# Executive summary

The document provides instructions for testing EVPN and PBB-EVPN scenarios. It includes a detailed overview of the EVPN technology, relevant standards, and test cases for both single and multi-home scenarios. The document also provides step-by-step instructions and traffic configuration guidance for PE, P, and CE sides.

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## Test case: Multi-Home Test Scenario for EVPN

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## Test Case: Designated Forwarding and Split Horizon test

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## Acronyms

- Spirent
- TestCenter
- EVPN
- PBB-EVPN
Executive summary

EVPN is a next generation technology that provides Ethernet multipoint services over MPLS networks with control plane based MAC learning. This document provides an overview on the EVPN technology and details out step by step instructions to test different EVPN use cases using Spirent Test Center.

Overview of EVPN

Ethernet VPN (EVPN) is next generation Ethernet L2VPN solution that uses BGP for MAC address learning over the core as well as for access topology and VPN endpoint discovery. EVPN provides sophisticated access redundancy, per flow load balancing and operational simplicity.

EVPN is designed to address the following requirements:

- All-active redundancy and load balancing
- Simplified provisioning and operation
- Optimal forwarding
- Fast convergence

In addition, PBB-EVPN and its inherent MAC-in-MAC hierarchy provide:

- Scale to millions of C-MAC (Virtual Machine) addressed
- MAC summarization co-existence with C-MAC (VM) mobility

MP-BGP has been successfully used in the NG MVPN to bridge C-Multicast domains through the core without the need for PIM. It advertises many Auto-Discovery (AD) routes & P-Tunnel types such as RSVP-TE P2MP, MLDP, Ingress Replication for traffic encapsulation. Based on the same concept of AD routes and P-tunnel delivery mechanism, a new set of AFI/SAFI is defined for EVPN and PBB-EVPN, new BGP NLRI types, as well as new extended communities are defined, as summarized below:

New NLRI Types for EVPN & PBB-EVPN:

- 0x1-Ethernet Auto-Discovery Route
- 0x2 MAC/IP Advertisement Route
- 0x3 Inclusive Multicast Route
- 0x4 Ethernet Segment Route
- 0x5 IP Prefix Route

New Extended communities:

- ESI MPLS Label
- ES-Import
- MAC Mobility
- Default Gateway
- Router’s MAC
The above diagram displays a high-level view of how EVPN works. PE routers learn the MAC from CE based on data plane forwarding, then advertise the MAC in the core through MP-BGP new NLRI types (MAC/IP Advertisement Routers). So the rest of PEs are aware of the new MACs. Unlike the traditional L2VPN PW emulation, P2P PWs across the core are no longer needed; instead, known unicast traffic (Destination MAC is advertised by peer PE) is encapsulated over the usual two-labels stack—the bottom being the transport tunnel (LDP or RSVP-TE), and the top is the label associated with the MAC advertisement route by the remote PE. The unknown unicast is part of the BUM (broadcast, unknown & multicast) traffic and it follows:

- Through a pre-negotiated label path through Ingress Replication or
- P2MP tunnels negotiated through MLDP or RSVP-TE P2MP.

There are many procedures, such as load balancing, Split Horizon, Designated Forwarder election, fast convergence that are introduced due to challenges of multi-homing. Spirent TestCenter offers feature-rich EVPN emulation, coupled with some of the industry unique Hardware features, Spirent TestCenter truly represents the best tool to test next generation VPN technologies.

**Relevant standards**

- RFC 7432 BGP MPLS-Based Ethernet VPN
- Draft-ietf-bess-evpn-prefix-advertisement-01
- Draft-ietf-l2vpn-pbb-evpn-10
Test case: Single Home Test Scenario for EVPN

Overview

Single Home test scenario is the simplest form of EVPN. Two Spirent TestCenter test ports are required to verify the basic functions of EVPN. One test port emulates CE routers connecting to DUT as PE & the other test port emulates PE routers as well as CE routers behind the emulated PE routers. In EVPN use cases, the CE routers are connected only to one PE router hence the term ‘Single home’. DUT and Spirent TestCenter emulated PE will exchange MAC/IP Advertisement Routes, Inclusive Multicast routes and Ethernet Segment Routes. DUT is responsible for encapsulating two label stack traffic sent by the simulated CE to DUT for de-capsulation and forwarding.

Objective

The objective of the test is to perform basic functional verification of Single Home EVPN. The example configuration will emulate single Ethernet Segment with 1 EVI but can be easily expanded to test many Ethernet Segments each with many EVIs. Different types of NLRI are exchanged between DUT and Spirent TestCenter emulated PE routers and can be verified via the View Binding Info functionality. Traffic will be created for both known Unicast as well as Broadcast, Unknown & Multicast (BUM). Two labels stack should be verified to ensure DUT and tester are both encapsulating the traffic with correct labels.

Topology
Step-by-step instructions

Application launch & adding ports

1. Launch Spirent TestCenter from the Desktop shortcut or from the start program menu.
2. Add two Spirent TestCenter ports with one port connected to CE side of DUT - rename this Spirent TestCenter port as CE & other port connected to PE side of DUT- rename this Spirent TestCenter port as PE.
3. Add three devices on PE Side. Rename the Spirent TestCenter Devices to P, PE1 & PE2. Add another device on CE Side & rename it as CE.

Steps to configure P Side:

On P Router configure OSPFv2 & LDP & create a VRF provider Link from PE Router

Create VRF Provider Link from PE Router

1. Select Emulated Devices Interface & select Incoming Links column
   
2. Add Incoming Links

![Link Editor Screenshot](attachment://link_editor.png)
3. Click on Add & Change Default link type to VRF Provider link.

4. Select Topology & P Router then add.
5. Select the P Router & then add PE routers & then finish.

5.1 After step –“Finish”, Emulated Device shows incoming links for P router & outgoing links for PE Routers.

<table>
<thead>
<tr>
<th>Emulated Device Interface</th>
<th>DHCP</th>
<th>IGMP</th>
<th>MLD</th>
<th>Gs/Go bi</th>
<th>DS-Line</th>
<th>VXLAN</th>
<th>DHCPV6</th>
<th>BFD</th>
<th>RSVP</th>
<th>LDP</th>
<th>ISIS</th>
<th>OSPFv2</th>
</tr>
</thead>
<tbody>
<tr>
<td>PortConfig2/1/1 (offline)</td>
<td>P Router</td>
<td>Click to add</td>
<td>1</td>
<td>2 VRF Provider Links</td>
<td>VRFP Router Link to P Router</td>
<td></td>
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</tr>
<tr>
<td>PortConfig2/1/1 (offline)</td>
<td>PE Router 1</td>
<td>Click to add</td>
<td>1</td>
<td></td>
<td>VRFP Router Link to PE Router 1</td>
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<tr>
<td>PortConfig2/1/1 (offline)</td>
<td>PE Router 2</td>
<td>Click to add</td>
<td>1</td>
<td></td>
<td>VRFP Router Link to PE Router 2</td>
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<td></td>
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</tr>
</tbody>
</table>

5.2 Configuration of LDP Device, Enable LDP

Add LSP:
From LDP, click on Edit LSPs. In the LDP LSPs pop up widow, Click on “Add”

5.3 Configuration of OSPFv2 Device, Enable OSPFv2.
1. Add LSA by clicking on Edit LSAs,

2. Configure Route LSA & Router LSA Link contents for P Routers to PE Routers from LSA Generator
   
   2.1 Click on LSA Generator & Select P Router
2.2 Select the Topology, default is Tree topology.

![Topology Selection](image1)

2.3 Configure OSPF, Specify PE Router ID as Start Router IP address

![OSPF Configuration](image2)
2.4 Configure Stub-Networks:
Set the primary metric & add total number of routers to create.

2.5 Specify None for Configure Summary Routes & Configure External Routers.

2.6 Click on Finish in the LSA Generator option.
Steps to configure iBGP on PE Side:

1. Enable iBGP on both PE Side as per the above topology.

2. Select BGP Device that need to Advertise EVPN routes and then click on Edit Routes.

3. For above topology add EVPN MAC/IP (Type2) & EVPN Inclusive Multicast (Type3):

   3.1 From EVPN MAC/IP (Type2) tab, click on Add. The below parameters can be edited: ESI, MAC Address, Data plane Encapsulation MAC Mobility, MPLS2, Include Router’s MAC & Include Default Gateway configuration.

   3.2 From EVPN Inclusive Multicast (Type3) tab, click on Add. Data Plane encapsulation parameter can be edited if needed.
Please note that BGP AFI/SAF added by default at this point.

### 4. Configure VRF in BGP:
- **Click on Edit Virtual Networks**

![Edit Virtual Networks](image)

4.1 **Add VRFs:** Click on Add

![Add VRF](image)
4.2 Add on Ethernet VPN:
In the Virtual Networks pop up, click on “Add” button above “Ethernet VPN tab”

4.3 Select ports
4.4 Select Routes/Devices: Select PE Router & CE router

4.5 Finish VRF Configure
Options:

1. **Unknown Unicast Traffic:**
   - Unselect “Use Inclusive Multicast Label”.
   - Type-2 Label (MAC End point) will be picked for Traffic generation.

2. **BUM Traffic:**
   - Select “Use Inclusive Multicast Label”.
   - Type-3 Label (MAC End point) will be picked for Traffic generation.

**Steps to configure CE Side:**

1. Add Device with MAC address.

2. Click on Edit Virtual Networks
   - “Add attached PE/DUT IPv4 address” for CE routers and click on Close.
Traffic configuration

1. Add Traffic

2. Endpoints select:
   Change the Encapsulation to EthernetII. Bidirectional option can be selected if needed.
3. Select Source & Destination:

4. Select BGP PE Router as Source and CE Router as Destination and click on Add. Click on Finish Traffic Wizard once done.
Verify results:
Check whether BGP View Binding for MAC & Inclusive Mcast Label is present.

 Verify Traffic:
Select All Stream block and verify whether all the streams are resolved.
Select stream and click on Edit.
Select preview tab & enable Show resolved encapsulations. Verify the labels are configured correctly.
Test case: Multi-Home Test Scenario for EVPN

Overview:
Multi-home test is more complex than single home testing. One of the very reasons for EVPN coming to existence is it supports multi-homing. Some of the key functions of multi-homing PEs are:

- Fast Convergence
- Aliasing

These key functions need to be verified in order to guarantee Spirent TestCenter feature rich EVPN emulation software, coupled with hardware unique ability to perform.

Objective
This test is to verify the Load Balancing, Fast Convergence, Aliasing functions in a multi-homing EVPN setup.

Setup

Fast convergence step-by-step instructions:
1. Launch Spirent TestCenter from the Desktop shortcut or from the start program menu.
2. Add Three Spirent TestCenter ports. Connect one port to CE side of DUT & rename CE. Connect other two ports to PE side of DUT & rename as PE.
3. Add Two Devices on one of the PE Side rename Spirent TestCenter Devices name as P, PE1 & add two devices on other PE2 & one Device on CE Side & rename Spirent TestCenter Devices name as CE.

Step to configure P Side.
On both the ports P Router, configure OSPFv2 & LDP.

Create a VRF provider Link from PE Router as show in the above test case.
Steps to configure PE Side

Please follow the same step as shown in the above test. Router need to be advertised in EVPN routes as show below.

1. Add AD Router (Type 1) with ESI by default it adds as Per ESI router and Per EVI

2. Add MAC/IP Router on both the PE ports: Provide same MAC address for both

3. Select “Include ESI Label” in Configure VRF in BGP & Click on Edit Virtual Networks
Steps to configure CE Side
Please follow the same step as show in the above test.

Traffic configuration
Please follow the same step as show in the above test.

Verify results
Verify BGP View Binding for ESI & MAC Label present.

Verify Traffic:
Select All Stream blocks and verify whether all the streams are resolved.
Select stream and click on Edit.
Select preview tab & enable Show Resolved Encapsulations. Verify the labels are configured correctly.
Test Case: Designated Forwarding and Split Horizon test

Overview:
Multi-home test is more complex than single home testing. One of the very reasons for EVPN coming to existence is it supports multi-homing. Some of the key functions of multi-homing PEs are:

- Designated Forwarding to avoid packet duplication
- Split Horizon to avoid forwarding loops.

These key functions need to be verified in order to guarantee Spirent TestCenter feature rich EVPN emulation software, coupled with hardware unique ability to perform.

Objective
This test is to verify Designated Forwarding & Split Horizon functionality in a multi-homing EVPN setup.

Setup:

Step-by-step instructions.
Application Launch & Adding ports
Please follow the same step as in first test.

Step to configure P Side.
Please follow the same step as in first test.

Steps to configure PE Side.
EVPN Router need to Advertised as Type1, Type2, and Type3 & Type4
Please follow the same step as show in above tests for Type1 Type2 & Type3. Type2 to be modified and Type4 to be added as per the screen shot below

1. Add Type4 router:
2. **Modify Type2 Router:**

Configure CE device MAC address to Advertised from the Type2 Router.

![Type2 Router Configuration](image1)

3. **VRF one step need to modify.**

Enable Include ESI label in traffic. It will use the ESI label as third label & send traffic.

![VRF Configuration](image2)

**Steps to configure CE Side**

Please follow the same step as show in the above test.

**Traffic configuration**

Please follow the same step as show in the above test.

**Verify results:**

Verify BGP View Binding for ESI, Inclusive & MAC Label present.

![BGP View Binding](image3)

Verify Traffic:

Select All Stream blocks and verify whether all the streams are resolved.

Select stream and click on Edit.

Select preview tab & enable Show resolved encapsulations. Verify the labels are configured correctly.
Acronyms

AFI/SAFI  Address Family Identifiers / Subsequent Address Family Identifiers
BGP       Border Gateway Protocol
BGP NLRI  Border Gateway Protocol Network Layer Reachability Information
BUM       Broadcast, Unknown & Multicast
CE        Customer Edge
DUT       Device Under Test
EVPN      Ethernet Virtual Private Network
iBGP      Internal Border Gateway Protocol
LDP       Label Distribution Protocol
MLDP      Multicast Label Distribution Protocol
MP-BGP    Multiprotocol Border Gateway Protocol
MPLS      Multiprotocol Label Switching
NG MVPN   Next-Generation Multicast Virtual Private Network
OSPFv2    Open Shortest Path First version 2
PE        Provider Edge
PBB-EVPN  Provider Backbone Bridging Ethernet Virtual Private Network
P2MP      Point to Multipoint Communication
RSVP-TE   Resource Reservation Protocol - Traffic Engineering
VRF       Virtual Routing and Forwarding