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EVPN E-Line on PTX10k platforms

An HPE Juniper Networking Techpost

Ramdas Machat

2022-12-12

HPE

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1 EVPN E-Line on PTX10k platforms

Ramdas Machat - 12/12/2022

Let's test EVPN ELINE/VPWS on Express4-based platforms playing the role of PE. In this article, we will describe the various approaches, the configurations and the instance scaling.

1.1 Introduction

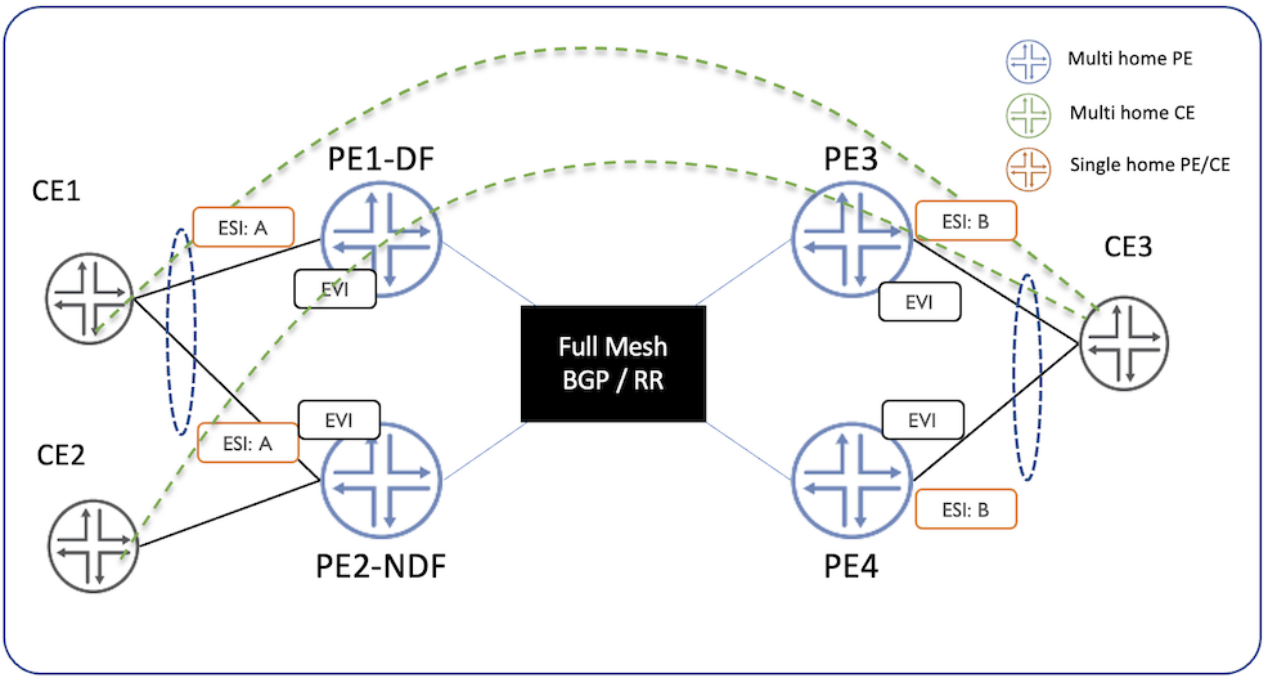
Service providers always look for the adoption of new technologies to improve their connectivity and the total uptime for the services they offer to their customers. There is a requirement to move to a more controlled and predictable network for the SP and Cloud providers. EVPN offers the most advanced L2 deployments with much better scale and performance in terms of availability, overcomes underutilization of revenue ports, faster convergence, and many more advantages over legacy technologies.

Ethernet EVPN (EVPN) as a technology has matured with large-scale deployment seen across various use case requirements including Service Provider and Cloud. EVPN helps with many benefits such as Faster convergence, Control plane MAC learning, Multiple Provider Edge (PE) participating in a single Ethernet Segment Identifier (ESI), and many more. Such features are not available in legacy L2 services.

1.2 Topology and Testing

This document covers the EVPN E-LINE service implementation on the PTX with Junos EVO. 400GE platforms powered by Express 4 ASIC were used to validate and produce the configurations.

Figure 1 is a reference topology and Figure 2 further down gives more details on the configuration and the different cases covered including Single homed, Multi-homed, and Scaling of the test scenario on a live topology with the configuration and operational status for each case.



Device Name	Model	Software Version
CE1	Hostname: R5-RE0Model: mx960	21.1R1.11
PE1	Hostname: r1-RE0-re0Model: ptx10008	22.2R2-202210200108.0-EVO
PE2	Hostname: r2-RE0-re0Model: ptx10008	22.2R2-202210200108.0-EVO
PE3	Hostname: r3-RE0-re0Model: ptx10008	22.2R2-202210200108.0-EVO
PE4	Hostname: r4-RE0-re0Model: ptx10008	22.2R2-202210200108.0-EVO
CE2	Hostname: R7-RE0Model: mx960	21.1R1.11

1.3 EVPN E-LINE/VPWS

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

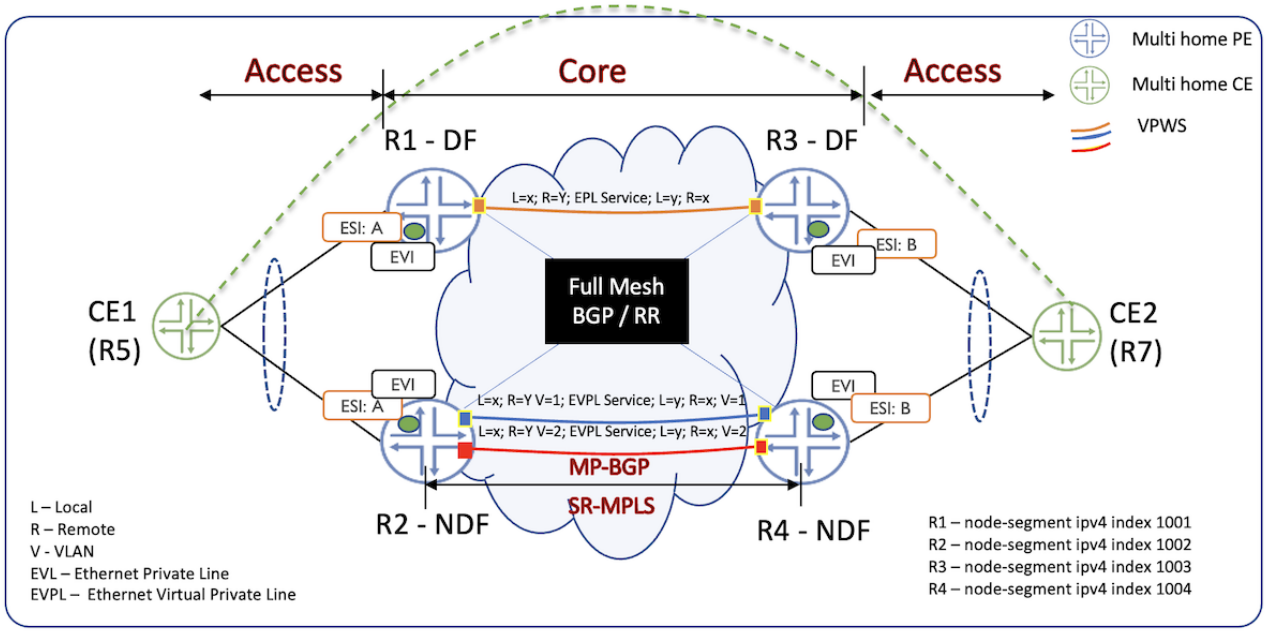
- Single homing (SH) and Multi homing (MH) scenario. One of the biggest advantages of the EVPN VPWS multi-homing is support for load balancing – both connections are active.
- Support for Inter-AS across the ASBR (Autonomous System Boundary Router) using the BGP EVPN signalled VPNs.

EVPN-VPWS is used to deliver private line services defined by the Metro Ethernet Forum (MEF)

- EPL (Ethernet Private Line)

Offers a point-to-point ethernet virtual connection (EVC) between a dedicated UNI (User Network Interface) with a high degree of transparency. - EVPL (Ethernet Virtual Private Line)

Offers service multiplexing which means multiple EVCs are paired per UNI



1.3.1 Underlay and Customer Equipment (CE) Configuration

All PEs as depicted in figure 2 are configured using the OSPF and MPLS for underlay or ISIS and SR. The PEs are configured with fully meshed BGP sessions with “family evpn signalling” enabled to exchange the EVPN routes among each other. A sample configuration is covered as part of Underlay Configuration – MPLS towards the end of the document for reference. Also, the CE configuration used during the testing is covered towards the end for reference.

1.4 EVPN VPWS EPL Test Scenarios

All four PEs in the above topology are BGP-EVPN PE and have the EVPN VPWS instance setup and then relevant configurations are made in each one of these PEs. These PEs discover each other in the network and established the EVPN sessions.

As covered above and as per the Metro Ethernet Forum standards, an EPL-based service is constructed based on the physical Ethernet Ports, and 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 Multi-homed scenario as depicted in the Topology above, the Designate Forwarder (DF) election here is Modulus (MOD) based (see RFC7432). As of time of writing this article, Express4 based PTX platforms support the preference-based DF election.

1.4.1 EVPN EPL Configuration – Single/Active mode

The below section highlights the EVPN Instance (EVI) and the UNI-facing interface configuration on all four PE nodes shown in figure 2 above for EVPN EVPL based service. This test focuses on the single-active mode.

PE1:

```
regress@r1-re0# show interfaces et-0/0/7
description "To R5";
encapsulation ethernet-ccc;
esi {
   00:11:11:11:11:11:11:11:11:11;
   single-active;
}
unit 0 {
   family ccc;
}
regress@r1-re0# show routing-instances
evpn-vpws-epl {
   instance-type evpn-vpws;
   protocols {
      evpn {
         interface et-0/0/7.0 {
            vpws-service-id {
               local 1;
               remote 2;
            }
         }
      }
   }
   interface et-0/0/7.0;
   route-distinguisher 11.11.11.11:1;
   vrf-target target:11:1;
}
```

PE2:

```
regress@r2-re0# show interfaces et-0/0/9
description "To R5";
encapsulation ethernet-ccc;
esi {
   00:11:11:11:11:11:11:11:11:11;
   single-active;
}
unit 0 {
   family ccc;
}
regress@r2-re0# show routing-instances
evpn-vpws-epl {
   instance-type evpn-vpws;
   protocols {
      evpn {
         interface et-0/0/9.0 {
            vpws-service-id {
               local 1;
               remote 2;
            }
         }
      }
   }
   interface et-0/0/9.0;
   route-distinguisher 22.22.22.22:1;
   vrf-target target:11:1;
}
```

PE3:

```
regress@r3-re0# show interfaces et-0/0/7
description "To R7";
encapsulation ethernet-ccc;
esi {
   00:22:22:22:22:22:22:22:22:22;
   single-active;
}
unit 0 {
   family ccc;
}
regress@r3-re0# show routing-instances
evpn-vpws-epl {
   instance-type evpn-vpws;
   protocols {
      evpn {
         interface et-0/0/7.0 {
            vpws-service-id {
               local 2;
```

```
                remote 1;
             }
          }
       }
    }
    interface et-0/0/7.0;
    route-distinguisher 33.33.33.33:1;
    vrf-target target:11:1;
}
```

PE4:

```
regress@r3-re0# show interfaces et-0/0/7
description "To R7";
encapsulation ethernet-ccc;
esi {
   00:22:22:22:22:22:22:22:22:22;
   single-active;
}
unit 0 {
   family ccc;
}
regress@r3-re0# show routing-instances
evpn-vpws-epl {
   instance-type evpn-vpws;
   protocols {
      evpn {
         interface et-0/0/7.0 {
            vpws-service-id {
               local 2;
               remote 1;
            }
         }
      }
   }
   interface et-0/0/7.0;
   route-distinguisher 33.33.33.33:1;
   vrf-target target:11:1;
}
```

1.4.2 EVPN EPL Configuration - Active/Active mode

The below section highlights the EVPN Instance (EVI) and the UNI-facing interface configuration on all four PE nodes shown in figure 2 above. This test focuses on the active-active mode.

In Active/Active we need to bundle the UNI links from CE to PE in order to load balance the traffic. So necessary configuration need to be done on the router to achieve the load balance behaviour.

Here we have a small change in the configurations to support active-active mode. The configuration shows just to add active-active on one of the MH PEs (PE1, PE2). But we cannot configure an MH PEs ESI in different modes like for example PE1 in active-standby and PE2 in active-active.

PE1:

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

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

PE2:

```
regress@r2-re0# show interfaces ae0
ae0 {
   encapsulation ethernet-ccc;
   esi {
      00:11:11:11:11:11:11:11:11:11;
      single-active;
   }
   aggregated-ether-options {
      lacp {
         active;
         system-id 00:00:00:00:11:01;
      }
   }
   unit 0 {
      family ccc;
   }
}
regress@r2-re0# show routing-instances
evpn-vpws-evpl {
   instance-type evpn-vpws;
   protocols {
      evpn {
         interface ae0.0 {
            vpws-service-id {
               local 1;
               remote 2;
            }
         }
      }
   }
   interface ae0.0;
   route-distinguisher 22.22.22.22:1;
   vrf-target target:11:1;
}
```

PE3:

```
regress@r3-re0# show interfaces ae0
ae0 {
   encapsulation ethernet-ccc;
   esi {
      00:22:22:22:22:22:22:22:22:22;
      single-active;
   }
   aggregated-ether-options {
      lacp {
         active;
         system-id 00:00:00:00:22:01;
      }
   }
   unit 0 {
      family ccc;
   }
}
regress@r3-re0# show routing-instances
evpn-vpws-evpl {
   instance-type evpn-vpws;
   protocols {
      evpn {
```

```
23          interface ae0.1 {
24             vpws-service-id {
25                local 2;
26                remote 1;
27             }
28          }
29       }
30    }
31    interface ae0.1;
32    route-distinguisher 33.33.33.33:1;
33    vrf-target target:11:1;
34 }
```

PE4:

```
1  regress@r4-re0# show interfaces ae0
2  ae0 {
3     encapsulation ethernet-ccc;
4     esi {
5        00:22:22:22:22:22:22:22:22:22;
6        single-active;
7     }
8     aggregated-ether-options {
9        lacp {
10          active;
11          system-id 00:00:00:00:22:01;
12       }
13    }
14    unit 0 {
15       family ccc;
16    }
17 }
18 regress@r4-re0# show routing-instances
19 evpn-vpws-evpl {
20    instance-type evpn-vpws;
21    protocols {
22       evpn {
23          interface ae0.1 {
24             vpws-service-id {
25                local 2;
26                remote 1;
27             }
28          }
29       }
30    }
31    interface ae0.1;
32    route-distinguisher 44.44.44.44:1;
33    vrf-target target:11:1;
34 }
```

1.4.3 EVPN EPL Operational – Single/Active mode

The below cli outputs show information learned by the multihomed PEs for the ESI (Ethernet Segment Information) to which these PEs belong and then also the ESI information learned from the remote end. PE3, PE4 outputs are not captured here.

You can see that PE2 is DF (Designated Forwarder) and PE1 is Backup DF which were elected based on the MOD operation.

PE1:

```
1  regress@r1-re0# run show evpn vpws-instance
2  Instance: evpn-vpws-epl, Instance type: EVPN VPWS
3   Route Distinguisher: 11.11.11.11:1
4   Number of local interfaces: 1 (1 up)
5
6     Interface name ESI Mode Role Status Control-Word Flow-Label-Tx Flow-Label-Rx
7     et-0/0/7.0 00:11:11:11:11:11:11:11:11:11single-active Backup Up Yes No No
8        Local SID: 1 Advertised Label: 104
9           PE addr ESI Label Mode Role TS Status
10          22.22.22.22 00:11:11:11:11:11:11:11:11:11 17 single-active Primary 2022-11-22
                22:18:59.989 Resolved
```

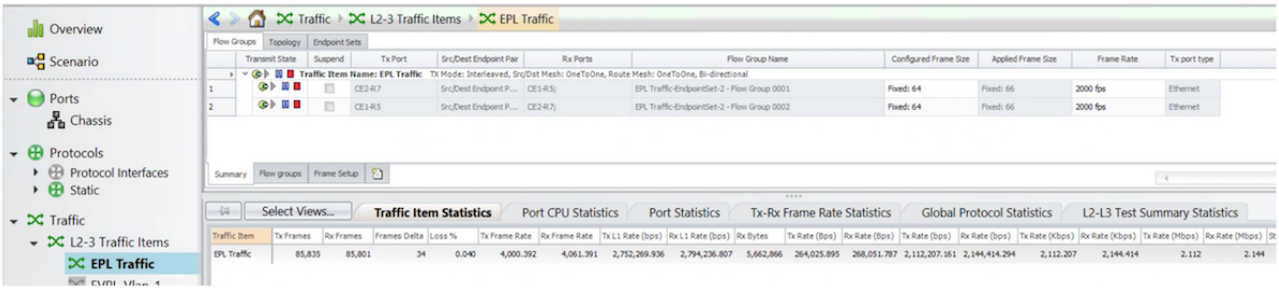
```
      Remote SID: 2
         PE addr ESI Label Mode Role TS Status
         44.44.44.44 00:22:22:22:22:22:22:22:22:22 57 single-active Backup 2022-11-23 00:41:37.218 Resolved
         33.33.33.33 00:22:22:22:22:22:22:22:22:22 91 single-active Primary 2022-11-23 00:41:36.999 Resolved
  Number of protect interfaces: 0

    Fast Convergence Information
    ESI: 00:11:11:11:11:11:11:11:11:11 Number of PE nodes: 1
      PE: 22.22.22.22
         Advertised SID: 1

    Fast Convergence Information
    ESI: 00:22:22:22:22:22:22:22:22:22 Number of PE nodes: 2
      PE: 44.44.44.44
         Advertised SID: 2
      PE: 33.33.33.33
         Advertised SID: 2

    DF Election Information for Single-Active ESI
    ESI: 00:11:11:11:11:11:11:11:11:11
    DF Election Algorithm: MOD based
    SID used for DF Election: 1
    Primary PE: 22.22.22.22
    Backup PE: 11.11.11.11
    Last DF Election: 2022-11-22 22:50:24

regress@r1-re0# run show interfaces et-0/0/7 terse
Interface Admin Link Proto Local Remote
et-0/0/7 up up
et-0/0/7.0 up down ccc

regress@r1-re0# run show route table mpls.0 ccc et-0/0/7

mpls.0: 23 destinations, 23 routes (23 active, 0 holddown, 0 hidden)
+ = Active Route, - = Last Active, * = Both

et-0/0/7.0 *[EVPN/7] 02:39:42, route-type Egress
                 Discard

regress@r1-re0# run show route table mpls.0 ccc et-0/0/7 detail

mpls.0: 23 destinations, 23 routes (23 active, 0 holddown, 0 hidden)
et-0/0/7.0 (1 entry, 1 announced)
      *EVPN Preference: 7
            Next hop type: Discard, Next hop index: 0
            Address: 0x564f543839dc
            Next-hop reference count: 187, key opaque handle: (nil), non-key opaque handle: (nil)
            State: <Active Int>
            Age: 2:40:25
            Validation State: unverified
            Task: evpn global task
            Announcement bits (1): 1-KRT
            AS path: I
            Route Type Egress
            Thread: junos-main
```

PE2:

```
regress@r2-re0# run show evpn vpws-instance
Instance: evpn-vpws-epl, Instance type: EVPN VPWS
  Route Distinguisher: 22.22.22.22:1
  Number of local interfaces: 1 (1 up)

    Interface name ESI Mode Role Status Control-Word Flow-Label-Tx Flow-Label-Rx
    et-0/0/9.0 00:11:11:11:11:11:11:11:11:11single-active Primary Up Yes No No
      Local SID: 1 Advertised Label: 17
         PE addr ESI Label Mode Role TS Status
         11.11.11.11 00:11:11:11:11:11:11:11:11:11 104 single-active Backup 2022-11-22 22:19:00.204 Resolved
      Remote SID: 2
         PE addr ESI Label Mode Role TS Status
         44.44.44.44 00:22:22:22:22:22:22:22:22:22 57 single-active Backup 2022-11-23 00:41:37.217 Resolved
         33.33.33.33 00:22:22:22:22:22:22:22:22:22 91 single-active Primary 2022-11-23 00:41:36.998 Resolved
  Number of protect interfaces: 0

```

```
    Fast Convergence Information
    ESI: 00:11:11:11:11:11:11:11:11:11 Number of PE nodes: 1
       PE: 11.11.11.11
          Advertised SID: 1

    Fast Convergence Information
    ESI: 00:22:22:22:22:22:22:22:22:22 Number of PE nodes: 2
       PE: 44.44.44.44
          Advertised SID: 2
       PE: 33.33.33.33
          Advertised SID: 2

    DF Election Information for Single-Active ESI
    ESI: 00:11:11:11:11:11:11:11:11:11
    DF Election Algorithm: MOD based
    SID used for DF Election: 1
    Primary PE: 22.22.22.22
    Backup PE: 11.11.11.11
    Last DF Election: 2022-11-22 22:50:24

{master}[edit]

regress@r2-re0# run show interfaces et-0/0/9 terse
Interface Admin Link Proto Local Remote
et-0/0/9 up up
et-0/0/9.0 up up ccc

{master}[edit]
regress@r2-re0# run show route table mpls.0 ccc et-0/0/9 detail

mpls.0: 22 destinations, 22 routes (22 active, 0 holddown, 0 hidden)
et-0/0/9.0 (1 entry, 1 announced)
      *EVPN Preference: 7
            Next hop type: Indirect, Next hop index: 0
            Address: 0x559b3cd59bdc
            Next-hop reference count: 8, key opaque handle: (nil), non-key opaque handle: (nil)
            Next hop type: Router, Next hop index: 23068
            Next hop: 23.1.1.2 via et-0/0/1.0, selected
            Label element ptr: 0x559b3d2a4868
            Label parent element ptr: (nil)
            Label element references: 3
            Label element child references: 0
            Label element lsp id: 0
            Session Id: 5
            Protocol next hop: 33.33.33.33
            Label operation: Push 91 Offset: 252
            Label TTL action: no-prop-ttl
            Load balance label: Label 91: None;
            Composite next hop: 0x559b3dea7100 23076 INH Session ID: 22
            Indirect next hop: 0x559b390b7b08 23056 INH Session ID: 22
            State: <Active Int>
            Age: 22:39
            Validation State: unverified
            Task: evpn global task
            Announcement bits (1): 1-KRT
            AS path: I
            Route Type Egress
            Thread: junos-main
```

Traffic Screenshot showing traffic flowing.



1.4.4 EVPN EPL Operational - Active/Active mode

PE1:

```
    Interface name ESI Mode Role Status Control-Word Flow-Label-Tx Flow-Label-Rx
    ae0.1 00:11:11:11:11:11:11:11:11:11all-active Primary Up Yes No No
       Local SID: 1 Advertised Label: 131
          PE addr ESI Label Mode Role TS Status
          22.22.22.22 00:11:11:11:11:11:11:11:11:11 120 all-active Primary 2022-11-23 03:37:06.808 Resolved
       Remote SID: 2
          PE addr ESI Label Mode Role TS Status
          44.44.44.44 00:22:22:22:22:22:22:22:22:22 57 all-active Primary 2022-11-23 03:37:08.809 Resolved
          33.33.33.33 00:22:22:22:22:22:22:22:22:22 91 all-active Primary 2022-11-23 03:37:16.805 Resolved
  Number of protect interfaces: 0

    Fast Convergence Information
    ESI: 00:11:11:11:11:11:11:11:11:11 Number of PE nodes: 1
       PE: 22.22.22.22
          Advertised SID: 1

    Fast Convergence Information
    ESI: 00:22:22:22:22:22:22:22:22:22 Number of PE nodes: 2
       PE: 44.44.44.44
          Advertised SID: 2
       PE: 33.33.33.33
          Advertised SID: 2

{master}[edit]
regress@r1-re0# run show interfaces ae0 terse
Interface Admin Link Proto Local Remote
ae0 up up
ae0.1 up up ccc
ae0.32767 up up multiservice

regress@r1-re0# run show route table mpls.0 ccc ae0.1 detail

mpls.0: 23 destinations, 23 routes (23 active, 0 holddown, 0 hidden)
ae0.1 (1 entry, 1 announced)
      *EVPN Preference: 7
            Next hop type: List, Next hop index: 25084
            Address: 0x564f5011851c
            Next-hop reference count: 3, key opaque handle: (nil), non-key opaque handle: (nil)
            Next hop: ELNH Address 0x564f5395f99c
               Next hop type: Indirect, Next hop index: 0
               Address: 0x564f5395f99c
               Next-hop reference count: 7, key opaque handle: (nil), non-key opaque handle: (nil)
               Protocol next hop: 33.33.33.33
               Label operation: Push 91 Offset: 252
               Composite next hop: 0x564f5395e840 25074 INH Session ID: 27
               Indirect next hop: 0x564f4fcb6988 25040 INH Session ID: 27
                  Next hop type: Router, Next hop index: 25076
                  Address: 0x564f54aadb1c
                  Next-hop reference count: 7, key opaque handle: (nil), non-key opaque handle: (nil)
                  Next hop: 13.1.1.2 via et-0/0/5.0
                  Label element ptr: 0x564f53ea43e8
                  Label parent element ptr: (nil)
                  Label element references: 3
                  Label element child references: 0
                  Label element lsp id: 0
            Next hop: ELNH Address 0x564f53962b1c, selected
               Next hop type: Indirect, Next hop index: 0
               Address: 0x564f53962b1c
               Next-hop reference count: 4, key opaque handle: (nil), non-key opaque handle: (nil)
               Protocol next hop: 44.44.44.44
               Label operation: Push 57 Offset: 252
               Composite next hop: 0x564f5395d880 25081 INH Session ID: 39
               Indirect next hop: 0x564f57a24b08 25079 INH Session ID: 39
                  Next hop type: Router, Next hop index: 25080
                  Address: 0x564f54ab069c
                  Next-hop reference count: 7, key opaque handle: (nil), non-key opaque handle: (nil)
                  Next hop: 14.1.1.2 via et-0/0/1.0
                  Label element ptr: 0x564f53ea43e8
```

```
                    Label parent element ptr: (nil)
                    Label element references: 3
                    Label element child references: 0
                    Label element lsp id: 0
                State: <Active Int>
                Age: 3:45
                Validation State: unverified
                Task: evpn global task
                Announcement bits (1): 1-KRT
                AS path: I
                Route Type Egress
                Thread: junos-main
```

1.5 EVPN VPWS EVPL Test Scenarios

All four PEs in the above topology are BGP-EVPN PE and have the EVPN VPWS instance setup and then relevant configurations are made in each one of these PEs. These PEs discover each other in the network and establishes the EVPN sessions.

We support both modes single/active and active-active offering EVPN VPWS service in multihomed PEs. The current configuration is with Single-Active for the Multihomed PEs.

As covered above and as per the Metro Ethernet Forum standards, an EVPL based service is constructed based on the IFD and 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 the Topology above, the DF election here is MOD based. Express4 based PTX platforms also support the preference-based DF election.

1.5.1 EVPN EVPL Configuration – Single/Active mode.

The below section highlights the EVPN Instance (EVI) and the UNI-facing interface configuration on all four PE nodes shown in figure 2 above for EVPN EVPL based service. This test focuses on the single-active mode.

PE1:

```
regress@r1-re0# show interfaces et-0/0/7
description "To R5";
flexible-vlan-tagging;
encapsulation vlan-ccc;
esi {
   00:11:11:11:11:11:11:11:11:11;
   single-active;
}
unit 1 {
   encapsulation vlan-ccc;
   vlan-id 1;
}

regress@r1-re0# show routing-instances evpn-vpws-epl
instance-type evpn-vpws;
protocols {
   evpn {
      interface et-0/0/7.1 {
         vpws-service-id {
            local 1;
            remote 2;
         }
      }
   }
}
interface et-0/0/7.1;
route-distinguisher 11.11.11.11:1;
vrf-target target:11:1;
```

PE2:

```
regress@r2-re0# show interfaces et-0/0/9
description "To R5";
flexible-vlan-tagging;
encapsulation vlan-ccc;
esi {
   00:11:11:11:11:11:11:11:11:11;
   single-active;
}
unit 1 {
   encapsulation vlan-ccc;
   vlan-id 1;
}

regress@r2-re0# show routing-instances evpn-vpws-epl
instance-type evpn-vpws;
protocols {
   evpn {
      interface et-0/0/9.1 {
         vpws-service-id {
            local 1;
            remote 2;
         }
      }
   }
}
interface et-0/0/9.1;
route-distinguisher 22.22.22.22:1;
vrf-target target:11:1;
```

1.5.2 EVPN EVPL Configuration – Active/Active mode

The below section highlights the EVPN Instance (EVI) and the UNI-facing interface configuration on all four PE nodes shown in figure 2 above for EVPN EVPL-based service. This test focuses on the active-active mode.

In Active/Active we need to bundle the UNI links from CE to PE in order to load balance the traffic. So necessary configuration needs to be done on the router to achieve the load balance behaviour.

Here we have a small change in the configurations to support active-active mode. The configuration shows just to add active-active on one of the MH PEs (PE1, PE2). But we cannot configure an MH PEs ESI in different modes, for example, PE1 in active-standby and PE2 in active-active.

PE1:

```
regress@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;
   }
}

regress@r1-re0# show routing-instances
evpn-vpws-evpl {
   instance-type evpn-vpws;
   protocols {
      evpn {
         interface ae0.1 {
            vpws-service-id {
               local 1;
```

```
                remote 2;
             }
          }
       }
    }
    interface ae0.1;
    route-distinguisher 11.11.11.11:1;
    vrf-target target:11:1;
}
```

PE2:

```
regress@r2-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;
   }
}

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

1.5.3 EVPN EVPL Operational – Single/Active mode

PE1

```
regress@r1-re0# run show evpn vpws-instance
Instance: evpn-vpws-epl, Instance type: EVPN VPWS
  Route Distinguisher: 11.11.11.11:1
  Number of local interfaces: 1 (1 up)

    Interface name ESI Mode Role Status Control-Word Flow-Label-Tx Flow-Label-Rx
    et-0/0/7.1 00:11:11:11:11:11:11:11:11:11single-active Backup Up Yes No No
       Local SID: 1 Advertised Label: 104
          PE addr ESI Label Mode Role TS Status
          22.22.22.22 00:11:11:11:11:11:11:11:11:11 17 single-active Primary 2022-11-23
              01:34:14.940 Resolved
       Remote SID: 2
          PE addr ESI Label Mode Role TS Status
          33.33.33.33 00:22:22:22:22:22:22:22:22:22 91 single-active Primary 2022-11-23
              01:51:10.610 Resolved
          44.44.44.44 00:22:22:22:22:22:22:22:22:22 57 single-active Backup 2022-11-23
              01:52:40.485 Resolved
  Number of protect interfaces: 0

    Fast Convergence Information
    ESI: 00:11:11:11:11:11:11:11:11:11 Number of PE nodes: 1
```

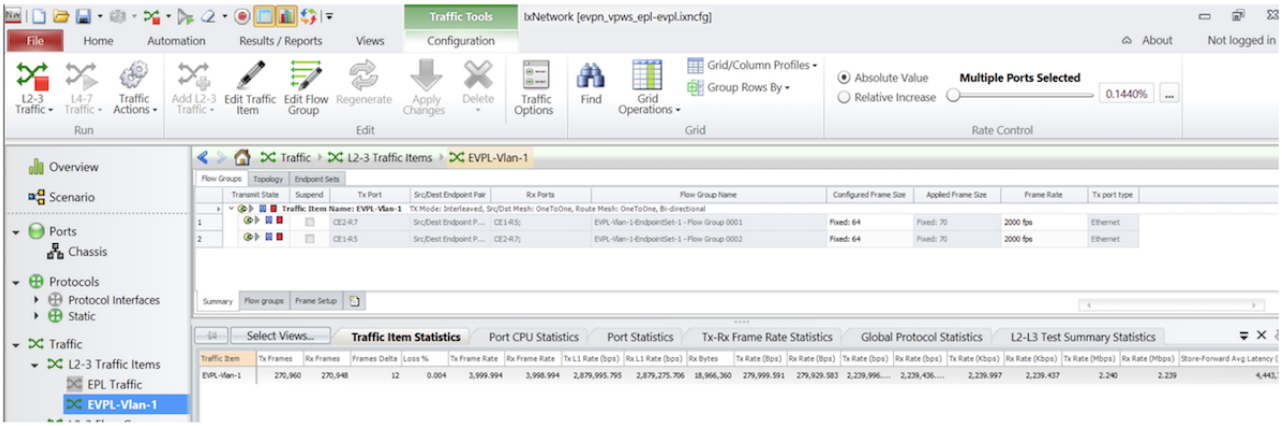
```
      PE: 22.22.22.22
         Advertised SID: 1

   Fast Convergence Information
   ESI: 00:22:22:22:22:22:22:22:22:22 Number of PE nodes: 2
      PE: 33.33.33.33
         Advertised SID: 2
      PE: 44.44.44.44
         Advertised SID: 2

   DF Election Information for Single-Active ESI
   ESI: 00:11:11:11:11:11:11:11:11:11
   DF Election Algorithm: MOD based
   SID used for DF Election: 1
   Primary PE: 22.22.22.22
   Backup PE: 11.11.11.11
   Last DF Election: 2022-11-23 01:50:02

{master}[edit]
regress@r1-re0# run show interfaces et-0/0/7 terse
Interface Admin Link Proto Local Remote
et-0/0/7 up up
et-0/0/7.1 up down ccc
et-0/0/7.32767 up up multiservice

{master}[edit]
regress@r1-re0# run show route table mpls.0 ccc et-0/0/7.1

mpls.0: 23 destinations, 23 routes (23 active, 0 holddown, 0 hidden)
+ = Active Route, - = Last Active, * = Both

et-0/0/7.1 *[EVPN/7] 01:00:57, route-type Egress
                 Discard

{master}[edit]
regress@r1-re0# run show route table mpls.0 ccc et-0/0/7.1 detail

mpls.0: 23 destinations, 23 routes (23 active, 0 holddown, 0 hidden)
et-0/0/7.1 (1 entry, 1 announced)
      *EVPN Preference: 7
            Next hop type: Discard, Next hop index: 0
            Address: 0x564f543839dc
            Next-hop reference count: 201, key opaque handle: (nil), non-key opaque handle: (nil)
            State: <Active Int>
            Age: 1:01:00
            Validation State: unverified
            Task: evpn global task
            Announcement bits (1): 1-KRT
            AS path: I
            Route Type Egress
            Thread: junos-main
```

PE2

```
regress@r2-re0# run show evpn vpws-instance
Instance: evpn-vpws-epl, Instance type: EVPN VPWS
  Route Distinguisher: 22.22.22.22:1
  Number of local interfaces: 1 (1 up)

   Interface name ESI Mode Role Status Control-Word Flow-Label-Tx Flow-Label-Rx
   et-0/0/9.1 00:11:11:11:11:11:11:11:11:11single-active Primary Up Yes No No
      Local SID: 1 Advertised Label: 17
         PE addr ESI Label Mode Role TS Status
         11.11.11.11 00:11:11:11:11:11:11:11:11:11 104 single-active Backup 2022-11-23 01:50:02.447 Resolved
      Remote SID: 2
         PE addr ESI Label Mode Role TS Status
         33.33.33.33 00:22:22:22:22:22:22:22:22:22 91 single-active Primary 2022-11-23 01:51:10.610 Resolved
         44.44.44.44 00:22:22:22:22:22:22:22:22:22 57 single-active Backup 2022-11-23 01:52:40.488 Resolved
  Number of protect interfaces: 0

   Fast Convergence Information
   ESI: 00:11:11:11:11:11:11:11:11:11 Number of PE nodes: 1
      PE: 11.11.11.11
         Advertised SID: 1

   Fast Convergence Information
```

```
    ESI: 00:22:22:22:22:22:22:22:22:22 Number of PE nodes: 2
       PE: 33.33.33.33
          Advertised SID: 2
       PE: 44.44.44.44
          Advertised SID: 2

    DF Election Information for Single-Active ESI
    ESI: 00:11:11:11:11:11:11:11:11:11
    DF Election Algorithm: MOD based
    SID used for DF Election: 1
    Primary PE: 22.22.22.22
    Backup PE: 11.11.11.11
    Last DF Election: 2022-11-23 01:50:01

{master}[edit]
regress@r2-re0# run show interfaces et-0/0/9 terse
Interface Admin Link Proto Local Remote
et-0/0/9 up up
et-0/0/9.1 up up ccc
et-0/0/9.32767 up up multiservice

{master}[edit]
regress@r2-re0# run show route table mpls.0 ccc et-0/0/9.1 detail

mpls.0: 23 destinations, 23 routes (23 active, 0 holddown, 0 hidden)
et-0/0/9.1 (1 entry, 1 announced)
      *EVPN Preference: 7
            Next hop type: Indirect, Next hop index: 0
            Address: 0x559b3cd59bdc
            Next-hop reference count: 16, key opaque handle: (nil), non-key opaque handle: (nil)
            Next hop type: Router, Next hop index: 23068
            Next hop: 23.1.1.2 via et-0/0/1.0, selected
            Label element ptr: 0x559b3d2a4868
            Label parent element ptr: (nil)
            Label element references: 3
            Label element child references: 0
            Label element lsp id: 0
            Session Id: 5
            Protocol next hop: 33.33.33.33
            Label operation: Push 91 Offset: 252
            Label TTL action: no-prop-ttl
            Load balance label: Label 91: None;
            Composite next hop: 0x559b3dea7100 23076 INH Session ID: 22
            Indirect next hop: 0x559b390b7b08 23056 INH Session ID: 22
            State: <Active Int>
            Age: 59:41
            Validation State: unverified
            Task: evpn global task
            Announcement bits (1): 1-KRT
            AS path: I
            Route Type Egress
            Thread: junos-main
```

Traffic Screenshot



1.5.4 EVPN EVPL Operational – Active/Active mode

PE1

```
regress@r1-re0# run show evpn vpws-instance
Instance: evpn-vpws-epl, Instance type: EVPN VPWS
  Route Distinguisher: 11.11.11.11:1
  Number of local interfaces: 1 (1 up)

    Interface name ESI Mode Role Status Control-Word Flow-Label-Tx Flow-Label-Rx
    ae0.1 00:11:11:11:11:11:11:11:11:11all-active Primary Up Yes No No
       Local SID: 1 Advertised Label: 131
          PE addr ESI Label Mode Role TS Status
          22.22.22.22 00:11:11:11:11:11:11:11:11:11 120 all-active Primary 2022-11-23 03:37:06.808 Resolved
       Remote SID: 2
          PE addr ESI Label Mode Role TS Status
          44.44.44.44 00:22:22:22:22:22:22:22:22:22 57 all-active Primary 2022-11-23 03:37:08.809 Resolved
          33.33.33.33 00:22:22:22:22:22:22:22:22:22 91 all-active Primary 2022-11-23 03:37:16.805 Resolved
  Number of protect interfaces: 0

    Fast Convergence Information
    ESI: 00:11:11:11:11:11:11:11:11:11 Number of PE nodes: 1
       PE: 22.22.22.22
          Advertised SID: 1

    Fast Convergence Information
    ESI: 00:22:22:22:22:22:22:22:22:22 Number of PE nodes: 2
       PE: 44.44.44.44
          Advertised SID: 2
       PE: 33.33.33.33
          Advertised SID: 2

{master}[edit]
regress@r1-re0# run show interfaces ae0 terse
Interface Admin Link Proto Local Remote
ae0 up up
ae0.1 up up ccc
ae0.32767 up up multiservice

regress@r1-re0# run show route table mpls.0 ccc ae0.1 detail

mpls.0: 23 destinations, 23 routes (23 active, 0 holddown, 0 hidden)
ae0.1 (1 entry, 1 announced)
      *EVPN Preference: 7
            Next hop type: List, Next hop index: 25084
            Address: 0x564f5011851c
            Next-hop reference count: 3, key opaque handle: (nil), non-key opaque handle: (nil)
            Next hop: ELNH Address 0x564f5395f99c
               Next hop type: Indirect, Next hop index: 0
               Address: 0x564f5395f99c
               Next-hop reference count: 7, key opaque handle: (nil), non-key opaque handle: (nil)
               Protocol next hop: 33.33.33.33
               Label operation: Push 91 Offset: 252
               Composite next hop: 0x564f5395e840 25074 INH Session ID: 27
               Indirect next hop: 0x564f4fcb6988 25040 INH Session ID: 27
                  Next hop type: Router, Next hop index: 25076
                  Address: 0x564f54aadb1c
                  Next-hop reference count: 7, key opaque handle: (nil), non-key opaque handle: (nil)
                  Next hop: 13.1.1.2 via et-0/0/5.0
                  Label element ptr: 0x564f53ea43e8
                  Label parent element ptr: (nil)
                  Label element references: 3
                  Label element child references: 0
                  Label element lsp id: 0
            Next hop: ELNH Address 0x564f53962b1c, selected
               Next hop type: Indirect, Next hop index: 0
               Address: 0x564f53962b1c
               Next-hop reference count: 4, key opaque handle: (nil), non-key opaque handle: (nil)
               Protocol next hop: 44.44.44.44
               Label operation: Push 57 Offset: 252
               Composite next hop: 0x564f5395d880 25081 INH Session ID: 39
               Indirect next hop: 0x564f57a24b08 25079 INH Session ID: 39
                  Next hop type: Router, Next hop index: 25080
                  Address: 0x564f54ab069c
                  Next-hop reference count: 7, key opaque handle: (nil), non-key opaque handle: (nil)
                  Next hop: 14.1.1.2 via et-0/0/1.0
                  Label element ptr: 0x564f53ea43e8
```

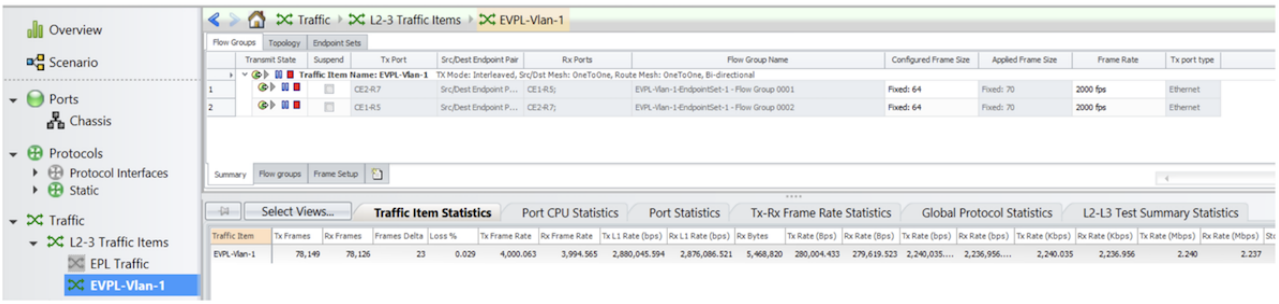
```
                    Label parent element ptr: (nil)
                    Label element references: 3
                    Label element child references: 0
                    Label element lsp id: 0
             State: <Active Int>
             Age: 3:45
             Validation State: unverified
             Task: evpn global task
             Announcement bits (1): 1-KRT
             AS path: I
             Route Type Egress
             Thread: junos-main
```

PE2

```
regress@r2-re0# run show evpn vpws-instance
Instance: evpn-vpws-epl, Instance type: EVPN VPWS
  Route Distinguisher: 22.22.22.22:1
  Number of local interfaces: 1 (1 up)

    Interface name ESI Mode Role Status Control-Word Flow-Label-Tx Flow-Label-Rx
    ae0.1 00:11:11:11:11:11:11:11:11:11all-active Primary Up Yes No No
       Local SID: 1 Advertised Label: 120
          PE addr ESI Label Mode Role TS Status
          11.11.11.11 00:11:11:11:11:11:11:11:11:11 131 all-active Primary 2022-11-23 03:37:07.242 Resolved
       Remote SID: 2
          PE addr ESI Label Mode Role TS Status
          44.44.44.44 00:22:22:22:22:22:22:22:22:22 57 all-active Primary 2022-11-23 03:37:08.809 Resolved
          33.33.33.33 00:22:22:22:22:22:22:22:22:22 91 all-active Primary 2022-11-23 03:37:16.821 Resolved
  Number of protect interfaces: 0

    Fast Convergence Information
    ESI: 00:11:11:11:11:11:11:11:11:11 Number of PE nodes: 1
       PE: 11.11.11.11
          Advertised SID: 1

    Fast Convergence Information
    ESI: 00:22:22:22:22:22:22:22:22:22 Number of PE nodes: 2
       PE: 44.44.44.44
          Advertised SID: 2
       PE: 33.33.33.33
          Advertised SID: 2

{master}[edit]
regress@r2-re0# run show interfaces ae0 terse
Interface Admin Link Proto Local Remote
ae0 up up
ae0.1 up up ccc
ae0.32767 up up multiservice

{master}[edit]
regress@r2-re0# run show route table mpls.0 ccc ae0.1 detail

mpls.0: 23 destinations, 23 routes (23 active, 0 holddown, 0 hidden)
ae0.1 (1 entry, 1 announced)
      *EVPN Preference: 7
             Next hop type: List, Next hop index: 23085
             Address: 0x559b3cdbe71c
             Next-hop reference count: 3, key opaque handle: (nil), non-key opaque handle: (nil)
             Next hop: ELNH Address 0x559b3cd59bdc, selected
                Next hop type: Indirect, Next hop index: 0
                Address: 0x559b3cd59bdc
                Next-hop reference count: 17, key opaque handle: (nil), non-key opaque handle: (nil)
                Protocol next hop: 33.33.33.33
                Label operation: Push 91 Offset: 252
                Composite next hop: 0x559b3dea7100 23076 INH Session ID: 22
                Indirect next hop: 0x559b390b7b08 23056 INH Session ID: 22
                   Next hop type: Router, Next hop index: 23068
                   Address: 0x559b3dea9b1c
                   Next-hop reference count: 7, key opaque handle: (nil), non-key opaque handle: (nil)
                   Next hop: 23.1.1.2 via et-0/0/1.0
                   Label element ptr: 0x559b3d2a4868
                   Label parent element ptr: (nil)
                   Label element references: 3
                   Label element child references: 0
```

```
                    Label element lsp id: 0
               Next hop: ELNH Address 0x559b3cd5bf1c
                  Next hop type: Indirect, Next hop index: 0
                  Address: 0x559b3cd5bf1c
                  Next-hop reference count: 31, key opaque handle: (nil), non-key opaque handle: (
                      nil)
                  Protocol next hop: 44.44.44.44
                  Label operation: Push 57 Offset: 252
                  Composite next hop: 0x559b3cd586c0 23089 INH Session ID: 15
                  Indirect next hop: 0x559b390b7d88 23061 INH Session ID: 15
                     Next hop type: Router, Next hop index: 23090
                     Address: 0x559b3deac5dc
                     Next-hop reference count: 7, key opaque handle: (nil), non-key opaque handle:
                         (nil)
                     Next hop: 24.1.1.2 via et-0/0/5.0
                     Label element ptr: 0x559b3d2a4868
                     Label parent element ptr: (nil)
                     Label element references: 3
                     Label element child references: 0
                     Label element lsp id: 0
               State: <Active Int>
               Age: 6:01
               Validation State: unverified
               Task: evpn global task
               Announcement bits (1): 1-KRT
               AS path: I
               Route Type Egress
               Thread: junos-main
```

Traffic Screenshot



1.6 EVPN EVPL Test Scenarios

1.6.1 EVPN EVPL DualTag Configuration – Active/Active mode.

The PE1, PE2 configuration remains the same for most part, just the vlan tags configuration different as highlighted below.

PE1:

```
regress@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-tags outer 1 inner 2;
   }
}
```

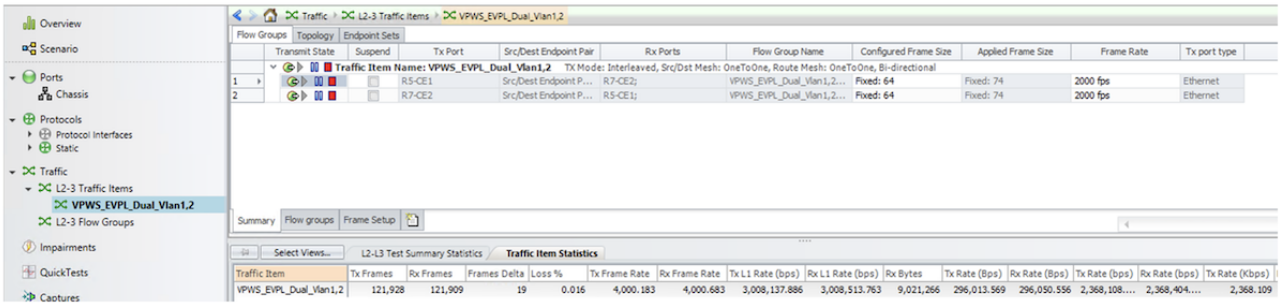
PE2:

```
regress@r2-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-tags outer 1 inner 2;
   }
}
```

1.6.2 EVPN EVPL Operational – Active/Active mode

The operational mode for this case is similar to test scenario covered above with single tag.

Traffic Screenshot:



1.6.3 EVPN EVPL – FAT Flow

The PE1, PE2 configuration remains the same for most part, just the highlighted part in the configuration enables the FAT Flow for the routing instance. Also the Control word is enabled by default and this needs to be disabled if remote PE's do not support control word or it is disabled by default.

PE1:

```
regress@r2-RE0-re0# show routing-instances
evpn-vpws-epl {
   instance-type evpn-vpws;
   protocols {
      evpn {
         interface ae0.1 {
            vpws-service-id {
               local 1;
               remote 2;
            }
         }
         flow-label-transmit-static;
         flow-label-receive-static;
      }
   }
   interface ae0.1;
   route-distinguisher 22.22.22.22:1;
   vrf-target target:11:1;
}
```

PE2:

```
regress@r2-RE0-re0# show routing-instances
evpn-vpws-epl {
   instance-type evpn-vpws;
   protocols {
      evpn {
         interface ae0.1 {
            vpws-service-id {
               local 1;
               remote 2;
            }
         }
         flow-label-transmit-static;
         flow-label-receive-static;
      }
   }
   interface ae0.1;
   route-distinguisher 22.22.22.22:1;
   vrf-target target:11:1;
}
```

1.6.4 EVPN EVPL FAT Flow Configuration Operational – Active/Active mode

The operational mode for this case is similar in single tag case.

PE1

```
regress@r1-RE0-re0# run show evpn vpws-instance
Instance: evpn-vpws-epl, Instance type: EVPN VPWS
  Route Distinguisher: 11.11.11.11:1
  Number of local interfaces: 1 (1 up)

    Interface name ESI Mode Role Status Control-Word Flow-Label-Tx Flow-Label-Rx
    ae0.1 00:11:11:11:11:11:11:11:11:11all-active Primary Up Yes Yes Yes
       Local SID: 1 Advertised Label: 20
          PE addr ESI Label Mode Role TS Status
          22.22.22.22 00:11:11:11:11:11:11:11:11:11 20 all-active Primary 2022-11-24 06:51:31.580
               Resolved
       Remote SID: 2
          PE addr ESI Label Mode Role TS Status
          33.33.33.33 00:22:22:22:22:22:22:22:22:22 19 all-active Primary 2022-11-24 06:51:30.512
               Resolved
          44.44.44.44 00:22:22:22:22:22:22:22:22:22 19 all-active Primary 2022-11-24 06:51:31.521
               Resolved
  Number of protect interfaces: 0

    Fast Convergence Information
    ESI: 00:11:11:11:11:11:11:11:11:11 Number of PE nodes: 1
       PE: 22.22.22.22
          Advertised SID: 1

    Fast Convergence Information
    ESI: 00:22:22:22:22:22:22:22:22:22 Number of PE nodes: 2
       PE: 33.33.33.33
          Advertised SID: 2
       PE: 44.44.44.44
          Advertised SID: 2
```

1.7 Scalability Test: EVPN VPWS – 16000 Instances

All the Express4-based platforms can support 16000 VPWS instances which is qualified internally. Here we scaled up each of the PEs to 16k VPWS instances along with the CEs to bring up VPWS services in a Multihomed Active/Active mode.

Use the below script to generate the configuration for each of the PE and CE devices depicted in Figure 2. The underlay configuration is not part of the script, refer to the Underlay configuration and the CE configuration for reference.

1.7.1 EVPN VPWS 16000 instances Scaling - Script

```
# while-else loop

outervlan = 1
ifl = 1
local = 1
remote = 16001
file1 = open('r1.txt', 'w')
file2 = open('r2.txt', 'w')
file3 = open('r3.txt', 'w')
file4 = open('r4.txt', 'w')
file5 = open('r5.txt', 'w')
file6 = open('r7.txt', 'w')
while outervlan < 3:
   innervlan = 1
   while innervlan < 4001:
     #print("set interfaces ae0 unit ", ifl, " vlan-tags outer ", outervlan, " inner ", innervlan)
     s = "set interfaces ae0 unit " + str(ifl) + " vlan-tags outer " + str(outervlan) + " inner " + str(innervlan) + "\n"
     s0 = "set interfaces ae0 unit " + str(ifl) + " encapsulation vlan-bridge" + "\n"
     s1 = "set routing-instances evpn-vpws16k" + str(ifl) + " instance-type evpn-vpws interface ae0." + str(ifl) + "\n"
     s3 = "set routing-instances evpn-vpws16k" + str(ifl) + " vrf-target target:11:" + str(ifl) + "\n"
     s8 = "set interfaces ae0 unit " + str(ifl) + " encapsulation vlan-ccc" + "\n"
     r1s2 = "set routing-instances evpn-vpws16k" + str(ifl) + " route-distinguisher 11.11.11.11:" + str(ifl) + "\n"
     r1s4 = "set routing-instances evpn-vpws16k" + str(ifl) + " protocols evpn interface ae0." + str(ifl) + " vpws-service-id local " + str(local) + " remote " + str(remote) + "\n"
     r2s2 = "set routing-instances evpn-vpws16k" + str(ifl) + " route-distinguisher 22.22.22.22:" + str(ifl) + "\n"
     r2s4 = "set routing-instances evpn-vpws16k" + str(ifl) + " protocols evpn interface ae0." + str(ifl) + " vpws-service-id local " + str(local) + " remote " + str(remote) + "\n"
     r3s2 = "set routing-instances evpn-vpws16k" + str(ifl) + " route-distinguisher 33.33.33.33:" + str(ifl) + "\n"
     r3s4 = "set routing-instances evpn-vpws16k" + str(ifl) + " protocols evpn interface ae0." + str(ifl) + " vpws-service-id local " + str(remote) + " remote " + str(local) + "\n"
     r4s2 = "set routing-instances evpn-vpws16k" + str(ifl) + " route-distinguisher 44.44.44.44:" + str(ifl) + "\n"
     r4s4 = "set routing-instances evpn-vpws16k" + str(ifl) + " protocols evpn interface ae0." + str(ifl) + " vpws-service-id local " + str(remote) + " remote " + str(local) + "\n"
     s5 = "set bridge-domains bd" + str(ifl) + " vlan-tags outer " + str(outervlan) + " inner " + str(innervlan) + "\n"
     s6 = "set bridge-domains bd" + str(ifl) + " interface ae0." + str(ifl) + "\n"
     s7 = "set bridge-domains bd" + str(ifl) + " bridge-options no-mac-learning" + "\n"
     r5s1 = "set interfaces ge-0/0/2 unit " + str(ifl) + " vlan-tags outer " + str(outervlan) + " inner " + str(innervlan) + "\n"
     r5s2 = "set interfaces ge-0/0/2 unit " + str(ifl) + " encapsulation vlan-bridge " + "\n"
     r5s3 = "set bridge-domains bd" + str(ifl) + " interface ge-0/0/2." + str(ifl) + "\n"
     r7s1 = "set interfaces ge-0/0/0 unit " + str(ifl) + " vlan-tags outer " + str(outervlan) + " inner " + str(innervlan) + "\n"
     r7s2 = "set interfaces ge-0/0/0 unit " + str(ifl) + " encapsulation vlan-bridge " + "\n"
     r7s3 = "set bridge-domains bd" + str(ifl) + " interface ge-0/0/0." + str(ifl) + "\n"

     file1.write(s)
     file1.write(s1)
     file1.write(s3)
     file1.write(s8)
     file1.write(r1s2)
     file1.write(r1s4)

     file2.write(s)
     file2.write(s1)
     file2.write(s3)
     file2.write(s8)
     file2.write(r2s2)
     file2.write(r2s4)

     file3.write(s)
     file3.write(s1)
     file3.write(s3)
     file3.write(s8)
     file3.write(r3s2)
     file3.write(r3s4)

     file4.write(s)
     file4.write(s1)
```

```
    file4.write(s3)
    file4.write(s8)
    file4.write(r4s2)
    file4.write(r4s4)

    file5.write(s)
    file5.write(s0)
    file5.write(s5)
    file5.write(s6)
    file5.write(s7)
    file5.write(r5s1)
    file5.write(r5s2)
    file5.write(r5s3)

    file6.write(s)
    file6.write(s0)
    file6.write(s5)
    file6.write(s6)
    file6.write(s7)
    file6.write(r7s1)
    file6.write(r7s2)
    file6.write(r7s3)

    innervlan += 1
    ifl += 1
    local += 1
    remote += 1
  outervlan += 1
```

1.7.2 EVPN VPWS 500 instances Scaling with Traffic - Operational

PE1

```
regress@r2-RE0-re0# run show bgp summary | match "Estab|bgp.evpn"
bgp.evpn.0
11.11.11.11 64512 13787 4732 0 0 5:42:26 Establ
  bgp.evpn.0: 1006/1006/1006/0
33.33.33.33 64512 1852 2428 0 1 21:49 Establ
  bgp.evpn.0: 1089/1089/1089/0
44.44.44.44 64512 3511 4608 0 0 5:39:12 Establ
  bgp.evpn.0: 1042/1042/1042/0
```

PE2

```
regress@r2-RE0-re0# run show bgp summary | match "Estab|bgp.evpn"
bgp.evpn.0
11.11.11.11 64512 13787 4732 0 0 5:42:26 Establ
  bgp.evpn.0: 1006/1006/1006/0
33.33.33.33 64512 1852 2428 0 1 21:49 Establ
  bgp.evpn.0: 1089/1089/1089/0
44.44.44.44 64512 3511 4608 0 0 5:39:12 Establ
  bgp.evpn.0: 1042/1042/1042/0
```

PE3

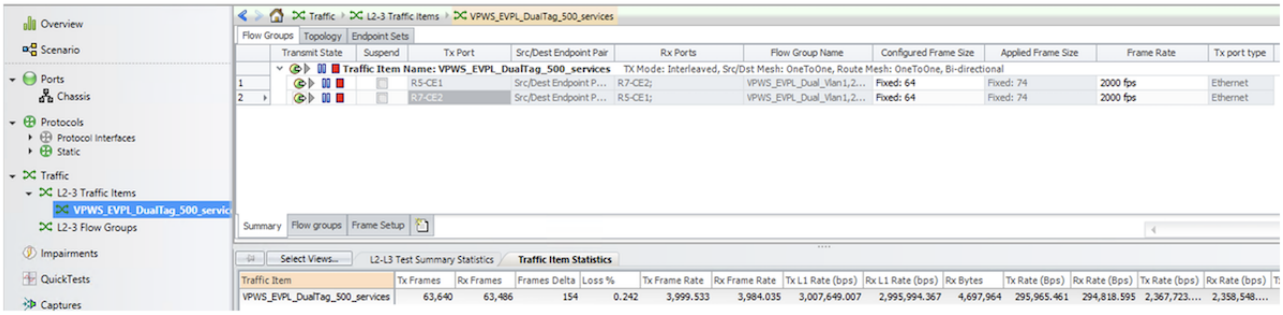
```
regress@r3-RE0-re0# run show bgp summary | match "Estab|bgp.evpn"
bgp.evpn.0
11.11.11.11 64512 5196 1256 0 0 21:42 Establ
  bgp.evpn.0: 1005/1005/1005/0
22.22.22.22 64512 2429 1850 0 0 21:51 Establ
  bgp.evpn.0: 1005/1005/1005/0
44.44.44.44 64512 1403 1835 0 0 21:48 Establ
  bgp.evpn.0: 1043/1043/1043/0
```

PE4

```
regress@r4-RE0-re0# run show bgp summary | match "Estab|bgp.evpn"
bgp.evpn.0
11.11.11.11 64512 10828 3126 0 0 5:39:22 Establ
  bgp.evpn.0: 1005/1005/1005/0
22.22.22.22 64512 4609 3509 0 0 5:39:17 Establ
  bgp.evpn.0: 1005/1005/1005/0
33.33.33.33 64512 1837 1402 0 1 21:50 Establ
```

```
  bgp.evpn.0: 1090/1090/1090/0
```

Traffic snapshot



1.7.3 EVPN VPWS 16000 instances Scaling - Operational

PE1

```
regress@r1-RE0-re0> show bgp summary | match "Establ|bgp.evpn"
bgp.evpn.0
22.22.22.22 64512 35452 36153 0 0 13:52:00 Establ
  bgp.evpn.0: 16081/16081/16081/0

33.33.33.33 64512 17945 68065 0 0 13:52:56 Establ
  bgp.evpn.0: 16081/16081/16081/0
44.44.44.44 64512 34105 45012 0 0 13:51:58 Establ
  bgp.evpn.0: 16080/16080/16080/0

regress@r1-RE0-re0> show evpn vpws-instance | match "all-active Primary Up" | count
Count: 16000 lines

regress@r1-RE0-re0> show evpn vpws-instance
Instance: evpn-vpws16k1, Instance type: EVPN VPWS
  Route Distinguisher: 11.11.11.11:1
  Number of local interfaces: 1 (1 up)

    Interface name ESI Mode Role Status Control-Word Flow-Label-Tx Flow-Label-Rx
    ae0.1 00:11:11:11:11:11:11:11:11:11all-active Primary Up Yes No No
       Local SID: 1 Advertised Label: 47
          PE addr ESI Label Mode Role TS Status
          22.22.22.22 00:11:11:11:11:11:11:11:11:11 53 all-active Primary 2022-12-05 23:35:56.191
               Resolved
       Remote SID: 16001
          PE addr ESI Label Mode Role TS Status
          44.44.44.44 00:22:22:22:22:22:22:22:22:22 47 all-active Primary 2022-12-05 23:35:56.636
               Resolved
          33.33.33.33 00:22:22:22:22:22:22:22:22:22 51 all-active Primary 2022-12-06 00:16:34.623
               Resolved
  Number of protect interfaces: 0

    Fast Convergence Information
    ESI: 00:11:11:11:11:11:11:11:11:11 Number of PE nodes: 1
       PE: 22.22.22.22
          Advertised SID: 1

    Fast Convergence Information
    ESI: 00:22:22:22:22:22:22:22:22:22 Number of PE nodes: 2
       PE: 44.44.44.44
          Advertised SID: 16001
       PE: 33.33.33.33
          Advertised SID: 16001
```

PE2

```
regress@r2-RE0-re0> show bgp summary | match "Establ|bgp.evpn"
bgp.evpn.0
11.11.11.11 64512 36168 35464 0 0 13:58:14 Establ
  bgp.evpn.0: 16081/16081/16081/0
33.33.33.33 64512 17949 70060 0 0 13:58:07 Establ
  bgp.evpn.0: 16081/16081/16081/0
44.44.44.44 64512 34116 52969 0 0 13:58:11 Establ
```

```
  bgp.evpn.0: 16080/16080/16080/0

regress@r2-RE0-re0> show evpn vpws-instance
Instance: evpn-vpws16k1, Instance type: EVPN VPWS
  Route Distinguisher: 22.22.22.22:1
  Number of local interfaces: 1 (1 up)
    Interface name ESI Mode Role Status Control-Word Flow-Label-Tx Flow-Label-Rx
    ae0.1 00:11:11:11:11:11:11:11:11:11all-active Primary Up Yes No No
       Local SID: 1 Advertised Label: 53
          PE addr ESI Label Mode Role TS Status
          11.11.11.11 00:11:11:11:11:11:11:11:11:11 47 all-active Primary 2022-12-05 23:34:28.430
               Resolved
       Remote SID: 16001
          PE addr ESI Label Mode Role TS Status
          44.44.44.44 00:22:22:22:22:22:22:22:22:22 47 all-active Primary 2022-12-05 23:36:08.229
               Resolved
          33.33.33.33 00:22:22:22:22:22:22:22:22:22 51 all-active Primary 2022-12-06 00:16:34.613
               Resolved
  Number of protect interfaces: 0

    Fast Convergence Information
    ESI: 00:11:11:11:11:11:11:11:11:11 Number of PE nodes: 1
       PE: 11.11.11.11
          Advertised SID: 1

    Fast Convergence Information
    ESI: 00:22:22:22:22:22:22:22:22:22 Number of PE nodes: 2
       PE: 44.44.44.44
          Advertised SID: 16001
       PE: 33.33.33.33
          Advertised SID: 16001

regress@r2-RE0-re0> show evpn vpws-instance | match "all-active Primary Up" | count
Count: 16000 lines
```

PE3

```
regress@r3-RE0-re0> show bgp summary | match "Establ|bgp.evpn"
bgp.evpn.0
11.11.11.11 64512 68086 17963 0 0 14:01:33 Establ
  bgp.evpn.0: 16080/16080/16080/0
22.22.22.22 64512 70067 17953 0 0 14:00:30 Establ
  bgp.evpn.0: 16080/16080/16080/0
44.44.44.44 64512 67805 17957 0 0 14:01:25 Establ
  bgp.evpn.0: 16081/16081/16081/0

{master}
regress@r3-RE0-re0> show evpn vpws-instance
Instance: evpn-vpws16k1, Instance type: EVPN VPWS
  Route Distinguisher: 33.33.33.33:1
  Number of local interfaces: 1 (1 up)

    Interface name ESI Mode Role Status Control-Word Flow-Label-Tx Flow-Label-Rx
    ae0.1 00:22:22:22:22:22:22:22:22:22all-active Primary Up Yes No No
       Local SID: 16001 Advertised Label: 51
          PE addr ESI Label Mode Role TS Status
          44.44.44.44 00:22:22:22:22:22:22:22:22:22 47 all-active Primary 2022-12-06 00:09:55.581
               Resolved
       Remote SID: 1
          PE addr ESI Label Mode Role TS Status
          22.22.22.22 00:11:11:11:11:11:11:11:11:11 53 all-active Primary 2022-12-06 00:09:39.917
               Resolved
          11.11.11.11 00:11:11:11:11:11:11:11:11:11 47 all-active Primary 2022-12-06 00:09:46.478
               Resolved
  Number of protect interfaces: 0

    Fast Convergence Information
    ESI: 00:11:11:11:11:11:11:11:11:11 Number of PE nodes: 2
       PE: 22.22.22.22
          Advertised SID: 1
       PE: 11.11.11.11
          Advertised SID: 1

    Fast Convergence Information
    ESI: 00:22:22:22:22:22:22:22:22:22 Number of PE nodes: 1
       PE: 44.44.44.44
          Advertised SID: 16001

{master}
regress@r3-RE0-re0> show evpn vpws-instance | match "all-active Primary Up" | count
```

```
Count: 16000 lines
```

PE4

```
regress@r4-RE0-re0> show bgp summary | match "Establ|bgp.evpn"
bgp.evpn.0
11.11.11.11 64512 45099 34188 0 0 14:30:45 Establ
  bgp.evpn.0: 16080/16080/16080/0
22.22.22.22 64512 53042 34186 0 0 14:30:43 Establ
  bgp.evpn.0: 16080/16080/16080/0
33.33.33.33 64512 18024 67869 0 0 14:31:35 Establ
  bgp.evpn.0: 16082/16082/16082/0

{master}
regress@r4-RE0-re0> show evpn vpws-instance
Instance: evpn-vpws16k1, Instance type: EVPN VPWS
  Route Distinguisher: 44.44.44.44:1
  Number of local interfaces: 1 (1 up)

    Interface name ESI Mode Role Status Control-Word Flow-Label-Tx Flow-Label-Rx
    ae0.1 00:22:22:22:22:22:22:22:22:22all-active Primary Up Yes No No
       Local SID: 16001 Advertised Label: 47
          PE addr ESI Label Mode Role TS Status
          33.33.33.33 00:22:22:22:22:22:22:22:22:22 51 all-active Primary 2022-12-06 00:16:34.651
               Resolved
       Remote SID: 1
          PE addr ESI Label Mode Role TS Status
          11.11.11.11 00:11:11:11:11:11:11:11:11:11 47 all-active Primary 2022-12-05 23:34:28.424
               Resolved
          22.22.22.22 00:11:11:11:11:11:11:11:11:11 53 all-active Primary 2022-12-05 23:34:33.433
               Resolved
  Number of protect interfaces: 0

    Fast Convergence Information
    ESI: 00:11:11:11:11:11:11:11:11:11 Number of PE nodes: 2
       PE: 11.11.11.11
          Advertised SID: 1
       PE: 22.22.22.22
          Advertised SID: 1

    Fast Convergence Information
    ESI: 00:22:22:22:22:22:22:22:22:22 Number of PE nodes: 1
       PE: 33.33.33.33
          Advertised SID: 16001

{master}
regress@r4-RE0-re0> show evpn vpws-instance | match "all-active Primary Up" | count
Count: 16000 lines
```

1.8 Configuration Snippets

Underlay Configuration – MPLS/OSPF

PE1:

```
regress@r1-re0# show interfaces
et-0/0/1 {
   unit 0 {
      description to-r4;
      family inet {
         address 14.1.1.1/30;
      }
      family mpls;
   }
}
et-0/0/3 {
   unit 0 {
      description to-r2;
      family inet {
         address 12.1.1.1/30;
      }
      family mpls;
   }
}
et-0/0/5 {
```

```
    unit 0 {
       description to-r3;
       family inet {
          address 13.1.1.1/30;
       }
       family mpls;
    }
 }
 et-0/0/7 {
    description "To R5";
    ether-options {
       802.3ad ae0;
    }
 }
 lo0 {
    unit 0 {
       family inet {
          address 11.11.11.11/32;
       }
    }
 }

 regress@r1-re0# show protocols
 bgp {
    group ibgp {
       type internal;
       local-address 11.11.11.11;
       family evpn {
          signaling;
       }
       neighbor 44.44.44.44;
       neighbor 33.33.33.33;
       neighbor 22.22.22.22;
    }
 }
 ldp {
    interface all;
    interface fxp0.0 {
       disable;
    }
 }
 mpls {
    interface all;
    interface fxp0.0 {
       disable;
    }
 }
 ospf {
    area 0.0.0.0 {
       interface et-0/0/1.0;
       interface et-0/0/3.0;
       interface et-0/0/5.0;
       interface lo0.0 {
          passive;
       }
    }
 }
 lldp {
    interface all;
 }

 regress@r1-re0# show routing-options
 router-id 11.11.11.11;
 autonomous-system 64512;
```

PE2:

```
 regress@r2-re0# show interfaces
 et-0/0/1 {
    unit 0 {
       description to-r3;
       family inet {
          address 23.1.1.1/30;
       }
       family mpls;
    }
 }
 et-0/0/3 {
    unit 0 {
       description to-r1;
```

```
14          family inet {
15             address 12.1.1.2/30;
16          }
17          family mpls;
18       }
19    }
20    et-0/0/5 {
21       unit 0 {
22          description to-r4;
23          family inet {
24             address 24.1.1.1/30;
25          }
26          family mpls;
27       }
28    }
29    et-0/0/9 {
30       description "To R5";
31       ether-options {
32          802.3ad ae0;
33       }
34    }
35    lo0 {
36       unit 0 {
37          family inet {
38             address 22.22.22.22/32;
39          }
40       }
41    }
42
43    regress@r2-re0# show protocols
44    bgp {
45       group ibgp {
46          type internal;
47          local-address 22.22.22.22;
48          family evpn {
49             signaling;
50          }
51          neighbor 11.11.11.11;
52          neighbor 44.44.44.44;
53          neighbor 33.33.33.33;
54       }
55    }
56    ldp {
57       interface all;
58       interface fxp0.0 {
59          disable;
60       }
61    }
62    mpls {
63       interface all;
64       interface fxp0.0 {
65          disable;
66       }
67    }
68    ospf {
69       area 0.0.0.0 {
70          interface et-0/0/1.0;
71          interface et-0/0/3.0;
72          interface et-0/0/5.0;
73          interface lo0.0 {
74             passive;
75          }
76       }
77    }
78    lldp {
79       interface all;
80    }
81
82    regress@r2-re0# show routing-options
83    router-id 22.22.22.22;
84    autonomous-system 64512;
```

PE3:

```
1     regress@r3-re0# show interfaces
2     et-0/0/1 {
3        unit 0 {
4           description to-r2;
5           family inet {
6              address 23.1.1.2/30;
```

```
        }
        family mpls;
     }
  }
  et-0/0/3 {
     unit 0 {
        description to-r1;
        family inet {
           address 13.1.1.2/30;
        }
        family mpls;
     }
  }
  et-0/0/5 {
     unit 0 {
        description to-r4;
        family inet {
           address 34.1.1.1/30;
        }
        family mpls;
     }
  }
  et-0/0/7 {
     description "To R7";
     ether-options {
        802.3ad ae0;
     }
  }
  lo0 {
     unit 0 {
        family inet {
           address 33.33.33.33/32;
        }
     }
  }

  regress@r3-re0# show protocols
  bgp {
     group ibgp {
        type internal;
        local-address 33.33.33.33;
        family evpn {
           signaling;
        }
        neighbor 11.11.11.11;
        neighbor 22.22.22.22;
        neighbor 44.44.44.44;
     }
  }
  ldp {
     interface all;
     interface fxp0.0 {
        disable;
     }
  }
  mpls {
     interface all;
     interface fxp0.0 {
        disable;
     }
  }
  ospf {
     area 0.0.0.0 {
        interface et-0/0/1.0;
        interface et-0/0/3.0;
        interface et-0/0/5.0;
        interface lo0.0 {
           passive;
        }
     }
  }
  lldp {
     interface all;
  }

  regress@r3-re0# show routing-options
  router-id 33.33.33.33;
  autonomous-system 64512;
```

PE4:

```
regress@r4-re0# show interfaces
et-0/0/1 {
   unit 0 {
      description to-r1;
      family inet {
         address 14.1.1.2/30;
      }
      family mpls;
   }
}
et-0/0/3 {
   unit 0 {
      description to-r2;
      family inet {
         address 24.1.1.2/30;
      }
      family mpls;
   }
}
et-0/0/5 {
   unit 0 {
      description to-r3;
      family inet {
         address 34.1.1.2/30;
      }
      family mpls;
   }
}
et-0/0/7 {
   description "To R7";
   ether-options {
      802.3ad ae0;
   }
}
lo0 {
   unit 0 {
      family inet {
         address 44.44.44.44/32;
      }
   }
}

regress@r4-re0# show protocols
bgp {
   group ibgp {
      type internal;
      local-address 44.44.44.44;
      family evpn {
         signaling;
      }
      neighbor 11.11.11.11;
      neighbor 22.22.22.22;
      neighbor 33.33.33.33;
   }
}
ldp {
   interface all;
   interface fxp0.0 {
      disable;
   }
}
mpls {
   interface all;
   interface fxp0.0 {
      disable;
   }
}
ospf {
   area 0.0.0.0 {
      interface et-0/0/1.0;
      interface et-0/0/3.0;
      interface et-0/0/5.0;
      interface lo0.0 {
         passive;
      }
   }
}
lldp {
   interface all;
}
```

```

regress@r4-re0# show routing-options
router-id 44.44.44.44;
autonomous-system 64512;
```

Underlay Configuration – SR, ISIS

PE1:

```
regress@r1-re0# show interfaces
et-0/0/1 {
   unit 0 {
      description to-r4;
      family inet {
         address 14.1.1.1/30;
      }
      family mpls;
      family iso;
   }
}
et-0/0/3 {
   unit 0 {
      description to-r2;
      family inet {
         address 12.1.1.1/30;
      }
      family mpls;
      family iso;
   }
}
et-0/0/5 {
   unit 0 {
      description to-r3;
      family inet {
         address 13.1.1.1/30;
      }
      family mpls;
      family iso;
   }
}
et-0/0/7 {
   description "To R5";
   ether-options {
      802.3ad ae0;
   }
}
lo0 {
   unit 0 {
      family inet {
         address 11.11.11.11/32;
      }
      family iso {
         address 49.0001.1111.1111.00
      }
   }
}

regress@r1-re0# show protocols
bgp {
   group ibgp {
      type internal;
      local-address 11.11.11.11;
      family evpn {
         signaling;
      }
      neighbor 44.44.44.44;
      neighbor 33.33.33.33;
      neighbor 22.22.22.22;
   }
}
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;
}

regress@r1-re0# show routing-options
router-id 11.11.11.11;
autonomous-system 64512;
```

PE2:

```
regress@r2-re0# show interfaces
et-0/0/1 {
    unit 0 {
        description to-r3;
        family inet {
            address 23.1.1.1/30;
        }
        family mpls;
        family iso;
    }
}
et-0/0/3 {
    unit 0 {
        description to-r1;
        family inet {
            address 12.1.1.2/30;
        }
        family mpls;
        family iso;
    }
}
et-0/0/5 {
    unit 0 {
        description to-r4;
        family inet {
            address 24.1.1.1/30;
        }
        family mpls;
        family iso;
    }
}
et-0/0/9 {
    description "To R5";
    ether-options {
        802.3ad ae0;
    }
}
lo0 {
    unit 0 {
        family inet {
            address 22.22.22.22/32;
        }
        family iso {
            address 49.0001.2222.2222.00
        }
    }
}

regress@r2-re0# show protocols
bgp {
    group ibgp {
        type internal;
        local-address 22.22.22.22;
        family evpn {
            signaling;
        }
        neighbor 11.11.11.11;
        neighbor 44.44.44.44;
        neighbor 33.33.33.33;
    }
```

```
}
isis {
   interface all {
      point-to-point;
   }
   interface fxp0.0 {
      disable;
   }
   source-packet-routing {
      node-segment ipv4-index 1002;
   }
   level 2 wide-metrics-only;
   level 1 disable;
}
mpls {
   interface all;
   interface fxp0.0 {
      disable;
   }
}
lldp {
   interface all;
}

regress@r2-re0# show routing-options
router-id 22.22.22.22;
autonomous-system 64512;
```

PE3:

```
regress@r3-re0# show interfaces
et-0/0/1 {
   unit 0 {
      description to-r2;
      family inet {
         address 23.1.1.2/30;
      }
      family mpls;
      family iso;
   }
}
et-0/0/3 {
   unit 0 {
      description to-r1;
      family inet {
         address 13.1.1.2/30;
      }
      family mpls;
      family iso;
   }
}
et-0/0/5 {
   unit 0 {
      description to-r4;
      family inet {
         address 34.1.1.1/30;
      }
      family mpls;
      family iso;
   }
}
et-0/0/7 {
   description "To R7";
   ether-options {
      802.3ad ae0;
   }
}
lo0 {
   unit 0 {
      family inet {
         address 33.33.33.33/32;
      }
      family iso {
         address 49.0001.3333.3333.00
      }
   }
}

regress@r3-re0# show protocols
bgp {
```

```
    group ibgp {
       type internal;
       local-address 33.33.33.33;
       family evpn {
          signaling;
       }
       neighbor 11.11.11.11;
       neighbor 22.22.22.22;
       neighbor 44.44.44.44;
    }
 }
 isis {
    interface all {
       point-to-point;
    }
    interface fxp0.0 {
       disable;
    }
    source-packet-routing {
       node-segment ipv4-index 1003;
    }
    level 2 wide-metrics-only;
    level 1 disable;
 }

 mpls {
    interface all;
    interface fxp0.0 {
       disable;
    }
 }
 lldp {
    interface all;
 }

 regress@r3-re0# show routing-options
 router-id 33.33.33.33;
 autonomous-system 64512;
```

PE4:

```
 regress@r4-re0# show interfaces
 et-0/0/1 {
    unit 0 {
       description to-r1;
       family inet {
          address 14.1.1.2/30;
       }
       family mpls;
       family iso;
    }
 }
 et-0/0/3 {
    unit 0 {
       description to-r2;
       family inet {
          address 24.1.1.2/30;
       }
       family mpls;
       family iso;
    }
 }
 et-0/0/5 {
    unit 0 {
       description to-r3;
       family inet {
          address 34.1.1.2/30;
       }
       family mpls;
       family iso;
    }
 }
 et-0/0/7 {
    description "To R7";
    ether-options {
       802.3ad ae0;
    }
 }
 lo0 {
    unit 0 {
```

```
        family inet {
           address 44.44.44.44/32;
        }
        family iso {
           address 49.0001.4444.4444.00
        }
     }
  }

  regress@r4-re0# show protocols
  bgp {
     group ibgp {
        type internal;
        local-address 44.44.44.44;
        family evpn {
           signaling;
        }
        neighbor 11.11.11.11;
        neighbor 22.22.22.22;
        neighbor 33.33.33.33;
     }
  }
  isis {
     interface all {
        point-to-point;
     }
     interface fxp0.0 {
        disable;
     }
     source-packet-routing {
        node-segment ipv4-index 1004;
     }
     level 2 wide-metrics-only;
     level 1 disable;
  }
  mpls {
     interface all;
     interface fxp0.0 {
        disable;
     }
  }
  lldp {
     interface all;
  }

  regress@r4-re0# show routing-options
  router-id 44.44.44.44;
  autonomous-system 64512;
```

CE Configuration in EPL, A/A mode

CE1:

```
  regress@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 - (10.49.119.55)";
     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:

```
regress@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;
   }
}
```

CE Configuration in EPL, A/S mode

CE1:

```
regress@r5_re0# show interfaces
ge-0/0/0 {
   description "To R2";
   encapsulation ethernet-bridge;
   unit 0 {
      family bridge;
   }
}
ge-0/0/1 {
   description "To R1";
   encapsulation ethernet-bridge;
   unit 0 {
      family bridge;
   }
}
ge-0/0/2 {
   description "To IXIA - (10.49.119.55)";
   encapsulation ethernet-bridge;
   unit 0 {
      family bridge;
   }
}
regress@r5_re0# show bridge-domains
bd1 {
   interface ge-0/0/2.0;
   interface ge-0/0/0.0;
   interface ge-0/0/1.0;
```

```
    bridge-options {
       no-mac-learning;
    }
 }
```

CE2:

```
regress@r7_re0# show interfaces
ge-0/0/0 {
   description "To IXIA-R10 - 10.49.106.252 ";
   inactive: flexible-vlan-tagging;
   encapsulation ethernet-bridge;
   unit 0 {
      family bridge;
   }
}
ge-0/0/1 {
   description "To R3";
   encapsulation ethernet-bridge;
   unit 0 {
      family bridge;
   }
}
ge-0/0/2 {
   description "To R4";
   encapsulation ethernet-bridge;
   unit 0 {
      family bridge;
   }
}
regress@r7_re0# show bridge-domains
bd1 {
   interface ge-0/0/0.0;
   interface ge-0/0/1.0;
   interface ge-0/0/2.0;
   bridge-options {
      no-mac-learning;
   }
}
```

CE Configuration in EPL & Dual-Tag with A/A mode

CE1:

```
regress@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;
    }
}

regress@R5-RE0> show configuration bridge-domains
bd1 {
    vlan-tags outer 1 inner 2;
    interface ae0.1;
    interface ge-0/0/2.1;
    bridge-options {
        no-mac-learning;
    }
}
```

CE2:

```
regress@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;
    }
}

regress@R7-RE0> show configuration bridge-domains
bd1 {
    vlan-tags outer 1 inner 2;
    interface ae0.1;
    interface ge-0/0/0.1;
    bridge-options {
        no-mac-learning;
    }
}
```

1.9 Glossary

- CE: Customer Edge
- DF: Designated Forwarder
- ESI: Ethernet Segment Identifier
- EVI: EVPN Instance
- EVPN: Ethernet VPN
- MOD: Modular Function

- NDF: Non Designated Forwarder
- PE: Provider Edge
- VPWS: Virtual Private Wired Service

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