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Requirements for Metro Ethernet Forum (MEF) Ethernet-Tree (E-Tree)  
Support in Layer 2 Virtual Private Network (L2VPN)

Abstract

This document provides functional requirements for the support of Metro Ethernet Forum (MEF) Ethernet Tree (E-Tree) in multipoint Layer 2 Virtual Private Network solutions (referred to as simply "L2VPN"). It is intended that potential solutions will use these requirements as guidelines.

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## 1. Introduction

This document provides functional requirements for the support of Metro Ethernet Forum (MEF) Ethernet Tree (E-Tree) in multipoint Layer 2 Virtual Private Network solutions (referred to as simply "L2VPN"). It is intended that potential solutions will use these requirements as guidelines.

A considerable number of service providers have adopted Virtual Private LAN Service (VPLS) to provide MEF Ethernet LAN (E-LAN) services to customers. Service providers currently need a simple and effective solution to emulate E-Tree services in addition to E-LAN services on their MPLS networks.

Service providers also expect E-Tree support in any newly developed L2VPN technologies.

### 1.1. Conventions Used in This Document

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 [RFC2119].

## 2. IETF Multipoint Ethernet L2VPN Services

### 2.1. VPLS

VPLS [RFC4761] [RFC4762] is an L2VPN service that provides multipoint-to-multipoint connectivity for Ethernet across an IP or MPLS-enabled IP Packet Switched Network (IP/MPLS PSN). VPLS emulates the Ethernet VLAN functionality of traditional Ethernet networks. Thus, in VPLS, the customer Ethernet frame is transported over the IP/MPLS PSN from the ingress Provider Edge (PE) to the egress PE where the destination is connected based on the Ethernet frame destination Media Access Control (MAC) address in the context of the virtual switching instance (VSI) to which it belongs.

### 2.2. Ethernet Virtual Private Network (E-VPN)

E-VPN is an enhanced L2 service that emulates an Ethernet VLAN across an IP/MPLS PSN, primarily targeted to support large scale L2VPNs with resiliency requirements not satisfied by other L2VPN solutions.

E-VPN is currently under development. Please refer to [EVPN].

### 3. MEF Multipoint Ethernet Services

MEF has defined two multipoint Ethernet service types:

- E-LAN (Ethernet LAN), multipoint-to-multipoint service
- E-Tree (Ethernet Tree), rooted-multipoint service

For the full specifications, please refer to [MEF6.1] and [MEF10.2].

#### 3.1. Similarities between E-LAN and E-Tree

The following are the similarities between E-LAN and E-Tree services.

- Data frame is an Ethernet frame.
- Data forwarding is MAC-based forwarding.
- A generic E-LAN/E-Tree service is always bidirectional in the sense that ingress frames can originate at any endpoint in the service.

#### 3.2. Differences between E-LAN and E-Tree

Within the context of a multipoint Ethernet service, each endpoint is designated as either a Root or a Leaf. A Root can communicate with all other endpoints in the same multipoint Ethernet service; however, a Leaf can only communicate with Roots but not Leaves.

The only differences between E-LAN and E-Tree are:

- E-LAN has Root endpoints only, which implies there is no communication restriction between endpoints.
- E-Tree has both Root and Leaf endpoints, which implies there is a need to enforce communication restriction between Leaf endpoints.

### 3.3. E-Tree Use Cases

Table 1 presents some major E-Tree use cases.

	Use Case	Root	Leaf
1	Hub & Spoke VPN	Hub Site	Spoke Site
2	Wholesale Access	Customer's Interconnect	Customer's Subscriber
3	Mobile Backhaul	Radio Access Network (RAN) Network Controller	RAN Base Station
4	IEEE 1588 PTPv2 Clock Synchronisation [IEEE1588]	Precision Time Protocol (PTP) Server	PTP Client
5	Internet Access [TR-101]	Broadband Network Gateway	Subscriber
6	Broadcast Video (unidirectional only)	Video Source	Subscriber
7	Broadcast/Multicast Video plus Control Channel	Video Source	Subscriber
8	Device Management	Management System	Managed Device

Table 1: E-Tree Use Cases

Common to all use cases, direct L2 Leaf-to-Leaf communication is not required or must be inhibited.

If direct L2 Leaf-to-Leaf communication is not allowed due to a security concern, then E-Tree should be used to prohibit communication between Leaf endpoints. Otherwise, E-LAN is also a feasible option.

### 3.4. Generic E-Tree Service

A generic E-Tree service supports multiple Root endpoints. The need for multiple Root endpoints is usually driven by a redundancy requirement. Whether a particular E-Tree service needs to support single or multiple Roots depends on the target application.

A generic E-Tree service supports all the following traffic flows:

- Ethernet Unicast from Root to Leaf
- Ethernet Unicast from Leaf to Root
- Ethernet Unicast from Root to Root
- Ethernet Broadcast/Multicast from Root to other Roots and Leaves
- Ethernet Broadcast/Multicast from Leaf to Roots

A particular E-Tree service may need to support all the above or only a subset depending on the target application.

## 4. Problem Statement

### 4.1. Motivation

L2VPN can be used to emulate MEF E-LAN service over an IP/MPLS PSN.

Service providers also require E-Tree support in L2VPN.

### 4.2. Leaf-to-Leaf Communication Restriction

In this section, VPLS is used to illustrate the problem; however, the same principle applies to other L2VPN technologies.

VPLS treats all attachment circuits (ACs) equally (essentially as Roots, although they not classified into Root or Leaf) and provides any-to-any connectivity among all ACs. VPLS does not include any mechanism for communication restriction between specific ACs. Therefore, it is insufficient for emulating generic E-Tree service over an IP/MPLS PSN.

As an example of the problems not addressed in VPLS solutions, consider the scenario in Figure 1 where there are two PEs, each with a Root AC and a Leaf AC and where VPLS is used to emulate an E-Tree service interconnecting these ACs over an IP/MPLS PSN.

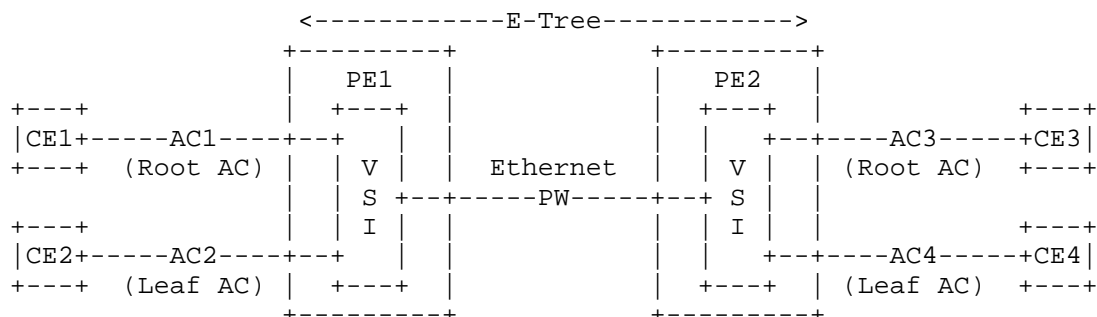


Figure 1: Problem Scenario for Leaf-to-Leaf Communication Restriction

When PE2 receives a frame from PE1 via the Ethernet pseudowire (PW),

- PE2 does not know which AC on PE1 is the ingress AC
- PE2 does not know whether or not the ingress AC is a Leaf AC
- PE2 does not have sufficient information to enforce the Leaf-to-Leaf communication restriction

Examples where the problems arise:

- Customer Edge 2 (CE2) sends a Broadcast/Multicast Ethernet frame to PE1 via AC2
- CE2 sends a Unicast Ethernet frame to PE1 via AC2 with a destination MAC address corresponding to CE4's MAC address

Note: Figure 1 is a hypothetical case solely used for explaining the problem; it is not meant to represent a typical E-Tree service.

There are some possible ways to get around this problem that do not require extensions to existing VPLS solutions, but they all come with significant design complexity or deployment constraints.

## 5. Requirements

### 5.1. Functional Requirements

The following are the E-Tree L2VPN functional requirements:

- (1) A solution MUST prohibit communication between any two Leaf ACs in an L2VPN instance.
- (2) A solution MUST allow multiple Root ACs in an L2VPN instance.

- (3) A solution MUST allow a Root AC and Leaf AC of an L2VPN instance to coexist on any PE.

## 5.2. Applicability

A solution MUST identify the L2VPN technology ([RFC4761], [RFC4762], [EVPN]) to which the solution is applicable.

## 5.3. Backward Compatibility

A solution SHOULD minimise the impact on VPLS and E-VPN L2VPN solutions, especially for the MEF E-LAN services already in operation.

A solution SHOULD be backward compatible with the VPLS and E-VPN L2VPN solutions. It SHOULD allow a case where a common L2VPN instance is composed of both PEs supporting the solution and PEs not supporting it, and the Leaf-to-Leaf communication restriction is enforced within the scope of the compliant PEs.

## 5.4. External Network Network Interface (ENNI)

A solution SHOULD support Root Operator Virtual Connection (OVC) End Point, Leaf OVC End Point and Trunk OVC End Point specified in [MEF26.1].

## 6. Security Considerations

This document introduces a requirement of prohibiting communication between any two Leaf ACs in an L2VPN instance. In some use cases, such a requirement is imposed because of security reasons. Other than that, there are no additional security considerations beyond those already described in [RFC4761], [RFC4762], and [EVPN].

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## Appendix A. Frequently Asked Question

### A.1. Are E-Tree Requirements Addressed in the Virtual Private Multicast Service (VPMS) Requirements?

VPMS requirements are defined in [VPMS].

The focus of VPMS is to provide point-to-multipoint connectivity.

VPMS provides single coverage of receiver membership (i.e., there is no distinct differentiation for multiple multicast groups). A VPMS service supports single or multiple Root ACs. All traffic from a Root AC will be forwarded to all Leaf ACs (i.e., Point-to-Multipoint (P2MP), from Root to all Leaves). The destination address in an Ethernet frame is not used in data forwarding. As an optional capability, a VPMS service may support reverse traffic from a Leaf AC to a Root AC (i.e., point-to-point (P2P), from Leaf to Root).

In contrast, the focus of MEF E-Tree is that a Leaf can only communicate with Roots, not Leaves.

A generic MEF E-Tree service supports multiple Root endpoints. Whether a particular E-Tree service needs to support single or multiple Root endpoints depends on the target application.

As discussion in a previous section, a generic MEF E-Tree service supports all the following traffic flows:

- Ethernet Unicast bidirectional Root to/from Root
- Ethernet Unicast bidirectional Root to/from Leaf
- Ethernet Broadcast/Multicast unidirectional Root to all Roots and Leaves
- Ethernet Broadcast/Multicast unidirectional Leaf to all Roots

A particular E-Tree service may need to support all the above or only a subset depending on the target application.

The IETF's VPMS definition and MEF's E-Tree definition are significantly different.

VPMS may be acceptable in cases where E-Tree service is needed, such as in the following cases:

- No Unicast traffic from Root destined for a specific Leaf (or there is no concern if such Unicast traffic is forwarded to all Leaves)
- No traffic between Roots

For generic E-Tree service, VPMS will not be able to meet the requirements.

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