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Network Configuration Example

EVPN E-LINE/E-LAN Service on ACX7000 Series

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Table of Contents

CHAPTER 1 EVPN Overview

About This Configuration Example

Scope

Use this network configuration example (NCE) to configure Ethernet Virtual Private Network (EVPN) Ethernet LAN (E-LAN) on ACX7000 Series.

This example covers:

- Provider Edge (PE) techniques and configurations including scaling of the instances.
- A requirement to move to a more controlled and predictable network for the Service providers and Cloud providers.
- Configuring the EVPN service implementation on the ACX7000 Series with Junos OS Evolved.

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Technology Primer: EVPN

EVPN Overview

Ethernet EVPN (EVPN) as a technology has matured with large-scale deployment seen across various use case requirements including Service Provider and Cloud. ACX7000 Series support of a wide range of EVPN services that includes E-LINE, E-LAN services with MPLS/SR-MPLS or VXLAN underlay.

Benefits

EVPN provides advanced L2 deployments with better scale and performance in terms of availability, overcoming underutilization of revenue ports, faster convergence, and advantages over legacy technologies.

Reference Topology

Figure 1 depicts a typical EVPN MPLS architecture.

Figure 1: EVPN Reference Topology – Single Home / Multi Home
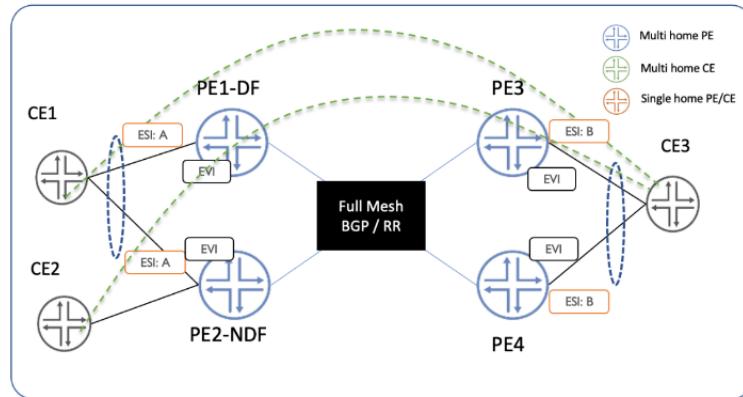
EVPN-VPWS E-LINE Service Overview

EVPN-Virtual Private Wired Service (VPWS) is a framework for delivering point-to-point VPN service with the EVPN signaling mechanisms. The endpoints are identified using a service identifier also called VPWS-ID discovered using Border Gateway Protocol (BGP) signaling. The service IDs are 24 bit values encoded in the Ethernet Tag of the Auto Discovery (AD) route /Type 1 per Ethernet Virtual Instance (EVI).

Benefits

- Support for Single homing (SH) and Multi homing (MH) scenario— Advantages in multihoming include load balancing. Both connections are active.
- Support for Inter-AS across the ASBR (Autonomous System Border Router) using the BGP EVPN signaled VPNs.

Private Line Services

EVPN-VPWS delivers the following private line services defined by the Metro Ethernet Forum (MEF):

- Ethernet Private Line (EPL):
    - Offers a point-to-point ethernet virtual connection (EVC) between a dedicated UNI (User Network Interface) with a high degree of transparency.
    - Constructs an EPL-based service based on the ports as per the Metro Ethernet Forum standards. The service is provisioned between a pair of UNI ports. The Ethernet Segment Identifier (ESI) is based on the Ethernet Virtual Instance (EVI) and port. In the multihomed scenario as depicted in Figure 1, the Designate Forwarder (DF) election is Modulus (MOD) based (see RFC7432). ACX Series supports the preference-based DF election.

- Ethernet Virtual Private Line (EVPL):

    o   Offers service multiplexing which means multiple EVCs are paired per UNI.
    o   Constructs an EVPL based service based on the IFD as per the Metro Ethernet Forum standards. The service is provisioned between a multiple pair of UNI ports. The ESI is based on the EVI and per IFD. In the multihomed scenario as depicted in Figure 1, the DF election is MOD based.

EVPN E-LAN

Overview

EVPN E-LAN is a framework for delivering multipoint-to-multipoint VPN service with the EVPN signaling mechanisms. E-LAN service allows service providers to offer services that manage the L2 learning very efficiently. In a multihoming scenario, the BUM is handled by the PE-DF, and the learned information is redistributed to other PEs in the network. The multihomed Customer Edge (CE) connects a customer site to two or more PE devices providing redundant services.

From a MEF standard, there are two different services for EVPN E-LAN:

- EP-LAN (Ethernet Private LAN)

    o   Offers a multipoint-to-multipoint ethernet virtual connection (EVC) between a dedicated UNI (User Network Interface). EP-LAN is a port-based service.

- EPV-LAN (Ethernet Virtual Private LAN)

    o   Offers VLAN based service multiplexing, which means multiple EVCs are paired per UNI.

Instance Types

EVPN E-LAN instance types that are supported across all the Juniper platforms are:

- MAC-VRF—Provides all 3 services (vlan-based, vlan-bundle, vlan-aware-bundle) associated with a single EVI.
- EVPN—Provides vlan-based and vlan-bundle services for an EVI.
- VIRTUAL-SWITCH—Provides vlan-aware-bundle services for an EVI.

ACX Series routers based on Junos OS Evolved support only MAC-VRF instance-type.

EVI Support - MAC-VRF vs EVPN vs VIRTUAL-SWITCH

Table 1 lists different EVIs supported for the MPLS/VXLAN based EVPN implementation on Juniper platforms. This content guides you to identify the Juniper platforms that can interop with ACX Series.

Table 1: EVI Support - MAC-VRF vs EVPN vs VIRTUAL-SWITCH

Instance Type	Platform with OS	VLAN-BASED		VLAN-BUNDLE		VLAN-AWARE	
		MPLS	VXLAN	MPLS	VXLAN	MPLS	VXLAN
MAC-VRF	PTX Series (Junos OS Evolved)	✓	✓	✓	✓	✓	✓
	ACX Series (Junos OS Evolved)	✓	✓	✓	✓	✓	✓

Instance Type	Platform with OS	VLAN-BASED		VLAN-BUNDLE		VLAN-AWARE	
		MPLS	VXLAN	MPLS	VXLAN	MPLS	VXLAN
	MX Series (Junos OS)	×	✓	×	✓	×	✓
EVPN	MX Series (Junos OS)	✓	×	✓	×	×	×
	ACX Series (Junos OS)	✓	×	✓	×	×	×
	PTX Series (Junos OS)	×	×	×	×	×	×
VIRTUAL-SWITCH	MX Series (Junos OS)	×	×	×	×	✓	✓
	ACX Series (Junos OS)	×	×	×	×	×	×
	PTX Series (Junos OS)	×	×	×	×	×	×

EVPN E-LAN Services Behavior Per Instance Type

Table 2 outlines the behavior of each EVPN E-LAN service model for implementation on ACX Series with Junos OS Evolved. This behavior is useful during interop with other Juniper platforms or other Networking Equipment Manufacturers (NEM).

Table 2: Service Comparison MAC-VRF vs EVPN vs VIRTUAL-SWITCH

Services	MAC-VRF	EVPN	Virtual-Switch
Control-word enabled by default	✓	×	×
Normalization	✓	✓	×
no-normalization	✓	✓	×
Default normalization behavior	No-normalization	Normalization	NA
Full RFC7432 Compliance	✓	✓	✓
Core Isolation	✓	✓	✓

EVPN E-LAN Services Behavior with the SP or EP Style of Configuration

Service Provider (SP) style and Enterprise (EP) have different styles for configuring interfaces using Juniper platforms.

Table 3 highlights the supported options available for configuring vlan-id or vlan-id-list.

Table 3: Configuration SP vs EP Style - MAC-VRF

Services vlan-id vs vlan-id-list	VLAN-BASED		VLAN-BUNDLE		VLAN-AWARE	
	SP Style	EP Style	SP Style	EP Style	SP Style	EP Style
VLAN-id	✓	✕	✓	✕	✓	✕
VLAN-id-list	✕	✕	✓	✕	✕	✕

EVPN MAC-VRF

Overview

MAC-VRF unifies EVPN E-LAN services configuration across all Juniper platforms for EVPN-MPLS or EVPN-VXLAN. With this instance, the CLI `service-type` drives the requirements of the service under a single umbrella for the E-LAN services. These are driven by the service provider requirements, RFC compliance, and design choices.

MAC-VRF is not just about simplicity, it also addresses RFC compliance without any additional CLIs. With `instance-type mac-vrf`, the bridge domains are extended into EVPN by default. There is no need to configure `extended-vlan-list` to extend the BDs in the EVPN. For MPLS encapsulation, only SP Style is supported in MAC-VRF instances.

VLAN-Based Service Models

VLAN-based service is a one-to-one mapping of the VLAN ID association with the EVPN Instance (EVI). The MAC-VRF EVI corresponds one VLAN to a single flooding domain and single MAC learning domain to handle all the BUM and Unicast traffic. In some use cases, VLANs on two ends of the EVPN network are different and, in that case, you need to perform VLAN translation.

Table 4 lists different translation models with examples. The ACX Series are flexible to adhere to the compliance partial or full based on the requirement.

Table 4: VLAN-Based Service Models Options

Options	Description	Route Example
No VLAN Translation, Ethernet tag = 0	This is a strict compliance of RFC7432 Section 6.1. The T2 route consists of Ethernet TAG=0	2:22.22.22.22:1::0::00:00:aa:00:00:00/304 MAC/IP
No VLAN Translation, Ethernet-tag = non zero	This is a partial compliance of RFC7432 Section 6.1. The T2 route consists of Ethernet TAG=non zero. In this case, the VLANs facing Access & Core are symmetric.	2:22.22.22.22:1::1::00:00:aa:00:00:00/304 MAC/IP
VLAN Translation, Ethernet-tag = non zero	This is a partial compliance of RFC7432 Section 6.1. The T2 route consists of Ethernet TAG=non zero. In this case, the VLANS	2:22.22.22.22:1::1::00:00:aa:00:00:00/304 MAC/IP

Options	Description	Route Example
	facing Access & Core are Asymmetric. A VLAN translation needs to be done.	

With MAC-VRF, the control plane advertises routes with ethernet-tag-id = 0 for vlan-based service by default. To interop with other Juniper platforms (Junos OS based), an EVPN instance is configured with `vlan-id none` and `protocol evpn no-normalization` for routing instances with `instance-type evpn`.

At the same time, routing-instance on other platforms configured using `instance-type evpn` in default mode without `vlan-id none` and `protocol evpn no-normalization`. Then, the MAC-VRF instance is configured with `normalize` tag.

EVPN vs MAC-VRF (Normalization)

Table 5 provides guidelines to Interop between different Juniper platforms implementing VLAN-based service using instance-type EVPN or MAC-VRF.

Table 5: Interop Configuration Guidelines

Feature	EVPN	MAC-VRF
normalization	Default behavior	With CLI under protocol evpn `set normalization`.
no normalization	Using CLIs, `set vlan-id none` and `set no-normalization`.	Default Behavior MAC/IP
control-word (default)	Disabled	Enabled

VLAN Bundle

MAC-VRF instance with service-type "vlan-bundle" offers service with multiple bridge-domain/VLANS under it. The MAC-VRF EVPN Instance (EVI) corresponds to one VLAN to a bridge table. Then, the created bridge domain handles all the BUM and Unicast traffic within the Bridge domain. For more information, see *RFC7432 Section 6.2*.

When maintaining single MAC learning domain (single MAC table, single bridge domain), you can apply VLAN bundle service to multiple broadcast domains (multiple VLANs). This implies that MAC address must be unique across VLANs. There cannot be MAC overlap between VLANs in the VLAN bundle service. Using VLAN bundle, you can consolidate many similar VLANs to be part of a single BD.

Underlay and Customer Equipment (CE)

Configuration

All PEs are configured using the OSPF and MPLS for underlay. The PEs are configured with fully meshed BGP session with `family evpn signaling` enabled to exchange the EVPN routes among each other. For sample configuration, see Underlay Configuration – MPLS/OSPF. For CE configuration, see CE Configuration in EPL, A/A Mode.

ESI

Configuration

Ethernet Segment Identifier (ESI) identifies multihomed Ethernet segments. Information about ESI in EVPN messages is encoded in NRLI and distributed through ES-Import Route Target (RT) communities (*RFC 7432, Section 7.6*) in Type 4 messages. For example:

```
4:11.11.11.11:0::111111111111111111111:11.11.11.11/296 ES (1 entry, 1 announced) <===== encoded
ESI: Type 0, Value: 11:11:11:11:11:11:00:00:00

TSI:
Page 0 idx 0, (group ibgp type Internal) Type 1 val 0x56375d6c5030 (adv_entry)
  Advertised metrics:
    Flags: Nexthop Change
    Nexthop: Self
    Localpref: 100
    AS path: [64512] I
    Communities: es-import-target:11-11-11-11-11-11   <===== ES-IMPORT RT
   Advertise: 00000003
Path 4:11.11.11.11:0::111111111111111111111:11.11.11.11
```

ESI generates the ES-Import RTs. For example:

```
set interfaces ae0 esi 00:11:11:11:11:11:11:11:11:11
```

ESI has 10 bytes and ES-Import RT has space for six bytes of payload. Therefore, the first 6 most significant bytes from ESI payload are taken to generate ES-Import RT. In ESI, the first byte is ESI Type. For example, Type 0: manually configured. In the above example, 11:11:11:11:11:11 are taken from configured ESI and used to populate advertised ES-Import RT. The ES-Import RT enables all the PEs connected to the same multi-homed site to import the Ethernet Segment (Type 4) routes.

If the following ESIs are configured on some interfaces, then the ES-Import RT is 00:00:00:11:11:11 with ESI configured as 00:00:00:00:11:11:11:11:11:11 on PE1 and PE2 in Figure 2. See the following configuration:

```
set interfaces ae0 esi 00:00:00:00:11:11:11:11:11:11
```

The output from the PE1 with ESIs configuration is as follows:

```
4:11.11.11.11:0::111111111111:11.11.11.11/296 ES (1 entry, 1 announced)
TSI:
Page 0 idx 0, (group ibgp type Internal) Type 1 val 0x56375d6c72c0 (adv_entry) <=====
encoded ESI: Type 0, Value: 00:00:00:11:11:11:11:11:11:00:00:00
  Advertised metrics:
    Flags: Nexthop Change
    Nexthop: Self
    Localpref: 100
    AS path: [64512] I
    Communities: es-import-target:0-0-0-11-11-11 <===== ES-IMPORT RT
   Advertise: 00000007
Path 4:11.11.11.11:0::111111111111:11.11.11.11
```

As the configuration is same for all ESIs, all PEs will import Type 4 routes. The route is not used if there is no match based on the actual ESI encoded as part of NRLI in these Type 4 routes and the actual ESI configured on some local interface. This EVPN configuration is not optimal. The most optimal configuration for control plane is to differentiate ESIs in the first six useful bytes instead of using the last three bytes. The generated ES-Import RT prevents the routes from being imported on PEs that do not need them.

CHAPTER 2 Configure EVPN E-LINE/ E-LAN Service on ACX7000 Series

This chapter explains the following configuration scenarios:

- EVPN-MPLS E-LINE/VPWS/FXC
- EVPN-MPLS E-LAN
- EVPN-VXLAN E-LAN

EVPN-MPLS E-LINE/VPWS/FXC

EVPN-MPLS VPWS

All three PEs in Figure 1 are BGP-EVPN PE. The PEs are set up using the EVPN VPWS instance and the required configurations on all the PEs. The PEs discover each other in the network and establish the EVPN sessions.

Figure 2: EVPN E-LINE/VPWS
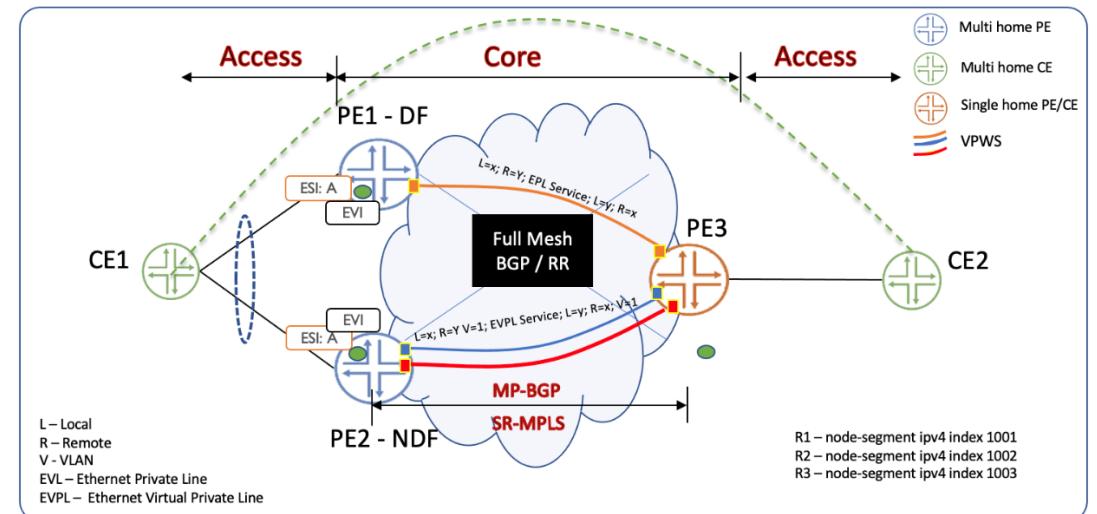
VPWS Configuration - Active/Active Mode

The output highlights the EVI and the UNI-facing interface configuration on all three PE nodes shown in Figure 2. This configuration focus on the Active/Active mode.

In Active/Active mode, you must bundle the UNI links from CE to PE for load balancing the traffic. You must make the necessary configuration on the router to achieve the load balance behavior.

Here, you change the configuration to support the Active/Active mode. The configuration shows only to add Active/Active on one of the MH PEs (PE1, PE2). You cannot configure an MH PEs ESI in different modes, for example: PE1 in Active/Standby and PE2 in Active/Active.

```
PE1                                             PE2
r1-re0# show interfaces ae0                     r2-re0# show interfaces ae0
ae0 {                                           ae0 {
    encapsulation ethernet-ccc;                     encapsulation ethernet-ccc;
    esi {                                           esi {
        00:11:11:11:11:11:11:11:11:11;                  00:11:11:11:11:11:11:11:11:11;
        all-active;                                     all-active;
    }                                               }
    aggregated-ether-options {                      aggregated-ether-options {
        lacp {                                          lacp {
            active;                                         active;
            system-id 00:00:00:00:11:01;                    system-id 00:00:00:00:11:01;
        }                                               }
    }                                               }
    unit 0 {                                        unit 0 {
        family ccc;                                     family ccc;
    }                                               }
}                                               }

r1-re0# show routing-instances                  r2-re0# show routing-instances
evpn-vpws-evpl {                                evpn-vpws-evpl {
    instance-type evpn-vpws;                        instance-type evpn-vpws;
    protocols {                                     protocols {
        evpn {                                          evpn {
            interface ae0.0 {                               interface ae0.0 {
                vpws-service-id {                               vpws-service-id {
                    local 1;                                        local 1;
                    remote 2;                                       remote 2;
                }                                               }
            }                                               }
        }                                               }
    }                                               }
    interface ae0.0;                                interface ae0.0;
    route-distinguisher 11.11.11.11:1;              route-distinguisher 22.22.22.22:1;
    vrf-target target:11:1;                         vrf-target target:11:1;
}                                               }
```

EVPN-MPLS VPWS FXC

All three PEs in Figure 2 are BGP-EVPN PE. The PEs are set up using the EVPN VPWS instance and the required configurations on all the PEs. These PEs discover each other in the network and establish the EVPN sessions.

Figure 3: EVPN VPWS FXC
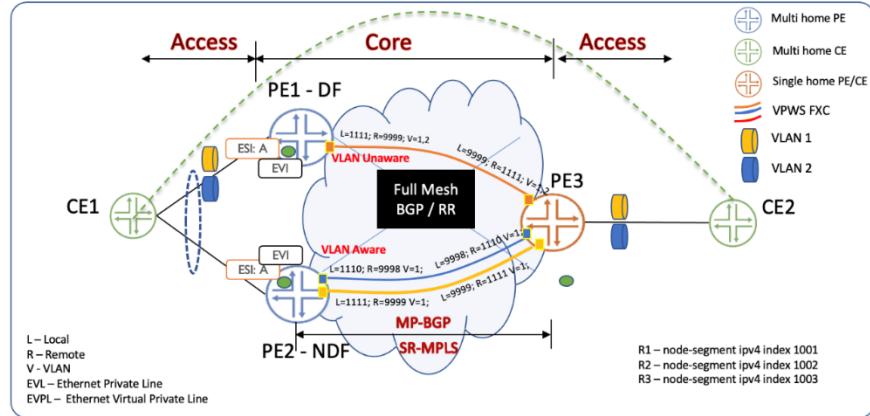
FXC VLAN-Aware Configuration - Active/Active Mode

The output highlights the EVI and the UNI-facing interface configuration on all three PE nodes (see Figure 3). This configuration focus on the Active/Active mode.

```
PE1
r1-re0# show interfaces ae0
ae0 {
    flexible-vlan-tagging;
    encapsulation flexible-ethernet-services;
    esi {
        00:11:11:11:11:11:11:11:11:11;
        all-active;
    }
    aggregated-ether-options {
        lacp {
            active;
            system-id 00:00:00:00:11:01;
        }
    }
    unit 1 {
        encapsulation vlan-ccc;
        vlan-id 1;
    }
    unit 2 {
        encapsulation vlan-ccc;
        vlan-id 2;
    }
}

r1-re0# show routing-instances
evpn-vpws-evpl {
    instance-type evpn-vpws;
    protocols {
        evpn {
            interface ae0.1 {
                vpws-service-id {
                    local 1111;
                    remote 9991;
                }
            }
            interface ae0.2 {
                vpws-service-id {
                    local 1112;
                    remote 9992;
                }
            }
            flexible-cross-connect-vlan-aware;
        }
    }
    interface ae0.1;
    interface ae0.2;
    route-distinguisher 11.11.11.11:1;
    vrf-target target:11:1;
}
```

```
PE3
r2-re0# show interfaces ae0
ae0 {
    flexible-vlan-tagging;
    encapsulation flexible-ethernet-services;
    aggregated-ether-options {
        lacp {
            active;
        }
    }
    unit 1 {
        encapsulation vlan-ccc;
        vlan-id 1;
    }
    unit 2 {
        encapsulation vlan-ccc;
        vlan-id 2;
    }
}

r2-re0# show routing-instances
evpn-vpws-evpl {
    instance-type evpn-vpws;
    protocols {
        evpn {
            interface ae0.1 {
                vpws-service-id {
                    local 9991;
                    remote 1111;
                }
            }
            interface ae0.2 {
                vpws-service-id {
                    local 9992;
                    remote 1112;
                }
            }
            flexible-cross-connect-vlan-aware;
        }
    }
    interface ae0.1;
    interface ae0.2;
    route-distinguisher 33.33.33.33:1;
    vrf-target target:11:1;
}
```

FXC VLAN-Unaware Configuration - Active/Active Mode

The output highlights the EVI and the UNI-facing interface configuration on all three PE nodes shown in Figure 3. This configuration focus on the Active/Active mode.

```
                                  PE1                                           PE3
r1-re0# show interfaces ae0                      r2-re0# show interfaces ae0
ae0 {                                            ae0 {
    flexible-vlan-tagging;                           flexible-vlan-tagging;
    encapsulation flexible-ethernet-services;        encapsulation flexible-ethernet-services;
    esi {                                            aggregated-ether-options {
        00:11:11:11:11:11:11:11:11:11;                   lacp {
        all-active;                                          active;
    }                                                    }
    aggregated-ether-options {                       }
        lacp {                                       unit 1 {
            active;                                      encapsulation vlan-ccc;
            system-id 00:00:00:00:11:01;                 vlan-id 1;
        }                                            }
    }                                                unit 2 {
    unit 1 {                                             encapsulation vlan-ccc;
        encapsulation vlan-ccc;                          vlan-id 2;
        vlan-id 1;                                   }
    }                                            }
    unit 2 {
        encapsulation vlan-ccc;
        vlan-id 2;                               r2-re0# show routing-instances
    }                                            evpn-vpws-evp1 {
                                                     instance-type evpn-vpws;
}                                                    protocols {
                                                         evpn {
r1-re0# show routing-instances                               flexible-cross-connect-vlan-unaware;
evpn-vpws-evp1 {                                             group fxc {
    instance-type evpn-vpws;                                     interface ae0.1;
    protocols {                                                  interface ae0.2;
        evpn {                                                   service-id {
            flexible-cross-connect-vlan-unaware;                     local 9999;
            group fxc {                                              remote 11111;
                interface ae0.1;                                 }
                interface ae0.2;                             }
                service-id {                             }
                    local 1111;                      }
                    remote 9999;                     route-distinguisher 33.33.33.33:1;
                }                                    vrf-target target:11:1;
            }                                    }
        }
    }
    route-distinguisher 11.11.11.11:1;
    vrf-target target:11:1;
}
```

EVPN-MPLS E-LAN

EVPN-MPLS E-LAN VLAN-Based

All four PEs in Figure 2 are BGP-EVPN PE. The PEs are set up using the EVPN MAC-VRF instance and the required configurations on the PEs. These PEs discover each other in the network, establish the EVPN sessions, and exchange the EVPN routes. With VLAN based service, there is one VLAN associated with an EVI. This VLAN has one-to-one mapping of the VLAN-ID and the EVI. So, one bridge table for one VLAN.

Table 1 highlights the different VLAN based models, which are mentioned in the RFC 7432. You can take actions in the Ingress router based on your requirements.

For more information on the VLAN-based service, see VLAN-Based Service for EVPN.

Figure 4: EVPN E-LAN VLAN-BASED
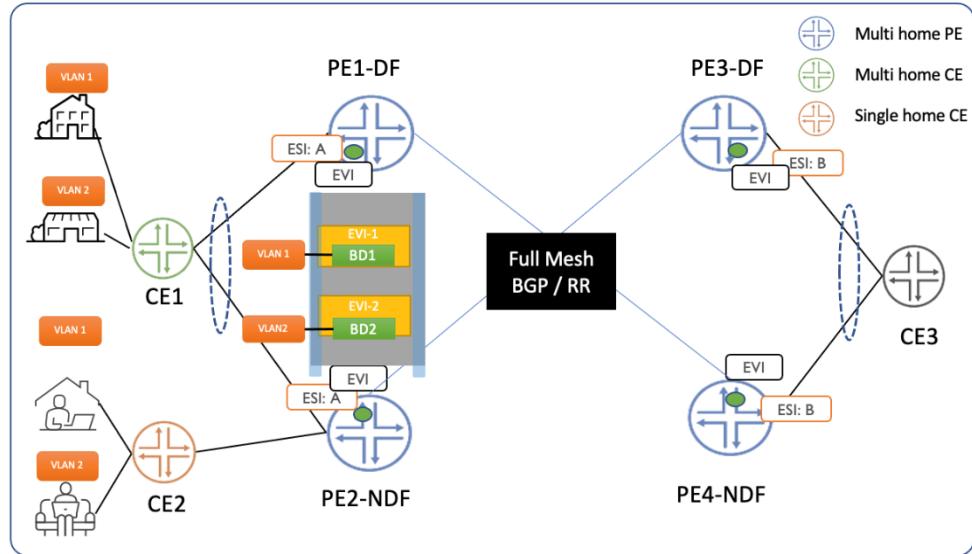
E-LAN (VLAN-Based) Configuration - Active/Active Mode

In the Active/Active mode, you need to bundle the UNI links from CE node to the multihomed
PE for load balancing the traffic.

```
                    PE1                                             PE3
r1-RE0-re0# show interfaces ae0              r3-RE0-re0# show interfaces ae0
flexible-vlan-tagging;                       flexible-vlan-tagging;
encapsulation flexible-ethernet-services;    encapsulation flexible-ethernet-services;
esi {                                        esi {
    00:11:11:11:11:11:11:11:11:11;               00:22:22:22:22:22:22:22:22:22;
    all-active;                                  all-active;
}                                            }
aggregated-ether-options {                   aggregated-ether-options {
    lacp {                                       lacp {
        active;                                      active;
        system-id 00:00:00:00:11:01;                 system-id 00:00:00:00:22:01;
    }                                            }
}                                            }
unit 1 {                                     unit 1 {
    encapsulation vlan-bridge;                   encapsulation vlan-bridge;
    vlan-id 1;                                   vlan-id 1;
}                                            }

r1-RE0-re0# show routing-instances           r2-RE0-re0# show routing-instances
evpn-vlan-based {                            evpn-vlan-based {
    instance-type mac-vrf;                       instance-type mac-vrf;
    protocols {                                  protocols {
        evpn {                                       evpn {
         encapsulation mpls;                          encapsulation mpls;
        }                                            }
    }                                            }
    service-type vlan-based;                     service-type vlan-based;
    route-distinguisher 11.11.11.11:1;           route-distinguisher 33.33.33.33:1;
    vrf-target target:11:1;                      vrf-target target:11:1;
    vlans {                                      vlans {
        bd1 {                                        bd1 {
            vlan-id 1;                                   vlan-id 1;
            interface ae0.1;                             interface ae0.1;
        }                                            }
    }                                            }
}                                            }
```

EVPN-MPLS E-LAN VLAN-BASED (Interop Junos-MX vs Evolved) – No-Normalization

All the four PEs in Figure 2 are BGP-EVPN PE. The PEs on one side are Junos OS EVO based platforms configured with MAC-VRF instance and on the other side are Junos OS based MX Series configured with EVPN instance type. This configuration is RFC compliant.

The PEs discover each other in the network, establish the EVPN sessions, and exchange the EVPN routes. With VLAN-based service, there is one VLAN associated with an EVI with a one-to-one mapping of the VLAN-ID and the EVI. So, one bridge table for one VLAN.

Table 1 highlights the different VLAN based models, which are mentioned in the RFC 7432. You can take actions in the Ingress router based on your requirements.

E-LAN (VLAN-Based Interop Junos-MX vs Evolved –> No-Normalization) Configuration – A/A Mode

In the Active/Active mode, you must bundle the UNI links from CE node to the multihomed PE for load balancing the traffic. In this case, you are provisioning VLAN-based service with no-normalization. The CEs connected on either side of the network are part of same or different VLANs. Ensure that the traffic is forwarded end-to-end. The RFC7432 section 6.1 mandates that the Ingress PE cannot modify the VLAN information coming from the CE (also known as no-normalization). The PE1 or PE3 preserves the Ethernet tag information when the traffic passes through the WAN. The control plane generates the Type2 (MAC/IP) route, and Type3 (IM) route Ethernet tag set to 0. The following configuration output is used for the Interop requirement.

```
                        PE1                                      PE3 (MX-Junos)
r1-RE0-re0# show interfaces ae0            r2-RE0-re0# show interfaces ae0
flexible-vlan-tagging;                     flexible-vlan-tagging;
encapsulation flexible-ethernet-services;  encapsulation flexible-ethernet-services;
esi {                                      esi {
    00:11:11:11:11:11:11:11:11:11;             00:22:22:22:22:22:22:22:22:22;
    all-active;                                all-active;
}                                          }
aggregated-ether-options {                 aggregated-ether-options {
    lacp {                                     lacp {
        active;                                    active;
        system-id 00:00:00:00:11:01;               system-id 00:00:00:00:22:01;
    }                                          }
}                                          }
unit 1 {                                   unit 1 {
    encapsulation vlan-bridge;                 encapsulation vlan-bridge;
    vlan-id 1;                                 vlan-id 1;
}                                          }

r1-RE0-re0# show routing-instances        r2-RE0-re0# show routing-instances
evpn-vlan-based {                          evpn-vlan-based {
    instance-type mac-vrf;                     instance-type evpn;
    protocols {                                protocols {
        evpn {                                     evpn {
            no-control-word;                           no-control-word;
            encapsulation mpls;                        encapsulation mpls;
        }                                          }
    }                                          }
    service-type vlan-based;                   Vlan-id none;
    route-distinguisher 11.11.11.11:1;         no-normalization;
    vrf-target target:11:1;                    route-distinguisher 22.22.22.22:1;
    vlans {                                    vrf-target target:11:1
        bd1 {                                  interface ae0.1;
            vlan-id 1;                     }
            interface ae0.1;
        }
    }
}
```

EVPN-MPLS E-LAN VLAN-BASED (Interop Junos-MX vs Evolved) – Normalization

All four PEs in Figure 2 are BGP-EVPN PE, where two PEs configured on one side are Junos OS Evolved based platforms with MAC-VRF instance and on the other side are Junos OS based MX Series configured with EVPN instance type. This configuration is partially RFC compliant.

The PEs discover each other in the network, establish the EVPN sessions, and exchange the EVPN routes. With VLAN-based service, there is one VLAN associated with an EVI with a one-to-one mapping of the VLAN-ID and the EVI. So, one bridge table for one VLAN.

Table 1 highlights the different VLAN based models, which are mentioned in the RFC 7432. You can take actions in the Ingress router based on your requirements.

E-LAN (VLAN-Based Interop Junos-MX vs Evolved –> Normalization) Configuration – A/A Mode

In the Active/Active mode, you must bundle the UNI links from CE node to the multihomed PE for load balancing the traffic.

In this case, you are provisioning VLAN-based service with normalization. The CEs connected on either side of the network are part of different VLANs. Ensure that the traffic is forwarded. This is not RFC compliant because the VLAN information is normalized in the ingress PE. The following configuration output is used for the Interop requirements.

```
                    PE1                                             PE3
r1-RE0-re0# show interfaces ae0          r2-RE0-re0# show interfaces ae0
flexible-vlan-tagging;                   flexible-vlan-tagging;
encapsulation flexible-ethernet-services; encapsulation flexible-ethernet-services;
esi {                                    esi {
    00:11:11:11:11:11:11:11:11:11;           00:22:22:22:22:22:22:22:22:22;
    all-active;                              all-active;
}                                        }
aggregated-ether-options {               aggregated-ether-options {
    lacp {                                   lacp {
        active;                                  active;
        system-id 00:00:00:00:11:01;             system-id 00:00:00:00:22:01;
    }                                        }
}                                        }
unit 1 {                                 unit 1 {
    encapsulation vlan-bridge;               encapsulation vlan-bridge;
    vlan-id 20;                              vlan-id 10;
}                                        }

r1-RE0-re0# show routing-instances      r2-RE0-re0# show routing-instances
evpn-vlan-based {                        evpn-vlan-based {
    instance-type mac-vrf;                   instance-type evpn;
    protocols {                              protocols {
        evpn {                                   evpn {
            normalization;                           no-control-word;
            no-control-word;                         encapsulation mpls;
            encapsulation mpls;                  }
        }                                    }
    }                                    vlan-id 20;
    service-type vlan-based;             route-distinguisher 22.22.22.22:1;
    route-distinguisher 11.11.11.11:1;   vrf-target target:11:1;
    vrf-target target:11:1;              interface ae0.1;
    vlans {                              }
        bd1 {
            vlan-id 20;
            interface ae0.1;
        }
    }
}
```

EVPN-MPLS E-LAN VLAN-BASED (Interop Junos-ACX vs Evolved) – Normalization

All the four PEs in Figure 2 are BGP-EVPN PE, where two configured PEs on one side are Junos OS EVO based platforms with MAC-VRF instance and on the other side are Junos OS based ACX platforms configured with setup EVPN instance type. This configuration is partially RFC compliant.

The PEs discover each other in the network, establish the EVPN sessions, and exchange the EVPN routes. With the VLAN-based service, one VLAN is associated with an EVI with a one-to-one mapping of the VLAN-ID and the EVI. So, one bridge table for one VLAN.

Table 1 highlights the different VLAN based models which are mentioned in the RFC 7432 where you would like take actions at the Ingress router based on your requirements.

E-LAN (VLAN-Based Interop Junos-ACX vs Evolved –> Normalization) Configuration – A/A Mode

In the Active/Active mode, you must bundle the UNI links from CE node to the multihomed PE for load balancing the traffic.

In this case, you are provisioning VLAN-based service with normalization. The CEs connected on either side of the network are part of different VLANs and ensure that the traffic is forwarded. It is not RFC compliant in this case because the VLAN information is normalized in the ingress PE. The following configuration output is used for the Interop requirements.

```
                    PE1                                            PE3
r1-RE0-re0# show interfaces ae0           r2-RE0-re0# show interfaces ae0
flexible-vlan-tagging;                    flexible-vlan-tagging;
encapsulation flexible-ethernet-services; encapsulation flexible-ethernet-services;
esi {                                     esi {
    00:11:11:11:11:11:11:11:11:11;            00:22:22:22:22:22:22:22:22:22;
    all-active;                               all-active;
}                                         }
aggregated-ether-options {                aggregated-ether-options {
    lacp {                                    lacp {
        active;                                   active;
        system-id 00:00:00:00:11:01;              system-id 00:00:00:00:22:01;
    }                                         }
}                                         }
unit 1 {                                  unit 1 {
    encapsulation vlan-bridge;                encapsulation vlan-bridge;
    vlan-id 20;                               vlan-id 10;
}                                         }

r1-RE0-re0# show routing-instances       r2-RE0-re0# show routing-instances
evpn-vlan-based {                         evpn-vlan-based {
    instance-type mac-vrf;                    instance-type evpn;
    protocols {                               protocols {
        evpn {                                    evpn;
            normalization;                    }
            no-control-word;                  vlan-id 20;
            encapsulation mpls;               route-distinguisher 22.22.22.22:1;
        }                                     vrf-target target:11:1;
    }                                         interface ae0.1;
    service-type vlan-based;              }
    route-distinguisher 11.11.11.11:1;
    vrf-target target:11:1;
    vlans {
        bd1 {
            vlan-id 20;
            interface ae0.1;
        }
    }
}
```

E-LAN (VLAN-Based Interop Junos-ACX vs Evolved -> Normalization) Operational – A/A Mode

```
MAC IP flags  (S - Static, D - Dynamic, L - Local , R - Remote, Lp - Local Proxy,
               Rp - Remote Proxy, K - Kernel, RT - Dest Route, (N)AD - (Not) Advt to remote,
               RE - Re-ARP/ND, RO - Router, OV - Override, Ur - Unresolved,
               RTS - Dest Route Skipped, RGw - Remote Gateway, FU - Fast Update)
 Routing instance : evpn-vlan
 Bridging domain : bd1
   IP                        MAC                  Flags            Logical          Active
   address                   address                               Interface        source
   6.6.6.2                   00:00:6e:9e:4e:65    DR,K                              00:11:11:11:11:11:11:11:11:11
   6.6.6.1                   00:00:6e:9e:4e:69    DL,K,AD          ae10.10

acx-48l-06>

acx-48l-06> show mac-vrf forwarding mac-table

MAC flags (S - static MAC, D - dynamic MAC, L - locally learned, P - Persistent static, C - Control MAC
          SE - statistics enabled, NM - non configured MAC, R - remote PE MAC, O - ovsdb MAC)

Ethernet switching table : 2 entries, 2 learned
Routing instance : evpn-vlan
   Vlan          MAC                   MAC       Age    Logical             NH       RTR
   name          address               flags            interface          Index    ID
   bd1           00:00:6e:9e:4e:65     DC        -                          15135    15135
   bd1           00:00:6e:9e:4e:69     D         -     ae10.10              0        0


acx-48l-06> show route advertising-protocol bgp 3.3.3.3

bgp.evpn.0: 11 destinations, 11 routes (11 active, 0 holddown, 0 hidden)
  Prefix            Nexthop       MED    Lclpref   AS path
  1:1.1.1.1:0::2222222222222222::FFFF:FFFF/192 AD/ESI
*                   Self                 100        I
  1:1.1.1.1:51::2222222222222222::10/192 AD/EVI
*                   Self                 100        I
  2:1.1.1.1:51::10::00:00:6e:9e:4e:69/304 MAC/IP
*                   Self                 100        I
  2:1.1.1.1:51::10::00:00:6e:9e:4e:69::6.6.6.1/304 MAC/IP
*                   Self                 100        I
  3:1.1.1.1:51::10::1.1.1.1/248 IM
*                   Self                 100        I
  4:1.1.1.1:0::2222222222222222:1.1.1.1/296 ES
*                   Self                 100        I
evpn-vlan.evpn.0: 9 destinations, 9 routes (9 active, 0 holddown, 0 hidden)
  Prefix            Nexthop       MED    Lclpref   AS path
  1:1.1.1.1:51::2222222222222222::10/192 AD/EVI
*                   Self                 100        I
  2:1.1.1.1:51::10::00:00:6e:9e:4e:69/304 MAC/IP
*                   Self                 100        I
  2:1.1.1.1:51::10::00:00:6e:9e:4e:69::6.6.6.1/304 MAC/IP
*                   Self                 100        I
  3:1.1.1.1:51::10::1.1.1.1/248 IM
*                   Self                 100        I
__default_evpn__.evpn.0: 2 destinations, 2 routes (2 active, 0 holddown, 0 hidden)
 Prefix            Nexthop       MED    Lclpref   AS path
 1:1.1.1.1:0::2222222222222222::FFFF:FFFF/192 AD/ESI
*          Self           100     I
 4:1.1.1.1:0::2222222222222222:1.1.1.1/296 ES
*          Self           100     I



        Remote-PE      MAC-label  Aliasing-label  Mode
        5.5.5.5        161        161             all-active
   ESI: 00:22:22:22:22:22:22:22:22:22
      Status: Resolved by IFL ae10.10
      Local interface: ae10.10, Status: Up/Forwarding
      DF Election Algorithm: MOD based
      Designated forwarder: 1.1.1.1
      Last designated forwarder update: Jan 17 23:38:10
      Advertised split horizon label: 232
   SMET Forwarding: Disabled

acx-48l-06> show mac-vrf forwarding mac-ip-table
```

```
                                                  PE3
acx18> show interfaces ae0
Physical interface: ae0, Enabled, Physical link is Up
  Interface index: 129, SNMP ifIndex: 573
  Link-level type: Flexible-Ethernet, MTU: 1522, Speed: 10Gbps, BPDU Error: None, Ethernet-Switching Error: None, MAC-REWRITE Error:
None, Loopback: Disabled, Source filtering: Disabled,
  Flow control: Disabled, Minimum links needed: 1, Minimum bandwidth needed: 1bps
  Device flags   : Present Running
  Interface flags: SNMP-Traps Internal: 0x4000
  Current address: 44:ec:ce:22:f8:bc, Hardware address: 44:ec:ce:22:f8:bc
  Last flapped   : 2023-01-17 23:30:48 PST (00:10:08 ago)
  Input rate     : 20007168 bps (5002 pps)
  Output rate    : 20006616 bps (5002 pps)

  Logical interface ae0.10 (Index 76) (SNMP ifIndex 574)
    Flags: Up SNMP-Traps 0x20004000 VLAN-Tag [ 0x8100.20 ] In(swap .10) Out(swap .20)  Encapsulation: VLAN-Bridge
    Statistics        Packets        pps         Bytes          bps
    Bundle:
        Input :       284096          0     142048000              0
        Output:       284096          0     142048000              0

acx18> show evpn instance extensive
Instance: __default_evpn__
  Route Distinguisher: 5.5.5.5:0
  Number of bridge domains: 0
  Number of neighbors: 0


Instance: evpn-junos
  Route Distinguisher: 5.5.5.5:1801
  VLAN ID: 10
  Per-instance MAC route label: 151
  Duplicate MAC detection threshold: 5
  Duplicate MAC detection window: 180
  MAC database status                    Local  Remote
    MAC advertisements:                     1      1
    MAC+IP advertisements:                  1      1
    Default gateway MAC advertisements:     0      0
  Number of local interfaces: 2 (2 up)
    Interface name  ESI                             Mode          Status     AC-Role
    .local..1801    00:00:00:00:00:00:00:00:00:00   single-homed  Up         Root
    ae0.10          00:11:11:11:11:11:11:11:11:11   all-active    Up         Root
  Number of IRB interfaces: 0 (0 up)
  Number of protect interfaces: 0
  Number of bridge domains: 1
    VLAN  Domain-ID Intfs/up   IRB-intf  Mode          MAC-sync v4-SG-sync v6-SG-sync
    10              1  1                 Extended      Enabled  Disabled   Disabled
  Number of neighbors: 1
    Address           MAC     MAC+IP       AD       IM       ES Leaf-label Remote-DCI-Peer
    1.1.1.1             1       1           2        1        0
  Number of ethernet segments: 2
    ESI: 00:11:11:11:11:11:11:11:11:11
      Status: Resolved by IFL ae0.10
      Local interface: ae0.10, Status: Up/Forwarding
      DF Election Algorithm: MOD based
      Designated forwarder: 5.5.5.5
      Last designated forwarder update: Jan 17 23:38:06
      Advertised MAC label: 161
      Advertised aliasing label: 161
Advertised split horizon label: 162
    ESI: 00:22:22:22:22:22:22:22:22:22
      Status: Resolved by NH 2097155
      Number of remote PEs connected: 1
        Remote-PE       MAC-label  Aliasing-label  Mode
        1.1.1.1         225        225             all-active
  SMET Forwarding: Disabled
acx18> show evpn database
Instance: evpn-junos
VLAN  DomainId  MAC address       Active source                   Timestamp       IP address
10              00:00:6e:9e:4e:65 00:11:11:11:11:11:11:11:11:11    Jan 17 23:36:00 6.6.6.2
10              00:00:6e:9e:4e:69 00:22:22:22:22:22:22:22:22:22    Jan 17 23:38:19 6.6.6.1

acx18> show evpn mac-ip-table

MAC IP flags  (S - Static, D - Dynamic, L - Local , R - Remote, Lp - Local Proxy,
               Rp - Remote Proxy, K - Kernel, RT - Dest Route, (N)AD - (Not) Advt to remote,
               RE - Re-ARP/ND, RO - Router, OV - Override, Ur - Unresolved,
               RTS - Dest Route Skipped, RGw - Remote Gateway)
```

```
Routing instance : evpn-junos
 Bridging domain : __evpn-junos__
   IP                        MAC                  Flags           Logical          Active
   address                   address                              Interface        source
   6.6.6.2                   00:00:6e:9e:4e:65    DL,K,AD         ae0.10
   6.6.6.1                   00:00:6e:9e:4e:69    DR,K                             00:22:22:22:22:22:22:22:22

acx18> show evpn mac-table

MAC flags (S - static MAC, D - dynamic MAC, L - locally learned, P - Persistent static, C - Control MAC
          SE - statistics enabled, NM - non configured MAC, R - remote PE MAC, O - ovsdb MAC)


Ethernet switching table : 2 entries, 2 learned
Routing instance : evpn-junos
   Vlan              MAC                MAC      Age   Logical              NH       RTR
   name              address            flags          interface            Index    ID
   __evpn-junos__    00:00:6e:9e:4e:65  D        -    ae0.10               0        0
   __evpn-junos__    00:00:6e:9e:4e:69  DC       -                         2097155  2097155

acx18> show route advertising-protocol bgp 3.3.3.3

bgp.evpn.0: 11 destinations, 11 routes (11 active, 0 holddown, 0 hidden)
  Prefix           Nexthop       MED    Lclpref   AS path
  1:5.5.5.5:0::1111111111111111::FFFF:FFFF/192 AD/ESI
*                  Self                  100       I
  1:5.5.5.5:1801::1111111111111111111::0/192 AD/EVI
*                  Self                  100       I
  2:5.5.5.5:1801::10::00:00:6e:9e:4e:65/304 MAC/IP
*                  Self                  100       I
  2:5.5.5.5:1801::10::00:00:6e:9e:4e:65::6.6.6.2/304 MAC/IP
*                  Self                  100       I
  3:5.5.5.5:1801::10::5.5.5.5/248 IM
*                  Self                  100       I
  4:5.5.5.5:0::1111111111111111111:5.5.5.5/296 ES
*                  Self                  100       I

evpn-junos.evpn.0: 9 destinations, 9 routes (9 active, 0 holddown, 0 hidden)
  Prefix          Nexthop       MED    Lclpref   AS path
  1:5.5.5.5:1801::1111111111111111111::0/192 AD/EVI
*                  Self                  100       I
  2:5.5.5.5:1801::10::00:00:6e:9e:4e:65/304 MAC/IP
*                  Self                  100       I
  2:5.5.5.5:1801::10::00:00:6e:9e:4e:65::6.6.6.2/304 MAC/IP
*                  Self                  100       I
  3:5.5.5.5:1801::10::5.5.5.5/248 IM
*                  Self                  100       I

__default_evpn__.evpn.0: 2 destinations, 2 routes (2 active, 0 holddown, 0 hidden)
  Prefix          Nexthop       MED    Lclpref   AS path
  1:5.5.5.5:0::1111111111111111111::FFFF:FFFF/192 AD/ESI
*                  Self                  100       I
  4:5.5.5.5:0::1111111111111111111:5.5.5.5/296 ES
*                  Self                  100       I
```

Figure 5: Traffic Snapshot
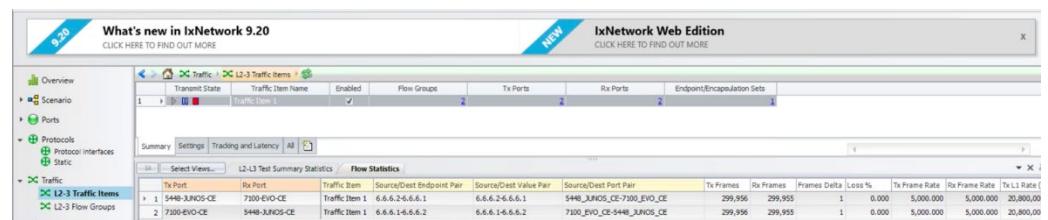
EVPN-MPLS E-LAN VLAN-Bundle

All three PEs in Figure 2 are BGP-EVPN PE. The PEs are set up using the EVPN MAC-VRF instance and the required configurations on all the PEs. These PEs discover each other in the network, establish the EVPN sessions, and exchange EVPN routes.

The current configuration is with the Active-Active mode for the multihomed PEs.

Figure 6: EVPN E-LAN VLAN-Bundle
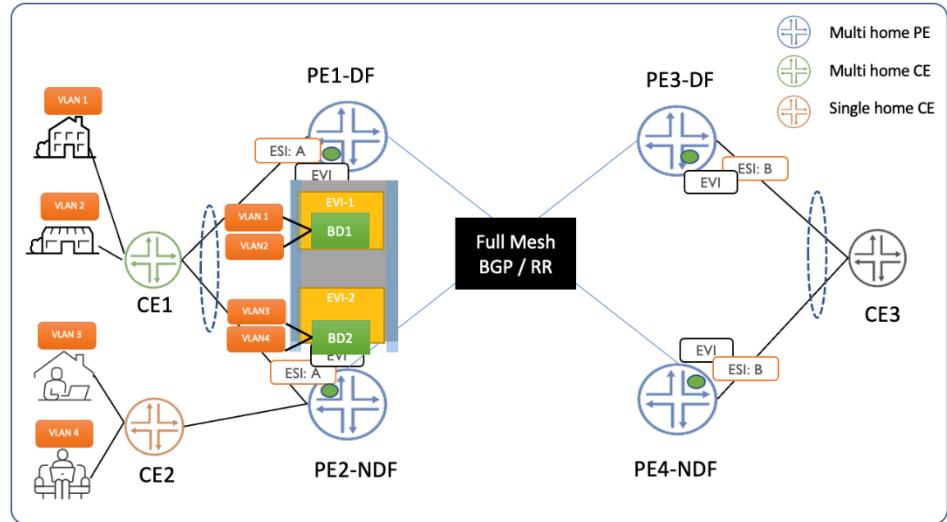
E-LAN (VLAN-Bundle) Configuration - Active/Active Mode

In the Active/Active mode, you must bundle the UNI links from CE node to the multihomed PE for load balancing the traffic. You have two VLAN-IDs part that are of the same EVI. In the multihomed scenario, the ESI must be defined individually for each IFLs.

For a single/active scenario, the common ESI can be defined for both vlan-id in an EVI.

```
                    PE1
r1-RE0-re0# show routing-instances evpn-vlan-
bundle
instance-type mac-vrf;
protocols {
        evpn {
         encapsulation mpls;
        }
}
service-type vlan-bundle;
route-distinguisher 11.11.11.11:1;
vrf-target target:11:1;
vlans {
    bd1 {
        interface ae0.1;
        interface ae0.2;
    }
}
r1-RE0-re0# show interfaces ae0
flexible-vlan-tagging;
encapsulation flexible-ethernet-services;
aggregated-ether-options {
    lacp {
        active;
        system-id 00:00:00:00:11:01;
    }
}
unit 1 {
    encapsulation vlan-bridge;
    vlan-id 1;
    esi {
        00:11:11:11:11:11:11:11:11:11;
        all-active;
    }
}
unit 2 {
    encapsulation vlan-bridge;
    vlan-id 2;
    esi {
        00:11:11:11:11:11:11:11:11:12;
        all-active;
    }
}
```

```
                    PE3
r2-RE0-re0# show routing-instances evpn-vlan-
bundle
instance-type mac-vrf;
protocols {
        evpn {
         encapsulation mpls;
        }
}
service-type vlan-bundle;
route-distinguisher 22.22.22.22:1;
vrf-target target:11:1;
vlans {
    bd1 {
        interface ae0.1;
        interface ae0.2;
    }
}
r2-RE0-re0# show interfaces ae0
flexible-vlan-tagging;
encapsulation flexible-ethernet-services;
aggregated-ether-options {
    lacp {
        active;
        system-id 00:00:00:00:22:01;
    }
}
unit 1 {
    encapsulation vlan-bridge;
    vlan-id 1;
    esi {
        00:22:22:22:22:22:22:22:22:21;
        all-active;
    }
}
unit 2 {
    encapsulation vlan-bridge;
    vlan-id 2;
    esi {
        00:22:22:22:22:22:22:22:22:22;
        all-active;
    }
}
```

EVPN-VXLAN E-LAN

EVPN-VXLAN E-LAN VLAN-BASED

All four PEs in Figure 4 are BGP-EVPN PE. The PEs are set up using the EVPN MAC-VRF instance and the required configurations on all the PEs. The PEs discover each other in the network, establish the EVPN sessions, and exchange the EVPN routes.

E-LAN (VLAN-Based) Configuration - Active/Active Mode

In the Active/Active mode, you must bundle the UNI links from CE node to the multihomed PE for load balancing the traffic.

```
                    PE1                                              PE3
r1-RE0-re0# show interfaces ae0              r2-RE0-re0# show interfaces ae0
flexible-vlan-tagging;                       flexible-vlan-tagging;
encapsulation flexible-ethernet-services;    encapsulation flexible-ethernet-services;
esi {                                        esi {
    00:11:11:11:11:11:11:11:11:11;               00:22:22:22:22:22:22:22:22:21;
    all-active;                                  all-active;
}                                            }
aggregated-ether-options {                   aggregated-ether-options {
    lacp {                                       lacp {
        active;                                      active;
        system-id 00:00:00:00:11:01;                 system-id 00:00:00:00:22:01;
    }                                            }
}                                            }
unit 1 {                                     unit 1 {
    encapsulation vlan-bridge;                   encapsulation vlan-bridge;
    vlan-id 1;                                   vlan-id 1;
}                                            }

{master}[edit]                               {master}[edit]
r1-RE0-re0# show routing-instances           r2-RE0-re0# show routing-instances
evpn-vlan-based {                            evpn-vlan-based {
    instance-type mac-vrf;                       instance-type mac-vrf;
    protocols {                                  protocols {
        evpn;                                        evpn;
        encapsulation vxlan;                         encapsulation vxlan;
    }                                            }
    service-type vlan-based;                     service-type vlan-based;
    vtep-source-interface lo0.0                  vtep-source-interface lo0.0
    route-distinguisher 11.11.11.11:1;           route-distinguisher 33.33.33.33:1;
    vrf-target target:11:1;                      vrf-target target:11:1;
    vlans {                                      vlans {
        bd1 {                                        bd1 {
            vlan-id 1;                                   vlan-id 1;
            interface ae0.1;                             interface ae0.1;
            vxlan vni 1                                  vxlan vni 1
        }                                            }
    }                                            }
}                                            }
```

EVPN-VXLAN E-LAN VLAN-Bundle

All four PEs in Figure 7 topology are BGP-EVPN PE. The PEs are set up using the EVPN MAC-VRF instance and the required configurations on all the PEs. The PEs discover each other in the network, establish the EVPN sessions, and exchange EVPN routes.

The current configuration is with the Active-Active mode for the multihomed PEs.

E-LAN (VLAN-Bundle) Configuration - Active/Active Mode

In the Active/Active mode, you must bundle the UNI links from CE node to the multihomed PE for load balancing the traffic. You have two VLAN-IDs part that are of the same EVI. In the multihomed scenario, the ESI must be defined individually for each IFLs.

For a single/active scenario, the common ESI can be defined for both vlan-id in an EVI.

```
                    PE1                                         PE3
acx-48l-09# show routing-instances evpn-vlan-   acx-48l-09# show routing-instances evpn-vlan-
bundle                                          bundle
instance-type mac-vrf;                          instance-type mac-vrf;
protocols {                                     protocols {
    evpn {                                          evpn {
        encapsulation vxlan;                            encapsulation vxlan;
    }                                               }
}                                               }
vtep-source-interface lo0.0;                    vtep-source-interface lo0.0;
service-type vlan-bundle;                        service-type vlan-bundle;
route-distinguisher 11.11.11.11:1;              route-distinguisher 22.22.22.22:1;
vrf-target target:11:1;                         vrf-target target:11:1;
vlans {                                         vlans {
    bd1 {                                           bd1 {
        interface ae0.1;                                interface ae0.1;
        interface ae0.2;                                interface ae0.2;
        vxlan {                                         vxlan {
            vni 1;                                          vni 1;
        }                                               }
    }                                               }
}                                               }

[edit]                                          [edit]
acx-48l-09# show interfaces ae3                 acx-48l-09# show interfaces ae0
flexible-vlan-tagging;                          flexible-vlan-tagging;
encapsulation flexible-ethernet-services;       encapsulation flexible-ethernet-services;
unit 1 {                                        unit 1 {
    encapsulation vlan-bridge;                      encapsulation vlan-bridge;
    vlan-id 1;                                      vlan-id 1;
    esi {                                           esi {
        00:11:11:11:11:11:11:11:11:11;                  00:22:22:22:22:22:22:22:22:21;
        all-active;                                     all-active;
    }                                               }
}                                               }
unit 2 {                                        unit 2 {
    encapsulation vlan-bridge;                      encapsulation vlan-bridge;
    vlan-id 2;                                      vlan-id 2;
    esi {                                           esi {
        00:11:11:11:11:11:11:11:11:12;                  00:11:11:11:11:11:11:11:11:12;
        all-active;                                     all-active;
    }                                               }
}                                               }
```

EVPN-VXLAN E-LAN VLAN-AWARE

All four PEs in the Figure 8 topology are BGP-EVPN PE. The PEs are set up using the EVPN MAC-VRF instance and the required configurations on all the PEs. The PEs discover each other in the network, establish the EVPN sessions, and exchange EVPN routes.

The current configuration is with the Active-Active mode for the multihomed PEs.

Figure 7: EVPN E-LAN VLAN-Bundle

E-LAN (VLAN-Aware Bundle) Configuration - Active/Active Mode

In the Active/Active mode, you must bundle the UNI links from CE node to the multihomed PE for load balancing the traffic. You have two VLAN-IDs part that are of the same EVI. In the multihomed scenario, the ESI must be defined individually for each IFLs.

For a single/active scenario, the common ESI can be defined for both vlan-id in an EVI.

```
                    PE1                                          PE3
r1-RE0-re0# show routing-instances evpn-vlan-aware   r2-RE0-re0# show routing-instances evpn-vlan-aware
instance-type mac-vrf;                               instance-type mac-vrf;
protocols {                                          protocols {
    evpn;                                                evpn;
    encapsulation vxlan;                                 encapsulation vxlan;
}                                                    }
service-type vlan-aware;                             service-type vlan-aware;
route-distinguisher 11.11.11.11:1;                   route-distinguisher 22.22.22.22:1;
vrf-target target:11:1;                              vrf-target target:11:1;
vtep-source-interface lo0.0                          vtep-source-interface lo0.0
vlans {                                              vlans {
    bd1 {                                                bd1 {
        interface ae0.1;                                     interface ae0.1;
        vxlan vni 1                                          vxlan vni 1
    }                                                    }
    bd2 {                                                bd2 {
        interface ae0.2;                                     interface ae0.2;
        vxlan vni 2                                          vxlan vni 2
    }                                                    }
}                                                    }
r1-RE0-re0# show interfaces ae0                      r2-RE0-re0# show interfaces ae0
flexible-vlan-tagging;                               flexible-vlan-tagging;
encapsulation flexible-ethernet-services;            encapsulation flexible-ethernet-services;
aggregated-ether-options {                           aggregated-ether-options {
    lacp {                                               lacp {
        active;                                              active;
        system-id 00:00:00:00:11:01;                         system-id 00:00:00:00:22:01;
    }                                                    }
}                                                    }
unit 1 {                                             unit 1 {
    encapsulation vlan-bridge;                           encapsulation vlan-bridge;
    vlan-id 1;                                           vlan-id 1;
    esi {                                                esi {
        00:11:11:11:11:11:11:11:11:11;                       00:22:22:22:22:22:22:22:22:21;
        all-active;                                          all-active;
    }                                                    }
}                                                    }
```

```
unit 2 {                                        unit 2 {
    encapsulation vlan-bridge;                      encapsulation vlan-bridge;
    vlan-id 2;                                      vlan-id 3;
    esi {                                           esi {
        00:11:11:11:11:11:11:11:11:12;                  00:22:22:22:22:22:22:22:22:22;
        all-active;                                     all-active;
    }                                               }
}                                               }
```

CHAPTER 3 Common Configuration

For any EVPN services (ELINE/ELAN/ETREE), the below mentioned common configurations are the underlay configurations for the four Multihomed PEs that remain same. Here, we have IGP as ISIS and Segment Routing (SR) as transport. Each PE has a unique System ID, Loopback ID, and Node segment ipv4-index. These configurations are operator/Network engineer's choice and can be different than the example given below.

Underlay Configuration – MPLS/OSPF

```
                PE1
r1-re0# show interfaces
et-0/0/1 {
    unit 0 {
        description to-r4;
        family inet {
            address 10.1.1.1/30;
        }
        family mpls;
    }
}
et-0/0/3 {
    unit 0 {
        description to-r2;
        family inet {
            address 10.1.2.1/30;
        }
        family mpls;
    }
}
et-0/0/5 {
    unit 0 {
        description to-r3;
        family inet {
            address 10.1.3.1/30;
        }
        family mpls;
    }
}
et-0/0/7 {
    description "To R5";
    ether-options {
        802.3ad ae0;
    }
}
lo0 {
    unit 0 {
        family inet {
            address 192.168.0.1/32;
        }
    }
}
r1-re0# show protocols
bgp {
    group ibgp {
        type internal;
        local-address 192.168.0.1;
        family evpn {
            signaling;
        }
        neighbor 192.168.0.2;
        neighbor 192.168.0.3;
        neighbor 192.168.0.4;
    }
}
ldp {
    interface all;
```

```
                PE2
r2-re0# show interfaces
et-0/0/1 {
    unit 0 {
        description to-r3;
        family inet {
            address 10.1.23.1/30;
        }
        family mpls;
    }
}
et-0/0/3 {
    unit 0 {
        description to-r1;
        family inet {
            address 10.1.2.2/30;
        }
        family mpls;
    }
}
et-0/0/5 {
    unit 0 {
        description to-r4;
        family inet {
            address 10.1.24.1/30;
        }
        family mpls;
    }
}
et-0/0/9 {
    description "To R5";
    ether-options {
        802.3ad ae0;
    }
}
lo0 {
    unit 0 {
        family inet {
            address 192.168.0.2/32;
        }
    }
}
r2-re0# show protocols
bgp {
    group ibgp {
        type internal;
        local-address 192.168.0.2;
        family evpn {
            signaling;
        }
        neighbor 192.168.0.1;
        neighbor 192.168.0.3;
        neighbor 192.168.0.4;
    }
}
ldp {
    interface all;
```

```
    interface fxp0.0 {                          i    interface fxp0.0 {
        disable;                                         disable;
    }                                                }
}                                               }
mpls {                                          mpls {
    interface all;                                  interface all;
    interface fxp0.0 {                              interface fxp0.0 {
        disable;                                         disable;
    }                                                }
}                                               }
ospf {                                          ospf {
    area 0.0.0.0 {                                  area 0.0.0.0 {
        interface et-0/0/1.0;                            interface et-0/0/1.0;
        interface et-0/0/3.0;                            interface et-0/0/3.0;
        interface et-0/0/5.0;                            interface et-0/0/5.0;
        interface lo0.0 {                                interface lo0.0 {
            passive;                                         passive;
        }                                                }
    }                                                }
}                                               }
lldp {                                          lldp {
    interface all;                                  interface all;
}                                               }

r1-re0# show routing-options                    r2-re0# show routing-options
router-id 192.168.0.1;                          router-id 192.168.0.2;
autonomous-system 65000;                        autonomous-system 65000;
```

```
            PE3                                             PE4
r3-re0# show interfaces                         r4-re0# show interfaces
et-0/0/1 {                                      et-0/0/1 {
    unit 0 {                                        unit 0 {
        description to-r2;                               description to-r1;
        family inet {                                   family inet {
            address 10.1.23.2/30;                           address 10.1.1.2/30;
        }                                               }
        family mpls;                                    family mpls;
        family iso;                                     family iso;
    }                                               }
}                                               }
et-0/0/3 {                                      et-0/0/3 {
    unit 0 {                                        unit 0 {
        description to-r1;                               description to-r2;
        family inet {                                   family inet {
            address 10.1.3.2/30;                            address 10.1.24.2/30;
        }                                               }
        family mpls;                                    family mpls;
        family iso;                                     family iso;
    }                                               }
}                                               }
et-0/0/5 {                                      et-0/0/5 {
    unit 0 {                                        unit 0 {
        description to-r4;                               description to-r3;
        family inet {                                   family inet {
            address 10.1.34.1/30;                           address 10.1.34.2/30;
        }                                               }
        family mpls;                                    family mpls;
        family iso;                                     family iso;
    }                                               }
}                                               }
et-0/0/7 {                                      et-0/0/7 {
    description "To R7";                            description "To R7";
    ether-options {                                 ether-options {
        802.3ad ae0;                                    802.3ad ae0;
    }                                               }
}                                               }
lo0 {                                           lo0 {
    unit 0 {                                        unit 0 {
        family inet {                                   family inet {
            address 192.168.0.3/32;                         address 192.168.0.4/32;
        }                                       }
        family iso {                                    family iso {
            address 49.0001.3333.3333.00                    address 49.0001.4444.4444.00
        }                                               }
    }                                               }
}                                               }
```

```
r3-re0# show protocols                                  r4-re0# show protocols
bgp {                                                   bgp {
    group ibgp {                                            group ibgp {
        type internal;                                          type internal;
        local-address 192.168.0.3;                              local-address 192.168.0.4;
        family evpn {                                           family evpn {
            signaling;                                              signaling;
        }                                                      }
        neighbor 192.168.0.1;                                  neighbor 192.168.0.1;
        neighbor 192.168.0.2;                                  neighbor 192.168.0.2;
        neighbor 192.168.0.4;                                  neighbor 192.168.0.3;
    }                                                      }
}                                                       }
isis {                                                  isis {
    interface all {                                         interface all {
        point-to-point;                                         point-to-point;
    }                                                      }
    interface fxp0.0 {                                      interface fxp0.0 {
        disable;                                                disable;
    }                                                      }
    source-packet-routing {                                 source-packet-routing {
        node-segment ipv4-index 1003;                           node-segment ipv4-index 1004;
    }                                                      }
    level 2 wide-metrics-only;                              level 2 wide-metrics-only;
    level 1 disable;                                        level 1 disable;
}                                                       }
                                                        mpls {
mpls {                                                      interface all;
    interface all;                                          interface fxp0.0 {
    interface fxp0.0 {                                          disable;
        disable;                                            }
    }                                                   }
}                                                       lldp {
lldp {                                                      interface all;
    interface all;                                      }
}
                                                        r4-re0# show routing-options
r3-re0# show routing-options                            router-id 192.168.0.4;
router-id 192.168.0.3;                                  autonomous-system 65000;
autonomous-system 65000;
```

Underlay Configuration – SR, ISIS

```
                    PE1
r1-re0# show interfaces
et-0/0/1 {
    unit 0 {
        description to-r4;
        family inet {
            address 10.1.1.1/30;
        }
        family mpls;
    }
}
et-0/0/3 {
    unit 0 {
        description to-r2;
        family inet {
            address 10.1.2.1/30;
        }
        family mpls;
    }
}
et-0/0/5 {
    unit 0 {
        description to-r3;
        family inet {
            address 10.1.3.1/30;
        }
        family mpls;
     }
}
et-0/0/7 {
    description "To R5";
    ether-options {
        802.3ad ae0;
    }
}
lo0 {
    unit 0 {
        family inet {
            address 192.168.0.1/32;
        }
    }
}

r1-re0# show protocols
bgp {
    group ibgp {
        type internal;
        local-address 192.168.0.1;
        family evpn {
            signaling;
        }
        neighbor 192.168.0.2;
        neighbor 192.168.0.3;
        neighbor 192.168.0.4;
    }
}
isis {
    interface all {
        point-to-point;
    }
    interface fxp0.0 {
        disable;
    }
    source-packet-routing {
        node-segment ipv4-index 1001;
    }
    level 2 wide-metrics-only;
    level 1 disable;
}
mpls {
    interface all;
    interface fxp0.0 {
        disable;
    }
}
lldp {
    interface all;
}

r1-re0# show routing-options
router-id 192.168.0.1;
autonomous-system 64512;
```

```
                    PE2
r2-re0# show interfaces
et-0/0/1 {
    unit 0 {
        description to-r3;
        family inet {
            address 10.1.23.1/30;
        }
        family mpls;
    }
}
et-0/0/3 {
    unit 0 {
        description to-r1;
        family inet {
            address 10.1.2.2/30;
        }
        family mpls;
    }
}
et-0/0/5 {
    unit 0 {
        description to-r4;
        family inet {
            address 10.1.24.1/30;
        }
        family mpls;
    }
}
et-0/0/9 {
    description "To R5";
    ether-options {
        802.3ad ae0;
    }
}
lo0 {
    unit 0 {
        family inet {
            address 192.168.0.2/32;
        }
    }
}

r2-re0# show protocols
bgp {
    group ibgp {
        type internal;
        local-address 192.168.0.2;
        family evpn {
            signaling;
        }
        neighbor 192.168.0.1;
        neighbor 192.168.0.3;
        neighbor 192.168.0.4;
    }
}
isis {
    interface all {
        point-to-point;
    }
    interface fxp0.0 {
        disable;
    }
    source-packet-routing {
        node-segment ipv4-index 1001;
    }
    level 2 wide-metrics-only;
    level 1 disable;
}
mpls {
    interface all;
    interface fxp0.0 {
        disable;
    }
}
lldp {
    interface all;
}

r2-re0# show routing-options
router-id 192.168.0.2;
autonomous-system 64512;
```

```
                  PE3                                              PE4
r3-re0# show interfaces                          r4-re0# show interfaces
et-0/0/1 {                                       et-0/0/1 {
    unit 0 {                                         unit 0 {
        description to-r2;                               description to-r1;
        family inet {                                   family inet {
            address 10.1.23.2/30;                           address 10.1.1.2/30;
        }                                               }
        family mpls;                                    family mpls;
        family iso;                                     family iso;
    }                                               }
}                                                }
et-0/0/3 {                                       et-0/0/3 {
    unit 0 {                                         unit 0 {
        description to-r1;                               description to-r2;
        family inet {                                   family inet {
            address 10.1.3.2/30;                            address 10.1.24.2/30;
        }                                               }
        family mpls;                                    family mpls;
        family iso;                                     family iso;
    }                                               }
}                                                }
et-0/0/5 {                                       et-0/0/5 {
    unit 0 {                                         unit 0 {
        description to-r4;                               description to-r3;
        family inet {                                   family inet {
            address 10.1.34.1/30;                           address 10.1.34.2/30;
        }                                               }
        family mpls;                                    family mpls;
        family iso;                                     family iso;
    }                                               }
}                                                }
et-0/0/7 {                                       et-0/0/7 {
    description "To R7";                             description "To R7";
    ether-options {                                 ether-options {
        802.3ad ae0;                                    802.3ad ae0;
    }                                               }
}                                                }
lo0 {                                            lo0 {
    unit 0 {                                         unit 0 {
        family inet {                                   family inet {
            address 192.168.0.3/32;                         address 192.168.0.4/32;
        }                                               }
        family iso {                                    family iso {
            address 49.0001.3333.3333.00                    address 49.0001.4444.4444.00
        }                                               }
    }                                               }
}                                                }

r3-re0# show protocols                           r4-re0# show protocols
bgp {                                            bgp {
    group ibgp {                                     group ibgp {
        type internal;                                  type internal;
        local-address 192.168.0.3;                      local-address 192.168.0.4;
        family evpn {                                   family evpn {
            signaling;                                      signaling;
        }                                               }
        neighbor 192.168.0.1;                           neighbor 192.168.0.1;
        neighbor 192.168.0.2;                           neighbor 192.168.0.2;
        neighbor 192.168.0.4;                           neighbor 192.168.0.3;
    }                                               }
}                                                }
isis {                                           isis {
    interface all {                                  interface all {
        point-to-point;                                 point-to-point;
    }                                               }
    interface fxp0.0 {                               interface fxp0.0 {
        disable;                                        disable;
    }                                               }
    source-packet-routing {                          source-packet-routing {
        node-segment ipv4-index 1001;                   node-segment ipv4-index 1001;
    }                                               }
    level 2 wide-metrics-only;                       level 2 wide-metrics-only;
    level 1 disable;                                 level 1 disable;
}                                                }
mpls {                                           mpls {
    interface all;                                   interface all;
    interface fxp0.0 {                               interface fxp0.0 {
        disable;                                        disable;
    }                                               }
}                                                }
lldp {                                           lldp {
    interface all;                                   interface all;
}                                                }

r3-re0# show routing-options                     r4-re0# show routing-options
router-id 192.168.0.3;                           router-id 192.168.0.4;
autonomous-system 65000;                         autonomous-system 65000;
```

The below CE configuration covers when the MX Series or ACX Series are used as only CE devices in different models that includes single vlan-tag and dual vlan-tag.

MX Series/ACX Series – CE Configuration in EPL, A/A Mode

```
                     CE1
r5_re0# show interfaces
ge-0/0/0 {
    description "To R2";
    gigether-options {
        802.3ad ae0;
    }
}
ge-0/0/1 {
    description "To R1";
    gigether-options {
        802.3ad ae0;
    }
}
ge-0/0/2 {
    description "To IXIA";
    flexible-vlan-tagging;
    encapsulation flexible-ethernet-services;
    unit 0 {
        encapsulation ethernet-bridge;
    }
}
ae0 {
    description "Connected to PE1";
    flexible-vlan-tagging;
    encapsulation flexible-ethernet-services;
    aggregated-ether-options {
        lacp {
            active;
            system-id 00:00:00:00:11:02;
        }
    }
    unit 1 {
        encapsulation ethernet-bridge;
    }
}
```

```
                     CE2
r7_re0# show interfaces
ge-0/0/0 {
    description "To IXIA";
    flexible-vlan-tagging;
    encapsulation flexible-ethernet-services;
    unit 0 {
        encapsulation ethernet-bridge;
    }
}
ge-0/0/1 {
    description "To R3";
    gigether-options {
        802.3ad ae0;
    }
}
ge-0/0/2 {
    description "To R4";
    gigether-options {
        802.3ad ae0;
    }
}
ae0 {
    description "Connected to PE3-4";
    flexible-vlan-tagging;
    encapsulation flexible-ethernet-services;
    aggregated-ether-options {
        lacp {
            active;
        }
    }
    unit 0 {
        encapsulation ethernet-bridge;
    }
}
```

MX Series – EVPL Configuration Single Tag, A/A mode

```
                      CE1
R5-RE0> show configuration interfaces
ge-0/0/0 {
    description "To R2";
    gigether-options {
        802.3ad ae0;
    }
}
ge-0/0/1 {
    description "To R1";
    gigether-options {
    802.3ad ae0;
    }
}
ge-0/0/2 {
description "To IXIA";
    flexible-vlan-tagging;
    encapsulation flexible-ethernet-services;
    unit 1 {
        encapsulation vlan-bridge;
        vlan-id 1;
    }
}
ae0 {
    description "Connected to PE1";
    flexible-vlan-tagging;
    encapsulation flexible-ethernet-services;
    aggregated-ether-options {
        lacp {
            active;
            system-id 00:00:00:00:11:02;
        }
    }
    unit 1 {
        encapsulation vlan-bridge;
        vlan-id 1;
    }
}

R5-RE0> show configuration bridge-domains
bd1 {
    vlan-id 1;
    interface ae0.1;
    interface ge-0/0/2.1;
}
```

```
                      CE2
R7-RE0> show configuration interfaces
ge-0/0/0 {
    description "To IXXIA";
    flexible-vlan-tagging;
    encapsulation flexible-ethernet-services;
    unit 1 {
        encapsulation vlan-bridge;
        vlan-id 1;
    }
}
ge-0/0/1 {
    description "To R3";
    gigether-options {
        802.3ad ae0;
    }
}
ge-0/0/2 {
    description "To R4";
    gigether-options {
        802.3ad ae0;
    }
}
ae0 {
    description "Connected to PE1";
    flexible-vlan-tagging;
    encapsulation flexible-ethernet-services;
    aggregated-ether-options {
        lacp {
            active;
            system-id 00:00:00:00:22:02;
        }
    }
    unit 1 {
        encapsulation vlan-bridge;
        vlan-id 1;
    }
}

R7-RE0> show configuration bridge-domains
bd1 {
    vlan-id 1;
    interface ae0.1;
    interface ge-0/0/0.1;
}
```

ACX Series – EVPL Configuration Single Tag, A/A Mode

The configuration remains same as MX Series - EVPL Configuration Single Tag, A/A mode except the following configuration:

```
                      CE1
R5-RE0> show configuration vlans
bd1 {
    vlan-id 1;
    interface ae0.1;
    interface ge-0/0/2.1;
}
```

```
                      CE2
R7-RE0> show configuration vlans
bd1 {
    vlan-id 1;
    interface ae0.1;
    interface ge-0/0/0.1;
}
```

MX Series – CE Configuration in EVPL & Dual-Tag, A/A Mode

```
                CE1
R5-RE0> show configuration interfaces
ge-0/0/0 {
    description "To R2";
    gigether-options {
        802.3ad ae0;
    }
}
ge-0/0/1 {
    description "To R1";
    gigether-options {
    802.3ad ae0;
    }
}
ge-0/0/2 {
description "To IXIA";
    flexible-vlan-tagging;
    encapsulation flexible-ethernet-services;
    unit 1 {
        encapsulation vlan-bridge;
        vlan-tags outer 1 inner 2;
    }
}
ae0 {
    description "Connected to PE1";
    flexible-vlan-tagging;
    encapsulation flexible-ethernet-services;
    aggregated-ether-options {
        lacp {
            active;
            system-id 00:00:00:00:11:02;
        }
    }
    unit 1 {
        encapsulation vlan-bridge;
        vlan-tags outer 1 inner 2;
    }
}

R5-RE0> show configuration bridge-domains
bd1 {
    vlan-tags outer 1 inner 2;
    interface ae0.1;
    interface ge-0/0/2.1;
}
```

```
                CE2
R7-RE0> show configuration interfaces
ge-0/0/0 {
    description "To IXXIA";
    flexible-vlan-tagging;
    encapsulation flexible-ethernet-services;
    unit 1 {
        encapsulation vlan-bridge;
        vlan-tags outer 1 inner 2;
    }
}
ge-0/0/1 {
    description "To R3";
    gigether-options {
        802.3ad ae0;
    }
}
ge-0/0/2 {
    description "To R4";
    gigether-options {
        802.3ad ae0;
    }
}
ae0 {
    description "Connected to PE1";
    flexible-vlan-tagging;
    encapsulation flexible-ethernet-services;
    aggregated-ether-options {
        lacp {
            active;
            system-id 00:00:00:00:22:02;
        }
    }
    unit 1 {
        encapsulation vlan-bridge;
        vlan-tags outer 1 inner 2;
    }
}

R7-RE0> show configuration bridge-domains
bd1 {
    vlan-tags outer 1 inner 2;
    interface ae0.1;
    interface ge-0/0/0.1;
}
```

ACX Series – EVPL Configuration Dual Tag, A/A mode

The configuration remains same as MX Series - CE Configuration in EVPL & Dual-Tag with A/A Mode except the following configuration:

```
                CE1
R5-RE0> show configuration vlans
bd1 {
    vlan-tags outer 1 inner 2;
    interface ae0.1;
    interface ge-0/0/2.0;
}
```

```
                CE2
R7-RE0> show configuration vlans
bd1 {
    vlan-id outer 1 inner 2;
    interface ae0.1;
    interface ge-0/0/0.0;
}
```