

High Availability Configuration Guide for vEdge Routers, Cisco SD-WAN Release 20

First Published: 2020-05-15

Last Modified: 2021-04-22

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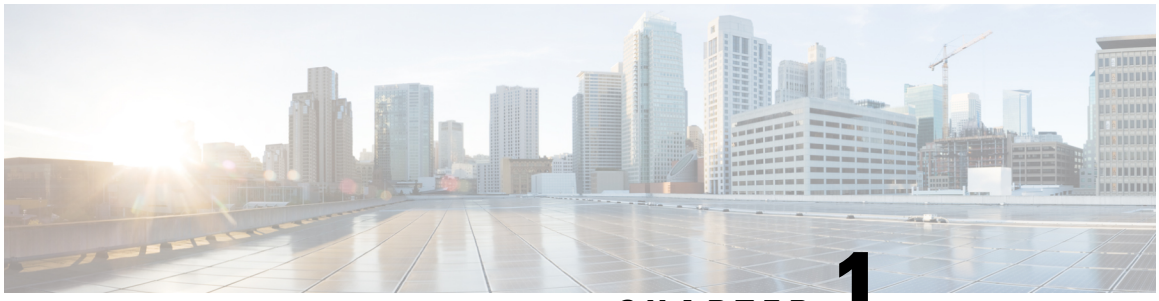
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CHAPTER 1

Read Me First

Note To achieve simplification and consistency, the Cisco SD-WAN solution has been rebranded as Cisco Catalyst SD-WAN. In addition, from Cisco IOS XE SD-WAN Release 17.12.1a and Cisco Catalyst SD-WAN Release 20.12.1, the following component changes are applicable: **Cisco vManage** to **Cisco Catalyst SD-WAN Manager**, **Cisco vAnalytics** to **Cisco Catalyst SD-WAN Analytics**, **Cisco vBond** to **Cisco Catalyst SD-WAN Validator**, **Cisco vSmart** to **Cisco Catalyst SD-WAN Controller**, and **Cisco Controllers** to **Cisco Catalyst SD-WAN Control Components**. See the latest Release Notes for a comprehensive list of all the component brand name changes. While we transition to the new names, some inconsistencies might be present in the documentation set because of a phased approach to the user interface updates of the software product.

Related References

- Cisco Catalyst SD-WAN Control Components Compatibility Matrix and Server Recommendations
- Cisco Catalyst SD-WAN Device Compatibility

User Documentation

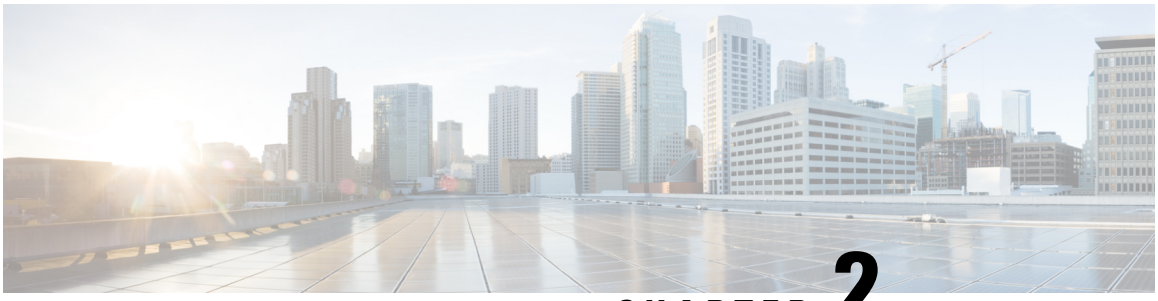
- User Documentation for Cisco SD-WAN Release 20

Communications, Services, and Additional Information

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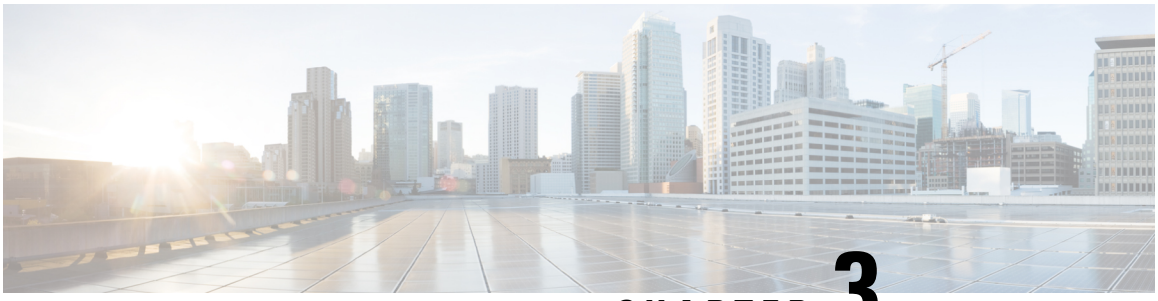


CHAPTER 2

What's New in Cisco IOS XE (Catalyst SD-WAN)

What's New in Cisco IOS XE Catalyst SD-WAN Release 17.x

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



CHAPTER 3

High Availability Overview

The goal of any high availability solution is to ensure that all network services are resilient to failure. Such a solution aims to provide continuous access to network resources by addressing the potential causes of downtime through functionality, design, and best practices. The core of the Cisco Catalyst SD-WAN high availability solution is achieved through a combination of three factors:

- Functional hardware device redundancy. The basic strategy consists of installing and provisioning redundant hardware devices and redundant components on the hardware. These devices are connected by a secure control plane mesh of Datagram Transport Layer Security (DTLS) connections among themselves, which allows for rapid failover should a device fail or otherwise become unavailable. A key feature of the Cisco Catalyst SD-WAN control plane is that it is established and maintained automatically, by the Cisco vEdge devices and software themselves.
- Robust network design.
- Software mechanisms ensure rapid recovery from a failure. To provide a resilient control plane, the Cisco Catalyst SD-WAN Overlay Management Protocol (OMP) regularly monitors the status of all Cisco vEdge devices in the network and automatically adjusts to changes in the topology as devices join and leave the network. For data plane resiliency, the Cisco Catalyst SD-WAN software implements standard protocol mechanisms, specifically Bidirectional Forwarding Detection (BFD), which runs on the secure IPsec tunnels between routers.

Recovery from a failure is a function of the time it takes to detect the failure and then repair or recover from it. TheCisco Catalyst SD-WAN solution provides the ability to control the amount of time to detect a failure in the network. In most cases, repair of the failure is fairly instantaneous.

Hardware Support of High Availability

A standard best practice in any network setup is to install redundant hardware at all levels, including duplicate parallel routers and other systems, redundant fans, power supplies and other hardware components within these devices, and backup network connections. Providing high availability in the Cisco Catalyst SD-WAN solution is no different. A network design that is resilient in the face of hardware failure should include redundant Cisco Catalyst SD-WAN Validators, Cisco Catalyst SD-WAN Controllers, and routers and any available redundant hardware components.

Recovery from the total failure of a hardware component in the Cisco Catalyst SD-WAN overlay network happens in basically the same way as in any other network. A backup component has been preconfigured, and it is able to perform all necessary functions by itself.

Robust Network Design

In addition to simple duplication of hardware components, the high availability of a Cisco Catalyst SD-WAN network can be enhanced by following best practices to design a network that is robust in the face of failure. In one such network design, redundant components are spread around the network as much as possible. Design practices include situating redundant Cisco Catalyst SD-WAN Validators and Cisco Catalyst SD-WAN Controllers at dispersed geographical locations and connecting them to different transport networks. Similarly, the routers at a local site can connect to different transport networks and can reach these networks through different NATs and DMZs.

Software Support of High Availability

The Cisco Catalyst SD-WAN software support for high availability and resiliency in the face of failure is provided both in the control plane, using the standard DTLS protocol and the proprietary Cisco Catalyst SD-WAN Overlay Management Protocol (OMP), and in the data plane, using the industry-standard protocols BFD, BGP, OSPF, and VRRP.

Control Plane Software Support of High Availability

The Cisco Catalyst SD-WAN control plane operates in conjunction with redundant components to ensure that the overlay network remains resilient if one of the components fails. The control plane is built on top of DTLS connections between the Cisco devices, and it is monitored by the Cisco Catalyst SD-WAN OMP protocol, which establishes peering sessions (similar to BGP peering sessions) between pairs of vSmart controllers and routers, and between pairs of vSmart controllers. These peering sessions allow OMP to monitor the status of the Cisco devices and to share the information among them so that each device in the network has a consistent view of the overlay network. The exchange of control plane information over OMP peering sessions is a key piece in the Cisco Catalyst SD-WAN high availability solution:

- vSmart controllers quickly and automatically learn when a vBond orchestrator or a router joins or leaves the network. They can then rapidly make the necessary modifications in the route information that they send to the routers.
- vBond orchestrators quickly and automatically learn when a device joins the network and when a vSmart controller leaves the network. They can then rapidly make the necessary changes to the list of vSmart controller IP addresses that they send to routers joining the network.
- vBond orchestrators learn when a domain has multiple vSmart controllers and can then provide multiple vSmart controller addresses to routers joining the network.
- vSmart controllers learn about the presence of other vSmart controllers, and they all automatically synchronize their route tables. If one vSmart controller fails, the remaining systems take over management of the control plane, simply and automatically, and all routers in the network continue to receive current, consistent routing and TLOC updates from the remaining vSmart controllers.

Let's look at the redundancy provided by each of the Cisco Catalyst SD-WAN hardware devices in support of network high availability.

Recovering from a Failure in the Control Plane

The combination of hardware component redundancy with the architecture of the Cisco Catalyst SD-WAN control plane results in a highly available network, one that continues to operate normally and without interruption when a failure occurs in one of the redundant control plane components. Recovery from the total failure of a vSmart controller, vBond orchestrator, or router in the Cisco Catalyst SD-WAN overlay network

happens in basically the same way as the recovery from the failure of a regular router or server on the network: A preconfigured backup component is able to perform all necessary functions by itself.

In the Cisco Catalyst SD-WAN solution, when a network device fails and a redundant device is present, network operation continues without interruption. This is true for all Cisco devices—vBond orchestrators, vSmart controllers, and routers. No user configuration is required to implement this behavior; it happens automatically. The OMP peering sessions running between Cisco devices ensure that all the devices have a current and accurate view of the network topology.

Let's examine failure recovery device by device.

Data Plane Software Support for High Availability

For data plane resiliency, the Cisco Catalyst SD-WAN software implements the standard BFD protocol, which runs automatically on the secure IPsec connections between routers. These IPsec connections are used for the data plane, and for data traffic, and are independent of the DTLS tunnels used by the control plane. BFD is used to detect connection failures between the routers. It measures data loss and latency on the data tunnel to determine the status of the devices at either end of the connection.

BFD is enabled, by default, on connections between Cisco IOS XE Catalyst SD-WAN devices and Cisco vEdge devices. BFD sends Hello packets periodically (by default, every 1 second) to determine whether the session is still operational. If a certain number of the Hello packets are not received, BFD considers that the link has failed and brings the BFD session down (the default dead time is 3 seconds). When BFD sessions goes down, any route that points to a next hop over that IPsec tunnel is removed from the forwarding table (FIB), but it is still present in the route table (RIB).

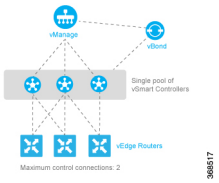
In the Cisco Catalyst SD-WAN software, you can adjust the Hello packet and dead time intervals. If the timers on the two ends of a BFD link are different, BFD negotiates to use the lower value.

Using Affinity To Manage Network Scaling

In the Cisco Catalyst SD-WAN overlay network, all Cisco IOS XE Catalyst SD-WAN devices and Cisco vEdge devices establish control connections to all vSmart controllers, to ensure that the routers are always able to properly route data traffic across the network. As networks increase in size, with routers at thousands of sites and with vSmart controllers in multiple data centers managing the flow of control and data traffic among routers, network operation can be improved by limiting the number of vSmart controllers that a router can connect to. When data centers are distributed across a broad geography, network operation can also be better managed by having routers establish control connections only with the vSmart controllers collocated in the same geographic region.

Establishing affinity between vSmart controllers and Cisco vEdge devices allow you to control the scaling of the overlay network, by limiting the number of vSmart controllers that a Cisco vEdge device can establish control connections (and form TLOCs) with. When you have redundant routers in a single data center, affinity allows you to distribute the vEdge control connections across the vSmart controllers. Similarly, when you have multiple data centers in the overlay network, affinity allows you to distribute the vEdge control connections across the data centers. With affinity, you can also define primary and backup control connections, to maintain overlay network operation in case the connection to a single vSmart controller or to a single data center fails.

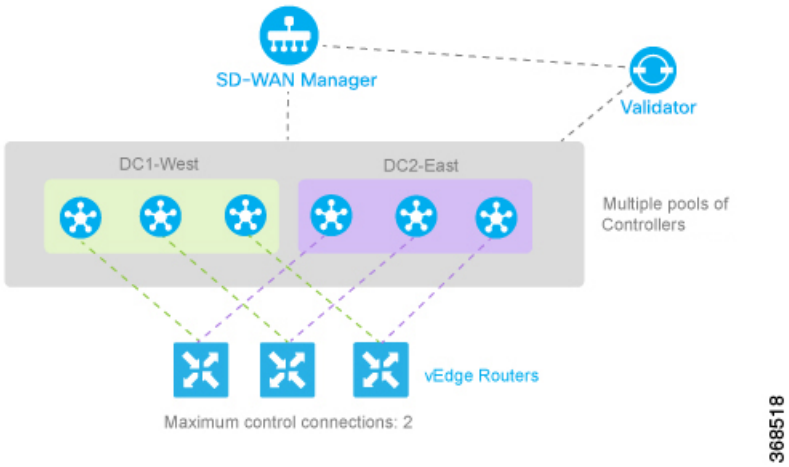
A simple case for using affinity is when redundant vSmart controllers are collocated in a single data center. Together, these vSmart controllers service all the Cisco vEdge devices in the overlay network. The figure below illustrates this situation, showing a scenario with three vSmart controllers in the data center and, for simplicity, showing just three of the many Cisco vEdge devices in the network.



If you do not enable affinity, each Cisco vEdge device establishes a control connection—that is, a TLOC—to each of the three vSmart controllers in the data center. Thus, a total of nine TLOCs are established, and each router exchanges OMP updates with each controller. Having this many TLOCs can strain the resources of both the vSmart controllers and the Cisco vEdge devices , and the strain increases in networks with larger numbers of Cisco vEdge devices .

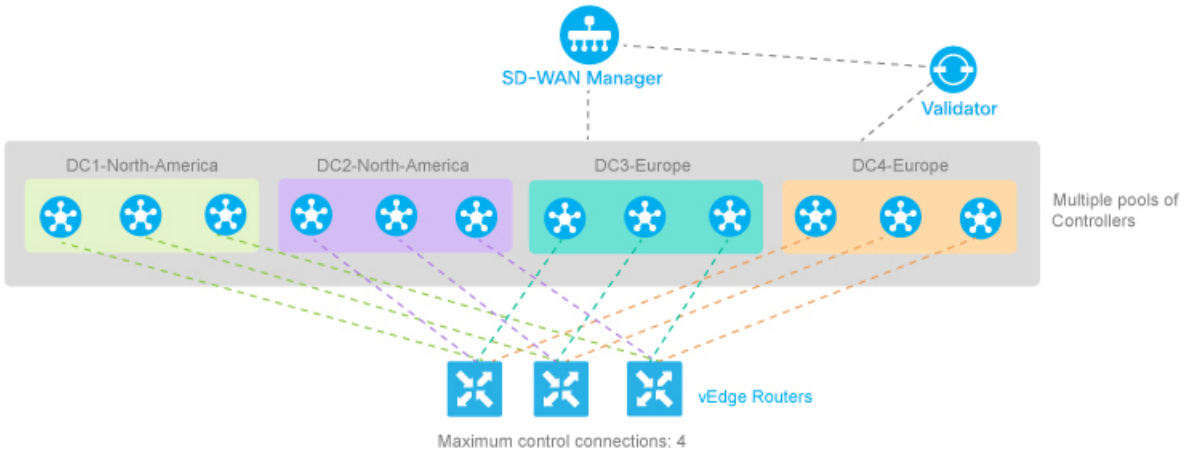
Enabling affinity allows each Cisco vEdge device to establish TLOC connections with only a subset of the vSmart controllers. The figure above shows each router connecting to just two of the three vSmart controllers, thus reducing the total number of TLOCs from nine to six. Both TLOC connections can be active, for a total of six control connections. It is also possible for one of the TLOC connections be the primary, or preferred, and the other to be a backup, to be used as an alternate only when the primary is unavailable, thus reducing the number of active TLOCs to three.

Affinity also enables redundancy among data centers, for a scenario in which multiple vSmart controllers are collocated in two or more data centers. Then, if the link between a Cisco vEdge device and one of the data centers goes down, the vSmart controllers in the second data center are available to continue servicing the overlay network. The figure below illustrates this scenario, showing three vSmart controllers in each of two data centers. Each of the three Cisco vEdge devices establishes a TLOC connection to one controller in the West data center and one in the East data center.



You might think of the scenario in the figure above as one where there are redundant data centers in the same region of the world, such as in the same city, province, or country. For an overlay network that spans a larger geography, such as across a continent or across multiple continents, you can use affinity to limit the network scale either by restricting Cisco vEdge devices so that they connect only to local vSmart controllers or by having Cisco vEdge devices preferentially establish control connections with data centers that are in their geographic region. With geographic affinity, Cisco vEdge devices establish their only or their primary TLOC connection or connections with vSmart controllers in more local data centers, but they have a backup available to a more distant region to provide redundancy in case the closer data centers become unavailable. The figure below illustrates this scenario, Here, the Cisco vEdge devices in Europe have their primary TLOC connections to the two European data centers and alternate connections to the data centers in North America. Similarly,

for the Cisco vEdge devices in North America, the primary connections are to the two North American data centers, and the backup connections are to the two European data centers.



As is the case with any overlay network that has multiple vSmart controllers, all policy configurations on all the vSmart controllers must be the same.

Before you cofigure High availability, to start with the configuration transaction, you can use the following command such as,

```
ntp server 198.51.241.229 source GigabitEthernet1 version 4
```


- Cisco Catalyst SD-WAN Validator Redundancy, on page 9
- Cisco Catalyst SD-WAN Manager Server Redundancy, on page 11
- Cisco Catalyst SD-WAN Controller Redundancy, on page 22
- Cisco vEdge Device Redundancy, on page 23
- Configure Affinity Between Cisco Catalyst SD-WAN Controllers and Cisco vEdge Device , on page 24

Cisco Catalyst SD-WAN Validator Redundancy

The Cisco SD-WAN Validator performs two key functions in the Cisco Catalyst SD-WAN overlay network:

- Authenticates and validates all Cisco SD-WAN Controllers and routers that attempt to join the Cisco Catalyst SD-WAN network.
- Orchestrates the control plane connections between the Cisco SD-WAN Controllers and routers, thus enabling Cisco SD-WAN Controller and routers to connect to each other in the Cisco Catalyst SD-WAN network.

The Cisco SD-WAN Validator runs as a VM on a network server. The Cisco SD-WAN Validator can also run on a router that is configured to be a Cisco SD-WAN Validator, however this is not recommended, and it limits the number of router control connections to 50. If using running the Cisco SD-WAN Validator daemon on a router, note that only one Cisco SD-WAN Validator daemon can run at a time on a router, so to provide redundancy and high availability, the network must have two or more routers that function as Cisco SD-WAN Validator orchestrators. (Note also that it is not recommended to use a router acting as a vBond orchestrator as a regular router.)

Having multiple Cisco SD-WAN Validators ensures that one of them is always available whenever a Cisco device such as a router or a Cisco SD-WAN Controller is attempting to join the network.

Configuration of Redundant Cisco Catalyst SD-WAN Validators

A vEdge Cloud router learns that it is acting as a Cisco SD-WAN Validator from its configuration. In the **system vbond** configuration command, specify the local IP address of the Cisco SD-WAN Validator and include the **local** keyword. Other Cisco IOS XE Catalyst SD-WAN devices use the **system vbond** configuration command without the **local** keyword to specify the IP address or DNS hostname of the Cisco SD-WAN Validator that those devices can connect to in order to join the overlay network and discover the other control components to establish control connections with

On Cisco SD-WAN Controllers, Cisco SD-WAN Managers and Cisco vEdge devices, when the network has only a single Cisco SD-WAN Validator, you can configure the Cisco SD-WAN Validator either as an IP address or as a host name (such as vbond.cisco.com) using the **system vbond** command. When the network has two or more Cisco SD-WAN Validators and they must all be reachable, you should use a DNS host name to specify the Cisco Catalyst SD-WAN Validators. If the DNS name resolves to multiple IP addresses, the tries each Cisco Catalyst SD-WAN Validator address sequentially until it forms a successful connection.

Note that even if your Cisco Catalyst SD-WAN network has only a single Cisco SD-WAN Validator, it is recommended as a best practice that you specify a DNS host name rather than an IP address in the **system vbond** configuration command, because this results in a scalable configuration. Then, if you add additional Cisco SD-WAN Validators to your network, you do not need to change the configurations on any of the routers or other devices in your network.



Note When configuring redundant Cisco SD-WAN Validators, ensure the following:

- If there is an IP host mapping for both public and private IPs of vBond, verify that both private and public IPs exists. Also, confirm that these IPs are associated with their respective private and public colors.
- Only include IPs that the device can reach over the designated color (internet/public or MPLS/private). If an address is not reachable, the edge may attempt it and time out, impacting performance.

Recovering from a Cisco Catalyst SD-WAN Validator Failure

In a network with multiple Cisco SD-WAN Validators, if one of them fails, the other Cisco SD-WAN Validators simply continue operating and are able to handle all requests by Cisco devices to join the network. From a control plane point of view, each Cisco SD-WAN Validator maintains permanent DTLS connections to each of the Cisco SD-WAN Controllers in the network.

Note however, that there are no connections between the Cisco SD-WAN Validators themselves. As long as one Cisco SD-WAN Validator is present in the domain, the Cisco Catalyst SD-WAN network is able to continue operating without interruption, because Cisco SD-WAN Controllers and routers are still able to locate each other and join the network.

Because Cisco SD-WAN Validators never participate in the data plane of the overlay network, the failure of any Cisco SD-WAN Validator has no impact on data traffic. Cisco SD-WAN Validators communicate with routers when the routers are first joining the network. The joining router establishes a transient DTLS connection with a Cisco SD-WAN Validator to learn the IP address of a Cisco SD-WAN Controller. When the Cisco vEdge device configuration lists the Cisco SD-WAN Validator address as a DNS name, the router tries each of the Cisco SD-WAN Validators in the list, one by one, until it is able to establish a DTLS connection. This

mechanism allows a router to always be able to join the network, even after one of a group of Cisco SD-WAN Validators has failed.

Cisco Catalyst SD-WAN Manager Server Redundancy

The Cisco SD-WAN Manager servers comprise a centralized network management system that enables configuration and management of the Cisco devices in the overlay network. It also provides a real-time dashboard into the status of the network and network devices. The Cisco SD-WAN Manager servers maintain permanent communication channels with all Cisco vEdge devices in the network. Over these channels, the Cisco SD-WAN Manager servers provide new software images as part of a software upgrade process. From each network device, the Cisco SD-WAN Manager servers receive various status information that is displayed on the Cisco SD-WAN Manager **Monitor** > **Overview** page.



Note In Cisco SD-WAN Release 20.6.1 and earlier releases, the status information is available on the **Dashboard** > **Main Dashboard** page.

The Cisco SD-WAN Manager can be deployed in two basic ways, either standalone or by clustering. A cluster consists of three or six Cisco SD-WAN Manager servers, and each Cisco SD-WAN Manager server in a cluster is referred to as a Cisco SD-WAN Manager instance.

Cisco vEdge devices are load-balanced among the Cisco SD-WAN Manager instances.

The Cisco SD-WAN Manager cluster is designed such that the cluster remains operational if one of the devices in that cluster fails.

The purpose of an Cisco SD-WAN Manager is scale. It provides a level of redundancy against a single Cisco SD-WAN Manager failure, but it does not protect against a cluster-level failure. For high availability, a standby cluster should be deployed in the event of a cluster failure or connectivity failure to the site where the Cisco SD-WAN Manager cluster resides. See more information about Disaster Recovery

See Recommended Computing Resources for your specific release to get vCPU, RAM, storage requirements, and number of control components required for your deployment.

A Cisco SD-WAN Manager cluster consists of the following architectural components:

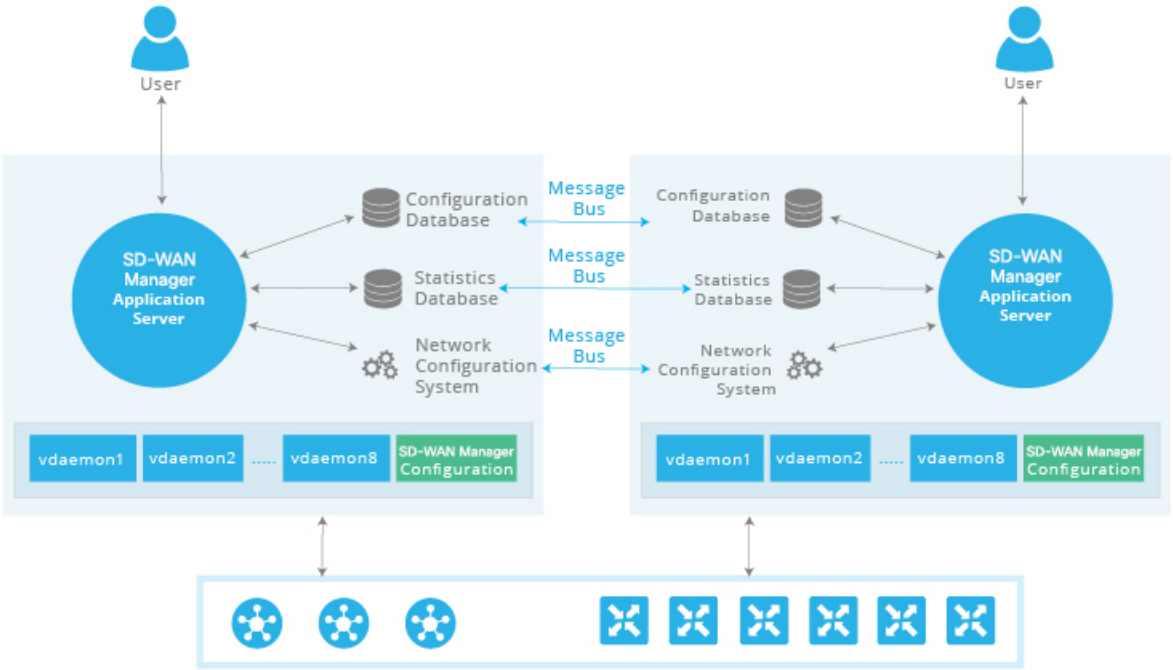
- Application server—This provides a web server for user sessions. Through these sessions, a logged-in user can view a high-level dashboard summary of networks events and status, and can drill down to view details of these events. A user can also manage network serial number files, certificates, software upgrades, device reboots, and configuration of the Cisco SD-WAN Manager cluster itself from the Cisco SD-WAN Manager application server.
- Configuration database—Stores the inventory and state and the configurations for all Cisco vEdge devices.
- Network configuration system—Stores all configuration information, policies, templates, certificates, and more.
- Statistics database—Stores the statistics information collected from all Cisco devices in the overlay network.
- Message server—Communication bus among the different Cisco SD-WAN Manager instances. This bus is used to share data and coordinate operations among the Cisco SD-WAN Manager instances in the cluster.

The Statistics database and Configuration database services must run on an odd number of Cisco SD-WAN Manager instances in a cluster, with a minimum of three. For these databases to be writeable, there must be a quorum of Cisco SD-WAN Manager instances running and they should be in sync. A quorum is a simple majority. For example, if you have a cluster of three Cisco SD-WAN Manager instances running these databases, then two must be running and in sync to have a majority.

Note that from Cisco SD-WAN Release 20.6.1, persona-based cluster configuration is used. A persona defines what services runs on a Cisco SD-WAN Manager server.

For more information, see Add a Cisco Catalyst SD-WAN Manager Server to a Cluster.

The following figure shows the interaction between Cisco SD-WAN Manager instances in a cluster, although a minimum of three devices is required. The figure illustrates the Cisco SD-WAN Manager services that synchronize between the Cisco SD-WAN Manager instances. Also in this figure, you see that each Cisco SD-WAN Manager instance resides on a virtual machine (VM). The VM can have from one to eight cores, with a Cisco Catalyst SD-WAN software process (vdaemon) running on each core. In addition, the VM stores the actual configuration for the Cisco SD-WAN Manager server itself.



The Cisco SD-WAN Manager cluster implements an active-active architecture in the following way:

- Each Cisco SD-WAN Manager instance in the cluster is an independent processing node.
- All control sessions between the Cisco SD-WAN Manager application servers and the Cisco vEdge devices are load balanced. All the controller sessions—the sessions between the Cisco SD-WAN Manager instances and the Cisco Catalyst SD-WAN Controllers, the sessions between the Cisco SD-WAN Manager instances and the Cisco Catalyst SD-WAN Validators are arranged in a full-mesh topology.
- The configuration and statistics databases can be replicated across Cisco SD-WAN Manager instances, and these databases can be accessed and used by all the Cisco SD-WAN Manager instances.

- If one of the Cisco SD-WAN Manager instances in the cluster fails or otherwise becomes unavailable, the network management services that are provided by the Cisco SD-WAN Manager server are still fully available across the network.

The message server among the Cisco SD-WAN Manager instances in the cluster allows all the instances to communicate using an out-of-band network. This design, which leverages a third vNIC on the Cisco SD-WAN Manager VM, avoids using WAN bandwidth for management traffic.

The following are the design considerations for a Cisco SD-WAN Manager cluster:

- A Cisco SD-WAN Manager cluster should only consist of three or six Cisco SD-WAN Manager instances.

  All members of a Cisco SD-WAN Manager cluster must be located in the same data center (database replication between cluster members requires four ms or less of delay between them). The cluster interface IP address of all members of the Cisco SD-WAN Manager cluster should be in the same subnet.
- From Cisco SD-WAN Release 20.6.1 onwards, a cluster supports:
  - three compute+data nodes,
  - three compute+data nodes and 3 data nodes,
  - three compute nodes and three data nodes are only supported by an upgrade from an existing deployment.



Note Data nodes should be added to the cluster only after a 3-node cluster with compute+data is added.

The main purpose of an Cisco SD-WAN Manager cluster is scale. It does provide a level of redundancy against a single Cisco SD-WAN Manager instance failure, but it does not protect against a cluster-level or data center location failure, so disaster recovery is also needed.

Deploy Cisco Catalyst SD-WAN Manager Cluster



Note **Prerequisites for Cisco SD-WAN Releases 20.3.1, 20.3.2, 20.3.2.1, and 20.4.1 Only**

Starting with Cisco SD-WAN Release 20.3.1, you must run the messaging server on all the active instances of the Cisco SD-WAN Manager cluster, and form a full-mesh messaging cluster.

When upgrading to Cisco SD-WAN Releases 20.3.1 and later from earlier releases, ensure that you run the messaging server on each of the Cisco SD-WAN Manager instance, prior to the upgrade.

Ensure that you have a minimum of three Cisco SD-WAN Manager instances in a Cisco SD-WAN Manager cluster.

The deployment process requires multiple reboots and should be performed during a scheduled maintenance window.

1. Back up the Cisco SD-WAN Manager database. Use the following command to back up.

   request nms configuration-db backup path /home/admin/<db _ backup _ filename>

2. If the current device has only two network interface cards (NICs), add a third NIC, don't use Dynamic Host Configuration Protocol (DHCP) for addressing. This third NIC is used for cluster messaging between the devices ofCisco SD-WAN Manager instances, within vpn 0. For a device to detect the new interface, the device must be rebooted. Configure the interface and verify that it has connectivity.

3. From the Cisco SD-WAN Manager menu, choose **Administration** > **Cluster Management**, edit the IP address to change localhost to the IP address of the third NIC, which is used for cluster messaging.

4. Restart the Cisco SD-WAN Manager services. This may take some time. You can view the */var/log/nms/vmanage-server.log* for the log output to stabilize, and then use the **request nms all status** command to determine for how long the processes have been running. When it comes up, verify that Cisco SD-WAN Manager is operational and stable.

5. Provision two more Cisco SD-WAN Manager VMs in your virtual environment with the appropriate disk size and third NIC.

6. Configure two more Cisco SD-WAN Manager VMs with minimal system configuration and addressing for the NICs. Configure the admin user password to match that is configured on the original device. If you're using enterprise certificates, ensure that you install the root certificate chain on the new device as you did with the first device. Also, ensure that the clocks of the new devices are in sync with the original device.

   The following is a sample of a minimal configuration:

```
system
            host-name             vManage3
            system-ip             10.0.1.102
            site-id               1
            organization-name     cisco-sdwan1
            vbond vbond!
            vpn 0
                host vbond ip 198.51.100.103 192.51.100.104
                interface eth0
                ip address 198.51.100.102/24
                tunnel-interface
                no shutdown
                !
                interface eth1
                ip address 198.51.100.102/24
                no shutdown !
                ip route 0.0.0.0/0 0.0.0.0
                !
                vpn 512
                interface eth2
                    ip address 198.56.101.102/24
                    no shutdown
                !
```

Note While a default gateway is given for the out of band Cisco SD-WAN Manager cluster interfaces, it's not required if the Cisco SD-WAN Manager cluster nodes are using addresses in the same subnet and are adjacent.

7. From the Cisco SD-WAN Manager menu, choose **Administration** > **Cluster Management**, to add one of the new Cisco SD-WAN Manager VMs to the cluster by adding the IP address of the third NIC for database replication, click **Add vManage**. Choose all services.

The processes for the second Cisco SD-WAN Manager instance restarts. This process might take some time. View the */var/log/nms/vmanage-server.log* and then use the **request nms all status** command to determine process completion time.

8. View the new device on the second Cisco SD-WAN Manager instances, by clicking **Configuration** > **Certificates** > **Controllers**.

9. Generate a certificate signing request (CSR), get the device signed, and install the signed device certificate for this new device. For more information, see Cluster Management.

   The cluster shows that the new device on the second instance of Cisco SD-WAN Manager is rebalancing and that the Cisco SD-WAN Manager services are restarting on the device on previous Cisco SD-WAN Manager instance. A new task appears in the task bar for the **Cluster Sync**. Although the task appears as Complete, view the */var/log/nms/vmanage-server.log* to resolve errors, if any.

   The first instance of Cisco SD-WAN Manager also restarts services, which eventually reset the GUI session. It might take several minutes for the GUI to become available after the services restarts. View the */var/log/nms/vmanage-server.log*, and then use the **request nms all status** command.

10. Wait for **Cluster Sync** to complete. View the *vmanage-server.log* to resolve errors, if any.

11. After the Cluster Sync is completed, add the second of the new Cisco SD-WAN Manager VMs to the cluster by adding the IP address of the third NIC for database replication. Select all services.

    The third instance of Cisco SD-WAN Manager restarts services. This might take some time. A new task appears in the task bar for the **Cluster Sync**. The first and second instances of Cisco SD-WAN Manager also restart services, which eventually reset the GUI session. It may take several minutes for the GUI to become available after the Cisco SD-WAN Manager services restart. The device on the new Cisco SD-WAN Manager instance appears on the **Configuration** > **Certificates** > **Controllers** page. Perform steps 9 and 10 for this device.

Upgrade Cisco Catalyst SD-WAN Manager Cluster

To upgrade a cluster, ensure that the services start in an orderly manner. After the upgrade steps, use the steps in the Restarting the NMS Processes section to start all the services in an orderly manner.

To get the software partitions prepared to be activated, upgrade the devices (without activating).

1. Take backup of the Cisco SD-WAN Manager server. This can take a while. If Cisco hosts the controllers and there's a recent snapshot, this step can be skipped.

   ```
   request nms configuration-db backup path/home/admin/<db _ backup _ filename>
   ```

2. Stop Cisco SD-WAN Manager services on all devices in the cluster by using the following command on each device.

   ```
   request nms all stop
   ```

3. Activate the new version on each device. This activation causes each device to reload.

   ```
   request software activate <version>
   ```

4. If you do the upgrade from CLI, ensure that you manually confirm the upgrade from the CLI after the reload and before it reverts to the previous version.

   ```
   request software upgrade-confirm
   ```

5. After the devices reboot, stop Cisco SD-WAN Manager services on all devices in the cluster.

   ```
   request nms all stop
   ```

Next, ensure that you perform the steps of restarting the Cisco SD-WAN Manager server manually.

Restarting the Cisco Catalyst SD-WAN Manager Server Manually

When the cluster is in a bad state as part of the upgrade, you should manually restart the Cisco SD-WAN Manager server. To start the Cisco SD-WAN Manager server, restart the processes one at a time in an orderly manner instead of using **request nms all restart** or a similar command. The following manual restart order might vary for your cluster, depending on what services you're running on the devices in the cluster. The following order is based on a basic cluster with three Cisco SD-WAN Manager instances.



Note Consider bringing up the services manually as mentioned in the following method whenever you have to reboot a Cisco SD-WAN Manager server or after an upgrade.

1. On each device, stop all Cisco SD-WAN Manager services.

   ```
   request nms all stop
   ```

2. Verify that all services have stopped. It's normal for the preceding command to give some message about failing to stop a service if it takes too long, so use the following command to verify that everything is stopped before proceeding.

   ```
   request nms all status
   ```

3. Start the Statistics database on each device that is configured to run it. Wait for the service to start each time before proceeding to the next device.

   ```
   request nms statistics-db start
   ```

4. Verify that the service is started before proceeding to start it on the next device. After service starts, perform step 3 to start the Statistics database on the next device. Once all the devices, ensure that the Statistics database is running, and then proceed to the next step.

   ```
   request nms statistics-db status
   ```

5. Start the Configuration database on each device that is configured to run it. Wait for the service to start each time before proceeding to the next device.

   ```
   request nms configuration-db start
   ```

6. Verify that the service has started before proceeding to start it on the next device. Go to vshell and tail a log file to look for a database is online message. When confirmed, go to step 5 to start the Configuration database on the next device. After all devices have the Configuration database running, proceed to the next step.

   ```
   tail -f -n 100 /var/log/nms/debug.log
   ```



Note For versions prior to 18.2, use this log file

```
tail -f -n 100 /var/log/nms/vmanage-orientdb-database.log
```

7. Start the Coordination server on each device. Wait for the service to start each time before proceeding to the next device.

   ```
   request nms coordination-server start
   ```

8. Verify that the service is started before proceeding to start it on the next device. After verifying, go to step 7 to start the Coordination server on the next device. After the Coordination server runs on all the devices, proceed to the next step.

   ```
   request nms coordination-server status
   ```

9. Start the Messaging server on each device. Wait for the service to start each time before proceeding to the next device.

   ```
   request nms messaging-server start
   ```

10. Verify that the service has started before proceeding to start it on the next device. After verifying, go to step 9 to start the Messaging server on the next device. After the Messaging server runs on all devices, proceed to the next step.

    ```
    request nms messaging-server status
    ```

11. Start the Application server on each device. Wait for the service to start each time before proceeding to the next device.

    ```
    request nms application-server start
    ```

12. Verify that the service has started before proceeding to start it on the next device. To verify if the service is fully started, open the GUI of that device. After the GUI is fully loaded and you're able to log in, go to step 11 to start the Application server on the next device.

13. Restart the Cisco SD-WAN Manager server cloud services on each device. Wait for the service to start each time before proceeding to the next device.

    ```
     request nms cloud-agent start
    ```

14. Verify that the service has started before proceeding to start it on the next device. After verifying, go to step 12 to start the cloud services on the next device. After the cloud services run on all devices, proceed to the next step.

    ```
    request nms cloud-agent status
    ```

15. To verify that there are no errors and everything has loaded cleanly, tail the log files.

Check Cisco SD-WAN Manager to verify that all devices appear as online and reachable, and that the statistics exist.

Cisco Catalyst SD-WAN Manager Disaster Recovery

Should an active standalone Cisco SD-WAN Manager node or cluster become unavailable at one data center site, disaster recovery can minimize disruption and fail management traffic over to another standalone Cisco SD-WAN Manager node or cluster at a different data center site.

Note that the failure of the Cisco SD-WAN Manager impacts only the ability to configure, upgrade, and receive statistics, and does not affect data plane traffic.

The following disaster recovery methods are available:

- **Manual** (Cisco SD-WAN Manager standalone or cluster): The backup SD-WAN Manager server or SD-WAN Manager cluster is kept shutdown in cold standby state.

  Regular backups of the active database are taken, and if the primary SD-WAN Manager or SD-WAN Manager cluster goes down, the standby SD-WAN Manager or SD-WAN Manager cluster is brought up manually and the backup database restored on it.

- **Administrator-triggered failover** (Cisco SD-WAN Manager standalone or cluster): The administrator-triggered disaster recovery switchover option can be configured on a cluster starting in Cisco SD-WAN Release 19.2.1 or on a single node starting in version Cisco SD-WAN Release 20.5.1.

  Data is replicated automatically between the primary and secondary Cisco SD-WAN Manager nodes/clusters. When needed, a switchover is manually performed to the secondary Cisco SD-WAN Manager node/cluster.

  See the Disaster Recovery chapter for more information.

Cisco Catalyst SD-WAN Manager Backups

In a Cisco cloud-managed SD-WAN overlay, Cisco takes regular snapshots of the Cisco SD-WAN Manager virtual machines for recovery due to a catastrophic failure or corruption. Another snapshot can be taken before any scheduled activity. In on-premise deployments, it is your responsibility to take regular snapshots of the Cisco SD-WAN Manager virtual machine and follow the example of frequency and retention that is followed by Cisco.

It is also recommended that regular backups for the configuration database should be taken and stored securely off-site. The greater the time between the backup and when it is needed for a recovery, the greater the risk that data might be lost.

Perform configuration database backups often. Use the following command to create a configuration database backup file:

```
request nms configuration-db backup path <path>
```

Deploy Cisco Catalyst SD-WAN Manager Cluster

Note **Prerequisites for Cisco SD-WAN Releases 20.3.1, 20.3.2, 20.3.2.1, and 20.4.1 Only**

Starting with Cisco SD-WAN Release 20.3.1, you must run the messaging server on all the active instances of the Cisco SD-WAN Manager cluster, and form a full-mesh messaging cluster.

When upgrading to Cisco SD-WAN Releases 20.3.1 and later from earlier releases, ensure that you run the messaging server on each of the Cisco SD-WAN Manager instance, prior to the upgrade.

Ensure that you have a minimum of three Cisco SD-WAN Manager instances in a Cisco SD-WAN Manager cluster.

The deployment process requires multiple reboots and should be performed during a scheduled maintenance window.

1. Back up the Cisco SD-WAN Manager database. Use the following command to back up.

   request nms configuration-db backup path /home/admin/<db _ backup _ filename>

2. If the current device has only two network interface cards (NICs), add a third NIC, don't use Dynamic Host Configuration Protocol (DHCP) for addressing. This third NIC is used for cluster messaging between the devices ofCisco SD-WAN Manager instances, within vpn 0. For a device to detect the new interface, the device must be rebooted. Configure the interface and verify that it has connectivity.

3. From the Cisco SD-WAN Manager menu, choose **Administration** > **Cluster Management**, edit the IP address to change localhost to the IP address of the third NIC, which is used for cluster messaging.

4. Restart the Cisco SD-WAN Manager services. This may take some time. You can view the */var/log/nms/vmanage-server.log* for the log output to stabilize, and then use the **request nms all status** command to determine for how long the processes have been running. When it comes up, verify that Cisco SD-WAN Manager is operational and stable.

5. Provision two more Cisco SD-WAN Manager VMs in your virtual environment with the appropriate disk size and third NIC.

6. Configure two more Cisco SD-WAN Manager VMs with minimal system configuration and addressing for the NICs. Configure the admin user password to match that is configured on the original device. If you're using enterprise certificates, ensure that you install the root certificate chain on the new device as you did with the first device. Also, ensure that the clocks of the new devices are in sync with the original device.

   The following is a sample of a minimal configuration:

```
system
            host-name             vManage3
            system-ip             10.0.1.102
            site-id               1
            organization-name     cisco-sdwan1
            vbond vbond!
            vpn 0
                host vbond ip 198.51.100.103 192.51.100.104
                interface eth0
                ip address 198.51.100.102/24
                tunnel-interface
                no shutdown
                !
                interface eth1
                ip address 198.51.100.102/24
                no shutdown !
                ip route 0.0.0.0/0 0.0.0.0
                !
                vpn 512
                interface eth2
                    ip address 198.56.101.102/24
                    no shutdown
                !
```



Note While a default gateway is given for the out of band Cisco SD-WAN Manager cluster interfaces, it's not required if the Cisco SD-WAN Manager cluster nodes are using addresses in the same subnet and are adjacent.

7. From the Cisco SD-WAN Manager menu, choose **Administration** > **Cluster Management**, to add one of the new Cisco SD-WAN Manager VMs to the cluster by adding the IP address of the third NIC for database replication, click **Add vManage**. Choose all services.

   The processes for the second Cisco SD-WAN Manager instance restarts. This process might take some time. View the */var/log/nms/vmanage-server.log* and then use the **request nms all status** command to determine process completion time.

8. View the new device on the second Cisco SD-WAN Manager instances, by clicking **Configuration** > **Certificates** > **Controllers**.

9. Generate a certificate signing request (CSR), get the device signed, and install the signed device certificate for this new device. For more information, see Cluster Management.

The cluster shows that the new device on the second instance of Cisco SD-WAN Manager is rebalancing and that the Cisco SD-WAN Manager services are restarting on the device on previous Cisco SD-WAN Manager instance. A new task appears in the task bar for the **Cluster Sync**. Although the task appears as Complete, view the */var/log/nms/vmanage-server.log* to resolve errors, if any.

The first instance of Cisco SD-WAN Manager also restarts services, which eventually reset the GUI session. It might take several minutes for the GUI to become available after the services restarts. View the */var/log/nms/vmanage-server.log*, and then use the **request nms all status** command.

10. Wait for **Cluster Sync** to complete. View the *vmanage-server.log* to resolve errors, if any.
11. After the Cluster Sync is completed, add the second of the new Cisco SD-WAN Manager VMs to the cluster by adding the IP address of the third NIC for database replication. Select all services.

    The third instance of Cisco SD-WAN Manager restarts services. This might take some time. A new task appears in the task bar for the **Cluster Sync**. The first and second instances of Cisco SD-WAN Manager also restart services, which eventually reset the GUI session. It may take several minutes for the GUI to become available after the Cisco SD-WAN Manager services restart. The device on the new Cisco SD-WAN Manager instance appears on the **Configuration** > **Certificates** > **Controllers** page. Perform steps 9 and 10 for this device.

Upgrade Cisco Catalyst SD-WAN Manager Cluster

To upgrade a cluster, ensure that the services start in an orderly manner. After the upgrade steps, use the steps in the Restarting the NMS Processes section to start all the services in an orderly manner.

To get the software partitions prepared to be activated, upgrade the devices (without activating).

1. Take backup of the Cisco SD-WAN Manager server. This can take a while. If Cisco hosts the controllers and there's a recent snapshot, this step can be skipped.

   ```
   request nms configuration-db backup path/home/admin/<db _ backup _ filename>
   ```

2. Stop Cisco SD-WAN Manager services on all devices in the cluster by using the following command on each device.

   ```
   request nms all stop
   ```

3. Activate the new version on each device. This activation causes each device to reload.

   ```
   request software activate <version>
   ```

4. If you do the upgrade from CLI, ensure that you manually confirm the upgrade from the CLI after the reload and before it reverts to the previous version.

   ```
   request software upgrade-confirm
   ```

5. After the devices reboot, stop Cisco SD-WAN Manager services on all devices in the cluster.

   ```
   request nms all stop
   ```

Next, ensure that you perform the steps of restarting the Cisco SD-WAN Manager server manually.

Restarting the Cisco Catalyst SD-WAN Manager Server Manually

When the cluster is in a bad state as part of the upgrade, you should manually restart the Cisco SD-WAN Manager server. To start the Cisco SD-WAN Manager server, restart the processes one at a time in an orderly manner instead of using **request nms all restart** or a similar command. The following manual restart order

might vary for your cluster, depending on what services you're running on the devices in the cluster. The following order is based on a basic cluster with three Cisco SD-WAN Manager instances.

Note Consider bringing up the services manually as mentioned in the following method whenever you have to reboot a Cisco SD-WAN Manager server or after an upgrade.

1. On each device, stop all Cisco SD-WAN Manager services.

   ```
   request nms all stop
   ```

2. Verify that all services have stopped. It's normal for the preceding command to give some message about failing to stop a service if it takes too long, so use the following command to verify that everything is stopped before proceeding.

   ```
   request nms all status
   ```

3. Start the Statistics database on each device that is configured to run it. Wait for the service to start each time before proceeding to the next device.

   ```
   request nms statistics-db start
   ```

4. Verify that the service is started before proceeding to start it on the next device. After service starts, perform step 3 to start the Statistics database on the next device. Once all the devices, ensure that the Statistics database is running, and then proceed to the next step.

   ```
   request nms statistics-db status
   ```

5. Start the Configuration database on each device that is configured to run it. Wait for the service to start each time before proceeding to the next device.

   ```
   request nms configuration-db start
   ```

6. Verify that the service has started before proceeding to start it on the next device. Go to vshell and tail a log file to look for a database is online message. When confirmed, go to step 5 to start the Configuration database on the next device. After all devices have the Configuration database running, proceed to the next step.

   ```
   tail -f -n 100 /var/log/nms/debug.log
   ```

Note For versions prior to 18.2, use this log file

```
tail -f -n 100 /var/log/nms/vmanage-orientdb-database.log
```

7. Start the Coordination server on each device. Wait for the service to start each time before proceeding to the next device.

   ```
   request nms coordination-server start
   ```

8. Verify that the service is started before proceeding to start it on the next device. After verifying, go to step 7 to start the Coordination server on the next device. After the Coordination server runs on all the devices, proceed to the next step.

   ```
   request nms coordination-server status
   ```

9. Start the Messaging server on each device. Wait for the service to start each time before proceeding to the next device.

```
request nms messaging-server start
```

10. Verify that the service has started before proceeding to start it on the next device. After verifying, go to step 9 to start the Messaging server on the next device. After the Messaging server runs on all devices, proceed to the next step.

    ```
    request nms messaging-server status
    ```

11. Start the Application server on each device. Wait for the service to start each time before proceeding to the next device.

    ```
    request nms application-server start
    ```

12. Verify that the service has started before proceeding to start it on the next device. To verify if the service is fully started, open the GUI of that device. After the GUI is fully loaded and you're able to log in, go to step 11 to start the Application server on the next device.

13. Restart the Cisco SD-WAN Manager server cloud services on each device. Wait for the service to start each time before proceeding to the next device.

    ```
     request nms cloud-agent start
    ```

14. Verify that the service has started before proceeding to start it on the next device. After verifying, go to step 12 to start the cloud services on the next device. After the cloud services run on all devices, proceed to the next step.

    ```
    request nms cloud-agent status
    ```

15. To verify that there are no errors and everything has loaded cleanly, tail the log files.

Check Cisco SD-WAN Manager to verify that all devices appear as online and reachable, and that the statistics exist.

Cisco Catalyst SD-WAN Controller Redundancy

Cisco Catalyst SD-WAN Controller Redundancy

The Cisco SD-WAN Controllers are the central orchestrators of the control plane. They have permanent communication channels with all the Cisco devices in the network. Over the DTLS or TLS connections between the Cisco SD-WAN Controllers and Cisco SD-WAN Validators and between pairs of Cisco SD-WAN Controllers, the devices regularly exchange their views of the network, to ensure that their route tables remain synchronized. The Cisco SD-WAN Controllers pass accurate and timely route information over DTLS or TLS connections to Cisco vEdge device s.

A highly available Cisco Catalyst SD-WAN network contains two or more Cisco SD-WAN Controllers in each domain. A Cisco Catalyst SD-WAN domain can have up to 12 Cisco SD-WAN Controllers, and each router, by default, connects to two of them. When the number of Cisco SD-WAN Controllers in a domain is greater than the maximum number of controllers that a domain's routers are allowed to connect to, the Cisco Catalyst SD-WAN software load-balances the connections among the available Cisco SD-WAN Controllers.

While the configurations on all the Cisco SD-WAN Controllers must be functionally similar, the control policies must be identical. This is required to ensure that, at any time, all Cisco vEdge devices receive consistent views of the network. If the control policies are not absolutely identical, different Cisco SD-WAN Controllers might give different information to a Cisco vEdge device , and the likely result will be network connectivity issues.

Note To reiterate, the Cisco Catalyst SD-WAN overlay network works properly only when the control policies on all Cisco SD-WAN Controllers are identical. Even the slightest difference in the policies will result in issues with the functioning of the network.

To remain synchronized with each other, the Cisco SD-WAN Controllers establish a full mesh of DTLS or TLS control connections, as well as a full mesh of OMP sessions, between themselves. Over the OMP sessions, the Cisco SD-WAN Controllers advertise routes, TLOCs, services, policies, and encryption keys. It is this exchange of information that allows the Cisco SD-WAN Controllers to remain synchronized.

You can place Cisco SD-WAN Controllers anywhere in the network. For availability, it is highly recommended that the Cisco SD-WAN Controllers be geographically dispersed.

Each Cisco SD-WAN Controller establishes a permanent DTLS connection to each of the Cisco SD-WAN Validators. These connections allow the Cisco SD-WAN Validators to track which Cisco SD-WAN Controllers are present and operational. So, if one of the Cisco SD-WAN Controller fails, the Cisco SD-WAN Validator does not provide the address of the unavailable Cisco SD-WAN Controller to a router that is just joining the network.

To reiterate, the Cisco Catalyst SD-WAN overlay network works properly only when the control policies on all Cisco SD-WAN Controllers are identical. Even the slightest difference in the policies result in issues with the functioning of the network.

Recovering from a Cisco Catalyst SD-WAN Controller Failure

The Cisco SD-WAN Controllers are the primary controllers of the network. To maintain this control, they maintain permanent DTLS connections to all the Cisco SD-WAN Validators and Cisco IOS XE Catalyst SD-WAN devices and Cisco vEdge devices. These connections allow the Cisco SD-WAN Controllers to be constantly aware of any changes in the network topology. When a network has multiple Cisco SD-WAN Controllers:

- There is a full mesh of OMP sessions among the Cisco SD-WAN Controllers.
- Each Cisco SD-WAN Controller has a permanent DTLS connection to each Cisco SD-WAN Validator.
- The Cisco SD-WAN Controllers have permanent TLS or DTLS connections to the Cisco IOS XE Catalyst SD-WAN devices and Cisco vEdge devices.

If one of the Cisco SD-WAN Controllers fails, the other Cisco SD-WAN Controllers seamlessly take over handling control of the network. The remaining Cisco SD-WAN Controllers are able to work with Cisco IOS XE Catalyst SD-WAN devices and Cisco vEdge devices joining the network and are able to continue sending route updates to the routers. As long as one Cisco SD-WAN Controller is present and operating in the domain, the Cisco Catalyst SD-WAN network may continue operating without interruption.

For more information about configuring graceful restart for OMP, see graceful restart.

Cisco vEdge Device Redundancy

The Cisco vEdge device is commonly used in two ways in the Cisco Catalyst SD-WAN network: to be the Cisco Catalyst SD-WAN routers at a branch site, and to create a hub site that branch routers connect to.

A branch site can have two or more Cisco vEdge device s for redundancy. Each of the router maintains the following connections:

- A secure control plane connection, via a TLS or DTLS connection, with one or more Cisco SD-WAN Controllers in its domain.
- A secure data plane connection with the other routers.

Because both the routers receive the same routing information from the Cisco SD-WAN Controllers, each one is able to continue to route traffic if one fails, even if they are connected to different transport providers.

When using Cisco IOS XE Catalyst SD-WAN devices and Cisco vEdge devices in a hub site, you can provide redundancy by installing two hub routers. The branch routers need to connect to each of the hub routers by using SD-WAN IPsec data plane tunnels.

You can also have Cisco vEdge device provide redundancy by configuring multiple tunnel interfaces on a single router. Each tunnel interface can go through the same or different firewalls, service providers, and network clouds.

Recovering from a Cisco vEdge Device Failure

The route tables on Cisco IOS XE Catalyst SD-WAN devices and Cisco vEdge devices are populated by OMP routes received from the Cisco SD-WAN Controllers. For a site or branch with redundant routers, the route tables on both routers remain synchronized, so if either of the routers fail, the other one continues to be able to route data traffic to its destination.

Configure Affinity Between Cisco Catalyst SD-WAN Controllers and Cisco vEdge Device

One way to manage network scale is to configure affinity between Cisco SD-WAN Controllers and Cisco vEdge device s. To do this, you place each Cisco SD-WAN Controller into a controller group, and then you configure which group or groups a Cisco vEdge device can establish control connections with. The controller groups are what establishes the affinity between Cisco SD-WAN Controllers and Cisco vEdge device .

Configure Controller Group Identifier on Cisco Catalyst SD-WAN Controllers

To participate in affinity, each Cisco SD-WAN Controller must be assigned a controller group identifier:

```
vSmart(config)#system controller-group-id number
```

The identifier number can be from 0 through 100.

For Cisco SD-WAN Controllers in the same data center, they can have the same controller group identifier or different identifiers:

- If the Cisco SD-WAN Controllers have the same controller group identifier, a Cisco vEdge device establishes a control connection to any one of them. If that Cisco SD-WAN Controller becomes unreachable, the router simply establishes a control connection with another one of the controllers in the data center. As an example of how this might work, if one Cisco SD-WAN Controller becomes unavailable during a software upgrade, the Cisco vEdge device immediately establishes control connections and an OMP session with another Cisco SD-WAN Controller, and the router's network operation is not interrupted. This network design provides redundancy among Cisco SD-WAN Controllers in a data center.

- If the Cisco SD-WAN Controllers have different controller group identifiers, a Cisco vEdge device can use one controller as the preferred and the other as backup. As an example of how this might work, if you are upgrading the Cisco SD-WAN Controller software, you can upgrade one controller group at a time. If a problem occurs with the upgrade, a Cisco vEdge device establishes control connections and an OMP session with the Cisco SD-WAN Controllers in the second, backup controller group, and the router's network operation is not interrupted. When the Cisco SD-WAN Controller in the first group again becomes available, the Cisco vEdge device switches its control connections and OMP session back to that controller. This network design, while offering redundancy among the Cisco SD-WAN Controllers in a data center, also provides additional fault isolation.

Configure Affinity on Cisco vEdge Device

For a Cisco vEdge device to participate in affinity, you configure the Cisco SD-WAN Controllers that the router is allowed to establish control connections with. By default, you can establish two OMP sessions and two control connections per TLOC.

Configure Cisco Catalyst SD-WAN Controller Groups

Configuring the Cisco SD-WAN Controllers that the router is allowed to establish control connections is a two-part process:

- At the system level, configure a single list of the controller group identifiers that are present in the overlay network.
- For each tunnel interface, you can choose to restrict which controller group identifiers the tunnel interface can establish control connections with. To do this, configure an exclusion list.

At a system level, configure the identifiers of the Cisco SD-WAN Controller groups:

```
vEdge(config)#system controller-group-list numbers
```

List the Cisco SD-WAN Controller group identifiers that any of the tunnel interfaces on the Cisco vEdge device might want to establish control connections with. It is recommended that this list contain the identifiers for all the Cisco SD-WAN Controller groups in the overlay network.

If you want a specific tunnel interface to establish control connections to only a subset of all the Cisco SD-WAN Controller groups, configure the group identifiers to exclude:

```
vEdge(config-vpn-0-interface)#tunnel-interface exclude-controller-group-list numbers
```

This command lists the identifiers of the Cisco SD-WAN Controller groups that this particular tunnel interface should not establish control connections with, when a Cisco SD-WAN Controller is available in configured controller groups. Ensure that the controller groups in this list are a subset of the controller groups that are configured with the **system controller-group-list** command.

If a Cisco vEdge device is not able to establish control connection with the configured controller group(s), the Cisco vEdge device will try to connect to the vSmart controllers from the excluded list.

To display the controller groups configured on a Cisco vEdge device, use the **show control connections** command.

Configure Maximum Number of Control Connections

By default, the maximum number of control connections that each tunnel interface can establish is the same as the maximum number of OMP sessions that is configured on the Cisco vEdge device. The default value for Maximum OMP sessions (MOS) is 2.

Configuring the maximum number of control connections for a tunnel interface for a Cisco vEdge device is a two-part process:

- At the system level, configure the MOS that the Cisco vEdge device can establish to Cisco SD-WAN Controllers.
- If a tunnel interface needs to connect to a different number Cisco SD-WAN Controllers than the configured MOS value, configure the maximum number of control connections that the tunnel can establish to Cisco SD-WAN Controllers,



Note If Max Control Connections (MCC) is not configured on a tunnel interface, its default value is the same as the MOS value.

Effectively, the maximum number of control connections a tunnel interface in a Cisco vEdge device can establish is determined by the following formula:

Max Control Connections for tunnel interface in VPN 0 = MIN(MOS, MCC)

To modify the maximum number of OMP sessions, enter the following command:

```
vEdge(config)# system max-omp-sessions number
```

A Cisco vEdge device establishes OMP sessions as follows:

- The device, not the individual tunnel interfaces, establishes OMP sessions with Cisco SD-WAN Controllers.
- When different tunnel interfaces on a router connect to the same Cisco SD-WAN Controller, the device creates a single OMP session with the Cisco SD-WAN Controller and the different tunnel interfaces use this single OMP session.



Note When each tunnel interface connects to the same set of Cisco SD-WAN Controllers, a Cisco vEdge device has the total number of OMP sessions equal to the configured maximum number of OMP sessions. However, if each tunnel interface connects to a different Cisco SD-WAN Controller (because of an excluded controller list), the total number of OMP sessions on the device is higher than the configured maximum number of OMP sessions,

Use the following command to modify the maximum number of control connections for a tunnel interface:

```
vEdge(config-vpn-0-interface)# vpn 0 interface interface-name tunnel-interface
max-control-connections number
```

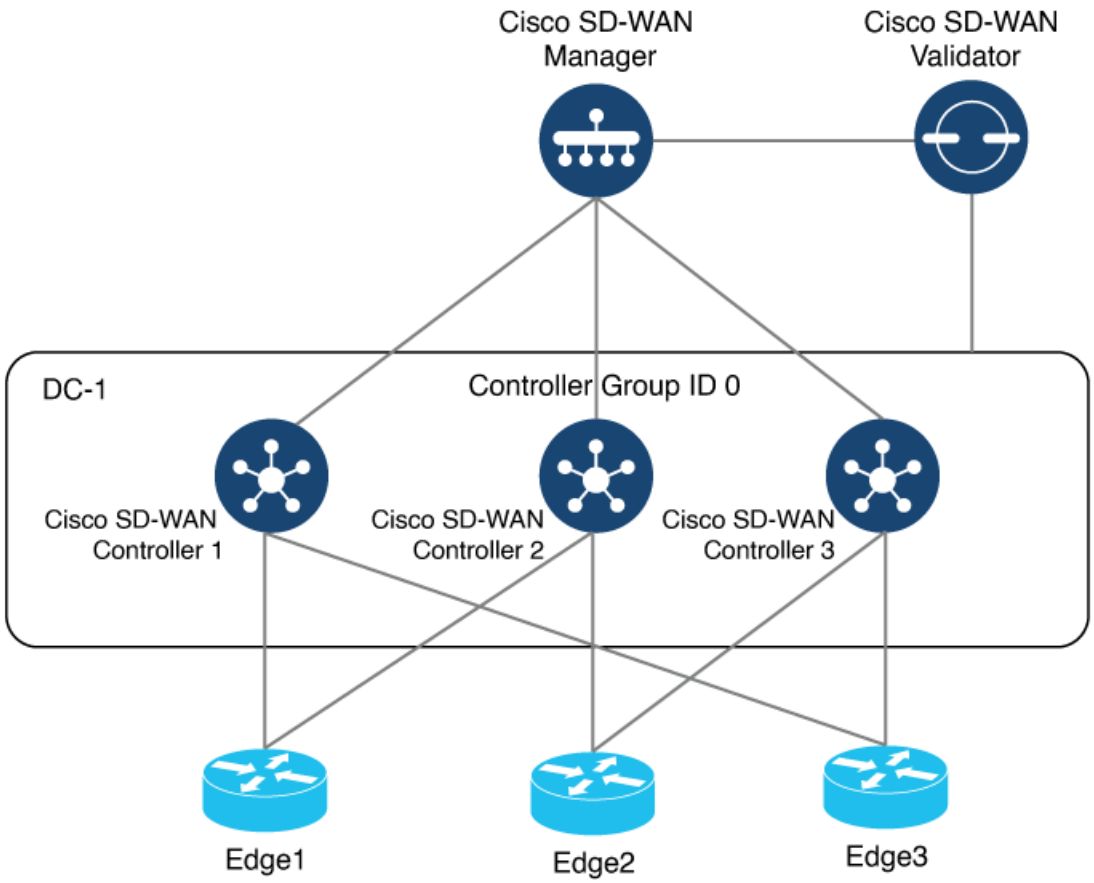
The number of control connections can be from 0 through 100. The default value is the maximum number of OMP sessions that is configured with the **system max-omp-sessions** command.

To display the actual number of control connections for each tunnel interface, use the **show control affinity config** command.

To display a list of the Cisco SD-WAN Controllers that each tunnel interface has established control connections with, use the **show control affinity status** command.

Configure Affinity for Cisco Catalyst SD-WAN Controllers on Single Data Center

In a Cisco Catalyst SD-WAN overlay network that has multiple Cisco SD-WAN Controllers, each tunnel interface in a Cisco vEdge device establishes control connections to two Cisco SD-WAN Controllers. This default behavior provides controller redundancy, so there is no need to configure affinity.



In the topology that is shown in the figure above, there are three Cisco SD-WAN Controllers in Data Center DC-1, all of which belong to default controller group 0. A Cisco vEdge device selects two Cisco SD-WAN Controllers, which are identified as its assigned Cisco SD-WAN Controllers. Each tunnel interface of the Cisco vEdge device connects to these assigned Cisco SD-WAN Controllers. When a tunnel interface connects to its assigned Cisco SD-WAN Controllers, that tunnel interface is said to be in *equilibrium*.

Note If exclude-controller-group-list is configured on a tunnel interface, that tunnel interface may have different Cisco SD-WAN Controllers assigned to it.

However, if you want to connect the Cisco vEdge device only to a subset of the Cisco SD-WAN Controllers in a data center, you can use affinity. Place the Cisco SD-WAN Controllers in different controller groups, and then configure the Cisco vEdge device with a list of controller groups that it can connect to. This design provides redundant control connections to the Cisco SD-WAN Controller and provides fault isolation among the Cisco SD-WAN Controller groups in the same data center.

In the topology that is shown in the figure above, assume that you want edge devices to connect to Cisco SD-WAN Controllers as follows:

- Edge1 connects only to Cisco SD-WAN Controller 1 and Cisco SD-WAN Controller 2
- Edge2 connects only to Cisco SD-WAN Controller 2 and Cisco SD-WAN Controller 3
- Edge3 connects only to Cisco SD-WAN Controller 1 and Cisco SD-WAN Controller 3

To achieve these connections, configure Cisco SD-WAN Controller 1 with controller group ID 1:

```
vSmart(config)# system controller-group-id 1
```

To verify the configuration, use the **show running-config** command:

```
vSmart# show running-config system
system
 description         "vSmart in data center 1"
 host-name           vSmart
 gps-location latitude 37.368140
 gps-location longitude -121.913658
 system-ip           172.16.255.19
 site-id             100
 controller-group-id 1
 organization-name   "Cisco"
 clock timezone America/Los_Angeles
```

Use the following commands to configure the other Cisco SD-WAN Controllers:

```
vSmart2(config)# system controller-group-id 2
```

```
vSmart3(config)# system controller-group-id 3
```

In this example, each Cisco SD-WAN Controller in the data center is added to its own controller group. Alternatively, you can add multiple Cisco SD-WAN Controllers to the same controller group.

Note When Cisco SD-WAN Controllers are assigned to controller groups, we recommend that you assign controller groups for all Cisco SD-WAN Controllers in the overlay network.

Next, because you want Edge1 to connect only to Cisco SD-WAN Controller 2 and Cisco SD-WAN Controller 3, configure Edge1 as follows:

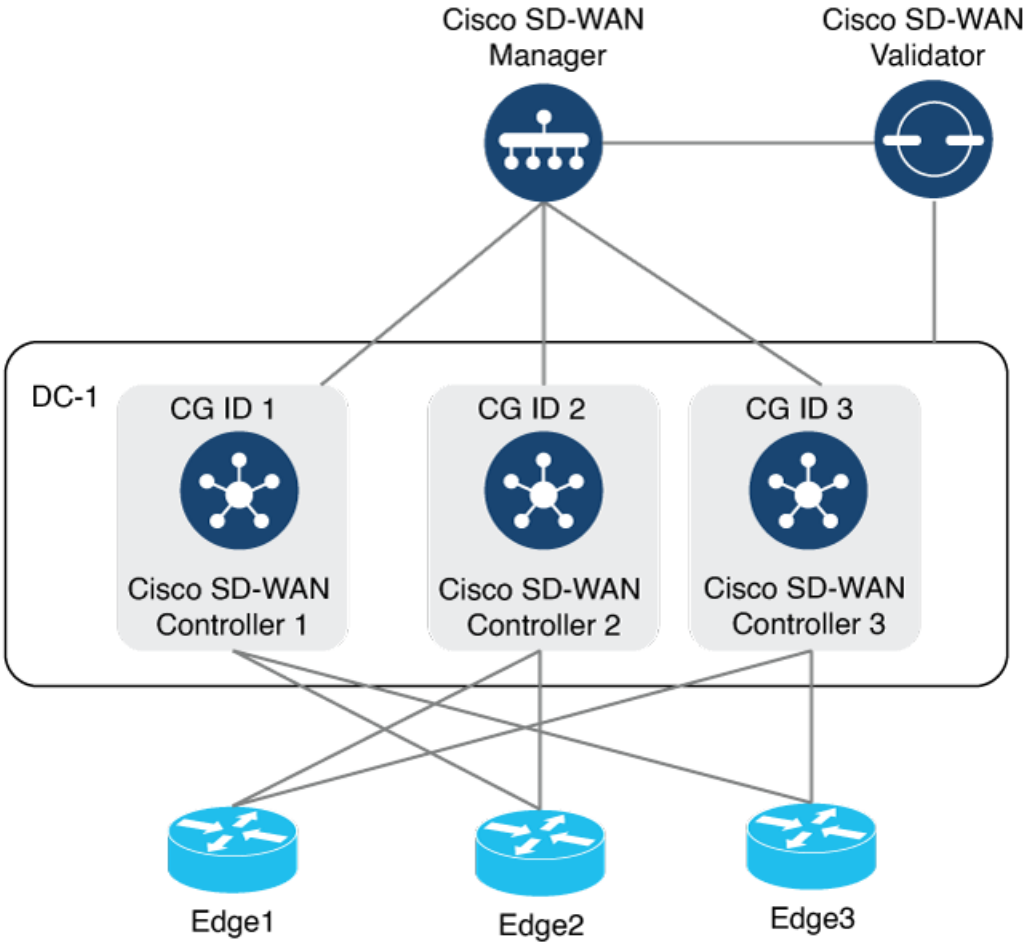
```
Edge1(config)# system controller-group-list 2 3
```

Configure Edge2 to connect only to Cisco SD-WAN Controller 1 and Cisco SD-WAN Controller 2:

```
Edge2(config)# system controller-group-list 1 2
```

Configure Edge3 to connect only to Cisco SD-WAN Controller 1 and Cisco SD-WAN Controller 3:

```
Edge3(config)# system controller-group-list 1 3
```



To display the control connections with the Cisco SD-WAN Controllers, use the **show control connections** command. The last column on the output, **Controller Group ID**, lists the Cisco SD-WAN Controller group that a router is in.

```
vEdge-1# show control connections

                                                                                PEER          PEER                                                CONTROLLER
PEER     PEER     PEER             SITE    DOMAIN   PEER           PRIVATE     PEER          PUBLIC                                              GROUP
TYPE     PROTOCOL SYSTEM IP        ID      ID       PRIVATE IP     PORT        PUBLIC IP     PORT    LOCAL COLOR    STATE    UPTIME      ID
-------------------------------------------------------------------------------------------------------------------------------------------------
vsmart   dtls     172.16.255.19    100     1        10.0.5.19      12446       10.0.5.19     12446   lte            up       0:00:00:53 1
vsmart   dtls     172.16.255.20    200     1        10.0.12.20     12446       10.0.12.20    12446   lte            up       0:00:00:22 1
```

To display the maximum number of control connections allowed on the router, use the **show control local-properties** command. The last line of the output lists the maximum controllers. The following is the abbreviated output for this command:

```
vEdge-1# show control local-properties

personality                vedge
organization-name          Cisco
certificate-status         Installed
root-ca-chain-status       Installed

certificate-validity       Valid
certificate-not-valid-before Mar 10 19:50:04 2016 GMT
certificate-not-valid-after  Mar 10 19:50:04 2017 GMT
...

                        PUBLIC          PUBLIC PRIVATE        PRIVATE                                PRIVATE                          MAX
```

```
 RESTRICT/           LAST         SPI
TIME    NAT  VM
INTERFACE               IPv4            PORT   IPv4            IPv6                                    PORT    VS/VM COLOR           STATE CNTRL
 CONTROL/     LR/LB  CONNECTION
REMAINING   TYPE CON

 STUN
              PRF
-------------------------------------------------------------------------------------------------------------------------------------------------------------------
-------------------
ge0/0                    2.1.1.11        12346  2.1.1.11        ::                                      12346    2/1  default         up     2
   no/yes/no   No/No  2:19:35:21
0:07:58:46  N    5
```

These two commands display information about the control connections established by the affinity configuration. To see, for each interface, which controller groups are configured and which Cisco SD-WAN Controller the interface is connected to, use the **show control affinity config** command:

```
vEdge-1# show control affinity config

EFFECTIVE CONTROLLER LIST FORMAT - G(C),...  - Where G is the Controller Group ID
                                                  C is the Required vSmart Count
CURRENT CONTROLLER LIST FORMAT - G(c)s,...   - Where G is the Controller Group ID
                                                  c is the current vSmart count
                                                  s Status □ when matches, χ when does not match
                 EFFECTIVE
                 REQUIRED
INDEX INTERFACE  VS COUNT   EFFECTIVE CONTROLLER LIST    CURRENT CONTROLLER LIST  EQUILIBRIUM
-----------------------------------------------------------------------------------------------
0     ge0/2      2           1(2)                        1(2)□                    Yes
```

The command output above shows that affinity is configured on interface ge0/2:

Table 1:

Field	Description
Effective Required VS Count	Shows that the interface is configured to create two control connections, and two control connections have been established.
Effective Controller List	Shows that affinity on the interface is configured to use one Cisco SD-WAN Controller from Controller Group 1, shown as 1(1), and one Cisco SD-WAN Controller from Controller Group 2, shown as 2(1). You configure the affinity controller identifiers with the **controller-group-list** command (at the **system** level) and, for the tunnel interface, the **exclude-controller-group-list** command.
Current Controller List	Lists the actual affinity configuration for the interface. The output here shows that the interface has two control connections with Cisco SD-WAN Controller in group 1 and another control connection. The “Y” indicates that the current and effective controller lists match each other.
Equilibrium	Indicates that the current controller lists match what is expected from the affinity configuration for that tunnel interface.

To determine the exact Cisco Catalyst SD-WAN Controllers with which the tunnel interface has established control connections, use the **show control affinity status** command:

```
vEdge-1# show control affinity status

ASSIGNED CONNECTED CONTROLLERS - System IP( G),..       - System IP of the assigned vSmart
                                                            G is the group ID to which the vSmart belongs to

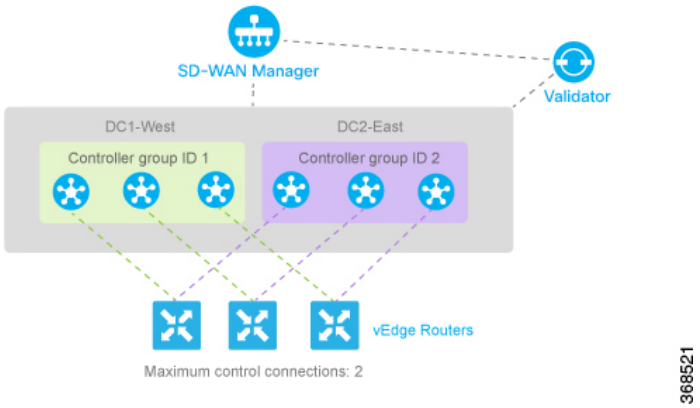
UNASSIGNED CONNECTED CONTROLLERS - System IP( G),..     - System IP of the unassigned vSmart
                                                            G is the group ID to which the vSmart belongs to

INDEX INTERFACE ASSIGNED CONNECTED  CONTROLLERS        UNASSIGNED CONNECTED CONTROLLERS
-----------------------------------------------------------------------------------------------------------------
0     ge0/2     172.16.255.19(  1), 172.16.255.20(  1)
```

The command output above shows that interface **ge0/2** has control connections to two Cisco SD-WAN Controllers, 172.16.255.19 and 172.16.255.20, that both controllers are in group 1, and that both controllers are in one of the groups configured in the controller group list. If the interface were connected to a Cisco SD-WAN Controller not in the controller group list, it would be listed in the Unassigned Connected Controllers column.

Configure Affinity for vSmart Controllers on Two Data Centers

You can use affinity to enable redundancy among data centers, for a network design in which multiple Cisco Catalyst SD-WAN Controllers are spread across two or more data centers. Then, if the link between a Cisco vEdge device and one of the data centers goes down, the Cisco Catalyst SD-WAN Controllers in the second data center are available to continue servicing the overlay network. The figure below illustrates this scenario, showing three Cisco Catalyst SD-WAN Controllers in each of two data centers. Each of the three Cisco vEdge device s establishes a TLOC connection to one controller in the West data center and one in the East data center.



You configure the three vSmart controllers in DC1-West with controller group identifier 1:

```
vSmart-DC1(config)# system controller-group-id 1
```

The three vSmart controllers in DC2-East are in controller group 2:

```
vSmart-DC2(config)# system controller-group-id 2
```

We want all the Cisco vEdge device s to have a maximum of two OMP sessions, and we want each tunnel interface to have a maximum of two control connections and to not exclude any controller groups. So the only

configuration that needs to be done on the routers is to set the controller group list. We want Cisco vEdge device s in the west to prefer Cisco Catalyst SD-WAN Controllers in DC1-West over DC2-East:

```
vEdge-West(config)# system controller-group-list 1 2
```

Similarly, we want Cisco vEdge device s in the east to prefer DC2-East:

```
vEdge-East(config)# system controller-group-list 2 1
```

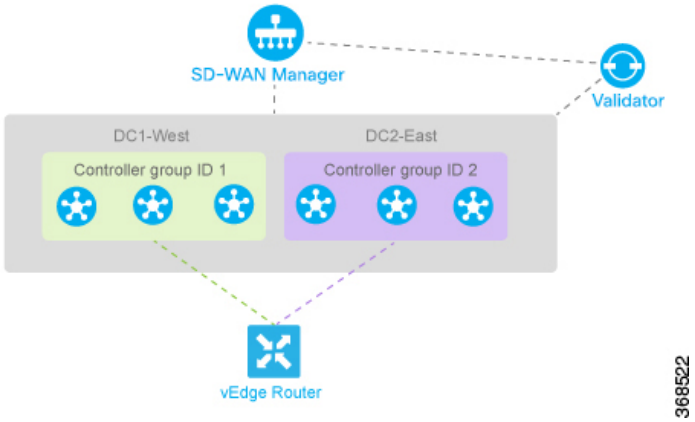
The software evaluates the controller group list in order, so with this configuration, the vEdge-West routers prefer vSmart controller group 1 (which is the West data center), and the vEdge-East routers prefer Cisco Catalyst SD-WAN Controller group 2.

You can fine-tune the controller group preference in other ways:

- Set the maximum number of OMP sessions allowed on the router to 1 (**system max-omp-sessions 1**). To illustrate how this works, let's look at a vEdge-West router. The router has only one tunnel interface, and that interface creates one control connection to Cisco Catalyst SD-WAN Controller list 1. If all the Cisco Catalyst SD-WAN Controllers in this group become unavailable, or if the connection between the router that the DC1-West data center goes down, the tunnel interface establishes one control connection to Cisco Catalyst SD-WAN Controller list 2, because this group is listed in the **system controller-group-list** command. If all Cisco Catalyst SD-WAN Controllers in both controller groups, or the connections to them, become unavailable, and if the vBond orchestrator also indicates that all these vSmart controllers are unreachable, the tunnel interface establishes a control connection to any other Cisco Catalyst SD-WAN Controller in the overlay network if other controllers are present.
- Set the maximum number of control connections that the tunnel interface can establish to 1 (**vpn 0 sdwan interface tunnel-interface max-control-connections 1**). Because the software evaluates the controller group list in order, for a vEdge-West router, this configuration forces the tunnel interface to establish a control connection to Cisco Catalyst SD-WAN Controller group 1. Again, if this controller group or data center becomes unreachable, the tunnel establishes a control connection with controller group 2, because this group is configured in the **system controller-group-list** command. And if neither controller group 1 or 2 is available, and if another vSmart controller is present in the network, the tunnel interface establishes a control connection with that controller.
- Exclude the non-preferred Cisco Catalyst SD-WAN Controller group for a particular tunnel. For example, for a vEdge-West router to prefer controller group 1, you configure **vpn 0 interface tunnel-interface exclude-controller-group-list 2** . As with the above configurations, if this controller group or data center becomes unreachable, the tunnel establishes a control connection with controller group 2, because this group is configured in the **system controller-group-list** command. And if neither controller group 1 or 2 is available, and if another Cisco Catalyst SD-WAN Controller is present in the network, the tunnel interface establishes a control connection with that controller.

Configure Redundant Control Connections on Single Device

When a Cisco IOS XE Catalyst SD-WAN device has two tunnel connections and the network has two (or more) data centers, you can configure redundant control connections from the Cisco vEdge device to Cisco SD-WAN Controllers in two of the data centers. It is recommended that do this using the minimum number of OMP sessions—in this case, two. To do this, you configure one of the tunnel interfaces to go only to one of the data centers and the other to go only to the second. This configuration provides Cisco SD-WAN Controller redundancy with the minimum number of OMP sessions.



On the Cisco vEdge device router, define the controller group list and configure the maximum number of OMP sessions to be 2:

```
vEdge(config-system)# controller-group-list 1 2
vEdge(config-system)# max-omp-sessions 2
```

For one of the tunnels, you can use the default affinity configuration (that is, there is nothing to configure) to have this tunnel prefer a Cisco Catalyst SD-WAN Controller in group 1. You can also explicitly force this tunnel to prefer Cisco Catalyst SD-WAN Controller group 1:

```
vEdge(config-tunnel-interface-1)# max-control-connections 1
```

You do not need to configure **exclude-controller-group-list 2** , because the software evaluates the controller group list in order, starting with group 1. However, you could choose to explicitly exclude Cisco SD-WAN Controller group 2.

Then, on the second tunnel, configure it to prefer a Cisco SD-WAN Controller in group 2. As with the other tunnel, you limit the maximum number of control connections to 1. In addition, you have to exclude controller group 1 for this tunnel.

```
vEdge(config-tunnel-interface-2)# max-control-connections 1
vEdge(config-tunnel-interface-2)# exclude-controller-group-list 1
```

Configure Control Plane and Data Plane High Availability Parameters

This topic discusses the configurable high availability parameters for the control plane and the data plane.

Control Plane High Availability

A highly available Cisco Catalyst SD-WAN network contains two or more Cisco SD-WAN Controllers in each domain. A Cisco Catalyst SD-WAN domain can have up to 12 Cisco SD-WAN Controllers, and each Cisco vEdge device , by default, connects to two of them. You change this value on a per-tunnel basis:

```
vEdge(config-tunnel-interface)# max-control-connections number
```

Note The **no-control-connections** command is not applicable. Instead, use the **max-control-connections** command.

Regardless of the number of Cisco SD-WAN Controller in the domain, the Cisco vEdge device connects to the maximum number of controllers based on MCC/MOS configuration (if there are enough controllers). The Cisco vEdge device connects to the same controllers across all TLOCs.



Note To maximize the efficiency of the load-balancing among Cisco SD-WAN Controllers, use sequential numbers when assigning system IP addresses to the Cisco vEdge devices in the domain. One example of a sequential numbering schemes is 172.1.1.1, 172.1.1.2, 172.1.1.3, and so forth. Another is 172.1.1.1, 172.1.2.1, 172.1.3.1, and so forth.

Data Plane High Availability

BFD, which detects link failures as part of the Cisco Catalyst SD-WAN high availability solution, is enabled by default on all Cisco devices. BFD runs automatically on all IPsec data tunnels between Cisco vEdge devices. It does not run on the control plane (DTLS or TLS) tunnels that Cisco SD-WAN Controllers establish with all Cisco devices in the network.

You can modify the BFD Hello packet interval and the number of missed Hello packets (the BFD interval multiplier) before BFD declares that a link has failed.

Change the BFD Hello Packet Interval

BFD sends Hello packets periodically to detect faults on the IPsec data tunnel between two Cisco vEdge devices. By default, BFD sends these packets every 1000 milliseconds (that is, once per second). To change this interval on one or more traffic flow, use the **hello-interval** command:

```
vEdge(config)#bfd color color hello-interval milliseconds
```

The interval can be a value from 100 to 300000 milliseconds (5 minutes).

Configure the interval for each tunnel connection, which is identified by a color. The color can be **3g**, **biz-internet**, **blue**, **bronze**, **custom1**, **custom2**, **custom3**, **default**, **gold**, **green**, **lte**, **metro-ethernet**, **mpls**, **private1**, **private2**, **public-internet**, **red**, or **silver**.

Change the BFD Packet Interval Multiplier

After BFD has not received a certain number of Hello packets on a link, it declares that the link has failed. This number of packets is a multiplier of the Hello packet interval time. By default, the multiplier is 7 for hardware routers and 20 for Cloud software routers. This means that if BFD has not received a Hello packet after 7 seconds, it considers that the link has failed and implements its redundancy plan.

To change the BFD packet interval multiplier, use the **multiplier** command:

```
vEdge(config)#bfd color color multiplier integer
```

Multiplier range: 1 to 60 (integer)

You configure the multiplier for each tunnel connection, which is represented by a color.

Control PMTU Discovery

On each transport connection (that is, for each TLOC, or color), the Cisco Catalyst SD-WAN BFD software performs path MTU (PMTU) discovery, which automatically negotiates the MTU size in an effort to minimize or eliminate packet fragmentation on the connection. BFD PMTU discovery is enabled by default, and it is recommended that you use BFD PMTU discovery and not disable it. To explicitly enable it:

```
vEdge(config)#bfd color color pmtu-discovery
```

With PMTU discovery enabled, the path MTU for the tunnel connection is checked periodically, about once per minute, and it is updated dynamically. With PMTU discovery enabled, 16 bytes might be required by PMTU discovery, so the effective tunnel MTU might be as low as 1452 bytes. From an encapsulation point of view, the default IP MTU for GRE is 1468 bytes, and for IPsec it is 1442 bytes because of the larger overhead. Enabling PMTU discovery adds to the overhead of the BFD packets that are sent between the Cisco vEdge devices, but does not add any overhead to normal data traffic.

If PMTU discovery is disabled, the expected tunnel MTU is 1472 bytes (tunnel MTU of 1500 bytes less 4 bytes for the GRE header, 20 bytes for the outer IP header, and 4 bytes for the MPLS header). However, the effective tunnel MTU might be 1468 bytes, because the software might sometimes erroneously add 4 bytes to the header.

Configure High Availability

CLI commands for configuring and monitoring high availability.

High Availability Configuration Commands

Use the following commands to configure high availability on a Cisco vEdge device:

```
bfd
  app-route
    multiplier number
    poll-interval milliseconds
  color color
    hello-interval milliseconds
    multiplier number
    pmtu-discovery
```

High Availability Monitoring Commands

show bfd sessions—Display information about the BFD sessions running on the local Cisco vEdge device.

Best Practices for Configuring Affinity

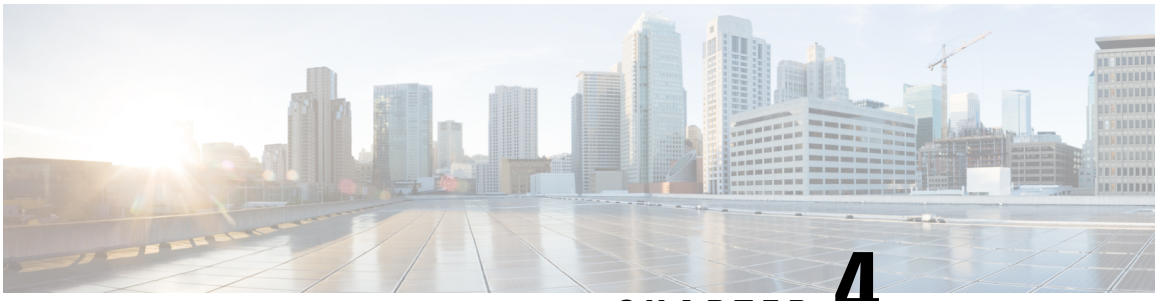
- In the **system controller-group-list** command on the Cisco vEdge device , list all the controller groups that are available in the overlay network. Doing so ensures that all the Cisco SD-WAN Controllers in the overlay network are available for the affinity configuration, and provides additional redundancy if connectivity to the preferred group or groups is lost. You can manipulate the number of control connections and their priority with the maximum number of OMP sessions for the router, the maximum number of control connections for the tunnel, and the controller groups that the tunnel should not use as the preferred group (**exclude-controller-group-list** command).

  Listing all controller groups in the **system controller-group-list** command provides an additional layer of redundancy in situations where the Cisco vEdge device site is experiencing connectivity problems with the Cisco SD-WAN Controllers in the controller group list.

  To illustrate, consider a network with three controller groups (1, 2, and 3), and in which the controller group list on a Cisco vEdge device includes only groups 1 and 2 as preferred groups. In this scenario, if the router learns from the Cisco SD-WAN Validator that the Cisco SD-WAN Controllers in groups 1 and 2 are operational, but the router is unable to establish a connection to either device, it loses connectivity to the overlay network. However, if the controller group list contains all three controller groups and

group 3 is set up as a less preferred (excluded) group, the router still normally prefers groups 1 and 2, but would fall back and connect to the controllers in group 3 if it cannot connect to group 1 or group 2.

- The controller groups listed in the **exclude-controller-group-list** command must be a subset of the controller groups configured for the entire router, in the **system controller-group-list** command.
- When a data center has multiple Cisco SD-WAN Controllers that use the same controller group identifier, and when the overlay network has two or more data centers, it is recommended that the number of Cisco SD-WAN Controllers in each of the controller groups be the same. For example, if Data Center 1 has three Cisco SD-WAN Controllers, all with the same group identifier (let's say, 1), Data Center 2 should also have three Cisco SD-WAN Controllers, all with the same group identifier (let's say, 2), and any additional data centers should also have three Cisco SD-WAN Controllers.
- When a data center has Cisco SD-WAN Controllers in the same controller group, the hardware capabilities—specifically, the memory and CPU—on all the Cisco SD-WAN Controllers should be identical. More broadly, all the Cisco SD-WAN Controllers in the overlay network, whether in one data center or in many, should have the same hardware capabilities. Each Cisco SD-WAN Controller should have equal capacity and capability to handle a control connection from any of the Cisco vEdge device s in the network.
- When a router has two tunnel connections and the network has two (or more) data centers, it we recommend that you configure one of the tunnel interfaces to go to one of the data centers and the other to go to the second. This configuration provides Cisco SD-WAN Controller redundancy with the minimum number of OMP sessions.
- Whenever possible in your network design, you should leverage affinity configurations to create fault-isolation domains.
- After affinity reconfiguration, controllers which were previously overloaded may continue to experience persistently high memory utilization that does not decrease. It is recommended to reboot such overloaded controllers, one at a time, to recover from memory overload. The rebalancing requires a reload of the Cisco SD-WAN Controller node.



CHAPTER 4

Disaster Recovery

Table 2: Feature History

Feature Name	Release Information	Description
Disaster Recovery for Cisco SD-WAN Manager	Cisco Catalyst SD-WAN Manager Release 20.12.1Cisco SD-WAN Release 19.2.1 Cisco vManage Release 19.2.1	This feature helps you configure Cisco SD-WAN Manager in an active or standby mode to counteract hardware or software failures that may occur due to unforeseen circumstances.
Disaster Recovery for a six Node Cisco SD-WAN Manager Cluster.	Cisco SD-WAN Release 20.4.1 Cisco vManage Release 20.4.1	This feature provides support for disaster recovery for a six node Cisco SD-WAN Manager cluster.
Disaster Recovery for a Single Node Cisco SD-WAN Manager Cluster	Cisco SD-WAN Release 20.5.1 Cisco vManage Release 20.5.1	This feature provides support for disaster recovery for a Cisco SD-WAN Manager deployment with a single primary node.
Multitenancy Support for Disaster Recovery	Cisco vManage Release 20.6.x	This feature provides support for multitenancy in disaster recovery.
Disaster Recovery User Password Change	Cisco SD-WAN Release 20.7.1 Cisco vManage Release 20.7.1	This feature lets you change the disaster recovery user password for disaster recovery components from the Cisco SD-WAN Manager **Disaster Recovery** window.
Disaster Recovery Alerts	Cisco SD-WAN Release 20.9.1 Cisco vManage Release 20.9.1 Also: Cisco SD-WAN Release 20.6.4 and later 20.6.x releases Cisco SD-WAN Manager Release 20.6.4 and later 20.6.x releases	You can configure Cisco SD-WAN Manager alerts to generate an alarm and a syslog message for any disaster recovery workflow failure or event that occurs.

Feature Name	Release Information	Description
Disaster Recovery Reliability Improvements Phase 1	Cisco Catalyst SD-WAN Manager Release 20.13.1	This feature removes the **Pause Replication** button from the **Disaster Recovery** screen. Replication pauses automatically when you pause disaster recovery and resumes when you resume disaster recovery.

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- Architecture Overview, on page 39
- Prerequisites for Registering Disaster Recovery, on page 39
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Information About Disaster Recovery

In the Cisco Catalyst SD-WAN solution, which includes Cisco SD-WAN Manager, Cisco Catalyst SD-WAN Controller, and Cisco Catalyst SD-WAN Validator, only the Cisco SD-WAN Manager is stateful and can't be deployed in an active/active mode. The disaster recovery solution aims to deploy Cisco SD-WAN Manager across two data centers in primary/secondary mode.

The user account used for disaster recovery supports only local authentication and does not support remote authentication methods such as TACACS+ or RADIUS. This user must be dedicated solely to disaster recovery tasks and must not be used for any other functions, such as cluster management because of the following reasons:

- Reliability: Using dedicated accounts for DR sync minimizes configuration errors and reduces operational risks.
- Resilience: Prevents issues related to user lockouts or account overrides, ensuring DR processes are not impacted by administrative changes to other accounts.
- Audit and compliance: Dedicated users provide clear separation for auditing purposes, making it easier to track and log DR-related activities.
- Industry standard: All our customers, including those in highly regulated sectors such as finance, follow this model. It is the recommended and supported deployment standard.
- Avoid remote authentication issues: TACACS-based users are prone to disruptions due to potential latency or connectivity issues with remote authentication servers. Using local accounts eliminates these risks, ensuring uninterrupted DR sync and cluster operations.

- Password rotation: Capabilities are provided via API/GUI on active cluster and through CLI on standby cluster.

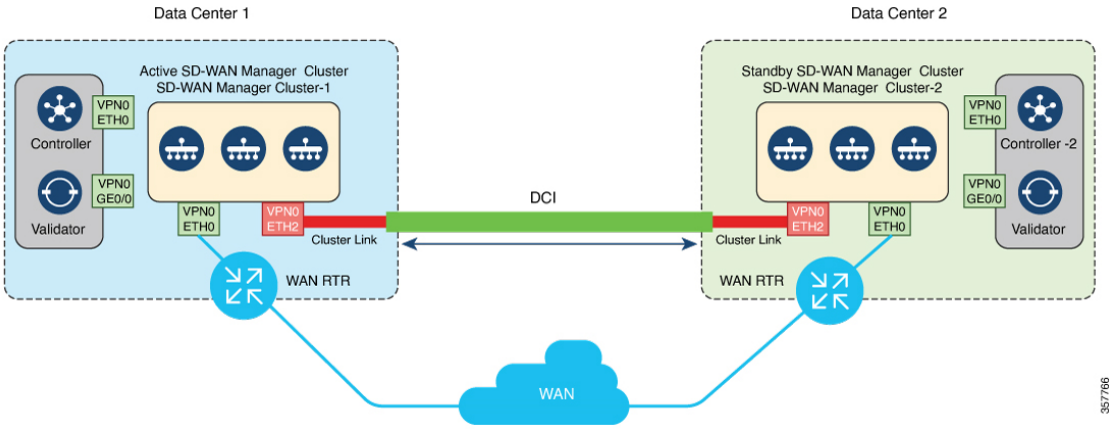
Disaster recovery provides an administrator-triggered failover process. When disaster recovery is registered, data is replicated automatically between the primary and secondary Cisco SD-WAN Manager clusters. If necessary, you can manually initiate a failover to the secondary cluster.

Disaster recovery is validated for these setups.

Release	Validated for
Cisco IOS XE Catalyst SD-WAN Release 17.4.1a, Cisco SD-WAN Release 20.4.1, and earlier	Three-node cluster
Cisco IOS XE Catalyst SD-WAN Release 17.4.1a and Cisco SD-WAN Release 20.4.1	Six-node cluster
Cisco IOS XE Catalyst SD-WAN Release 17.5.1a and Cisco SD-WAN Release 20.5.1	Deployment with a single primary node

Architecture Overview

The following figure illustrates the high-level architecture of the disaster recovery solution.



Prerequisites for Registering Disaster Recovery

Cluster Requirements

- Ensure that you have two Cisco SD-WAN Manager clusters that contain the specific number of nodes as validated for your release. The validated number of nodes for each release is described in the *Information About Disaster Recovery* section.
- Ensure that the primary and the secondary cluster are reachable by HTTPS on a transport VPN (VPN 0).

- Ensure that Cisco Catalyst SD-WAN Controllers and Cisco Catalyst SD-WAN Validators on the secondary cluster are connected to the primary cluster.
- Ensure that the Cisco SD-WAN Manager nodes in the primary cluster and secondary cluster are running the same Cisco SD-WAN Manager version.
- Ensure that no operations are currently running on either the active or standby Cisco SD-WAN Manager cluster. For example, make sure that no servers are in the process of upgrading or no templates are in the process of attaching templates to devices.

Node Specifications

- Ensure that services such as application-server, configuration-db, messaging server, coordination server, and statistics-db, are enabled on all Cisco SD-WAN Manager nodes in the cluster.
- Ensure that all Cisco SD-WAN Manager nodes in a cluster reside on the same LAN segment.
- Ensure that both the active and standby Cisco SD-WAN Manager nodes are not in managed mode for disaster recovery to operate effectively.
- Distribute each Cisco SD-WAN Manager VM on a separate physical server so that a single physical server outage does not affect the Cisco SD-WAN Manager cluster in a data center.

IP Address Configurations

- Configure an out-of-band or cluster interface on the VPN 0 of each Cisco SD-WAN Manager node that is to be used for disaster recovery. This is the same interface that Cisco SD-WAN Manager uses to communicate with other nodes in a cluster.
- Ensure that you change the local host address of the primary Cisco SD-WAN Manager to an out-of-band IP address. This is necessary even if the Cisco SD-WAN Manager is a standalone node.



Note For information on configuring the cluster IP address, see Configure the Cluster IP Address of a Cisco Catalyst SD-WAN Manager Server.

- Ensure that all Cisco SD-WAN Manager nodes can reach each other through the out-of-band interface.

User Configurations

Create a new local netadmin username and password that are identical on both the active and standby Cisco SD-WAN Manager nodes. Use this newly created user exclusively for disaster recovery registration instead of the default admin user. This user must be dedicated solely to disaster recovery tasks and must not be used for any other functions, such as cluster management.

Control Components Configurations

- Distribute all controllers, including Cisco Catalyst SD-WAN Validators, across both primary and secondary data centers. Ensure that these controllers are reachable by Cisco SD-WAN Manager nodes that are located in these data centers. The controllers connect only to the primary Cisco SD-WAN Manager cluster.

- Before you start the disaster recovery registration process, go to the **Tools** > **Rediscover Network** window on the primary Cisco SD-WAN Manager node and rediscover the Cisco Catalyst SD-WAN Validators.
- Ensure the Cisco Catalyst SD-WAN Validator has the tunnel-interface configuration in place and it allows SSH connectivity.

Device Switchover

- Enable TCP ports 8443 and 830 on your data center firewalls to allow Cisco SD-WAN Manager clusters to communicate with each other across data centers.

  During a device switchover, active Cisco SD-WAN Manager interacts with Cisco SD-WAN Validator or Cisco SD-WAN Controller through Netconf (port 830) for initial connection. To connect the cluster, shutdown the tunnel interface and configure controller serial list to controller components through Netconf (port 830). If port 830 is unavailable, the Cisco SD-WAN Manager fails.. and shuts down the tunnel interface.

Proxy Configuration

- To configure an HTTP/HTTPS proxy before setting up disaster recovery, rnsure that the Cisco SD-WAN Manager's HTTP/HTTPS proxy server is disabled if it is currently active. See HTTP/HTTPS Proxy Server for Cisco SD-WAN Manager Communication with External Servers. If you don't disable the proxy server, Cisco SD-WAN Manager attempts to establish disaster recovery communication through the proxy IP address, even when the out-of-band cluster IP addresses are reachable.

  You can re-enable the Cisco SD-WAN Manager HTTP/HTTPS proxy server after disaster recovery registration is complete.

SD-AVC Configuration

- If you wish to enable Cisco Software-Defined Application Visibility and Control (SD-AVC) and disaster recovery is already configured, first delete the existing disaster recovery. Next, enable Cisco SD-AVC on both the primary and secondary nodes. Re-register Disaster Recovery to proceed.

Cisco SD-WAN Validator Configurations

For a successful disaster recovery registration, configure a tunnel interface with netconf service enabled on a VPN 0 interface.

This is an example of a Cisco SD-WAN Validator configuration:

```
vpn 0
interface ge0/0
ip address 10.0.46.6/24
tunnel-interface
encapsulation ipsec
allow-service netconf
```

Guidelines for Registering Disaster Recovery

IP Address and Configurations

- Specify the VPN 0 interface IP address when you configure the IP address that the Cisco SD-WAN Validator uses for disaster recovery authentication. Ensure that the IP address is reachable by both the primary and secondary Cisco SD-WAN Manager clusters. If a tunnel interface is configured, make sure that NETCONF is permitted on it.
- Before you configure a new Cisco SD-WAN Validator, deregister disaster recovery on Cisco SD-WAN Manager. Then, add the new Cisco SD-WAN Validator on the active cluster and re-register with the new Cisco SD-WAN Validator.
- The system configurations on Cisco SD-WAN Manager should be identical on all the active and standby nodes.

Disaster Recovery Operations

- Regularly take backup of the configuration database from the active Cisco SD-WAN Manager instance. See, request nms configuration-db command. Use only a system administrator user to restore configuration database and to onboard Cisco Catalyst SD-WAN Control Components.
- Pause disaster recovery before initiating manual disaster recovery. Performing manual switchover operation while disaster recovery is active can lead to cluster failure.
- Configuration changes via Command Line Interface is not recommended on standby nodes.

Replication history

(Minimum supported release: Cisco Catalyst SD-WAN Manager Release 20.18.1) The replication logs are retained for one year. Any historical data older than one year is automatically pruned.

Workflow for Disaster Recovery

Enable Disaster Recovery

You need to bring up two separate clusters with no devices being shared, which means do not share any Cisco SD-WAN Controller, or Cisco SD-WAN Validator or Cisco SD-WAN Manager device.

Perform these actions:

- Bring up two separate Cisco SD-WAN Manager clusters without devices and Cisco Catalyst SD-WAN Control Components.
- The active cluster is onboarded with Cisco Catalyst SD-WAN Control Components and edge devices that are not shared with the standby cluster.
- For disaster recovery on a single node Cisco SD-WAN Manager, configure both the primary and secondary nodes with cluster IP address on the **Cluster Management** page.

- Ensure that there is connectivity between the primary and secondary clusters through the cluster IP interface.

Register Disaster Recovery

The registration can take up to 30 minutes to complete. After the registration starts, the message **No Data Available** may display for a short time in the registration task view on Cisco SD-WAN Manager. During the registration process, the message **In-progress** is displayed.

For Cisco Catalyst SD-WAN Manager Release 20.13.1 and earlier releases, Cisco SD-WAN Manager nodes restart after registration. If you see the message **Error occurred retrieving status for action disaster_recovery_registration**, click the **Reload** button in your browser after the last active Cisco SD-WAN Manager node restarts.

From Cisco Catalyst SD-WAN Manager Release 20.13.1, nodes do not restart after registration.

Before you begin

Disaster recovery must be registered on the primary Cisco SD-WAN Manager cluster. You can use the out-of-band IP address of a reachable Cisco SD-WAN Manager node in the cluster for disaster recovery registration.

Procedure

Step 1 Log in to Cisco SD-WAN Manager as the netadmin user.

Step 2 Use the netadmin user, which was specifically created for disaster recovery, for the registration. Use the same user for all disaster recovery operations.

Step 3 From the Cisco SD-WAN Manager menu, choose **Administration > Disaster Recovery**.

Step 4 Click **Manage Disaster Recovery**.

Step 5 To configure the primary and secondary clusters, on the **Manage Disaster Recovery** > **Connectivity Info** page, enter the cluster IP address of any primary and secondary Cisco SD-WAN Manager node and the netadmin user from step 2.

If a cluster is behind a load balancer, specify the IP address of the load balancer.

Step 6 On the **Validator Info** page, enter all the Cisco SD-WAN Validator IP addresses. If you miss adding any Cisco SD-WAN Validator details, it can be added after you delete disaster recovery and enable it again.

Step 7 Choose **Manual** as the type of recovery in the **Recovery Mode**.

Step 8 Specify the **Replication Interval** and **Delay Threshold** for replicating data from the primary to the secondary cluster.

The default value for **Delay Threshold** is 30 minutes.

The default value for **Replication Interval** is 15 minutes.

For releases earlier than 26.1.1, also specify the **Start Time**, which has a default value of 12:00 AM.

Note

When there is a failure in data replication, disaster recovery waits for six times the configured replication interval before initiating the next replication cycle. For example, if the replication interval is set to one hour and a failure occurs, disaster recovery waits for an additional 6 hours, resulting in a total wait time of 7 hours before attempting the next replication.

Verify Disaster Recovery Registration

Successful Registration

After successfully registering for disaster recovery, perform status checks as follows:

- Registration Task: Confirm that the registration task is successful.
- Monitor alarms: From the Cisco SD-WAN Manager menu, choose **Monitor** > **Logs** > **Alarms**. Check for the **DR Registration Success** alarm.
- Node health: From the Cisco SD-WAN Manager menu, choose **Administration** > **Disaster Recovery**. Confirm that all nodes of both the primary and secondary clusters are displayed. Also verify the health status of the nodes.
- Replication: Verify that replication from the primary cluster to the secondary cluster happens at the configured intervals. Check the delay threshold, the time of last replication, and size of the data that is replicated. Choose **Monitor** > **Logs** > **Alarms** and check for **Primary Successfully Exported** and **Secondary Successfully Imported** alarms.
- Switchover: Verify the time when the primary cluster switched over to the secondary cluster. Additionally, check the reason for the switchover.

Registration Failure

If disaster recovery registration fails, verify the following:

- Reachability to the Cisco SD-WAN Validator from all cluster members on the secondary cluster.
- Reachability between the secondary cluster and primary cluster on the cluster interface (VPN 0).
- Check that you have provided the correct user name and password during registration.

Delete Disaster Recovery

If you want to delete disaster recovery, we recommend that you initiate the delete operation on the primary cluster. Before deleting, make sure that there is no data replication in progress.

We recommend that you pause disaster recovery to prevent the replication from restarting before a deletion attempt.

If the secondary Cisco SD-WAN Manager is down, you can perform the delete operation on the primary Cisco SD-WAN Manager cluster.

If any Cisco SD-WAN Manager in an active or standby cluster that was offline during the disaster recovery delete operation comes back online, execute the following POST request on that cluster to complete the delete disaster recovery operation:

POST /dataservice/disasterrecovery/deleteLocalDataCenter

After you delete disaster recovery, makes sure that the primary and secondary clusters are operating correctly. To do so, go to the **Administration** > **Cluster Management** window and make sure that all Cisco SD-WAN Manager nodes are present in the cluster. If the nodes are not present, restart the application server. Also go to the **Administration** > **Disaster Recovery** window and make sure that no nodes appear. Choose **Monitor** > **Logs** > **Alarms** and check for the DR De-Registration Success alarm.

Data centers must be deleted from disaster recovery before you can reregister disaster recovery for the data centers.

Perform an Administrator-Triggered Failover

Procedure

Step 1 From a Cisco SD-WAN Manager system on the secondary cluster, choose **Administration** > **Disaster Recovery**.

Step 2 Choose **Make Primary**.

Step 3 If replication is in progress and the standby cluster is not ready to switchover, **Make Primary** option is not available to trigger the failover.

Devices and controllers converge to the secondary cluster and that cluster assumes the role of the primary cluster. When this process completes, the original primary cluster assumes the role of the secondary cluster. Then data replicates from the new primary cluster to the new secondary cluster.

Disaster Recovery Operations

Loss of Primary Cisco SD-WAN Manager Cluster

Procedure

Step 1 From a Cisco SD-WAN Manager system on the secondary cluster, choose **Administration** > **Disaster Recovery**.

Step 2 Click **Make Primary**.

Devices and controllers converge to the secondary cluster and that cluster assumes the role of the primary cluster.

When the original primary cluster recovers and is back on line, it assumes the role of the secondary cluster and begins to receive data from the primary cluster.

Loss of Primary Data Center

Procedure

Step 1 From a Cisco SD-WAN Manager system on the secondary cluster, choose **Administration** > **Disaster Recovery**.

Step 2 Click **Make Primary**.

The switchover process begins. During the process, only the Cisco SD-WAN Validators in the secondary data center are updated with a new valid Cisco SD-WAN Manager list. Devices and controllers that are online converge to the secondary cluster which assumes the role of the primary cluster.

After the original primary data center recovers and all VMs, including controllers, are back online, the controllers are updated with a new valid Cisco SD-WAN Manager and converge to the new primary Cisco SD-WAN Manager cluster. The original primary cluster assumes the role of secondary cluster and begins to receive data from the primary cluster.

Partial Loss of Primary Cisco SD-WAN Manager Cluster

If you experience a partial loss of the primary Cisco SD-WAN Manager cluster, we recommend that you try to recover that cluster instead of switching over to the secondary cluster.

A cluster with N nodes is considered to be operational if (N/2)+1 nodes are operational.

A cluster with N nodes becomes read only, if (N/2)+1 or more nodes are lost.

Loss of Enterprise Network Between Data Centers

If there is a link failure between data centers but the WAN in the primary data center is operational, data replication fails. You can attempt to recover the link to resume the data replication.

To avoid a possible split brain scenario, do not perform a switchover operation.

Changing the Cisco SD-WAN Manager or Cisco Catalyst SD-WAN Validator Administrator Password Used for Disaster Recovery

For releases earlier than Cisco SD-WAN Release 20.7.1, if you use the Cisco SD-WAN Manager to change a user password that you entered during disaster recovery registration, first deregister disaster recovery from the Cisco SD-WAN Manager cluster, change the password, and then reregister disaster recovery on the cluster.

Changing the Disaster Recovery User Password for Disaster Recovery Components

During disaster recovery registration, you provide the user name and password of a Cisco SD-WAN Manager or a Cisco SD-WAN Validator user.

Procedure

Step 1 From the Cisco SD-WAN Manager menu, choose **Administration** > **Disaster Recovery**.

Step 2 Click **Pause Disaster Recovery**, and then click **OK**.

Data replication between the primary and secondary data centers stops and this option changes to **Resume Disaster Recovery**.

Step 3 To change the Cisco SD-WAN Manager or Cisco SD-WAN Validator password used for disaster recovery:

- To update the password of Cisco SD-WAN Manager in an active cluster, navigate to **Administration**>**Manage Users** and modify the user's password. For information, refer to the *Cisco Catalyst SD-WAN Systems and Interfaces Configuration Guide, Cisco IOS XE Catalyst SD-WAN Release 17.x*.
- For a standby cluster, the password must be updated individually on each node. This can be done using the CLI on all Cisco SD-WAN Manager nodes in the standby cluster. For information, refer to the sections about users and access in the *Cisco Catalyst SD-WAN Systems and Interfaces Configuration Guide, Cisco IOS XE Catalyst SD-WAN Release 17.x*.

Step 4 Click **Manage Password**.

a) Click **Active Cluster**, and in the **Password** field that appears, enter the new active cluster password for the disaster recovery user.
b) Click **Standby Cluster**, and in the **Password** field that appears, enter the same password that you entered in the **Active Cluster** field for the disaster recovery user.
c) Click **Validator**, and in each **Password** field that appears, enter the new Cisco Catalyst SD-WAN Validator password. There is one **Password** field for each Cisco SD-WAN Validator.
d) Click **Update**.

The passwords are updated and the **Manage Password** window closes.

Step 5 Click **Resume Disaster Recovery**, and then click **OK**.

Data replication between the primary and secondary data centers restarts.

Change the Cisco SD-WAN Manager Password Used to Create the Cisco SD-WAN Manager Cluster with Disaster Recovery Configured

Procedure

Step 1 To change the password of the Cisco SD-WAN Manager cluster that is used to create the active cluster, login to any of the Cisco SD-WAN Manager of the active cluster and navigate to **Administration**> **Manage Users** to edit the user password.

For information, refer to the information about users and access in the *Cisco Catalyst SD-WAN Systems and Interfaces Configuration Guide, Cisco IOS XE Catalyst SD-WAN Release 17.x*.

Step 2 To change the password of the Cisco SD-WAN Manager cluster that is used to create the standby cluster:

a) Perform switchover to make the standby cluster as the new active cluster. After a successful switchover, ensure that the status of all the services in the **Cluster Management** page is healthy or reachable.

b) Login to any of the Cisco SD-WAN Manager of the new active cluster and navigate to **Administration** > **Manage Users** and edit the user password. For information, refer to the information about users and access in the *Cisco Catalyst SD-WAN Systems and Interfaces Configuration Guide, Cisco IOS XE Catalyst SD-WAN Release 17.x*.

Configure Disaster Recovery Alerts

Minimum supported releases: Cisco vManage Release 20.6.4, Cisco vManage Release 20.9.1, and later releases

You can configure Cisco SD-WAN Manager alerts to generate an alarm and a syslog message for any disaster recovery workflow failure or event that occurs. You can then monitor disaster recovery workflows and events through syslog notifications, event notifications, and webhooks.

Procedure

Step 1 On any Cisco SD-WAN Manager server in the primary cluster, pause Disaster Recovery by choosing **Administration** > **Disaster Recovery** and clicking **Pause Disaster Recovery**.

Step 2 On any Cisco SD-WAN Manager server in the primary cluster and any Cisco SD-WAN Manager server in the secondary cluster, enable **Alarm Notifications** in the **Administration** > **Settings** window.

See Enable Email Notifications section in Alarms in *Cisco Catalyst SD-WAN Monitor and Maintain Configuration Guide*.

Step 3 Perform the following actions on any Cisco SD-WAN Manager server in the primary cluster and any Cisco SD-WAN Manager server in the secondary cluster to define a disaster recovery alarm notification rule:

a) From the Cisco SD-WAN Manager menu, choose **Monitor** > **Logs**.

b) Click **Alarms**.

c) Click **Alarm Notifications**.

d) Click **Add Alarm Notification**.

e) From the **Severity** drop-down list, choose the severity of the events for which an alarm is generated.

f) From the **Alarm Name** drop-down list, choose **Disaster Recovery**.

g) Configure other options for the rule as needed.

For detailed instructions, see “Send Alarm Notifications” in Alarms in *Cisco Catalyst SD-WAN Monitor and Maintain Configuration Guide*.

h) In the **Select Devices** area, click **Custom**.

i) Choose the Cisco SD-WAN Manager servers for which the disaster recovery alarms are generated by clicking the corresponding devices in the **Available Devices** list and then clicking the arrow to move them to the **Selected Devices** list.

Step 4 On any Cisco SD-WAN Manager server in the primary cluster, restart Disaster Recovery by choosing **Administration** > **Disaster Recovery** and clicking **Resume Disaster Recovery**.

What to do next

After you configure disaster recovery alerts, from each Cisco SD-WAN Manager server in the primary cluster and secondary cluster, configure logging of syslog messages to a local device and remote device, if needed. For instructions, see "Log Syslog Messages to a Local Device" and "Log Syslog Messages to a Remote Device" in Configure System Logging Using CLI in *Cisco Catalyst SD-WAN Systems and Interfaces Configuration Guide*.

Upgrade Disaster Recovery Overlays

Upgrade both the active and standby Cisco SD-WAN Manager clusters.

Before you begin

- Use the Command Line Interface method to upgrade both the active and standby Cisco SD-WAN Managers.
- Ensure that the replication status on the **Administration** > **Disaster Recovery** page is stable and not in a transient state such as **Import Pending**, **Export Pending**, or **Download Pending**.
- Pause the disaster recovery before the upgrade using **Pause Disaster Recovery**. For Cisco Catalyst SD-WAN Manager Release 20.13.1 and earlier releases, do not use **Pause Replication**.

  If you upgrade Cisco SD-WAN Manager without pausing disaster recovery the following error occurs: Error: error-reason 'Disaster Recovery is not Paused. Terminating Activation.

Procedure

Step 1 Upgrade the active Cisco SD-WAN Manager nodes. See, Upgrade and Activate procedure described in the *Cisco Catalyst SD-WAN Monitor and Maintain* guide.

Step 2 Upgrade the standby Cisco SD-WAN Manager nodes.

Step 3 Upgrade the Cisco SD-WAN Validators and Cisco SD-WAN Controllers nodes accordingly.

Step 4 Upgrade the WAN edge devices if required.

What to do next

Once upgrade is complete, **UnPause Disaster Recovery** and verify that disaster recovery has resumed. See, Verify Disaster Recovery Registration, on page 44.

Add or Delete Cisco SD-WAN Control Components from the Disaster Recovery Overlays

To add or remove any node in the active or standby Cisco SD-WAN Control Components, perform the following steps:

Before you begin

Cisco SD-WAN Control Components

Procedure

Step 1 Delete disaster recovery.

Step 2 Add or remove the Cisco SD-WAN Control Components.

Step 3 Register disaster recovery.

How Features Operate When Disaster Recovery is Enabled

Zero Touch Provisioning (ZTP)

When a standby cluster becomes active, it does not inherit Zero Touch Provisioning (ZTP) settings from the other cluster. After the failover is complete, enable ZTP for the new active cluster. See the Start the Enterprise ZTP Server section in the *Cisco Catalyst SD-WAN Getting Started Guide*.

SD-AVC

It's important to maintain the classification of SD-AVC custom applications, especially during a switchover from a primary to a secondary Cisco SD-WAN Manager.

- Any custom application configured in the primary Cisco SD-WAN Manager under **Configuration**> **Policies**> **Centralized Policy**> **Lists**> **Custom Applications** is automatically replicated to the secondary Cisco SD-WAN Manager.
- After a switchover, a new Cisco SD-WAN Manager becomes primary. You can edit each custom application on the new primary Cisco SD-WAN Manager and save each custom application to ensure a continuity in classification.
- Any new custom applications configured after the switchover does not require an additional edit and save action for continuity in classification.

Note Starting with Cisco Catalyst SD-WAN Manager Release 20.18.1 for single-node deployments and Cisco Catalyst SD-WAN Manager Release 20.13.1 for cluster deployments, SD-AVC custom applications are automatically replicated to the secondary Cisco SD-WAN Manager as part of the disaster recovery process.

From these versions onward, SD-AVC custom applications are backed up within the configuration database and synchronized across the disaster recovery setup, ensuring continuity and consistency of application classification after failover.

User Management

When managing user accounts on a Cisco SD-WAN Manager, it's important to understand the replication behavior between the primary and the secondary Cisco SD-WAN Managers.

- Adding a new user or modifying an existing user on the primary Cisco SD-WAN Manager is automatically replicated to the secondary Cisco SD-WAN Manager when done using the Cisco SD-WAN Manager.
- Deleting a user on the primary Cisco SD-WAN Manager is not replicated to the secondary Cisco SD-WAN Manager. The user account still exists on the secondary Cisco SD-WAN Manager and may need to be deleted manually for consistency across both the Cisco SD-WAN Managers.
- Adding, modifying and deleting the user using the Command Line Interface is not replicated.

HTTP Proxy

When managing HTTP proxy settings in relation to disaster recovery on Cisco Catalyst SD-WAN, perform the following steps:

1. Remove the HTTP proxy from the configuration before proceeding with the disaster recovery registration to avoid any conflicts.
2. HTTP proxy configuration is automatically replicated to the standby Cisco SD-WAN Manager.
3. After a switchover, edit and save the proxy configurations for the HTTP proxy settings to take effect on the new primary Cisco SD-WAN Manager.

Admin-tech Collection and Management

When managing admin-tech data on Cisco SD-WAN Manager, consider the following guidelines:

- Admin-tech data for the primary Cisco SD-WAN Manager can be collected and downloaded using both the Cisco SD-WAN Manager and Command Line Interface (CLI).
- Admin-tech data for the standby Cisco SD-WAN Manager can only be collected and downloaded using the CLI.
- Admin-tech entries are replicated to the standby Cisco SD-WAN Manager but the actual admin-tech files are not transferred.
- After a switchover to the standby Cisco SD-WAN Manager, the replicated admin-tech entries become dummy entries.
- You must manually clean up these dummy entries post-switchover to ensure data integrity and system cleanliness.

Cisco SD-WAN Manager Software Repository

When managing software repository on Cisco SD-WAN Manager, consider the following guidelines:

- Software repository entries are replicated to the standby Cisco SD-WAN Manager. The actual software files are not transferred.
- After a switchover to the standby Cisco SD-WAN Manager, the replicated software repository entries becomes dummy entries.
- You must manually clean up these dummy entries after switchover to ensure data integrity and system cleanliness.

Cisco SD-WAN Manager, Validator, Controller Certificate Renewal

Certificate renewal of primary Cisco SD-WAN Manager, secondary Cisco SD-WAN Manager, Cisco Catalyst SD-WAN Validator, and Cisco Catalyst SD-WAN Controller should be performed using the following steps when Disaster Recovery (DR) is enabled:

1. Delete Disaster recovery.
2. Renew the necessary certificates for the respective Cisco SD-WAN Manager components using the Control Components Certificate Management workflow available in Cisco SD-WAN Manager.

   This workflow supports both automatic and manual renewal methods.
3. After successful certificate renewal, register the DR again to resume disaster recovery operations.

For Cisco IOS XE Catalyst SD-WAN device certificate renewal, certificates can be renewed while DR is enabled.

However, an administrator triggered failover should only be performed after at least one successful replication to ensure that the edge device certificate renewals are up to date on the standby Cisco SD-WAN Manager.