit Details**.

Step 4 To enter DIA information, follow the instructions in Step 7 (iv) of Configure Cisco SD-WAN Cloud OnRamp for IaaS on AWS, on page 10.

This operation might trigger autoscale, if required.

Microsoft Azure Prerequisites

1. Have a valid Microsoft Azure account.
2. Accept the terms and conditions for the Cisco Cloud vEdge Routers in the Azure Marketplace.

   To use a Cisco SD-WAN cloud router as part of the Cisco SD-WAN Cloud OnRamp for IaaS workflow, you must accept marketplace terms for using a virtual machine (VM). You can accept the Azure Terms of Service in one of the following ways:

   - Bring up the cloud device on the portal manually, and accept the terms as part of the final page of the onboarding wizard.
   - In the Azure APIs or on the Powershell/Cloud Shell scripts, use the Set-AzureRmMarketplaceTerms command.

3. Create an App Registration in Microsoft Azure and retrieve the credentials for your Azure account. For Cisco SD-WAN Cloud OnRamp for IaaS, these credentials are used to authenticate the Cisco vManage server with Azure and bring up the VNet and the Virtual Machine instances.

   To create and retrieve Azure credentials, create an App Registration in Azure with Owner privileges:

   a. Launch the Microsoft Azure Portal.

   b. Verify Azure Active Directory (AD) Permissions. Select Azure Active Directory, and note your role. Only roles with admin privileges can register applications in your Azure AD tenant.

   c. Verify subscription permissions.

After verifying your role and privileges associated with the Azure AD, ensure that your Azure subscription account has **Microsoft.Authorization/*/Write** access to assign a role to an Azure AD application. This access is associated only with the Owner role or User Access Administrator role.

1. On the Azure portal, click **Subscriptions**.
2. Navigate to a **Subscriptions** service, and click the **More Actions** icon to the right of the row.

   The **Microsoft Azure Enterprise** page appears.
3. Choose **My permissions**. Then, click **Click here to view complete access details for this subscription**.
4. Click **View my access** to view your assigned roles.
5. Determine if you have adequate permissions to assign a role to an AD application. If not, ask your Azure subscription administrator to add you to **User Access Administrator** role.

d. Create an application ID and service principal:

1. In the left pane of the Azure portal, click **Azure Active Directory**.
2. From the sub-menu, click **App registrations**.
3. Click **New registration**. The system displays the **Register an application** screen.
4. In the **Name** field, enter a descriptive name such as, CloudOnRampApp.
5. In **Suported account types**, choose **Accounts in this organizational directory only (Microsoft only - Single tenant)**.
6. Under **Redirect URI**, choose **Web** for the type of application you want to create.
7. After setting the values, click **Register**.

You've now created your Azure AD application and service principal.

e. Create a secret key for the Cloud OnRamp application:

1. From **App registrations** in Azure AD, click your application.
2. On the left pane, click **Certificates & secrets**.
3. Under **Client secrets**, click **New client secret**.
4. Provide a description of the secret key, and an expiry time period for the secret key.
5. Click **Add**.

After saving the client secret, the value of the client secret or key value appears. Note this value because you can't retrieve the key later, if required. You need to provide the key value with the application ID to sign into the application you have created.

f. Get Subscription ID:

1. On the Azure portal, click **Subscriptions**.
2. Navigate to a **Subscriptions** service, and click the **More Actions** icon to the right of the row.

   The **Microsoft Azure Enterprise** page appears.

3. From the page, note the **Subscription ID**.

   You need the Subscription ID to provide Cisco vManage with programmatic access to your Azure Subscription.

If you have multiple subscriptions, copy and save the subscription ID which you're planning to use for configuring the CloudOnRampApp.

g. View the Tenant ID:

1. On the left pane of the Azure portal, click **Azure Active Directory**.
2. From the left pane, click **Properties**. The system displays the directory ID which is equivalent to the tenant ID.

h. Assign the Owner role to the application:

In this guide, we've provided the steps for assigning the Owner role, which lets you access and manage everything.

Note To know an appropriate role for an application, contact your Azure administrator.

1. On the left pane of the Azure portal, click **Subscriptions**.
2. Click the subscription to assign to the Cloud OnRamp application.
3. In the subscription pane, navigate to Access Control (IAM).
4. Click **Add a role assignment**. The **Add role assignment** pop-up appears.
5. From the **Role** drop-down list, choose **Owner**.
6. In the **Assign Access To** drop-down list, choose the default value, **Azure AD user**, **group**, or **service principal**.
7. From the **Select** drop-down list, choose the Cloud OnRamp application that you created in Step d.
8. Click **Save**.

You can see your application in the list of users with a role for that scope.

You can now log into the Cloud OnRamp application with the Azure credentials you created and saved.

4. Check the Azure limits associated with your account by going to your subscription in the Azure portal. Under **Settings**, choose **Usage + Quotas**.

a. Choose a provider from the **All Providers** drop-down list.

b. Check **Microsoft.Network**.

You can view the amount of available availability sets for this subscription. Ensure that availability sets are sufficient that allows you to create the following resources in your account:

- One VNet, which is required for creating the transit VNet.

- One availability set required for Virtual Machine distribution in the transit VNet.
- Six Static Public IP addresses associated with the transit cloud routers.
- One Azure Virtual Network transit and two Static Public IP Addresses for each host VNet
- Four VPN connections for mapping each host VNet

Note F-Series Azure VMs (F4 and F8) are supported on the Cisco SD-WAN cloud devices.

Configure Cisco SD-WAN Cloud OnRamp for IaaS on Microsoft Azure

In the configuration process, map one or more host VNets to a single transit VNet. When mapping, you're configuring the cloud-based applications that branch users can access.

The mapping process establishes IPsec and BGP connections between the transit VNet and each host VNet. The IPsec tunnel that connects the transit and host VNet runs IKE to provide security for the connection. For Azure, the IPsec tunnel uses IKE version 2. The BGP connection that is established over the secure IPsec tunnel allows the transit and host VNet to exchange routes. The BGP connections or the BGP routes are then re-distributed into OMP within the Cisco SD-WAN cloud devices, which then advertises the OMP routes to the vSmart controllers in the domain. The transit VNet can then direct traffic from the branch to the proper host VNet and to the proper cloud-based application.

During the mapping process, the IPsec tunnels and BGP peering sessions are configured and established automatically. After establishing the mappings, you can view the IPsec and BGP configurations in the VPN Interface IPsec and BGP feature configuration templates, and modify them as necessary.

Points to Consider:

To configure Cisco SD-WAN Cloud OnRamp for IaaS on Azure, create Azure transit VNets, each of which consist of a pair of routers. Then, map the host VNets to transit VNets that exist in the Azure cloud. All VNets reside in the same resource group.

- Transit VNets provide the connection between the overlay network and the cloud-based applications running on the host VNet. Each transit VNet consists of two cloud devices that reside in their own VNet. Two cloud devices provide redundancy for the connection between the overlay network and cloud-based applications. On each of these two cloud devices, the transport VPN (VPN 0) connects to the simulated branch device, and the service-side VPNs (any VPN except for VPN 0 and VPN 512) connect to applications and application providers in the public cloud.
- The Cisco SD-WAN Cloud OnRamp for IaaS workflow uses a public IP address of the second WAN interface to set up the Customer Gateway for mapping (ipsec tunnels) the host VNets to a transit VNet. To add the public IP address of the WAN interface, configure the VPN Interface Ethernet template with ge0/0 interface for the devices used in Cisco SD-WAN Cloud OnRamp for IaaS. In vEdge Cloud routers, the tunnel interface is on the ge0/0 interface. See sample VPN Interface Ethernet template configuration in VPN0 Interface Feature Template, on page 34.

- Host VNets are virtual private clouds in which your cloud-based applications reside. When a transit VNet connects to an application or application provider, it's simply connecting to a host VNet.

Step 1 From the Cisco vManage menu, choose **Configuration** > **Cloud onRamp for IaaS**.

Step 2 Click **Add New Cloud Instance**

Step 3 Click the **Microsoft Azure** radio button.

Step 4 In the next pop-up screen, perform the following:

a) In the **Subscription ID** field, enter the ID of the Microsoft Azure subscription you want to use as part of the Cisco SD-WAN Cloud OnRamp for IaaS workflow.

b) In the **Client ID** field, enter the ID of an existing application or create a new application. To create an application, go to your **Azure Active Directory** > **App Registrations** > **New registration**. See Microsoft Azure documentation for more information on creating an application.

c) In the **Tenant ID** field, enter the ID of your account. To find the tenant ID, go to your Microsoft Azure Active Directory and click **Properties**.

d) In the **Secret Key** key field, enter the password associated with the client ID.

e) In the **Environment** field, choose **commercial** or **GovCloud**.

By default, commercial environment is selected. You can choose the geographical locations based on the environment specifications.

Note Azure Government Cloud isn't supported for vEdge Cloud routers. Therefore, ensure that you don't choose the **govcloud** option.

f) Click **Login**.

The cloud instance configuration wizard opens.

The wizard consists of three screens that you use to select a location, add a transit VNet, discover host VNets, and map host VNets to the transit VNet. A graphic on the right side of each wizard screen illustrates the steps in the cloud instance configuration process. The steps not yet completed are shown in light gray. The current step is highlighted within a blue box. All completed steps are indicated with a green checkmark and are shown in light orange.

Step 5 From the **Choose Location** drop-down list, choose a location where you want to create the transit VNet.

The locations available are based on the commercial cloud or GovCloud selection.

Step 6 Add a transit VNet:

a) In the **Transit VNet Name** field, type a name for the transit VNet.

The name can contain 32 alphanumeric characters, hyphens (–), and underscore (_). It can't contain spaces or any other characters.

b) Under **Device Information**, enter information about the transit VNet:

1. In the **WAN Edge Version** drop-down list, choose the software version to run on the transit VNet. The drop-down list includes the published versions of the device software in the Microsoft Azure marketplace.

2. In the **Size of Transit WAN Edge** drop-down list, choose an option to determine the memory and CPUs you can use for each of the Cisco SD-WAN cloud devices that run on the transit VNet. See Supported Instance Types for Cisco Cloud vEdge Routers in the *Cisco SD-WAN Getting Started Guide*.

Note We recommend that you choose the following size:

3. To set up the transit VNet devices for Direct Internet Access (DIA), click one of the following:
   - **Disabled**: No Internet access.
   - **Enabled via Transport**: Configure or enable NAT for the WAN interface on a device.
   - **Enabled via Umbrella SIG**: Configure Cisco Umbrella to enable secure DIA on a device.
4. In the **Device 1** drop-down list, choose the serial number of the first device.
5. In the **Device 2** drop-down list, choose the serial number of the second device in the device pair.
6. Click **Advanced** if you wish to enter more specific configuration options.
7. In the **Transit VNet CIDR** field, enter a custom CIDR that has a network mask in the range of 16–25. If you leave this field empty, the Transit VNet is created with a default CIDR of 10.0.0.0/16.

c) To complete the transit VNet configuration. click **Save and Finish**, or optionally to continue with the wizard, click **Proceed to Discovery and Mapping**.

Step 7 Map host VNets to transit VNets:

a) In the **Select an account to discover** drop-down list, choose your Azure subscription ID.

Alternatively, to add a new Azure account from which you wish to discover host VNets, click **New Account**.

b) Click **Discover Host VNets**.

c) In the **Select a VNet** drop-down list, choose a desired host VNet.

d) Click **Next**.

e) From the table of host VNets, choose a desired host VNet.

f) Click **Map VNets**. The Map Host VNets pop-up appears.

g) In the **Transit VNet** drop-down list, choose the transit VNet to map to the host VNets.

h) In the **VPN** drop-down list, choose a VPN in the overlay network in which to place the mapping.

i) In the IPSec Tunnel CIDR section, to configure IPSec tunnels to reach the Azure virtual network transit, enter two pairs of interface IP addresses and a pair of loopback IP addresses for each of the Cisco Cloud vEdge Routers. Ensure that the IP addresses are network addresses in the /30 subnet, unique across the overlay network, and they aren't part of the host VNet CIDR. If they are part of the host VNet CIDR, Microsoft Azure returns an error when attempting to create VPN connections to the transit VNet.

Note The IP addresses aren't part of the host VNet and Transit VPC CIDR.

Microsoft Azure supports single Virtual Private Gateway (VGW) configuration over IPSec tunnels with redundancy provided over a single tunnel. Therefore, Cisco SD-WAN Cloud OnRamp for IaaS supports two VGWs for redundancy. During a planned maintenance or an unplanned event of a VGW, the IPSec tunnel from the VGW to the cloud devices get disconnected. This loss of connectivity causes the cloud devices lose BGP peering with Cisco vManage over IPSec tunnel. To enable BGP peering with the cloud routers rather than the IP address of the IPSec tunnel, provide the loopback addresses for each cloud device.

Note The loopback option for BGP peering supports single and multiple Virtual Gateways, or Customer Gateway configuration or both on Azure cloud. The loopback option applies only to the new host VNets mapped to transit VNets and not on the existing VNets.

j) In the Azure Information section:

1. In the **BGP ASN** field, enter the ASN that you configure on the Azure Virtual Network Gateway, which is brought up within the host VNet. Use an ASN that isn't part of an existing configuration on Azure. For acceptable ASN values, refer to Microsoft Azure documentation.

2. In the **Host VNet Gateway Subnet** field, enter a host VNet subnet in which the Virtual Network Gateway can reside. We recommend you use a /28 subnet or higher. Ensure not to provide a subnet that is already created in the VNet.

   Note Ensure that there’s an unused CIDR inside the host VNet CIDR.

k) Click **Map VNets**.

l) Click **Save and Complete**.

Note When configuring the VPN feature template for VPN 0 for the two Cisco SD-WAN cloud devices that form the transit VNet, ensure that the color you assign to the tunnel interface is a public color, and not a private color. Public colors are:

- **3g**
- **biz-internet**
- **blue**
- **bronze**
- **custom1**
- **custom2**
- **custom3**
- **default**
- **gold**
- **green**
- **lte**
- **metro-ethernet**
- **mpls**
- **public-internet**
- **red**
- **silver**

The **Task View** screen appears, confirming that the host VNet has been mapped to the transit VNet successfully.

The creation of VNet Gateway can take up to 45 minutes.

Manage Host and Transit VNets

Display Host VNets

Step 1 From the Cisco vManage menu, choose **Configuration** > **Cloud onRamp for IaaS**. Click the desired VNet. The **Host VNets/Transit VNets** window opens.

By default, the **Mapped Host VNets** field is selected and the table under mapped host VNets list the mapped host and transit VNets, the state of the transit VNets, and the VPN ID.

Step 2 To list unmapped host VNets, click **Un-Mapped Host VNets**. Then click **Discover Host VNets**.

Step 3 To display the transit VNets, click **Transit VNets**.

Map Host VNets to an Existing Transit VNet

Step 1 From the Cisco vManage menu, choose **Configuration** > **Cloud onRamp for IaaS**. Click the desired VNet. The **Host VNets/Transit VNets** window opens.

Step 2 Click **Un-Mapped Host VNets**.

Step 3 Click **Discover Host VNets**.

Step 4 From the list of discovered host VNets, choose the desired host VNets.

Step 5 Click **Map VNet**. The Map Host VNets pop-up opens.

Step 6 From the **Transit VNet** drop-down list, choose the desired transit VNet.

Step 7 From the **VPN** drop-down list, choose the VPN in the overlay network in which to place the mapping.

Step 8 Click **Map VNets**.

Unmap Host VNets

Step 1 From the Cisco vManage menu, choose **Configuration** > **Cloud onRamp for IaaS**. Click the desired VNet. The **Host VNets/Transit VNets** window opens.

Step 2 Click **Mapped Host VNets**.

Step 3 From the list of VNets, choose the desired host VNets. We recommend that you unmap one VNet at a time. If you want to unmap multiple VNets, don't choose more than three in a single unmapping operation.

Step 4 Click **Un-Map VNets**.

Step 5 Click **OK** to confirm the unmapping.

Display Transit VNets

Step 1 From the Cisco vManage menu, choose **Configuration** > **Cloud onRamp for IaaS**. Click the desired VNet. The **Host VNets/Transit VNets** window opens.

Step 2 Click **Transit VNets**.

A table lists all the transit VNets.

Add Transit VNet

Step 1 From the Cisco vManage menu, choose **Configuration** > **Cloud onRamp for IaaS**. Click the desired VNet. The **Host VNets/Transit VNets** window opens.

Step 2 Click **Transit VNets**.

Step 3 Click **Add Transit VNet**.

To add a transit VNet, follow the instructions in step 5 of Configure Cisco SD-WAN Cloud OnRamp for IaaS on Microsoft Azure, on page 22.

Delete Transit VNet

Step 1 From the Cisco vManage menu, choose **Configuration** > **Cloud onRamp for IaaS**. Click the desired VNet. The **Host VNets/Transit VNets** window opens.

Step 2 Click **Mapped Host VNets**.

Step 3 Choose the desired host VNet, and click **Un-Map VNets**.

Ensure that you unmap all host VNets that are mapped to the transit VNet that you want to delete.

Step 4 Click **OK** to confirm the unmapping.

Step 5 Click **Transit VNets**.

Step 6 For the desired transit VNet to be deleted, click the trash icon.

Step 7 Click **OK** to confirm.

Troubleshoot Cisco SD-WAN Cloud OnRamp for IaaS

This section describes how to troubleshoot common problems with Cisco SD-WAN Cloud OnRamp for IaaS.

Two Cisco Cloud vEdge Routers are Not Available

From the Cisco vManage menu, choose **Configuration** > **Cloud onRamp for IaaS**. After you click **Add New Cloud instance**, you see an error message indicating that two Cisco vEdge Cloud Routers aren't available.

Resolve the Problem

The Cisco vManage server doesn't have two Cisco Cloud vEdge Cloud Routers that are running licensed Cisco SD-WAN software. Contact your operations team so that they can create the necessary Cisco vEdge Cloud Routers.

If the Cisco vEdge Cloud Routers are present and the error message persists, the two routers aren't attached to configuration templates. Attach these templates in the Cisco vManage **Configuration** > **Templates** > **Device Templates** window. For the desired device template, click **…** and choose **Attach Devices**.

Note In Cisco vManage Release 20.7.x and earlier releases, **Device Templates** is titled **Device**.

Required API Permissions are Unavailable

When you enter your API keys, you get an error message indicating that this user doesn't have the required permissions.

Resolve the Problem

Ensure that the Cisco vManage server can reach the internet and has a DNS server configured so that it can reach AWS or Microsoft Azure. To configure a DNS server, in the Cisco vManage VPN feature configuration template, enter the IP address of a DNS server, and then reattach the configuration template to the Cisco vManage server.

For AWS, check the API keys belonging to your AWS account. If you think you have the wrong keys, generate another pair of keys.

For AWS, if you're entering the correct keys and the error message persists, the keys don't have the required permissions. Check the user permissions associated with the key. Give necessary permissions to the user to create and edit VPCs and EC2 instances.

If the error message persists, check the time of the Cisco vManage server to ensure that it's set to the current time. If it's not, configure the Cisco vManage server time to point to the Google NTP server. To configure the server time, in the Cisco vManage NTP feature configuration template, enter the hostname of an NTP server. Next, reattach the configuration template to the NTP feature using Cisco vManage. The Google NTP servers are time.google.com, time2.google.com,time3.google.com, and time4.google.com, and so on.

WAN Edge Router Software Versions don't Appear in the Drop-Down List When Configuring for AWS

Problem Statement

When you're trying to configure transit VPC parameters for the transit VPC, Cisco vEdge Cloud Routers software versions aren't listed in the drop-down list.

Resolve the Problem

Ensure that you subscribe to the Cisco vEdge Cloud Router Amazon machine image (AMI) in your account within the AWS Marketplace.

Ensure that the Cisco vEdge Cloud Router is running software Release 19.2.1 or later.

VPNs aren't Listed During Configuration

Problem Statement

After you select the host VPCs or VNets to map, VPNs aren't listed in the drop-down list.

Resolve the Problem

The problem occurs when the device configuration template attached to the Cisco SD-WAN cloud devices doesn’t include service-side VPNs. You require the service-side VPNs (VPNs other than VPN 0 and VPN 512) to configure the IPsec connection between the two Cisco SD-WAN cloud devices that you select for the transit and host VPCs or VNets.

This problem can also occur if the two Cisco SD-WAN cloud devices that you select for the transit VPC or VNet have no overlapping service-side VPNs. Because the two Cisco vEdge Cloud routers form an active–active pair, configure the same service-side VPNs on both of them.

To configure service-side VPNs, in the Cisco vManage VPN feature configuration template, configure at least one service-side VPN. Ensure that at least one of the service-side VPNs is the same on both routers. Then reattach the configuration template to the routers.

Cisco SD-WAN Cloud OnRamp for IaaS Task Fails

Problem Statement

After you have completed mapping the host VPCs to the transit VPCs, or host VNets to transit VNets, the configuration of Cisco SD-WAN Cloud OnRamp for IaaS fails.

Resolve the Problem

Review the displayed task information that appears on the screen to determine why the task failed. If the errors are related to AWS or Azure resources, ensure that all required resources are in place.

Cisco SD-WAN Cloud OnRamp for IaaS Task Succeeds, but Cisco SD-WAN Cloud Devices Are Down

Problem Statement

The Cisco SD-WAN Cloud OnRamp for IaaS task was successful, but the Cisco SD-WAN cloud devices are still in the down state.

Resolve the Problem

Check the configuration templates:

- Check that all portions of the Cisco SD-WAN cloud devices configuration, including policies, are valid and correct. If the configurations are invalid, they aren’t applied to the router, and the router never comes up.
- Check that the configuration for the Cisco vBond Orchestrator is correct. If the DNS name or IP address configured in the Cisco vBond Orchestrator is wrong, the Cisco vEdge Cloud Router are unable to reach the Cisco vBond Orchestrator, and hence they are unable to join the overlay network.

After you have determined what the configuration issues are:

1. Delete the Cisco SD-WAN Cloud OnRamp for IaaS components:
    a. Unmap the host VPCs or VNets and the transit VPCs or VNets.
    b. Delete the transit VPC for the Cisco vEdge Cloud Routers.
2. Edit the configuration templates and reattach them to the Cisco SD-WAN cloud devices.
3. Repeat the Cisco SD-WAN Cloud OnRamp for IaaS configuration process.

Desired Routes are Not Exchanged

Problem Statement

The Cisco SD-WAN Cloud OnRamp for IaaS configuration workflow is successful, the Cisco vEdge Cloud Routers are available and running, but the desired routes aren't getting exchanged.

Resolve the Problem

In Cisco vManage, check the BGP configuration on the transit cloud routers. During the mapping process, when you configureCisco SD-WAN Cloud OnRamp for IaaS service, BGP is configured to advertise the network address, 0.0.0.0/0. Make sure that the service-side VPN contains an IP route that points to 0.0.0.0/0. If necessary, add a static route in the VPN feature configuration template, and then reattach the configuration to the two cloud routers that you selected for the transit VPC or VNet.

On AWS, go to the host VPC and check the route table. In the route table, click **Enable route propagation** to ensure that the VPC receives the routes.

End-to-End Ping Is Unsuccessful

Problem Statement

Routing is working properly, but an end-to-end ping isn't working.

Resolve the Problem

On AWS, check the security group rules of the host VPC. On Azure, check the network security group rules of the host VNet. The security group rules must allow the source IP address range subnets of the on-premises or branch-side devices to allow traffic from the branch to reach AWS.

Sample Feature Template Settings

Feature Templates

The following is a sample of the various feature templates settings for Cisco vEdge Cloud Routers.

System Feature Template

Template: Basic Information/System

Template Name: System_Template

Description: System Template

Table 1: System feature template settings

Section	Parameter	Type	Variable/Value
Basic Configuration	Site ID	Device Specific	system_site_id
	System IP	Device Specific	system_system_ip
	Hostname	Device Specific	system_host_name
	Device Groups	Device Specific	system_device_groups
	Console Baud Rate	Global	115200
GPS	Latitude	Device Specific	system_latitude
	Longitude	Device Specific	system_longitude
Advanced	Port Hopping	Device Specific	system_port_hop
	Port Offset	Device Specific	system_port_offset

Logging Feature Template

Template: Other Templates/Logging

Template Name: Logging_Template

Description: Logging Template

Table 2: Logging feature template settings

Section	Parameter	Type	Variable/Value
Server (Optional)	Hostname/IP address	Device Specific	logging_server_name
	VPN ID	Device Specific	logging_server_vpn

The logging server is optional within the Logging_Template.

BFD Feature Template

Template: Basic Information/BFD_Template

Template Name: BFD_Template

Description: BFD Template

Table 3: BFD feature template settings

Section	Parameter	Type	Variable/Value
Basic Configuration	Poll Interval	Global	120000
Color (Biz Internet)	Color	Drop-down list	Biz Internet
	Hello Interval (milliseconds)	Device Specific	biz_internet_bfd_hello_interval
	Path MTU	Global	Off

VPN512 Feature Template

Template: VPN/VPN

Template Name: Transit_VPN512_Template

Description: VPN 512 Out-of-Band Management

Table 4: VPN512 feature template settings

Section	Parameter	Type	Variable/Value
Basic Configuration	VPN	Global	512
	Name	Global	Management VPN

VPN512 Interface Ethernet Feature Template

Template: VPN / VPN Interface Ethernet

Template Name: Transit_VPN512_Interface_Template

Description: VPN 512 Management Interface

Table 5: VPN512 Interface Ethernet feature template settings

Section	Parameter	Type	Variable/Value
Basic Configuration	Shutdown	Global	No
	Interface Name	Device Specific	vpn512_mgmt_int
	Description	Global	Management Interface
IPv4 Configuration	IPv4 Address	Radio Button	Dynamic

NTP Feature Template

Template: Basic Information/NTP

Template Name: NTP_Template

Description: NTP Template

Table 6: NTP feature template settings

Section	Parameter	Type	Variable/Value
Server	Hostname/IP address	Global	time.nist.gov

You should be careful to use only known and trusted NTP servers. Disruptions to time synchronizations can affect the ability of the Cisco SD-WAN Cloud devices within the transit VPC or transit VNet to connect to the controllers, and the ability to establish IPsec connections to other Cisco SD-WAN devices.

AAA Feature Template

Template: Basic Information/AAA

Template Name: AAA_Template

Description: AAA Template

Table 7: AAA feature template settings

Section	Parameter	Type	Variable/Value
Authentication	Authentication Order	Drop-down list	local
Local	User/admin/Password	Global	<your admin password>

OMP Feature Template

Template: Basic Information/OMP

Template Name: OMP_Template

Description: OMP Template

Table 8: OMP feature template settings

Section	Parameter	Type	Variable/Value
Basic configuration	Number of Paths Advertised per Prefix	Global	16
	ECMP Limit	Global	16
Advertise	BGP	Global	On
	Connected	Global	Off
	Static	Global	Off

Security Feature Template

Template: Basic Information/Security

Template Name: Security_Template

Description: Security Template

Table 9: Security feature template settings

Section	Parameter	Type	Variable/Value
Basic configuration	Replay window	Global/drop-down list	4096

VPN0 Feature Template

Template: VPN/VPN

Template Name: Transit_VPN0_Template

Description: VPN0 Transport Template

Table 10: VPN0 feature template settings

Section	Parameter	Type	Variable/Value
Basic configuration	VPN	Global	0
	Name	Global	Transport VPN

VPN0 Interface Feature Template

Template: VPN/VPN Interface Ethernet

Template Name: Transit_VPN0_Interface

Description: VPN0 Transport Interface

Table 11: VPN0 interface feature template settings

Section	Parameter	Type	Variable/Value
Basic configuration	Shutdown	Device Specific	vpn0_inet_int_shutdown
	Interface Name	Device Specific	vpn0_inet_int_gex|x
	Description	Global	Internet Interface

Section	Parameter	Type	Variable/Value
IPv4 Configuration	IPv4 Address	Radio Button	Dynamic
	Bandwidth Upstream	Device Specific	vpn0_inet_int_bandwidth_up
	Bandwidth Downstream	Device Specific	vpn0_inet_int_bandwidth_down
Tunnel	Tunnel Interface	Global	On
	Color	Global	biz-internet
	Allow Service>NTP	Global	On
Tunnel>Advanced Options>Encapsulation	IPsec Preference	Device Specific	vpn0_inet_tunnel_ipsec_preference
Advanced	TCP MSS	Global	1350
	Clear-Don’t-Fragment	Global	On

VPN1 Feature Template

Template: VPN/VPN

Template Name: Transit_VPN1_Template

Description: VPN1 Service Template

Table 12: VPN1 feature template settings

Section	Parameter	Type	Variable/Value
Basic configuration	VPN	Global	1
	Name	Global	Service VPN 1
	Enhance ECMP Keying	Global	On
Advertise OMP	BGP (IPv4)	Global	On
	Connected (IPv4)	Global	On

VPN2 Feature Template

Template: VPN/VPN

Template Name: Transit_VPN2_Template

Description: VPN2 Service Template

Table 13: VPN2 feature template settings

Section	Parameter	Type	Variable/Value
Basic configuration	VPN	Global	2
	Name	Global	Service VPN 2
	Enhance ECMP Keying	Global	On
Advertise OMP	BGP (IPv4)	Global	On

Device Templates

The following table summarizes the device template for the Cisco vEdge Cloud routers .

Template Name: Cloud_OnRamp_vEdge_Template_vEdge

Table 14: Transit VPC or Transit VNet Device Template

Template Type	Template Sub-Type	Template Name
System		System_Template
	Logging	Logging_Template
	NTP	NTP_Template
	AAA	AAA_Template
BFD		BFD_Template
OMP		OMP_Template
Security		Security_Template
VPN0		Transit_VPN0_Template
	VPN Interface	Transit_VPN0_Interface
VPN512		Transit_VPN512_Template
	VPN Interface	Transit_VPN512_Interface_Template
VPN1		Transit_VPN1_Template
VPN2		Transit_VPN2_Template

Sample Device Template Variable Values

The following sample information provides the device template variable values that you can use for the first and second Cisco vEdge Cloud Router.

Table 15: Cisco vEdge Cloud Routers Device Template Variable Values for First Device

Variable	Value
Shutdown(snmp_shutdown)	o
Name of Device for SNMP(snmp_device_name)	onRamp-Cloud1
Location of Device(snmp_device_location)	Azure us-west-1
IPv4 Address(vpn1_lo0_int_ip_addr|maskbits)	10.0.0.136/32
Interface Name(vpn512_mgmt_int)	eth0
Hostname(system_host_name)	onRamp_Cloud1
Latitude(system_latitude)	37.3541
Longitude(system_longitude)	-121.9552
Device Groups(system_device_groups)	AWS or Azure
System IP(system_system_ip)	10.0.0.136
Site ID(system_site_id)	115001
Port Offset(system_port_offset)	0
Hello Interval(milliseconds)(bfd_biz_internet_hello_interval)	10000
Interface name(vpn0_inet_int_gex|x)	ge0/0
Preference(vpn0_inet_tunnel_ipsec_preference)	100
Shutdown(vpn0_inet_int_shutdown)	o
Bandwidth Upstream(vpn0_inet_int_bandwidth_up)	1000000
Bandwidth Downstream(vpn0_inet_int_bandwidth_down)	1000000
VPN ID(logging_server_vpn)	1
snmp_trap_vpn_id	1
snmp_trap_source_interface	loopback0
snmp_trap_ip	10.0.1.68
Console Baud Rate (system_console_baud_rate)	115200

Table 16: Cisco vEdge Cloud Routers Device Template Variable Values for Second Device

Variable	Value
Shutdown(snmp_shutdown)	o

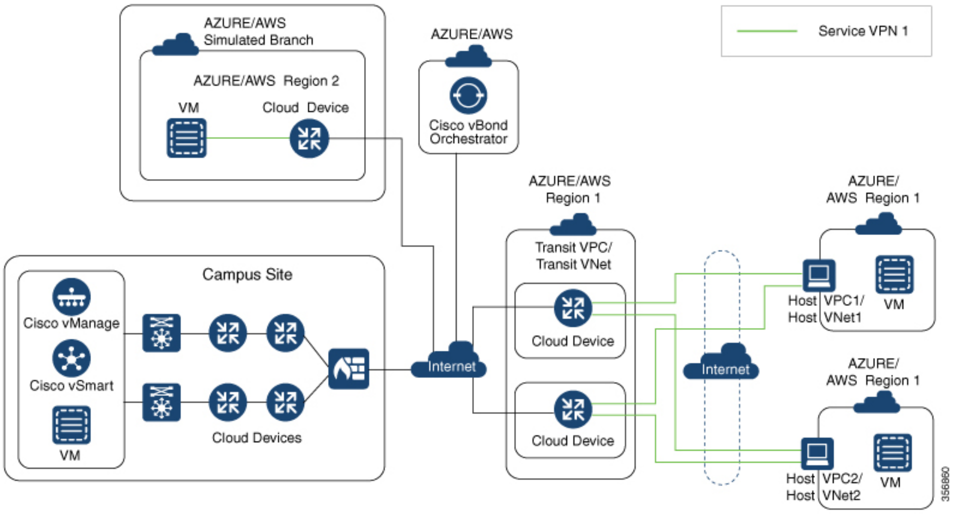
Variable	Value
Name of Device for SNMP(snmp_device_name)	onRamp-Cloud2
Location of Device(snmp_device_location)	Azure us-west-2
IPv4 Address(vpn1_lo0_int_ip_addr|maskbits)	10.0.0.137/32
Interface Name(vpn512_mgmt_int)	eth0
Hostname(system_host_name)	onRamp_Cloud2
Latitude(system_latitude)	37.3541
Longitude(system_longitude)	-121.9552
Device Groups(system_device_groups)	AWS or Azure
System IP(system_system_ip)	10.0.0.137
Site ID(system_site_id)	115001
Port Offset(system_port_offset)	0
Hello Interval(milliseconds)(bfd_biz_internet_hello_interval)	10000
Interface name(vpn0_inet_int_gex|x)	ge0/0
Preference(vpn0_inet_tunnel_ipsec_preference)	100
Shutdown(vpn0_inet_int_shutdown)	o
Bandwidth Upstream(vpn0_inet_int_bandwidth_up)	1000000
Bandwidth Downstream(vpn0_inet_int_bandwidth_down)	1000000
VPN ID(logging_server_vpn)	1
snmp_trap_vpn_id	1
snmp_trap_source_interface	loopback0
snmp_trap_ip	10.0.1.68
Console Baud Rate (system_console_baud_rate)	115200

Example for Cisco SD-WAN Cloud OnRamp for IaaS

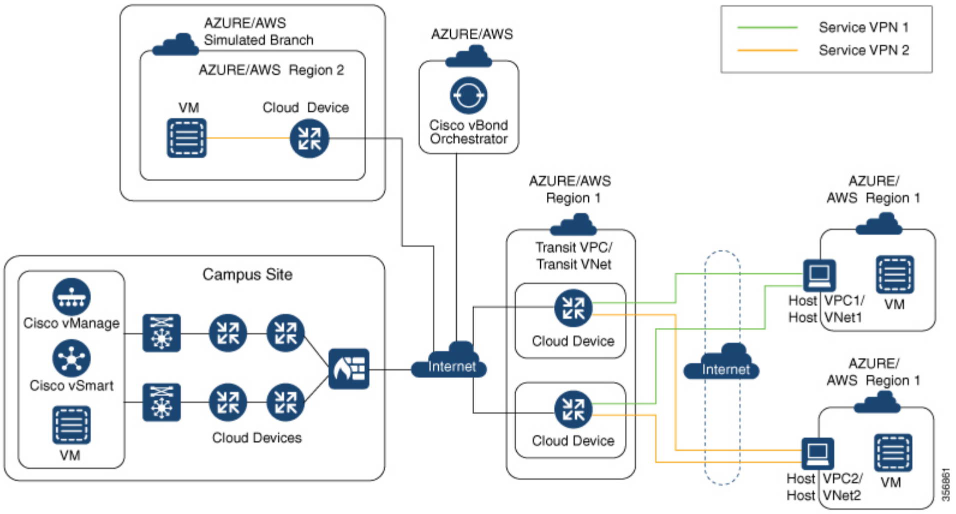
In this example, a single transit VPC or VNet is created within an AWS or Microsoft Azure region and you map two existing host VPCs or VNets within the same region to a transit VPC or VNet. Then, you can access the host VPCs or VNets from a campus and a simulated branch location.

Cisco SD-WAN deployments implement connectivity using different VPNs that range 0–512. VPN 0 represents the transport (WAN) network and VPN 512 represents the management network. Use the remaining VPNs (1–511) as service VPNs. The following two scenarios to deploy Cisco SD-WAN Cloud OnRamp for IaaS are considered:

- Full connectivity: Map both host VPCs or VNets to service VPN 1 within the transit VPC or VNet. You can configure service VPN 1 on the service-side of vEdge Cloud router deployed within the campus, and vEdge Cloud router deployed within the simulated branch. This connectivity allows communication from both the campus and the branch sites to AWS Elastic Compute Cloud (EC2) instances within either of the host VPCs. The connectivity also allows communication between AWS or Azure EC2 instances deployed within the two host VPCs. The deployment demonstrates a scenario where all entities within the organization have full connectivity to the public cloud resources deployed by the organization. The following image illustrates the first scenario.



- Segmentation to the cloud provider: Map one of the host VPCs or VNets to service VPN 1 and the other host VPC or VNet to service VPN 2 within the transit VPC or VNet. This mapping provides segmentation and therefore traffic isolation between the two host VPCs or VNets. You can configure the campus only for service VPN 1, and allowing it to communicate with AWS or Azure EC2 instances within the first host VPC. Configure the branch for service VPN 2, allowing it to communicate with AWS or Azure EC2 instances within the second host VPC. This deployment demonstrates a scenario where different entities within an organization require access only to specific public cloud resources. The following figure illustrates the second scenario.



Map Host VPCs or VNets to the Transit VPC or VNet in the Same Service VPN

To map both host VPCs or VNets to service VPN 1 within the transit VPC or VNet, perform the following:

1. From the Cisco vManage menu, choose **Configuration** > **Cloud onRamp for IaaS**. Choose both the host VPCs or host VNets that you want to map, and click **Map VPCs** or **Map VNets**.

   The **Map Host VPCs** or **Map Host VNets** pop-up opens.

2. In the **Transit VPC** or **Transit VNet** drop-down list, choose the transit VPC or VNet to map to the host VPCs or VNets.

3. In the **VPN** drop-down list, select **1**.

   Mapping host VPCs or host VNets to the same service VPN allows communication between the host VPCs or VNets.

4. For AWS configuration, disable **Route Propagation**.

   Enabling route propagation propagates the BGP routes to the host VPC selected for mapping.

5. Click **Map VPCs** or **Map VNets**.

   After a few minutes, the Task View window appears, confirming that the host VPC or VNet has been mapped to the transit VPC or VNet.

These steps complete the mapping of both the host VPCs or VNets to service VPN 1. You can verify connectivity between EC2 instances with each host VPC or VNet by establishing an SSH connection between them. Similarly, by mapping both the campus and branch to service VPN 1, you can verify connectivity to both host VPCs or VNets by establishing SSH connections from the campus and branch to the EC2 instances within the host VPCs or VNets.

Map Each Host VPC or VNet to the Transit VPC or VNet in Different Service VPNs

To map one host VPC or VNet to service VPN 1; while the other host VPC or VNet to service VPN 2, perform the following steps:

1. From the Cisco vManage menu, choose **Configuration** > **Cloud onRamp for IaaS**. Choose the host VPC or VNet that you want to map, and click **Map VPCs** or **Map VNets**.

The **Map Host VPCs** or **Map Host VNets** pop-up opens.

2. In the **Transit VPC** or **Transit VNet** drop-down list, choose the transit VPC or VNet to map to the host VPCs or VNets.
3. In the **VPN** drop-down list, choose **1**.

   The first host VPC or VNet is now mapped to service VPN 1.
4. Click **Map VPCs** or **Map VNets**.

   After a few minutes, the Task View window appears, confirming that the host VPC or VNet has been mapped to the transit VPC or VNet.
5. Repeat Steps 1–3 for the second host VPC or VNet

   When selecting the VPN value, map the host VPC or VNet to service VPN 2.

This process completes the mapping of the first host VPC or VNet to service VPN 1 and the second host VPC or VNet to service VPN 2.

By mapping the campus to service VPN 1, you can verify connectivity to the first host VPC or VNet by establishing SSH connections from the campus to the EC2 instances within that host VPC or VNet. However, SSH connections from the campus to the EC2 instances within the second host VPC or VNet can’t be established. By mapping the branch to service VPN 2, you can verify connectivity to the second host VPC or VNet by establishing SSH connections from the branch to the EC2 instances within that host VPC or VNet. However, SSH connections from the branch to the EC2 instances within the first host VPC or VNet can’t be established.

CHAPTER 4

Cloud onRamp for Colocation

As more applications move to the cloud, the traditional approach of backhauling traffic over expensive WAN circuits to a data center is no longer relevant. The conventional WAN infrastructure was not designed for accessing applications in the cloud. The infrastructure is expensive and introduces unnecessary latency that degrades the experience.

Network architects are reevaluating the design of the WANs to achieve the following:

- Support a cloud transition.
- Reduce network costs.
- Increase the visibility and manageability of the cloud traffic.

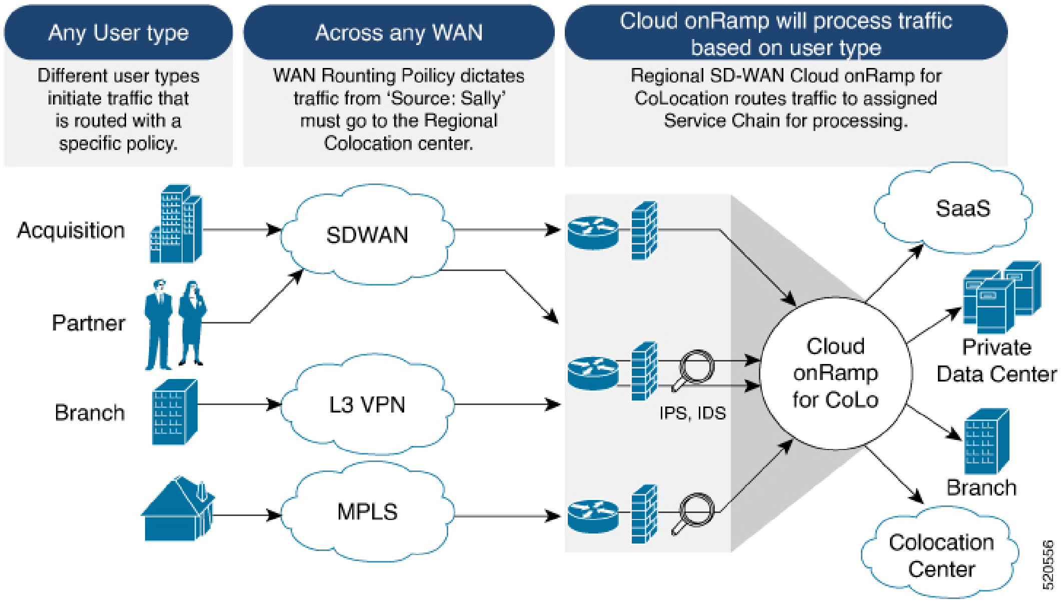
The architects are turning to Software-Defined WAN (SD-WAN) fabric to take advantage of inexpensive broadband Internet services and to route intelligently a trusted SaaS cloud-bound traffic directly from remote branches.

With the Cisco SD-WAN Cloud onRamp for Colocation solution built specifically for colocation facilities, the solution routes the traffic to the best-permissible path from branches and remote workers to where all applications are hosted. The solution also allows distributed enterprises to have an alternative to enabling direct internet access at the branch and enhance their connectivity to infrastructure-as-a-service (IaaS) and software-as-a-service (SaaS) providers.

The solution provides enterprises with multiple distributed branch offices that are clustered around major cities or spread over several countries the ability to regionalize the routing services in colocation facilities. Reason being, these facilities are physically closer to the branches and can host the cloud resources that the enterprise needs to access. So, essentially by distributing a virtual Cisco SD-WAN over a regional architecture of colocation centers, the processing power is brought to the cloud edge.

The following image shows how you can aggregate the access to the multicloud applications from multiple branches to regional colocation facilities.

Figure 2: Cisco SD-WAN Cloud onRamp for CoLocations


Any User type
Different user types initiate traffic that is routed with a specific policy.
Across any WAN
WAN Rounting Poilicy dictates traffic from 'Source: Sally' must go to the Regional Colocation center.
Cloud onRamp will process traffic based on user type
Regional SD-WAN Cloud onRamp for CoLocation routes traffic to assigned Service Chain for processing.
Acquisition
Partner
Branch
SDWAN
L3 VPN
MPLS
IPS, IDS
Cloud onRamp for CoLo
SaaS
Private Data Center
Branch
Colocation Center
520556

The solution can serve four specific types of enterprises:

- Multinational companies that cannot use direct internet connections to the cloud and SaaS platforms due to security restrictions and privacy regulations.
- Partners and vendors without Cisco SD-WAN but still need connectivity to their customers. They do not want to install SD-WAN routing appliances in their site.
- Global organizations with geographically distributed branch offices that require high bandwidth, optimum application performance, and granular security.
- Remote access that need secure VPN connections to an enterprise over inexpensive direct internet links.

The Cisco SD-WAN Cloud onRamp for Colocation solution can be hosted within certain colocation facilities by a colocation IaaS provider. You can select the colocation provider that meets your needs in a region on a regional basis as long as it supports the necessary components.

- Deploy Cloud onRamp for Colocation Solution, on page 44
- Manage Cloud onRamp for Colocation Devices, on page 46
- Manage Clusters , on page 48
- Manage Service Groups, on page 72
- Manage VM Catalog and Repository, on page 89
- Monitor Operational Status of Cloud OnRamp for Colocation Devices from Cisco vManage, on page 101
- Cisco SD-WAN Cloud onRamp for Colocation Multitenancy, on page 110

Deploy Cloud onRamp for Colocation Solution

This topic outlines the sequence of how to get started with the colo devices and build clusters on Cisco vManage. Once a cluster is created and configured, you can follow the steps that are required to activate the cluster. Understand how to design service groups or service chains and attach them to an activated cluster. The supported Day-N operations are also listed in this topic.

1. Complete the solution prerequisites and requirements. See Prerequisites and Requirements of Cloud onRamp for Colocation Solution .

    - Complete wiring the CSP devices (set up CIMC for initial CSP access) and Cisco Catalyst 9500-40X or Cisco Catalyst 9500-48Y4C switches (set up console server) along with OOB or management switches. Power on all devices.

    - Set up and configure DHCP server. See Provision DHCP Server per Colocation.

2. Verify the installed version of Cisco NFVIS and install NFVIS, if necessary. See Install Cisco NFVIS Cloud OnRamp for Colocation on Cisco CSP.

3. Set up or provision a cluster. A cluster constitutes of all the physical devices including CSP devices, and Cisco Catalyst 9500-40X or Cisco Catalyst 9500-48Y4C switches. See Get Started with Cisco SD-WAN Cloud onRamp for CoLocation Solution.

    - Bring up CSP devices. See Bring Up Cloud Services Platform Devices.

    - Bring up Cisco Catalyst 9500-40X or Cisco Catalyst 9500-48Y4C switches. See Bring Up Switch Devices.

    - Provision and configure a cluster. See Provision and Configure Cluster.

      Configure a cluster through cluster settings. See Cluster Settings.

4. Activate a cluster. See Create and Activate Clusters, on page 50.

5. Design service group or service chain. See Manage Service Groups, on page 72.

Note You can design a service chain and create a service group anytime before creating clusters or activating clusters after all VMs are uploaded to the repository.

6. Attach or Detach service group and service chains to a cluster. See Attach or Detach a Service Group in a Cluster, on page 88.

Note Service chains can be attached to a cluster after the cluster is active.

7. (Optional) Perform all Day-N operations.

    - Detach a service group to detach service chains. See Attach or Detach a Service Group in a Cluster, on page 88.

    - Add and delete CSP devices from a cluster. See Add Cloud OnRamp Colocation Devices , on page 46 and Delete Cloud OnRamp for Colocation Devices , on page 47.

    - Deactivate a cluster. See Remove Cluster , on page 71.

    - Reactivate a cluster. See Reactivate Cluster , on page 72.

- Design more service group or service chain. See Create Service Chain in a Service Group, on page 72.

Manage Cloud onRamp for Colocation Devices

You can add CSP devices, Catalyst 9500-40X devices, and VNFs through Cisco vManage.

Add Cloud OnRamp Colocation Devices

You can add CSP devices, switch devices, and VNFs using Cisco vManage. When you order the Cisco SD-WAN Cloud onRamp for Colocation solution product identifier (PID), the device information is available from the smart account that can be accessed by Cisco vManage.

Before you begin

Ensure that the setup details are as follows:

- Cisco SD-WAN setup details such as, Cisco vManage IP address and credentials, Cisco vBond IP address and credentials
- NFVIS setup details such as, Cisco CSP device CIMC IP address and credentials or UCSC CIMC IP address and credentials
- Able to access both the switch consoles

Step 1 From the Cisco vManage menu, choose **Tools** > **SSH Terminal** to start an SSH session with Cisco vManage.

Step 2 Choose a CSP device or a switch device.

Step 3 Enter the username and password for the CSP device or switch device, and click **Enter**.

Step 4 Get the PID and serial number (SN) of a CSP device.

The following sample output shows the PID for one of the CSP devices.

```
CSP# show pl
platform-detail hardware_info Manufacturer "Cisco Systems Inc"
platform-detail hardware_info PID CSP-5444
platform-detail hardware_info SN WZP224208MB
platform-detail hardware_info hardware-version 74-105773-01
platform-detail hardware_info UUID da39edec-d831-e549-b663-9e407afd5ac6
platform-detail hardware_info Version 4.6.0-15
```

The output shows both the CSP device PID and serial number.

Step 5 Get the serial number of both the Catalyst 9500 switch devices.

The following sample shows the serial number of the first switch.

```
Switch1# show version
Cisco IOS XE Software, Version 17.03.03
Cisco IOS Software [Amsterdam], Catalyst L3 Switch Software (CAT9K_IOSXE), Version 17.3.3, RELEASE
SOFTWARE (fc2)
Technical Support: http://www.cisco.com/techsupport
Copyright (c) 1986-2021 by Cisco Systems, Inc.
Compiled Fri 26-Feb-21 02:01 by mcpre
```

```
Technology Package License Information:

------------------------------------------------------------------------------
Technology-package                                     Technology-package
Current                        Type                       Next reboot
------------------------------------------------------------------------------
network-advantage    Smart License                    network-advantage
dna-advantage        Subscription Smart License       dna-advantage
AIR License Level: AIR DNA Advantage
Next reload AIR license Level: AIR DNA Advantage


Smart Licensing Status: Registration Not Applicable/Not Applicable

cisco C9500-40X (X86) processor with 1331521K/6147K bytes of memory.
Processor board ID FCW2229A0RK
1 Virtual Ethernet interface
96 Ten Gigabit Ethernet interfaces
4 Forty Gigabit Ethernet interfaces
2048K bytes of non-volatile configuration memory.
16777216K bytes of physical memory.
1638400K bytes of Crash Files at crashinfo:.
1638400K bytes of Crash Files at crashinfo-1:.
11264000K bytes of Flash at flash:.
11264000K bytes of Flash at flash-1:.

Base Ethernet MAC Address          : 00:aa:6e:f3:02:00
Motherboard Assembly Number        : 73-18140-03
Motherboard Serial Number          : FOC22270RF8
Model Revision Number              : D0
Motherboard Revision Number        : B0
Model Number                       : C9500-40X
System Serial Number               : FCW2229A0RK
CLEI Code Number                   :
```

From this output, you can know the Catalyst 9500 switch series and the serial number.

Step 6 Create a .CSV file with the PID and serial number records for all the CSP devices and Catalyst 9500 switches in a colocation cluster.

For example, from the information available from Steps 4,5, the CSV-formatted file can be as follows:

```
C9500-40,FCW2229A0RK CSP-5444,SN WZP224208MB
```

Note You can create a single .CSV file for all devices in a colocation cluster.

Step 7 Upload all the CSP and switch devices using Cisco vManage. For more information, see Uploading a device authorized serial number file.

After upload, you can see all the CSP and switch devices listed in the table of devices.

Delete Cloud OnRamp for Colocation Devices

To delete the CSP devices from Cisco vManage, perform the following steps:

Before you begin

Ensure that you consider the following:

- If any service chains are attached to a device that is deleted, detach service groups. See Attach or Detach a Service Group in a Cluster, on page 88.

Step 1 From the Cisco vManage menu, choose **Configuration** > **Certificates**.

Step 2 For the desired device, click **...** and choose **Invalid**.

Step 3 In the **Configuration** > **Certificates** window, click **Send to Controller**.

Step 4 In the **Configuration** > **Devices** window, for the desired device, click **...** and choose **Delete WAN Edge**.

Step 5 Click **OK** to confirm the deletion of the device.

Deleting a device removes the serial and chassis numbers from the **WAN edge router serial number** list, and also permanently removes the configuration from Cisco vManage.

Manage Clusters

Use the Cloud onRamp for Colocation screen to configure a colocation cluster and service groups that can be used with the cluster.

The three steps to configure are:

- Create a cluster. See Create and Activate Clusters, on page 50.
- Create a service group. See Create Service Chain in a Service Group, on page 72.
- Attach a cluster with a service group. See Attach or Detach a Service Group in a Cluster, on page 88.

A colocation cluster is a collection of two to eight CSP devices and two switches. The supported cluster templates are:

- Small cluster—2 Cisco Catalyst 9500-40X or Cisco Catalyst 9500-48Y4C+2 CSP
- Medium Cluster—2 Cisco Catalyst 9500-40X or Cisco Catalyst 9500-48Y4C+4 CSP
- Large Cluster—2 Cisco Catalyst 9500-40X or Cisco Catalyst 9500-48Y4C+6 CSP
- X-Large Cluster—2 Cisco Catalyst 9500-40X or Cisco Catalyst 9500-48Y4C+8 CSP

Note Ensure that you add a minimum of two CSP devices one-by-one to a cluster. You can keep adding three, four, and so on, up to a maximum of eight CSP devices. You can edit a Day-N configuration of any cluster, and add pairs of CSP devices to each site up to a maximum of eight CSP devices.

Ensure that all devices that you bring into a cluster have the same software version.

Note You can’t use the CSP-5444 and CSP-5456 devices in the same cluster.

Following are the cluster states:

- Incomplete—When a cluster is created from the Cisco vManage interface without providing the minimum requirement of two CSP devices and two switches. Also, cluster activation is not yet triggered.
- Inactive—When a cluster is created from the Cisco vManage interface after providing the minimum requirement of two CSP devices and two Switches, and cluster activation is not yet triggered.
- Init—When the cluster activation is triggered from the Cisco vManage interface and Day-0 configuration push to the end devices is pending.
- Inprogress—When one of the CSP devices within a cluster comes up with control connections, the cluster moves to this state.
- Pending—When the Day-0 configuration push is pending or VNF install is pending.
- Active—When a cluster is activated successfully and NCS has pushed the configuration to the end device.
- Failure—If Cisco Colo Manager has not been brought up or if any of the CSP devices that failed to receive an UP event.

A cluster transitioning to an active state or failure state is as follows:

- **Inactive** > **Init** > **Inprogress** > **Pending** > **Active**—Success
- **Inactive** > **Init** > **Inprogress** > **Pending** > **Failure**—Failure

Provision and Configure Cluster

This topic describes about activating a cluster that enables deployment of service chains.

To provision and configure a cluster, perform the following:

1. Create a colocation cluster by adding two to eight CSP devices and two switches.

   CSP devices can be added to a cluster and configured using Cisco vManage before bringing them up. You can configure CSP devices and Catalyst 9K switches with the global features such as, AAA, default user (admin) password, NTP, syslog, and more.

2. Configure colocation cluster parameters including IP address pool input such as, service chain VLAN pool, VNF management IP address pool, management gateway, VNF data plane IP pool, and system IP address pool.

3. Configure a service group.

   A service group consists of one or more service chains.

Note You can add a service chain by selecting one of the predefined or validated service chain template, or create a custom one. For each service chain, configure input and output VLAN handoff and service chain throughput or bandwidth, as mentioned.

4. Configure each service chain by selecting each VNF from the service template. Choose a VNF image that is already uploaded to the VNF repository to bring up the VM along with required resources (CPU, memory, and disk). Provide the following information for each VNF in a service chain:

   - The specific VM instance behavior such as, HA, shared VM can be shared across service chains.

- Day-0 configuration values for tokenized keys and not part of the VLAN pool, management IP address, or data HA IP address. The first and last VMs handoff-related information such as peering IP and autonomous system values must be provided. The internal parameters of a service chain are automatically updated by Cisco vBond Orchestrator from the VLAN, or Management, or Data Plane IP address pool provided.

5. Add the required number of service chains for each service group and create the required number of service groups for a cluster.
6. To attach a cluster to a site or location, activate the cluster after all configuration is complete.

   You can watch the cluster status change from In progress to active or error in the **Task View** window.

To edit a cluster:

1. Modify the activated cluster by adding or deleting service groups or service chains.
2. Modify the global features configuration such as, AAA, system setting, and more.

You can predesign a service group and service chain before creating a cluster. You can then attach the service group with a cluster after the cluster is active.

Create and Activate Clusters

This topic provides the steps on how you can form a cluster with CSP devices, Cisco Catalyst switches as a single unit, and provision the cluster with cluster-specific configuration.

Before you begin

- Ensure that you synchronize the clocks for Cisco vManage and CSP devices. To synchronize a clock for CSP devices, configure the NTP server for CSP devices when you enter information about cluster settings.
- Ensure that you configure the NTP server for Cisco vManage and Cisco vBond Orchestrator. To configure the NTP server, see the Cisco SD-WAN System and Interface Configuration Guide.
- Ensure that you configure the OTP for the CSP devices to bring up the CSP devices. See Bring Up Cloud Services Platform in Cisco SD-WAN Cloud OnRamp for Colocation Solution Guide.
- Ensure that you power on both the Catalyst 9500 switches and ensure that they are operational.

Step 1 From the Cisco vManage menu, choose Cisco vManage, click **Configuration** > **Cloud OnRamp for Colocation**.

a) Click **Configure & Provision Cluster**.

b) Provide the following information:

Table 17: Cluster Information

Field	Description
Cluster Name	The cluster name can contain 128 alphanumeric characters.
Description	The description can contain 2048 alphanumeric characters.

Field	Description
Site ID	The overlay network site identifier. Ensure that the value you enter for Site ID is similar to the organizations Site ID structure for the other Cisco SD-WAN overlay elements.
Location	The location can contain 128 alphanumeric characters.
Cluster Type	To configure a cluster in a multitenant mode so that it can be shared across multiple tenants, choose **Shared**. **Note** In the single-tenant mode, the cluster type **Non Shared** is selected by default.

c) To configure switches, click a switch icon in the **Switches** box. In the **Edit Switch** dialog box, enter a switch name and choose the switch serial number from the drop-down list. Click **Save**.

The switch name can contain128 alphanumeric characters.

The switch serial numbers that you view in the drop-down list are obtained and integrated with Cisco vManage using the PnP process. These serial numbers are assigned to switches when you order Cisco SD-WAN Cloud onRamp for Colocation solution PID on the CCW and procure the switch devices.

Note You can keep the serial number field blank for switch devices and CSP devices, design your colocation cluster, and then edit the cluster later to add the serial number after you procure the devices. However, you can’t activate a cluster with the CSP devices or switch devices without the serial numbers.

d) To configure another switch, repeat Step c.

e) To configure CSP devices, click a CSP icon in the **Appliances** box. The **Edit CSP** dialog box is displayed. Provide a CSP device name and choose the CSP serial number from the drop-down list. Click **Save**.

The CSP device name can contain 128 alphanumeric characters.

f) Configure OTP for the CSP devices to bring up the devices.

g) To add remaining CSP devices, repeat Step e.

h) Click **Save**.
After you create a cluster, on the cluster configuration window, an ellipsis enclosed in a yellow circle appears next to a device where the serial number isn't assigned for the device. You can edit a device to enter the serial numbers.

i) To edit a CSP device configuration, click a CSP icon, and perform the process mentioned in substep e.

j) To set the mandatory and optional global parameters for a cluster, on the cluster configuration page, enter the parameters for **Cluster Configuration**. See Cluster Configuration, on page 52.

k) Click **Save**.

You can view the cluster that you created in a table on the cluster configuration page.

Step 2 To activate a cluster,

a) Click a cluster from the cluster table.

b) For the desired cluster, click **…** and choose **Activate**.

When you activate the cluster, Cisco vManage establishes a DTLS tunnel with the CSP devices in the cluster, where it connects with the switches through Cisco Colo Manager. When the DTLS tunnel connection is running, a CSP device in the cluster is chosen to host the Cisco Colo Manager. Cisco Colo Manager starts up and Cisco vManage sends global parameter configurations to the CSP devices and Cisco Catalyst 9500 switches. For information about cluster activation progress, see Progress of Cluster Activation, on page 61.

Note In Cisco vManage Release 20.7.x and earlier releases, the Cisco Colo Manager (CCM) and CSP device configuration tasks time out 30 minutes after the tasks are created. In the case of long-running image installation operations, these configuration tasks may time out and fail, while the cluster activation state continues to be in a pending state.

From Cisco vManage Release 20.8.1, the CCM and CSP device configuration tasks time out 30 minutes after the last heartbeat status message that Cisco vManage received from the target devices. With this change, long-running image installation operations do not cause configuration tasks to fail after a predefined interval of time after task creation.

Cluster Configuration

The cluster configuration parameters are:

Login Credentials

1. On the **Cluster Topology** window, click **Add** next to **Credentials**. In the **Credentials** configuration window, enter the following:
   - (Mandatory) Template Name—The template name can contain 128 alphanumeric characters.
   - (Optional) Description—The description can contain 2048 alphanumeric characters.
2. Click **New User**.
   - In the **Name** field, enter the username.
   - In the **Password** field, enter the password and confirm the password in the **Confirm Password** field.
   - In the **Role** drop-down list, select administrators.
3. Click **Add**.

   The new user with username, password, and role with action appears.
4. Click **Save**.

   The login credentials for the new user are added.
5. To cancel the configuration, click **Cancel**.
6. To edit the existing credential for the user, click **Edit** and save the configuration.

Resource Pool

1. On the **Cluster Topology** window, click **Add** next to **Resource Pool**. In the **Resource Pool** configuration window, enter values for the following fields:
   - Name—The name of the IP address pool should contain 128 alphanumeric characters.
   - Description—The description can contain 2048 alphanumeric characters.

2. In the **DTLS Tunnel IP** field, enter the IP addresses to be used for the DTLS tunnel. To enter multiple IP addresses, separate them by commas. To enter a range, separate the IP addresses with a hyphen (for example, 172.16.0.180-172.16.255.190).

3. In the **Service Chain VLAN Pool** field, enter the VLAN numbers to be used for service chains. To enter multiple numbers, separate them by commas. To enter a numeric range, separate the numbers with a hyphen (for example, 1021-2021).

   Consider the following points when entering the VLAN information:

   1002-1005 are the reserved VLAN values, and they shouldn’t be used in the cluster creation VLAN pool.

   Note Valid VNF VLAN pool: 1010-2000 and 1003-2000

   Invalid: 1002-1005 (shouldn’t be used)

   Caution 1002-1005 isn't allowed for configuration. The VLANs tht are allowed should be contiguous.

   Example: Enter data VLAN pool as 1006-2006. Ensure that this VLAN range isn’t used in the Input/Output VLAN during service chain creations.

4. In the **VNF Data Plane IP Pool** field, enter the IP addresses to be used for auto configuring data plane on a VNF interface. To enter multiple IP addresses, separate them by commas. To enter a range, separate the IP addresses with a hyphen (for example, 10.0.0.1-10.0.0.100).

5. In the **VNF Management IP Pool** field, enter the IP addresses to be used for the VNF. To enter multiple IP addresses, separate them by commas. To enter a range, separate the IP addresses with a hyphen (for example, 192.168.30.99-192.168.30.150).

   Note These addresses are IP addresses for secure interfaces.

6. In the **Management Subnet Gateway** field, enter the IP address of the gateway to the management network. It enables DNS to exit the cluster.

7. In the **Management Mask** field, enter the mask value for the failover cluster. For example, /24 and not 255.255.255.0

8. In the **Switch PNP Server IP** field, enter the IP address of the switch device.

   Note The IP address of the switch is automatically fetched from the management pool, which is the first IP address. You can change it if a different IP address is configured in the DHCP server for the switch.

9. Click **Save**.

Port Connectivity

Table 18: Feature History

Feature Name	Release Information	Description
Flexible Topologies	Cisco SD-WAN Release 20.3.1 Cisco vManage Release 20.3.1 Cisco NFVIS Release 4.2.1	This feature provides the ability to flexibly insert the NIC cards and interconnect the devices (CSP devices and Catalyst 9500 switches) within the Cloud onRamp for Colocation cluster. Any CSP ports can be connected to any port on the switches. The Stackwise Virtual Switch Link (SVL) ports can be connected to any port and similarly the uplink ports can be connected to any port on the switches.
Support for SVL Port Configuration on 100G Interfaces	Cisco SD-WAN Release 20.8.1 Cisco vManage Release 20.8.1 Cisco NFVIS Release 4.8.1	With this feature, you can configure SVL ports on 100-G Ethernet interfaces of Cisco Catalyst 9500-48Y4C switches, thus ensuring a high level of performance and throughput.

Prerequisites for Configuring SVL and Uplink Ports

- When configuring the SVL and uplink ports, ensure that the port numbers you configure on Cisco vManage match the physically cabled ports.
- Ensure that you assign serial numbers to both the switches. See Create and Activate Clusters.

Configure SVL and Uplink Ports

- On the **Cluster Topology** window, click **Add** next to **Port Connectivity**.

  In the **Port Connectivity** configuration window, both the configured switches appear. Hover over a switch port to view the port number and the port type.

Note For more information about SVL and uplink ports, see Wiring Requirements in the Cisco SD-WAN Cloud OnRamp for Colocation Solution Guide.

Change Default SVL and Uplink Ports

Before you change the default port number and port type, note the following information about Cisco Catalyst 9500-40X and Cisco Catalyst 9500-48Y4C switches:

- From Cisco vManage Release 20.8.1, you can configure two SVL ports and one Dual-Active Detection (DAD) port when creating a colocation cluster with two Cisco Catalyst 9500-40X switches or two Cisco Catalyst 9500-48Y4C switches.
- To ensure that SVL and DAD ports are configured correctly for Cisco Catalyst 9500-48Y4C switches, note the following information:

    - Configure the SVL ports on same-speed interfaces, that is, either 25-G interfaces or 100-G interfaces. Ensure that both switches have the same configuration.
    - Configure the DAD port only on 25-G interfaces on both switches.
    - In case of an existing cluster, you can change the SVL ports only if it is inactive.
    - A cluster created in releases earlier than Cisco vManage Release 20.8.1 automatically displays two SVL ports and one DAD port after the upgrade to Cisco vManage Release 20.8.1.

- In case of Cisco Catalyst 9500-40X switches, you must configure the SVL and DAD ports on 10-G interfaces on both switches.
- The following are the default SVL, DAD, and uplink ports of Cisco Catalyst 9500 switches:

  Cisco Catalyst 9500-40X

    - SVL ports: Te1/0/38-Te1/0/39, and Te2/0/38-Te2/0/39

      In Cisco vManage Release 20.7.x and earlier releases, the default SVL ports are Te1/0/38-Te1/0/40 and Te2/0/38-Te2/0/40.
    - DAD ports: Te1/0/40 and Te2/0/40
    - Uplink ports: Te1/0/36, Te2/0/36 (input VLAN handoff), Te1/0/37, and Te2/0/37 (output VLAN handoff)

  Cisco Catalyst 9500-48Y4C

    - SVL ports: Hu1/0/49-Hu1/0/50 and Hu2/0/49-Hu2/0/50

      In Cisco vManage Release 20.7.x and earlier releases, the default SVL ports are Twe1/0/46-Twe1/0/48 and Twe2/0/46-Twe2/0/48.
    - DAD ports: Twe1/0/48 and Twe2/0/48
    - Uplink ports: Twe1/0/44, Twe2/0/44 (input VLAN handoff), Twe1/0/45, and Twe2/0/45 (output VLAN handoff) for 25-G throughput.

- I, E, and S represent the ingress, egress, and SVL ports, respectively.
- Ensure that the physical cabling is the same as the default configuration, and click **Save**.

To change the default ports when the connectivity is different for SVL and uplink ports, perform the following:

1. If both the switches are using the same ports:

   a. Click a port on a switch that corresponds to a physically connected port.

   b. To add the port configuration to the other switch, check the **Apply change** check box.

   If both the switches aren’t using the same ports:

   a. Click a port on **Switch1**.

   b. Choose a port type from the **Port Type** drop-down list.

   c. Click a port on **Switch2** and then choose the port type.

2. To add another port, repeat step 1.
3. Click **Save**.
4. To edit port connectivity information, in the **Cluster Topology** window, click **Edit** next to **Port Connectivity**.

Note You can modify the SVL and uplink ports of a cluster when the cluster hasn't been activated.

5. To reset the ports to default settings, click **Reset**.

The remaining ports (SR-IOV and OVS) on the Cisco CSP devices and the connections with switches are automatically discovered using Link Layer Discovery Protocol (LLDP) when you activate a cluster. You don't need to configure those ports.

Cisco Colo Manager (CCM) discovers switch neighbor ports and identifies whether all Niantic and Fortville ports are connected. If any port isn't connected, CCM sends notifications to Cisco vManage that you can view in the task view window.

NTP

Optionally, configure the NTP server for the cluster:

1. On the **Cluster Topology** window, click **Add** next to **NTP**. In the **NTP** configuration window, enter the following:
   - Template Name—Name of the NTP template should be in alphanumeric characters and the name should contain upto 128 characters.
   - Description—The description should be in alphanumeric characters and can be upto 2048 characters.
2. In the **Preferred server** field, enter the IP address of the primary NTP server.
3. In the **Backup server** field, enter the IP address of the secondary NTP server.
4. Click **Save**.

   The NTP servers are added.
5. To cancel the NTP server configuration, click **Cancel**.
6. To edit the NTP server configuration details, click **Edit**.

Syslog Server

Optionally, configure the syslog parameters for the cluster:

1. On the **Cluster Topology** window, click **Add** next to **Syslog**. In the **Syslog** configuration window, enter the following:
   - Template Name—Name of the system template should be in alphanumeric characters and the name can contian upto 128 characters.
   - Description—The description can be up to 2048 characters and can contain only alphanumeric characters.

2. In the **Severity** drop-down list, choose the severity of syslog messages to be logged.
3. To add a new syslog server, click **New Server**.

   Type the IP address of a syslog server.
4. Click **Save**.
5. To cancel the configuration, click **Cancel**.
6. To edit the existing syslog server configuration, click **Edit** and save the configuration.

TACACS Authentication

Table 19: Feature History

Feature Name	Release Information	Description
TACACS Authentication	Cisco SD-WAN Release 20.3.1 Cisco vManage Release 20.3.1	This feature allows you to configure the TACACS authentication for users accessing the Cisco CSP and Cisco Catalyst 9500 devices. Authenticating the users using TACACS validates and secures their access to the Cisco CSP and Cisco Catalyst 9500 devices.

The TACACS authentication determines the valid users who can access the Cisco CSP and Cisco Catalyst 9500 devices after a cluster is active.

Points to consider

- By default, the admin users with Role-based access control (RBAC) are authorized to access the Cisco CSP and Cisco Catalyst 9500 devices.
- Do not configure the same user with different passwords when configuring using TACACS and RBAC. If same user with a different password is configured on TACACS and RBAC, the RBAC user and password authentication is used. For information about how to configure RBAC on the devices, see Login Credentials, on page 52.

To authenticate users:

1. To add TACACS server configuration, on the **Cluster Topology** window, click **Other Settings** > **Add** next to **TACACS**.

   To edit TACACS server configuration, in the **Cluster Topology** window, click **Other Settings** > **Edit** next to **TACACS**.

   In the **TACACS** configuration window, enter information about the following:

   - Template Name—The TACACS template name can contain 128 alphanumeric characters.
   - (Optional) Description—The description can contain 2048 alphanumeric characters.

2. To add a new TACACS server, click **+ New TACACS SERVER**.

   - In **Server IP Address**, enter the IPv4 address.

     Use IPv4 addresses for hostnames of TACACS server.
   - In **Secret** enter the password and confirm the password in **Confirm Secret**.

3. Click **Add**

   The new TACACS server details are listed in the **TACACS** configuration window.

   Note You can add a maximum of four TACACS servers.

4. To add another TACACS server, repeat step 2 to step 3.

   When authenticating users, if the first TACACS server is not reachable, the next server is verified until all the four servers are verified.

5. Click **Save**.

6. To delete a TACACS server configuration, choose a row from the TACACS server details list and click **Delete** under **Action**.

   Note To modify an existing TACACS server information, ensure to delete a TACACS server and then add a new server.

7. To view the TACACS server configuration, in Cisco vManage, click **Configuration** > **Devices**.

   For the desired Cisco CSP device or Cisco Catalyst 9500 switch, click **...** and choose **Running Configuration**.

Backup Server Settings

Points to Consider

- If you don't use an NFS server, Cisco vManage can’t successfully create backup copies of a CSP device for future RMA requirements.
- The NFS server mount location and configurations are same for all the CSP devices in a cluster.
- Don't consider an existing device in a cluster as the replacement CSP device.

  Note If a replacement CSP device isn’t available, wait until the device appears in Cisco vManage.

- Don't attach further service chains to a cluster after you identify that a CSP device in the cluster is faulty.
- The backup operation on a CSP device creates backup files containing NFVIS configuration and VMs (if VMs are provisioned on the CSP device). You can use the following information for reference.
  - An automated backup file is generated and is in the format:

    serial_number + "_" + time_stamp + ".bkup"

    For example,

    ```
    WZP22180EW2_2020_06_24T18_07_00.bkup
    ```

- An internal state model is maintained that specifies the status of the overall backup operation and internal states of each backup component:
  - NFVIS: A configuration backup of the CSP device as an xml file, config.xml.
  - VM_Images: All VNF tar.gz packages in `data/intdatastore/uploads` which are listed individually.
  - VM_Images_Flavors: The VM images such as, img_flvr.img.bkup.
  - Individual tar backups of the VNFs: The files such as, vmbkp.
- The backup.manifest file contains information of files in the backup package and their checksum for verification during restore operation.

To create backup copies of all CSP devices in a cluster, perform the following steps:

1. On the **Cluster Topology** window, click **Add** next to **Backup**.

   To edit backup server settings, on the **Cluster Topology** window, click **Edit** next to **Backup**

   In the **Backup** configuration window, enter information about the following fields:

   - Mount Name—Enter the name of the NFS mount after mounting an NFS location.
   - Storage Space—Enter the disk space in GB.
   - Server IP: Enter the IP address of the NFS server.
   - Server Path: Enter the folder path of the NFS server such as, `/data/colobackup`
   - Backup: Click **Backup** to enable it.
   - Time: Set a time for scheduling the backup operation.
   - Interval: Choose from the options to schedule a periodic backup process.
     - Daily: The first backup is created a day after the backup configuration is saved on the device, and everyday thereafter.
     - Weekly: The first backup is created seven days after the backup configuration is saved on the device, and every week thereafter.
     - Once: The backup copy is created on a chosen day and it's valid for the entire lifetime of a cluster. You can choose a future calendar date.

2. Click **Save**.

3. To view the status of the previous five backup operations, use the **show hostaction backup status** command. To know about the backup status configuration command, see Backup and Restore NFVIS and VM Configurations. To use this command:

   a. In Cisco vManage, click the **Tools** > **SSH Terminal** screen to start an SSH session with Cisco vManage.

   b. Choose the CSP device.

   c. Enter the username and password for the CSP device and click **Enter** to log in to the CSP device and run the **show hostaction backup status** command.

Restore CSP Device

You can perform the restore operation only by using the CLI on the CSP device that you're restoring.

1. Use the **mount nfs-mount storage** command to mount NFS:

   For more information, see Network File System Support.

   Note To access the backup file, the configuration for mounting an NFS file system should match the faulty device. You can view this information from other healthy CSP devices as the NFS mount location and configurations are same for all the CSP devices. To view and capture the information, you can do one of the following:

   - In the **Cluster Topology** window, click **Add** next to **Backup**.
   - Use the **show running-config** command to view the active configuration that is running on a CSP device.

   mount nfs-mount storage { *mount-name* | **server_ip** *server_ip* | **server_path** *server_path* | **storage_space_total_gb** *storage_space_total_gb* | **storage_type** *storage_type* }

   For example, `mount nfs-mount storage nfsfs/ server_ip 172.19.199.199 server_path /data/colobackup/ storage_space_total_gb 100.0 storagetype nfs`

2. Restore the backup information on a replacement CSP device using the **hostaction restore** command:

   For example,

   ```
   hostaction restore except-connectivity file-path
   nfs:nfsfs/WZP22180EW2_2020_06_24T18_07_00.bkup
   ```

   Note Specify the except-connectivity parameter to retain the connectivity with the NFS server mounted in Step 2.

3. Use the **show hostaction backup status** command to view the status of the previous five backup images and their operational status.

   Also, you can view the backup images from the notifications available on the Cisco vManage **Monitor** > **Logs** > **Events** page.

   Note In Cisco vManage Release 20.6.x and earlier releases, you can view the backup images from the notifications available on the Cisco vManage **Monitor** > **Events** page.

4. Use the **show hostaction restore-status** command on the CSP device to view the status of the overall restore process and each component such as system, image and flavors, VM and so on.

5. To fix any failure after viewing the status, perform a factory default reset of the device.

Note The factory default reset sets the device to default configuration. Therefore, before performing the restore operation from Steps 1-4 on the replacement device, verify that all the restore operation prerequisites are met.

To know more about how to configure the restore operation on CSP devices, see Backup and Restore NFVIS and VM Configurations.

Progress of Cluster Activation

Table 20: Feature History

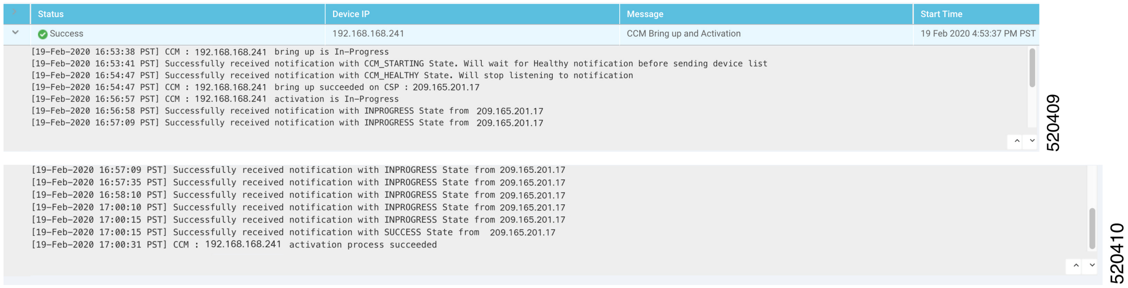
Feature Name	Release Information	Description
Monitor Cluster Activation Progress	Cisco SD-WAN Release 20.1.1	This feature displays the cluster activation progress at each step and shows any failures that may occur during the process. The process of activating a cluster takes approximately 30 minutes or longer, and you can monitor the progress using the Cisco vManage task view window and events from the Monitoring page.

To check cluster activation status after activating a cluster, view the progress on the task view window:

Note In Cisco vManage Release 20.7.x and earlier releases, Cisco Colo Manager (CCM) bring up and activation progress is reported as part of the CLOUD ONRAMP CCM task. This task shows the seven steps in the CCM bring up and activation sequence and indicates whether the sequence was successfully completed or not. The Push Feature Template Configuration task shows the status of the RBAC settings configuration push.

From Cisco vManage Release 20.8.1, CLOUD ONRAMP CCM task is completed when Cisco vManage receives CCM Healthy from the target CSP device. The Push Feature Template Configuration task shows the seven steps in the CCM bring up and activation sequence and indicates whether the sequence was successfully completed or not, along with the status of the RBAC settings configuration push.

Figure 3: Cluster Activation (Cisco vManage Release 20.7.x and earlier)

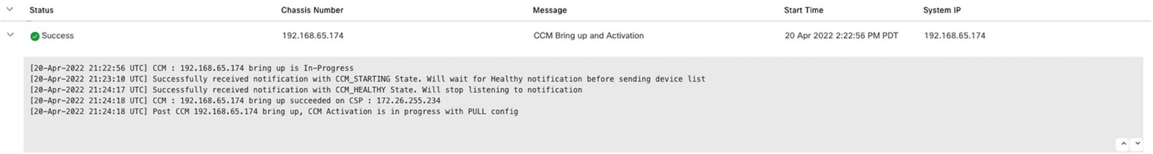


Status	Device IP	Message	Start Time
✓ Success	192.168.168.241	CCM Bring up and Activation	19 Feb 2020 4:53:37 PM PST

```
[19-Feb-2020 16:53:38 PST] CCM : 192.168.168.241  bring up is In-Progress
[19-Feb-2020 16:53:41 PST] Successfully received notification with CCM_STARTING State. Will wait for Healthy notification before sending device list
[19-Feb-2020 16:54:47 PST] Successfully received notification with CCM_HEALTHY State. Will stop listening to notification
[19-Feb-2020 16:54:47 PST] CCM : 192.168.168.241  bring up succeeded on CSP : 209.165.201.17
[19-Feb-2020 16:56:57 PST] CCM : 192.168.168.241  activation is In-Progress
[19-Feb-2020 16:56:58 PST] Successfully received notification with INPROGRESS State from  209.165.201.17
[19-Feb-2020 16:57:09 PST] Successfully received notification with INPROGRESS State from  209.165.201.17
```

```
[19-Feb-2020 16:57:09 PST] Successfully received notification with INPROGRESS State from 209.165.201.17
[19-Feb-2020 16:57:35 PST] Successfully received notification with INPROGRESS State from 209.165.201.17
[19-Feb-2020 16:58:10 PST] Successfully received notification with INPROGRESS State from 209.165.201.17
[19-Feb-2020 17:00:10 PST] Successfully received notification with INPROGRESS State from 209.165.201.17
[19-Feb-2020 17:00:15 PST] Successfully received notification with INPROGRESS State from 209.165.201.17
[19-Feb-2020 17:00:15 PST] Successfully received notification with SUCCESS State from  209.165.201.17
[19-Feb-2020 17:00:31 PST] CCM : 192.168.168.241  activation process succeeded
```

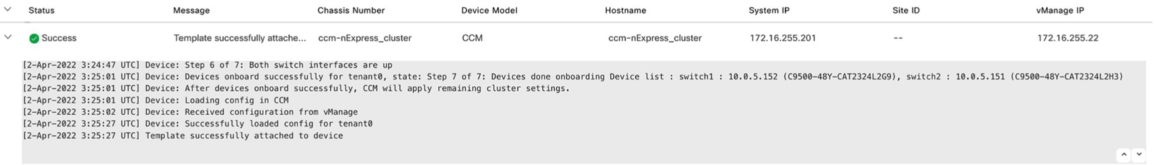
Figure 4: CLOUD ONRAMP CCM Task (Cisco vManage Release 20.8.1 and later)



Status	Chassis Number	Message	Start Time	System IP
✓ Success	192.168.65.174	CCM Bring up and Activation	20 Apr 2022 2:22:56 PM PDT	192.168.65.174

```
[20-Apr-2022 21:22:56 UTC] CCM : 192.168.65.174 bring up is In-Progress
[20-Apr-2022 21:23:10 UTC] Successfully received notification with CCM_STARTING State. Will wait for Healthy notification before sending device list
[20-Apr-2022 21:24:17 UTC] Successfully received notification with CCM_HEALTHY State. Will stop listening to notification
[20-Apr-2022 21:24:18 UTC] CCM : 192.168.65.174 bring up succeeded on CSP : 172.26.255.234
[20-Apr-2022 21:24:18 UTC] Post CCM 192.168.65.174 bring up, CCM Activation is in progress with PULL config
```

Figure 5: Push Feature Template Configuration Task (Cisco vManage Release 20.8.1 and later)



Status	Message	Chassis Number	Device Model	Hostname	System IP	Site ID	vManage IP
✓ Success	Template successfully attache...	ccm-nExpress_cluster	CCM	ccm-nExpress_cluster	172.16.255.201	--	172.16.255.22

```
[2-Apr-2022 3:24:47 UTC] Device: Step 6 of 7: Both switch interfaces are up
[2-Apr-2022 3:25:01 UTC] Device: Devices onboard successfully for tenant0, state: Step 7 of 7: Devices done onboarding Device list : switch1 : 10.0.5.152 (C9500-48Y-CAT2324L2G9), switch2 : 10.0.5.151 (C9500-48Y-CAT2324L2H3)
[2-Apr-2022 3:25:01 UTC] Device: After devices onboard successfully, CCM will apply remaining cluster settings.
[2-Apr-2022 3:25:01 UTC] Device: Loading config in CCM
[2-Apr-2022 3:25:02 UTC] Device: Received configuration from vManage
[2-Apr-2022 3:25:27 UTC] Device: Successfully loaded config for tenant0
[2-Apr-2022 3:25:27 UTC] Template successfully attached to device
```

Perform the following verification steps:

1. To view cluster state and change the state:
   1. From the Cisco vManage menu, choose **Configuration** > **Cloud onRamp for Colocation**. For the cluster that is goes into a "PENDING" state, click **...**, and choose **Sync**. This action moves a cluster back to an "ACTIVE" state.
   2. To view if a cluster moves back to an "ACTIVE" state, you can view the successful activation for the cluster.

2. To view the service groups present on CSP devices, from the Cisco vManage menu, choose **Monitor** > **Devices** > **Colocation Cluster**.

   Cisco vManage Release 20.6.x and earlier: To view the service groups present on CSP devices, from the Cisco vManage menu, choose **Monitor** > **Network** > **Colocation Clusters**.

   Choose a cluster and then choose a CSP device. You can choose and view other CSP devices.

3. To check if cluster is activated from a CSP device:
   1. From the Cisco vManage menu, choose **Configuration** > **Devices**.
   2. View device status of all the CSP devices and ensure that they are in synchronization with Cisco vManage.
   3. View the state of CSP devices and verify that the certificates are installed for CSP devices.

   Note If the state of CSP devices doesn’t show "cert installed" for more than five minutes after CSP activation through OTP, see .

   After a cluster is activated from a CSP device, the Cisco Colo Manager (CCM) performs the cluster activation tasks on the Cisco NFVIS host.

4. To view if CCM is enabled for a CSP device,
   1. From the Cisco vManage menu, choose **Monitor** > **Devices**.

Cisco vManage Release 20.6.x and earlier: From the Cisco vManage menu, choose **Monitor** > **Network**.

b. Click **Colocation Cluster**.

Cisco vManage Release 20.6.x and earlier: Click **Colocation Clusters**.

View whether CCM is enabled for specific CSP devices.

5. To monitor CCM health,

a. From the Cisco vManage menu, choose **Monitor** > **Devices**.

Cisco vManage Release 20.6.x and earlier: From the Cisco vManage menu, choose **Monitor** > **Network**.

b. Click **Colocation Cluster**.

Cisco vManage Release 20.6.x and earlier: Click **Colocation Clusters**.

View whether CCM is enabled for the desired CSP devices.

c. For the CCM-enabled CSP device, click the CSP device.

d. To view CCM health, click **Colo Manager**.

If the Cisco Colo Manager status doesn't change to "HEALTHY" after "STARTING", see the "Troubleshoot Cisco Colo Manager Issues" topic in the Cisco SD-WAN Cloud OnRamp for Colocation Solution Guide .

If the status of Cisco Colo Manager changes to "HEALTHY" after "STARTING" but the status of Cisco Colo Manager shows IN-PROGRESS for more than 20 minutes after the switch configurations are already complete, see the Switch devices are not calling home to PNP or Cisco Colo Manager topic in the Cisco SD-WAN Cloud OnRamp for Colocation Solution Guide.

View Cluster

To view cluster configuration, perform the following steps:

Step 1 From the Cisco vManage menu, choose **Configuration** > **Cloud OnRamp for Colocation**.

Step 2 For the desired cluster, click **...** and choose **View**.

The **Cluster** window displays the switch devices and CSP devices in the cluster and shows the cluster settings that are configured.

You can only view the global parameters of a cluster, configuration of switch devices and CSP devices.

Step 3 Click **Cancel** to return to the **Cluster** window.

Edit Cluster

To modify any existing cluster configuration such as global parameters, perform the following steps:

Step 1 From the Cisco vManage menu, choose **Configuration** > **Cloud OnRamp for Colocation**

Step 2 For the desired cluster, click **...** and choose **Edit**.

The **Cluster** window displays the switch devices and CSP devices in the cluster and shows the cluster settings that are configured.

Step 3 In the cluster design window, you can modify some of the global parameters. Based on whether a cluster is in active or inactive state, you can perform the following operations on a cluster:

a. Inactive state:

- Edit all global parameters, and the Resource Pool parameter.
- Add more CSP devices (up to eight).
- Can’t edit the name or serial number of a switch or CSP device. Instead, delete the CSP or switch and add another switch or CSP with a different name and serial number.
- Delete an entire cluster configuration.

b. Active state:

- Edit all global parameters, except the Resource Pool parameter.

  Note You can't change the Resource pool parameter when the cluster is active. However, the only option to change the Resource Pool parameter is to delete the cluster and recreate it with the correct Resource Pool parameter.

- Can’t edit the name or serial number of a switch or CSP device.
- Can’t delete a cluster in an active state.
- Add more CSP devices (up to eight).

Step 4 Click **Save Cluster**.

Add CSP Device to Cluster

You can add and configure the CSP devices using Cisco vManage.

Before you begin

Ensure that the Cisco NFVIS version that you use is same for all the CSP devices in the cluster.

Step 1 From the Cisco vManage menu, choose **Configuration** > **Cloud OnRamp for Colocation**

Step 2 For the desired cluster, click **...** and choose **Add/Delete CSP**.

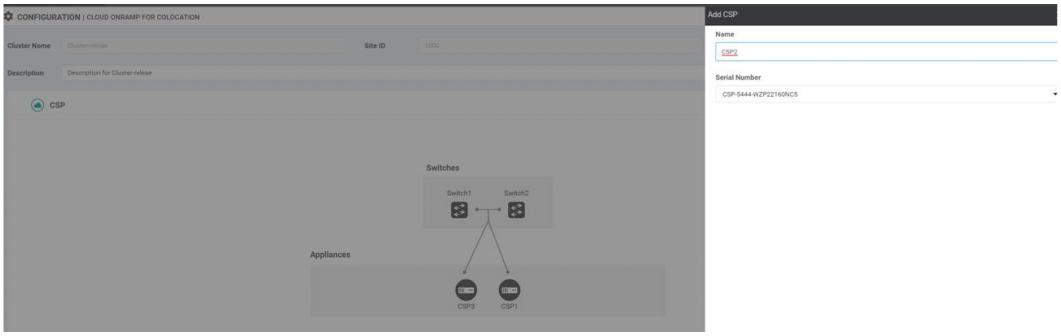
Step 3 To add a CSP device, click **+ Add CSP**. The **Add CSP** dialog box appears. Enter a name and choose the CSP device serial number. Click **Save**.

Step 4 To configure a CSP device, click the CSP icon in the CSP box. The **Edit CSP** dialog box appears. Enter a name and choose the CSP device serial number. Click **Save**.

The name can contain 128 alphanumeric characters.

Note To bring up the CSP devices, ensure that you configure the OTP for the devices.

Figure 6: Add a CSP Device

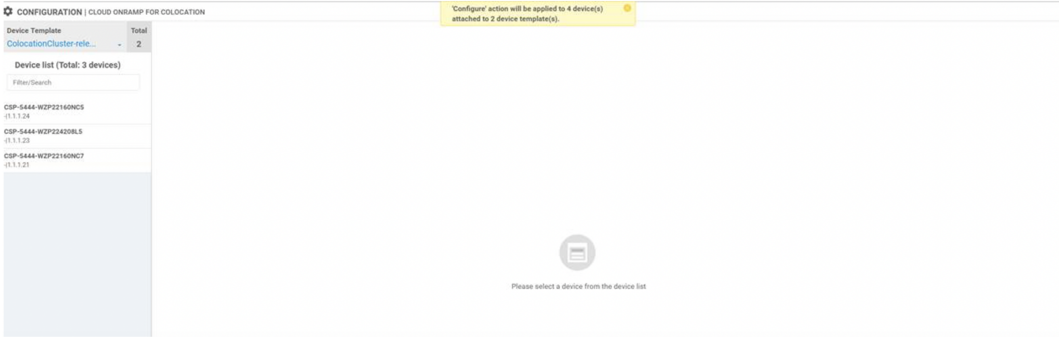


Cluster Name: Cluster-releae
Site ID: 1000
Description: Description for Cluster-releae

Name: CSP2
Serial Number: CSP-5444-WZP22160NC5

Step 5 Click **Save**.

Step 6 After saving, perform the onscreen configuration instructions as shown in the following images:



'Configure' action will be applied to 4 device(s) attached to 2 device template(s).

Device Template	Total
ColocationCluster-rele...	2

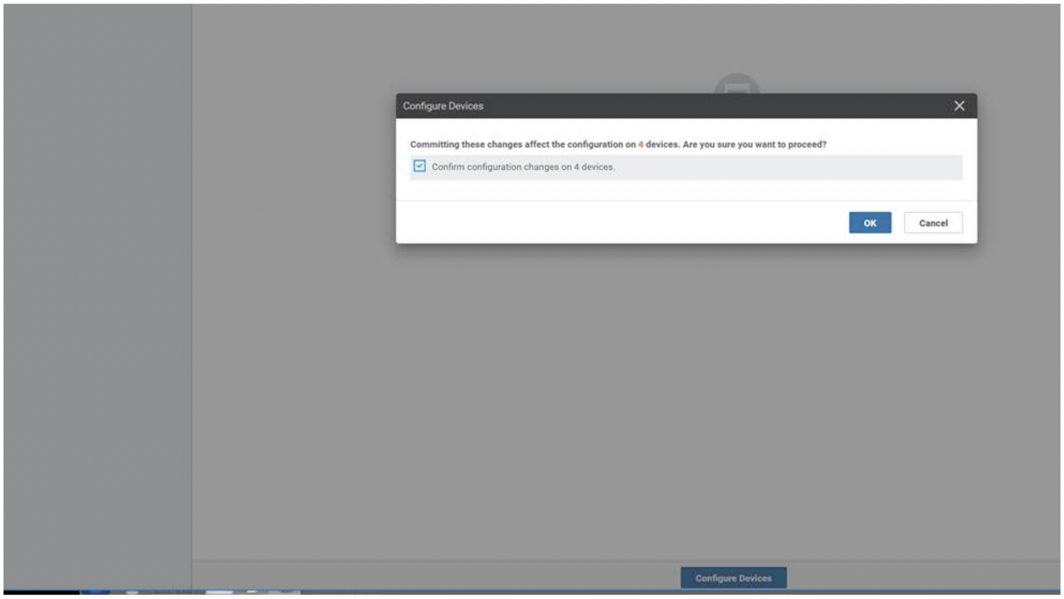
Device list (Total: 3 devices)

CSP-5444-WZP22160NC5
-|1.1.1.24

CSP-5444-WZP224208L5
-|1.1.1.23

CSP-5444-WZP22160NC7
-|1.1.1.21

Please select a device from the device list



Committing these changes affect the configuration on 4 devices. Are you sure you want to proceed?

☑ Confirm configuration changes on 4 devices.

Step 7 To check whether the CSP device is added, use the **Task View** window that displays a list of all running tasks.

Delete CSP Devices from Cluster

You can delete CSP devices using Cisco vManage.

Step 1 From the Cisco vManage menu, choose **Configuration** > **Cloud OnRamp for Colocation**

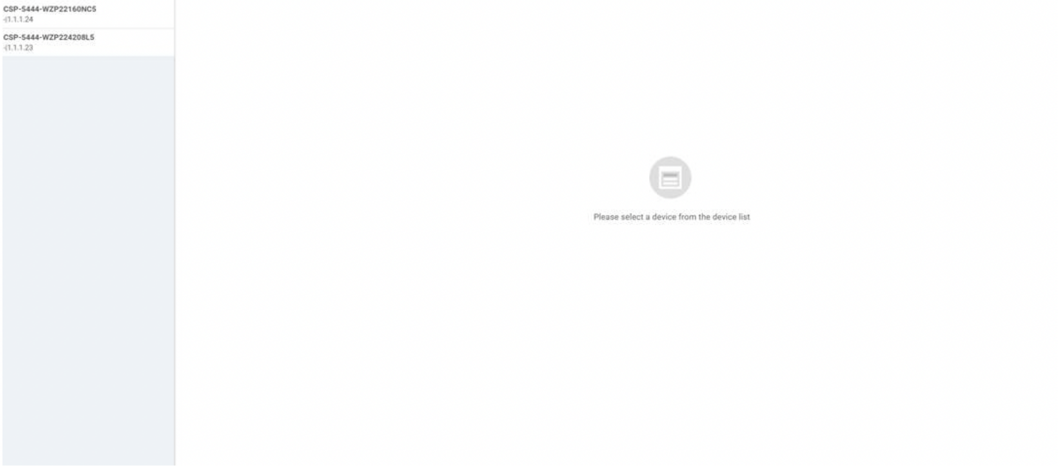
Step 2 For the desired cluster, click **...** and choose **Add/Delete CSP**.

Step 3 To delete a CSP device, click the CSP icon from the **Appliances** box.

Step 4 Click **Delete**.

Step 5 Click **Save**.

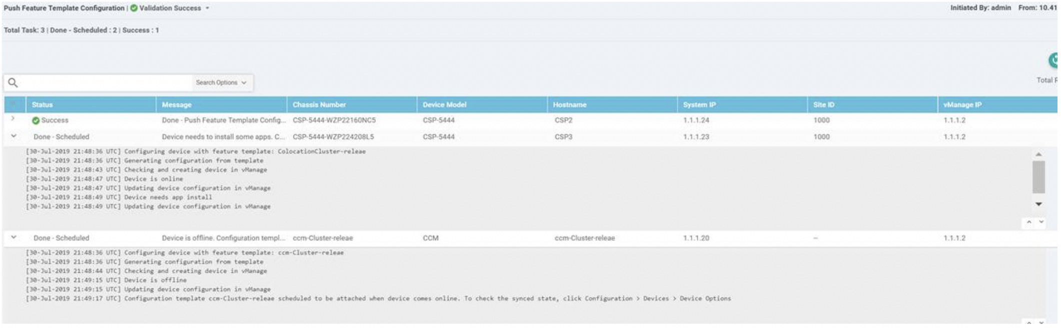
Step 6 Perform the onscreen instructions to proceed with the deletion as shown in the following images.



CSP-5444-WZP22160NC5
1.1.1.24

CSP-5444-WZP224208L5
1.1.1.23

Please select a device from the device list



Push Feature Template Configuration | ✓ Validation Success

Initiated By: admin From: 10.41

Total Task: 3 | Done - Scheduled : 2 | Success : 1

Status	Message	Chassis Number	Device Model	Hostname	System IP	Site ID	vManage IP
✓ Success	Done - Push Feature Template Config...	CSP-5444-WZP22160NC5	CSP-5444	CSP2	1.1.1.24	1000	1.1.1.2
Done - Scheduled	Device needs to install some apps. C...	CSP-5444-WZP224208L5	CSP-5444	CSP3	1.1.1.23	1000	1.1.1.2

```
[30-Jul-2019 21:48:36 UTC] Configuring device with feature template: ColocationCluster-releae
[30-Jul-2019 21:48:36 UTC] Generating configuration from template
[30-Jul-2019 21:48:43 UTC] Checking and creating device in vManage
[30-Jul-2019 21:48:47 UTC] Device is online
[30-Jul-2019 21:48:47 UTC] Updating device configuration in vManage
[30-Jul-2019 21:48:49 UTC] Device needs app install
[30-Jul-2019 21:48:49 UTC] Updating device configuration in vManage
```

Status	Message	Chassis Number	Device Model	Hostname	System IP	Site ID	vManage IP
Done - Scheduled	Device is offline. Configuration templ...	ccm-Cluster-releae	CCM	ccm-Cluster-releae	1.1.1.20	–	1.1.1.2

```
[30-Jul-2019 21:48:36 UTC] Configuring device with feature template: ccm-Cluster-releae
[30-Jul-2019 21:48:36 UTC] Generating configuration from template
[30-Jul-2019 21:48:44 UTC] Checking and creating device in vManage
[30-Jul-2019 21:49:15 UTC] Device is offline
[30-Jul-2019 21:49:15 UTC] Updating device configuration in vManage
[30-Jul-2019 21:49:17 UTC] Configuration template ccm-Cluster-releae scheduled to be attached when device comes online. To check the synced state, click Configuration > Devices > Device Options
```

Step 7 Reset the CSP devices to factory-default settings.

Step 8 To decommission invalid CSP devices, from the Cisco vManage menu, choose **Configuration** > **Devices**.

Step 9 For the CSP devices that are in the deactivated cluster, click the **...** and choose **Decommission WAN Edge**.

This action provides new tokens to the devices.

If an HA service chain is deployed on a CSP device that is deleted, the corresponding HA service chains are deleted from the CSP device that hosts the HA instances.

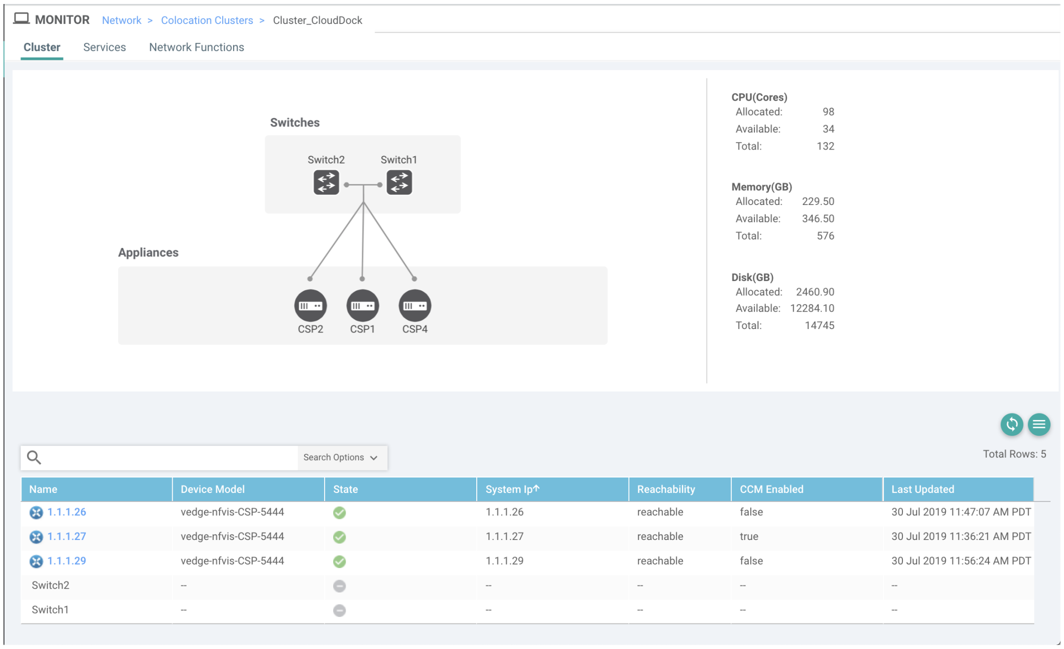
Delete CSP with CCM

Step 1 Determine the CSP device that hosts the CCM.

Step 2 If **CCM Enabled** is true on a CSP device and you decide to delete this CSP device, for the device, click **...** and choose **Add/Delete CSP**.

From the **Montior** window, you can view whether CCM is enabled. The following image shows how where you can view the CCM status.

Figure 7: CSP Device with CCM



CPU(Cores)
Allocated: 98
Available: 34
Total: 132

Memory(GB)
Allocated: 229.50
Available: 346.50
Total: 576

Disk(GB)
Allocated: 2460.90
Available: 12284.10
Total: 14745

Name	Device Model	State	System Ip	Reachability	CCM Enabled	Last Updated
1.1.1.26	vedge-nfvis-CSP-5444	✓	1.1.1.26	reachable	false	30 Jul 2019 11:47:07 AM PDT
1.1.1.27	vedge-nfvis-CSP-5444	✓	1.1.1.27	reachable	true	30 Jul 2019 11:36:21 AM PDT
1.1.1.29	vedge-nfvis-CSP-5444	✓	1.1.1.29	reachable	false	30 Jul 2019 11:56:24 AM PDT
Switch2	--	⊖	--	--	--	--
Switch1	--	⊖	--	--	--	--

When the CSP device that you choose to remove from a cluster, runs the service chain monitoring service and CCM, ensure that you click **Sync** for the cluster. Clicking the sync button starts the service chain health monitoring service on a different CSP device and continues monitoring the existing service chain health.

Ensure that Cisco vManage has control connections to all the CSP devices for a cluster so that it can bring up CCM instance on another CSP device.

Note For Cisco vManage Release 20.8.x and earlier releases, if you delete a CSP device hosting a CCM instance, you have to add a CSP device to bring up the CCM instance on one or more of the CSP devices.

After you delete a CSP device with CCM, the CCM instance starts on another CSP device on the cluster.

Note The service chain monitoring is disabled until the CCM instance doesn't start in any of the remaining CSP devices.

Replace Cisco CSP Devices After RMA

SUMMARY STEPS

1. From the Cisco vManage menu, choose **Configuration** > **Cloud OnRamp for Colocation**
2. For the desired cluster, click **...** and choose **RMA**.
3. Do the following in the **RMA** dialog box:

DETAILED STEPS

Step 1 From the Cisco vManage menu, choose **Configuration** > **Cloud OnRamp for Colocation**

Step 2 For the desired cluster, click **...** and choose **RMA**.

Step 3 Do the following in the **RMA** dialog box:

a) Select Appliance: Choose a CSP device that you want to replace.

All CSP devices in a specific colocation cluster are displayed in the format, CSP Name-<Serial Number>.

b) Choose a serial number for a new CSP device from the drop-down list.

c) Click **Save**.

After saving, you can view the configuration.

Return of Materials of Cisco CSP Devices

Table 21: Feature History

Feature Name	Release Information	Description
RMA Support for Cisco CSP Devices	Cisco SD-WAN Release 20.5.1 Cisco vManage Release 20.5.1	This feature allows you to replace a faulty CSP device by creating backup copies of the device, and then restoring the replacement device to a state it was in before the replacement. The VMs running in HA mode operate uninterrupted with continuous flow of traffic during device replacement.

You can now create backup copies and restore NFVIS configurations and VMs.

Points to Consider

- You can use Network File Storage (NFS) servers to create regular backup copies of the CSP devices.

- If you’re using an external NFS server for the backup operation, ensure that you maintain and clean the NFS directory regularly. This maintenance ensures that the NFS server has sufficient space for the incoming backup packages.
- If you don’t use NFS servers, don't configure the backup server settings using Cisco vManage. However, if you're not configuring the backup server settings, you can't restore the replacement device. You can use delete CSP to remove the faulty device, add a new CSP device, and then start provisioning the service chains onto the added CSP device.

RMA Process for Cisco CSP Devices

Ensure that you perform the Return of Materials (RMA) process in the following order:

1. Create a backup copy of all the CSP devices in a cluster using Cisco vManage. See Backup Server Settings, on page 58.

   Note During CSP device replacement, create a backup copy of the device in the NFS server when creating a cluster using Cisco vManage. Perform one of the following if you’re bringing up a cluster or editing an existing cluster.

   - Bring up a colocation cluster: At the time of cluster creation and activation, provide information about the NFS storage server and backup intervals. If the backup task fails on a CSP device, the device returns an error, but the cluster activation continues. Ensure that you update the cluster after addressing the failure and wait for a successful cluster activation.
   - Edit a colocation cluster: For an existing active cluster, edit the cluster and provide information about the NFS storage server and backup intervals.

2. Contact Cisco Technical Support to get a replacement CSP device. See Cisco Cloud Services Platform 5000 Hardware Installation Guide for more information about replacing a CSP device.
3. Rewire the replacement Cisco CSP device with the Cisco Catalyst 9500 switches to move the wiring of the faulty device to the replacement device.
4. Verify that the Cisco CSP ISO image running on the replacement device is the same that was running on the faulty device.
5. Restore the replacement device using CLI.

Prerequisites and Restrictions for Backup and Restore of CSP Devices

Prerequisites

Backup Operation

- The connectivity to the NFS server from CSP devices should be established before configuring the backup server settings using Cisco vManage.
- The backup directory on the NFS server should have write permission.

- The external NFS server should be available, reachable, and maintained. The maintenance of the external NFS server requires you to check the available storage space and network reachability regularly.
- The schedule for the backup operation should be synced with the local date and time on the CSP device.

Restore Operation

- The replacement device should have the same resources as the faulty device. These resources are, Cisco NFVIS image version, CPU, memory and storage as the faulty CSP device.
- The connectivity between the replacement device and switch ports should be same as the faulty device and switches.
- The PNIC wiring of the replacement device should match the faulty device on the Catalyst 9500 switches.

  For example,

  If slot-1/port-1 (eth1-1) on the faulty device is connected to switch-1 and port, 1/0/1, then connect slot-1/port-1 (eth1-1) of the replacement device to the same switch port, such as switch-1 and port, 1/0/1.
- The onboarding of the replacement device should be completed using the PnP process for CSP devices.
- To prevent the loss of backup access during the restore operation, the configuration for mounting an NFS server to access the backup package should match the configuration on the faulty device.

  You can view configuration information from other CSP devices as the NFS mount location and configurations are same for all the CSP devices. To view the active configuration that is running on a healthy CSP device, use the **show running-config** command. Use this active configuration information when creating a mount point during the restore operation.

  For example,

  ```
  nfvis# show running-config mount
  mount nfs-mount storage nfsfs/
  storagetype            nfs
  storage_space_total_gb 123.0
  server_ip              172.19.199.199
  server_path            /data/colobackup/
  !
  ```
- The authentication of the replacement device with the Cisco SD-WAN controllers using the OTP process should be completed after restoring the replacement device.

Note Use the **request activate chassis-number** *chassis-serial-number* **token** *token-number* command to authenticate a device by logging in to Cisco NFVIS.

- The replacement device shouldn't have any configuration other than the configuration of the faulty device.

Restrictions

Backup Operation

- The periodic backup operation doesn't start during the upgrade of a CSP device.
- If the NFS folder path isn't available on the NFS server, the backup operation doesn't start.

- Only one backup operation can occur at a specific time.
- The backup operation fails if the available disk space on the NFS server is less than the combined size of the VM export size and tar.gz VM packages.
- The backup device information can only be restored on a replacement CSP device and not on any existing device that is already part of the cluster.
- The NFS mount configurations can’t be updated after they are configured for a CSP device. To update, delete the NFS configuration and reapply an updated configuration to the NFS server and reconfigure the backup schedule. Perform this update when the backup operation isn't in progress.

Restore Operation

- Only one restore operation can occur at a specific time.
- If a backup file doesn’t exist in the NFS server, the restore operation doesn't start.
- The restore operation isn't supported when you convert a cluster from a single tenant mode to multitenant mode, and conversely.

Remove Cluster

To decommission an entire cluster , perform the following steps:

Step 1 From the Cisco vManage menu, choose **Configuration** > **Certificates**.

Step 2 Verify the **Validate** column for the CSP devices that you wish to delete, and click **Invalid**.

Step 3 For the invalid devices, click **Send to Controllers**.

Step 4 From the Cisco vManage menu, choose **Configuration** > **Cloud OnRamp for Colocation**.

Step 5 For the cluster that has invalid CSP devices, click **...** and choose **Deactivate**.

If the cluster is attached to one or more service groups, a message appears that displays the service chains hosting the VMs that are running on the CSP device and whether you can continue with the cluster deletion. However, although you confirm the deletion of a cluster, you’re not allowed to remove the cluster without detaching the service groups that are hosted on this CSP device. If the cluster isn’t attached to any service group, a message appears that gets a confirmation from you about the cluster deletion.

Note You can delete the cluster, if necessary, or can keep it in deactivated state.

Step 6 To delete the cluster, choose **Delete**.

Step 7 Click **Cancel** if you don't wish to delete the cluster.

Step 8 To decommission invalid devices, from the Cisco vManage menu, choose **Configuration** > **Devices**.

Step 9 For the devices that are in the deactivated cluster, click **...** and choose **Decommission WAN Edge**.

This action provides new tokens to your devices.

Step 10 Reset the devices to the factory default by using the command:

factory-default-reset all

Step 11 Log into Cisco NFVIS by using **admin** as the login name and **Admin123#** as the default password.

Step 12 Reset switch configuration and reboot switches. See the Troubleshooting chapter in Cisco SD-WAN Cloud OnRamp for Colocation Solution Guide.

Reactivate Cluster

To add new CSP devices or when CSP devices are considered for RMA process, perform the following steps:

Step 1 From the Cisco vManage menu, choose **Configuration** > **Devices**.

Step 2 Locate the devices that are in a deactivated cluster.

Step 3 Get new token from Cisco vManage for the devices.

Step 4 Log into Cisco NFVIS using **admin** as the login name and **Admin123#** as the default password.

Step 5 Use the **request activate chassis-number** *chassis-serial-number* **token** *token-number* command.

Step 6 Use Cisco vManage to configure the colocation devices and activate the cluster. See Create and Activate Clusters, on page 50.

If you've deleted the cluster, recreate and then activate it.

Step 7 From the Cisco vManage menu, choose **Configuration** > **Certificates**. Locate and verify status of the colocation devices.

Step 8 For the desired device that should be valid, click **Valid**.

Step 9 For the valid devices, click **Send to Controllers**.

Manage Service Groups

A service group consists of one or more service chains. You can configure a service group using Cisco vManage. A service chain is the structure of a network service, and consists of a set of linked network functions.

Create Service Chain in a Service Group

A service group consists of one or more service chains.

Table 22: Feature History

Feature Name	Release Information	Feature Description
Monitor Service Chain Health	Cisco SD-WAN Release 19.2.1	This feature lets you configure periodic checks on the service chain data path and reports the overall status. To enable service chain health monitoring, NFVIS version 3.12.1 or later should be installed on all CSP devices in a cluster.

From the Cisco vManage menu, choose **Configuration** > **Cloud OnRamp for Colocation**

a) Click **Service Group** and click **Create Service Group**. Enter the service group name, description, and colocation group.

The service group name can contain 128 alphanumeric characters.

The service group description can contain 2048 alphanumeric characters.

For a multitenant cluster, choose a colocation group or a tenant from the drop-down list. For a single-tenant cluster, the colocation group **admin** is chosen by default.

b) Click **Add Service Chain**.
c) In the **Add Service Chain** dialog box, enter the following information:

Table 23: Add Service Chain Information

Field	Description
Name	The service chain name can contain 128 alphanumeric characters.
Description	The service chain description can contain alphanumeric 2048 characters.
Bandwidth	The service chain bandwidth is in Mbps. The default bandwidth is 10 Mbps and you can configure a maximum bandwidth of 5 Gbps.
Input Handoff VLANS and Output Handoff VLANS	The Input VLAN handoff and output VLAN handoff can be comma-separated values (10, 20), or a range from 10–20.
Monitoring	A toggle button that allows you to enable or disable service chain health monitoring. The service chain health monitoring is a periodic monitoring service that checks health of a service chain data path and reports the overall service chain health status. By default, the monitoring service is disabled. A service chain with subinterfaces such as, SCHM (Service Chain Health Monitoring Service) can only monitor the service chain including the first VLAN from the subinterface VLAN list. The service chain monitoring reports status based on end-to-end connectivity. Therefore, ensure that you take care of the routing and return traffic path, with attention to the Cisco SD-WAN service chains for better results. **Note** • Ensure that you provide input and output monitoring IP addresses from input and output handoff subnets. However, if the first and last VNF devices are VPN terminated, you don't need to provide input and output monitoring IP addresses. For example, if the network function isn’t VPN terminated, the input monitoring IP can be 192.0.2.1/24 from the inbound subnet, 192.0.2.0/24. The inbound subnet connects to the first network function and the output monitoring IP can be, 203.0.113.11/24 that comes from outbound subnet, 203.0.113.0/24 of the last network function of a service chain. • If the first or last VNF firewall in a service chain is in transparent mode, you can't monitor these service chains.

Field	Description
Service Chain	A topology to choose from the service chain drop-down list. For a service chain topology, you can choose any of the validated service chains such as, Router - Firewall - Router, Firewall, Firewall - Router. See the Validated Service Chains topic in Cisco SD-WAN Cloud OnRamp Colocation Solution Guide. You can also create a customized service chain. See Create Custom Service Chain, on page 82.

d) In the **Add Service Chain** dialog box, click **Add**.
Based on the service chain configuration information, a graphical representation of the service group with all the service chains and the VNFs automatically appear in the design view window. A VNF or PNF appears with a "V" or "P" around the circumference for a virtual a physical network function. It shows all the configured service chains within each service group. A check mark next to the service chain indicates that the service chain configuration is complete.

After you activate a cluster, attach it with the service group and enable monitoring service for the service chain, when you bring up the CSP device where CCM is running. Cisco vManage chooses the same CSP device to start the monitoring service. The monitoring service monitors all service chains periodically in a round robin fashion by setting the monitoring interval to 30 minutes. See Monitor Cloud onRamp Colocation Clusters, on page 104.

e) In the design view window, to configure a VNF, click a VNF in the service chain.
The **Configure VNF** dialog box appears.

f) Configure the VNF with the following information and perform the actions, as appropriate:

Note The following fields are available from Cisco vManage Release 20.7.1:

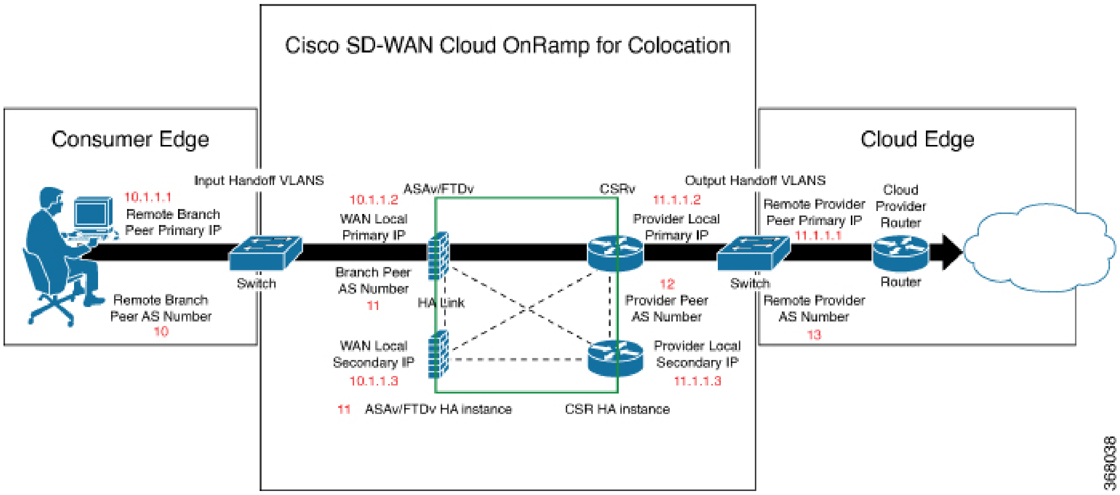
- **Disk Image/Image Package (Select File)**
- **Disk Image/Image Package (Filter by Tag, Name and Version)**
- **Scaffold File (Select File)**
- **Scaffold File (Filter by Tag, Name and Version)**

Table 24: VNF Properties of Router and Firewall

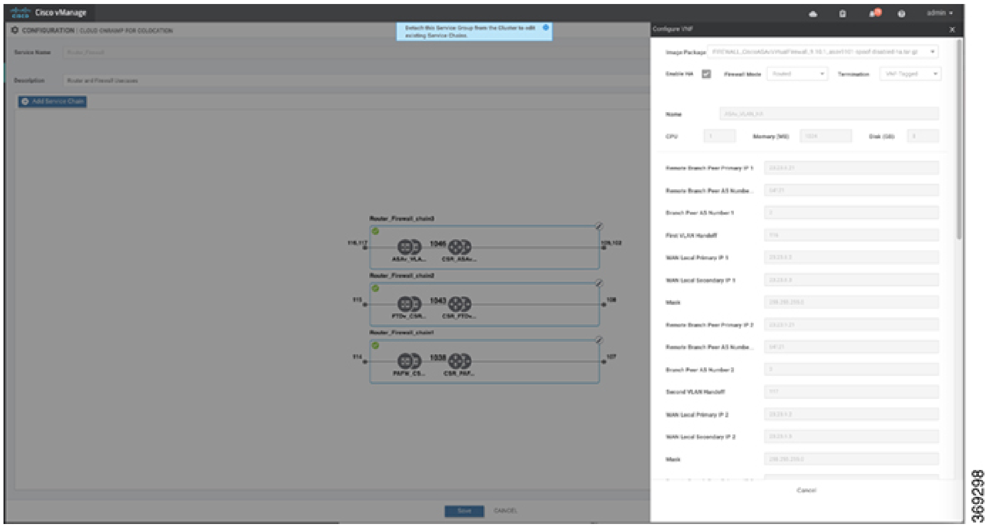
Field	Description
Image Package	Choose a router, firewall package.
Disk Image/Image Package (Select File)	Choose a tar.gz package or a qcow2 image file.
Disk Image/Image Package (Filter by Tag, Name and Version)	(Optional) Filter an image or a package file based on the name, version, and tags that you specified when uploading a VNF image.

Field	Description
Scaffold File (Select File)	Choose a scaffold file. **Note** • This field is mandatory if a qcow2 image file has been chosen. It is optional if a tar.gz package has been chosen. • If you choose both a tar.gz package and a scaffold file, then all image properties and system properties from the scaffold file override the image properties and system properties, including the Day-0 configuration files, specified in the tar.gz package.
Scaffold File (Filter by Tag, Name and Version)	(Optional) Filter a scaffold file based on the name, version, and tags that you specified when uploading a VNF image.
Click **Fetch VNF Properties**. The available information for the image is displayed in the **Configure VNF** dialog box.	
Name	VNF image name
CPU	(Optional) Specifies the number of virtual CPUs that are required for a VNF. The default value is 1 vCPU.
Memory	(Optional) Specifies the maximum primary memory in MB that the VNF can use. The default value is 1024 MB.
Disk	(Optional) Specifies disk in GB required for the VM. The default value is 8 GB.
A dialog box with any custom tokenized variables from Day-0 that requires your input appears. Provide the values.	

In the following image, all IP addresses, VLAN, and autonomous system within the green box are system-specific information that is generated from the VLAN, IP pools provided for the cluster. The information is automatically added into the Day-0 configurations of VMs.



The following images are a sample configuration for VNF IP addresses and autonomous system numbers, in Cisco vManage.



Configure VNF

Image Package: [illegible]

Enable HA ☑ Firewall Mode [illegible] Termination [illegible]

Name [illegible]

CPU [illegible] Memory (MB) [illegible] Disk (GB) [illegible]

Remote Branch Peer Primary IP 1 [illegible]

Remote Branch Peer AS Numbe... [illegible]

Branch Peer AS Number 1 [illegible]

First VLAN Handoff [illegible]

WAN Local Primary IP 1 [illegible]

WAN Local Secondary IP 1 [illegible]

Mask [illegible]

Remote Branch Peer Primary IP 2 [illegible]

Remote Branch Peer AS Numbe... [illegible]

Branch Peer AS Number 2 [illegible]

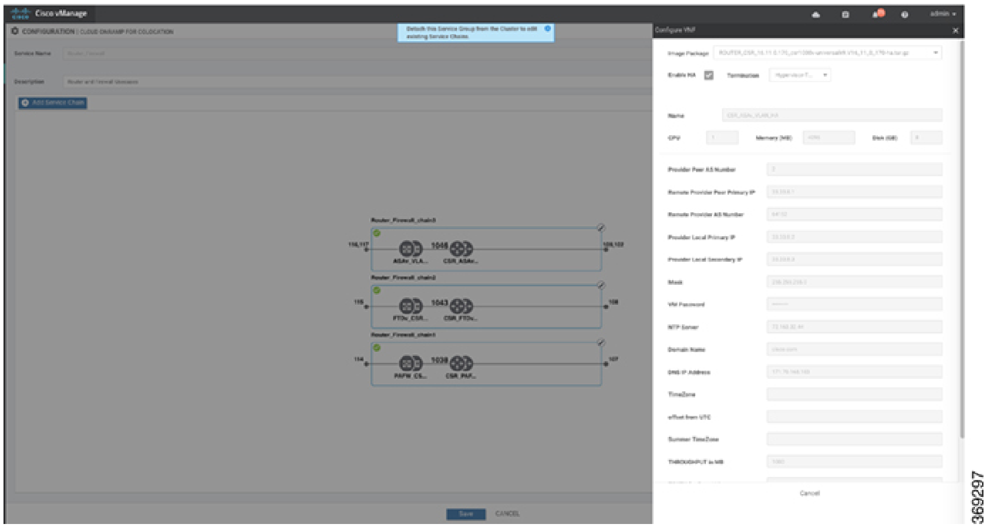
Second VLAN Handoff [illegible]

WAN Local Primary IP 2 [illegible]

WAN Local Secondary IP 2 [illegible]

Mask [illegible]

Cancel



If you're using a multitenant cluster and a comanged scenario, configure the Cisco SD-WAN VM by entering the values for the following fields and the remaining fields, as required for the service chain design:

Note To join the tenant overlay network, the provider should provide correct values for the following fields.

Field	Description
Serial Number	The authorized serial number of a Cisco SD-WAN device. The service provider can get the device serial number from the tenant before creating the service chain.
OTP	The OTP of the Cisco SD-WAN device that is available after authenticating it with Cisco SD-WAN Controllers. The service provider can get the OTP for the corresponding serial number from the tenant before creating the service chain.
Site Id	The identifier of the site in the tenant Cisco SD-WAN overlay network domain in which the Cisco SD-WAN device resides, such as a branch, campus, or data center. The service provider can get the site Id from the tenant before creating the service chain.
Tenant ORG Name	The tenant organization name that is included in the Certificate Signing Request (CSR). The service provider can get the organization name from the tenant before creating the service chain.
System IP connect to Tenant	The IP address to connect to the tenant overlay network. The service provider can get the IP address from the tenant before creating the service chain.
Tenant vBond IP	The IP address of the tenant Cisco vBond Orchestrator. The service provider can get the Cisco vBond Orchestrator IP address from the tenant before creating the service chain.

For edge VMs such as first and last VM in a service chain, you must provide the following addresses as they peer with a branch router and the provider router.

Table 25: VNF Options for First VM in Service Chain

Field	Mandatory or Optional	Description
Firewall Mode	Mandatory	Choose Routed or Transparent mode. **Note** Firewall mode is applicable to firewall VMs only.
Enable HA	Optional	Enable HA mode for the VNF.

Termination	Mandatory	Choose one of the following modes:
		• L3 mode selection with subinterfaces that are in trunk mode
		`<type>selection</type> <val help="L3 Mode With Sub-interfaces(Trunked)" display="VNF-Tagged">vlan</val>`
		• L3 mode with IPSEC termination from a consumer-side and rerouted to the provider gateway
		`<val help="L3 Mode With IPSEC Termination From Consumer and Routed to Provider GW" display="Tunneled">vpn</val>`
		• L3 mode with access mode (nontrunk mode)
		`<val help="L3 Mode In Access Mode (Non-Trunked)" display="Hypervisor-Tagged">routed</val>`

g) Click **Configure**. The service chain is configured with the VNF configuration.
h) To add another service chain, repeat the procedure from Steps b-g.
i) Click **Save**.

The new service group appears in a table under the **Service Group**. To view the status of the service chains that are monitored, use the **Task View** window, which displays a list of all running tasks along with the total number of successes and failures. To determine the service chain health status, use the **show system:system status** command on the CSP device that has service chain health monotioring enabled.

QoS on Service Chains

Table 26: Feature History

Feature Name	Release Information	Description
QoS on Service Chains	Cisco SD-WAN Release 20.1.1	This feature classifies the network traffic based on the Layer 2 virtual local-area network (VLAN) identification number. The QoS policy allows you to limit the bandwidth available for each service chain by applying traffic policing on bidirectional traffic. The bidirectional traffic is the ingress side that connects Cisco Catalyst 9500-40X switches to the consumer and egress side that connects to the provider.

Prerequisites

- Ensure that you use the Quality of Service (QoS) traffic policing on service chains that do not have shared VNF and PNF devices.

Note You cannot apply QoS policy on service chains with shared VNF devices where input and output VLANs are same for multiple service chains.

- Ensure that you use the following versions of software for QoS traffic policing:

Software	Release
Cisco NFVIS Cloud OnRamp for Colocation	4.1.1 and later
Catalyst 9500-40X	16.12.1 and later

The QoS policing policy is applied on the network traffic based on the following workflow:

1. Cisco vManage saves the bandwidth, input, or output VLAN information to VNF and PNF devices. To provide bandwidth and VLAN information, see Create Service Chain in a Service Group, on page 72.

2. CCM saves the bandwidth, input, or output VLAN values information to the Cisco Catalyst 9500-40X or Cisco Catalyst 9500-48Y4C switches.

3. CCM creates corresponding class-maps and policy-maps in Cisco Catalyst 9500-40X or Cisco Catalyst 9500-48Y4C switches based on VLAN match criteria.

4. CCM applies input service-policy on the ingress and egress ports.

Note From Cisco vManage Release 20.7.1, the QoS traffic policy on service chains is not supported for Cisco Catalyst 9500 switches.

- If an active cluster is upgraded to Cisco vManage Release 20.7.1 and CSPs 4.7.1, and if there are service chains provisioned prior to upgrade, the QoS configuration will be removed from switches during the upgrade automatically.
- When new service chains are provisioned in Cisco vManage Release 20.7.1, the QoS policy will not be configured on switches.
- Similarly, new clusters created in Cisco vManage Release 20.7.1 will not configure QoS configuration for service chains on switches.

Clone Service Groups

Table 27: Feature History

Feature Name	Release Information	Description
Clone Service Groups in Cisco vManage	Cisco SD-WAN Release 20.5.1 Cisco vManage Release 20.5.1	This feature allows you to create copies of service groups for different RBAC users, without having to enter the same configuration information multiple times. By cloning a service group, you can easily create service chains by leveraging the stored service chain templates.

When you clone or create copies of service chains, remember the following:

- Cisco vManage copies all configuration information of a service group to a cloned service group regardless of whether the cloned service group is attached to a cluster.
- Verify the CSV file and ensure that configuration information has a matching service group name during CSV file upload. Otherwise, an unmatched service group name can result in an error message during CSV file upload.
- To get an updated list of service group configuration values, always download service group configuration properties from the service group design view.

Step 1 From the Cisco vManage menu, choose **Configuration** > **Cloud OnRamp for Colocation**

Step 2 Click **Service Group**.
The service group configuration page appears and all the service groups are displayed.

Step 3 For the desired service group, click **...** and choose **Clone Service Group**.

A clone of the original service group appears in the service group design view. Note the following points:

- By default, the cloned service group name and VM names are suffixed with a unique string.
- To view any VM configuration, click a VM in service chains.

- Cisco vManage marks the service chains that require configuration as **Unconfigured**, next to the edit button of the service chain.

Step 4 Modify the service group name, if required. Provide a description for the service group.

Step 5 To configure a service chain, use one of the following methods:

- Click the edit button for a service chain, enter the values, and then click **Save**.
- Download the configuration values from a CSV file, modify the values, upload the file, and then click **Save**. See Steps 6, 7, 8 on how to download, modify, and upload a CSV file.

The cloned service group appears on the service group configuration page. You can now download the updated service group configuration values.

Step 6 To download the cloned service group configuration values, do one of the following:

Note The download and upload of a CSV file is supported for creating, editing, and cloning of the service groups that aren't attached to a cluster.

- On the service group configuration page, click a cloned service group, click **More Actions** to the right of the service group, and choose **Download Properties (CSV)**.
- In the service group design view, click **Download CSV** in the upper right corner of the screen.

Cisco vManage downloads all configuration values of the service group to an Excel file in CSV format. The CSV file can consist of multiple service groups and each row represents configuration values for one service group. To add more rows to the CSV file, copy service group configuration values from existing CSV files and paste them in this file.

For example, ServiceGroup1_Clone1 that has two service chains with one VM in each of the service chains is represented in a single row.

Note In the Excel file, the headers and their representation in the service chain design view is as follows:

- sc1/name represents the name of the first service chain.
- sc1/vm1/name represents the name of the first VNF in the first service chain.
- sc2/name represents the name of the second service chain.
- sc2/vm2/name represents the name of the second VNF in the second service chain.

Step 7 To modify service group configuration values, do one of the following:

- To modify the service group configuration in the design view, click a cloned service group from the service group configuration page.

  Click any VM in service chains to modify the configuration values, and then click **Save**.

- To modify the service group configuration using the downloaded Excel file, enter the configuration values in the Excel file manually. Save the Excel file in CSV format.

Step 8 To upload a CSV file that includes all the configuration values of a service group, click a service group in the service group configuration page, and then click **Upload CSV** from the right corner of the screen.

Click **Browse** to choose a CSV file, and then click **Upload**.

You can view the updated values displayed for the service group configuration.

Note You can use the same CSV file to add configuration values for multiple service groups. But, you can update configuration values for a specific service group only, when uploading a CSV file using Cisco vManage.

Step 9 To know the representation of service group configuration properties in the CSV file and Cisco vManage design view, click a service group from the service group configuration page.

Click **Show Mapping Names**.

A text appears next to all the VMs in the service chains. Cisco vManage displays this text after mapping it with the configuration properties in the CSV file.

Create Custom Service Chain

You can customize service chains,

- By including extra VNFs or add other VNF types.
- By creating new VNF sequence that isn't part of the predefined service chains.

Step 1 Create a service group and service chains within the service group. See Create Service Chain in a Service Group, on page 72.

Step 2 In the **Add Service Chain** dialog box, enter the service chain name, description, bandwidth, input VLAN handoff, output VLAN handoff, monitoring health information of a service chain, and service chain configuration. Click **Add**.

For the service chain configuration, choose **Create Custom** from the drop-down. An empty service chain in the design view window is available.

Step 3 To add a VNF such as a router, load balancer, firewall, and others, click a VNF icon and drag the icon to its proper location within the service group box. After adding all required VNFs and forming the VNF service chain, configure each of the VNFs. Click a VNF in the service group box. The **Configure VNF** dialog box appears. Enter the following parameters:

a) Choose the software image to load from the **Disk Image/Image Package** (**Select File**) drop-down list.

Note You can select a qcow2 image file from Cisco vManage Release 20.7.1.

b) Choose a scaffold file from the **Scaffold File** (**Select File**) drop-down list if you have chosen a qcow2 image file.

Note This option is available from Cisco vManage Release 20.7.1.

c) Optionally, filter an image, a package file, or a scaffold file based on the name, version, and tags that you specified when uploading a VNF image.

Note This option is available from Cisco vManage Release 20.7.1.

d) Click **Fetch VNF Properties**.
e) In the **Name** field, enter a name of the VNF.
f) In the **CPU** field, enter the number of virtual CPUs required for the VNF.
g) In the **Memory** field, enter the amount of memory in megabytes to be allocated for the VNF.
h) In the **Disk** field, enter the amount of memory for storage in gigabytes to be allocated for the VNF.
i) Enter VNF-specific parameters, as required.

Note These VNF details are the custom variables that are required for Day-0 operations of the VNF.

j) Click **Configure**.

k) To delete the VNF or cancel the VNF configuration, click **Delete** or **Cancel** respectively.

The customized service chains are added to a service group.

Note You can customize a VNF sequence with only up to four VNFs in a service chain.

Custom Service Chain with Shared PNF Devices

You can customize service chains by adding supported PNF devices.

Caution Ensure that you don't share PNF devices across colocation clusters. A PNF device can be shared across service chains, or across service groups. However, a PNF device can now be shared only across a single cluster.

Table 28: Feature History

Feature Name	Release Information	Feature Description
Manage PNF Devices in Service Chains	Cisco SD-WAN Release 19.2.1	This feature lets you add Physical Network Function (PNF) devices to a network, in addition to the Virtual Network function (VNF) devices. These PNF devices can be added to service chains and shared across service chains, service groups, and a cluster. Inclusion of PNF devices in the service chain can overcome the performance and scaling issues caused by using only VNF devices in a service chain.

Before you begin

For more information about validated physical network functions, see the Validated Physical Network Functions topic in the Cisco SD-WAN Cloud OnRamp for Colocation Solution Guide, Release 19.2 book.

To create a customized service chain by adding a router or firewall to an existing service chain, ensure that you note the following points:

- If a PNF device needs to be managed by Cisco vManage, ensure that the serial number is already available in Cisco vManage, which can then be available for selection during PNF configuration.
- The FTD device can be in any position in a service chain.
- An ASR 1000 Series Aggregation Services Routers can only be in the first and last position in a service chain.
- PNF devices can be added across service chains and service groups.
- PNF devices can be shared across service groups. They can be shared across service groups by entering the same serial numbers.

- PNF devices can be shared across a single colocation cluster, and can't be shared across multiple colocation clusters.

Step 1 Create a service group and service chains within the service group. See Create Service Chain in a Service Group, on page 72.

Step 2 In the **Add Service Chain** dialog box, enter the service chain name, description, bandwidth, input VLAN handoff, output VLAN handoff, monitoring health information of a service chain, and service chain configuration. Click **Add**.

For the service chain configuration, choose **Create Custom** from the drop-down list. An empty service chain in the design view window is available. At the left, a set of VNF devices and PNF devices that you can add into the service chain appears. The 'V' in the circumference of VNF devices represents a VNF and 'P' in the circumference of PNF devices represent a PNF.

Note Ensure that you choose the **Create Custom** option for creating service chains by sharing PNF devices.

Step 3 To add a PNF such as physical routers, physical firewalls in a service chain, click the required PNF icon, and drag the icon to the proper location within the service chain box.

After adding all required PNF devices, configure each of them.

a) Click a PNF device in the service chain box.

The **Configure PNF** dialog box appears. To configure a PNF, enter the following parameters:

b) Check **HA Enabled** if HA is enabled for the PNF device.

c) If the PNF is HA enabled, ensure that you add the HA serial number in **HA Serial**.

If the PNF device is FTD, enter the following information.

1. In the **Name** field, enter a name of the PNF.
2. Choose Routed or Transparent mode as the **Firewall Mode**.
3. In the **PNF Serial** field, enter the serial number of the PNF device.

If the PNF device is ASR 1000 Series Aggregation Services Routers, enter the following information.

1. Check the **vManaged** check box if the device is managed by Cisco vManage.
2. Click **Fetch Properties**.
3. In the **Name** field, enter a name of the PNF.
4. In the **PNF Serial** field, enter the serial number of the PNF device.

d) Click **Configure**.

Step 4 To add service chains and share PNF devices, repeat from Step 2.

Step 5 To edit an existing PNF configuration, click the PNF.

Step 6 In the **Share NF To** drop-down list, choose the service chains with which the PNF should be shared.

After a PNF is shared, if you hover over a PNF, the respective shared PNF devices are highlighted in blue color. However, the PNFs from different service groups aren’t highlighted in blue color. After you choose an NF to be shared, a blue color rim appears. If the same PNF is shared across multiple service chains, it can be used in different positions by dragging and placing the PNF icons in a specific positon.

Figure 8: Single PNF in a Service Chain

The following image shows a service chain that consists of a single PNF, Ftd_Pnf (not shared with other service chains).

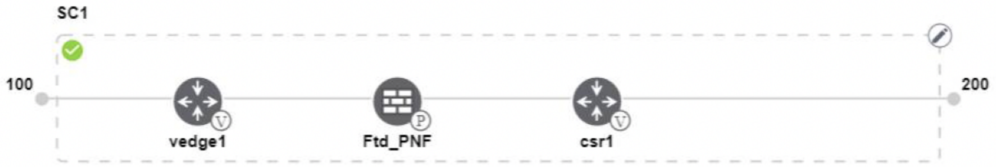


Figure 9: Two PNF Devices in Service Chains

The following image shows service chains that consist of two PNFs, FTdv_PNF shared across service chain 1 (SC1) and service chain 2 (SC2) and ASR_PNF (non-shared).

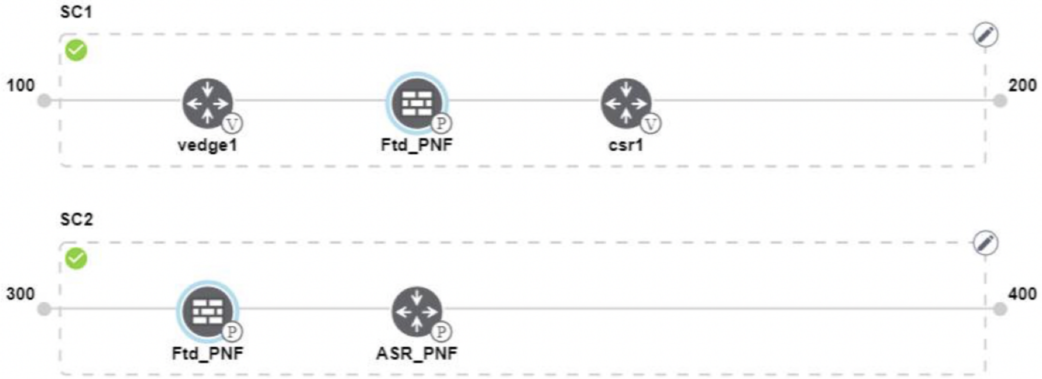
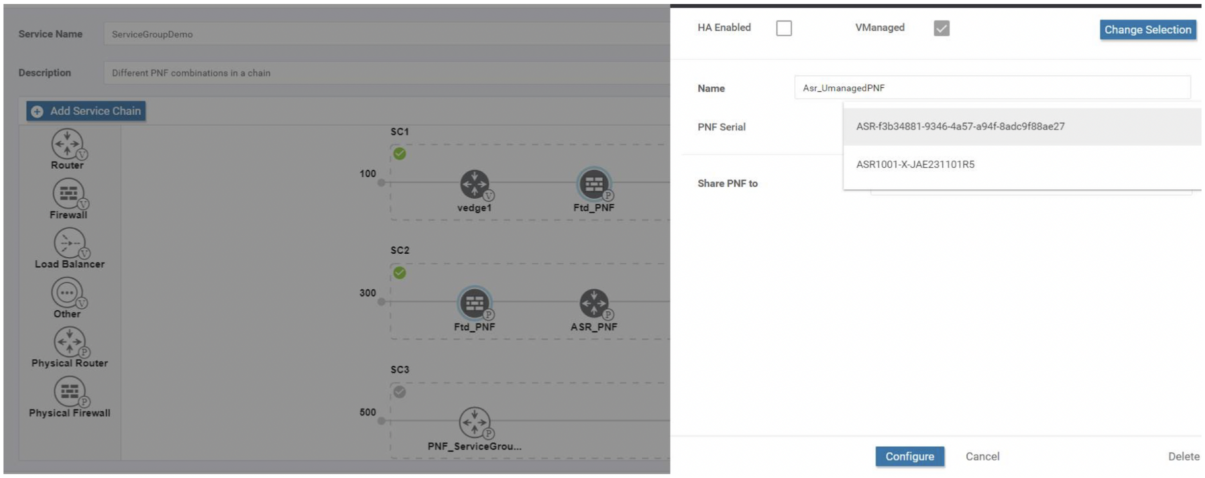


Figure 10: Three PNF Devices in Service Chains

The following image shows service chains that consist of three PNF devices in two different positions along with Cisco vManage configuration.



Service Name: ServiceGroupDemo

Description: Different PNF combinations in a chain

HA Enabled ☐ VManaged ☑

Name: Asr_UmanagedPNF

PNF Serial: ASR-f3b34881-9346-4a57-a94f-8adc9f88ae27 / ASR1001-X-JAE231101R5

Share PNF to

Step 7 To delete or cancel a Network Function configuration, click **Delete** or **Cancel** respectively.

You must attach the service groups to a colocation cluster. After attaching service groups that contain PNF devices, the PNF configuration isn't automatically pushed to the PNF devices unlike VNF devices. Instead, you must manually configure the PNF device by noting configuration that is generated on the Monitor Cloud onRamp Colocation Clusters window. The VLANs must be also configured on the Cisco Catalyst 9500-40X switch devices. See the ASR 1000 Series Aggregation Services Routers Configuration Guides and Cisco Firepower Threat Defense Configuration Guides for more information about the specific PNF configuration.

Custom Service Chain with Shared VNF Devices

You can customize service chains by including supported VNF devices.

Table 29: Feature History

Feature Name	Release Information	Feature Description
Share VNF Devices Across Service Chains	Cisco SD-WAN Release 19.2.1	This feature lets you share Virtual Network Function (VNF) devices across service chains to improve resource utilisation and reduce resource fragmentation.

Before you begin

Ensure that you note the following points about sharing VNF devices:

- You can share only the first, last, or both first and last VNF devices in a service chain.
- You can share a VNF with a minimum of one more service chain and maximum up to five service chains.
- Each service chain can have a maximum of up to four VNF devices in a service chain.
- You can share VNF devices only in the same service group.

Step 1 Create a service group and service chains within the service group. See Create Service Chain in a Service Group, on page 72.

Step 2 In the **Add Service Chain** dialog box, enter the service chain name, description, bandwidth, input VLAN handoff, output VLAN handoff, monitoring health information of a service chain, and service chain configuration. Click **Add**.

For the service chain configuration, choose **Create Custom** from the drop-down list. An empty service chain in the design view window is available. At the left, a set of VNF devices and PNF devices that you can add into the service chain appears. The 'V' in the circumference of VNF devices represents a VNF and 'P' in the circumference of PNF devices represent a PNF.

Note Ensure that you choose the **Create Custom** option for creating a shared VNF package.

Step 3 To add a VNF such as a router, load balancer, firewall, and others, click a VNF icon from the left panel, and drag the icon to a proper location within the service chain box.

After adding all required VNF devices, configure each of them.

a) Click a VNF in the service chain box.

The **Configure VNF** dialog box appears. To configure VNF, enter the following parameters:

b) From the **Image Package** drop-down list, choose the software image to load.

To create a customized VNF package from Cisco vManage, see Create Customized VNF Image, on page 92.

c) Click **Fetch VNF Properties**.
d) In the **Name** field, enter a name of the VNF.
e) In the **CPU** field, enter the number of virtual CPUs required for the VNF.
f) In the **Memory** field, enter the amount of memory in megabytes to be allocated for the VNF.
g) In the **Disk** field, enter the amount of memory for storage in gigabytes to be allocated for the VNF.
h) Enter VNF-specific parameters, as required. See Create Service Chain in a Service Group, on page 72 for more information about VNF-specific properties.

These VNF-specific parameters are the custom user variables that are required for Day-0 operations of a VNF.

For a complete information about the list of user and system variables for different VNF types when located at various positions, see .

Note Ensure that you enter the values of the user variables if they are defined as mandatory, and the system variables are automatically set by Cisco vManage.

i) Click **Configure**.

Step 4 To share VNF devices, repeat from Step 2.

Step 5 To edit an existing VNF configuration, click the VNF.

Step 6 Scroll down the VNF configuration to find the **Share NF To** field. From the **Share NF To** drop-down list, choose the service chains with which the VNF should be shared.

After a VNF is shared, if you hover over a VNF, the specific shared VNF devices are highlighted in blue color. After you choose an NF to be shared, a blue rim appears on it.

Step 7 To delete a VNF or cancel the VNF configuration, click **Delete** or **Cancel** respectively.

You must attach service groups to a cluster.

View Service Groups

To view service groups, perform the following steps:

Step 1 From the Cisco vManage menu, choose **Configuration** > **Cloud OnRamp for Colocation**

Step 2 Click **Service Group**.

Step 3 For the desired service group, click **...** and choose **View**.

You can view the service chains in the design window.

Edit Service Groups

Before attaching a service group with a cluster, you can edit all parameters. After attaching a service group with a cluster, you can only edit monitoring configuration parameters. Also, after attaching a service group, you can only add new service chains but not edit or attach a service chain. Hence, ensure that you detach a service group from a cluster before editing an existing service chain. To edit and delete a service group, perform the following steps:

Step 1 From the Cisco vManage menu, choose **Configuration** > **Cloud OnRamp for Colocation**.

Step 2 Click **Service Group**.

Step 3 For the desired service group, click **...** and choose **Edit**.

Step 4 To modify either service chain configuration or modify a VNF configuration, click a router or firewall VNF icon.

Step 5 To add new service chains, click **Add Service Chain**.

Attach or Detach a Service Group in a Cluster

To complete the Cisco SD-WAN Cloud onRamp for Colocation configuration, you must attach service groups to a cluster. To attach or detach a service group to and from a cluster, perform the following steps:

Step 1 From the Cisco vManage menu, choose **Configuration** > **Cloud OnRamp for Colocation**.

Step 2 Click **...** adjacent to the corresponding cluster and choose **Attach Service Groups**.

Step 3 In the **Attach Service Groups** dialog box, choose one or more service groups in **Available Service Groups** and click **Add** to move the selected groups to **Selected Service Groups**.

Step 4 Click **Attach**.

Step 5 To detach a service group from a cluster, click **...** adjacent to the corresponding cluster and choose **Detach Service Groups**.

You can't attach or detach a single service chain within a service group.

Step 6 In the **Config Preview** window that is displayed, click **Cancel** to cancel the attach or detach task.

Note .

Step 7 To verify if service groups are attached or detached, you can view the status using Cisco vManage. Note the following points:

- If the status of the tasks in the **Task View** window is displayed as **FAILURE** or in **PENDING** for a long duration, see the "Troubleshoot Service Chain Issues" topic in the Cisco SD-WAN Cloud OnRamp for Colocation Solution Guide.
- If a Cisco Colo Manager task fails, see the "Troubleshoot Cisco Colo Manager Issues" topic in the Cisco SD-WAN Cloud OnRamp for Colocation Solution Guide.

If a colocation cluster moves to **PENDING** state, for a cluster, click **...**, and choose **Sync**. This action moves the cluster back to **ACTIVE** state. The **Sync** option keeps Cisco vManage synchronized with the colocation devices.

Manage VM Catalog and Repository

Table 30: Feature History

Feature Name	Release Information	Description
Support for Cisco VM Image Upload in qcow2 Format	Cisco SD-WAN Release 20.7.1 Cisco vManage Release 20.7.1	This feature allows you to upload a virtual machine image to Cisco vManage in qcow2 format. Earlier, you could upload only a prepackaged image file in tar.gz format.

Cisco vManage supports uploading a prepackaged Cisco virtual machine image, tar.gz, or an image in qcow2 format. It is mandatory to upload a scaffold file if you choose a qcow2 image file. Similarly, you can now select either an image package file or a qcow2 image file with a scaffold file when configuring a Virtual Network Function (VNF) during service chain creation.

A scaffold file contains the following components:

- VNF metadata (image_properties.xml)
- System-generated variables from cluster resource pools for service chaining (system_generated_propeties.xml)
- Tokenized Day-0 configuration files
- Package manifest file (package.mf)

Alternatively, you can package the VM image by providing a root disk image in any of the supported formats (qcow2). Use the linux command-line NFVIS VM packaging tool, **nfvpt.py** to package the qcow2 or alternatively create a customized VM image using Cisco vManage. See Create Customized VNF Image, on page 92.

A VM is SR-IOV capable means sriov_supported is set to true in image_properties.xml in the vm package *.tar.gz. Also, the service chain network is automatically connected to SR-IOV network. If sriov_supported is set to false, an OVS network is created on the data port channel. It's attached to VM VNICs for service chaining by using the OVS network. For the Cloud OnRamp for Colocation solution, a VM uses homogeneous type of network in service chains. This type of network means it's either OVS or SR-IOV, and not a combination of SR-IOV and OVS.

Only two data VNICs are attached to any VM–one for inbound traffic and the other for outbound traffic. If more than two data interfaces are required, use subinterfaces configuration within the VM. The VM packages are stored in the VM catalog.

Note Each VM type such as firewall can have multiple VM images that are uploaded to Cisco vManage from same or different vendors and added to a catalog. Also, different versions that are based on the release of the same VM can be added to a catalog. However, ensure that the VM name is unique.

The Cisco VM image format can be bundled as *.tar.gz and can include:

- Root disk images to boot the VM.
- Package manifest for checksum validation of the file listing in the package.
- Image properties file in XML format that lists the VM meta data.
- (Optional) Day-0 configuration, other files that are required to bootstrap the VM.
- (Optional) HA Day-0 configuration if VM supports stateful HA.
- System-generated properties file in XML format that lists the VM system properties.

VM images can be hosted on both HTTP server local repository that Cisco vManage hosts or on the remote server.

If VM is in Cisco NFVIS supported VM package format such as, tar.gz, Cisco vManage performs all the processing and you can provide variable key and values during VNF provisioning.

Note Cisco vManage manages the Cisco VNFs, and the Day-1 and Day-N configurations within VNF aren't supported for other VNFs. See the Cisco NFVIS Configuration Guide, VM Image Packaging for more information about VM package format and content, and samples on image_properties.xml and manifest (package.mf).

To upload multiple packages for the same VM, same version, communication manager (CM) type, ensure that one of the three values (name, version, VNF type) are different. Then, you can repackage the VM *.tar.gz to be uploaded.

Upload VNF Images

The VNF images are stored in the Cisco vManage software repository. These VNF images are referenced during service chain deployment, and then they are pushed to Cisco NFVIS during service chain attachment.

Step 1 From the Cisco vManage menu, choose **Maintenance** > **Software Repository**.

Step 2 To add a prepackaged VNF image, click **Virtual Images**, and then click **Upload Virtual Image**.

Step 3 Choose the location to store the virtual image.

- To store the virtual image on the local Cisco vManage server and download it to CSP devices over a control plane connection, click **vManage**. The **Upload VNF's Package to vManage** dialog box appears.

a. Drag and drop the virtual image file or the qcow2 image file to the dialog box or click **Browse** to choose the virtual image from the local Cisco vManage server. For example, CSR.tar.gz, ASAv.tar.gz, or ABC.qcow2

b. If you upload a file, specify the type of the uploaded file: **Image Package** or **Scaffold**. Optionally, specify a description of the file and add custom tags to the file. The tags can be used to filter images and scaffold files when creating a service chain.

c. If you upload a qcow2 image file, specify the service or VNF type: **FIREWALL** or **ROUTER**. Optionally, specify the following:

   - Description of the image
   - Version number of the image
   - Checksum
   - Hash algorithm

   You can also add custom tags to the file that can be used to filter images and scaffold files when creating a service chain.

   Note
   - It is mandatory to upload a scaffold file if you choose a qcow2 image file.
   - The option to select a qcow2 image file is available from Cisco vManage Release 20.7.1. In Cisco vManage Release 20.6.1 and earlier releases, you can select only a tar.gz file.

d. Click **Upload** to add the image to the virtual image repository. The virtual image repository table displays the added virtual image, and it available for installing on the CSP devices.

- To store the image on a remote Cisco vManage server and then download it to CSP devices, click **Remote Server - vManage**. The **Upload VNF's Package to Remote Server-vManage** dialog box appears.

a. In the **vManage Hostname/IP Address** field, enter the IP address of an interface on Cisco vManage server that is in the management VPN (typically, VPN 512).

b. Drag and drop the virtual image file or the qcow2 image file to the dialog box, or click **Browse** to choose the virtual image from the local Cisco vManage server.

c. If you upload a file, specify the type of the uploaded file: **Image Package** or **Scaffold**. Optionally, specify a description of the file and add custom tags to the file. The tags can be used to filter images and scaffold files when creating a service chain.

d. If you upload a qcow2 image file, specify the service or VNF type: **FIREWALL** or **ROUTER**. Optionally, specify the following:

   - Description of the image
   - Version number of the image
   - Checksum
   - Hash algorithm

   You can also add custom tags to the file that can be used to filter images and scaffold files when creating a service chain.

Note

- It is mandatory to upload a scaffold file if you choose a qcow2 image file.
- The option to select a qcow2 image file is available from Cisco vManage Release 20.7.1. In Cisco vManage Release 20.6.1 and earlier releases, you can select only a tar.gz file.

e. Click **Upload** to add the image to the virtual image repository. The virtual image repository table displays the added virtual image, and it is available for installing on the CSP devices.

You can have multiple VNF entries such as a firewall from same or from different vendors. Also, you can add different versions of VNF that are based on the release of the same VNF. However, ensure that the VNF name is unique.

Create Customized VNF Image

Before you begin

You can upload one or more qcow2 images in addition to a root disk image as an input file along with VM-specific properties, bootstrap configuration files (if any), and generate a compressed TAR file. Through custom packaging, you can:

- Create a custom VM package along with image properties and bootstrap files (if needed) into a TAR archive file.
- Tokenize custom variables and apply system variables that are passed with the bootstrap configuration files.

Ensure that the following custom packaging requirements are met:

- Root disk image for a VNF–qcow2
- Day-0 configuration files–system and tokenized custom variables
- VM configuration–CPU, memory, disk, NICs
- HA mode–If a VNF supports HA, specify Day-0 primary and secondary files, NICs for a HA link.
- Additional Storage–If more storage is required, specify predefined disks (qcow2), storage volumes (NFVIS layer)

Step 1 From the Cisco vManage menu, choose **Maintenance** > **Software Repository** .

Step 2 Click **Virtual Images** > **Add Custom VNF Package**.

Step 3 Configure the VNF with the following VNF package properties and click **Save**.

Table 31: VNF Package Properties

Field	Mandatory or Optional	Description
Package Name	Mandatory	The filename of the target VNF package. It’s the Cisco NFVIS image name with .tar or .gz extensions.

Field	Mandatory or Optional	Description
App Vendor	Mandatory	Cisco VNFs or third-party VNFs.
Name	Mandatory	Name of the VNF image.
Version	Optional	Version number of a program.
Type	Mandatory	Type of VNF to choose. Supported VNF types are: Router, Firewall, Load Balancer, and Other.

Step 4 To package a VM qcow2 image, click **File Upload**, and browse to choose a qcow2 image file.

Step 5 To choose a bootstrap configuration file for VNF, if any, click **Day 0 Configuration** and click **File Upload** to browse and choose the file.

Include the following Day-0 configuration properties:

Table 32: Day-0 Configuration

Field	Mandatory or Optional	Description
Mount	Mandatory	The path where the bootstrap file gets mounted.
Parseable	Mandatory	A Day-0 configuration file can be parsed or not. Options are: **Enable** or **Disable**. By default, **Enable** is chosen.
High Availability	Mandatory	High availability for a Day-0 configuration file to choose. Supported values are: Standalone, HA Primary, HA Secondary.

Note If any bootstrap configuration is required for a VNF, create a *bootstrap-config* or a *day0-config* file.

Step 6 To add a Day-0 configuration, click **Add**, and then click **Save**. The Day-0 configuration appears in the **Day 0 Config File** table. You can tokenize the bootstrap configuration variables with system and custom variables. To tokenize variables of a Day-0 configuration file, click **View Configuration File** next to the desired Day-0 configuration file. In the **Day 0 configuration file** dialog box, perform the following tasks:

Note The bootstrap configuration file is an XML or a text file, and contains properties specific to a VNF and the environment. For a shared VNF, see the topic, Additional References in Cisco SD-WAN Cloud OnRamp for Colocation Solution Guide for the list of system variables that must be added for different VNF types..

a) To add a system variable, in the **CLI configuration** dialog box, select, and highlight a property from the text fields. Click **System Variable**. The **Create System Variable** dialog box appears.

b) Choose a system variable from the **Variable Name** drop-down list, and click **Done**. The highlighted property is replaced by the system variable name.

c) To add a custom variable, in the **CLI configuration** dialog box, choose and highlight a custom variable attribute from the text fields. Click **Custom Variable**. The **Create Custom Variable** dialog box appears.

d) Enter the custom variable name and choose a type from **Type** drop-down list.

e) To set the custom variable attribute, do the following:

- To ensure that the custom variable is mandatory when creating a service chain, click **Type** next to **Mandatory**.
- To ensure that a VNF includes both primary and secondary day-0 files, click **Type** next to **Common**.

f) Click **Done**, and then click **Save**. The highlighted custom variable attribute is replaced by the custom variable name.

Step 7 To upload extra VM images, expand **Advance Options**, click **Upload Image**, and then browse to choose an extra qcow2 image file. Choose the root disk, Ephemeral disk 1, or Ephemeral disk 2, and click **Add**. The newly added VM image appears in the **Upload Image** table.

Note Ensure that you don’t combine ephemeral disks and storage volumes when uploading extra VM images.

Step 8 To add the storage information, expand **Add Storage**, and click **Add volume**. Provide the following storage information and click **Add**. The added storage details appear in the **Add Storage** table.

Table 33: Storage Properties

Field	Mandatory or Optional	Description
Size	Mandatory	The disk size that is required for the VM operation. If the size unit is GiB, the maximum disk size can be 256 GiB.
Size Unit	Mandatory	Choose size unit. The supported units are: MIB, GiB, TiB.
Device Type	Optional	Choose a disk or CD-ROM. By default, disk is chosen.
Location	Optional	The location of the disk or CD-ROM. By default, it’s local.
Format	Optional	Choose a disk image format. The supported formats are: qcow2, raw, and vmdk. By default, it’s raw.
Bus	Optional	Choose a value from the drop-down list. The supported values for a bus are: virtio, scsi, and ide. By default, it’s virtio.

Step 9 To add VNF image properties, expand **Image Properties** and enter the following image information.

Table 34: VNF Image Properties

Field	Mandatory or Optional	Description
SR-IOV Mode	Mandatory	Enable or disable SR-IOV support. By default, it's enabled.
Monitored	Mandatory	VM health monitoring for those VMs that you can bootstrap. The options are: enable or disable. By default, it's enabled.
Bootup Time	Mandatory	The monitoring timeout period for a monitored VM. By default, it's 600 seconds.
Serial Console	Optional	The serial console that is supported or not. The options are: enable or disable. By default, it's disabled.
Privileged Mode	Optional	Allows special features like promiscuous mode and snooping. The options are: enable or disable. By default, it's disabled.
Dedicate Cores	Mandatory	Facilitates allocation of a dedicated resource (CPU) to supplement a VM's low latency (for example, router and firewall). Otherwise, shared resources are used. The options are: enable or disable. By default, it's enabled.

Step 10 To add VM resource requirements, expand **Resource Requirements** and enter the following information.

Table 35: VM Resource Requirements

Field	Mandatory or Optional	Description
Default CPU	Mandatory	The CPUs supported by a VM. The maximum numbers of CPUs supported are 8.
Default RAM	Mandatory	The RAM supported by a VM. The RAM can range 2–32.
Disk Size	Mandatory	The disk size in GB supported by a VM. The disk size can range 4–256.

Field	Mandatory or Optional	Description
Max number of VNICs	Optional	The maximum number of VNICs allowed for a VM. The number of VNICs can from range 8–32 and by default, the value is 8.
Management VNIC ID	Mandatory	The management VNIC ID corresponding to the management interface. The valid range is from 0 to maximum number of VNICs.
Number of Management VNICs ID	Mandatory	The number of VNICs.
High Availability VNIC ID	Mandatory	The VNIC IDs where high availability is enabled. The valid range is from 0–maximum number of VNICs. It shouldn't conflict with management VNIC Id. By default, the value is 1.
Number of High Availability VNICs ID	Mandatory	The maximum number of VNIC IDs where high availability is enabled. The valid range is 0–(maximum number of VNICs-number of management VNICs-2) and by default, the value is 1.

Step 11 To add day-0 configuration drive options, expand **Day 0 Configuration Drive options** and enter the following information.

Table 36: Day-0 Configuration Drive Options

Field	Mandatory or Optional	Description
Volume Label	Mandatory	The volume label of the Day-0 configuration drive. The options are: V1 or V2. By default, the option is V2. V2 is the config-drive label config-2. V1 is config-drive label cidata.
Init Drive	Optional	The Day-0 configuration file as a disk when mounted. The default drive is CD-ROM.
Init Bus	Optional	Choose an init bus. The supported values for a bus are: virtio, scsi, and ide. By default, it's ide.

The Software Repository table displays the customized VNF image, and image is available for choosing when creating a custom service chain.

View VNF Images

Step 1 From the Cisco vManage menu, choose **Maintenance** > **Software Repository**.

Step 2 Click **Virtual Images**.

Step 3 To filter the search results, use the filter option in the search bar.

The Software Version column provides the version of the software image.

The Software Location column indicates where the software images are stored. Software images can be stored either in the repository on the Cisco vManage server or in a repository in a remote location.

The **Version Type Name** column provides the type of firewall.

The **Available Files** column lists the names of the VNF image files.

The **Update On** column displays when the software image was added to the repository.

Step 4 For the desired VNF image, click **...** and choose **Show Info**.

Delete VNF Images

Step 1 From the Cisco vManage menu, choose **Maintenance** > **Software Repository**.

Step 2 Click **Virtual Images**. The images in the repository are displayed in a table.

Step 3 For the desired image, click **...** and choose **Delete**.

Note If you're downloading a VNF image to a device, you can’t delete the VNF image until the download process completes.

Note If the VNF image is referenced by a service chain, it can’t be deleted.

Upgrade Cisco NFVIS Using Cisco vManage

To upload and upgrade Cisco NFVIS, the upgrade image must be available as an archive file that can be uploaded to the Cisco vManage repository using Cisco vManage. After you upload the Cisco NFVIS image, the upgraded image can be applied to a CSP device by using the **Software Upgrade** window in Cisco vManage. You can perform the following tasks when upgrading Cisco NFVIS software using Cisco vManage:

- Upload Cisco NFVIS upgrade image. See Upload NFVIS Upgrade Image, on page 98.

- Upgrade a CSP device with the uploaded image. See Upgrade a CSP Device with a Cisco NFVIS Upgrade Image, on page 98.
- View the upgrade status for the CSP device by clicking the Tasks icon located in the Cisco vManage toolbar.

Upload NFVIS Upgrade Image

Step 1 Download the Cisco NFVIS upgrade image from a prescribed location to your local system. You can also download the software image to an FTP server in your network.

Step 2 From the Cisco vManage menu, choose **Maintenance** > **Software Repository** .

Step 3 Click **Add New Software** > **Remote Server/Remote Server - vManage**.

You can either store the software image on a remote file server, on a remote Cisco vManage server, or on a Cisco vManage server.

Cisco vManage server: Saves software images on a local Cisco vManage server.

Remote server: Saves the URL pointing to the location of the software image and can be accessed using an FTP or HTTP URL.

Remote Cisco vManage server: Saves software images on a remote Cisco vManage server and location of the remote Cisco vManage server is stored in the local Cisco vManage server.

Step 4 To add the image to the software repository, browse and choose the Cisco NFVIS upgrade image that you had downloaded in Step1.

Step 5 Click **Add|Upload**.

The Software Repository table displays the added NFVIS upgrade image, and it's available for installing on the CSP devices. See the Software Repository topic in the Cisco SD-WAN Configuration Guides.

Upgrade a CSP Device with a Cisco NFVIS Upgrade Image

Before you begin

Ensure that the Cisco NFVIS software versions are the files that have `.nfvispkg` extension.

Step 1 From the Cisco vManage menu, choose **Maintenance** > **Software Upgrade** > **WAN Edge**.

Step 2 Check one or more CSP device check boxes for the devices you want to choose.

Step 3 Click **Upgrade**. The **Software Upgrade** dialog box appears.

Step 4 Choose the Cisco NFVIS software version to install on the CSP device. If software is located on a remote server, choose the appropriate remote version.

Step 5 To automatically upgrade and activate with the new Cisco NFVIS software version and reboot the CSP device, check the **Activate and Reboot** check box.

If you don't check the **Activate and Reboot** check box, the CSP device downloads and verifies the software image. However, the CSP device continues to run the old or current version of the software image. To enable the CSP device to run the new software image, you must manually activate the new Cisco NFVIS software version by choosing the device again and clicking the **Activate** button in the **Software Upgrade** window.

Step 6 Click **Upgrade**.

The **Task View** window displays a list of all running tasks along with total number of successes and failures. The window periodically refreshes and displays messages to indicate the progress or status of the upgrade. You can easily access the software upgrade status window by clicking the **Task View** icon located in the Cisco vManage toolbar.

Note If two or more CSP devices belonging to the same cluster are upgraded, the software upgrade for the CSP devices happens in a sequence.

Note The **Set the Default Software Version** option isn't available for the Cisco NFVIS images.

The CSP device reboots and the new NFVIS version is activated on the device. This reboot happens during the **Activate** phase. The activation can either happen immediately after upgrade if you check the **Activate and Reboot** check box, or by manually clicking **Activate** after choosing the CSP device again.

To verify if CSP device has rebooted and is running, use the task view window. Cisco vManage polls your entire network every 90 seconds up to 30 times and shows the status on th task view window.

Note You can delete a Cisco NFVIS software image from a CSP device if the image version isn't the active version that is running on the device.

Supported Upgrade Scenarios and Recommended Connections

The following are the various upgrade scenarios and cluster states that determine the use of prescriptive or flexible connections.

Table 37: Supported Connections

Cisco vManage	Cisco NFVIS	Cluster State	Supported Connections
Upgrade from Releases 19.3 or 20.1.1.1 to Release 20.3.1	Upgrade from Releases 3.12 or 4.1 to Releases 4.1.1 or 4.2.1	Cluster created and active inCisco vManage Releases 19.3 or 20.1.1.1	Use prescriptive connections
Use the latest Release, 20.3.1	Use the latest Release, 4.2.1	Cluster created and active in Cisco vManage Release 20.3.1	Can use prescriptive or flexible connections
Upgrade from Release 20.1.1.1 to Release 20.3.1	Upgrade from Release 4.1 to Releases 4.1.1 or 4.2.1	Cluster created and active in Cisco vManage Release 20.1.1.1.	Use prescriptive connections

Cisco vManage	Cisco NFVIS	Cluster State	Supported Connections
Upgrade from Release 20.1.1.1 to Release 20.3.1	Upgrade from Release 4.1 to Releases 4.1.1 or 4.2.1	Cluster created and active in Cisco vManage Release 20.1.1.1. To add a new Cisco CSP device after upgrade, see Add Cisco CSP Device to Cluster After Upgrading Cisco vManage and Cisco NFVIS.	Use prescriptive connections
Upgrade from Release 20.1.1.1 to Release 20.3.1	Upgrade from Release 4.1 to Releases 4.1.1 or 4.2.1	Cluster created and active in Cisco vManage Release 20.3.1	Can use prescriptive or flexible connections

Add Cisco CSP Device to Cluster After Upgrading Cisco vManage and Cisco NFVIS

To add a Cisco CSP device to a cluster if the cluster was created before upgrading Cisco vManage to Release 20.3.1, perform the following steps:

1. Connect the cables for the newly added Cisco CSP device according to prescriptive connections.
2. Upgrade Cisco NFVIS to Release 4.2.1
3. Use the following commands on the newly added Cisco CSP device by logging into Cisco NFVIS:
   - **request csp-prescriptive-mode**

     Requests the newly added Cisco CSP device to run in prescriptive mode.
   - **request activate chassis-number** *chassis number* **token** *serial number*

     Activates the Cisco CSP device

     Example

     ```
     request activate chassis-number 71591a3b-7d52-24d4-234b-58e5f4ad0646 token
     e0b6f073220d85ad32445e30de88a739
     ```

Recommendations Prior to Updating a Cluster

- To use an already active cluster when you upgrade to the latest release of the Cisco SD-WAN Cloud onRamp for Colocation solution, ensure that you upgrade Cisco vManage and Cisco NFVIS to the latest releases.
- To create a new cluster when you upgrade to the latest release of the Cisco SD-WAN Cloud onRamp for Colocation solution, ensure that you upgrade Cisco vManage and Cisco NFVIS to the latest releases for flexible connections.

Monitor Operational Status of Cloud OnRamp for Colocation Devices from Cisco vManage

Monitoring colocation devices is the process of reviewing and analyzing a device, such as Cloud Services Platform (CSP) devices and Cisco Colo Manager for health, inventory, availability, and other operation-related processes. You can also monitor the components of CSP devices such as CPU, memory, fan, temperature, and so on. For more information about the Cisco vManage Monitoring screens, see the Cisco SD-WAN Configuration Guides configuration guides.

All notifications are sent to the Cisco vManage notification stream. To use the notification stream command, see Cisco SD-WAN Command Reference.

Step 1 From the Cisco vManage menu, choose **Monitor** > **Devices**.

Cisco vManage Release 20.6.x and earlier: From the Cisco vManage menu, choose **Monitor** > **Network**.

If Cisco vManage can’t reach the CSP devices and Cisco Colo Manager (CCM) cannot reach the switches, the CSP devices and CCM are shown as unreachable.

Step 2 Click a CSP device or a switch from the list by clicking the hostname.

By default, the VNF Status window appears.

Step 3 Click **Select Device** and to filter the search results for devices, use the Filter option in the search bar.

The following are the categories of information about the device that are displayed:

- VNF Status—Displays performance specifications, required resources, and component network functions for each VNF See View Information About VNFs , on page 102.
- Interface—Displays Interface status and statistics See the "View Interfaces" topic in the Cisco SD-WAN Configuration Guides.
- Control Connections—Displays status and statistics for control connections See the View Control Connections topic in the Cisco SD-WAN Configuration Guides.
- System Status—Displays reboot and crash information, hardware component status, and CPU and memory usage. See the View Control Connections topic in the Cisco SD-WAN Configuration Guides.
- Colo Manager—Displays Cisco Colo Manager health status See View Cisco Colo Manager Health, on page 102.
- Events—Displays latest system logging (syslog) events. See the View Events topic in the Cisco SD-WAN Configuration Guides.
- Troubleshooting—Displays information about pings and traceroute traffic connectivity tools See the Troubleshoot a Device topic in the Cisco SD-WAN Configuration Guides.
- Real Time—Displays real-time device information for feature-specific operational commands. See the View Real-Time Data topic in the Cisco SD-WAN Configuration Guides.

Step 4 To monitor colocation clusters, from the Cisco vManage menu, choose **Monitor** > **Devices** and click **Colocation Cluster**.

Cisco vManage Release 20.6.x and earlier: To monitor colocation clusters, from the Cisco vManage menu, choose **Monitor** > **Network** and click **Colocation Clusters**.

Step 5 Click the desired cluster name. See Monitor Cloud onRamp Colocation Clusters, on page 104 for more information.

View Cisco Colo Manager Health

You can view Cisco Colo Manager (CCM) health for a device, CCM host system IP, CCM IP, and CCM state. Reviewing this information can help you to determine which VNF to use when you're designing a network service chain. To view information about VNFs, perform the following steps:

Step 1 From the Cisco vManage menu, choose **Monitor** > **Devices**.

Cisco vManage Release 20.6.x and earlier: From the Cisco vManage menu, choose **Monitor** > **Network**.

The information of all devices is displayed in a tabular format.

Step 2 Click a CSP device from the table.

Step 3 From the left pane, click **Colo Manager**.

The right pane displays information about the memory usage, CPU usage, uptime, and so on, of the colo manager.

View Information About VNFs

Table 38: Feature History

Feature Name	Release Information	Description
VNF States and Color Codes	Cisco SD-WAN Release 20.1.1	This feature allows you to determine the state of a deployed VM using color codes, which you can view on the **Monitor** > **Devices** page. These color codes help you make decisions on creating service chains based on the state of the VM.

Table 39: Feature History

Feature Name	Release Information	Description
Network Utilization Charts for SR-IOV Enabled NICs and OVS Switch	Cisco SD-WAN Release 20.1.1	This feature allows you to view network utilization charts of VM VNICs connected to both SR-IOV enabled NICs and OVS switch. These charts help you determine if the VM utilization is optimal to create service chains.

You can view performance specifications and required resources for each VNF. Reviewing this information can help you to determine which VNF to use when you're designing a network service. To view information about VNFs, perform the following steps:

Step 1 From the Cisco vManage menu, choose **Monitor** > **Devices**.

Cisco vManage Release 20.6.x and earlier: From the Cisco vManage menu, choose **Monitor** > **Network**.

Cisco vManage displays the VNF information in a tabular format. The table includes information such as CPU use, memory consumption, and disk, and other core parameters that define performance of a network service.

Step 2 Click a CSP device from the table.

Step 3 From the left pane, click **VNF Status**.

Step 4 From the table, click the VNF name. Cisco vManage displays information about the specific VNF. You can click the network utilization, CPU utilization, memory utilization, and disk utilization to monitor the VNF resources utilization.

The following VNF information is displayed:

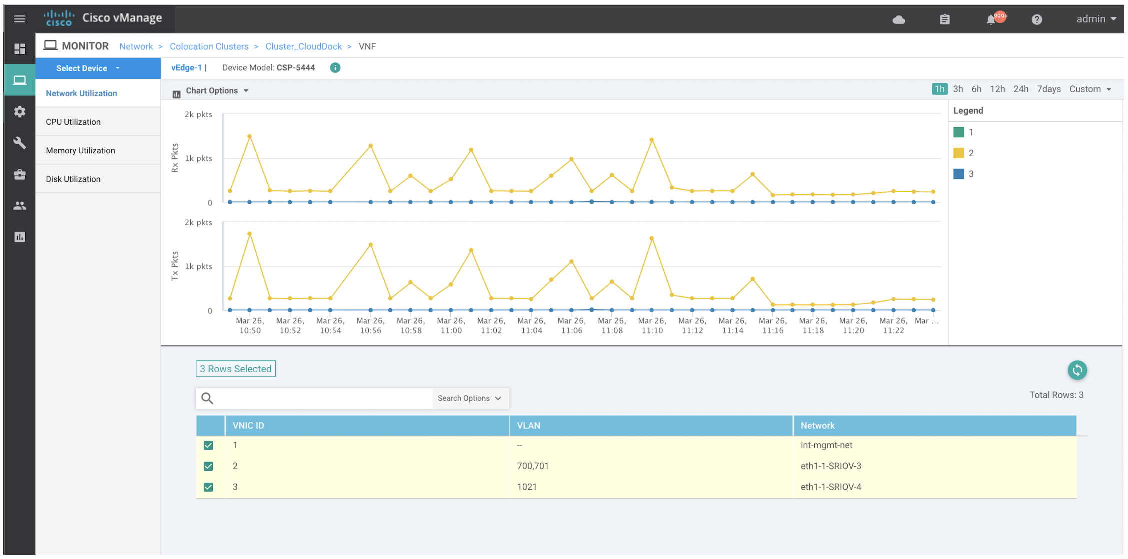
Table 40: VNF Information

Chart options bar	VNF information in graphical format	VNF information in color coded format
• Chart Options drop-down—Click Chart Options drop-down list to select the type of data to display. • Time periods—Click either a predefined time period, or a custom time period for which to display data.	Choose a VNF from the **Select Device** drop-down list to display information for the VNF.	The VNFs are shown in specific colors based on the following operational status of the VNF life cycle: • Green—VNF is healthy, deployed, and successfully booted up. • Red—VNF deployment or any other operation fails, or VNF stops. • Yellow—VNF is transitioning from one state to another.

The right pane displays the following:

- Filter criteria
- VNF table that lists information about all VNFs or VMs. By default, the first six VNFs are selected. The network utilization charts for VNICs connected to SR-IOV enabled NICs and OVS switch are displayed.

Figure 11: VNF Information



	VNIC ID	VLAN	Network
☑	1	--	int-mgmt-net
☑	2	700,701	eth1-1-SRIOV-3
☑	3	1021	eth1-1-SRIOV-4

The graphical display plots information for the VNFs that you have selected by checking the check box.

- Click the check box at the left to select and deselect VNFs. You can select and display information for a maximum of six VNFs at a time.
- To change the sort order of a column, click the column title.

Monitor Cloud onRamp Colocation Clusters

Table 41: Feature History

Feature Name	Release Information	Description
Network Assurance –VNFs: Stop/Start/Restart	Cisco SD-WAN Release 20.3.1 Cisco vManage Release 20.3.1	This feature provides the capability to stop, start, or restart VNFs on Cisco CSP devices from the **Colocation Cluster** tab. You can easily perform the operations on VNFs using Cisco vManage.

You can view the cluster information and their health states. Reviewing this information can help you to determine which Cisco CSP device is responsible for hosting each VNF in a service chain. To view information about a cluster, perform the following steps:

Step 1 From the Cisco vManage menu, choose **Monitor** > **Devices**.

Cisco vManage Release 20.6.x and earlier: From the Cisco vManage menu, choose **Monitor** > **Network**.

Step 2 To monitor clusters, click **Colocation Cluster**.

Cisco vManage Release 20.6.x and earlier: Click **Colocation Clusters**.

All clusters with relevant information are displayed in a tabular format. Click a cluster name. You can monitor cluster by clicking **Config. View** and **Port Level View**.

- **Config. View**: The primary part of the window displays the CSP devices and switch devices that form the cluster. In the right pane, you can view the cluster information such as the available and total CPU resources, available and allocated memory, and so on, based on colocation size.

  The detail part of the window contains:

  - Search: To filter the search results, use the Filter option in the search bar.
  - A table that lists information about all devices in a cluster (Cisco CSP devices, PNFs, and switches).

    Click a Cisco CSP device. VNF information is displayed in a tabular format. The table includes information such as VNF name, service chains, number of CPUs, memory consumption, and other core parameters that define performance of a network service chain. See View Information About VNFs , on page 102 .

    To start, stop, or reboot a VNF, for the desired VNF, click **...** and choose one of the following operations:

    - **Start**.
    - **Stop**.
    - **Restart**.

  Note Ensure that service chain provisioning is complete and VMs are deployed, before issuing start, stop, restart operations on any of the VNFs in the service chain.

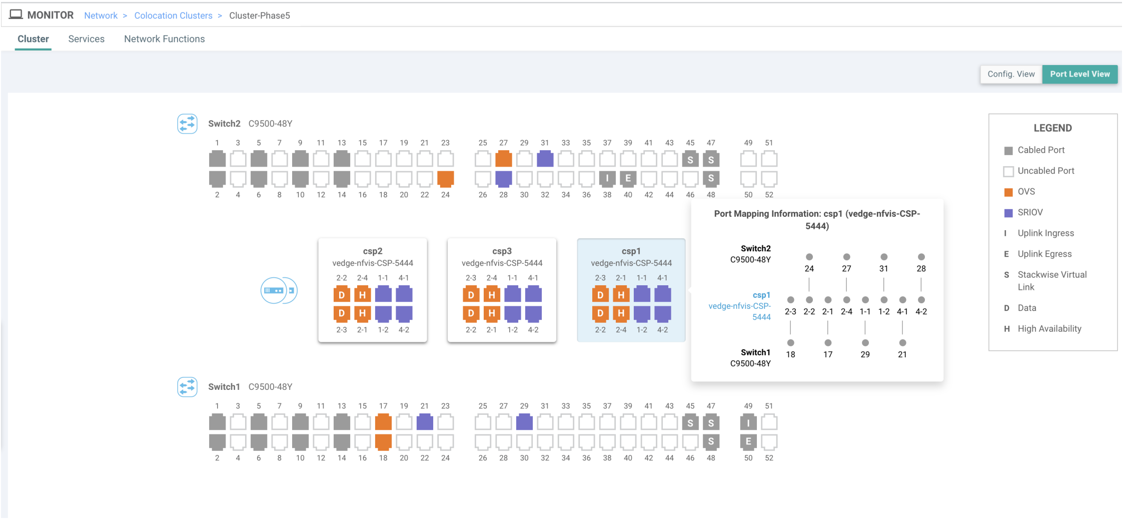
  After you choose an operation on a VNF, wait until the operation is complete before you issue another operation. You can view the progress of an operation from the **Task View** window.

- **Port Level View**: After you activate the cluster, to view the port connectivity details, click **Port Level View**.

  You can view detailed port connectivity information for the switches and CSP devices in a color coded format based on the SR-IOV and OVS modes.

  To view the mapping of ports between the Catalyst 9500 switches and CSP devices, click or hover over a CSP device.

Figure 12: Monitor Port Connectivity Details of a Cluster



Step 3 Click **Services**.

Here, you can view the following:

- Complete information of a service chain. The first two columns display the name and description of the service chain in the service group and the remaining columns mention about the VNF, PNF statuses, monitoring service enablement, and the overall health of a service chain. You can also view the colocation user group associated with a service chain. The various health statuses and their representations are:
  - Healthy—An up arrow in green. A service chain is in 'Healthy' status when all the VNF, PNF devices are running and are in healthy state. Ensure that you configure the routing and policy correctly.
  - Unhealthy—A down arrow in red. If one of the VNFs or PNFs are in unhealthy state, the service chain is reported to be in 'Unhealthy' status. For example, after deploying a service chain, if one of the network function IP address changes on the WAN or LAN side, or the firewall policy isn't configured to let the traffic pass through, then unhealthy state is reported. This is because the network function or overall service chain is Unhealthy or both are in Unhealthy state.
  - Undetermined—Down arrow in yellow. This state is reported when the health of the service chain can't be determined. This state is also reported when there's no status such as healthy or unhealthy available for the monitored service chain over a time period. You can't query or search a service chain with undetermined status.

    If a service chain consists of a single PNF and PNF is outside the reachability of Cisco vManage, it can't be monitored. If a service chain consists of a single network function, the firewall that has VPN termination on both sides which can't be monitored, then it's reported as Undetermined.

    Note If the status of a service chain is undetermined, you can't choose the service chain to view the detailed monitoring information.

- If you had configured a service chain by enabling the monitoring field, then click a service group that is in Healthy or Unhealthy state. The primary part of the service chain monitoring window contains the following elements:

  Graphical display that plots the latency information of the service chain, VNFs, PNFs.

  The detail part of the service chain monitoring window contains:

  - Search: To filter the search results, use the Filter option in the search bar.

  - A table that lists information about all service chains, VNFs, PNFs, their health status, and types.
    - Check the service chain, VNF, PNF check boxes for the service chains, VNFs, PNFs you want to choose.
    - To change the sort order of a column, click the column title.

  The status details column indicates the monitored data path and it provides the per hop analysis.

- Click **Diagram** and view the service group with all the service chains and VNFs in the design view window.
- Click a VNF. You can view CPU, memory, and disk allocated to the VNF in a dialog box.
- Choose a service group from the **Service Groups** drop-down. The design view displays the selected service group with all the service chains and VNFs.

Step 4 Click **Network Functions**.

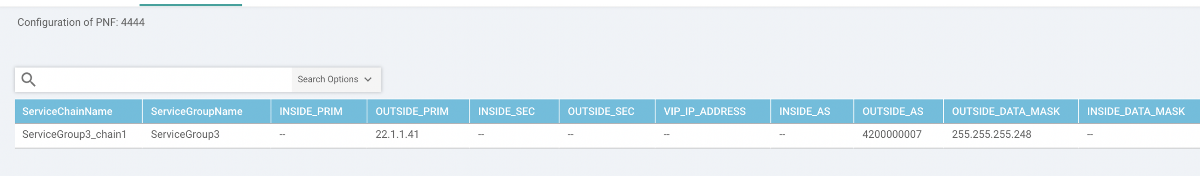
Here, you can view the following:

- All the virtual or physical network functions in a tabular format. Use the **Show** button, and choose to display either a VNF or PNF.

  VNF information is displayed in a tabular format. The table includes information such as VNF name, service chains, colocation user groups, CPU use, memory consumption, and other core parameters that define performance of network service. To view more information about the VNF, click a VNF name. See View Information About VNFs , on page 102 .

- PNF information is displayed in tabular format. The table includes information such as the serial number and PNF type. To view and note configuration of a specific PNF, click the desired PNF serial number. Ensure that you manually note all the configuration of the PNFs and then configure the PNF devices. For example, the following are some of the PNF configuration where you position the PNF at various locations in the service chain. See the ASR 1000 Series Aggregation Services Routers Configuration Guides and Cisco Firepower Threat Defense Configuration Guides to configure the PNFs manually.

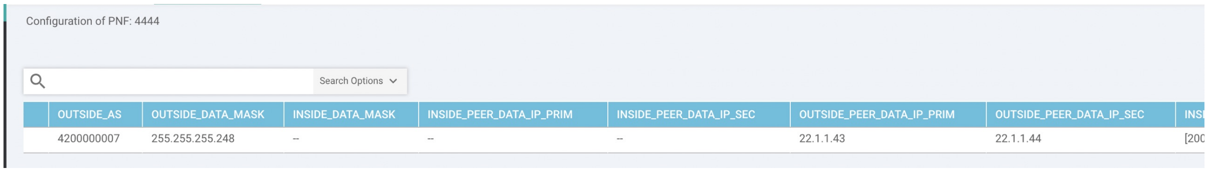
Figure 13: PNF in the First Position with Service Chain Side Parameters



Configuration of PNF: 4444

ServiceChainName	ServiceGroupName	INSIDE_PRIM	OUTSIDE_PRIM	INSIDE_SEC	OUTSIDE_SEC	VIP_IP_ADDRESS	INSIDE_AS	OUTSIDE_AS	OUTSIDE_DATA_MASK	INSIDE_DATA_MASK
ServiceGroup3_chain1	ServiceGroup3	--	22.1.1.41	--	--	--	--	4200000007	255.255.255.248	--

Figure 14: PNF in the First Position with Outside Neighbor Information

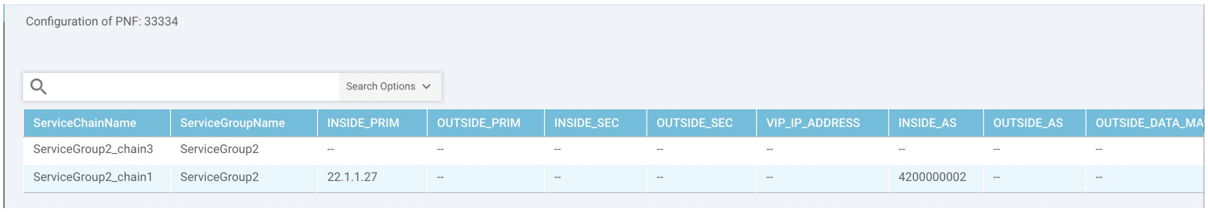


Configuration of PNF: 4444

	OUTSIDE_AS	OUTSIDE_DATA_MASK	INSIDE_DATA_MASK	INSIDE_PEER_DATA_IP_PRIM	INSIDE_PEER_DATA_IP_SEC	OUTSIDE_PEER_DATA_IP_PRIM	OUTSIDE_PEER_DATA_IP_SEC	INSI
	4200000007	255.255.255.248	--	--	--	22.1.1.43	22.1.1.44	[200

Figure 15: PNF Shared Across Two Service Chains

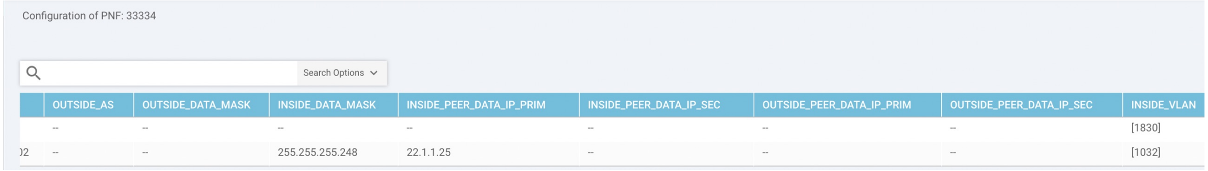
The ServiceGroup2_chain3 is a PNF-only service chain and therefore no configuration gets generated. The PNF is in the last position of the ServiceGroup2_chain1, so only INSIDE variables gets generated.



Configuration of PNF: 33334

ServiceChainName	ServiceGroupName	INSIDE_PRIM	OUTSIDE_PRIM	INSIDE_SEC	OUTSIDE_SEC	VIP_IP_ADDRESS	INSIDE_AS	OUTSIDE_AS	OUTSIDE_DATA_MA
ServiceGroup2_chain3	ServiceGroup2	--	--	--	--	--	--	--	--
ServiceGroup2_chain1	ServiceGroup2	22.1.1.27	--	--	--	--	4200000002	--	--

Figure 16: PNF Shared Across Two Service Chains with Outside Neighbor Information



Configuration of PNF: 33334

	OUTSIDE_AS	OUTSIDE_DATA_MASK	INSIDE_DATA_MASK	INSIDE_PEER_DATA_IP_PRIM	INSIDE_PEER_DATA_IP_SEC	OUTSIDE_PEER_DATA_IP_PRIM	OUTSIDE_PEER_DATA_IP_SEC	INSIDE_VLAN
	--	--	--	--	--	--	--	[1830]
)2	--	--	255.255.255.248	22.1.1.25	--	--	--	[1032]

Packet Capture for Cloud onRamp Colocation Clusters

Table 42: Feature History

Feature Name	Release Information	Description
Packet Capture for Cloud onRamp Colocation Clusters	Cisco SD-WAN Release 20.7.1 Cisco vManage Release 20.7.1	This feature lets you capture packets at either the physical network interface card (PNIC) level or the virtual network interface card (VNIC) level on a Cloud Services Platform (CSP) device of a colocation cluster. You can capture packets on one or more PNIC or VNIC on the same device or different devices with different browsers at the same time. This feature lets you gather information about the packet format, and helps in application analysis, security, and troubleshooting.

You can capture packets flowing to, through, and from a CSP device of a colocation cluster. You can capture packets at either the PNIC or the VNIC level on the CSP device.

Supported Ports for Packet Capture for Cloud onRamp Colocation Clusters

Packet capture is supported for the following ports:

Table 43: Supported Ports for Packet Capture

Mode	VNIC Level	PNIC Level
Single Tenancy	OVS-DPDK, HA-OVS-DPDK, SR-IOV, OVS-MGMT	SR-IOV, MGMT
Multitenancy (Role-Based Access Control)	OVS-DPDK, HA-OVS-DPDK, OVS-MGMT	MGMT

Enable Packet Capture on Cisco vManage

Enable the packet capture feature on Cisco vManage before capturing packets at the PNIC or VNIC level on a CSP device of a colocation cluster:

1. From the Cisco vManage menu, choose **Administration** > **Settings**.
2. In **Data Stream**, choose **Enabled**.

Capture Packets at PNIC Level

1. From the Cisco vManage menu, choose **Monitor** > **Devices**.
2. Click **Colocation Cluster**, and choose a cluster.
3. From the list of devices that is displayed, click a CSP device name.
4. In the left pane, click **Packet Capture**.
5. From the **PNIC ID** drop-down list, choose a PNIC.
6. (Optional) Click **Traffic Filter** to filter the packets that you want to capture based on the values in their IP headers.

   Table 44: Packet Capture Filters

Field	Description
Source IP	Source IP address of the packet.
Source Port	Source port number of the packet.
Protocol	Protocol ID of the packet. The supported protocols are: ICMP, IGMP, TCP, UDP, ESP, AH, ICMP Version 6 (ICMPv6), IGRP, PIM, and VRRP.
Destination IP	Destination IP address of the packet.
Destination Port	Destination port number of the packet.

7. Click **Start**.

   The packet capture begins, and its progress is displayed:

- Packet Capture in Progress: Packet capture stops after the file size reaches 20 MB, or 5 minutes after you started packet capture, or when you click **Stop**.
- Preparing file to download: Cisco vManage creates a file in libpcap format (a .pcap file).
- File ready, click to download the file: Click the download icon to download the generated file.

Capture Packets at VNIC Level

1. From the Cisco vManage menu, choose **Monitor** > **Devices**.
2. Click **Colocation Cluster**, and choose a cluster.
3. From the list of devices that is displayed, click a CSP device name.
4. Choose a VNF, and then click **Packet Capture** in the left pane.
5. Alternatively, choose **Monitor** > **Devices** > **Colocation Cluster**. Next, choose a cluster and click **Network Functions**, choose a VNF, and then click **Packet Capture** in the left pane.
6. From the **VNIC ID** drop-down list, choose a VNIC.
7. (Optional) Click **Traffic Filter** to filter the packets to capture based on values in their IP headers. For more information on these filters, see the above section.
8. Click **Start**. The packet capture begins, and displays its progress.

Cisco SD-WAN Cloud onRamp for Colocation Multitenancy

Table 45: Feature History

Feature Name	Release Information	Description
Colocation Multitenancy Using Role-Based Access Control	Cisco SD-WAN Release 20.5.1 Cisco vManage Release 20.5.1	This feature enables a service provider to manage multiple colocation clusters and share these clusters across tenants by using multiple colocation groups. In a multitenant setup, service providers don't need to deploy a unique colocation cluster for each tenant. Instead, the hardware resources of a colocation cluster are shared across multiple tenants. With multitenancy, service providers ensure that tenants view only their data by restricting access based on roles of individual tenant users.

Overview of Colocation Multitenancy

In Cisco SD-WAN Cloud onRamp for Colocation multitenancy, a service provider can manage multiple colocation clusters using Cisco vManage in single-tenant mode. A service provider can bring up a multitenant cluster in the same way as bringing up a cluster in a single-tenant mode. A multitenant cluster can be shared across multiple tenants. See Create and Activate Clusters.

The tenants share the hardware resources such as the Cisco Cloud Services Platform (CSP) devices and Cisco Catalyst 9500 devices of a colocation cluster. The following are the key points of this feature.

- A service provider deploys and configures the Cisco SD-WAN Controllers (Cisco vManage, Cisco vBond Orchestrator, and Cisco vSmart Controller) with valid certificates.
- A service provider sets up colocation clusters after onboarding the Cisco CSP devices and Cisco Catalyst 9500 switches.
- Cisco SD-WAN operates in a single-tenant mode and Cisco vManage appears in a single-tenant mode.
- In a colocation multitenant deployment, a service provider ensures that tenants see only their service chains by, creating roles. A service provider creates roles for each tenant in a colocation group. These tenants are permitted to access and monitor the service chains based on their roles. However, they can't configure their service chains or change the system-level settings. The roles ensure that tenants can access only the information that they are authorized to view.
- Each tenant traffic is segmented using VXLAN across the compute devices, and VLAN across the Cisco Catalyst switch fabric.
- A service provider can provision service chains on a specific cluster.

The following are the two scenarios of a colocation multitenant setup:

- Service provider owned Cisco SD-WAN devices: In this scenario, the Cisco SD-WAN devices used in a service chain belong to the corresponding service provider. The CSP devices and Catalyst 9500 switches are owned, monitored, maintained by the service provider. The virtual machine (VM) packages are owned, uploaded, and maintained by a service provider. See Monitor Colocation Cluster Devices and Cisco SD-WAN Devices in Comanaged Multitenant Environment, on page 118.
- Comanaged Cisco SD-WAN devices: In this scenario, the Cisco SD-WAN devices that are used in a service chain belong to a tenant overlay network. The colocation cluster devices are owned by the service provider, whereas the Cisco SD-WAN devices of a service chain are controlled by the Cisco SD-WAN Controllers (Cisco vManage, Cisco vBond Orchestrator, and Cisco vSmart Controller) of a tenant. The CSP devices and Catalyst 9500 switches are owned, monitored, maintained by the service provider. The VM packages are owned, uploaded, and maintained by a service provider. See Monitor Colocation Cluster Devices and Cisco SD-WAN Devices in Comanaged Multitenant Environment, on page 118.

Roles and Functionalities in a Multitenant Environment

Multitenant environments include a service provider and multiple tenants. Each role has distinct responsibilities and associated functions.

Service Provider

A service provider owns all the hardware infrastructure and manages the clusters. The service provider also onboards tenants by creating their roles, provisions the service chains for tenants, and can view all the service chains of all the tenants.

A service provider logs in to Cisco vManage as the **admin** user or a user who has the write permission for the manage users permission. A service provider can add, edit, or delete users and user groups from the Cisco vManage server, and is typically responsible for the following activities:

- Create and manage clusters for tenants.

- Upload prepackaged VM image packages and Cisco Enterprise NFV Infrastructure Software (NFVIS) software images on the CSP devices.
- Create custom colocation groups and role-based access control (RBAC) users.
- Create service groups and associate a colocation group to multiple service groups.
- Upgrade CSP devices and Catalyst 9500 switches.
- Monitor service chains and VMs of all the tenants.
- Start, stop, or restart operations on any of the tenant virtual network functions (VNFs).
- Administer Cisco vManage and record system-wide logging of Cisco SD-WAN devices.

Tenants

Tenants can initiate operations on the VNFs for the service chains that belong to themselves, but they can't view, access, or initiate operations on VNFs for the service chains that belong to another tenant. Tenants are responsible for the following activities:

- Monitor all the service groups and the health status of the service chains that belong to themselves.
- Monitor event or alarms for VNFs that are a part of the service chains that belong to themselves.
- Initiate start, stop, or restart operations on VNFs that are a part of the service chains that belongs to themselves.
- Collaborate with the corresponding service provider for issues, if any, on cluster, service chains, or VNFs.

Recommended Specifications in a Multitenant Environment

We recommend that service providers use the following information to decide on the number of tenants, clusters, service chains per tenant, and VLANs for various colocation sizes:

Table 46: Specifications for a Multitenant Environment

Tenants	Clusters (CPUs)	Service Chains (CPUs) per Tenant	VLANs
150	2 (608)	1 (4)–Small	~300
75-150	2 (608)	2-3 (4-8)–Medium	300-450
25-50	2 (608)	4-6 (12-24)–Large	~400
300	4 (1216)	Small	~600
150-300	4 (1216)	Medium	600-900
50-100	4 (1216)	Large	~800
600	8 (2432)	Small	~1200
300-600	8 (2432)	Medium	900-1200
100-200	8 (2432)	Large	~1050

Tenants	Clusters (CPUs)	Service Chains (CPUs) per Tenant	VLANs
750	10 (3040)	Small	~1500
375-750	10 (3040)	Medium	600-1500
125-230	10 (3040)	Large	~1250

For example, if a service provider provisions four vCPUs per tenant for a service chain that consists of a single VM, the service provider can onboard approximately 150 tenants on two clusters with eight CSP devices. Each of these tenants or service chains requires 300 hand-off VLANs, one ingress, and one egress VLAN per service chain. .

Assumptions and Restrictions in Colocation Multitenancy

The following sections provide detailed information about the assumptions and restrictions in a colocation multitenant environment.

Assumptions

- The wiring between Cisco CSP devices and Cisco Catalyst 9500 switches is completed as per the prescriptive connections or flexible topology. To bring up multiple clusters, ensure that the wiring between the CSP devices and Catalyst 9500 switches of a cluster are in the same way as a single cluster. For more information about wiring, see Wiring Requirements.
- Each Cisco CSP device has two 1-GB management ports that are manually configured as port channels to the out of band (OOB) management switch.
- A tenant can only monitor the event or alarms from the **Monitor** window for the VNFs that are a part of the service chains that they own. The tenant-monitoring windows display the corresponding colocation group when a tenant is viewing a service chain.

Note In a comanaged multitenant setup, the service provider provisions service chains for tenants by gathering the required information from tenants. For example, a tenant provides the tenant organization name, tenant Cisco vBond Orchestrator IP address, tenant site ID, system IP address, and so on, out of band. See Create Service Chain in a Service Group, on page 72.

Restrictions

- Altering a colocation cluster from a single-tenant mode to a multitenant mode and conversely isn’t supported.
- Sharing VNF devices across multiple tenants isn't supported.
- Service providers can provision multiple service groups for a tenant. But, the same service group can’t be provisioned for multiple tenants.

- Upgrading from Cisco SD-WAN Cloud onRamp for Colocation Release 20.4.1 having a single-tenant mode, to Release 20.5.1 or later having a multitenant mode isn’t supported. This restriction means you can’t upgrade from a single-tenant mode to multitenant mode.
- Multitenancy in single-root IO virtualization enabled (SR-IOV-enabled) physical network interface cards (PNICs) isn't supported; only open virtual switch (OVS) for VNF VNICs is supported. All the PNICs in the CSP devices are in OVS mode because the current SR-IOV drivers don’t support VXLAN. The VNF VNICs are connected to OVS networks, and the ability to forward traffic at the desired speed might reduce.
- Managing billing and subscription of the resources utilized by tenants isn't supported.
- In a comanaged multitenant setup, a tenant can monitor only the VNF devices that the tenant owns.

Service Provider Functionalities

Provision a New Tenant

The service provider can provision a new tenant by creating a colocation group, and then provide access to a tenant by creating an RBAC user for the user group associated with the colocation group. RBAC users can perform limited administrative duties within their own tenant environment.

Before you begin

A service provider should bring up clusters in shared mode by establishing control connections with the CSP devices and activating the cluster. The service provider can create several clusters, and each of these clusters can have between two to eight CSP devices and two Catalyst 9500 switches. The cluster-creation operation supports an option to choose if the cluster is for a multitenant or a single-tenant deployment. See Create and Activate Clusters.

Step 1 To onboard a tenant, create a colocation group. For more information, see Create Colocation Group . This group provides access to tenants to monitor their service groups and VMs.

Step 2 Add an RBAC user and associate it with the colocation group created in Step 1. For more information, see Create an RBAC User and Associate to Colocation Group.

Note Don't add an RBAC user if you're authenticating the user using the TACACS server instead of Cisco vManage. If you're authenticating a user using a TACACS server, associate the user with the colocation group created in Step 1.

Step 3 Create a service group, associate it with the colocation group, and attach the service group to a specific cluster. See Create Service Chain in a Service Group.

When a tenant requires a new service chain, use the handoff VLANs that are specific to the tenant.

Create Colocation Group

In a single-tenant Cisco vManage, a colocation cluster can be shared across multiple tenants by using colocation groups. The colocation groups are a mechanism to associate a service chain to a particular tenant. The RBAC users created for the tenants are called the colocation groups. These users can log in to Cisco vManage using their credentials to view only their tenant-specific service chains and VNF information. If the service provider chooses to use a service group for a tenant, the colocation group needs to be created prior to creating a service group so that the colocation group can be associated with the service group.

Step 1 From the Cisco vManage menu, choose **Administration** > **Colo Groups**.

Step 2 Click **Add Colo Group**.

Step 3 Enter a colocation group name, name of a user group with which the colocation group must be associated with, and description.

Note The colocation group name you provide here is displayed when you create a service group for a multitenant setup.

Step 4 Click **Add**.

View Permissions of a User Group

Step 1 From the Cisco vManage menu, choose **Administration** > **Manage Users**.

Step 2 Click **User Groups**.

Step 3 To view the permissions of a user group, in the**Group Name** list, and click the name of the user group that you created.

Note The user group and their permissions are displayed. To know about the list of user group permissions in a multitenant environment, see the Manage Users Using Cisco vManage topic in the *Cisco SD-WAN Systems and Interfaces Configuration Guide*.

Create an RBAC User and Associate to Colocation Group

Step 1 From the Cisco vManage menu, choose **Administration** > **Manage Users**.

Step 2 Click **Add User**.

Step 3 In the **Add User** dialog box, enter the full name, username, and password for the user.

Note You can’t enter uppercase characters for usernames.

Step 4 From the **User Groups** drop-down list, add the groups that the user must belong to, by choosing one group after another, for example, a user group that you created for the colocation feature. By default, the resource group **global** is chosen.

Step 5 Click **Add**.

Cisco vManage now lists the user is in the **Users** table.

Note The RBAC users who are created for tenants or colocation groups can log in to Cisco vManage using their credentials. These users can view their tenant-specific service chains and VNF information after the service group associated with a tenant is attached to a cluster.

Delete an RBAC User from a Colocation User Group

To delete an RBAC user, remove the RBAC user from a colocation group if the user is configured using Cisco vManage. If the user is authenticated using the TACACS server, disassociate the user from the user group in the TACACS server.

After an RBAC user is deleted, the user can no longer access or monitor the devices of the cluster. If an RBAC user is logged into Cisco vManage, deleting the user doesn't log out the RBAC user.

Step 1 From the Cisco vManage menu, choose **Administration** > **Manage Users**.

Step 2 Click an RBAC user you want to delete.

Step 3 For the RBAC user you want to delete, click **...** and choose **Delete**.

Step 4 Click **OK** to confirm the deletion of the RBAC user.

Delete Tenants

To delete a tenant, remove the service groups associated with the tenant and then remove the colocation group for the tenant.

Step 1 Locate the list of service groups associated with the tenant that you want to delete. See View Service Groups.

Note A tenant is a colocation group having one or more RBAC users associated to the same colocation group. In the service group configuration page, you can view the colocation group of the tenant.

Step 2 Detach the service group from the cluster for the tenant that you want to delete. See Attach or Detach a Service Group in a Cluster, on page 88.

Note To reuse the service group for another tenant, change the colocation group associated with the service group. If you delete the service group, you need to re-create it.

Step 3 Delete the colocation group for the tenant. See the Manage a User Group topic in the *Cisco SD-WAN Systems and Interfaces Configuration Guide*.

Manage Tenant Colocation Clusters

A service provider can perform the following managing tasks:

- Activate clusters: A service provider can configure devices, resource pool, system settings, and activate a cluster in the multitenant or shared mode. See Create and Activate Clusters.
- Create service groups and associate RBAC users to colocation groups: A service provider can create a colocation group, associate RBAC users to the colocation group, create a service group, associate the service group with the colocation group for the multitenant mode, and attach the service group to a specific cluster. See Create Service Chain in a Service Group.

Note A service provider must associate specific service groups for each tenant.

- Create VM packages: A service provider can create and upload the VM packages into the Cisco vManage repository. The same packages can be used to provision VNFs in service chains for multiple tenants.

Note When a service group is associated with a colocation group, the SR-IOV option in the VM package creation that is used for configuring the VNF, is ignored. In a multitenant mode, VNF packages support only OVS-DPDK with VXLAN.

- Monitor service chains and VNFs of tenants: A service provider can monitor all the tenant service chains and identify the service chains that are unhealthy along with the tenants associated with these service chains. The service providers can also collect logs from Cisco vManage or CSP devices and notify the tenants.
- Add and remove Cisco CSP devices: To manage colocation clusters, a service provider can add or remove CSP devices.

Tenant Functionalities

Manage Colocation Clusters as Tenants

All tenants must monitor the service chains and VMs associated with the service chains, and collaborate with service providers if any health issues arise with the service chains. Tenants can only monitor those events or alarms for VNFs that are a part of the service chains that belongs to the tenant.

Tenants don’t have any administrative privileges and can only see the service chains that service providers create. The tenant-monitoring windows display the corresponding colocation group when a tenant is viewing service chains. Tenants can perform the following tasks:

1. Log in to Cisco vManage as a tenant by entering the RBAC username and password.
2. View and monitor the health of the tenant service chains along with the health of the VNFs. To know more about the different service chain health statuses, see Monitor Cloud onRamp Colocation Clusters, on page 104.

   In the **Monitor. Network** window, click **Diagram** for a service chain to view all the tenant service groups along with the service chains and VNFs in the design view.
3. View the VNF health of a tenant:
   a. In the Monitor window, click **Network Functions**.
   b. Click a VNF name from the **Virtual NF** table.

   In the left pane, click **CPU Utilization**, **Memory Utilization**, and **Disk Utilization** to monitor the resources utilization of a VNF.

   You can also view the VM-specific alarms and events from the left pane.
4. Start, stop, or reboot a VNF:
   a. In the Monitor window, click a VNF name from the **Virtual NF** table.
   b. For the clicked VNF name, click **...** and choose one of the following operations:

- **Start**
- **Stop**
- **Restart**

Monitor Colocation Cluster Devices and Cisco SD-WAN Devices in Comanaged Multitenant Environment

Before you begin

- When creating a service chain using a service provider Cisco vManage, the service provider should ensure that the correct UUID, and device OTP for the Cisco SD-WAN VM in a service chain are entered. The service provider has no access to the tenant overlay, and therefore, a tenant should provide this information.
- When a service provider detaches a service group from a colocation cluster, the service provider should notify the tenant that the corresponding VM devices must be decommissioned using the tenant Cisco vManage.
- If a service provider needs to reattach a service group to a colocation cluster, a new OTP of the Cisco SD-WAN VM should be entered. This OTP is provided by the tenant. The service group in the service provider Cisco vManage should be edited to save the new OTP of the Cisco SD-WAN VM.

Step 1 Associate the tenant Cisco SD-WAN devices with the service provider service group when creating a service chain. See Create Service Chain in a Service Group.

Step 2 Monitor the VNFs from the service provider Cisco vManage. See Monitor Cloud OnRamp Colocation Clusters.

Step 3 Monitor the information about the Cisco SD-WAN devices of the VNFs from the tenant Cisco vManage.

Note The service provider can't view information about the Cisco SD-WAN devices of the VNFs from the service provider **Cisco vManage** > **Configuration** > **Devices** window under **WAN Edge List**, because these devices are controlled by the tenant.

PART I

Cloud onRamp for SaaS

CHAPTER 5

Cloud onRamp for SaaS, Cisco SD-WAN Release 20.3.1 and Later

Table 47: Feature History

Feature Name	Release Information	Description
View Details of Microsoft Telemetry and View Application Server Information for Office 365 Traffic	Cisco SD-WAN Release 20.8.1 Cisco vManage Release 20.8.1	This feature adds better visibility into how Cloud onRamp for SaaS determines the best path for Microsoft Office 365 traffic, if you have opted to use Microsoft telemetry. One enhancement is a chart that shows how Microsoft rates the connection quality of different interfaces, specifically for different types (called service areas) of Office 365 traffic. This is helpful for troubleshooting Office 365 performance issues. Another addition is the **SD-AVC Cloud Connector** page, which shows a list of Microsoft URL and IP endpoints and categories that Cisco SD-WAN receives from Microsoft Cloud.

Many organizations rely on software-as-a-service (SaaS) applications for business-critical functions. These cloud-based services include Amazon AWS, Box, Dropbox, Google Apps, Office 365, and many others. As cloud-based services, these SaaS applications must communicate with their own remote servers, which are available through internet connections.

At remote sites, SaaS applications may pose these special challenges:

- **Performance**: If remote sites, such as branch offices, route SaaS traffic through a centralized location, such as a data center, performance degrades, with latency that affects the user experience.
- **Inability to optimize routing**: Network administrators may not have any visibility into the performance of these SaaS applications, or any ability to change the routing of the SaaS traffic to more efficient paths.

Cloud onRamp for SaaS (formerly called CloudExpress service) addresses these challenges. It enables you to select specific SaaS applications and interfaces, and to let Cisco SD-WAN determine the best performing path for each SaaS application, using the specified interfaces. For example, you can enable:

- routing through a direct internet access (DIA) connection at a branch site, if available
- routing through a gateway location, such as a regional data center

Ensuring the best path for cloud traffic is critical. SD-WAN monitors each available path for each SaaS application continually, so if a problem occurs in one path, it can adjust dynamically and move SaaS traffic to a better path.

Information About Cloud onRamp for SaaS

Common Scenarios for Using Cloud onRamp for SaaS

For an organization using SD-WAN, a branch site typically routes SaaS application traffic by default over SD-WAN overlay links to a data center. From the data center, the SaaS traffic reaches the SaaS server.

For example, in a large organization with a central data center and branch sites, employees might use Office 365 at a branch site. By default, the Office 365 traffic at a branch site would be routed over SD-WAN overlay links to a centralized data center, and from there to the Office 365 cloud server.

Scenario 1: If the branch site has a direct internet access (DIA) connection, you may choose to improve performance by routing the SaaS traffic through that direct route, bypassing the data center.

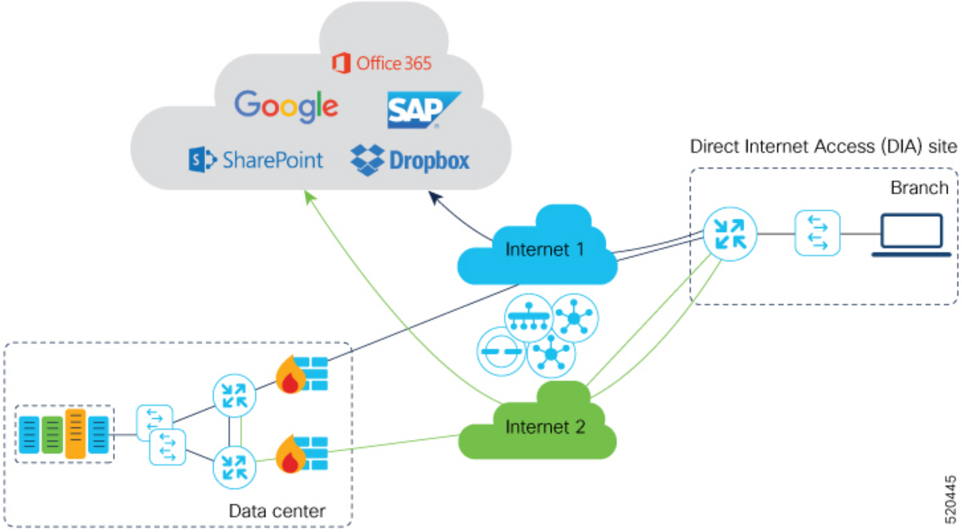
Scenario 2: If the branch site connects to a gateway site that has DIA links, you may choose to enable SaaS traffic to use the DIA of the gateway site.

Scenario 3: Hybrid method.

Scenario 1: Cloud Access through Direct Internet Access Links

In this scenario, a branch site has one or more direct internet access (DIA) links, as shown in the illustration below.

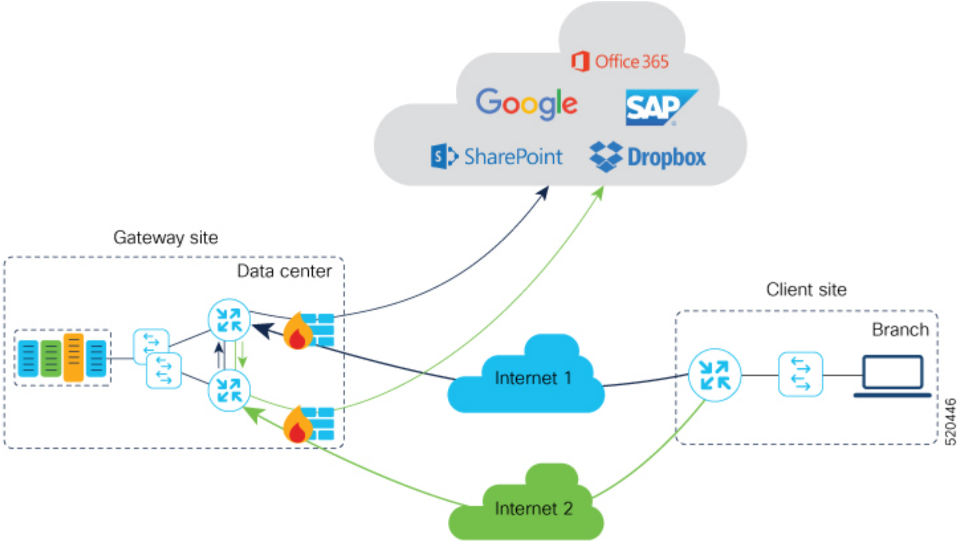
Using Cloud onRamp for SaaS, SD-WAN can select the best connection for each SaaS application through the DIA links or through the SD-WAN overlay links. Note that the best connection may differ for different SaaS applications. For example, Office365 traffic may be faster through one link, and Dropbox traffic may be faster through a different link.



Scenario 2: Cloud Access through a Gateway Site

In this scenario, a branch site has one or more direct connections to a gateway site, and the gateway site has links to the internet.

Using Cloud onRamp for SaaS, SD-WAN can select the best connection for each SaaS application through the gateway site. If the branch site connects to more than one gateway site, SD-WAN ensures that SaaS traffic uses the best path for each SaaS application, even through different gateway sites.



Scenario 3: Hybrid Approach

In this scenario, a branch site has both direct internet access (DIA) links, and links to a gateway site, which also has links to the internet.

Using Cloud onRamp for SaaS, SD-WAN can select the best connection for each SaaS application, either through DIA links or through the gateway site.

Best Path Determination

Cloud onRamp for SaaS selects the best path for each application using an algorithm that takes input from the following sources.

	Input	All Cloud Application Traffic	Office 365 Traffic
1	Cloud onRamp for SaaS metrics based on path probing	Yes	Yes
2	Application response time (ART) metrics	No	Yes (if enabled)
3	Microsoft telemetry metrics	No	Yes (if enabled)

Information About Cloud OnRamp for SaaS Probing Through VPN 0 Interfaces at Gateway Sites

A branch site may connect to the internet through one or more direct internet access (DIA) interfaces at the branch site itself, or through a gateway site, which might use a service VPN or VPN 0 to connect to the internet.

In addition to probing the DIA interfaces at a branch site, Cloud OnRamp for SaaS can probe interfaces at a gateway site, whether they use service VPNs (VPN 1, VPN 2, …) or the transport VPN (VPN 0), when determining the best path to use for the traffic of specified cloud applications. This is helpful when the branch site connects to the internet through a gateway site.

When configuring Cloud OnRamp for SaaS to use the gateway site, specify whether the gateway site uses service VPNs or VPN 0 to connect to the internet, as shown in the following illustrations.

Figure 17: Branch Site Connects to a Gateway Site That Uses Service VPNs to Connect to the Internet

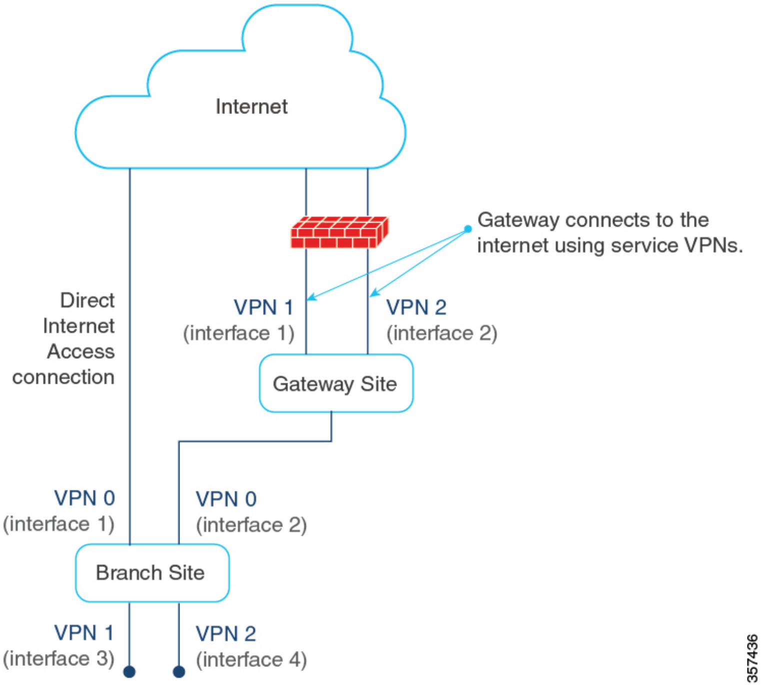
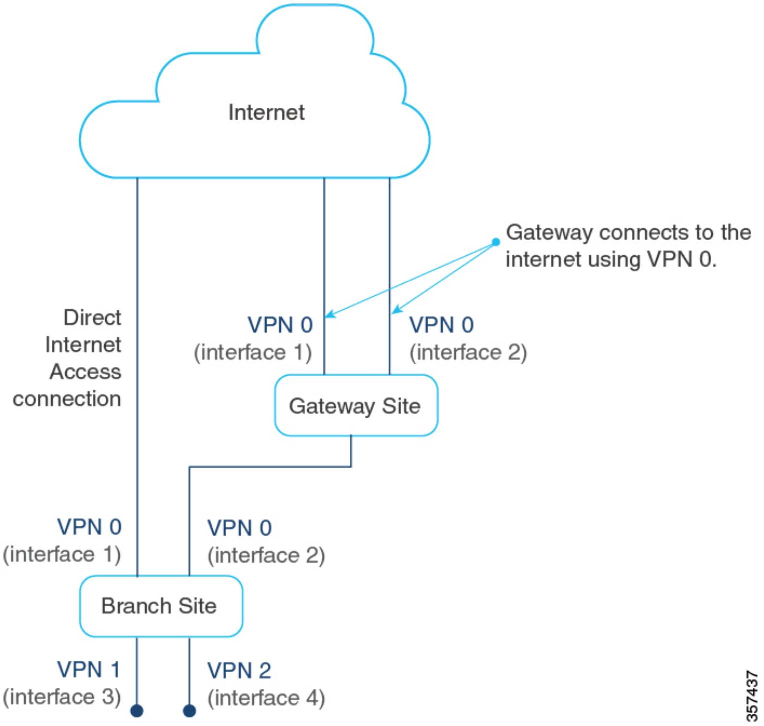


Figure 18: Branch Site Connects to a Gateway Site That Uses VPN 0 to Connect to the Internet



Benefits of Cloud onRamp for SaaS

Benefits of Cloud OnRamp for SaaS Probing Through VPN 0 Interfaces at Gateway Sites

In some network scenarios, a site connects to the internet, entirely or in part, through a gateway site that uses a VPN 0 interface to connect to the internet. This is in contrast to using service VPNs (VPN 1, VPN 2, …).

When the gateway site connects to the internet using VPN 0, the best path to cloud application servers may be through the VPN 0 interface. When Cloud onRamp for SaaS probes for the best path for the traffic of specified cloud applications, it can probe through VPN 0 interfaces at gateway sites. This extends the best path options to include more of the available interfaces connected to the internet.

Note A branch site that connects to the internet through a gateway site may also connect to the internet through one or more DIA interfaces at the branch site itself.

Supported Devices for Cloud onRamp for SaaS

Cisco IOS XE SD-WAN devices and Cisco vEdge devices support Cloud onRamp for SaaS.

The following table describes the device support for specific Cloud onRamp for SaaS features.

Table 48: Device Feature Support

Feature	Cisco IOS XE SD-WAN Device Support	Cisco vEdge Device Support
Basic Cloud onRamp for SaaS functionality	Yes	Yes
Cloud OnRamp for SaaS Probing Through VPN 0 Interfaces at Gateway Sites	Yes	Yes
Webex application support	Yes	No
Application Feedback Metrics for Office 365 Traffic	Yes	No
Microsoft to Provide Traffic Metrics for Office 365 Traffic	Yes	No
SD-AVC Cloud Connector	Yes	No
Viewing Path Scores for Office 365 Traffic	Yes	No
Cloud onRamp for SaaS Over SIG Tunnels	Yes	Yes
SaaS Application Lists	Yes	No
Webex Server-Side Metrics	Yes	No

For information about features supported on Cisco IOS XE SD-WAN devices, see Cloud onRamp for SaaS, Cisco IOS XE Release 17.3.1a and Later.

Prerequisites for Cloud OnRamp for SaaS

The following sections describe the prerequisites for Cloud OnRamp for SaaS features.

Prerequisites for Cloud onRamp for SaaS, General

The prerequisites for using Cloud onRamp for SaaS differ for Cisco vEdge devices and Cisco IOS XE SD-WAN devices. For information about using Cloud onRamp for SaaS with Cisco vEdge devices, see Cloud OnRamp Configuration Guide for vEdge Routers, Cisco SD-WAN Release 20.

For Cisco IOS XE SD-WAN devices, the requirements are:

- The devices must be running Cisco IOS XE Release 17.3.1a or later.
- The devices must be in vManage mode.
- All Cisco vSmart Controller instances must be in vManage mode.
- A centralized policy that includes an application-aware policy must be activated. You can configure more than one centralized policy in Cisco vManage, but only one can be active.

Note This is an important difference from using Cloud onRamp for SaaS with Cisco vEdge devices, which do not have this requirement.

- Cloud onRamp for SaaS is enabled (**Administration** > **Settings**).

To specify traffic by Office 365 traffic category, the following are also required:

- Cisco SD-AVC is enabled (**Administration** > **Cluster Management**).
- Cisco SD-AVC Cloud Connector is enabled (**Administration** > **Settings**). If Cloud Connector is not enabled, policies specifying Office 365 traffic cannot match the Office 365 traffic. The traffic uses the default path, rather than the best path selected by Cloud onRamp for SaaS.

Prerequisites for Cloud OnRamp for SaaS Probing Through VPN 0 Interfaces at Gateway Sites

Cloud onRamp for SaaS probing through VPN 0 interfaces at gateway sites presupposes that a branch site connects to the internet through a gateway site, and that the gateway site connects to the internet using a VPN 0 interface. The branch site may or may not also connect to the internet through one or more DIA connections.

Restrictions for Cloud onRamp for SaaS

The following section(s) describe the restrictions applicable to Cloud OnRamp for SaaS features.

Restrictions for Cloud onRamp for SaaS, General

Configuring Cloud onRamp for SaaS when a site is using a loopback as a transport locator (TLOC) interface is not supported.

Configuring Cloud OnRamp for SaaS on Cisco IOS XE SD-WAN devices is only through centralized app-aware policy using match condition "cloud-saas-app-list" and action "cloud-saas". For mixed deployments including Cisco SD-WAN and Cisco IOS XE SD-WAN devices, we recommend to have different app-aware policies for Cisco SD-WAN and Cisco IOS-XE SD-WAN devices.

Use Cases for Cloud onRamp for SaaS

Use Cases for Cloud OnRamp for SaaS Probing Through VPN 0 Interfaces at Gateway Sites

Enable gateway probing through VPN 0 interfaces if the following conditions apply:

- A branch site connects to the internet through a gateway site. The branch site may or may not also connect to the internet through one or more DIA interfaces.
- The gateway site has internet exits that use the transport VPN (VPN 0) through one or more interfaces.

Configure Cloud onRamp for SaaS

The following sections describe configuration procedures for Cloud OnRamp for SaaS features.

Enable Cloud OnRamp for SaaS, Cisco IOS XE SD-WAN Devices

You can enable Cloud OnRamp for SaaS in your Cisco SD-WAN overlay network on sites with Direct Internet Access (DIA) and on DIA sites that access the internet. You can also enable Cloud OnRamp for SaaS on client sites that access the internet through another site in the overlay network, called a gateway site. Gateway sites can include regional data centers or carrier-neutral facilities. When you enable Cloud OnRamp for SaaS on a client site that accesses the internet through a gateway, you also enable Cloud OnRamp for SaaS on the gateway site.

Note You can only enable Cloud OnRamp for SaaS features using the Cisco vManage procedures described in this document. We do not support configuring Cloud OnRamp for SaaS using CLI templates. Even when you configure other features on a device using a CLI template, you must nevertheless use Cisco vManage for configuring Cloud OnRamp for SaaS features.

Enable Cloud OnRamp for SaaS

1. From the Cisco vManage menu, choose **Administration** > **Settings**.
2. Click **Edit**, next to **Cloud onRamp for SaaS**.

3. In the **Cloud onRamp for SaaS** field, click **Enabled**.
4. Click **Save**.

Configure Applications for Cloud onRamp for SaaS Using Cisco vManage

1. Open Cloud onRamp for Saas.
   - From the Cisco vManage menu, choose **Configuration** > **Cloud onRamp for SaaS**.

     or

   - In Cisco vManage, click the cloud icon near the top right and choose **Cloud onRamp for SaaS**.

2. In the **Manage Cloud OnRamp for SaaS** drop-down list, choose **Applications and Policy**.

   The **Applications and Policy** window displays all SaaS applications.

3. Optionally, you can filter the list of applications by clicking an option in the **App Type** field.
   - **Standard**: Applications included by default for Cloud onRamp for SaaS.
   - **Custom**: User-defined SaaS application lists (see Information About SaaS Application Lists).

4. Enable applications and configure.

Column	Description
Applications	Applications that can be used with Cloud onRamp for SaaS.
Monitoring	**Enabled**: Enables Cloud OnRamp for SaaS to initiate the Quality of Experience probing to find the best path. **Disabled**: Cloud onRamp for SaaS stops the Quality of Experience probing for this application.
VPN	(Cisco vEdge devices) Specify one or more VPNs.

Column	Description
Policy/Cloud SLA	(Cisco IOS XE SD-WAN devices) Select **Enable** to enable Cloud onRamp for SaaS to use the best path for this application. **Note** You can select **Enable** only if there is a centralized policy that includes an application-aware policy has been activated.
	(Cisco IOS XE SD-WAN devices) For Microsoft 365 (M365), select one of the following to specify which types of M365 traffic to include for best path determination: • **Optimize**: Include only M365 traffic categorized by Microsoft as “optimize” – the traffic most sensitive to network performance, latency, and availability. • **Optimize and Allow**: Include only M365 traffic categorized by Microsoft as “Optimize” or “Allow”. The “Allow” category of traffic is less sensitive to network performance and latency than the “Optimize” category. • **All**: Include all M365 traffic.
	Starting from Cisco IOS XE Release 17.5.1a, you can choose the service area that your M365 application belongs to. This allows you to apply the policy to only those applications in the specified service area. Microsoft allows the following service area options: • **Common**: M365 Pro Plus, Office in a browser, Azure AD, and other common network endpoints. • **Exchange**: Exchange Online and Exchange Online Protection. • **SharePoint**: SharePoint Online and OneDrive for Business. • **Skype**: Skype for Business and Microsoft Teams. See the Microsoft documentation for information about updates to the service areas.

5. Click **Save Applications and Next**.

   The **Application Aware Routing Policy** window appears, showing the application-aware policy for the current active centralized policy.

   - You can select the application-aware policy and click **Review and Edit** to view the policy details. The match conditions of the policy show the SaaS applications for which monitoring has been enabled.
   - For an existing policy, you cannot edit the site list or VPN list.
   - You can create a new policy for sites that are not included in existing centralized policies. If you create a new policy, you must add a VPN list for the policy.
   - You can delete one or more new sequences that have been added for the SaaS applications, or change the order of the sequences.

6. Click **Save Policy and Next**. This saves the policy to the Cisco vSmart Controller.

Configure Sites for Cloud onRamp for SaaS Using Cisco vManage

Configure two types of sites:

- Client sites
- Direct internet access (DIA) sites

Configure Client Sites

To configure Cloud OnRamp for SaaS on client sites that access the internet through gateways, configure Cloud OnRamp for SaaS both on the client sites and on the gateway sites.

Note You cannot configure Cloud OnRamp for SaaS with Point-to-Point Protocol (PPP) interface on the gateway sites.

Client sites in the Cloud onRamp service choose the best gateway site for each application to use for accessing the internet.

1. From the Cisco vManage menu, choose **Configuration** > **Cloud onRamp for SaaS**. The **Cloud OnRamp for SaaS** Dashboard appears.
2. Click **Manage Cloud OnRamp for SaaS** and choose **Client Sites**. The page displays the following elements:
    - Attach Sites: Add client sites to Cloud onRamp for SaaS service.
    - Detach Sites: Remove client sites from Cloud onRamp for SaaS service.
    - Client sites table: Display client sites configured for Cloud onRamp for SaaS service.
3. On the **Cloud onRamp for SaaS** > **Manage Sites** window, click **Attach Sites**. The **Attach Sites** dialog box displays all sites in the overlay network with available sites highlighted. For a site to be available, all devices at that site must be running in vManage mode.
4. Choose one or more client sites from **Available Sites** and move them to **Selected Sites**.
5. Click **Attach**. The Cisco vManage NMS saves the feature template configuration to the devices. The Task View window displays a Validation Success message.
6. From the Cisco vManage menu, choose **Configuration** > **Cloud onRamp for SaaS** to return to the Cloud OnRamp for SaaS Dashboard screen.
7. Click **Manage Cloud OnRamp for SaaS** and choose **Gateways**. The page displays the following elements:
    - Attach Gateways: Attach gateway sites.
    - Detach Gateways: Remove gateway sites from the Cloud onRamp service.
    - Edit Gateways: Edit interfaces on gateway sites.

- Gateways table: Display gateway sites configured for Cloud onRamp service.

8. In the **Manage Gateways** window, click **Attach Gateways**. The **Attach Gateways** dialog box displays all sites in your overlay network with available sites highlighted. For a site to be available, all devices at that site must be running in vManage mode.

9. In the **Device Class** field, choose one of the following operating systems:

   - **Cisco OS**: Cisco IOS XE SD-WAN devices

   - **Viptela OS (vEdge)**: Cisco vEdge devices

10. Choose one or more gateway sites from **Available Sites** and move them to **Selected Sites**.

11. (Cisco vEdge devices for releases before Cisco IOS XE Release 17.7.1a) To specify GRE interfaces for Cloud OnRamp for SaaS to use, perform the actions in Steps 11a through 11d.

    (Cisco vEdge devices for releases from Cisco IOS XE Release 17.7.1a) To specify the VPN 0 interfaces or service VPN interfaces in gateway sites for Cloud OnRamp for SaaS to use, perform the actions in Steps 11a through 11d.

Note If you do not specify interfaces for Cloud OnRamp for SaaS to use, the system selects a NAT-enabled physical interface from VPN 0.

   a. Click **Add interfaces** to selected sites (optional), located in the bottom-right corner of the **Attach Gateways** window.

   b. Click **Select Interfaces**.

   c. From the available interfaces, choose the GRE interfaces to add (for releases before Cisco IOS XE Release 17.7.1a), or the VPN 0 interfaces or service VPN interfaces to add (for releases from Cisco IOS XE Release 17.7.1a).

   d. Click **Save Changes**.

12. (Cisco IOS XE SD-WAN devices) To configure the routers at a gateway site, perform the following steps.

Note If you don’t specify interfaces for Cloud OnRamp for SaaS, an error message indicates that the interfaces aren’t VPN 0.

   a. Click **Add interfaces to selected sites**.

   b. The **Attach Gateways** window shows each WAN edge router at the gateway site.

      Beginning with Cisco IOS XE Release 17.6.1a, you can choose Service VPN or VPN 0 if the gateway uses Cisco IOS XE SD-WAN devices.

      - If the routers at the gateway site connect to the internet using service VPN connections (VPN 1, VPN 2, …), choose **Service VPN**.

      - If the routers at the gateway site connect to the internet using VPN 0, choose **VPN 0**.

Note

- Correctly choosing **Service VPN** or **VPN 0** requires information about how the gateway site connects to the internet.
- All WAN edge routers at the gateway site must use either service VPN or VPN 0 connections for internet access. Cloud OnRamp for SaaS does not support a mix of both.

c. Do one of the following:

- If you chose **Service VPN**, then for each WAN edge router, choose the interfaces to use for internet connectivity.
- If you chose **VPN 0**, then either choose **All DIA TLOC**, or choose **TLOC list** and specify the colors to include in the TLOC list.

d. Click **Save Changes**.

13. Click **Attach**. Cisco vManage saves the feature template configuration to the devices. The Task View window displays a Validation Success message.
14. To return to the Cloud OnRamp for SaaS Dashboard, from the Cisco vManage menu, choose **Configuration** > **Cloud onRamp for SaaS**.

Edit Interfaces on Gateway Sites

1. Select the sites you want to edit and click **Edit Gateways**.
2. In the **Edit Interfaces of Selected Sites** window, select a site to edit.
   - To add interfaces, click the **Interfaces** field to select available interfaces.
   - To remove an interface, click the **X** beside its name.
3. Click **Save Changes** to push the template to the device(s).

Configure Direct Internet Access (DIA) Sites

Note Cloud onRamp for SaaS requires an SD-WAN tunnel to each physical interface to enable SaaS probing through the interface. For a physical interface configured for DIA only, without any SD-WAN tunnels going to the SD-WAN fabric, configure a tunnel interface with a default or any dummy color in order to enable use of Cloud onRamp for SaaS. Without a tunnel interface and color configured, no SaaS probing can occur on a DIA-only physical interface.

1. From the Cisco vManage menu, choose **Configuration** > **Cloud onRamp for SaaS**.
2. From the **Manage Cloud OnRamp for SaaS** drop-down list, located to the right of the title bar, choose **Direct Internet Access (DIA) Sites**.

   The **Manage DIA**window provides options to attach, detach, or edit DIA sites, and shows a table of sites configured for the Cloud onRamp service.

3. Click **Attach DIA Sites**. The **Attach DIA Sites** dialog box displays all sites in your overlay network with available sites highlighted. For a site to be available, all devices at that site must be running in vManage mode.

4. In the **Device Class** field, select one of the following:

   - **Cisco OS**: Cisco IOS XE SD-WAN devices
   - **Viptela OS (vEdge)**: Cisco vEdge devices

5. Choose one or more DIA sites from **Available Sites** and move them to **Selected Sites**.

6. (For Cisco vEdge devices) By default, if you don't specify interfaces for Cloud OnRamp for SaaS to use, the system selects all NAT-enabled physical interfaces from VPN 0. Use the following steps to specify particular interfaces for Cloud OnRamp for SaaS.

   Note You can't select a loopback interface.

   a. Click the link, **Add interfaces to selected sites** (optional), located in the bottom-right corner of the window.

   b. In the **Select Interfaces** drop-down list, choose interfaces to add.

   c. Click **Save Changes**.

7. (For Cisco IOS XE SD-WAN devices, optional) Specify TLOCs for a site.

   Note Configuring Cloud onRamp for SaaS when using a loopback as a TLOC interface is not supported.

   Note If you do not specify TLOCs, the **All DIA TLOC** option is used by default.

   a. Click the **Add TLOC to selected sites** link at the bottom-right corner of the **Attach DIA Sites** dialog box.

   b. In the **Edit Interfaces of Selected Sites** dialog box, choose **All DIA TLOC**, or **TLOC List** and specify a TLOC list.

   c. Click **Save Changes**.

8. Click **Attach**. The Cisco vManage NMS saves the feature template configuration to the devices. The **Task View** window displays a Validation Success message.

9. To return to the Cloud OnRamp for SaaS Dashboard, from the Cisco vManage menu, choose **Configuration** > **Cloud onRamp for SaaS**.

Edit Interfaces on Direct Internet Access (DIA) Sites

1. Select the sites to edit and click **Edit DIA Sites**.

2. (Cisco vEdge devices) On the **Edit Interfaces of Selected Sites** screen, select a site to edit.
   - To add interfaces, click the **Interfaces** field to select available interfaces.
   - To remove an interface, click the **X** beside its name.
3. (Cisco IOS XE SD-WAN devices) In the **Edit Interfaces of Selected Sites** dialog box, do the following:
   a. Click **All DIA TLOC** to include all TLOCs, or click **TLOC List** to select specific TLOCs.
4. Click **Save Changes** to push the new template to the devices.

To return to the Cloud OnRamp for SaaS Dashboard, select **Configuration** > **Cloud onRamp for SaaS**.

Verify Cloud onRamp for SaaS

The following section(s) describe the procedures for verifying Cloud OnRamp for SaaS features.

Verify That an Application is Enabled for Cloud onRamp for SaaS

1. From the Cisco vManage menu, choose **Configuration** > **Cloud onRamp for SaaS**.
2. Click **Manage Cloud OnRamp for SaaS** and choose **Applications and Policy**.

   The **Applications and Policy** window displays all SaaS applications.
3. In the row of the application that you are verifying, check that the **Monitoring** column and the **Policy/Cloud SLA** column both show **Enabled**.

Monitor Cloud onRamp for SaaS

The following section(s) describe the procedures for monitoring Cloud OnRamp for SaaS features.

View Details of Monitored Applications

1. Open Cloud onRamp for SaaS.
   - From the Cisco vManage menu, choose **Configuration** > **Cloud onRamp for SaaS**.

     or
   - In Cisco vManage, click the cloud icon at the top right and click **Cloud onRamp for SaaS**.

   The page includes a tile for each monitored application, with the following information:
   - How many sites are operating with Cloud onRamp for SaaS.
   - A color-coded rating of the Quality of Experience (vQoE) score for the application (green=good score, yellow=moderate score, red=poor score) on the devices operating at each site.

2. Optionally, you can click a tile to show details of Cloud onRamp for SaaS activity for the application, including the following:

Field	Description
vQoE Status	A green checkmark indicates that the vQoE score for the best path meets the criteria of an acceptable connection. The vQoE is calculated based on average loss and average latency. For Office 365 traffic, other connection metrics are also factored in to the vQoE score.
vQoE Score	For each site, this is the vQoE score of the best available path for the cloud application traffic. The vQoE score is determined by the Cloud onRamp for SaaS probe. Depending on the type of routers at the site, you can view details of the **vQoE Score** as follows: • Cisco IOS XE SD-WAN devices: To show a chart of the vQoE score history for each available interface, click the chart icon. In the chart, each interface vQoE score history is presented as a colored line. A solid line indicates that Cloud onRamp for SaaS has designated the interface as the best path for the cloud application at the given time on the chart. You can place the cursor over a line, at a particular time on the chart, to view details of the vQoE score of an interface at that time. From Cisco vManage Release 20.8.1, for the Office 365 application, the chart includes an option to show the vQoE score history for a specific service area, such as Exchange, Sharepoint, or Skype. For each service area, a solid line in the chart indicates the interface chosen as the best path at a given time. If you have enabled Cloud onRamp for SaaS to use Microsoft traffic metrics for Office 365 traffic, the choice of best path takes into account the Microsoft traffic metrics. • Cisco vEdge devices: To show a chart of the vQoE score history, click the chart icon. The chart shows the vQoE score for the best path chosen by Cloud onRamp for SaaS.
DIA Status	The type of connection to the internet, such as local (from the site), or through a gateway site.
Selected Interface	The interface providing the best path for the cloud application. **Note** If the DIA status is Gateway, this field displays **N/A**.
Activated Gateway	For a site that connects to the internet through a gateway site, this indicates the IP address of the gateway site. **Note** If the DIA status is Local, this field displays **N/A**.

Field	Description
Local Color	For a site that connects to the internet through a gateway site, this is the local color identifier of the tunnel used to connect to the gateway site. **Note** If the DIA status is Local, this field displays **N/A**.
Remote Color	For a site that connects to the internet through a gateway site, this is the remote (gateway site) color identifier of the tunnel used to connect to the gateway site. **Note** If the DIA status is Local, this field displays **N/A**.
SDWAN Computed Score	This field is applicable only if the site uses Cisco IOS XE SD-WAN devices. It does not apply for Cisco vEdge devices. From Cisco vManage Release 20.8.1, for the Microsoft Office 365 application, an **SDWAN Computed Score** column provides links to view charts of the path scores (OK, NOT-OK, or INIT) provided by Microsoft telemetry for each Microsoft service area, including Exchange, Sharepoint, and Skype. The chart shows the scores over time for each available interface. The scores are defined as follows: • **OK**: Acceptable path • **NOT-OK**: Unacceptable path • **INIT**: Insufficient data These charts provide visibility into how Cloud onRamp for SaaS chooses a best path for each type of Microsoft Office 365 traffic. A use case for viewing the path score history is for determining whether Microsoft consistently rates a particular interface as NOT-OK for some types of traffic, such as Skype traffic.