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Generalized MPLS (GMPLS) Support for Metro Ethernet Forum and G.8011 Ethernet Service Switching

Abstract

This document describes a method for controlling two specific types of Ethernet switching via Generalized Multi-Protocol Label Switching (GMPLS). This document supports the types of switching corresponding to the Ethernet services that have been defined in the context of the Metro Ethernet Forum (MEF) and International Telecommunication Union (ITU) G.8011. Specifically, switching in support of Ethernet private line and Ethernet virtual private line services are covered. Support for MEF- and ITU-defined parameters is also covered.

Status of This Memo

This is an Internet Standards Track document.

This document is a product of the Internet Engineering Task Force (IETF). It represents the consensus of the IETF community. It has received public review and has been approved for publication by the Internet Engineering Steering Group (IESG). Further information on Internet Standards is available in Section 2 of RFC 5741.

Information about the current status of this document, any errata, and how to provide feedback on it may be obtained at http://www.rfc-editor.org/info/rfc6004.

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1. Introduction

[MEF6] and [G.8011] provide parallel frameworks for defining network-oriented characteristics of Ethernet services in transport networks. The framework discusses general Ethernet connection characteristics, Ethernet User-Network Interfaces (UNIs) and Ethernet Network-Network Interfaces (NNIs). Within this framework, [G.8011.1] defines the Ethernet Private Line (EPL) service and [G.8011.2] defines the Ethernet Virtual Private Line (EVPL) service. [MEF6] covers both service types. [MEF10.1] defines service parameters and [MEF11] provides UNI requirements and framework.

[MEF6] and [G.8011] are focused on service interfaces and not the underlying technology used to support the service. For example, [G.8011] refers to the defined services being transported over one of several possible "server layers". This document focuses on the types of switching that may directly support these services and provides a method for GMPLS-based control of such switching technologies. This document defines the GMPLS extensions needed to support such switching, but does not define the UNI or External NNI (E-NNI) reference points. See [RFC6005] for a description of the UNI reference point. This document makes use of the traffic parameters defined in [RFC6003] and the generic extensions defined in [RFC6002].

1.1. Overview

This document uses a common approach to supporting the switching corresponding to the Ethernet services defined in [MEF6], [G.8011.1], and [G.8011.2]. The approach builds on standard GMPLS mechanisms to deliver the required control capabilities. This document reuses the GMPLS mechanisms specified in [RFC3473] and [RFC4974]. The document uses the extensions defined in [RFC6002].

Two types of connectivity between Ethernet endpoints are defined in [MEF6] and [G.8011]: point-to-point (P2P) and multipoint-to-multipoint (MP2MP). [MEF6] uses the term Ethernet Line (E-line) to refer to point-to-point virtual connections, and Ethernet LAN (E-LAN) to refer to multipoint-to-multipoint virtual connections. [G.8011] also identifies point-to-multipoint (P2MP) as an area for "further study". Within the context of GMPLS, support is defined for point-to-point unidirectional and bidirectional Traffic Engineering Label Switched Paths (TE LSPs), see [RFC3473], and unidirectional point-to-multipoint TE LSPs, see [RFC4875].

Support for P2P and MP2MP services is defined by [G.8011] and required by [MEF11]. Note that while [MEF11] and [G.8011] discuss MP2MP, [G.8011.1] and [G.8011.2] only define support for P2P. There is a clear correspondence between E-Line/P2P service and GMPLS P2P TE

LSPs, and support for such LSPs is included in the scope of this document. There is no such clear correspondence between E-LAN/MP2MP service and GMPLS TE LSPs. Although, it is possible to emulate this service using multiple P2P or P2MP TE LSPs, the definition of support for MP2MP service is left for future study and is not addressed in this document.

[MEF11] defines multiple types of control for UNI Ethernet services. In MEF UNI Type 1, services are configured manually. In MEF UNI Type 2, services may be configured manually or via a link management interface. In MEF UNI Type 3, services may be established and managed via a signaling interface. From the MEF perspective, this document, along with [RFC6005], is aimed at the network control needed to support the MEF UNI Type 3 mode of operation.

[G.8011.1], [G.8011.2], and [MEF11], together with [MEF10.1], define a set of service attributes that are associated with each Ethernet connection. Some of these attributes are based on the provisioning of the local physical connection and are not modifiable or selectable per connection. Other attributes are specific to a particular connection or must be consistent across the connection. The approach taken in this document to communicate these attributes is to exclude the static class of attributes from signaling. This class of attributes will not be explicitly discussed in this document. The other class of attributes is communicated via signaling and will be reviewed in the sections below. The major attributes that will be supported in signaling include:

- Endpoint identifiers
- Connection identifiers
- Traffic parameters (see [RFC6003])
- Bundling / VLAN IDs map (EVPL only)
- VLAN ID Preservation (EVPL only)

Common procedures used to support Ethernet LSPs are described in Section 2 of this document. Procedures related to the signaling of switching in support of EPL services are described in Section 3. Procedures related to the signaling of switching in support of EVPL services are described in Section 4.

1.2. 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. Common Signaling Support

This section describes the common mechanisms for supporting GMPLS signaled control of LSPs that provide Ethernet connections as defined in [MEF11], [G.8011.1], and [G.8011.2].

Except as specifically modified in this document, the procedures related to the processing of RSVP objects are not modified by this document. The relevant procedures in existing documents, such as [RFC3473], MUST be followed in all cases not explicitly described in this document.

2.1. Ethernet Endpoint Identification

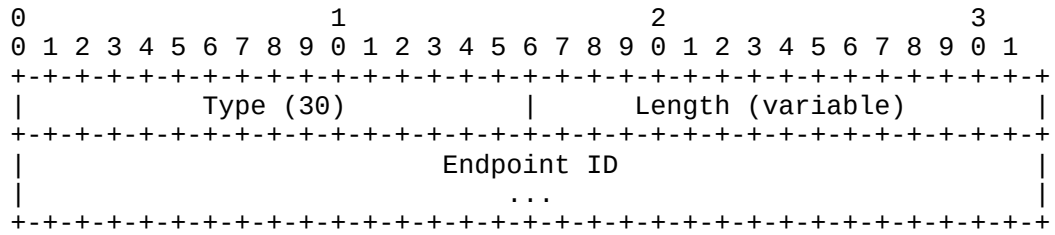
Ethernet endpoint identifiers, as they are defined in [G.8011] and [MEF10.1], differ significantly from the identifiers used by GMPLS. Specifically, the Ethernet endpoint identifiers are character based as opposed to the GMPLS norm of being IP address based.

The approach taken by this document to address this disparity leverages the solution used for connection identification, see Section 2.2 and [RFC4974], and a new CALL_ATTRIBUTES TLV defined in this document. The solution makes use of the [RFC4974] short Call ID, and supports the Ethernet endpoint identifier similar to how [RFC4974] supports the long Call ID. That is, the SENDER_TEMPLATE and SESSION objects carry IP addresses and a short Call ID, and long identifiers are carried in the CALL_ATTRIBUTES object. As with the long Call ID, the Ethernet endpoint identifier is typically only relevant at the ingress and egress nodes.

As defined below, the Ethernet endpoint identifier is carried in the CALL_ATTRIBUTES object in a new TLV. The new TLV is referred to as the Endpoint ID TLV. The processing of the Endpoint ID TLV parallels the processing of the long Call ID in [RFC4974]. This processing requires the inclusion of the CALL_ATTRIBUTES object in a Notify message.

2.1.1. Endpoint ID TLV

The Endpoint ID TLV follows the Attributes TLV format defined in [RFC6001]. The Endpoint ID TLV has the following format:



Type and Length fields are defined in [RFC6001]. Note that as defined in [RFC6001], the Length field is set to length of the whole TLV including the Type, Length, and Endpoint ID fields.

Endpoint ID

The Endpoint ID field is a variable-size field that carries an endpoint identifier, see [MEF10.1] and [G.8011]. This field MUST be null padded as defined in [RFC6001].

2.1.1.1. Procedures

The use of the Endpoint ID TLV is required during Call management. When a Call is established or torn down per [RFC4974], a CALL_ATTRIBUTES object containing an Endpoint ID TLV MUST be included in the Notify message along with the long Call ID.

Short Call ID processing, including those procedures related to Call and connection processing, is not modified by this document and MUST proceed according to [RFC4974].

2.2. Connection Identification

Signaling for Ethernet connections follows the procedures defined in [RFC4974]. In particular, the Call-related mechanisms are used to support endpoint identification. In the context of Ethernet connections, a Call is only established when one or more LSPs (connections in [RFC4974] terms) are needed. An LSP will always be established within the context of a Call and, typically, only one LSP will be used per Call. See Section 4.4 for the case where more than one LSP may exist within a Call.

2.2.1. Procedures

Any node that supports Ethernet connections MUST be able to accept and process Call setups per [RFC4974]. Ethernet connections established according to this document MUST treat the Ethernet (virtual) connection identifier as the long "Call identifier (ID)",

described in [RFC4974]. The short Call ID MUST be used as described in [RFC4974]. Use of the LINK_CAPABILITY object is OPTIONAL. Both network-initiated and user-initiated Calls MUST be supported.

When establishing an Ethernet connection, the initiator MUST first establish a Call per the procedures defined in [RFC4974]. LSP management, including removal and addition, then follows [RFC4974]. As stated in [RFC4974], once a Call is established, the initiator SHOULD establish at least one Ethernet LSP. Also, when the last LSP associated with a Call is removed, the Call SHOULD be torn down per the procedures in [RFC4974].

2.3. Traffic Parameters

Several types of service attributes are carried in the traffic parameters defined in [RFC6003]. These parameters are carried in the FLOWSPEC and TSPEC objects as discussed in [RFC6003]. The service attributes that are carried are:

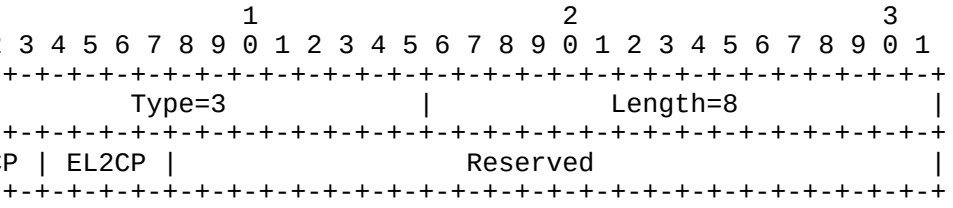
- Bandwidth Profile
- VLAN Class of Service (CoS) Preservation
- Layer 2 Control Protocol (L2CP) Processing (see Section 2.3.1)

Ethernet connections established according to this document MUST use the traffic parameters defined in [RFC6003] in the FLOWSPEC and TSPEC objects. Additionally, the Switching Granularity field of the Ethernet SENDER_TSPEC object MUST be set to zero (0).

2.3.1. L2 Control Protocol TLV

[MEF10.1], [G.8011.1], and [G.8011.2] define service attributes that impact the layer two (L2) control protocol processing at the ingress and egress. [RFC6003] does not define support for these service attributes, but does allow the attributes to be carried in a TLV. This section defines the L2CP TLV to carry the L2CP-processing-related service attributes.

The format of the L2 Control Protocol (L2CP) TLV is as follows:



See [RFC6003] for a description of the Type and Length fields. Per [RFC6003], the Type field MUST be set to three (3), and the Length field MUST be set to eight (8) for the L2CP TLV.

Ingress Layer 2 Control Processing (IL2CP): 4 bits

This field controls processing of Layer 2 Control Protocols on a receiving interface. Valid usage is service specific, see [MEF10.1], [G.8011.1], and [G.8011.2].

Permitted values are:

Value	Description	Reference
0	Reserved	
1	Discard/Block	[MEF10.1], [G.8011.1], and [G.8011.2]
2	Peer/Process	[MEF10.1], [G.8011.1], and [G.8011.2]
3	Pass to EVC/Pass	[MEF10.1], [G.8011.1], and [G.8011.2]
4	Peer and Pass to EVC	[MEF10.1]

Egress Layer 2 Control Processing (EL2CP): 4 bits

This field controls processing of Layer 2 Control Protocols on a transmitting interface. When MEF services are used a value of 1 MUST be used, other valid usage is service specific, see [G.8011.1] and [G.8011.2].

Permitted values are:

Value	Description	Reference
0	Reserved	
1	Based on IL2CP Value	[MEF10.1]
2	Generate	[G.8011.1] and [G.8011.2]
3	None	[G.8011.1] and [G.8011.2]
4	Reserved	

Reserved: 24 bits

This field is reserved. It MUST be set to zero on transmission and MUST be ignored on receipt. This field SHOULD be passed unmodified by transit nodes.

Ethernet connections established according to this document MUST include the L2CP TLV in the [RFC6003] traffic parameters carried in the FLOWSPEC and TSPEC objects.

2.4. Bundling and VLAN Identification

The control of bundling and listing of VLAN identifiers is only supported for EVPL services. EVPL service specific details are provided in Section 4.

3. EPL Service

Both [MEF6] and [G.8011.1] define an Ethernet Private Line (EPL) service. In the words of [G.8011.1], EPL services carry "Ethernet characteristic information over dedicated bandwidth, point-to-point connections, provided by SDH, ATM, MPLS, PDH, ETY or OTH server layer networks". [G.8011.1] defines two types of Ethernet Private Line (EPL) services. Both types present a service where all data presented on a port is transported to the corresponding connected port. The types differ in that EPL type 1 service operates at the MAC frame layer, while EPL type 2 service operates at the line (e.g., 8B/10B) encoding layer. [MEF6] only defines one type of EPL service, and it matches [G.8011.1] EPL type 1 service. Signaling for LSPs that support both types of EPL services are detailed below.

3.1. EPL Service Parameters

Signaling for the EPL service types only differ in the LSP Encoding Type used. The LSP Encoding Type used for each are:

EPL Service	LSP Encoding Type (Value)	Reference
Type 1/MEF	Ethernet (2)	[RFC3471]
Type 2	Line (e.g., 8B/10B)(14)	[RFC6004]

The other LSP parameters specific to EPL Service are:

Parameter	Name (Value)	Reference
Switching Type	DCSC (125)	[RFC6002]
G-PID	Ethernet PHY (33)	[RFC3471][RFC4328]

The parameters defined in this section MUST be used when establishing and controlling LSPs that provide EPL service type Ethernet switching. The procedures defined in Section 2 and the other procedures defined in [RFC3473] for the establishment and management of bidirectional LSPs MUST be followed when establishing and controlling LSPs that provide EPL service type Ethernet switching.

4. EVPL Service

EVPL service is defined within the context of both [G.8011.2] and [MEF6]. EVPL service allows for multiple Ethernet connections per port, each of which supports a specific set of VLAN IDs. The service attributes identify different forms of EVPL services, e.g., bundled or unbundled. Independent of the different forms, LSPs supporting EVPL Ethernet type switching are signaled using the same mechanisms to communicate the one or more VLAN IDs associated with a particular LSP (Ethernet connection).

The relevant [RFC3471] parameter values that MUST be used for EVPL connections are:

Parameter	Name (Value)	Reference
Switching Type	EVPL (30)	[RFC6004]
LSP Encoding Type	Ethernet (2)	[RFC3471]
G-PID	Ethernet PHY (33)	[RFC3471][RFC4328]

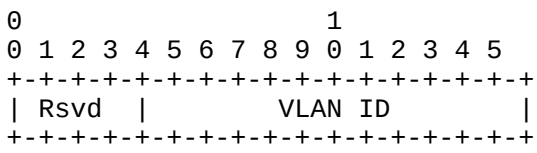
As with EPL, the procedures defined in Section 2 and the other procedures defined in [RFC3473] for the establishment and management of bidirectional LSPs MUST be followed when establishing and controlling LSPs that provide EVPL service type Ethernet switching.

LSPs that provide EVPL service type Ethernet switching MUST use the EVPL Generalized Label Format per Section 4.1, and the Generalized Channel_Set Label Objects per [RFC6002]. A notable implication of bundled EVPL services and carrying multiple VLAN IDs is that a Path message may grow to be larger than a single (fragmented or non-fragmented) IP packet. The basic approach to solving this is to allow for multiple LSPs which are associated with a single Call, see Section 2.2. The specifics of this approach are describe below in Section 4.4.

4.1. EVPL Generalized Label Format

Bundled EVPL services require the use of a service-specific label, called the EVPL Generalized Label. For consistency, non-bundled EVPL services also use the same label.

The format for the Generalized Label (Label Type value 2) used with EVPL services is:



Reserved: 4 bits

This field is reserved. It MUST be set to zero on transmission and MUST be ignored on receipt. This field SHOULD be passed unmodified by transit nodes.

VLAN ID: 12 bits

A VLAN identifier.

4.2. Egress VLAN ID Control and VLAN ID Preservation

When an EVPL service is not configured for both bundling and VLAN ID preservation, [MEF6] allows VLAN ID mapping. In particular, the single VLAN ID used at the incoming interface of the ingress may be mapped to a different VLAN ID at the outgoing interface at the egress UNI. Such mapping MUST be requested and signaled based on the explicit label control mechanism defined in [RFC3473] and clarified in [RFC4003].

When the explicit label control mechanism is not used, VLAN IDs MUST be preserved, i.e., not modified, across an LSP.

4.3. Single Call - Single LSP

For simplicity in management, a single LSP SHOULD be used for each EVPL type LSP whose Path and Resv messages fit within a single unfragmented IP packet. This allows the reuse of all standard LSP modification procedures. Of particular note is the modification of the VLAN IDs associated with the Ethernet connection. Specifically, [RFC6002], make-before-break procedures SHOULD be used to modify the Channel_Set LABEL object.

4.4. Single Call - Multiple LSPs

Multiple LSPs MAY be used to support an EVPL service connection. All such LSPs MUST be established within the same Call and follow Call-related procedures, see Section 2.2. The primary purpose of multiple LSPs is to support the case in which the related objects result in a Path message being larger than a single unfragmented IP packet.

When using multiple LSPs, all LSPs associated with the same Call/EVPL connection MUST be signaled with the same LSP objects with the exception of the SENDER_TEMPLATE, SESSION, and label-related objects. All such LSPs SHOULD share resources. When using multiple LSPs, VLAN IDs MAY be added to the EVPL connection using either a new LSP or make-before-break procedures, see [RFC3209]. Make-before-break procedures on individual LSPs SHOULD be used to remove VLAN IDs.

To change other service parameters it is necessary to re-signal all LSPs associated with the Call via make-before-break procedures.

5. IANA Considerations

IANA has assigned new values for namespaces defined in this document and summarized in this section. The registries are available from http://www.iana.org.

5.1. Endpoint ID Attributes TLV

IANA has made the following assignment in the "Call Attributes TLV" section of the "RSVP Parameters" registry.

Type	Name	Reference
2	Endpoint ID	[RFC6004]

5.2. Line LSP Encoding

IANA has made the following assignment in the "LSP Encoding Types" section of the "GMPLS Signaling Parameters" registry.

Value	Type	Reference
14	Line (e.g., 8B/10B)	[RFC6004]

5.3. Ethernet Virtual Private Line (EVPL) Switching Type

IANA has made the following assignment in the "Switching Types" section of the "GMPLS Signaling Parameters" registry.

Value	Type	Reference
30	Ethernet Virtual Private Line (EVPL)	[RFC6004]

The assigned value has been reflected in IANAGmplsSwitchingTypeTC of the IANA-GMPLS-TC-MIB available from http://www.iana.org.

6. Security Considerations

This document introduces new message object formats for use in GMPLS signaling [RFC3473]. It does not introduce any new signaling messages, nor change the relationship between Label Switching Routers (LSRs) that are adjacent in the control plane. As such, this document introduces no additional security considerations to those discussed in [RFC3473].

7. References

7.1. Normative References

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7.2. Informative References

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