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LDP Extensions for Flex-Algo
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Abstract

This document specifies extensions to LDP to support the use Flex-Algo, enabling Label Switched Paths (LSPs) to follow a specific Flex-Algo.

Status of this Memo

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This Internet-Draft will expire on 20 October 2025.

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1. Introduction

Multi-Topology Routing (MTR) is a technology that enables service differentiation within an IP network. The Flexible Algorithm (FA) is another mechanism for creating a sub-topology within a topology using defined topology constraints and computation algorithms.

To deploy Label Distribution Protocol (LDP) in a network that supports Flex-Algo, or other methods of signaling non-default IGP Algorithms (IPAs), it is necessary for LDP to become algorithm aware. This document specifies extensions to LDP to support the use of IPAs, enabling Label Switched Paths (LSPs) to follow a specific algorithm.

[RFC7307] describes how to extend the LDP protocol to support Multi-Topology (MT), but it only uses one byte to carry the MT-ID and does not support IPAs. This document updates RFC 7307 by allowing LSPs to follow a specific topology and algorithm.

This document defines how LDP can utilize a specific combination of topology and algorithm, referred to as Topology-Algorithm(TA). In

this context, LDP's functionality is enhanced to ensure that the LSPs are constructed and maintained according to the specified TA parameters, thus optimizing the routing and resource utilization in diverse network environments.

These enhancements to LDP provide the flexibility needed to support advanced topological and algorithmic configurations, making it a robust choice for modern, dynamic network infrastructures.

1.1. Terminology

This document uses terminologies defined in [RFC7307].

- MT-ID: A 16-bit value used to represent the Multi-Topology ID.
- Algorithm: A 1-octet value from the IGP Algorithm Types registry under IGP Parameters registry.

2. Signaling Extensions

2.1. New Address Families: FA IP/FA IPv6

[RFC7307] defines MT IP and MT IPv6 address families, which are used to specify IPv4 and IPv6 prefixes within a topology scope, but they can only carry MT-ID information.

To extend IP address families for Flex-Algo, two new Address Families named "FA IP" and "FA IPv6" are used to specify IPv4 and IPv6 prefixes within a Flex-Algo scope.

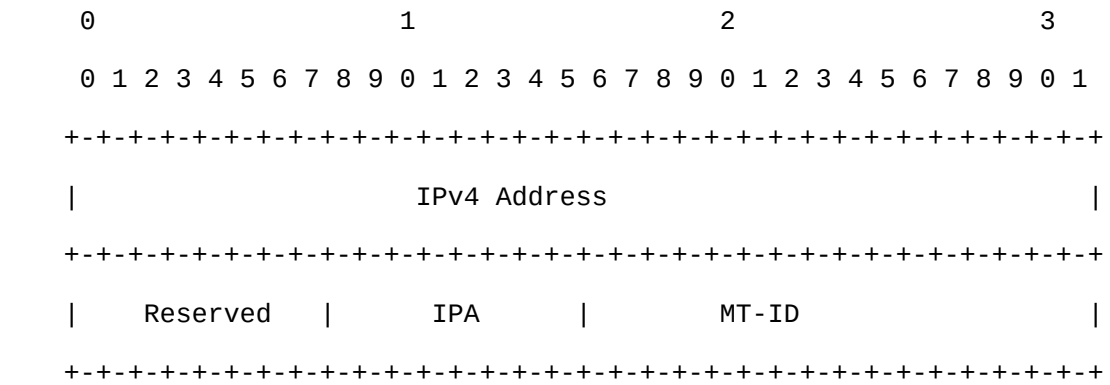


Figure 1: FA IP Address Family Format

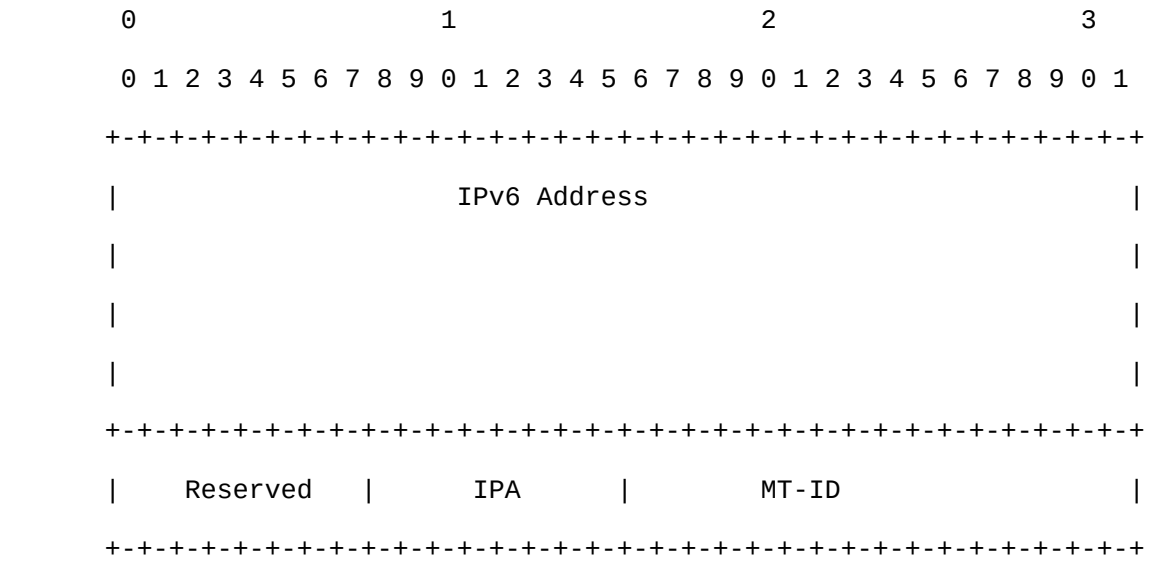


Figure 1: FA IPv6 Address Family Format

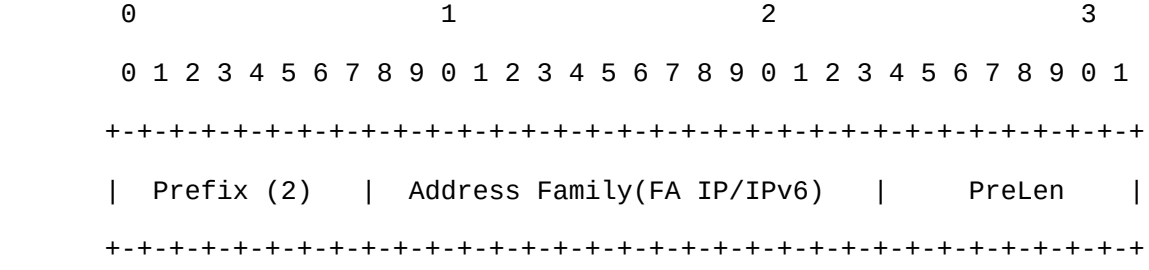
IPA: A 1-octet value from the IGP Algorithm Types registry under IGP Parameters registry.

MT-ID: A 2-octet field MT-ID (see Section 3.7 of [RFC4915], Section 7 of [RFC5120]) to special the topology. If this field is set to zero, it means the default topology.

2.2. LDP FEC Elements with FA IP AF

The following section specifies the format extensions of the existing LDP FEC elements to support Flex-Algo. The "Address Family" of these FEC elements will be set to "FA IP" or "FA IPv6".

The encoding of the Flex-Algo Prefix FEC element is as follows:



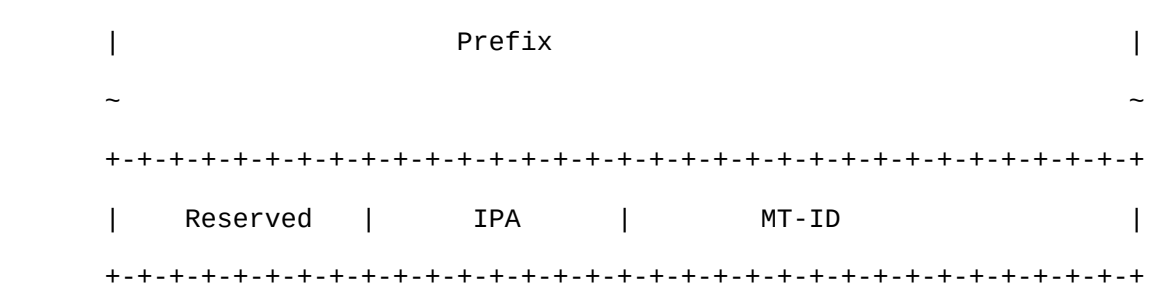


Figure 2: FA Prefix FEC Element Format

The Flex-Algo Typed Wildcard FEC element encoding is as follows:

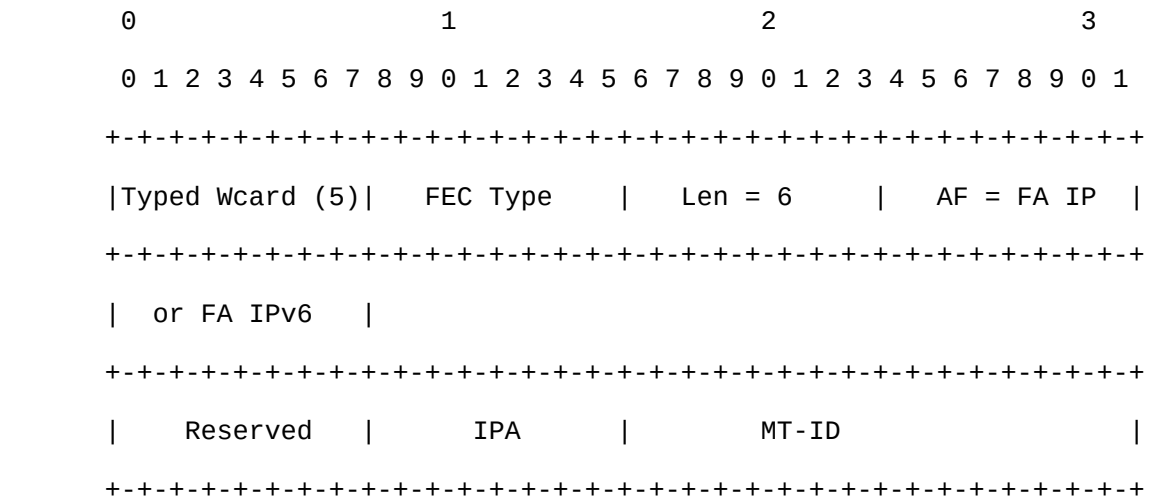


Figure 4: Flex-Algo Typed Wildcard FEC Element

2.3. IGP IPA Mapping and Translation

The non-reserved non-special IGP IPA values can be used and carried in LDP without the need for translation. However, there is a need for translating reserved or special IGP IPA values to corresponding LDP IPAs.

2.4. LDP Flex-Algo Capability Advertisement

2.4.1. Protocol Extension

We specify a new LDP capability, named "Flex-Algo (FA)", which is defined in accordance with the LDP capability guidelines [RFC5561].

The LDP "FA" capability can be advertised by an LDP speaker to its peers either during the LDP session initialization or after the LDP session is set up. The advertisement is to announce the capability of the Label Switching Router (LSR) to support FA for the given IP address family. An LDP speaker MUST NOT send messages containing FA FEC elements unless the peer has said it can handle it.

The format of the FA Capability TLV is as follows:

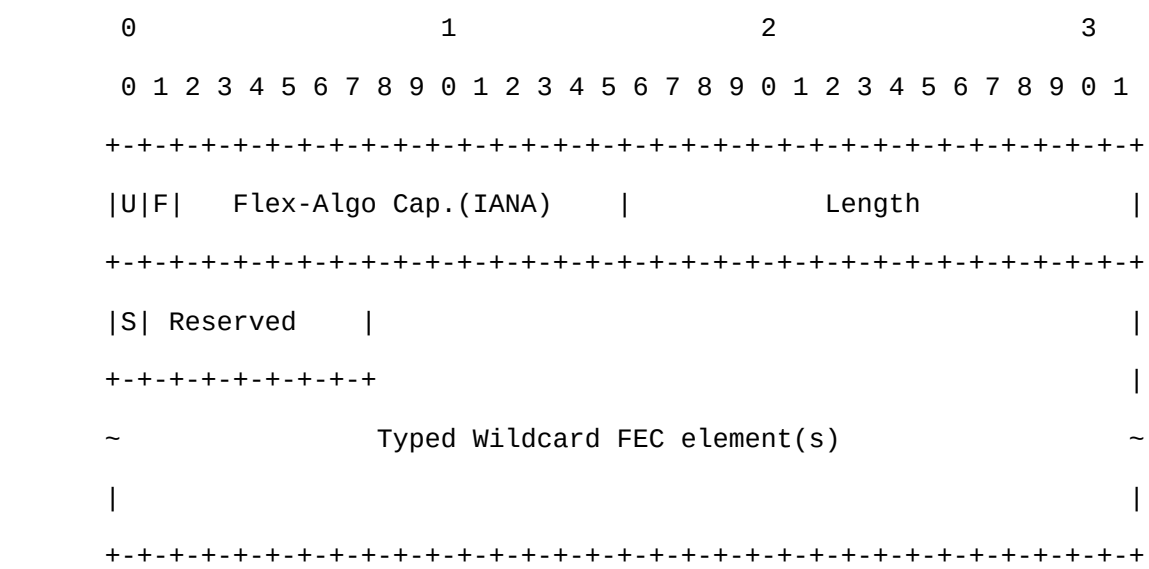


Figure 5: Flex-Algo Capability TLV Format

Where:

o Flex-Algo Capability: Capability TLV type (IANA assigned)

2.4.2. Procedures

To announce its Flex-Algo capability for an IP address family, LDP FEC type, an LDP speaker sends an "FA Capability" including the exact Typed Wildcard FEC element with the corresponding "AddressFamily" field (i.e., set to "FA IP" for IPv4 and set to "FA IPv6" for IPv6 address family), corresponding "FEC Type" field (i.e., set to "Prefix"), and corresponding "IPA". To announce its Flex-Algo capability for both the IPv4 and IPv6 address family, or for multiple FEC types, or for multiple Flex-Algos, an LDP speaker sends an "FA Capability" with one or more FA Typed FEC elements in it.

3. FA Applicability on FEC-Based Features

3.1. Typed Wildcard FEC Element

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

The FA extensions defined in this document do not require any extension to procedures for the Typed Wildcard FEC element, and these procedures apply as is to FA wildcarding. The FA extensions, though, allow use of "FA IP" or "FA IPv6" in the Address Family field of the Typed Wildcard FEC element in order to use wildcard operations in the context of a given Flex-Algo. The use of FA-scoped address family also allows us to specify Flex-Algo in these operations.

3.2. LSP Ping

3.2.1. New FEC Sub-Types

We define two new FEC types for LSP ping:

- FA LDP IPv4 FEC
- FA LDP IPv6 FEC

3.2.2. FA LDP IPv4 FEC Sub-TLV

The format of the "FA LDP IPv4 FEC" sub-TLV to be used in a "Target FEC Stack" [RFC4379] is:

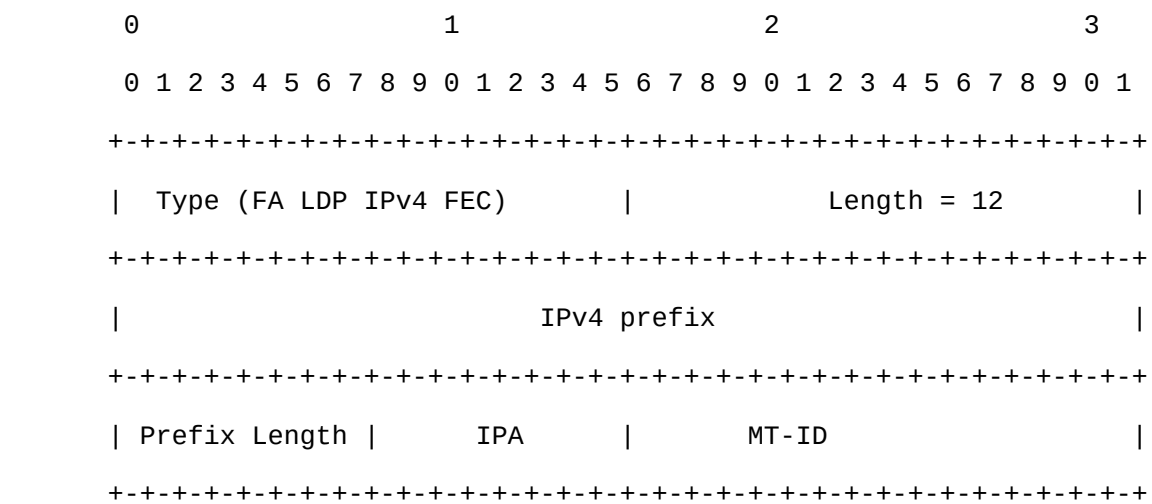


Figure 5: FA LDP IPv4 FEC Sub-TLV

3.2.3. FA LDP IPv6 FEC Sub-TLV

The format of the "FA LDP IPv6 FEC" sub-TLV to be used in a "Target FEC Stack" [RFC4379] is:

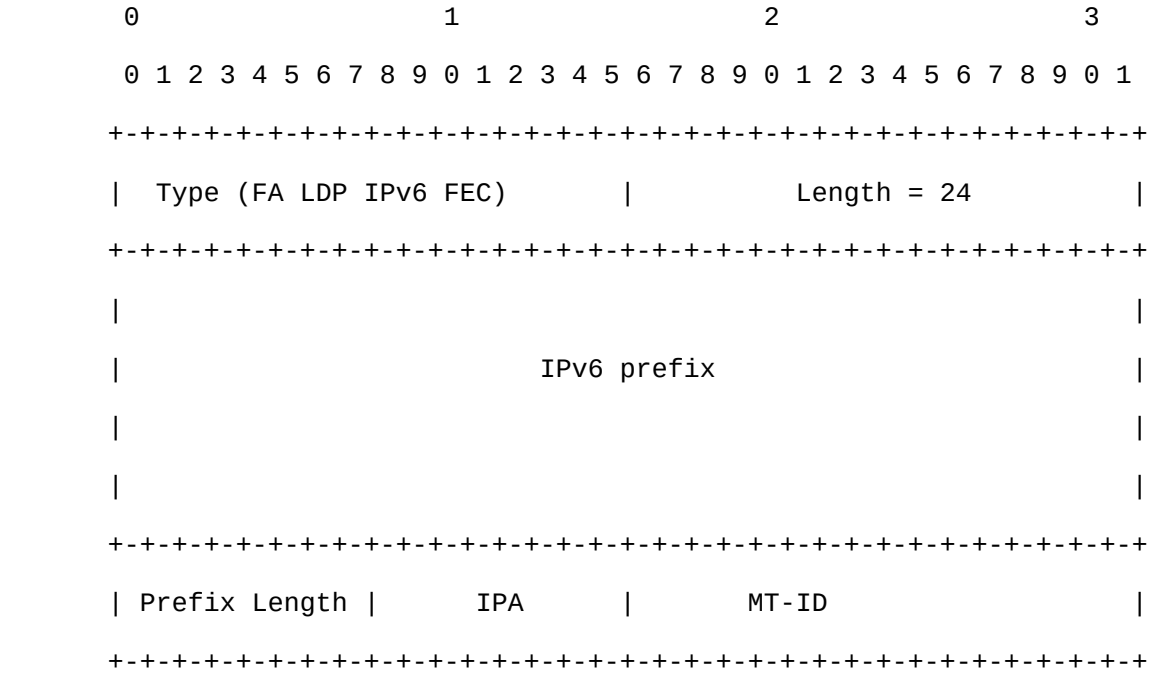


Figure 6: FA LDP IPv6 FEC Sub-TLV

3.2.4. Operation Considerations

To detect data-plane failures using LSP ping for a specific Flex-Algo, the router will initiate an LSP ping request with the target FEC stack TLV containing the LDP FA IP Prefix Sub-TLV in the Echo Request packet. The Echo Request packet is sent with the label bound to the IP Prefix in the Flex-Algo. Once the Echo Request packet reaches the target router, it will process the packet and perform checks for the LDP FA IP Prefix sub-TLV present in the Target FEC Stack as described in [RFC4379] and respond according to the processing rules in [RFC4379]. For the case that the LSP ping with return path is not specified, the reply packet must go through the default Flex-Algo instead of the Flex-Algo where the Echo Request goes through.

4. Error Handling

4.1. Error Notification for Invalid IPA ID

An LSR should respond with an "Invalid IPA ID" status code in the LDP Notification message when it receives an LDP message with a FEC element specifying an IPA that is not locally known or not supported. The LSR MUST also discard the entire message before sending the Notification message.

5. IANA Considerations

5.1. FA Capability TLV

New LDP Capability TLV "Flex-Algo Capability" TLV is requested from the LDP Parameters registry "TLV Type Name Space".

5.2. New Status Code

A new status code, "Invalid IPA ID," was requested from the LDP Parameters registry "Status Code Name Space".

Registry:

Range/Value	Description
TBD1	Invalid IPA ID

5.3. New address families

New address families under the IANA registry "Address Family Numbers":

Number	Description
TBD2	FA IP: Flex-Algo IP version 4
TBD3	FA IPv6: Flex-Algo IP version 6

6. References

6.1. Normative References

[RFC7307] Q. Zhao, Huawei Technology, K. Raza, C. Zhou, Cisco Systems, L. Fang, Microsoft, L. Li, China Mobile, D. King, Old Dog Consulting, "LDP Extensions for Multi-Topology", RFC 5286,DOI 10.17487/RFC7307, July 2014,<http://www.rfc-editor.org/info/rfc7307>.

[RFC9658] IJ. Wijnands, Individual, M. Mishra, Ed., K. Raza, Cisco Systems, Inc., Z. Zhang, Juniper Networks, A. Gulko, Edward Jones, "Multipoint LDP Extensions for Multi-Topology Routing", RFC 9658,DOI 10.17487/RFC9658, October 2024,<http://www.rfc-editor.org/info/rfc9658>.

6.2. Informative References

TBD

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