# Cisco SD-WAN: Application-Aware Routing

## Prescriptive Deployment Guide

May, 2020

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# Contents

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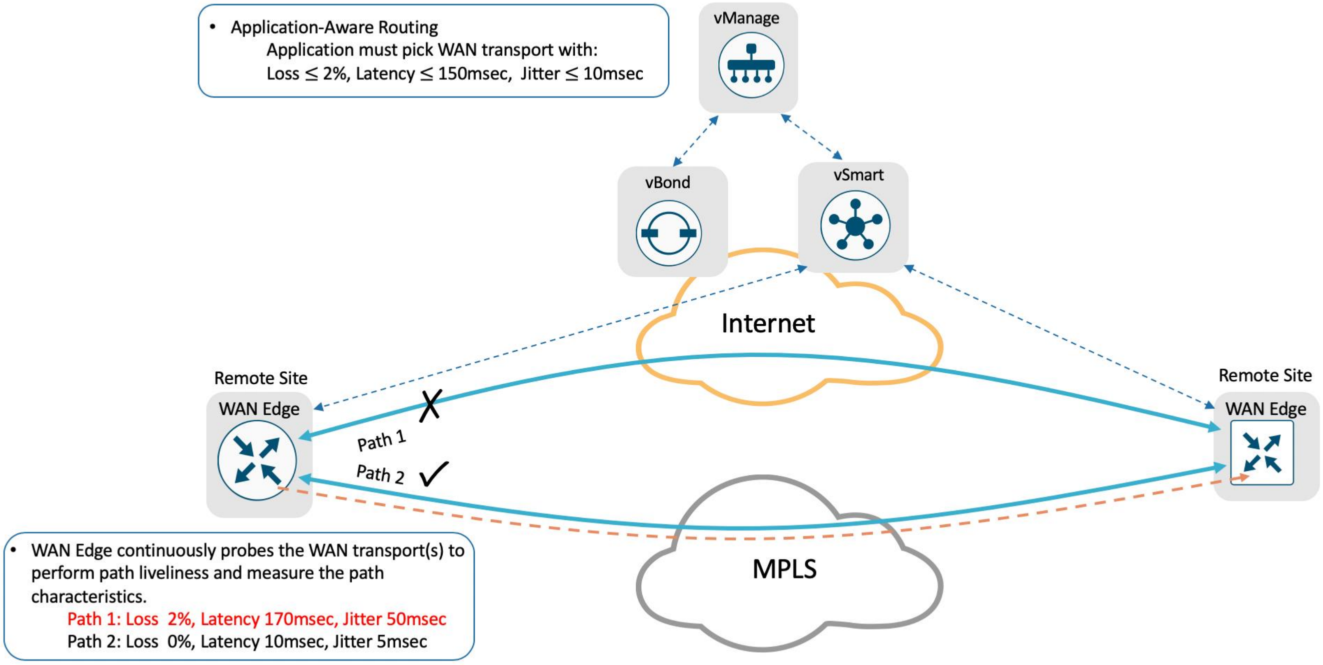
# Introduction

This guide is intended to provide design and deployment guidance to deploy Application-Aware Routing on the Cisco SD-WAN solution providing Service Level Agreement (SLA) based routing for business-critical applications to optimize application performance. The guide focuses on the step-by-step procedures for defining the network characteristics requirements for an application and leveraging the calculated path liveness and quality measurement to influence the traffic path dynamically, providing the best experience for the applications at all times.

The ability to consider the path characteristic in path selection offers a number of advantages to the Cisco SD-WAN solution:

- In normal network operation, the path taken by application traffic through the network can be optimized by directing it to WAN links that support the required levels of packet loss, latency, and jitter defined in an application's SLA.
- In the face of network brownouts or soft failures, performance degradation can be minimized. The tracking of network and path conditions by application-aware routing in real time can quickly reveal performance issues, and it automatically activates strategies that redirect business critical data traffic to the best available paths that meets the SLA. As the network recovers from the brownout or soft failure conditions, application-aware routing automatically readjusts the data traffic paths.
- Network costs can be reduced because data traffic can be more efficiently load-balanced.
- Application performance can be increased without the need for WAN upgrades.

**Figure 1. Application Performance optimization using Application-Aware Routing overview**


• Application-Aware Routing
Application must pick WAN transport with:
Loss ≤ 2%, Latency ≤ 150msec, Jitter ≤ 10msec
vManage
vBond
vSmart
Internet
Remote Site
WAN Edge
Path 1
Path 2
Remote Site
WAN Edge
MPLS
• WAN Edge continuously probes the WAN transport(s) to perform path liveliness and measure the path characteristics.
Path 1: Loss 2%, Latency 170msec, Jitter 50msec
Path 2: Loss 0%, Latency 10msec, Jitter 5msec

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# About this Guide

This prescriptive deployment guide focuses on design considerations and deployment best practices for Application Aware Routing within the Cisco SD-WAN solution. In this guide, SD-WAN controllers are deployed in the cloud and WAN Edge routers are deployed either at remote sites or at the datacenter and are connected to two WAN transports, Internet and MPLS.

Although this deployment guide is about Application Aware Routing. It is presumed that

- Cisco SD-WAN Controllers (vManage, vBond, and vSmart) are already deployed with valid certificates.
- Cisco WAN Edge device is onboarded and have established control connections to Cisco SD-WAN controllers and data tunnels to other WAN Edge devices across all available transports.
- Cisco SD-WAN WAN Edge and vSmart controller have configuration – feature templates defined, and device template associated and are in vManage mode.

For more information on SD-WAN controller design and deployment, please refer to the Cisco SD-WAN Design guide, Cisco SD-WAN End-to-End Deployment guide and the Cisco WAN Edge Onboarding Prescriptive Deployment guide.

This document contains four major sections:

The **Define** section provides a high-level overview of the SD-WAN architecture and components and Application-Aware Routing components.

The **Design** section provides detailed discussion on the design considerations and prerequisites needed to deploy Application-Aware Routing.

The **Deploy** section discusses step-by-step procedures to configure Application-Aware Routing policies in the Cisco SD-WAN network. It walks through the best practices and gotchas to consider during the process.

The **Operate** section briefly discusses how to monitor and troubleshoot the common issues.

Refer to Appendix A for details on the platform and software versions used to build this document.

## Audience

The intended audience for this document includes network design engineers and network operations personnel who have deployed the Cisco SD-WAN components and are looking for the best viable option to provide service level quality for applications running on the Cisco SD-WAN infrastructure.

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# Define

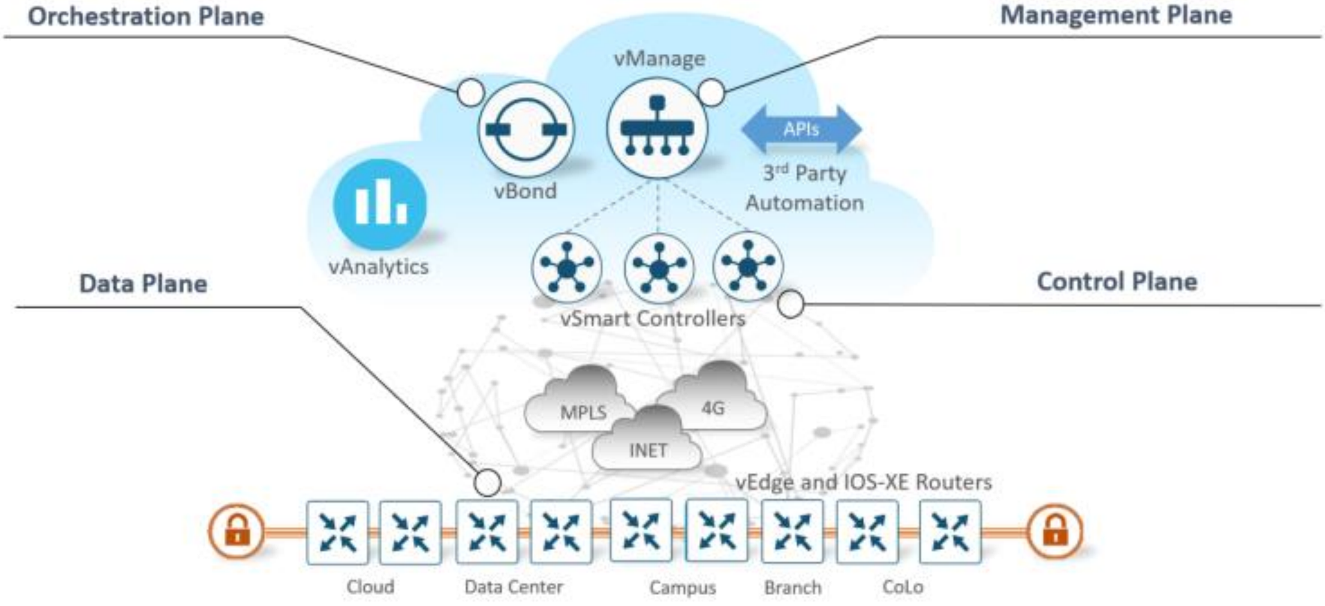
## About the solution

The Cisco SD-WAN solution is an enterprise-grade SD-WAN architecture overlay that enables digital and cloud transformation for enterprise. The solution fully integrates routing, security, centralized policy and orchestration into large-scale networks and addresses the problems and challenges of common WAN deployments.

The Cisco SD-WAN solution is comprised of separate orchestration, management, control and data plane.

- **Orchestration plane** assists in securely onboarding the SD-WAN WAN Edge routers into the SD-WAN overlay. The vBond controller, or orchestrator, authenticates and authorizes the SD-WAN components onto the network. The vBond orchestrator takes an added responsibility to distribute the list of vSmart and vManage controller information to the WAN Edge routers.
- **Management plane** is responsible for central configuration and monitoring. The vManage controller is the centralized network management system that provides a single pane of glass GUI interface to easily deploy, configure, monitor and troubleshoot all Cisco SD-WAN components in the network.
- **Control plane** builds and maintains the network topology and make decisions on the traffic flows. The vSmart controller disseminates control plane information between WAN Edge devices, implements control plane policies and distributes data plane policies to network devices for enforcement.
- **Data plane** is responsible for forwarding packets based on decisions from the control plane. WAN Edge physical or virtual devices provide secure data-plane connectivity between the sites in the same SD-WAN overlay network. WAN Edge devices are responsible for establishing secure connections for traffic forwarding, for security, encryption, Quality of Service (QoS) enforcement and more.

**Figure 2. Cisco SD-WAN solution components**



In this prescriptive deployment guide, we focus on ensuring real-time dynamic path selection for business-critical application based on the end-to-end WAN network traffic conditions.

Upon securely onboarding the WAN Edge device in the Cisco SD-WAN overlay network, the WAN Edge device establishes secure control connections with all the controllers (vBond, vManage, vSmart) where it receives

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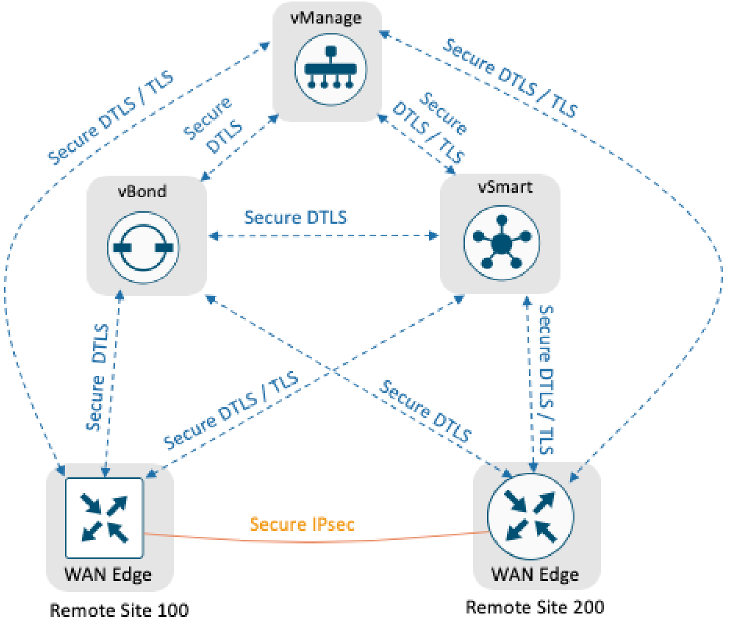
configuration, policies and routing information. The WAN Edge device would then establish secure IPsec tunnels with other WAN Edges, which is part of the same SD-WAN overlay network, to forward data-traffic.

**Figure 3. SD-WAN components secure connections**



The Cisco SD-WAN solution leverages NETCONF to provision the WAN Edge devices with the associated template configuration in the vManage and Overlay Management Protocol (OMP) to convey the control-plane information such as route-prefixes, next-hop routes, crypto keys and policy information between the vSmart controllers and the WAN Edge devices. By default, with no policies defined, the SD-WAN overlay network would form full-mesh topology, allowing each WAN Edge device to establish a secure IPsec connection to other WAN Edge device.

It is important to note that the WAN Edge device establishes a permanent persistent connection to the vSmart controller over each available WAN transport and a single permanent persistence connection to the vManage over only one WAN transport.

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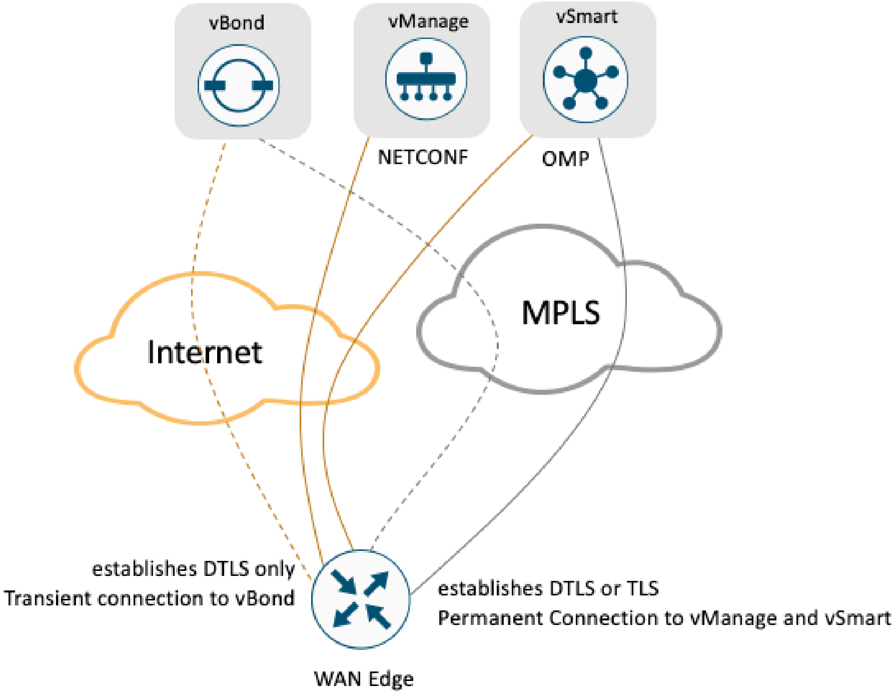
**Figure 4.** SD-WAN components – secure control and data connections



### Bi-directional Forward Detection (BFD)

Upon establishing secure IPsec data-plane tunnels between the WAN Edge devices, BFD session are initiated on each of the tunnel established between the WAN Edge devices. The BFD probes monitors the network characteristics – loss, latency and jitter on the tunnels. By default, the BFD Hello packet is sent every 1 second and this value can be changed on a per tunnel basis.

The BFD operates in echo mode where BFD messages generated by the WAN Edge device are reflected (echoed) back by the remote WAN Edge device. Each BFD packet is time-stamped by the originating WAN Edge device to determine the round-trip latency and jitter. Path loss or tunnel liveness is determined based on the lost BFD packets.

The WAN Edge device collects the packet loss, latency and jitter for every BFD probe (default BFD Hello packets are sent 1 sec on every WAN transport) and is preserved for every poll interval (the default poll interval value is 10 minutes). The network path liveliness, by default, is calculated for a period of 6 poll intervals for better accuracy and to dampen any intermittent reclassification (flapping) of the tunnel. At the seventh poll interval, the earliest polling data is discarded to accommodate the latest information.

BFD packets being forwarded at regular intervals enables the SD-WAN overlay network to not only detect any blackout situations but also detect path characteristics such loss, latency, jitter, path-MTU that can then be leveraged by other SD-WAN protocols to make dynamic decision and provide the best quality of experience for business-critical applications.

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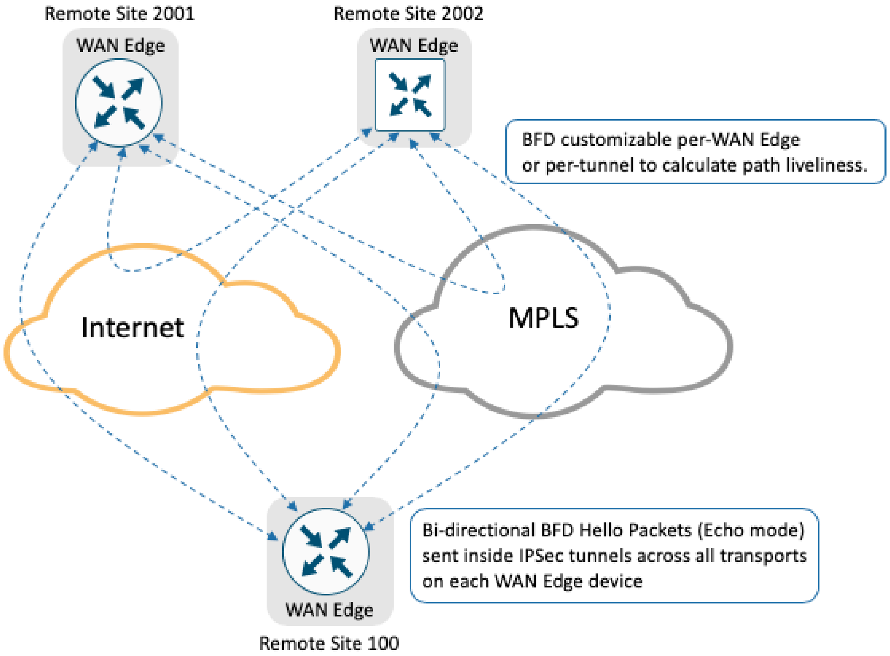
Figure 5. Bi-directional Forward Detection



Remote Site 2001
WAN Edge
Remote Site 2002
WAN Edge
BFD customizable per-WAN Edge or per-tunnel to calculate path liveliness.
Internet
MPLS
Bi-directional BFD Hello Packets (Echo mode) sent inside IPSec tunnels across all transports on each WAN Edge device
WAN Edge
Remote Site 100

### Service Level Agreement (SLA)

Cisco SD-WAN solution provides the network administrator procedure to define the desired SLA for the business-critical traffic. The SLA characteristics defines the desired loss, latency and jitter for the specified classified traffic.

The WAN Edge devices determines the WAN transports path characteristics - loss, latency and jitter from the previously discussed BFD probes sent across each tunnel between the WAN Edge devices.

- Packet loss is calculated on the WAN Edge device on a per tunnel basis and is measured as percentage 0 through 100 percent.
- Jitter is calculated on the WAN Edge device on a per tunnel basis and is a measurement of millisecond, 0 through 1000 milliseconds.
- Latency is calculated on the WAN Edge device on a per tunnel basic and is a measurement of millisecond, 0 through 1000 milliseconds.

Note: Calculated Packet Loss, Jitter and Latency are average values for the poll intervals and are round-trip measurements on each tunnel interface on the WAN Edge device.

Application-Aware Routing leverages the calculated network path characteristics values as a measurement and compares with the desired SLA for the application, to dynamically optimize the data path selection for the traffic on the WAN Edge device.

### Policies

The Cisco SD-WAN solution separates the control plane functionality managed by vSmart controller with the data plane functionality operated by the WAN Edge devices. Similarly, the Cisco SD-WAN policy architecture separates the control policies that influence the routing information shared between vSmart controllers and the WAN Edge devices, with the data policies that influences the data traffic between the WAN Edge devices.

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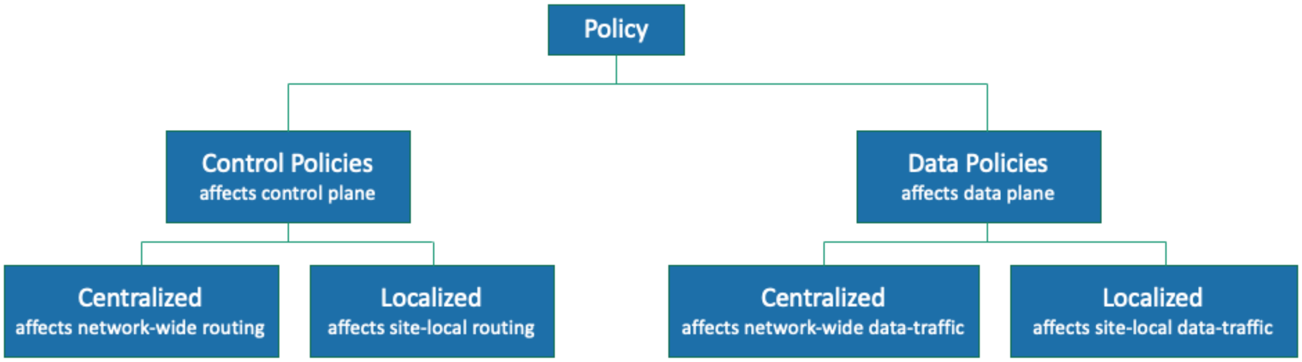
Policies, either control or data, are configured in vManage, provisioned and enforced either at vSmart controller influencing network-wide or locally on the WAN Edge influencing a specific parameter for the device.

**Figure 6. Cisco SD-WAN Policy framework**


Policy
Control Policies
affects control plane
Data Policies
affects data plane
Centralized
affects network-wide routing
Localized
affects site-local routing
Centralized
affects network-wide data-traffic
Localized
affects site-local data-traffic

By default, with no policy associated to the any SD-WAN components in the solution. In this scenario:

- WAN Edge devices advertise routes to vSmart controllers through the OMP protocol.
- The vSmart controller advertises the full routing information that is learnt from all WAN Edge devices to all other WAN Edge devices through the OMP protocol.
- SD-WAN WAN Edge devices establish data plane connections to all other WAN Edge devices forming a full-mesh topology.

Centralized policy, either control policy or data policy, is configured in vManage.

- The centralized control policy is applied to the routing information that is stored in the vSmart controller and enforced before the routes are advertised to the WAN Edge devices allowing for customizing routing decisions and determining the routing paths through the overlay network.

  The centralized control policy configuration remains on the vSmart controller and is never pushed to the WAN Edge devices.
- The centralized data policy is applied to the data traffic flow for the specified VPNs in the overlay network. These policies permit or restrict access based on 6-tuples (source-ip, destination-ip, source-port, destination-port, protocol, dscp values) or based on VPN memberships allowing for customizing routing decision and determining routing paths at a local site.

  Depending on the policies, the policy is provisioned on vSmart, pushed (via OMP protocol) and enforced on the WAN Edge devices.

Localized policy, either control policy or data policy, is configured in vManage.

- Localized control policy is applied to the routing information that is stored on the WAN Edge device influencing the routing behavior on the device at local site level.
- Localized data policy is applied on the interface of the WAN Edge device. The data policy is leveraged to match traffic and defines QoS, policing, mirroring at the interface level of the WAN Edge device.

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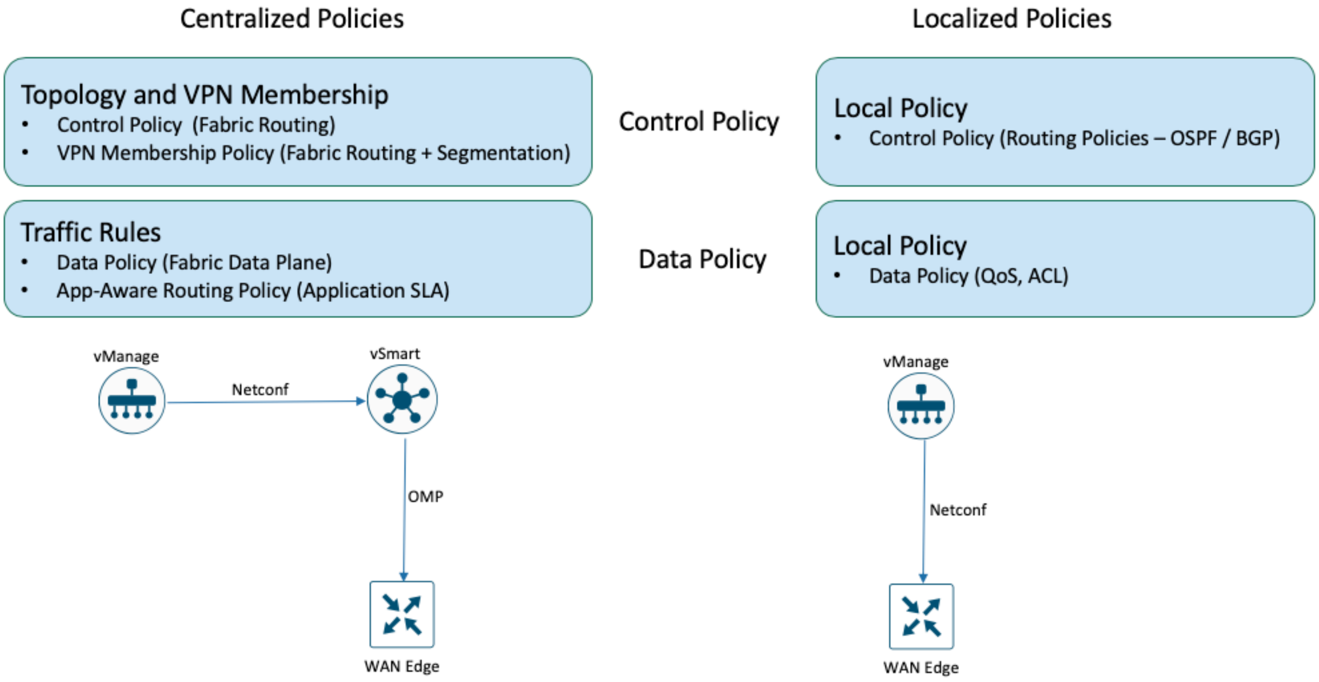
**Figure 7. Centralized and Localized Policies**


Centralized Policies
Localized Policies
Topology and VPN Membership
Control Policy (Fabric Routing)
VPN Membership Policy (Fabric Routing + Segmentation)
Control Policy
Local Policy
Control Policy (Routing Policies – OSPF / BGP)
Traffic Rules
Data Policy (Fabric Data Plane)
App-Aware Routing Policy (Application SLA)
Data Policy
Local Policy
Data Policy (QoS, ACL)
vManage
vSmart
Netconf
OMP
WAN Edge
vManage
Netconf
WAN Edge

### Application-Aware Routing

Advanced features set such as Application-Aware Routing provide network administrators the necessary flexibility to pin certain business-critical application to a specific WAN transport on the device. Actively probe the network and path characteristics and dynamically re-route the application traffic, in real-time, on the WAN transport links that meets the specified application SLA requirements.

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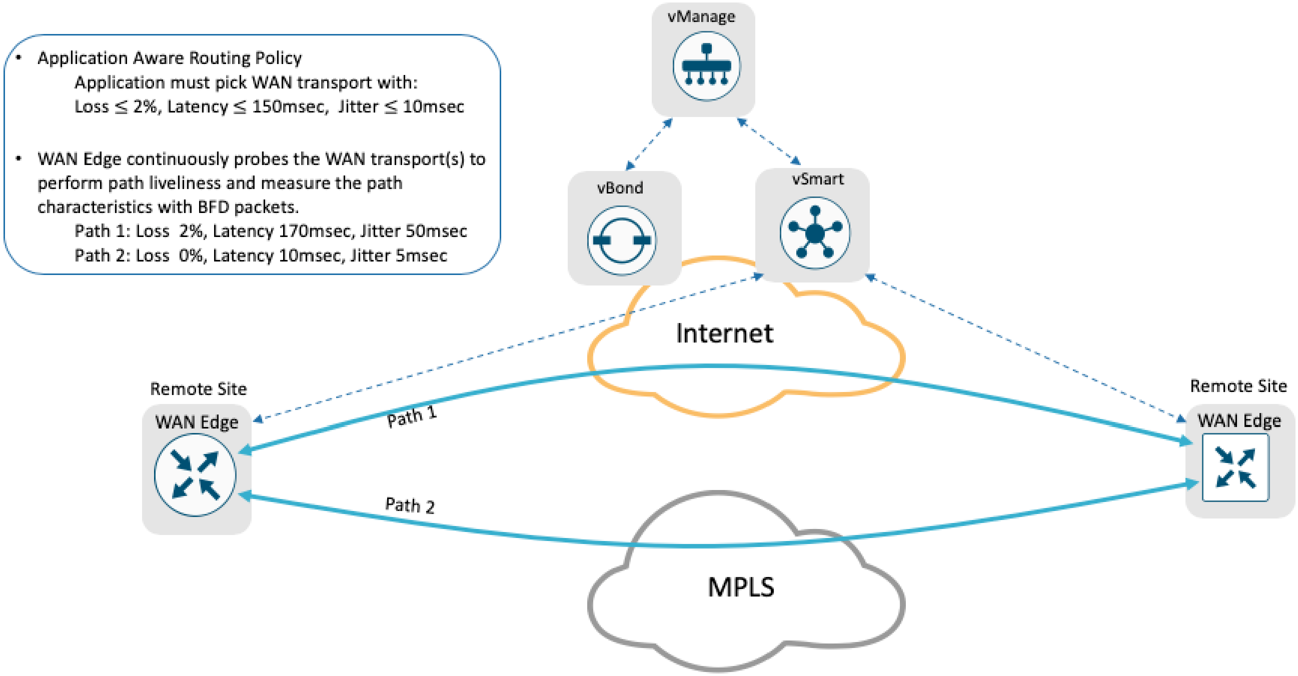
**Figure 8. Application-Aware Routing**



- Application Aware Routing Policy
  Application must pick WAN transport with:
  Loss ≤ 2%, Latency ≤ 150msec, Jitter ≤ 10msec
- WAN Edge continuously probes the WAN transport(s) to perform path liveliness and measure the path characteristics with BFD packets.
  Path 1: Loss 2%, Latency 170msec, Jitter 50msec
  Path 2: Loss 0%, Latency 10msec, Jitter 5msec

Cisco SD-WAN WAN Edge device supports up to 8 TLOCs, allowing a single device to be connected to 8 different WAN transports. Each WAN Edge device in the SD-WAN environment advertises its local routes to the vSmart controller using OMP protocol. The vSmart controller computes the best path selection algorithm for the entire SD-WAN environment and applies any configured centralized control policy before advertises the route-selection to the WAN Edge devices.

The WAN Edge device installs the received OMP route in its forwarding table. For destination prefixes with multiple best paths, the device natively performs Layer-3 ECMP (Equal Cost Multiple Path) load-balancing across 4 reachable next-hop TLOCs. The number of paths installed on the WAN Edge device can be increased to 16 as long as the next-hop is reachable.

SLAs for each of the transport tunnels are calculated periodically using BFD probes by the WAN Edge device and is made available for advanced features like Application-Aware Routing to leverage and provide deterministic experience for business-critical applications.

Application-Aware Routing allows the network administrator to evaluate the network path characteristics for the selected business critical applications and set a preferred path as long as the SLAs are satisfied and a backup preferred path. The backup preferred path is chosen when no available WAN transport(s) meets the specified SLA.

Application-Aware Routing policy is configured in vManage as a centralized data policy that maps the service-side application(s) to specific SLA requirements. The centralized policies provisioned in vSmart controller is pushed to relevant WAN Edge devices for enforcement. The defined policy consists of match-action pairs, where the match statement defines the application-list or the type of traffic to match, and the action statement defines the SLA action the WAN Edge devices must enforce for the specified traffic.

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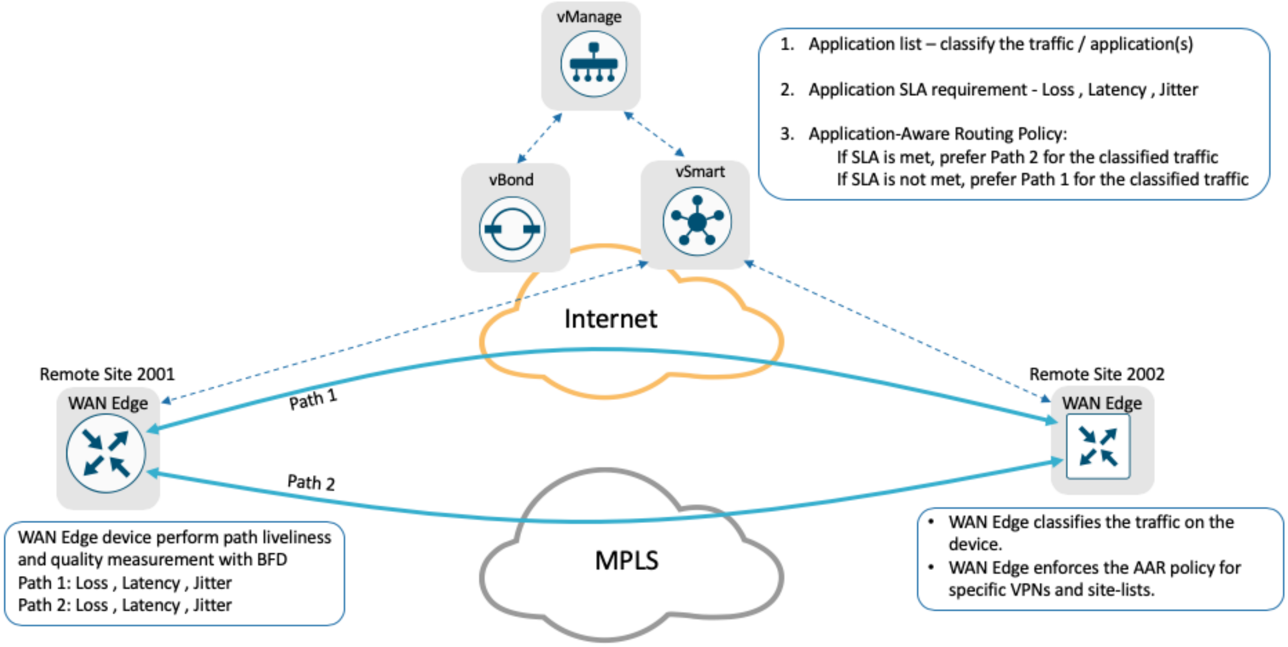
# Design

## Application-Aware Routing Components

Cisco SD-WAN Application-Aware Routing consists of three components:

- Identification – Classify the traffic / Application group of interest.
- Application SLA Requirement – Defining the application SLA requirements.
- Application-Aware Routing Policy – Policy maps the classified traffic to the transport tunnel based on the defined SLA requirement.

**Figure 9. Application Aware Routing components**



1. Application list – classify the traffic / application(s)
2. Application SLA requirement - Loss , Latency , Jitter
3. Application-Aware Routing Policy:
   If SLA is met, prefer Path 2 for the classified traffic
   If SLA is not met, prefer Path 1 for the classified traffic

WAN Edge device perform path liveliness and quality measurement with BFD
Path 1: Loss , Latency , Jitter
Path 2: Loss , Latency , Jitter

- WAN Edge classifies the traffic on the device.
- WAN Edge enforces the AAR policy for specific VPNs and site-lists.

### Identification – Classify the traffic / Application group of interest

First step in defining the Application-Aware Routing (AAR) is to choose the traffic or application group of interest that requires preferred treatment or Service Level Agreement (SLA) to be met. The vManage centralized policy wizard provides the network administrator options to match and define groups of interest as shown below:

| List Type | Groups of Interest |
|---|---|
| Application List | Application – specify the application or application list<br>Application Family – specify the application family list(s) |
| Prefix | Network prefix that can be matched for source or destination addresses |

In addition to above, network administrator can also match traffic based on:

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| List Type | Groups of Interest |
|---|---|
| Cloud SaaS Application List | Leverage the pre-defined Cloud-SaaS Application list |
| DNS Application List | DNS application list is mainly used when the network deployment needs split DNS lookup for certain application or application-lists. |
| DNS | DNS lookup (DNS request / response) packets can be matched. |
| DSCP | Pre-configured traffic with DSCP values, through QoS policy on the service-side traffic, can be leveraged. |
| PLP | Pre-configured traffic part of the Packet Loss Priority (PLP) queue, configured part of QoS policy, can be matched. |
| Protocol | Traffic with certain protocol number. |
| Source Data Prefix | Pre-defined custom data-prefix of the traffic. |
| Source Port | Data traffic with defined port number. |
| Destination Data Prefix | Pre-defined custom data-prefix of the traffic. |
| Destination Port | Data traffic with defined port number. |

### Deep Packet Inspection

Cisco WAN Edge device have integrated Deep packet Inspection (DPI) engine to identify and classify applications including voice and video, email, file sharing, gaming, peer-to-peer (P2P), and cloud-based applications. Viptela WAN Edge devices leverages Qosmos DPI to classify the traffic and Cisco IOS-XE SD-WAN devices uses NBAR2 to identify a wide variety of applications from the network traffic flows using L3 to L7 data.

Cisco IOS-XE SD-WAN devices can incorporate SD-AVC along with the NBAR2 DPI engine providing the capability to inspect and classify the flows on the first packet. Once the applications are classified, policies can leverage this information to match on the application and/or application-list and influence the traffic.

### Service Level Agreement

Next step in defining the Application-Aware Routing (AAR) Policy is to set Service Level Agreement (SLA). The Service Level Agreement specifics the network path characteristics (loss, latency and jitter) that the application can handle for optimized performance.

The vManage centralized policy wizard provides network administrator options to define custom Service Level Agreement (SLA) or leverage the pre-defined SLA's as shown below:

| Name | Loss (%) | Latency (msec) | Jitter (msec) |
|---|---|---|---|
| Transactional-Data | 5 | 50 | 100 |
| Bulk-Data | 10 | 300 | 100 |
| Voice-And-Video | 2 | 45 | 100 |
| Default | 25 | 300 | 100 |

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The pre-defined SLA values (Loss, Latency and Jitter) are specific to the WAN transport characteristics and are round-trip measurement. The pre-defined SLA class values, shown in the above table, may or may not fit the deployment needs. vManage provides administrates the flexibility to define custom SLA class instead of leveraging the pre-defined SLA class.

| **Tech tip** |
|---|
| Before defining custom SLA values, monitor the current WAN transport SLA statistics across the SD-WAN environment by navigating to **vManage > Main Dashboard > Application-Aware Routing** widget.<br>By default, the Loss, Latency and Jitter values are calculated for every WAN transport available on the WAN Edge device and are made available for a period of up to 7 days. This historical data can be used as a baseline to evaluate and define custom SLA values to better fit the environment and the application requirements. |

Careful consideration must to taken when choosing the SLA values. Choosing a more aggressive values might cause undesired result with too many SLA violations, while choosing a more relaxed values might not yield the desired result for the enterprise.

Administrators can define any number of custom SLA's but can associate only 4 SLA's to the Application-Aware Routing policy. Please check the Release Notes for the corresponding software version on the number of SLA supported for the release.

**Application-Aware Routing Policy – Policy maps the classified traffic to the WAN transport based on the defined SLA requirement.**

The Application-Aware Routing policy defined in vManage binds the selected application/traffic list with the SLA. For all matched data-traffic traversing from LAN/Service side to remote site through the device WAN transports, the AAR policy defines the

- Preferred Color – the selected data traffic is pinned to the chosen WAN transport(s) as long as the transport(s) meets the specified SLA.

  Note that when multiple WAN transports are selected and transports satisfying the SLA requirements, the WAN Edge performs ECMP load balancing across the tunnels for the selected data traffic.
- Strict – if enabled, the selected data traffic would be dropped if all the WAN transport(s) do not meet the specified SLA. If there is at least one path meeting the SLA, traffic is forwarded on that path.
- Backup SLA Preferred Color – the selected data traffic is pinned to the chosen WAN transport(s) only when no transport(s) meets the specified SLA and Strict option is not enabled.
- Log – if enabled, a syslog message is generated first time a packet flow is logged and every 5 minutes thereafter, as long as the flow is active.

For all other data traffic that doesn't match the selected application/traffic list, the traffic would be load-balanced across all the available WAN transport links available on the WAN Edge device.

Along with defining the preferred dynamic path selection, AAR policy provides the network administrators with flexibility of defining Site-list's and VPN-list's where the policy needs to be enforced across the SD-WAN overlay network.

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### Monitoring and Measuring WAN transport path characteristics

The network path characteristics is measured by running Bi-directional Forward Detection (BFD's) probes periodically on device's each WAN transport tunnel interfaces. The BFD probe measures the transport's loss, latency, jitter every polling intervals.

Following the WAN Edge onboarding – authenticating and joining the overlay network, the device would establish secure data-tunnel to other WAN Edge devices part of the same SD-WAN overlay network. Upon establishing the data-tunnel, the WAN Edge device would:

- probe each WAN transport tunnel with BFD Hello packets at every 1 second interval. Below table lists the BFD default values.

| List | Description | Default Values |
|---|---|---|
| Hello interval | Interval at which BFD Hello Interval are send across the WAN transport | 1000 msec<br>(configurable) |
| BFD Multiplier | Value defines number of BFD Hello Packet Intervals the device waits before declaring that tunnel has failed. | 7<br>(configurable) |

Note: The BFD Hello Interval and BFD Multiplier can be changed per tunnel or across all the WAN transports on the WAN Edge device.

- collect and preserve the packet loss, latency and jitter for every BFD poll and calculate the network path characteristics at each poll interval. The default poll interval value is 10 minutes, implies 600 BFD hello packets are considered for each poll interval calculation.

  Poll Interval = poll-interval in secs * BFD Hello packet interval

- collect 6 poll intervals and average these values to calculate network path liveliness for better accuracy and to dampen any intermittent reclassification (flapping) of the tunnel. At the seventh poll interval, the earliest polling data is discarded to accommodate the latest information.

  Below table lists the default values for the Application Aware Routing polling data:

| List | Description | Default Values |
|---|---|---|
| Poll Interval | Interval at which WAN Edge calculates the average loss, latency and jitter for each WAN transport. | 10 minutes<br>(configurable) |
| Multiplier | Value defines number of poll interval(s) to be considered to calculate the tunnel statistics for the AAR. | 6<br>(configurable) |

Note:  The Poll Interval and Multiplier values can be modified on the WAN Edge device effecting all the tunnel/WAN transport(s) associated with the device.

Careful consideration must be taken before changing the default values as the BFD packets gets high priority treatment on the WAN Edge device. The BFD packets are marked with high priority DSCP 48 marking. By default, the control traffic and the BFD packets are mapped to Queue 0 on the device and is configured for low-latency queuing, strict-priority traffic queue for control and delay-sensitive traffic. Packets in this queue is transmitted before any other packets in other queues and for congestion avoidance tail-drop is implemented on Queue 0.

Being aggressive by lowering the BFD values would impact the WAN Edge device performance and being conservative by increasing the BFD values would delay the calculations of the network path resulting in undesired dynamic path selection for the business-critical applications.

| **Tech tip** |
|---|
| For optimal device performance, Cisco recommends not to change the default BFD values as this might impact WAN Edge performance. |

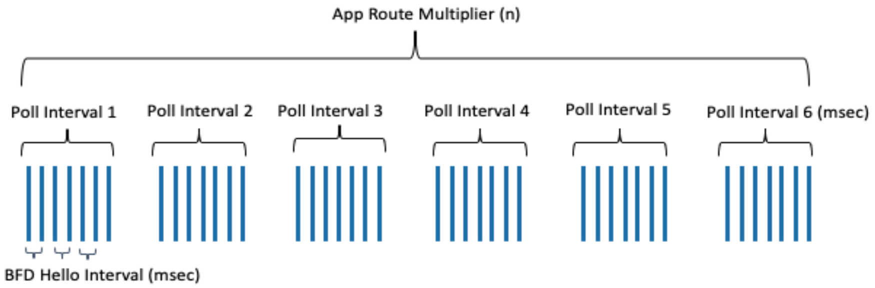
In situation where the default values need to be modified to meet the business requirements, such as to meet the SLA requirements for highly susceptible applications or to reduce bandwidth consumption on the tunnel or to reduce the WAN charges at the remote site. Additional caution and tests must be done before deploying in production environment.

It is always recommended to have a consistent BFD values configured across WAN Edge devices in the same site for the same WAN transport type.

Below table shows examples on the modified values and how quickly the path characteristics are calculated:

| | **Example 3 (Recommended)** | **Example 1 (Aggressive)** | **Example 2 (Moderate)** |
|---|---|---|---|
| BFD Hello Interval | 1000 msec (Default) | 1000 msec (Default) | 1000 msec (Default) |
| Poll Interval | 120 sec | 30 sec | 120 sec |
| App-route Multiplier | 6 intervals (Default) | 2 intervals | 5 intervals |
| Path characteristics calculated every | 120 sec intervals using last 12 minutes poll data | 30 sec intervals using last 1minute poll data | 120 sec intervals using 10 minutes poll data |

**Figure 10.** **Values determining the network path characteristics**



## Policies

Policies are an important part of the Cisco SD-WAN solution and are used to influence the overlay topology and to influence the flow of data traffic across the WAN Edge devices in the overlay network. Policies are applied either at control plane or data plane level, configured in the vManage and enforced either on vSmart controllers or on the WAN Edge devices.

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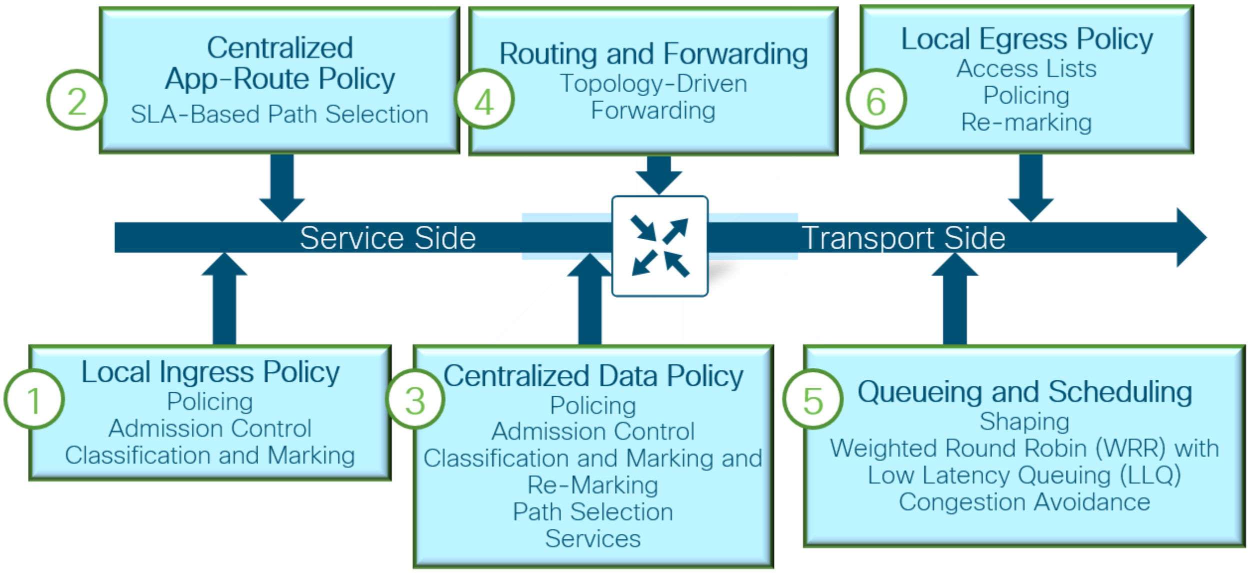
It is to be noted that only one centralized policy can be activated at any time on the vSmart controller. The activated policy can contain several different policy definitions that make up the centralized policy, such as Topology, VPN Membership, Application-Aware Routing policy, Traffic Data (QoS, Service Chaining, Traffic Engineering etc.) and Cflowd policy.

Application Aware Routing policy is part of the centralized policy associated to the vSmart controller. The vSmart controller would distribute the policy through the OMP protocol to the appropriate WAN Edge devices in the overlay network that are part of the selected Site Lists, VPN lists and enforced on the WAN Edge devices for the selected traffic traversing from service-side (LAN network) to the WAN-transport (WAN network).

The WAN Edge device can also be associated with other localized policy. Similar to the centralized policy, only one localized policy can be applied to WAN Edge device. The localized policy can contain several different policies such as prefix-lists, access control list policy, route policy, community-lists, QoS etc.

With multiple policies being configured and enforced on the WAN Edge device, it is important to understand the order of precedence when the packet is moving from service-side to WAN transport-side.

**Figure 11.** **Policy order of operations on a WAN Edge device.**



- Local policy/configuration – includes QoS classification, policer and marking
- Centralized application – application aware routing policy
- Centralized data policy – includes QoS classification, policies, marking and path selection
- Routing/Forwarding
- Scheduling and queuing
- Local policy shaping and ACL – includes shaping, re-marking and policer

It is possible for a centralized data policy to overwrite the actions of a centralized application-aware routing policy. Careful consideration must be kept in mind when defining multiple policies for the network as mutually exclusive policies can influence the traffic traversing the WAN Edge device.

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## Deploy

This section covers needed steps to

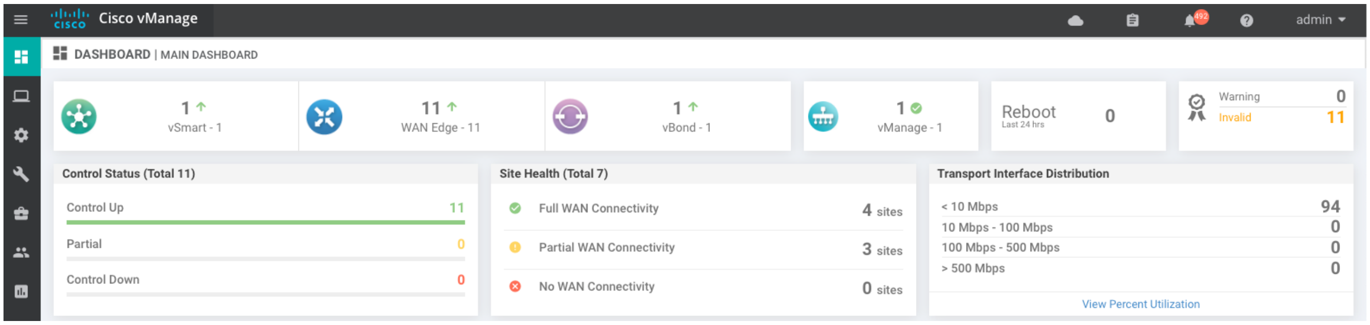
- Verify the prerequisites required before proceeding to deploy Application-Aware routing.
- Procedures involved in deploying centralized policy with Application-Aware routing
- Procedures to append Application-Aware Routing policy to the existing centralized policy.

## Process: Prerequisites for Application-Aware Routing

The below procedure lists the prerequisites that are needed before configuring the Application Aware Routing policies.

### Procedure 1. Verify the WAN Edge device is successfully onboarded in the SD-WAN overlay network.

**Step 1.** In vManage, navigate to **Dashboard > Main Dashboard**, make sure WAN Edge devices are successfully onboarded.



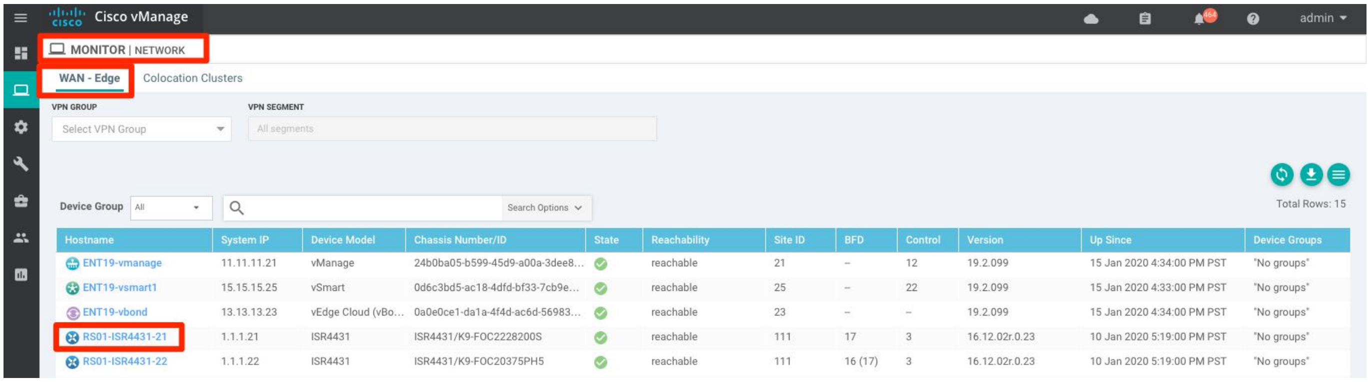
| | |
|---|---|
| vSmart - 1 | 1 ↑ |
| WAN Edge - 11 | 11 ↑ |
| vBond - 1 | 1 ↑ |
| vManage - 1 | 1 ✓ |
| Reboot (Last 24 hrs) | 0 |
| Warning | 0 |
| Invalid | 11 |

| Control Status (Total 11) | |
|---|---|
| Control Up | 11 |
| Partial | 0 |
| Control Down | 0 |

| Site Health (Total 7) | |
|---|---|
| Full WAN Connectivity | 4 sites |
| Partial WAN Connectivity | 3 sites |
| No WAN Connectivity | 0 sites |

| Transport Interface Distribution | |
|---|---|
| < 10 Mbps | 94 |
| 10 Mbps - 100 Mbps | 0 |
| 100 Mbps - 500 Mbps | 0 |
| > 500 Mbps | 0 |

**Step 2.** In vManage, navigate to **Monitor > Network**, select the device from the **WAN-Edge** list.



| Hostname | System IP | Device Model | Chassis Number/ID | State | Reachability | Site ID | BFD | Control | Version | Up Since | Device Groups |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ENT19-vmanage | 11.11.11.21 | vManage | 24b0ba05-b599-45d9-a00a-3dee8… | ✓ | reachable | 21 | – | 12 | 19.2.099 | 15 Jan 2020 4:34:00 PM PST | "No groups" |
| ENT19-vsmart1 | 15.15.15.25 | vSmart | 0d6c3bd5-ac18-4dfd-bf33-7cb9e… | ✓ | reachable | 25 | – | 22 | 19.2.099 | 15 Jan 2020 4:33:00 PM PST | "No groups" |
| ENT19-vbond | 13.13.13.23 | vEdge Cloud (vBo… | 0a0e0ce1-da1a-4f4d-ac6d-56983… | ✓ | reachable | 23 | – | – | 19.2.099 | 15 Jan 2020 4:34:00 PM PST | "No groups" |
| RS01-ISR4431-21 | 1.1.1.21 | ISR4431 | ISR4431/K9-FOC2228200S | ✓ | reachable | 111 | 17 | 3 | 16.12.02r.0.23 | 10 Jan 2020 5:19:00 PM PST | "No groups" |
| RS01-ISR4431-22 | 1.1.1.22 | ISR4431 | ISR4431/K9-FOC20375PH5 | ✓ | reachable | 111 | 16 (17) | 3 | 16.12.02r.0.23 | 10 Jan 2020 5:19:00 PM PST | "No groups" |

select **System Status** from the left panel to view the device status.

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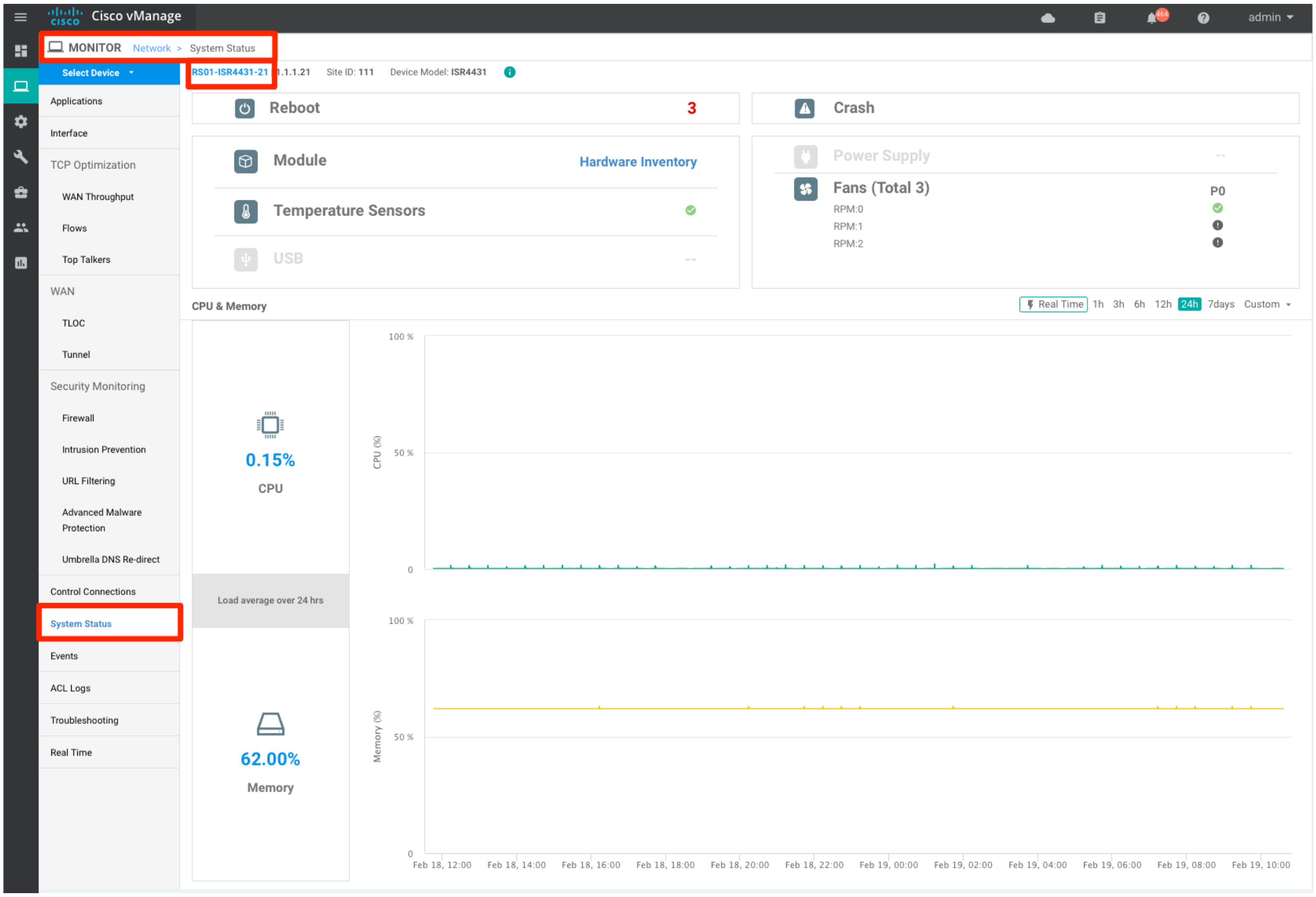


RS01-ISR4431-21 | 1.1.1.21 Site ID: 111 Device Model: ISR4431

Reboot 3

Crash

Module Hardware Inventory

Temperature Sensors ✓

USB --

Power Supply --

Fans (Total 3) P0

RPM:0 ✓

RPM:1 ●

RPM:2 ●

CPU & Memory

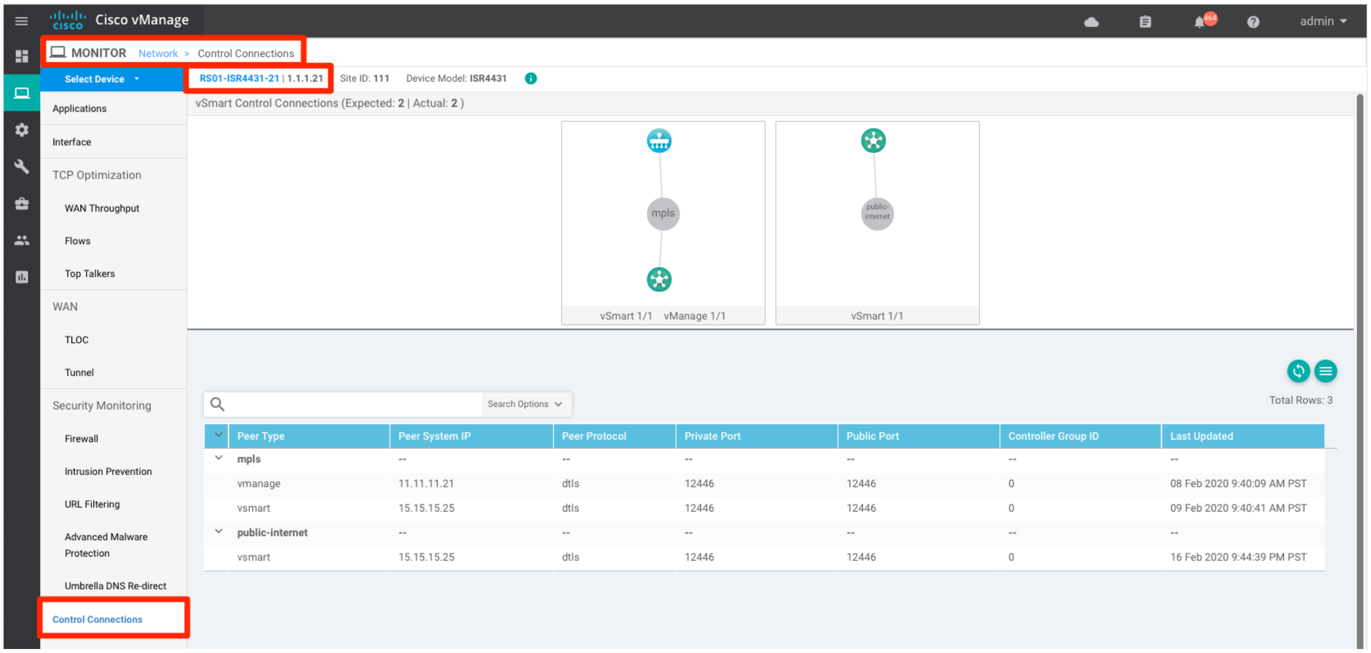
0.15%
CPU

Load average over 24 hrs

62.00%
Memory

## Procedure 2. Verify the WAN Edge device control connections to all the SD-WAN controllers.

**Step 1.** In vManage, navigate to **Monitor > Network**, select the device from the **WAN-Edge** list and select **Control Connections** option from the left panel.



RS01-ISR4431-21 | 1.1.1.21 Site ID: 111 Device Model: ISR4431

vSmart Control Connections (Expected: 2 | Actual: 2 )

Total Rows: 3

| Peer Type | Peer System IP | Peer Protocol | Private Port | Public Port | Controller Group ID | Last Updated |
|---|---|---|---|---|---|---|
| **mpls** | -- | -- | -- | -- | -- | -- |
| vmanage | 11.11.11.21 | dtls | 12446 | 12446 | 0 | 08 Feb 2020 9:40:09 AM PST |
| vsmart | 15.15.15.25 | dtls | 12446 | 12446 | 0 | 09 Feb 2020 9:40:41 AM PST |
| **public-internet** | -- | -- | -- | -- | -- | -- |
| vsmart | 15.15.15.25 | dtls | 12446 | 12446 | 0 | 16 Feb 2020 9:44:39 PM PST |

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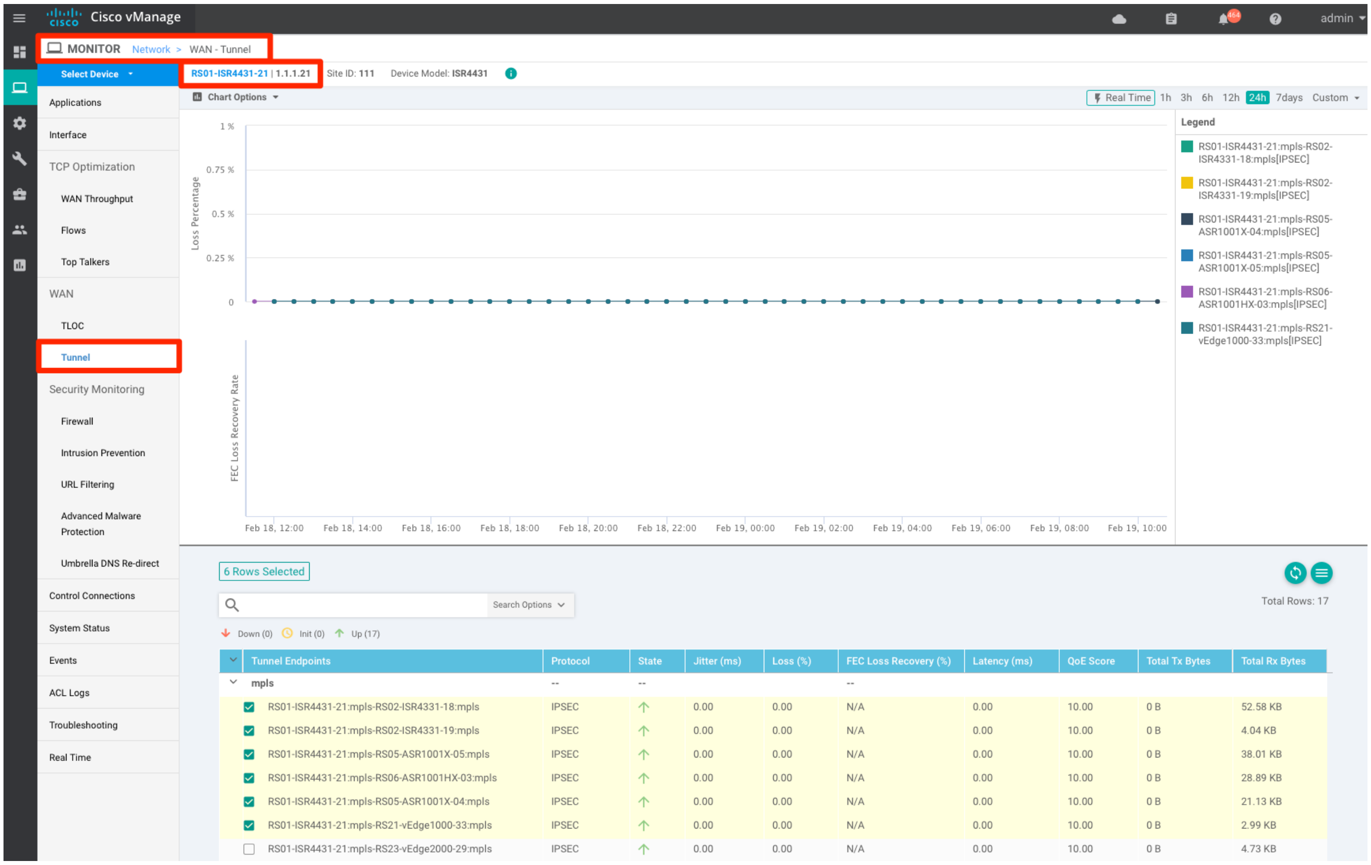
## Procedure 3. Verify the WAN Edge device IPSec connections to other WAN Edge devices.

**Step 1.** In vManage, navigate to **Monitor > Network**, select the device from the **WAN-Edge** list and select **WAN > Tunnel** option from the left panel.



| Tunnel Endpoints | Protocol | State | Jitter (ms) | Loss (%) | FEC Loss Recovery (%) | Latency (ms) | QoE Score | Total Tx Bytes | Total Rx Bytes |
|---|---|---|---|---|---|---|---|---|---|
| mpls | -- | -- | | | -- | | | | |
| ☑ RS01-ISR4431-21:mpls-RS02-ISR4331-18:mpls | IPSEC | ↑ | 0.00 | 0.00 | N/A | 0.00 | 10.00 | 0 B | 52.58 KB |
| ☑ RS01-ISR4431-21:mpls-RS02-ISR4331-19:mpls | IPSEC | ↑ | 0.00 | 0.00 | N/A | 0.00 | 10.00 | 0 B | 4.04 KB |
| ☑ RS01-ISR4431-21:mpls-RS05-ASR1001X-05:mpls | IPSEC | ↑ | 0.00 | 0.00 | N/A | 0.00 | 10.00 | 0 B | 38.01 KB |
| ☑ RS01-ISR4431-21:mpls-RS06-ASR1001HX-03:mpls | IPSEC | ↑ | 0.00 | 0.00 | N/A | 0.00 | 10.00 | 0 B | 28.89 KB |
| ☑ RS01-ISR4431-21:mpls-RS05-ASR1001X-04:mpls | IPSEC | ↑ | 0.00 | 0.00 | N/A | 0.00 | 10.00 | 0 B | 21.13 KB |
| ☑ RS01-ISR4431-21:mpls-RS21-vEdge1000-33:mpls | IPSEC | ↑ | 0.00 | 0.00 | N/A | 0.00 | 10.00 | 0 B | 2.99 KB |
| □ RS01-ISR4431-21:mpls-RS23-vEdge2000-29:mpls | IPSEC | ↑ | 0.00 | 0.00 | N/A | 0.00 | 10.00 | 0 B | 4.73 KB |

## Procedure 4. Verify the BFD sessions are established between WAN Edge devices.

**Step 1.** In vManage, navigate to **Monitor > Network**, select the device from the **WAN-Edge** list and select **Real Time** option from the left panel. Search for **BFD sessions** option in the **Device Options** search bar.

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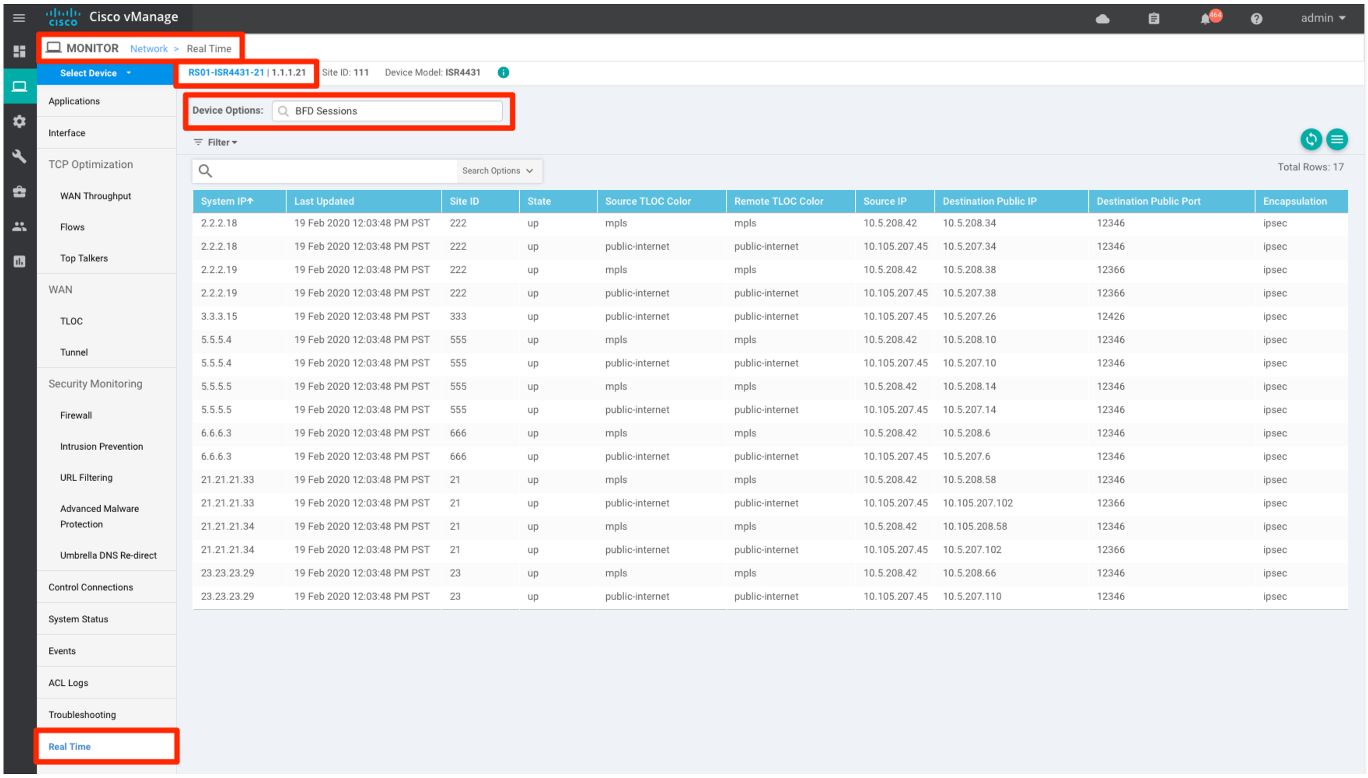


RS01-ISR4431-21 | 1.1.1.21 Site ID: 111 Device Model: ISR4431

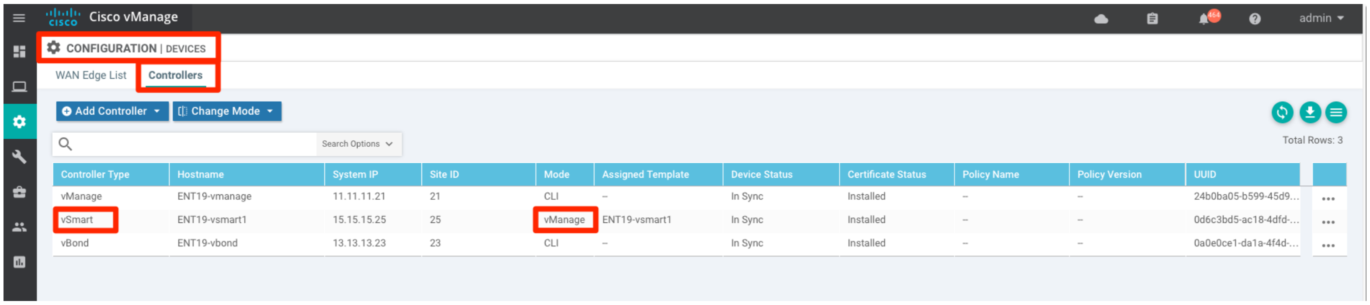
Device Options: BFD Sessions

Total Rows: 17

| System IP↑ | Last Updated | Site ID | State | Source TLOC Color | Remote TLOC Color | Source IP | Destination Public IP | Destination Public Port | Encapsulation |
|---|---|---|---|---|---|---|---|---|---|
| 2.2.2.18 | 19 Feb 2020 12:03:48 PM PST | 222 | up | mpls | mpls | 10.5.208.42 | 10.5.208.34 | 12346 | ipsec |
| 2.2.2.18 | 19 Feb 2020 12:03:48 PM PST | 222 | up | public-internet | public-internet | 10.105.207.45 | 10.5.207.34 | 12346 | ipsec |
| 2.2.2.19 | 19 Feb 2020 12:03:48 PM PST | 222 | up | mpls | mpls | 10.5.208.42 | 10.5.208.38 | 12366 | ipsec |
| 2.2.2.19 | 19 Feb 2020 12:03:48 PM PST | 222 | up | public-internet | public-internet | 10.105.207.45 | 10.5.207.38 | 12366 | ipsec |
| 3.3.3.15 | 19 Feb 2020 12:03:48 PM PST | 333 | up | public-internet | public-internet | 10.105.207.45 | 10.5.207.26 | 12426 | ipsec |
| 5.5.5.4 | 19 Feb 2020 12:03:48 PM PST | 555 | up | mpls | mpls | 10.5.208.42 | 10.5.208.10 | 12346 | ipsec |
| 5.5.5.4 | 19 Feb 2020 12:03:48 PM PST | 555 | up | public-internet | public-internet | 10.105.207.45 | 10.5.207.10 | 12346 | ipsec |
| 5.5.5.5 | 19 Feb 2020 12:03:48 PM PST | 555 | up | mpls | mpls | 10.5.208.42 | 10.5.208.14 | 12346 | ipsec |
| 5.5.5.5 | 19 Feb 2020 12:03:48 PM PST | 555 | up | public-internet | public-internet | 10.105.207.45 | 10.5.207.14 | 12346 | ipsec |
| 6.6.6.3 | 19 Feb 2020 12:03:48 PM PST | 666 | up | mpls | mpls | 10.5.208.42 | 10.5.208.6 | 12346 | ipsec |
| 6.6.6.3 | 19 Feb 2020 12:03:48 PM PST | 666 | up | public-internet | public-internet | 10.105.207.45 | 10.5.207.6 | 12346 | ipsec |
| 21.21.21.33 | 19 Feb 2020 12:03:48 PM PST | 21 | up | mpls | mpls | 10.5.208.42 | 10.5.208.58 | 12346 | ipsec |
| 21.21.21.33 | 19 Feb 2020 12:03:48 PM PST | 21 | up | public-internet | public-internet | 10.105.207.45 | 10.105.207.102 | 12366 | ipsec |
| 21.21.21.34 | 19 Feb 2020 12:03:48 PM PST | 21 | up | mpls | mpls | 10.5.208.42 | 10.105.208.58 | 12346 | ipsec |
| 21.21.21.34 | 19 Feb 2020 12:03:48 PM PST | 21 | up | public-internet | public-internet | 10.105.207.45 | 10.5.207.102 | 12366 | ipsec |
| 23.23.23.29 | 19 Feb 2020 12:03:48 PM PST | 23 | up | mpls | mpls | 10.5.208.42 | 10.5.208.66 | 12346 | ipsec |
| 23.23.23.29 | 19 Feb 2020 12:03:48 PM PST | 23 | up | public-internet | public-internet | 10.105.207.45 | 10.5.207.110 | 12346 | ipsec |

## Procedure 5. Verify the SD-WAN vSmart controller is in vManage mode.

**Step 1.** In vManage, navigate to **Configuration > Devices**, select the **Controllers** options to verify the vSmart mode.



Total Rows: 3

| Controller Type | Hostname | System IP | Site ID | Mode | Assigned Template | Device Status | Certificate Status | Policy Name | Policy Version | UUID |  |
|---|---|---|---|---|---|---|---|---|---|---|---|
| vManage | ENT19-vmanage | 11.11.11.21 | 21 | CLI | – | In Sync | Installed | – | – | 24b0ba05-b599-45d9... | ••• |
| vSmart | ENT19-vsmart1 | 15.15.15.25 | 25 | vManage | ENT19-vsmart1 | In Sync | Installed | – | – | 0d6c3bd5-ac18-4dfd-... | ••• |
| vBond | ENT19-vbond | 13.13.13.23 | 23 | CLI | – | In Sync | Installed | – | – | 0a0e0ce1-da1a-4f4d-... | ••• |

## Process: (Optional) Configuring custom BFD template

This process walks through procedure and steps needed to configure custom BFD template for the SD-WAN environment.

## Procedure 1. (optional) Create custom BFD Template

Following the WAN Edge onboarding, the device establishes secure IPSec data tunnels with other WAN Edge devices and periodically probes the secure tunnels, with BFD Hello packets, to measure the transport tunnel liveliness and path characteristics.

Below table lists the default values for the BFD polling data defined globally for all tunnel on the WAN Edge device:

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| List | Description | Default Values |
|---|---|---|
| Hello interval | Interval at which BFD Hello Interval are send across the WAN transport | 1000 msec<br>(configurable) |
| BFD Multiplier | Value defines number of BFD Hello Packet Intervals the device waits before declaring that tunnel has failed. | 7<br>(configurable) |

and the default values used to calculate the network path characteristics:

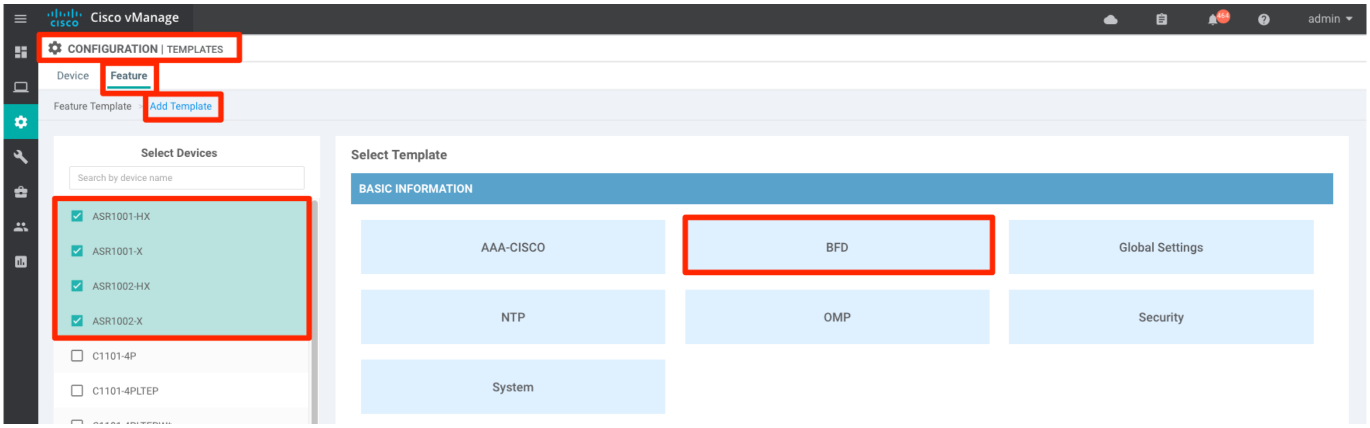
| List | Description | Default Values |
|---|---|---|
| Poll Interval | Interval at which WAN Edge calculates the average loss, latency and jitter for each WAN transport. | 10 minutes<br>(configurable) |
| Multiplier | Value defines number of poll interval(s) to be considered to calculate the tunnel statistics for the AAR. | 6<br>(configurable) |

The above default value can be changed either effecting all the tunnels on the WAN Edge device or on each tunnel basis on the WAN Edge device. Careful consideration must be taken when changing the BFD values as this may cause adverse effect on the performance of the WAN Edge device.

Below procedure walks through steps on the procedure to change the default BFD values.

**Step 1.** Create BFD template for the WAN Edge device(s) in the SD-WAN network.

In vManage, navigate to **Configuration > Templates > Feature** and click **Add Template.** Select all the appropriate devices deployed in the SD-WAN network from the **Select Devices** list and choose **BFD** template from the **Basic Information** category.



**Step 2.** Create custom BFD template for the SD-WAN network.

Input the **Template Name** and **Description** for the template and modify the **Multiplier** and **Poll Interval** under **Basic configuration** section. The modified values in the section would influence all the associated tunnels on the WAN Edge device.

Alternatively, to influence values on the tunnel/color basis, select the **New Color** from the **Color** section, choose the appropriate **Color** from the drop-down menu option and modify the **Hello Interval** and **Multiplier** values. Click **Add** in the Color section and **Save** at the bottom of the page to save the BFD feature template.

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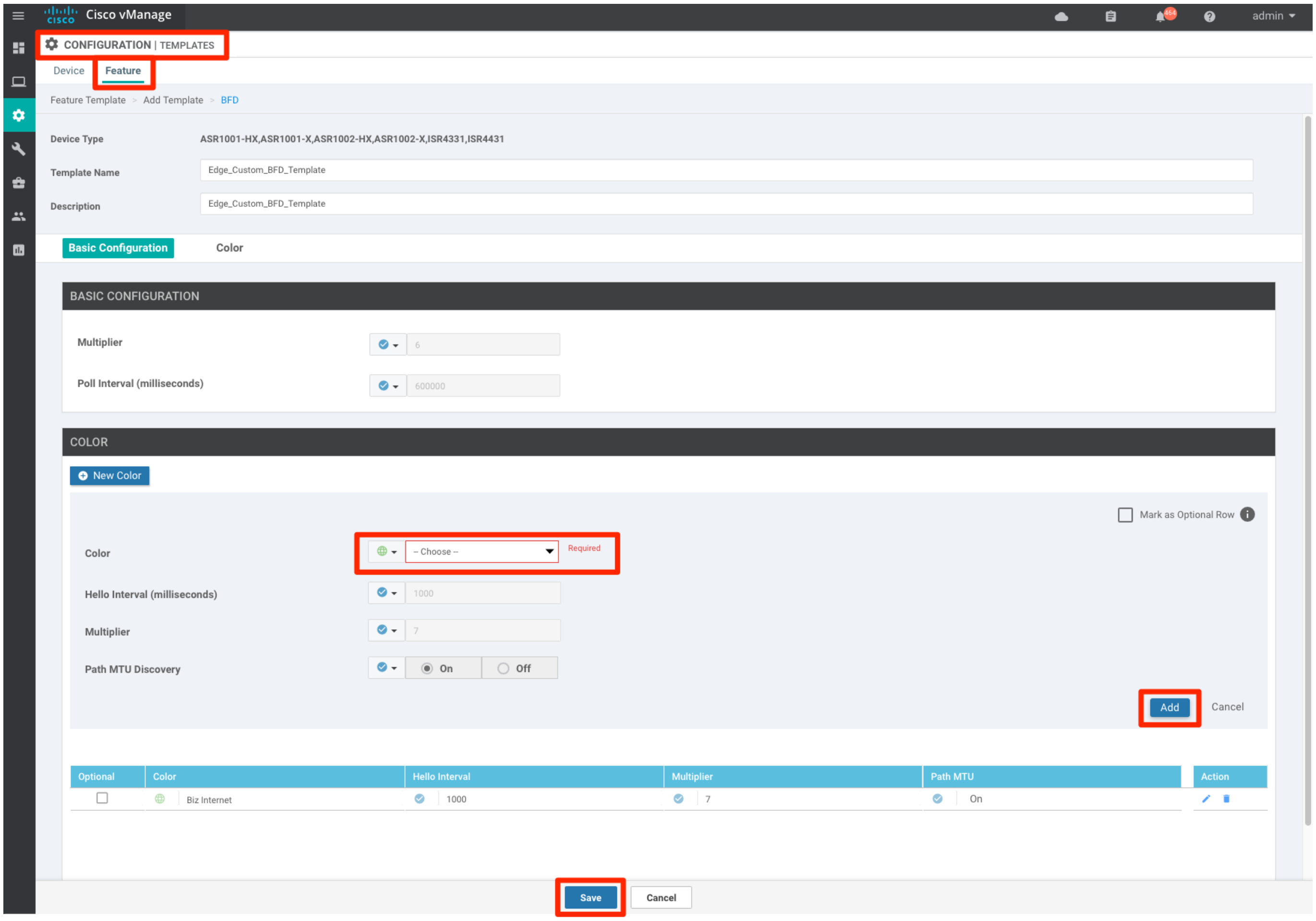


Device Type ASR1001-HX,ASR1001-X,ASR1002-HX,ASR1002-X,ISR4331,ISR4431

Template Name Edge_Custom_BFD_Template

Description Edge_Custom_BFD_Template

BASIC CONFIGURATION

Multiplier 6

Poll Interval (milliseconds) 600000

COLOR

Color -- Choose -- Required

Hello Interval (milliseconds) 1000

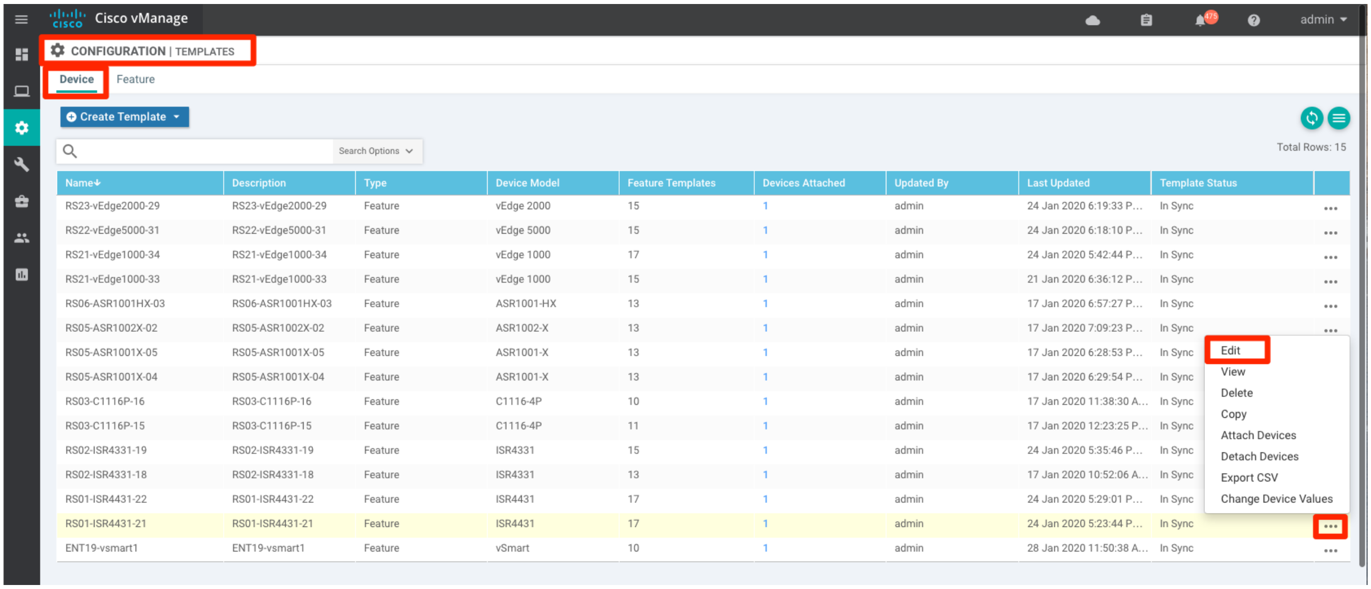
Multiplier 7

Path MTU Discovery ● On ○ Off

| Optional | Color | Hello Interval | Multiplier | Path MTU | Action |
|---|---|---|---|---|---|
| □ | Biz Internet | 1000 | 7 | On | |

**Step 3.** Associate the custom BFD template to the WAN Edge device(s).

In vManage, navigate to **vManage > Configuration > Templates > Device**, select the devices from the device list and click the three dots (**…**), located at the end of each table row and choose the **Edit** option from the drop-down options



Total Rows: 15

| Name↓ | Description | Type | Device Model | Feature Templates | Devices Attached | Updated By | Last Updated | Template Status | |
|---|---|---|---|---|---|---|---|---|---|
| RS23-vEdge2000-29 | RS23-vEdge2000-29 | Feature | vEdge 2000 | 15 | 1 | admin | 24 Jan 2020 6:19:33 P... | In Sync | ••• |
| RS22-vEdge5000-31 | RS22-vEdge5000-31 | Feature | vEdge 5000 | 15 | 1 | admin | 24 Jan 2020 6:18:10 P... | In Sync | ••• |
| RS21-vEdge1000-34 | RS21-vEdge1000-34 | Feature | vEdge 1000 | 17 | 1 | admin | 24 Jan 2020 5:42:44 P... | In Sync | ••• |
| RS21-vEdge1000-33 | RS21-vEdge1000-33 | Feature | vEdge 1000 | 15 | 1 | admin | 21 Jan 2020 6:36:12 P... | In Sync | ••• |
| RS06-ASR1001HX-03 | RS06-ASR1001HX-03 | Feature | ASR1001-HX | 13 | 1 | admin | 17 Jan 2020 6:57:27 P... | In Sync | ••• |
| RS05-ASR1002X-02 | RS05-ASR1002X-02 | Feature | ASR1002-X | 13 | 1 | admin | 17 Jan 2020 7:09:23 P... | In Sync | ••• |
| RS05-ASR1001X-05 | RS05-ASR1001X-05 | Feature | ASR1001-X | 13 | 1 | admin | 17 Jan 2020 6:28:53 P... | In Sync | |
| RS05-ASR1001X-04 | RS05-ASR1001X-04 | Feature | ASR1001-X | 13 | 1 | admin | 17 Jan 2020 6:29:54 P... | In Sync | |
| RS03-C1116P-16 | RS03-C1116P-16 | Feature | C1116-4P | 10 | 1 | admin | 17 Jan 2020 11:38:30 A... | In Sync | |
| RS03-C1116P-15 | RS03-C1116P-15 | Feature | C1116-4P | 11 | 1 | admin | 17 Jan 2020 12:23:25 P... | In Sync | |
| RS02-ISR4331-19 | RS02-ISR4331-19 | Feature | ISR4331 | 15 | 1 | admin | 24 Jan 2020 5:35:46 P... | In Sync | |
| RS02-ISR4331-18 | RS02-ISR4331-18 | Feature | ISR4331 | 13 | 1 | admin | 17 Jan 2020 10:52:06 A... | In Sync | |
| RS01-ISR4431-22 | RS01-ISR4431-22 | Feature | ISR4431 | 17 | 1 | admin | 24 Jan 2020 5:29:01 P... | In Sync | |
| RS01-ISR4431-21 | RS01-ISR4431-21 | Feature | ISR4431 | 17 | 1 | admin | 24 Jan 2020 5:23:44 P... | In Sync | ••• |
| ENT19-vsmart1 | ENT19-vsmart1 | Feature | vSmart | 10 | 1 | admin | 28 Jan 2020 11:50:38 A... | In Sync | ••• |

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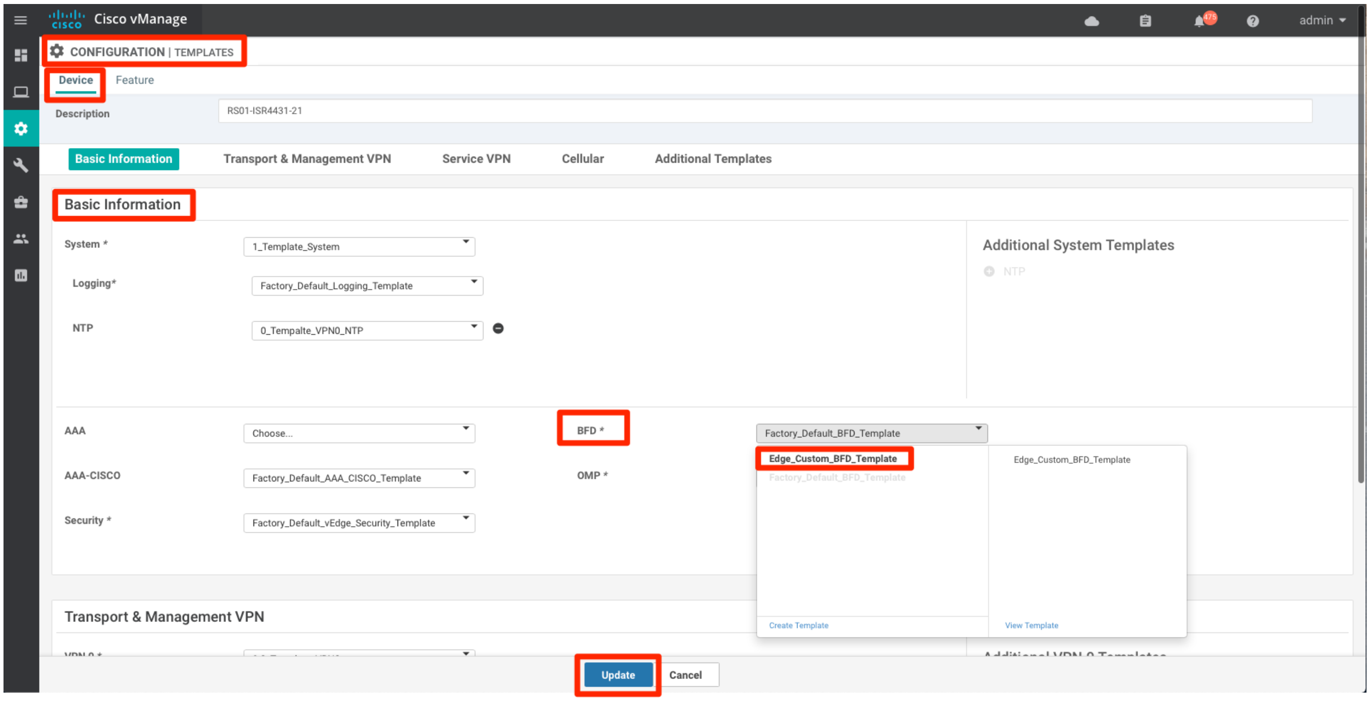
navigate to the **Basic Information > BFD** section and choose the previously created custom BFD template and click **Update**.



Description: RS01-ISR4431-21

Basic Information

| | |
|---|---|
| System * | 1_Template_System |
| Logging* | Factory_Default_Logging_Template |
| NTP | 0_Tempalte_VPN0_NTP |
| AAA | Choose... |
| AAA-CISCO | Factory_Default_AAA_CISCO_Template |
| Security * | Factory_Default_vEdge_Security_Template |
| BFD * | Factory_Default_BFD_Template |
| OMP * | |

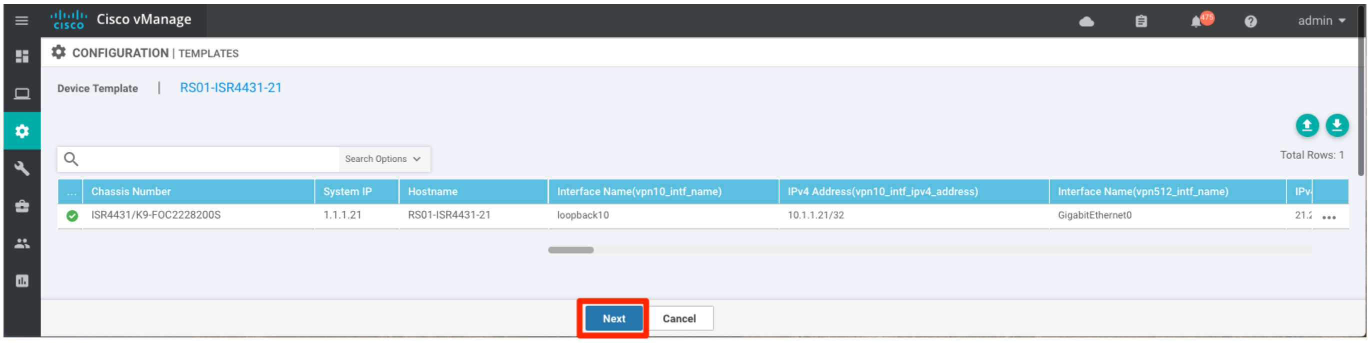
Additional System Templates

NTP

BFD dropdown: Edge_Custom_BFD_Template, Factory_Default_BFD_Template — Edge_Custom_BFD_Template

Transport & Management VPN

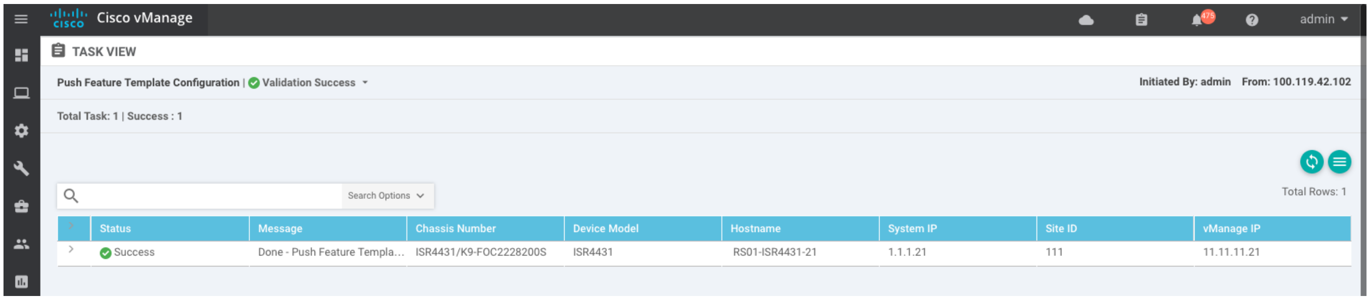
**Step 4.** Click **Next**, **Configure Devices** to configure the WAN Edge(s) with custom BFD template.



Device Template | RS01-ISR4431-21

Total Rows: 1

| ... | Chassis Number | System IP | Hostname | Interface Name(vpn10_intf_name) | IPv4 Address(vpn10_intf_ipv4_address) | Interface Name(vpn512_intf_name) | IPv |
|---|---|---|---|---|---|---|---|
| ✓ | ISR4431/K9-FOC2228200S | 1.1.1.21 | RS01-ISR4431-21 | loopback10 | 10.1.1.21/32 | GigabitEthernet0 | 21.2 |



Push Feature Template Configuration | ✓ Validation Success

Initiated By: admin From: 100.119.42.102

Total Task: 1 | Success : 1

Total Rows: 1

| | Status | Message | Chassis Number | Device Model | Hostname | System IP | Site ID | vManage IP |
|---|---|---|---|---|---|---|---|---|
| › | ✓ Success | Done - Push Feature Templa... | ISR4431/K9-FOC2228200S | ISR4431 | RS01-ISR4431-21 | 1.1.1.21 | 111 | 11.11.11.21 |

## Process: Configuring Application-Aware Routing policy

Creating Application Aware Routing policies consists of defining the three core components:

- Identification – Classify the traffic / Application group of interest.
- Application SLA Requirement – Defining the application SLA requirements.

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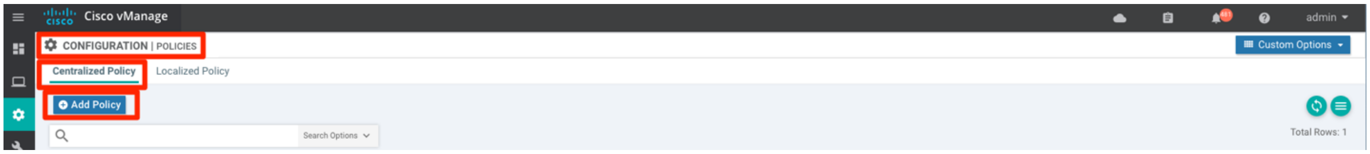
- Application-Aware Routing Policy – Policy maps the classified traffic to the transport tunnel based on the defined SLA requirement.

On creating the policy, associate and activate the centralized policy to appropriate Site list(s) and VPN list(s).

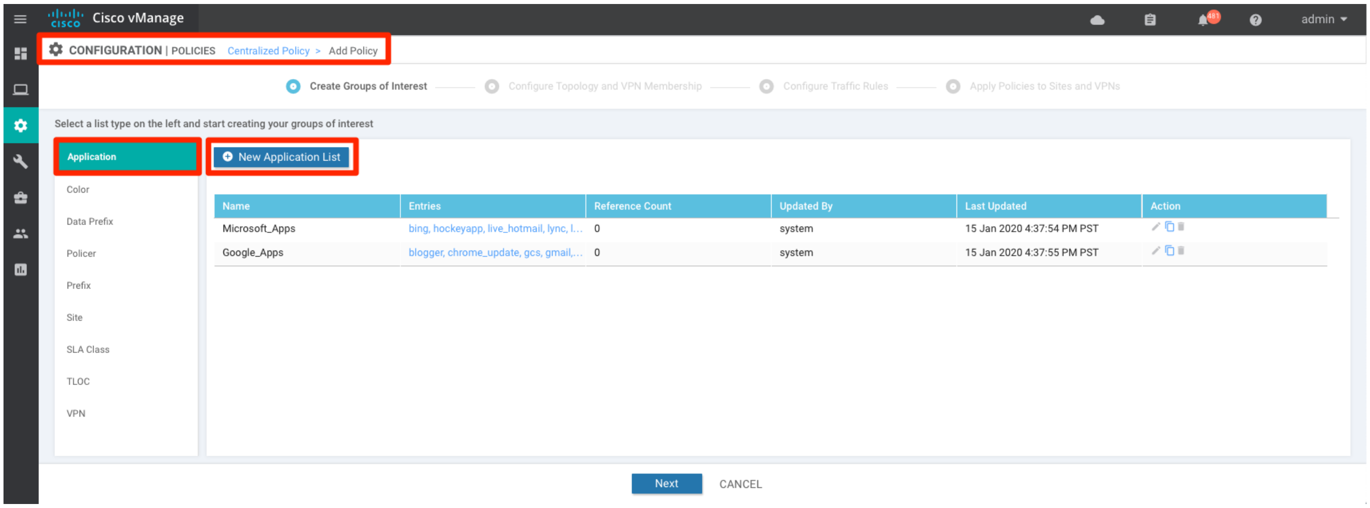
## Procedure 1. Identification – Classify the traffic / Application group of interest.

Below steps walks through steps for classifying the traffic class of interest for the preferred treatment in the SD-WAN environment.

**Step 1.** In vManage, navigate to **Configuration > Policies > Centralized Policy** and select **Add Policy**.



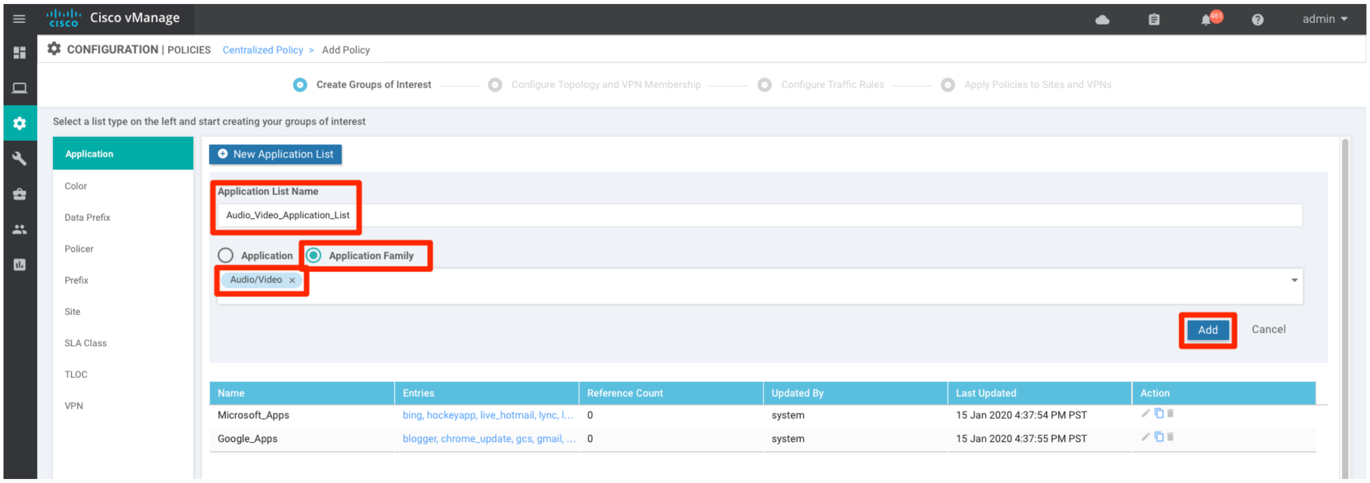
**Step 2.** Select **Application** from the left panel and click **New Application List**


Cisco vManage
admin
CONFIGURATION | POLICIES Centralized Policy > Add Policy
Create Groups of Interest
Configure Topology and VPN Membership
Configure Traffic Rules
Apply Policies to Sites and VPNs
Select a list type on the left and start creating your groups of interest
Application
Color
Data Prefix
Policer
Prefix
Site
SLA Class
TLOC
VPN
New Application List
Next
CANCEL

| Name | Entries | Reference Count | Updated By | Last Updated | Action |
|---|---|---|---|---|---|
| Microsoft_Apps | bing, hockeyapp, live_hotmail, lync, l... | 0 | system | 15 Jan 2020 4:37:54 PM PST | |
| Google_Apps | blogger, chrome_update, gcs, gmail,... | 0 | system | 15 Jan 2020 4:37:55 PM PST | |

name the custom application list and select either **Application** or **Application Family** option.

Choose appropriate application family category option from the drop-down option and Click **Add.**


Cisco vManage
admin
CONFIGURATION | POLICIES Centralized Policy > Add Policy
Create Groups of Interest
Configure Topology and VPN Membership
Configure Traffic Rules
Apply Policies to Sites and VPNs
Select a list type on the left and start creating your groups of interest
Application
Color
Data Prefix
Policer
Prefix
Site
SLA Class
TLOC
VPN
New Application List
Add
Cancel

Application List Name: Audio_Video_Application_List

○ Application ● Application Family

Audio/Video ×

| Name | Entries | Reference Count | Updated By | Last Updated | Action |
|---|---|---|---|---|---|
| Microsoft_Apps | bing, hockeyapp, live_hotmail, lync, l... | 0 | system | 15 Jan 2020 4:37:54 PM PST | |
| Google_Apps | blogger, chrome_update, gcs, gmail, ... | 0 | system | 15 Jan 2020 4:37:55 PM PST | |

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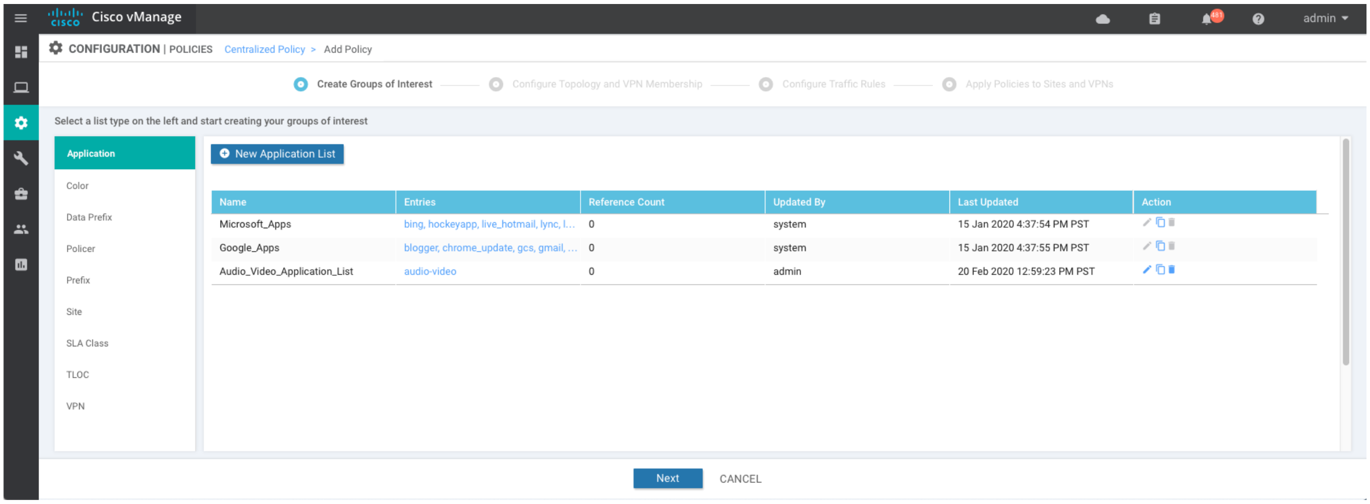


CONFIGURATION | POLICIES Centralized Policy > Add Policy

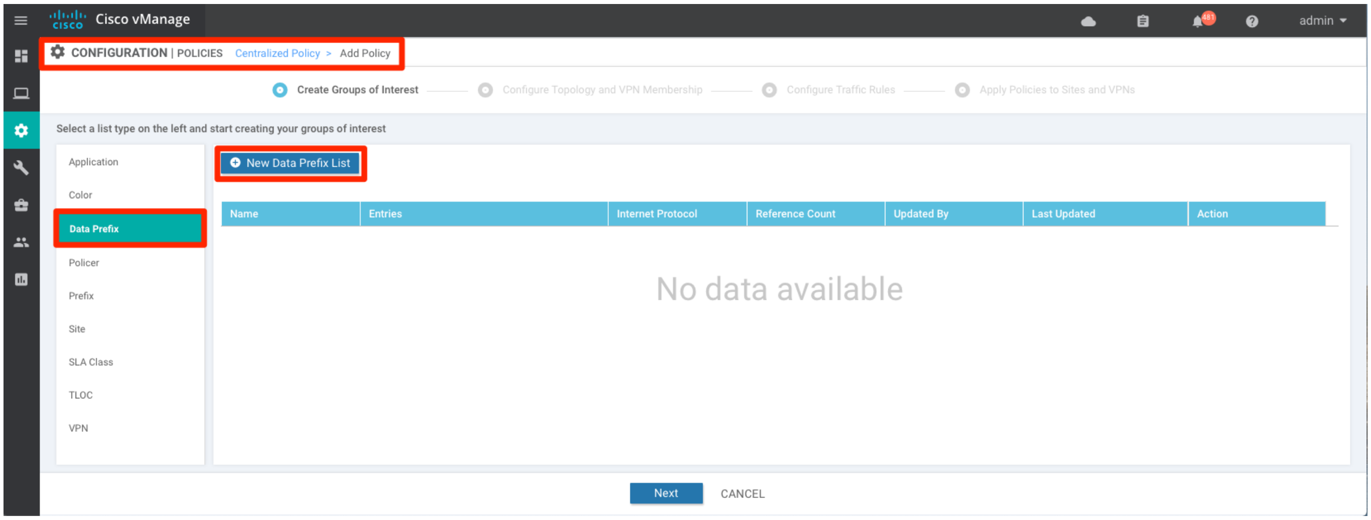
Create Groups of Interest — Configure Topology and VPN Membership — Configure Traffic Rules — Apply Policies to Sites and VPNs

Select a list type on the left and start creating your groups of interest

| Name | Entries | Reference Count | Updated By | Last Updated | Action |
|---|---|---|---|---|---|
| Microsoft_Apps | bing, hockeyapp, live_hotmail, lync, l... | 0 | system | 15 Jan 2020 4:37:54 PM PST | |
| Google_Apps | blogger, chrome_update, gcs, gmail, ... | 0 | system | 15 Jan 2020 4:37:55 PM PST | |
| Audio_Video_Application_List | audio-video | 0 | admin | 20 Feb 2020 12:59:23 PM PST | |

**Step 3.** Alternatively, to previous **Step 2**, network administrators can match on **Data Prefix** to identify traffic based of the network traffic.

To define the data prefix, select the **Data Prefix** option from the list type on the left side panel and click **New Data Prefix List**



CONFIGURATION | POLICIES Centralized Policy > Add Policy

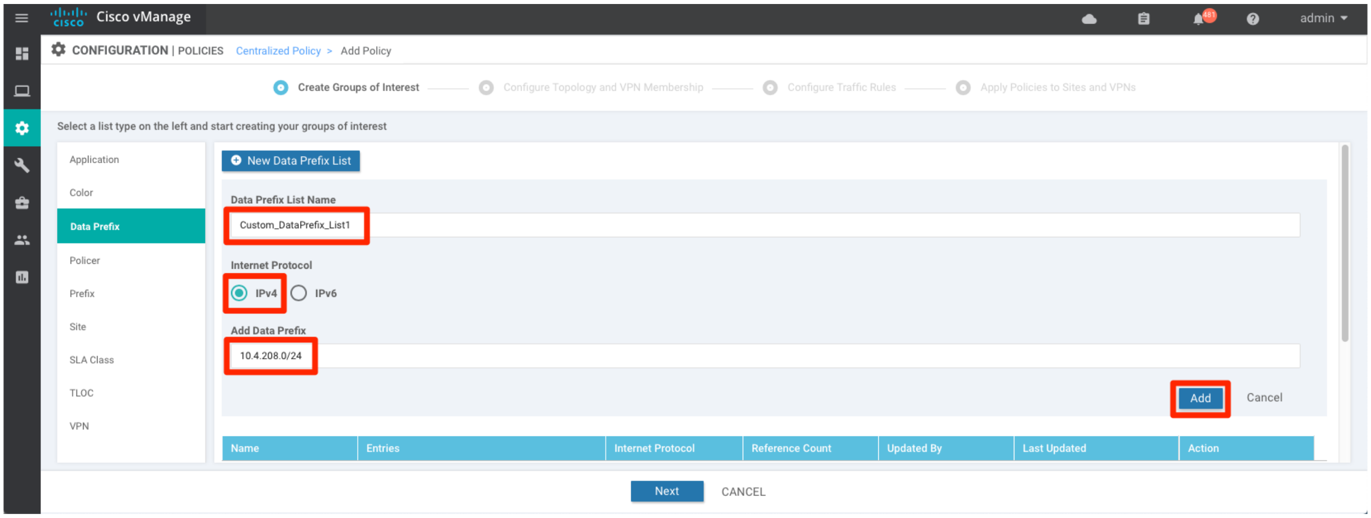
Create Groups of Interest — Configure Topology and VPN Membership — Configure Traffic Rules — Apply Policies to Sites and VPNs

Select a list type on the left and start creating your groups of interest

| Name | Entries | Internet Protocol | Reference Count | Updated By | Last Updated | Action |
|---|---|---|---|---|---|---|

No data available

Input the **Data Prefix List Name** and select either **IPv4 / IPv6** from the **Internet Protocol** option and add the network prefix that needs to be matched and select **Add**



CONFIGURATION | POLICIES Centralized Policy > Add Policy

Create Groups of Interest — Configure Topology and VPN Membership — Configure Traffic Rules — Apply Policies to Sites and VPNs

Select a list type on the left and start creating your groups of interest

Data Prefix List Name: Custom_DataPrefix_List1

Internet Protocol: ● IPv4 ○ IPv6

Add Data Prefix: 10.4.208.0/24

| Name | Entries | Internet Protocol | Reference Count | Updated By | Last Updated | Action |
|---|---|---|---|---|---|---|

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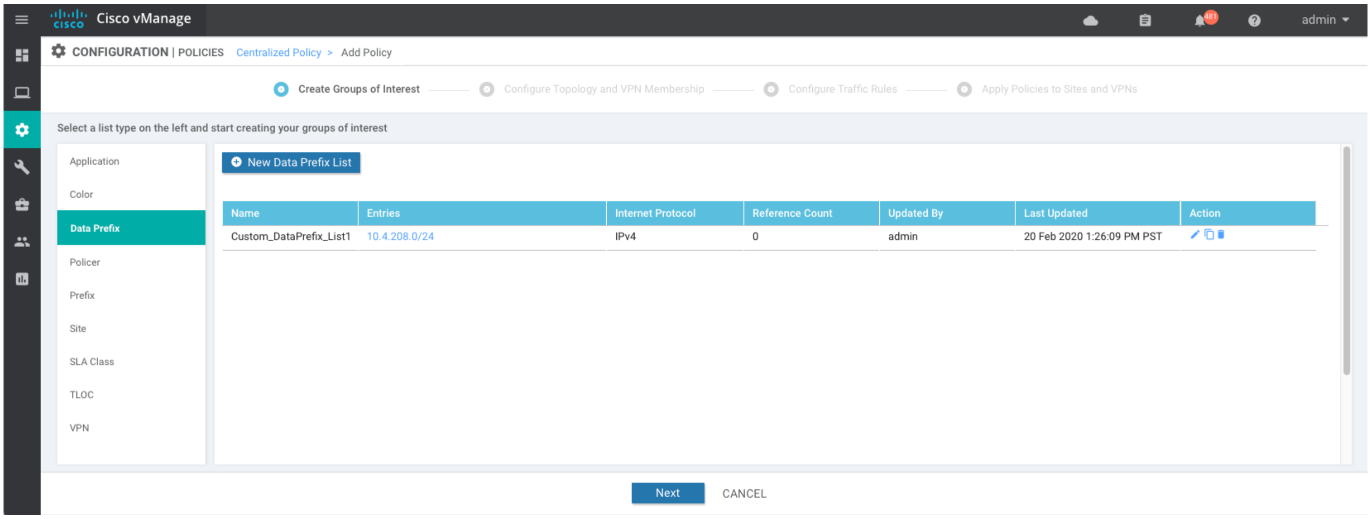

Cisco vManage
admin
CONFIGURATION | POLICIES Centralized Policy > Add Policy
Create Groups of Interest
Configure Topology and VPN Membership
Configure Traffic Rules
Apply Policies to Sites and VPNs
Application
Color
Data Prefix
Policer
Prefix
Site
SLA Class
TLOC
VPN
New Data Prefix List
Next
CANCEL

Select a list type on the left and start creating your groups of interest

| Name | Entries | Internet Protocol | Reference Count | Updated By | Last Updated | Action |
|---|---|---|---|---|---|---|
| Custom_DataPrefix_List1 | 10.4.208.0/24 | IPv4 | 0 | admin | 20 Feb 2020 1:26:09 PM PST | |

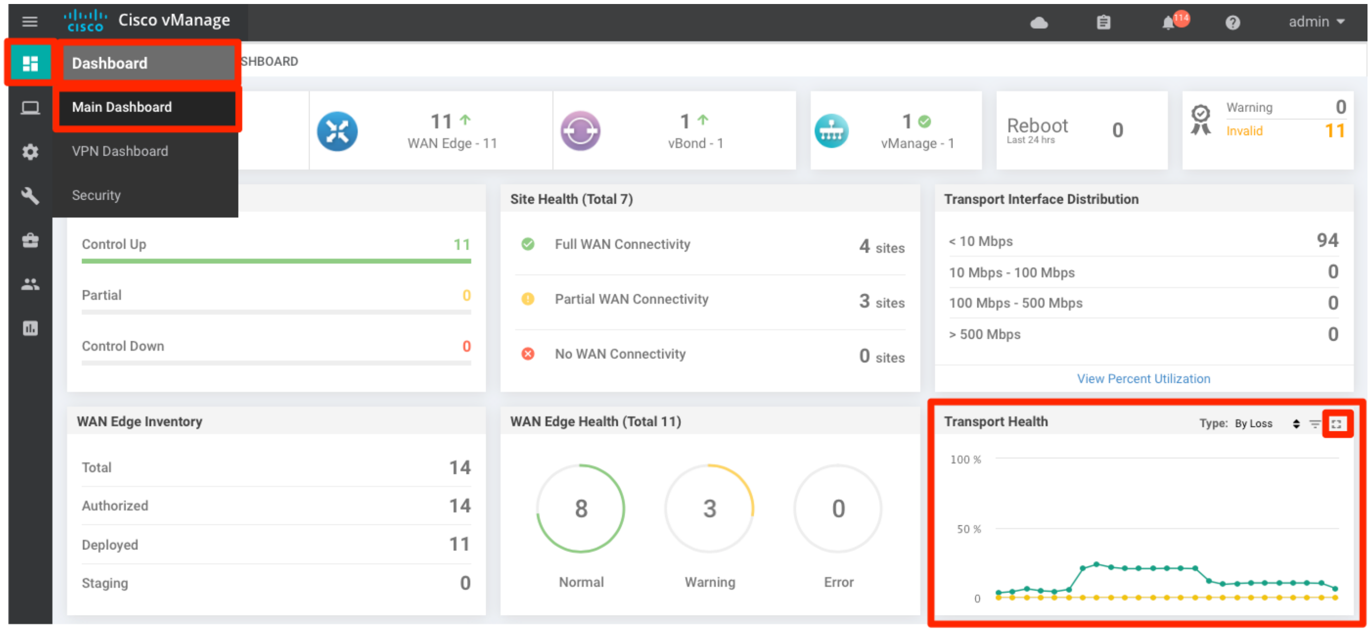
**Step 4.** Repeat the above steps to add any additional Application List and/or Data Traffic for the SD-WAN deployment.

## Procedure 2. Define Application Service Level requirements.

Below steps walks through steps on defying custom SLA class. But, before defining the custom SLA, it is important to understand the current historical WAN Transport health characteristics.

**Step 1.** Monitor transports health characteristics across the SD-WAN environment.

To view the tunnel characteristics across the SD-WAN infrastructure. Navigate to **vManage** > **Dashboard > Main Dashboard > Transport Health** widget.



**Step 2.** Expand the widget by clicking the **square icon** in the top right corner of the Transport Health widget and select the **Type** option to view the chart **By Loss, By Latency or by Jitter** values and view the transport health over the maximum of past 7 days.

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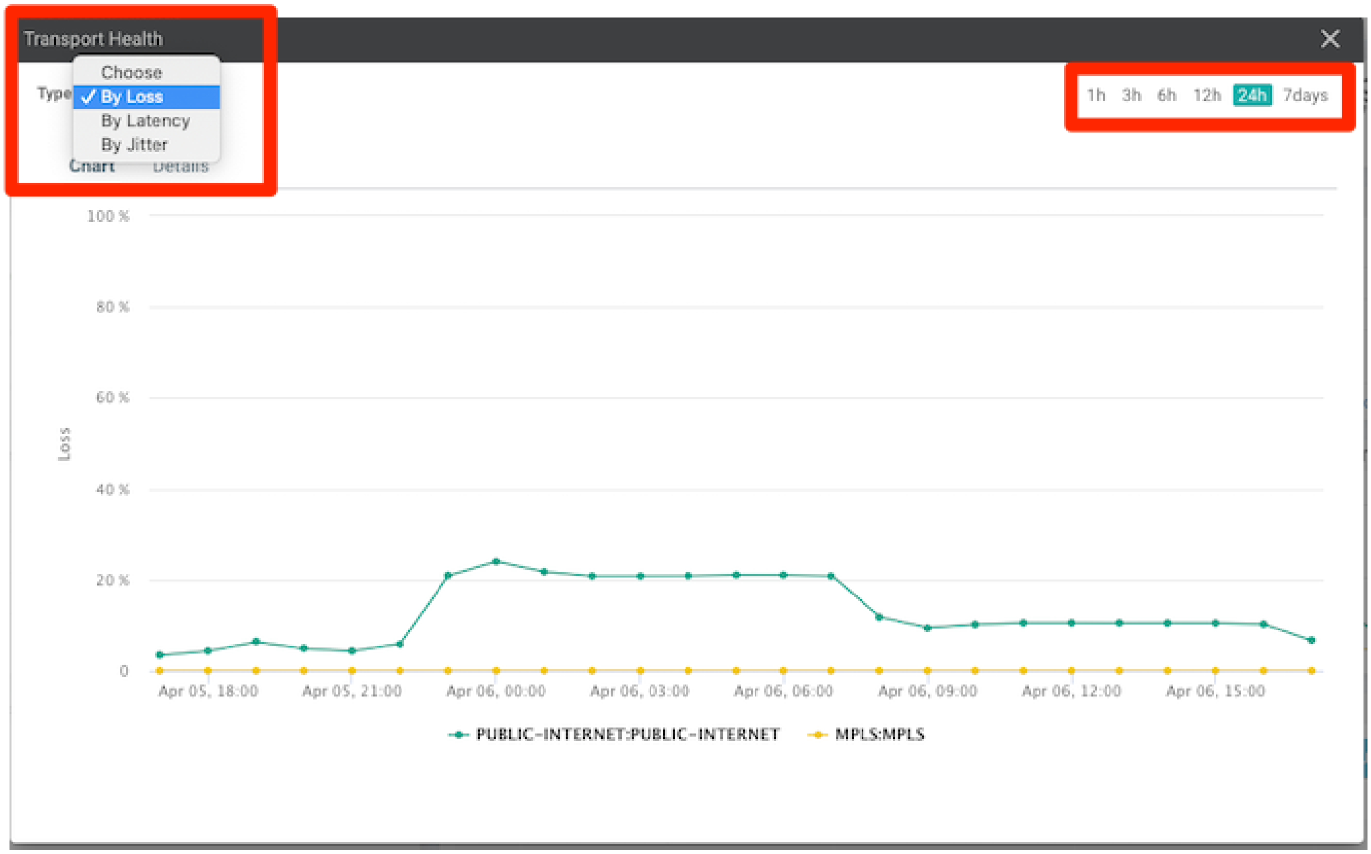
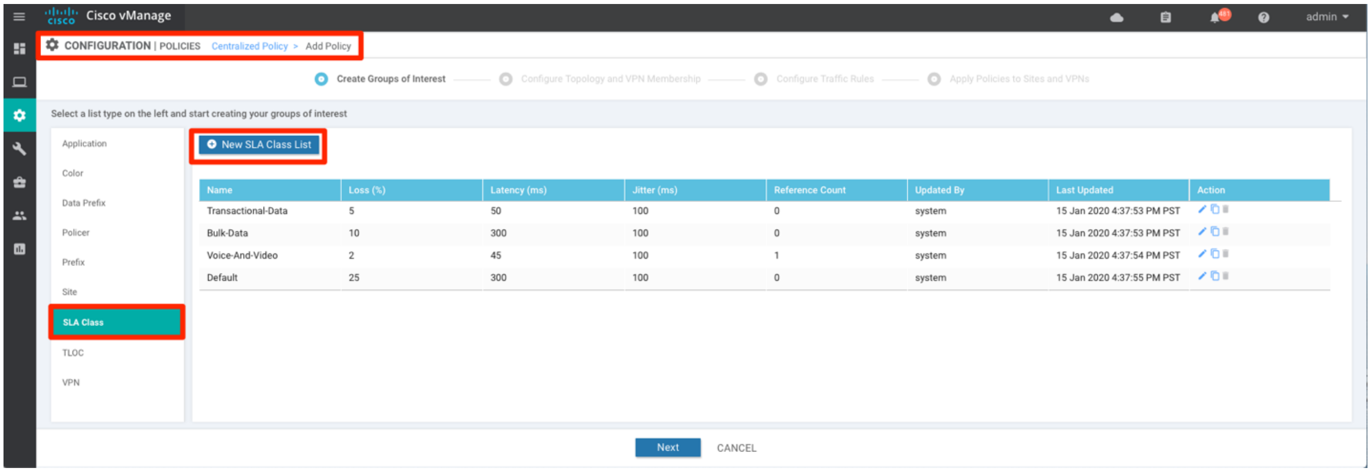


**Step 3.** Select **SLA Class** from the left panel, in the **Configuration > Policies > Centralized Policy** page**,** to create additional SLA Class list. By default, vManage has 4 pre-defined SLA class (Transactional-Data, Bulk-Data, Voice-And-Video and Default).

In case the pre-defined SLA class does not fit the deployment requirements, Click **New SLA Class List** to add additional list



Select a list type on the left and start creating your groups of interest

| Name | Loss (%) | Latency (ms) | Jitter (ms) | Reference Count | Updated By | Last Updated | Action |
|---|---|---|---|---|---|---|---|
| Transactional-Data | 5 | 50 | 100 | 0 | system | 15 Jan 2020 4:37:53 PM PST | |
| Bulk-Data | 10 | 300 | 100 | 0 | system | 15 Jan 2020 4:37:53 PM PST | |
| Voice-And-Video | 2 | 45 | 100 | 1 | system | 15 Jan 2020 4:37:54 PM PST | |
| Default | 25 | 300 | 100 | 0 | system | 15 Jan 2020 4:37:55 PM PST | |

Input the **SLA Class List Name** and **Loss**, **Latency**, **Jitter** value requirement for the application family and click **Add.**

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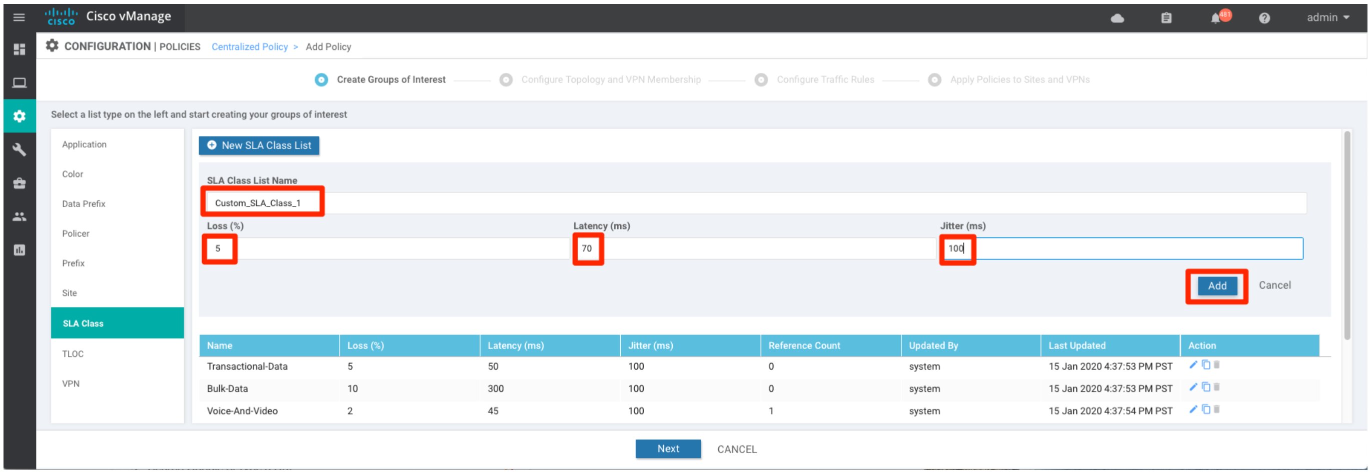

Cisco vManage
admin
CONFIGURATION | POLICIES Centralized Policy > Add Policy
Create Groups of Interest
Configure Topology and VPN Membership
Configure Traffic Rules
Apply Policies to Sites and VPNs
Application
Color
Data Prefix
Policer
Prefix
Site
SLA Class
TLOC
VPN
New SLA Class List
Add
Cancel
Next
CANCEL

Select a list type on the left and start creating your groups of interest

SLA Class List Name: Custom_SLA_Class_1

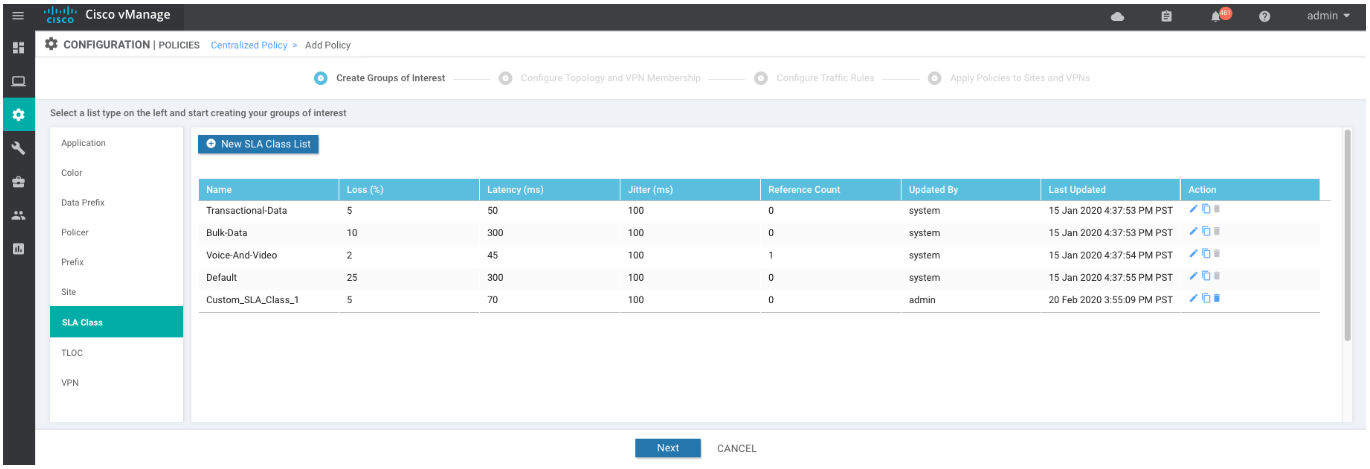
Loss (%): 5

Latency (ms): 70

Jitter (ms): 100

| Name | Loss (%) | Latency (ms) | Jitter (ms) | Reference Count | Updated By | Last Updated | Action |
|---|---|---|---|---|---|---|---|
| Transactional-Data | 5 | 50 | 100 | 0 | system | 15 Jan 2020 4:37:53 PM PST | |
| Bulk-Data | 10 | 300 | 100 | 0 | system | 15 Jan 2020 4:37:53 PM PST | |
| Voice-And-Video | 2 | 45 | 100 | 1 | system | 15 Jan 2020 4:37:54 PM PST | |

**Step 4.** Repeat the previous step to create any additional SLA Class needed


Cisco vManage
admin
CONFIGURATION | POLICIES Centralized Policy > Add Policy
Create Groups of Interest
Configure Topology and VPN Membership
Configure Traffic Rules
Apply Policies to Sites and VPNs
Application
Color
Data Prefix
Policer
Prefix
Site
SLA Class
TLOC
VPN
New SLA Class List
Next
CANCEL

Select a list type on the left and start creating your groups of interest

| Name | Loss (%) | Latency (ms) | Jitter (ms) | Reference Count | Updated By | Last Updated | Action |
|---|---|---|---|---|---|---|---|
| Transactional-Data | 5 | 50 | 100 | 0 | system | 15 Jan 2020 4:37:53 PM PST | |
| Bulk-Data | 10 | 300 | 100 | 0 | system | 15 Jan 2020 4:37:53 PM PST | |
| Voice-And-Video | 2 | 45 | 100 | 1 | system | 15 Jan 2020 4:37:54 PM PST | |
| Default | 25 | 300 | 100 | 0 | system | 15 Jan 2020 4:37:55 PM PST | |
| Custom_SLA_Class_1 | 5 | 70 | 100 | 0 | admin | 20 Feb 2020 3:55:09 PM PST | |

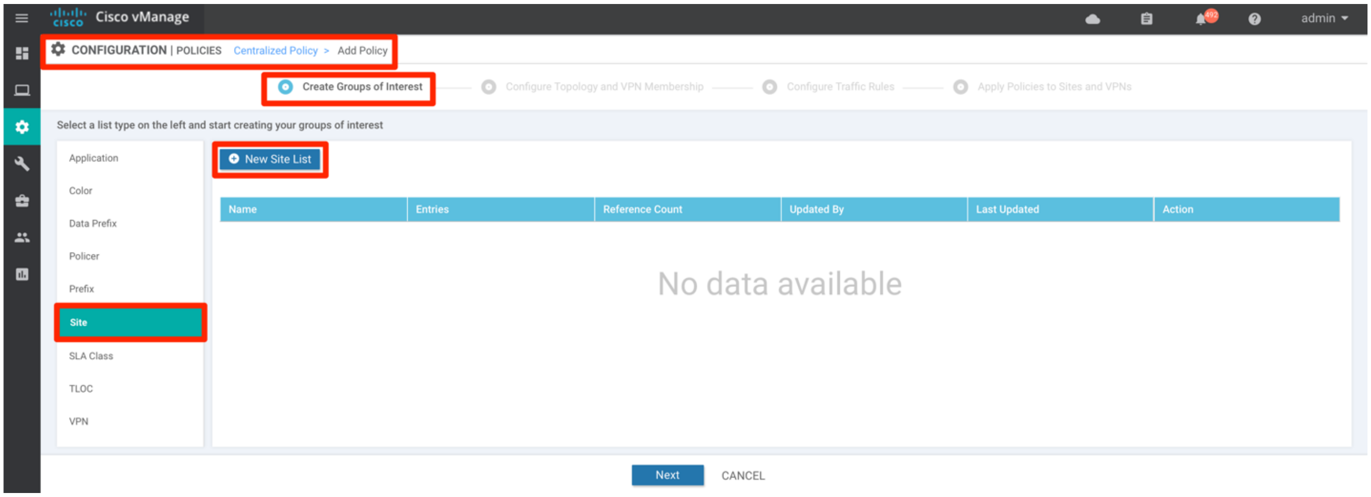
### Tech tip

Note that any number of SLA Class can be created, but only 4 SLA class can be associated to the Application Aware Routing policy. Please refer to the Software Release Notes for the latest supported number of SLAs for the version in use.

## **Procedure 3.** Create Site List

The Site list defines all the sites in the SD-WAN environment. This site-list would be used in the Application-Aware Routing policy to enforce the policy, influencing WAN Edge devices part of the selected site(s).

**Step 1.** To create Site List, select **Site** from the left panel and create Site list by clicking **New Site List**

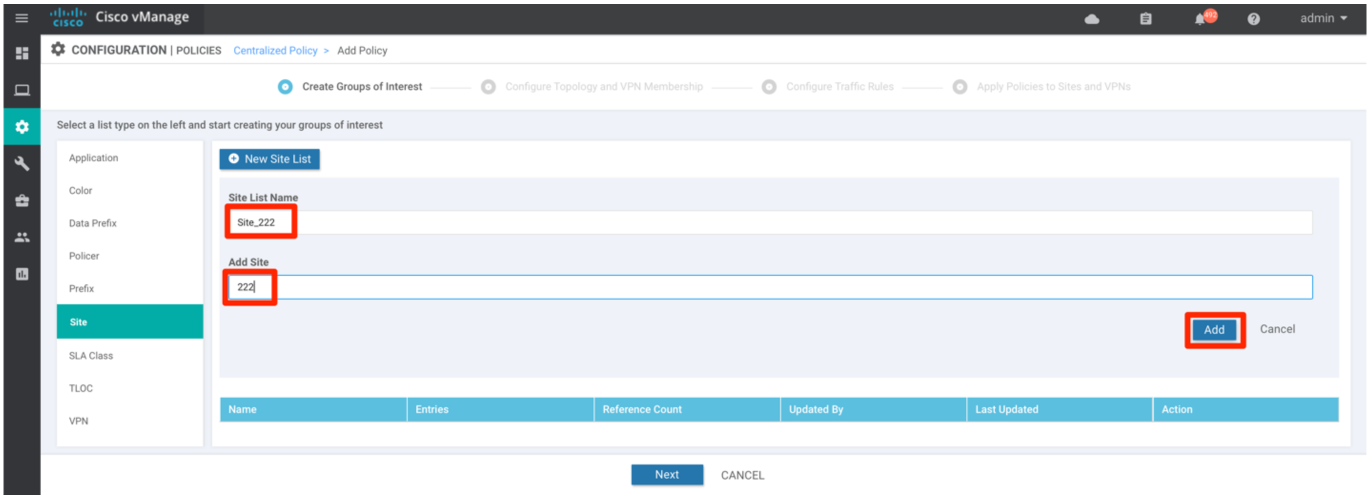

Cisco vManage
admin
CONFIGURATION | POLICIES Centralized Policy > Add Policy
Create Groups of Interest
Configure Topology and VPN Membership
Configure Traffic Rules
Apply Policies to Sites and VPNs
Application
Color
Data Prefix
Policer
Prefix
Site
SLA Class
TLOC
VPN
New Site List
Next
CANCEL

Select a list type on the left and start creating your groups of interest

| Name | Entries | Reference Count | Updated By | Last Updated | Action |
|---|---|---|---|---|---|

No data available

Input the **Site List Name** and **Add Site**. click **Add**.


Cisco vManage
admin
CONFIGURATION | POLICIES Centralized Policy > Add Policy
Create Groups of Interest
Configure Topology and VPN Membership
Configure Traffic Rules
Apply Policies to Sites and VPNs
Application
Color
Data Prefix
Policer
Prefix
Site
SLA Class
TLOC
VPN
New Site List
Add
Cancel
Next
CANCEL

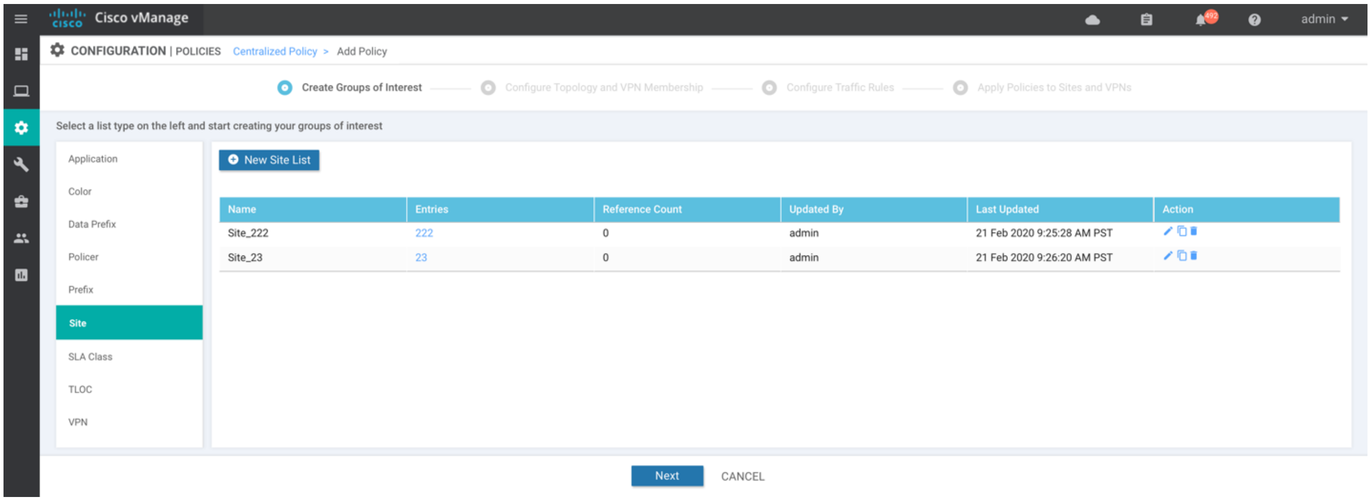
Select a list type on the left and start creating your groups of interest

Site List Name: Site_222

Add Site: 222

| Name | Entries | Reference Count | Updated By | Last Updated | Action |
|---|---|---|---|---|---|

**Step 2.** Repeat above step to add additional sites


Cisco vManage
admin
CONFIGURATION | POLICIES Centralized Policy > Add Policy
Create Groups of Interest
Configure Topology and VPN Membership
Configure Traffic Rules
Apply Policies to Sites and VPNs
Application
Color
Data Prefix
Policer
Prefix
Site
SLA Class
TLOC
VPN
New Site List
Next
CANCEL

Select a list type on the left and start creating your groups of interest

| Name | Entries | Reference Count | Updated By | Last Updated | Action |
|---|---|---|---|---|---|
| Site_222 | 222 | 0 | admin | 21 Feb 2020 9:25:28 AM PST | |
| Site_23 | 23 | 0 | admin | 21 Feb 2020 9:26:20 AM PST | |

## **Procedure 4.** Create VPN List

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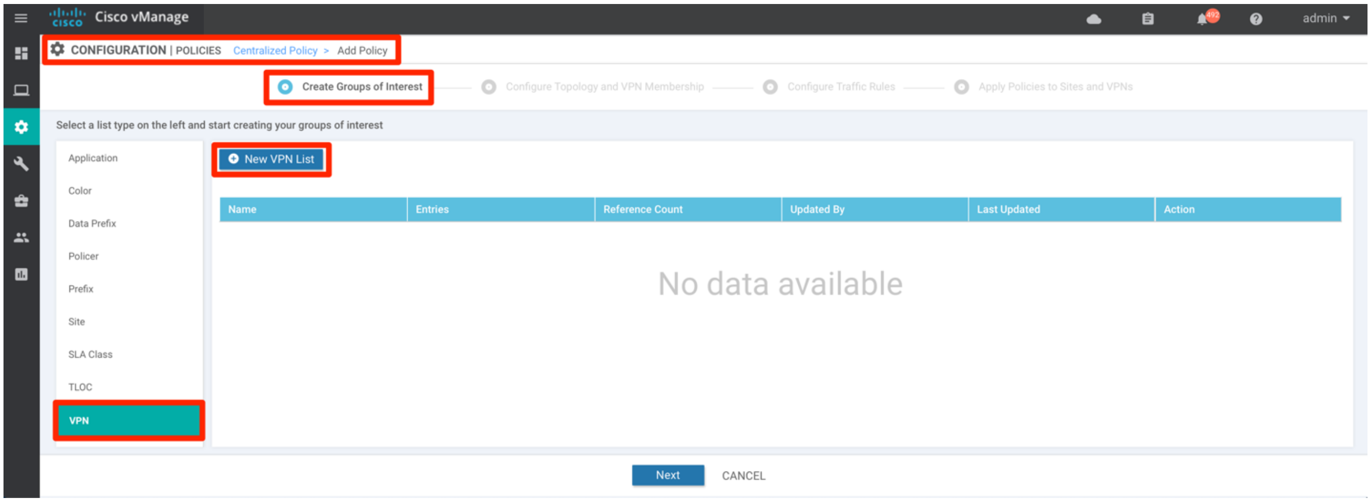
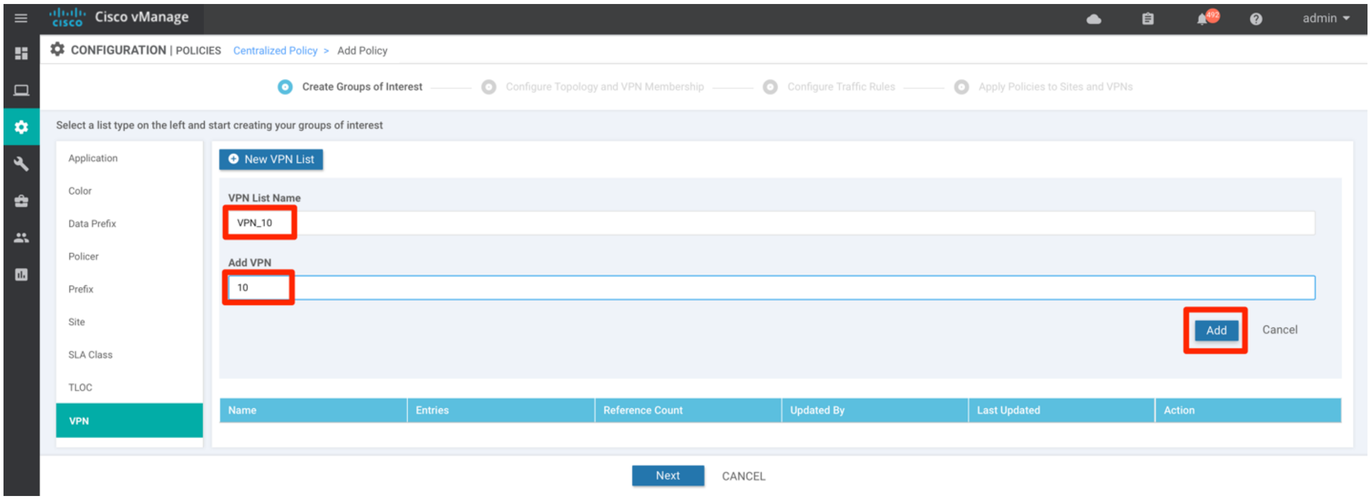
The VPN list defines the service VPN deployed in the SD-WAN environment. This VPN-list would be used in the Application-Aware Routing policy to enforce the policy, influencing WAN Edge devices that are associated with the selected VPN.

**Step 1.** To create VPN List, select **VPN** from the left panel and click **New VPN List**


Cisco vManage
admin
CONFIGURATION | POLICIES Centralized Policy > Add Policy
Create Groups of Interest
Configure Topology and VPN Membership
Configure Traffic Rules
Apply Policies to Sites and VPNs
Select a list type on the left and start creating your groups of interest
Application
Color
Data Prefix
Policer
Prefix
Site
SLA Class
TLOC
VPN
New VPN List
Name
Entries
Reference Count
Updated By
Last Updated
Action
No data available
Next
CANCEL

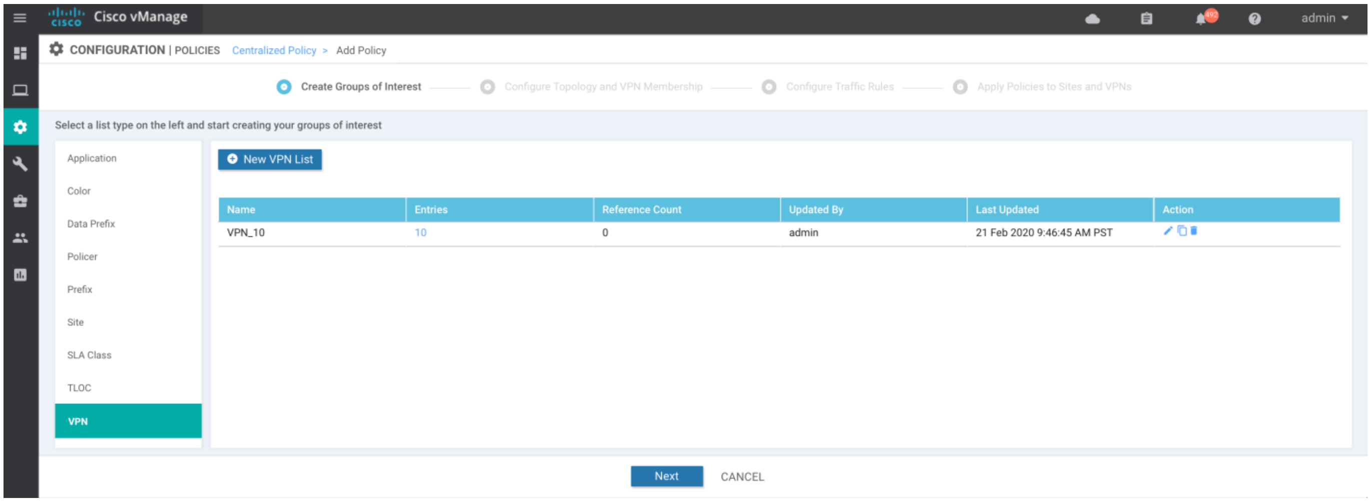
Input the **VPN List Name** and **Add VPN**. click **Add**.


Cisco vManage
admin
CONFIGURATION | POLICIES Centralized Policy > Add Policy
Create Groups of Interest
Configure Topology and VPN Membership
Configure Traffic Rules
Apply Policies to Sites and VPNs
Select a list type on the left and start creating your groups of interest
Application
Color
Data Prefix
Policer
Prefix
Site
SLA Class
TLOC
VPN
New VPN List
Add
Cancel
Name
Entries
Reference Count
Updated By
Last Updated
Action
Next
CANCEL

VPN List Name: VPN_10

Add VPN: 10

**Step 2.** Repeat previous step to add additional VPNs


Cisco vManage
admin
CONFIGURATION | POLICIES Centralized Policy > Add Policy
Create Groups of Interest
Configure Topology and VPN Membership
Configure Traffic Rules
Apply Policies to Sites and VPNs
Select a list type on the left and start creating your groups of interest
Application
Color
Data Prefix
Policer
Prefix
Site
SLA Class
TLOC
VPN
New VPN List
Next
CANCEL

| Name | Entries | Reference Count | Updated By | Last Updated | Action |
|---|---|---|---|---|---|
| VPN_10 | 10 | 0 | admin | 21 Feb 2020 9:46:45 AM PST | ✎ ⧉ 🗑 |

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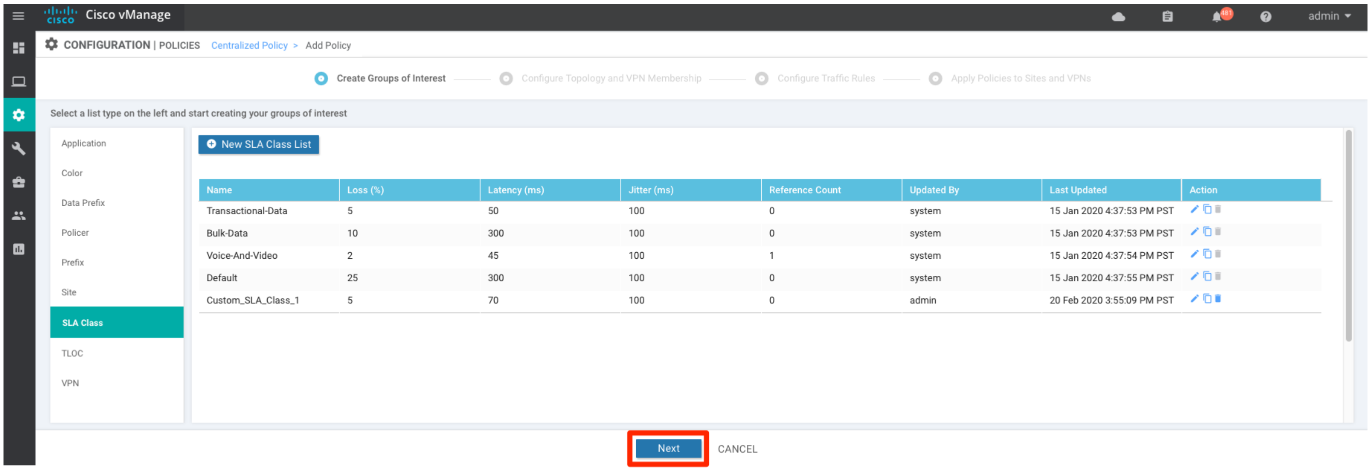
## Procedure 5. Configuring Application-Aware Routing policy

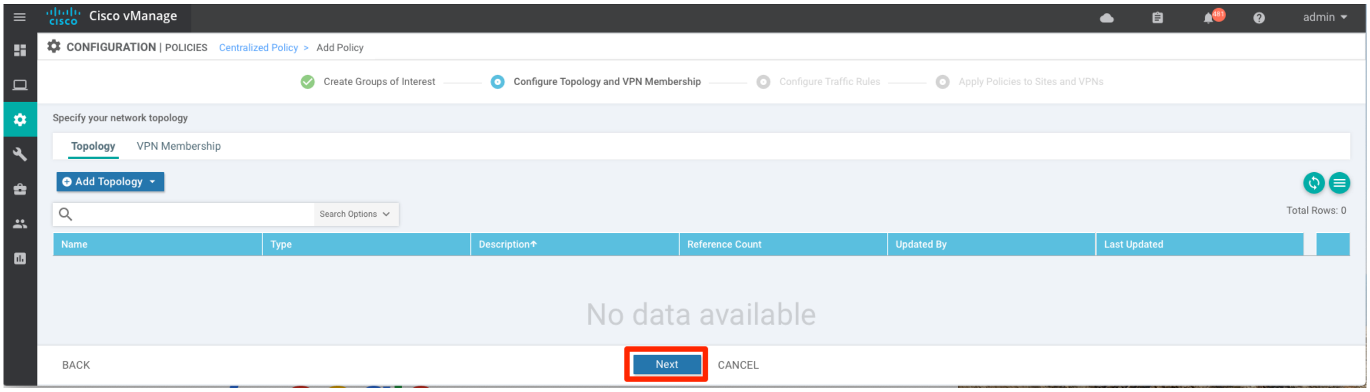
This procedure walks through steps to create Application-Aware Routing policy.

**Step 1.** Click **Next** twice to navigate the Centralized Policy wizard to **Configure Traffic Rules** and select the **Application Aware Routing** tab.


Cisco vManage
admin
CONFIGURATION | POLICIES Centralized Policy > Add Policy
Create Groups of Interest
Configure Topology and VPN Membership
Configure Traffic Rules
Apply Policies to Sites and VPNs
Application
Color
Data Prefix
Policer
Prefix
Site
SLA Class
TLOC
VPN
New SLA Class List
Next
CANCEL

Select a list type on the left and start creating your groups of interest

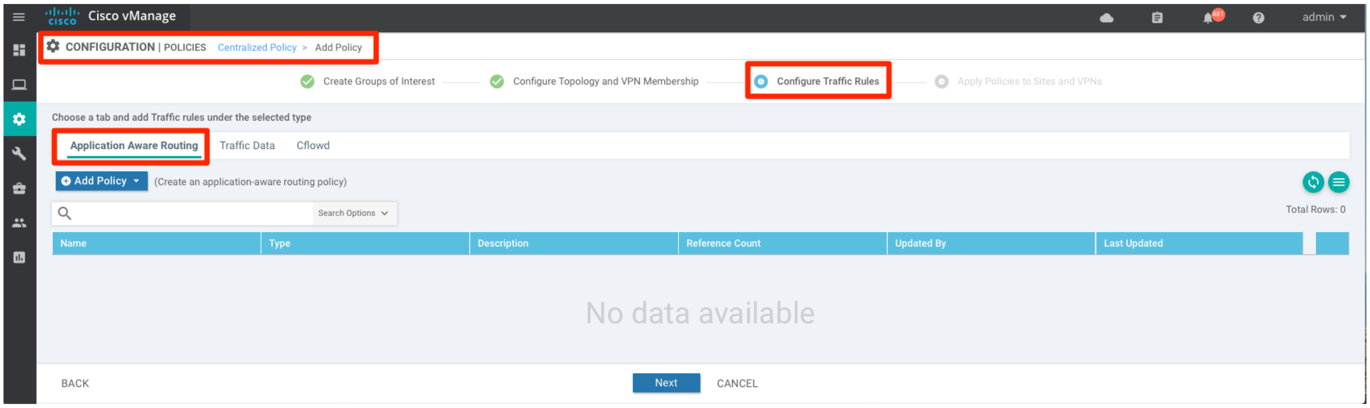
| Name | Loss (%) | Latency (ms) | Jitter (ms) | Reference Count | Updated By | Last Updated | Action |
|---|---|---|---|---|---|---|---|
| Transactional-Data | 5 | 50 | 100 | 0 | system | 15 Jan 2020 4:37:53 PM PST | |
| Bulk-Data | 10 | 300 | 100 | 0 | system | 15 Jan 2020 4:37:53 PM PST | |
| Voice-And-Video | 2 | 45 | 100 | 1 | system | 15 Jan 2020 4:37:54 PM PST | |
| Default | 25 | 300 | 100 | 0 | system | 15 Jan 2020 4:37:55 PM PST | |
| Custom_SLA_Class_1 | 5 | 70 | 100 | 0 | admin | 20 Feb 2020 3:55:09 PM PST | |


Cisco vManage
admin
CONFIGURATION | POLICIES Centralized Policy > Add Policy
Create Groups of Interest
Configure Topology and VPN Membership
Configure Traffic Rules
Apply Policies to Sites and VPNs
Topology
VPN Membership
Add Topology
Search Options
Total Rows: 0
BACK
Next
CANCEL

Specify your network topology

| Name | Type | Description↑ | Reference Count | Updated By | Last Updated |
|---|---|---|---|---|---|

No data available


Cisco vManage
admin
CONFIGURATION | POLICIES Centralized Policy > Add Policy
Create Groups of Interest
Configure Topology and VPN Membership
Configure Traffic Rules
Apply Policies to Sites and VPNs
Application Aware Routing
Traffic Data
Cflowd
Add Policy
(Create an application-aware routing policy)
Search Options
Total Rows: 0
BACK
Next
CANCEL

Choose a tab and add Traffic rules under the selected type

| Name | Type | Description | Reference Count | Updated By | Last Updated |
|---|---|---|---|---|---|

No data available

**Step 2.** Click **Add Policy** > **Create New** to create a new **Application Aware Routing Policy**.

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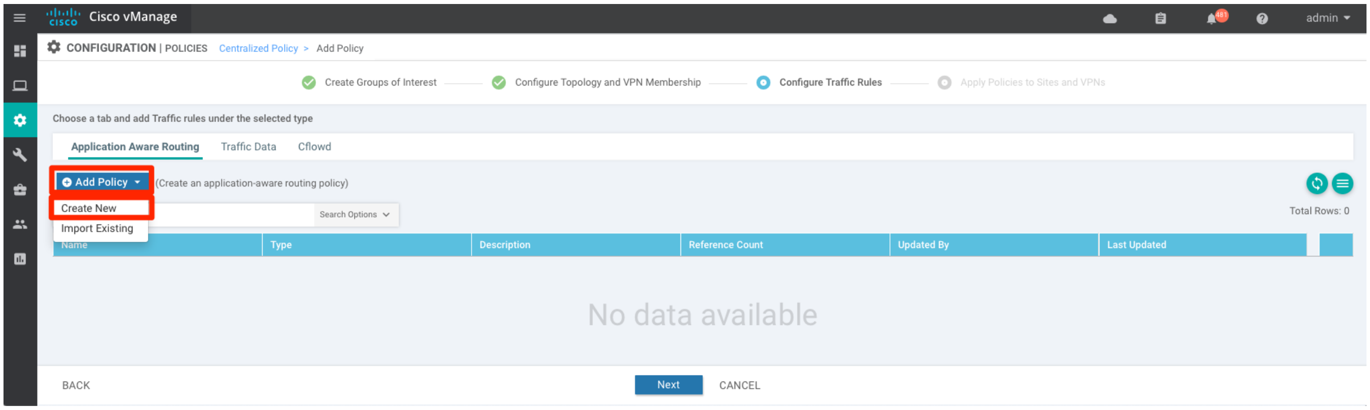
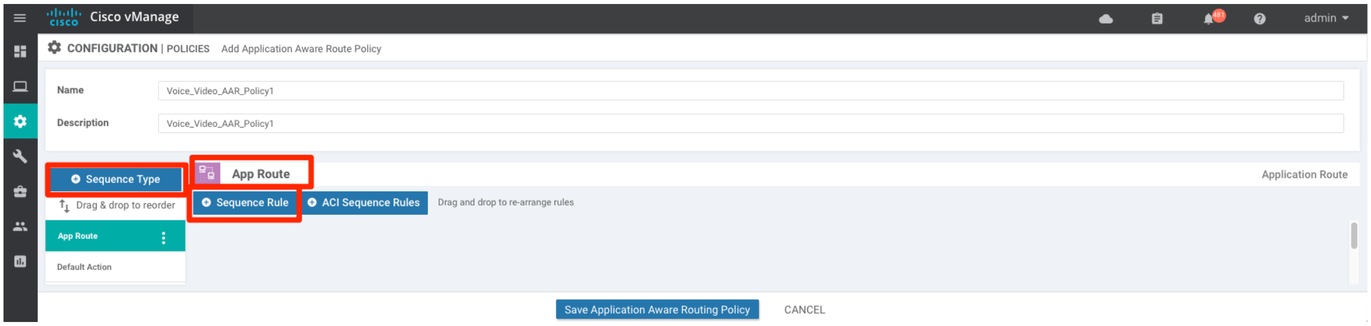
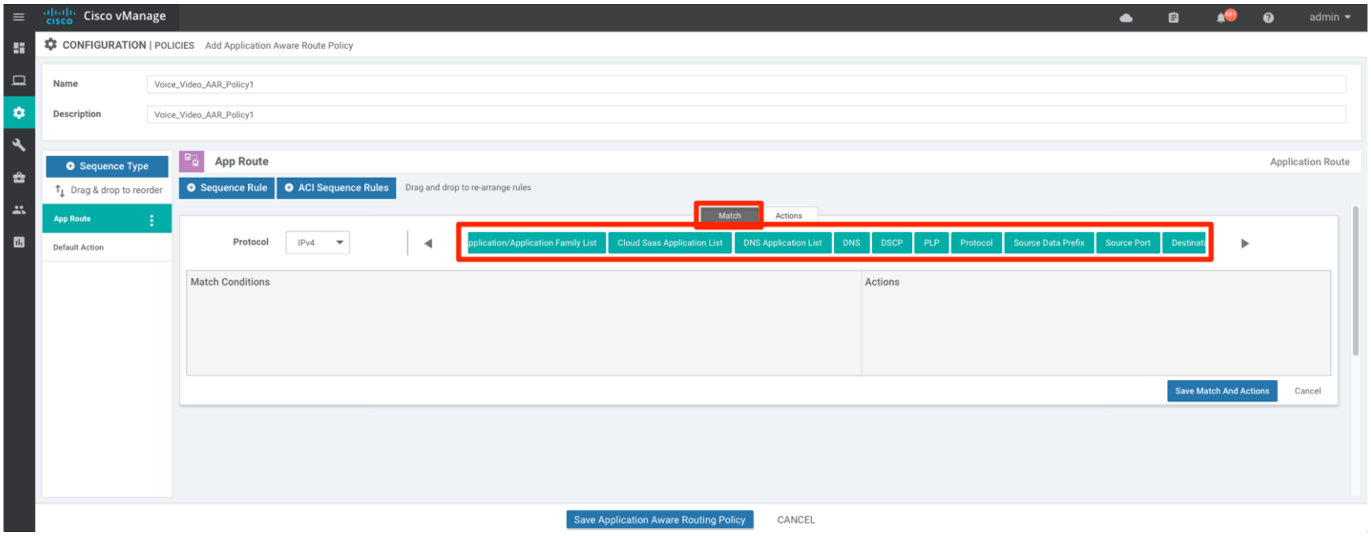

Cisco vManage
admin
CONFIGURATION | POLICIES Centralized Policy > Add Policy
Create Groups of Interest
Configure Topology and VPN Membership
Configure Traffic Rules
Apply Policies to Sites and VPNs
Choose a tab and add Traffic rules under the selected type
Application Aware Routing
Traffic Data
Cflowd
Add Policy
(Create an application-aware routing policy)
Create New
Import Existing
Search Options
Total Rows: 0
Name
Type
Description
Reference Count
Updated By
Last Updated
No data available
BACK
Next
CANCEL

Input the **Name** and **Description** for the policy. To add the policy, click **Sequence Type** and under **App Route** tab select **Sequence Rule** option


Name: Voice_Video_AAR_Policy1

Description: Voice_Video_AAR_Policy1

**Step 3.** select the traffic by matching on the options available in the **Match** tab.


Name: Voice_Video_AAR_Policy1

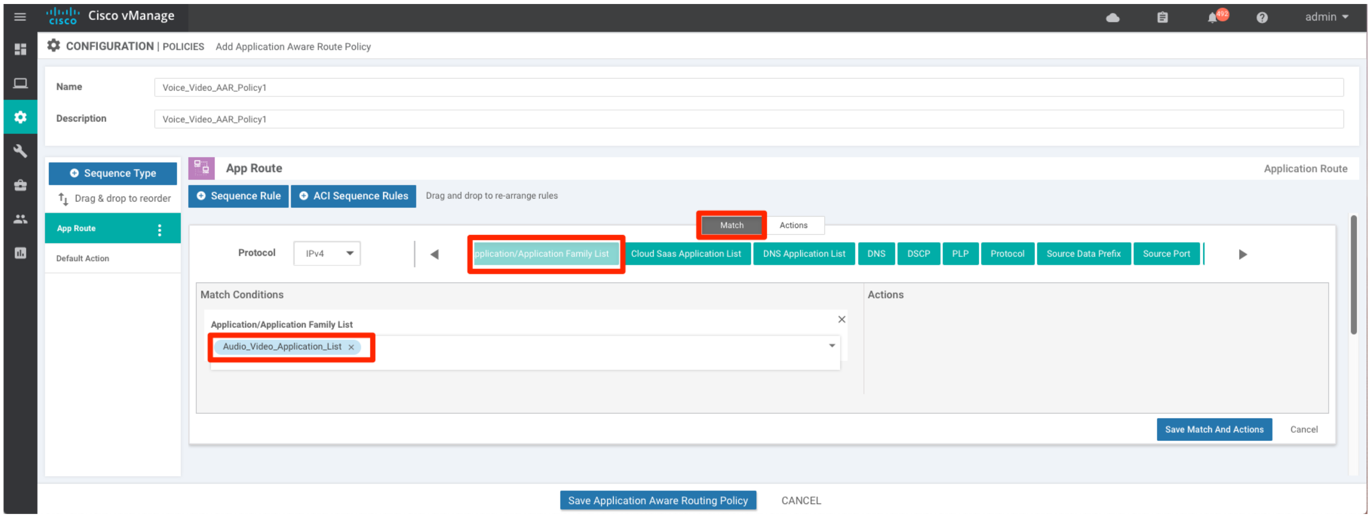
Description: Voice_Video_AAR_Policy1

The match criteria matches the data traffic originating from the service side. Below table lists the different options available to match on:

| Possible Match options | | Description |
|---|---|---|
| Application / Application Family List | Pre-defined / custom-defined list | Leverage the pre-defined Application/Applications-list or create custom application-list to match (defined in the guide steps 1 -5). |

| | | |
|---|---|---|
| Cloud SaaS Application List | Pre-defined list | Leverage the pre-defined Cloud-Saas Application list |
| DNS Application List | Pre-defined / custom-defined list | DNS application list is used to split DNS lookup per the selected application-lists. |
| DNS | DNS request / response option | DNS packets. |
| DSCP | 0-63 | Pre-configured traffic with DSCP values through QoS policy on the service-side traffic can be used to match the traffic. |
| PLP | High / Low options | Pre-configured traffic part of the Packet Loss Priority (PLP) queue, configured part of Policer QoS section policy, can be matched. By default, packets have a PLP value of low. To set the PLP value to high, apply a policer that includes the exceed remark option. |
| Protocol | Protocol number | Traffic with defined protocol number can be matched |
| Source Data Prefix | custom-defined data prefix | Pre-defined custom data-prefix of the traffic can be matched on |
| Source Port | Port number | Data traffic with defined port number can be matched. |
| Destination Data Prefix | custom-defined data prefix | Pre-defined custom data-prefix of the traffic can be matched on |
| Destination Port | Port number | Data traffic with defined port number can be matched. |

For this guide, lets pick the previously created custom Application Family list.



CONFIGURATION | POLICIES Add Application Aware Route Policy

Name: Voice_Video_AAR_Policy1

Description: Voice_Video_AAR_Policy1

Protocol: IPv4

Match Conditions

Application/Application Family List: Audio_Video_Application_List

Note that multiple match statements can be configured within the same sequence to select more specific traffic, as shown below

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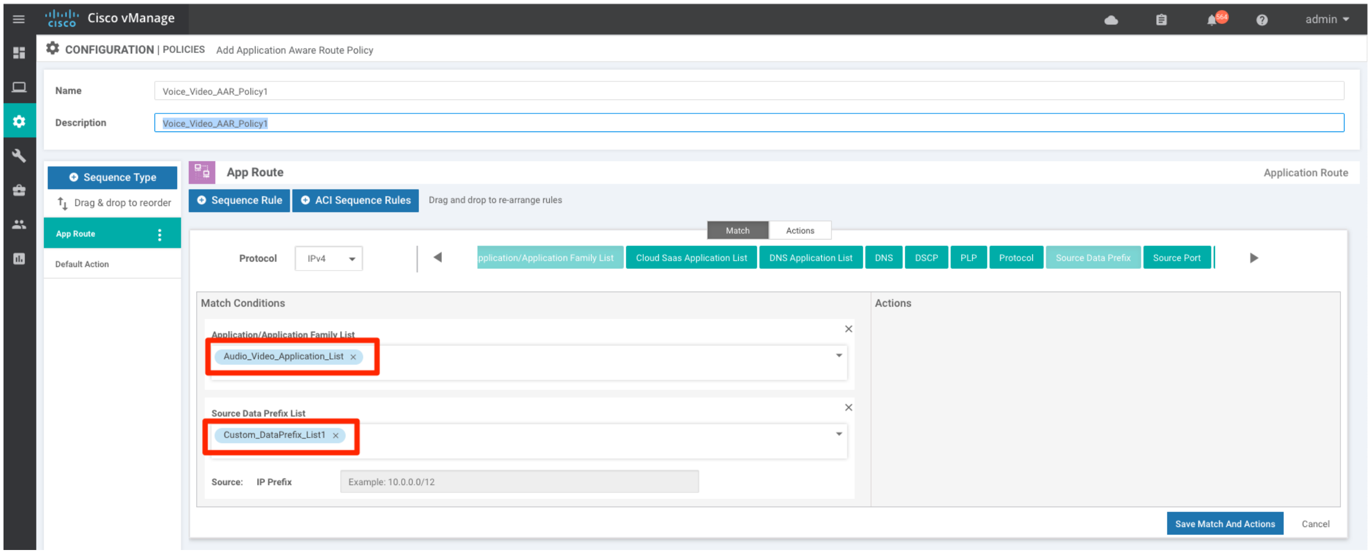


Name: Voice_Video_AAR_Policy1

Description: Voice_Video_AAR_Policy1

Protocol: IPv4

Application/Application Family List: Audio_Video_Application_List

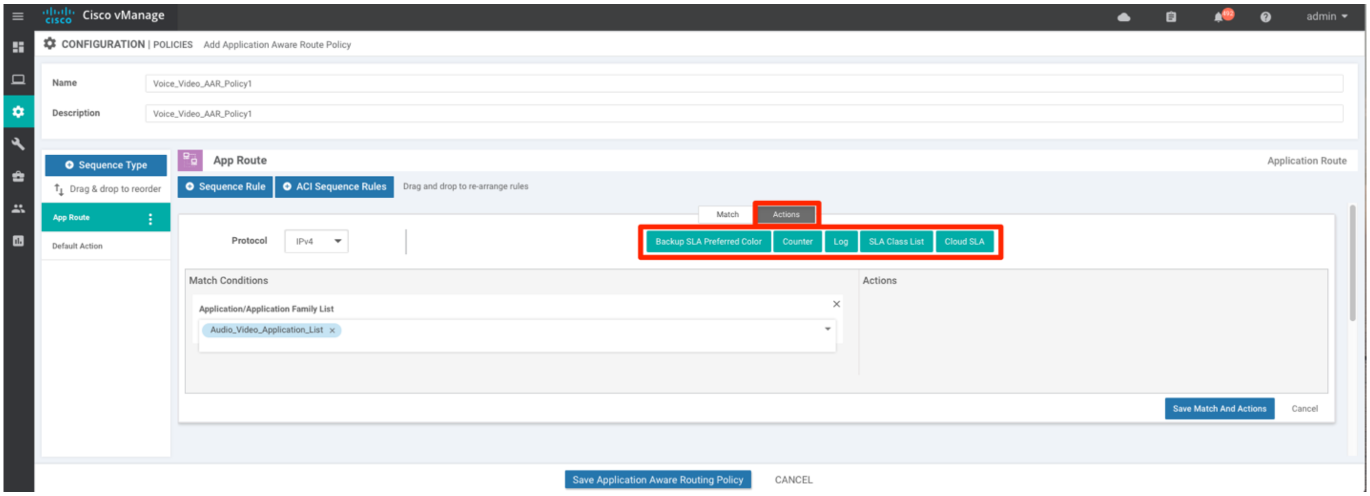
Source Data Prefix List: Custom_DataPrefix_List1

Source: IP Prefix Example: 10.0.0.0/12

**Step 4.** Select the preferred **Actions** to be performed for the matched traffic.

| Possible Action options | |
|---|---|
| Backup SLA Preferred Color | choose predefined color(s) that traffic is forwarded if the SLA is not met |
| Counter | Specify name to store the count for matching packets |
| Log | If enabled, syslog message is generated first time a packet flow is logged and every 5 minutes thereafter, as long as the flow is active. **'show log'** can be leveraged to view the log. |
| SLA Class List | Select the custom/pre-defined SLA Class List and choose preferred color(s) that traffic gets forwarded as long as the specified SLA is satisfied. |
| Cloud SLA | Enabled (if selected) |

App Route policy actions statement allows us to define **Preferred Color** list as long as the **SLA class** is satisfied and action if SLA is breached, either to use the **Backup SLA Preferred Color** or drop the traffic by enabling the **Strict** option.



Name: Voice_Video_AAR_Policy1

Description: Voice_Video_AAR_Policy1

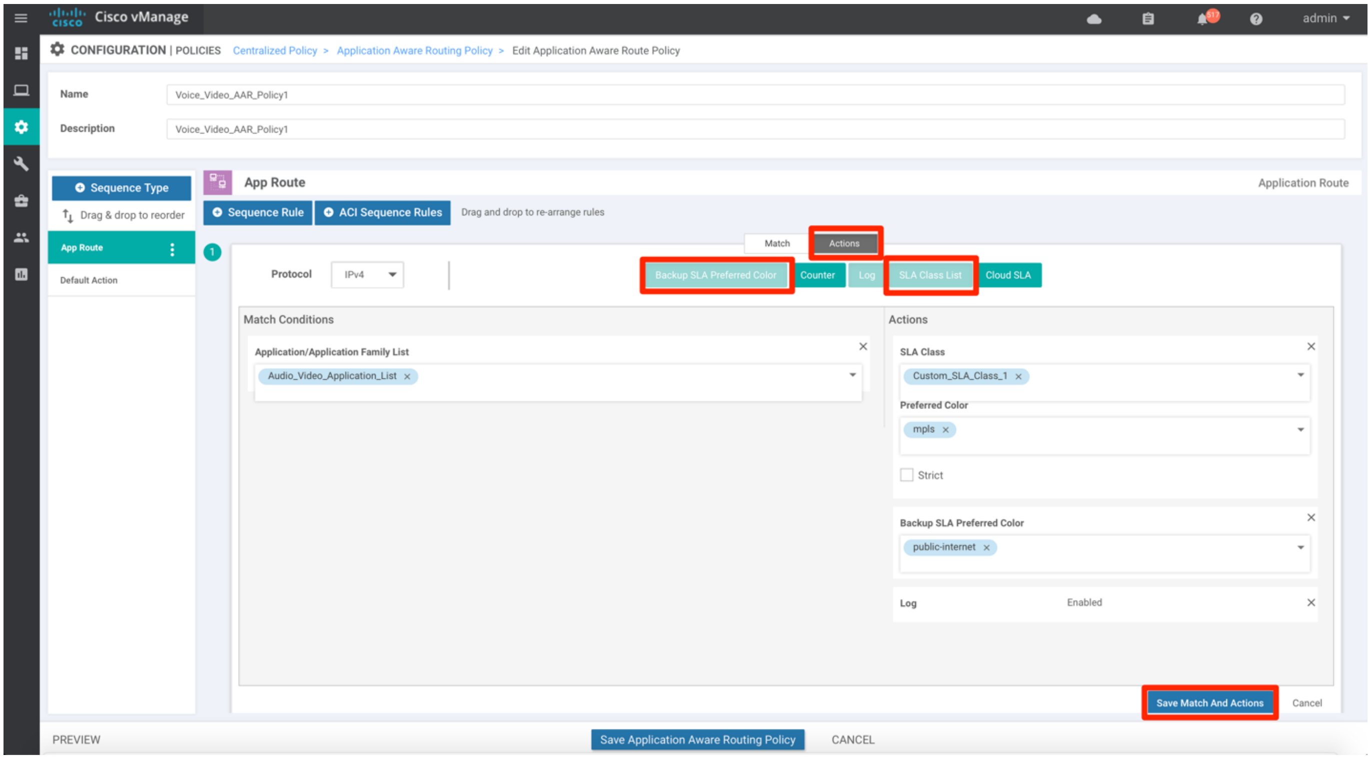
Protocol: IPv4

Application/Application Family List: Audio_Video_Application_List

App Route policy actions statement allows us to define **Preferred Color** list as long as the **SLA class** is satisfied and action if SLA is breached, either to use the **Backup SLA Preferred Color** or drop the traffic by enabling the **Strict** option.

Select **SLA class List,** Backup **SLA Preferred Color** option from the Actions. Select the previously created **SLA Class**, **Preferred Color** and **Backup SLA Preferred Color** from the drop-down menu.

Click **Save Match and Actions** option.



Name: Voice_Video_AAR_Policy1

Description: Voice_Video_AAR_Policy1

App Route

1 Protocol: IPv4

Match Conditions

Application/Application Family List: Audio_Video_Application_List

Actions

SLA Class: Custom_SLA_Class_1

Preferred Color: mpls

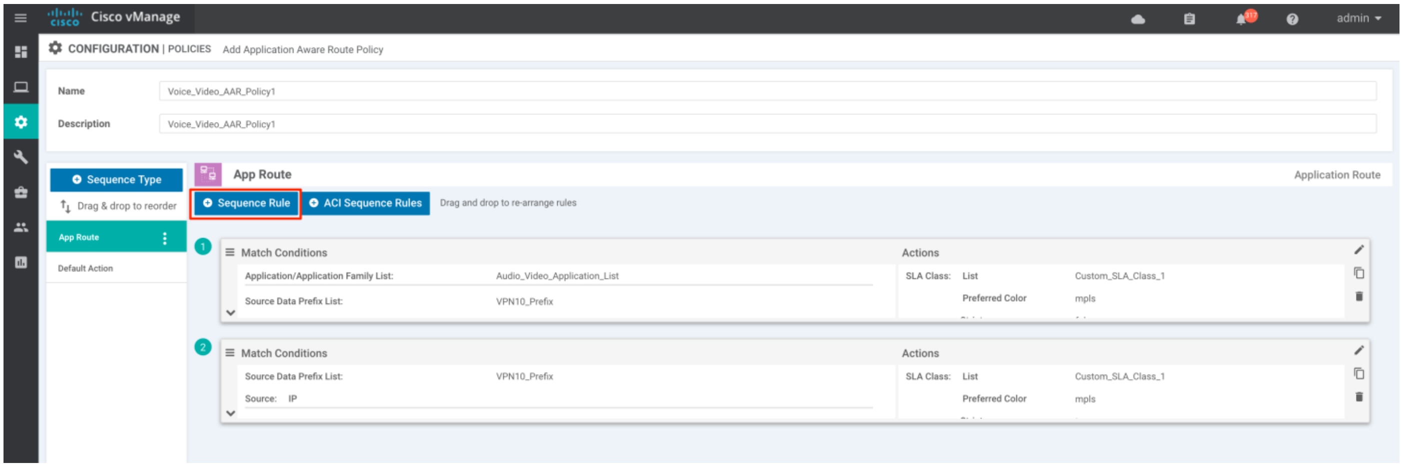
□ Strict

Backup SLA Preferred Color: public-internet

Log: Enabled

**Step 5.** Multiple App-Route rule can be defined part of the same policy, each rule is recognized by different sequence number, each rule containing a match-action pair defining the preferred treatment for the classified traffic. The data-traffic matching a sequence rule (executed from low to high sequence number), executes the appropriate action and exists the policy.

If no policy matches the traffic, Default Action rule is applied for the traffic. The WAN Edge behavior for Default Action is to perform load-balance the traffic across all available WAN transports



Name: Voice_Video_AAR_Policy1

Description: Voice_Video_AAR_Policy1

App Route

1 Match Conditions

Application/Application Family List: Audio_Video_Application_List

Source Data Prefix List: VPN10_Prefix

Actions

SLA Class: List Custom_SLA_Class_1

Preferred Color mpls

2 Match Conditions

Source Data Prefix List: VPN10_Prefix

Source: IP

Actions

SLA Class: List Custom_SLA_Class_1

Preferred Color mpls

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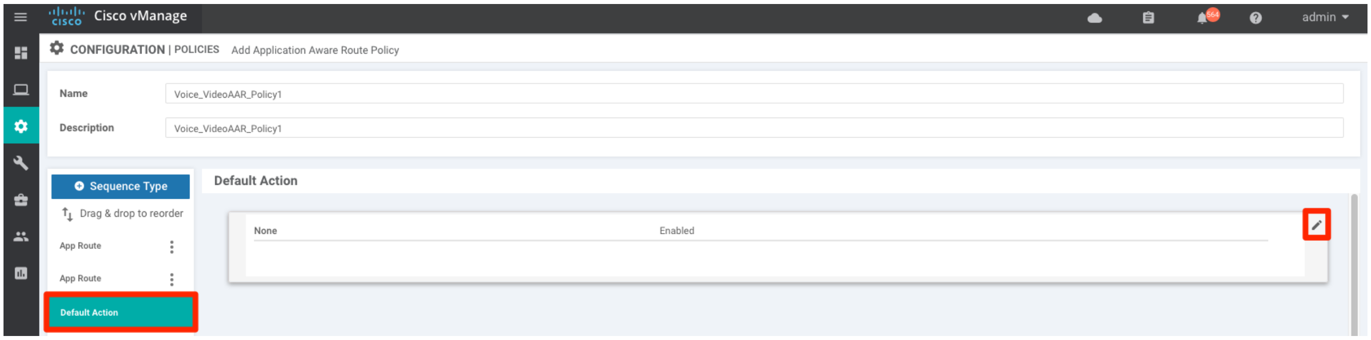
**Step 6.** (optional) Changing the Default Action behavior.

Modify the default behavior to redirect the data traffic to a preferred WAN transport that meets the specified SLA class list.

Click the **Default Action** and click **Edit** option.



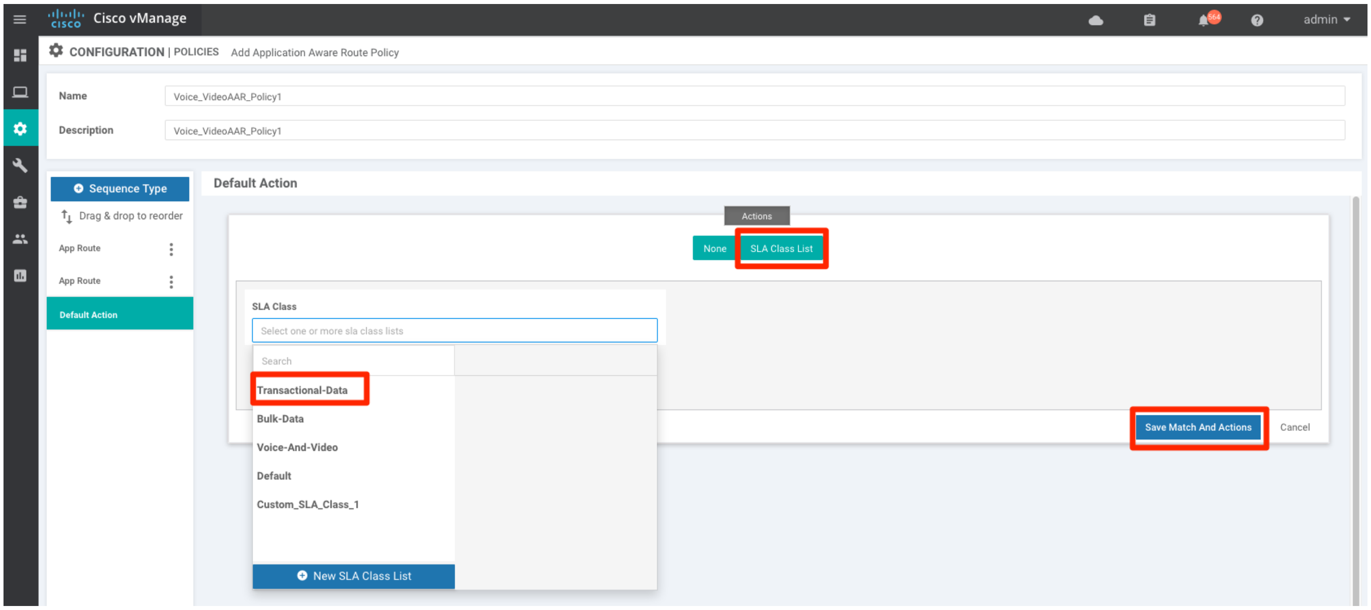
Name: Voice_VideoAAR_Policy1

Description: Voice_VideoAAR_Policy1

Default Action

| None | Enabled |
|---|---|

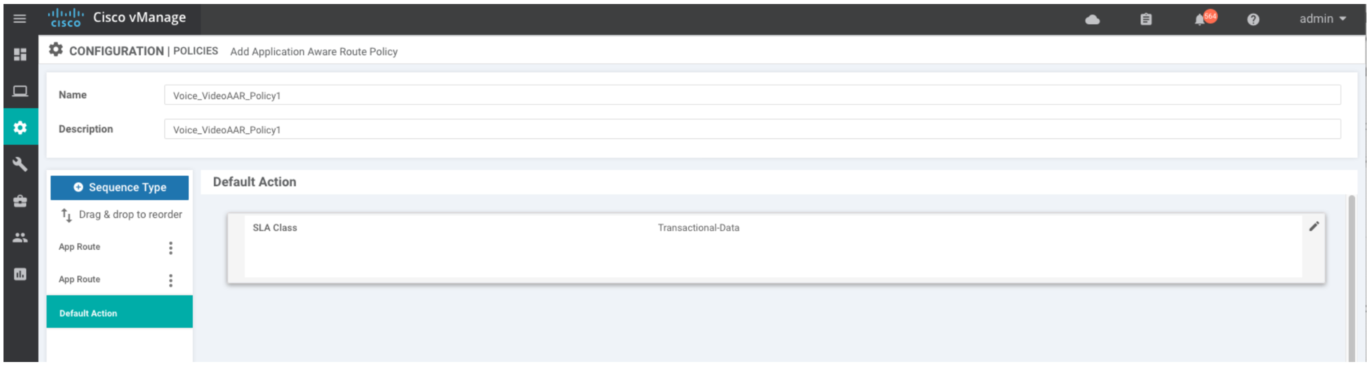
select the **SLA Class List** and select the appropriate **SLA Class** from the drop-down menu. Click **Save Match and Actions** option.



Name: Voice_VideoAAR_Policy1

Description: Voice_VideoAAR_Policy1

Default Action



Name: Voice_VideoAAR_Policy1

Description: Voice_VideoAAR_Policy1

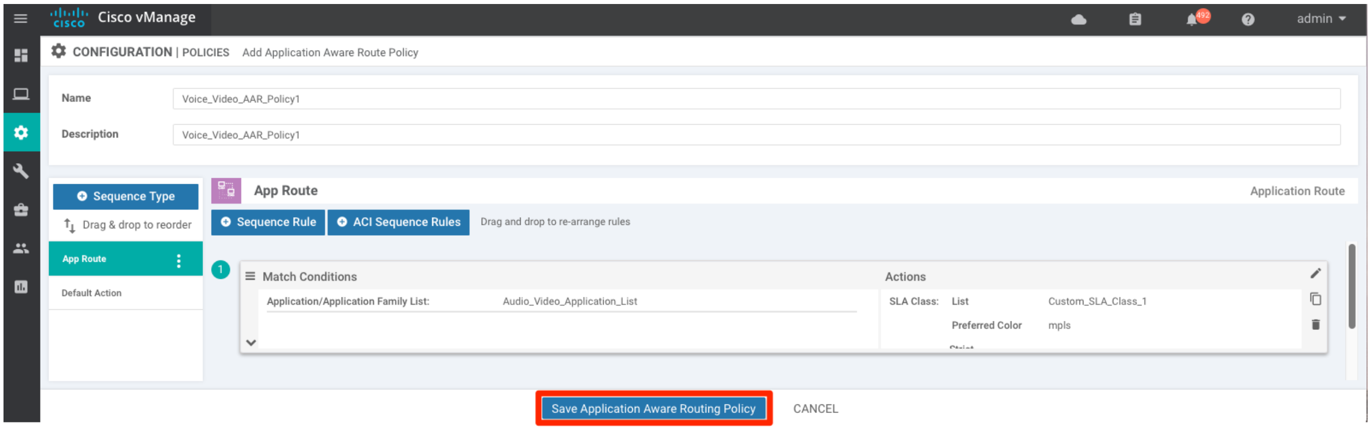
Default Action

| SLA Class | Transactional-Data |
|---|---|

**Tech tip**

If no WAN transports satisfies the selected SLA class in the default action, the WAN Edge device will load-balance the data traffic across all the available links.

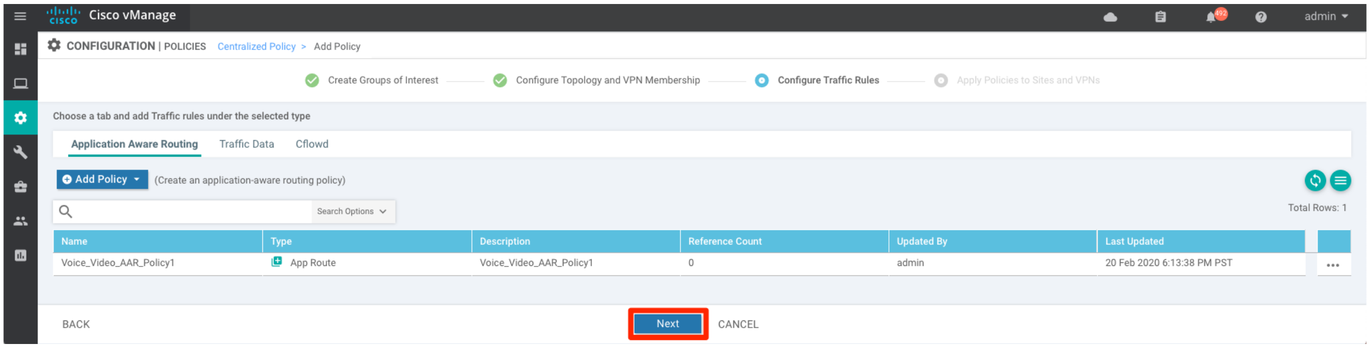
**Step 7.** Click **Save Application Aware Routing Policy** and then **Next.**



Name: Voice_Video_AAR_Policy1

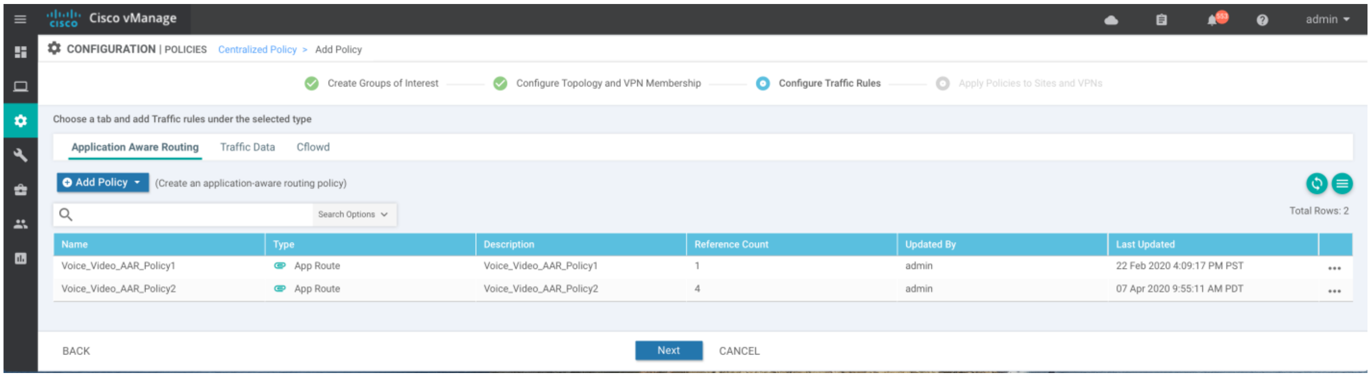
Description: Voice_Video_AAR_Policy1

| Match Conditions | | Actions | | |
|---|---|---|---|---|
| Application/Application Family List: | Audio_Video_Application_List | SLA Class: | List | Custom_SLA_Class_1 |
| | | | Preferred Color | mpls |


Cisco vManage
admin
CONFIGURATION | POLICIES Centralized Policy > Add Policy
Create Groups of Interest
Configure Topology and VPN Membership
Configure Traffic Rules
Apply Policies to Sites and VPNs
Choose a tab and add Traffic rules under the selected type
Application Aware Routing
Traffic Data
Cflowd
Add Policy
(Create an application-aware routing policy)
Search Options
Total Rows: 1
BACK
Next
CANCEL

| Name | Type | Description | Reference Count | Updated By | Last Updated |
|---|---|---|---|---|---|
| Voice_Video_AAR_Policy1 | App Route | Voice_Video_AAR_Policy1 | 0 | admin | 20 Feb 2020 6:13:38 PM PST |

**Step 8.** Create any additional Application-Aware Routing policies as shown in previous steps if necessary.


Cisco vManage
admin
CONFIGURATION | POLICIES Centralized Policy > Add Policy
Create Groups of Interest
Configure Topology and VPN Membership
Configure Traffic Rules
Apply Policies to Sites and VPNs
Choose a tab and add Traffic rules under the selected type
Application Aware Routing
Traffic Data
Cflowd
Add Policy
(Create an application-aware routing policy)
Search Options
Total Rows: 2
BACK
Next
CANCEL

| Name | Type | Description | Reference Count | Updated By | Last Updated |
|---|---|---|---|---|---|
| Voice_Video_AAR_Policy1 | App Route | Voice_Video_AAR_Policy1 | 1 | admin | 22 Feb 2020 4:09:17 PM PST |
| Voice_Video_AAR_Policy2 | App Route | Voice_Video_AAR_Policy2 | 4 | admin | 07 Apr 2020 9:55:11 AM PDT |

**Step 9.** Final step in configuring the Application Aware Routing Policy is to choose the Site List and VPN list for the policy to be associated with

In the Centralized Policy wizard, select **Next** to navigate to **Apply Policies to Sites and VPNS** and select **Application-Aware Routing** tab.

Input **Policy Name** and **Policy Description** and under the previously created App-Aware policy section, click the **New Site List and VPN List** option.

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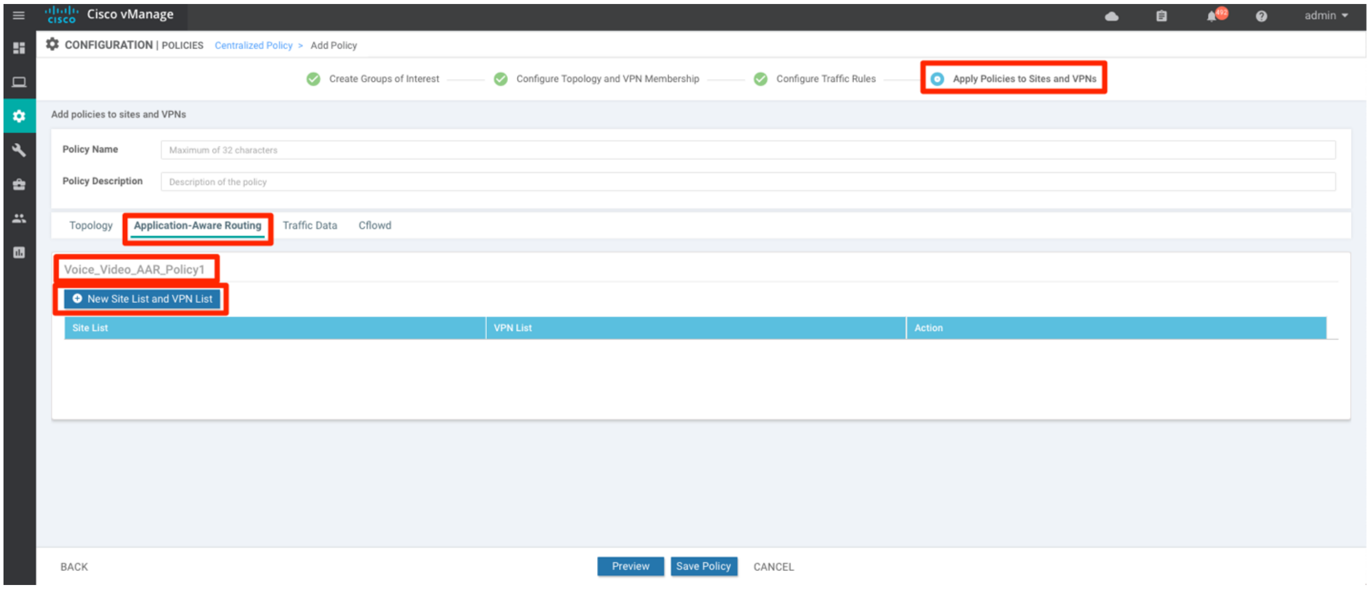

Cisco vManage
admin
CONFIGURATION | POLICIES Centralized Policy > Add Policy
Create Groups of Interest
Configure Topology and VPN Membership
Configure Traffic Rules
Apply Policies to Sites and VPNs
Topology
Application-Aware Routing
Traffic Data
Cflowd
New Site List and VPN List
BACK
Preview
Save Policy
CANCEL

Add policies to sites and VPNs

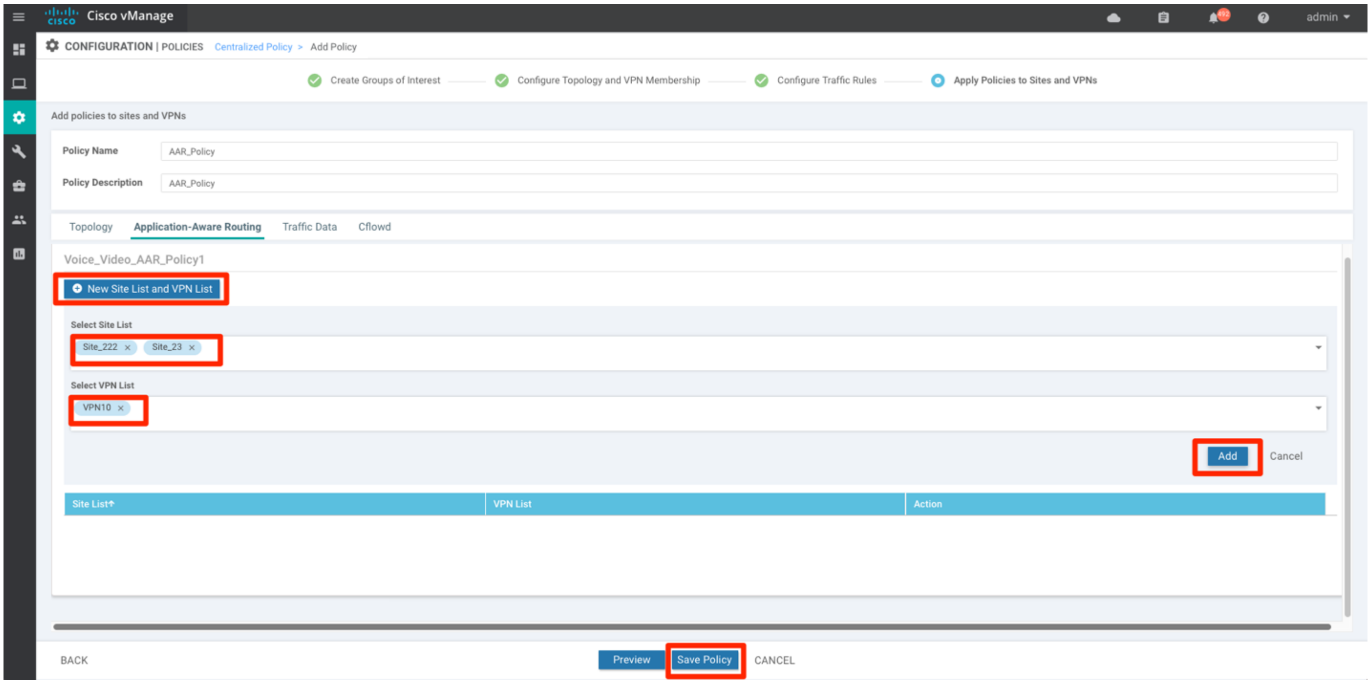
Policy Name: Maximum of 32 characters

Policy Description: Description of the policy

Voice_Video_AAR_Policy1

| Site List | VPN List | Action |
|---|---|---|

Select the previously defined **Site List** and **VPN List**. Click **Add** and click **Save Policy**.


Cisco vManage
admin
CONFIGURATION | POLICIES Centralized Policy > Add Policy
Create Groups of Interest
Configure Topology and VPN Membership
Configure Traffic Rules
Apply Policies to Sites and VPNs
Topology
Application-Aware Routing
Traffic Data
Cflowd
New Site List and VPN List
Add
Cancel
BACK
Preview
Save Policy
CANCEL

Add policies to sites and VPNs

Policy Name: AAR_Policy

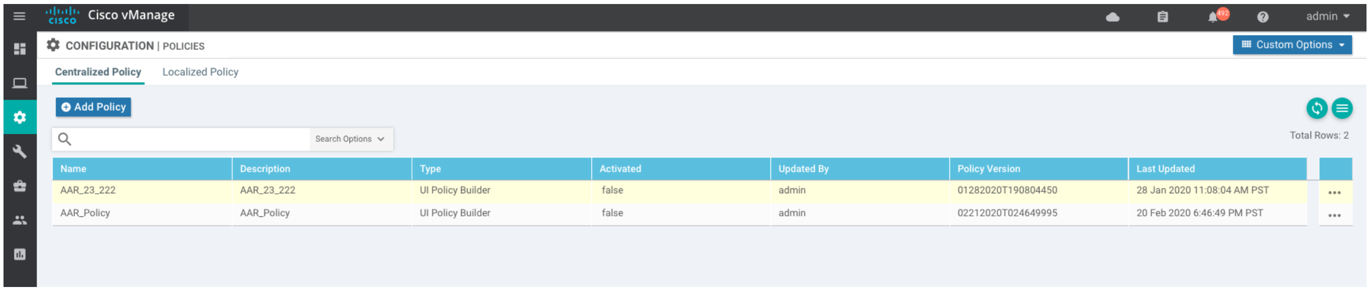
Policy Description: AAR_Policy

Voice_Video_AAR_Policy1

Select Site List: Site_222 × Site_23 ×

Select VPN List: VPN10 ×

| Site List↑ | VPN List | Action |
|---|---|---|



Total Rows: 2

| Name | Description | Type | Activated | Updated By | Policy Version | Last Updated | |
|---|---|---|---|---|---|---|---|
| AAR_23_222 | AAR_23_222 | UI Policy Builder | false | admin | 01282020T190804450 | 28 Jan 2020 11:08:04 AM PST | ••• |
| AAR_Policy | AAR_Policy | UI Policy Builder | false | admin | 02212020T024649995 | 20 Feb 2020 6:46:49 PM PST | ••• |

**Step 10.** Activate the policy

Configuring the Application Aware Routing policy does not push the policy to vSmart controller. Final step is to configure the vSmart controller and enforce the policy by activating the policy.

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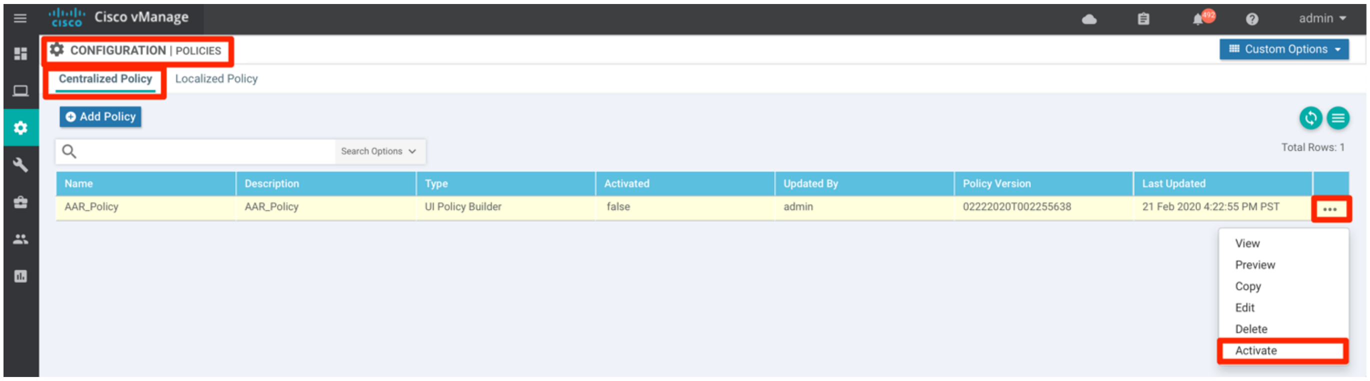
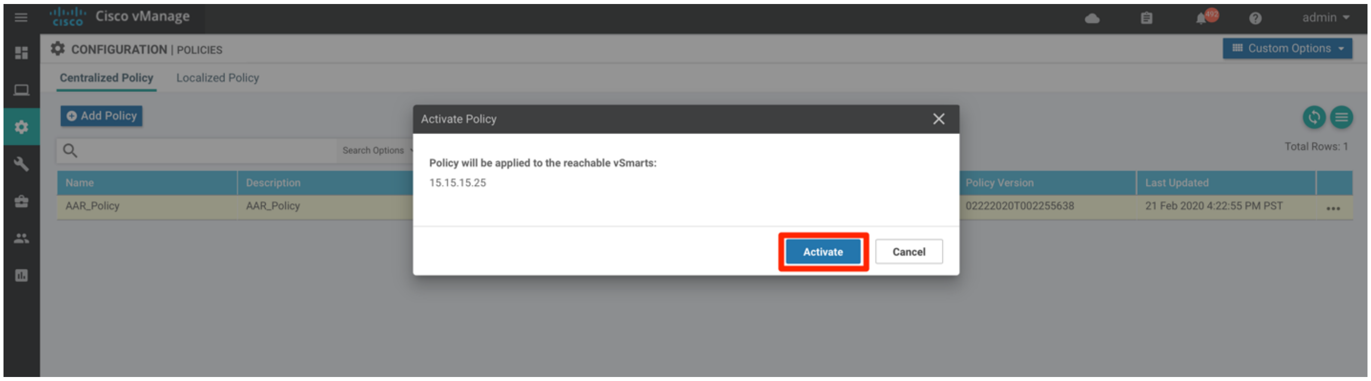
In vManage, navigate to **Configuration > Policies > Centralized Policy**. Choose the configured Application Aware Routing Policy, on the far right-side select the three dots (**...**) to the right of each table row and select **Activate** option from the menu.



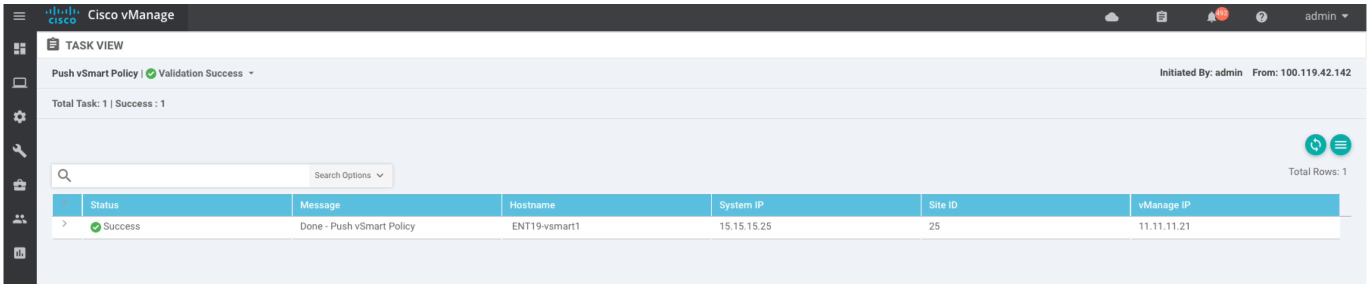
| Name | Description | Type | Activated | Updated By | Policy Version | Last Updated |
|---|---|---|---|---|---|---|
| AAR_Policy | AAR_Policy | UI Policy Builder | false | admin | 02222020T002255638 | 21 Feb 2020 4:22:55 PM PST |

Pop-up window will ask for confirmation to push the configuration to all vSmart controllers for enforcement. Click **Activate**



Policy will be applied to the reachable vSmarts:

15.15.15.25



Push vSmart Policy | ✓ Validation Success

Initiated By: admin From: 100.119.42.142

Total Task: 1 | Success : 1

| Status | Message | Hostname | System IP | Site ID | vManage IP |
|---|---|---|---|---|---|
| ✓ Success | Done - Push vSmart Policy | ENT19-vsmart1 | 15.15.15.25 | 25 | 11.11.11.21 |

## Process: Appending Application-Aware Routing policy

It is important to note that only one Centralized Policy can be associated and activated in the SD-WAN environment. The centralized policy can have multiple policies embedded within the same policy.

Deployments with an existing active centralized policy can add the Application-Aware Routing policy to the existing policy. This process walks through procedure needed to append the Application-Aware routing policy

Creating Application Aware Routing policies consists of defining the three core components:

- Identification – Classify the traffic / Application group of interest.
- Application SLA Requirement – Defining the application SLA requirements.

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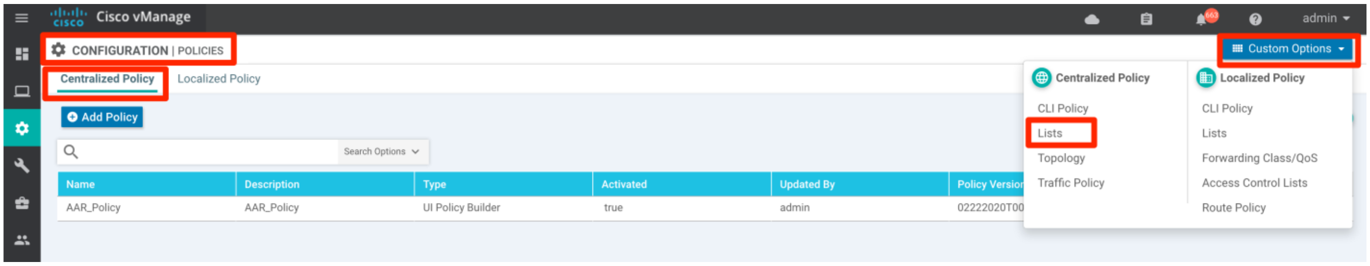
- Application-Aware Routing Policy – Policy maps the classified traffic to the transport tunnel based on the defined SLA requirement.

On creating the policy, associate and activate the centralized policy to appropriate Site list(s) and VPN list(s).

## Procedure 1. Identification – Classify the traffic / Application group of interest.

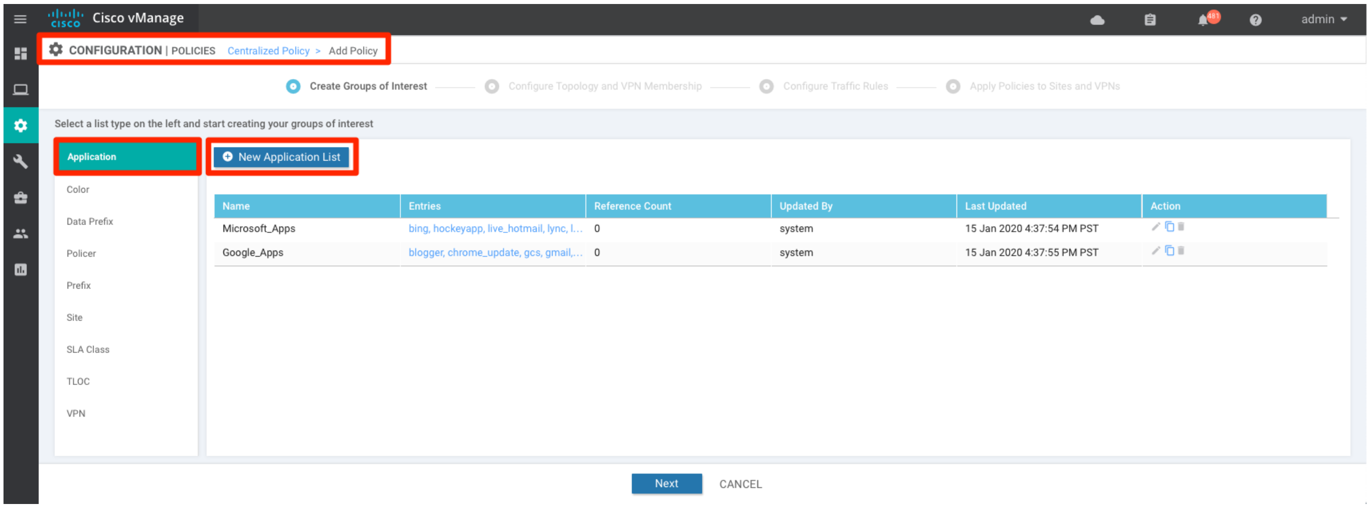
The below procedure walks through steps needed to classify the traffic.

**Step 1.** In vManage, navigate to **Configuration > Policies > Centralized Policy**. Click **Custom Options** from the top right menu options and select **Lists** from the **Centralized Policy** section.



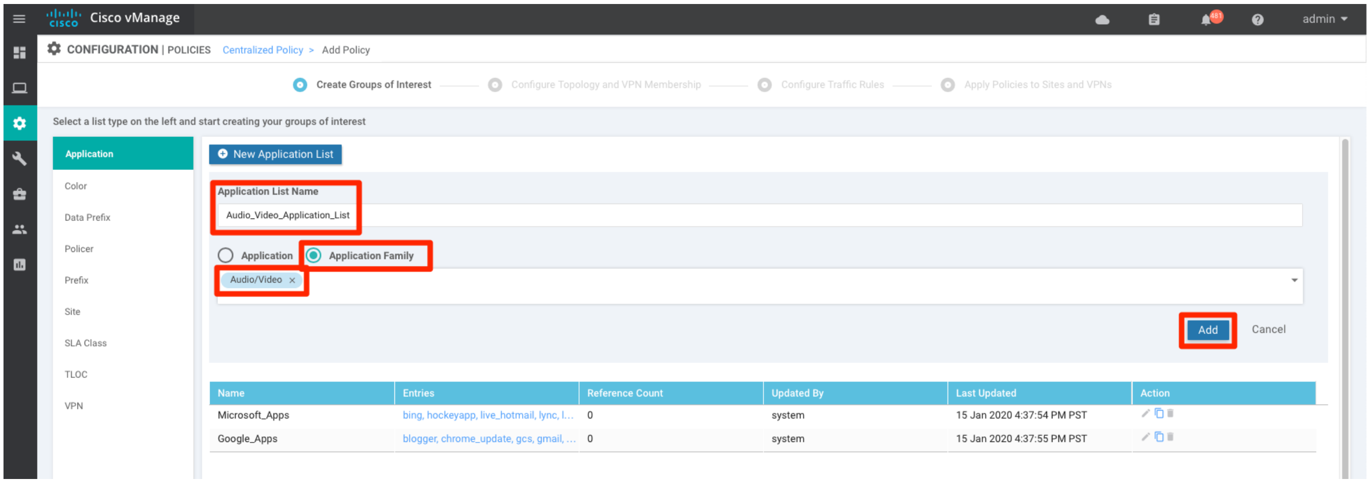
| Name | Description | Type | Activated | Updated By | Policy Versio |
|---|---|---|---|---|---|
| AAR_Policy | AAR_Policy | UI Policy Builder | true | admin | 02222020T00 |

**Step 2.** Select **Application** from the left panel and click **New Application List**


Cisco vManage
admin
CONFIGURATION | POLICIES Centralized Policy > Add Policy
Create Groups of Interest
Configure Topology and VPN Membership
Configure Traffic Rules
Apply Policies to Sites and VPNs
Select a list type on the left and start creating your groups of interest
Application
Color
Data Prefix
Policer
Prefix
Site
SLA Class
TLOC
VPN
New Application List
Next
CANCEL

| Name | Entries | Reference Count | Updated By | Last Updated | Action |
|---|---|---|---|---|---|
| Microsoft_Apps | bing, hockeyapp, live_hotmail, lync, l... | 0 | system | 15 Jan 2020 4:37:54 PM PST | |
| Google_Apps | blogger, chrome_update, gcs, gmail,... | 0 | system | 15 Jan 2020 4:37:55 PM PST | |

Select the **Application** or **Application Family** and choose appropriate option from the drop-down option. Provide an **Application List Name** and Click **Add**.


Cisco vManage
admin
CONFIGURATION | POLICIES Centralized Policy > Add Policy
Create Groups of Interest
Configure Topology and VPN Membership
Configure Traffic Rules
Apply Policies to Sites and VPNs
Select a list type on the left and start creating your groups of interest
Application
Color
Data Prefix
Policer
Prefix
Site
SLA Class
TLOC
VPN
New Application List
Add
Cancel

Application List Name: Audio_Video_Application_List

○ Application ● Application Family

Audio/Video ×

| Name | Entries | Reference Count | Updated By | Last Updated | Action |
|---|---|---|---|---|---|
| Microsoft_Apps | bing, hockeyapp, live_hotmail, lync, l... | 0 | system | 15 Jan 2020 4:37:54 PM PST | |
| Google_Apps | blogger, chrome_update, gcs, gmail, ... | 0 | system | 15 Jan 2020 4:37:55 PM PST | |

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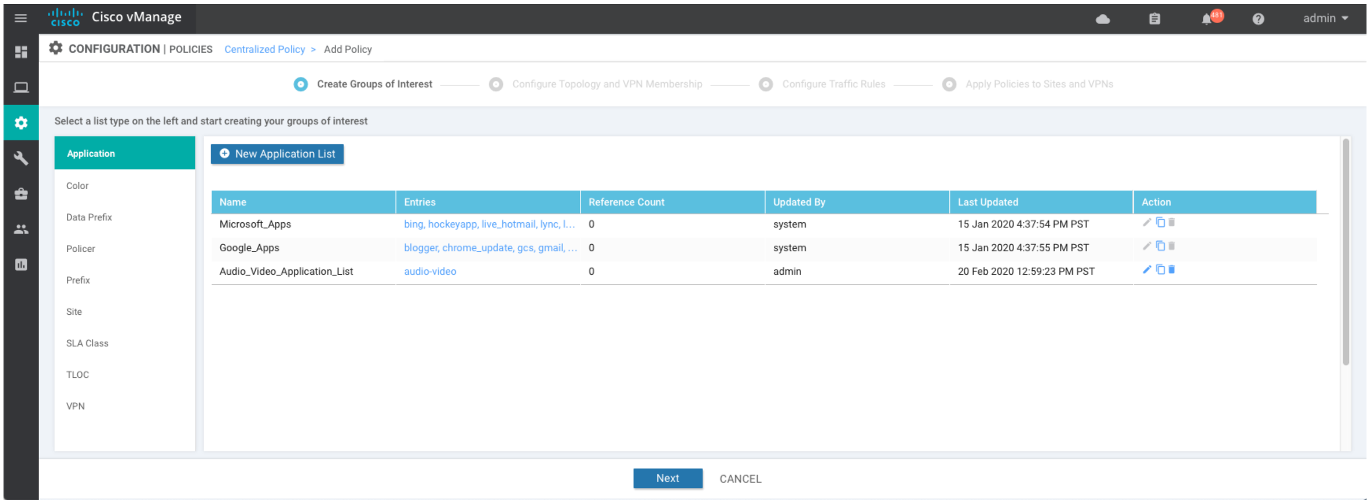
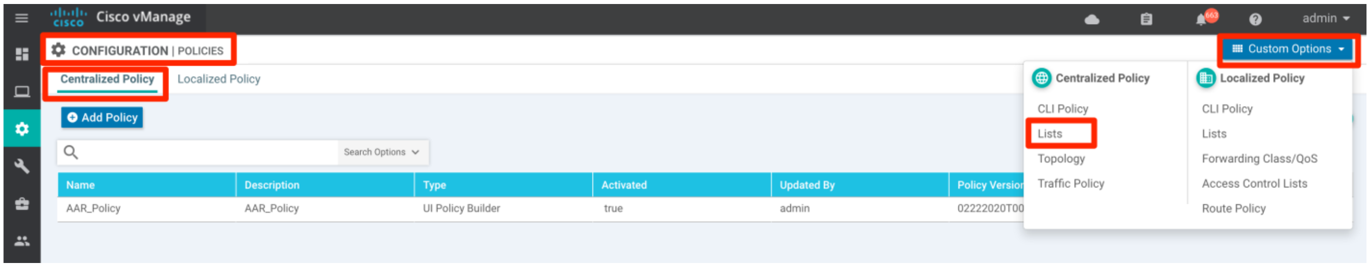

Cisco vManage
admin
CONFIGURATION | POLICIES Centralized Policy > Add Policy
Create Groups of Interest
Configure Topology and VPN Membership
Configure Traffic Rules
Apply Policies to Sites and VPNs
Select a list type on the left and start creating your groups of interest
Application
Color
Data Prefix
Policer
Prefix
Site
SLA Class
TLOC
VPN
New Application List
Next
CANCEL

| Name | Entries | Reference Count | Updated By | Last Updated | Action |
|---|---|---|---|---|---|
| Microsoft_Apps | bing, hockeyapp, live_hotmail, lync, l... | 0 | system | 15 Jan 2020 4:37:54 PM PST | |
| Google_Apps | blogger, chrome_update, gcs, gmail, ... | 0 | system | 15 Jan 2020 4:37:55 PM PST | |
| Audio_Video_Application_List | audio-video | 0 | admin | 20 Feb 2020 12:59:23 PM PST | |

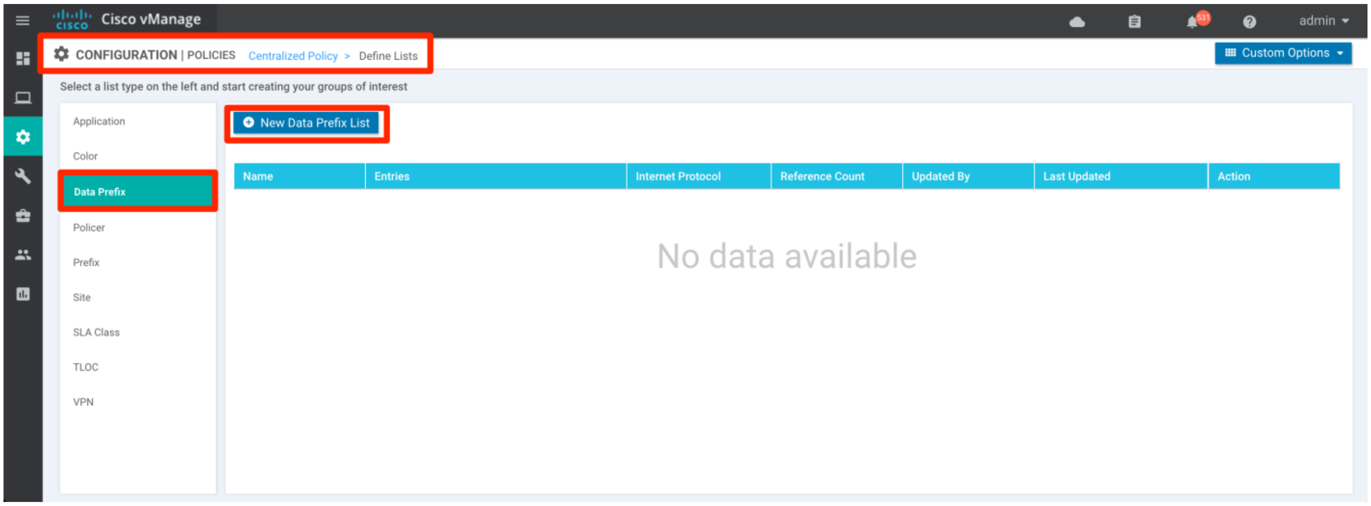
**Step 3.** Alternatively, to previous step, network administrator can match on Data Prefix to identify the traffic.

To define the data prefix. In vManage, navigate to **Configuration > Policies > Centralized Policy**. Click **Custom Options** from the top right menu options and select **Lists** from the **Centralized Policy** section.



| Name | Description | Type | Activated | Updated By | Policy Versio |
|---|---|---|---|---|---|
| AAR_Policy | AAR_Policy | UI Policy Builder | true | admin | 02222020T00 |

select the **Data Prefix** option from the List type on the left side panel, and click **New Data Prefix List**


Cisco vManage
admin
CONFIGURATION | POLICIES Centralized Policy > Define Lists
Custom Options
Select a list type on the left and start creating your groups of interest
Application
Color
Data Prefix
Policer
Prefix
Site
SLA Class
TLOC
VPN
New Data Prefix List

| Name | Entries | Internet Protocol | Reference Count | Updated By | Last Updated | Action |
|---|---|---|---|---|---|---|

No data available

Input the **Data Prefix List Name** and select either **IPv4** / **IPv6** from the **Internet Protocol** option and add the prefix that needs to be matched and select **Add**

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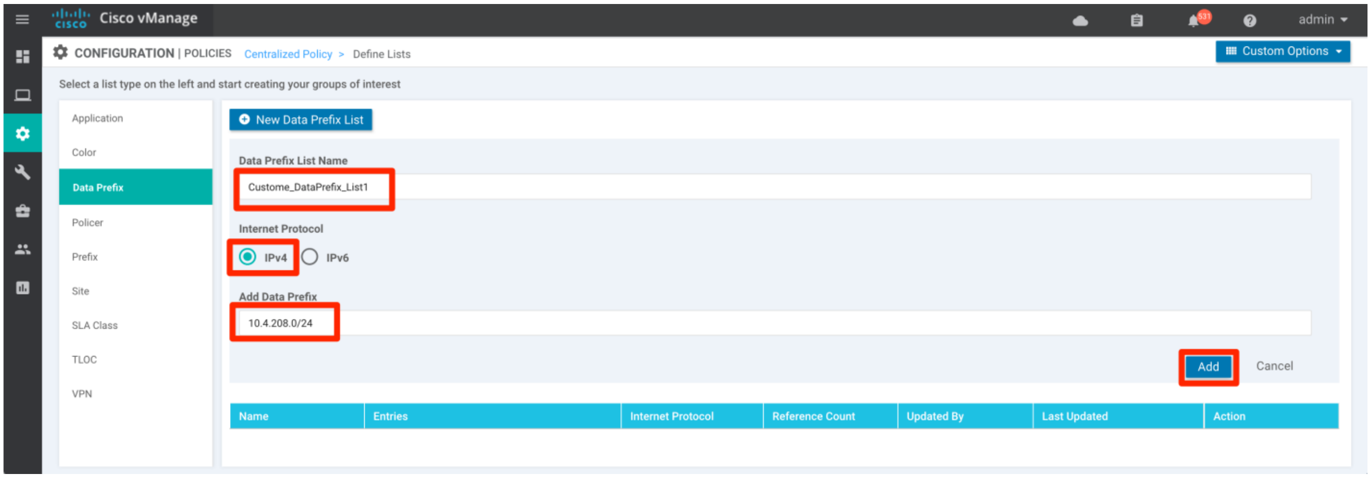


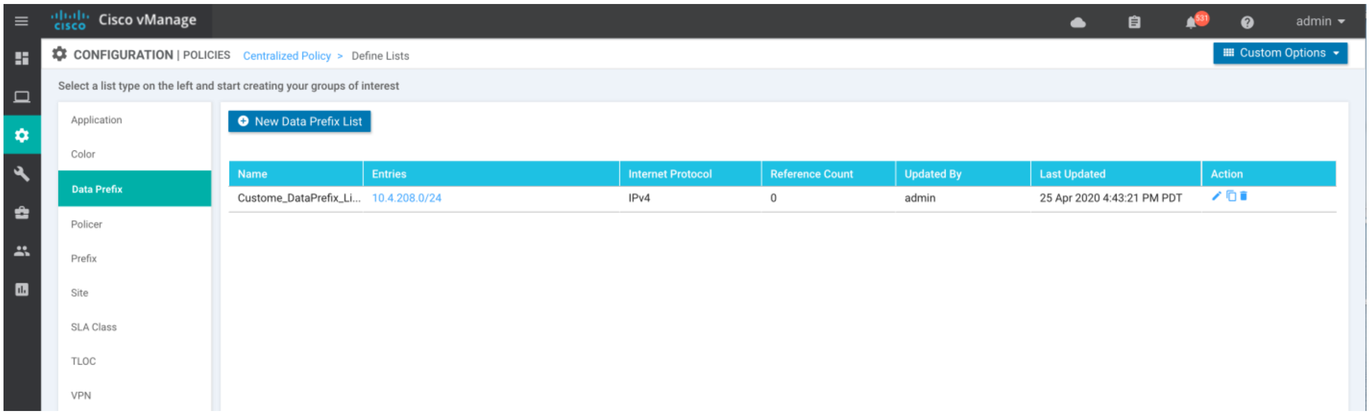
Select a list type on the left and start creating your groups of interest

Data Prefix List Name: Custome_DataPrefix_List1

Internet Protocol: ● IPv4 ○ IPv6

Add Data Prefix: 10.4.208.0/24

| Name | Entries | Internet Protocol | Reference Count | Updated By | Last Updated | Action |
|---|---|---|---|---|---|---|



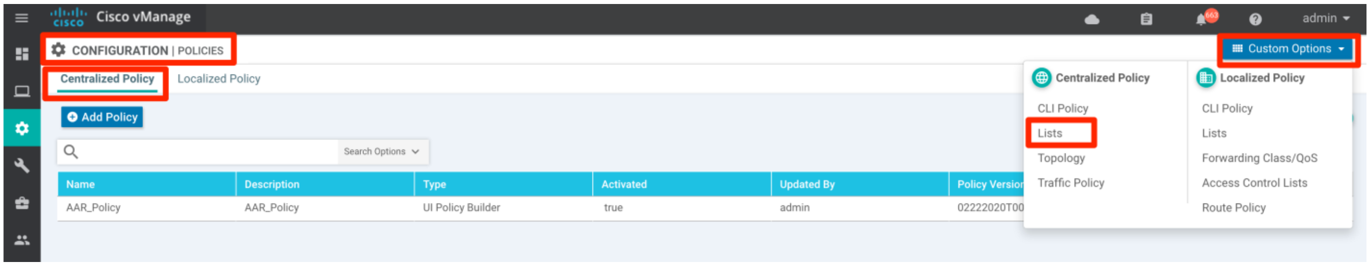
Select a list type on the left and start creating your groups of interest

| Name | Entries | Internet Protocol | Reference Count | Updated By | Last Updated | Action |
|---|---|---|---|---|---|---|
| Custome_DataPrefix_Li... | 10.4.208.0/24 | IPv4 | 0 | admin | 25 Apr 2020 4:43:21 PM PDT | |

## Procedure 2. Define Application Service Level requirements.

This procedure walks through steps needed to define custom SLA class.

**Step 1.** In vManage, navigate to **Configuration > Policies > Centralized Policy**. Click **Custom Options** from the top right menu options and select **Lists** from the **Centralized Policy** section.



| Name | Description | Type | Activated | Updated By | Policy Versior |
|---|---|---|---|---|---|
| AAR_Policy | AAR_Policy | UI Policy Builder | true | admin | 02222020T00 |

**Step 2.** select the **SLA Class** option from the List type on the left side panel, and click **New SLA Class List**

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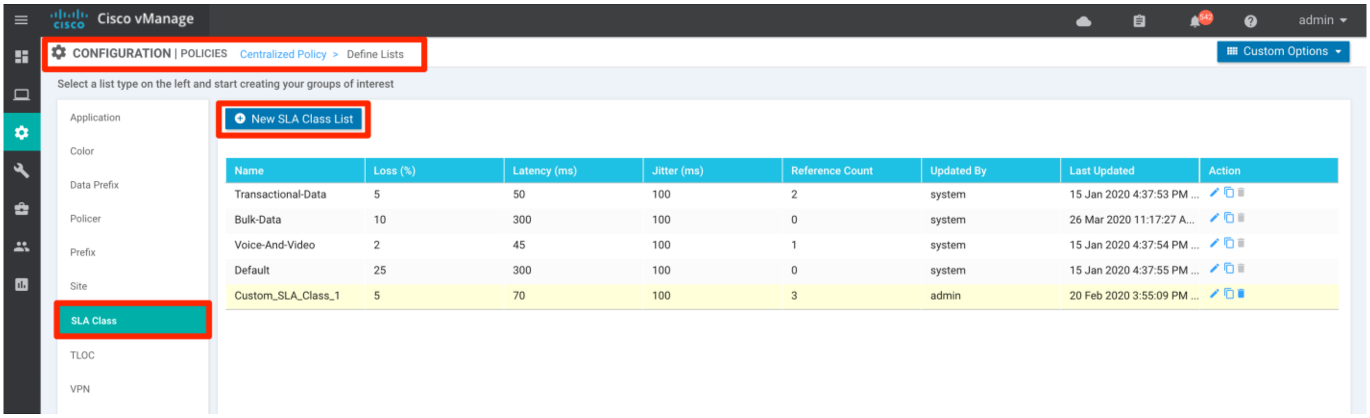
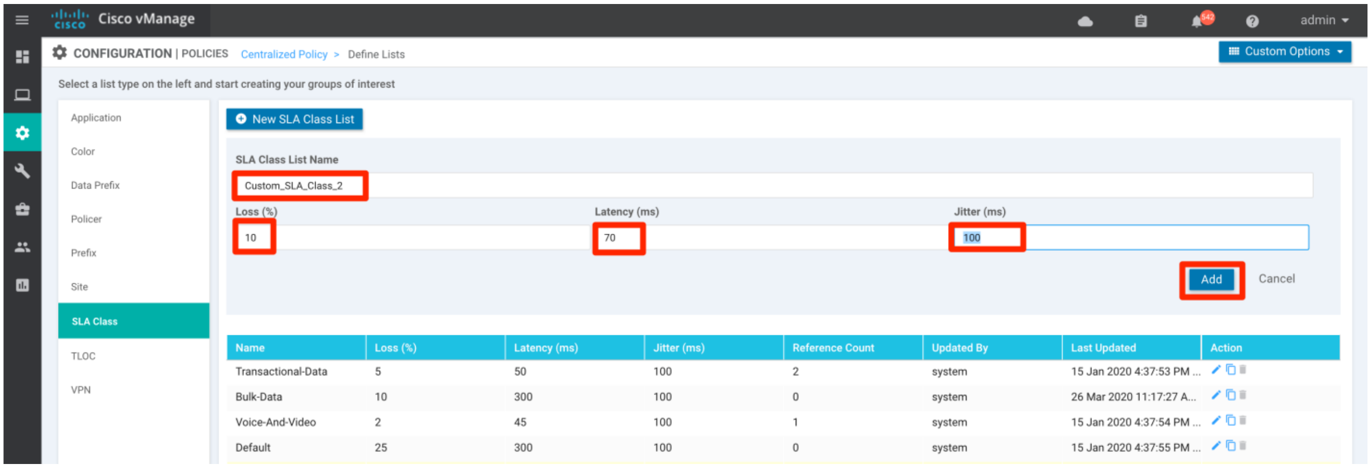


CONFIGURATION | POLICIES Centralized Policy > Define Lists

Select a list type on the left and start creating your groups of interest

| Name | Loss (%) | Latency (ms) | Jitter (ms) | Reference Count | Updated By | Last Updated | Action |
|---|---|---|---|---|---|---|---|
| Transactional-Data | 5 | 50 | 100 | 2 | system | 15 Jan 2020 4:37:53 PM ... | |
| Bulk-Data | 10 | 300 | 100 | 0 | system | 26 Mar 2020 11:17:27 A... | |
| Voice-And-Video | 2 | 45 | 100 | 1 | system | 15 Jan 2020 4:37:54 PM ... | |
| Default | 25 | 300 | 100 | 0 | system | 15 Jan 2020 4:37:55 PM ... | |
| Custom_SLA_Class_1 | 5 | 70 | 100 | 3 | admin | 20 Feb 2020 3:55:09 PM ... | |

Input the **SLA Class List Name** and **Loss, Latency, Jitter** value requirement for the application and click **Add.**



CONFIGURATION | POLICIES Centralized Policy > Define Lists

Select a list type on the left and start creating your groups of interest

SLA Class List Name: Custom_SLA_Class_2

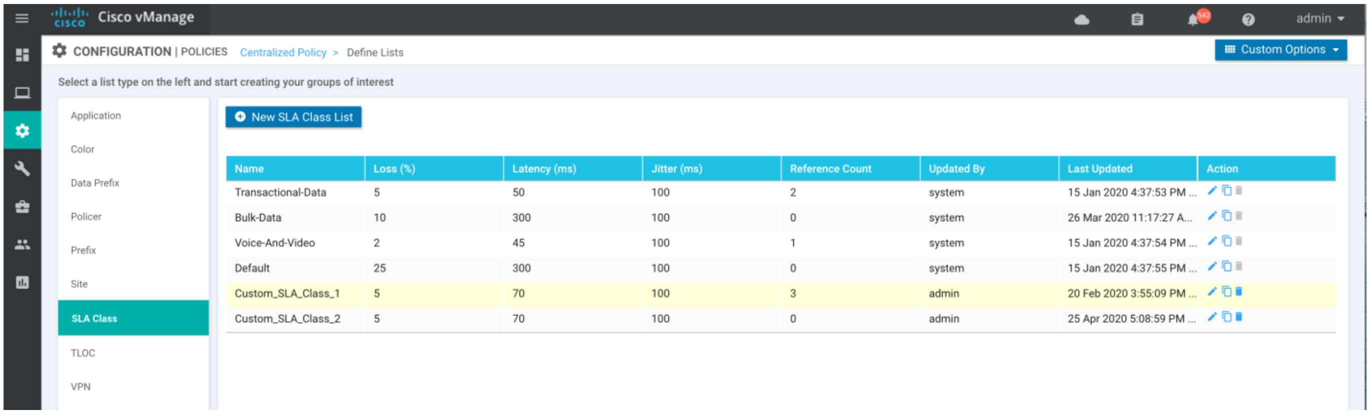
Loss (%): 10

Latency (ms): 70

Jitter (ms): 100

| Name | Loss (%) | Latency (ms) | Jitter (ms) | Reference Count | Updated By | Last Updated | Action |
|---|---|---|---|---|---|---|---|
| Transactional-Data | 5 | 50 | 100 | 2 | system | 15 Jan 2020 4:37:53 PM ... | |
| Bulk-Data | 10 | 300 | 100 | 0 | system | 26 Mar 2020 11:17:27 A... | |
| Voice-And-Video | 2 | 45 | 100 | 1 | system | 15 Jan 2020 4:37:54 PM ... | |
| Default | 25 | 300 | 100 | 0 | system | 15 Jan 2020 4:37:55 PM ... | |

**Step 3.** Create additional SLA Class as shown in the previous step, if needed.



CONFIGURATION | POLICIES Centralized Policy > Define Lists

Select a list type on the left and start creating your groups of interest

| Name | Loss (%) | Latency (ms) | Jitter (ms) | Reference Count | Updated By | Last Updated | Action |
|---|---|---|---|---|---|---|---|
| Transactional-Data | 5 | 50 | 100 | 2 | system | 15 Jan 2020 4:37:53 PM ... | |
| Bulk-Data | 10 | 300 | 100 | 0 | system | 26 Mar 2020 11:17:27 A... | |
| Voice-And-Video | 2 | 45 | 100 | 1 | system | 15 Jan 2020 4:37:54 PM ... | |
| Default | 25 | 300 | 100 | 0 | system | 15 Jan 2020 4:37:55 PM ... | |
| Custom_SLA_Class_1 | 5 | 70 | 100 | 3 | admin | 20 Feb 2020 3:55:09 PM ... | |
| Custom_SLA_Class_2 | 5 | 70 | 100 | 0 | admin | 25 Apr 2020 5:08:59 PM ... | |

### Tech tip

Any number of SLA Class can be created, but only 4 SLA class can be associated to the Application Aware Policy. Please refer to the corresponding version Release Notes for the latest supports number of SLAs.

## Procedure 3. Create Site List

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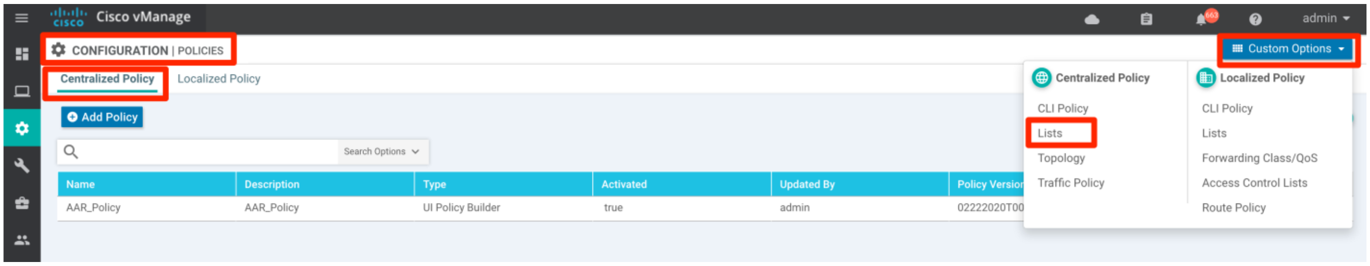
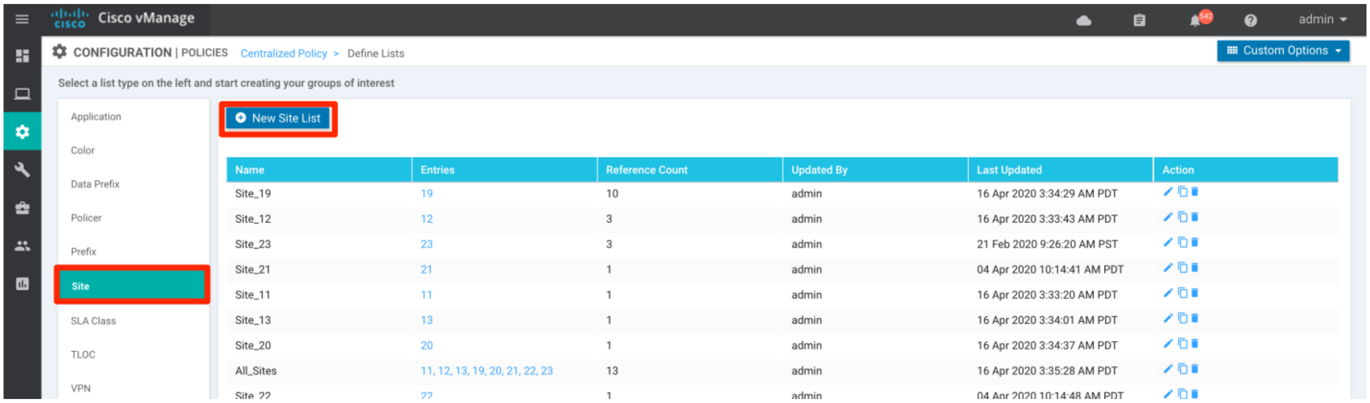
The Site list defines the sites in the SD-WAN environment. This site list can be used to enforce the Application-Aware Routing to influence WAN Edge devices in the specified site(s).

**Step 1.** In vManage, navigate to **Configuration > Policies > Centralized Policy**. Click **Custom Options** from the top right menu options and select **Lists** from the **Centralized Policy** section.



| Name | Description | Type | Activated | Updated By | Policy Version |
|---|---|---|---|---|---|
| AAR_Policy | AAR_Policy | UI Policy Builder | true | admin | 02222020T00 |

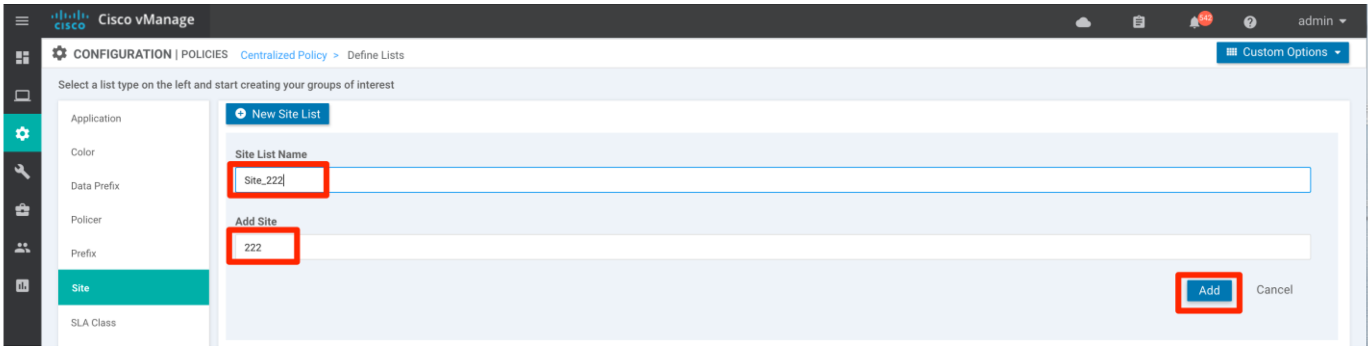
**Step 2.** Select **Site** from the left panel and create Site list by clicking **New Site List**



Select a list type on the left and start creating your groups of interest

| Name | Entries | Reference Count | Updated By | Last Updated | Action |
|---|---|---|---|---|---|
| Site_19 | 19 | 10 | admin | 16 Apr 2020 3:34:29 AM PDT | |
| Site_12 | 12 | 3 | admin | 16 Apr 2020 3:33:43 AM PDT | |
| Site_23 | 23 | 3 | admin | 21 Feb 2020 9:26:20 AM PST | |
| Site_21 | 21 | 1 | admin | 04 Apr 2020 10:14:41 AM PDT | |
| Site_11 | 11 | 1 | admin | 16 Apr 2020 3:33:20 AM PDT | |
| Site_13 | 13 | 1 | admin | 16 Apr 2020 3:34:01 AM PDT | |
| Site_20 | 20 | 1 | admin | 16 Apr 2020 3:34:37 AM PDT | |
| All_Sites | 11, 12, 13, 19, 20, 21, 22, 23 | 13 | admin | 16 Apr 2020 3:35:28 AM PDT | |
| Site_22 | 22 | 1 | admin | 04 Apr 2020 10:14:48 AM PDT | |

Input the Site **List Name** and **Add Site.** click **Add**

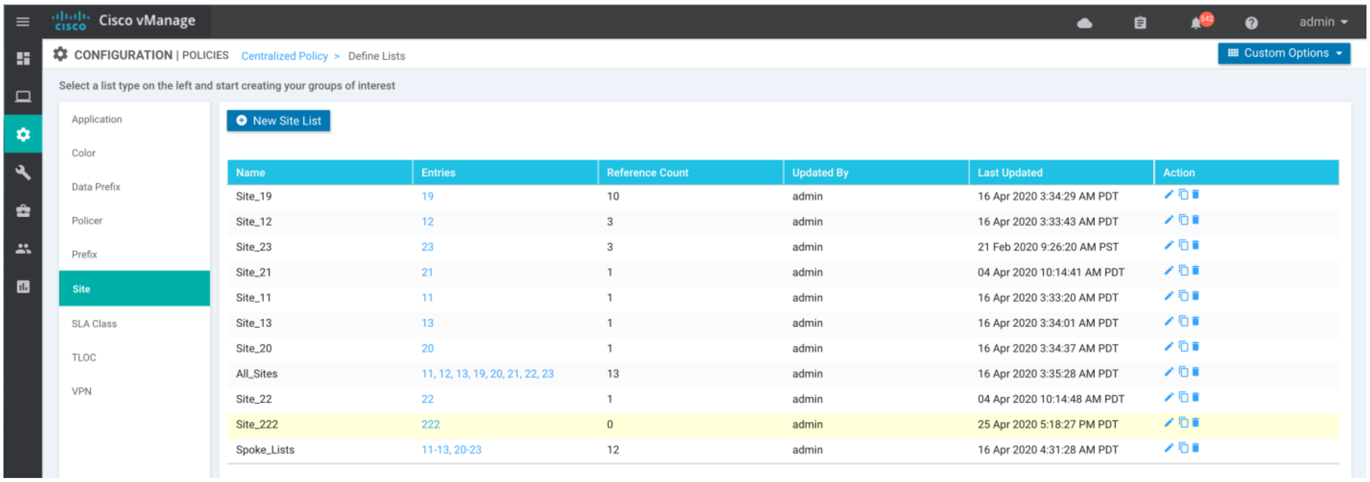


Select a list type on the left and start creating your groups of interest

Site List Name: Site_222

Add Site: 222

**Step 3.** Add additional sites by clicking the **New Site List**.



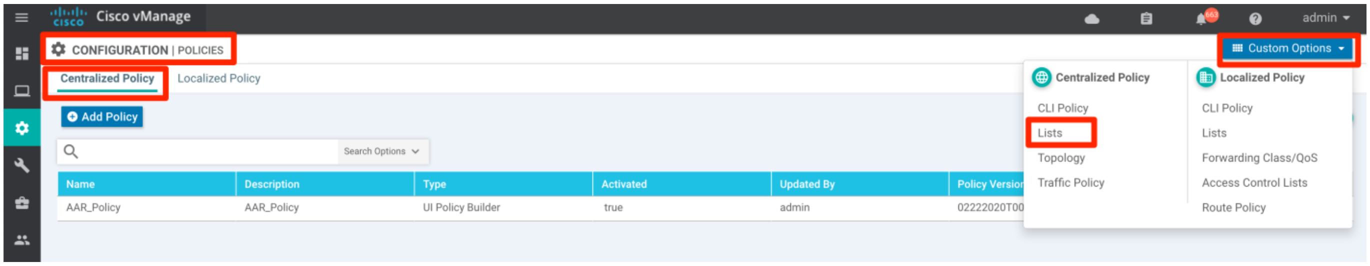
Select a list type on the left and start creating your groups of interest

| Name | Entries | Reference Count | Updated By | Last Updated | Action |
|---|---|---|---|---|---|
| Site_19 | 19 | 10 | admin | 16 Apr 2020 3:34:29 AM PDT | |
| Site_12 | 12 | 3 | admin | 16 Apr 2020 3:33:43 AM PDT | |
| Site_23 | 23 | 3 | admin | 21 Feb 2020 9:26:20 AM PST | |
| Site_21 | 21 | 1 | admin | 04 Apr 2020 10:14:41 AM PDT | |
| Site_11 | 11 | 1 | admin | 16 Apr 2020 3:33:20 AM PDT | |
| Site_13 | 13 | 1 | admin | 16 Apr 2020 3:34:01 AM PDT | |
| Site_20 | 20 | 1 | admin | 16 Apr 2020 3:34:37 AM PDT | |
| All_Sites | 11, 12, 13, 19, 20, 21, 22, 23 | 13 | admin | 16 Apr 2020 3:35:28 AM PDT | |
| Site_22 | 22 | 1 | admin | 04 Apr 2020 10:14:48 AM PDT | |
| Site_222 | 222 | 0 | admin | 25 Apr 2020 5:18:27 PM PDT | |
| Spoke_Lists | 11-13, 20-23 | 12 | admin | 16 Apr 2020 4:31:28 AM PDT | |

## Procedure 4. Create VPN List

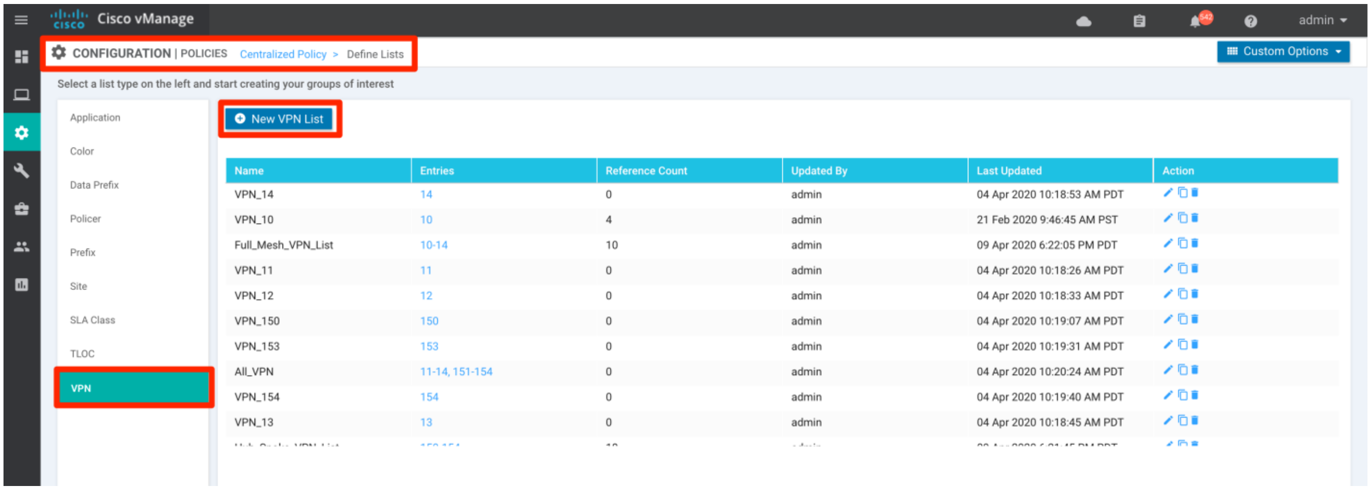
The VPN list defines the VPN defined in the SD-WAN environment. This VPN list can be used to enforce the Application-Aware Routing to influence traffic in the specified VPN.

**Step 1.** In vManage, navigate to **Configuration > Policies > Centralized Policy**. Click **Custom Options** from the top right menu options and select **Lists** from the **Centralized Policy** section.



| Name | Description | Type | Activated | Updated By | Policy Versio |
|---|---|---|---|---|---|
| AAR_Policy | AAR_Policy | UI Policy Builder | true | admin | 02222020T00 |

**Step 2.** Select **VPN** from the left panel and create VPN list by clicking **New VPN List**



Select a list type on the left and start creating your groups of interest

| Name | Entries | Reference Count | Updated By | Last Updated | Action |
|---|---|---|---|---|---|
| VPN_14 | 14 | 0 | admin | 04 Apr 2020 10:18:53 AM PDT | |
| VPN_10 | 10 | 4 | admin | 21 Feb 2020 9:46:45 AM PST | |
| Full_Mesh_VPN_List | 10-14 | 10 | admin | 09 Apr 2020 6:22:05 PM PDT | |
| VPN_11 | 11 | 0 | admin | 04 Apr 2020 10:18:26 AM PDT | |
| VPN_12 | 12 | 0 | admin | 04 Apr 2020 10:18:33 AM PDT | |
| VPN_150 | 150 | 0 | admin | 04 Apr 2020 10:19:07 AM PDT | |
| VPN_153 | 153 | 0 | admin | 04 Apr 2020 10:19:31 AM PDT | |
| All_VPN | 11-14, 151-154 | 0 | admin | 04 Apr 2020 10:20:24 AM PDT | |
| VPN_154 | 154 | 0 | admin | 04 Apr 2020 10:19:40 AM PDT | |
| VPN_13 | 13 | 0 | admin | 04 Apr 2020 10:18:45 AM PDT | |

Input the **VPN List Name** and **Add VPN.** click **Add.**

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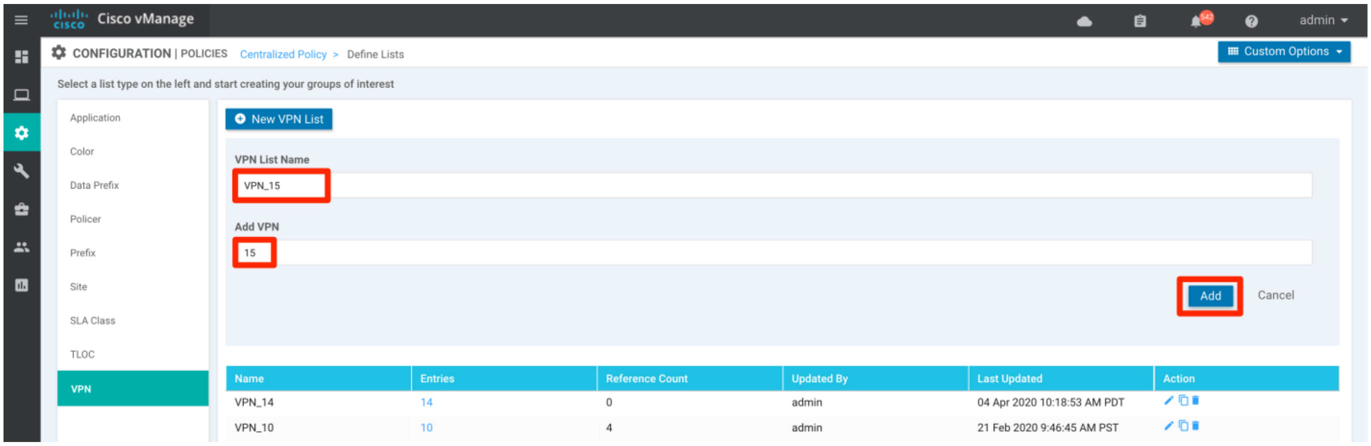


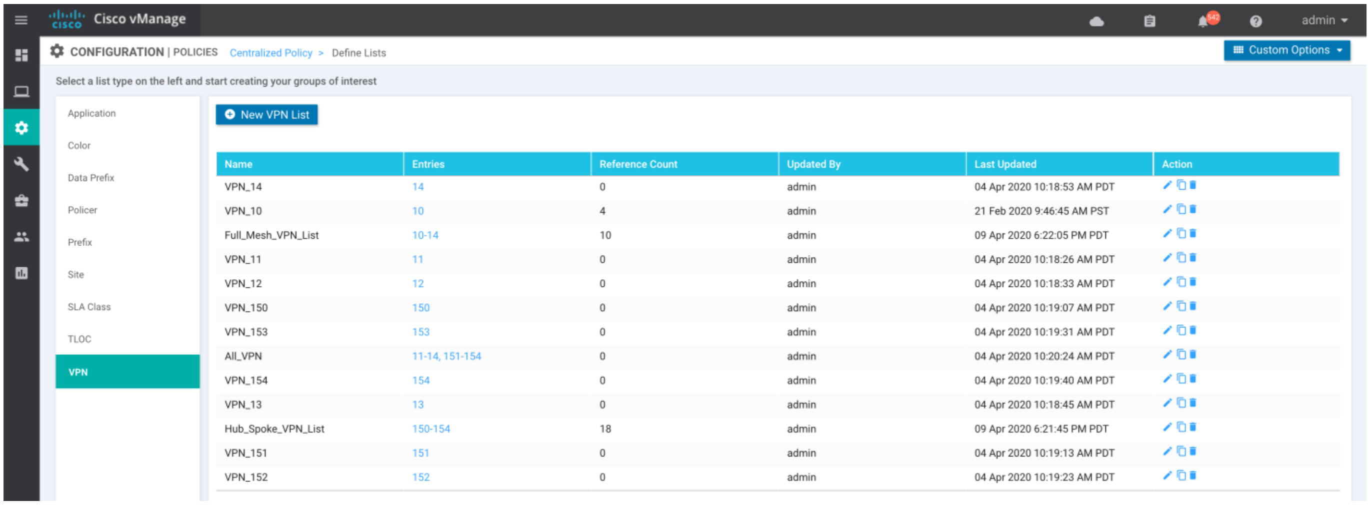
Select a list type on the left and start creating your groups of interest

VPN List Name: VPN_15

Add VPN: 15

| Name | Entries | Reference Count | Updated By | Last Updated | Action |
|---|---|---|---|---|---|
| VPN_14 | 14 | 0 | admin | 04 Apr 2020 10:18:53 AM PDT | |
| VPN_10 | 10 | 4 | admin | 21 Feb 2020 9:46:45 AM PST | |

**Step 3.** Add any additional VPN by clicking the **New VPN List**.



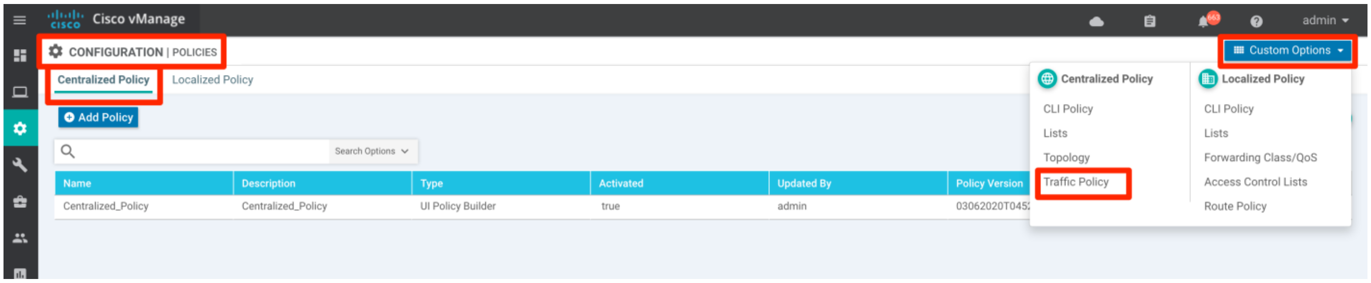
Select a list type on the left and start creating your groups of interest

| Name | Entries | Reference Count | Updated By | Last Updated | Action |
|---|---|---|---|---|---|
| VPN_14 | 14 | 0 | admin | 04 Apr 2020 10:18:53 AM PDT | |
| VPN_10 | 10 | 4 | admin | 21 Feb 2020 9:46:45 AM PST | |
| Full_Mesh_VPN_List | 10-14 | 10 | admin | 09 Apr 2020 6:22:05 PM PDT | |
| VPN_11 | 11 | 0 | admin | 04 Apr 2020 10:18:26 AM PDT | |
| VPN_12 | 12 | 0 | admin | 04 Apr 2020 10:18:33 AM PDT | |
| VPN_150 | 150 | 0 | admin | 04 Apr 2020 10:19:07 AM PDT | |
| VPN_153 | 153 | 0 | admin | 04 Apr 2020 10:19:31 AM PDT | |
| All_VPN | 11-14, 151-154 | 0 | admin | 04 Apr 2020 10:20:24 AM PDT | |
| VPN_154 | 154 | 0 | admin | 04 Apr 2020 10:19:40 AM PDT | |
| VPN_13 | 13 | 0 | admin | 04 Apr 2020 10:18:45 AM PDT | |
| Hub_Spoke_VPN_List | 150-154 | 18 | admin | 09 Apr 2020 6:21:45 PM PDT | |
| VPN_151 | 151 | 0 | admin | 04 Apr 2020 10:19:13 AM PDT | |
| VPN_152 | 152 | 0 | admin | 04 Apr 2020 10:19:23 AM PDT | |

## Procedure 5. Configuring Application-Aware Routing policy

This procedure walks through the steps needed to create Application-Aware Routing policy. The policy binds the previously created traffic class to the specified WAN Edge device transport tunnel that satisfies the selected SLA class requirements.

**Step 1.** In vManage, navigate to **Configuration > Policies > Centralized Policy**. Click **Custom Options** and select **Traffic Policy** from the **Centralized Policy** section.



| Name | Description | Type | Activated | Updated By | Policy Version |
|---|---|---|---|---|---|
| Centralized_Policy | Centralized_Policy | UI Policy Builder | true | admin | 03062020T045 |

**Step 2.** Select the **Application Aware Routing** tab and select **Add Policy > Create New**

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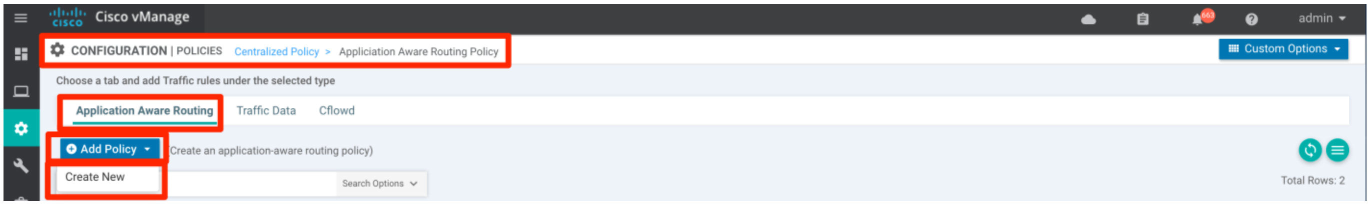
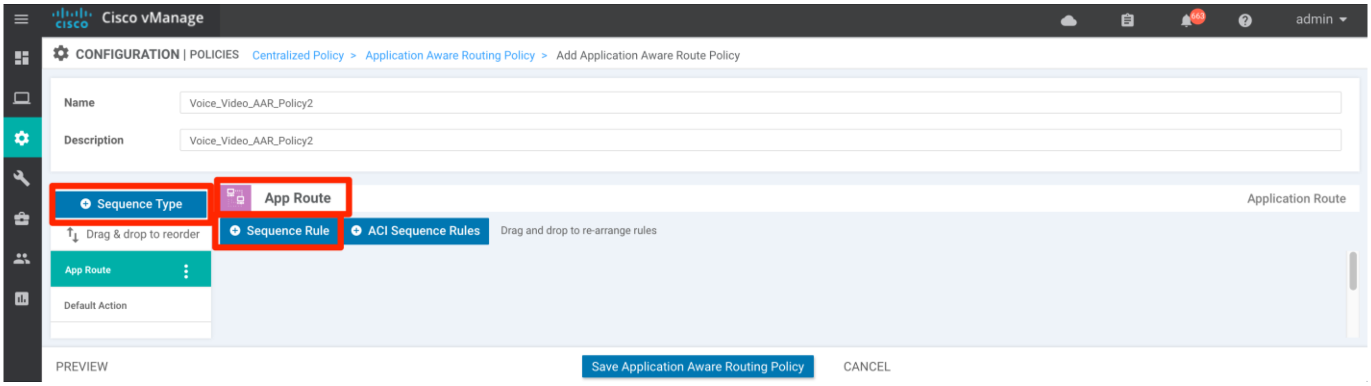

Cisco vManage
admin
CONFIGURATION | POLICIES Centralized Policy > Application Aware Routing Policy
Custom Options
Choose a tab and add Traffic rules under the selected type
Application Aware Routing
Traffic Data
Cflowd
Add Policy
(Create an application-aware routing policy)
Create New
Search Options
Total Rows: 2

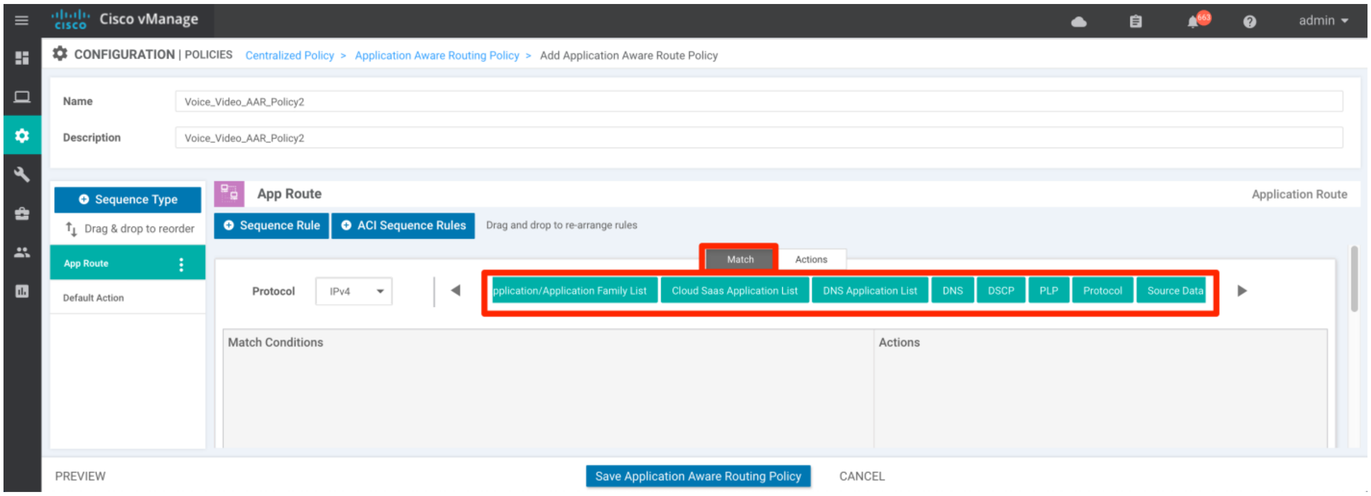
**Step 3.** Input the **Name** and **Description** for the policy and click **Sequence Type** and under **App Route** tab select **Sequence Rule** option.


Cisco vManage
admin
CONFIGURATION | POLICIES Centralized Policy > Application Aware Routing Policy > Add Application Aware Route Policy
Sequence Type
Drag & drop to reorder
App Route
Default Action
Sequence Rule
ACI Sequence Rules
Drag and drop to re-arrange rules
Application Route
PREVIEW
Save Application Aware Routing Policy
CANCEL

Name: Voice_Video_AAR_Policy2

Description: Voice_Video_AAR_Policy2

**Step 4.** Select the match statement options to match the application/traffic set by clicking on the options available.


Cisco vManage
admin
CONFIGURATION | POLICIES Centralized Policy > Application Aware Routing Policy > Add Application Aware Route Policy
Sequence Type
Drag & drop to reorder
App Route
Default Action
Sequence Rule
ACI Sequence Rules
Drag and drop to re-arrange rules
Application Route
Match
Actions
pplication/Application Family List
Cloud Saas Application List
DNS Application List
DNS
DSCP
PLP
Protocol
Source Data
Match Conditions
Actions
PREVIEW
Save Application Aware Routing Policy
CANCEL

Name: Voice_Video_AAR_Policy2

Description: Voice_Video_AAR_Policy2

Protocol: IPv4

Data traffic originating from the service side can be classified and matched. Below table points on to different possible options to match on:

| Possible Match options | | Description |
|---|---|---|
| Application / Application Family List | Pre-defined / custom-defined list | Leverage the pre-defined Application/Applications-list or create custom application-list to match (defined in the guide steps 1 -5). |
| Cloud SaaS Application List | Pre-defined list | Leverage the pre-defined Cloud-Saas Application list |
| DNS Application List | Pre-defined / custom-defined list | DNS application list is used to split DNS lookup per the selected application-lists. |

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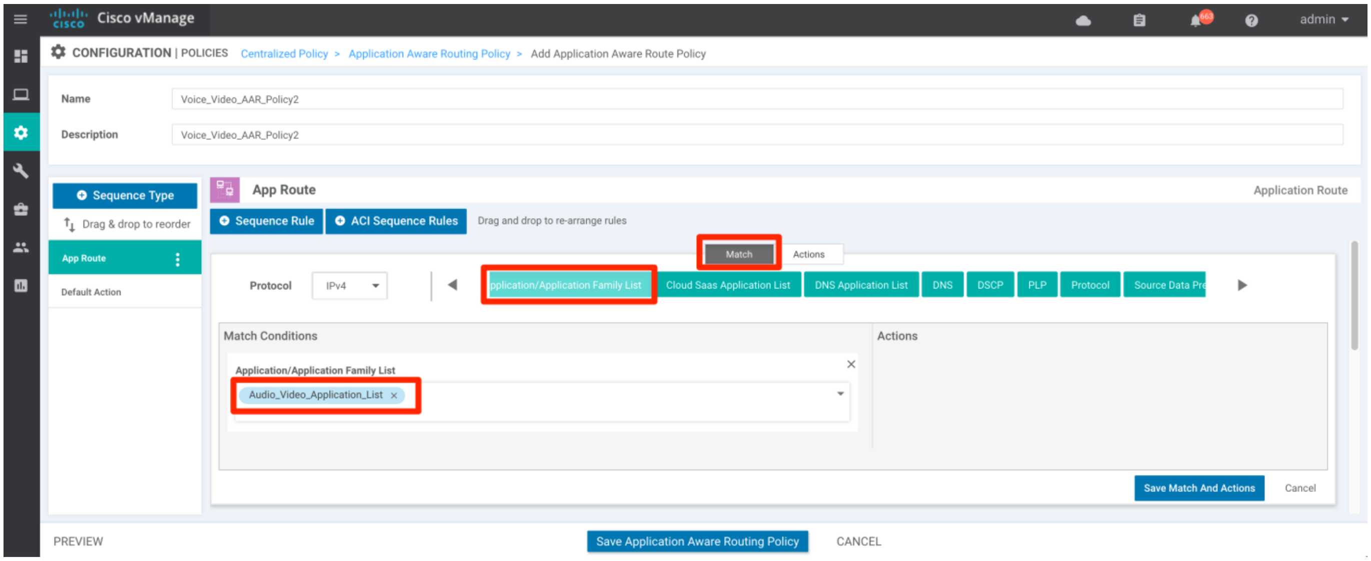
| | | |
|---|---|---|
| DNS | DNS request / response option | DNS packets. |
| DSCP | 0-63 | Pre-configured traffic with DSCP values through QoS policy on the service-side traffic can be used to match the traffic. |
| PLP | High / Low options | Pre-configured traffic part of the Packet Loss Priority (PLP) queue, configured part of Policer QoS section policy, can be matched. By default, packets have a PLP value of low. To set the PLP value to high, apply a policer that includes the exceed remark option. |
| Protocol | Protocol number | Traffic with defined protocol number can be matched |
| Source Data Prefix | custom-defined data prefix | Pre-defined custom data-prefix of the traffic can be matched on |
| Source Port | Port number | Data traffic with defined port number can be matched. |
| Destination Data Prefix | custom-defined data prefix | Pre-defined custom data-prefix of the traffic can be matched on |
| Destination Port | Port number | Data traffic with defined port number can be matched. |

In this guide, we would pick the previously created custom **Application Family list**.



CONFIGURATION | POLICIES Centralized Policy > Application Aware Routing Policy > Add Application Aware Route Policy

Name: Voice_Video_AAR_Policy2

Description: Voice_Video_AAR_Policy2

Protocol: IPv4

Match Conditions

Application/Application Family List: Audio_Video_Application_List

Multiple match statements can be configured within the same sequence to select more specific traffic, as shown below:

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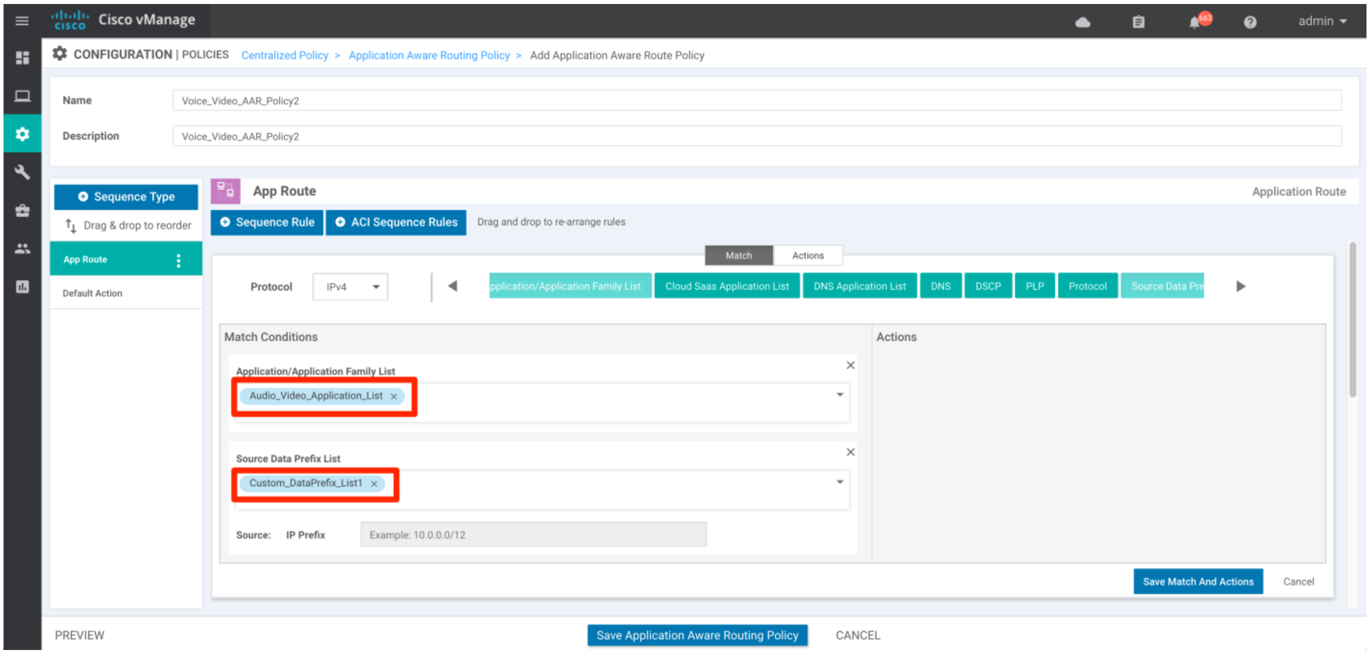


CONFIGURATION | POLICIES Centralized Policy > Application Aware Routing Policy > Add Application Aware Route Policy

Name: Voice_Video_AAR_Policy2

Description: Voice_Video_AAR_Policy2

Protocol: IPv4

Match Conditions

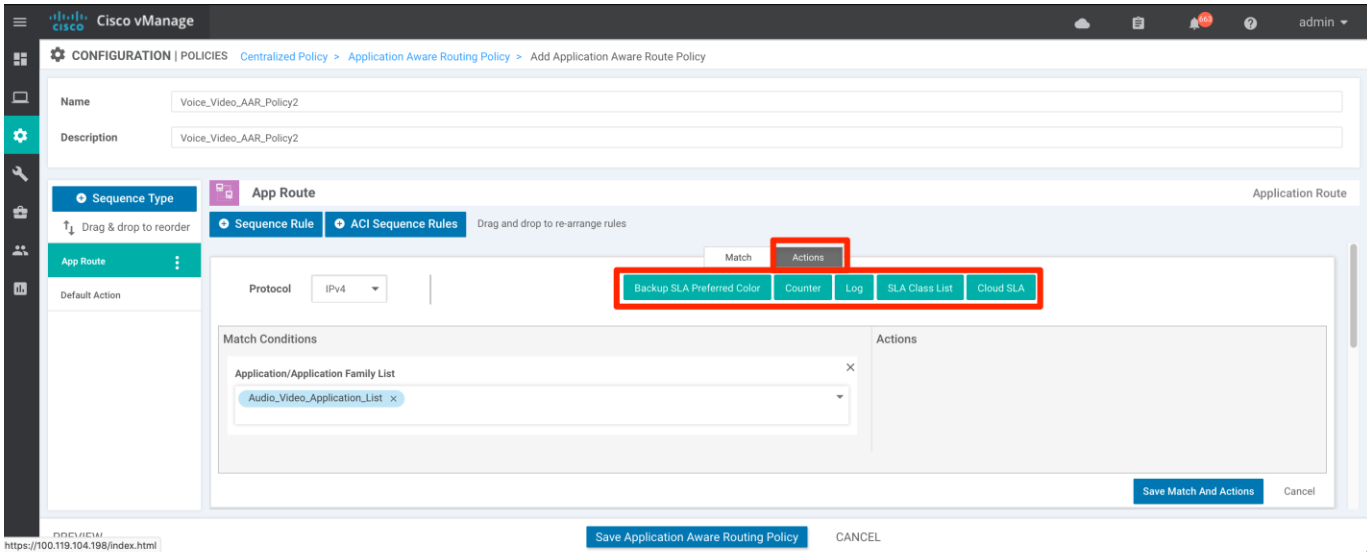
Application/Application Family List: Audio_Video_Application_List

Source Data Prefix List: Custom_DataPrefix_List1

Source: IP Prefix Example: 10.0.0.0/12

**Step 5.** Select the Actions to be performed for the above matched traffic.

| Possible Action options | |
|---|---|
| Backup SLA Preferred Color | choose predefined color(s) that traffic is forwarded if the SLA is not met |
| Counter | Specify name to store the count for matching packets |
| Log | If enabled, syslog message is generated first time a packet flow is logged and every 5 minutes thereafter, as long as the flow is active. 'show log' can be leveraged to view the log. |
| SLA Class List | Select the custom/pre-defined SLA Class List and choose preferred color(s) that traffic gets forwarded as long as the specified SLA is satisfied. |
| Cloud SLA | Enabled (if selected) |



CONFIGURATION | POLICIES Centralized Policy > Application Aware Routing Policy > Add Application Aware Route Policy

Name: Voice_Video_AAR_Policy2

Description: Voice_Video_AAR_Policy2

Protocol: IPv4

Match Conditions

Application/Application Family List: Audio_Video_Application_List

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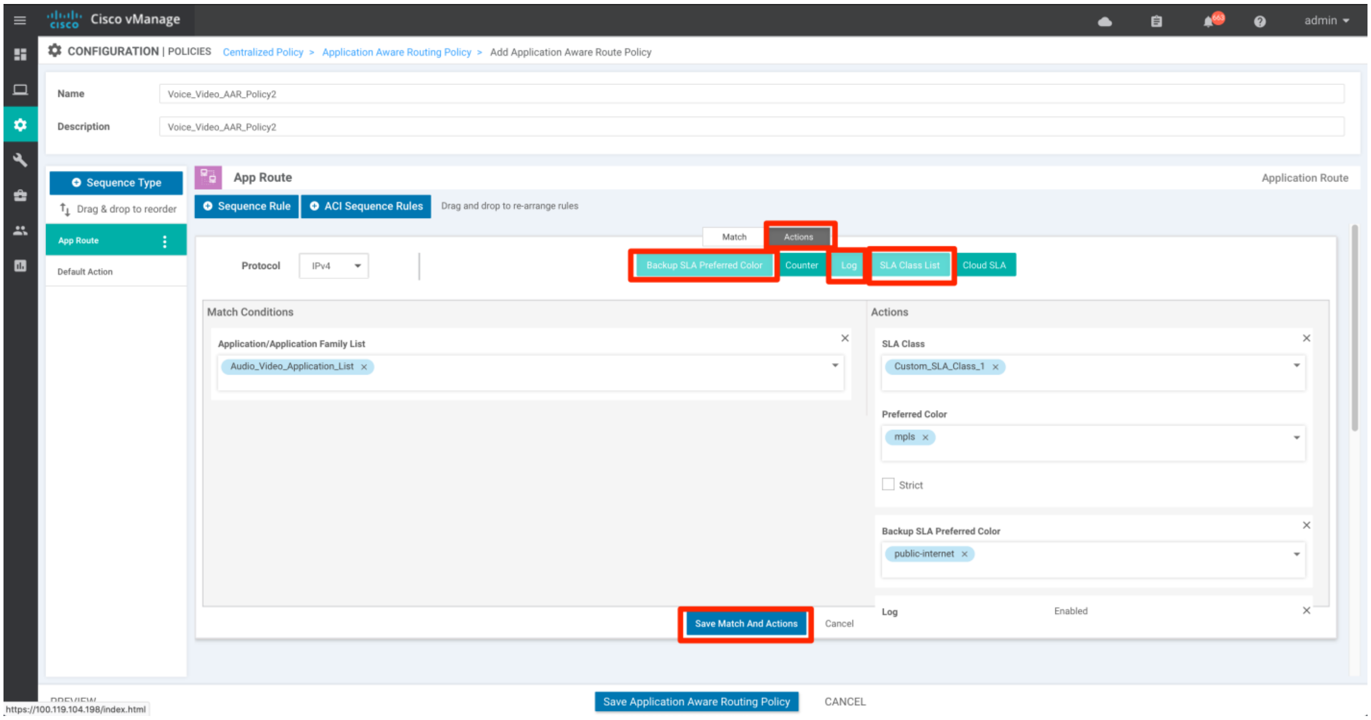
Application Aware Routing actions statement allows us to define **Preferred Color** list as long as the **SLA class** is satisfied and action to be performed in case the SLA is not met, either to use the **Backup SLA Preferred Color** or drop the traffic by enabling the **Strict** option.

Select **SLA class List,** Backup **SLA Preferred Color** option from the Actions. Select the previously created **SLA Class**, **Preferred Color** and **Backup SLA Preferred Color** from the drop-down menu.

Click **Save Match and Actions** option



Name: Voice_Video_AAR_Policy2

Description: Voice_Video_AAR_Policy2

Protocol: IPv4

Application/Application Family List: Audio_Video_Application_List

SLA Class: Custom_SLA_Class_1

Preferred Color: mpls

□ Strict

Backup SLA Preferred Color: public-internet

Log: Enabled

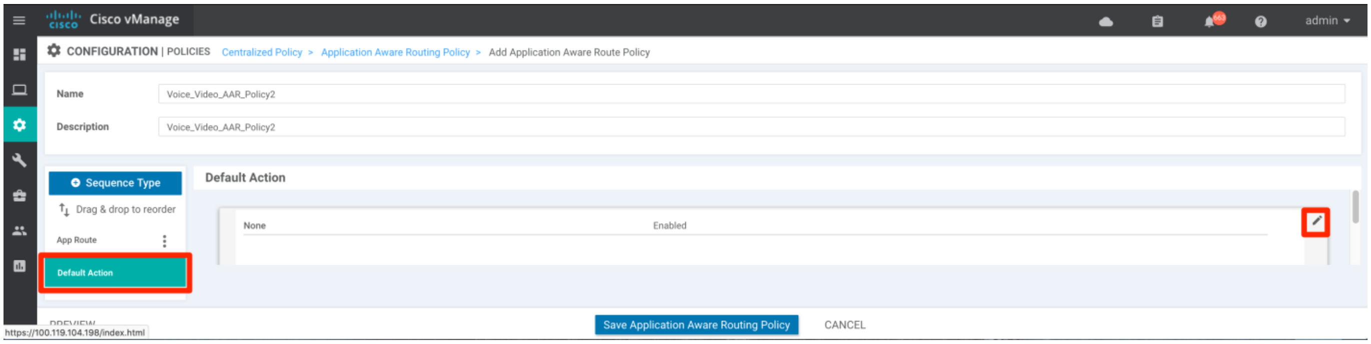
Multiple App-Route rule can be defined part of the same policy, each rule recognized by sequence number, each rule containing a match-action pair defining the preferred treatment for the classified traffic. When the data-traffic matches a rule (executed from low to high sequence number), the appropriate action is applied for the classified traffic. If no policy matches the traffic, Default Action rule is applied for the traffic.

WAN Edge behavior for Default Action is to perform load-balance the traffic across all available WAN transports.

**Step 6.** (optional) Changing the Default Action behavior.

Modify the default behavior to redirect data traffic to the WAN transports that meets the selected SLA Class List in the Actions tab as shown below.

Click the **Default Action** from the **Sequence Type** section and click **Edit** option.

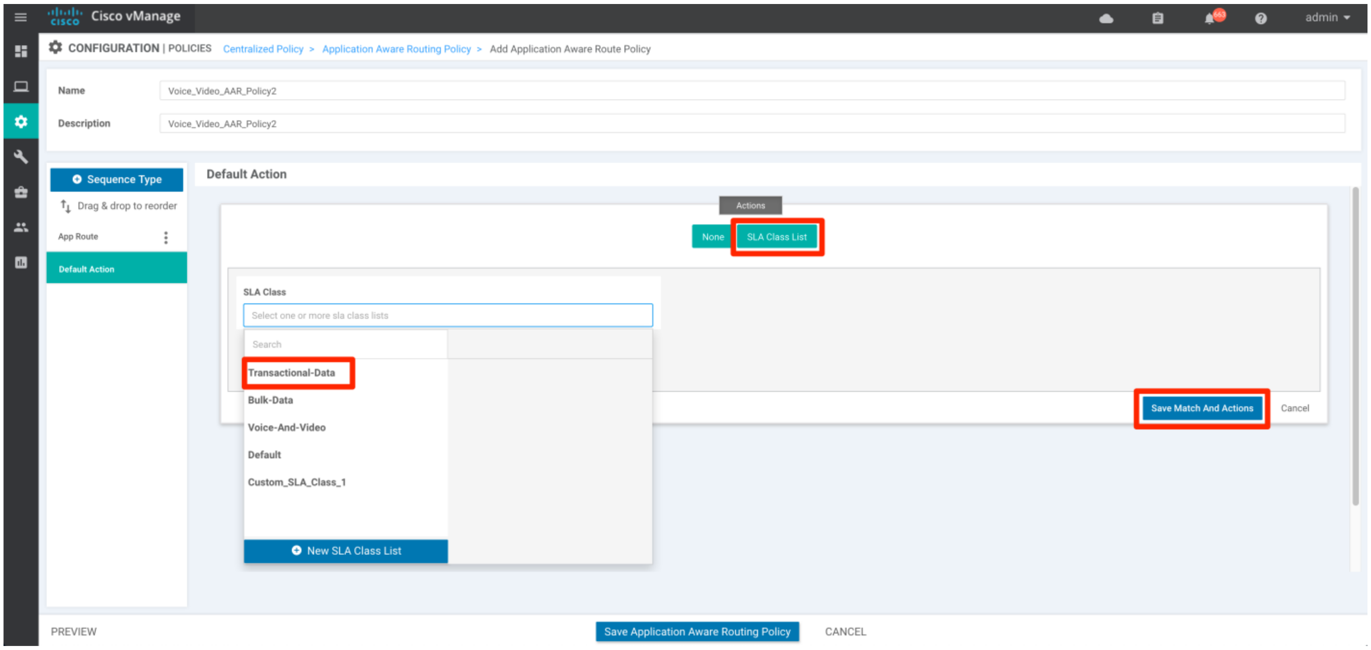

Cisco vManage
admin
CONFIGURATION | POLICIES
Centralized Policy > Application Aware Routing Policy > Add Application Aware Route Policy
Sequence Type
Drag & drop to reorder
App Route
Default Action
Default Action
PREVIEW
Save Application Aware Routing Policy
CANCEL
https://100.119.104.198/index.html

Name: Voice_Video_AAR_Policy2

Description: Voice_Video_AAR_Policy2

None Enabled

Select the **SLA Class List** and select the appropriate **SLA Class** from the drop-down menu. Click **Save Match and Actions** option.



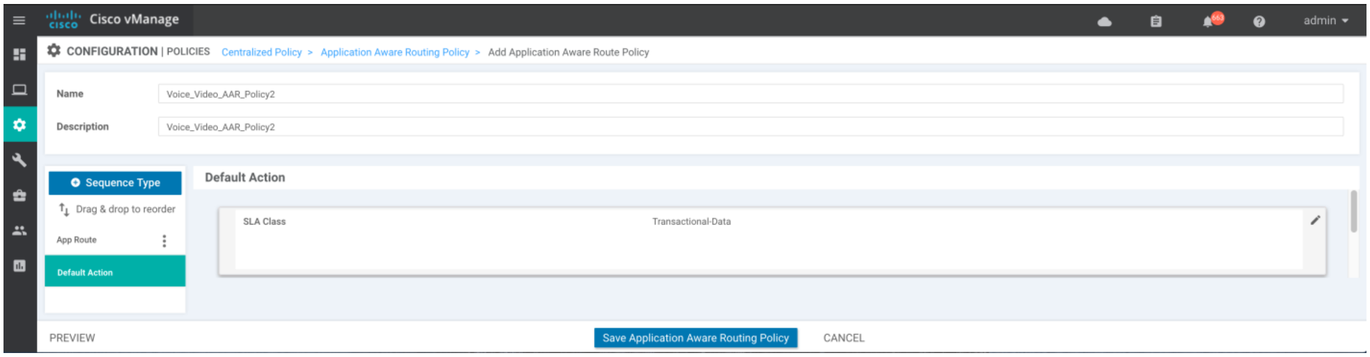
Name: Voice_Video_AAR_Policy2

Description: Voice_Video_AAR_Policy2

Default Action

SLA Class: Select one or more sla class lists

- Transactional-Data
- Bulk-Data
- Voice-And-Video
- Default
- Custom_SLA_Class_1



Cisco vManage
admin
CONFIGURATION | POLICIES
Centralized Policy > Application Aware Routing Policy > Add Application Aware Route Policy
Sequence Type
Drag & drop to reorder
App Route
Default Action
PREVIEW
Save Application Aware Routing Policy
CANCEL

Name: Voice_Video_AAR_Policy2

Description: Voice_Video_AAR_Policy2

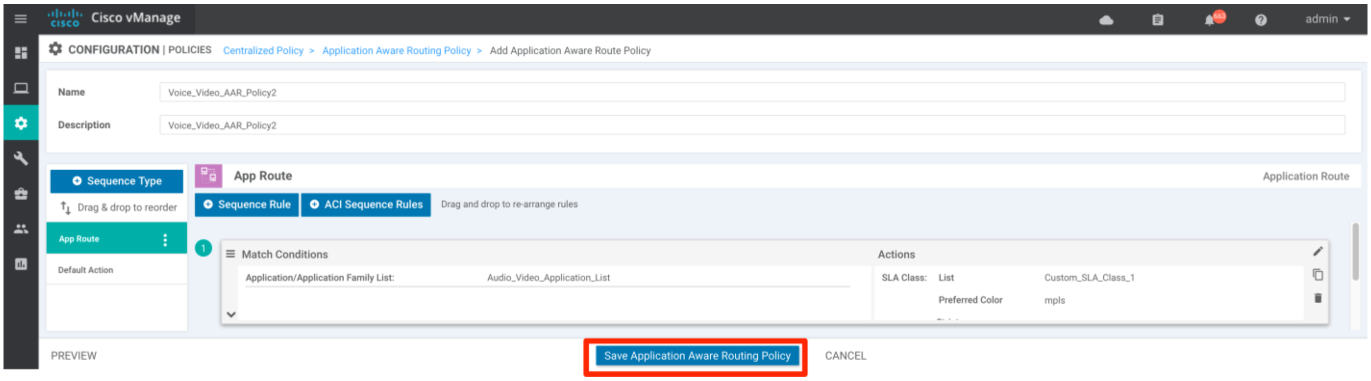
Default Action

SLA Class: Transactional-Data

### Tech tip

If none of the WAN transports satisfies the selected SLA class in the default action, the WAN Edge device will load-balance the data traffic across all the available links.

**Step 7.** Click Save Application Aware Routing Policy.



Name: Voice_Video_AAR_Policy2

Description: Voice_Video_AAR_Policy2

App Route

1 Match Conditions: Application/Application Family List: Audio_Video_Application_List

Actions: SLA Class: List Custom_SLA_Class_1; Preferred Color mpls

**Step 8.** Create any additional Application Aware Routing policies if necessary.

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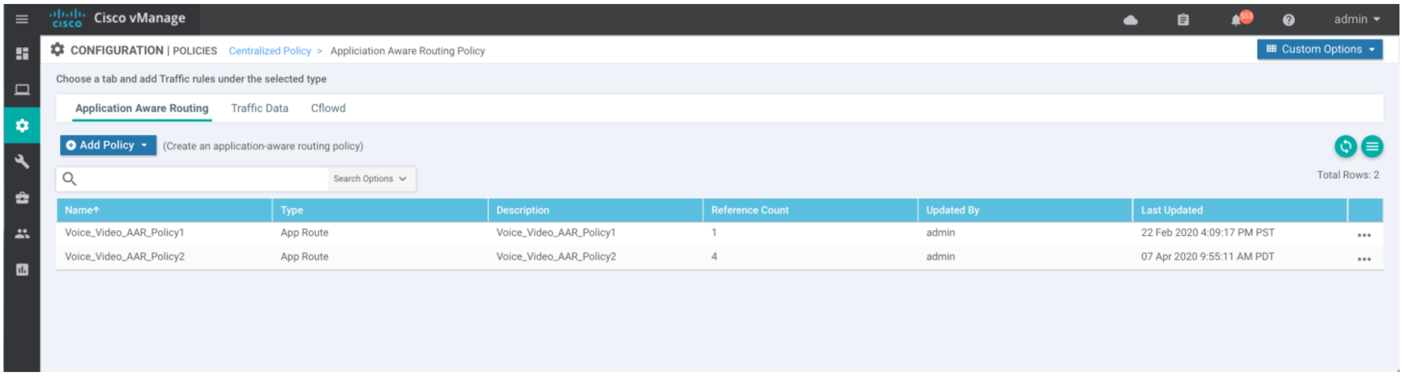


Choose a tab and add Traffic rules under the selected type

(Create an application-aware routing policy)

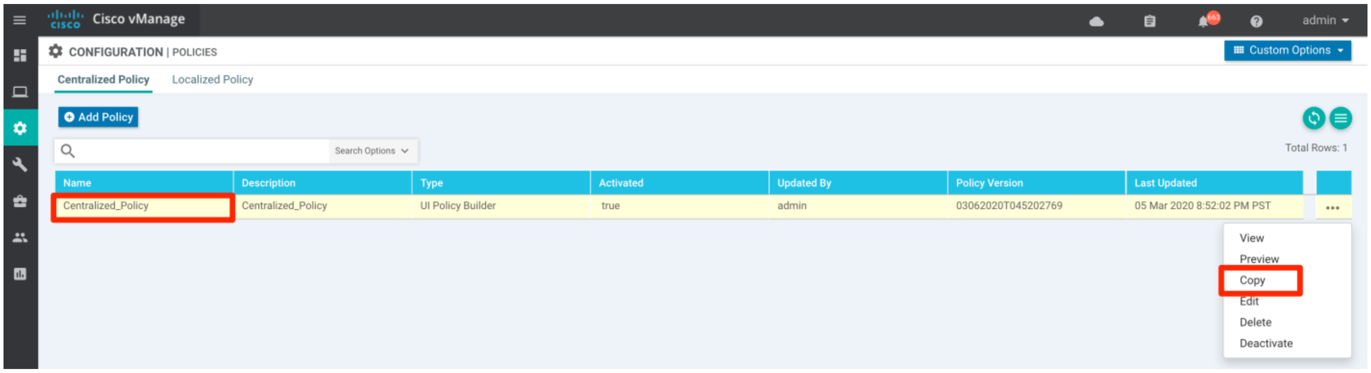
Total Rows: 2

| Name↑ | Type | Description | Reference Count | Updated By | Last Updated | |
|---|---|---|---|---|---|---|
| Voice_Video_AAR_Policy1 | App Route | Voice_Video_AAR_Policy1 | 1 | admin | 22 Feb 2020 4:09:17 PM PST | ••• |
| Voice_Video_AAR_Policy2 | App Route | Voice_Video_AAR_Policy2 | 4 | admin | 07 Apr 2020 9:55:11 AM PDT | ••• |

## Procedure 6. Associate and activate the Application-Aware Routing policy

To apply the App-Aware routing policy to the already existing centralized policy, create a copy of the existing activated policy and edit the copied policy. Making a copy of the existing policy allows administrators to keep the existing configured policy active, while making the new changes to the copied policy.

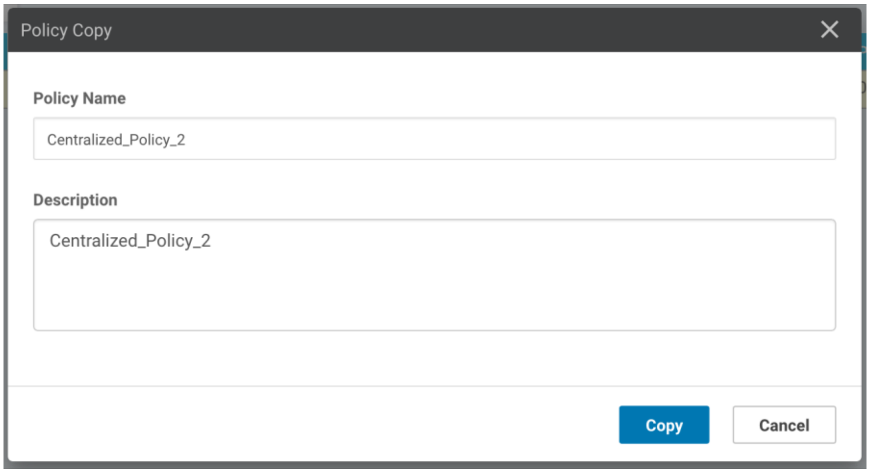
**Step 1.** In vManage, navigate to **Configuration > Policies > Centralized Policy**. Select the policy and click the three dots (**…**) and select **Copy**.



Total Rows: 1

| Name | Description | Type | Activated | Updated By | Policy Version | Last Updated | |
|---|---|---|---|---|---|---|---|
| Centralized_Policy | Centralized_Policy | UI Policy Builder | true | admin | 03062020T045202769 | 05 Mar 2020 8:52:02 PM PST | ••• |

**Step 2.** Input the **Policy Name** and **Description** for the new policy and click **Copy**



Policy Name: Centralized_Policy_2

Description: Centralized_Policy_2

**Step 3.** Confirm that the newly created Policy is inactive (column **Activated: false** status) and then select the three dots (**…**) against the policy and choose **Edit** to add App-Aware routing policy.

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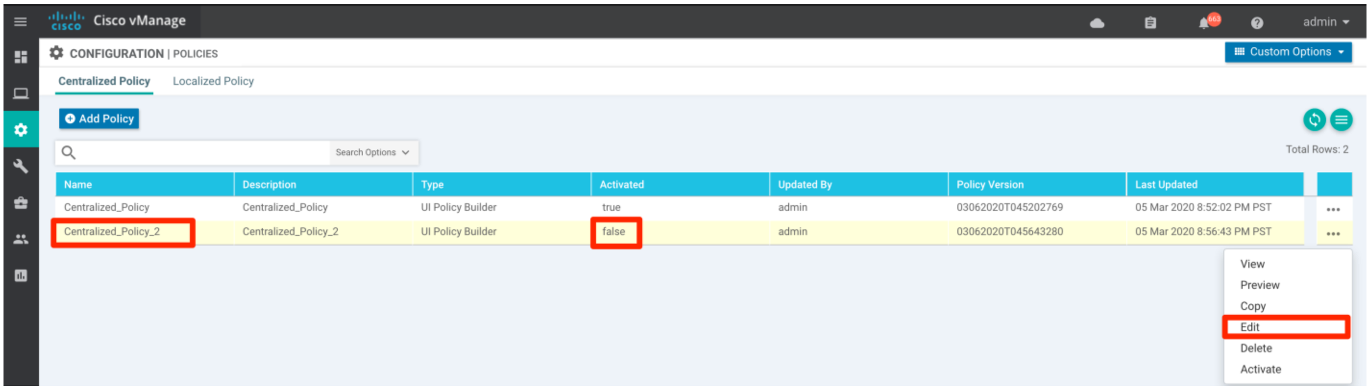
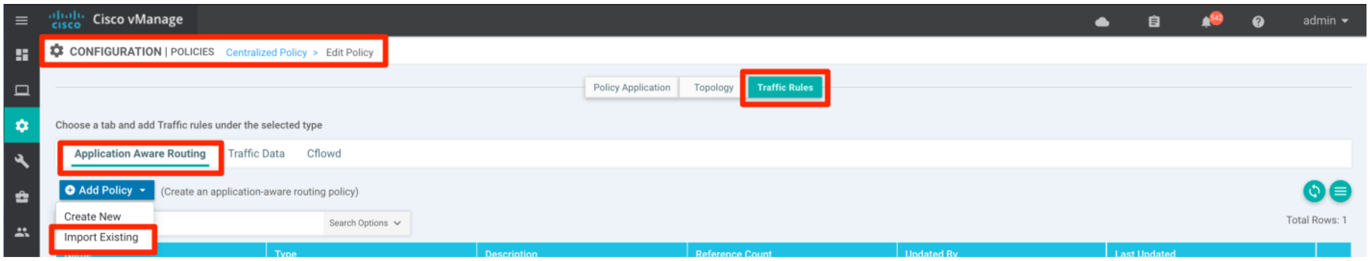


| Name | Description | Type | Activated | Updated By | Policy Version | Last Updated |
|---|---|---|---|---|---|---|
| Centralized_Policy | Centralized_Policy | UI Policy Builder | true | admin | 03062020T045202769 | 05 Mar 2020 8:52:02 PM PST |
| Centralized_Policy_2 | Centralized_Policy_2 | UI Policy Builder | false | admin | 03062020T045643280 | 05 Mar 2020 8:56:43 PM PST |

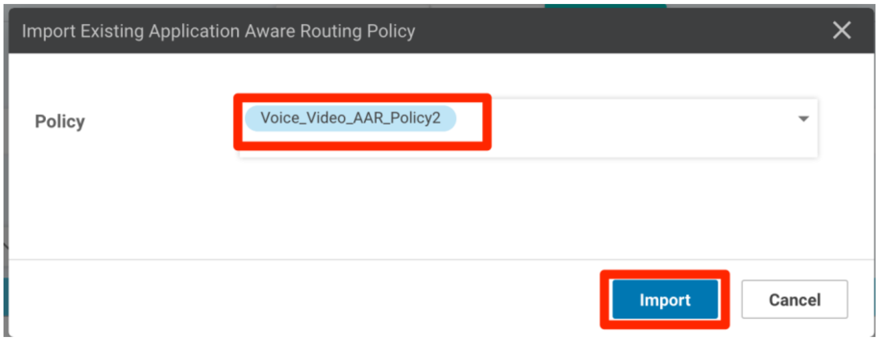
**Step 4.** Click **Traffic Rules** tab and choose **Application Aware Routing** and click **Add Policy**, select **Import Existing** option from the drop-down menu.



Choose a tab and add Traffic rules under the selected type

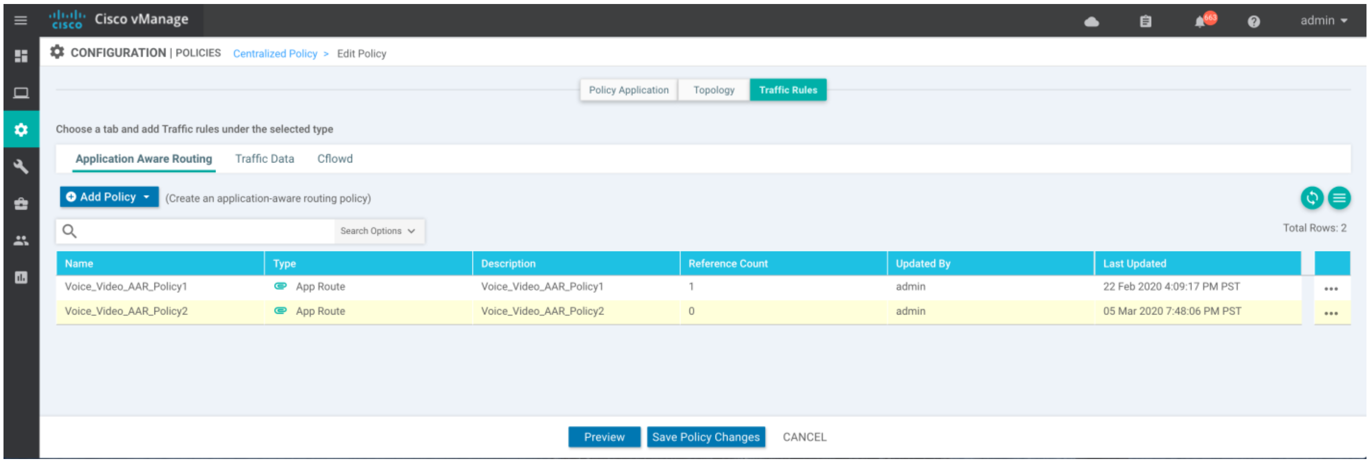
(Create an application-aware routing policy)

Select the policy created from the drop-down menu and click **Import**.



Policy: Voice_Video_AAR_Policy2

**Step 5.** Import any additional Application Aware Routing policies if necessary.



Choose a tab and add Traffic rules under the selected type

(Create an application-aware routing policy)

| Name | Type | Description | Reference Count | Updated By | Last Updated |
|---|---|---|---|---|---|
| Voice_Video_AAR_Policy1 | App Route | Voice_Video_AAR_Policy1 | 1 | admin | 22 Feb 2020 4:09:17 PM PST |
| Voice_Video_AAR_Policy2 | App Route | Voice_Video_AAR_Policy2 | 0 | admin | 05 Mar 2020 7:48:06 PM PST |

**Step 6.** Select the **Policy Application** and select the **Application-Aware Routing** tab.

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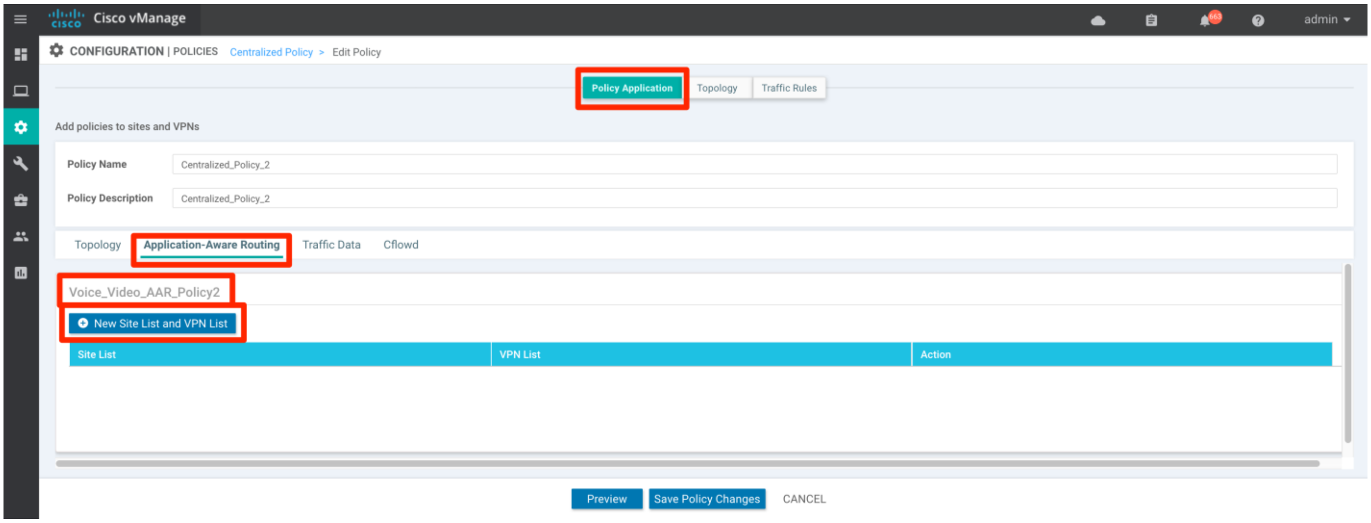
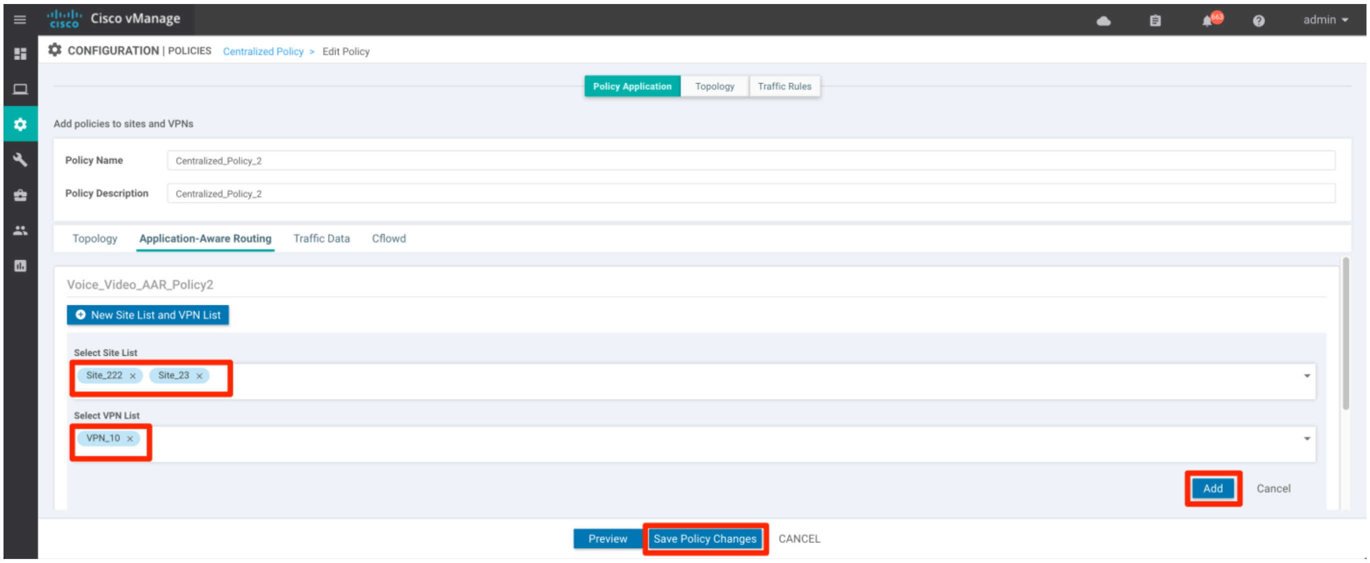
Under the imported App-Aware routing policy, click the **New Site List and VPN List** and select the appropriate **Site List** and the **VPN List** from the drop-down menu



Policy Name: Centralized_Policy_2

Policy Description: Centralized_Policy_2

click **Add** and click **Save Policy Changes**.



Policy Name: Centralized_Policy_2

Policy Description: Centralized_Policy_2

Select Site List: Site_222 × Site_23 ×

Select VPN List: VPN_10 ×

**Step 7.** Activate the modified Centralized Policy.

Configuring and associating the Application Aware Routing policy does not push the policy to vSmart controller or enforce the policy in the SD-WAN environment. Final step is to activate the policy, which provisions the vSmart controller and enforces the policy.

In vManage, navigate to **Configuration > Policies > Centralized Policy**. Choose the newly configured centralized policy from the list, on the far right-side select the three dots (**...**) and select **Activate** option from the menu.

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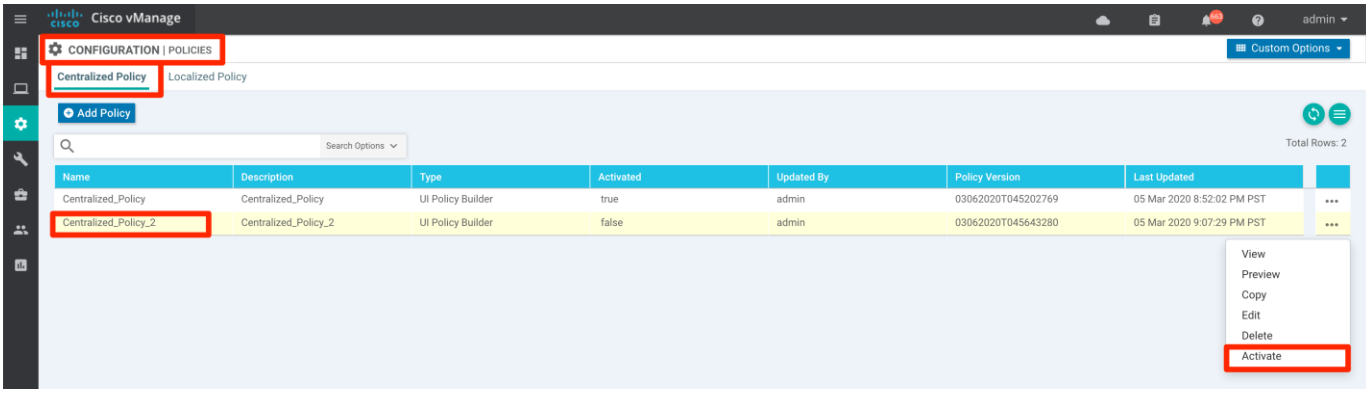
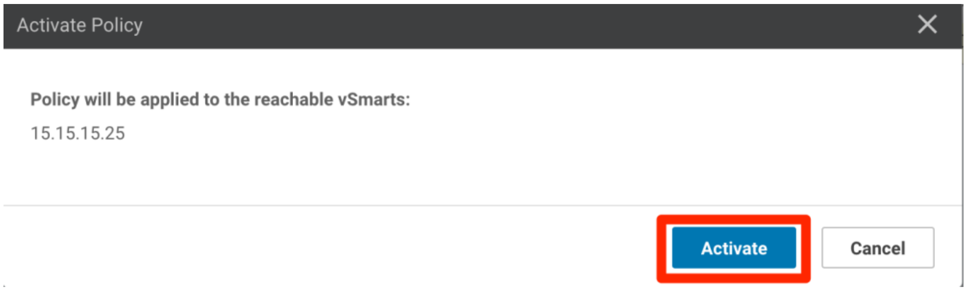


| Name | Description | Type | Activated | Updated By | Policy Version | Last Updated |
|---|---|---|---|---|---|---|
| Centralized_Policy | Centralized_Policy | UI Policy Builder | true | admin | 03062020T045202769 | 05 Mar 2020 8:52:02 PM PST |
| Centralized_Policy_2 | Centralized_Policy_2 | UI Policy Builder | false | admin | 03062020T045643280 | 05 Mar 2020 9:07:29 PM PST |

Pop-up window would ask for confirmation to push the configuration to all vSmart controllers for enforcement. Click **Activate.**

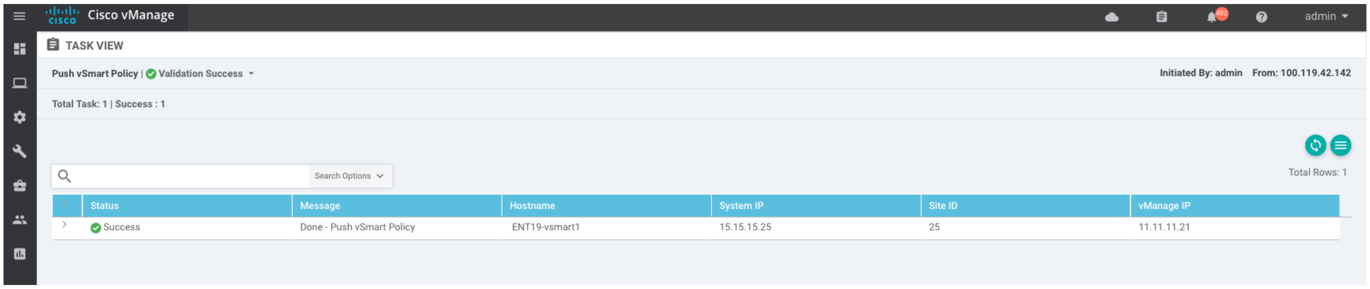


Activate Policy

**Policy will be applied to the reachable vSmarts:**

15.15.15.25

the new policy configuration is pushed to vSmart and the configuration is activated for enforcement.



Push vSmart Policy | ✓ Validation Success

Initiated By: admin From: 100.119.42.142

Total Task: 1 | Success : 1

| Status | Message | Hostname | System IP | Site ID | vManage IP |
|---|---|---|---|---|---|
| ✓ Success | Done - Push vSmart Policy | ENT19-vsmart1 | 15.15.15.25 | 25 | 11.11.11.21 |

## Operate

With Application-Aware routing deployed and activated, this section covers steps to manage, monitor and troubleshoot the various component in the SD-WAN environment using vManage GUI.

## Process: Monitor the Application-Aware Routing policy

### Procedure 1. View the Application-Aware routing policy configuration

**Step 1.** View the activated centralized policy

To confirm the centralized policy that contains Application-Aware Routing policy is activated, navigate to **vManage** > **Configuration > Policies > Centralized Policy** and the **Activated** section should be **true.**

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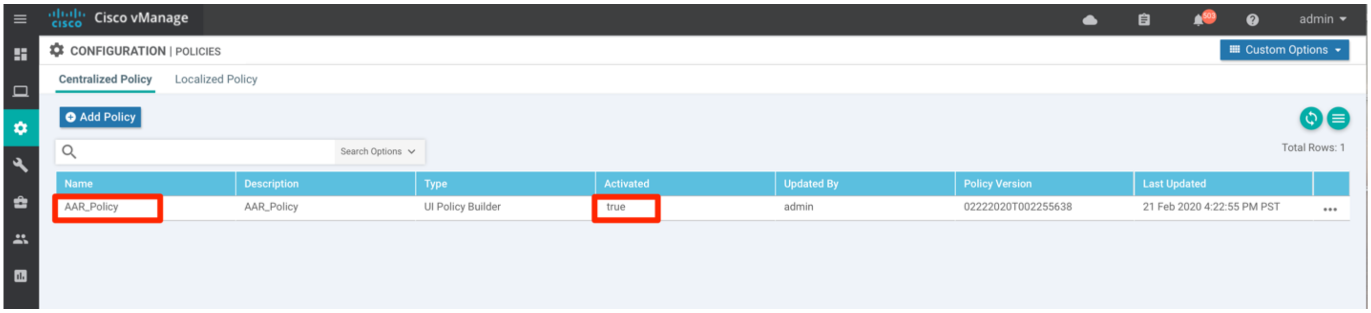
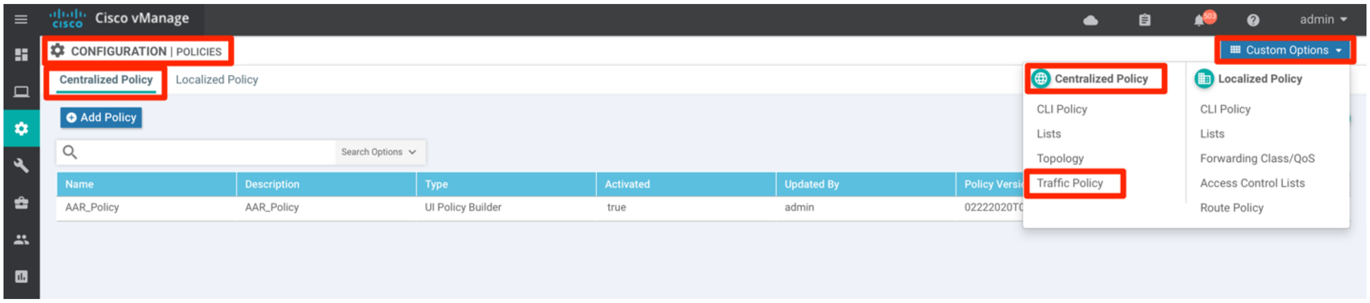


| Name | Description | Type | Activated | Updated By | Policy Version | Last Updated |
|---|---|---|---|---|---|---|
| AAR_Policy | AAR_Policy | UI Policy Builder | true | admin | 02222020T002255638 | 21 Feb 2020 4:22:55 PM PST |

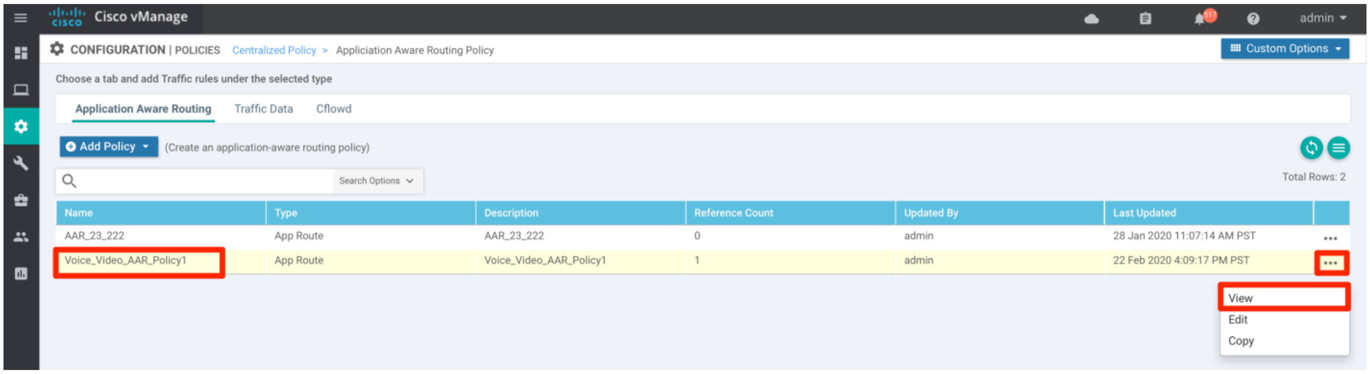
**Step 2.** View the Application-Aware routing policy from the vManage User Interface.

To view the Application-Aware Routing Policy, navigate to **vManage** > **Configuration > Policies.** Click the **Custom Options** on the top right corner and select the **Centralized Policy** > **Traffic Policy**.

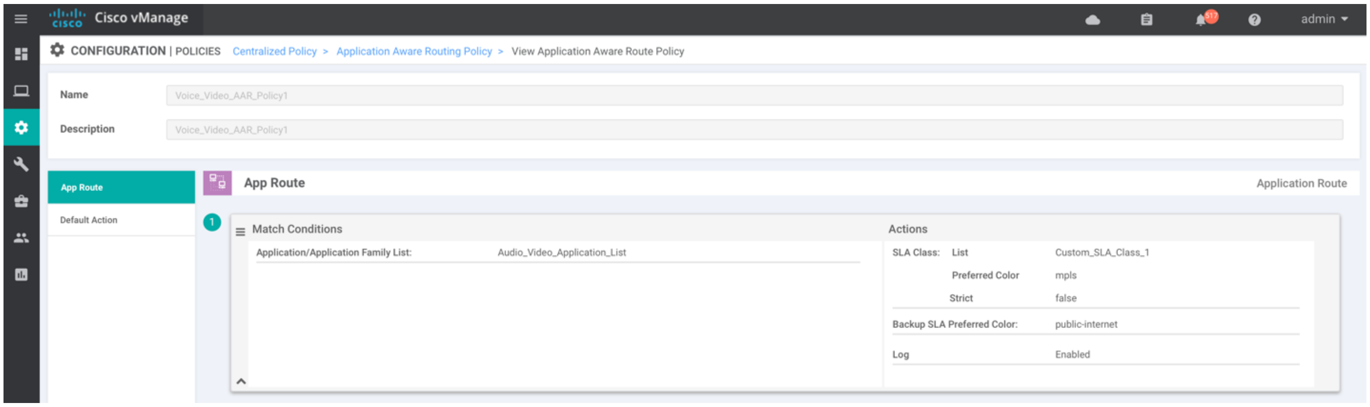


| Name | Description | Type | Activated | Updated By | Policy Versi |
|---|---|---|---|---|---|
| AAR_Policy | AAR_Policy | UI Policy Builder | true | admin | 02222020T |

Click the three dots (**...**) to the right of each table row against the policy and select **View** from the options


Cisco vManage
admin
CONFIGURATION | POLICIES
Centralized Policy > Application Aware Routing Policy
Custom Options
Choose a tab and add Traffic rules under the selected type
Application Aware Routing
Traffic Data
Cflowd
Add Policy
(Create an application-aware routing policy)
Search Options
Total Rows: 2
View
Edit
Copy

| Name | Type | Description | Reference Count | Updated By | Last Updated |
|---|---|---|---|---|---|
| AAR_23_222 | App Route | AAR_23_222 | 0 | admin | 28 Jan 2020 11:07:14 AM PST |
| Voice_Video_AAR_Policy1 | App Route | Voice_Video_AAR_Policy1 | 1 | admin | 22 Feb 2020 4:09:17 PM PST |



Name: Voice_Video_AAR_Policy1

Description: Voice_Video_AAR_Policy1

Application/Application Family List: Audio_Video_Application_List

| | | |
|---|---|---|
| SLA Class: | List | Custom_SLA_Class_1 |
| | Preferred Color | mpls |
| | Strict | false |
| Backup SLA Preferred Color: | | public-internet |
| Log | | Enabled |

**Step 3.** To verify the Application-Aware routing policy configuration on the vSmart controller

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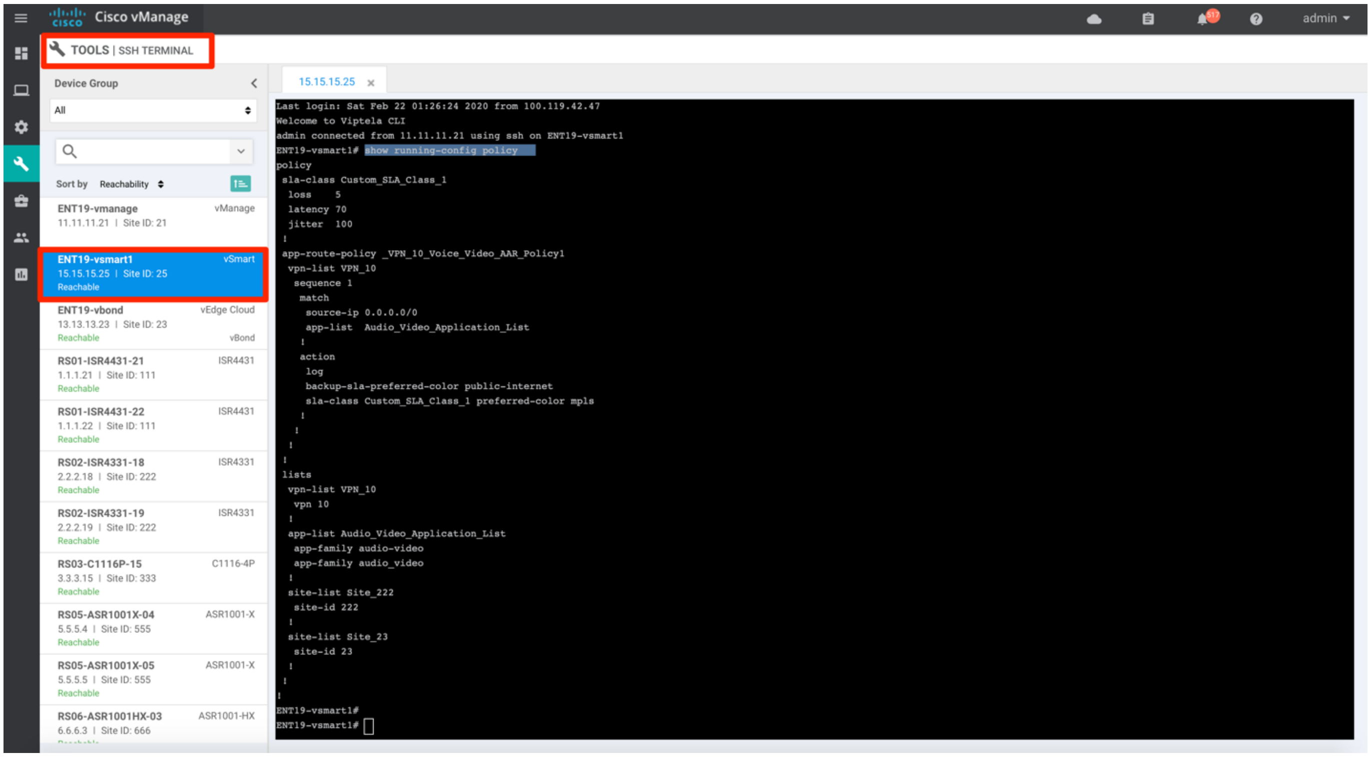
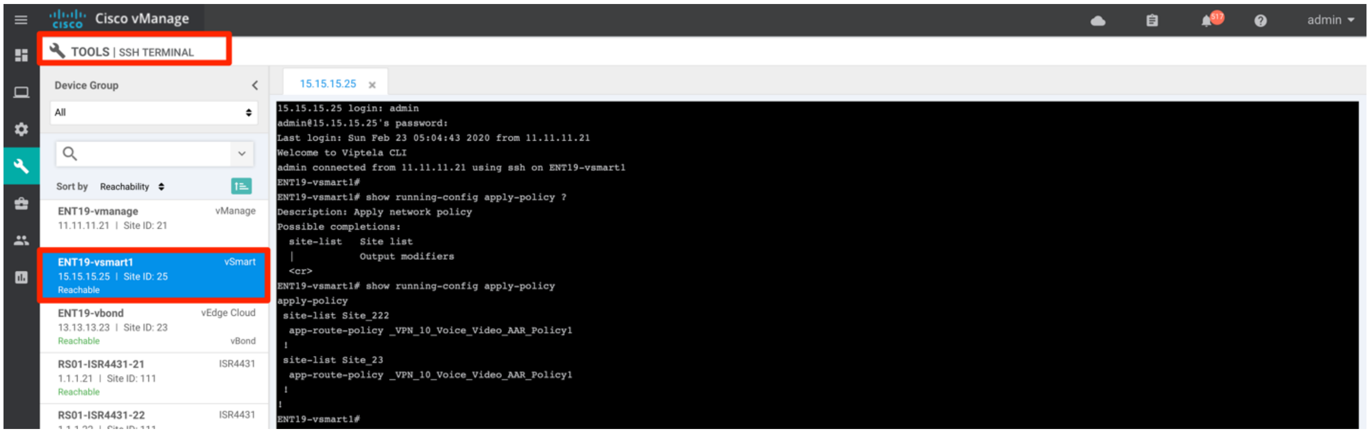
To view the Application-Aware Routing Policy, navigate to vManage, **Tools > SSH Terminal.** Select the vSmart controller and issue **show running-config policy.**



```
Last login: Sat Feb 22 01:26:24 2020 from 100.119.42.47
Welcome to Viptela CLI
admin connected from 11.11.11.21 using ssh on ENT19-vsmart1
ENT19-vsmart1# show running-config policy
policy
 sla-class Custom_SLA_Class_1
  loss    5
  latency 70
  jitter  100
 !
 app-route-policy _VPN_10_Voice_Video_AAR_Policy1
  vpn-list VPN_10
   sequence 1
    match
     source-ip 0.0.0.0/0
     app-list  Audio_Video_Application_List
    !
    action
     log
     backup-sla-preferred-color public-internet
     sla-class Custom_SLA_Class_1 preferred-color mpls
    !
   !
  !
 !
 lists
  vpn-list VPN_10
   vpn 10
  !
  app-list Audio_Video_Application_List
   app-family audio-video
   app-family audio_video
  !
  site-list Site_222
   site-id 222
  !
  site-list Site_23
   site-id 23
  !
 !
!
ENT19-vsmart1#
ENT19-vsmart1# 
```

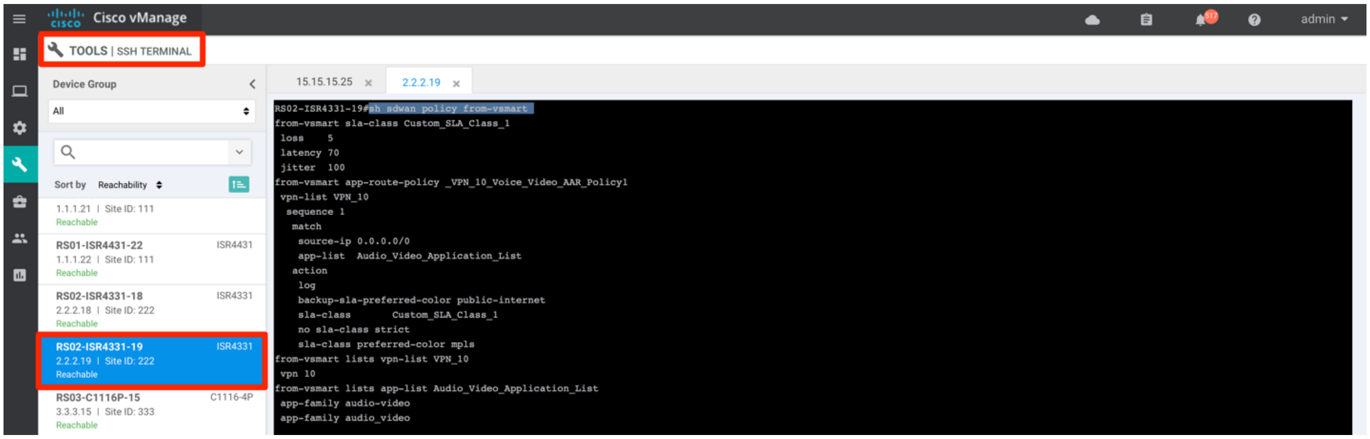
and **show running-config apply-policy**



```
15.15.15.25 login: admin
admin@15.15.15.25's password:
Last login: Sun Feb 23 05:04:43 2020 from 11.11.11.21
Welcome to Viptela CLI
admin connected from 11.11.11.21 using ssh on ENT19-vsmart1
ENT19-vsmart1#
ENT19-vsmart1# show running-config apply-policy ?
Description: Apply network policy
Possible completions:
  site-list   Site list
  |           Output modifiers
  <cr>
ENT19-vsmart1# show running-config apply-policy
apply-policy
 site-list Site_222
  app-route-policy _VPN_10_Voice_Video_AAR_Policy1
 !
 site-list Site_23
  app-route-policy _VPN_10_Voice_Video_AAR_Policy1
 !
!
ENT19-vsmart1#
```

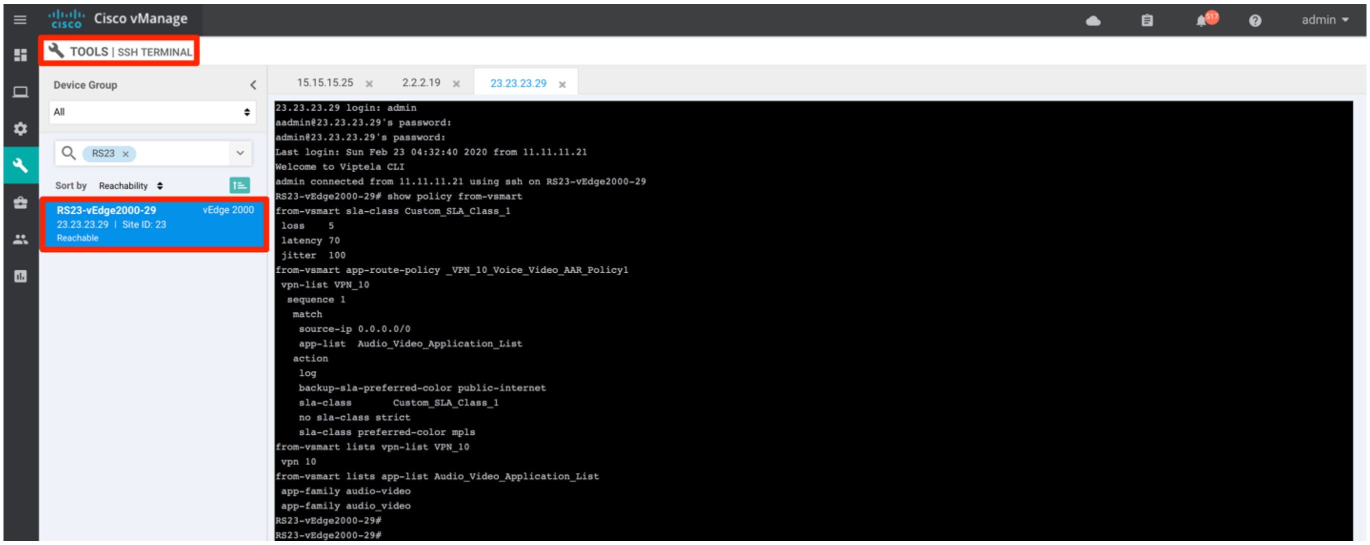
**Step 4.** View the Application-Aware routing policy configured on the WAN Edge device.

To view the Application-Aware Routing Policy configured on the WAN Edge device, navigate to **vManage** > **Tools > SSH Terminal.** Select the WAN Edge device and issue **show sdwan policy from-vsmart** on IOS-XE SD-WAN platform


Cisco vManage
TOOLS | SSH TERMINAL
Device Group
All
Sort by Reachability
1.1.1.21 | Site ID: 111 Reachable
RS01-ISR4431-22 ISR4431 1.1.1.22 | Site ID: 111 Reachable
RS02-ISR4331-18 ISR4331 2.2.2.18 | Site ID: 222 Reachable
RS02-ISR4331-19 ISR4331 2.2.2.19 | Site ID: 222 Reachable
RS03-C1116P-15 C1116-4P 3.3.3.15 | Site ID: 333 Reachable
15.15.15.25
2.2.2.19
admin

```
RS02-ISR4331-19#sh sdwan policy from-vsmart
from-vsmart sla-class Custom_SLA_Class_1
 loss    5
 latency 70
 jitter  100
from-vsmart app-route-policy _VPN_10_Voice_Video_AAR_Policy1
 vpn-list VPN_10
  sequence 1
   match
    source-ip 0.0.0.0/0
    app-list  Audio_Video_Application_List
   action
    log
    backup-sla-preferred-color public-internet
    sla-class       Custom_SLA_Class_1
    no sla-class strict
    sla-class preferred-color mpls
from-vsmart lists vpn-list VPN_10
 vpn 10
from-vsmart lists app-list Audio_Video_Application_List
 app-family audio-video
 app-family audio_video
```

and **show policy from-vsmart** on Viptela platform.

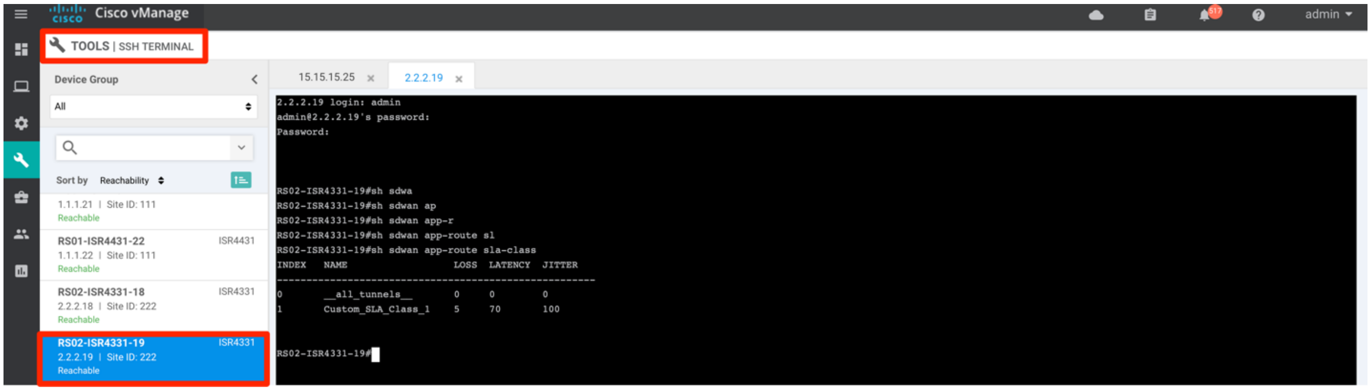


```
23.23.23.29 login: admin
aadmin@23.23.23.29's password:
admin@23.23.23.29's password:
Last login: Sun Feb 23 04:32:40 2020 from 11.11.11.21
Welcome to Viptela CLI
admin connected from 11.11.11.21 using ssh on RS23-vEdge2000-29
RS23-vEdge2000-29# show policy from-vsmart
from-vsmart sla-class Custom_SLA_Class_1
 loss    5
 latency 70
 jitter  100
from-vsmart app-route-policy _VPN_10_Voice_Video_AAR_Policy1
 vpn-list VPN_10
  sequence 1
   match
    source-ip 0.0.0.0/0
    app-list  Audio_Video_Application_List
   action
    log
    backup-sla-preferred-color public-internet
    sla-class       Custom_SLA_Class_1
    no sla-class strict
    sla-class preferred-color mpls
from-vsmart lists vpn-list VPN_10
 vpn 10
from-vsmart lists app-list Audio_Video_Application_List
 app-family audio-video
 app-family audio_video
RS23-vEdge2000-29#
RS23-vEdge2000-29#
```

## Procedure 2. View the SLA configuration on the WAN Edge device

### Step 1. View the SLA configured on the WAN Edge device.

To view the SLA configured, navigate to vManage, **Tools > SSH Terminal.** Select the WAN Edge device and issue **sh sdwan app-route sla-class** on IOS-XE SD-WAN platform **sh app-route sla-class** on vipteal platform.


Cisco vManage
TOOLS | SSH TERMINAL
Device Group
All
Sort by Reachability
1.1.1.21 | Site ID: 111 Reachable
RS01-ISR4431-22 ISR4431 1.1.1.22 | Site ID: 111 Reachable
RS02-ISR4331-18 ISR4331 2.2.2.18 | Site ID: 222 Reachable
RS02-ISR4331-19 ISR4331 2.2.2.19 | Site ID: 222 Reachable
15.15.15.25
2.2.2.19
admin

```
2.2.2.19 login: admin
admin@2.2.2.19's password:
Password:



RS02-ISR4331-19#sh sdwa
RS02-ISR4331-19#sh sdwan ap
RS02-ISR4331-19#sh sdwan app-r
RS02-ISR4331-19#sh sdwan app-route sl
RS02-ISR4331-19#sh sdwan app-route sla-class
INDEX   NAME                  LOSS  LATENCY  JITTER
-------------------------------------------------------
0       __all_tunnels__       0     0        0
1       Custom_SLA_Class_1    5     70       100


RS02-ISR4331-19#
```

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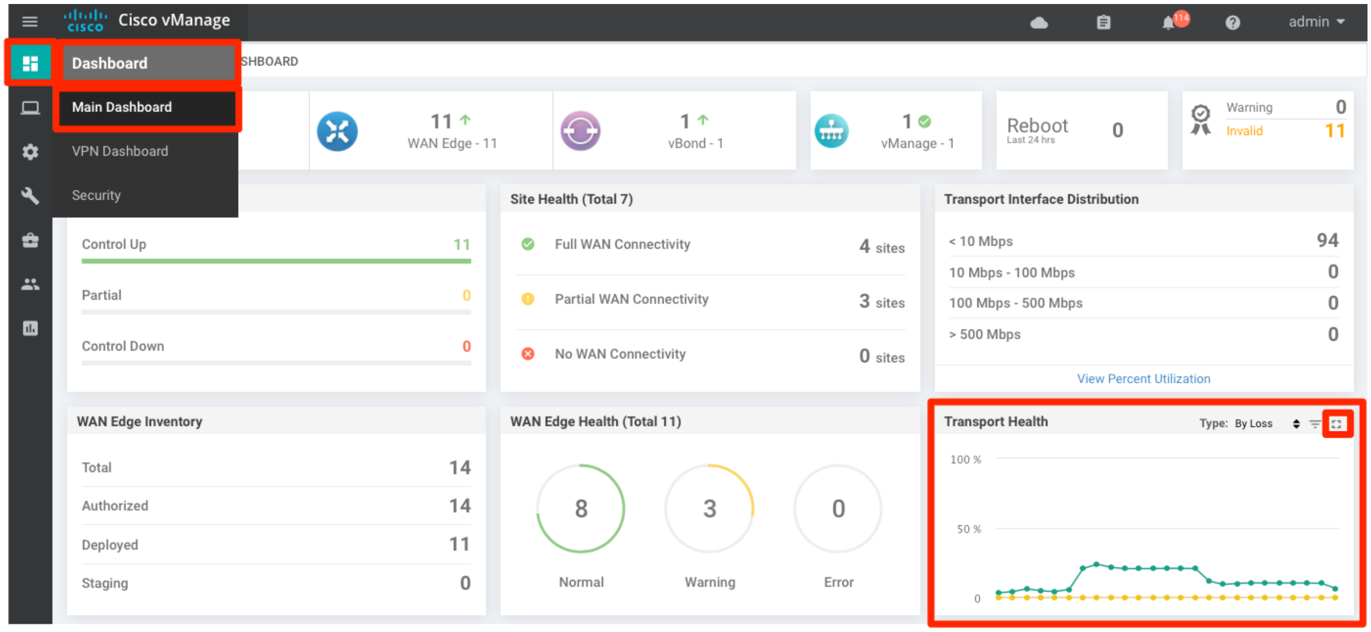
# Process: Monitor the WAN transport path characteristics

## Procedure 1. View the WAN transport path characteristics across the SD-WAN environment

SD-WAN transport tunnel characteristics across the SD-WAN environment or specific to the WAN Edge can be monitored from the vManage.

**Step 2.** Monitor transports health characteristics across the SD-WAN environment.

To view the tunnel characteristics across the SD-WAN infrastructure. Navigate to **vManage** > **Dashboard > Main Dashboard > Transport Health** widget.



11 WAN Edge - 11

1 vBond - 1

1 vManage - 1

Reboot Last 24 hrs 0

| | |
|---|---|
| Warning | 0 |
| Invalid | 11 |

| | |
|---|---|
| Control Up | 11 |
| Partial | 0 |
| Control Down | 0 |

Site Health (Total 7)

| | |
|---|---|
| Full WAN Connectivity | 4 sites |
| Partial WAN Connectivity | 3 sites |
| No WAN Connectivity | 0 sites |

Transport Interface Distribution

| | |
|---|---|
| < 10 Mbps | 94 |
| 10 Mbps - 100 Mbps | 0 |
| 100 Mbps - 500 Mbps | 0 |
| > 500 Mbps | 0 |

View Percent Utilization

WAN Edge Inventory

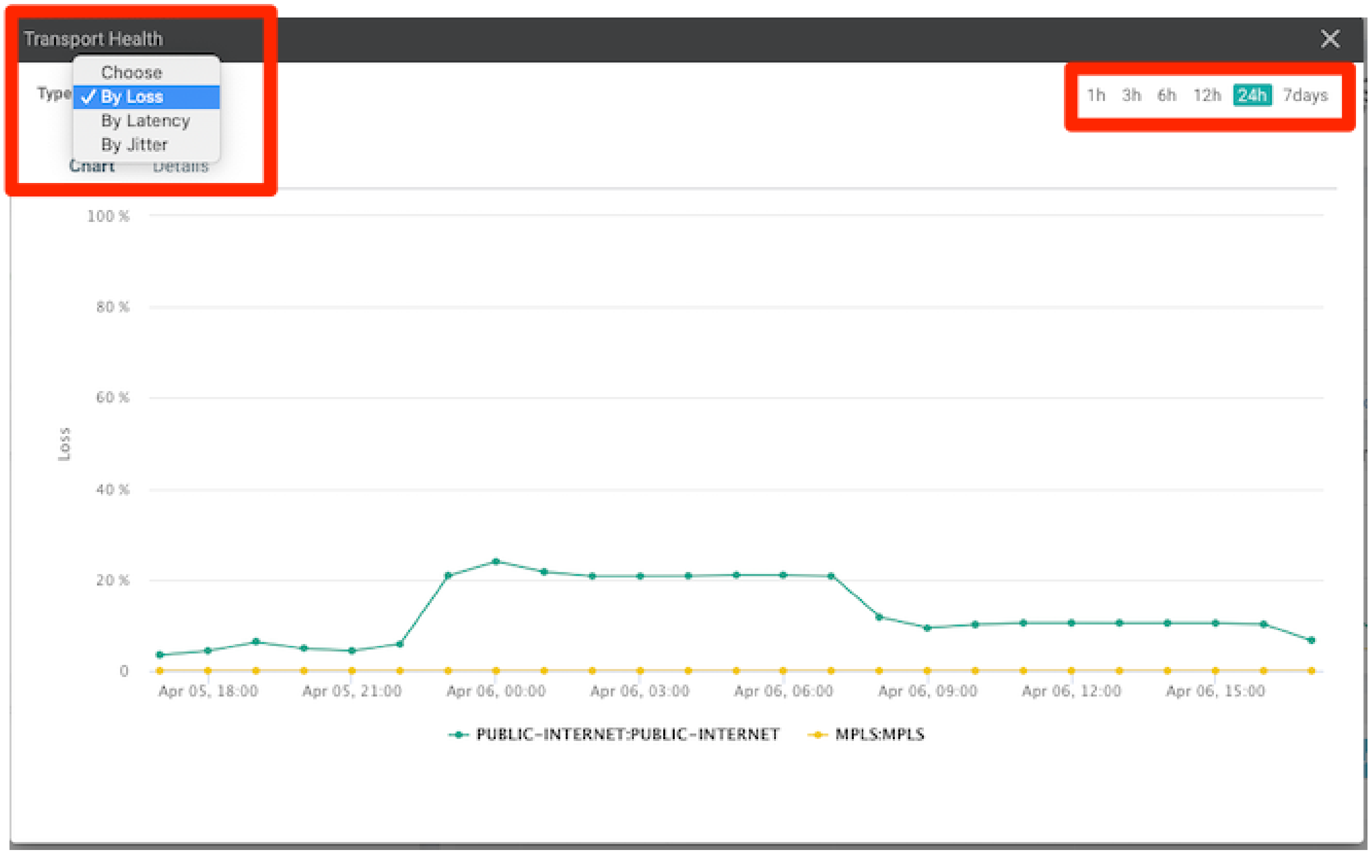
| | |
|---|---|
| Total | 14 |
| Authorized | 14 |
| Deployed | 11 |
| Staging | 0 |

WAN Edge Health (Total 11)

| Normal | Warning | Error |
|---|---|---|
| 8 | 3 | 0 |

Transport Health Type: By Loss

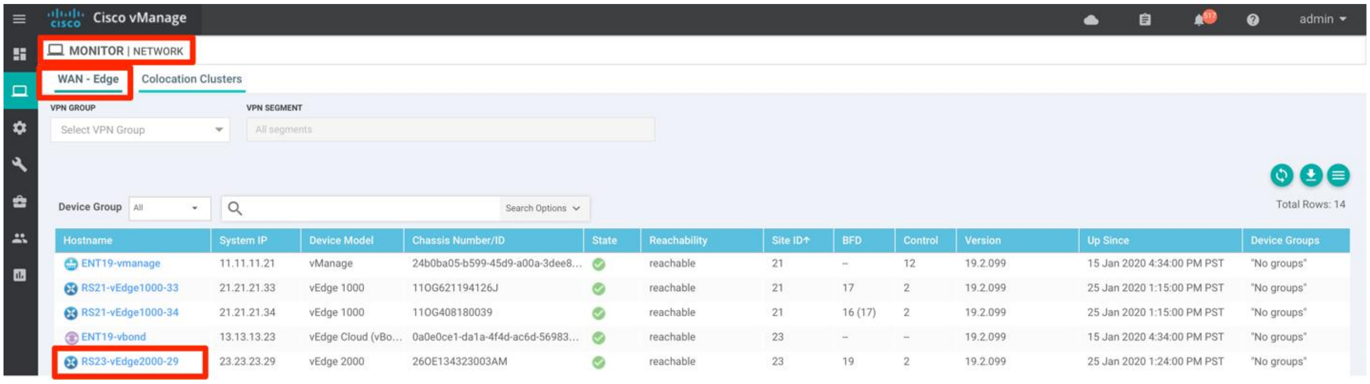
**Step 3.** Expand the widget by clicking the **square icon** in the top right corner of the Transport Health widget and select the **Type** option to view the chart **By Loss, By Latency or by Jitter** values and view the transport health over the maximum of past 7 days.



## Procedure 2. View the path characteristics for the WAN Edge device

**Step 1.** Monitor WAN transport TLOC path characteristics for the WAN Edge device.

To view the tunnel characteristics on the WAN Edge device, navigate to vManage, **Monitor > Network > WAN - Edge.** select the WAN Edge device.



| Hostname | System IP | Device Model | Chassis Number/ID | State | Reachability | Site ID↑ | BFD | Control | Version | Up Since | Device Groups |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ENT19-vmanage | 11.11.11.21 | vManage | 24b0ba05-b599-45d9-a00a-3dee8... | ✓ | reachable | 21 | -- | 12 | 19.2.099 | 15 Jan 2020 4:34:00 PM PST | "No groups" |
| RS21-vEdge1000-33 | 21.21.21.33 | vEdge 1000 | 11OG621194126J | ✓ | reachable | 21 | 17 | 2 | 19.2.099 | 25 Jan 2020 1:15:00 PM PST | "No groups" |
| RS21-vEdge1000-34 | 21.21.21.34 | vEdge 1000 | 11OG408180039 | ✓ | reachable | 21 | 16 (17) | 2 | 19.2.099 | 25 Jan 2020 1:15:00 PM PST | "No groups" |
| ENT19-vbond | 13.13.13.23 | vEdge Cloud (vBo... | 0a0e0ce1-da1a-4f4d-ac6d-56983... | ✓ | reachable | 23 | -- | -- | 19.2.099 | 15 Jan 2020 4:34:00 PM PST | "No groups" |
| RS23-vEdge2000-29 | 23.23.23.29 | vEdge 2000 | 26OE134323003AM | ✓ | reachable | 23 | 19 | 2 | 19.2.099 | 25 Jan 2020 1:24:00 PM PST | "No groups" |

**Step 2.** click **WAN > TLOC** from the left panel options for the device.

Select the **Chart options** and choose **Loss percentage** or **Latency/Jitter** option. By default, the value is shown for 24hours, but can be changed.

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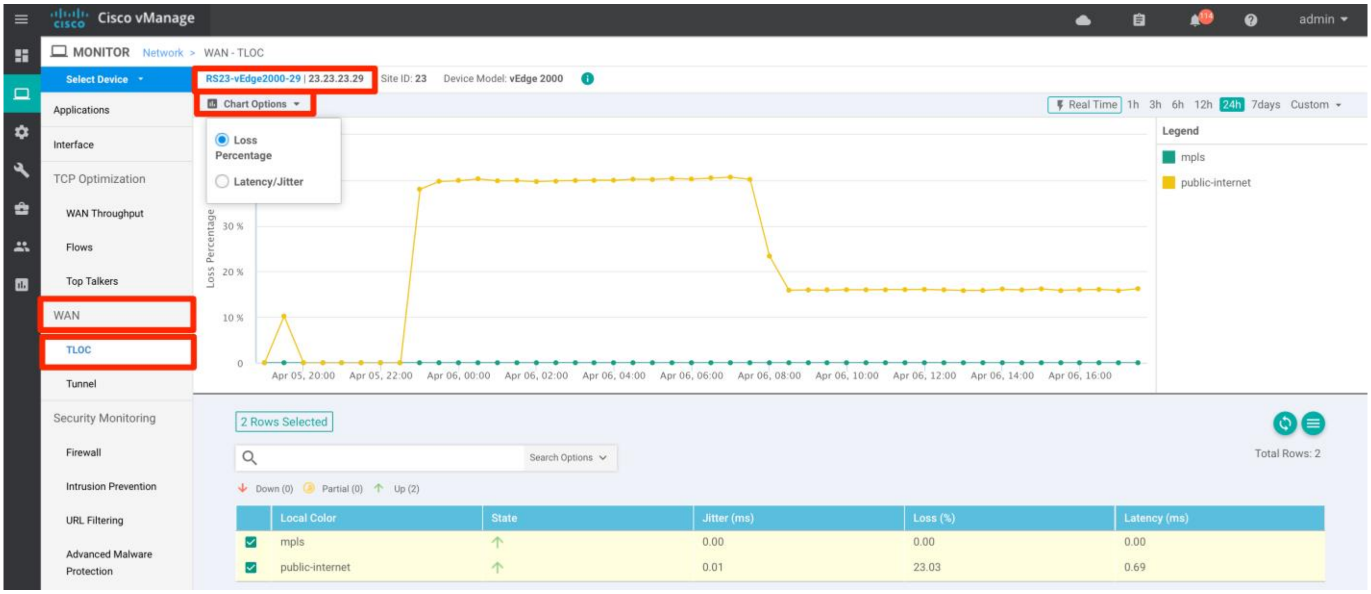
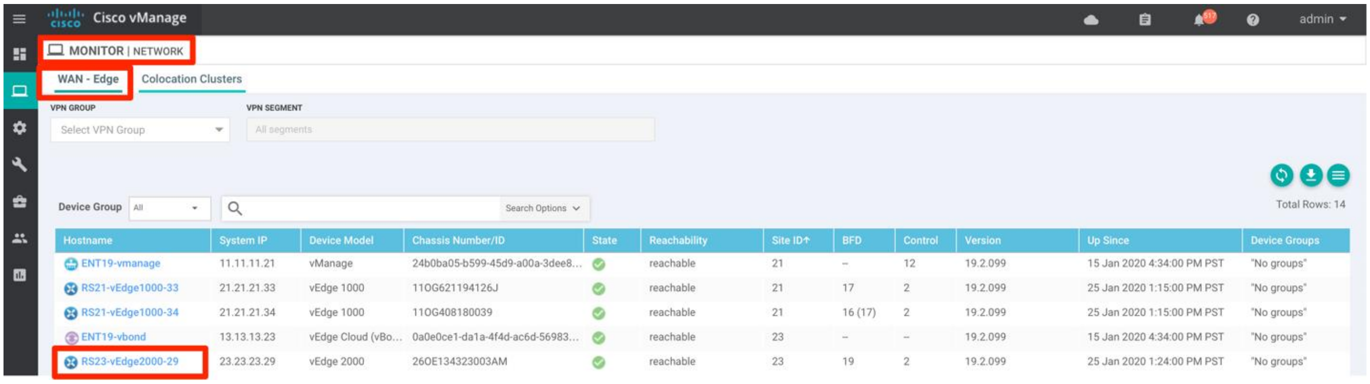


| | Local Color | State | Jitter (ms) | Loss (%) | Latency (ms) |
|---|---|---|---|---|---|
| ☑ | mpls | ↑ | 0.00 | 0.00 | 0.00 |
| ☑ | public-internet | ↑ | 0.01 | 23.03 | 0.69 |

## Procedure 3. View the WAN transport tunnel characteristics for the WAN Edge device

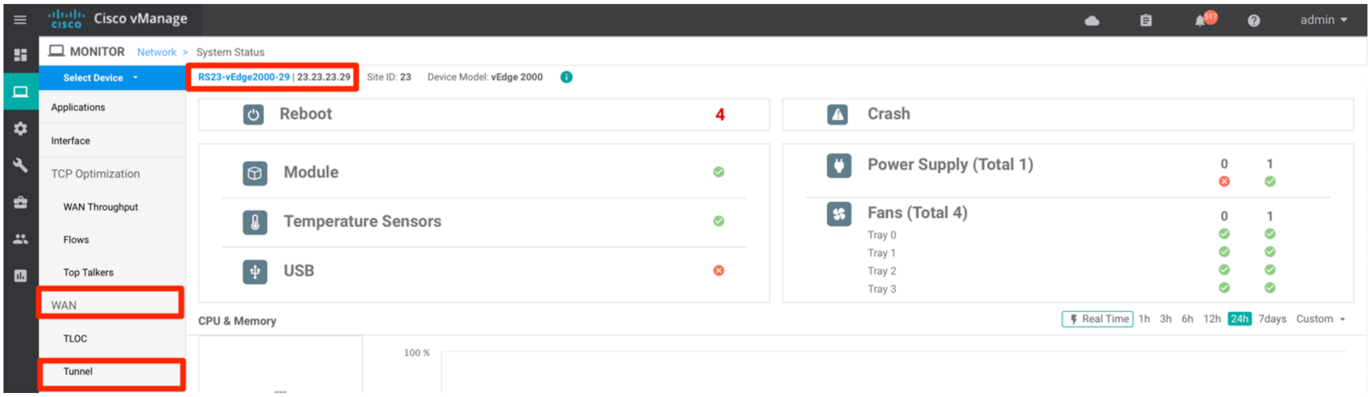
### Step 1. Monitor WAN transport Tunnel characteristics for the WAN Edge device

To view the tunnel characteristics on the WAN Edge device, navigate to vManage, **Monitor > Network > WAN – Edge.** click on the WAN Edge device.



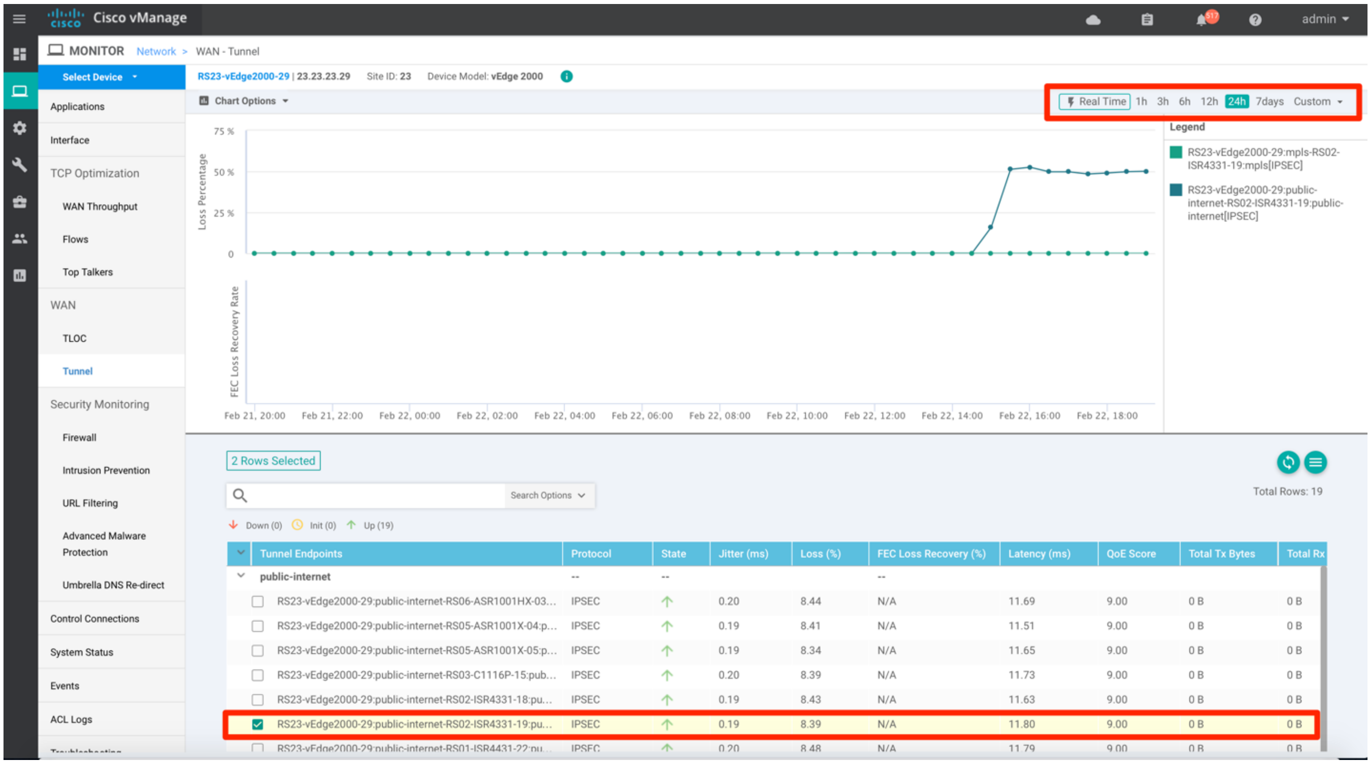
| Hostname | System IP | Device Model | Chassis Number/ID | State | Reachability | Site ID↑ | BFD | Control | Version | Up Since | Device Groups |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ENT19-vmanage | 11.11.11.21 | vManage | 24b0ba05-b599-45d9-a00a-3dee8... | ✓ | reachable | 21 | – | 12 | 19.2.099 | 15 Jan 2020 4:34:00 PM PST | "No groups" |
| RS21-vEdge1000-33 | 21.21.21.33 | vEdge 1000 | 110G621194126J | ✓ | reachable | 21 | 17 | 2 | 19.2.099 | 25 Jan 2020 1:15:00 PM PST | "No groups" |
| RS21-vEdge1000-34 | 21.21.21.34 | vEdge 1000 | 110G408180039 | ✓ | reachable | 21 | 16 (17) | 2 | 19.2.099 | 25 Jan 2020 1:15:00 PM PST | "No groups" |
| ENT19-vbond | 13.13.13.23 | vEdge Cloud (vBo... | 0a0e0ce1-da1a-4f4d-ac6d-56983... | ✓ | reachable | 23 | – | – | 19.2.099 | 15 Jan 2020 4:34:00 PM PST | "No groups" |
| RS23-vEdge2000-29 | 23.23.23.29 | vEdge 2000 | 260E134323003AM | ✓ | reachable | 23 | 19 | 2 | 19.2.099 | 25 Jan 2020 1:24:00 PM PST | "No groups" |

### Step 2. click **WAN > Tunnel** from the left panel options for the device.



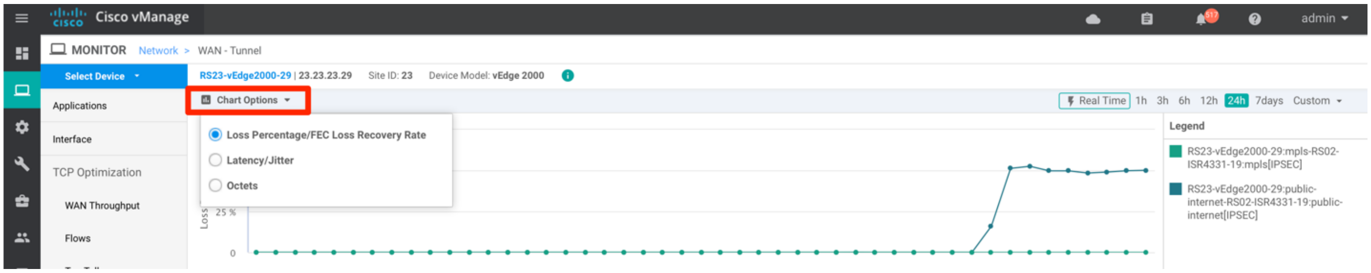
Select the Tunnel Endpoints from the list and view the path characteristics – **Jitter, Loss, Latency** for all transports (mpls, public-internet).

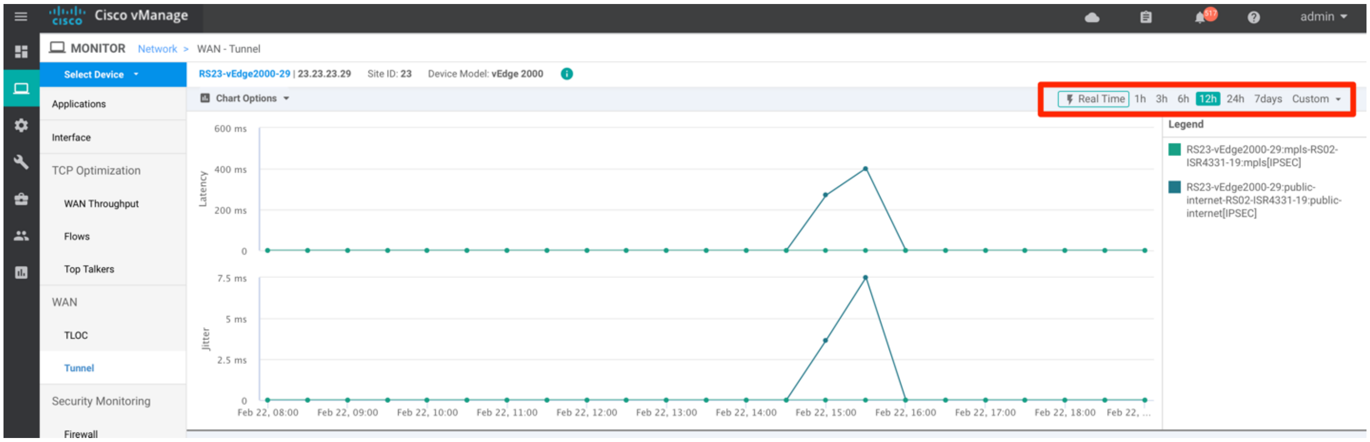
By default, the value is shown for 24hours, but can be changed.



| Tunnel Endpoints | Protocol | State | Jitter (ms) | Loss (%) | FEC Loss Recovery (%) | Latency (ms) | QoE Score | Total Tx Bytes | Total Rx |
|---|---|---|---|---|---|---|---|---|---|
| public-internet | -- | -- | | | -- | | | | |
| □ RS23-vEdge2000-29:public-internet-RS06-ASR1001HX-03... | IPSEC | ↑ | 0.20 | 8.44 | N/A | 11.69 | 9.00 | 0 B | 0 B |
| □ RS23-vEdge2000-29:public-internet-RS05-ASR1001X-04:p... | IPSEC | ↑ | 0.19 | 8.41 | N/A | 11.51 | 9.00 | 0 B | 0 B |
| □ RS23-vEdge2000-29:public-internet-RS05-ASR1001X-05:p... | IPSEC | ↑ | 0.19 | 8.34 | N/A | 11.65 | 9.00 | 0 B | 0 B |
| □ RS23-vEdge2000-29:public-internet-RS03-C1116P-15:pub... | IPSEC | ↑ | 0.20 | 8.39 | N/A | 11.73 | 9.00 | 0 B | 0 B |
| □ RS23-vEdge2000-29:public-internet-RS02-ISR4331-18:pu... | IPSEC | ↑ | 0.19 | 8.43 | N/A | 11.63 | 9.00 | 0 B | 0 B |
| ☑ RS23-vEdge2000-29:public-internet-RS02-ISR4331-19:pu... | IPSEC | ↑ | 0.19 | 8.39 | N/A | 11.80 | 9.00 | 0 B | 0 B |
| □ RS23-vEdge2000-29:public-internet-RS01-ISR4431-22:pu... | IPSEC | ↑ | 0.20 | 8.48 | N/A | 11.79 | 9.00 | 0 B | 0 B |

The chart can be changed to view the **Latency/Jitter** path characteristics by selecting the appropriate option form the **Chart Options** option as shown below.


Cisco vManage
admin
MONITOR Network > WAN - Tunnel
Select Device
RS23-vEdge2000-29 | 23.23.23.29 Site ID: 23 Device Model: vEdge 2000
Chart Options
● Loss Percentage/FEC Loss Recovery Rate
○ Latency/Jitter
○ Octets
Real Time 1h 3h 6h 12h 24h 7days Custom
Applications
Interface
TCP Optimization
WAN Throughput
Flows
25 %
0
Legend
RS23-vEdge2000-29:mpls-RS02-ISR4331-19:mpls[IPSEC]
RS23-vEdge2000-29:public-internet-RS02-ISR4331-19:public-internet[IPSEC]



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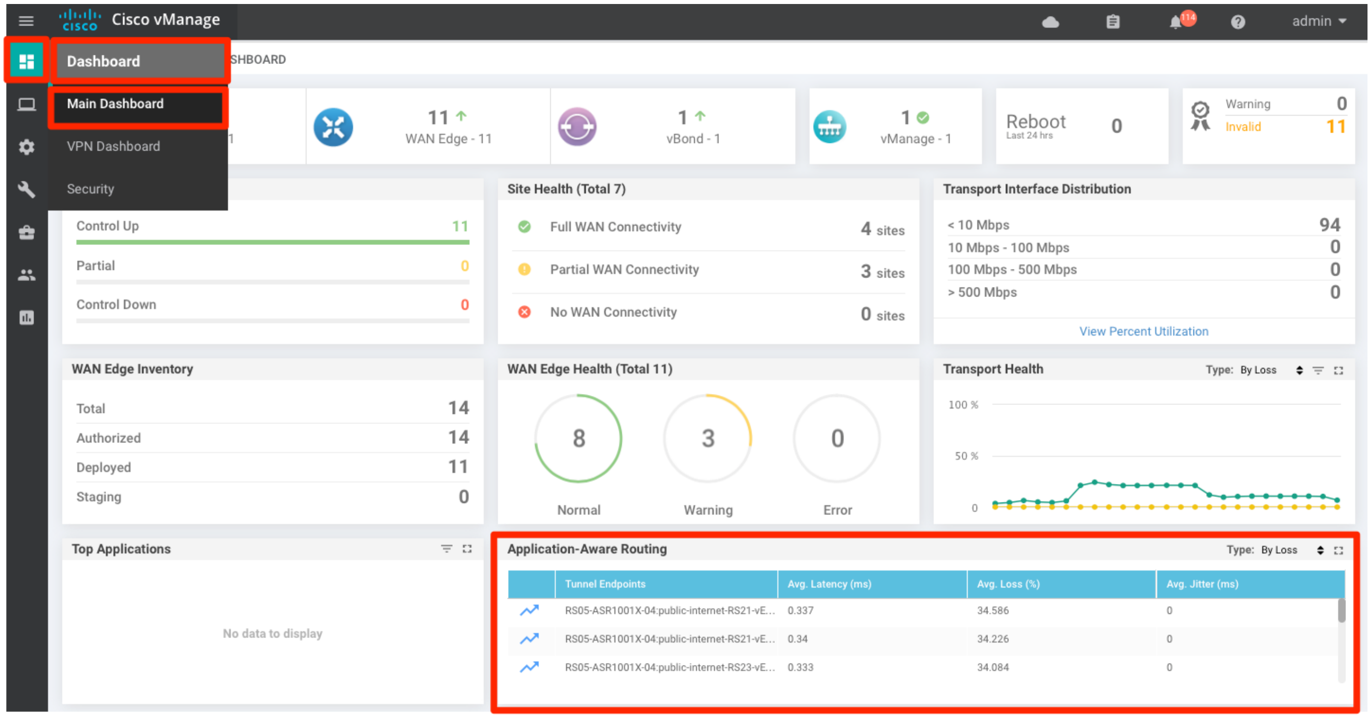
## Process: Monitor the Application-Aware Routing Statistics

### Procedure 1. View the Application-Aware routing statistics across the SD-WAN environment

Application Aware statistics can be monitored for each WAN transport in the SD-WAN environment from vManage GUI.

**Step 1.** Monitor the Application-Aware Routing across the SD-WAN environment.

To view the tunnel characteristics across the SD-WAN infrastructure, navigate to **vManage** >**Dashboard > Main Dashboard > Application-Aware Routing** widget.



| | |
|---|---|
| Control Up | 11 |
| Partial | 0 |
| Control Down | 0 |

**Site Health (Total 7)**

| | |
|---|---|
| Full WAN Connectivity | 4 sites |
| Partial WAN Connectivity | 3 sites |
| No WAN Connectivity | 0 sites |

**Transport Interface Distribution**

| | |
|---|---|
| < 10 Mbps | 94 |
| 10 Mbps - 100 Mbps | 0 |
| 100 Mbps - 500 Mbps | 0 |
| > 500 Mbps | 0 |

View Percent Utilization

**WAN Edge Inventory**

| | |
|---|---|
| Total | 14 |
| Authorized | 14 |
| Deployed | 11 |
| Staging | 0 |

**WAN Edge Health (Total 11)**

| Normal | Warning | Error |
|---|---|---|
| 8 | 3 | 0 |

**Application-Aware Routing** Type: By Loss

| Tunnel Endpoints | Avg. Latency (ms) | Avg. Loss (%) | Avg. Jitter (ms) |
|---|---|---|---|
| RS05-ASR1001X-04:public-internet-RS21-vE... | 0.337 | 34.586 | 0 |
| RS05-ASR1001X-04:public-internet-RS21-vE... | 0.34 | 34.226 | 0 |
| RS05-ASR1001X-04:public-internet-RS23-vE... | 0.333 | 34.084 | 0 |

**Step 2.** expand the widget by clicking the square icon in the top right corner of the Application-Aware Routing widget and select the **Chart options** to view the **Loss Percentage, Latency, Jitter** as far as past 7 days on the WAN transports.

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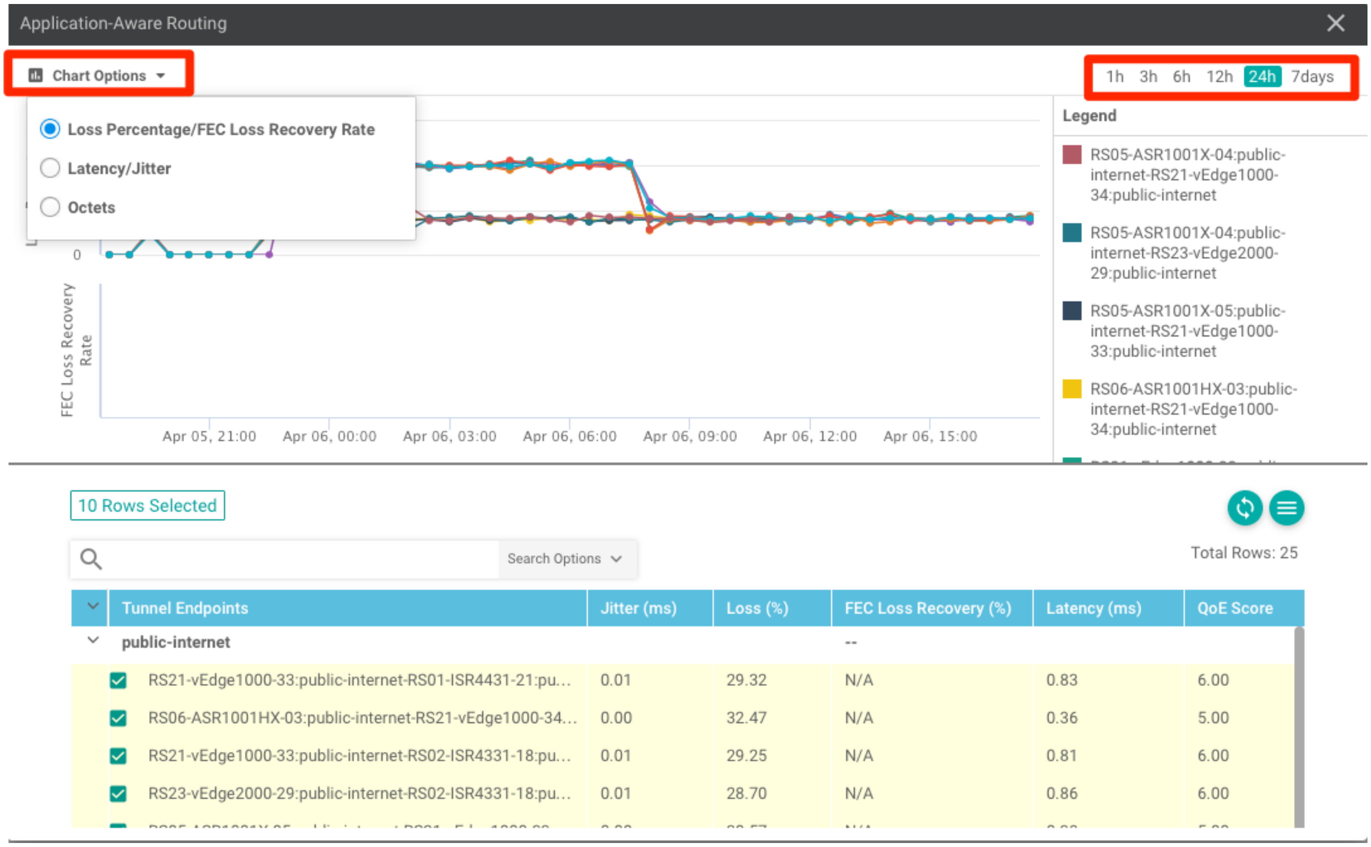

Application-Aware Routing

Chart Options

● Loss Percentage/FEC Loss Recovery Rate
○ Latency/Jitter
○ Octets

1h 3h 6h 12h [✓ 24h] 7days

Legend

- 🟥 RS05-ASR1001X-04:public-internet-RS21-vEdge1000-34:public-internet
- 🟦 RS05-ASR1001X-04:public-internet-RS23-vEdge2000-29:public-internet
- ■ RS05-ASR1001X-05:public-internet-RS21-vEdge1000-33:public-internet
- 🟨 RS06-ASR1001HX-03:public-internet-RS21-vEdge1000-34:public-internet

10 Rows Selected

Search Options

Total Rows: 25

| Tunnel Endpoints | Jitter (ms) | Loss (%) | FEC Loss Recovery (%) | Latency (ms) | QoE Score |
|---|---|---|---|---|---|
| public-internet | | | -- | | |
| ☑ RS21-vEdge1000-33:public-internet-RS01-ISR4431-21:pu... | 0.01 | 29.32 | N/A | 0.83 | 6.00 |
| ☑ RS06-ASR1001HX-03:public-internet-RS21-vEdge1000-34... | 0.00 | 32.47 | N/A | 0.36 | 5.00 |
| ☑ RS21-vEdge1000-33:public-internet-RS02-ISR4331-18:pu... | 0.01 | 29.25 | N/A | 0.81 | 6.00 |
| ☑ RS23-vEdge2000-29:public-internet-RS02-ISR4331-18:pu... | 0.01 | 28.70 | N/A | 0.86 | 6.00 |

## Procedure 2. View the Application-Aware routing statistics for the WAN Edge device

**Step 1.** Monitor the Application-Aware Routing statistics specific for the WAN Edge health.

To view the tunnel characteristics across the SD-WAN infrastructure, navigate to **vManage > Dashboard > Main Dashboard > Application-Aware Routing** widget.

Expand the widget by clicking the square icon in the top right corner of the Application-Aware Routing widget and select the **Chart options** to view the **Loss Percentage**, **Latency**, **Jitter.** Search the WAN Edge device in the search options and select the transports to view in the chart

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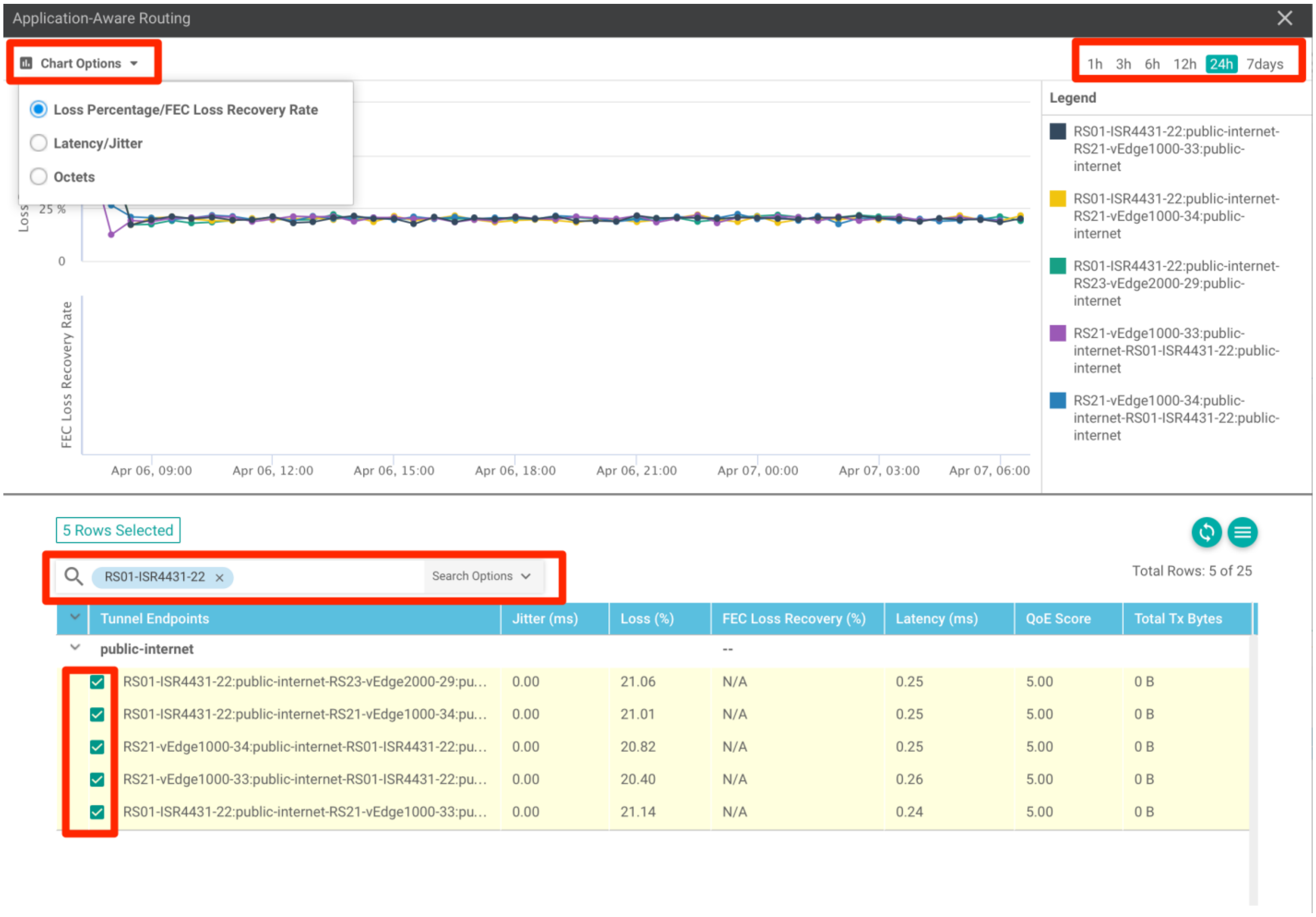
Application-Aware Routing
Chart Options
○ Loss Percentage/FEC Loss Recovery Rate
○ Latency/Jitter
○ Octets
1h 3h 6h 12h 24h 7days
Legend
RS01-ISR4431-22:public-internet-RS21-vEdge1000-33:public-internet
RS01-ISR4431-22:public-internet-RS21-vEdge1000-34:public-internet
RS01-ISR4431-22:public-internet-RS23-vEdge2000-29:public-internet
RS21-vEdge1000-33:public-internet-RS01-ISR4431-22:public-internet
RS21-vEdge1000-34:public-internet-RS01-ISR4431-22:public-internet
Loss
25 %
0
FEC Loss Recovery Rate
Apr 06, 09:00
Apr 06, 12:00
Apr 06, 15:00
Apr 06, 18:00
Apr 06, 21:00
Apr 07, 00:00
Apr 07, 03:00
Apr 07, 06:00
5 Rows Selected
RS01-ISR4431-22 ×
Search Options

Total Rows: 5 of 25

| | Tunnel Endpoints | Jitter (ms) | Loss (%) | FEC Loss Recovery (%) | Latency (ms) | QoE Score | Total Tx Bytes |
|---|---|---|---|---|---|---|---|
| | public-internet | | | -- | | | |
| ☑ | RS01-ISR4431-22:public-internet-RS23-vEdge2000-29:pu... | 0.00 | 21.06 | N/A | 0.25 | 5.00 | 0 B |
| ☑ | RS01-ISR4431-22:public-internet-RS21-vEdge1000-34:pu... | 0.00 | 21.01 | N/A | 0.25 | 5.00 | 0 B |
| ☑ | RS21-vEdge1000-34:public-internet-RS01-ISR4431-22:pu... | 0.00 | 20.82 | N/A | 0.25 | 5.00 | 0 B |
| ☑ | RS21-vEdge1000-33:public-internet-RS01-ISR4431-22:pu... | 0.00 | 20.40 | N/A | 0.26 | 5.00 | 0 B |
| ☑ | RS01-ISR4431-22:public-internet-RS21-vEdge1000-33:pu... | 0.00 | 21.14 | N/A | 0.24 | 5.00 | 0 B |

**Step 2.** View the App-route statistics on the WAN Edge device.

To view the App-route statistics, navigate to **vManage** > **Tools > SSH Terminal.** Select the WAN Edge device and issue **show sdwan app-route stats** on IOS-XE SD-WAN platform and **show app-route stats** on vipteal platform.

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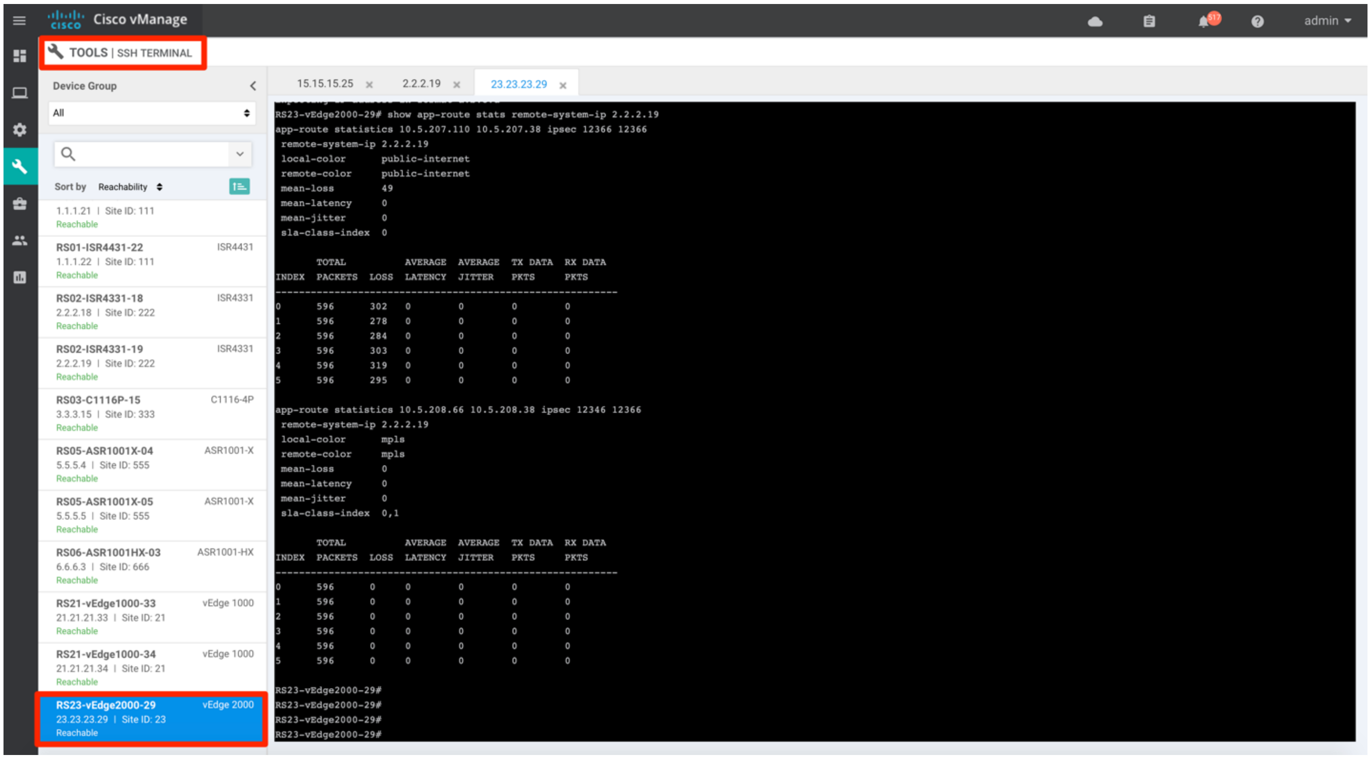


1.1.1.21 | Site ID: 111
Reachable

RS01-ISR4431-22 ISR4431
1.1.1.22 | Site ID: 111
Reachable

RS02-ISR4331-18 ISR4331
2.2.2.18 | Site ID: 222
Reachable

RS02-ISR4331-19 ISR4331
2.2.2.19 | Site ID: 222
Reachable

RS03-C1116P-15 C1116-4P
3.3.3.15 | Site ID: 333
Reachable

RS05-ASR1001X-04 ASR1001-X
5.5.5.4 | Site ID: 555
Reachable

RS05-ASR1001X-05 ASR1001-X
5.5.5.5 | Site ID: 555
Reachable

RS06-ASR1001HX-03 ASR1001-HX
6.6.6.3 | Site ID: 666
Reachable

RS21-vEdge1000-33 vEdge 1000
21.21.21.33 | Site ID: 21
Reachable

RS21-vEdge1000-34 vEdge 1000
21.21.21.34 | Site ID: 21
Reachable

RS23-vEdge2000-29 vEdge 2000
23.23.23.29 | Site ID: 23
Reachable

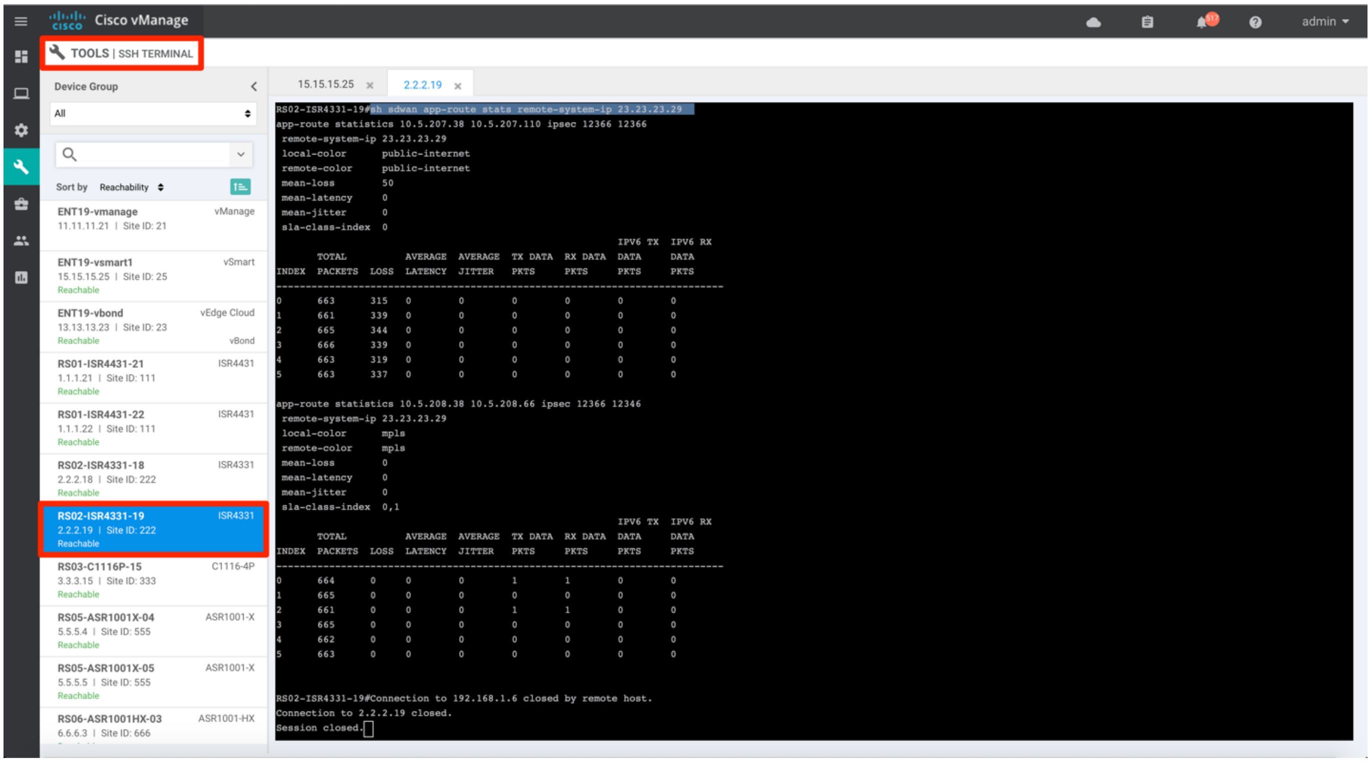
```
RS23-vEdge2000-29# show app-route stats remote-system-ip 2.2.2.19
app-route statistics 10.5.207.110 10.5.207.38 ipsec 12366 12366
 remote-system-ip 2.2.2.19
 local-color      public-internet
 remote-color     public-internet
 mean-loss        49
 mean-latency     0
 mean-jitter      0
 sla-class-index  0

       TOTAL          AVERAGE  AVERAGE  TX DATA  RX DATA
INDEX  PACKETS  LOSS  LATENCY  JITTER   PKTS     PKTS
----------------------------------------------------------
0      596      302   0        0        0        0
1      596      278   0        0        0        0
2      596      284   0        0        0        0
3      596      303   0        0        0        0
4      596      319   0        0        0        0
5      596      295   0        0        0        0

app-route statistics 10.5.208.66 10.5.208.38 ipsec 12346 12366
 remote-system-ip 2.2.2.19
 local-color      mpls
 remote-color     mpls
 mean-loss        0
 mean-latency     0
 mean-jitter      0
 sla-class-index  0,1

       TOTAL          AVERAGE  AVERAGE  TX DATA  RX DATA
INDEX  PACKETS  LOSS  LATENCY  JITTER   PKTS     PKTS
----------------------------------------------------------
0      596      0     0        0        0        0
1      596      0     0        0        0        0
2      596      0     0        0        0        0
3      596      0     0        0        0        0
4      596      0     0        0        0        0
5      596      0     0        0        0        0

RS23-vEdge2000-29#
RS23-vEdge2000-29#
RS23-vEdge2000-29#
RS23-vEdge2000-29#
```



ENT19-vmanage vManage
11.11.11.21 | Site ID: 21

ENT19-vsmart1 vSmart
15.15.15.25 | Site ID: 25
Reachable

ENT19-vbond vEdge Cloud
13.13.13.23 | Site ID: 23
Reachable vBond

RS01-ISR4431-21 ISR4431
1.1.1.21 | Site ID: 111
Reachable

RS01-ISR4431-22 ISR4431
1.1.1.22 | Site ID: 111
Reachable

RS02-ISR4331-18 ISR4331
2.2.2.18 | Site ID: 222
Reachable

RS02-ISR4331-19 ISR4331
2.2.2.19 | Site ID: 222
Reachable

RS03-C1116P-15 C1116-4P
3.3.3.15 | Site ID: 333
Reachable

RS05-ASR1001X-04 ASR1001-X
5.5.5.4 | Site ID: 555
Reachable

RS05-ASR1001X-05 ASR1001-X
5.5.5.5 | Site ID: 555
Reachable

RS06-ASR1001HX-03 ASR1001-HX
6.6.6.3 | Site ID: 666

```
RS02-ISR4331-19#sh sdwan app-route stats remote-system-ip 23.23.23.29
app-route statistics 10.5.207.38 10.5.207.110 ipsec 12366 12366
 remote-system-ip 23.23.23.29
 local-color      public-internet
 remote-color     public-internet
 mean-loss        50
 mean-latency     0
 mean-jitter      0
 sla-class-index  0
                                                          IPV6 TX  IPV6 RX
       TOTAL          AVERAGE  AVERAGE  TX DATA  RX DATA  DATA     DATA
INDEX  PACKETS  LOSS  LATENCY  JITTER   PKTS     PKTS     PKTS     PKTS
----------------------------------------------------------------------------
0      663      315   0        0        0        0        0        0
1      661      339   0        0        0        0        0        0
2      665      344   0        0        0        0        0        0
3      666      339   0        0        0        0        0        0
4      663      319   0        0        0        0        0        0
5      663      337   0        0        0        0        0        0

app-route statistics 10.5.208.38 10.5.208.66 ipsec 12366 12346
 remote-system-ip 23.23.23.29
 local-color      mpls
 remote-color     mpls
 mean-loss        0
 mean-latency     0
 mean-jitter      0
 sla-class-index  0,1
                                                          IPV6 TX  IPV6 RX
       TOTAL          AVERAGE  AVERAGE  TX DATA  RX DATA  DATA     DATA
INDEX  PACKETS  LOSS  LATENCY  JITTER   PKTS     PKTS     PKTS     PKTS
----------------------------------------------------------------------------
0      664      0     0        0        1        1        0        0
1      665      0     0        0        0        0        0        0
2      661      0     0        0        1        1        0        0
3      665      0     0        0        0        0        0        0
4      662      0     0        0        0        0        0        0
5      663      0     0        0        0        0        0        0


RS02-ISR4331-19#Connection to 192.168.1.6 closed by remote host.
Connection to 2.2.2.19 closed.
Session closed.
```

## Process: Monitor Events – SLA, BFD, App-route changes

### Procedure 1. View the Events – SLA, BFD, App-Route

Application-Aware routing specific events related to SLA changes, BFD events, and App-route events can be monitored across the SD-WAN environment from vManage GUI.

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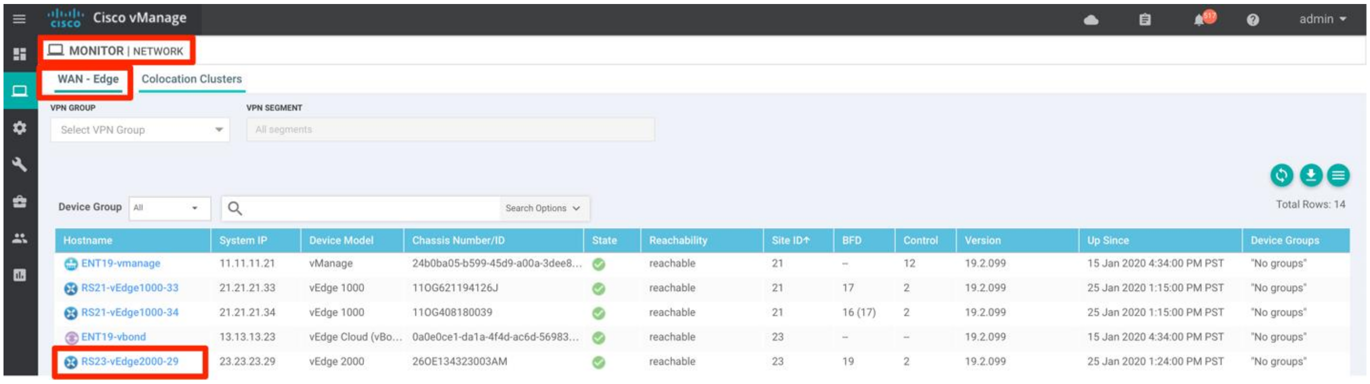
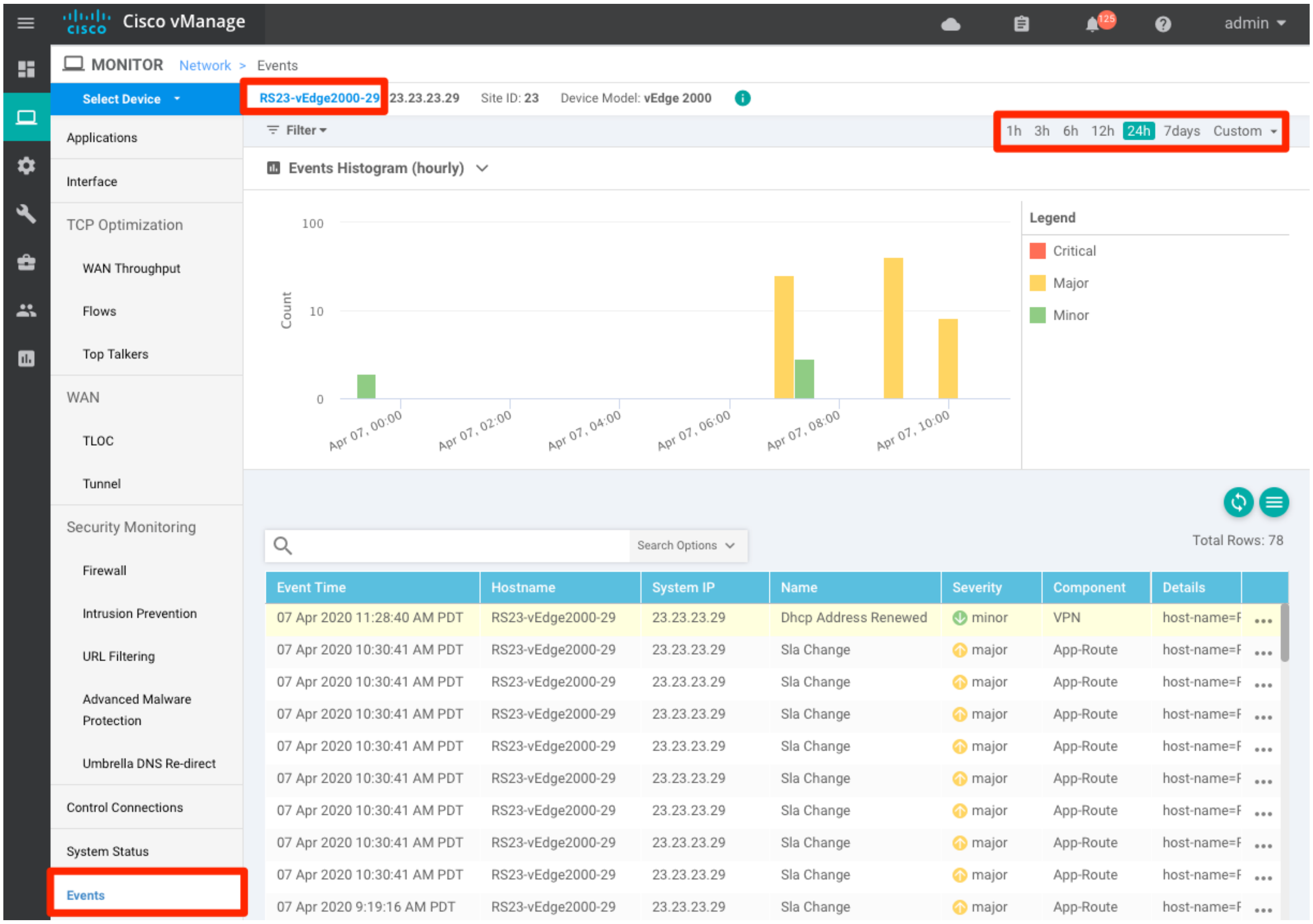
**Step 1.** To view the events on the WAN Edge device, navigate to **vManage > Monitor > Network > WAN - Edge**. click on the specific WAN Edge device.



| Hostname | System IP | Device Model | Chassis Number/ID | State | Reachability | Site ID↑ | BFD | Control | Version | Up Since | Device Groups |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ENT19-vmanage | 11.11.11.21 | vManage | 24b0ba05-b599-45d9-a00a-3dee8... | ✓ | reachable | 21 | – | 12 | 19.2.099 | 15 Jan 2020 4:34:00 PM PST | "No groups" |
| RS21-vEdge1000-33 | 21.21.21.33 | vEdge 1000 | 11OG621194126J | ✓ | reachable | 21 | 17 | 2 | 19.2.099 | 25 Jan 2020 1:15:00 PM PST | "No groups" |
| RS21-vEdge1000-34 | 21.21.21.34 | vEdge 1000 | 11OG408180039 | ✓ | reachable | 21 | 16 (17) | 2 | 19.2.099 | 25 Jan 2020 1:15:00 PM PST | "No groups" |
| ENT19-vbond | 13.13.13.23 | vEdge Cloud (vBo... | 0a0e0ce1-da1a-4f4d-ac6d-56983... | ✓ | reachable | 23 | – | – | 19.2.099 | 15 Jan 2020 4:34:00 PM PST | "No groups" |
| RS23-vEdge2000-29 | 23.23.23.29 | vEdge 2000 | 26OE134323003AM | ✓ | reachable | 23 | 19 | 2 | 19.2.099 | 25 Jan 2020 1:24:00 PM PST | "No groups" |

**Step 2.** click **Events** from the left panel options for the device.



| Event Time | Hostname | System IP | Name | Severity | Component | Details |
|---|---|---|---|---|---|---|
| 07 Apr 2020 11:28:40 AM PDT | RS23-vEdge2000-29 | 23.23.23.29 | Dhcp Address Renewed | minor | VPN | host-name=F ... |
| 07 Apr 2020 10:30:41 AM PDT | RS23-vEdge2000-29 | 23.23.23.29 | Sla Change | major | App-Route | host-name=F ... |
| 07 Apr 2020 10:30:41 AM PDT | RS23-vEdge2000-29 | 23.23.23.29 | Sla Change | major | App-Route | host-name=F ... |
| 07 Apr 2020 10:30:41 AM PDT | RS23-vEdge2000-29 | 23.23.23.29 | Sla Change | major | App-Route | host-name=F ... |
| 07 Apr 2020 10:30:41 AM PDT | RS23-vEdge2000-29 | 23.23.23.29 | Sla Change | major | App-Route | host-name=F ... |
| 07 Apr 2020 10:30:41 AM PDT | RS23-vEdge2000-29 | 23.23.23.29 | Sla Change | major | App-Route | host-name=F ... |
| 07 Apr 2020 10:30:41 AM PDT | RS23-vEdge2000-29 | 23.23.23.29 | Sla Change | major | App-Route | host-name=F ... |
| 07 Apr 2020 10:30:41 AM PDT | RS23-vEdge2000-29 | 23.23.23.29 | Sla Change | major | App-Route | host-name=F ... |
| 07 Apr 2020 10:30:41 AM PDT | RS23-vEdge2000-29 | 23.23.23.29 | Sla Change | major | App-Route | host-name=F ... |
| 07 Apr 2020 9:19:16 AM PDT | RS23-vEdge2000-29 | 23.23.23.29 | Sla Change | major | App-Route | host-name=F ... |

**Step 3.** Click **Filter** > **Filter By** > **Component.** choose **BFD**, **App-route** from the drop-down options and click **Search.**

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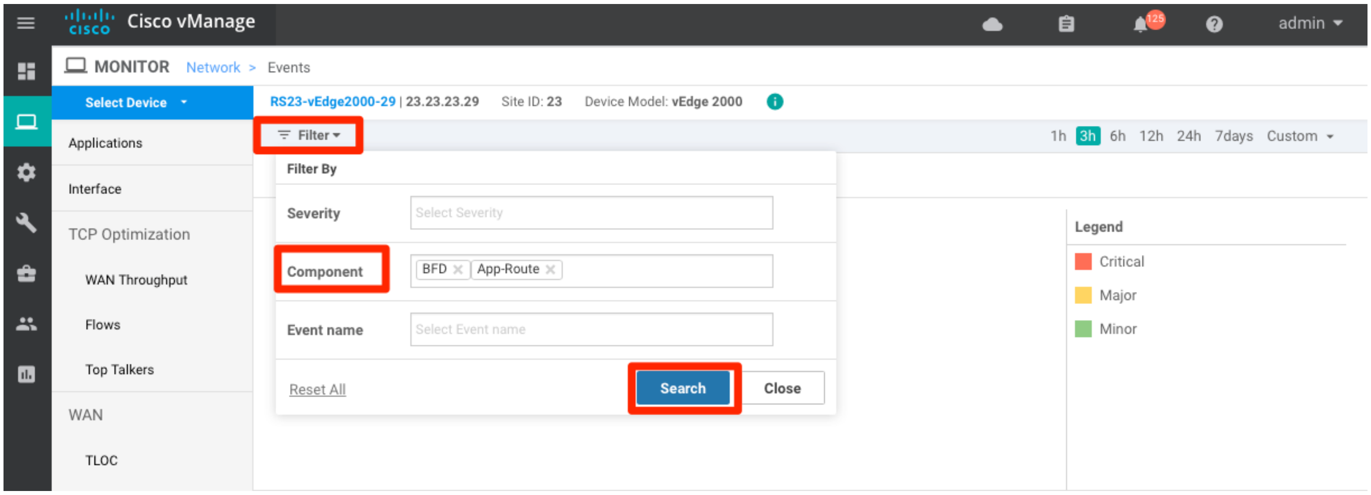


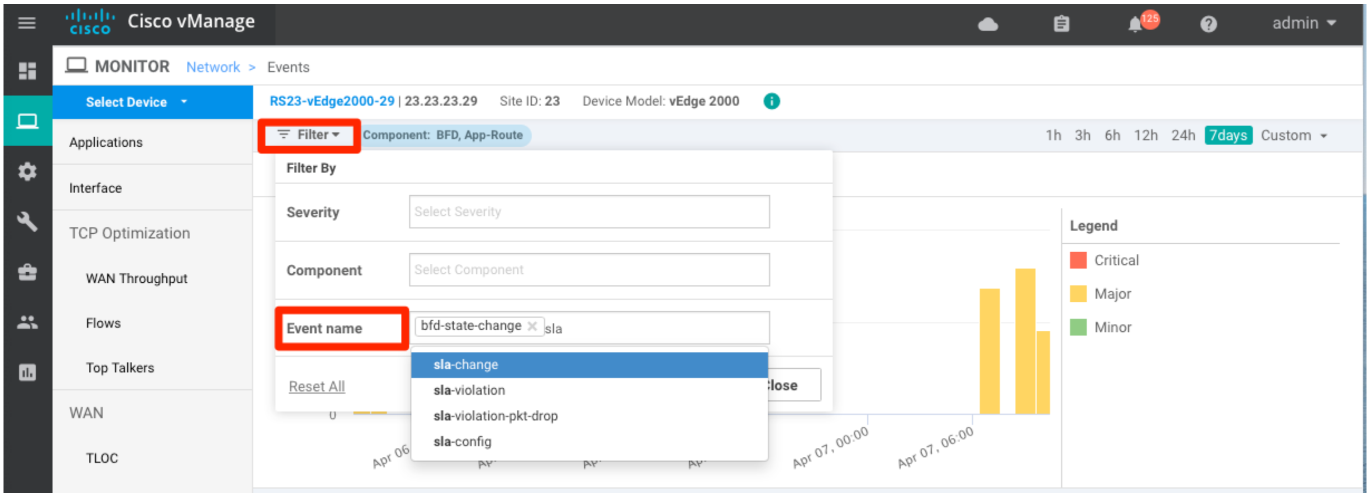
RS23-vEdge2000-29 | 23.23.23.29 Site ID: 23 Device Model: vEdge 2000

Severity:

Component: BFD, App-Route

Event name:

Alternatively, you can also filter on **Event Name** as shown below



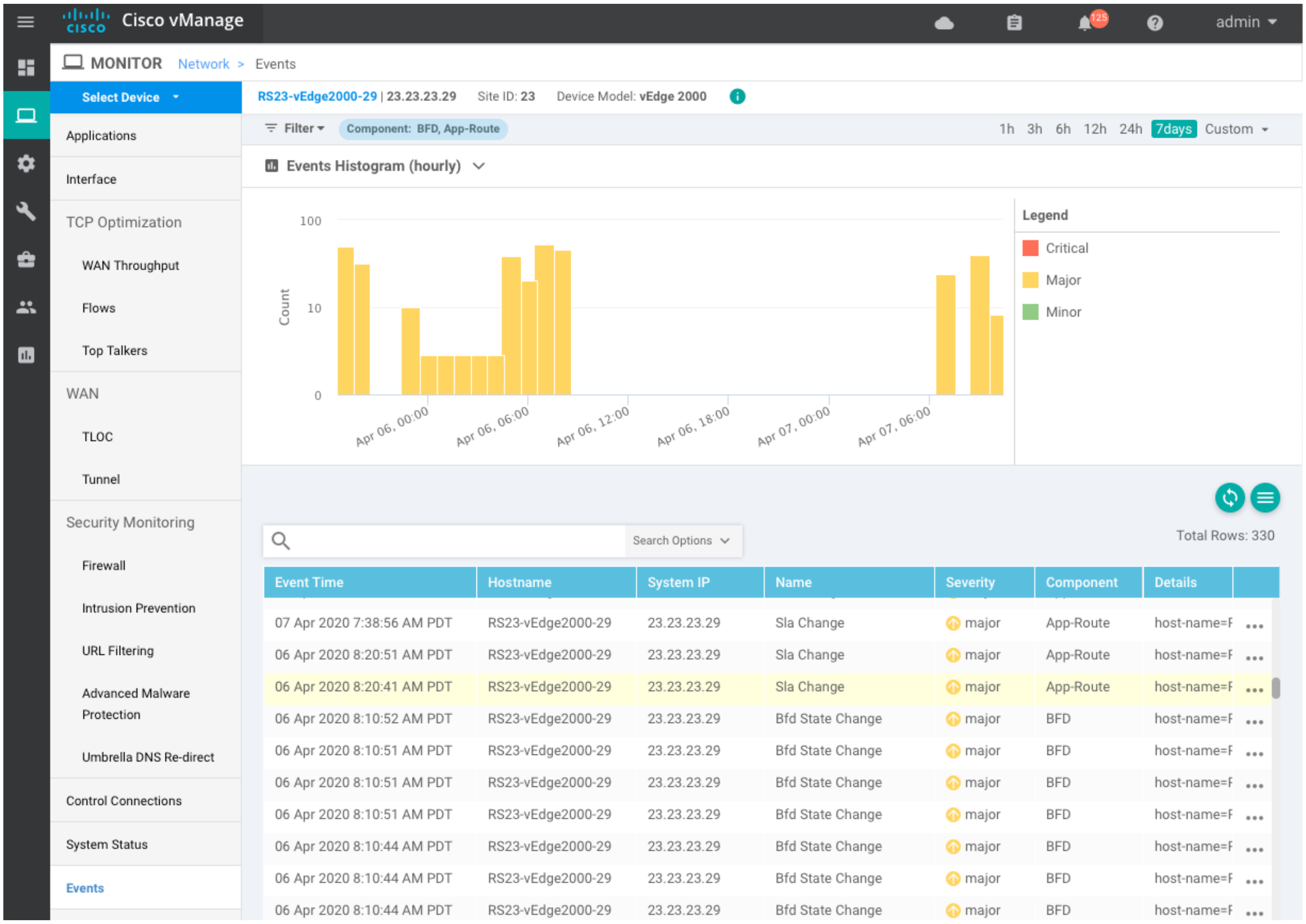
RS23-vEdge2000-29 | 23.23.23.29 Site ID: 23 Device Model: vEdge 2000

Component: BFD, App-Route

Severity:

Component:

Event name: bfd-state-change sla



RS23-vEdge2000-29 | 23.23.23.29 Site ID: 23 Device Model: vEdge 2000

Component: BFD, App-Route

Total Rows: 330

| Event Time | Hostname | System IP | Name | Severity | Component | Details |
|---|---|---|---|---|---|---|
| 07 Apr 2020 7:38:56 AM PDT | RS23-vEdge2000-29 | 23.23.23.29 | Sla Change | major | App-Route | host-name=F ••• |
| 06 Apr 2020 8:20:51 AM PDT | RS23-vEdge2000-29 | 23.23.23.29 | Sla Change | major | App-Route | host-name=F ••• |
| 06 Apr 2020 8:20:41 AM PDT | RS23-vEdge2000-29 | 23.23.23.29 | Sla Change | major | App-Route | host-name=F ••• |
| 06 Apr 2020 8:10:52 AM PDT | RS23-vEdge2000-29 | 23.23.23.29 | Bfd State Change | major | BFD | host-name=F ••• |
| 06 Apr 2020 8:10:51 AM PDT | RS23-vEdge2000-29 | 23.23.23.29 | Bfd State Change | major | BFD | host-name=F ••• |
| 06 Apr 2020 8:10:51 AM PDT | RS23-vEdge2000-29 | 23.23.23.29 | Bfd State Change | major | BFD | host-name=F ••• |
| 06 Apr 2020 8:10:51 AM PDT | RS23-vEdge2000-29 | 23.23.23.29 | Bfd State Change | major | BFD | host-name=F ••• |
| 06 Apr 2020 8:10:44 AM PDT | RS23-vEdge2000-29 | 23.23.23.29 | Bfd State Change | major | BFD | host-name=F ••• |
| 06 Apr 2020 8:10:44 AM PDT | RS23-vEdge2000-29 | 23.23.23.29 | Bfd State Change | major | BFD | host-name=F ••• |
| 06 Apr 2020 8:10:44 AM PDT | RS23-vEdge2000-29 | 23.23.23.29 | Bfd State Change | major | BFD | host-name=F ••• |

**Step 4.** Click the three dots on the right hands side of the event to view more details of the event

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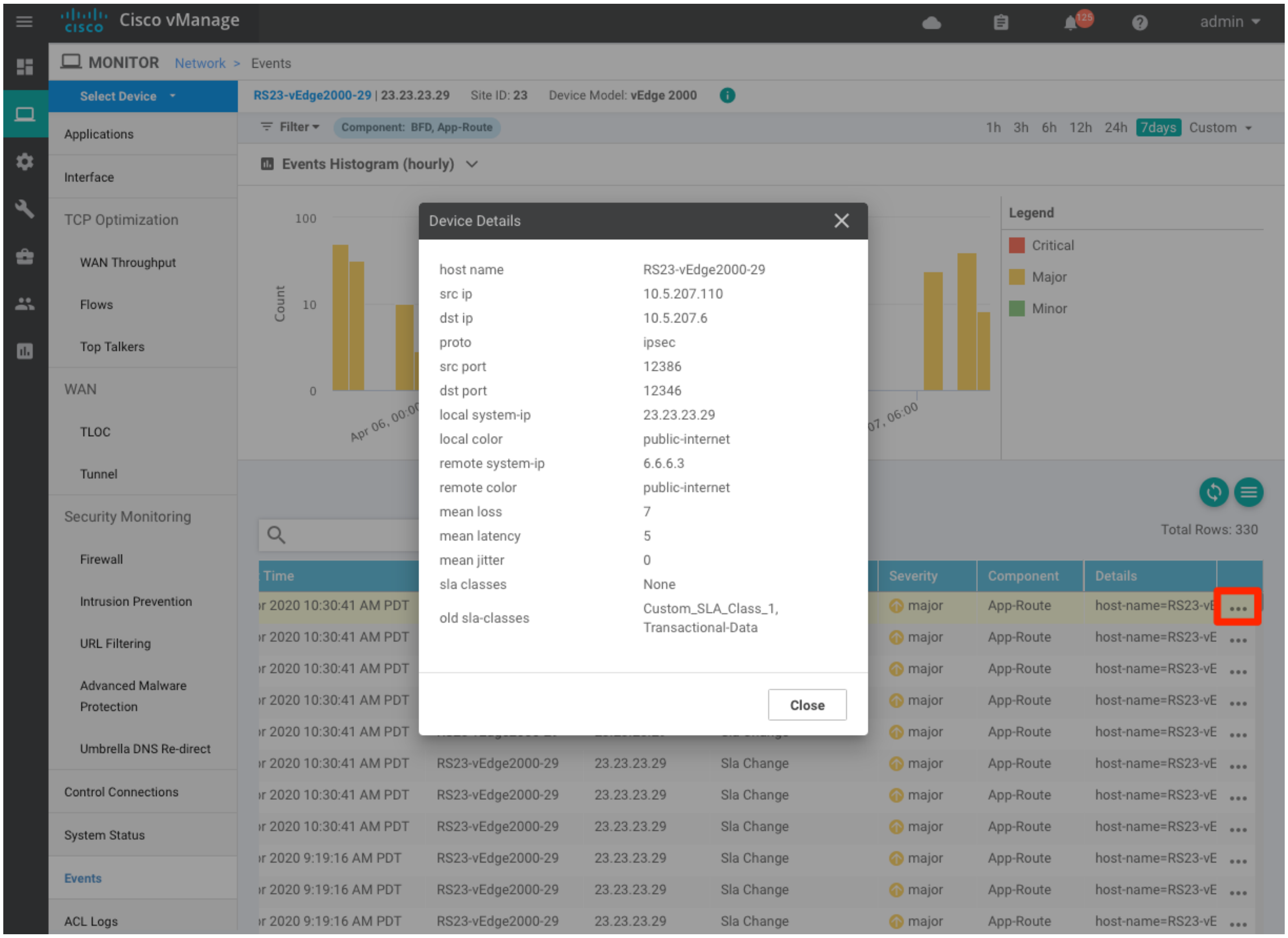

| | |
|---|---|
| host name | RS23-vEdge2000-29 |
| src ip | 10.5.207.110 |
| dst ip | 10.5.207.6 |
| proto | ipsec |
| src port | 12386 |
| dst port | 12346 |
| local system-ip | 23.23.23.29 |
| local color | public-internet |
| remote system-ip | 6.6.6.3 |
| remote color | public-internet |
| mean loss | 7 |
| mean latency | 5 |
| mean jitter | 0 |
| sla classes | None |
| old sla-classes | Custom_SLA_Class_1,<br>Transactional-Data |

| Time | | | | Severity | Component | Details |
|---|---|---|---|---|---|---|
| r 2020 10:30:41 AM PDT | | | | major | App-Route | host-name=RS23-vE |
| r 2020 10:30:41 AM PDT | | | | major | App-Route | host-name=RS23-vE |
| r 2020 10:30:41 AM PDT | | | | major | App-Route | host-name=RS23-vE |
| r 2020 10:30:41 AM PDT | | | | major | App-Route | host-name=RS23-vE |
| r 2020 10:30:41 AM PDT | | | | major | App-Route | host-name=RS23-vE |
| r 2020 10:30:41 AM PDT | RS23-vEdge2000-29 | 23.23.23.29 | Sla Change | major | App-Route | host-name=RS23-vE |
| r 2020 10:30:41 AM PDT | RS23-vEdge2000-29 | 23.23.23.29 | Sla Change | major | App-Route | host-name=RS23-vE |
| r 2020 10:30:41 AM PDT | RS23-vEdge2000-29 | 23.23.23.29 | Sla Change | major | App-Route | host-name=RS23-vE |
| r 2020 9:19:16 AM PDT | RS23-vEdge2000-29 | 23.23.23.29 | Sla Change | major | App-Route | host-name=RS23-vE |
| r 2020 9:19:16 AM PDT | RS23-vEdge2000-29 | 23.23.23.29 | Sla Change | major | App-Route | host-name=RS23-vE |
| r 2020 9:19:16 AM PDT | RS23-vEdge2000-29 | 23.23.23.29 | Sla Change | major | App-Route | host-name=RS23-vE |

## Process: Visualize traffic path selection on the WAN Edge

### Procedure 1. Visualize real-time Application-Aware routing enforcement in vManage

vManage has a very useful tool for network administrators to simulate traffic on the Service side on the Viptela platform and view the traffic path taken on the WAN Edge to confirm the desired policy enforcement.

**Step 1.** Simulate the traffic flow from service side to remote branch service site with App-Aware routing enabled.

In vManage, navigate to **Monitor > Network.** Select the WAN Edge device and click the **Troubleshooting** option from the left-side panel. Click **Traffic** section > **Simulate Flows**

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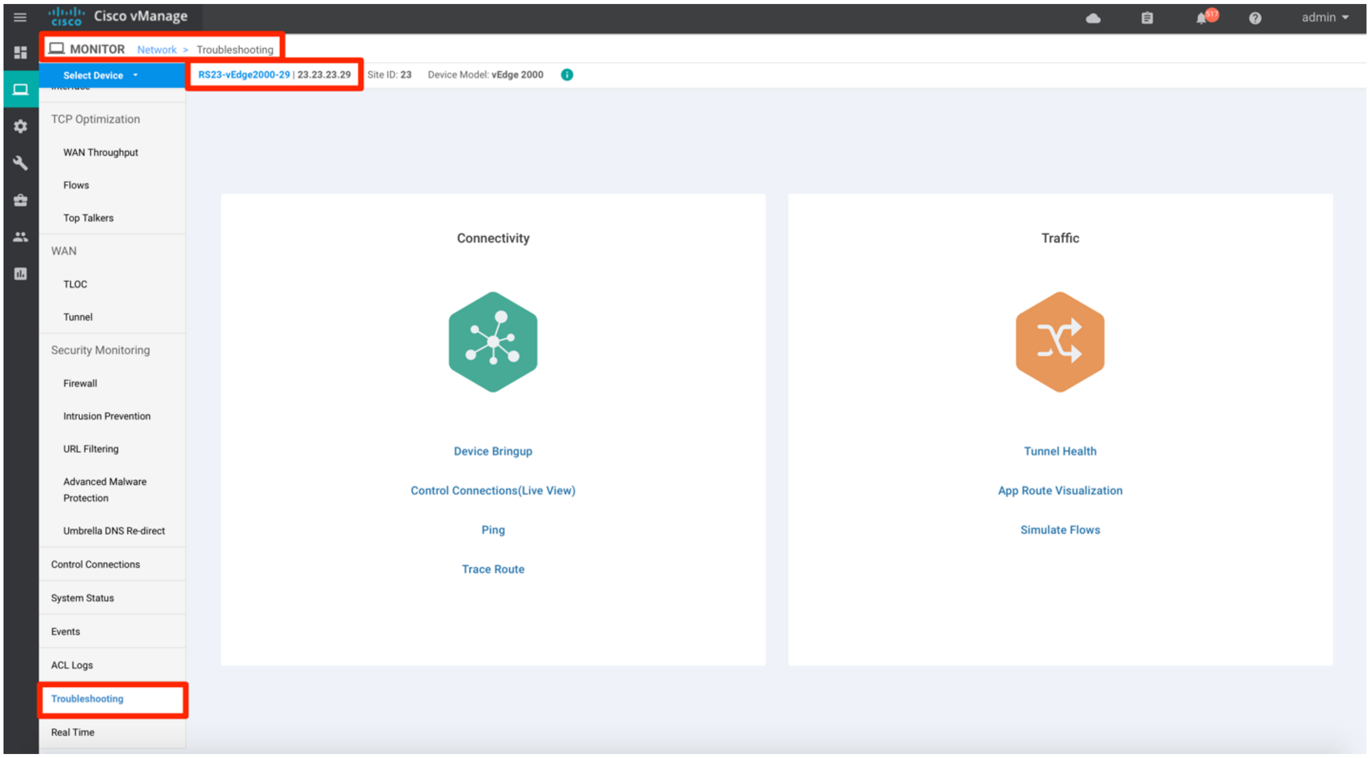
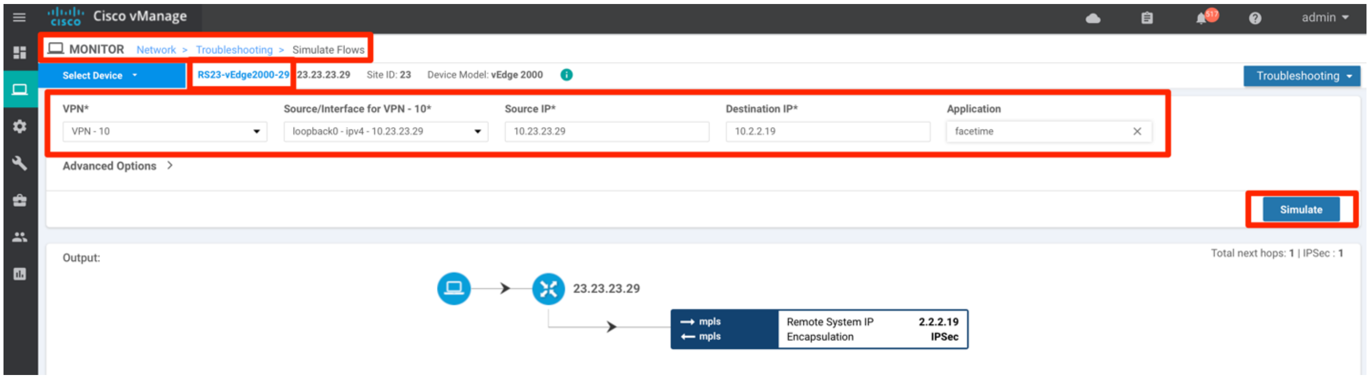




VPN*: VPN - 10

Source/Interface for VPN - 10*: loopback0 - ipv4 - 10.23.23.29

Source IP*: 10.23.23.29

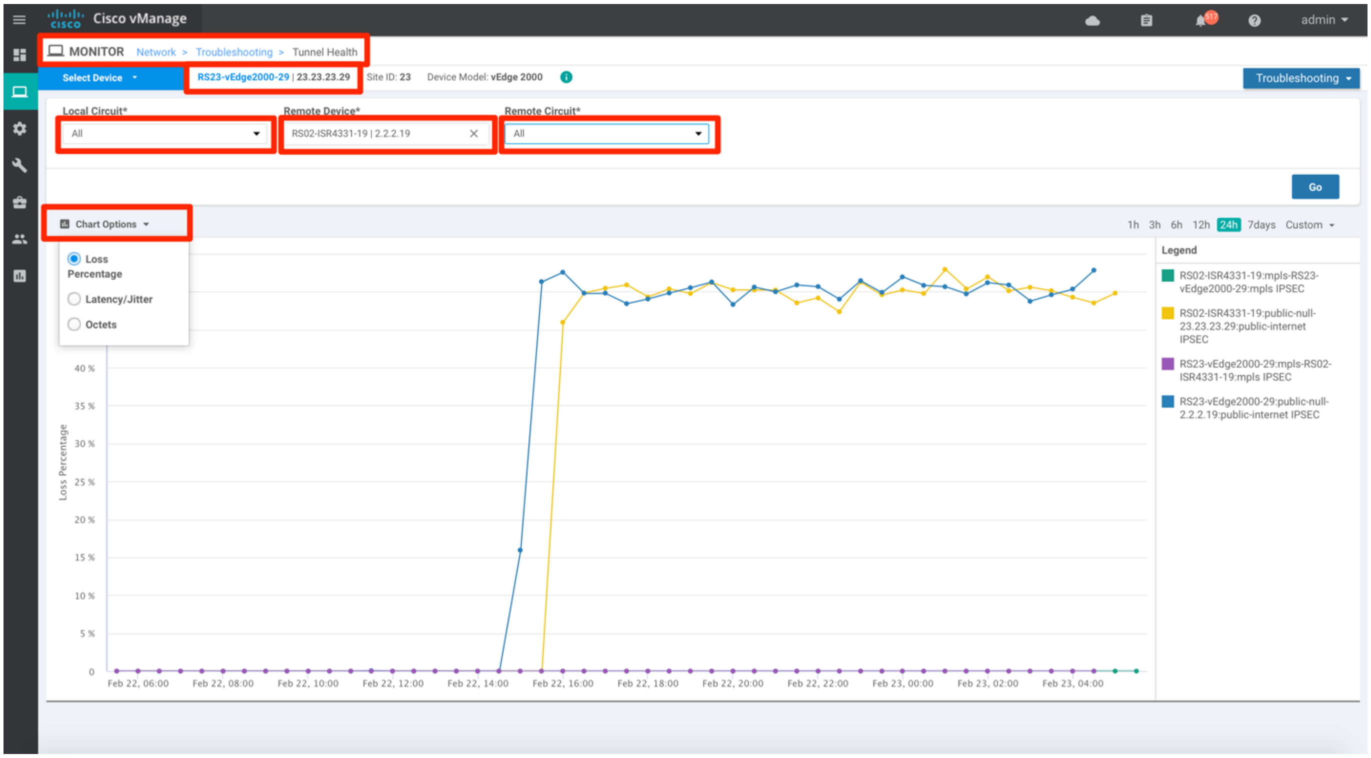
Destination IP*: 10.2.2.19

Application: facetime

Total next hops: 1 | IPSec : 1

Remote System IP 2.2.2.19
Encapsulation IPSec

**Step 2.** View the Tunnel health by navigating to vManage, **Monitor > Network,** select the WAN Edge device and click the **Troubleshooting** option from the left-side panel. Click **Traffic** section > **Tunnel Health** to view the tunnel health (**Loss percentage, Latency, Jitter**) between the WAN Edge device and the selected Remote WAN Edge device.



MONITOR Network > Troubleshooting > Tunnel Health

Select Device: RS23-vEdge2000-29 | 23.23.23.29 Site ID: 23 Device Model: vEdge 2000

Local Circuit*: All

Remote Device*: RS02-ISR4331-19 | 2.2.2.19

Remote Circuit*: All

Chart Options: ● Loss Percentage ○ Latency/Jitter ○ Octets

Legend

- 🟩 RS02-ISR4331-19:mpls-RS23-vEdge2000-29:mpls IPSEC
- 🟨 RS02-ISR4331-19:public-null-23.23.23.29:public-internet IPSEC
- 🟪 RS23-vEdge2000-29:mpls-RS02-ISR4331-19:mpls IPSEC
- 🟦 RS23-vEdge2000-29:public-null-2.2.2.19:public-internet IPSEC

With Application-Aware Routing policy enabled, the WAN Edge device considers the tunnel health to forward the traffic. In the above example, the public-internet WAN transport has significant loss, Latency and doesn't meet the SLA defined. The WAN Edge is preferring the MPLS transport to forward the service-side traffic as defined in the policy.

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# Appendix A: Product List

The following products and software versions are included as part of validation in this deployment guide. This validated set is not inclusive of all possibilities.

**Table 1.** Cisco SD-WAN Solution

| Functional area | Product | Software version |
|---|---|---|
| Cisco SD-WAN controllers | Cisco vManage, Cisco vSmart, and Cisco vBond controllers | 19.2.099 |
| Cisco IOS-XE SD-WAN Device | ISR4K, ASR1K | 16.12.02r |
| Cisco vEdge Device | vEdge, vEdge 1000 | 19.2.099 |
| Server | Hypervisor/vSphere client | VMware ESXi, 6.7.0, 10302608/version 6.7.0.20000 |

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## Feedback

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