MPLS Working Group
Internet-Draft
Intended status: Standards Track
Expires: September 4, 2011

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March 3, 2011

MPLS-TP Identifiers
draft-ietf-mpls-tp-identifiers-04

Abstract

This document specifies identifiers for MPLS-TP objects. Included are identifiers conformant to existing ITU conventions and identifiers which are compatible with existing IP, MPLS, GMPLS, and Pseudowire definitions.

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1. Introduction

This document specifies identifiers to be used in within the Transport Profile of Multiprotocol Label Switching (MPLS-TP) to support bidirectional (co-routed and associated) point-to-point MPLS-TP LSPs, including SPMEs, PWs and Sections. The MPLS-TP requirements (RFC 5654) [7] require that the elements and objects in an MPLS-TP environment are able to be configured and managed without a control plane. In such an environment many conventions for defining identifiers are possible. This document defines identifiers for MPLS-TP management and OAM functions suitable to ITU conventions and to IP/MPLS conventions. Applicability of the different identifier schemas to different applications is outside the scope of this document.

Comment [M1]: Previous comment not addressed: Proposed text change to clarify the scope of the draft to avoid confusion when a new draft covering other cases is produced.

1.1. Terminology

AII: Attachment Interface Identifier

ASN: Autonomous System Number

FEC: Forwarding Equivalence Class

GMPLS: Generalized Multi-Protocol Label Switching

ICC: ITU Carrier Code

LSP: Label Switched Path

LSR: Label Switching Router

ME: Maintenance Entity

MEG: Maintenance Entity Group

MEP: Maintenance Entity Group End Point

MIP: Maintenance Entity Group Intermediate Point

MPLS: Multi-Protocol Label Switching

NNI: Network-to-Network Interface

OAM: Operations, Administration and Maintenance

P2MP: Point to Multi-Point

P2P: Point to Point

PW: Pseudowire

RSVP: Resource Reservation Protocol

RSVP-TE: RSVP Traffic Engineering

S-PE: Switching Provider Edge

T-PE: Terminating Provider Edge

1.2. Requirements Language

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 [1].

1.3. Notational Conventions in Backus-Naur Form

All multiple-word atomic identifiers use underscores (_) between the words to join the words. Many of the identifiers are composed of a concatenation of other identifiers. These are expressed using Backus-Naur Form (using double-colon - "::" - notation).

Where the same identifier type is used multiple times in a concatenation, they are qualified by a prefix joined to the identifier by a dash (-). For example East-Node_ID is the Node_ID of a node referred to as East.

The ordering of the information elements involved in a concatenated identifier MUST be as defined in this document.

Comment [M2]: Previous comment not satisfied: This RFC must define the order of the information elements that are encoded in the TLVs to allow processing of the identifiers. The convention for defining which node is East and which node is West should also be defined (e.g. in the case of a North – South route).

2. Named Entities

In order to configure, operate and manage a transport network based on the MPLS Transport Profile, a number of entities require identification. Identifiers for the follow entities are defined in this document:

- Operator
  - Global_ID
  - ICC
- LSR
- LSP
- PW
- Interface

o MEG

o MEP

o MIP

o Tunnel

Note that we have borrowed the term tunnel from RSVP-TE (RFC 3209) [2] where it is used to describe an entity that provides a logical association between a source and destination LSR. The tunnel in turn is instantiated by one or more LSPs, where the additional LSPs are used for protection or re-grooming of the tunnel.

3. Uniquely Identifying an Operator

An operator is uniquely identified by an Operator Identifier (Opr_ID). Two formats are defined, one that is compatible with IP operational practice, called a Global_ID, and ~~or~~ one compatible with ITU practice, ~~the~~ called ICC. ~~An~~ The Opr_ID MAY use either the Global_ID or ICC format.

Comment [M3]: Editorial improvement

3.1. The Global ID

RFC 5003 [3] defines a globally unique Attachment Interface Identifier (AII). That AII is composed of three parts, a Global_ID which uniquely identifies a operator, a prefix, and finally and attachment circuit identifier. We have chosen to use that Global ID for MPLS-TP. Quoting from RFC 5003, section 3.2, "The global ID can contain the 2-octet or 4-octet value of the operator's Autonomous System Number (ASN). It is expected that the global ID will be derived from the globally unique ASN of the autonomous system hosting the PEs containing the actual AIIs. The presence of a global ID based on the operator's ASN ensures that the AII will be globally unique."

A non-zero Global ID MUST be derived from an ASN owned by the operator. When the Global_ID is derived from a 2-octet AS number, the two high-order octets of this 4-octet identifier MUST be set to zero and the last two octets MUST be set equal to the ASN. When the Global ID is derived from a 4-octect AS number, it is set equal to the ASN. Further ASN 0 is reserved. A Global_ID of zero means that no Global_ID is present. Note that a Global_ID of zero is limited to entities contained within a single operator and MUST NOT be used across an NNI~~. A non-zero Global_ID MUST be derived from an ASN owned by the operator~~.

Comment [M4]: Previous comments not fully satisfied: "if the ASN is used how can we be sure the global ID is unique unless the method of derivation is defined":
The proposed text changes address this comment

Note that this Global_ID is used solely to provide a globally unique context for other MPLS-TP identifiers. It has nothing to do with the use of the ASN in protocols such as BGP.

3.2. ITU Carrier Code

M.1400 defines the ITU Carrier Code (ICC) assigned to a network operator/service provider and maintained by the ITU-T Telecommunication Standardization Bureau (TSB): www.itu.int/ITU-T/inr/icc/index.html.

ICCs can be assigned both to ITU-T and non-ITU-T members and the referenced local ICC website may contain ICCs of operators of both kinds.

The ICC is a string of one to six characters, each character being either alphabetic (i.e. A-Z) or numeric (i.e. 0-9) characters. Alphabetic characters in the ICC SHOULD be represented with upper case letters.

4. Node and Interface Identifiers

An LSR requires identification of the node itself and of its interfaces. An interface is the attachment point to a server (sub-)layer e.g. MPLS-TP section or MPLS-TP tunnel.

Comment [M5]: Definition aligned with the one used by the OAM framework draft

We call the identifier associated with a node a Node Identifier (Node_ID). The Node_ID is a unique 32-bit value assigned by the operator within the scope of the ~~Global~~Opr_ID. The structure of the Node_ID is operator specific and is outside the scope of this document. However, the value zero is reserved and MUST NOT be used. Where IPv4 addresses are used, it may be convenient to use the Node's IPv4 loopback address as the Node_ID, however the Node_ID does not need to have any association with the IPv4 address space used in the operator's IGP or BGP. Where IPv6 addresses are used exclusively, a 32-bit value unique within the scope of the ~~Global~~Opr_ID is assigned.

Comment [M6]: Align with change of Global_ID to Opr_ID

Comment [M7]: Align with change of Global_ID to Opr_ID

A LSR can support multiple layers (e.g. hierarchical LSPs) and the Node_ID belongs to the multiple layer context i.e. it is applicable to all LSPs or PWs that originate on, have a midpoint on, or terminate on the node.

In situations where a Node_ID needs to be globally unique, this is accomplished by prefixing the identifier with the operator's Opr_ID. The particular combination of ~~Global~~Opr_ID::Node_ID we call a Global Node ID or Global_Node_ID.

Comment [M8]: Align with change of Global_ID to Opr_ID

Within the context of a particular node, we call the identifier associated with an interface an Interface Number or IF_Num. The IF_Num is a 32-bit unsigned integer assigned by the operator and MUST be unique within the scope of a Node_ID. The IF_Num value 0 has special meaning (see section 7.3, MIP Identifiers) (Section 7.3) and MUST NOT be used to identify an MPLS-TP interface.

An Interface Identifier or IF_ID identifies an interface uniquely within the context of an Opr_ID. It is formed by concatenating the Node_ID with the IF_Num. That is an IF_ID is a 64-bit identifier formed as Node_ID::IF_Num.

This convention was chosen to allow compatibility with GMPLS. GMPLS signaling [4] requires interface identification. GMPLS allows three formats for the Interface_ID. The third format consists of an IPv4 Address plus a 32-bit unsigned integer for the specific interface. The format defined for MPLS-TP is consistent with this format, but uses the Node_ID instead of an IPv4 Address.

If an IF_ID needs to be globally unique, this is accomplished by prefixing the identifier with the operator's Opr_ID. The combination of Opr_ID:Node_ID:IF-Num is called the Global_IF_ID.

The attachment point to an MPLS-TP Tunnel (see section Section 5.1 also needs an interface identifier. Note that MPLS-TP supports hierarchical tunnels. The attachment point to a MPLS-TP Tunnel at any-–sub layer requires a unique IF_ID.

Sub-Path Maintenance Elements (SPMEs) as defined in RFC 5921 are a particular instance of MPLS-TP LSPs. Therefore, the attachment point of an SPME at any sub-layer also requires a unique IF_ID.

5. MPLS-TP Tunnel and LSP Identifiers

In MPLS the actual transport of packets is provided by label switched paths (LSPs). A transport service may be composed of multiple LSPs. Further the LSPs providing a service may change over time due to protection and restoration events. In order to clearly identify the service we use the term "MPLS-TP Tunnel" or simply "tunnel" for a service provided by (for example) a working LSP and protected by a protection LSP. The Tunnel_ID identifies the transport service and provides a stable binding to the client in the face of changes in the data plane LSPs used to provide the service due to protection andor restoration events. This section defines an MPLS-TP Tunnel_ID to uniquely identify a tunnel and a MPLS-TP LSP_IDs to identify a LSP within the context of that tunnel.

For the case where multiple LSPs (for example) are used to support a single service with a common set of end-points, using this identifier allows for a trivial mapping between the server and client layers to a common service identifier which may be either defined by, or used by, the client.

Note that this usage is not intended to constrain protection schemes, and may be used to identify any service (protected or un-protected) that may appear to the client as a single service attachment point.

Comment [M9]: Editorial

Comment [M10]: This was in the -03 version and should be retained.

Comment [M11]: Editorial

Comment [M12]: Clarifies that SPMEs require identifiers

Comment [M13]: Previous comment not addressed: It is still not clear if a bi-directional service is provided by a single tunnel that may contain uni-directional LSPs. Previous text proposal that would satisfy this comment:
For example a bi-direction service supported by a pair of uni-directional LSPs

Comment [M14]: Editorial

Comment [M15]: Below both a LSP_ID and LSP_Num are defined. They are both in the context of the tunnel so the need for both is not clear. Please explain the relationship between these identifiers.

Comment [M16]: Editorial clarification

Keeping the tunnel number consistent across working and protection LSPs is a useful construct currently employed within GMPLS. However there is no requirement that a protection LSP use the same tunnel number as the working LSP.

Comment [M17]: Not consistent with the text in the first paragraph of this section.

5.1. MPLS-TP Point to Point Tunnel Identifiers

At each endpoint a tunnel is uniquely identified by the endpoint's Node_ID and a locally assigned tunnel number. Specifically a Tunnel_Num is a 16-bit unsigned integer unique within the context of the Node_ID. The motivation for each endpoint having its own tunnel number is to allow a compact form for the MEP-ID. See section Section 7.1.2.1.

Having two tunnel numbers also serves to simplify other signaling (e.g., setup of associated bi-directional tunnels as described in section Section 5.3.)

The concatenation of the two endpoint identifiers serves as the full identifier. In a configured environment the endpoints are often called East and West. Using this convention the format of the format of a Tunnel_ID is:

```
East-Node_ID::East-Tunnel_Num::West-Node_ID::West-Tunnel_Num
```

Where the Tunnel_ID needs to be globally unique, this is accomplished by using globally unique Node_IDs as defined above. Thus a globally unique Tunnel_ID becomes:

```
East-Global_Node_ID::East-Tunnel_Num::West-Global_Node_ID::
West-Tunnel_Num
```

When an MPLS-TP Tunnel is configured, it MUST be assigned a unique IF_ID at both the source and destination endpoints. As usual, the IF_ID is composed of the local NODE_ID concatenated with a 32-bit IF_Num.

5.2. MPLS-TP LSP Identifiers

5.2.1. MPLS-TP Co-Routed Bidirectional LSP Identifiers

~~For~~ When ~~a~~ co-routed bidirectional LSPs are used they can be uniquely identified by a single LSP number within the scope of an MPLS-TP Tunnel_ID. Specifically an LSP_Num is a 16-bit unsigned integer unique within the Tunnel_ID. Thus the format of a LSP_ID is:

Comment [M18]: Clarify that the uni-directional LSPs share a common identifier

```
East-Node_ID::East-Tunnel_Num::West-Node_ID::West-
Tunnel_Num::LSP_Num
```

Where the LSP_ID needs to be globally unique, this is accomplished by using globally unique Node_IDs as defined above. Thus a globally unique LSP_ID becomes:

East-Global_Node_ID::East-Tunnel_Num::West-Global_Node_ID::
West-Tunnel_Num::LSP_Num

~~The corresponding ICC-based version of this identifier would be:~~

~~East-ICC::East-Node_ID::East-Tunnel_Num::West-ICC::West-Node_ID::~~
~~West-Tunnel_Num::LSP_Num~~

Comment [M19]: Redundant text – the Global_Node_ID uses the Opr_ID which can be either Global_ID or ICC

5.2.2. MPLS-TP Associated Bidirectional LSP Identifiers

~~For~~ When ~~an~~ associated bidirectional LSPs are used each of the unidirectional LSPs from East to West and West to East require LSP IDs. The each LSP can be uniquely identified by a single LSP number within the scope of the senders Tunnel_Num. Specifically an LSP_Num is a 16-bit unsigned integer unique within the Tunnel_Num. Thus the format of a LSP_ID is:

Comment [M20]: Clarify that each of the uni-directional LSPs requires an independent identifier.

Comment [M21]: Use of independent LSP IDs conflicts with the naming of MEGs defined in section 7.1.2.1

East-Node_ID::East-Tunnel_Num::East-LSP_Num::

West-Node_ID::West-Tunnel_Num::West-LSP_Num

Where the LSP_ID needs to be globally unique, this is accomplished by using globally unique Node_IDs as defined above. Thus a globally unique LSP_ID becomes:

East-Global_Node_ID::East-Tunnel_Num::East-LSP_Num::
West-Global_Node_ID::West-Tunnel_Num::West-LSP_Num

~~The corresponding ICC-based version of this identifier would be:~~

~~East-ICC::East-Node_ID::East-Tunnel_Num::East-LSP_Num::~~
~~West-ICC::West-Node_ID::West-Tunnel_Num::West-LSP_Num~~

Comment [M22]: Redundant text – the Global_Node_ID uses the Opr_ID which can be either Global_ID or ICC

5.3. Mapping to GMPLS and RSVP-TE Signalling

Comment [M23]: Please explain the difference between GMPLS and RSVP-TE

This section defines the mapping from an MPLS-TP LSP_ID to GMPLS. At this time, GMPLS has yet to be extended to accommodate Global_IDs. Thus a mapping is only made for the network unique form of the LSP_ID. This limits the scope of the control plane to a single network operator.

Comment [M24]: Make the restriction explicit.

GMPLS signaling [5] uses a 5-tuple to uniquely identify an LSP within a operator's network. This tuple is composed of a Tunnel Endpoint Address, Tunnel_ID, Extended Tunnel ID, and Tunnel Sender Address and (GMPLS) LSP_ID.

A co-routed bi-directional data plane LSP between two nodes East and West can be setup as a single bi-directional control plane LSP. RSVP-TE is capable of signalling such LSP. The East node acts as the source and the west node acts as the destination.

Comment [M25]: Clarify that thie mapping below applies to co-routed bi-directiional LSPs

In situations where a mapping to the GMPLS 5-tuple is required, the

following mapping is used.

- o Tunnel Endpoint Address = West-Node_ID
- o Tunnel_ID = East-Tunnel_Num
- o Extended Tunnel_ID = East-Node_ID
- o Tunnel Sender Address = East-Node_ID
- o GMPLS LSP_ID = East-LSP_Num

An associated bi-directional LSP between two nodes East and West consists of two uni-directional LSPs, one from East to West and one from West to East. RSVP-TE is capable of signaling such LSPs.

In situations where a mapping to the RSVP 5-tuples is required, the following mappings are used. For the East to West LSP the mapping would be:

- o Tunnel Endpoint Address = West-Node_ID
- o Tunnel_ID = East-Tunnel_Num
- o Extended Tunnel_ID = East-Node_ID
- o Tunnel Sender Address = East-Node_ID
- o GMPLS LSP_ID = East-LSP_Num

Likewise, the ~~East~~ West to ~~West~~ East LSP the mapping would be:

- o Tunnel Endpoint Address = East-Node_ID
- o Tunnel_ID = West-Tunnel_Num
- o Extended Tunnel_ID = West-Node_ID
- o Tunnel Sender Address = West-Node_ID
- o GMPLS LSP_ID = West-LSP_Num

6. Pseudowire Path Identifiers

Pseudowire signaling (RFC 4447 [6]) defines two FECs used to signal pseudowires. Of these, FEC Type 129 along with AII Type 2 as defined in RFC 5003 [3] fits the identification requirements of MPLS-TP.

Comment [M26]: To be consistent with the notation used earlier in this section

Comment [M27]: To be consistent with the notation used earlier in this section

Comment [M28]: For the reverse direction

Comment [M29]: To be consistent with the notation used earlier in this section

Comment [M30]: Previous comment not fully addressed: The section needs to distinguish between data plane and control plane identifiers for a PW

In an MPLS-TP environment, a PW is identified by a set of identifiers which can be mapped directly to the elements required by FEC 129 and AII Type 2. To distinguish this identifier from other Pseudowire Identifiers, we call this a Pseudowire Path Identifier or PW_Path_Id.

The AII Type 2 is composed of three fields. These are the Global_ID, the Prefix, and the AC_ID. The Global_ID used in this document is identical to the Global_ID defined in RFC 5003. The Node_ID is used as the Prefix. The AC_ID is as defined in RFC 5003.

To complete the FEC 129, all that is required is a Attachment Group Identifier (AGI). That field is exactly as specified in RFC 4447. FEC 129 has a notion of Source AII (SAII) and Target AII (TAII). These terms are used relative to the direction of the signaling. In a purely configured environment when referring to the entire PW, this distinction is not critical. That is a FEC 129 of AGIa::AIIb::AIIc is equivalent to AGIa::AIIc::AIIb. We note that in a signaled environment, the required convention in RFC 4447 is that at a particular endpoint, the AII associated with that endpoint comes first. The complete PW_Path_Id is:

```
AGI::East-Global_Node_ID::East-AC_ID::West-Global_Node_ID::
West-AC_ID.
```

The corresponding ICC-based version for this identifier would be:

```
AGI::East-ICC::East-Node_ID::East-AC_ID::West-ICC::West-Node_ID::
West-AC_ID
```

Comment [M31]: Previous comment not addressed:
It is not clear why other PW FEC types (e.g., FEC 128) are not allowed/supported in MPLS-TP
Separating data plane from control plane identifiers would simplify its resolution

7. Maintenance Identifiers

In MPLS-TP a Maintenance Entity Group (MEG) represents an Entity that requires management and defines a relationship between a set of maintenance points. A maintenance point is either Maintenance Entity Group End-point (MEP) or a Maintenance Entity Group Intermediate Point (MIP). Maintenance points are uniquely associated with a MEG. Within the context of a MEG, MEPs and MIPs must be uniquely identified. This section defines a means of uniquely identifying Maintenance Entity Groups, Maintenance Entities and uniquely defining MEPs and MIPs within the context of a Maintenance Entity Group.

7.1. Maintenance Entity Group Identifiers

Maintenance Entity Group Identifiers (MEG_IDs) are required for MPLS-TP LSPs and Pseudowires. Two classes of MEG_IDs are defined, one that follows the IP compatible identifier defined above as well as the ICC-format.

7.1.1. ICC-based MEG Identifiers

MEG_ID for MPLS-TP LSPs, sections and Pseudowires MAY use the globally unique ICC-based format.

Comment [M32]: Can also be used for a section.

In this case, the MEG_ID is a string of up to thirteen characters, each character being either alphabetic (i.e. A-Z) or numeric (i.e. 0-9) characters. It consists of two subfields: the ICC (as defined in section 3) followed by a unique MEG code (UMC). The UMC MUST be unique within the organization identified by the ICC.

The ICC MEG_ID may be applied equally to a single MPLS-TP LSP, section or Pseudowires~~. Note that when encoded in a protocol such as in a TLV, a different type needs to be defined for LSP and PWs as the OAM capabilities may be different~~.

Comment [M33]: This text is not consistent with draft-ietf-mpls-tp-cc-cv-rdi. It is proposed to remove it.

7.1.2. IP Compatible MEG_IDs

Comment [M34]: The definition of an IP compatible section ID is missing.

7.1.2.1. MPLS-TP LSP MEG_IDs

Since a MEG pertains to a single MPLS-TP LSP, IP compatible MEG_IDs for MPLS-TP LSPs are simply the corresponding LSP_IDs. We note that while the two identifiers are syntactically identical, they have different semantics. This semantic difference needs to be made clear. For instance if both a MPLS-TP LSP_ID and MPLS-TP LSP MEG_IDs are to be encoded in TLVs different types need to be assigned for these two identifiers.

Comment [M35]: Not clear how this applies to associated bi-directional LSPs.

7.1.2.2. Pseudowire MEG_IDs

For Pseudowires a MEG pertains to a single PW. The IP compatible MEG_ID for a PW is simply the corresponding PW_Path_ID. We note that while the two identifiers are syntactically identical, they have different semantics. This semantic difference needs to be made clear. For instance if both a PW_Path_ID and a PW_MEG_ID is to be encoded in TLVs different types need to be assigned for these two identifiers.

7.2. MEP_IDs

7.2.1. ICC-based MEP Identifiers

ICC-based MEP_IDs for MPLS-TP LSPs and Pseudowires are formed by appending a unique number to the MEG_ID defined in section Section 7.1.1 above. Within the context of a particular MEG, we call the identifier associated with a MEP the MEP Index (MEP_Index). The MEP_Index is administratively assigned. It is encoded as a 16-bit unsigned integer and MUST be unique within the MEG. An ICC-based

MEP_ID is:

MEG_ID::MEP_Index

An ICC-based MEP ID is globally unique by construction given the ICC-based MEG_ID global uniqueness.

7.2.2. IP based MEP_IDs

7.2.2.1. MPLS-TP LSP_MEP_ID

In order to automatically generate MEP_IDs for MPLS-TP LSPs, we use the elements of identification that are unique to an endpoint. This ensures that MEP_IDs are unique for all LSPs within a operator. When Tunnels or LSPs cross operator boundaries, these are made unique by pre-pending them with the operator's Global_ID.

~~The~~ For co-routed bi-directional MPLS-TP LSPs the LSP_MEP_ID is

Node_ID::Tunnel_Num::LSP_Num,

where the Node_ID is the node in which the MEP is located and Tunnel_Num is the tunnel number unique to that node. In the case of Associated Bi-directional LSPs, the LSP_Num is unique to where the MEP resides.

In situations where global uniqueness is required this becomes:

Global_ID::Node_ID::Tunnel_Num::LSP_Num

7.2.2.2. MEP_IDs for Pseudowires

Like MPLS-TP LSPs, Pseudowire endpoints (T-PEs) require MEP_IDs. In order to automatically generate MEP_IDs for PWs, we simply use the AGI plus the AII associated with that end of the PW. Thus a MEP_ID used in end-to-end for an Pseudowire T-PE takes the form

AGI:Global_ID::Node_ID::AC_ID,

where the Node_ID is the node in which the MEP is located and the AC_ID is the AC_ID of the Pseudowire at that node.

7.2.2.3. Pseudowire Segments Endpoint IDs

In some OAM communications, messages are originated by the node at one end of a PW segment and relayed to the other end of that same segment by setting the TTL of the PW label to one (1). For a multi-segment pseudowire, TTL could be set to any value that would cause

Comment [M36]: Clarify that this applies to the co-routed case:

Comment [M37]: Not clear if we have one MEP for each unidirectional LSP or if we have a single MEP for both. IN this case which LSP_Num is selected?

Comment [M38]: Previous comment not addressed: This section is still not consistent with the OAM framework.

OAM messages to reach the target segment end-point (up to and including 255). In such communications an identifier for the pseudowire segment endpoint is needed. ~~We call this~~ It is referred to as a Pseudowire Segments Endpoint ID or PW_SE_ID.

Comment [M39]: Editorial

The PW_SE_ID is formed by a combination of a PW MEP_ID and the identification of the local node. At an S-PE, there are two PW segments. We distinguish the segments by using the MEP_ID which is upstream of the PW segment in question. To complete the identification ~~we suffix this~~it is appended with the identification of the local node.

Comment [M40]: Editorial

```
  +--------+         +--------+         +--------+         +--------+
  |        |         |        |         |        |         |        |
  |       A|---------|B      C|---------|D      E|---------|F       |
  |        |         |        |         |        |         |        |
  +--------+         +--------+         +--------+         +--------+
   (T)PE1             (S)PE2             (S)PE3             (T)PE4
```

Pseudowire Maintenance Points

For example, suppose that in the above figure all of the nodes have Global_ID GID1; the node are represented as named in the figure; and The identification for the Pseudowire is:

```
        AGI            = AGI1
        East-~~Global~~Opr_ID = GID1
        East-Node_ID   = PE1
        East-AC_ID     = AII1
        West-~~Global~~Opr_ID = GID1
        West-Node_ID   = PE4
        West-AC_ID     = AII4
```

Comment [M41]: Align with change from Global_ID to Opr_ID

The MEP_ID at point A would be -

AGI1::GID1::PE1::AII1

The PW_SE_ID at point C would be -

AGI1::GID1::PE1::AII1::GID1::PE2

Comment [M42]: How are B and C differentiated since both are in the same node

7.3. MIP Identifiers

At a cross-connect point, in order to automatically generate MIP_IDs for MPLS-TP, we simply use the IF_IDs of the two interfaces which are cross-connected via the label bindings of the MPLS-TP LSP or PW. This

Comment [M43]: Also applies to a PW

allows, two MIPs to be independently identified in one node where a per-interface MIP model is used. If only a per node MIP model is used then one MIP is configured. In this case the MIP_ID is formed using the Node_ID and an IF_Num of 0.

8. IANA Considerations

There are no IANA actions resulting from this document.

9. Security Considerations

This document describes an information model and, as such, does not introduce security concerns. Protocol specifications that describe use of this information model - however - may introduce security risks and concerns about authentication of participants. For this reason, the writers of protocol specifications for the purpose of describing implementation of this information model need to describe security and authentication concerns that may be raised by the particular mechanisms defined and how those concerns may be addressed.

10. References

10.1. Normative References

[1] Bradner, S., "Key words for use in RFCs to Indicate Requirement Levels", BCP 14, RFC 2119, March 1997.

[2] Awduche, D., Berger, L., Gan, D., Li, T., Srinivasan, V., and G. Swallow, "RSVP-TE: Extensions to RSVP for LSP Tunnels", RFC 3209, December 2001.

[3] Metz, C., Martini, L., Balus, F., and J. Sugimoto, "Attachment Individual Identifier (AII) Types for Aggregation", RFC 5003, September 2007.

[4] Berger, L., "Generalized Multi-Protocol Label Switching (GMPLS) Signaling Functional Description", RFC 3471, January 2003.

[5] Berger, L., "Generalized Multi-Protocol Label Switching (GMPLS) Signaling Resource ReserVation Protocol-Traffic Engineering (RSVP-TE) Extensions", RFC 3473, January 2003.

[6] Martini, L., Rosen, E., El-Aawar, N., Smith, T., and G. Heron, "Pseudowire Setup and Maintenance Using the Label Distribution

Protocol (LDP)", RFC 4447, April 2006.

10.2. Informative References

[7] Niven-Jenkins, B., Brungard, D., Betts, M., Sprecher, N., and S. Ueno, "Requirements of an MPLS Transport Profile", RFC 5654, September 2009.

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