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LDP Extensions for Multi-Topology

Abstract

Multi-Topology (MT) routing is supported in IP networks with the use of MT-aware IGPs. In order to provide MT routing within Multiprotocol Label Switching (MPLS) Label Distribution Protocol (LDP) networks, new extensions are required.

This document describes the LDP protocol extensions required to support MT routing in an MPLS environment.

Status of This Memo

Table of Contents

1. Introduction

Multi-Topology (MT) routing is supported in IP networks with the use of MT-aware IGPs. It would be advantageous for Communications Service Providers (CSPs) to support an MPLS Multi-Topology (MPLS-MT) environment. The benefits of MPLS-MT technology are features for various network scenarios, including:

- A CSP may want to assign varying Quality of Service (QoS) profiles to different traffic classes, based on a specific topology in an MT routing network;

- Separate routing and MPLS domains may be used to isolate multicast and IPv6 islands within the backbone network;

- Specific IP address space could be routed across an MT based on security or operational isolation requirements;

- Low-latency links could be assigned to an MT for delay-sensitive traffic;

- Management traffic may be divided from customer traffic using different MTs utilizing separate links, thus ensuring that management traffic is separated from customer traffic.

This document describes the Label Distribution Protocol (LDP) procedures and protocol extensions required to support MT routing in an MPLS environment.

This document defines two new Forwarding Equivalence Class (FEC) types for use in Label Switched Path (LSP) ping [RFC4379].

2. Terminology

This document uses MPLS terminology defined in [RFC5036]. Additional terms are defined below:

- MT-ID: A 16-bit value used to represent the Multi-Topology ID.

- Default MT Topology: A topology that is built using the MT-ID default value of 0.

- MT Topology: A topology that is built using the corresponding MT-ID.

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 [RFC2119].

3. Signaling Extensions

3.1. Topology-Scoped Forwarding Equivalence Class (FEC)

LDP assigns and binds a label to a FEC, where a FEC is a list of one or more FEC elements. To set up LSPs for unicast IP routing paths, LDP assigns local labels for IP prefixes and advertises these labels to its peers so that an LSP is set up along the routing path. To set up MT LSPs for IP prefixes under a given topology scope, the LDP prefix-related FEC element must be extended to include topology information. This implies that the MT-ID becomes an attribute of the prefix-related FEC element, and all FEC-Label binding operations are performed under the context of a given topology (MT-ID).

The following section ("New Address Families: MT IP") defines the extension required to bind the prefix-related FEC to a topology.

3.2. New Address Families: MT IP

Section 2.1 of the LDP base specification [RFC5036] defines the Address Prefix FEC element. The Prefix encoding is defined for a given "Address Family" (AF), and has length (in bits) specified by the "PreLen" field.

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

The format of data associated with these new Address Families is described below:

```
 0                   1                   2                   3
 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                      IPv4 Address                             |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|          Reserved             |        MT-ID                  |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

Figure 1: MT IP Address Family Format

```
 0                   1                   2                   3
 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                      IPv6 Address                             |
|                                                               |
|                                                               |
|                                                               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|          Reserved             |        MT-ID                  |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

Figure 2: MT IPv6 Address Family Format

Where "IP Address" is an IPv4 and IPv6 address/prefix for "MT IP" and "MT IPv6" AF respectively, and the field "MT-ID" corresponds to the 16-bit Topology ID for a given address.

The definition and usage for the remaining fields in the FEC elements are as defined for IP/IPv6 AF. The value of MT-ID 0 corresponds to the default topology and MUST be ignored on receipt so as to not cause any conflict/confusion with existing non-MT procedures.

The defined FEC elements with "MT IP" Address Family can be used in any LDP message and procedures that currently specify and allow the use of FEC elements with IP/IPv6 Address Family.

3.3. LDP FEC Elements with MT IP AF

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

The MT Prefix FEC element encoding is as follows:

```
 0                   1                   2                   3
 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|  Prefix (2)   | Address Family (MT IP/MT IPv6)|     PreLen    |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                     Prefix                                    |
~                                                               ~
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|          Reserved             |        MT-ID                  |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

Figure 3: MT Prefix FEC Element Format

The MT Typed Wildcard FEC element encoding is as follows:

```
 0                   1                   2                   3
 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|Typed Wcard (5)|    FEC Type   |   Len = 6     |  AF = MT IP ..|
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|... or MT IPv6 |         MT-ID                 |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

Figure 4: MT Typed Wildcard FEC Element

The above format can be used for any LDP FEC element that allows use of the IP/IPv6 Address Family. In the scope of this document, the allowed "FEC Type" in a MT Typed Wildcard FEC element is the Prefix FEC element.

3.4. IGP MT-ID Mapping and Translation

The non-reserved non-special IGP MT-ID values can be used and carried in LDP without the need for translation. However, there is a need for translating reserved or special IGP MT-ID values to corresponding LDP MT-IDs. The assigned, unassigned, and special LDP MT-ID values have been assigned as described in Section 9 ("IANA Considerations").

How future LDP MT-ID values are allocated is outside the scope of this document. Instead, a separate document will be created to detail the allocation policy and process for requesting new MT-ID values.

3.5. LDP MT Capability Advertisement

3.5.1. Protocol Extension

We specify a new LDP capability, named "Multi-Topology (MT)", which is defined in accordance with the LDP capability guidelines [RFC5561]. The LDP "MT" 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 MT for the given IP address family. An LDP speaker MUST NOT send messages containing MT FEC elements unless the peer has said it can handle it.

The MT capability is specified using the Multi-Topology Capability TLV. The Multi-Topology Capability TLV format is in accordance with the LDP capability guidelines as defined in [RFC5561]. To be able to specify IP address family, the capability-specific data (i.e., the "Capability Data" field of Capability TLV) is populated using the "Typed Wildcard FEC element" as defined in [RFC5918].

The format of the Multi-Topology Capability TLV is as follows:

```
 0                   1                   2                   3
 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|U|F| Multi-Topology Cap.(IANA) |            Length             |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|S| Reserved    |                                               |
+-+-+-+-+-+-+-+-+                                               |
~                Typed Wildcard FEC element(s)                  ~
|                                                               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

Figure 5: Multi-Topology Capability TLV Format

Where:

- o U-bit: MUST be 1 so that the TLV will be silently ignored by a recipient if it is unknown, according to the rules of [RFC5036].

- o F-bit: MUST be 0 as per Section 3 ("Specifying Capabilities in LDP Messages") of LDP Capabilities [RFC5561].

- o Multi-Topology Capability: Capability TLV type (IANA assigned)

- o S-bit: MUST be 1 if used in LDP "Initialization" message. MAY be set to 0 or 1 in dynamic "Capability" message to advertise or withdraw the capability, respectively.

- o Typed Wildcard FEC element(s): One or more elements specified as the "Capability data".

- o Length: length of Value field, starting from the S-bit, in octets.

- o The encoding of the Typed Wildcard FEC element, as defined in [RFC5918], is defined in Section 4.1 ("Typed Wildcard FEC element") of this document. The MT-ID field of the MT Typed Wildcard FEC element MUST be set to "Wildcard Topology" when it is specified in the MT Capability TLV.

3.5.2. Procedures

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

- The capability for supporting multi-topology in LDP can be advertised during LDP session initialization stage by including the LDP MT capability TLV in LDP Initialization message. After an LDP session is established, the MT capability can also be advertised or withdrawn using the Capability message (only if the "Dynamic Capability Announcement" capability [RFC5561] has already been successfully negotiated).

- If an LSR has not advertised MT capability, its peer MUST NOT send to this LSR any LDP messages with FEC elements that include an MT identifier.

- If an LSR is changed from non-MT capable to MT capable, it sets the S-bit in the MT capability TLV and advertises via the Capability message (if it supports Dynamic Capability Announcement). The existing LSP is treated as an LSP for default MT (ID 0).

- If an LSR is changed from LDP-MT capable to non-MT capable, it initiates withdrawal of all label mapping for existing LSPs of all non-default MTs. It also cleans up all the LSPs of all non-default MTs locally. Then, it clears the S-bit in the MT capability TLV and advertises via the Capability message (if it supports Dynamic Capability Announcement). When an LSR knows the peer node is changed from LDP-MT capable to non-MT capable, it cleans up all the LSPs of all non-default MTs locally and initiates withdrawal of all label mapping for existing LSPs of all non-default MTs. Each side of the node sends a label release to its peer once it receives the label release messages even though each side has already cleaned up all the LSPs locally.

- If an LSR does not support "Dynamic Capability Announcement", it MUST reset the session with its peer whenever the LSR changes its local capability with regards to supporting LDP MT.

- o If an LSR is changed from IGP-MT capable to non-MT capable, it may wait until the routes update to withdraw the FEC and release the label mapping for existing LSPs of a specific MT.

3.6. Label Spaces

The use of multiple topologies for LDP does not require different label spaces for each topology. An LSR can use the same label space for all MT FECs as for the default topology.

Similarly, signaling for different topologies can and should be done within a single LDP session.

3.7. Reserved MT-ID Values

Certain MT topologies are assigned to serve predetermined purposes.

In Section 9 ("IANA Considerations"), this document defines a new IANA registry "MPLS Multi-Topology Identifiers" to keep LDP MT-ID reserved values.

If an LSR receives a FEC element with an "MT-ID" value that is "Unassigned" for future use (and not IANA allocated yet), the LSR MUST abort the processing of the FEC element and SHOULD send a notification message with status code "Invalid Topology ID" to the sender.

4. MT Applicability on FEC-Based Features

4.1. 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 MT 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 MT wildcarding. The MT extensions, though, allow use of "MT IP" or "MT IPv6" in the Address Family field of the Typed Wildcard FEC element in order to use wildcard operations in the context of a given topology. The use of MT-scoped address family also allows us to specify MT-ID in these operations.

The defined format in Section 4.1 ("Typed Wildcard FEC element") allows an LSR to perform wildcard FEC operations under the scope of a topology. If an LSR wishes to perform a wildcard operation that applies to all topologies, it can use a "Wildcard Topology" MT-ID.

For example, upon local de-configuration of a topology "x", an LSR may send a typed wildcard Label Withdraw message with MT-ID "x" to withdraw all its labels from the peer that advertised under the scope of topology "x". Additionally, upon a global configuration change, an LSR may send a typed wildcard Label Withdraw message with the MT-ID set to "Wildcard Topology" to withdraw all its labels under all topologies from the peer.

4.2. Signaling LDP Label Advertisement Completion

[RFC5919] specifies extensions and procedures for an LDP speaker to signal its convergence for a given FEC type towards a peer. The procedures defined in [RFC5919] apply as they are to an MT FEC element. This allows an LDP speaker to signal its IP convergence using Typed Wildcard FEC element, and its MT IP convergence per topology using a MT Typed Wildcard FEC element.

4.3. LSP Ping

[RFC4379] defines procedures to detect data-plane failures in MPLS LSPs via LSP ping. That specification defines a "Target FEC Stack" TLV that describes the FEC stack being tested. This TLV is sent in an MPLS Echo Request message towards the LSP’s egress LSR and is forwarded along the same data path as other packets belonging to the FEC.

"Target FEC Stack" TLV contains one or more sub-TLVs pertaining to different FEC types. Section 3.2 of [RFC4379] defines the Sub-Types and format of the FEC. To support LSP ping for MT LDP LSPs, this document defines the following extensions to [RFC4379].

4.3.1. New FEC Sub-Types

We define two new FEC types for LSP ping:

- o MT LDP IPv4 FEC

- o MT LDP IPv6 FEC

We also define the following new sub-types for sub-TLVs to specify these FECs in the "Target FEC Stack" TLV of [RFC4379]:

Sub-Type	Length	Value Field
31	8	MT LDP IPv4 prefix
32	20	MT LDP IPv6 prefix

Figure 6: New Sub-Types for Sub-TLVs

The rules and procedures of using these sub-TLVs in an MPLS echo request message are the same as defined for LDP IPv4/IPv6 FEC sub-TLV types in [RFC4379].

4.3.2. MT LDP IPv4 FEC Sub-TLV

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

```
 0                   1                   2                   3
 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|  Type = 31 (MT LDP IPv4 FEC)  |          Length = 8           |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                          IPv4 prefix                          |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
| Prefix Length |      MBZ      |       MT-ID                   |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

Figure 7: MT LDP IPv4 FEC Sub-TLV

The format of this sub-TLV is similar to the LDP IPv4 FEC sub-TLV as defined in [RFC4379]. In addition to "IPv4 prefix" and "Prefix Length" fields, this new sub-TLV also specifies the MT-ID (Multi-Topology ID). The Length for this sub-TLV is 5.

The term "Must Be Zero" (MBZ) is used in object descriptions for reserved fields. These fields MUST be set to zero when sent and ignored on receipt.

4.3.3. MT LDP IPv6 FEC Sub-TLV

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

```
 0                   1                   2                   3
 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|  Type = 32 (MT LDP IPv6 FEC)  |         Length = 20           |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                                                               |
|                          IPv6 prefix                          |
|                                                               |
|                                                               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
| Prefix Length |     MBZ       |       MT-ID                   |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

Figure 8: MT LDP IPv6 FEC Sub-TLV

The format of this sub-TLV is similar to the LDP IPv6 FEC sub-TLV as defined in [RFC4379]. In addition to the "IPv6 prefix" and "Prefix Length" fields, this new sub-TLV also specifies the MT-ID (Multi-Topology ID). The Length for this sub-TLV is 17.

4.3.4. Operation Considerations

To detect data-plane failures using LSP ping for a specific topology, the router will initiate an LSP ping request with the target FEC stack TLV containing the LDP MT 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 topology. Once the Echo Request packet reaches the target router, it will process the packet and perform checks for the LDP MT 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 topology instead of the topology where the Echo Request goes through.

It should be noted that the existing MIB modules for an MPLS LSR [RFC3813] and MPLS LDP managed objects [RFC3815] do not provide the necessary information to support the extensions in this document. For example, the absence of the MT-ID as an index into the MIB modules means that there is no way to disambiguate different topology instances.

5. Error Handling

The extensions defined in this document utilize the existing LDP error handling defined in [RFC5036]. If an LSR receives an error notification from a peer for a session, it terminates the LDP session by closing the TCP transport connection for the session and discarding all multi-topology label mappings learned via the session.

5.1. MT Error Notification for Invalid Topology ID

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

6. Backwards Compatibility

The MPLS-MT solution is backwards compatible with existing LDP enhancements defined in [RFC5036], including message authenticity, integrity of message, and topology loop detection.

The legacy node that does not support MT should not receive any MT-related LDP messages. In case bad things happen, according to [RFC5036], processing of such messages should be aborted.

7. MPLS Forwarding in MT

Although forwarding is out of the scope of this document, we include some forwarding consideration for informational purposes here.

The specified signaling mechanisms allow all the topologies to share the platform-specific label space. This feature allows the existing data-plane techniques to be used. Also, there is no way for the data plane to associate a received packet with any one topology, meaning that topology-specific label spaces cannot be used.

8. Security Considerations

The use of MT over existing MPLS solutions does not offer any specific security benefit.

General LDP communication security threats and how these may be mitigated are described in [RFC5036]; these threats include:

- spoofing

- privacy

- denial of service

For further discussion regarding possible LDP communication threats and mitigation techniques, see [RFC5920].

9. IANA Considerations

This document introduces the following new protocol elements, which have been assigned by IANA:

- New LDP Capability TLV: "Multi-Topology Capability" TLV (0x050C) from the LDP Parameters registry "TLV Type Name Space".

- New Status Code: "Invalid Topology ID" (0x00000031) from the LDP Parameters registry "Status Code Name Space").

Registry:

Range/Value	Description
0x00000031	Invalid Topology ID

Figure 9: New Code Point for LDP Multi-Topology Extensions

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

Number	Description
29	MT IP: Multi-Topology IP version 4
30	MT IPv6: Multi-Topology IP version 6

Figure 10: Address Family Numbers

- New registry "MPLS Multi-Topology Identifiers".

  This is a registry of the "Multiprotocol Label Switching Architecture (MPLS)" category.

  The initial registrations and allocation policies for this registry are:

Range/Value	Purpose	Reference
0	Default/standard topology	RFC 7307
1	IPv4 in-band management	RFC 7307
2	IPv6 routing topology	RFC 7307
3	IPv4 multicast topology	RFC 7307
4	IPv6 multicast topology	RFC 7307
5	IPv6 in-band management	RFC 7307
6-3995	Unassigned for future IGP topologies	RFC 7307
	Assigned by Standards Action	RFC 7307
3996-4095	Experimental	RFC 7307
4096-65534	Unassigned for MPLS topologies	RFC 7307
	Assigned by Standards Action	
65535	Wildcard Topology	RFC 7307

Figure 11: MPLS Multi-Topology Identifier Registry

- New Sub-TLV Types for LSP ping: The following new sub-type values under TLV type 1 (Target FEC Stack) have been registered from the "Sub-TLVs for TLV Types 1, 16, and 21" sub-registry within the "Multi-Protocol Label Switching (MPLS) Label Switched Paths (LSPs) Ping Parameters" registry.

Sub-Type	Value Field
31	MT LDP IPv4 prefix
32	MT LDP IPv6 prefix

Figure 12: New Sub-TLV Types for LSP Ping

As highlighted at the end of Section 3.4 ("IGP MT-ID Mapping and Translation"), a new document will be created to detail the policy and process for allocating new MT-ID values.

10. Manageability Considerations

10.1. Control of Function and Policy

There are capabilities that should be configurable to enable good manageability. One such example is to allow that the LDP Multi-Topology capability be enabled or disabled. It is assumed that the mapping of the LDP MT-ID and IGP MT-ID is manually configured on every router by default. If an automatic mapping between IGP MT-IDs and LDP MT-IDs is needed, there must be explicit configuration to do so.

10.2. Information and Data Models

Any extensions that may be required for existing MIBs are beyond the scope of this document.

10.3. Liveness Detection and Monitoring

Mechanisms defined in this document do not imply any new liveness detection and monitoring requirements.

10.4. Verify Correct Operations

In order to debug an LDP-MT-enabled network, it may be necessary to associate between the LDP label advertisement and the IGP routing advertisement. In this case, the user MUST understand the mapping mechanism to convert the IGP MT-ID to the LDP MT-ID. The method and type of mapping mechanism is out of the scope of this document.

10.5. Requirements on Other Protocols

If the LDP MT-ID has an implicit dependency on IGP MT-ID, then the corresponding IGP MT features will need to be supported.

10.6. Impact on Network Operations

Mechanisms defined in this document do not have any impact on network operations.

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