Device Onboarding

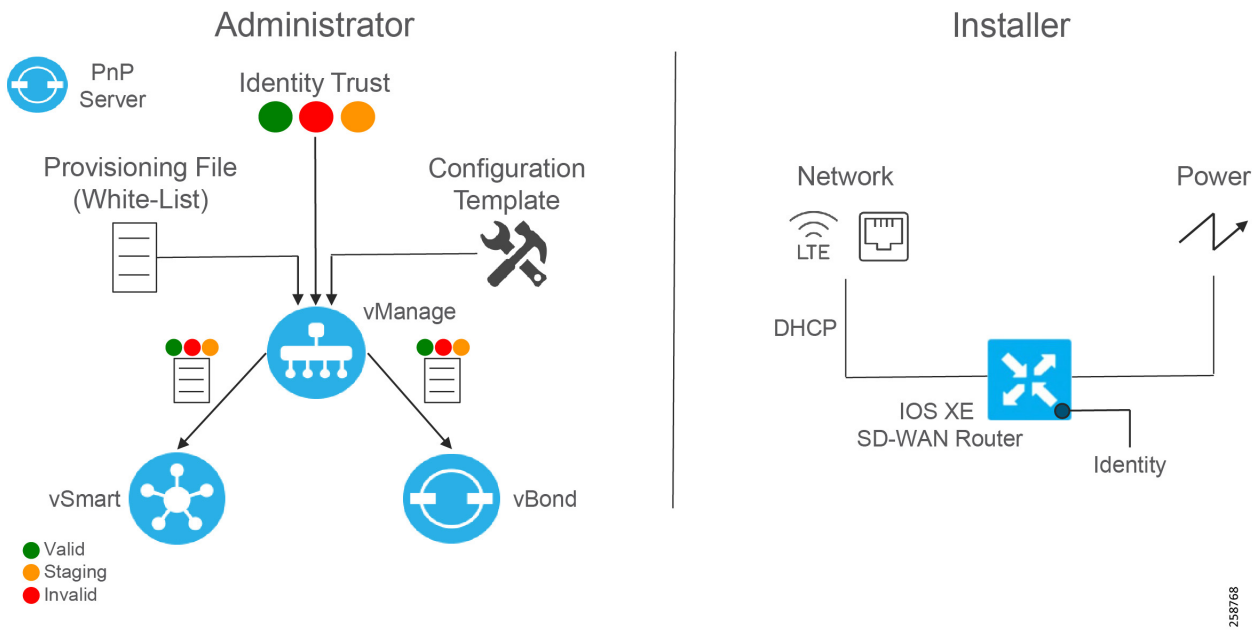
Device onboarding is a process initiated by the network administrator by completing the following tasks:

- Load device(s) on Plug and Play Connect if not added during procurement process
- Load device(s) on vManage, push them to vSmart and vBond, and declare the device(s) as valid or staging device(s).
- Attach the device to a template

After the steps are completed, an installer on the remote site could connect the device to the network, after which the device will reach vBond, establish DTLS connectivity with controllers, and download the configuration defined on the template.

The following graph illustrates the device onboarding activities. Detailed steps are provided in this chapter.

Figure 28 Device Onboarding



Cisco Plug and Play Connect

In order for the WAN Edge devices to join and be active in the overlay, a valid, authorized serial number file has to be uploaded to vManage. This authorized serial number file lists the serial and chassis numbers for all WAN Edge routers allowed in the network. vManage will send this file to the controllers, and only devices that match serial numbers on this list will be validated and authenticated successfully by the controllers. The authorized serial number for IOS XE SD-WAN routers is obtained from Plug and Play (PnP) Connect portal. PnP Connect portal is also used to automate onboarding of network devices and apply configuration settings without manual intervention. This guide will provide required steps to

add a device on PnP Connect using a smart account and associate it to a vBond profile. Refer to the following link for deeper understanding on PnP connect https://www.cisco.com/c/en/us/products/collateral/software/smart-accounts/guide-c07-744931.html#4Deploymentoptions.

Prerequisites

- Smart account and virtual account
- If the deployment is on premises, vBond has to be defined in PnP connect. Refer to **https://www.cisco.com/c/dam/en_us/services/downloads/SD-WAN_pnp_support_guide.pdf** for specific steps. Note that for cloud deployments, controller information is reflected automatically on the PnP portal.

Adding a device on PnP Connect

A device can be added to PnP Connect automatically if the smart account and virtual account are added to the order on Cisco Commerce Workspace.

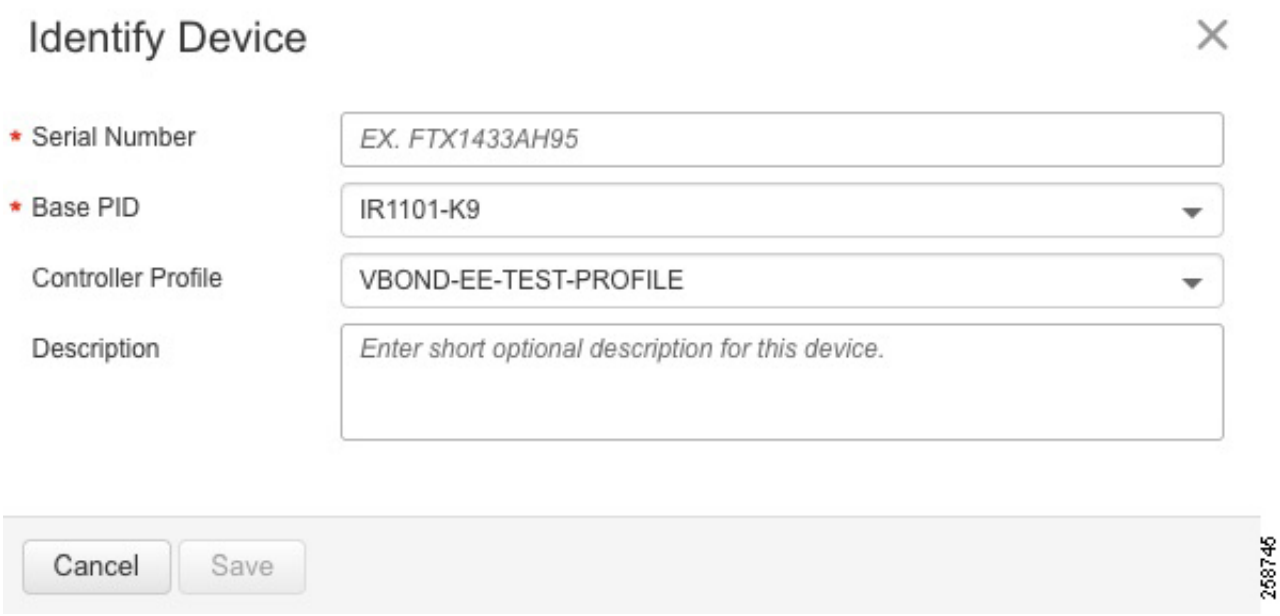
If the device is not added through the procurement process, follow these steps:

1. Get serial number and certificate serial number from the device using the *show crypto pki certificates* **CISCO_IDEVID_SUDI** command:

```
Router#show crypto pki certificates CISCO_IDEVID_SUDI
Certificate
Status: Available
Certificate Serial Number (hex): XXXXXXXX
Certificate Usage: General Purpose
Issuer:
cn=ACT2 SUDI CA
o=Cisco
Subject:
Name: IR1101-K9
Serial Number: PID:IR1101-K9 SN:XXXXXXXXXXX
cn=IR1101-K9
ou=ACT-2 Lite SUDI
o=Cisco
serialNumber=PID:IR1101-K9 SN: XXXXXXXXXXX
Validity Date:
start date: 07:49:10 UTC Mar 9 2019
end date: 20:25:41 UTC May 14 2029
Associated Trustpoints: CISCO_IDEVID_SUDI
```

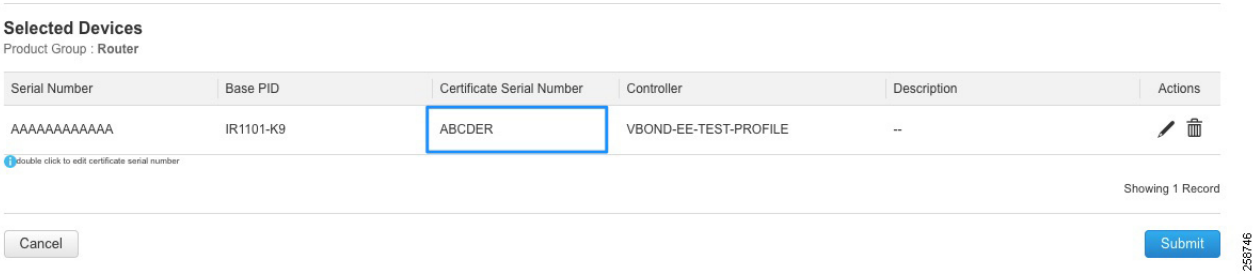
2. Navigate to **https://software.cisco.com**.
3. Under the Network Plug and Play section, click the **Plug and Play Connect** link.
4. Ensure the correct virtual account is chosen in the top right corner.
5. Click **Add Devices** button.
6. Select **Enter Device Info Manually** radio button. Alternatively, you could upload a Comma Separated Values (CSV) file.
7. Click **Next**.
8. Click **Identify Device** button.
9. Fill out the serial number obtained in Step 1, base PID (IR1101-K9), and the selected vBond controller profile.

Figure 29 Connect - Identify Device



10. Click **Save**. On the wizard screen, click **Next**.
11. On Review & Submit, click **Submit**.
12. Click **Done**.
13. After the router is added, a list of devices is displayed. Select the recently added device and then click **Edit Selected**.
14. Click the space under the Certificate Serial Number column for the device and enter the information from Step 1.

Figure 30 Add Certificate Serial Number



15. Click **Submit**.
16. The device will show with yellow status showing Pending (Redirection). If the device is onboarded using the PnP automatic onboarding process, this state will change to Redirect Successful; otherwise it will stay in current state.

Load authorized WAN edge serial numbers to vManage

There are two methods to upload the authorized devices to vManage.

Method 1: Sync to the Smart Account

1. In the vManage GUI, go to **Configuration > Devices.**
2. Ensure that **WAN Edge List tab** is selected.
3. Click **Sync Smart Account** and a window pops up which prompts you for your Username and Password.
4. Enter your username and password for the Cisco website. The check box which validates the uploaded list is checked by default.
5. Click **Sync**. Wait for status to show success.

Tip: You must re-sync vManage with the Smart Account/Virtual Account for any new devices added to the PNP portal.

Method 2: Upload File Manually

1. Navigate to **https://software.cisco.com.**
2. Under the Network Plug and Play section, click the **Plug and Play Connect** link.
3. Ensure the correct virtual account is chosen in the top right corner.
4. Click **Controller Profiles** text.
5. Next to the correct controller profile, click **Provisioning File** text.
6. In the pop-up window, select the controller versions from the drop-down list. Choose **18.3 and newer**. Click **Download** button and save the file to your computer.
7. In the vManage GUI, go to **Configuration > Devices** on the left panel.
8. Ensure that WAN Edge List tab is selected.
9. Click the **Upload WAN Edge List** button. A pop-up window appears. Choose **file**.
10. Check the check box in order to validate the list and send it to the controllers. Click **Upload**. If you do not select **Validate**, then all the devices will show up as invalid, and you will need to individually change them to valid if you want to bring them up on the network and participate in the overlay.
11. Select **OK** in the confirmation box that appears.
12. A pop-up window appears to inform you that the list uploaded successfully and informs you of the number of routers that were uploaded successfully. Select **OK**. A page will indicate that the list has been successfully pushed out to the vBond and vSmart controllers.

Stage Devices (Optional)

Optionally, it is possible to put the devices in a staging state. In this state the control plane could be initialized but they will not join the overlay and forward traffic until they are put into a valid state. The WAN Edge routers will become OMP peers with the vSmart controllers, but no OMP routes will be sent, nor will any local routes be redistributed into OMP.

1. From the vManage GUI, go to **Configuration > Certificates**. Find the appropriate device by matching the chassis serial number.
2. To the right of the targeted router, select **Staging**. A pop-up window will ask for confirmation. Select **OK**.

3. Repeat for any number of routers.
4. Click the **Send to Controllers** button in the upper left portion of the screen when finished.

Attach device to template

Attaching the device to a device template will associate the configuration to the device. During this process, all variables on the templates need to be assigned to a value.

1. Go to **Configuration > Templates**.
2. In the **Device** tab, identify the template you want to use.
3. Click the more actions (**...**) icon to the right of the row and then click **Attach Devices**. The **Attach Devices** dialog box opens.
4. In the **Available Devices** column on the left, select a group and search for one or more devices, select a device from the list, or click **Select All**.
5. Click the arrow pointing right to move the device to the **Selected Devices** column on the right.
6. Click **Attach**.
7. Before the full configurations can be built and pushed out, you need to first define all variables associated with the feature templates attached to the device template. There are two ways to do this: either by entering the values of the variables manually within the GUI, or by uploading a CSV file with a list of the variables and their values. Detailed steps for each option will be provided at the end of this section. The variables used for each device in this deployment are documented in **Appendix D Device Template Values**.
8. Click the **Next** button. The next screen will indicate that the configure action will be applied to the devices being attached to the template.
9. (Optional) Select a device on the left side to show the configuration that will be pushed to the IOS XE SD-WAN router on the **Config Preview** tab.
10. (Optional) Select the **Config Diff** tab at the top of the screen to see the difference in the current local configuration versus the new configuration which is about to be pushed.
11. (Optional) You may select the **Configure Device Rollback Timer** text in the lower left corner to view or change the rollback timer. Rollback timer is a protection mechanism; if the router is unreachable after a configuration change it rolls back to the previous configuration. You can configure the timer to any value between 6 and 15 minutes. It is not recommended to disable it. Click **Save** or **Cancel** to go back to main window.
12. Select **Configure Devices.** If configuring more than one device**,** a pop-up window warns of committing changes to multiple devices. Check the check box to Confirm configuration changes on the devices. Select **OK**. The configuration then gets pushed out to the devices. When complete, vManage should show the **Done-Scheduled** status, indicating the device is offline but template is scheduled to be pushed when connectivity is established.
13. (Optional) To view devices attached to a device template, go to **Configuration > Templates**. From the **Device** tab, identify the template and click the **Device Attached** column that indicates how many devices are attached. The pop out window will show attached devices.

Add Variables with a File

1. Download the .csv file by clicking the download arrow symbol in the upper right corner.
2. Fill out variables on the file and click **Save**.
3. Click the upload arrow in the top right corner of the screen to upload the .csv file.

4. A window will pop up. Choose the file and click the **Upload** button. The message “File Uploaded Successfully” should appear in green at the top of the screen.
5. (Optional) Scroll to the right and view or modify the values of the variables that have been used for input.

Tip: Adding variables with a file is the preferred method when you have used a feature template multiple times. In this scenario same variable name will appear more than once in the screen without context. On the other hand, The CSV file provides variable parent context in addition to variable name. As an example, when using same SVI template for VPN10 and VPN11, CSV file header will show VPN context in the header like this:

```
/11/vpn_if_svi_if_name_SVI_2/interface/if-name
```

Add Variables Manually

To add values manually, enter the values of the variables in the text boxes. There may also be variables with check boxes for enabling them; if the check box is checked, the variable will be included. If you leave a non-optional text field empty, the text box will be highlighted red when you try to move to the next page. Optionally, you can click the more actions icon (**...**) at the end of the row and fill out the variables on the pop-out window. Click the **Update** button when finished.

Tip: When you are finished filling out the variables and before moving further, download the .csv file by clicking the download arrow symbol in the upper right corner. The .csv file will be populated with the values you have filled in so far. If you deploy the configuration, and for any reason there is an error in one of the input variables and the configuration fails to deploy, when you come back to this page, all the values you entered earlier will not be available and you will need to enter them again. If you downloaded the populated .csv file, just upload it by clicking the up arrow. Then you can click **Edit Device Template** to the right of the desired device, and all of your latest values will be populated in the text boxes. Modify any input values and try to deploy again.

Modify Variables

To modify variables even after the device has been provisioned, follow the following steps.

1. Go to **Configuration > Devices**.
2. Identify the device you want to update and click more actions (**...**) at the end of the row.
3. Choose **Change Device Values** from the list.
4. Use the manual or file method to update variables.

Generate Bootstrap Configuration File

This step is only needed if onboarding devices using the bootstrap method described in the next section.

1. On vManage, navigate to **Configuration > Devices**.
2. Click the More Actions icon (**...**) to the right of the row for the applicable device and choose **Generate Bootstrap Configuration**.
3. In the dialog box that opens, make sure that the **Cloud-init** radio button is selected, and then click **OK**.
4. The system generates a file and displays its contents in a pop-up window.
5. Click **Download**.
6. Rename the file to **ciscosdwan.cfg** (case sensitive).
7. Copy the ciscosdwan.cfg file to a bootable USB drive or to the bootflash of the device. The file must be named exactly as shown or the device will not read it.

Bring up Devices

Bringing up a router to connect to SD-WAN network can be done by three methods:

- PnP for zero touch deployment.
- Bootstrap, for devices that cannot get Internet connectivity without additional configuration, such as devices connected to transport with a static IP configuration or non-default cellular profiles.
- CLI, adding manual configuration via the console.

This guide focuses on PnP and bootstrap methods since they don't require network administration expertise to bring up the device. These methods are explained below.

Plug and Play

When a device meets the requirements stated below, it boots and reaches PNP Connect portal to get the vBond IP address. The router establishes a secure tunnel to vBond, and after authentication vBond sends the vManage IP address to the Cisco IOS XE router. The router contacts vManage over a secure tunnel and vManage sends the full configuration to the Cisco IOS XE router. Finally, the router contacts vSmart over a secure tunnel; after authentication, it will join the SD-WAN fabric. This process does not require any manual intervention or configuration.

Prerequisites

- IR1101 has IOS XE SD-WAN Release 16.12.1b or newer. For image installation refer to Appendix A - Upgrade Cisco IR1101 with IOS XE SD-WAN Image.
- Device is connected to a network.
- Device can get a DHCP IP address and reach PnP portal and vBond.
- Device does not have any configuration.
- Device is imported to vManage as valid or staging.
- Device is assigned to a device template.

Bootstrap

If the device meets prerequisites mentioned below, when the device boots, it reads the configuration file from the USB drive from or the bootflash and uses the configuration information to join the network. The configuration will enable network connectivity as well as provide system parameters and vBond address. Once the device is authenticated by vBond, it gets vManage information. The router establishes communication with vManage and joins the overlay network.

Tip: it is recommended to copy the configuration file on bootflash before performing IOS XE SD-WAN installation. After IOS XE SD-WAN installation is completed the default one-time user admin is deleted, and the default password can be used once and then must be changed. If the initial configuration session times out or if the session is interrupted or terminated before the password is changed and saved, subsequent login attempts fail. To avoid this situation when using bootstrap configuration, copy the configuration file before upgrading; the bootstrap configuration will contain configured user information that can be used for subsequent login.

- If using enterprise root certificate, issue the following command to install the certificates after the switch is configured:

```
Router# request platform software sdwan root-cert-chain install bootflash: certificate
```

Prerequisites

- IR1101 has IOS XE SD-WAN Release 16.12.1b or newer. For image installation refer to Appendix A - Upgrade Cisco IR1101 with IOS XE SD-WAN Image.
- Device is connected to a network.
- SD-WAN controllers should be reachable on the network.
- Bootstrap configuration is loaded on bootflash of the device or on a bootable USB drive plugged to the device.
- Device is imported to vManage as valid or staging.
- Device is assigned to a device template.
- If using your enterprise root certificate to authenticate the router, copy the certificate on bootflash.

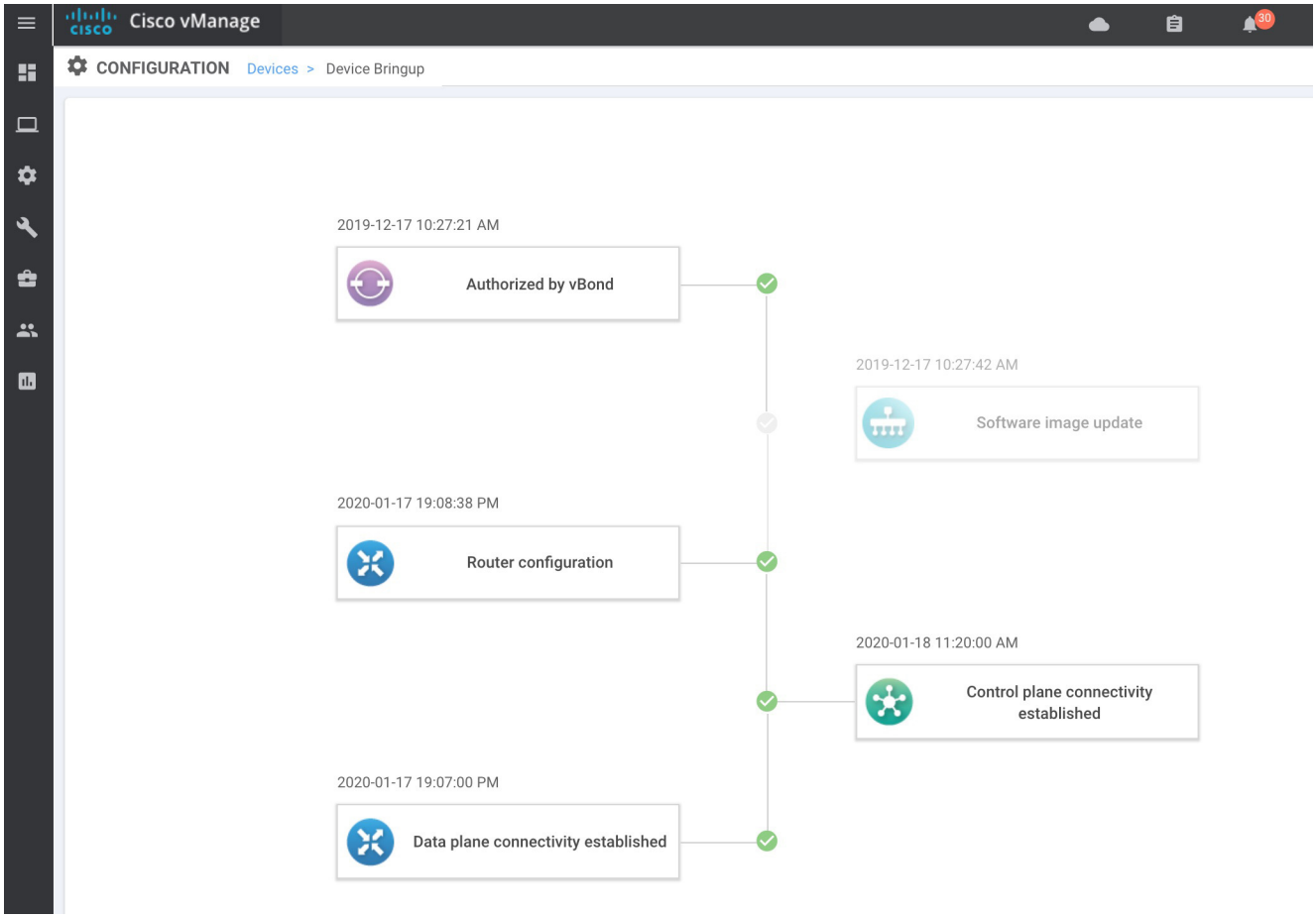
Activate Devices in Staging State

If IOS XE SD-WAN routers are in staging mode, the status won't be seen from the vManage dashboard and they won't be able to establish data plane connectivity. To move those devices into a valid state, go to **Configuration > Certificates**. If device is in Staging mode, switch to **Active** and click **Send to Controllers** at the top of the page.

Device Onboarding Troubleshooting

To check device onboarding status, go to **Configuration > Devices**. Click on more actions (**...**) at the end of the row and choose **Device Bring up** to see status of onboarding process. All stages should be passed with a green check mark. The only exception is the Software Image Update that may be grayed out. If there are any issues or the device is not found on the device list use this troubleshooting section.

Figure 31 Device Bring up



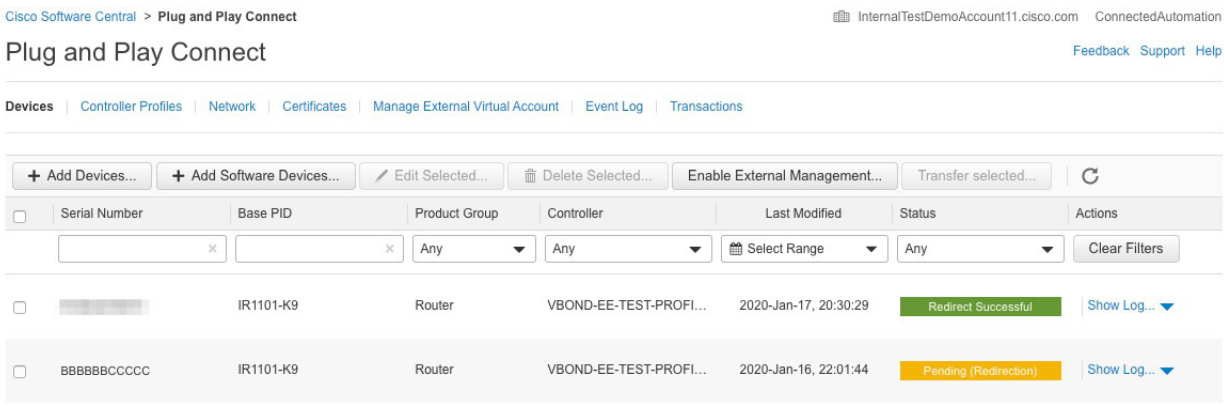
Device is Not Authorized by vBond

- Check the device is in the staging or valid state. Go to **Configuration > Certificates** and confirm the status of the device. If device is not in the list, make sure is added on PNP Connect portal and imported into vManage. If device is in invalid state, change to **Valid** or **Staging** and then click **Send to Controllers** at the top of the page.
- Make sure the device is associated to a template on vManage. Go to **Configuration > Devices**. Click more actions (**...**) at the end of the row and choose **Template Log**. If logs show "*No logs available*", associate to a template by following the Attach Device to Template section.
- If using PnP make sure the device got its IP configuration using DHCP, and check that the device is able to reach `devicehelper.cisco.com`. If the device is not getting an IP address, check physical connectivity and contact the service provider. If using cellular interfaces refer to Troubleshooting LTE Connectivity.
- The following is expected in the logs when doing PnP:

```
*Jan 17 20:12:18.433: %PNP-6-HTTP_CONNECTING: PnP Discovery trying to connect to PnP server
https://devicehelper.cisco.com.:443/pnp/HELLO
*Jan 17 20:12:18.658: %PNP-6-HTTP_CONNECTED: PnP Discovery connected to PnP server
https://devicehelper.cisco.com.:443/pnp/HELLO
……
*Jan 17 20:12:49.322: SDWAN INFO: SDWAN pnp send vbond info: Org name iot-ee Host x.x.x.x port 12346
intf Cellular0/1/0
*Jan 17 20:12:50.313: %PNP-6-PNP_REDIRECTION_DONE: PnP Redirection Done successfully
```

- Successful communication with the PnP server is shown on PnP Connect portal on the Devices tab as shown in the image below. The device Status column will show Redirect Successful instead of Pending Redirection. Click the Show Log link for more information, it will show timestamps, if the device contacted the server, and authentication results.

Figure 32 PnP Connect Device Redirected



- If device is onboarded using bootstrap, PnP Connect portal does not show any updates. Instead check if the configuration was loaded to the device with the **show sdwan running-config** command. If the configuration is not present, check that the configuration file **ciscosdwan.cfg** is present on bootflash or the bootable USB as described in the Bootstrap section.
- If the device is successfully redirected in the case of PnP or has the right configuration in the case of bootstrap, confirm the device is able to reach vBond. If using a domain name instead of IP address, check that the DNS server IP address is configured on the VPN0 feature template attached to the device and reachable from the router.
- The command **show sdwan control connections** shows control connections, and if the device is not authenticated by vBond, use the **show sdwan control connection-history** command to see attempts to connect with code for failure. Common errors are:
  - DCONFAIL: DTLS Connection Failure. Check connectivity, firewall or NAT configuration
  - CRTREJSER/BIDNTVRFD: Serial Number(s) Not Present.
  - The serial number is not present on the controllers for a given device, you will see that control connections fail.
  - VSCRTREV/CRTVERFL: Certificate Revoked/Invalidated
  - In cases when the certificate is revoked on controllers or WAN Edge serial number is invalidated.
  - For more information on control connections troubleshooting refer to

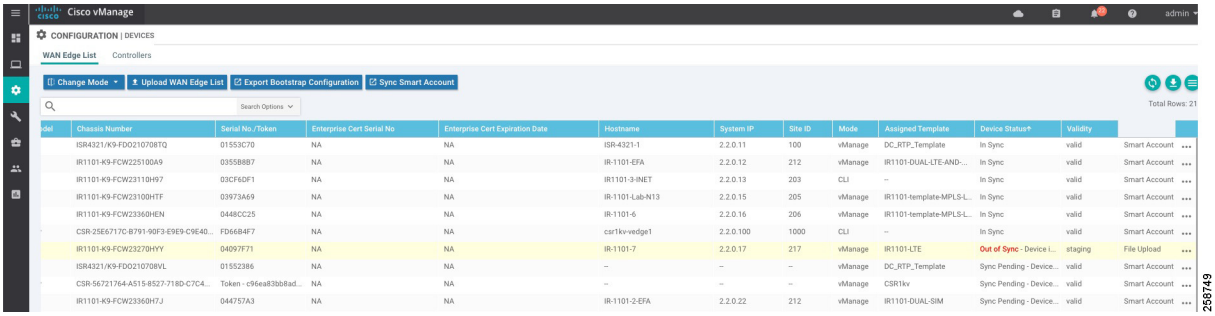
  https://www.cisco.com/c/en/us/support/docs/routers/sd-wan/214509-troubleshoot-control-connections.html
- The command **show sdwan control statistics** shows if control packets are being transmitted and received. If packets are sent but not received check connectivity.

Router Configuration Failure

vManage was not able to push configuration to the device. Go to **Configuration > Devices**. Click more actions (**...**) at the end of the row and choose **Template Log**. There are also options to review the configuration by selecting **Running Configuration (on device)** or **Local Configuration (on vManage)**.

The Status column on **Configuration > Devices** will show Out of Sync if the template is not attached successfully to device. It is possible to click the **Out of Sync** link to view configuration differences.

Figure 33 Device Out of Sync with Template



Control Plane Connectivity Not Established

Go to **Monitor > Network** and select the device. Select **Control Connections** from the left panel to view connectivity to vManage and vSmart. If connectivity is not established, use the **ping** command to check connectivity.

Data Plane Connectivity Not Established

Check that the device is not in staging mode by going to **Configuration > Certificates**. If device is in **Staging** mode, switch to **Active** and click **Send to Controllers** at the top of the page.

Refer to the following link for more tips on data plane connectivity:
https://www.cisco.com/c/en/us/support/docs/routers/sd-wan/214510-troubleshoot-bidirectional-forwarding-de.html

Configuration Reset

Clearing the configuration of the router may be needed in order to restart the PnP process. To clear the SD-WAN configuration from a router take either of the following actions.

```
Device# request platform software sdwan config reset
Device# reload
```

Or:

```
Device# request platform software sdwan software reset
```

Troubleshooting LTE Connectivity

Make sure the following requirements are addressed:

- If the signal is not good at the router, use the Cisco offered antenna accessories and extension cables to place the antenna away from router in a better coverage area.
- You must have 4G LTE network coverage where your router is physically placed.
- You must subscribe to a service plan with a wireless service provider and obtain a Subscriber Identity Module (SIM) card. Only micro SIM is supported. The SIM cards are usually provided in an unlocked state so that it can be used without a Personal Identification Number (PIN). If the SIM is unlocked, it can be inserted into a 4G LTE-Advanced module and used without an authorization code.
- You must install the SIM card before configuring the 4G LTE or router.

- Make sure APN is configured per provider instructions. The **show cellular** *unit* **profile** command shows information about the modem data profiles created and attached. The *unit* argument identifies the router slot, module slot, and port separated by slashes (i.e. 0/1/0).

  ```
  Router# show cellular 0/1/0 profile
  ```

- The **show cellular** *unit* **network** command displays information about the carrier network, cell site, and available service.
- The **show cellular** *unit* **radio** command shows the radio signal strength.
- Note that cellular networks have higher latency compared to wired networks. Latency rates depend on the technology and carrier. Latency also depends on the signal conditions and can be higher because of network congestion.

Device Management

Software Upgrade

When upgrading using vManage, you can upgrade using a code image that is directly loaded onto vManage or a remote vManage, and you can also upgrade using a code image located on a remote file server. In this procedure, software for any device is uploaded to the vManage software repository.

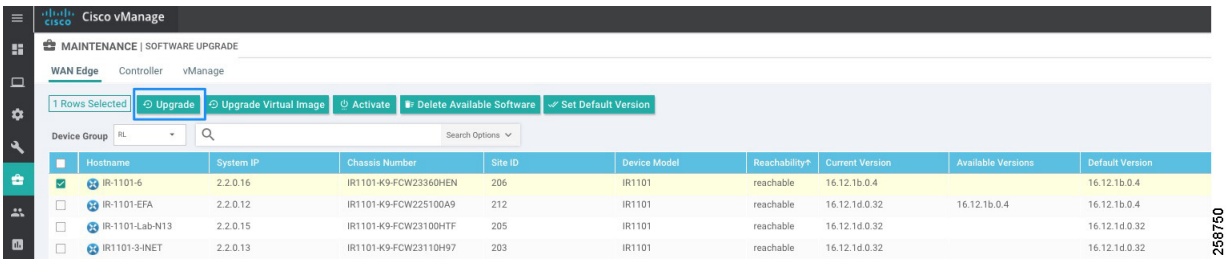
Uploading Images on vManage

1. Go to **Maintenance > Software Repository**. The repository stores the image locally on vManage, a remote file server, or remote vManage.
2. Click **Add New Software** and choose **vManage** from the drop-down list.
3. A dialog box will appear prompting you to drop an image file or browse for an image on the local computer.
4. Load the desired images and click the **Upload** button. A window will indicate that the images are being loaded to the vManage. Once completed, a message will indicate the images were uploaded successfully, and the version, software location (vManage), and available files will be added to the repository.

Device Upgrade

1. Confirm there is enough space on the device for an image download using the **dir bootflash:** command. Free space is shown at the bottom. Remove files if needed.
2. Go to **Maintenance > Software Upgrade** to check the code versions under the **Current Version** column.

Figure 34 Device Upgrade



3. If an upgrade is needed, check the check boxes next to the routers you want to upgrade and click the **Upgrade** button. A dialog box will appear.

4. Verify **vManage** is selected. Choose the new code version from the drop-down list.
5. Check the **Activate and Reboot** check box and then click **Upgrade**. The device will retrieve the software, install it, and then reboot in order to activate it. Optionally you can leave the box unchecked and activate the image later.

Warning: upgrade may fail if there is insufficient disk space (CSCvq13666). Check release notes for more information. Make sure you check disk space before starting the upgrade on the device.

Activate an Image

For images already installed but not activated follow the steps:

1. Go to **Maintenance > Software Upgrade** to check the code versions under the **Current Version** column.
2. Check the check boxes next to the routers you want to activate and click **Activate**. A dialog box will appear.
3. If there is an image installed ready to activate it will show in the **Version** drop-down menu. Select the version and click **Activate**. The router will reboot with the new version.

Best Practices

- Break up the routers into different upgrade groups. You can identify them with a tag in the device-groups field in the system template. Target a test site or multiple test sites and put those routers into the first upgrade group.
- In dual-router sites, put each router into a different upgrade group and do not upgrade both of them at the same time.
- All routers in an upgrade group can be upgraded in parallel (up to 32 WAN Edge routers), however, take into account the ability for vManage or a remote file server to be able to handle the concurrent file transfers to the routers.
- Upgrade the first upgrade group and let the code run stable for a predetermined amount of time, then proceed to upgrade the additional upgrade groups.
- To keep the disk from getting full, clean up older versions using vManage. To delete older versions, go to **Maintenance > Software Upgrade**, select the device you want to clear and select **Delete Available Software**. On the dialog box select the images you want to delete and then click **Delete**.

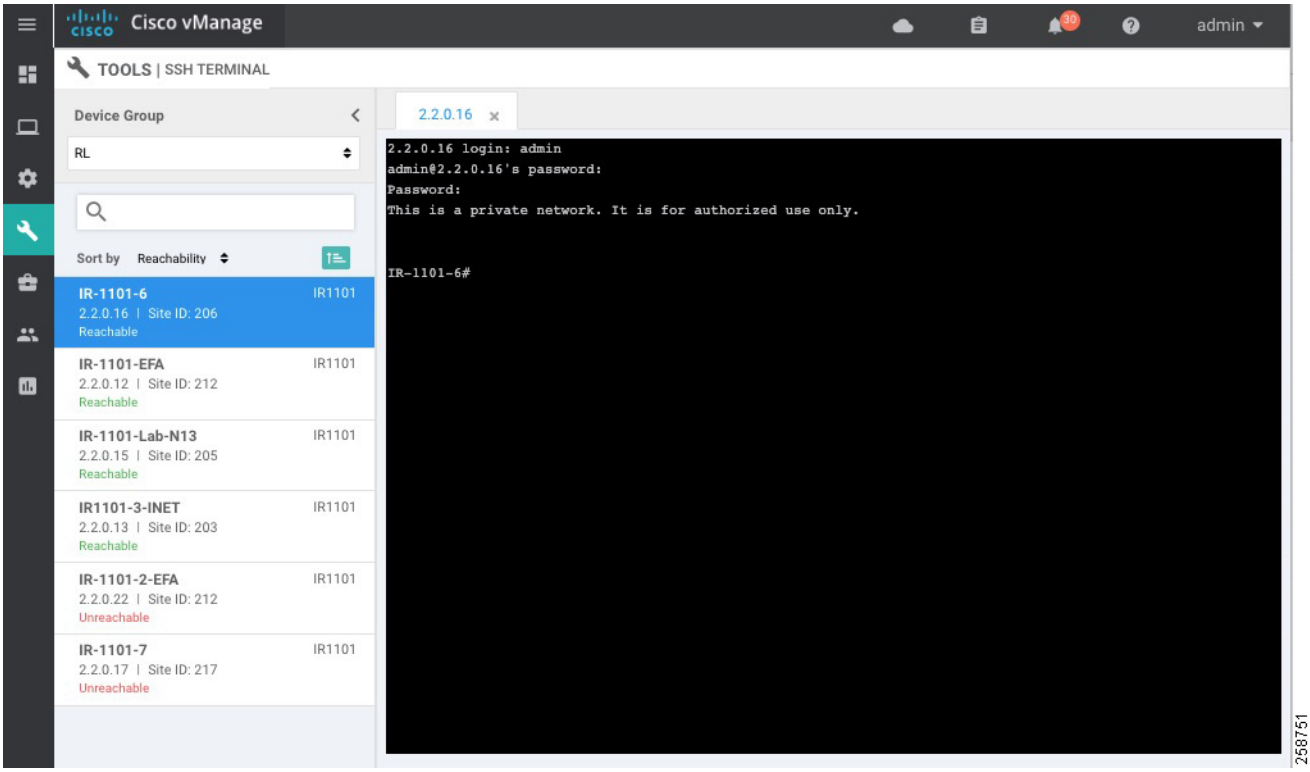
Reboot a Device

Reboot a router by going into **Maintenance > Device Reboot**. Make sure you are on the **WAN Edge** tab. Select the device to reboot and click **Reboot**. Confirm the action on the pop out window.

Connect to the Device Terminal

Go to **Tools > SSH terminal**. Choose the device you want to connect on the left panel. A terminal window to the device will be displayed. Provide device credentials.

Figure 35 Device Terminal



Generate Admin Tech

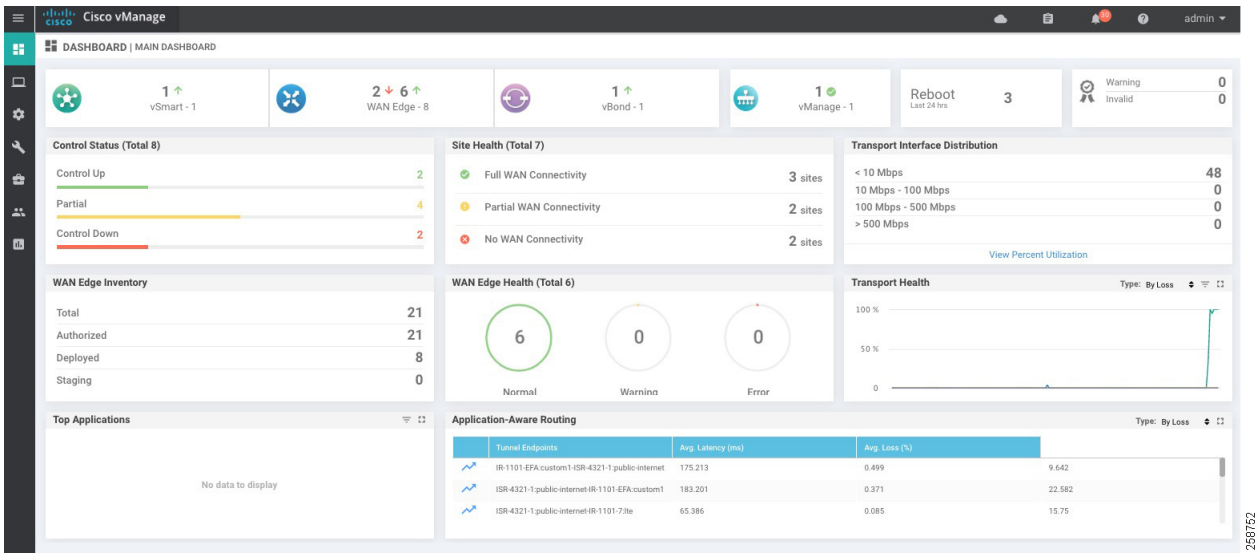
Go to **Tools > Operational Commands**. Choose the router and click on more actions (**...**) at the end of the row. Click **Admin Tech**. Select the information you want to collect and click **Generate**. Wait until the file is generated and then click **Download**.

Monitor

Main Dashboard

Use the dashboard screen to monitor, at a glance, the overall health of the SD-WAN overlay network.

Figure 36 Dashboard



The top bar shows tasks and alarms on the system. The dashboard also displays all control connections from vManage to the vSmart controllers, WAN Edge routers, and vBond orchestrators in the overlay network as well as the status of the vManage NMSes in the network. You can click on the number or the Up or Down arrow to display a table with detailed information for each connection.

The dashboard displays the total number of reboots in the last 24 hours for all devices in the network. Click the **Reboot pane** for more information.

The **Control Status** pane displays whether vSmart and WAN Edge routers are connected to the required number of vSmart controllers. Each vSmart controller must connect to all other vSmart controllers in the network. Each WAN Edge router must connect to the configured maximum number of vSmart controllers. The **Control Status** pane shows three counts:

- Control Up: Total number of devices with the required number of operational control plane connections to a vSmart controller.
- Partial: Total number of devices with some, but not all, operational control plane connections to vSmart controllers.
- Control Down: Total number of devices with no control plane connection to a vSmart controller.

Click any row to display a table with device details.

The **Site Health View** pane displays the state of a site data connections. When a site has multiple WAN edge routers, this pane displays the state for the entire site, not for individual devices. The pane displays three states:

- Full WAN Connectivity: Total number of sites where all BFD sessions on all WAN edge routers are in the up state.
- Partial WAN Connectivity: Total number of sites where a TLOC or a tunnel is in the down state. These sites still have limited data plane connectivity.
- No WAN Connectivity: Total number of sites where all BFD sessions on all WAN edge are in the down state. These sites have no data plane connectivity.

Click a row to display a pop-up window with detailed information on each site, node, or tunnel.

The **Transport Interface Distribution** pane displays interface usage in the last 24 hours for all WAN Edge interfaces in VPN 0. This includes all TLOC interfaces. Click a row to see details of interface usage.

The **WAN Edge Inventory** pane provides four counts:

- Total: Total number of WAN Edge routers whose authorized serial number has been uploaded on the vManage server.
- Authorized: Total number of authorized WAN Edge routers in the overlay network. These are routers marked as Valid.
- Deployed: Total number of deployed WAN Edge routers. These are routers marked as Valid that are now operational in the network.
- Staging: Total number of WAN Edge routers in staging state.

Click any row to display a table with the hostname, system IP, site ID, and other details of each router.

The **WAN Edge Health** pane displays an aggregated view for each router state according to resource utilization and a count of how many WAN Edge routers are in that state

The **Transport Health** pane displays the aggregated average loss, latency, and jitter for all links and all combinations of colors. From the Type drop-down, select loss, latency, or jitter. Click the **Expand** icon to open the **Transport Health** window. This full-screen window displays a more detailed view of the same information.

The **Application-Aware Routing** pane displays the 10 worst tunnels over the last 24 hours based on criteria specified from the **Type** drop-down list, including loss, latency, and jitter.

Geography

Use the **Geography** page (**Monitor > Geography**) to view information about the Cisco SD-WAN devices and links in the overlay management network. The Geography page provides a map displaying the geographic location of the Cisco SD-WAN devices. It is possible to filter by tag.

To choose the devices you want to display on the map use the Filter button, and the map is dynamically updated to reflect your selections. Also, as you make the device group, device type, and link selections, the tabs next to the **Filter** button are updated.

To display basic information for a device, hover over the device icon. A window displays the system IP address, hostname, site ID, device type, and device status.

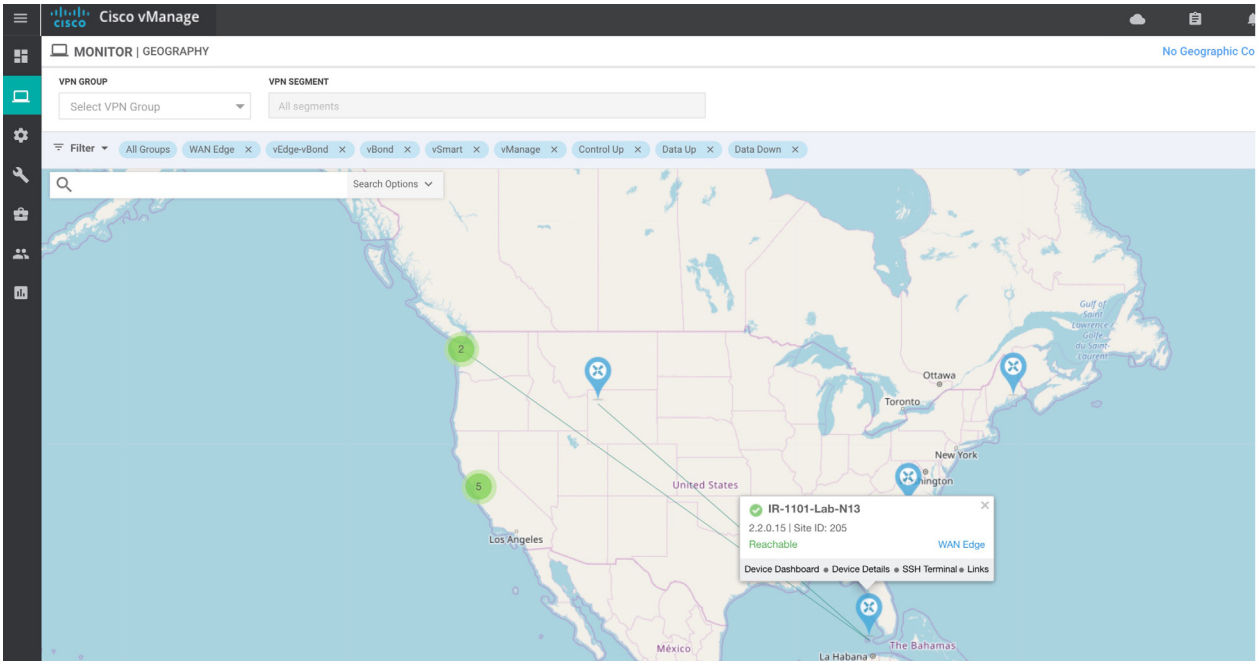
By default, control and data connections are not displayed on the map. To see control and data connections for a device double-click the device icon to open a window with details about the device. Click **Links**.

- An active control connection between two devices is displayed on the map as a thin blue line. Multiple active connections between devices are displayed by a bold blue line. A control connection that is down is displayed on the map as a dotted red line. Multiple control connections that are down are displayed by a bold dotted red line. If you hover over the line, the connection status (up or down) is shown.
- An active data connection between two devices is displayed on the map as a thin green line. Multiple active data connections are displayed by a bold green line. A data connection that is down is displayed on the map as a dotted red line. Multiple data connections that are down are displayed by a bold dotted red line. If you hover over the line, the connection status (up or down) is shown.
- An active consolidated control and data connection between two devices is displayed on the map as a thick gray line.

Similarly, it is possible to double-click on the device to go to **Device Dashboard**, **Device Details**, or **SSH terminal**.

Tip: Device location and device groups are configured using System Feature Template.

Figure 37 Monitor Geography

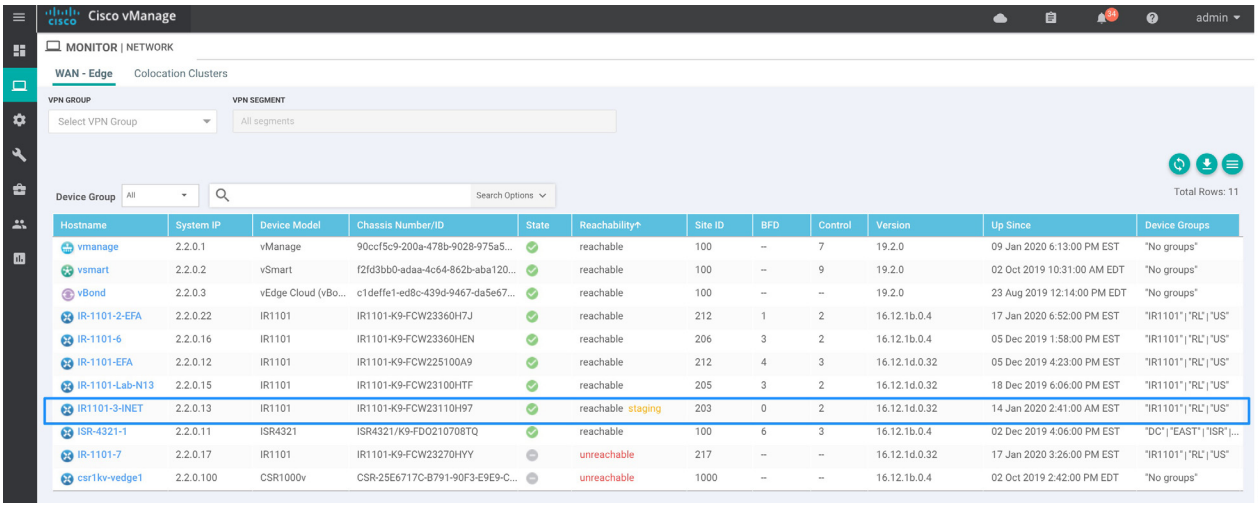


Network

Use the **Network** page (**Monitor > Network**) to display a list of Cisco SD-WAN devices in the overlay network and to display detailed information about individual devices. The device list can be filtered by group, reachability, hostname, system IP address, site ID, and device model. Choose options from the **Sort** drop-down list or enter a string in the **Search** box.

The following image shows how to use the Network page to view devices in Staging state. Sort or filter by reachability. Note that this view also shows BFD and control connections. Devices in Staging will show control connections, but BFD will be 0. Information can be downloaded to a CSV file using the arrow at the top right of the table.

Figure 38 Monitor Network Reachability



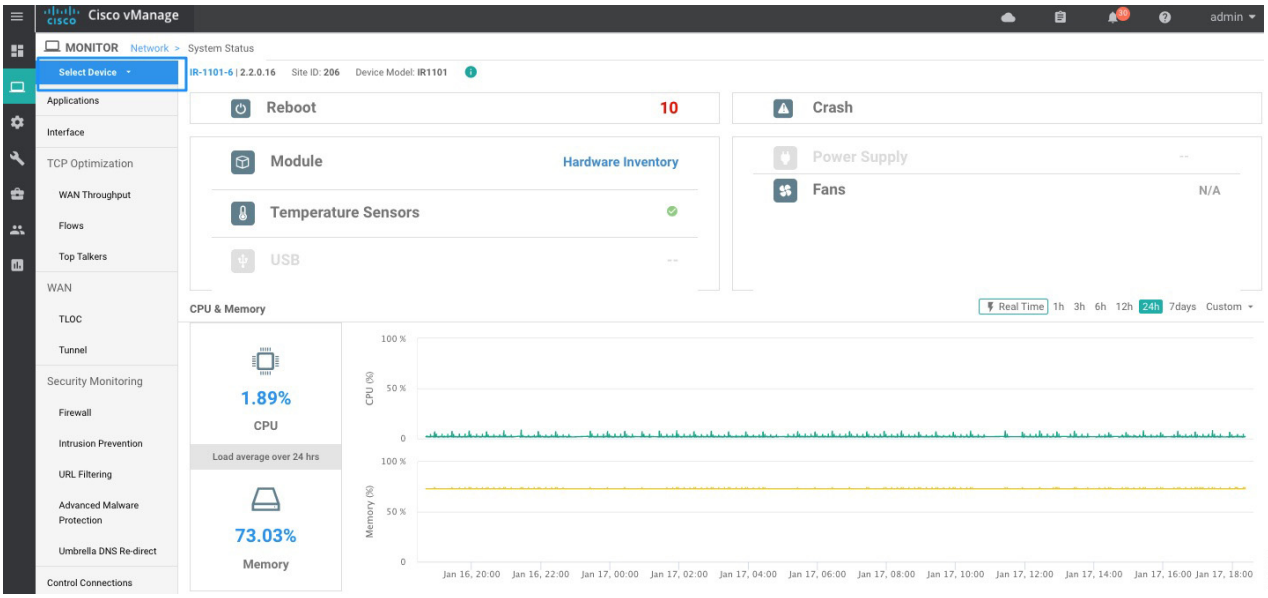
To display information about an individual device, click the device hostname. The left pane lists the information categories about the device. In the right pane, the **System Status** category is selected, which displays status information about the device.

To select a different device, either choose a device from the **Select Device** drop-down list located at the top of the left pane or click **Network** in the title bar and then click a device hostname.

System Status

To view system status for a device, go to **Monitor > Network**, then click a device hostname. The **System Status** page shows information such as CPU, memory, hardware inventory and number of times the device has rebooted.

Figure 39 System Status

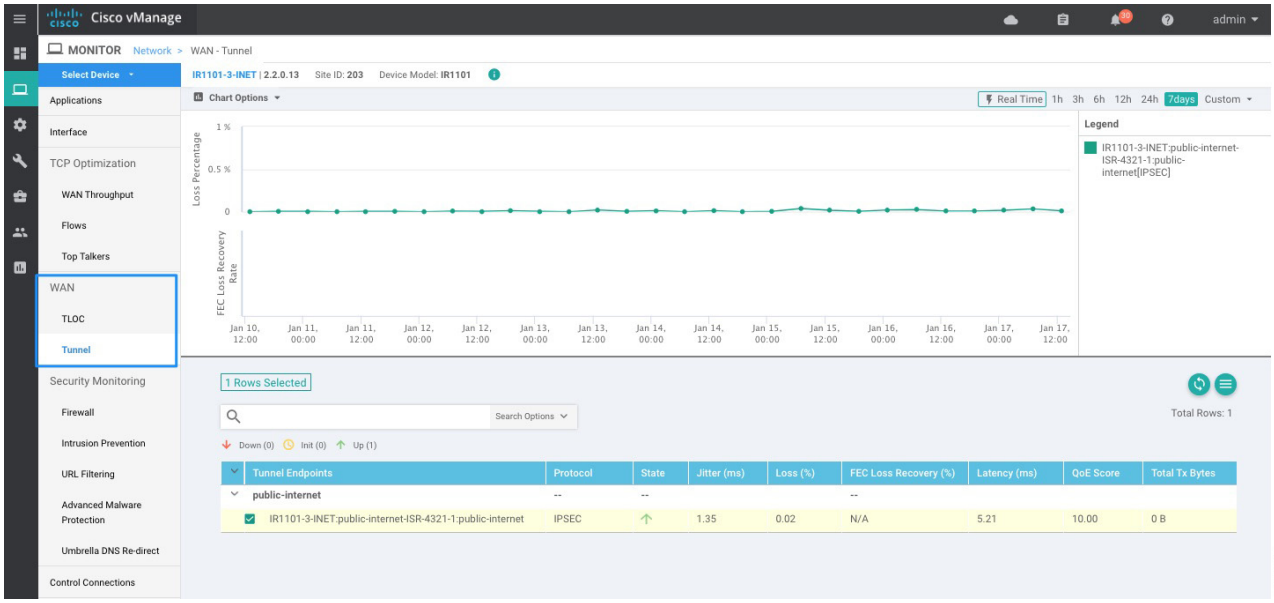


WAN Information

Go to **Monitor > Network** and then click a device hostname.

- **WAN >TLOC** on the left panel shows information about TLOC loss, latency, and jitter.
- **WAN > Tunnel** on the left panel displays information about all data plane tunnels, you can easily see if you are sending or receiving packets for a particular tunnel. This can help you understand if packets are making it on each end, and isolate connectivity issues between the nodes.

Figure 40 Monitor Device WAN Information



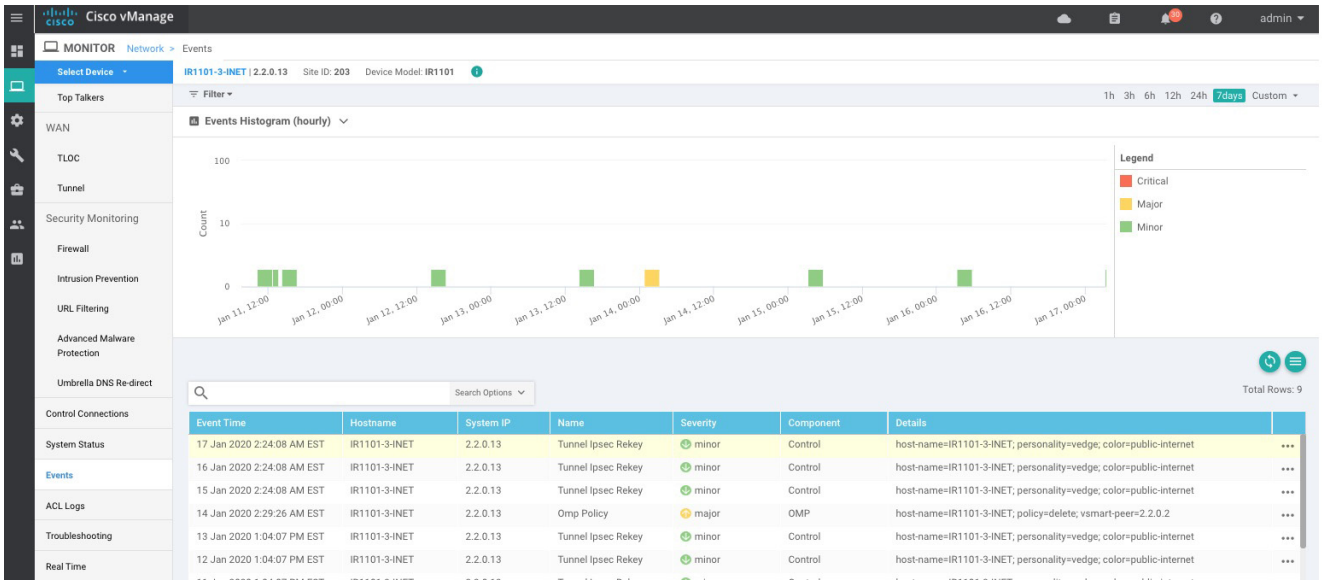
Control Connections

Go to **Monitor > Network** and click a device hostname, then choose **Control Connections** on the left panel. It shows the expected and actual number of connections and the control connections data in graphical and tabular format.

Events

To view the number of critical, major, or minor events on a device go to **Monitor > Network** and click a device hostname, then choose Events on the left panel. It shows a list of the events and a histogram.

Figure 41 Events



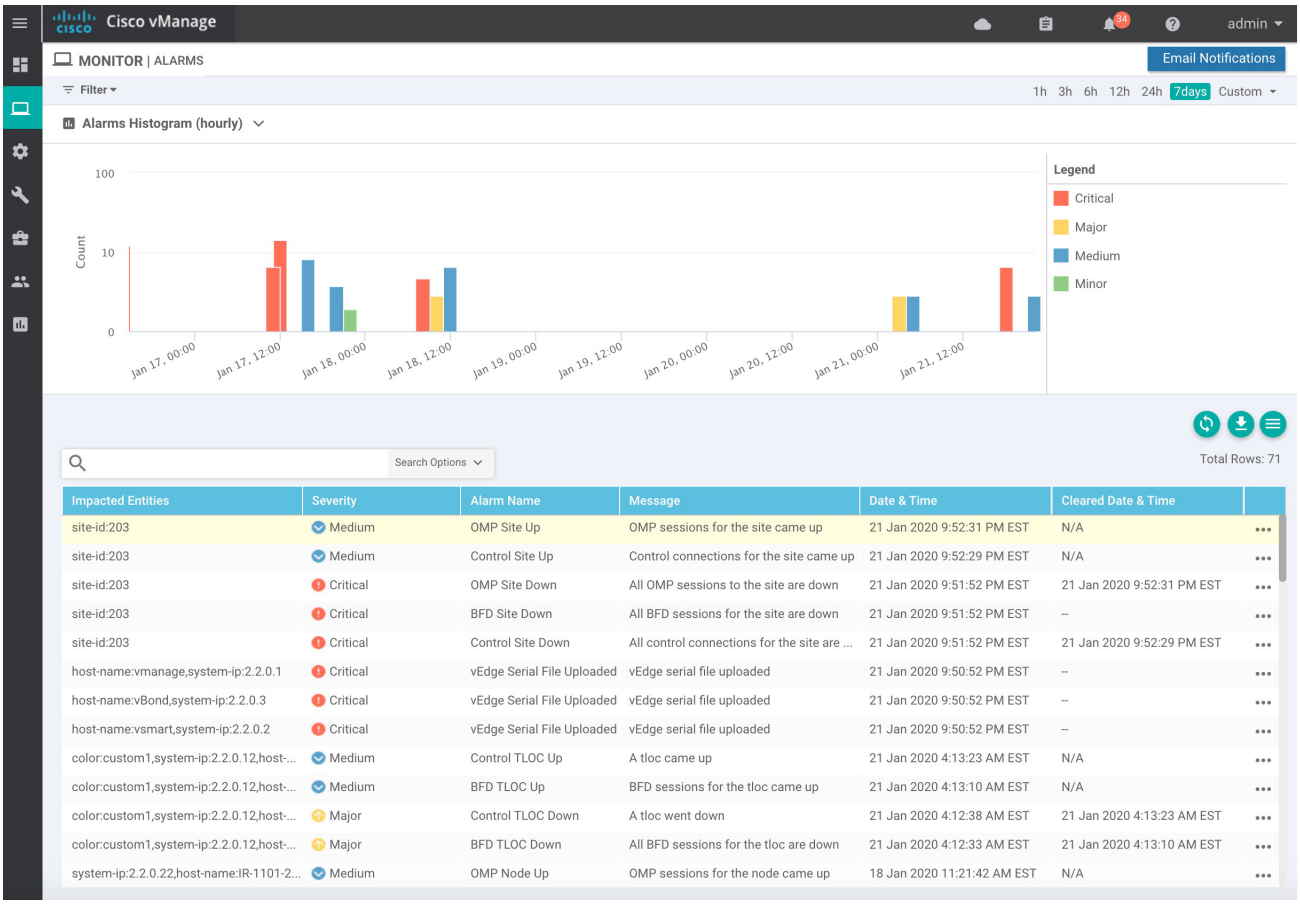
Tip: Events can be useful to troubleshoot a device that went offline. Choose **Events** from the left panel to display events from the device before it went down, such as bfd-state-change, omp-state-change, or control-connection-state-change.

Alarms

Use the Alarms (**Monitor > Alarms**) page to display detailed information about alarms generated by controllers and routers in the overlay network.

To set filters for searching alarms generated by one or more Cisco SD-WAN devices click the Filter drop-down menu. You can filter by severity, status, alarm name, severity and impacted entity. To view detailed information about any alarm, click the table row and click the More Actions icon (**...**) to the right of the row, then choose **Alarm Details**. The Alarms Details window opens, displaying the possible cause of the alarm, impacted entities, and other details.

Figure 42 Alarms



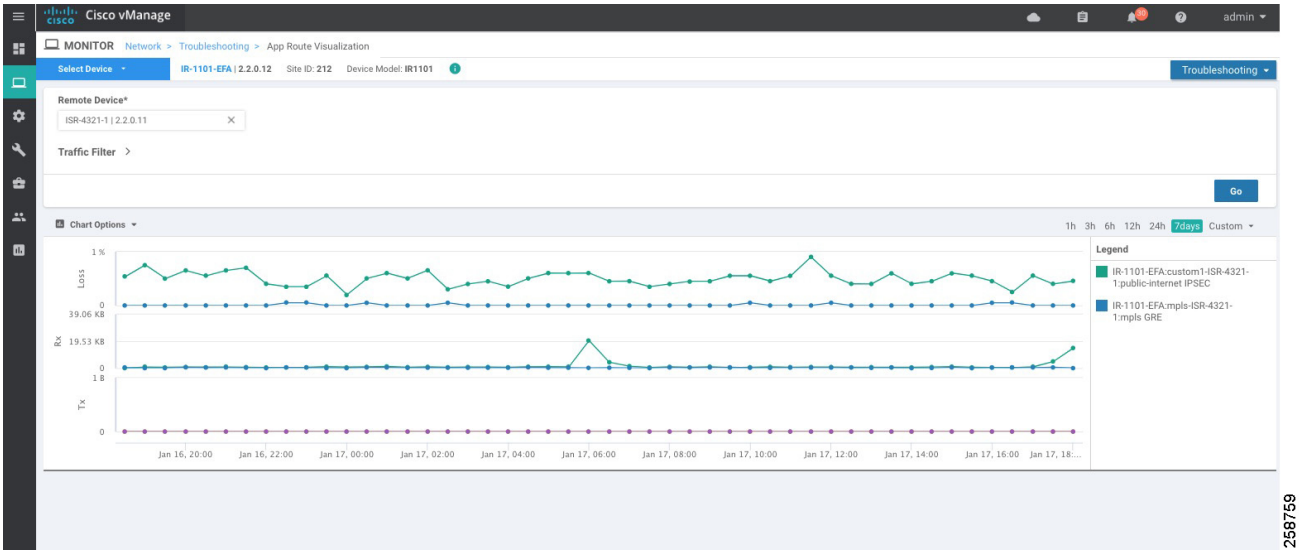
The software generates alarms when a state or condition changes, such as when a software component starts, transitions from down to up, or transitions from up to down. Refer to **https://www.cisco.com/c/en/us/td/docs/routers/sdwan/configuration/Monitor-And-Maintain/monitor-maintain-book/monitor.html#c_Alarms_12333.xml** for available alarms.

Troubleshooting

You can troubleshoot connectivity or traffic health for all devices in the overlay network. Go to **Monitor > Network**, click a device hostname, then choose **Troubleshooting** on the left panel. Some troubleshooting features are grayed out because they do not apply to IOS XE SD-WAN routers in this release.

- Device Bring up is used to verify the status of device onboarding up as explained in Device Onboarding Troubleshooting.
- Control Connections (Live View) shows Control Connections in Real Time. This view not only shows actual connections but detail on expected connections color and current status.
- Tunnel Health displays either loss, latency, or jitter in graphical format for all tunnels between the two devices in each direction.
- App route visualization is useful to check application-aware routing traffic from the source device to the destination device

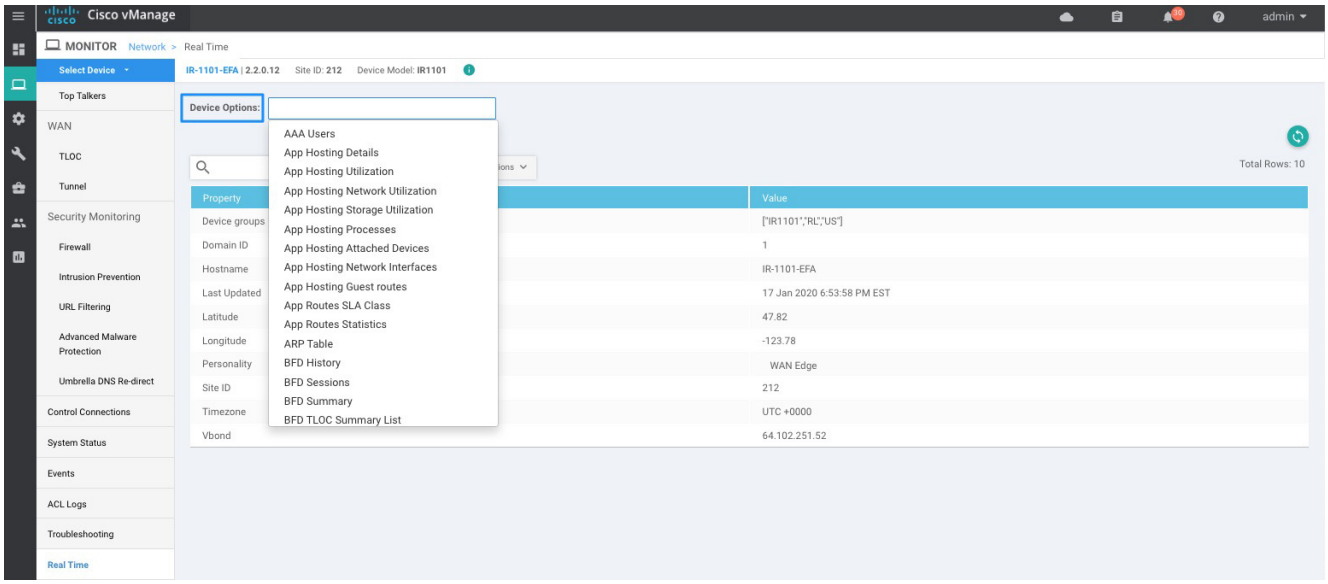
Figure 43 App Route Visualization



Real Time

To see device information in real time, go to **Monitor > Network**, click a device hostname, then choose **Real Time**. You will see the **Device Options** drop-down list located directly under the device name, from which you can choose a feature-specific operational command to display real-time device information for the selected command. The commands in the drop-down are listed alphabetically. The commands available vary depending on the device selected. When you first choose **Real Time**, the **System Information** command is selected, and real-time system information about the device is displayed in tabular format. For some commands, you can add filters to speed up the display of information.

Figure 44 Real Time



Some useful options are included in the table that follows.

BFD commands are useful to troubleshoot data plane connectivity. If BFD tunnels are flapping or down, then there may be packet loss, latency, or NAT issues. You can check which tunnels are up and down with the **show bfd sessions** and **show bfd history** commands. If too many BFD packets are dropped, the tunnel will go down.

OMP commands are useful to troubleshoot centralized control policy and tunnel preferences.

Table 38 Real Time Commands

Device Options	Description
App Routes SLA Class	Displays information on SLA classes on the device
App Routes Statistics	Display statistics about data traffic, jitter, loss, and latency and other interface characteristics for all operational data plane tunnels
bfd history	Display the history of the BFD sessions
bfd sessions	Display information about the BFD sessions running on the local router. The following information is displayed: ■ System IP: Peers system-ip ■ Source and Remote TLOC Color: This is useful to know what TLOC you are expecting to receive and send. ■ Source IP: It is the private source IP. ■ DST public IP: It is the destination that the router is using to form the Data Plane tunnel. ■ DST public PORT: Public NAT-ed port that the router uses in order to form the Data Plane tunnel to the remote WAN Edge. ■ Transitions: Number of times the BFD session has changed its status, from NA to UP and vice versa.
bfd summary	Display summary information about the BFD sessions running
bfd tloc summary list	Display BFD session summary information per TLOC
cellular connection	Display cellular connection stats, active profile, IP address and DNS
cellular network	Display information about cellular network
cellular radio	Displays cellular radio status and details
control connections	Display information about active control plane connections
control connections history	Display information about control plane connection attempts initiated by the local device.
control local properties	Display the basic configuration parameters and local properties related to the control plane and certificates
control statistics	Display statistics about the packets that router has transmitted and received in the process of establishing and maintaining secure DTLS connections
interface detail	Display information about IPv4 interfaces on the router
omp services	Display the services learned from OMP peering sessions.
omp peers	Display information about the OMP peering sessions that are active

omp received routes	Display routes received from vSmart. Use the following reference for status Codes: C -> chosen I -> installed Red -> redistributed Rej -> rejected L -> looped R -> resolved S -> stale Ext -> extranet Inv -> invalid
omp received TLOCS	Display information learned from the TLOC routes advertised over the OMP sessions running between vSmart controllers and routers. You can also run this command on vSmart to check if the vSmart Receives TLOCs sent by router
policy access list associations	Display the IPv4 access lists that are operating on each interface.
policy access list counters	Display the number of packets counted by IPv4 access lists configured on the router. Counters are defined on the policy creation
policy access list names	Display the names of the IPv4 access lists configured on the router

Additional Command Line Interface Commands

You can use SSH connection from vManage to run any CLI command. Some useful commands are described in the following sections.

Check Connectivity

Use the ping and traceroute commands to check connectivity. Make sure you are pinging from the right VPN; VPN 0 is default. Use VRF keyword to select VPN.

```
ROUTER#traceroute vrf 1 10.2.1.1
```

Check Template Attachment

If a template is not attaching, or if the configuration of the device is not changing, you can check the status of the template with the **show sdwan** system command. It will show vManage: true, Commit Pending: false and display configuration template name when template is attached successfully.

```
IR-1101-2-EFA#show sdwan system
Viptela (tm) vedge Operating System Software
……
Personality:          vedge
Model name:          vedge-IR-1101
Services:            None
vManage:            true
Commit pending:       false
Configuration template:  IR1101-DUAL-SIM
Chassis serial number:   FFFFFXXXXAB
```

Check QoS Scheduler

Use the show policy-map interface int command to check stats for scheduler on the WAN interface. It will display the service policy name and statistics for rate and packets.

```
IR-1101-EFA#show policy-map interface gi 0/0/0
 GigabitEthernet0/0/0

  Service-policy output: shape_GigabitEthernet0/0/0
```

```
…

Service-policy : qos_class

     …

  Class-map: Queue0 (match-any)
6727731 packets, 3111326413 bytes
5 minute offered rate 28190000 bps, drop rate 0000 bps
Match: qos-group 0
Priority: 30% (30000 kbps), burst bytes 750000, b/w exceed drops: 2328

  Class-map: Queue3 (match-any)
 5 minute offered rate 683000 bps, drop rate 0000 bps

Match: qos-group 3
queue limit 64 packets
(queue depth/total drops/no-buffer drops) 0/27/0
(pkts output/bytes output) 785297/73853878
 bandwidth 5% (5000 kbps)
```

Check if Tunnel Meets SLA

Display statistics about jitter, loss, and latency and other interface characteristics for all operational data plane tunnels using the show sdwan app-route stats command. Sla-class-index line in the output displays SLA classes for which the tunnel meets SLA criteria.

```
IR-1101-EFA#show sdwan app-route stats remote-system-ip 2.2.0.11
app-route statistics 10.12.255.10 10.22.255.2 gre 0 0
 remote-system-ip 2.2.0.11
 local-color    public-internet
 remote-color    public-internet
 mean-loss      0
 mean-latency    123
 mean-jitter    6
 sla-class-index  0,1,2,3,4



     TOTAL      AVERAGE AVERAGE   TX DATA   RX DATA   DATA      DATA
INDEX   PACKETS   LOSS   LATENCY   JITTER    PKTS      PKTS      PKTS      PKTS
------------------------------------------------------------------------------
0       132       01     0    6035    1         0  0
1       133       01         0 0       0      0    0
```

Check Policy from vSmart

Display a centralized data policy, an application-aware policy, or a cflowd policy that a vSmart controller has pushed to the router with the command **show sdwan policy from-vsmart**.

Caveats and Limitations

- Although profiles can be created, modified and deleted, current versions of vManage do not allow you to select the default profiles. If you need to use customized profiles (for example, Access Point Name (APN) in mobile networks), you must overwrite the selected default profile as explained in 4G LTE Configuration.

- The rollback feature does not support restoring changes to default APN configuration. If there is not an APN profile explicitly provisioned with a feature template before applying a template that overwrites the APN and control connection is lost due to that change, the rollback feature will not restore default APN configuration.
- Dual SIM cards with different APNs is not possible when using customized profiles due to a current vManage limitation. Using vManage version 19.2 (and older) it is not possible to associate a specific APN per slot using feature templates. Because of that any customization applied to a cellular unit will apply to all SIM slots on the module.
- An upgrade may fail if there is insufficient disk space (CSCvq13666). Check release notes for more information. Make sure you check disk space before starting the upgrade on the device.