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I. Wijnands
K. Raza
Cisco Systems, Inc.

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# mLDP Extensions for Multi-Topology Routing

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## Abstract

The Multi-Topology Routing (MTR) enables service differentiation through class-based forwarding. IGP protocols (OSPF and IS-IS) and LDP have already been extended to setup MTR. In order to deploy mLDP in an MTR network, mLDP is also required to become topology-aware. This document specifies extensions to mLDP to support Multi-Topology Routing.

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## 1. Glossary

MT - Multi-Topology

MT-ID - Multi-Topology Identifier

MTR - Multi-Topology Routing

IGP - Interior Gateway Protocol

MP - Multipoint (P2MP or MP2MP)

LDP - Label Distribution Protocol

mLDP - Multipoint LDP

P2MP - Point-to-Multipoint

MP2MP - Multipoint-to-Multipoint

FEC - Forwarding Equivalence Class

LSP - Label Switched Path

## 2. Introduction

The Multi-Topology Routing (MTR) enables service differentiation through class-based forwarding. For example, MTR can be used to define separate IP topologies for voice, video, and data traffic classes. To support MTR, an IGP maintains independent IP topologies, termed as "Multi-Topologies" (MT), and computes/installs routes per topology. OSPF extensions [RFC4915] and ISIS extensions [RFC5120] specify the MT extensions under respective IGPs. To support IGP MT, similar LDP extensions [RFC7307] have been proposed to make LDP MT-aware and be able to setup unicast Label Switched Paths (LSPs) along IGP MT routing paths.

Multipoint LDP (mLDP) refers to extensions in LDP to setup multi-point LSPs, point-to-multipoint (P2MP) or multipoint-to-multipoint (MP2MP), by means of set of extensions and procedures defined in [RFC6388]. In order to work in an MTR network to take advantage of MTs, it is a natural extension to make mLDP become MT-aware. This document specifies the extensions to mLDP to support IGP Multi-Topology Routing (MTR).

## 3. Specification of Requirements

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].

In this document, these words will appear with that interpretation only when in ALL CAPS. Lower case uses of these words are not to be interpreted as carrying RFC-2119 significance.

## 4. MT-Scoped mLDP FECs

As defined in [RFC7307], MPLS Multi-Topology Identifier (MT-ID) is an identifier that is used to associate an LSP with a certain MTR topology. In the context of MP LSPs, this identifier is part of the mLDP FEC encoding so that LDP peers are able to setup an MP LSP via their own defined MTR policy. In order to avoid conflicting MTR policies for the same mLDP FEC, the MT-ID needs to be a part of the FEC, so that different MT-ID values will result in unique MP-LSP FEC elements.

Since the MT-ID is part of the FEC, it will apply to all the LDP messages that potentially include an mLDP FEC element.

### 4.1. MP FEC Extensions for MT

Following subsections propose the extensions to bind an mLDP FEC to a topology. The mLDP MT extensions reuse some of the extensions specified in [RFC7307].

#### 4.1.1. MP FEC Element

Base mLDP specification [RFC6388] defines MP FEC Element as follows:

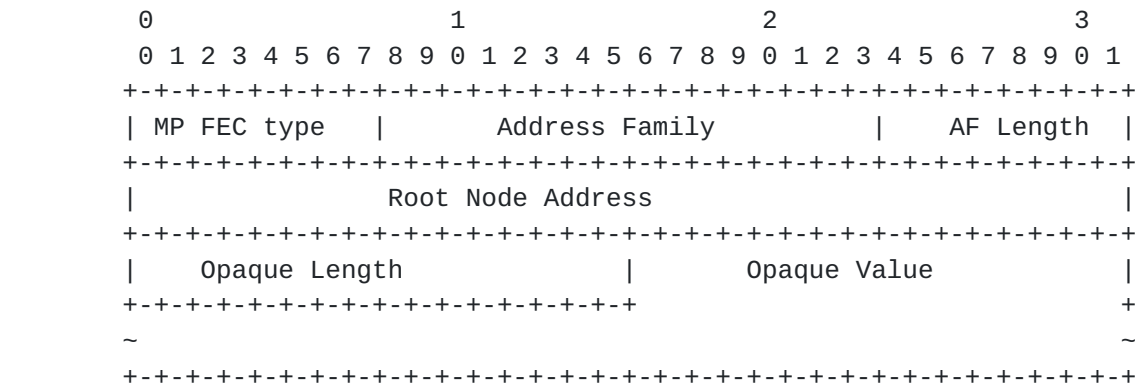


Figure 1: MP FEC Element Format [RFC6388]

Where "Root Node Address" encoding is as defined for given "Address Family", and whose length (in octets) is specified by the "AF Length" field.

To extend MP FEC elements for MT, the MT-ID is an identifier that is relevant in the context of the root address of the MP LSP. The MT-ID identifier determines in which topology the root address needs to be resolved. Since the MT-ID should be considered part of the mLDP FEC, the most natural place to encode the MT-ID is as part of the root address. To encode MT-ID as part of the root address, we are proposing to use "MT IP" Address Families as described in following sub section.

#### 4.1.2. MT IP Address Families

[RFC7307] specification proposes new address families, named "MT IP" and "MT IPv6", to allow specification of an IP prefix within a topology scope. The Figure 1 and 2 of [RFC7307] specification

defines the format of the data associated with these new Address Families as follows:

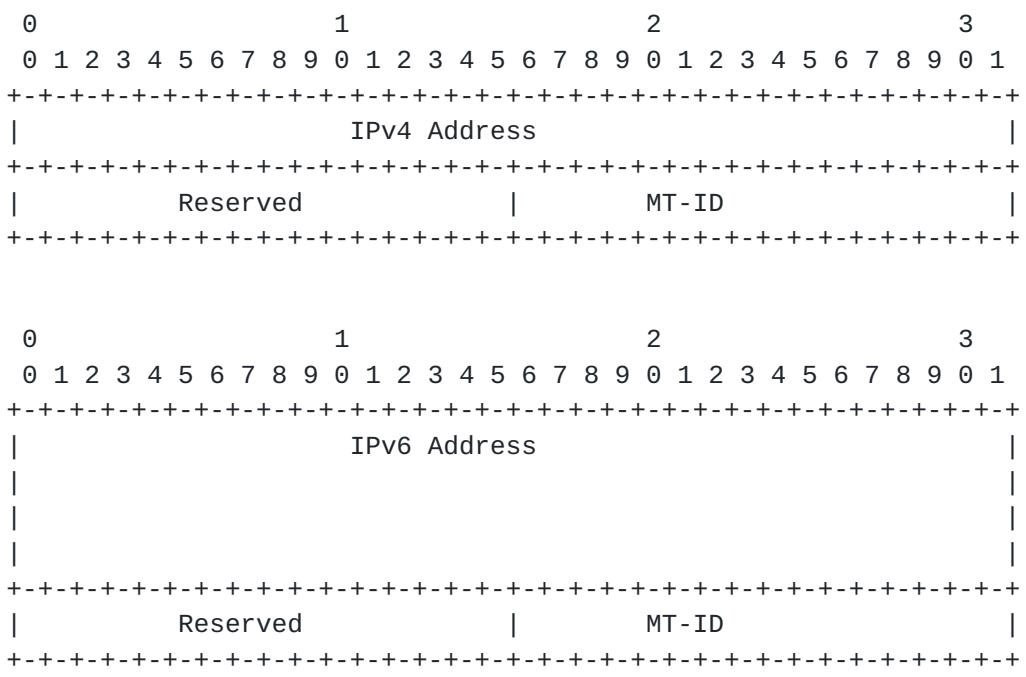


Figure 2: MT IP Address Families Data Format [RFC7307]

Where "(IP) Prefix" is an IPv4 or IPv6 address corresponding to "MT IP" and "MT IPv6" address families respectively.

### 4.1.3. MT MP FEC Element

We extend MP FEC Element for MT by using MT IP Address Family (and its associated MT-ID) in an MP FEC Element. The resultant MT MP FEC element will be encoded as follows:

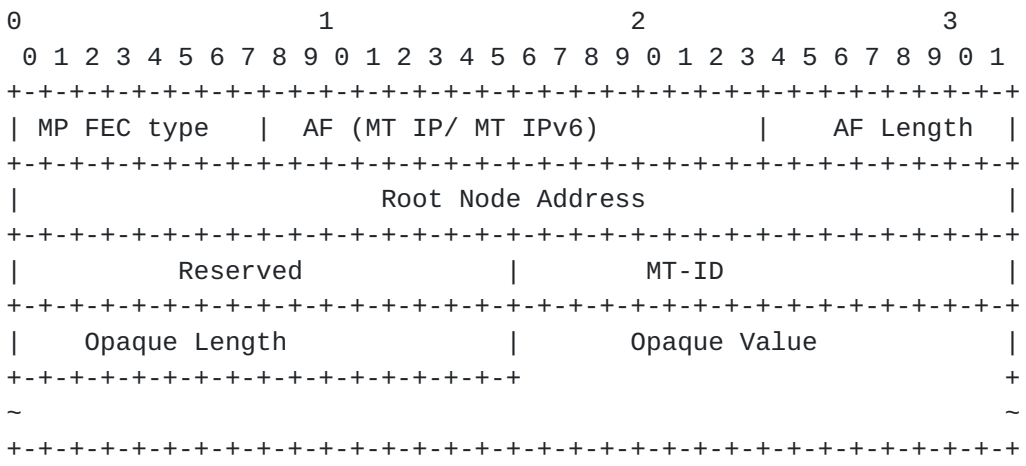


Figure 3: IP MT-Scoped MP FEC Element Format

In the context of this document, the applicable LDP FECs for MT mLDP include:

- MP FEC Elements:
  - P2MP (type 0x6)
  - MP2MP-up (type 0x7)
  - MP2MP-down (type 0x8)
- Typed Wildcard FEC Element (type 0x5)

In case of "Typed Wildcard FEC Element", the sub FEC Element type MUST be one of the MP FECs listed above.

This specification allows the use of Topology-scoped mLDP FECs in LDP label and notification messages, as applicable.

## 4.2. Topology IDs

This document assumes the same definitions and procedures associated with MPLS MT-ID as defined in [RFC7307] specification.

## 5. MT Multipoint Capability

"MT Multipoint Capability" is a new LDP capability, defined in accordance with LDP Capability definition guidelines [RFC5561], that is to be advertised to its peers by an mLDP speaker to announce its capability to support MTR and the procedures specified in this document. This capability MAY be sent either in an Initialization

message at the session establishment time, or in a Capability message dynamically during the lifetime of a session (only if "Dynamic Announcement" capability [RFC5561] has been successfully negotiated with the peer).

The format of this capability is as follows:

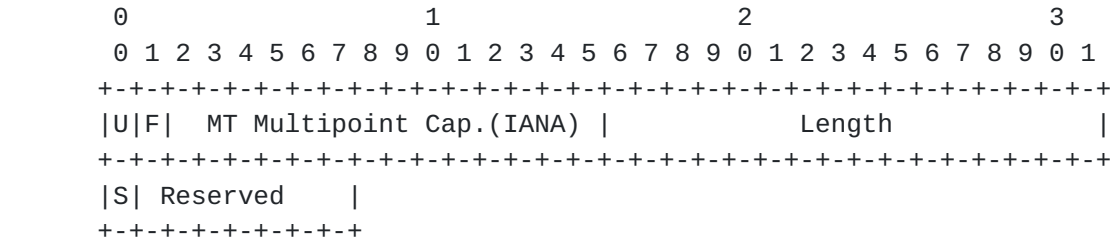


Figure 4: MT Multipoint Capability TLV Format

Where:

U- and F-bits: MUST be 1 and 0, respectively, as per Section 3 of LDP Capabilities [RFC5561].

MT Multipoint Capaility: TLV type (IANA assigned).

Length: The length (in octets) of TLV. The value of this field MUST be 1 as there is no Capability-specific data [RFC5561] that follows in the TLV.

S-bit: Set to 1 to announce and 0 to withdraw the capability (as per [RFC5561].

An mLDP speaker that has successfully advertised and negotiated "MT Multipoint" capability MUST support the following:

1. Topology-scoped mLDP FECs in LDP messages (Section 4.1)

2. Topology-scoped mLDP forwarding setup (Section 7)

## 6. MT Applicability on FEC-based features

### 6.1. Typed Wildcard MP FEC Elements

[RFC5918] extends base LDP and defines Typed Wildcard FEC Element framework. Typed Wildcard FEC element can be used in any LDP message to specify a wildcard operation for a given type of FEC.

The MT extensions proposed in document do not require any extension in procedures for Typed Wildcard FEC Element support [RFC5918], and

these procedures apply as-is to Multipoint MT FEC wildcarding. Like Typed Wildcard MT Prefix FEC Element, as defined in [RFC7307], the MT extensions allow use of "MT IP" or "MT IPv6" in the Address Family field of the Typed Wildcard MP FEC element in order to use wildcard operations for MP FECs in the context of a given topology as identified by the MT-ID field.

This document proposes following format and encoding for a Typed Wildcard MP FEC element:

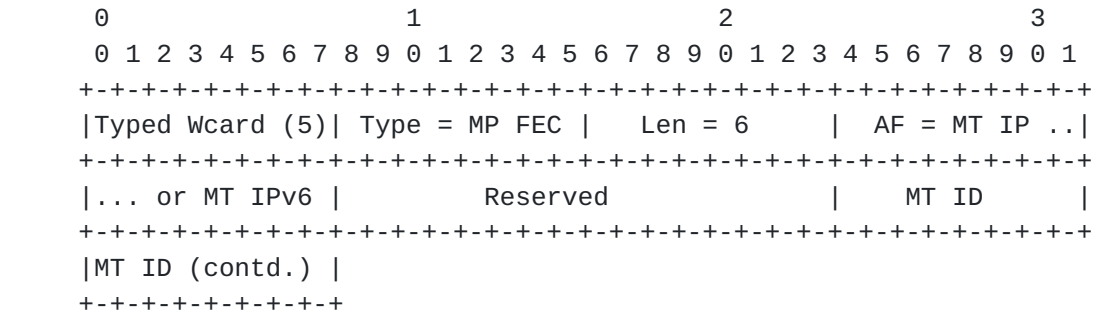


Figure 5: Typed Wildcard MT MP FEC Element

Where:

Type: One of MP FEC Element type (P2MP, MP2MPup, MP2MP-down).

The proposed format allows an LSR to perform wildcard MP FEC operations under the scope of a topology.

## 6.2. End-of-LIB

[RFC5919] specifies extensions and procedures that allows an LDP speaker to signal its End-of-LIB (i.e. convergence) for a given FEC type towards a peer. MT extensions for MP FEC do not require any change in these procedures and they apply as-is to MT MP FEC elements. This means that an MT mLDP speaker MAY signal its convergence per topology using MT Typed Wildcard MP FEC element.

## 7. Topology-Scoped Forwarding

Since the MT-ID is part of an mLDP FEC, there is no need to support the concept of multiple topology tables in mLDP. Each MP LSP will be unique due to the MT-ID being part of the FEC. There is also no need to have specific label forwarding tables per topology, and each MP LSP will have its own unique local label in the table. However, In order to implement MTR in an mLDP network, the selection procedures for upstream LSR and downstream forwarding interface need be changed.

### 7.1. Upstream LSR selection

The procedures as described in RFC-6388 section-2.4.1.1 depend on the best path to reach the root. When the MT-ID is signaled as part of the FEC, the MT-ID is used to select the topology that must be used to find the best path to the root address. Using the next-hop from this best path, a LDP peer is selected following the procedures as defined in [RFC6388].

### 7.2. Downstream forwarding interface selection

The procedures as described in RFC-6388 section-2.4.1.2 describe how a downstream forwarding interface is selected. In these procedures, any interface leading to the downstream LDP neighbor can be considered as candidate forwarding interface. When the MT-ID is part of the FEC, this is no longer true. An interface must only be selected if it is part of the same topology that was signaled in the mLDP FEC element. Besides this restriction, the other procedures in [RFC6388] apply.

## 8. LSP Ping Extensions

[RFC6425] defines procedures to detect data plane failures in Multipoint MPLS LSPs. Section 3.1.2 of [RFC6425] defines new Sub-Types and Sub-TLVs for Multipoint LDP FECs to be sent in "Target FEC Stack" TLV of an MPLS echo request message [RFC4379].

To support LSP ping for MT Multipoint LSPs, this document uses existing sub-types "P2MP LDP FEC Stack" and "MP2MP LDP FEC Stack" defined in [RFC6425]. The proposed extension is to specify "MT IP" or "MT IPv6" in the "Address Family" field, set the "Address Length" field to 8 (for MT IP) or 20 (for MT IPv6), and encode the sub-TLV with additional MT-ID information as an extension to the "Root LSR Address" field. The resultant format of sub-tlv is as follows:

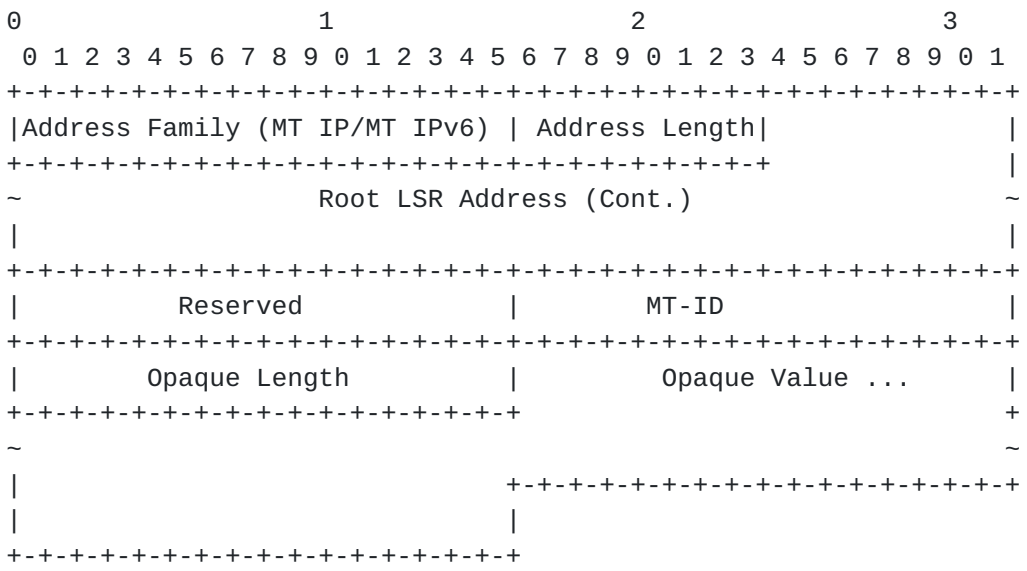


Figure 6: Multipoint LDP FEC Stack Sub-TLV Format for MT

The rules and procedures of using this new sub-TLV in an MPLS echo request message are same as defined for P2MP/MP2MP LDP FEC Stack Sub-TLV in [RFC6425] with only difference being that Root LSR address is now topology scoped.

## 9. Security Considerations

This extension to mLDP does not introduce any new security considerations beyond that already apply to the base LDP specification [RFC5036], base mLDP specification [RFC6388], and MPLS security framework [RFC5920].

## 10. IANA Considerations

This document defines a new LDP capability parameter TLV. IANA is requested to assign the lowest available value after 0x0500 from "TLV Type Name Space" in the "Label Distribution Protocol (LDP) Parameters" registry within "Label Distribution Protocol (LDP) Name Spaces" as the new code point for the LDP TLV code point.

| Value | Description | Reference | Notes/Registration Date |
|---|---|---|---|
| TBA | MT Multipoint Capability | This document | |

Figure 7: IANA Code Point

## 11. Acknowledgments

The authors would like to acknowledge Eric Rosen for his input on this specification.

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## Authors' Addresses

IJsbrand Wijnands
Cisco Systems, Inc.

Email: ice@cisco.com

Kamran Raza
Cisco Systems, Inc.

Email: skraza@cisco.com