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VPWS support in EVPN  
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## Abstract

This document describes how EVPN can be used to support virtual private wire service (VPWS) in MPLS/IP networks. EVPN enables the following characteristics for VPWS: single-active as well as all-active multi-homing with flow-based load-balancing, eliminates the need for single-segment and multi-segment PW signaling, and provides fast protection using data-plane prefix independent convergence upon node or link failure.

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## 1 Introduction

This document describes how EVPN can be used to support virtual private wire service (VPWS) in MPLS/IP networks. The use of EVPN mechanisms for VPWS brings the benefits of EVPN to p2p services. These benefits include single-active redundancy as well as all-active redundancy with flow-based load-balancing. Furthermore, the use of EVPN for VPWS eliminates the need for signaling single-segment and multi-segment PWs for p2p Ethernet services.

[EVPN] has the ability to forward customer traffic to/from a given customer Attachment Circuit (AC), aka Ethernet Segment in EVPN terminology, without any MAC lookup. This capability is ideal in providing p2p services (aka VPWS services). [MEF] defines Ethernet Virtual Private Line (EVPL) service as p2p service between a pair of ACs (designated by VLANs) and Ethernet Private Line (EPL) service, in which all traffic flows are between a single pair of ESes. EVPL can be considered as a VPWS with only two ACs. In delivering an EVPL service, the traffic forwarding capability of EVPN based on the exchange of a pair of Ethernet AD routes is used; whereas, for more general VPWS, traffic forwarding capability of EVPN based on the exchange of a group of Ethernet AD routes (one Ethernet AD route per AC/segment) is used. In a VPWS service, the traffic from an originating Ethernet Segment can be forwarded only to a single destination Ethernet Segment; hence, no MAC lookup is needed and the MPLS label associated with the per-EVI Ethernet AD route can be used in forwarding user traffic to the destination AC.

Both services are supported by using the Ethernet A-D per EVI route

which contains an Ethernet Segment Identifier, in which the customer ES is encoded, and an Ethernet Tag, in which the VPWS service instance identifier is encoded. I.e., for both EPL and EVPL services, a specific VPWS service instance is identified by a pair of Ethernet A-D per EVI routes which together identify the VPWS service instance endpoints and the VPWS service instance. In the control plane the VPWS service instance is identified using the VPWS service instance identifiers advertised by each PE and in the data plane the MPLS label advertised by one PE is used by the other PE to send traffic for that VPWS service instance. As with the Ethernet Tag in standard EVPN, the VPWS service instance identifier has uniqueness within an EVPN instance. Unlike standard EVPN where the Ethernet Tag MUST be carried in the MPLS encapsulated frames, VPWS does not use the Ethernet Tag value in the data plane. The MPLS label is enough to identify the VPWS service instance and provide egress tag translation at the disposition PE, if required. The Ethernet Segment identifier encoded in the Ethernet A-D per EVI route is not used to identify the service, however it can be used for flow-based load-balancing and mass withdraw functions.

As with standard EVPN, the Ethernet A-D per ES route is used for fast convergence upon link or node failure and the Ethernet Segment route is used for auto-discovery of the PEs attached to a given multi-homed CE and to synchronize state between them.

## 1.1 Terminology

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in [RFC 2119](#) [[RFC2119](#)].

MAC: Media Access Control

MPLS: Multi Protocol Label Switching.

OAM: Operations, Administration and Maintenance.

PE: Provide Edge Node.

CE: Customer Edge device e.g., host or router or switch.

EVPL: Ethernet Virtual Private Line.

EPL: Ethernet Private Line.

VPWS: Virtual private wire service.

EVI: EVPN Instance.

Single-Active Mode: When a device or a network is multi-homed to two or more PEs and when only a single PE in such redundancy group can forward traffic to/from the multi-homed device or network for a given VLAN, then such multi-homing or redundancy is referred to as "Single-Active".

All-Active: When a device is multi-homed to two or more PEs and when all PEs in such redundancy group can forward traffic to/from the multi-homed device for a given VLAN, then such multi-homing or redundancy is referred to as "All-Active".

## [1.2](#) Requirements

1. EPL service access circuit maps to the whole Ethernet port.
2. EVPL service access circuits are VLANs on single or double tagged trunk ports. Each VLAN individually will be considered to be an endpoint for an EVPL service, without any direct dependency on any other VLANs on the trunk. Other VLANs on the same trunk could also be

used for EVPL services, but could also be associated with other services.

3. If multiple VLANs on the same trunk are associated with EVPL services, the respective remote endpoints of these EVPLs could be dispersed across any number of PEs, i.e. different VLANs may lead to different destinations.

4. The VLAN tag on the access trunk only has PE-local significance. The VLAN tag on the remote end could be different, and could also be double tagged when the other side is single tagged.

5. Also, multiple EVPL service VLANs on the same trunk could belong to the same EVPN instance (EVI), or they could belong to different EVIs. This should be purely an administrative choice of the network

operator.

6. A given access trunk could have hundreds of EVPL services, and a given PE could have thousands of EVPLs configured. It must be possible to configure multiple EVPL services within the same EVI.

7. Local access circuits configured to belong to a given EVPN instance could also belong to different physical access trunks.

8. EPL-LAN and EVP-LAN are possible on the same system and also ESIs can be shared between EVPL and EVP-LANs.

## [2. BGP Extensions](#)

This document proposes the use of the Ethernet A-D per EVI route to signal VPWS services. The Ethernet Segment Identifier field is set to the customer ES and the Ethernet Tag ID 32-bit field is set to the 24-bit VPWS service instance identifier. For both EPL and EVPL services, for a given VPWS service instance the pair of PEs instantiating that VPWS service instance will each advertise an Ethernet A-D per EVI route with its VPWS service instance identifier and will each be configured with the other PE's VPWS service instance identifier. When each PE has received the other PE's Ethernet A-D per EVI route the VPWS service instance is instantiated. It should be noted that the same VPWS service instance identifier may be configured on both PEs.

The Route-Target (RT) extended community with which the Ethernet A-D per EVI route is tagged identifies the EVPN instance in which the VPWS service instance is configured. It is the operator's choice as to how many and which VPWS service instances are configured in a

given EVPN instance. However, a given EVPN instance MUST NOT be configured with both VPWS service instances and standard EVPN multi-point services.

## [3 Operation](#)

The following figure shows an example of a P2P service deployed with

```

Ethernet
Native Service (AC) |<----- EVPN Instance ----->| Native Service (AC)
                    |<-PSN1->|<-PSN2->|
                    |V|V|V|V|V|V|
+---+ | +---+ +---+ +---+ +---+
| | | PE1 |====| ASBR1 |==| ASBR2 |==| PE3 | | +---+
| | | +---+ +---+ +---+ +---+
| CE1 | | +---+ +---+ +---+ +---+ | CE2 |
| | | +---+ +---+ +---+ +---+
+---+ | PE2 |====| ASBR3 |==| ASBR4 |==| PE4 | | +---+
^ +---+ +---+ +---+ +---+ ^
| Provider Edge 1 ^ Provider Edge 2 |
| | | |
| | | EVPN Inter-provider point |
| | |
|<----- Emulated Service ----->|

```

All PEs and ASBRs are enabled for the EVPN SAFI and exchange Ethernet A-D per EVI routes, one route per VPWS service instance. For inter-AS option B, the ASBRs re-advertise these routes with Next Hop attribute set to their IP addresses. The link between the CE and the PE is either a C-tagged or S-tagged interface, as described in [802.1Q], that can carry a single VLAN tag or two nested VLAN tags and it is configured as a trunk with multiple VLANs, one per VPWS service instance. It should be noted that the VLAN ID used by the customer at either end of a VPWS service instance to identify that service instance may be different and EVPN doesn't perform that translation between the two values. Rather, the MPLS label will identify the VPWS service instance and if translation is needed, it should be done by the Ethernet interface for each service.

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ESI field is set to 0 and the Ethernet Tag field is set to the VPWS



service instance identifier that identifies the EVPL or EPL service.

For a multi-homed CE, in an advertised Ethernet A-D per EVI route the ESI field is set to the CE's ESI and the Ethernet Tag field is set to the VPWS service instance identifier, which MUST have the same value on all PEs attached to that ES. This allows an ingress PE to perform flow-based load-balancing of traffic flows to all of the PEs attached to that ES. In all cases traffic follows the transport paths, which may be asymmetric.

The VPWS service instance identifier encoded in the Ethernet Tag field in an advertised Ethernet A-D per EVI route MUST either be unique across all ASs, or an ASBR needs to perform a translation when the Ethernet A-D per EVI route is re-advertised by the ASBR from one AS to the other AS.

Ethernet A-D per ES route can be used for mass withdraw to withdraw all Ethernet A-D per EVI routes associated with the multi-home site on a given PE.

#### [4](#) EVPN Comparison to PW Signaling

In EVPN, service endpoint discovery and label signaling are done concurrently using BGP. Whereas, with VPWS based on [[RFC4448](#)], label signaling is done via LDP and service endpoint discovery is either through manual provisioning or through BGP.

In existing implementation of VPWS using pseudowires(PWs), redundancy is limited to single-active mode, while with EVPN implementation of VPWS both single-active and all-active redundancy modes can be supported.

In existing implementation with PWs, backup PWs are not used to carry traffic, while with EVPN, traffic can be load-balanced among different PEs multi-homed to a single CE.

Upon link or node failure, EVPN can trigger failover with the withdrawal of a single BGP route per EVPL service or multiple EVPL services, whereas with VPWS PW redundancy, the failover sequence requires exchange of two control plane messages: one message to deactivate the group of primary PWs and a second message to activate the group of backup PWs associated with the access link. Finally, EVPN may employ data plane local repair mechanisms not available in VPWS.

#### [5](#) ESI Bandwidth

The ESI Bandwidth will be encoded using the Link Bandwidth Extended community defined in [[draft-ietf-idr-link-bandwidth](#)] and associated with the Ethernet AD route used to realize the EVPL services.

When a PE receives this attribute for a given EVPL it MUST request the required bandwidth from the PSN towards the other EVPL service destination PE originating the message. When resources are allocated from the PSN for a given EVPL service, then the PSN SHOULD account for the Bandwidth requested by this EVPL service.

In the case where PSN resources are not available, the PE receiving this attribute MUST re-send its local Ethernet AD routes for this EVPL service with the ESI Bandwidth = All FFs to declare that the "PSN Resources Unavailable".

The scope of the ESI Bandwidth is limited to only one Autonomous System.

## [6](#) Failure Scenarios

On a link or port failure between the CE and the PE for both single and multi-homed CEs, the PE must withdraw all the associated Ethernet AD routes for the VPWS service instances on the failed port or link.

### [6.1](#) Single-Homed CEs

Unlike [[EVPN](#)], EVPN-VPWS uses Ethernet AD route advertisements for single-homed Ethernet Segments. Therefore, upon a link/port failure of this single-homed Ethernet Segment, the PE MUST withdraw the associated Ethernet A-D routes.

### [6.1](#) Multi-Homed CEs

For a faster convergence in multi-homed scenarios with either Single-Active Redundancy or All-active redundancy, mass withdraw technique as per [[EVPN](#)] baseline is used. A PE previously advertising an Ethernet A-D per ES route, can withdraw this route signaling to the remote PEs to switch all the VPWS service instances associated with this multi-homed ES to the backup PE

## [7](#) VPWS with multiple sites

The VPWS among multiple sites (full mesh of P2P connections - one per pair of sites) that can be setup automatically without any explicit provisioning of P2P connections among the sites is outside the scope

of this document.

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## [8](#) Acknowledgements

The authors would like to acknowledge Wen Lin contributions to this document.

## [9](#) Security Considerations

This document does not introduce any additional security constraints.

## [10](#) IANA Considerations

TBD.

## [11](#) References

### [11.1](#) Normative References

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[EVPN] A. Sajassi, R. Aggarwal et. al., "BGP MPLS Based Ethernet VPN", [draft-ietf-l2vpn-evpn-11.txt](#).

[PBB-EVPN] A. Sajassi et. al., "PBB-EVPN", [draft-ietf-l2vpn-pbb-evpn-08.txt](#).

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