Configuring Ethernet Virtual Connections on the Cisco ASR 903 Router

An Ethernet Virtual Connection (EVC) is defined by the Metro-Ethernet Forum (MEF) as an association between two or more user network interfaces that identifies a point-to-point or multipoint-to-multipoint path within the service provider network. An EVC is a conceptual *service pipe* within the service provider network. A *bridge domain* is a local broadcast domain that is VLAN-ID-agnostic. An Ethernet flow point (EFP) service instance is a logical interface that connects a bridge domain to a physical port or to an EtherChannel group.

An EVC broadcast domain is determined by a bridge domain and the EFPs that are connected to it. You can connect multiple EFPs to the same bridge domain on the same physical interface, and each EFP can have its own matching criteria and rewrite operation. An incoming frame is matched against EFP matching criteria on the interface, learned on the matching EFP, and forwarded to one or more EFPs in the bridge domain. If there are no matching EFPs, the frame is dropped.

You can use EFPs to configure VLAN translation. For example, if there are two EFPs egressing the same interface, each EFP can have a different VLAN rewrite operation, which is more flexible than the traditional switchport VLAN translation model.

This document describes how to configure EVC features on the Cisco ASR 903 Series Router.

For detailed information about the commands, see:

- the Cisco IOS XE 3S Carrier Ethernet Command Reference: http://www.cisco.com/en/US/docs/ios/cether/command/reference/ce_book.html
- Master Command Index for Cisco IOS XE Release 3S: http://www.cisco.com/en/US/docs/ios/mcl/allreleasemcl/all_book.html

This chapter includes:

Supported EVC Features

- Service instance—you create, delete, and modify EFP service instances on Ethernet interfaces.
- Encapsulation—you can map traffic to EFPs based on:
  - 802.1Q VLANs (a single VLAN or a list or range of VLANs)
  - 802.1Q tunneling (QinQ) VLANs (a single outer VLAN and a list or range of inner VLANs)
  - Double-tagged frames mapped to EVC based on C-tags (wildcard S-Tags)
- Bridge domains—you can configure EFPs as members of a bridge domain (up to 64 EFPs per bridge domain).
- Rewrite (VLAN translation)
  - Pop symmetric

    pop 1 removes the outermost tag

    pop 2 removes the two outermost tags

    pop symmetric adds a tag (or 2 tags for **pop 2 symmetric**) on egress for a *push* operation
  - Ingress push—The **rewrite ingress tag push dot1q** *vlan-id* **symmetric** command adds a tag to an ingress packet
  - QinQ with rewrite
- EVC forwarding
- MAC address learning and aging
- EVCs on EtherChannels
- Hairpinning
- Split horizon
- Layer 2 protocol tunneling and QinQ
- Bridging between EFPs
- MSTP (MST on EVC bridge domain)
- EFP statistics (packets and bytes)
- QoS aware EVC/EFP per service instance
- Static MAC Addresses

These Layer 2 port-based features can run with EVC configured on the port:

- LACP
- CDP
- MSTP

Limitations

The following limitations apply when configuring EVC features on the Cisco ASR 903 Series Router:

- Translate operations are not supported
- You can create a maximum of 4000 EVCs per interface

- You can create a maximum of 64 EFPs per bridge-domain
- The **no mac address-table learning bridge-domain** *bridge-id* global configuration command is not currently supported.
- Only dot1q encapsulation is supported on trunk EFPs.

Understanding EVC Features

Ethernet Virtual Connections

You use the **ethernet evc** *evc-id* global configuration command to create an Ethernet virtual connection (EVC). The *evc-id* or name is a text string from 1 to 100 bytes. Entering this command puts the device into service configuration mode (config-srv) where you configure all parameters that are common to an EVC.

In this mode you can enter these commands:

- **default**—Sets a command to its defaults
- **exit**—Exits EVC configuration mode
- **no**— Negates a command or sets its defaults
- **oam**—Specifies the OAM Protocol
- **uni**—Configures a count UNI under EVC

Service Instances and EFPs

Configuring a service instance on a Layer 2 port or EtherChannel creates a pseudoport or Ethernet flow point (EFP) on which you configure EVC features. Each service instance has a unique number per interface, but you can use the same number on different interfaces because service instances on different ports are not related.

If you have defined an EVC by entering the **ethernet evc** *evc-id* global configuration command, you can associate the EVC with the service instance (optional). There is no default behavior for a service instance.

Use the **service instance** *number* **ethernet** [*name*] interface configuration command to create an EFP on a Layer 2 interface or EtherChannel and to enter service instance configuration mode. You use service instance configuration mode to configure all management and control date plane attributes and parameters that apply to the service instance on a per-interface basis.

- The **service instance** *number* is the EFP identifier, an integer from 1 to 4000.

- The optional **ethernet** *name* is the name of a previously configured EVC. You do not need to enter an EVC *name*, but you must enter **ethernet**. Different EFPs can share the same name when they correspond to the same EVC. EFPs are tied to a global EVC through the common name.

When you enter service instance configuration mode, you can configure these options:

- **default**—Sets a command to its defaults
- **description**—Adds a service instance specific description
- **encapsulation**—Configures Ethernet frame match criteria
- **ethernet**—Configures Ethernet-lmi parameters
- **exit**— Exits from service instance configuration mode
- **ip**—Interface Internet Protocol config commands
- **ipv6**—IPv6 interface subcommands
- **l2protocol**—Configures Layer 2 control protocol processing
- **mac**—Commands for MAC address-based features
- **no**—Negates a command or sets its defaults
- **service-policy** —Attaches a policy-map to an EFP
- **shutdown**—Takes the service instance out of service

  Enter the [**no**] **shutdown** service-instance configuration mode to shut down or bring up a service instance.
- snmp—Modify SNMP service instance parameters

Encapsulation

Encapsulation defines the matching criteria that maps a VLAN, a range of VLANs, cost of service (CoS) bits, Ethertype, or a combination of these to a service instance. You configure encapsulation in service instance configuration mode. You must configure one encapsulation command per EFP (service instance).

Use the **encapsulation** service-instance configuration mode command to set encapsulation criteria. Different types of encapsulations are default, dot1q, priority-tagged and untagged. Supported Ethertypes include ipv4, ipv6, pppoe-all, pppoe-discovery, and pppoe-session.

Encapsulation classification options also include:

- outer tag VLAN
- outer tag CoS
- inner tag VLAN
- inner tag CoS
- payload ethertype

After you have entered an encapsulation method, these keyword options are available in service instance configuration mode:

- **bridge-domain**—Configures a bridge domain
- **rewrite**—Configures Ethernet rewrite criteria

Table 1 Supported Encapsulation Types

Command	Description
encapsulation dot1q *vlan-id* [,*vlan-id*[-*vlan-id*]]	Defines the matching criteria to be used to map 802.1Q frames ingress on an interface to the appropriate EFP. The options are a single VLAN, a range of VLANs, or lists of VLANs or VLAN ranges. VLAN IDs are 1 to 4094. • Enter a single VLAN ID for an exact match of the outermost tag. • Enter a VLAN range for a ranged outermost match.
encapsulation dot1q *vlan-id* **second-dot1q** *vlan-id* [,*vlan-id*[-*vlan-id*]]	Double-tagged 802.1Q encapsulation. Matching criteria to be used to map QinQ frames ingress on an interface to the appropriate EFP. The outer tag is unique and the inner tag can be a single VLAN, a range of VLANs or lists of VLANs or VLAN ranges. • Enter a single VLAN ID in each instance for an exact match of the outermost two tags. • Enter a VLAN range for **second-dot1q** for an exact outermost tag and a ranged second tag.
encapsulation dot1q {**any** | *vlan-id* [,*vlan-id*[-*vlan-id*]]} **etype** *ethertype*	Ethertype encapsulation is the payload encapsulation type after VLAN encapsulation. • ethertype—The etype string can have these values: ipv4, ipv6, pppoe-discovery, pppoe-session, or pppoe-all. • Matches any or an exact outermost VLAN or VLAN range and a payload ethertype.
encapsulation dot1q *vlan_id* **cos** *cos_value* **second-dot1q** *vlan-id* **cos** *cos_value*	CoS value encapsulation defines match criterion after including the CoS for the S-Tag and the C-Tag. The CoS value is a single digit between 1 and 7 for S-Tag and C-Tag. You cannot configure CoS encapsulation with **encapsulation untagged**, but you can configure it with **encapsulation priority-tag**. The result is an exact outermost VLAN and CoS match and second tag. You can also use VLAN ranges.
encapsulation dot1q any	Matches any packet with one or more VLANs.
encapsulation untagged	Matching criteria to be used to map untagged (native) Ethernet frames entering an interface to the appropriate EFP. Only one EFP per port can have untagged encapsulation. However, a port that hosts EFP matching untagged traffic can also host other EFPs that match tagged frames.
encapsulation default	Configures the default EFP on an interface, acting as a catch-all encapsulation. All packets are seen as native. If you enter the **rewrite** command with encapsulation default, the command is rejected. If the default EFP is the only one configured on a port, it matches all ingress frames on that port. If you configure the default EFP on a port, you cannot configure any other EFP on the same port with the same bridge domain. You can configure only one default EFP per interface. If you try to configure more than one, the command is rejected.
encapsulation priority-tagged	Specifies priority-tagged frames. A priority-tagged packet has VLAN ID 0 and CoS value of 0 to 7.

If a packet entering or leaving a port does not match any of the encapsulations on that port, the packet is dropped, resulting in *filtering* on both ingress and egress. The encapsulation must match the packet *on the wire* to determine filtering criteria. *On the wire* refers to packets ingressing the router before any rewrites and to packets egressing the router after all rewrites.

Note The router does not allow overlapping encapsulation configurations.

Bridge Domains

A service instance must be attached to a bridge domain. Flooding and communication behavior of a bridge domain is similar to that of a VLAN domain. Bridge-domain membership is determined by which service instances have joined it, while VLAN domain membership is determined by the VLAN tag in the packet.

Note You must configure encapsulation before you can configure the bridge domain.

Use the **bridge-domain** *bridge-id* service-instance configuration mode command to bind the EFP to a bridge domain instance. The *bridge-id* is the identifier for the bridge domain instance, an integer from 1 to 4000.

Split-Horizon

The split-horizon feature allows service instances in a bridge domain to join groups. Service instances in the same bridge domain and split-horizon group cannot forward data between each other, but can forward data between other service instances that are in the same bridge domain, but not in the same split-horizon group.

Service instances do not have to be in a split-horizon group. If a service instance does not belong to a group, it can send and receive from all ports within the bridge domain. A service instance cannot join more than one split-horizon group.

Enter the **bridge-domain** *bridge-id* **split-horizon group** *group_id* service-instance configuration mode command to configure a split-horizon group. The *group_id* is an integer from 0 to 2. All members of the bridge-domain that are configured with the same *group_id* are part of the same split-horizon group.EFPs that are not configured with an explicit *group_id* do not belong to any group.

You can configure no more than 64 service instances per bridge domain. When a bridge domain contains a service instance that is part of a split-horizon group, this decreases the number of service instances allowed to be configured in that split-horizon group. The switch supports up to three split-horizon groups plus the default (no group).

In Table 2, the left column means that a bridge domain belongs to a service instance that is part of the indicated split horizon group. Therefore, if a service instance joins split-horizon group 2, it can have no more than 16 members in split horizon group 2 in the same bridge domain. We recommend that you add split horizon groups in numerical order to maximize the number of service instances that can belong to a group.

Table 2 Maximum Allowed Service Instance Configuration with and without Split Horizons

Configured in Bridge Domain	Maximum Service Instances in the Group				Total Service Instances in Bridge Domain
	No group	Group 0	Group 1	Group 2	
No Group	64	–	–	–	64
Split Group 0	32	16	–	–	48

Table 2 Maximum Allowed Service Instance Configuration with and without Split Horizons

Configured in Bridge Domain	Maximum Service Instances in the Group				Total Service Instances in Bridge Domain
	No group	Group 0	Group 1	Group 2	
Split Group 1	16	16	16	-	48
Split Group 2	16	16	16	16	64

Rewrite Operations

You can use the **rewrite** command to modify packet VLAN tags. You can use this command to emulate traditional 802.1Q tagging, where packets enter a router on the native VLAN and VLAN tagging properties are added on egress. You can also use the **rewrite** command to facilitate VLAN translation and QinQ.

The Cisco ASR 903 Series Router supports only these **rewrite** commands.

- **rewrite ingress tag pop 1 symmetric**
- **rewrite ingress tag pop 2 symmetric**
- **rewrite ingress tag push dot1q** *vlan-id* **symmetric**

Enter the **rewrite ingress tag pop** {**1** | **2**} **symmetric** service-instance configuration mode command to specify the encapsulation adjustment to be performed on the frame ingress to the EFP. Entering **pop 1** pops (removes) the outermost tag; entering **pop 2** removes two outermost tags.

Note The **symmetric** keyword is required to complete **rewrite** to configuration.

When you enter the **symmetric** keyword, the egress counterpart performs the inverse action and pushes (adds) the encapsulation VLAN. You can use the **symmetric** keyword only with ingress rewrites and only when single VLANs are configured in encapsulation. If you configure a list of VLANs or a VLAN range or **encapsulation default** or **encapsulation any**, the **symmetric** keyword is not accepted for rewrite operations.

The router does not support **rewrite** commands for **translate** in release 3.7.

Possible translation combinations are 1-to-1, 1-to-2, 2-to-1, and 2-to-2. When forwarding to or from a Layer 2 port, you cannot achieve 2-to2 translation because a Layer 2 port is implicitly defined to be **rewrite ingress tag pop 1 symmetric**.

The router does not support egress rewrite operations beyond the second VLAN that a packet carries. Because of the egress rewrite limitation, if an EFP has a **pop 2 rewrite** operation at ingress, no other EFP in the same bridge domain can have a rewrite operation.

Static MAC Addresses

The Cisco ASR 903 Series Router supports multicast static MAC addresses, which allow you to enable multicast at the layer 2 level. You can use multicast static MAC addresses to forward multicast packets to specific EFPs on a network.

For instructions on how to configure static MAC addresses, see Configuring a Static MAC Address, page 27.

Layer 2 Protocol Features

The Cisco ASR 903 Series Router supports layer 2 protocol peering, forwarding, and tunneling on CDP, LACP, LLDP, PAGP, STP, UDLD, and VTP traffic. For more information about these features, see:

- Layer 2 Protocol Peering, page 14
- Layer 2 Protocol Forwarding, page 15
- Layer 2 Protocol Tunneling, page 21

Configuring EFPs

Default EVC Configuration

No EFPs are configured. No service instances or bridge domains are configured.

Configuration Guidelines

The following guidelines apply when you configure EVCs on the Cisco ASR 903 Series Router.

Note For information about supported EVC scale, see the Cisco ASR 903 Router Chassis Software Configuration Guide.

- To configure a service instance on an interface, these commands are prerequisites:

```
Router (config)# interface gigabitethernet0/0/1
Router (config-if)# service instance 22 Ethernet ether
Router (config-if-srv)# encapsulation dot1q 10
Router (config-if-srv)# bridge-domain 10
```

- You must configure encapsulation on a service instance before configuring bridge domain.
- ISL trunk encapsulation is not supported.
- The router does not support overlapping configurations on the same interface and same bridge domain. If you have configured a VLAN range encapsulation, or encapsulation default, or encapsulation any on service instance 1, you cannot configure any other encapsulations that also match previous encapsulations in the same interface and bridge domain.
- QinQ is not supported on Trunk EFP interfaces.

Creating Service Instances

Beginning in privileged EXEC mode, follow these steps to create an EFP service instance:

	Command	Purpose
Step 1	**configure terminal**	Enter global configuration mode.
Step 2	**interface** *interface-id*	Specify the port to attach to the policy map, and enter interface configuration mode. Valid interfaces are physical ports.
Step 3	**service instance** *number* **ethernet** [*name*]	Configure an EFP (service instance) and enter service instance configuration) mode. • The *number* is the EFP identifier, an integer from 1 to 4000. • (Optional) **ethernet** *name* is the name of a previously configured EVC. You do not need to use an EVC name in a service instance.
Step 4	**encapsulation** {**default** | **dot1q** | **priority-tagged** | **untagged**}	Configure encapsulation type for the service instance. • **default**—Configure to match all unmatched packets. • **dot1q**—Configure 802.1Q encapsulation. See Table 1 for details about options for this keyword. • **priority-tagged**—Specify priority-tagged frames, VLAN-ID 0 and CoS value of 0 to 7. • **untagged**—Map to untagged VLANs. Only one EFP per port can have untagged encapsulation.
Step 5	**bridge-domain** *bridge-id* [**split-horizon group** *group-id*]	Configure the bridge domain ID. The range is from 1 to 4000. You can use the **split-horizon** keyword to configure the port as a member of a split horizon group. The *group-id* range is from 0 to 2.
Step 6	**rewrite ingress tag pop** {**1** | **2**} **symmetric**	(Optional) Specify that encapsulation modification to occur on packets at ingress. • **pop 1**—Pop (remove) the outermost tag. • **pop 2**—Pop (remove) the two outermost tags. • **symmetric—**Configure the packet to undergo the reverse of the ingress action at egress. If a tag is popped at ingress, it is pushed (added) at egress. This keyword is required for **rewrite** to function properly.
Step 7	**end**	Return to privileged EXEC mode.
Step 8	**show ethernet service instance** **show bridge-domain** [*n* | **split-horizon**]	Verify your entries.
Step 9	**copy running-config startup-config**	(Optional) Save your entries in the configuration file.

Use the **no** forms of the commands to remove the service instance, encapsulation type, or bridge domain or to disable the rewrite operation.

Creating a Trunk EFP

Beginning in privileged EXEC mode, follow these steps to create an EFP service instance:

	Command	Purpose
Step 1	**configure terminal**	Enter global configuration mode.
Step 2	**interface** *interface-id*	Specify the port to attach to the policy map, and enter interface configuration mode. Valid interfaces are physical ports. **Note** Release 3.8 introduces support for Trunk EFPs on port-channel interfaces.
Step 3	**service instance** [**trunk**] *number* **ethernet**	Configure an EFP (service instance) and enter service instance configuration) mode. • The *number* is the EFP identifier, an integer from 1 to 4000. • The trunk keyword identifies the trunk ID to which the service instance is assigned. **Note** Trunk EFP (without port channel) supports encapsulation of up to 1000 VLANS.
Step 4	**encapsulation** {**default** | **dot1q** | **priority-tagged** | **untagged**}	Configure encapsulation type for the service instance. **Note** Only dot1q encapsulation is supported on trunk EFPs. • **default—**Configure to match all unmatched packets. • **dot1q**—Configure 802.1Q encapsulation. See Table 1 for details about options for this keyword. • **priority-tagged**—Specify priority-tagged frames, VLAN-ID 0 and CoS value of 0 to 7. • **untagged**—Map to untagged VLANs. Only one EFP per port can have untagged encapsulation.
Step 5	**bridge-domain** *bridge-id* **from-encapsulation**	Configures the router to derive bridge domains from the encapsulation VLAN list.
Step 6	**rewrite ingress tag pop** {**1** | **2**} **symmetric**	(Optional) Specify that encapsulation modification to occur on packets at ingress. • **pop 1**—Pop (remove) the outermost tag. • **pop 2**—Pop (remove) the two outermost tags. **Caution** The pop2 option is not currently supported on Trunk EFPs. • **symmetric—**Configure the packet to undergo the reverse of the ingress action at egress. If a tag is popped at ingress, it is pushed (added) at egress. This keyword is required for **rewrite** to function properly.
Step 7	**end**	Return to privileged EXEC mode.

	Command	Purpose
Step 8	**show ethernet service instance** **show bridge-domain** [*n* | **split-horizon**]	Verify your entries.
Step 9	**copy running-config startup-config**	(Optional) Save your entries in the configuration file.

Use the **no** forms of the commands to remove the service instance, encapsulation type, or bridge domain or to disable the rewrite operation.

Configuration Examples

Configuring a Service Instance

```
Router (config)# interface gigabitethernet0/0/1
Router (config-if)# service instance 22 Ethernet ether
Router (config-if-srv)# encapsulation dot1q 10
Router (config-if-srv)# bridge-domain 10
```

Encapsulation Using a VLAN Range

```
Router (config)# interface gigabitethernet0/0/1
Router (config-if)# service instance 22 Ethernet
Router (config-if-srv)# encapsulation dot1q 22-44
Router (config-if-srv)# bridge-domain 10
```

Two Service Instances Joining the Same Bridge Domain

In this example, service instance 1 on interfaces Gigabit Ethernet 0/0/1 and 0/0/2 can bridge between each other.

```
Router (Router (config)# interface gigabitethernet0/0/1
Router (config-if)# service instance 1 Ethernet
Router (config-if-srv)# encapsulation dot1q 10
Router (config-if-srv)# bridge-domain 10

Router (config)# interface gigabitethernet0/0/2
Router (config-if)# service instance 1 Ethernet
Router (config-if-srv)# encapsulation dot1q 10
Router (config-if-srv)# bridge-domain 10
```

Bridge Domains and VLAN Encapsulation

Unlike VLANs, the bridge-domain number does not need to match the VLAN encapsulation number.

```
Router (config)# interface gigabitethernet0/0/1
Router (config-if)# service instance 1 Ethernet
Router (config-if-srv)# encapsulation dot1q 10
Router (config-if-srv)# bridge-domain 3000

Router (config)# interface gigabitethernet0/0/2
Router (config-if)# service instance 1 Ethernet
Router (config-if-srv)# encapsulation dot1q 10
Router (config-if-srv)# bridge-domain 3000
```

However, when encapsulations do not match in the same bridge domain, traffic cannot be forwarded. In this example, the service instances on Gigabit Ethernet 0/0/1 and 0/0/2 can not forward between each other, since the encapsulations don't match (filtering criteria). However, you can use the **rewrite** command to allow communication between these two.

```
Router (config)# interface gigabitethernet0/0/1
Router (config-if)# service instance 1 Ethernet
Router (config-if-srv)# encapsulation dot1q 10
Router (config-if-srv)# bridge-domain 3000

Router (config)# interface gigabitethernet0/0/2
Router (config-if)# service instance 1 Ethernet
Router (config-if-srv)# encapsulation dot1q 99
Router (config-if-srv)# bridge-domain 3000
```

Rewrite

In this example, a packet that matches the encapsulation will have one tag removed (popped off). The **symmetric** keyword allows the reverse direction to have the inverse action: a packet that egresses out this service instance will have the encapsulation (VLAN 10) added (pushed on).

```
Router (config)# interface gigabitethernet0/0/1
Router (config-if)# service instance 1 Ethernet
Router (config-if-srv)# encapsulation dot1q 10
Router (config-if-srv)# rewrite ingress tag pop 1 symmetric
Router (config-if-srv)# bridge-domain 3000
```

Split Horizon

In this example, service instances 1 and 2 cannot forward and receive packets from each other. Service instance 3 can forward traffic to any service instance in bridge domain 3000 since no other service instance in bridge domain 3000 is in split-horizon group 2. Service instance 4 can forward traffic to any service instance in bridge domain 3000 since it has not joined any split-horizon groups.

```
Router (config)# interface gigabitethernet0/0/1
Router (config-if)# service instance 1 Ethernet
Router (config-if-srv)# encapsulation dot1q 10
Router (config-if-srv)# rewrite ingress pop 1 symmetric
Router (config-if-srv)# bridge-domain 3000 split-horizon group 1
Router (config-if-srv)# exit
Router (config-if)# service instance 2 Ethernet
Router (config-if-srv)# encapsulation dot1q 99
Router (config-if-srv)# rewrite ingress pop 1 symmetric
Router (config-if-srv)# bridge-domain 3000 split-horizon group 1

Router (config)# interface gigabitethernet0/0/2
Router (config-if)# service instance 3 Ethernet
Router (config-if-srv)# encapsulation dot1q 10
Router (config-if-srv)# rewrite ingress pop 1 symmetric
Router (config-if-srv)# bridge-domain 3000 split-horizon group 2
Router (config-if-srv)# exit
Router (config-if)# service instance 4 Ethernet
Router (config-if-srv)# encapsulation dot1q 99
Router (config-if-srv)# rewrite ingress pop 1 symmetric
Router (config-if-srv)# bridge-domain 3000
```

Hairpinning

The switch supports *hairpinning*, which refers to traffic ingressing and egressing same interface. To achieve haripinning, configure two EFPs in the same bridge domain on the same physical interface, as in this example.

```
Router (config)# interface gigabitethernet0/0/2
Router (config-if)# service instance 1 Ethernet
Router (config-if-srv)# encapsulation dot1q 10
Router (config-if-srv)# rewrite ingress tag pop 1 symmetric
Router (config-if-srv)# bridge-domain 4000
Router (config-if-srv)# exit
Router (config-if)# service instance 2 Ethernet
Router (config-if-srv)# encapsulation dot1q 20
Router (config-if-srv)# rewrite ingress tag pop 1 symmetric
Router (config-if-srv)# bridge-domain 4000
```

Egress Filtering

In EVC switching, egress filtering is performed before the frame is sent on the egress EFP. Egress filtering ensures that when a frame is sent, it conforms to the matching criteria of the service instance applied on the ingress direction. EFP does not require egress filtering if the number of pops is the same as the number of VLANs specified in the **encapsulation** command.

Note Specifying the **cos** keyword in the encapsulation command is relevant only in the ingress direction. For egress filtering, **cos** is ignored.

For example, consider the following configuration.

```
Router (config)# interface gigabitethernet0/0/1
Router (config-if)# service instance 1 Ethernet
Router (config-if-srv)# encapsulation dot1q 20
Router (config-if-srv)# bridge-domain 19

Router (config)# interface gigabitethernet0/0/2
Router (config-if)# service instance 2 Ethernet
Router (config-if-srv)# encapsulation dot1q 30
Router (config-if-srv)# bridge-domain 19

Router (config)# interface gigabitethernet0/0/3
Router (config-if)# service instance 3 Ethernet
Router (config-if-srv)# encapsulation dot1q 10 second-dot1q 20
Router (config-if-srv)# rewrite ingress pop 1 symmetric
Router (config-if-srv)# bridge-domain 19
```

If a packet with VLAN tag 10 or 20 is received on Gigabit Ethernet 0/0/3, the ingress logical port would be service instance 3. For the frame to be forwarded on a service instance, the egress frame must match the encapsulation defined on that service instance after the rewrite is done. Service instance 1 checks for outermost VLAN 20; service instance 2 checks for VLAN 30. In this example, the frame with VLAN tags 10 and 20 can be sent to service instance 1 but not to service instance 2.

Configuring Other Features on EFPs

- EFPs and EtherChannels, page 14

EFPs and EtherChannels

You can configure EFP service instances on EtherChannel port channels, but EtherChannels are not supported on ports configured with service instances. Load-balancing on port channels is based on the MAC address or IP address of the traffic flow on the EtherChannel interface.

This example configures a service instance on an EtherChannel port channel. Configuration on the ports in the port channel are independent from the service instance configuration.

```
Router (config)# interface port-channel 4
Router (config-if)# service instance 1 ethernet
Router (config-if-srv)# encapsulation untagged
Router (config-if-srv)# bridge-domain {native vlan}
Router (config-if-srv)# l2protocol peer {lacp | pagp}
```

Layer 2 Protocol Peering

For Layer 2 protocols (CDP, UDLD, LLDP, MSTP, LACP, PAgP, VTP, and DTP) to peer with a neighbor on a port that has an EFP service instance configured, you need to enter the **l2 protocol peer** *protocol* service-instance configuration command on the service instance.

This example shows how to configure CDP to peer with a neighbor on a a service instance:

```
Router (config)# interface gigabitethernet0/0/1
Router (config-if)# service instance 1 Ethernet
Router (config-if-srv)# encapsulation untagged
Router (config-if-srv)# l2protocol peer cdp
Router (config-if-srv)# bridge-domain 10
Router (config-if-srv)# end
```

Note For information about layer 2 tunneling, see Layer 2 Protocol Tunneling, page 21

Layer 2 Protocol Forwarding

Layer 2 protocol forwarding is based on the bridge domain ID and the destination MAC address.

Selecting the l2protocol forward option causes the router to flood interfaces in the same VLAN or bridge-domain with untagged or tagged BPDU packets. You can apply the l2protocol forward command to CDP, LACP, LLDP, PAGP, STP, UDLD, and VTP traffic. This is an example how to configure the l2protocol forward option:

```
interface GigabitEthernet0/0/9
ethernet uni id PRAV-PE2
service instance 1 ethernet
encapsulation untagged
l2protocol forward cdp
bridge-domain 500
!
service instance 10 ethernet xcon
  encapsulation dot1q 100
  l2protocol forward cdp
  xconnect 4.3.2.1 12 encapsulation mpls
 !
```

Note For information about layer 2 tunneling, see Layer 2 Protocol Tunneling, page 21

MAC Address Forwarding, Learning and Aging on EFPs

- Layer 2 forwarding is based on the bridge domain ID and the destination MAC address. The frame is forwarded to an EFP if the binding between the bridge domain, destination MAC address, and EFP is known. Otherwise, the frame is flooded to all the EFPs or ports in the bridge domain.
- MAC address learning is based on bridge domain ID, source MAC addresses, and logical port number. MAC addresses are managed per bridge domain when the incoming packet is examined and matched against the EFPs configured on the interface. If there is no EFP configured, the bridge domain ID equal to the outer-most VLAN tag is used as forwarding and learning look-up key.

  If there is no matching entry in the Layer 2 forwarding table for the ingress frame, the frame is flooded to all the ports within the bridge domain. Flooding within the bridge domain occurs for unknown unicast, unknown multicast, and broadcast.
- Dynamic addresses are addresses learned from the source MAC address when the frame enters the router. All unknown source MAC addresses are sent to the CPU along with ingress logical port number and bridge domain ID for learning. Once the MAC address is learned, the subsequent frame with the destination MAC address is forwarded to the learned port. When a MAC address moves to a different port, the Layer 2 forwarding entry is updated with the corresponding port.

  Note The Cisco ASR 903 Series Router does not currently support the **no mac address-table learning bridge-domain** *bridge-id* global configuration command.
- Dynamic addresses are aged out if there is no frame from the host with the MAC address. If the aged-out frame is received by the switch, it is flooded to the EFPs in the bridge domain and the Layer 2 forwarding entry is created again. The default for aging dynamic addresses is 5 minutes. However,

when MST undergoes a topology change, the aging time is reduced to the *forward-delay* time configured by the spanning tree. The aging time reverts back to the last configured value when the topology change expires.

You can configure a dynamic address aging time per bridge domain using the **mac aging-time** *time* command. The range is in seconds and valid values are 10-600. The default value is 300. An aging time of 0 means that the address aging is disabled.

- MAC address movement is detected when the host moves from one port to another. If a host moves to another port or EFP, the learning lookup for the installed entry fails because the ingress logical port number does not match and a new learning cache entry is created. The detection of MAC address movement is disabled for static MAC addresses where the forwarding behavior is configured by the user.

Configuring IEEE 802.1Q Tunneling and Layer 2 Protocol Tunneling Using EFPs

Tunneling is a feature used by service providers whose networks carry traffic of multiple customers and who are required to maintain the VLAN and Layer 2 protocol configurations of each customer without impacting the traffic of other customers. The Cisco ASR 903 Series Router uses EFPs to support QinQ and Layer 2 protocol tunneling.

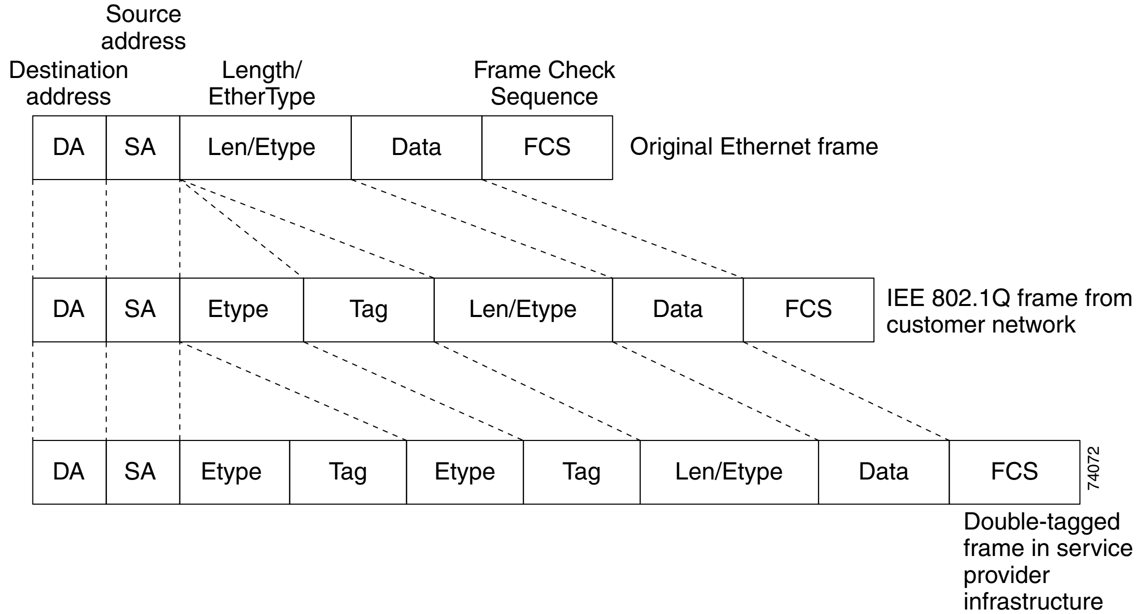
802.1Q Tunneling (QinQ)

Service provider customers often have specific requirements for VLAN IDs and the number of VLANs to be supported. The VLAN ranges required by different customers in the same service-provider network might overlap, and traffic of customers through the infrastructure might be mixed. Assigning a unique range of VLAN IDs to each customer would restrict customer configurations and could easily exceed the VLAN limit (4096) of the 802.1Q specification.

Using the EVCs, service providers can encapsulate packets that enter the service-provider network with multiple customer VLAN IDs (C-VLANs) and a single 0x8100 Ethertype VLAN tag with a service provider VLAN (S-VLAN). Within the service provider network, packets are switched based on the S-VLAN. When the packets egress the service provider network onto the customer network, the S-VLAN tag is decapsulated and the original customer packet is restored.

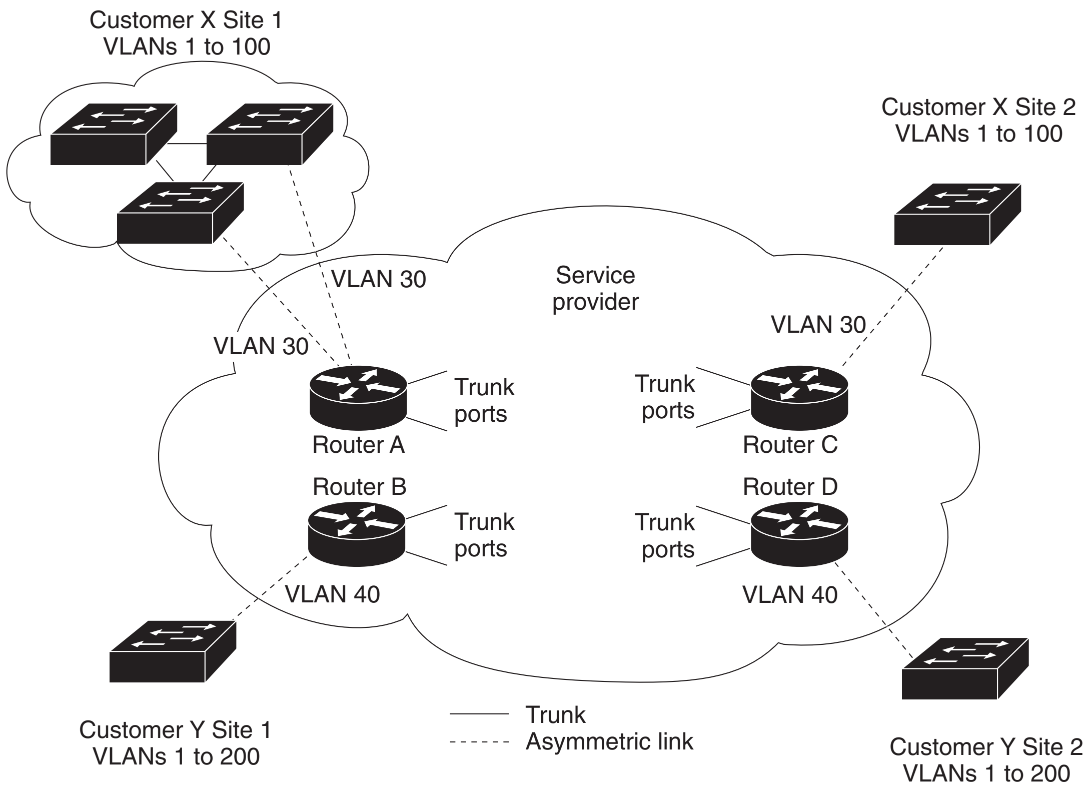
Figure 1 shows the tag structures of the double-tagged packets.

Figure 1 Original (Normal), 802.1Q, and Double-Tagged Ethernet Packet Formats



In Figure 2, Customer A was assigned VLAN 30, and Customer B was assigned VLAN 40. Packets entering the edge switches with 802.1Q tags are double-tagged when they enter the service-provider network, with the outer tag containing VLAN ID 30 or 40, appropriately, and the inner tag containing the original VLAN number, for example, VLAN 100. Even if both Customers A and B have VLAN 100 in their networks, the traffic remains segregated within the service-provider network because the outer tag is different. Each customer controls its own VLAN numbering space, which is independent of the VLAN numbering space used by other customers and the VLAN numbering space used by the service-provider network. At the outbound port, the original VLAN numbers on the customer's network are recovered.

Figure 2 802.1Q Tunnel Ports in a Service Provider Network



You can use EFPs to configure 802.1Q tunneling in two ways:

Method 1

In this example, for Customer A, interface Gigabit Ethernet 0/0/1 is the customer-facing port, and Gigabit Ethernet 0/0/2 is a trunk port facing the service provider network. For Customer B, Gigabit Ethernet 0/0/3 is the customer-facing port, and Gigabit Ethernet 0/0/4 is the trunk port facing the service provider network.

Customer A

```
Router (config)# interface gigabitethernet0/0/1
Router (config-if)# service instance 1 Ethernet
Router (config-if-srv)# encapsulation dot1q 1-100
Router (config-if-srv)# bridge-domain 4000

Router (config)# interface gigabitethernet0/0/2
Router (config-if)# service instance 2 Ethernet
Router (config-if-srv)# encapsulation dot1q 30
Router (config-if-srv)# rewrite ingress pop 1 symmetric
Router (config-if-srv)# bridge-domain 4000
```

For Customer A, service instance 1 on Gigabit Ethernet port 0/0/1 is configured with the VLAN encapsulations used by the customer: C-VLANs 1–100. These are forwarded on bridge-domain 4000. The service provider facing port is configured with a service instance on the same bridge-domain and with an **encapsulation dot1q** command matching the S-VLAN. The **rewrite ingress pop 1 symmetric** command also implies a push of the configured encapsulation on egress packets. Therefore, the original packets with VLAN tags between 1 and 100 are encapsulated with another S-VLAN (VLAN 30) tag when exiting Gigabit Ethernet port 0/0/2.

Similarly, for double- tagged (S-VLAN = 30, C-VLAN = 1–100) packets coming from the provider network, the **rewrite ingress pop 1 symmetric** command causes the outer S-VLAN tag to be popped and the original C-VLAN tagged frame to be forwarded over bridge-domain 4000 out to Gigabit Ethernet port 0/0/1.

The same scenario applies to Customer B.

Customer B

```
Router (config)# interface gigabitethernet0/0/3
Router (config-if)# service instance 1 Ethernet
Router (config-if-srv)# encapsulation dot1q 1-200
Router (config-if-srv)# bridge-domain 4000

Router (config)# interface gigabitethernet0/0/4
Router (config-if)# service instance 2 Ethernet
Router (config-if-srv)# encapsulation dot1q 40
Router (config-if-srv)# rewrite ingress pop 1 symmetric
Router (config-if-srv)# bridge-domain 4000
```

Method 2

QinQ is also supported when sending packets between an EFP and a trunk EFP, because the trunk is implicitly defined as rewrite ingress pop 1 symmetric. The same external behavior as Method 1 can be achieved with this configuration:

Customer A

```
Router (config)# interface gigabitethernet0/0/1
Router (config-if)# service instance 1 Ethernet
Router (config-if-srv)# encapsulation dot1q 1-100
Router (config-if-srv)# bridge-domain 30
Router (config)# interface gigabitethernet0/0/2
Router (config-if)# service instance trunk 1 ethernet
Router (config-if-srv)# encapsulation dot1q 30
Router (config-if-srv)# rewrite ingress pop 1 symmetric
Router (config-if-srv)# bridge-domain from-encapsulation
```

Again, service instance 1 on Gigabit Ethernet port 0/0/1 is configured with the VLAN encapsulations used by the customer. These are forwarded on bridge-domain 30. The service provider facing port is configured as a trunk port. The trunk port implicitly pushes a tag matching the bridge-domain that the packet is forwarded on (in this case S-VLAN 30).

For double tagged (S-VLAN = 30, C-VLAN = 1 to 100) packets coming in from the provider network, the trunk port implicitly pops the outer S-VLAN (30) and forwards the packet on that bridge-domain.

Customer B

```
Router (config)# interface gigabitethernet0/0/3
Router (config-if)# service instance 1 Ethernet
Router (config-if-srv)# encapsulation dot1q 1-200
Router (config-if-srv)# bridge-domain 40
Router (config)# interface gigabitethernet0/0/4
Router (config-if)# service instance trunk 2 Ethernet
Router (config-if-srv)# encapsulation dot1q 40
Router (config-if-srv)# rewrite ingress pop 1 symmetric
Router (config-if-srv)# bridge-domain from-encapsulation
```

You can also combine the customer A and B configurations, as follows:

Customer A and B

```
Router (config)# interface gigabitethernet0/0/2
Router (config-if)# service instance trunk 1 ethernet
Router (config-if-srv)# encapsulation dot1q 30,40
Router (config-if-srv)# rewrite ingress pop 1 symmetric
Router (config-if-srv)# bridge-domain from-encapsulation
```

For information about the effect on cost of service (CoS) for different EFT tagging operations, see the Cisco ASR 903 Router Chassis Software Configuration Guide.

VLAN Translation Example Configurations

- For 1-to-1 VLAN translation (EFP to EFP), ingress port configuration:

```
Router (config)# interface gigabitethernet0/0/1
Router (config-if)# service instance 10 Ethernet
Router (config-if-srv)# encapsulation dot1q 10
Router (config-if-srv)# rewrite ingress tag pop 1 symmetric
Router (config-if-srv)# bridge-domain 10
```

  Egress port configuration:

```
Router (config)# interface gigabitethernet0/0/1
Router (config-if)# service instance 10 Ethernet
Router (config-if-srv)# encapsulation dot1q 20
Router (config-if-srv)# rewrite ingress tag pop 1 symmetric
Router (config-if-srv)# bridge-domain 10
```

- For 1-to-2 VLAN translation (EFP to EFP), ingress port configuration:

```
Router (config)# interface gigabitethernet0/0/1
Router (config-if)# service instance 10 Ethernet
Router (config-if-srv)# encapsulation dot1q 10
Router (config-if-srv)# rewrite ingress tag pop 1 symmetric
Router (config-if-srv)# bridge-domain 10
```

  Egress port configuration:

```
Router (config)# interface gigabitethernet0/0/2
Router (config-if)# service instance 10 Ethernet
Router (config-if-srv)# encapsulation dot1q 20 second dot1q 30
Router (config-if-srv)# rewrite ingress tag pop 2 symmetric
Router (config-if-srv)# bridge-domain 10
```

- For 2-to-1 VLAN translation (EFP to EFP), ingress port configuration:

```
Router (config)# interface gigabitethernet0/0/1
Router (config-if)# service instance 10 Ethernet
Router (config-if-srv)# encapsulation dot1q 10 second-dot1q 20
Router (config-if-srv)# rewrite ingress tag pop 2 symmetric
Router (config-if-srv)# bridge-domain 10
```

  Egress port configuration:

```
Router (config)# interface gigabitethernet0/0/2
Router (config-if)# service instance 10 Ethernet
Router (config-if-srv)# encapsulation dot1q 30
Router (config-if-srv)# rewrite ingress tag pop 1 symmetric
Router (config-if-srv)# bridge-domain 10
```

- For 2-to-2 VLAN translation (EFP to EFP), ingress port configuration:

```
Router (config)# interface gigabitethernet0/0/1
Router (config-if)# service instance 10 Ethernet
```

```
Router (config-if-srv)# encapsulation dot1q 10 second-dot1q 20
Router (config-if-srv)# rewrite ingress tag pop 2 symmetric
Router (config-if-srv)# bridge-domain 10
```

Egress port configuration:

```
Router (config)# interface gigabitethernet0/0/2
Router (config-if)# service instance 10 Ethernet
Router (config-if-srv)# encapsulation dot1q 30 second-dot1q 40
Router (config-if-srv)# rewrite ingress tag pop 2 symmetric
Router (config-if-srv)# bridge-domain 10
```

Layer 2 Protocol Tunneling

Customers at different sites connected across a service-provider network need to use various Layer 2 protocols to scale their topologies to include all remote sites, as well as the local sites. STP must run properly, and every VLAN should build a proper spanning tree that includes the local site and all remote sites across the service-provider network. Cisco Discovery Protocol (CDP) must discover neighboring Cisco devices from local and remote sites.

VLAN Trunking Protocol (VTP) must provide consistent VLAN configuration throughout all sites in the customer network that are participating in VTP. Similarly, DTP, LACP, LLDP, PAgP, and UDLD can also run across the service-provider network.

When protocol tunneling is enabled, edge switches on the inbound side of the service-provider network encapsulate Layer 2 protocol packets with a special MAC address (0100.0CCD.CDD0) and send them across the service-provider network. Core switches in the network do not process these packets but forward them as normal (unknown multicast data) packets. Layer 2 protocol data units (PDUs) for the configured protocols cross the service-provider network and are delivered to customer switches on the outbound side of the service-provider network. Identical packets are received by all customer ports on the same VLANs with these results:

- Users on each of a customer's sites can properly run STP, and every VLAN can build a correct spanning tree based on parameters from all sites and not just from the local site.
- CDP discovers and shows information about the other Cisco devices connected through the service-provider network.
- VTP provides consistent VLAN configuration throughout the customer network, propagating to all switches through the service provider that support VTP.

Customers use Layer 2 protocol tunneling to tunnel BPDUs through a service-provider network without interfering with internal provider network BPDUs.

Note On the Cisco ASR 903 Series Router, Layer 2 protocol tunneling is supported on EFPs, but *not* on switchports. Layer 2 protocol tunneling is supported on cross-connect EFPs.

In Figure 3, Customer X has four switches in the same VLAN, which are connected through the service-provider network. If the network does not tunnel PDUs, switches on the far ends of the network cannot properly run STP, CDP, and other Layer 2 protocols. For example, STP for a VLAN on a switch in Customer X, Site 1, will build a spanning tree on the switches at that site without considering convergence parameters based on Customer X's switch in Site 2. This could result in the topology shown in Figure 4.

Figure 3 Layer 2 Protocol Tunneling

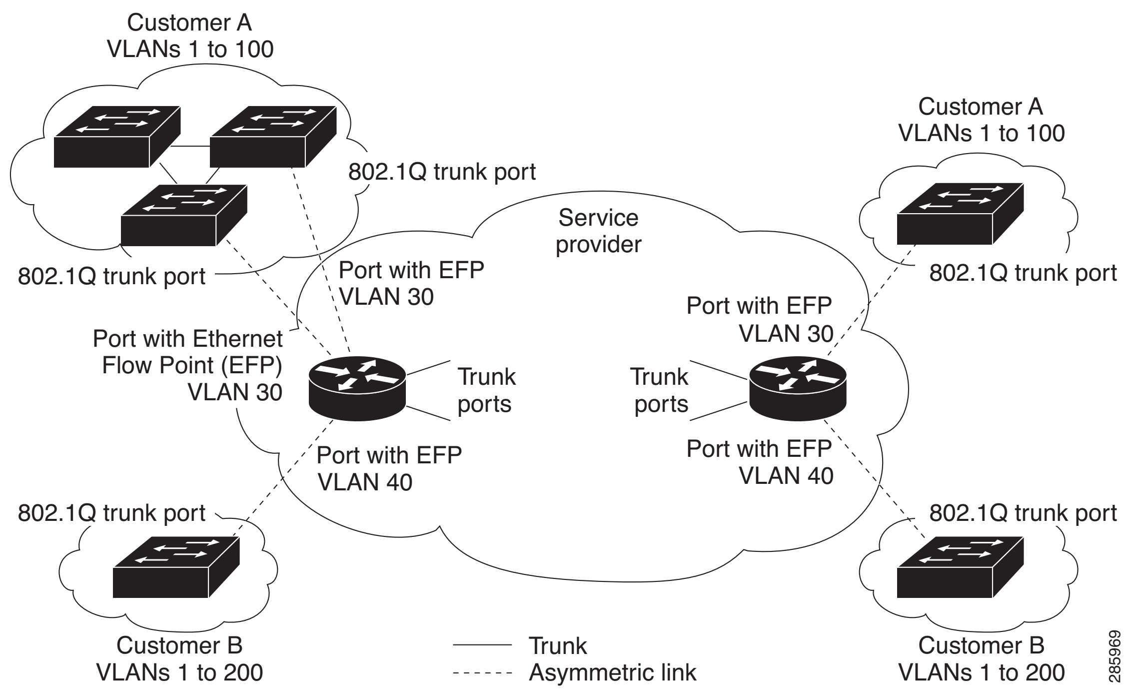
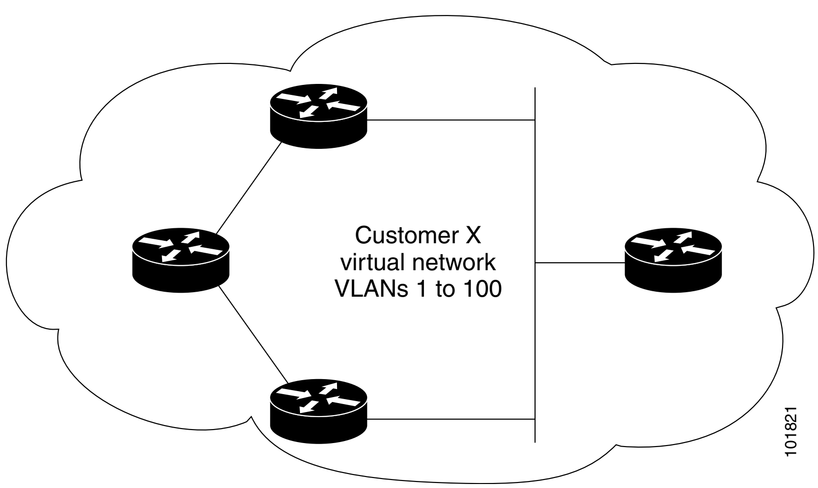


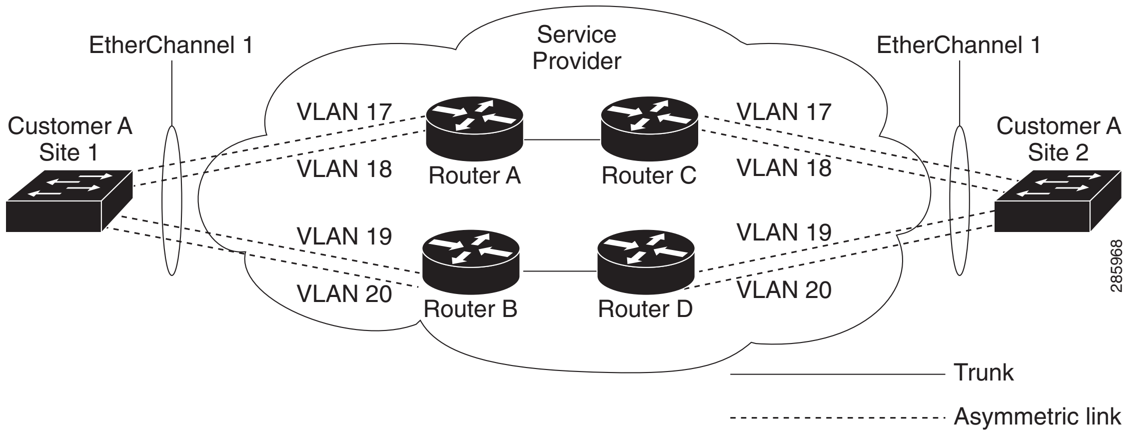
Figure 4 Layer 2 Network Topology without Proper Convergence



In a service-provider network, you can use Layer 2 protocol tunneling to enhance the creation of EtherChannels by emulating a point-to-point network topology. When you enable protocol tunneling (PAgP or LACP) on the service-provider switch, remote customer switches receive the PDUs and can negotiate the automatic creation of EtherChannels.

For example, in Figure 5, Customer A has two switches in the same VLAN that are connected through the SP network. When the network tunnels PDUs, switches on the far ends of the network can negotiate the automatic creation of EtherChannels without needing dedicated lines.

Figure 5 Layer 2 Protocol Tunneling for EtherChannels



Use the **l2protocol tunnel** *protocol* service-instance configuration command to enable Layer 2 protocol tunneling on a service instance:

Valid protocols include CDP, LACP, LLDP, PAgP, STP, UDLD, and VTP. If a protocol is not specified for a service instance, the protocol frame is dropped at the interface.

This is an example of Layer 2 protocol tunneling configuration:

```
Router (config)# interface gigabitethernet0/0/2
Router (config-if)# service instance 10 Ethernet
Router (config-if-srv)# encapsulation untagged, dot1q 200 second-dot1q 300
Router (config-if-srv)# l2protocol tunnel cdp stp vtp dtp pagp lacp
Router (config-if-srv)# bridge-domain 10
```

Note To enable tunneling of most Layer 2 protocol, you must configure **encapsulation untagged** because Layer 2 protocol PDUs are usually untagged.

Note For information about layer 2 protocol peering, see Layer 2 Protocol Peering, page 14. For information about layer 2 protocol forwarding, see Layer 2 Protocol Forwarding, page 15.

EFPs and Ethernet over Multiprotocol Layer Switching (EoMPLS)

When you configure a pseudowire under a VLAN interface (for example, VLAN 33), the pseudowire becomes a virtual Layer 2 port in that VLAN (VLAN 33), or bridge domain. In this bridge domain, you can configure other types of Layer 2 ports, such as EFP portss. Switching functionalities, such as MAC address learning, flooding, and forwarding to learned MAC addresses, apply to all the Layer 2 ports, including the pseudowire.

Note When a pseudowire is present in the same bridge domain as an EFP, you cannot configure the EFP with the **rewrite ingress tag pop 2 symmetric** service instance configuration command. Other restrictions about switching between EFPs or between EFPs also still apply.

For more information about configuring pseudowire, see the Cisco ASR 903 Router Chassis Software Configuration Guide.

Bridge Domain Routing

The switch supports IP routing and multicast routing for bridge domains, including Layer 3 and Layer 2 VPNs, using the BDI model. There are the limitations:

- You must configure BDIs for bridge-domain routing.
- The bridge domain must be in the range of 1 to 4094 to match the supported VLAN range.
- You can use bridge domain routing with only native packets.

This is an example of configuring bridge-domain routing with a single tag EFP:

```
Router (config)# interface gigabitethernet0/0/2
Router (config-if)# service instance 1 Ethernet
Router (config-if-srv)# encapsulation dot1q 10
Router (config-if-srv)# rewrite ingress tag pop 1 symmetric
Router (config-if-srv)# bridge-domain 100

Router (config)# interface bdi 100
Router (config-if)# ip address 20.1.1.1 255.255.255.255
```

This is an example of configuring bridge-domain routing with two tags:

```
Router (config)# interface gigabitethernet0/0/2
Router (config-if)# service instance 1 Ethernet
Router (config-if-srv)# encapsulation dot1q 10 second-dot1q 20
Router (config-if-srv)# rewrite ingress tag pop 2 symmetric
Router (config-if-srv)# bridge-domain 100

Router (config)# interface bdi 100
Router (config-if)# ip address 20.1.1.1 255.255.255.255
```

EFPs and Trunk Port MAC Addresses

Because forwarding can occur between EFPs and trunk ports, MAC address movement can occur on learned addresses. Addresses learned on EFPs will have the format of interface + EFP ID, for example gigabitethernet 0/0/1 + EFP 1. When an address moves between a non-secured EFP and a trunk port, the behavior is similar to that of moving between trunk ports.

To see MAC address information for bridge domains, use the **show mac-address-table bdomain** *domain* command.

When an EFP property changes (bridge domain, rewrite, encapsulation, split-horizon, secured or unsecured, or a state change), the old dynamic MAC addresses are flushed from their existing tables. This is to prevent old invalid entries from lingering.

EFPs and MSTP

EFP bridge domains are supported by the Multiple Spanning Tree Protocol (MSTP). These restrictions apply when running STP with bridge domains.

- All incoming VLANs (outer-most or single) mapped to a bridge domain must belong to the same MST instance or loops could occur.
- For all EFPs that are mapped to the same MST instance, you must configure backup EFPs on every redundant path to prevent loss of connectivity due to STP blocking a port.

- When STP mode is PVST+ or PVRST, EFP information is not passed to the protocol. EVC only supports only MSTP.
- Changing STP mode from MST to PVRST is not allowed.

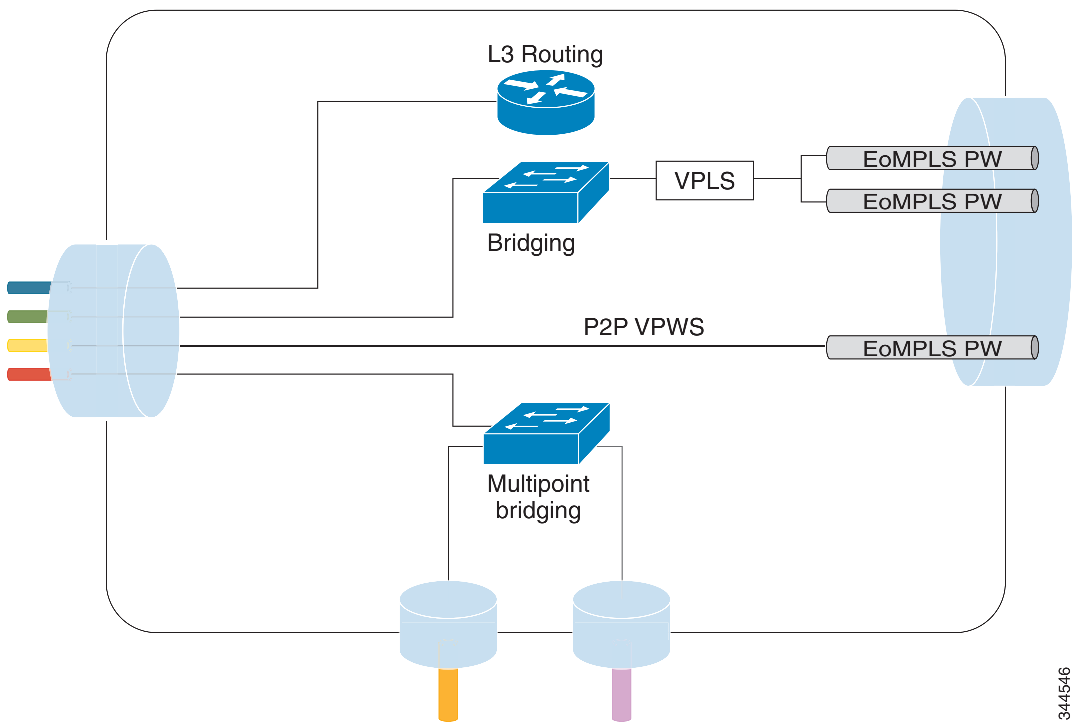
L3 Unicast and Multicast Routing on a Bridge Domain with Multiple EFPs

L3 unicast routing and L3 multicast routing are supported on bridge domains with multiple EFPs. This feature provides the following functionality:

- Broadcast domains are determined through bridge-domains rather than VLANs
- Multiple EFPs on a single bridge domain and physical interface with L3 multicast routing enabled is supported
- Each EFP has its own match criteria and its own ingress and egress rewrite operations

Figure 6 shows an access-facing port with multiple EFPs configured to the route or bridge.

Figure 6 Multiple EFPs



Restrictions

IRB is required for L3 termination at the SVI with redundant L2 links.

For core-based deployments, MPLS is a preferred transport for any traffic type.

Configuring L3 Multicast Routing on a Bridge Domain

The following example shows how to configure L3 multicast routing on a bridge domain using existing IOS commands.

```
ip routing
Ip multicast-routing
!
!
interface bdi 100
    ip address 1.1.1.1 255.255.255.0
    ip pim sparse-mode
    Igmp version v3
!
interface GigabitEthernet0/0/1
 service instance 1 ethernet
  encapsulation dot1q 33
rewrite ingress tag pop 1 symmetric
bridge-domain 100
!
service instance 2 ethernet
  encapsulation dot1q 55
rewrite ingress tag pop 1 symmetric
   bridge-domain 100
```

Cross-Connect on EFP Interfaces

Cross-connect provides the ability to match the encapsulation of received packets on the ingress side of an EFP interface and send them out with the same encapsulation through the egress side of the EFP interface. Cross-connect bridge-domain entries are provided, and encapsulation matching is achieved by matching bridge-domain entries for the EFPs on which cross-connect is configured.

The following types of encapsulation tags are supported:

- untagged
- rewrite tags with pop1

Restrictions

- A bridge-domain cannot be configured on an EFP if cross-connect is already configured.
- Cross-connect works only when the MPLS license is enabled.
- Priority-tagged encapsulation is not a supported.

Configuring Cross-Connect on an EFP Interface

Beginning in privileged EXEC mode, follow these steps to configure cross-Connect on an EFP Interface.

Summary Steps

1. **configure terminal**
2. **interface** *interface-id*
3. **service instance** *number* **ethernet** [*name*]
4. **encapsulation dot1q** *vlan_id* **cos** *cos_value* **second-dot1q** *vlan-id* **cos** *cos_value*
5. **xconnect** *peer-router-id vcid* **pw-class** *pw-class name*
6. **end**

Detailed Steps

	Command	Purpose
Step 1	**configure terminal**	Enter global configuration mode.
Step 2	**interface** *interface-id*	Specify an interface to configure, and enter interface configuration mode.
Step 3	**service instance** *number* **ethernet** [*name*]	Configure an EFP (service instance) and enter service instance configuration) mode. • The *number* is the EFP identifier, an integer from 1 to 4000. • (Optional) **ethernet** *name* is the name of a previously configured EVC. You do not need to use an EVC name in a service instance.
Step 4	**encapsulation dot1q** *vlan_id* **cos** *cos_value* **second-dot1q** *vlan-id* **cos** *cos_value*	CoS value encapsulation defines match criterion after including the CoS for the S-Tag and the C-Tag. The CoS value is a single digit between 1 and 7 for S-Tag and C-Tag. You cannot configure CoS encapsulation with **encapsulation untagged**. The result is an exact outermost VLAN and CoS match and second tag. You can also use VLAN ranges.
Step 5	**xconnect** *peer-router-id vcid* **pw-class** *pw-class name*	Bind the attachment circuit to a pseudowire virtual circuit (VC) and enter xconnect configuration mode.
Step 6	**end**	Return to privileged EXEC mode.

This is an example configuration of cross-connect on an EFP interface:

```
interface gigabitethernet 0/0/3
    service instance 30 ethernet
    encap dot1q x second dot1q y
    xconnect <10.10.10.10> 123 encapsulation mpls
```

Configuring a Static MAC Address

This section describes how to configure a static MAC address on the Cisco ASR 903 Series Router. For an overview of static MAC addresses, see Static MAC Addresses, page 7.

Limitations

The following limitations apply when configuring static MAC addresses:

- Static MAC addresses are supported only on egress ports.
- You can configure up to 1024 multicast static MAC addresses
- You can assign up to 24 EFPs to a bridge domain configured with a multicast static MAC address.
- MAC entries configured across different bridge-domains are represented as separate entries in the router MAC table.

- Multicast static MAC addresses apply only to layer 2 traffic; layer 3 multicast traffic is not affected by a static MAC configuration and is forwarded to all EFPs in a bridge domain.

Configuring a Multicast Static MAC Address

Follow these steps to configure a multicast static MAC address.

Summary Steps

1. **configure terminal**
2. **interface** *interface-id*
3. **service instance** *number* **ethernet** [*name*]
4. **encapsulation** {**default** | **dot1q** | **priority-tagged** | **untagged**}
5. **bridge-domain** *bridge-id*
6. **mac static address** *address*
7. **end**

Detailed Steps

	Command	Purpose
Step 1	**configure terminal**	Enter global configuration mode.
Step 2	**interface** *interface-id*	Specify an interface to configure, and enter interface configuration mode.
Step 3	**service instance** *number* **ethernet** [*name*]	Configure an EFP (service instance) and enter service instance configuration) mode. • The *number* is the EFP identifier, an integer from 1 to 4000. • (Optional) **ethernet** *name* is the name of a previously configured EVC. You do not need to use an EVC name in a service instance.
Step 4	**encapsulation** {**default** | **dot1q** | **priority-tagged** | **untagged**}	Configure encapsulation type for the service instance. • **default**—Configure to match all unmatched packets. • **dot1q**—Configure 802.1Q encapsulation. See Table 1 for details about options for this keyword. • **priority-tagged**—Specify priority-tagged frames, VLAN-ID 0 and CoS value of 0 to 7. • **untagged**—Map to untagged VLANs. Only one EFP per port can have untagged encapsulation.
Step 5	**bridge-domain** *bridge-id*	Configure the bridge domain ID.
Step 6	**mac static address** *address*	Specifies the multicast MAC address.
Step 7	**end**	Return to privileged EXEC mode.

This is an example configuration of a static MAC address on an EFP interface:

```
interface gigabitEthernet 0/0/3
    service instance 10 ethernet
    encapsulation dot1q 10
    bridge-domain 100
    mac static address 1302.4302.23c3
```

This configuration specifies that any layer 2 traffic sent to destination MAC address 1302.4302.23c3 is forwarded only to service instance 10 of bridge-domain interface gigabitEthernet 0/0/3.

To disable a static MAC configuration, apply the **mac static address** *address* command to the service instance:

```
Router (config)# interface gigabitethernet0/0/1
Router (config-if)# service instance 1 Ethernet
Router (config-if-srv)# mac static address 1302.4302.23c3
```

Monitoring EVC

Table 3 Supported show Commands

Command	Description
show ethernet service evc [**id** *evc-id* | **interface** i*nterface-id*] [**detail**]	Displays information about all EVCs, or a specific EVC when you enter an EVC ID, or all EVCs on an interface when you enter an interface ID. The **detail** option provides additional information about the EVC.
show ethernet service instance [**id** *instance-id* **interface** i*nterface-id* | **interface** i*nterface-id*] {[**detail**] | [**stats**]}	Displays information about one or more service instance (EFPs). If you specify an EFP ID and interface, only data pertaining to that particular EFP is displayed. If you specify only an interface ID, data is displayed for all EFPs on the interface.
show bridge-domain [*n*]	When you enter *n*, this command displays all the members of the specified bridge-domain, if a bridge-domain with the specified number exists. If you do not enter *n,* the command displays all the members of all bridge-domains in the system.
show bridge-domain *n* **split-horizon** [**group** {*group_id* | **all**}]	When you do not specify a **group** *group_id*, this command displays all the members of bridge-domain *n* that belong to split horizon group 0. If you specify a numerical *group_id*, this command displays all the members of the specified group id. When you enter **group all**, the command displays all members of any split horizon group.

Table 3 Supported show Commands

Command	Description

show ethernet service instance detail	This command displays detailed service instance information, including Layer 2 protocol information. This is an example of the output:
	`Router# show ethernet service instance detail`
	`Service Instance ID: 1`
	`Associated Interface: Ethernet0/0`
	`Associated EVC:`
	`L2protocol tunnel pagp`
	`CE-Vlans:`
	`State: Up`
	`EFP Statistics:`
	`Pkts In   Bytes In   Pkts Out  Bytes Out`
	`0          0          0          0`

show mac address-table	This command displays dynamically learned or statically configured MAC security addresses.
show mac address-table bridge-domain *bridge-domain id*	This command displays MAC address table information for the specified bridge domain.
show mac address-table count bridge-domain *bridge-domain id*	This command displays the number of addresses present for the specified bridge domain.
show mac address-table learning **bridge-domain** *bridge-domain id*	This command displays the learning status for the specified bridge domain.

This is an example of output from the **show ethernet service instance detail** command:

```
Router# show ethernet service instance id 1 interface gigabitEthernet 0/0/1 detail
Service Instance ID: 1
Associated Interface: GigabitEthernet0/0/13
Associated EVC: EVC_P2P_10
L2protocol drop
CE-Vlans:
Encapsulation: dot1q 10 vlan protocol type 0x8100
Interface Dot1q Tunnel Ethertype: 0x8100
State: Up
EFP Statistics:
   Pkts In   Bytes In   Pkts Out  Bytes Out
       214      15408      97150    6994800
EFP Microblocks:
****************
Microblock type: Bridge-domain
Bridge-domain: 10
```

This is an example of output from the **show ethernet service instance** statistics command:

```
Router# show ethernet service instance id 1 interface gigabitEthernet 0/0/13 stats
Service Instance 1, Interface GigabitEthernet0/0/13
Pkts In   Bytes In   Pkts Out  Bytes Out
       214      15408      97150    6994800
```

This is an example of output from the **show mac-address table count** command:

```
Router# show mac address-table count bridge-domain 10

Mac Entries for BD   10:
---------------------------
Dynamic Address Count  : 20
Static  Address Count  : 0
```

```
Total Mac Addresses    : 20
```