

MPLS Working Group  
Internet Draft

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LDP Extensions for Optical User Network Interface (O-UNI) Signaling

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## 1. Abstract

General requirements for signaling across the Optical UNI (O-UNI) are discussed in [1]. This draft describes extensions to the LDP protocol [2] to support those requirements. The LDP extensions described here address two areas:

- The addition of new TLVs to support the attributes required for

# lightpath establishment at the O-UNI

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- Two new LDP messages to allow for the exchange of lightpath status information across the UNI.

## 2. Conventions used in this document

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](#) [3].

## 3. Use of LDP for the O-UNI

This draft describes how LDP with extensions will be used as a signaling mechanism for the O-UNI. Several O-UNI abstract messages are defined in [1]. This draft specifies how to use the existing LDP messages for that purpose. Two new LDP messages are introduced to meet the requirements for the exchange of status information across the O-UNI.

### 3.1. Overview

LDP is one of the candidate protocols described in [1] for O-UNI signaling implementation.

Applying LDP at the O-UNI allows for:

- The reuse of already defined LDP messages and message formats
- The reuse of LDP session management and control procedures
- Additions to the already specified procedures for notification of errors.
- The reuse of the LDP security mechanism

Support for the O-UNI signaling requirements depends upon the use of the following LDP behaviors and mechanisms as defined in [2].

- Use of Basic and/or Extended discovery mechanisms.
- Use of the Label Request Message in downstream on demand label advertisement mode with ordered control.
- Use of the Label Mapping Message in downstream on demand label advertisement mode with ordered control.
- Use of the Notification Message.
- Use of the Withdraw and Release Messages.

Additional messages are defined to support the propagation of lightpath status information as defined in [1].

Additional TLVs are specified to support the lightpath attributes specified in [1].

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#### [4. O-UNI Session Management and Control](#)

LDP messages that relevant to the O-UNI session management and control are Hello Message, Initialization Message, and KeepAlive Message.

##### [4.1. Hello Message](#)

This draft does not change the format or the procedures of the LDP Hello Message as described in [section 3.5.2](#). of [2].

##### [4.2. KeepAlive Message](#)

This draft does not change the format or the procedures of the LDP KeepAlive Message as defined in [section 3.5.4](#) of [2].

##### [4.3. Initialization Message](#)

The Initilaization Message is as defined in [section 3.5.3](#) of [2] with the following modifications:

- The Label Advertisement Discipline (the  $\hat{A}$  bit) is always set at 1 to indicate Downstream on Demand label distribution mode. Downstream on Demand is the only label distribution mode supported at the O-UNI. The assignment  $A=0$  should result in generating a Notification Message with

the appropriate error code.

- Loop Detection is always disabled, D=0. The assignment D=1 should result in generating a Notification Message with the appropriate error code.

## 5. The Use of LDP Messages for O-UNI

A set of abstract O-UNI messages is defined in [1]. Those abstract messages support the basic functions of the optical UNI. Those functions are,

- Lightpath Create: Creates a lightpath with certain attributes between two ends in the optical networks

- Lightpath Delete: Deletes an already existing lightpath

- Lightpath Modify: Modifies one or more of the attributes of already existing lightpath

- Lightpath Status Enquiry: Enquires about the status of an already existing lightpath

Each of the above functions is accomplished by a set of O-UNI messages using LDP protocol. The procedures for handling LDP messages across the optical UNI are augmented to add the additional O-UNI functionality. Common across the O-UNI are:

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- The LDP FEC TLV should be ignored at the O-UNI since it has no significance, and

- The use of LDP messages for O-UNI does not change the semantics of the LDP Message ID.

### 5.1. Lightpath Create Action

Lightpath Create Action requires two messages, the lightpath Create Request and the Lightpath Create Response. The mapping of the LDP messages to fulfill the lightpath create action is:

- Lightpath Create Request: The create request function is achieved by the LDP Label Request Message. The Generalized Label Request TLV defined in [4] is used to convey some lightpath attributes to the network side.
- Lightpath Create Response: The create response function is achieved by the use of the LDP Label Mapping Message. The create response function makes use of the Generalized label defined in [4]. The Label Mapping procedures are limited to downstream on demand, ordered control mode with conservative label retention mode.

## 5.2. Lightpath Delete Action

Lightpath Delete Action requires two messages, the Lightpath Delete Request and the Lightpath Delete Response. The mapping of the LDP messages to fulfill the function of the lightpath delete action is:

- Lightpath Delete Request: The delete request is achieved by the LDP Label Release Request Message. The Label Release Message is sent from the client or the network at any time after the establishment of the lightpath to delete it.
- Lightpath Delete Response: The delete Response is achieved by the LDP Label Withdraw Message. The Label Withdraw Message is sent from the client or the network in response to a Label Release Request.

## 5.3. Lightpath Modify Action

After a lightpath is setup, some of its attributes, e.g. bandwidth, may need to be changed by the network operator due to new requirements for the traffic carried on that lightpath. Lightpath Modify Action does not require the definition of new LDP messages. The modify action follows the procedure described in [5].

Lightpath modification can only be allowed when the lightpath is already established. The procedure described in [5] allows for modification of lightpath attributes without service interruption. Only modifications requested by the owner of a particular lightpath are allowed.





Node Address:

The Node Address is the IPv4 address associated with the optical network element

Port Id:

Port Id is a two-octet unsigned integer indicating the port number in an optical network element

Channel Id:

Channel Id is a single octet unsigned integer indicating a channel with respect to the specified Port Id.

Sub-Channel Id:

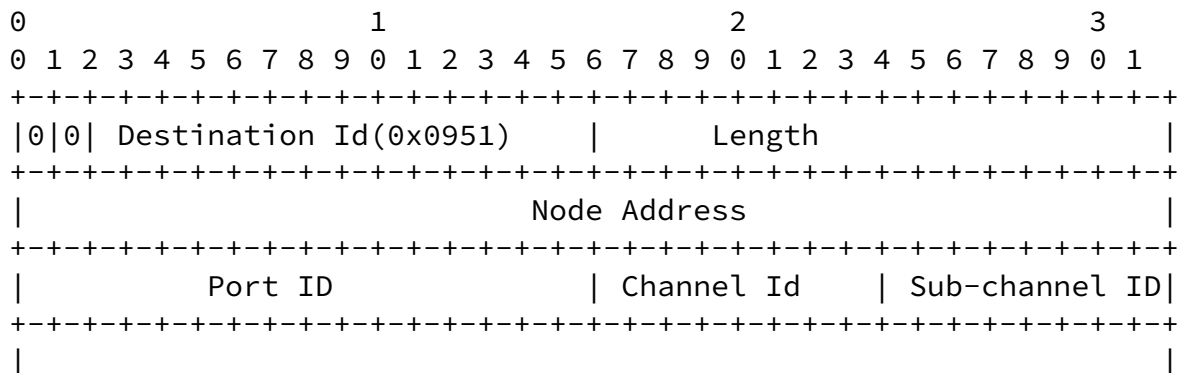
Sub-Channel Id is a single octet unsigned integer indicating a sub-channel with respect to the specified Channel Id.

Source User Group:

The Source User Group identifies the logical network or group to which the optical client belongs. The Source User group is the 7-octet structure as defined in [6].

6.1.2. Destination Id TLV:

The Destination Id TLV has the same structure as the Source Id TLV. The format of the Destination Id TLV is:





```

+          Source User Group          +-----+-----+
|                                     | Reserved |
+-----+-----+-----+-----+

```

### 6.2.3. Lightpath Id TLV

The format of the Lightpath Id is as follows:

```

+-----+-----+-----+-----+-----+-----+-----+-----+-----+
|U|F| lightpath Id (0x0952) | Length |
+-----+-----+-----+-----+-----+-----+-----+-----+-----+
|          Reserved          | ActFlg|
+-----+-----+-----+-----+-----+-----+-----+-----+-----+
|          optical network element IPv4 address          |
+-----+-----+-----+-----+-----+-----+-----+-----+-----+
|                                     Index                                     |
+-----+-----+-----+-----+-----+-----+-----+-----+-----+

```

#### ActFlag

A 4-bit field that explicitly indicates the action that should be taken on an already existing lightpath. A set of indicator code points is proposed as follows

- 0x0 = initial lightpath setup
- 0x1 = modify lightpath

#### Optical Network Element Ipv4 Address

The Ipv4 address of the optical network element

#### Index

A 4-octet field uniquely identifies a lightpath.

### 6.1.3. Generalized Label Request TLV

The Generalized Label TLV format and procedure are as defined in [section 3.1](#) of [4]. It supports communication of characteristics (attributes) required for the lightpath(LSP) being requested. These

characteristics include the desired link protection, the lightpath (LSP) encoding, and the lightpath (LSP) payload.

#### 6.1.4. Suggested Label TLV

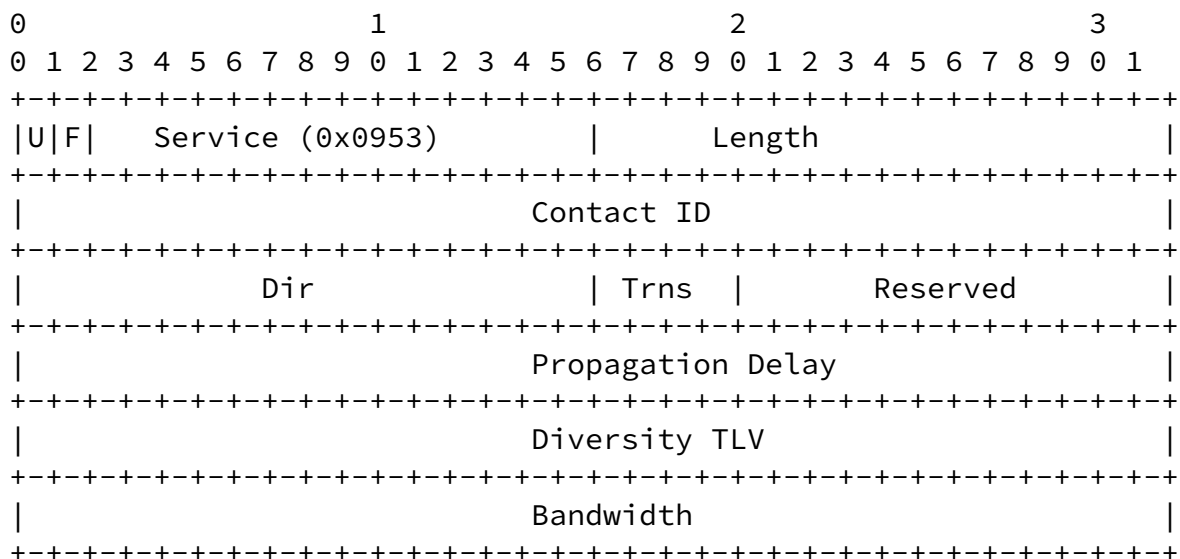
The Suggested Label TLV format and procedure are as defined in [section 3.4.](#) of [4].

#### 6.1.5. Label Set TLV

The format and the procedure of the Label Set TLV is as described in [section 3.5.](#) of [4].

#### 6.1.6. Service TLV

The Service TLV defines the service attributes requested by the network client. The encoding for the Service TLV is as follows:



Contact Id:  
 Contact Id is a 4-octet unsigned integer that uniquely identifies the lightpath owner. It is administratively used for call acceptance, billing, policy decisions, etc.

Dir, Directionality



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Lightpath TLV n:

is the Lightpath Id of the LSP from which the requested lightpath must be diverse.

DivT, Diversity Type

DivT specifies the manner by which the requested lightpath should be diverse. The allowed values are:

0x0 = Link diverse

0x1 = Node diverse

0x2 = Shared Risk Link Group (SRLG) diverse

Bandwidth

It defines the lightpath bandwidth. Bandwidth is a 4-Octet number in IEEE floating point format (the unit is bytes per second). Some bandwidth values are enumerated in [section 3.1.4.](#) of [4]

#### [6.1.7.](#) Procedure

The O-UNI Label Request Message flows between an optical network client and the edge optical network element. Upon initiating the Label Request Message, the optical client sets the addresses in the optical network for the two ends of the lightpath (Source Id and Destination Id TLVs). For initial setup (ActFlg=0), the lightpath Id is set to all 0s when sent from the client to the network. The lightpath Id is assigned by the optical networks. It is globally unique within the optical network. The Lightpath Id is obtained by combining the IPv4 address associated with the optical network element and an integer index that is locally unique. The Lightpath Id is passed to the called client in the Label Request Message from the network to the optical client.

Upon the reception of the O-UNI Label Request Message, the edge optical network element might consult with a policy server to verify that the signaled attributes (including the verification of the Source and the Destination Ids) can be supported. Failure to support one or more of



```

|                               Lightpath ID TLV   (O-UNI mandatory)                               |
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
|                               Source Id TLV (O-UNI mandatory)                               |
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
|                               Destination Id TLV (O-UNI mandatory)                       |
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
|                               Service TLV (O-UNI optional)                               |
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
|                               Optional Parameters                                       |
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+

```

[6.2.1.](#) Generalized Label TLV

The Generalized Label TLV format and procedures are as in [section 3.2.](#) of [4].

[6.2.2.](#) O-UNI Label Request Message ID TLV

The O-UNI Label Request Message ID TLV has the same format and procedures as described in [7]

[6.2.3.](#) Procedure

The O-UNI Label Mapping Message flows between an optical network client and the edge optical network element.

The reception of the O-UNI Label Mapping Message signifies the successful establishment of a lightpath with the desired attributes. It also signifies the successful modification of one or more of the lightpath attributes.

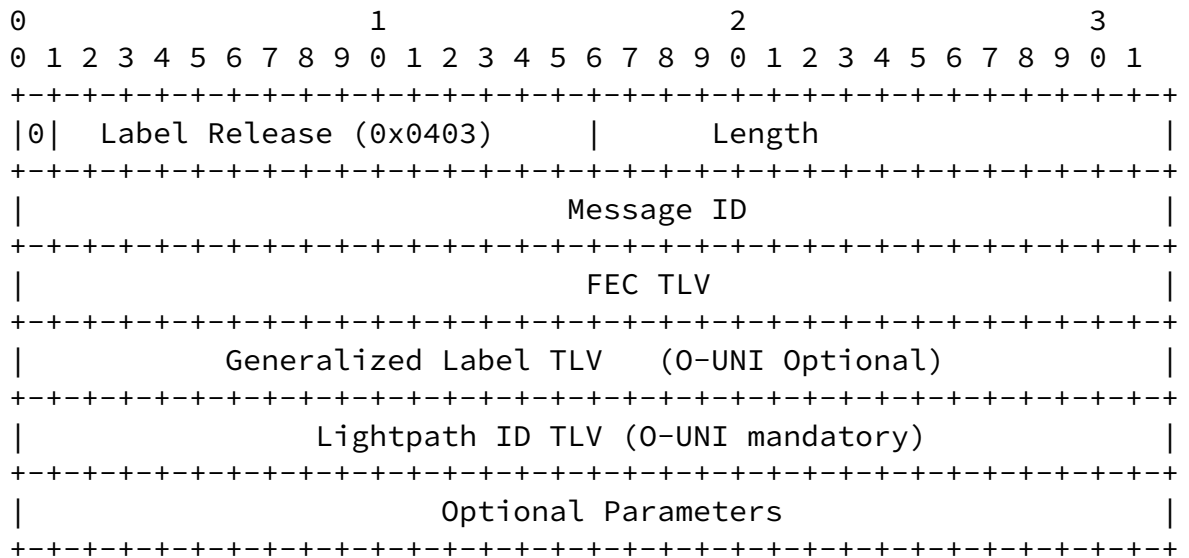
The network transports the assigned Lightpath Id to the calling client in the Label Mapping Message. This Lightpath Id value is used by the client and the network for the exchange of lightpath status information.

The O-UNI Label Mapping Message also includes a Generalized Label TLV. Its purpose is to indicate to the client label value, e.g. which wavelength, to be used.

The 0-UNI Label Mapping Message optionally includes a Service TLV that summarizes the level of service extended from the optical network to its client. The Service TLV must be included for the cases where reserved lightpath attributes, e.g. its bandwidth, are different from those requested by the customer.

### 6.3. The Label Release Message

The format of the 0-UNI Label Release Message is as follows:

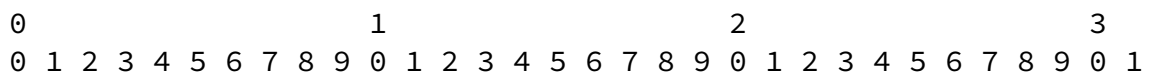


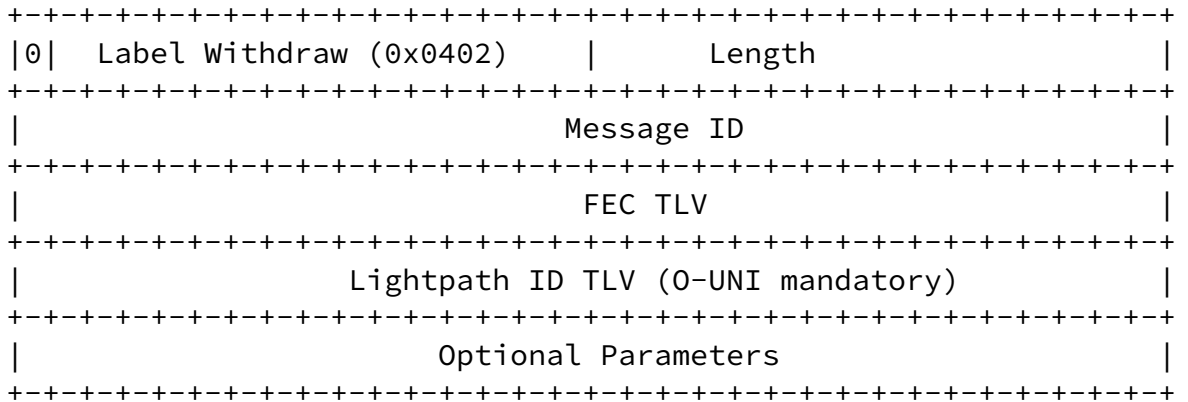
#### 6.3.1. Procedure

The procedure for the 0-UNI Label Release Message is as described in [section 3.5.11](#) of [2]. The 0-UNI Label Release Message is sent by either the client or the network to indicate the desire to delete an already established lightpath. The 0-UNI Label Release Message carries a mandatory lightpath Id to indicate which lightpath should be terminated.

### 6.4. The Label Withdraw Message

The format for the 0-UNI Label Withdraw Message is as follows:





#### 6.4.1. Procedure

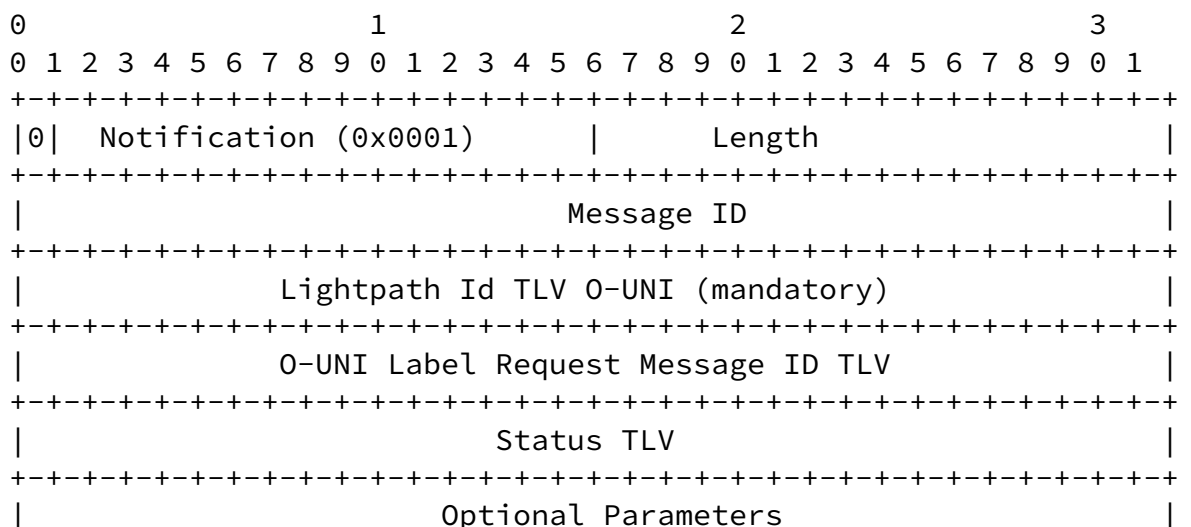
The procedure for the Label Withdraw Message follows that defined in [section 3.5.10](#) of [2]. The Label Withdraw Message is sent by the network or the client in response to a Label Release Request.

The Label withdraw Message for 0-UNI carries a mandatory lightpath Id. The reception of the Label Withdraw Message acts as an indication to the client or the network that the lightpath defined by its Lightpath Id has been terminated.

#### 6.5. The Notification Message

The Notification Message is as defined in [section 3.5.1](#). of [2] with the following modifications:

- The 0-UNI Notification Message is sent autonomously from the network side of the 0-UNI to the client to indicate the status of the lightpath request.
- The 0-UNI Notification Message includes a mandatory Lightpath Id TLV





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The Status TLV is as defined in [section 3.4.6.](#) of [2].

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### [6.5.1.](#) Procedure

The O-UNI Notification Message is used by the optical network to signal to its clients failure condition during or after the connection establishment phase. New Status codes relevant to lightpath operation are:

- 0x00001000 = not able to connect to destination user group
- 0x00001001 = invalid destination address
- 0x00001002 = invalid port Id
- 0x00001003 = invalid channel Id
- 0x00001004 = invalid sub-channel Id
- 0x00001005 = bandwidth unavailable
- 0x00001006 = protection mode unavailable
- 0x00001007 = routing directive unavailable
- 0x00001008 = failure to create lightpath
- 0x00001009 = failure to modify lightpath
- 0x0000100A = Failure to delete lightpath
- 0x0000100B = Encoding unavailable

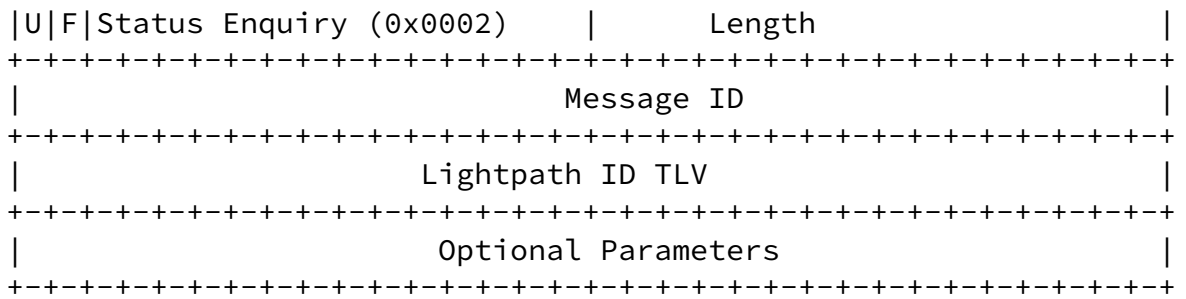
If it has been already set, the Notification Messages includes the Lightpath Id TLV. If not set, e.g. for initial set up, the Lightpath Id TLV is set to 0. If the Lightpath Id is not set, the Notification Message MUST includes a O-UNI Label Request Message ID TLV as defined in [section 6.2.2.](#)

### [6.6.](#) The Status Enquiry Message

The Status Enquiry Message is a new LDP message. The encoding for the Status Enquiry Message 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			

+++++

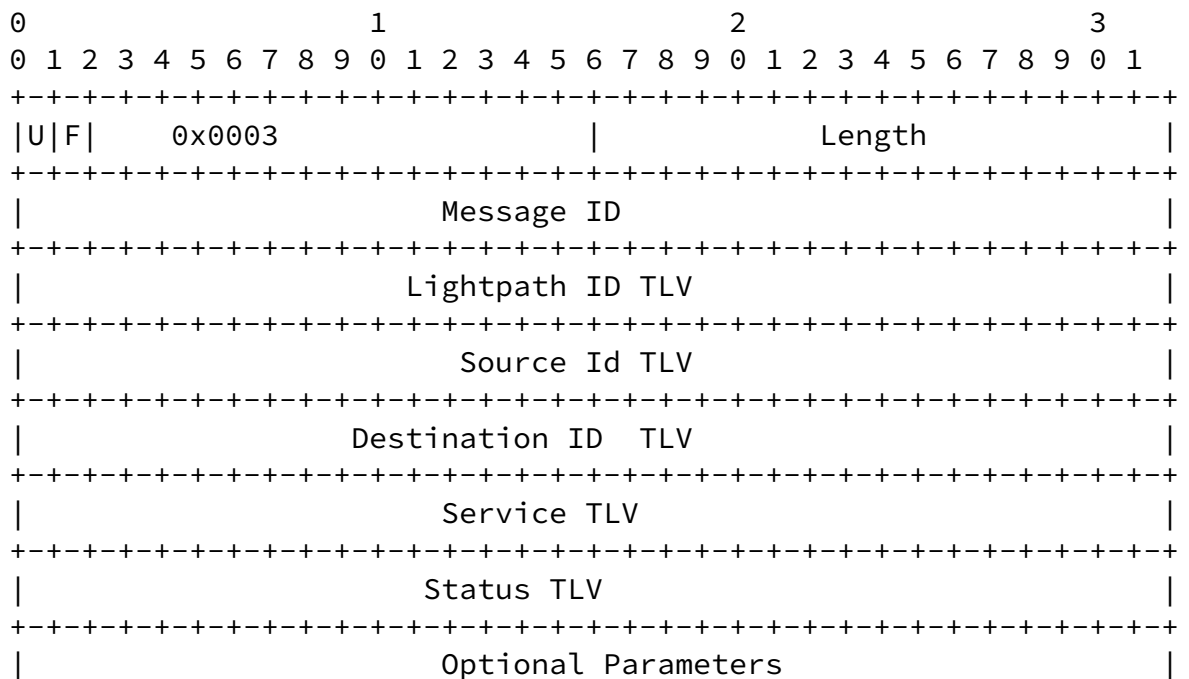


### 6.6.1 Procedure

The Status Enquiry Message is sent by the client or the network at any time to solicit a Status Response Message from its peer. The lightpath under consideration is identified by the Lightpath Id TLV.

### 6.7. The Status Response Message

The Status Response Message is a new LDP message. The encoding for the Status Response Message is:





The Status codes for the lightpath states are:

0x0000100C = Null  
0x0000100D = Call Initiated  
0x0000100E = Call Present  
0x0000100F = Active  
0x00001010 = Release Request  
0x00001011 = Release Indication

## 7. Security Considerations

This security mechanisms defined in [2] shall be used.

## 8. Author's Addresses

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## 9. References

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