Bridging

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.

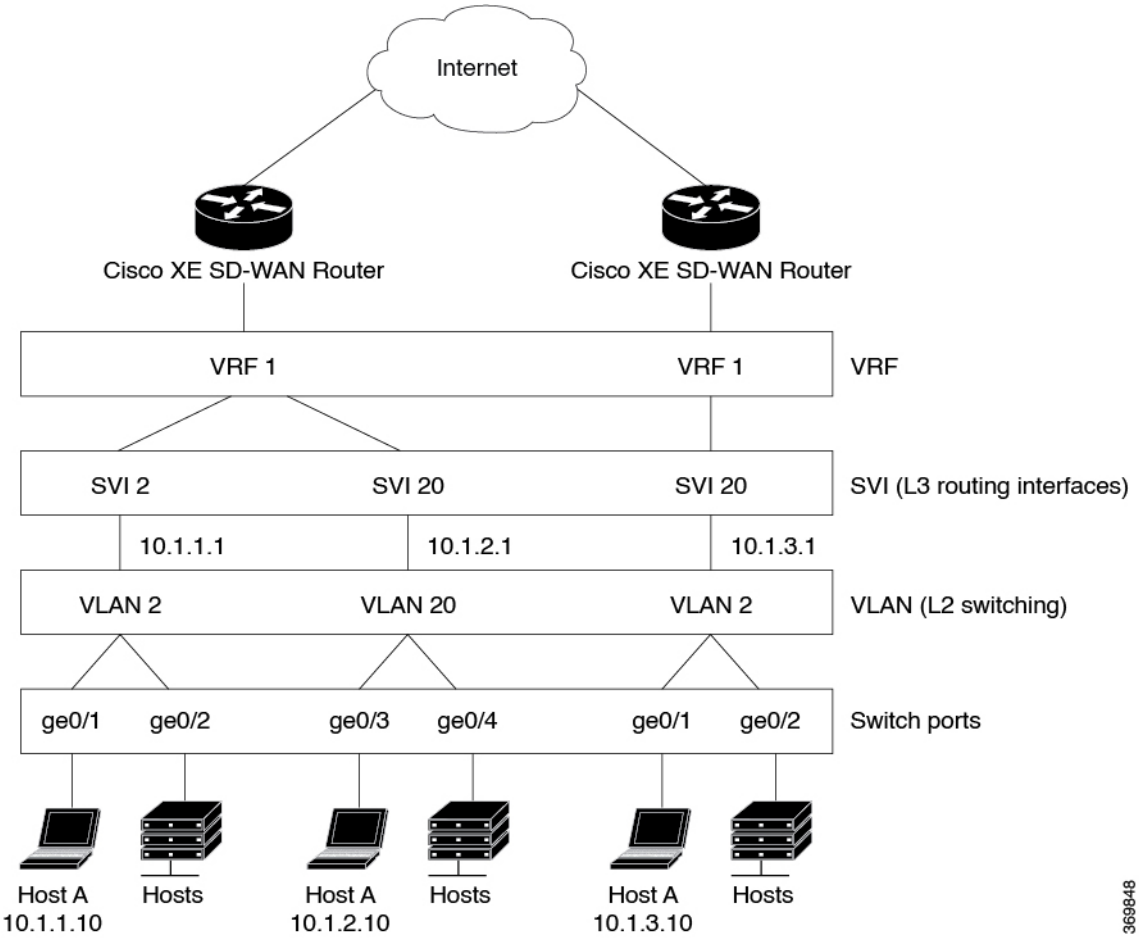
A Cisco IOS XE Catalyst SD-WAN device can act as a transparent bridge, switching traffic between LANs that are part of a Virtual Local Area Network (VLAN) at the site of local router. To implement bridging, each VLAN acts as a separate broadcast domain, and each has its own Ethernet switching table (or MAC table) to use for switching traffic within the broadcast domain. Multiple VLANs can coexist in a single Cisco IOS XE Catalyst SD-WAN device.

To allow hosts associated with different VLANs to communicate with each other, Cisco IOS XE Catalyst SD-WAN devices support Switch Virtual Interface (SVI). SVIs provide Layer 3 routing services to allow traffic exchange between various VLANs. Each VLAN can have a single SVI.

Components of Bridging

The following figure illustrates the components of bridging in Cisco Catalyst SD-WAN for Cisco IOS XE Catalyst SD-WAN devices.

Figure 1: Components of Bridging



VLANs

What is a VLAN

A VLAN is a switched network that is logically segmented by function, project team, or application, without regard to the physical locations of the users. VLANs provide the means to divide LAN into smaller broadcast domains. VLANs have the same attributes as physical LANs, but you can group end stations even if they are not physically located on the same LAN segment. Any device port can belong to a VLAN, and unicast, broadcast, and multicast packets are forwarded and flooded only to end stations in the VLAN. Each VLAN is considered a logical network, and packets destined for stations that do not belong to the VLAN must be forwarded through a router or a device supporting fallback bridging. In a device stack, VLANs can be formed with ports across the stack. Because a VLAN is considered a separate logical network, it contains its own bridge Management Information Base (MIB) information and can support its own implementation of spanning tree.

VLANs are often associated with IP subnetworks. For example, all the end stations in a particular IP subnet belong to the same VLAN. Interface VLAN membership on the device is assigned manually on an interface-by-interface basis. When you assign device interfaces to VLANs by using this method, it is known as interface-based, or static, VLAN membership. Traffic between VLANs must be routed. The device can

route traffic between VLANs by using device virtual interfaces (SVIs). An SVI must be explicitly configured and assigned an IP address to route traffic between VLANs.

Ports that connect to WAN segments are associated with VLANs. In the Cisco Catalyst SD-WAN overlay network, these ports are the physical Gigabit Ethernet interfaces on Cisco IOS XE Catalyst SD-WAN devices. Specifically, they are the base interfaces, for example, Gi0/1/0.

There is a one-to-one association between an SVI and a VLAN. An SVI can be associated only with one VLAN, and the other way around.

Native VLANs

Native VLAN is used primarily on trunk ports. VLAN provides backwards compatibility for devices that do not support VLAN tagging. For example, native VLAN allows trunk ports to accept all traffic regardless of what devices are connected to the port. Without native VLAN, the trunk ports would accept traffic only from devices that support VLAN tagging.

SVI

VLANS divide a LAN into smaller broadcast domains. Each VLAN is a separate broadcast domain, and switching within that domain directs traffic to destinations within the VLAN. The result is that hosts within a single bridge domain can communicate among themselves, but cannot communicate with hosts in other VLANs.

The only way for the traffic to cross Layer 2 VLAN boundaries to allow communication between VLANs is through Layer 3 routing. Switch Virtual Interfaces (SVI) on Cisco IOS XE Catalyst SD-WAN devices is designed to provide basic Layer 3 functions for the Layer 2 switch ports that belong to a specific VLAN. SVI is a logical interface that inherits all the properties of a regular interface, but is not associated with a port or with a physical interface.

The switch ports on Cisco IOS XE Catalyst SD-WAN devices do not natively support Layer 3 addresses. They must be assigned to an SVI and use a VLAN interface to enable Layer 3 features.

To configure IP routing, you need to assign IP addresses to Layer 3 network interfaces, in this case SVI. This enables communication with the hosts on those interfaces that use IP. IP routing is disabled by default, and no IP addresses are assigned to Switch Virtual Interfaces (SVIs).

VRF

Virtual Routing and Forwarding (VRF) associates a VRF instance with an SVI to map VLANs to different logical or physical VPN WAN connections. VRF allows a single physical router to have multiple route tables to enable multiple routing instances. In a single network component, multiple VRF resources create the isolation between virtual networks.

VLAN and Switchport Support

Supported Switch Modules

The following switch modules are supported.

Cisco 1000 Series Integrated Services Routers:

- NIM-ES2-4: Single-wide NIM form factor
- NIM-ES2-8: Single-wide NIM form factor
- NIM-ES2-8-P: Single-wide NIM form factor

Cisco 4000 Series Integrated Services Routers (see Interfaces and Modules**):**

- NIM-ES2-4: Single-wide NIM form factor
- NIM-ES2-8: Single-wide NIM form factor
- NIM-ES2-8-P: Single-wide NIM form factor
- SM-X-16G4M2X: Single-wide SM form factor
- SM-X-40G8M2X: Double-wide SM form factor

Cisco Catalyst 8300 Series Edge Platforms (see Interfaces and Modules**):**

- C-SM-16P4M2X: Single-wide SM form factor
- C-SM-40P8M2X: Double-wide SM form factor

Restrictions for Cisco IOS XE Catalyst SD-WAN Devices

- Configuring MAC aging time per VLAN is not supported. You can only configure global MAC aging time.
- Setting a maximum limit for MAC addresses per VLAN is not supported.
- Configuring a single static MAC address on multiple switch ports is not supported.
- Packet statistics is not supported on VLANs.
- Bridge Domain Interface (BDI) is not supported on the Cisco ASR 1000.

Configure Bridging Using Cisco SD-WAN Manager

Use the Switch Port template to configure bridging for Cisco Catalyst SD-WAN.

To have a Cisco IOS XE Catalyst SD-WAN device act as a bridge, configure VLANs on the router. A router can have up to 16 VLANS.

Configure Switchports

1. From the Cisco SD-WAN Manager menu, choose **Configuration** > **Templates**.
2. In **Device Templates**, click **Create Template**.
3. From the Create Template drop-down, choose **From Feature Template**.
4. From the Device Model drop-down, choose the type of device for which you are creating the template.

5. Click **Additional Templates**, or scroll to the Additional Templates section.
6. Click the plus sign (+) next to Switch Port.
7. In the Switch Port drop-down, choose the port number.
8. If the switch port you want to choose does not exist, from the lower Switch Port drop-down, click **Create Template**. The Switch Port template form is displayed. The form contains fields for naming the template, and fields for defining switch port parameters.
9. In the Template Name field, enter a name for the template. The name can be up to 128 characters and can contain only alphanumeric characters.
10. In the Template Description field, enter a description of the template. The description can be up to 2048 characters and can contain only alphanumeric characters.

When you first open a feature template, for each parameter that has a default value, the scope is set to Default (indicated by a check mark), and the default setting or value is shown. To change the default or to enter a value, click the scope drop-down next to the parameter field and choose one of the following:

Table 1:

Parameter Scope	Scope Description
Device Specific (indicated by a host icon)	Use a device-specific value for the parameter. For device-specific parameters, you cannot enter a value in the feature template. You enter the value when you attach a Viptela device to a device template . When you click Device Specific, the Enter Key box opens. This box displays a key, which is a unique string that identifies the parameter in a CSV file that you create. This file is an Excel spreadsheet that contains one column for each key. The header row contains the key names (one key per column), and each row after that corresponds to a device and defines the values of the keys for that device. You upload the CSV file when you attach a Cisco Catalyst SD-WAN device to a device template. To change the default key, type a new string and move the cursor out of the Enter Key box. Examples of device-specific parameters are system IP address, hostname, GPS location, and site ID.
Global (indicated by a globe icon)	Enter a value for the parameter, and apply that value to all devices. Examples of parameters that you might apply globally to a group of devices are DNS server, syslog server, and interface MTUs.

Configure Basic Switch Port Parameters

To configure basic switch port parameters, choose Basic Configuration and configure the following parameters:

Table 2:

Parameter Name	Description
Slot	Enter the number of the slot in which the Layer 2 switch port module is installed.

Parameter Name	Description
Sub-Slot	Enter the number of the sub-slot.
Module	Choose the switch port module type. You can choose from 4, 8, or 22 ports.

To save the feature template, click **Save**.

Associate Interfaces with the Switch Port

To associate an interface with the switch port, click Interface and click **Add New Interface**.

The Wlan-GigabitEthernet0/1/8 interface applies only to C1111-8PW and C1111-8PLTExxW routers. When you configure this interface, choose either **C1111-8PW** or **C1111-8PLTExxW** when you create a switch port, and choose **8 port** from the Module drop-down list. In addition, from the New Interface drop-down menu, make sure to choose **Wlan-GigabitEthernet0/1/8**.

Table 3:

Parameter Name	Description
Interface Name	Enter the name of the interface to associate with the bridging domain, in the format **Gi** *slot*/*sub-slot*/*port*.
Shutdown	Click No to enable the interface. By default, an interface is disabled.

Switch Port	Choose the switch port mode:
	• Access—Configure the interface as an access port. You can configure only one VLAN on an access port, and the port can carry traffic for only one VLAN.
	  • VLAN Name—Enter a description for the VLAN.
	  • VLAN ID—Enter the VLAN number, which can be a value from 1 through 4094.
	• Trunk—Configure the interface as a trunk port. You can configure a range of VLANs on a trunk port, and the port can carry traffic for multiple VLANs. This range should include the VLAN from SVI. Alternatively, you can assign one of the switchport interfaces to access mode. This ensures that the VLAN is added to the VLAN database.
	  • Allowed VLANs—Enter the range of the VLANs for which the trunk can carry traffic for the VLAN.
	  • Native VLAN ID—Enter the number of the VLAN allowed to carry untagged traffic.

Click **Save**.

To use the switch port for routing, associate it with an SVI.

Configure Other Interface Properties

To configure other interface properties, choose Advanced and configure the following properties:

Note For Cisco IOS XE Catalyst SD-WAN devices, you cannot configure MAC age-out time and static MAC address per interface. You can only configure them globally.

Table 4:

Parameter Name	Description
Age-Out Time	Enter how long an entry is in the MAC table before it ages out. Set the value to 0 to prevent entries from timing out.*Range:* 0, 10 through 1000000 seconds*Default:* 300 seconds
Static MAC Address	Click **Add Static MAC Address** to map a MAC address to a switch port. In the MAC Static Address field that appears, enter the following: • MAC Address—Enter the static MAC address to map to the switch port interface. • Switch Port Interface Name—Enter the name of the switch port interface. • VLAN ID—Enter the number of the VLAN for the switch port. Click **Add** to save the static MAC address mapping.

Click **Save**.

Configure VPN Interface SVI using Cisco SD-WAN Manager

Use the VPN Interface SVI template to configure SVI for Cisco IOS XE Catalyst SD-WAN devices. You configure a switch virtual interface (SVI) to configure a VLAN interface.

To configure DSL interfaces on Cisco routers using Cisco SD-WAN Manager templates, create a VPN Interface SVI feature template to configure VLAN interface parameters.

Create VPN Interface SVI Template

1. From the Cisco SD-WAN Manager menu, choose **Configuration** > **Templates**.
2. In **Device Templates**, click **Create Template**.

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

3. From the **Create Template** drop-down, choose **From Feature Template**.
4. From the **Device Model** drop-down, choose the type of device for which you are creating the template.
5. If you are configuring the SVI in the transport VPN (VPN 0):
   a. Click **Transport & Management VPN**, or scroll to the Transport & Management VPN section.
   b. Under Additional VPN 0 Templates, click **VPN Interface SVI**.

6. If you are configuring the SVI in a service VPN (VPNs other than VPN 0):
   a. Click **Service VPN**, or scroll to the Service VPN section.
   b. In the **Service VPN** drop-down list, enter the number of the service VPN.
   c. Under **Additional VPN Templates**, click **VPN Interface SVI**.
7. From the **VPN Interface SVI** drop-down, click **Create Template**. The VPN Interface SVI template form is displayed.

   The form contains fields for naming the template, and fields for defining VLAN Interface parameters.
8. In **Template Name**, enter a name for the template. The name can be up to 128 characters and can contain only alphanumeric characters.
9. In **Template Description**, enter a description of the template. The description can be up to 2048 characters and can contain only alphanumeric characters.

When you open a feature template initially, for each parameter that has a default value, the scope is set to Default (indicated by a check mark), and the default setting or value is shown. To change the default or to enter a value, click the **scope** drop-down next to the parameter field.

Note To get the SVI interface up and functional, ensure that the appropriate VLAN is explicitly configured on the Switch Port Access or Trunk interface.

Configure Basic Interface Functionality

Table 5: Feature History

Feature Name	Release Information	Description
Support for Configuring Secondary IP Address	Cisco IOS XE Catalyst SD-WAN Release 17.2.1r	You can configure up to four secondary IPv4 or IPv6 addresses, and up to four DHCP helpers. Secondary IP addresses can be useful for forcing unequal load sharing between different interfaces, for increasing the number of IP addresses in a LAN when no more IPs are available from the subnet, and for resolving issues with discontinuous subnets and classful routing protocol.

To configure basic VLAN interface functionality in a VPN, choose **Basic Configuration** and configure the following parameters. Parameters marked with an asterisk are required to configure an interface.

Table 6:

Parameter Name	Description
Shutdown*	Click **No** to enable the VLAN interface.
VLAN Interface Name*	Enter the VLAN identifier of the interface. *Range:* 1 through 1094.
Description	Enter a description for the interface.
IP MTU	Specify the maximum MTU size of packets on the interface. *Range:* 576 through 1500. *Default:* 2000 bytes
IPv4* or IPv6	Click to configure one or more IPv4 of IPv6 addresses for the interface. (Beginning with Cisco IOS XE SD-WAN Release 17.2.)
IPv4 Address* IPv6 Address	Enter the IPv4 address for the interface.
Secondary IP Address	Click **Add** to enter up to four secondary IP addresses. (Beginning with Cisco IOS XE SD-WAN Release 17.2.)
DHCP Helper*	Enter up to eight IP addresses for DHCP servers in the network to have the interface be a DHCP helper. Separate each address with a comma. A DHCP helper interface forwards BOOTP (Broadcast) DHCP requests that it receives from the specified DHCP servers. Click **Add** to configure up to four DHCP helpers. (Beginning with Cisco IOS XE SD-WAN Release 17.2, for IPv6.)

To save the feature template, click **Save**.

Apply Access Lists

To apply a rewrite rule, access lists, and policers to a router interface, choose **ACL** and configure the following parameters:

Table 7:

Parameter Name	Description
Ingress ACL – IPv4	Click **On** and specify the name of the access list to apply to IPv4 packets being received on the interface.
Egress ACL – IPv4	Click **On** and specify the name of the access list to apply to IPv4 packets being transmitted on the interface.
Ingress Policer	Click **On** and specify the name of the policer to apply to packets being received on the interface.
Egress Policer	Click **On** and specify the name of the policer to apply to packets being transmitted on the interface.

To save the feature template, click **Save**.

Configure VRRP

To have an interface run the Virtual Router Redundancy Protocol (VRRP), which allows multiple routers to share a common virtual IP address for default gateway redundancy, choose **VRRP**. Then click **Add New VRRP** and configure the following parameters:

Table 8:

Parameter Name	Description
Group ID	Enter the virtual router ID, which is a numeric identifier of the virtual router. You can configure a maximum of 24 groups. *Range:* 1 through 255
Priority	Enter the priority level of the router. There router with the highest priority is elected as the primary router. If two Cisco IOS XE Catalyst SD-WAN devices have the same priority, the one with the higher IP address is elected as the primary one. *Range:* 1 through 254 *Default:* 100
Timer	Specify how often the primary VRRP router sends VRRP advertisement messages. If the subordinate routers miss three consecutive VRRP advertisements, they elect a new primary router. *Range:* 1 through 3600 seconds *Default:* 1 second
Track OMP Track Prefix List	By default, VRRP uses of the state of the service (LAN) interface on which it is running to determine which Cisco IOS XE Catalyst SD-WAN device is the primary virtual router. if a Cisco IOS XE Catalyst SD-WAN device loses all its WAN control connections, the LAN interface still indicates that it is up even though the router is functionally unable to participate in VRRP. To take WAN side connectivity into account for VRRP, configure one of the following: Track OMP—Click **On** for VRRP to track the Overlay Management Protocol (OMP) session running on the WAN connection. If the primary VRRP router loses all its OMP sessions, VRRP elects a new default gateway from those that have at least one active OMP session. Track Prefix List—Track both the OMP session and a list of remote prefixes, which is defined in a prefix list configured on the local router. If the primary VRRP router loses all its OMP sessions, VRRP failover occurs as described for the Track OMP option. In addition, if reachability to all of the prefixes in the list is lost, VRRP failover occurs immediately, without waiting for the OMP hold timer to expire, thus minimizing the amount of overlay traffic is dropped while the Cisco IOS XE Catalyst SD-WAN device determines the primary VRRP router.
IP Address	Enter the IP address of the virtual router. This address must be different from the configured interface IP addresses of both the local Cisco IOS XE Catalyst SD-WAN device and the peer running VRRP.

Add ARP Table Entries

To configure static Address Resolution Protocol (ARP) table entries on the interface, choose **ARP**. Then click **Add New ARP** and configure the following parameters:

Table 9:

Parameter Name	Description
IP Address	Enter the IP address for the ARP entry in dotted decimal notation or as a fully qualified host name.
MAC Address	Enter the MAC address in colon-separated hexadecimal notation.

To save the ARP configuration, click **Add**.

To save the feature template, click **Save**.

Configure Other Interface Properties

To configure other interface properties, choose **Advanced** and configure the following properties:

Table 10:

Parameter Name	Description
TCP MSS	Specify the maximum segment size (MSS) of TPC SYN packets passing through the Cisco IOS XE Catalyst SD-WAN device. By default, the MSS is dynamically adjusted based on the interface or tunnel MTU such that TCP SYN packets are never fragmented. *Range:* 552 to 1460 bytes *Default:* None
ARP Timeout	Specify how long it takes for a dynamically learned ARP entry to time out. *Range:* 0 through 2678400 seconds (744 hours) *Default:* 1200 (20 minutes)

To save the feature template, click **Save**.

Configure Bridging Using CLI for Cisco IOS XE Catalyst SD-WAN Devices

To configure bridging on Cisco IOS XE Catalyst SD-WAN devices, you must create VLANs to enable L2 switching, and SVIs to enable routing traffic between various VLANs. Follow these steps to configure Bridging on Cisco IOS XE Catalyst SD-WAN devices.

Configure VLANs

VLANs enable L2 switching by creating separate broadcast domains.

1. Create a VLAN.

```
vlan 10
name atm
commit
```

2. Configure a trunk interface. A trunk interface allows a switch port to carry traffic from multiple VLANs.

```
interface GigabitEthernet0/2/0
switchport mode trunk
switchport trunk allowed vlan10-20
commit
```

3. Configure native VLAN for trunk interface.

```
interface GigabitEthernet0/2/0
switchport trunk native vlan100
commit
```

4. Configure access interface.

```
interface GigabitEthernet0/2/0
switchport mode access
switchport access vlan20
commit
```

5. [Optional] Modify MAC aging time.

```
mac address-table aging-time60
commit
```

Note: Cisco IOS XE Catalyst SD-WAN devices do not support modifying MAC aging-time for individual VLANs. Only global configuration on MAC aging-time is supported.

6. [Optional] Configure static MAC address.

```
mac address-table static0001.1111.1111
vlan 100 interface Gigabitethernet0/1/0
commit
```

Configuration Example

The following example shows how to attach an access mode switchport to a VLAN name.

```
config-transaction
  vlan 10
   name test
   commit
   exit
   !
 interface GigabitEthernet0/1/2
  switchport mode access
  switchport access vlan name test
  commit
```

Configure SVI

After you create VLANs to enable L2 switching between hosts, you must configure Switch Virtual Interfaces (SVI) to be able to route traffic between various VLANs.

Create an SVI interface to associate it with the VLAN you created in the Create VLAN topic.

```
interface vlan10
ip address192.0.2.1 255.255.255.0
commit
```

Run the **show ip interface brief** command to verify the creation of SVI.

```
Device# show ip interface brief
Interface              IP-Address      OK? Method Status                Protocol

GigabitEthernet0/1/1   unassigned      YES NVRAM  up                    up

GigabitEthernet0/2/0   unassigned      YES unset  up                    up

GigabitEthernet0/2/1   unassigned      YES unset  up                    up

GigabitEthernet0       10.10.10.1      YES other  up                    up

Vlan1                  unassigned      YES unset  up                    up

Vlan10                 192.0.2.1       YES other  up                    up
```