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MPLS-TP Identifiers
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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). where compatibility with existing MPLS control plane conventions are necessary. The MPLS-TP requirements [13] 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. In particular, identifiers conformant to existing ITU conventions are defined. It is also anticipated that operational environments where MPLS-TP objects, e.g. Label Switched Paths (LSPs) and Pseudowires (PWs) will be signaled via existing protocols such as the Label Distribution Protocol (RFC 4447) [1] and the Resource Reservation Protocol as it is applied to Generalized Multi-protocol Label Switching (RFCs 3471 & 3473) [2][3] (GMPLS). This document defines a set of identifiers for MPLS-TP which are both compatible with those protocols and applicable to MPLS-TP management and OAM functions.

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 End Point

MIP: Maintenance Intermediate Point

MPLS: Multi-Protocol Label Switching

OAM: Operations, Administration and Maintenance

P2MP: Point to Multi-Point

P2P: Point to Point

PSC: Protection State Coordination

PW: Pseudowire

RSVP: Resource Reservation Protocol

RSVP-TE: RSVP Traffic Engineering

S-PE: Switching Provider Edge

T-PE: Terminating Provider Edge

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 [4].

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:

- o Operator
  - * ICC
  - * Global_ID
- o LSR
- o LSP
- o PW
- o Interface
- o MEG
- o MEP
- o MIP

o Tunnel

Note that we have borrowed the term tunnel from RSVP-TE (RFC 3209) [5] where it is used to describe an entity that provides an LSP connection between a source and destination LSR which 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

Two forms of identification are defined, one that is compatible with IP operational practice called a Global_ID and one compatible with ITU practice, the ICC. An Operator MAY be identified either by its Global_ID or by its ICC.

3.1. The Global ID

RFC 5003 [6] 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."

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.

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. We call the identifier associated with a node a Node Identifier (Node_ID). Within the context of a particular node, we call the identifier associated with an interface an Logical Interface Handle or LIH. The combination of Node_ID::LIH we call an Network Interface ID or IF_ID.

In existing MPLS deployments Node_IDs are IPv4 addresses. Therefore we have chosen the Node_ID to be a 32-bit value assigned by the operator. Where IPv4 addresses are in use the Node_ID can be automatically mapped to the LSR's /32 IPv4 loopback address. Note that, when IP reachability is not needed, the 32-bit Node_ID is not required to have any association with the IPv4 address space used in the operator's IGP or BGP, other that that they be uniquely chosen within the scope of that operator.

GMPLS signaling [2] requires interface identification. We have chosen to adopt the conventions of that RFC. GMPLS allows three formats for the Interface_ID. For IP numbered links, it is simply the IPv4 or IPv6 address associated with the interface. The third format consists of an IPv4 Address plus a 32-bit unsigned integer for the specific interface.

For MPLS-TP, we have adopted a format consistent with the third format above. In MPLS-TP, each interface is assigned a 32-bit identifier which we call a Logical Interface Handle (LIH). The LIH MUST be unique within the context of the Node_ID. We map the Node_ID to the field the field which carries the IP address. That is, an IF_ID is a 64-bit identifier consisting of the Node_ID followed by the LIH. The LIH in turn is a 32-bit unsigned integer unique to the node. The LIH value 0 has special meaning (see section Section 7.2.1.3 and must not be used as the LIH in an MPLS-TP IF_ID.

In situations where a Node_ID or an IF_ID needs to be globally unique, this is accomplished by prefixing the identifier with the operator's Global_ID. The combination of Global_ID::Node_ID we call an Global Node ID or Global_Node_ID. Likewise, the combination of Global_ID::Node_ID::LIH we call an Global Interface ID or Global_IF_ID.

MPLS-TP Tunnels (see section Section 5.1) also need interface identifiers. A procedure for automatically generating these is contained in that section.

5. MPLS-TP Tunnel and LSP Identifiers

A important construct within MPLS_TP is a connection which is provided across a working and a protection LSP. Within this document we will use the term MPLS-TP Tunnel or simply tunnel for the connection provided by the working and protect LSPs. This section defines an MPLS-TP Tunnel_ID to uniquely identify a tunnel and MPLS-TP LSP_IDs within the context of a tunnel.

5.1. MPLS-TP Tunnel Identifiers

At each endpoint a tunnel is uniquely identified by the Source Node_ID and a locally assigned tunnel number. Specifically a Tunnel_Num is a 16-bit unsigned integer unique to the node. The concatenation of the two endpoint identifier servers as the full identifier. Thus the format of a Tunnel_ID is:

```
Src-Node_ID::Src-Tunnel_Num::Dst-Node_ID::Dst-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:

```
Src-Global_ID::Src-Node_ID::Src-Tunnel_Num:: Dst-Global_ID::Dst-
Node_ID::Dst-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 LIH. It is RECOMMENDED that the LIH be auto-generated by adding 2^31 to the local Tunnel_Num.

5.2. MPLS-TP LSP Identifiers

Within the scope of an MPLS-TP Tunnel_ID an LSP can be uniquely identified by a single LSP number. Specifically an LSP_Num is a 16-bit unsigned integer unique within the Tunnel_ID. Thus the format of a Tunnel_ID is:

```
Src-Node_ID::Src-Tunnel_Num::Dst-Node_ID::Dst-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 Tunnel_ID becomes:

Src-Global_ID::Src-Node_ID::Src-Tunnel_Num:: Dst-Global_ID::Dst-Node_ID::Dst-Tunnel_Num::LSP_Num

5.3. Mapping to GMPLS Signalling

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.

GMPLS signaling [3] 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.

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

o Tunnel Endpoint Address = Dst-Node_ID

o Tunnel_ID = Src-Tunnel_Num

o Extended Tunnel_ID = Src-Node_ID

o Tunnel Sender Address = Src-Node_ID

o LSP_ID = LSP_Num

6. Pseudowire Path Identifiers

Pseudowire signaling (RFC 4447 [1]) defines two FECs used to signal pseudowires. Of these, FEC Type 129 along with AII Type 2 as defined in RFC 5003 [6] fits the identification requirements of MPLS-TP.

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:Src-Global_ID::Src-Node_ID::Src-AC_ID:: Dst-Global_ID::Dst-Node_ID::Dst-AC_ID.

7. Maintenance Identifiers

[Note this section needs to reconciled with on going ITU and MPLS WG discussions on Maintenance Points.]

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 End-point (MEP) or a Maintenance Intermediate Point (MIP). A Maintenance Entity is a relationship between two MEPs. 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 Paths 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_IDs

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

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 MPLS-TP tunnels, a single

MPLS-TP LSP, groups of MPLS-TP LSPs, Pseudowires, and groups of 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.

7.1.2. IP Compatible MEG_IDs

7.1.2.1. MPLS-TP Tunnel MEG_IDs

Since a MEG pertains to a single MPLS-TP Tunnel, IP compatible MEG_IDs for MPLS-TP Tunnels are simply the corresponding Tunnel_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 Tunnel_ID and MPLS-TP Tunnel MEG_IDs are to be encoded in TLVs different types need to be assigned for these two identifiers.

7.1.2.2. MPLS-TP LSP MEG_IDs

MEG_IDs for MPLS-TP LSPs may pertain to one or more LSPs. Therefore the direct mapping used for tunnels is not possible. However an indirect mapping which keeps the formats aligned is possible. This is done by replacing the LSP_Num with a LSP_MEG_Num. Thus the format of a MPLS-TP LSP MEG_ID is:

Src-Global_ID::Src-Node_ID::Src-Tunnel_Num:: Dst-Global_ID::Dst-Node_ID::Dst-Tunnel_Num::LSP_MEG_Num

When a MEG_ID is assigned to a single MPLS-TP LSP it is RECOMMENDED that the LSP_MEG_Num be assigned equal to the LSP_Num. When a MEG_ID is assigned to a group of MPLS-TP LSPs within a single MPLS-TP Tunnel, it is recommended that the MEG_ID be assigned equal to the LSP_Num of one member of the group of MPLS-TP LSPs. In this situation if the chosen LSP is later deconfigured it is RECOMMENDED that this LSP_Num not be reused unless the new LSP in question will become a member of the same MEG.

7.1.2.3. 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. Maintenance Points

Maintenance points are uniquely associated with a MEG. Within the context of a MEG, MEPs and MIPs must be uniquely identified. This section describes how MIPs and MEPs are identified.

Note that depending on the requirements of a particular OAM interaction, the MPLS-TP maintenance entity context may be provided either explicitly using the MEG_IDs described above or implicitly by the label of the received OAM message.

7.2.1. Maintenance Point_IDs for MPLS-TP LSPs and Tunnels

In order to automatically generate MEP_IDs for MPLS-TP Tunnels and LSPs, we use the elements of identification that are unique to an endpoint. This ensures that MEP_IDs are unique for all Tunnels and 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.

7.2.1.1. MPLS-TP Tunnel_MEP_ID

A MPLS-TP Tunnel_MEP_ID is:

```
Src-Node_ID::Src-Tunnel_Num
```

In situations where global uniqueness is required this becomes:

```
Src-Global_ID::Src-Node_ID::Src-Tunnel_Num
```

7.2.1.2. MPLS-TP LSP_MEP_ID

A MPLS-TP LSP_MEP_ID is:

```
Src-Node_ID::Src-Tunnel_Num::LSP_Num
```

In situations where global uniqueness is required this becomes:

```
Src-Global_ID::Src-Node_ID::Src-Tunnel_Num::LSP_Num
```

7.2.1.3. MPLS-TP LSP_MIP_ID

At a cross connect point, in order to automatically generate MIP_IDs for MPLS-TP LSPs, we simply use the IF_IDs of the two interfaces which are cross connected via the label bindings of the MPLS-TP LSP. If only one MIP is configured, then the MIP_ID is formed using the Node_ID and an LIH of 0.

7.2.2. Maintenance Identifiers for Pseudowires

Like MPLS-TP LSPs, Pseudowire endpoints (T-PEs) require MEP-IDs. Pseudowire S-PEs, however, are a special case. Here the Maintenance Entity takes on some of the functionality of both a MIP and a MEP. Provisionally we are calling these a Maintenance Point or MP.

7.2.2.1. MEP_IDs for PW T-PEs

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 for an Pseudowire T-PE takes the form:

```
AGI:Src-Global_ID::Src-Node_ID::Src-AC_ID
```

7.2.2.2. MP_IDs for Pseudowires

The MP_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 with the identification of the local node.

```
+-------+        +-------+        +-------+        +-------+
|       |        |       |        |       |        |       |
|      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
Src-Global_ID = GID1
Src-Node_ID   = T-PE1
Src-AC_ID     = AII1
Dst-Global_ID = GID1
Dst-Node_ID   = T-PE1
Dst-AC_ID     = AII4
```

The MEP_ID at point A would be AGI1::GID1:T-PE1::AII1. The MP_ID at

point C would be AGI1::GID1:T-PE1::AII1::GID1:S-PE2.

For interaction where the T-PE is acting as the segment endpoint, it too may use the MP_ID.

8. Open issues

1. We have two means of identifying operators. Should either be allowed in all cases or can we constrain this. I.e. when there are both IP compatible and ITU compatible IDs for an Object can we constrain the operator ID to the corresponding format? Clearly when only one identifier is defined the both must be allowed.

2. Details on MEP and MIP identifiers are subject to ongoing discussions. Further based on some discussion in Stockholm, ITU style identifiers for MEPs and MIPs were removed from this version. However, consensus for this needs to be verified.

3. Pseudowire Maintenance Points need to be kept aligned with the model for Pseudowire maintenance.

4. Identifiers for P2MP entities

5. Tandem connection Identification - the identification should be exactly the same as any other MPLS-TP LSP. However, in the ACH TLV draft we could have a different TLV with the same format as an MPLS-TP LSP, if there are places where the distinction becomes important.

9. References

9.1. Normative References

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