

MPLS Working Group  
Internet-Draft  
Intended status: Standards Track  
Expires: 8 September 2022

IJ. Wijnands  
Individual  
K. Raza  
M. Mishra  
A. Budhiraja  
Cisco Systems, Inc.  
Z. Zhang  
Juniper Networks  
A. Gulko  
Edward Jones wealth management  
7 March 2022

mLDP Extensions for Multi-Topology Routing  
draft-wijnands-mpls-mlbp-multi-topology-04

## Abstract

Multi-Topology Routing (MTR) is a technology to enable service differentiation within an IP network. Flexible Algorithm (FA) is another mechanism of creating a sub-topology within a topology using defined topology constraints and computation algorithm. In order to deploy mLDP in a network that supports MTR and/or FA, mLDP is required to become topology and FA aware. This document specifies extensions to mLDP to support MTR with FA such that when building a Multi-Point LSPs it can follow a particular topology and algorithm.

## Status of This Memo

This Internet-Draft is submitted in full conformance with the provisions of [BCP 78](#) and [BCP 79](#).

Internet-Drafts are working documents of the Internet Engineering Task Force (IETF). Note that other groups may also distribute working documents as Internet-Drafts. The list of current Internet-Drafts is at <https://datatracker.ietf.org/drafts/current/>.

Internet-Drafts are draft documents valid for a maximum of six months and may be updated, replaced, or obsoleted by other documents at any time. It is inappropriate to use Internet-Drafts as reference material or to cite them other than as "work in progress."

This Internet-Draft will expire on 8 September 2022.

## Copyright Notice

Copyright (c) 2022 IETF Trust and the persons identified as the document authors. All rights reserved.

Internet-Draft

Multi-Topology mLDP

March 2022

This document is subject to [BCP 78](#) and the IETF Trust's Legal Provisions Relating to IETF Documents (<https://trustee.ietf.org/license-info>) in effect on the date of publication of this document. Please review these documents carefully, as they describe your rights and restrictions with respect to this document. Code Components extracted from this document must include Revised BSD License text as described in Section 4.e of the [Trust Legal Provisions](#) and are provided without warranty as described in the Revised BSD License.

## Table of Contents

<a href="#">1.</a>	Glossary . . . . .	<a href="#">2</a>
<a href="#">2.</a>	Introduction . . . . .	<a href="#">3</a>
<a href="#">3.</a>	Specification of Requirements . . . . .	<a href="#">4</a>
<a href="#">4.</a>	MT Scoped mLDP FECs . . . . .	<a href="#">4</a>
<a href="#">4.1.</a>	MP FEC Extensions for MT . . . . .	<a href="#">4</a>
<a href="#">4.1.1.</a>	MP FEC Element . . . . .	<a href="#">5</a>
<a href="#">4.1.2.</a>	MT IP Address Families . . . . .	<a href="#">5</a>
<a href="#">4.1.3.</a>	MT MP FEC Element . . . . .	<a href="#">6</a>
<a href="#">4.2.</a>	Topology IDs . . . . .	<a href="#">7</a>
<a href="#">5.</a>	MT Multipoint Capability . . . . .	<a href="#">8</a>
<a href="#">6.</a>	MT Applicability on FEC-based features . . . . .	<a href="#">9</a>
<a href="#">6.1.</a>	Typed Wildcard MP FEC Elements . . . . .	<a href="#">9</a>
<a href="#">6.2.</a>	End-of-LIB . . . . .	<a href="#">10</a>
<a href="#">7.</a>	Topology-Scoped Signaling and Forwarding . . . . .	<a href="#">10</a>
<a href="#">7.1.</a>	Upstream LSR selection . . . . .	<a href="#">10</a>
<a href="#">7.2.</a>	Downstream forwarding interface selection . . . . .	<a href="#">10</a>
<a href="#">8.</a>	LSP Ping Extensions . . . . .	<a href="#">10</a>
<a href="#">9.</a>	Security Considerations . . . . .	<a href="#">11</a>
<a href="#">10.</a>	IANA Considerations . . . . .	<a href="#">11</a>
<a href="#">11.</a>	Acknowledgments . . . . .	<a href="#">12</a>
<a href="#">12.</a>	References . . . . .	<a href="#">12</a>
<a href="#">12.1.</a>	Normative References . . . . .	<a href="#">12</a>
<a href="#">12.2.</a>	Informative References . . . . .	<a href="#">13</a>
	Authors' Addresses . . . . .	<a href="#">13</a>

[1.](#) Glossary

MT - Multi-Topology

MT-ID - Multi-Topology Identifier

MTR - Multi-Topology Routing

IGP - Interior Gateway Protocol

MP - Multipoint (P2MP or MP2MP)

Internet-Draft

Multi-Topology mLDP

March 2022

LDP - Label Distribution Protocol

mLDP - Multipoint LDP

P2MP - Point-to-Multipoint

MP2MP - Multipoint-to-Multipoint

FEC - Forwarding Equivalence Class

LSP - Label Switched Path

FA - Flexible Algorithm

IPA - IGP Algorithm

## [2.](#) Introduction

Multi-Topology Routing (MTR) is a technology to enable service differentiation within an IP network. IGP protocols (OSPF and IS-IS) and LDP have already been extended to support MTR. 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 specified to make LDP MT-aware and be able to setup unicast Label Switched Paths (LSPs) along IGP MT routing paths.

A more light weight mechanism to define constraint-based topologies is Flexible Algorithm (FA) [[I-D.ietf-lsr-flex-algo](#)]. FA can be seen as creating a sub-topology within a topology using defined topology constraints and computation algorithm. This can be done within a MTR topology or just the default Topology. An instance of such a sub-topology is identified by a 1 octet value as documented in [[I-D.ietf-lsr-flex-algo](#)]). Flexible Algorithm is a mechanism to

create a sub-topology, but in the future different algorithms might be defined on how to achieve that. For that reason, in the remainder of this document we'll refer to this as the IGP Algorithm (IPA).

Multipoint LDP (mLDP) refers to extensions in LDP to setup multipoint LSPs (point-to-multipoint (P2MP) or multipoint-to-multipoint (MP2MP)), by means of set of extensions and procedures defined in [\[RFC6388\]](#). In order to deploy mLDP in a network that supports MTR and FA, mLDP is required to become topology and algorithm aware. This document specifies extensions to mLDP to support MTR/IPA such that when building a Multi-Point LSPs it can follow a particular topology and algorithm. This means that the identifier for the particular Topology to be used by mLDP have to become a two tuple (MTR Topology Id, IGP Algorithm).

### [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.

The same applies to the IPA. The IPA needs to be encoded as part of the mLDP FEC to create unique MP-LSPs and at the same time is used to signal to mLDP (hop-by-hop) which Algorithm needs to be used to create the MP-LSP.

Since the MT-ID and IPA are part of the FEC, they 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:

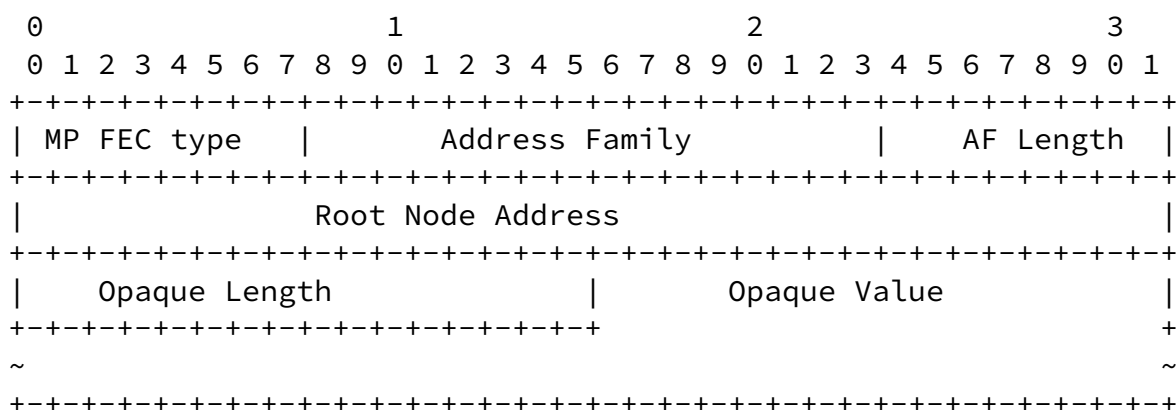


Figure 1: MP FEC Element Format [\[RFC6388\]](#)

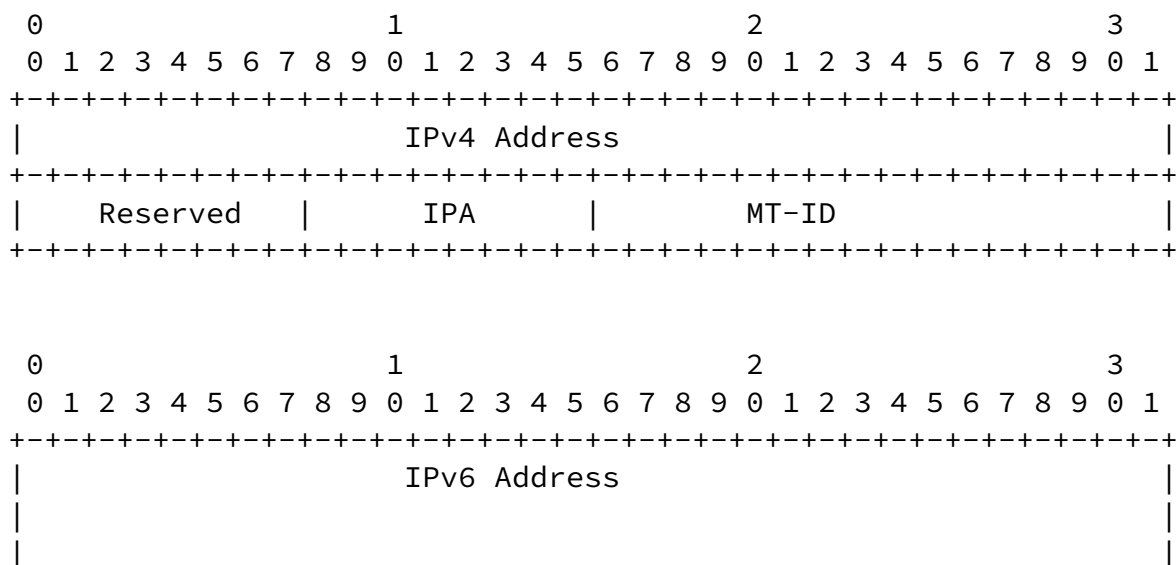
Where "Root Node Address" encoding is as defined for given "Address Family", and whose length (in octets) is specified by the "AF Length"

field.

To extend MP FEC elements for MT, the {MT-ID, IPA} is a tuple that is relevant in the context of the root address of the MP LSP. The {MT-ID, IPA} tuple determines in which (sub)-topology the root address needs to be resolved. Since the {MT-ID, IPA} tuple should be considered part of the mLDP FEC, the most natural place to encode this tuple is as part of the root address. While encoding it, we also propose to use "MT IP" Address Families as described in following sub section.

#### [4.1.2.](#) MT IP Address Families

[RFC7307] has specified new address families, named "MT IP" and "MT IPv6", to allow specification of an IP prefix within a topology scope. In addition to using this address family for mLDP, we also use 8 bits of the 16 bits Reserved field to encode the IGP Algorithm (IPA) Registry. The resulting format of the data associated with these new Address Families is as follows:



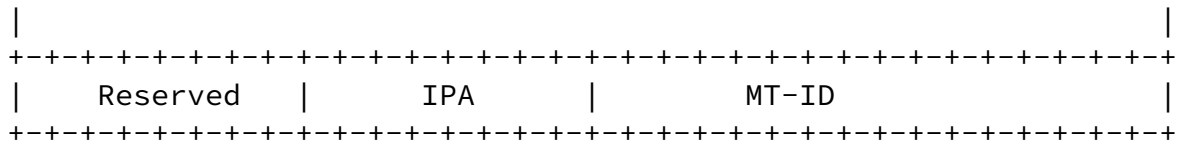


Figure 2: Modified MT IP Address Families Data Format

Where:

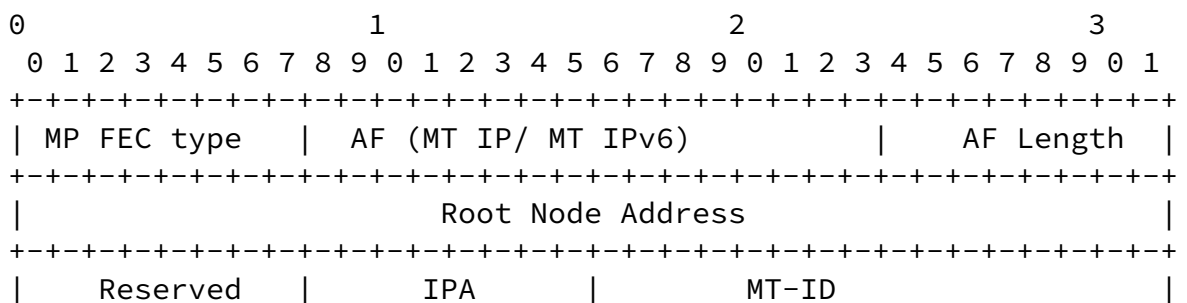
IPv4/IPv6 Address: An IP address corresponding to "MT IP" and "MT IPv6" address families respectively.

IPA: The IGP Algorithm, values are from the IGP Algorithm registry.

Reserved: This 8-bit field SHOULD be zero.

#### 4.1.3. MT MP FEC Element

By using extended MT IP Address Family, the resultant MT MP FEC element is to be encoded as follows:



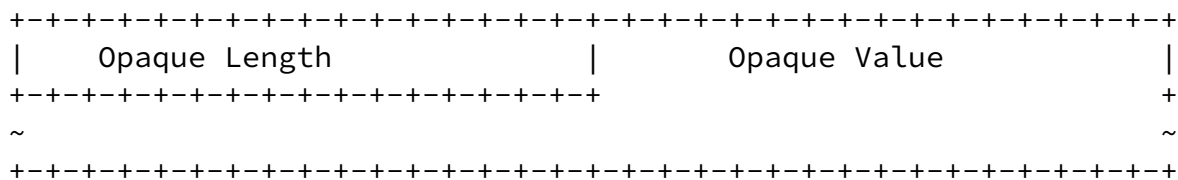


Figure 3: IP MT-Scoped MP FEC Element Format

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.

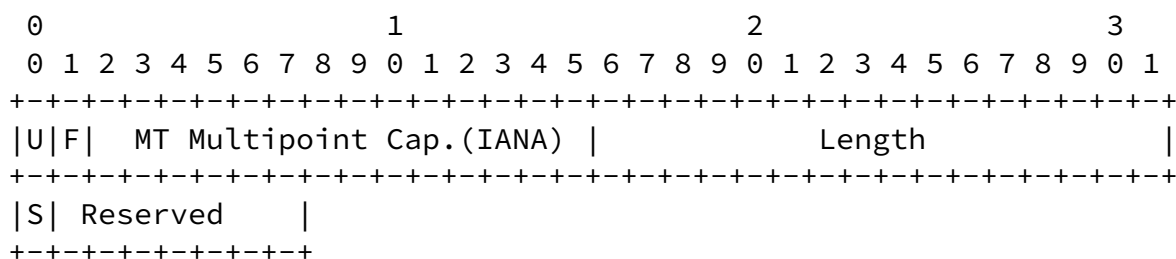
4.2. Topology IDs

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).



Where:

## 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 (sub)-topology as identified by the MT-ID and IPA field.

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

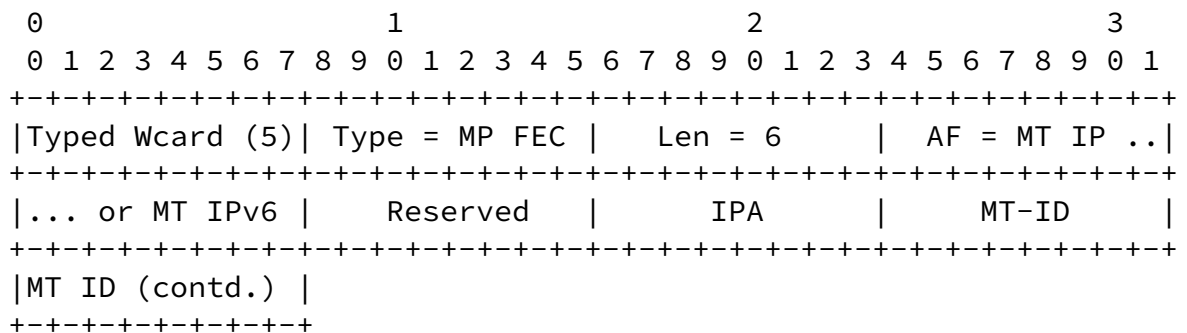


Figure 5: Typed Wildcard MT MP FEC Element

Where:

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

MT ID: MPLS MT ID

IPA: The IGP Algorithm, values are from the IGP Algorithm registry.

The proposed format allows an LSR to perform wildcard MP FEC operations under the scope of a (sub-)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 (sub-)topology using MT Typed Wildcard MP FEC element.

## [7.](#) Topology-Scoped Signaling and Forwarding

Since the {MT-ID, IPA} tuple is part of an mLDP FEC, there is no need to support the concept of multiple (sub-)topology forwarding tables in mLDP. Each MP LSP will be unique due to the tuple 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 to 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, IPA} tuple is signaled as part of the FEC, this tuple is used to select the (sub-)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, IPA} tuple is part of the FEC, this is no longer true. An interface must only be selected if it is part of the same (sub-)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].

Wijnands, et al.

Expires 8 September 2022

[Page 10]

Internet-Draft

Multi-Topology mLDP

March 2022

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, IPA} information as an extension to the "Root LSR Address" field. The resultant format of sub-tlv is as follows:

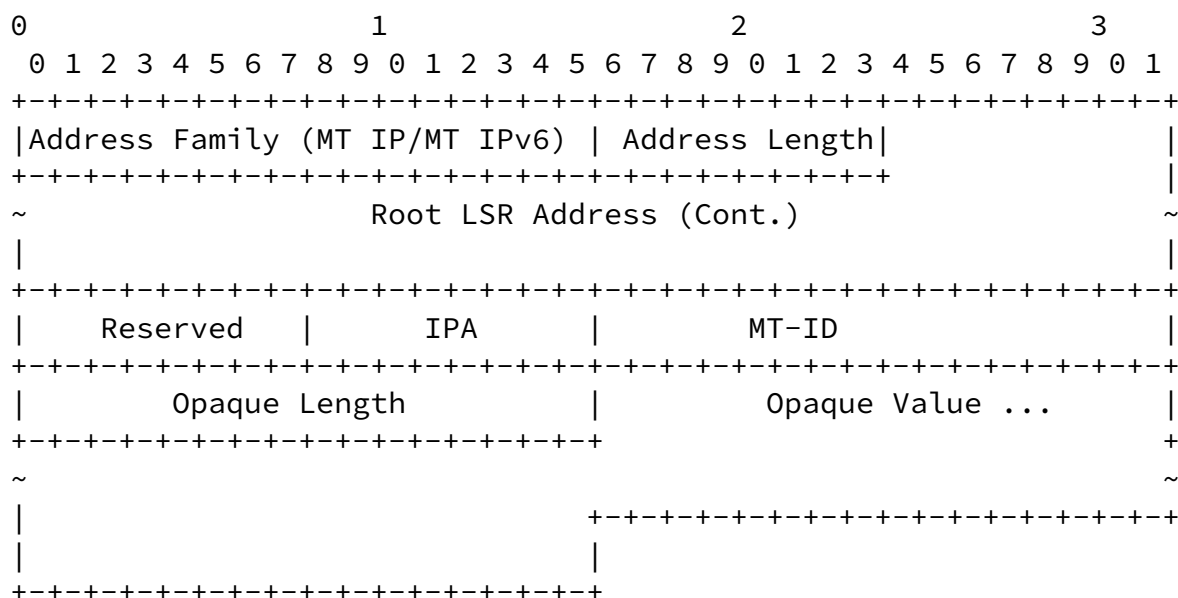


Figure 6: Multipoint LDP FEC Stack Sub-TLV Format for MT

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 (sub-)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.

Wijnands, et al.

Expires 8 September 2022

[Page 11]

Internet-Draft

Multi-Topology mLDP

March 2022

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.

## 12. References

### 12.1. Normative References

[I-D.ietf-lsr-flex-algo]

Psenak, P., Hegde, S., Filsfils, C., Talaulikar, K., and A. Gulko, "IGP Flexible Algorithm", Work in Progress, Internet-Draft, [draft-ietf-lsr-flex-algo-18](https://www.ietf.org/archive/id/draft-ietf-lsr-flex-algo-18.txt), 25 October 2021, <<https://www.ietf.org/archive/id/draft-ietf-lsr-flex-algo-18.txt>>.

- [RFC2119] Bradner, S., "Key words for use in RFCs to Indicate Requirement Levels", [BCP 14](#), [RFC 2119](#), DOI 10.17487/RFC2119, March 1997, <<https://www.rfc-editor.org/info/rfc2119>>.
- [RFC4379] Kompella, K. and G. Swallow, "Detecting Multi-Protocol Label Switched (MPLS) Data Plane Failures", [RFC 4379](#), DOI 10.17487/RFC4379, February 2006, <<https://www.rfc-editor.org/info/rfc4379>>.
- [RFC4915] Psenak, P., Mirtorabi, S., Roy, A., Nguyen, L., and P. Pillay-Esnault, "Multi-Topology (MT) Routing in OSPF", [RFC 4915](#), DOI 10.17487/RFC4915, June 2007, <<https://www.rfc-editor.org/info/rfc4915>>.
- [RFC5120] Przygienda, T., Shen, N., and N. Sheth, "M-ISIS: Multi Topology (MT) Routing in Intermediate System to Intermediate Systems (IS-ISs)", [RFC 5120](#), DOI 10.17487/RFC5120, February 2008, <<https://www.rfc-editor.org/info/rfc5120>>.

- [RFC6388] Wijnands, IJ., Ed., Minei, I., Ed., Kompella, K., and B. Thomas, "Label Distribution Protocol Extensions for Point-to-Multipoint and Multipoint-to-Multipoint Label Switched Paths", [RFC 6388](#), DOI 10.17487/RFC6388, November 2011, <<https://www.rfc-editor.org/info/rfc6388>>.
- [RFC6425] Saxena, S., Ed., Swallow, G., Ali, Z., Farrel, A., Yasukawa, S., and T. Nadeau, "Detecting Data-Plane Failures in Point-to-Multipoint MPLS - Extensions to LSP Ping", [RFC 6425](#), DOI 10.17487/RFC6425, November 2011, <<https://www.rfc-editor.org/info/rfc6425>>.
- [RFC7307] Zhao, Q., Raza, K., Zhou, C., Fang, L., Li, L., and D. King, "LDP Extensions for Multi-Topology", [RFC 7307](#), DOI 10.17487/RFC7307, July 2014, <<https://www.rfc-editor.org/info/rfc7307>>.

- [RFC5036] Andersson, L., Ed., Minei, I., Ed., and B. Thomas, Ed., "LDP Specification", [RFC 5036](#), DOI 10.17487/RFC5036, October 2007, <<https://www.rfc-editor.org/info/rfc5036>>.
- [RFC5561] Thomas, B., Raza, K., Aggarwal, S., Aggarwal, R., and JL. Le Roux, "LDP Capabilities", [RFC 5561](#), DOI 10.17487/RFC5561, July 2009, <<https://www.rfc-editor.org/info/rfc5561>>.
- [RFC5918] Asati, R., Minei, I., and B. Thomas, "Label Distribution Protocol (LDP) 'Typed Wildcard' Forward Equivalence Class (FEC)", [RFC 5918](#), DOI 10.17487/RFC5918, August 2010, <<https://www.rfc-editor.org/info/rfc5918>>.
- [RFC5919] Asati, R., Mohapatra, P., Chen, E., and B. Thomas, "Signaling LDP Label Advertisement Completion", [RFC 5919](#), DOI 10.17487/RFC5919, August 2010, <<https://www.rfc-editor.org/info/rfc5919>>.
- [RFC5920] Fang, L., Ed., "Security Framework for MPLS and GMPLS Networks", [RFC 5920](#), DOI 10.17487/RFC5920, July 2010, <<https://www.rfc-editor.org/info/rfc5920>>.

#### Authors' Addresses

IJsbrand Wijnands  
Individual  
Email: ice@braindump.be

Wijnands, et al.

Expires 8 September 2022

[Page 13]

---

Internet-Draft

Multi-Topology mLDP

March 2022

Kamran Raza  
Cisco Systems, Inc.  
2000 Innovation Drive  
Kanata ON K2K-3E8  
Canada  
Email: skraza@cisco.com

Mankamana Mishra  
Cisco Systems, Inc.  
821 Alder Drive

Milpitas, CA 95035  
United States of America  
Email: [mankamis@cisco.com](mailto:mankamis@cisco.com)

Anuj Budhiraja  
Cisco Systems, Inc.  
821 Alder Drive  
Milpitas, CA 95035  
United States of America  
Email: [abudhira@cisco.com](mailto:abudhira@cisco.com)

Zhaohui Zhang  
Juniper Networks  
10 Technology Park Dr.  
Westford, MA 01886  
United States of America  
Email: [zzhang@juniper.net](mailto:zzhang@juniper.net)

Arkadiy Gulko  
Edward Jones wealth management  
United States of America  
Email: [Arkadiy.gulko@edwardjones.com](mailto:Arkadiy.gulko@edwardjones.com)