EVPN Features

This chapter describes how to configure Layer 2 (L2) Ethernet VPN (EVPN) features on the Cisco ASR 9000 Series Aggregation Services Routers supporting Cisco IOS XR software.

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**EVPN Overview**

Ethernet VPN (EVPN) is a next generation solution that provide Ethernet multipoint services over MPLS networks. EVPN operates in contrast to the existing Virtual Private LAN Service (VPLS) by enabling control-plane based MAC learning in the core. In EVPN, PE's participating in the EVPN instances learn customer MAC routes in Control-Plane using MP-BGP protocol. Control-plane MAC learning brings a number
of benefits that allow EVPN to address the VPLS shortcomings, including support for multi-homing with per-flow load balancing.

The EVPN control-plane MAC learning has the following benefits:

- Eliminate flood and learn mechanism
- Fast-reroute, resiliency, and faster reconvergence when link to dual-homed server fails
- Enables load balancing of traffic to and from CEs that are multihomed to multiple PEs

The following EVPN modes are supported:

- Single homing - This enables you connect a customer edge (CE) device to one provider edge (PE) device.
- Multihoming - This enables you to connect a customer edge (CE) device to two or more provider edge (PE) devices to provide redundant connectivity. The redundant PE device ensures that there is no traffic disruption when there is a network failure. Following are the types of multihoming:
  - Single-Active - In single-active mode, only a single PE among a group of PEs attached to the particular Ethernet-Segment is allowed to forward traffic to and from that Ethernet Segment.
  - Active-Active - In active-active mode, all the PEs attached to the particular Ethernet-Segment is allowed to forward traffic to and from that Ethernet Segment.

### EVPN Timers

The following table shows various EVPN timers:

#### Table 1: EVPN Timers

<table>
<thead>
<tr>
<th>Timer</th>
<th>Range</th>
<th>Default Value</th>
<th>Trigger</th>
<th>Applicability</th>
<th>Action</th>
<th>Sequence</th>
</tr>
</thead>
<tbody>
<tr>
<td>startup-cost-in</td>
<td>30-86400</td>
<td>disabled</td>
<td>node recovered*</td>
<td>Single-Homed, All-Active, Single-Active</td>
<td>Postpone EVPN startup procedure and Hold AC link(s) down to prevent CE to PE forwarding. Startup-cost-in timer allows PE to set core protocols first.</td>
<td>1</td>
</tr>
<tr>
<td>recovery</td>
<td>0-3600s</td>
<td>30s</td>
<td>node recovered, interface recovered**</td>
<td>Single-Homed (ESI configured), Single-Active</td>
<td>Postpone EVPN Startup procedure. Recovery timer allows PE to set access protocols (STP) before reachability towards EVPN core is advertised.</td>
<td>2</td>
</tr>
</tbody>
</table>
### EVPN Features

<table>
<thead>
<tr>
<th>Timer</th>
<th>Range</th>
<th>Default Value</th>
<th>Trigger</th>
<th>Applicability</th>
<th>Action</th>
<th>Sequence</th>
</tr>
</thead>
<tbody>
<tr>
<td>peering</td>
<td>0-3600s</td>
<td>3s</td>
<td>node recovered, interface recovered</td>
<td>All-Active, Single-Active</td>
<td>Starts after sending EVPN RT4 to postpone rest of EVPN startup procedure. Peering timer allows remote PE (multihoming AC with same ESI) to process RT4 before DF election will happen.</td>
<td>3</td>
</tr>
</tbody>
</table>

### EVPN Operation

At startup, PEs exchange EVPN routes in order to advertise the following:

- **VPN membership:** The PE discovers all remote PE members of a given EVI. In the case of a multicast ingress replication model, this information is used to build the PE’s flood list associated with an EVI.

- **Ethernet segment reachability:** In multi-home scenarios, the PE auto-discovers remote PE and their corresponding redundancy mode (all-active or single-active). In case of segment failures, PEs withdraw the routes used at this stage in order to trigger fast convergence by signaling a MAC mass withdrawal on remote PEs.

- **Redundancy Group membership:** PEs connected to the same Ethernet segment (multi-homing) automatically discover each other and elect a Designated Forwarder (DF) that is responsible for forwarding Broadcast, Unknown unicast and Multicast (BUM) traffic for a given EVI.

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* indicates all required software components are loaded.

** indicates link status is up.
EVPN can operate in single homing or dual homing mode. Consider single homing scenario, when EVPN is enabled on PE, routes are advertised where each PE discovers all other member PEs for a given EVPN instance. When an unknown unicast (or BUM) MAC is received on the PE, it is advertised as EVPN type-2 routes to other PEs. MAC routes are advertised to the other PEs using EVPN type-2 routes. In multi-homing scenarios Type 1, 3 and 4 are advertised to discover other PEs and their redundancy modes (single active or active-active). Use of Type-1 route is to auto-discover other PE which hosts the same CE. The other use of this route type is to fast route unicast traffic away from a broken link between CE and PE. Type-4 route is used for electing designated forwarder. For instance, consider the topology when customer traffic arrives at the PE, EVPN MAC advertisement routes distribute reachability information over the core for each customer MAC address learned on local Ethernet segments. Each EVPN MAC route announces the customer MAC address and the Ethernet segment associated with the port where the MAC was learned from and is associated MPLS label. This EVPN MPLS label is used later by remote PEs when sending traffic destined to the advertised MAC address.

EVPN Route Types

The EVPN network layer reachability information (NLRI) provides different route types.

<table>
<thead>
<tr>
<th>Route Type</th>
<th>Name</th>
<th>Usage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Ethernet Auto-Discovery (AD) Route</td>
<td>Few routes sent per ES, carry the list of EVIs that belong to ES</td>
</tr>
<tr>
<td>2</td>
<td>MAC/IP Advertisement Route</td>
<td>Advertise MAC, address reachability, advertise IP/MAC binding</td>
</tr>
<tr>
<td>3</td>
<td>Inclusive Multicast Ethernet Tag Route</td>
<td>Multicast Tunnel End point discovery</td>
</tr>
<tr>
<td>4</td>
<td>Ethernet Segment Route</td>
<td>Redundancy group discovery, DF election</td>
</tr>
</tbody>
</table>
**Route Type 1: Ethernet Auto-Discovery (AD) Route**

The Ethernet (AD) routes are advertised on per EVI and per ESI basis. These routes are sent per ES. They carry the list of EVIs that belong to the ES. The ESI field is set to zero when a CE is single-homed.

**Route Type 2: MAC/IP Advertisement Route**

The host's IP and MAC addresses are advertised to the peers within NRLI. The control plane learning of MAC addresses reduces unknown unicast flooding.

**Route Type 3: Inclusive Multicast Ethernet Tag Route**

This route establishes the connection for broadcast, unknown unicast, and multicast (BUM) traffic from a source PE to a remote PE. This route is advertised on per VLAN and per ESI basis.

**Route Type 4: Ethernet Segment Route**

Ethernet segment routes enable to connect a CE device to two or PE devices. ES route enables the discovery of connected PE devices that are connected to the same Ethernet segment.

### Configure EVPN L2 Bridging Service

Perform the following steps to configure EVPN L2 bridging service.

#### SUMMARY STEPS

1. configure
2. l2vpn
3. bridge group bridge-group-name
4. bridge-domain bridge-domain-name
5. interface GigabitEthernet GigabitEthernet Interface Instance
6. evi ethernet vpn id
7. exit
8. exit
9. bridge-domain bridge-domain-name
10. interface GigabitEthernet GigabitEthernet Interface Instance
11. evi ethernet vpn id
12. Use the commit or end command.

#### DETAILED STEPS

**Step 1**

configure

Example:

RP/0/RSP0/CPU0:router# configure
Enters the global configuration mode.

**Step 2**

l2vpn
Example:
RP/0/RSP0/CPU0:router(config)# l2vpn
Enters the l2vpn configuration mode.

Step 3 bridge group bridge-group-name
Example:
RP/0/RSP0/CPU0:router(config-l2vpn)# bridge group 1
Enters the bridge group configuration mode.

Step 4 bridge-domain bridge-domain-name
Example:
RP/0/RSP0/CPU0:router(config-l2vpn-bg)# bridge-domain 1-1
Enters the bridge domain configuration mode.

Step 5 interface GigabitEthemet GigabitEthernet Interface Instance
Example:
RP/0/RSP0/CPU0:router(config-l2vpn-bg-bd)# interface GigabitEthernet 0/0/0/1.1
Enters interface configuration mode.

Step 6 evi ethernet vpn id
Example:
RP/0/RSP0/CPU0:router(config-l2vpn-bg-bd-ac)# evi 1
Creates the ethernet VPN ID.

Step 7 exit
Example:
RP/0/RSP0/CPU0:router(config-l2vpn-bg-bd-ac-evi)# exit
Exits the current configuration mode.

Step 8 exit
Example:
RP/0/RSP0/CPU0:router(config-l2vpn-bg-bd)# exit
Exits the current configuration mode.

Step 9 bridge-domain bridge-domain-name
Example:
RP/0/RSP0/CPU0:router(config-l2vpn-bg)# bridge-domain 1-2
Enters the bridge domain configuration mode.

Step 10 interface GigabitEthernet GigabitEthernet Interface Instance
Example:
Enters interface configuration mode.

**Step 11**

```bash
RP/0/RSP0/CPU0:router(config-evpn)# interface GigabitEthernet 0/0/0/1.2
```

Enters interface configuration mode.

**Step 11**

```bash
RP/0/RSP0/CPU0:router(config-l2vpn-bd-ac)# evi 1
```

Creates the ethernet VPN ID.

**Step 12**

Use the `commit` or `end` command.

- **commit** - Saves the configuration changes and remains within the configuration session.
- **end** - Prompts user to take one of these actions:
  - **Yes** - Saves configuration changes and exits the configuration session.
  - **No** - Exits the configuration session without committing the configuration changes.
  - **Cancel** - Remains in the configuration mode, without committing the configuration changes.

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**EVPN Software MAC Learning**

MAC learning is the method of learning the MAC addresses of all devices available in a VLAN.

The MAC addresses learned on one device needs to be learned or distributed on the other devices in a VLAN. EVPN Native with software MAC Learning feature enables the distribution of the MAC addresses learned on one device to the other devices connected to a network. The MAC addresses are learnt from the remote devices using BGP.

*Figure 2: EVPN Native with Software MAC Learning*

The above figure illustrates the process of Software MAC Learning. The following are the steps involved in the process:

1. Traffic comes in on one port in the bridge domain.
2. The source MAC address (AA) is learnt on DCI1 and is stored as a dynamic MAC entry.
3. The MAC address (AA) is converted into a type-2 BGP route and is sent over BGP to all the remote PEs in the same EVI.
4. The MAC address (AA) is updated on DCI3 as a static remote MAC address.

Software and Hardware Support

The EVPN Native with Software MAC Learning feature is supported on Cisco ASR 9000 Series Routers that support Cisco IOS XR software and Cisco IOS XR 64-bit.

Configure EVPN Native with Software MAC Learning

The following section describes how you can configure EVPN Native with Software MAC Learning:

```plaintext
/* Configure bridge domain. */
RP/0/RSP0/CPU0:router(config)# l2vpn
RP/0/RSP0/CPU0:router(config-l2vpn)# bridge group EVPN_SH
RP/0/RSP0/CPU0:router(config-l2vpn-bg)# bridge-domain EVPN_2001
RP/0/RSP0/CPU0:router(config-l2vpn-bg-bd)# interface TenGigE0/4/0/10.2001
RP/0/RSP0/CPU0:router(config-l2vpn-bg-bd)# interface BundleEther 20.2001
RP/0/RSP0/CPU0:router(config-l2vpn-bg-bd)# storm-control broadcast pps 10000
RP/0/RSP0/CPU0:router(config-l2vpn-bg-bd)# neighbor 20.20.20.20 pw-id 1020001
evi 2001
RP/0/RSP0/CPU0:router(config-l2vpn-bg-bd)# exit
RP/0/RSP0/CPU0:router(config-l2vpn-bg)# exit
RP/0/RSP0/CPU0:router(config-l2vpn)# exit

/* Configure advertisement of MAC routes, suppress unknown unicast, disable the control word, */
/* configure the flow label, configure BGP route-exchange using RT. */
RP/0/RSP0/CPU0:router(config)# evpn
RP/0/RSP0/CPU0:router(config-evpn)# evi 2001
/* Use the advertise-mac command to control the advertisement of MAC routes through BGP to other neighbors. */
RP/0/RSP0/CPU0:router(config-evpn-evi)# advertise-mac
/* Use the unknown-unicast-suppress command to prevent the flooding of unknown unicast traffic received from the EVPN core towards all other EVPN bridge-ports. */
RP/0/RSP0/CPU0:router(config-evpn-evi)# unknown-unicast-suppress
/* Use the control-word-disable command to prevent the control word from being sent */
/* in the packet that is sent to MPLS core. The control word functionality is enabled by default. */
RP/0/RSP0/CPU0:router(config-evpn-evi)# control-word-disable
/* Use the load-balance flow label static command to add additional flow label header to the packet */
/* that is sent to MPLS core. The loadbalance flow functionality is disabled by default. */
RP/0/RSP0/CPU0:router(config-evpn-evi)# load-balance flow label static
/* Perform the following steps to configure BGP route-exchange using RT */
RP/0/RSP0/CPU0:router(config-evpn-evi)# bgp
RP/0/RSP0/CPU0:router(config-evpn-evi)# route-target import 200:101
RP/0/RSP0/CPU0:router(config-evpn-evi)# route-target export 200:101
/* Configure address family session in BGP. */
RP/0/RSP0/CPU0:router# configure
RP/0/RSP0/CPU0:router(config)# router bgp 200
RP/0/RSP0/CPU0:router(config-bgp)# bgp router-id 40.40.40.40
RP/0/RSP0/CPU0:router(config-bgp)# address-family 12vpn evpn
RP/0/RSP0/CPU0:router(config-bgp)# neighbor 10.10.10.10
RP/0/RSP0/CPU0:router(config-bgp-nbr)# remote-as 200
```
Supported Modes for EVPN Native with Software MAC Learning

The following are the modes in which EVPN MAC Learning is supported:

- Single Home Device or Single Home Network
- Dual Home Device (DHD) - All Active Load Balancing
- Dual Home Device - Single-Active Load Balancing

Single Home Device or Single Home Network

The following section describes how you can configure EVPN Native with Software MAC Learning feature in single home device or single home network:

Figure 3: Single Home Device or Single Home Network (SHD/SHN)

In the above figure, the PE (PE1) is attached to Ethernet Segment using bundle or physical interfaces. Null Ethernet Segment Identifier (ESI) is used for SHD/SHN.

Configure EVPN in Single Home Device or Single Home Network

/* Configure bridge domain. */

RP/0/RSP0/CPU0:router(config)# l2vpn
RP/0/RSP0/CPU0:router(config-l2vpn)# bridge group EVPN_ALL_ACTIVE
RP/0/RSP0/CPU0:router(config-l2vpn-bg)# bridge-domain EVPN_2001
RP/0/RSP0/CPU0:router(config-l2vpn-bg-bd)# interface BundleEther1.2001
RP/0/RSP0/CPU0:router(config-l2vpn-bg-bd)# evi 2001

/* Configure advertisement of MAC routes. */

RP/0/RSP0/CPU0:router(config)# evpn
RP/0/RSP0/CPU0:router(config-evpn)# evi 2001
RP/0/RSP0/CPU0:router(config-evpn-evi)# advertise-mac

/* Configure address family session in BGP. */

RP/0/RSP0/CPU0:router# configure
RP/0/RSP0/CPU0:router#(config)# router bgp 200
RP/0/RSP0/CPU0:router#(config-bgp)# bgp router-id 40.40.40.40
RP/0/RSP0/CPU0:router#(config-bgp)# address-family l2vpn evpn
RP/0/RSP0/CPU0:router#(config-bgp)# neighbor 10.10.10.10
RP/0/RSP0/CPU0:router#(config-bgp-nbr)# remote-as 200
Running Configuration

l2vpn
bridge group EVPN_ALL_ACTIVE
  bridge-domain EVPN_2001
  interface BundleEther1.2001
evi 2001
!
evpn
evi 2001
  advertise-mac
!
router bgp 200 bgp
  router-id 40.40.40.40
  address-family l2vpn evpn
  neighbor 10.10.10.10
    remote-as 200
description MPLS-FACING-PEER
  updatesource Loopback0
  addressfamily l2vpn evpn

Verification

Verify EVPN in single home devices.

RP/0/RSP0/CPU0:router# show evpn ethernet-segment interface Te0/4/0/10 detail

<table>
<thead>
<tr>
<th>Ethernet Segment Id</th>
<th>Interface</th>
<th>Nexthops</th>
</tr>
</thead>
<tbody>
<tr>
<td>N/A</td>
<td>Te0/4/0/10</td>
<td>20.20.20.20</td>
</tr>
</tbody>
</table>

Topology :

- Operational : SH
- Configured : Single-active (AAS) (default)

Dual Home Device—All-Active Load Balancing Mode

The following section describes how you can configure EVPN Software MAC Learning feature in dual home device (DHD) in all-active load balancing mode:
All-active load-balancing is known as Active/Active per Flow (AApF). In the above figure, identical Ethernet Segment Identifier is used on both EVPN PEs. PEs are attached to Ethernet Segment using bundle interfaces. In the CE, single bundles are configured towards two EVPN PEs. In this mode, the MAC address that is learnt is stored on both PE1 and PE2. Both PE1 and PE2 can forward the traffic within the same EVI.

Configure EVPN Software MAC Learning in Dual Home Device—All-Active Mode

This section describes how you can configure EVPN Software MAC Learning feature in dual home device—all-active mode:

```bash
/* Configure bridge domain. */
RP/0/RSP0/CPU0:router(config)# l2vpn
RP/0/RSP0/CPU0:router(config-l2vpn)# bridge group EVPN_ALL_ACTIVE
RP/0/RSP0/CPU0:router(config-l2vpn)# bridge-domain EVPN_2001
RP/0/RSP0/CPU0:router(config-l2vpn)# interface BundleEther1.2001
RP/0/RSP0/CPU0:router(config-l2vpn)# evi 2001

/* Configure advertisement of MAC routes. */
RP/0/RSP0/CPU0:router(config)# evpn
RP/0/RSP0/CPU0:router(config-evpn)# evi 2001
RP/0/RSP0/CPU0:router(config-evpn-evi)# advertise-mac
RP/0/RSP0/CPU0:router(config-evpn-evi)# exit
RP/0/RSP0/CPU0:router(config-evpn)# interface bundle-ether1
RP/0/RSP0/CPU0:router(config-evpn-ac)# ethernet-segment
RP/0/RSP0/CPU0:router(config-evpn-ac-es)# identifier type 0 01.11.00.00.00.00.00.01

/* Configure address family session in BGP. */
RP/0/RSP0/CPU0:router# configure
RP/0/RSP0/CPU0:router#(config)# router bgp 200
RP/0/RSP0/CPU0:router#(config-bgp)# bgp router-id 209.165.200.227
RP/0/RSP0/CPU0:router#(config-bgp)# address-family l2vpn evpn
RP/0/RSP0/CPU0:router#(config-bgp)# neighbor 10.10.10.10
RP/0/RSP0/CPU0:router#(config-bgp)# neighbor 10.10.10.10 remote-as 200
RP/0/RSP0/CPU0:router#(config-bgp-nbr)# description MPLS Facing-PEER
RP/0/RSP0/CPU0:router#(config-bgp-nbr)# update-source Loopback 0
RP/0/RSP0/CPU0:router#(config-bgp-nbr)# address-family family l2vpn evpn
```
/* Configure Link Aggregation Control Protocol (LACP) bundle. */
RP/0/RSP0/CPU0:router# configure
RP/0/RSP0/CPU0:router(config)# interface Bundle-Ether1 300
RP/0/RSP0/CPU0:router(config-if)# lACP switchover suppress-flaps 300
RP/0/RSP0/CPU0:router(config-if)# exit

/* Configure VLAN Header Rewrite. */
RP/0/RSP0/CPU0:router# configure
RP/0/RSP0/CPU0:router(config)# interface bundle-Ether1.2001 l2transport
RP/0/RSP0/CPU0:router(config-if)# encapsulation dot1q 10
RP/0/RSP0/CPU0:router(config-if)# rewrite ingress tag pop 1 symmetric

Running Configuration

l2vpn
bridge group EVPN_ALL_ACTIVE
bridge-domain EVPN_2001
interface Bundle-Ether1.2001
!
ev1 2001
!
evpn
ev1 2001
! advertise-mac
! interface bundle-ether1
ethernet-segment
identifier type 0 01.11.00.00.00.00.00.00.01
!
! router bgp 200
bgp router-id 209.165.200.227
address-family l2vpn evpn
!
neighbor 10.10.10.10
remote-as 200
description MPLS-FACING-PEER
update-source Loopback0
address-family l2vpn evpn
!
interface Bundle-Ether1
lACP switchover suppress-flaps 300
load-interval 30
!
interface Bundle-Ether1.2001 l2transport
encapsulation dot1aq 2001
rewrite ingress tag pop 1 symmetric
!

Verification

Verify EVPN in dual home devices in All-Active mode.

RP/0/RSP0/CPU0:router# show evpn ethernet-segment interface bundle-Ether1 carvin$
Dual Home Device—Single-Active Load Balancing

The following section describes how you can configure EVPN Native with Software MAC Learning feature in dual home device in single-active load balancing mode:

Figure 5: Dual Home Device (DHD)—Single-Active Load Balancing

Single-active load balancing also is known as Active/Active per Service (AApS).

Identical ESI are configured on both EVPN PEs. In the CE, separate bundles or independent physical interfaces are configured towards two EVPN PEs. In this mode, the MAC address that is learnt is stored on both PE1 and PE2. Only one PE can forward traffic within the EVI at a given time.

Configure EVPN in Dual Home Device—Single-Active Mode

/* Configure bridge domain. */

```
RP/0/RSP0/CPU0:router(config)# l2vpn
RP/0/RSP0/CPU0:router(config-l2vpn)# bridge group EVPN_ALL_ACTIVE
RP/0/RSP0/CPU0:router(config-l2vpn-bg)# bridge-domain EVPN_2001
RP/0/RSP0/CPU0:router(config-l2vpn-bg-bd)# interface BundleEther1.2001
evi 2001
```
/* Configure VLAN Header Rewrite (Single-tagged sub-interface). */

RP/0/RSP0/CPU0:router# configure
RP/0/RSP0/CPU0:router(config)# interface bundle-Ether1.21 l2transport
RP/0/RSP0/CPU0:router(config-if)# lACP switchover suppress-flaps 300
RP/0/RSP0/CPU0:router(config-if)# exit
RP/0/RSP0/CPU0:router(config)# interface Bundle-Ether1.2001 l2transport
RP/0/RSP0/CPU0:router(config-if)# encapsulation dot1q 10
RP/0/RSP0/CPU0:router(config-if)# rewrite ingress tag pop 1 symmetric

/* Configure advertisement of MAC routes. */

RP/0/RSP0/CPU0:router(config)# evpn
RP/0/RSP0/CPU0:router(config-evpn)# evi 2001
RP/0/RSP0/CPU0:router(config-evpn-evi)# advertise-mac

/* Configure load balancing. */

RP/0/RSP0/CPU0:router(config)# evpn
RP/0/RSP0/CPU0:router(config-evpn)# evi 2001
RP/0/RSP0/CPU0:router(config-evpn-evi)# advertise-mac
RP/0/RSP0/CPU0:router(config-evpn-evi)# exit
RP/0/RSP0/CPU0:router(config-evpn-ac)# Ethernet-segment
RP/0/RSP0/CPU0:router(config-evpn-ac-es)# load-balancing-mode single-active
RP/0/RSP0/CPU0:router(config-evpn-ac-es)# identifier type 0 12.12.00.00.00.00.00.00.02
RP/0/RSP0/CPU0:router(config-evpn-ac-es)# bgp route-target 1212.0000.0002

/* Configure address family session in BGP. */

RP/0/RSP0/CPU0:router# configure
RP/0/RSP0/CPU0:router(config)# router bgp 200
RP/0/RSP0/CPU0:router(config-bgp)# bgp router-id 40.40.40.40
RP/0/RSP0/CPU0:router(config-bgp)# address-family l2vpn evpn
RP/0/RSP0/CPU0:router(config-bgp)# neighbor 10.10.10.10
RP/0/RSP0/CPU0:router(config-bgp-nbr)# remote-as 200
RP/0/RSP0/CPU0:router(config-bgp-nbr)# description MPLSFACING-PEER
RP/0/RSP0/CPU0:router(config-bgp-nbr)# update-source Loopback 0
RP/0/RSP0/CPU0:router(config-bgp-nbr)# address-family l2vpn evpn

Verification

Verify EVPN in dual home devices in Single-Active mode.

RP/0/RSP0/CPU0:router# show evpn ethernet-segment int bundleEther 21 carving detail

...  Ethernet Segment Id Interface Nexthops
----- --------------- --------- ------------
0012.1200.0000.0000.0002 BE21 10.10.10.10 30.30.30.30

ESI type : 0
Value : 12.1200.0000.0000.0002
ES Import RT : 1212.0000.0000 (from ESI)

Source MAC : 0000.0000.0000 (N/A)

Topology :
- Operational : MHN
- Configured : Single-active (AApS)
Primary Services : Auto-selection

14
Verify EVPN Native with Software MAC Learning

Verify the packet drop statistics.

```
RP/0/RSP0/CP00:router# show 12vpn bridge-domain bd-name EVPN_2001 details
```

```
Bridge group: EVPN_ALL_ACTIVE, bridge-domain: EVPN_2001, id: 1110,
state: up, ShgId: 0, MST1: 0
List of EVPNs:
EVPN, state: up
evi: 2001
XC ID 0x80000458
Statistics:
packets: received 28907734874 (unicast 9697466652), sent
76882059953
bytes: received 5550285095808 (unicast 1861913597184), sent
1479978185136
MAC move: 0
List of ACs:
AC: TenGigE0/4/0/10.2001, state is up
... Type VLAN; Num Ranges: 1
... Statistics:
packets: received 0 (multicast 0, broadcast 0, unknown
unicast 0, unicast 0), sent 45573594908
bytes: received 0 (multicast 0, broadcast 0, unknown unicast
0, unicast 0), sent 8750130222336
MAC move: 0
........
```

Verify the EVPN EVI information with the VPN-ID and MAC address filter.

```
RP/0/RSP0/CP00:router# show evpn evi vpn-id 2001 neighbor
```

```
Neighbor IP    vpn-id
------------- ----
20.20.20.20    2001
30.30.30.30    2001
```

Verify the BGP L2VPN EVPN summary.

```
RP/0/RSP0/CP00:router# show bgp 12vpn evpn summary
... Neighor Spk  AS  MagRcvd MagSent TblVer  InQ  OutQ  Up/Down  St/PfxRcd
20.20.20.20  0   200  216739  229871  200781341  0  0  3d00h  348032
30.30.30.30  0   200  6462962 4208831  200781341 10 0  2d22h  35750
```

Verify the MAC updates to the L2FIB table in a line card.

```
RP/0/RSP0/CP00:router# show 12vpn mac mac all location 0/6/CP00
```
Verifying the MAC updates to the L2FIB table in a route switch processor (RSP).

```
RP/0/RSP0/CPU0:router# show l2vpn mac mac all location 0/6/CPU0
```

```
Topo ID  Producer         Next Hop(s)  Mac Address  IP Address
--------  --------  -----------  -------------  --------------
1112      0/6/CPU0      Te0/6/0/1.36001  00a3.0001.0001
```

Verify the summary information for the MAC address.

```
RP/0/RSP0/CPU0:router# show l2vpn forwarding bridge-domain EVPN_ALL_ACTIVE:EVPN_2001
mac-address location 0/6/CPU0
```

```
Mac Address  Type       Learned from/Filtered on  LC learned  Resync Age/Last Change
Mapped to
0000.2001.5555 dynamic  Te0/0/0/2/0.2001  N/A         11 Jan 14:37:22
0000.2001.1111 EVPN      BD id: 1110        N/A         N/A
00a9.2002.0001 EVPN      BD id: 1110        N/A         N/A
```

Verify the EVPN EVI information with the VPN-ID and MAC address filter.

```
RP/0/RSP0/CPU0:router# show evpn evi vpn-id 2001 mac
```

```
EVI  MAC address  IP address  Nexthop  Label
----  ------------  ----------  -------  -----
2001  00a9.2002.0001 ::  10.10.10.10  34226  <-- Remote MAC
2001  00a9.2002.0001 ::  30.30.30.30  34202  <-- local MAC
```

```
RP/0/RSP0/CPU0:router# show evpn evi vpn-id 2001 mac 00a9.2002.0001 detail
```

```
EVI  MAC address  IP address  Nexthop  Label
----  ------------  ----------  -------  -----
2001  00a9.2002.0001 ::  10.10.10.10  34226
2001  00a9.2002.0001 ::  30.30.30.30  34202
```

Ethernet Tag : 0
Multi-paths Resolved : True <--- aliasing to two remote PE with All-Active load balancing

Static : No
Local Ethernet Segment : N/A
Remote Ethernet Segment : 0100.211b.fce5.df00.0b00
Local Sequence Number : N/A
Remote Sequence Number : 0
Local Encapsulation: N/A
Remote Encapsulation: MPLS

Verify the BGP routes associated with EVPN with bridge-domain filter.

```
RP/0/RSP0/CPU0:router# show bgp l2vpn evpn bridge-domain EVPN_2001 route-type 2
*> [2] [0] [48] [00bb.2001.0001] [0] /104
  0.0.0.0 0 i <------ locally learnt MAC
*> i [2] [0] [48] [00a9.2002.00be] [0] /104
  10.10.10.10 100 i <----- remotely learnt MAC
* i 30.30.30.30 100 0 1
```

**EVPN Software MAC Aging**

You can configure MAC aging on a bridge domain to set the maximum aging time for learned MAC addresses. Decrease the aging time when you want to move the hosts to allow the bridge to adapt to the changes quickly. However, in an EVPN network, the data plane and control plane are always synchronized. Furthermore, it is desirable to have a longer aging time for:

- MAC route stability and reliability
- Support for very high scale of MAC routes
- Reliable and consistent accounting without overloading the control plane

For the above-mentioned reasons, when you enable EVPN, maximum MAC aging times are not fully considered for the configured MAC aging values on the bridge domain. Also, it is observed that the aging times can be long, more than 2 hours.

**EVPN VXLAN Layer 2 Data Center Interconnect Gateway**

The Cisco ASR 9000 Series Routers serve as a Data Center Interconnect (DCI) Layer 2 gateway to provide Layer 2 connectivity between EVPN VXLAN based data centers, over a MPLS-based L2VPN network. The data centers are connected through the intermediate service provider network. The EVPN VXLAN enabled data centers use EVPN control plane for distributing Layer 2 forwarding information from one data center to another data center. This feature provides redundancy, resiliency, and ease of provisioning.

The EVPN VXLAN layer 2 DCI gateway feature supports these functions:

- VXLAN access for single homing
- VXLAN access for all-active multi homing with anycast VXLAN Terminal EndPoint (VTEP) IP address
- VXLAN access for all-active multi homing with unique VTEP IP address
- EVPN ESI Multipath with VXLAN encapsulation
All-Active Multi Homing with Anycast VTEP IP Address

The DCIs use the same anycast VTEP IP address for all-active multi-homing with anycast VTEP IP address. Consider the following topology where Top of Racks (ToRs) are connected to the DCIs using multiple paths: The traffic passes from ToRs to the DCIs through multiple physical paths and uses anycast IP address for load balancing. DCI1 and DCI2 advertise MAC routes to ToRs using the same anycast IP address as that of the next-hop. So, the ToR sends the traffic to the same anycast IP address of the DCIs, and uses IGP ECMP for load balancing. A virtual PortChannel (vPC) allows ToR1 and ToR2 to have the same IP configuration. ToR1 and ToR2 advertise MAC routes to DCIs using the same IP address as that of the next-hop. So, the DCI sends the traffic to the same IP address of the ToRs, and uses IGP ECMP for load balancing. The DCI sends the traffic to the remote data center through MPLS forwarding.

Figure 6: All-Active Multi Homing with Anycast VTEP IP Address

All-Active Multi Homing with Unique VTEP IP Address

The DCIs do not share anycast VTEP IP address for all-active multi homing with unique VTEP IP address. Each DCI uses a unique VTEP IP address. Consider the following topology where ToR receives the MAC routes from DCIs. Each MAC route has a unique next-hop. Because both DCI1 and DCI2 advertise routes for the same MAC with different next-hops, ToR has two equal cost next-hops for the same MAC. When ToR sends the traffic to the MAC, ToR load balances the traffic on both next-hops.

Figure 7: All-Active Multi Homing with Unique VTEP IP Address

EVPN ESI Multipath for VxLAN - EVI Based Load balancing

The EVPN Ethernet Segment Identifier (ESI) Multipath feature supports multi-path traffic to active-active dual-homed TORs and DCIs to provide redundant connectivity within the data center. ESI multi paths are discovered by the ASR9k DCI router through EVPN signalling. The path selection is based on Ethernet
Segment Identifier (ESI) and EVPN instance (EVI). To resolve paths for MAC routes received, use Ethernet A-D routes per ES (ES-EAD) and Ethernet A-D routes per EVI (EVI-EAD) as specified in RFC 7432.

Consider the following topology where DCIs receive the MAC routes from ToRs and each MAC route has a next-hop for each ToR. Similarly, DCIs advertise MAC routes with different next-hops to ToRs. When DCI sends the traffic to VM, which is behind a pair of ToRs, there are two paths (ToR) for every MAC. The DCI load balances the traffic on the two paths. The selection of path is based on EVI. For example, DCI1 and DCI2 selects ToR1 for all traffic destined to the MAC address learnt on EVI1; DCI1 and DCI2 selects ToR2 for all traffic destined to the MAC address learnt on EVI2.

**Figure 8: EVPN ESI Multipath**

### EVPN ESI Multipath for VxLAN - Flow-based Load Balancing

The EVPN Ethernet Segment Identifier (ESI) Multipath for VxLAN feature supports flow-based load balancing to forward the traffic between Top of Racks (ToRs) and Data Center Interconnect (DCI), and between the source and remote DCIs. A flow is identified either by the source and destination IP address of the traffic, or the source and destination MAC address of the traffic.

In Release 6.2.1, the default load balancing mode is flow-based. You can change the load balancing mode based on per EVI. See Configure Network Virtualization Endpoint (NVE) Interface, on page 26 task to change the load balancing mode based on per EVI.

In Release 6.1.2, only per EVI-based load balancing was supported. Starting from Release 6.2.1, both flow-based load balancing and per EVI based load balancing are supported. The following table shows the support matrix:

**Table 3: Support Matrix for EVPN ESI Multipath for VxLAN Load Balancing**

<table>
<thead>
<tr>
<th>Line Card</th>
<th>Release 6.1.2</th>
<th>Release 6.2.1</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASR 9000 Enhanced Ethernet Line Card</td>
<td>Supports only per EVI-based load balancing</td>
<td>Supports only per EVI-based load balancing</td>
</tr>
</tbody>
</table>
The unknown unicast flooding on traffic received from VxLAN segment is supported. In Release 6.2.1, by default, the unknown unicast flooding on traffic received from VxLAN segment is enabled. To disable the unknown unicast flooding, use the `suppress-unknown-unicast-flooding` command. See Configure Network Virtualization Endpoint (NVE) Interface, on page 26 task to disable unknown unicast flooding on traffic received from VxLAN segment.

In Release 6.1.2, by default, the unknown unicast flooding on traffic received from VxLAN segment is disabled.

| Table 4: Support Matrix for Unknown Unicast Flooding |

<table>
<thead>
<tr>
<th>Release</th>
<th>Unknown Unicast Flooding</th>
</tr>
</thead>
<tbody>
<tr>
<td>Release 6.1.2</td>
<td>The unknown unicast flooding on traffic received from VxLAN segment is disabled.</td>
</tr>
<tr>
<td>Release 6.2.1</td>
<td>The unknown unicast flooding on traffic received from VxLAN segment is enabled. To disable, use the <code>suppress-unknown-unicast-flooding</code> command.</td>
</tr>
</tbody>
</table>

## Configure EVPN VXLAN Layer 2 Data Center Interconnect Gateway

Perform the following tasks to configure EVPN VXLAN Layer 2 Data Center Interconnect Gateway.

If you want to configure EVPN ESI Multipath feature, do not configure anycast IP address, the remaining configuration tasks remain the same.

## Configure L2 EVPN Address Family under BGP Routing Process

Perform this task to enable EVPN address family under BGP routing process.

### SUMMARY STEPS

1. `configure`
2. `router bgp asn_id`
3. `nsr`
4. `bgp graceful-restart`
5. `bgp router-id ip-address`
6. `address-family l2vpn evpn`
7. Use the `commit` or `end` command.

**DETAILED STEPS**

**Step 1**

Configure

Example:
```
RP/0/RSP0/CPU0:router# configure
```
Enters the global configuration mode.

**Step 2**

`router bgp asn_id`

Example:
```
RP/0/RSP0/CPU0:router(config)# router bgp 100
```
Specifies the BGP AS number and enters the BGP configuration mode, allowing you to configure the BGP routing process.

**Step 3**

`nsr`

Example:
```
RP/0/RSP0/CPU0:router(config-bgp)# nsr
```
Enables non-stop routing.

**Step 4**

`bgp graceful-restart`

Example:
```
RP/0/RSP0/CPU0:router(config-bgp)# bgp graceful-restart
```
Enables graceful restart on the router.

**Step 5**

`bgp router-id ip-address`

Example:
```
RP/0/RSP0/CPU0:router(config-bgp)# bgp router-id 209.165.200.227
```
Configures the router with a specified router ID.

**Step 6**

`address-family l2vpn evpn`

Example:
```
RP/0/RSP0/CPU0:router(config-bgp)# address-family l2vpn evpn
```
Enables EVPN address family globally under BGP routing process and enters EVPN address family configuration submode.

**Step 7**

Use the `commit` or `end` command.

- `commit` - Saves the configuration changes and remains within the configuration session.
- `end` - Prompts user to take one of these actions:
  - `Yes` - Saves configuration changes and exits the configuration session.
Configure the Routing Sessions Between the DCI and ToR

Perform this task to configure the routing sessions between the DCI and ToR.

SUMMARY STEPS

1. `configure`
2. `router bgp asn_id`
3. `neighbor ip-address`
4. `remote-as autonomous-system-number`
5. `ebgp-multihop maximum hop count`
6. `update-source loopback`
7. `address-family l2vpn evpn`
8. `import stitching-rt reoriginate`
9. `route-policy route-policy-name in`
10. `encapsulation-type type`
11. `route-policy route-policy-name out`
12. `advertise l2vpn evpn re-originated stitching-rt`
13. Use the `commit` or `end` command.

DETAILED STEPS

Step 1  
**configure**

**Example:**

```
RP/0/RSP0/CPU0:router# configure
```

Enters the global configuration mode.

Step 2  
**router bgp asn_id**

**Example:**

```
RP/0/RSP0/CPU0:router(config)# router bgp 100
```

Specifies the BGP AS number and enters the BGP configuration mode, allowing you to configure the BGP routing process.

Step 3  
**neighbor ip-address**

**Example:**

```
RP/0/RSP0/CPU0:router(config-bgp)# neighbor 209.165.200.225
```

Places the router in neighbor configuration mode for BGP routing and configures the neighbor IP address 209.165.200.225 as a BGP peer.
Step 4  \texttt{remote-as} \textit{autonomous-system-number}

\textbf{Example:}
\begin{verbatim}
RP/0/RSP0/CPU0:router(config-bgp-nbr)# remote-as 2000
\end{verbatim}

Creates a neighbor and assigns it a remote autonomous system number.

Step 5  \texttt{ebgp-multihop} \textit{maximum hop count}

\textbf{Example:}
\begin{verbatim}
RP/0/RSP0/CPU0:router(config-bgp-nbr)# ebgp-multihop 255
\end{verbatim}

Enables multihop peerings with external BGP neighbors.

Step 6  \texttt{update-source} \textit{loopback}

\textbf{Example:}
\begin{verbatim}
RP/0/RSP0/CPU0:router(config-bgp-nbr)# update-source loopback1
\end{verbatim}

Allows BGP sessions to use the primary IP address from a particular interface as the local address.

Step 7  \texttt{address-family l2vpn evpn}

\textbf{Example:}
\begin{verbatim}
RP/0/RSP0/CPU0:router(config-bgp-nbr)# address-family l2vpn evpn
\end{verbatim}

Configures EVPN address family.

Step 8  \texttt{import stitching-rt reoriginate}

\textbf{Example:}
\begin{verbatim}
RP/0/RSP0/CPU0:router(config-bgp-nbr-af)# import stitching-rt reoriginate
\end{verbatim}

Enables import of routing information from BGP EVPN NLRIs that has route target identifier matching the stitching route target identifier and exports this routing information after re-origination to the L2VPN BGP neighbor.

Step 9  \texttt{route-policy} \textit{route-policy-name in}

\textbf{Example:}
\begin{verbatim}
RP/0/RSP0/CPU0:router(config-bgp-nbr-af)# route-policy pass-all in
\end{verbatim}

Applies the route policy to inbound unicast routes.

Step 10  \texttt{encapsulation-type} \textit{type}

\textbf{Example:}
\begin{verbatim}
RP/0/RSP0/CPU0:router(config-bgp-nbr-af)# encapsulation-type vxlan
\end{verbatim}

Configures VXLAN as encapsulation type.

Step 11  \texttt{route-policy} \textit{route-policy-name out}

\textbf{Example:}
\begin{verbatim}
RP/0/RSP0/CPU0:router(config-bgp-nbr-af)# route-policy pass-all out
\end{verbatim}

Applies the route policy to outbound unicast routes.

Step 12  \texttt{advertise l2vpn evpn re-originated stitching-rt}

\textbf{Example:}
Configure BGP session for remote DCI Connectivity

Perform this task to configure BGP session for remote DCI connectivity.

SUMMARY STEPS

1. configure
2. router bgp asn_id
3. neighbor ip-address
4. remote-as autonomous-system-number
5. update-source loopback
6. address-family l2vpn evpn
7. import re-originate stitching-rt
8. advertise l2vpn evpn re-originated
9. Use the commit or end command.

DETAILED STEPS

Step 1  configure
Example:
RP/0/RSP0/CPU0:router# configure
Enters the global configuration mode.

Step 2  router bgp asn_id
Example:
RP/0/RSP0/CPU0:router(config)# router bgp 200
Specifies the BGP AS number and enters the BGP configuration mode, allowing you to configure the BGP routing process.

Step 3  neighbor ip-address
Configure BGP session for remote DCI Connectivity

Example:
RP/0/RSP0/CPU0:router(config-bgp)# neighbor 209.165.201.1
Places the router in neighbor configuration mode for BGP routing and configures the neighbor IP address 209.165.201.1 as a BGP peer.

Step 4  remote-as autonomous-system-number
Example:
RP/0/RSP0/CPU0:router(config-bgp-nbr)# remote-as 100
Creates a neighbor and assigns it a remote autonomous system number.

Step 5  update-source loopback
Example:
RP/0/RSP0/CPU0:router(config-bgp-nbr)# update-source loopback2
Allows BGP sessions to use the primary IP address from a particular interface as the local address.

Step 6  address-family l2vpn evpn
Example:
RP/0/RSP0/CPU0:router(config-bgp-nbr)# address-family l2vpn evpn
Configures EVPN address family.

Step 7  import re-originate stitching-rt
Example:
RP/0/RSP0/CPU0:router(config-bgp-nbr-af)# import re-originate stitching-rt
Enables import of routing information from BGP EVPN NLRIs that have route target identifier matching the stitching route target identifier, and exports this routing information after re-origination to the L2VPN BGP neighbor.

Step 8  advertise l2vpn evpn re-originated
Example:
RP/0/RSP0/CPU0:router(config-bgp-nbr-af)# advertise l2vpn evpn re-originated
Configures the advertisement of L2VPN EVPN routes to be received from the L2VPN BGP neighbor.

Step 9  Use the commit or end command.

commit - Saves the configuration changes and remains within the configuration session.
end - Prompts user to take one of these actions:

• Yes - Saves configuration changes and exits the configuration session.
• No - Exits the configuration session without committing the configuration changes.
• Cancel - Remains in the configuration mode, without committing the configuration changes.
Configure Network Virtualization Endpoint (NVE) Interface

Perform this task to create an NVE interface and configure it as a VXLAN Tunnel EndPoint (VTEP) for VxLAN.

**SUMMARY STEPS**

1. configure
2. interface nve nve-identifier
3. source-interface loopback loopback-interface-identifier
4. anycast source-interface loopback loopback-interface-identifier
5. redundancy
6. backbone vxlan
7. iccp group group number
8. exit
9. backbone mpls
10. iccp group group number
11. exit
12. exit
13. member vni vni_number
14. load-balance per-evi
15. suppress-unknown-unicast-flooding
16. mcast-group ip_address
17. host-reachability protocol protocol
18. Use the commit or end command

**DETAILED STEPS**

**Step 1**

configure

**Example:**
RP/O/RSP0/CPU0:router# configure

Enters the global configuration mode.

**Step 2**

interface nve nve-identifier

**Example:**
RP/O/RSP0/CPU0:router(config)# interface nve 1

Creates the NVE interface and enters the NVE interface configuration sub-mode.

**Step 3**

source-interface loopback loopback-interface-identifier

**Example:**
RP/O/RSP0/CPU0:router(config-if)# source-interface loopback 1

Sets a loopback interface as the source interface for the VTEP.
Step 4  
**anycast source-interface loopback**  
*loopback-interface-identifier*  
**Example:**  
RP/0/RSP0/CPU0:router(config-if)# anycast source-interface loopback 1  
Configures anycast mode parameters and source interface for the anycast mode.  
Anycast IP address is used for BGP next hop on the fabric side. If you want to configure the ESI multipath feature, do not configure anycast IP address.

Step 5  
**redundancy**  
**Example:**  
RP/0/RSP0/CPU0:router(config-if)# redundancy  
Configures the redundancy path.

Step 6  
**backbone vxlan**  
**Example:**  
RP/0/RSP0/CPU0:router(config-nve-red)# backbone vxlan  
Configures Inter-Chassis Communication Protocol (ICCP) VXLAN backbone.

Step 7  
**iccp group**  
**group number**  
**Example:**  
RP/0/RSP0/CPU0:router(config-nve-red-backbone-vxlan)# iccp group 11  
Configures the ICCP group number.

Step 8  
**exit**  
**Example:**  
RP/0/RSP0/CPU0:router(config-nve-red-backbone-vxlan)# exit  
Exits the backbone-vxlan submode and returns to redundancy submode.

Step 9  
**backbone mpls**  
**Example:**  
RP/0/RSP0/CPU0:router(config-nve-red)# backbone mpls  
Configures ICCP MPLS backbone.

Step 10  
**iccp group**  
**group number**  
**Example:**  
RP/0/RSP0/CPU0:router(config-nve-red-backbone-mpls)# iccp group 12  
Configures ICCP group number for MPLS backbone.

Step 11  
**exit**  
**Example:**  
RP/0/RSP0/CPU0:router(config-nve-red-backbone-mpls)# exit  
Exits the backbone-mpls submode and returns to redundancy submode.

Step 12  
**exit**
Example:
```
RP/0/RSP0/CPU0:router(config-nve-red)# exit
```
Exits the redundancy submode and returns to interface submode.

**Step 13**  
`member vni vni_number`

Example:
```
RP/0/RSP0/CPU0:router(config-nve)# member vni 1
```
Associates a single VxLAN with the NVE interface using the VxLAN Network Identifier (VNI) and specifies a multicast address associated with this VNI.

**Step 14**  
`load-balance per-evi`

Example:
```
RP/0/RSP0/CPU0:router(config-nve-vni)# load-balance per-evi
```
Configures per-evi load balance mode (default is per-flow).

**Step 15**  
`suppress-unknown-unicast-flooding`

Example:
```
RP/0/RSP0/CPU0:router(config-nve-vni)# suppress-unknown-unicast-flooding
```
Configures the suppression of unknown unicast flooding.

**Step 16**  
`mcast-group ip_address`

Example:
```
RP/0/RSP0/CPU0:router(config-nve-vni)# mcast-group 209.165.202.129
```
Specifies a multicast address associated with the VNI.

**Step 17**  
`host-reachability protocol protocol`

Example:
```
RP/0/RSP0/CPU0:router(config-nve-vni)# host-reachability protocol bgp
```
Configures the BGP control protocol for VxLAN tunnel endpoint reachability.

**Step 18**  
Use the `commit` or `end` command

- `commit` - Saves the configuration changes and remains within the configuration session.
- `end` - Prompts user to take one of these actions:
  - Yes - Saves configuration changes and exits the configuration session.
  - No - Exits the configuration session without committing the configuration changes.
  - Cancel - Remains in the configuration mode, without committing the configuration changes.

---

**Configure a Bridge Domain**

Perform the following steps to configure the bridge domain on the DCI Gateway.
SUMMARY STEPS

1. configure
2. l2vpn
3. bridge group bridge-group-name
4. bridge-domain bridge-domain-name
5. evi ethernet vpn id
6. exit
7. member vni vxlan-id
8. Use the commit or end command.

DETAILED STEPS

Step 1 configure
Example:
RP/0/RSP0/CPU0:router# configure
Enters the global configuration mode.

Step 2 l2vpn
Example:
RP/0/RSP0/CPU0:router(config)# l2vpn
Enters the l2vpn configuration mode.

Step 3 bridge group bridge-group-name
Example:
RP/0/RSP0/CPU0:router(config-l2vpn)# bridge group bg1
Enters the bridge group configuration mode.

Step 4 bridge-domain bridge-domain-name
Example:
RP/0/RSP0/CPU0:router(config-l2vpn-bg)# bridge-domain bd1
Enters the bridge domain configuration mode.

Step 5 evi ethernet vpn id
Example:
RP/0/RSP0/CPU0:router(config-l2vpn-bg-bd)# evi 1
Creates the ethernet VPN ID.

Step 6 exit
Example:
RP/0/RSP0/CPU0:router(config-l2vpn-bg-bd-evi)# exit
Exits the EVI configuration mode and returns to bridge domain configuration mode.

Step 7 member vni vxlan-id
Example:
RP/0/RSP0/CPU0:router(config-l2vpn-bd-bd)# member vni 1
Associates a member VNI with the bridge domain.

Step 8
Use the commit or end command.
commit - Saves the configuration changes and remains within the configuration session.
end - Prompts user to take one of these actions:
• Yes - Saves configuration changes and exits the configuration session.
• No - Exits the configuration session without committing the configuration changes.
• Cancel - Remains in the configuration mode, without committing the configuration changes.

Configure BGP Route Targets Import/Export Rules
By default, these parameters are auto-derived from the DCI's configuration:
• Route Distinguisher (RD) for global Ethernet Segment table
Default: Auto-generated RD based on loopback IP address
• EVI’s BGP Route Distinguisher (RD)
Default: Auto-generated RD based on loopback IP address
• EVI’s BGP Route Target. Default: Auto-generated RT based on EVI ID
Perform this task to overwrite the auto-generated BGP RD/RT values and define route targets to be used for import and export of forwarding information.

SUMMARY STEPS
1. configure
2. evpn
3. bgp
4. rd { 2-byte as_number | 4-byte as_number | IP_address | none } : { nn }
5. exit
6. evi evi_id
7. bgp
8. route-target import { 2-byte as_number | 4-byte as_number | IP_address | none } : { nn } [stitching]
9. route-target export { 2-byte as_number | 4-byte as_number | IP_address | none } : { nn } [stitching]
10. Use the commit or end command.

DETAILED STEPS

Step 1 configure
Example:
RP/0/RSP0/CPU0:router# configure
Enters the global configuration mode.

Step 2  evpn

Example:
RP/0/RSP0/CPU0:router(config)# evpn
Enters EVPN configuration mode.

Step 3  bgp

Example:
RP/0/RSP0/CPU0:router(config-evpn)# bgp
Enters EVPN BGP configuration mode and configures static BGP settings for the Ethernet Segment ES:GLOBAL EVI, which is used for handling ES routes.

Step 4  rd  { 2-byte as_number | 4-byte as_number | IP_address | none } : { nn }

Example:
RP/0/RSP0/CPU0:router(config-evpn-bgp)# rd 200:50
Configures the route distinguisher.

Step 5  exit

Example:
RP/0/RSP0/CPU0:router(config-evpn-bgp)# exit
Exits the current configuration mode and returns to evpn submode.

Step 6  evi evi_id

Example:
RP/0/RSP0/CPU0:router(config-evpn)# evi 1
Configures Ethernet VPN ID.
The EVI ID range is from 1 to 65534.

Step 7  bgp

Example:
RP/0/RSP0/CPU0:router(config-evpn-evi)# bgp
Enters the BGP configuration mode for the specific EVI.

Step 8  route-target import  { 2-byte as_number | 4-byte as_number | IP_address | none } : { nn } [stitching]

Example:
RP/0/RSP0/CPU0:router(config-evpn-evi-bgp)# route-target import 101:1 stitching
Configures importing of routes from the L2 EVPN BGP NLRI that have the matching route-target value.

Step 9  route-target export  { 2-byte as_number | 4-byte as_number | IP_address | none } : { mn } [stitching]

Example:
Configure Ethernet Segment Identifier

Perform this task to configure Ethernet Segment Identifier (ESI).

SUMMARY STEPS

1. configure
2. evpn
3. interface nve nve-identifier
4. ethernet-segment
5. identifier type esi-type esi-identifier
6. bgp route-target route target value
7. Use the commit or end command

DETAILED STEPS

Step 1 configure
Example:
RP/0/RSP0/CPU0:router# configure
Enters the global configuration mode.

Step 2 evpn
Example:
RP/0/RSP0/CPU0:router# evpn
Enters EVPN configuration mode.

Step 3 interface nve nve-identifier
Example:
RP/0/RSP0/CPU0:router(config-evpn)# interface nve 1

RP/0/RSP0/CPU0:router(config-evpn-evi-bgp)# route-target export 101:1 stitching

Configures exporting of routes to the L2 EVPN BGP NLRIs and assigns the specified route-target identifiers to the BGP EVPN NLRIs.

Step 10
Use the commit or end command.

commit - Saves the configuration changes and remains within the configuration session.
end - Prompts user to take one of these actions:
• Yes - Saves configuration changes and exits the configuration session.
• No - Exits the configuration session without committing the configuration changes.
• Cancel - Remains in the configuration mode, without committing the configuration changes.

EVPN Features
Create the NVE interface and enters the NVE interface configuration sub-mode.

**Step 4**
- **ethernet-segment**

  **Example:**
  ```
  RP/0/RSP0/CPU0:router(config-evpn-ac)# ethernet-segment
  ```

  Enters the EVPN ethernet-segment configuration mode.

**Step 5**
- **identifier type** `esi-type esi-identifier`

  **Example:**
  ```
  RP/0/RSP0/CPU0:router(config-evpn-ac-es)# identifier type 0 88.00.00.00.00.00.00.00.01
  ```

  Configures Ethernet Segment Identifier.

**Step 6**
- **bgp route-target** `route target value`

  **Example:**
  ```
  RP/0/RSP0/CPU0:router(config-evpn-ac-es)# bgp route-target 8888.0000.0001
  ```

  Configures the BGP import route-target for the Ethernet-Segment.

**Step 7**
- Use the **commit** or **end** command
  
  **commit** - Saves the configuration changes and remains within the configuration session.
  
  **end** - Prompts user to take one of these actions:
  
  - **Yes** - Saves configuration changes and exits the configuration session.
  - **No** - Exits the configuration session without committing the configuration changes.
  - **Cancel** - Remains in the configuration mode, without committing the configuration changes.

---

**Configure ICCP Group**

Perform this task to configure Inter Chassis Communication Protocol (ICCP) parameters.

Configure ICCP group for core interface tracking. If all interfaces are down, the DCI is isolated from the core/fabric network. The associated nve interface is brought down, and BGP NLRIs are withdrawn.

**SUMMARY STEPS**

1. **configure**
2. **redundancy**
3. **iccp group** `group number`
4. **mode singleton**
5. **backbone**
6. **interface GigabitEthernet** `GigabitEthernet Interface Instance`
7. Use the **commit** or **end** command
**DETAILED STEPS**

**Step 1**  configure  
*Example:*  
RP/0/RSP0/CPU0:router# configure  
Enters the global configuration mode.

**Step 2**  redundancy  
*Example:*  
RP/0/RSP0/CPU0:router(config)# redundancy  
Enters redundancy configuration mode.

**Step 3**  iccp group group number  
*Example:*  
RP/0/RSP0/CPU0:router(config-redundancy)# iccp group 11  
Configures ICCP group number.

**Step 4**  mode singleton  
*Example:*  
RP/0/RSP0/CPU0:router(config-redundancy-iccp-group)# mode singleton  
Enables to run the group in singleton mode.

**Step 5**  backbone  
*Example:*  
RP/0/RSP0/CPU0:router(config-redundancy-iccp-group)# backbone  
Configures ICCP backbone interface.

**Step 6**  interface GigabitEthernet GigabitEthernet Interface Instance  
*Example:*  
RP/0/RSP0/CPU0:router(config-redundancy-group-iccp-backbone)# interface GigabitEthernet 0/2/0/12  
Configures GigabitEthernet interface.

**Step 7**  Use the commit or end command  
*commit* - Saves the configuration changes and remains within the configuration session.  
*end* - Prompts user to take one of these actions:  
  • *Yes* - Saves configuration changes and exits the configuration session.  
  • *No* - Exits the configuration session without committing the configuration changes.  
  • *Cancel* - Remains in the configuration mode, without committing the configuration changes.
Enable Flow-based Load Balancing

Perform this task to enable flow-based load balancing.

SUMMARY STEPS

1. configure
2. l2vpn
3. load-balancing flow {src-dst-mac | src-dst-ip}
4. Use the commit or end command.

DETAILED STEPS

Step 1 configure

Example:

RP/0/RSP0/CPU0:router# configure

Enters the Global Configuration mode.

Step 2 l2vpn

Example:

RP/0/RSP0/CPU0:router(config)# l2vpn

Enters the L2VPN configuration mode.

Step 3 load-balancing flow {src-dst-mac | src-dst-ip}

Example:

RP/0/RSP0/CPU0:router(config-l2vpn)# load-balancing flow src-dst-ip

Enables flow-based load balancing.

Step 4 Use the commit or end command.

commit - Saves the configuration changes and remains within the configuration session.

end - Prompts user to take one of these actions:

- Yes - Saves configuration changes and exits the configuration session.
- No - Exits the configuration session without committing the configuration changes.
- Cancel - Remains in the configuration mode, without committing the configuration changes.
Example: All-Active Multi Homing with Anycast VTEP IP Address Configuration

The following example shows the all-active multi homing with anycast VTEP IP address configuration:

```conf
interface nve1
  source-interface loopback1
  anycast source-interface loopback2
    member vni 5100
    mcast-address 239.1.1.1
    host-reachability protocol bgp
  !
  evpn
  evi 10
    bgp
      route-target import 100:10
      route-target import 200:5100 stitching
      route-target export 200:5100 stitching
    !
  l2vpn
    bridge group DCI
    bridge-domain V1
      evpn evi 10
      member vni 5100
    !
  router bgp 100
    bgp router-id 209.165.200.226
    address-family l2vpn evpn
      !
    neighbor 209.165.201.2
      remote-as 100
      description core-facing
      update-source Loopback1
      address-family l2vpn evpn
        import re-originate stitching-rt
        advertise l2vpn evpn re-originated
      !
    neighbor 209.165.202.130
      remote-as 200
      ebgp-multihop 255
      update-source Loopback1
      address-family l2vpn evpn
        import stitching-rt re-originate
        route-policy passall in
        encapsulation-type vxlan
        route-policy passall out
        advertise l2vpn evpn re-originated stitching-rt
      !
```

Example: All-Active Multi Homing with Unique VTEP IP Address Configuration

The following example shows the all-active multi homing with unique VTEP IP address configuration:
interface nve1
    source-interface loopback1
    member vni 5100
    mcast-address 239.1.1.1
    host-reachability protocol bgp

! evpn
    evi 10
    bgp
        route-target import 100:10
        route-target import 200:5100 stitching
        route-target export 200:5100 stitching
!
    l2vpn
        bridge group DCI
        bridge-domain V1
            evpn evi 10
                member vni 5100
        
    ! router bgp 100
        bgp router-id 209.165.200.226
        address-family l2vpn evpn


! neighbor 209.165.201.2
    remote-as 100
    description core-facing
    update-source Loopback1
    address-family l2vpn evpn
        import re-originate stitching-rt multipath
        advertise l2vpn evpn re-originated
!
neighbor 209.165.202.130
    remote-as 200
    ebgp-multihop 255
    update-source Loopback1
    address-family l2vpn evpn
        import stitching-rt re-originate multipath
        route-policy passall in
        encapsulation-type vxlan
        route-policy passall out
        advertise l2vpn evpn re-originated stitching-rt
!

EVPN MPLS Seamless Integration with VPLS

VPLS is a widely-deployed L2VPN technology. As service providers are looking to adopt EVPN on their existing VPLS networks, it is required to provide a mechanism by which EVPN can be introduced without a software upgrade. The EVPN MPLS Seamless Integration with VPLS feature allows EVPN service introduced gradually in the network on a few PE nodes at a time. It eliminates the need to network wide software upgrade at the same time. This feature allows a VPLS service migrated to EVPN service. This feature allows for staged migration where new EVPN sites can be provisioned on existing VPLS enabled PEs. This feature also allows for the co-existence of PE nodes running EVPN and VPLS for the same VPN instance. This allows VPLS or legacy network to be upgraded to the next generation EVPN network without service disruption.
Migrate VPLS Network to EVPN Network through Seamless Integration

In EVPN network, VPN instances are identified by EVPN instance ID (EVI-ID). Similar to other L2VPN technologies, EVPN instances are also associated with route-targets and route-distinguisher. EVPN uses control plane for learning and propagating MAC unlike traditional VPLS, where MAC is learnt in the data plane (learns using "flood and learn technique"). In EVPN, MAC routes are carried by MP-BGP protocol. In EVPN enabled PEs, PEs import the MAC route along with the label to their respective EVPN forwarding table only if their route targets (RTs) match. An EVPN PE router is capable of performing VPLS and EVPN L2 bridging in the same VPN instance. When both EVPN and BGP-AD PW are configured in a VPN instance, the EVPN PEs advertise the BGP VPLS auto-discovery (AD) route as well as the BGP EVPN Inclusive Multicast route (type-3) for a given VPN Instance. Route type-3 referred to as ingress replication multicast route, is used to send broadcast, unknown unicast, and multicast (BUM) traffic. Other remote PEs import type-3 routes for the same VPN instance only if the sending PE RTs match with their configured RT. Thus, at the end of these route-exchanges, EVPN capable PEs discover all other PEs in the VPN instance and their associated capabilities. The type-3 routes used by PE to send its BUM traffic to other PEs ensure that PEs with the same RTs receive the BUM traffic. EVPN advertises the customer MAC address using type-2 route. This feature allows you to upgrade the VPLS PE routers to EVPN one by one and the network works without any service disruption. Consider the following topology where PE1, PE2, PE3, and PE4 are interconnected in a full-meshed network using VPLS PW.

The EVPN service can be introduced in the network one PE node at a time. The VPLS to EVPN migration starts on PE1 by enabling EVPN in a VPN instance of VPLS service. As soon as EVPN is enabled, PE1 starts advertising EVPN inclusive multicast route to other PE nodes. Since PE1 does not receive any inclusive multicast routes from other PE nodes, VPLS pseudo wires between PE1 and other PE nodes remain up. PE1 keeps forwarding traffic using VPLS pseudo wires. At the same time, PE1 advertises all MAC address learned from CE1 using EVPN route type-2. In the second step, EVPN is enabled in PE3. PE3 starts advertising inclusive multicast route to other PE nodes. Both PE1 and PE3 discover each other through EVPN routes. As a result, PE1 and PE3 shut down the pseudo wires between them. EVPN service replaces VPLS service between PE1 and PE3. At this stage, PE1 keeps running VPLS service with PE2 and PE4. It starts EVPN service with PE3 in the same VPN instance. This is called EVPN seamless integration with VPLS. The VPLS to EVPN migration then continues to remaining PE nodes. In the end, all four PE nodes are enabled with EVPN service. VPLS service is completely replaced with EVPN service in the network. All VPLS pseudo wires are shut down.

Configure EVPN on the Existing VPLS Network

Perform the following tasks to configure EVPN on the existing VPLS network.

- Configure L2VPN EVPN address-family
Configure EVI and corresponding BGP route-targets under EVPN configuration mode

Configure EVI under a bridge-domain

See EVI Configuration under L2VPN Bridge-Domain, on page 45 section for how to migrate various VPLS-based network to EVPN.

**Configure L2 EVPN Address-Family**

Perform this task to enable EVPN address family under both BGP and participating neighbor.

**SUMMARY STEPS**

1. `configure`
2. `router bgp asn_id`
3. `nsr`
4. `bgp graceful-restart`
5. `bgp router-id ip-address`
6. `address-family l2vpn evpn`
7. `exit`
8. `neighbor ip-address`
9. `remote-as autonomous-system-number`
10. `update-source loopback`
11. `address-family l2vpn evpn`
12. Use the `commit` or `end` command.

**DETAILED STEPS**

**Step 1**

**Example:**

```
RP/0/RSP0/CPU0:router# configure
```

Enters the global configuration mode.

**Step 2**

`router bgp asn_id`

**Example:**

```
RP/0/RSP0/CPU0:router(config)# router bgp 65530
```

Specifies the BGP AS number and enters the BGP configuration mode, allowing you to configure the BGP routing process.

**Step 3**

`nsr`

**Example:**

```
RP/0/RSP0/CPU0:router(config-bgp)# nsr
```

Enables non-stop routing.

**Step 4**

`bgp graceful-restart`

**Example:**

```
Configure L2 EVPN Address-Family

RP/0/RSP0/CPU0:router(config-bgp)# bgp graceful-restart
Enables graceful restart on the router.

Step 5  
**bgp router-id** *ip-address*

**Example:**
RP/0/RSP0/CPU0:router(config-bgp)# bgp router-id 200.0.1.1
Configures the router with a specified router ID.

Step 6  
**address-family** l2vpn evpn

**Example:**
RP/0/RSP0/CPU0:router(config-bgp)# address-family l2vpn evpn
Enables EVPN address family globally under BGP routing process and enters EVPN address family configuration submode.

Step 7  
**exit**

**Example:**
RP/0/RSP0/CPU0:router(config-bgp-af)# exit
Exits the current configuration mode.

Step 8  
**neighbor** *ip-address*

**Example:**
RP/0/RSP0/CPU0:router(config-bgp)# neighbor 200.0.4.1
Places the router in neighbor configuration mode for BGP routing and configures the neighbor IP address 200.0.4.1 as a BGP peer.

Step 9  
**remote-as** *autonomous-system-number*

**Example:**
RP/0/RSP0/CPU0:router(config-bgp-nbr)# remote-as 65530
Creates a neighbor and assigns it a remote autonomous system number.

Step 10  
**update-source** *loopback*

**Example:**
RP/0/RSP0/CPU0:router(config-bgp-nbr)# update-source Loopback0
Allows BGP sessions to use the primary IP address from a particular interface as the local address.

Step 11  
**address-family** l2vpn evpn

**Example:**
RP/0/RSP0/CPU0:router(config-bgp-nbr)# address-family l2vpn evpn
Enables EVPN address family globally under BGP routing process and enters EVPN address family configuration submode.

Step 12  
Use the **commit** or **end** command.

**commit** - Saves the configuration changes and remains within the configuration session.

**end** - Prompts user to take one of these actions:
- Yes - Saves configuration changes and exits the configuration session.
- No - Exits the configuration session without committing the configuration changes.
- Cancel - Remains in the configuration mode, without committing the configuration changes.

**Configure EVI and Corresponding BGP Route Targets under EVPN Configuration Mode**

Perform this task to configure EVI and define the corresponding BGP route targets. Also, configure advertise-mac, else the MAC routes (type-2) are not advertised.

**SUMMARY STEPS**

1. configure
2. evpn
3. evi evi_id
4. bgp
5. table-policy policy name
6. route-target import { 2-byte as_number | 4-byte as_number | IP_address | none } : { nn }
7. route-target export { 2-byte as_number | 4-byte as_number | IP_address | none } : { nn }
8. exit
9. advertise-mac
10. Use the commit or end command.

**DETAILED STEPS**

**Step 1**

`configure`

**Example:**

```
RP/0/RSP0/CPU0:router# configure
```

Enters the global configuration mode.

**Step 2**

`evpn`

**Example:**

```
RP/0/RSP0/CPU0:router(config)# evpn
```

Enters EVPN configuration mode.

**Step 3**

`evi evi_id`

**Example:**

```
RP/0/RSP0/CPU0:router(config-evpn)# evi 1
```

Configures Ethernet VPN ID.

The EVI ID range is from 1 to 65534.

**Step 4**

`bgp`

**Example:**
**Step 5**  
**table-policy** *policy name*

**Example:**
```sh
RP/0/RSP0/CPU0:router(config-evpn-evi-bgp)# table-policy spp-basic-6
```

Configures policy for installation of forwarding data to L2FIB.

The EVI ID range is from 1 to 65534.

**Step 6**  
**route-target import**  
{ 2-byte as_number | 4-byte as_number | IP_address | none } : { nn }

**Example:**
```sh
RP/0/RSP0/CPU0:router(config-evpn-evi-bgp)# route-target import 100:6005
```

Configures importing of routes from the L2 EVPN BGP NLRI that have the matching route-target value.

**Step 7**  
**route-target export**  
{ 2-byte as_number | 4-byte as_number | IP_address | none } : { nn }

**Example:**
```sh
RP/0/RSP0/CPU0:router(config-evpn-evi-bgp)# route-target export 100:6005
```

Configures exporting of routes to the L2 EVPN BGP NLRIs and assigns the specified route-target identifiers to the BGP EVPN NLRIs.

**Step 8**  
**exit**

**Example:**
```sh
RP/0/RSP0/CPU0:router(config-evpn-evi-bgp)# exit
```

Exits the current configuration mode.

**Step 9**  
**advertise-mac**

**Example:**
```sh
RP/0/RSP0/CPU0:router(config-evpn-evi)# advertise-mac
```

Advertises MAC route (type-2).

**Step 10**  
Use the **commit** or **end** command.

**commit** - Saves the configuration changes and remains within the configuration session.

**end** - Prompts user to take one of these actions:

- **Yes** - Saves configuration changes and exits the configuration session.
- **No** - Exits the configuration session without committing the configuration changes.
- **Cancel** - Remains in the configuration mode, without committing the configuration changes.

**Example:**

Every participating EVPN instances are identified by EVI_ID. EVI_ID must be defined under EVPN configuration mode as shown below.
Configure EVI under a Bridge Domain

Perform this task to configure EVI under the corresponding L2VPN bridge domain.

**SUMMARY STEPS**

1. configure
2. l2vpn
3. bridge group bridge group name
4. bridge-domain bridge-domain name
5. interface type interface-path-id
6. exit
7. vfi { vfi name }
8. neighbor { A.B.C.D } { pw-id value }
9. mpls static label local label remote label
10. Use the commit or end command.

**DETAILED STEPS**

---

Step 1  configure

**Example:**

```
RP/0/RSP0/CPU0:router# configure
```

Enters the global configuration mode.

Step 2  l2vpn

**Example:**

```
RP/0/RSP0/CPU0:router(config)# l2vpn
```

Enters the L2VPN configuration mode.

Step 3  bridge group bridge group name

**Example:**

```
RP/0/RSP0/CPU0:router(config-l2vpn)# bridge group bg1
```

Creates a bridge group so that it can contain bridge domains and then assigns network interfaces to the bridge domain.

Step 4  bridge-domain bridge-domain name
Configure EVI under a Bridge Domain

Example:

RP/0/RSP0/CPU0:router(config-l2vpn-bg)# bridge-domain bd1

Establishes a bridge domain and enters L2VPN bridge group bridge domain configuration mode.

Step 5

interface type interface-path-id

Example:

RP/0/RSP0/CPU0:router(config-l2vpn-bg-bd)# interface GigabitEthernet0/2/0/0.1

Enters interface configuration mode and adds an interface to a bridge domain that allows packets to be forwarded and received from other interfaces that are part of the same bridge domain.

Step 6

exit

Example:

RP/0/RSP0/CPU0:router(config-l2vpn-bg-bd-ac)# exit

Exits the current configuration mode.

Step 7

vfi { vfi name }

Example:

RP/0/RSP0/CPU0:router(config-l2vpn-bg-bd)# vfi v1

Configures virtual forwarding interface (VFI) parameters and enters L2VPN bridge group bridge domain VFI configuration mode.

Step 8

neighbor { A.B.C.D } { pw-id value }

Example:

RP/0/RSP0/CPU0:router(config-l2vpn-bg-bd-vfi)# neighbor 10.1.1.2 pw-id 1000

Adds an access pseudowire port to a bridge domain or a pseudowire to a bridge virtual forwarding interface (VFI).

- Use the A.B.C.D argument to specify the IP address of the cross-connect peer.
- Use the pw-id keyword to configure the pseudowire ID and ID value. The range is 1 to 4294967295.

Step 9

mpls static label local label remote label

Example:

RP/0/RSP0/CPU0:router(config-l2vpn-bg-bd-vfi-pw)# mpls static label local 20001 remote 10001

Configures the MPLS static local label to associate a remote label with a pseudowire or any other bridge interface.

Step 10

Use the commit or end command.

commit - Saves the configuration changes and remains within the configuration session.
end - Prompts user to take one of these actions:
EVI Configuration under L2VPN Bridge-Domain

The following examples show EVI configuration under L2VPN bridge-domain for various VPLS-based network:

**MPLS static labels based VPLS**

```conf
l2vpn
  bridge group bg1
  bridge-domain bd-1-1
    interface GigabitEthernet0/2/0/0.1
      vfi vfi-1-1
        neighbor 200.0.2.1 pw-id 1200001
          mpls static label local 20001 remote 10001
        neighbor 200.0.3.1 pw-id 1300001
          mpls static label local 30001 remote 10001
        neighbor 200.0.4.1 pw-id 1400001
          mpls static label local 40001 remote 10001
      !
    evi <VPN-ID>
  !
```

**AutoDiscovery BGP and BGP Signalling based VPLS**

```conf
l2vpn
  bridge group bg1
  bridge-domain bd-1-2
    interface GigabitEthernet0/2/0/0.2
      vfi vfi-1-2
        vpn-id 2
        autodiscovery bgp
          rd 101:2
          route-target 65530:200
          signaling-protocol bgp
            ve-id 11
            ve-range 16
        !
    evi <VPN-ID>
  !
```

**AutoDiscovery BGP and LDP signaling based VPLS**

```conf
l2vpn
  bridge group bg1
  bridge-domain bd-1-3
    interface GigabitEthernet0/2/0/0.3
      vfi vfi-1-3
        vpn-id 3
```
autodiscovery bgp
rd 101:3
route-target 65530:300
signaling-protocol ldp
vpls-id 65530:3
!
!
ev <VPN-ID>
!

Targeted LDP based VPLS

bridge-domain bd-1-4
interface GigabitEthernet0/2/0/0.4
!
vfi vfi-1-4
neighbor 200.0.2.1 pw-id 1200004
!
neighbor 200.0.3.1 pw-id 1300004
!
neighbor 200.0.4.1 pw-id 1400004
!
ev <VPN-ID>
!

Verify EVPN Configuration

Verify EVPN configuration and MAC advertisement.

Verify EVPN status, AC status, and VFI status

RP/0/#show l2vpn bridge-domain bd-name bd-1-1
Mon Feb 20 21:03:40.244 EST
Legend: pp = Partially Programmed.
Bridge group: bg1, bridge-domain: bd-1-1, id: 0, state: up, ShgId: 0, MSTi: 0
Aging: 300 s, MAC limit: 4000, Action: none, Notification: syslog
Filter MAC addresses: 0
ACs: 1 (1 up), VFIs: 1, PWS: 3 (2 up), PBBs: 0 (0 up), VNIs: 0 (0 up)
List of EVPNs:
EVVPN, state: up
List of ACs:
Gi0/2/0/0.1, state: up, Static MAC addresses: 0, MSTi: 2
List of Access PWS:
List of VFIs:
VFI vfi-1-1 (up)
Neighbor 200.0.2.1 pw-id 1200001, state: up, Static MAC addresses: 0
Neighbor 200.0.3.1 pw-id 1300001, state: down, Static MAC addresses: 0
Neighbor 200.0.4.1 pw-id 1400001, state: up, Static MAC addresses: 0
List of Access VFIs:
When PEs are evpn enabled, pseudowires that are associated with that BD will be brought
down. The VPLS BD pseudowires are always up.

Verify the number of EVI’s configured, local and remote MAC-routes that are advertised.

RP/0/#show evpn summary
Mon Feb 20 21:05:16.755 EST
-------------------------------
Global Information
-------------------------------
Number of EVIs : 6
Number of Local EAD Entries : 0
Number of Remote EAD Entries : 0
Number of Local MAC Routes : 4
MAC : 4
MAC-IPv4 : 0
MAC-IPv6 : 0
Number of Local ES:Global MAC : 1
Number of Remote MAC Routes : 0
MAC : 0
MAC-IPv4 : 0
MAC-IPv6 : 0
Number of Remote SOO MAC Routes : 0
Number of Local IMCAST Routes : 4
Number of Remote IMCAST Routes : 4
Number of Internal Labels : 0
Number of ES Entries : 1
Number of Neighbor Entries : 4
EVPN Router ID : 200.0.1.1
BGP ASN : 65530
PBB BSA MAC address : 0026.982b.c1e5
Global peering timer : 3 seconds
Global recovery timer : 30 seconds

Verify EVPN route-targets.

```
RP/0/# show bgp rt l2vpn evpn
Mon Feb 20 21:06:18.882 EST
EXTCOMM IMP/EXP
RT:65530:1 1 / 1
RT:65530:2 1 / 1
RT:65530:3 1 / 1
RT:65530:4 1 / 1
Processed 4 entries
```

Locally learnt MAC routes can be viewed by forwarding table
```
show l2vpn forwarding bridge-domain mac-address location 0/0/cpu0
```
To Resynchronize MAC table from the Network Processors, use the command...
```
l2vpn resynchronize forwarding mac-address-table location <r/s/i>
```

<table>
<thead>
<tr>
<th>Mac Address</th>
<th>Type</th>
<th>Learned from/Filtered on</th>
<th>LC learned</th>
<th>Resync Age/Last Change</th>
<th>Mapped</th>
</tr>
</thead>
<tbody>
<tr>
<td>0033.0000.0001</td>
<td>dynamic Gi0/2/0/0.1</td>
<td>N/A</td>
<td>20 Feb 21:06:59</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>0033.0000.0002</td>
<td>dynamic Gi0/2/0/0.2</td>
<td>N/A</td>
<td>20 Feb 21:06:59</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>0033.0000.0003</td>
<td>dynamic Gi0/2/0/0.3</td>
<td>N/A</td>
<td>20 Feb 21:04:29</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>0033.0000.0004</td>
<td>dynamic Gi0/2/0/0.4</td>
<td>N/A</td>
<td>20 Feb 21:06:59</td>
<td>N/A</td>
<td></td>
</tr>
</tbody>
</table>

The remote routes learned via evpn enabled BD
```
show l2vpn forwarding bridge-domain mac-address location 0/0$
```
To Resynchronize MAC table from the Network Processors, use the command...
```
l2vpn resynchronize forwarding mac-address-table location <r/s/i>
```

<table>
<thead>
<tr>
<th>Mac Address</th>
<th>Type</th>
<th>Learned from/Filtered on</th>
<th>LC learned</th>
<th>Resync Age/Last Change</th>
<th>Mapped</th>
</tr>
</thead>
<tbody>
<tr>
<td>0033.0000.0001</td>
<td>EVPN BD id: 0</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>0033.0000.0002</td>
<td>EVPN BD id: 1</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>0033.0000.0003</td>
<td>EVPN BD id: 2</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>0033.0000.0004</td>
<td>EVPN BD id: 3</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td></td>
</tr>
</tbody>
</table>
Verify EVPN MAC routes pertaining to specific VPN instance.

```
RP/0/# show evpn evi vpn-id 1 mac
Mon Feb 20 21:36:23.574 EST
EVI MAC address IP address Nexthop
Label
---------- -------------- ----------------------------------------
----------
1 0033.0000.0001 :: 200.0.1.1 45106
```

Verify L2 routing.

```
RP/0/# show l2route evpn mac all
Mon Feb 20 21:39:43.953 EST
Topo ID Mac Address Prod Next Hop(s)
-------- -------------- ------ ----------------------------------------
0 0033.0000.0001 L2VPN 200.0.1.1/45106/ME
1 0033.0000.0002 L2VPN 200.0.1.1/45108/ME
2 0033.0000.0003 L2VPN 200.0.1.1/45110/ME
3 0033.0000.0004 L2VPN 200.0.1.1/45112/ME
```

Verify EVPN route-type 2 routes.

```
RP/0/# show bgp l2vpn evpn route-type 2
Mon Feb 20 21:43:23.616 EST
BGP router identifier 200.0.3.1, local AS number 65530
BGP generic scan interval 60 secs
Non-stop routing is enabled
BGP table state: Active
Table ID: 0x0 RD version: 0
BGP main routing table version 21
BGP NSR Initial initstate version 1 (Reached)
BGP NSR/ISSU Sync-Group versions 0/0
BGP scan interval 60 secs
Status codes: s suppressed, d damped, h history, * valid, > best
Origin codes: i - IGP, e - EGP, ? - incomplete
Network Next Hop Metric LocPrf Weight Path
Route Distinguisher: 200.0.1.1:1
*>i[2][0][48][0033.0000.0001][0]/104
  200.0.1.1 100 0 i
Route Distinguisher: 200.0.1.1:2
*>i[2][0][48][0033.0000.0002][0]/104
  200.0.1.1 100 0 i
Route Distinguisher: 200.0.1.1:3
*>i[2][0][48][0033.0000.0003][0]/104
  200.0.1.1 100 0 i
Route Distinguisher: 200.0.1.1:4
*>i[2][0][48][0033.0000.0004][0]/104
  200.0.1.1 100 0 i
Route Distinguisher: 200.0.3.1:1 (default for vrf bd-1-1)
*>i[2][0][48][0033.0000.0001][0]/104
  200.0.1.1 100 0 i
Route Distinguisher: 200.0.3.1:2 (default for vrf bd-1-2)
*>i[2][0][48][0033.0000.0002][0]/104
  200.0.1.1 100 0 i
Route Distinguisher: 200.0.3.1:3 (default for vrf bd-1-3)
```
Verify inclusive multicast routes and route-type 3 routes.

RP/0/1 # show bgp l2vpn evpn route-type 3
Mon Feb 20 21:43:33.970 EST
BGP router identifier 200.0.3.1, local AS number 65530
BGP generic scan interval 60 secs
Non-stop routing is enabled
BGP table state: Active
Table ID: 0x0 RD version: 0
BGP main routing table version 21
BGP MSR Initial init-sync version 1 (Reached)
BGP NSR/ISSU Sync-Group versions 0/0
BGP scan interval 60 secs

Status codes: s suppressed, d damped, h history, * valid, > best
              i - internal, r RIB-failure, S stale, N Nexthop-discard
Origin codes: i - IGP, e - EGP, ? - incomplete

+--------------------------------+----------------+----------+----------+-------------+----------------+----------------+----------+----------+
| Network                         | Next Hop       | Metric   | LocPrf   | Weight     | Path           | Route Distinguisher       |
+--------------------------------+----------------+----------+----------+-------------+----------------+----------------+----------+----------+
| Route Distinguisher: 200.0.1.1:1| 200.0.1.1       | 100      | 0        | i           |                | >i[3][0][32]200.0.1.1/80|
| Route Distinguisher: 200.0.1.1:2| 200.0.1.1       | 100      | 0        | i           |                | >i[3][0][32]200.0.1.1/80|
| Route Distinguisher: 200.0.1.1:3| 200.0.1.1       | 100      | 0        | i           |                | >i[3][0][32]200.0.1.1/80|
| Route Distinguisher: 200.0.1.1:4| 200.0.1.1       | 100      | 0        | i           |                | >i[3][0][32]200.0.1.1/80|
| Route Distinguisher: 200.0.3.1:1| 200.0.1.1       | 100      | 0        | i           |                | >[3][0][32]200.0.3.1/80|
| Route Distinguisher: 200.0.3.1:2| 200.0.1.1       | 100      | 0        | i           |                | >[3][0][32]200.0.3.1/80|
| Route Distinguisher: 200.0.3.1:3| 200.0.1.1       | 100      | 0        | i           |                | >[3][0][32]200.0.3.1/80|
| Route Distinguisher: 200.0.3.1:4| 200.0.1.1       | 100      | 0        | i           |                | >[3][0][32]200.0.3.1/80|
EVPN Single-Active Multi-Homing

The EVPN Single-Active Multi-Homing feature supports single-active redundancy mode. In single-active mode, the PE nodes locally connected to an Ethernet Segment load balance traffic to and from the Ethernet Segment based on EVPN service instance (EVI). Within an EVPN service instance, only one PE forwards traffic to and from the Ethernet Segment.

Figure 10: EVPN: Single-Active Multi-Homing

Here is a topology in which CE1 is multihomed to PE1 and PE2. PE1 and PE2 are connected to PE3 through MPLS core. CE3 is connected to PE3 through an Ethernet interface bundle. PE1 and PE2 advertise Type 4 routes, and then do designated forwarder (DF) election. The non-DF blocks the traffic in both the directions in single-active mode.

Consider a traffic flow from CE1 to CE2. CE1 sends an address resolution protocol (ARP) broadcast request to both PE1 and PE2. If PE1 is the designated forwarder for the EVI, PE1 forwards the ARP request from CE1. PE2 drops the traffic from CE1. Thereafter, all the unicast traffic is sent through PE1. PE2 will be stand-by or blocked. Traffic is not sent over this path. PE1 advertises MAC to PE3. PE3 always sends and receives traffic through PE1. PE3 sends the traffic to CE2 over Ethernet interface bundle.

Configure EVPN Single-Active Multi-Homing

Perform the following tasks on PE1 and PE2 to configure EVPN Single-Active Multi-Homing feature:

Configuring EVPN Ethernet Segment

Perform this task to configure the EVPN Ethernet segment.

SUMMARY STEPS

1. configure
2. evpn
3. (Optional) timers
4. (Optional) peering seconds
5. (Optional) recovery seconds
6. exit
7. interface Bundle-Ether bundle-id
8. ethernet-segment
9. identifier type esi-type esi-identifier
10. load-balancing-mode single-active
11. bgp route-target ipv4/v6-address
12. (Optional) service-carving manual primary {isid} secondary {isid}
13. exit
14. exit
15. (Optional) mac-flush mvrp
16. (Optional) timers
17. (Optional) peering seconds
18. (Optional) recovery seconds
19. Use the commit or end command.

DETAILED STEPS

Step 1  configure
Example:

RP/0/RSP0/CPU0:router# configure

Enters the Global Configuration mode.

Step 2  evpn
Example:

RP/0/RSP0/CPU0:router(config)# evpn

Enters EVPN configuration mode.

Step 3  (Optional) timers
Example:

RP/0/RSP0/CPU0:router(config-evpn)# timers

Configures global EVPN timers.

Step 4  (Optional) peering seconds
Example:

RP/0/RSP0/CPU0:router(config-evpn-timers)# peering 15

Configures the global peering timer. Default is 3 seconds. Range is 0 to 300 seconds.

Step 5  (Optional) recovery seconds
Example:

RP/0/RSP0/CPU0:router(config-evpn-timers)# recovery 30

Configures the global recovery timer. Default is 30 seconds. Range is 20 to 3600 seconds.

Step 6  exit
Example:
RP/0/RSP0/CPU0:router(config-evpn-timers)# exit

Exits the current configuration mode.

Step 7 interface Bundle-Ether bundle-id
Example:
RP/0/RSP0/CPU0:router(config-evpn)# interface Bundle-Ether1

Enters bundle interface configuration mode.

Step 8 ethernet-segment
Example:
RP/0/RSP0/CPU0:router(config-evpn-ac)# ethernet-segment

Enters the EVPN ethernet-segment configuration mode.

Step 9 identifier type esi-type esi-identifier
Example:
RP/0/RSP0/CPU0:router(config-evpn-ac-es)# identifier type 0 40.00.00.00.00.00.00.00.01

Configures the Ethernet segment identifier (ESI) of an interface.

Step 10 load-balancing-mode single-active
Example:
RP/0/RSP0/CPU0:router(config-evpn-ac-es)# load-balancing-mode single-active

Specifies the load balancing mode.

Step 11 bgp route-target ipv4/v6-address
Example:
RP/0/RSP0/CPU0:router(config-evpn-ac-es)# bgp route-target 4000.0000.0001

Configures the BGP Import Route-Target for the Ethernet-Segment.

Step 12 (Optional) service-carving manual primary {isid} secondary {isid}
Example:
RP/0/RSP0/CPU0:router(config-evpn-ac-es)# service-carving manual primary 100 secondary 200

Specifies a list of service identifiers (isid) as active and standby services. The isid range is from 256 to 16777216.
Step 13  
exit
Example:

```
RP/0/RSP0/CPU0:router(config-evpn-ac-es-man)# exit
```

Exits the current configuration mode.

Step 14  
exit
Example:

```
RP/0/RSP0/CPU0:router(config-evpn-ac-es)# exit
```

Exits the current configuration mode.

Step 15  
(Optional) mac-flush mvrp
Example:

```
RP/0/RSP0/CPU0:router(config-evpn-ac)# mac-flush mvrp
```

Specifies MAC flush mode for this Ethernet Segment.

Step 16  
(Optional) timers
Example:

```
RP/0/RSP0/CPU0:router(config-evpn-ac)# timers
```

Configures per Ethernet segment timers.

Step 17  
(Optional) peering seconds
Example:

```
RP/0/RSP0/CPU0:router(config-evpn-ac-timers)# peering 15
```

Configures the interface specific peering timer. Default is 3 seconds. Range is 0 to 300 seconds.

Step 18  
(Optional) recovery seconds
Example:

```
RP/0/RSP0/CPU0:router(config-evpn-ac-timers)# recovery 30
```

Configures the interface specific recovery timer. Default is 30 seconds. Range is 20 to 3600 seconds.

Step 19  
Use the commit or end command.

commit - Saves the configuration changes and remains within the configuration session.

end - Prompts user to take one of these actions:

- Yes - Saves configuration changes and exits the configuration session.
- No - Exits the configuration session without committing the configuration changes.
Configure EVPN Service Instance (EVI) Parameters

Perform this task to define EVPN service instance (EVI) parameters.

**SUMMARY STEPS**

1. configure
2. evpn
3. evi evi_id
4. bgp
5. (Optional) rd { 2-byte as_number | 4-byte as_number | IP_address | none } : \{ nn \}
6. (Optional) route-target import { 2-byte as_number | 4-byte as_number | IP_address | none } : \{ nn \}
7. (Optional) route-target export { 2-byte as_number | 4-byte as_number | IP_address | none } : \{ nn \}
8. exit
9. advertise-mac
10. Use the commit or end command.

**DETAILED STEPS**

**Step 1**

configure

**Example:**

RP/0/RSP0/CPU0:router# configure

Enters the global configuration mode.

**Step 2**

evpn

**Example:**

RP/0/RSP0/CPU0:router(config)# evpn

Enters EVPN configuration mode.

**Step 3**

evi evi_id

**Example:**

RP/0/RSP0/CPU0:router(config-evpn)# evi 6005

Configures Ethernet VPN ID.

The EVI ID range is from 1 to 65534.

**Step 4**

bgp

**Example:**

RP/0/RSP0/CPU0:router(config-evpn-evi)# bgp

Enters the BGP configuration mode for the specific EVI.
**Step 5** (Optional) \( \text{rd} \{ 2\text{-byte as}\_\text{number} \mid 4\text{-byte as}\_\text{number} \mid \text{IP}\_\text{address} \mid \text{none} \} : \{ \text{nn} \} \)

**Example:**

```
RP/0/RSP0/CPU0:router(config-evpn-evi-bgp)# rd 200:50
```

Configures the route distinguisher.

**Step 6** (Optional) \( \text{route-target import} \{ 2\text{-byte as}\_\text{number} \mid 4\text{-byte as}\_\text{number} \mid \text{IP}\_\text{address} \mid \text{none} \} : \{ \text{nn} \} \)

**Example:**

```
RP/0/RSP0/CPU0:router(config-evpn-evi-bgp)# route-target import 100:6005
```

Configures importing of routes from the L2 EVPN BGP NLRI that have the matching route-target value.

**Step 7** (Optional) \( \text{route-target export} \{ 2\text{-byte as}\_\text{number} \mid 4\text{-byte as}\_\text{number} \mid \text{IP}\_\text{address} \mid \text{none} \} : \{ \text{nn} \} \)

**Example:**

```
RP/0/RSP0/CPU0:router(config-evpn-evi-bgp)# route-target export 100:6005
```

Configures exporting of routes to the L2 EVPN BGP NLRIs and assigns the specified route-target identifiers to the BGP EVPN NLRIs.

**Step 8** \( \text{exit} \)

**Example:**

```
RP/0/RSP0/CPU0:router(config-evpn-evi-bgp)# exit
```

Exits the current configuration mode.

**Step 9** \( \text{advertise-mac} \)

**Example:**

```
RP/0/RSP0/CPU0:router(config-evpn-evi)# advertise-mac
```

Advertises the MAC route.

**Step 10** Use the \texttt{commit} or \texttt{end} command.

- \texttt{commit} - Saves the configuration changes and remains within the configuration session.
- \texttt{end} - Prompts user to take one of these actions:
  - \texttt{Yes} - Saves configuration changes and exits the configuration session.
  - \texttt{No} - Exits the configuration session without committing the configuration changes.
  - \texttt{Cancel} - Remains in the configuration mode, without committing the configuration changes.

---

**Configure Layer 2 Interface**

Perform this task to define Layer 2 interface.

**SUMMARY STEPS**

1. \texttt{configure}
2. `interface bundle-ether instance.subinterface l2transport`
3. (Optional) `no shut`
4. `encapsulation dot1q vlan-id`
5. (Optional) `rewrite tag pop dot1q vlan-id symmetric`
6. Use the `commit` or `end` command.

**DETAILED STEPS**

**Step 1**  
**configure**  
**Example:**  
RP/0/RSP0/CPU0:router# configure  
Enters the global configuration mode.

**Step 2**  
`interface bundle-ether instance.subinterface l2transport`  
**Example:**  
RP/0/RSP0/CPU0:router(config)# interface bundle-ether2.1 l2transport  
Configures the bundle ethernet interface and enables Layer 2 transport mode on the bundle ethernet interface.

**Step 3**  
(Optional) `no shut`  
**Example:**  
RP/0/RSP0/CPU0:router(config-subif-l2)# no shut  
If a link is in the down state, bring it up. The `no shut` command returns the link to an up or down state depending on the configuration and state of the link.

**Step 4**  
`encapsulation dot1q vlan-id`  
**Example:**  
RP/0/RSP0/CPU0:router(config-subif-l2)# encapsulation dot1q 1  
Assigns a VLAN attachment circuit to the subinterface.

**Step 5**  
(Optional) `rewrite tag pop dot1q vlan-id symmetric`  
**Example:**  
RP/0/RSP0/CPU0:router(config-subif-l2)# rewrite ingress tag pop 1 symmetric  
Specifies the encapsulation adjustment that is to be performed on the frame ingress to the service instance.

**Step 6**  
Use the `commit` or `end` command.  
- `commit` - Saves the configuration changes and remains within the configuration session.  
- `end` - Prompts user to take one of these actions:  
  - `Yes` - Saves configuration changes and exits the configuration session.  
  - `No` - Exits the configuration session without committing the configuration changes.
• **Cancel** - Remains in the configuration mode, without committing the configuration changes.

---

### Configure a Bridge Domain

Perform the following steps to configure the bridge domain on PE1 and PE2.

#### SUMMARY STEPS

1. `configure`
2. `l2vpn`
3. `bridge group bridge-group-name`
4. `bridge-domain bridge-domain-name`
5. `interface Bundle-Ether bundle-id`
6. `evi ethernet vpn id`
7. Use the `commit` or `end` command.

#### DETAILED STEPS

**Step 1** `configure`

**Example:**

```
RP/0/RSP0/CPU0:router# configure
```

Enters the global configuration mode.

**Step 2** `l2vpn`

**Example:**

```
RP/0/RSP0/CPU0:router(config)# l2vpn
```

Enters the l2vpn configuration mode.

**Step 3** `bridge group bridge-group-name`

**Example:**

```
RP/0/RSP0/CPU0:router(config-l2vpn)# bridge group 6005
```

Enters the bridge group configuration mode.

**Step 4** `bridge-domain bridge-domain-name`

**Example:**

```
RP/0/RSP0/CPU0:router(config-l2vpn-bg)# bridge-domain 6005
```

Enters the bridge domain configuration mode.

**Step 5** `interface Bundle-Ether bundle-id`

**Example:**

```
RP/0/RSP0/CPU0:router(config-evpn)# interface Bundle-Ether2.1
```
Enters bundle interface configuration mode.

**Step 6**  
`evi ethernet vpn id`  
**Example:**  
RP/0/RSP0:CPU0:router(config-l2vpn-bg-bd-ac)# evi 6005

Creates the ethernet VPN ID.

**Step 7**  
Use the **commit** or **end** command.

- **commit** - Saves the configuration changes and remains within the configuration session.
- **end** - Prompts user to take one of these actions:
  - **Yes** - Saves configuration changes and exits the configuration session.
  - **No** - Exits the configuration session without committing the configuration changes.
  - **Cancel** - Remains in the configuration mode, without committing the configuration changes.

---

**Virtual Ethernet Segment (vES)**

Traditionally, multi-homing access to EVPN bridge is through bundle Ethernet connection or a physical Ethernet connection. The Virtual Ethernet Segment (vES) allows a Customer Edge (CE) to access EVPN bridge through MPLS network. The logical connection between CE and EVPN provider edge (PE) is a pseudowire (PW). Using vES you can connect VxLAN EVPN-based data center and a legacy data center through PW based virtual circuit.

The VxLAN EVPN-based data centers and legacy data centers are interconnected through access pseudowire (PW), access virtual forwarding instance (VFI), or both. One vES is created for each access PW and one vES is created per access VFI. This feature supports only single-active mode.

Use access VFI for connecting multiple sites in a mesh topology. Use access PW for connecting few sites in hub and spoke topology.
Consider the topology where EVPN data centers are connected to legacy data centers through access PW or access VFI on a single Ethernet segment, which is vES.

Consider a traffic flow from CE2 to PE3. CE2 sends the traffic to DCI1 or DCI2 through EVPN VxLAN. DCI1 and DCI2 are connected to PE3 through access PW on a single Ethernet segment. DCI1 and DCI2 advertise Type 4 routes, and then do designated forwarder (DF) election. The non-DF blocks the traffic on that particular Ethernet segment. Both DCI1 and DCI2 can do the DF election. DCI1 and DCI2 perform DF election after they discover each other. Either one of them can be a DF and other a non-DF. The traffic is forwarded through the DF. The non-DF path is in stand-by mode. DF election is used to prevent traffic loop. DCI1 or DCI2 sends the traffic to PE3.

Consider a traffic flow from CE2 to PE1 and PE2. CE2 sends the traffic to DCI1 or DCI2 through EVPN VxLAN. DCI1 and DCI2 are connected to PE1 and PE2 through access VFI. DCI1 and DCI2 are connected to PE1 and PE2 through access VFI on a single Ethernet segment. DCI1 or DCI2 sends the traffic to PE1 and PE2. DCI1 and DCI2 advertise Type 4 routes, and then do designated forwarder (DF) election. The non-DF blocks the traffic on that particular Ethernet segment. Both DCI1 and DCI2 can do the DF election. DCI1 and DCI2 perform DF election after they discover each other. Either one of them can be a DF and other a non-DF. The traffic is forwarded through the DF. The non-DF path is in stand-by mode. DF election is used to prevent traffic loop. DCI1 or DCI2 sends the traffic to PE3.

**Interoperability Between VxLAN and vES**

When all-active VxLAN and single-active vES are integrated together, some traffic may take non-optimal path. Consider a traffic flow from CE2 to PE1. VxLAN is in all-active mode and vES is in single active mode. CE2 sends the traffic to ToR1, and ToR1 sends the traffic to DCI1 and DCI2. Both DCI1 and DCI2 can receive the traffic from VxLAN because it is in all-active mode. But, either DCI1 or DCI2 (which is a DF) can forward the traffic through vES. If DCI1 is a non-DF, the traffic is sent from DCI2 to PE1.

**Limitations**

The vES feature is supported with the following limitations:
Configure Virtual Ethernet Segment (vES)

The following sections describe how to configure access PW and access VFI.

Configure Access PW

This section describes how you can configure access PW.

/* Configure DCI1 */
RP/0/RSP0/CPU0:router# configure
RP/0/RSP0/CPU0:router(config)# l2vpn
RP/0/RSP0/CPU0:router(config-l2vpn)# bridge group bg1
RP/0/RSP0/CPU0:router(config-l2vpn-bg)# bridge-domain bd1
RP/0/RSP0/CPU0:router(config-bg-bd)# neighbor 70.70.70.70 pw-id 17300001
RP/0/RSP0/CPU0:router(config-bg-bd-pw)# evi 1
RP/0/RSP0/CPU0:router(config-bg-bd-pw-evi)# member vni 10001

/* Configure EVPN */
RP/0/RSP0/CPU0:router# configure
RP/0/RSP0/CPU0:router(config)# evpn
RP/0/RSP0/CPU0:router(config-evpn)# virtual neighbor 70.70.70.70 pw-id 17300001
RP/0/RSP0/CPU0:router(config-evpn-ac-pw)# ethernet-segment
RP/0/RSP0/CPU0:router(config-evpn-ac-pw-es)# identifier type 0 12.12.00.00.00.01.00.00.03
RP/0/RSP0/CPU0:router(config-evpn-ac-pw-es)# bgp route-target 1212.8888.0003
RP/0/RSP0/CPU0:router(config-evpn-ac-pw-es)# exit
RP/0/RSP0/CPU0:router(config-evpn-ac-pw)# timers peer 15
RP/0/RSP0/CPU0:router(config-evpn-ac-pw-timers)# commit

/* Configure DCI2 */
RP/0/RSP0/CPU0:router# configure
RP/0/RSP0/CPU0:router(config)# l2vpn
RP/0/RSP0/CPU0:router(config-l2vpn)# bridge group bg1
RP/0/RSP0/CPU0:router(config-l2vpn-bg)# bridge-domain bd1
RP/0/RSP0/CPU0:router(config-bg-bd)# neighbor 70.70.70.70 pw-id 27300001
RP/0/RSP0/CPU0:router(config-bg-bd-pw)# evi 1
RP/0/RSP0/CPU0:router(config-bg-bd-pw-evi)# member vni 10001

/* Configure EVPN */
RP/0/RSP0/CPU0:router# configure
RP/0/RSP0/CPU0:router(config)# evpn
RP/0/RSP0/CPU0:router(config-evpn)# virtual neighbor 70.70.70.70 pw-id 27300001
RP/0/RSP0/CPU0:router(config-evpn-ac-pw)# ethernet-segment
RP/0/RSP0/CPU0:router(config-evpn-ac-pw-es)# identifier type 0 12.12.00.00.00.01.00.00.03
RP/0/RSP0/CPU0:router(config-evpn-ac-pw-es)# bgp route-target 1212.8888.0003
RP/0/RSP0/CPU0:router(config-evpn-ac-pw-es)# exit

This does not restrict the number of vES.
RP/0/RSP0/CPU0:router(config-evpn-ac-pw)# timers peering 15
RP/0/RSP0/CPU0:router(config-evpn-ac-pw-timers)# commit

/* Configure PE3 */
RP/0/RSP0/CPU0:router# configure
RP/0/RSP0/CPU0:router(config)# l2vpn
RP/0/RSP0/CPU0:router(config-l2vpn)# bridge group 73
RP/0/RSP0/CPU0:router(config-l2vpn-bg)# bridge-domain 73-1
RP/0/RSP0/CPU0:router(config-l2vpn-bg-bd)# neighbor 10.10.10.10 pw-id 17300001
RP/0/RSP0/CPU0:router(config-l2vpn-bg-bd-pw)# neighbor 20.20.20.20 pw-id 27300001
RP/0/RSP0/CPU0:router(config-l2vpn-bg-bd-pw)# commit

Running Configuration - Access PW

This section shows access PW running configuration.

/* On DCI1 */
!
configure
l2vpn
  bridge group bg1
  bridge-domain bd1
  neighbor 70.70.70.70 pw-id 17300001
evi 1
  member vni 10001
!
evpn
  virtual neighbor 70.70.70.70 pw-id 17300001
ethernet-segment
    identifier type 0 12.12.00.00.00.01.00.00.03
    bgp route-target 1212.8888.0003
  !
timers peering 15
!

/* On DCI2 */
!
configure
l2vpn
  bridge group bg1
  bridge-domain bd1
  neighbor 70.70.70.70 pw-id 27300001
evi 1
  member vni 10001
!
evpn
  virtual neighbor 70.70.70.70 pw-id 27300001
ethernet-segment
    identifier type 0 12.12.00.00.00.01.00.00.03
    bgp route-target 1212.8888.0003
  !
timers peering 15
!

/* On PE3 */
!
configure
l2vpn
  bridge group bg73
  bridge-domain bd73-1
  neighbor 10.10.10.10 pw-id 17300001

Configure Access VFI

This section describes how you can configure access VFI. RTs must match on the redundant DCIs that are connected to the same Ethernet segment.

/* Configure DCI1 */
RP/0/RSP0/CPU0:router# configure
RP/0/RSP0/CPU0:router(config)# l2vpn
RP/0/RSP0/CPU0:router(config-l2vpn)# bridge group bg1
RP/0/RSP0/CPU0:router(config-l2vpn-bg)# bridge-domain bd1
RP/0/RSP0/CPU0:router(config-bg-bd)# access-vfi ac-vfi-1
RP/0/RSP0/CPU0:router(config-bg-bd-accessvfi)# neighbor 70.70.70.70 pw-id 17100005
RP/0/RSP0/CPU0:router(config-bg-bd-accessvfi-pw)# neighbor 80.80.80.80 pw-id 18100005
RP/0/RSP0/CPU0:router(config-bg-bd-accessvfi-pw)# exit
RP/0/RSP0/CPU0:router(config-bg-bd-accessvfi)# evi 1
RP/0/RSP0/CPU0:router(config-bg-bd-accessvfi-evi)# member vni 10001

/* Configure DCI2 */
RP/0/RSP0/CPU0:router# configure
RP/0/RSP0/CPU0:router(config)# l2vpn
RP/0/RSP0/CPU0:router(config-l2vpn)# bridge group bg1
RP/0/RSP0/CPU0:router(config-l2vpn-bg)# bridge-domain bd1
RP/0/RSP0/CPU0:router(config-bg-bd)# access-vfi ac-vfi-1
RP/0/RSP0/CPU0:router(config-bg-bd-accessvfi)# neighbor 70.70.70.70 pw-id 27100005
RP/0/RSP0/CPU0:router(config-bg-bd-accessvfi-pw)# neighbor 80.80.80.80 pw-id 28100005
RP/0/RSP0/CPU0:router(config-bg-bd-accessvfi-pw)# exit
RP/0/RSP0/CPU0:router(config-bg-bd-accessvfi)# evi 1
RP/0/RSP0/CPU0:router(config-bg-bd-accessvfi-evi)# member vni 10001

/* Configure EVPN */
RP/0/RSP0/CPU0:router# configure
RP/0/RSP0/CPU0:router(config)# evpn
RP/0/RSP0/CPU0:router(config-evpn)# virtual vfi ac-vfi-1
RP/0/RSP0/CPU0:router(config-evpn-ac-vfi)# ethernet-segment
RP/0/RSP0/CPU0:router(config-evpn-ac-vfi-es)# identifier type 0 12.12.00.00.00.01.00.00.01
RP/0/RSP0/CPU0:router(config-evpn-ac-vfi-es)# bgp route-target 1212.0005.0001
RP/0/RSP0/CPU0:router(config-evpn-ac-vfi-es)# exit
RP/0/RSP0/CPU0:router(config-evpn-ac-vfi-timers)timers peering 15
RP/0/RSP0/CPU0:router(config-evpn-ac-vfi-timers)# exit
RP/0/RSP0/CPU0:router(config-evpn-ac-vfi)# ethernet-segment
RP/0/RSP0/CPU0:router(config-evpn-ac-vfi-es)# identifier type 0 12.12.00.00.05.00.00.00.03
RP/0/RSP0/CPU0:router(config-evpn-ac-vfi-es)# bgp route-target 1212.0005.0003
RP/0/RSP0/CPU0:router(config-evpn-ac-vfi-es)# commit

/* Configure DCI2 */
RP/0/RSP0/CPU0:router# configure
RP/0/RSP0/CPU0:router(config)# l2vpn
RP/0/RSP0/CPU0:router(config-l2vpn)# bridge group bg1
RP/0/RSP0/CPU0:router(config-l2vpn-bg)# bridge-domain bd1
RP/0/RSP0/CPU0:router(config-bg-bd)# access-vfi ac-vfi-1
RP/0/RSP0/CPU0:router(config-bg-bd-accessvfi)# neighbor 70.70.70.70 pw-id 27100005
RP/0/RSP0/CPU0:router(config-bg-bd-accessvfi-pw)# neighbor 80.80.80.80 pw-id 28100005
RP/0/RSP0/CPU0:router(config-bg-bd-accessvfi-pw)# exit
RP/0/RSP0/CPU0:router(config-bg-bd-accessvfi)# evi 1
RP/0/RSP0/CPU0:router(config-bg-bd-accessvfi-evi)# member vni 10001

/* Configure EVPN */
RP/0/RSP0/CPU0:router# configure
RP/0/RSP0/CPU0:router(config)# evpn
RP/0/RSP0/CPU0:router(config-evpn)# virtual vfi ac-vfi-1
RP/0/RSP0/CPU0:router(config-evpn-ac-vfi)# ethernet-segment
RP/0/RSP0/CPU0:router(config-evpn-ac-vfi-es)# identifier type 0 12.12.00.00.00.01.00.00.01
RP/0/RSP0/CPU0:router(config-evpn-ac-vfi-es)# bgp route-target 1212.0005.0001
RP/0/RSP0/CPU0:router(config-evpn-ac-vfi-es)# exit
RP/0/RSP0/CPU0:router(config-evpn-ac-vfi-timers)timers peering 15
RP/0/RSP0/CPU0:router(config-evpn-ac-vfi-timers)# exit
RP/0/RSP0/CPU0:router(config-evpn-ac-vfi)# ethernet-segment
RP/0/RSP0/CPU0:router(config-evpn-ac-vfi-es)# identifier type 0 12.12.00.05.00.00.00.03
RP/0/RSP0/CPU0:router(config-evpn-ac-vfi-es)# commit
/* Configure PE1 */
RP/0/RSP0/CPU0:router# configure
RP/0/RSP0/CPU0:router(config)# l2vpn
RP/0/RSP0/CPU0:router(config-l2vpn)# bridge group 71
RP/0/RSP0/CPU0:router(config-l2vpn-bg)# bridge-domain 71-1
RP/0/RSP0/CPU0:router(config-bg-bd)# vfi vfi-71-1
RP/0/RSP0/CPU0:router(config-bg-bd-vfi)# neighbor 10.10.10.10 pw-id 17100005
RP/0/RSP0/CPU0:router(config-bg-bd-vfi-pw)# neighbor 20.20.20.20 pw-id 27100005
RP/0/RSP0/CPU0:router(config-bg-bd-vfi-pw)# neighbor 80.80.80.80 pw-id 78100005
RP/0/RSP0/CPU0:router(config-bg-bd-vfi-pw)# commit

/* Configure PE2 */
RP/0/RSP0/CPU0:router# configure
RP/0/RSP0/CPU0:router(config)# l2vpn
RP/0/RSP0/CPU0:router(config-l2vpn)# bridge group 71
RP/0/RSP0/CPU0:router(config-l2vpn-bg)# bridge-domain 71-1
RP/0/RSP0/CPU0:router(config-bg-bd)# vfi vfi-71-1
RP/0/RSP0/CPU0:router(config-bg-bd-vfi)# neighbor 10.10.10.10 pw-id 18100005
RP/0/RSP0/CPU0:router(config-bg-bd-vfi-pw)# neighbor 20.20.20.20 pw-id 28100005
RP/0/RSP0/CPU0:router(config-bg-bd-vfi-pw)# neighbor 70.70.70.70 pw-id 78100005
RP/0/RSP0/CPU0:router(config-bg-bd-vfi-pw)# commit

Running Configuration - Access VFI

This section shows access VFI running configuration.

/* On DCI1 */
!
configure
l2vpn
bridge group bg1
bridge-domain bd1
    access-vfi ac-vfi-1
    neighbor 70.70.70.70 pw-id 17100005
    neighbor 80.80.80.80 pw-id 18100005
evi 1
    member vni 10001
!
evpn
virtual vfi ac-vfi-1
    ethernet-segment
        identifier type 0 12.12.00.00.00.01.00.00.01
        bgp route-target 1212.0005.0001
        !
timers peering 15
!
!

ethernet-segment
    identifier type 0 12.12.00.00.05.00.00.00.03
    bgp route-target 1212.0005.0003
!

/* On DCI2 */
!
configure
EVPN Routing Policy

The EVPN Routing Policy feature provides the route policy support for address-family L2VPN EVPN. This feature adds EVPN route filtering capabilities to the routing policy language (RPL). The filtering is based on various EVPN attributes.

A routing policy instructs the router to inspect routes, filter them, and potentially modify their attributes as they are accepted from a peer, advertised to a peer, or redistributed from one routing protocol to another.
This feature enables you to configure route-policies using EVPN network layer reachability information (NLRI) attributes of EVPN route type 1 to 5 in the route-policy match criteria, which provides more granular definition of route-policy. For example, you can specify a route-policy to be applied to only certain EVPN route-types or any combination of EVPN NLRI attributes. This feature provides flexibility in configuring and deploying solutions by enabling route-policy to filter on EVPN NLRI attributes.

To implement this feature, you need to understand the following concepts:

• Routing Policy Language
• Routing Policy Language Structure
• Routing Policy Language Components
• Routing Policy Language Usage
• Policy Definitions
• Parameterization
• Semantics of Policy Application
• Policy Statements
• Attach Points

For information on these concepts, see Implementing Routing Policy.

Currently, this feature is supported only on BGP neighbor "in" and "out" attach points. The route policy can be applied only on inbound or outbound on a BGP neighbor.

## EVPN Route Types

The EVPN NLRI has the following different route types:

### Route Type 1: Ethernet Auto-Discovery (AD) Route

The Ethernet (AD) routes are advertised on per EVI and per Ethernet Segment Identifier (ESI) basis. These routes are sent per Ethernet segment (ES). They carry the list of EVIs that belong to the ES. The ESI field is set to zero when a CE is single-homed.

An Ethernet A-D route type specific EVPN NLRI consists of the following fields:

```
+-----------------------------+*    
|Route Type (1 octet)        |    
+-----------------------------+    
|Length (1 octet)            |    
+-----------------------------+    
|Route Distinguisher (RD) (8 octets) |*   
+-------------------------------+    
|Ethernet Segment Identifier (10 octets) |*  
+----------------------------------------+    
|Ethernet Tag ID (4 octets)           |*   
+-------------------------------+    
|MPLS Label (3 octets)               |    
+----------------------------------------+    
```

**NLRI Format: Route-type 1:**
EVPN Route Types

Net attributes: [Type][Len][RD][ESI][ETag]

Path attributes: [MPLS Label]

Example

route-policy evpn-policy
  if rd in (1.1.1.1:0) [and/or evpn-route-type is 1] [and/or esi in (0a1.a2a3.a4a5.a6a7.a8a9)] [and/or etag is 4294967295] then
    set ..
  endif
end-policy

route-policy evpn-policy
  if rd in (1.1.1.2:0) [and/or evpn-route-type is 1] [and/or esi in (00a1.a2a3.a4a5.a6a7.a8a9)] [and/or etag is 4294967295] then
    set ..
  endif
end-policy

Route Type 2: MAC/IP Advertisement Route

The host's IP and MAC addresses are advertised to the peers within NLRI. The control plane learning of MAC addresses reduces unknown unicast flooding.

A MAC/IP Advertisement Route type specific EVPN NLRI consists of the following fields:
NLRI Format: Route-type 2:

|Route Type (1 octet)| [*]
|---------------------|
|Length (1 octet)     | [*]
|RD (8 octets)        | [*]
|Ethernet Segment Identifier (10 octets)| [*]
|Ethernet Tag ID (4 octets)| [*]
|MAC Address Length (1 octet) | [*]
|MAC Address (6 octets)    | [*]
|IP Address Length (1 octet) | [*]
|IP Address (0, 4, or 16 octets)| [*]
|MPLS Label1 (3 octets)   | |
|MPLS Label2 (0 or 3 octets) | |

Net attributes: [Type], [RD], [ETag], [MAC Addr Len], [MAC Addr], [IP Addr Len], [IP Addr]

Path attributes: [ESI], [MPLS Label1], [MPLS Label2]

Example

```plaintext
route-policy evpn-policy
  if rd in (1.1.1.2:0) [and/or evpn-route-type is 2] [and/or esi in (0000.0000.0000.0000)] [and/or etag is 0] [and/or macaddress in (0013.aabb.ccdd)] [and/or destination in (1.2.3.4/32)] then
    set ..
  endif
end-policy
```

Route Type 3: Inclusive Multicast Ethernet Tag Route

This route establishes the connection for broadcast, unknown unicast, and multicast (BUM) traffic from a source PE to a remote PE. This route is advertised on per VLAN and per ESI basis.

An Inclusive Multicast Ethernet Tag route type specific EVPN NLRI consists of the following fields:
**Route Type 3:**

<table>
<thead>
<tr>
<th>Field</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type</td>
<td>1 octet</td>
</tr>
<tr>
<td>Len</td>
<td>1 octet</td>
</tr>
<tr>
<td>RD</td>
<td>8 octets</td>
</tr>
<tr>
<td>ETag</td>
<td></td>
</tr>
<tr>
<td>IP Len</td>
<td>1 octet</td>
</tr>
<tr>
<td>IP Addr</td>
<td></td>
</tr>
<tr>
<td>Originating Router's IP Addr</td>
<td></td>
</tr>
</tbody>
</table>

**Example**

```plaintext```
route-policy evpn-policy
  if rd in (1.1.1.1:300) [and/or evpn-route-type is 3] [and/or etag is 0] [and/or evpn-originator in (1.1.1.1)] then
    set ..
  endif
end-policy```
```

**Route Type 4: Ethernet Segment Route**

Ethernet segment routes enable to connect a CE device to two or PE devices. ES route enables the discovery of connected PE devices that are connected to the same Ethernet segment.

An Ethernet Segment route type specific EVPN NLRI consists of the following fields:
NLRI Format: Route-type 4:

<table>
<thead>
<tr>
<th>Type</th>
<th>Len</th>
<th>RD</th>
<th>ESI</th>
<th>IP Addr Len</th>
<th>Originating Router's IP Addr</th>
</tr>
</thead>
</table>

Net attributes: [Type][RD][ESI][IP Addr Len][Originating Router's IP Addr]

Example

```
route-policy evpn-policy
   if rd in (1.1.1.1:0) [and/or evpn-route-type is 4] [and/or esi in (0a1.a2a3.a4a5.a6a7.a8a9)] [and/or evpn-originator in (1.1.1.1)] then
       set ...
   endif
end-policy
```

Route Type 5: IP Prefix Route

An IP Prefix Route type specific EVPN NLRI consists of the following fields:
NLRI Format: Route-type 5:

<table>
<thead>
<tr>
<th>Type</th>
<th>Len</th>
<th>RD</th>
<th>ESI</th>
<th>ETag</th>
<th>IP Addr Len</th>
<th>IP Addr</th>
<th>GW IP Addr</th>
<th>Label</th>
</tr>
</thead>
</table>

Net attributes: [Type][RD][ETag][IP Addr Len][IP Addr]
Path attributes: [ESI], [GW IP Addr], [Label]

Example

route-policy evpn-policy
  if rd in (30.30.30.30:1) [and/or evpn-route-type is 5] [and/or esi in (0000.0000.0000.0000.0000) [and/or etag is 0] [and/or destination in (12.2.0.0/16)] [and/or evpn-gateway in (0.0.0.0)] then
    set ..
  endif
end-policy

EVPN RPL Attribute

Route Distinguisher

A Route Distinguisher (rd) attribute consists of eight octets. An rd can be specified for each of the EVPN route types. This attribute is not mandatory in route-policy.

Example

rd in (1.2.3.4:0)

EVPN Route Type

EVPN route type attribute consists of one octet. This specifies the EVPN route type. The EVPN route type attribute is used to identify a specific EVPN NLRI prefix format. It is a net attribute in all EVPN route types.
Example
evpn-route-type is 3

The following are the various EVPN route types that can be used:
1 - ethernet-ad
2 - mac-advertisement
3 - inclusive-multicast
4 - ethernet-segment
5 - ip-advertisement

IP Prefix
An IP prefix attribute holds IPv4 or IPv6 prefix match specification, each of which has four parts: an address, a mask length, a minimum matching length, and a maximum matching length. The address is required, but the other three parts are optional. When IP prefix is specified in EVPN route type 2, it represents either a IPv4 or IPv6 host IP Address (/32 or /128). When IP prefix is specified in EVPN route type 5, it represents either IPv4 or IPv6 subnet. It is a net attribute in EVPN route type 2 and 5.

Example
destination in (128.47.10.2/32)
destination in (128.47.0.0/16)
destination in (128:47::1/128)
destination in (128:47::0/112)

esi
An Ethernet Segment Identifier (ESI) attribute consists of 10 octets. It is a net attribute in EVPN route type 1 and 4, and a path attribute in EVPN route type 2 and 5.

Example
esi in (ffff.ffff.ffff.ffff.fff0)

etag
An Ethernet tag attribute consists of four octets. An Ethernet tag identifies a particular broadcast domain, for example, a VLAN. An EVPN instance consists of one or more broadcast domains. It is a net attribute in EVPN route type 1, 2, 3 and 5.

Example
etag in (10000)
mac
The mac attribute consists of six octets. This attribute is a net attribute in EVPN route type 2.

Example
mac in (0206.acb1.e806)

evpn-originator
The evpn-originator attribute specifies the originating router's IP address (4 or 16 octets). This is a net attribute in EVPN route type 3 and 4.

Example
evpn-originator in (1.2.3.4)

evpn-gateway
The evpn-gateway attribute specifies the gateway IP address. The gateway IP address is a 32-bit or 128-bit field (IPv4 or IPv6), and encodes an overlay next-hop for the IP prefixes. The gateway IP address field can be zero if it is not used as an overlay next-hop. This is a path attribute in EVPN route type 5.

Example
evpn-gateway in (1.2.3.4)

EVPN RPL Attribute Set
In this context, the term set is used in its mathematical sense to mean an unordered collection of unique elements. The policy language provides sets as a container for groups of values for matching purposes. Sets are used in conditional expressions. The elements of the set are separated by commas. Null (empty) sets are allowed.

prefix-set
A prefix-set holds IPv4 or IPv6 prefix match specifications, each of which has four parts: an address, a mask length, a minimum matching length, and a maximum matching length. The address is required, but the other three parts are optional. The prefix-set specifies one or more IP prefixes.

Example
prefix-set ip_prefix_set
14.2.0.0/16,
54.0.0.0/16,
12.12.12.0/24,
50:50::1:0/112
end-set
**mac-set**

The mac-set specifies one or more MAC addresses.

**Example**

```
mac-set mac_address_set
1234.2345.6789,
2345.3456.7890
end-set
```

**esi-set**

The esi-set specifies one or more ESI's.

**Example**

```
esi-set evpn esi_set
1234.2345.3456.4567.5678,
1234.2345.3456.4567.5670
end-set
```

**etag-set**

The etag-set specifies one or more Ethernet tags.

**Example**

```
etag-set evpn etag_set
10000,
20000
end-set
```

**EVPN Attributes and Operators**

This table summarizes the EVPN attributes and operators per attach points.
### Table 5: EVPN Attributes and Operators

<table>
<thead>
<tr>
<th>Attach Point</th>
<th>Attribute</th>
<th>Match</th>
<th>Attribute-Set</th>
</tr>
</thead>
<tbody>
<tr>
<td>neighbor-in</td>
<td>destination</td>
<td>in</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td>rd</td>
<td>in</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td>evpn-route-type</td>
<td>is</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td>esi</td>
<td>in</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>etag</td>
<td>in</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>mac</td>
<td>in</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>evpn-originator</td>
<td>in</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td>evpn-gateway</td>
<td>in</td>
<td>—</td>
</tr>
<tr>
<td>neighbor-out</td>
<td>destination</td>
<td>in</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td>rd</td>
<td>in</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td>evpn-route-type</td>
<td>is</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td>esi</td>
<td>in</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>etag</td>
<td>in</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>mac</td>
<td>in</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>evpn-originator</td>
<td>in</td>
<td>—</td>
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<tr>
<td></td>
<td>evpn-gateway</td>
<td>in</td>
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</tbody>
</table>

### Configure EVPN RPL Feature

The following section describe how to configure mac-set, esi-set, evpn-gateway, and evpn-originator.

```bash
/* Configuring a mac-set and refering it in a route-policy (Attach point = neighbor-in) */
Router(config)# configure
Router(config)# mac-set demo_mac_set
Router(config-mac)# 1234.ffff.aaa3,
Router(config-mac)# 2323.4444.ffff
Router(config-mac)# end-set
Router(config)# !
Router(config)# route-policy policy_use_pass_mac_set
Router(config-rpl)# if mac in demo_mac_set then
Router(config-rpl-if)# set med 200
Router(config-rpl-if)# else
Router(config-rpl-else)# set med 1000
Router(config-rpl-else)# endif
Router(config-rpl)# end-policy
Router(config)# commit
Router(config)# router bgp 100
```
Router(config-bgp)# address-family ipv4 unicast
Router(config-bgp-af)# !
Router(config-bgp-af)# neighbor 10.0.0.10
Router(config-bgp-nbr)# remote-as 8
Router(config-bgp-nbr-af)# address-family ipv4 unicast
Router(config-bgp-nbr-af)# route-policy policy_use_pass_mac_set in
Router(config-bgp-nbr-af)# commit

/* Configuring a esi-set and refering it in a route-policy (Attach point = neighbor-in) */
Router# configure
Router(config)# esi-set demo_esi
Router(config-esi)# ad34.1233.1222.ffff.44ff,
Router(config-esi)# ad34.1233.1222.ffff.6666
Router(config-esi)# end-set
Router(config)# !
Router(config)# route-policy use_esi
Router(config-rpl)# if esi in demo_esi then
Router(config-rpl-if)# set local-preference 100
Router(config-rpl-if)# else
Router(config-rpl-else)# set local-preference 300
Router(config-rpl-else)# endif
Router(config-rpl)# end-policy
Router(config)# commit

/* Configuring evpn-gateway/evpn-originator in a route-policy (Attach point = neighbor-in and out) */
Router# configure
Router(config)# route-policy gateway_demo
Router(config-rpl)# if evpn-gateway in (10.0.0.0/32) then
Router(config-rpl-if)# pass
Router(config-rpl-if)# endif
Router(config-rpl)# end-policy
Router(config)# commit
Router(config)# route-policy originator_demo
Router(config-rpl)# if evpn-originator in (10.0.0.1/32) then
Router(config-rpl-if)# set local-preference 100
Router(config-rpl-if)# else
Router(config-rpl-else)# set med 200
Router(config-rpl-else)# endif
Router(config-rpl)# end-policy
Router(config)# commit
Router(config)# router bgp 100
Router(config-bgp)# address-family ipv4 unicast
Router(config-bgp-af)# !
Router(config-bgp-af)# neighbor 10.0.0.10
Router(config-bgp-nbr)# remote-as 8
Router(config-bgp-nbr-af)# address-family ipv4 unicast
Router(config-bgp-nbr-af)# route-policy gateway_demo in
Router(config-bgp-nbr-af)# route-policy originator_demo out
Router(config-bgp-nbr-af)# commit

Running Configuration

/* Configuring a mac-set and refering it in a route-policy (Attach point = neighbor-in) */
mac-set demo_mac_set
1234.ffff.aaa3,
2323.4444.ffff
end-set
!
route-policy policy_use_pass_mac_set
if mac in demo_mac_set then
set med 200
else
    set med 1000
endif
end-policy

router bgp 100
    address-family ipv4 unicast
    neighbor 10.0.0.10
        remote-as 8
        address-family ipv4 unicast
        route-policy policy_use_pass_mac_set in
    !
!
end

/* Configuring a esi-set and refering it in a route-policy (Attach point - neighbor-in) */
Wed Oct 26 11:52:23.720 IST
esi-set demo_esi
    ad34.1233.1222.ffff.44ff,
    ad34.1233.1222.ffff.6666
end-set

route-policy use_esi
    if esi in demo_esi then
        set local-preference 100
    else
        set local-preference 300
    endif
end-policy

EVPN Route Policy Examples

route-policy ex_2
    if rd in (2.2.18.2:1004) and evpn-route-type is 1 then
        drop
    elseif rd in (2.2.18.2:1009) and evpn-route-type is 1 then
        drop
    else
        pass
    endif
end-policy

route-policy ex_3
    if evpn-route-type is 5 then
        set extcommunity bandwidth (100:9999)
    else
        pass
    endif
end-policy

route-policy samp
end-policy

route-policy samp1
    if rd in (30.0.101.2:0) then
        pass
    endif
end-policy
route-policy samp2
  if rd in (30.0.101.2:0, 1:1) then
    pass
  endif
end-policy
!
oroute-policy samp3
  if rd in (*:**) then
    pass
  endif
end-policy
!
oroute-policy samp4
  if rd in (30.0.101.2:*) then
    pass
  endif
end-policy
!
oroute-policy samp5
  if evpn-route-type is 1 then
    pass
  endif
end-policy
!
oroute-policy samp6
  if evpn-route-type is 2 or evpn-route-type is 5 then
    pass
  endif
end-policy
!
oroute-policy samp7
  if evpn-route-type is 4 or evpn-route-type is 3 then
    pass
  endif
end-policy
!
oroute-policy samp8
  if evpn-route-type is 1 or evpn-route-type is 2 or evpn-route-type is 3 then
    pass
  endif
end-policy
!
oroute-policy samp9
  if evpn-route-type is 1 or evpn-route-type is 2 or evpn-route-type is 3 or evpn-route-type
  is 4 then
    pass
  endif
end-policy
!
oroute-policy test1
  if evpn-route-type is 2 then
    set next-hop 10.2.3.4
  else
    pass
  endif
end-policy
!
oroute-policy test2
  if evpn-route-type is 2 then
    set next-hop 10.10.10.10
  else
    drop
  endif
end-policy
route-policy test3
  if evpn-route-type is 1 then
    set tag 9988
  else
    pass
  endif
end-policy
!
route-policy samp21
  if mac in (6000.6000.6000) then
    pass
  endif
end-policy
!
route-policy samp22
  if extcommunity rt matches-any (100:1001) then
    pass
  else
    drop
  endif
end-policy
!
route-policy samp23
  if evpn-route-type is 1 and esi in (aaaa.bbbb.ccccdddd.eeee) then
    pass
  else
    drop
  endif
end-policy
!
route-policy samp24
  if evpn-route-type is 5 and extcommunity rt matches-any (100:1001) then
    pass
  else
    drop
  endif
end-policy
!
route-policy samp25
  if evpn-route-type is 2 and esi in (1234.1234.1234.1234.1236) then
    pass
  else
    drop
  endif
end-policy
!
route-policy samp26
  if etag in (20000) then
    pass
  else
    drop
  endif
end-policy
!
route-policy samp27
  if destination in (99.99.99.1) and etag in (20000) then
    pass
  else
    drop
  endif
end-policy
!
route-policy samp31
if evpn-route-type is 1 or evpn-route-type is 2 or evpn-route-type is 3 or evpn-route-type is 4 or evpn-route-type is 5 then
    pass
else
    drop
endif
end-policy
!
route-policy samp33
    if esi in evpn_esi_set1 then
        pass
    else
        drop
    endif
end-policy
!
route-policy samp34
    if destination in (90:1:1::9/128) then
        pass
    else
        drop
    endif
end-policy
!
route-policy samp35
    if destination in evpn_prefix_set1 then
        pass
    else
        drop
    endif
end-policy
!
route-policy samp36
    if evpn-route-type is 3 and evpn-originator in (80:1:1::3) then
        pass
    else
        drop
    endif
end-policy
!
route-policy samp37
    if evpn-gateway in (10:10::10) then
        pass
    else
        drop
    endif
end-policy
!
route-policy samp38
    if mac in evpn_mac_set1 then
        pass
    else
        drop
    endif
end-policy
!
route-policy samp39
    if mac in {6000.6000.6002} then
        pass
    else
        drop
    endif
end-policy
!
route-policy samp41
  if evpn-gateway in (10.10.10.10, 10:10::10) then
    pass
  else
    drop
  endif
end-policy
!
route-policy samp42
  if evpn-originator in (24.162.160.1/32, 70:1:1::1/128) then
    pass
  else
    drop
  endif
end-policy
!
route-policy example
  if rd in (62300:1903) and evpn-route-type is 1 then
    drop
  elseif rd in (62300:19032) and evpn-route-type is 1 then
    drop
  else
    pass
  endif
end-policy
!
route-policy samp100
  if evpn-route-type is 4 or evpn-route-type is 5 then
    drop
  else
    pass
  endif
end-policy
!
route-policy samp101
  if evpn-route-type is 4 then
    drop
  else
    pass
  endif
end-policy
!
route-policy samp102
  if evpn-route-type is 4 then
    drop
  elseif evpn-route-type is 5 then
    drop
  else
    pass
  endif
end-policy
!
route-policy samp103
  if evpn-route-type is 2 and destination in evpn_prefix_set1 then
    drop
  else
    pass
  endif
end-policy
!
route-policy samp104
  if evpn-route-type is 1 and etag in evpn_etag_set1 then
    drop
  elseif evpn-route-type is 2 and mac in evpn_mac_set1 then

drop
elseif evpn-route-type is 5 and esi in evpn_esi_set1 then
    drop
else
    pass
endif
end-policy
!
