

MPLS Working Group
Internet Draft
Document: [draft-ietf-mpls-ldp-optical-uni-01.txt](#)

O. Aboul-Magd
Sandra Ballare
Ewart Tempest
Nortel Networks

Raj Jain
Nayna Networks

LiangYu Jia
ONI Systems

Bala Rajagopalan
Tellium Inc.

Robert Rennison
Laurel Networks

Yangguang Xu
Lucent Technology

Zhensheng Zhang
Sorrento Networks

July 2001

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

Status of this Memo

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1. Abstract

In OTNs using overlay model, clients request network services through a user network interface (UNI). This draft describes LDP necessary extensions for signaling support across the optical UNI

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(O-UNI). LDP extensions are those needed to satisfy the main functions supported at the O-UNI. Those functions are: connection create, connection delete, connection modify, and connection status enquiry.

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](#) [2].

3. Introduction

Several models have been discussed for the support of IP traffic over the transport layer (L1/L0) [3]. Three models are identified and are differentiated based on the amount of routing/topological information exchanged between the optical transport network (OTN) and its clients. Those models are overlay, peer, and augmented models.

In an overlay network architecture such as the ITU-T automatic switched OTN (ASTN) [4], there is a clear boundary between the client and the network layers. Routing and topological information does not cross this boundary in the sense that each layer is running its own instant of a routing protocol, e.g. OSPF or entirely different routing protocols. Network clients request network services, e.g. connections, across a well-defined interface. This interface is generally called the optical user network interface (O-UNI).

MPLS based protocols have already been proposed for the realization of the optical layer control plane in what is termed as generalized MPLS (GMPLS) [5]. Both CR-LDP [6] and RSVP-TE [7] have been extended for possible use as the control plane signaling protocols. It therefore makes sense to use the same set of protocols for the implementation of the O-UNI. This draft introduces the necessary LDP [8] extensions to support the basic O-UNI functionality.

At the O-UNI, four O-UNI actions are provided. Those actions are:

- Connection Create: Creates an end-to-end connection across the OTN with specified connection attributes such as bandwidth, diversity, etc. Numerous connection attributes have been articulated in [9]
- Connection Delete: Deletes an already existing connection.
- Connection Modify: Modifies one or more of the connection attributes of the existing connections. Connection Modify is not supported in this version of the draft.
- Status Enquiry: Allows the client to enquire the status of a connection or a group of connections. A connection can be in one

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of a number of states such as, active, redialing, etc [9]. This operation also allows querying connection information in order to recover connection state.

Tightly related to the O-UNI, and any UNI in general, is the need to uniquely identify clients and their points of attachment to the network. An addressing scheme for the OTN has been discussed in [9]. Client identification is based on a transport network address (TNA) that is globally unique and is assigned to the client by the network provider. The scope of the TNA could be on a one-to-one basis with logical links that the network provider provision between an OTN network element (NE) and an OTN client, or it could be a single TNA per OTN (optical transport network) client. In the latter case there is the need to introduce a logical port identifier (LPI) to differentiate between multiple logical links between an OTN client and an OTN NE that share the same TNA address. Similar to the TNA, LPI is assigned to the client by the network provider. Protocol extensions are required to support signaling of the TNA and LPI.

O-UNI reference models have been discussed in [9]. The client side of the O-UNI has been denoted as UNI-C, while the term UNI-N has been used to identify the network side of the O-UNI. One or more signaling channels exist between the UNI-C and UNI-N. The UNI control channel MUST support the transport of IP protocols. This capability is necessary since IP based protocols, e.g. LDP, are proposed for O-UNI signaling.

[4.0](#) LDP for the O-UNI

In extending LDP for implementation at the O-UNI, there have been two main guiding principles. Firstly every effort was made to limit the introduction of new LDP messages. New messages are only introduced whenever the desired functionality could not be supported by existing messages, and have been limited to only those required

to support the status enquiry function of the O-UNI.

Secondly care has been taken not to violate any of the LDP semantics as defined in [8]. Therefore LDP O-UNI extensions could easily be implemented as a simple add-on to the already existing LDP implementations.

The mode of operation of the LDP at the O-UNI is downstream on demand label advertisement with ordered control.

4.1 LDP Session Initialization

For the O-UNI the LDP session is established between UNI-C and UNI-N. Furthermore the client (UNI-C) MUST play the active role during the LDP session initialization phase. Moreover, if all logical links are in the same O-VPN,:

- There will be a single LDP session between an OTN client and an OTN NE, regardless of the number of logical links between them.

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- In the case of proxy signaling, there will be a single LDP session between a proxy agent and an OTN NE regardless of the number of OTN clients and logical links the proxy agent signals on behalf of.

The LDP Hello and Extended Hello SHALL be used for neighbor discovery as specified in [8].

An LDP session starts by UNI-C sending an LDP Initialization message to its neighbor UNI-N over the TCP session. In addition to the parameters described in [8], the Initialization message from the UNI-C to the UNI-N contains all the O-UNI version numbers that are supported by the UNI-C.

The UNI-N follows the procedure specified in [section 2.5.3](#) of [8] for the passive LSR. It replies with an Initialization message to propose the parameters it wishes to use. Those parameters MUST include the highest version number from the list advertised by the UNI-C that the UNI-N supports. If the UNI-C and UNI-N have no UNI version in common, the LDP session establishment will fail.

The Initialization message also includes a Contract ID TLV. Contract ID is determined by the network provider and identifies the contract agreement between the OTN client and the OTN operator. Its format is determined by the OTN operator.

Maintaining the LDP session at the O-UNI MUST follow the procedure explained in [section 2.5.6](#) of [8].

[4.2](#) Connection Create using LDP

In LDP, the connection create request is implemented using the Label Request message as defined in [8]. The Label Request message is from the source UNI-C to the source UNI-N. At the other end of the network the Label Request message is sent from the destination UNI-N to destination UNI-C.

The requested connection might need to support a number of attributes. Extensions are needed to the Label Request message to support the client signaling of those attributes.

OTN connections are usually bi-directional. As in GMPLS, a bi-directional connection is signaled at the O-UNI by the inclusion of the Upstream Label in the Label Request message. Reception of the Label Request message by the destination UNI-C signifies the reservation success, i.e. all the requested connection attributes can be satisfied, of the bi-directional connection. However it doesn't imply that the connection is available for data transport. Connection is only available when configuration of intermediate cross connects is complete. The Configuration of any intermediate cross connect likely to require some time to complete and, depending on the technology used, this delay may be significant, e.g. in the order of 10's or 100's of ms.

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The destination UNI-C sends a Label Mapping message in response to the Label Request message, only once it has setup its own switch fabric. If it so desires, the destination UNI-C MAY indicate to the source UNI-C that a reservation confirmation indication is needed. The reservation confirmation indication is implemented using the LDP Notification message with the status code `reservation_confirm`. In general, Uni-directional connections do not require a reservation confirmation indication, and depending on the nature of the application on the destination OTN client that terminates the OTN connection, maybe not even in the case of bi-directional connections.

Contention for labels may occur between two bidirectional connection setup requests traveling in opposite directions. This contention occurs when both sides allocate the same resources (labels) at effectively the same time. To resolve contention, the node with the higher node ID will win the contention and it MUST issue a NOTIFICATION message with a "Routing problem/Label allocation

failure" indication. Upon receipt of such an error, the node SHOULD try to allocate a different Upstream label (and a different Suggested Label if used) to the bidirectional path. However, if no other resources are available, the node must proceed with standard error handling.

Similarly the source UNI-N sends a Label Mapping message to the source UNI-C. At this instant the transport connection is available to the source UNI-C for use provided that its own switch fabric have been setup. Figure 1 shows a timing diagram for a successful establishment of a bi-directional connection.

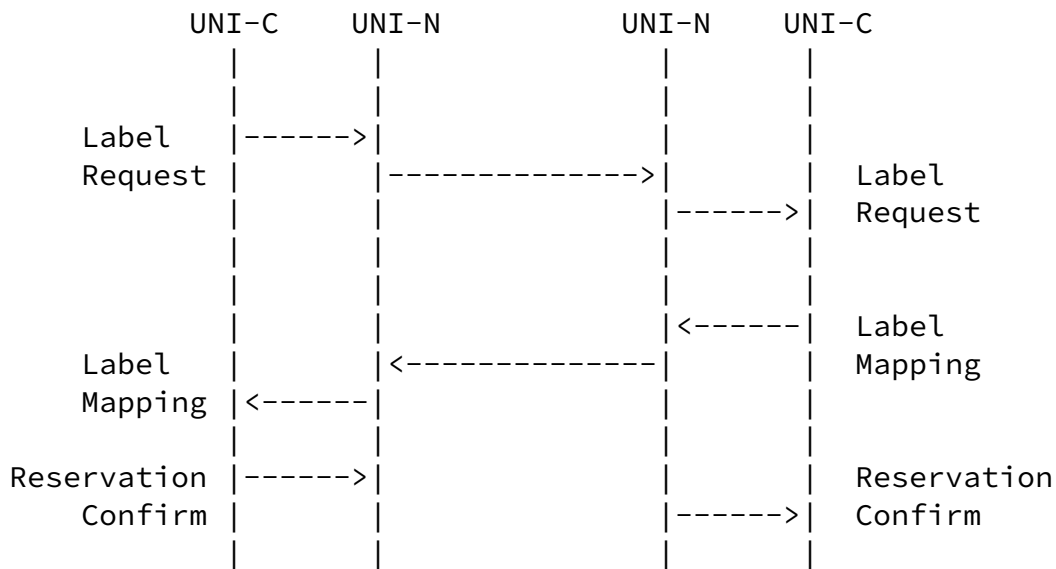
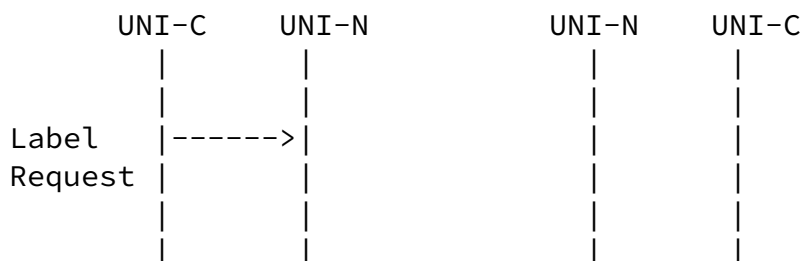


Figure 1: Successful Setup of Bi-Directional Connection

The connection create request might fail for a number of reasons, e.g. no bandwidth available, no physical connectivity, SLA violation, connection rejected by far end OTN client. In this case failure of the create request is indicated to the source UNI-C using the LDP Notification message with the status code reflecting the

reason for the failure. Figure 2 shows a create request rejection by the network.



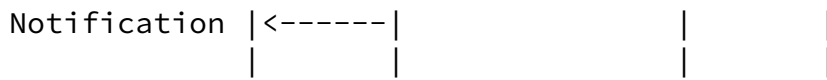


Figure 2: Connection Setup Rejection by the Network

Should a client desire to abort the connection create process after sending the Label Request message, an LDP Abort message MUST be sent as defined in [section 3.5.9](#). of [8]. Specifically the Message ID used in the Label Request Message is used in the Abort Message as the temporary local connection identifier.

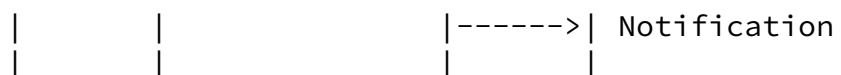
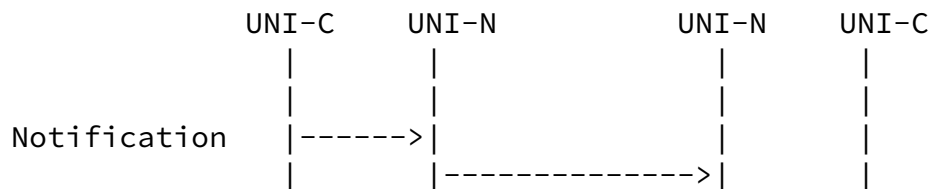
4.3 Connection Deletion Using LDP

LDP employs two mechanisms for an LSR (label switched router) to inform its peer to stop using a particular label. The first method is based on the use of Label Withdraw message and it is used to signal to a peer that the peer may not continue to use a specific label mapping that the LSR has previously advertised. The second method is based on the use of Label Release message and it is sent to signal to a peer that the LSR no longer needs a specific label mapping previously requested and/or advertised by the peer.

The 0-UNI LDP extensions make use of the Label Release and Label Withdraw messages for connection deletion. The choice of which message to use depends on the entity that initiates the deletion. The Label Withdraw message is used for the case where the connection deletion is in the upstream direction. As per the LDP procedure in [section 3.5.10](#) of [8], Label Release message is used in this case to acknowledge the delete request.

The Label Release message is used for the cases where connection deletion is in the downstream direction. In this case the delete request is confirmed by the use of LDP Notification message with the status code "delete_success".

Figures 3 and 4 show graceful connection deletion requested by the source UNI-C and the destination UNI-C respectively.



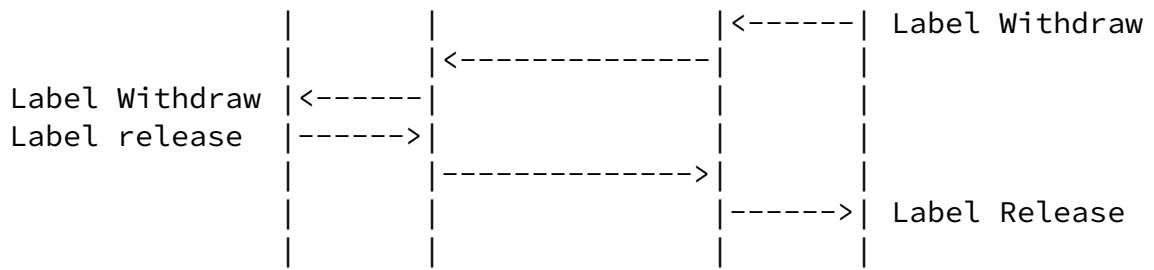


Figure 3: Graceful Connection Deletion by the Source UNI-C

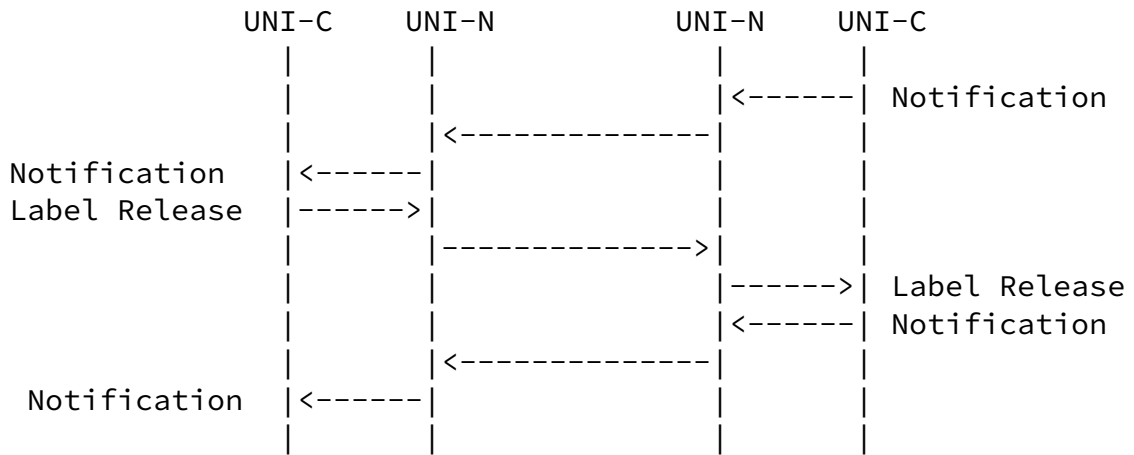
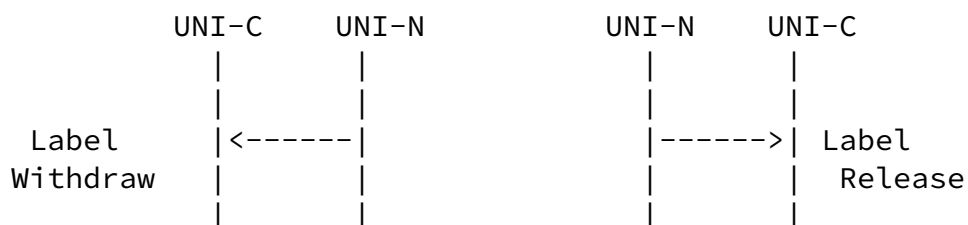


Figure 4: Graceful Connection Deletion by the Destination UNI-C

Figure 3 shows that the delete request is preceded by an LDP Notification message with status code `delete_indication`. In all optical networks, loss of light will propagate faster than the delete request. Thus downstream NE will detect loss of light and potentially alarm on it. This alarm could be used to incorrectly trigger restoration and/or protection. To address this issue, a Notification message SHOULD be sent along the connection's route to inform all nodes of the intended deletion. Upon the receipt of this message, each node SHOULD disable its alarm reporting and protection mechanisms on the indicated connection.

Figure 5 shows a connection deletion scenario initiated by the network, or a force deletion requested from an OAM entity. In this case both Label Withdraw and Label Release messages are used to initiate the deletion request.



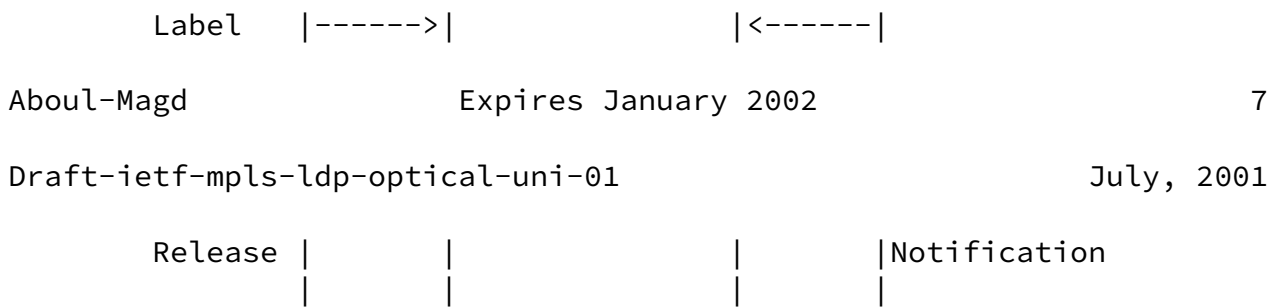


Figure 5: Connection Deletion Initiated by the Network

4.4 Failure Detection and Recovery Using LDP

In optical transport networks, failures in the out-of-fiber signaling communication or optical UNI control plane should not have service impact on the existing optical connections. Under such circumstances, a mechanism MUST exist to detect a signaling communication failure and a recovery procedure SHALL guarantee connection integrity at both UNI-C and UNI-N.

The LDP Keep Alive mechanism MUST be used to detect signaling communication failures between a UNI-C and a UNI-N, unless an alternative mechanism is in place to detect such failures more efficiently. During the signaling communication failure all active connections are maintained (the bearer connection is active) and all transient connections (in-progress) are cleared.

Upon signaling communication re-establishment (i.e. re-establishment of LDP Keep Alive) a resynchronization period is required in order to synchronize connection state information across the UNI. This synchronization period shall be performed prior to processing new connection requests.

The resynchronization period starts by the UNI-C either querying the network (UNI-N) for the (summary or detailed) states of all connections associated with a particular logical link, or otherwise (implicitly or explicitly) deleting them. In the former case, the UNI-N will respond with appropriate status information. The OTN is the master of all OTN connection information. An OTN connection, once created, remains within the OTN until implicitly or explicitly deleted by either of the terminating OTN clients through UNI signaling, or via OTN operator intervention. Specifically the burden is on the OTN client to resynchronize with the OTN. Under no circumstances will the OTN resynchronize with its OTN connection view with that of an OTN client.

There are three cases to consider during recovery:

- a) Both UNI-C and UNI-N have retained connection information during the signaling communication failure. In this case, the recovery consists of synchronizing connection state information. This

synchronization process requires UNI-C to send Status Enquiry messages requesting summary connection information.

- b) The client device lost all connection information in its UNI-C control plane during the signaling communication failure. In this case, the recovery procedure requires the UNI-C to query each connection to its peer UNI-N in order to rebuild the connection state information. This can be performed using the Status Enquiry

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message(s) requesting detailed connection information based on LDP session, logical link or TNA address.

- c) The client device lost all connection information in its UNI-C control plane and requires all OTN connections to be deleted on:

- A per LDP session basis.
- A specific logical link
- All logical links that share a specified TNA address

In this case, the synchronization is a simple restart process that can be achieved by sending a Label Release message with the corresponding TNA and optional logical port parameters. Figure 6 shows the scenario for graceful and forced deletion of all connection in this case (for the purpose of simplicity, the diagram assumes that the OTN connections to be deleted all terminate on the same destination OTN client. In reality, this will almost certainly not be the case). Graceful deletion is indicated by source UNI-N sending a Notification message indicating the intended delete. This Notification message is OPTIONALLY sent in response to the source UNI-C Label Release message. For multiple destinations a separate Notification message SHLL be sent per destination.

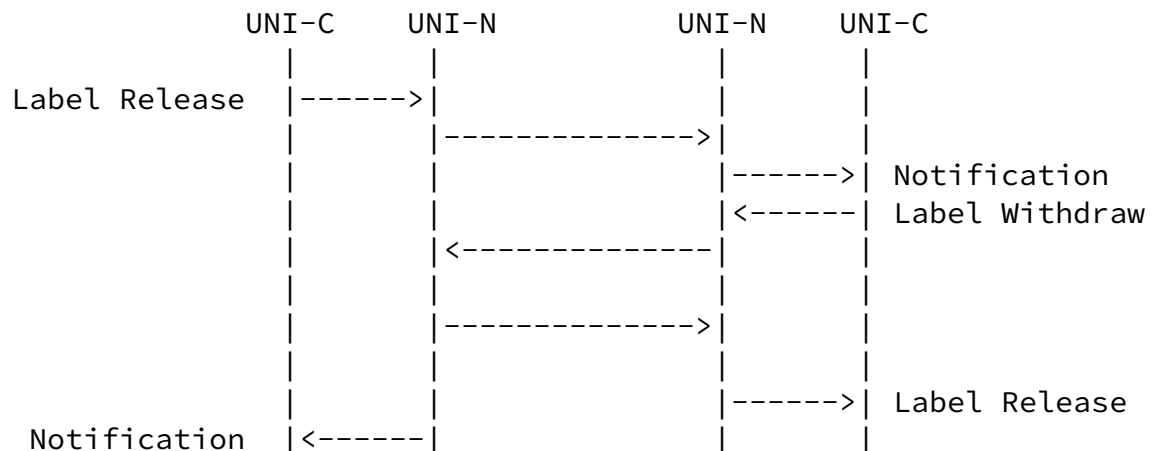




Figure 6: Deletion of All Connections

Resynchronization is deemed to be complete between a given OTN client and OTN NE when each connection for which OTN NE knows about is either queried or deleted by the OTN client. Until such time, no new connections can be established for which the OTN client would be a terminating point.

[5.0](#) LDP Extensions for O-UNI

This section describes LDP extensions specific for the support of signaling across the optical UNI.

[5.1](#) TLV Encoding for Commonly Used Parameters

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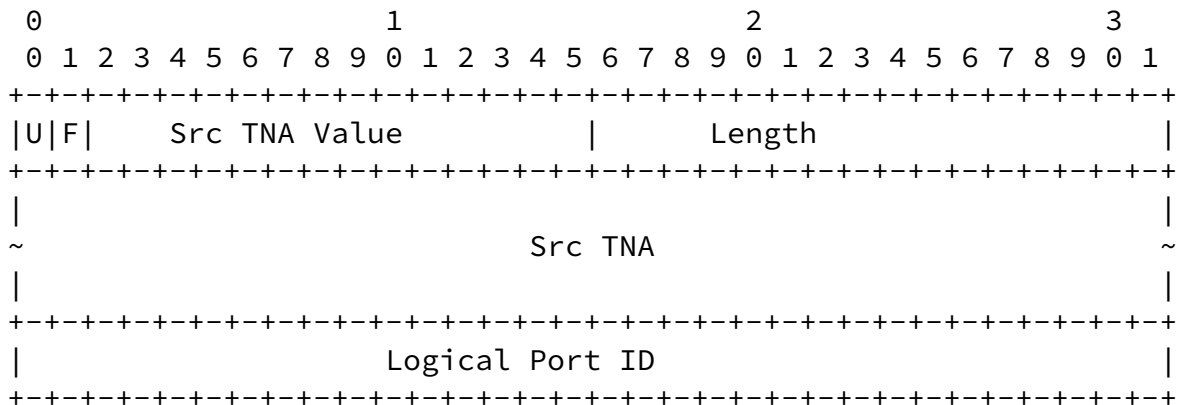
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The TLV encoding described in [section 3.4](#) of [8] and in [10] MUST be applicable at the O-UNI. This section describes the O-UNI specific TLV encoding.

[5.1.1](#) Src ID TLV

A client used the Src ID TLV to indicate its identification parameters. The Src ID TLV MUST contain the source TNA, and OPTIONALLY contain a Logical Link ID. The encoding for the Src ID is:



Src TNA:

Src TNA can be in one of three formats [9]. It can be in either IPv4, IPv6, or NSAP format. Only TNA addresses of the same type can be compared for equivalence. The Src TNA values are:

Value	Type
-------	------

-----	-----
0x960	IPv4
0x961	IPv6
0x962	NSAP

The NSAP format is structured according to ISO/IEC 8348, 1993 (identical to ITU X.213, 1992)

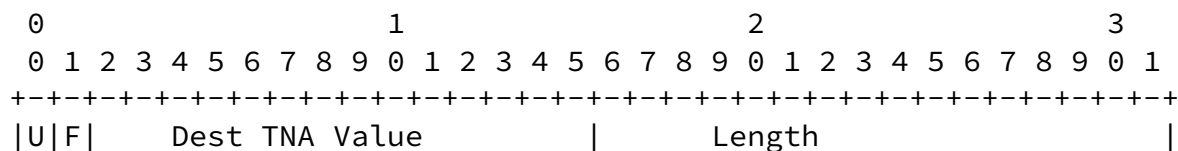
Only TNA addresses of the same type SHOULD be compared for equality.

Logical Port ID:

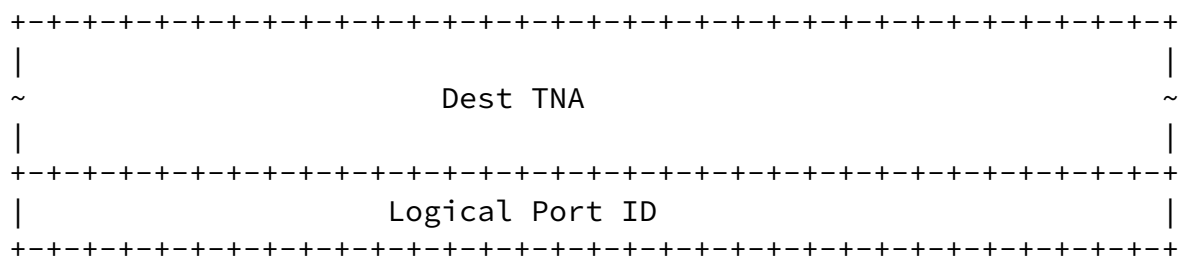
A 32-bit unsigned number indicating identifying a logical port at the source OTN NE. Logical Port ID is OPTIONAL and, as such, may not be present.

[5.1.2](#) Dest ID TLV

Dest ID TLV is used to identify the destination end of the connection. The Dest ID TLV encoding is:



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Dest TNA:

Similar to the Src TLV, the following values MUST be supported

Value	Type
-----	-----
0x963	IPv4
0x964	IPv6
0x965	NSAP

The NSAP format is structured according to ISO/IEC 8348, 1993 (identical to ITU X.213, 1992)

Only TNA addresses of the same type SHOULD be compared for

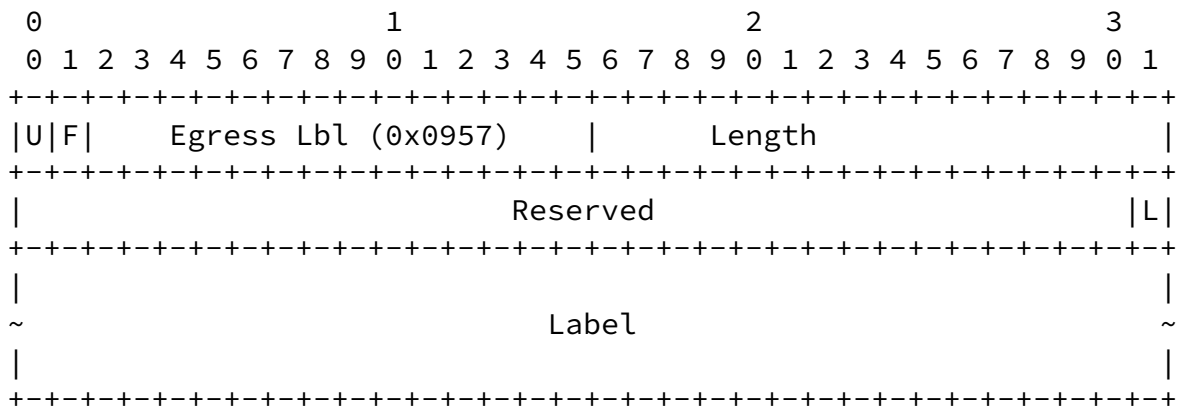
equality.

Logical Port ID:

A 32-bit unsigned number indicating identifying a logical port at the destination client device. Logical Port ID is OPTIONAL and, as such, may not be present.

5.1.3 Egress Label TLV

Egress Label TLV is an OPTIONAL O-UNI defined TLV. Egress Label TLV, when present, indicates the egress label to be used at the destination end of the O-UNI. The encoding for the Egress Label is:



L-bit:

If L=0, then the Label value MUST be copied into Label Set TLV in the corresponding outgoing Label Request message from the destination UNI-N to destination UNI-C. If L=1, then the Label value MUST be copied into an Upstream Label TLV in corresponding outgoing Label Request message from the destination UNI-N to the destination UNI-C. As such, the Label Request message originated

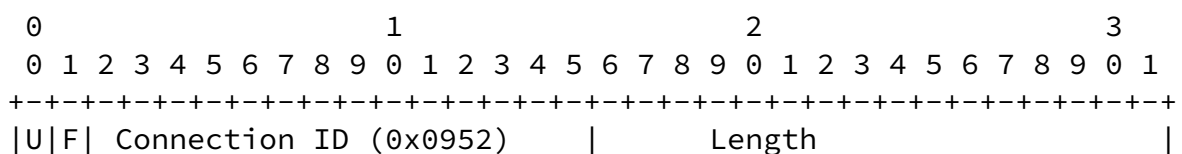
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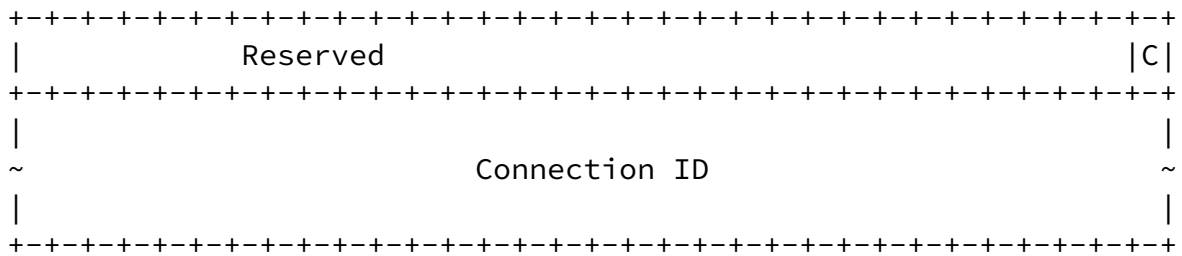
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by the source UNI-C may contain up to two Egress Label TLVs, one with the L-bit set, and the other with the L-bit not set.

5.1.4. Connection ID TLV

The Connection ID TLV is used to uniquely identify a connection established by the network. The format of the Connection ID TLV is as follows:





C-bit:

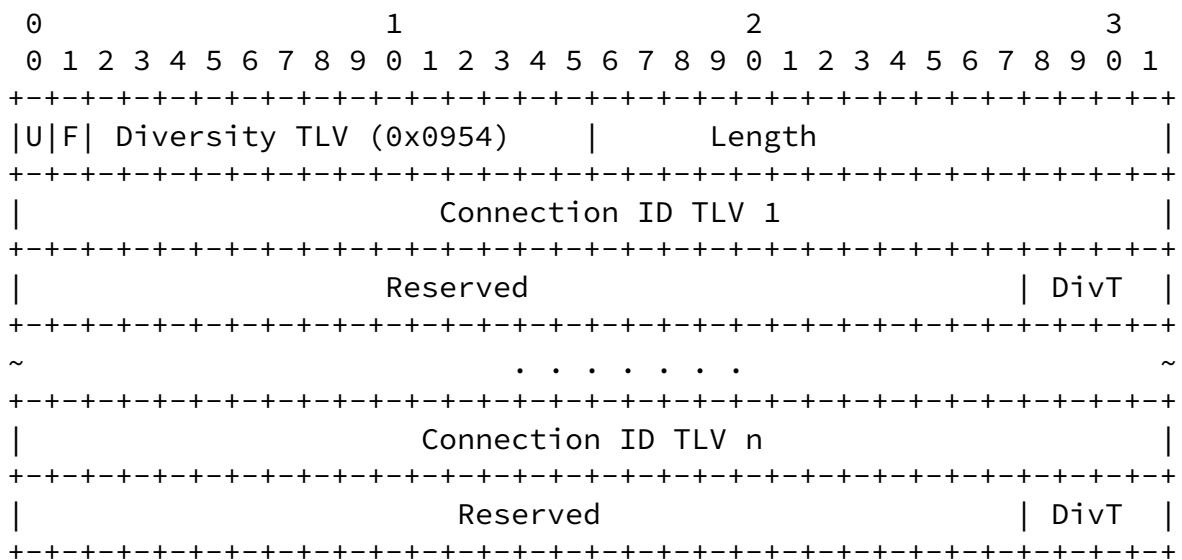
The value of the C bit is set by the destination UNI-C whenever a reservation confirmation indication is needed.

Connection ID:

Connection ID has a variable length in multiple of 32, and is at least 64 bits wide.

5.1.5 Diversity TLV

Diversity TLV lists all the other connections from which the requested connection MUST be diverse. It also specifies the type of diversity. The encoding of the Diversity TLV is as follows:



Connection ID TLV i:

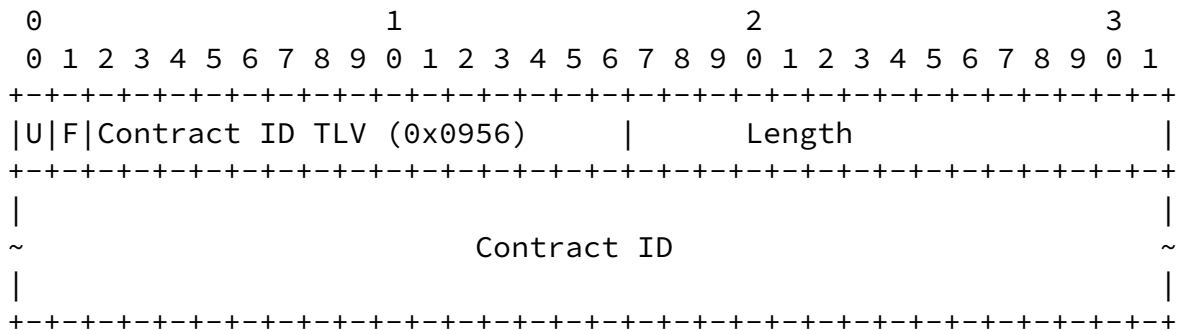
This is the Connection ID of an existing connection from which the requested connection must be diverse.

DivT (Diversity Type):

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

- 0x0 = Link diverse
- 0x1 = Node diverse
- 0x2 = Shared Risk Link Group (SRLG) diverse
- 0x3 = Link non-diverse
- 0x4 = Node non-diverse
- 0x5 = SRLG non-diverse

5.1.6 Contract ID TLV

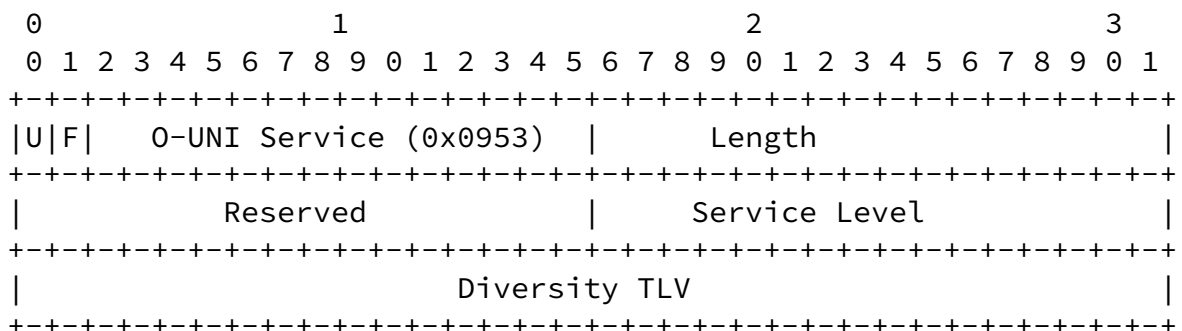


Contract ID:

This is a variable-length string of characters whose format will be determined by the OTN provider. Contract ID identifies the contracted service level agreement (SLA) that the OTN client has with the OTN operator, and in whose context the connection setup request is made. Contract IDs therefore only have local significance between an OTN client and an OTN NE.

5.1.8 0-UNI Service TLV

The 0-UNI Service TLV describes connection attributes in terms of restoration and routing diversity. The encoding of the 0-UNI Service TLV is:

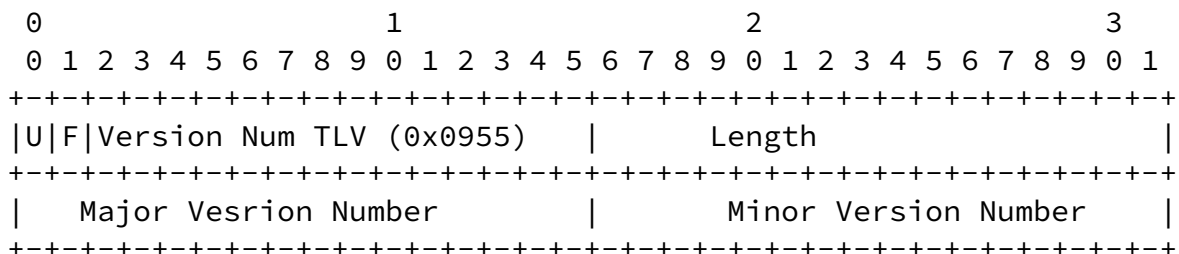


Service Level:

A Service Level corresponds to carrier-defined characteristics such as time to restore, BER, bumping priority, etc.

5.1.9 0-UNI Version Number TLV

The O-UNI Version Number TLV is of the form:



Minor version number is set relative to the major version number.

5.2 LDP Message Extensions for O-UNI

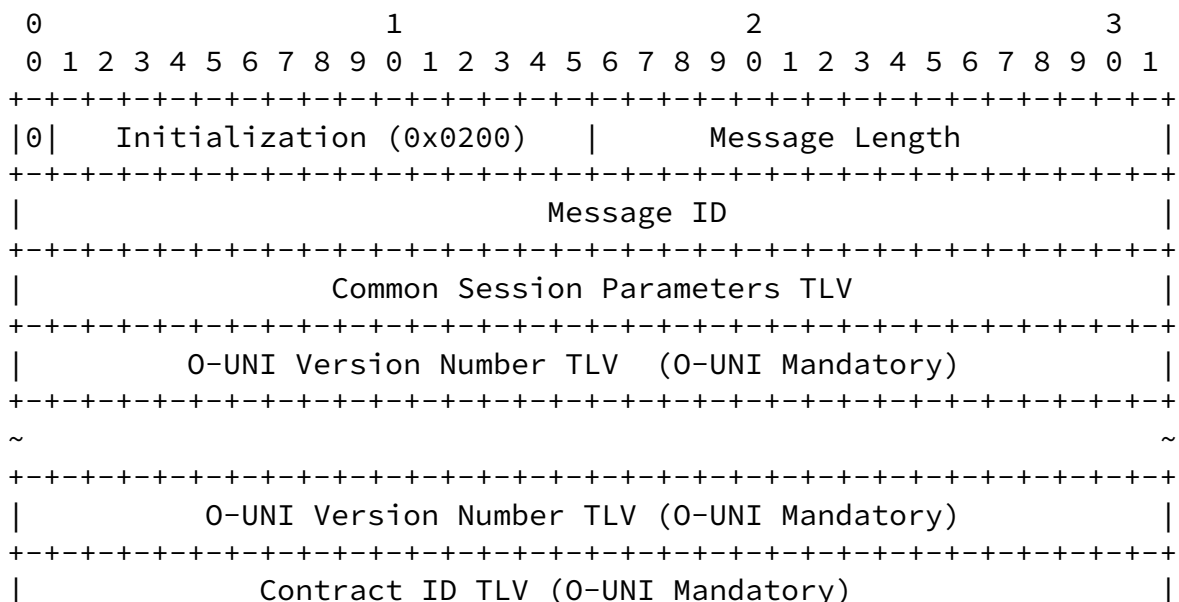
This section describes the necessary extensions for LDP messages for the support of signaling across the O-UNI. This section also includes the definition of the two new messages needed for status enquiry. Those messages are Status Enquiry message and Status Response Message.

5.2.1 Hello Message

The format and the procedure for the Hello message is as defined in [section 3.5.2](#) in [8].

5.2.2 Initialization Message

The encoding for the Initialization message is:




```

+-----+
|                               Optional Parameters                               |
+-----+

```

The initialization message procedure is as described in [section 2.5](#). in [8] and [section 4.1](#) of this draft.

Message ID is as defined in [section 3.5](#). in [8]. Common Session Parameter TLV is as defined in [section 3.5.3](#) in [8].

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The currently defined values for the O-UNI version Number are:

For OIF Demo UNI:

Major Version Number = 0x0000, Minor Version Number = 0x0001

For OIF UNI 1.0:

Major Version Number = 0x0001, Minor Version Number = 0x0000

[5.2.3](#) Label Request Message

The encoding of the Label Request Message for O-UNI 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
+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
|0| Label Request (0x0401) | Length |
+-----+-----+-----+-----+-----+-----+-----+-----+
|                               Message ID                               |
+-----+-----+-----+-----+-----+-----+-----+-----+
|                               FEC TLV                                |
+-----+-----+-----+-----+-----+-----+-----+-----+
| Src ID TLV (UNI mandatory) |
+-----+-----+-----+-----+-----+-----+-----+-----+
| Dest ID TLV TLV (UNI mandatory) |
+-----+-----+-----+-----+-----+-----+-----+-----+
| Egress Label TLV (UNI Optional) |
+-----+-----+-----+-----+-----+-----+-----+-----+
| Connection ID TLV (UNI mandatory) |
+-----+-----+-----+-----+-----+-----+-----+-----+
| Generalized Label Request TLV (UNI mandatory) |
+-----+-----+-----+-----+-----+-----+-----+-----+
| O-UNI Service TLV (UNI mandatory) |
+-----+-----+-----+-----+-----+-----+-----+-----+
| SONET/SDH Traffic Parameters TLV (UNI mandatory) |
+-----+-----+-----+-----+-----+-----+-----+-----+
| Upstream Label TLV (UNI optional) |

```

```

+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
|           Suggested Label TLV   (UNI optional)           |
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
|           Label Set TLV         (UNI optional)           |
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
|                               Optional Parameters         |
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+

```

The Label Request Message is sent from:

- the source UNI-C to source UNI-N to indicate an outgoing connection request;
- the destination UNI-N to the destination UNI-C to indicate an incoming connection request.

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How the Label Request message is propagated through OTN from the source UNI-N to the destination UNI-N is outside the scope of this specification.

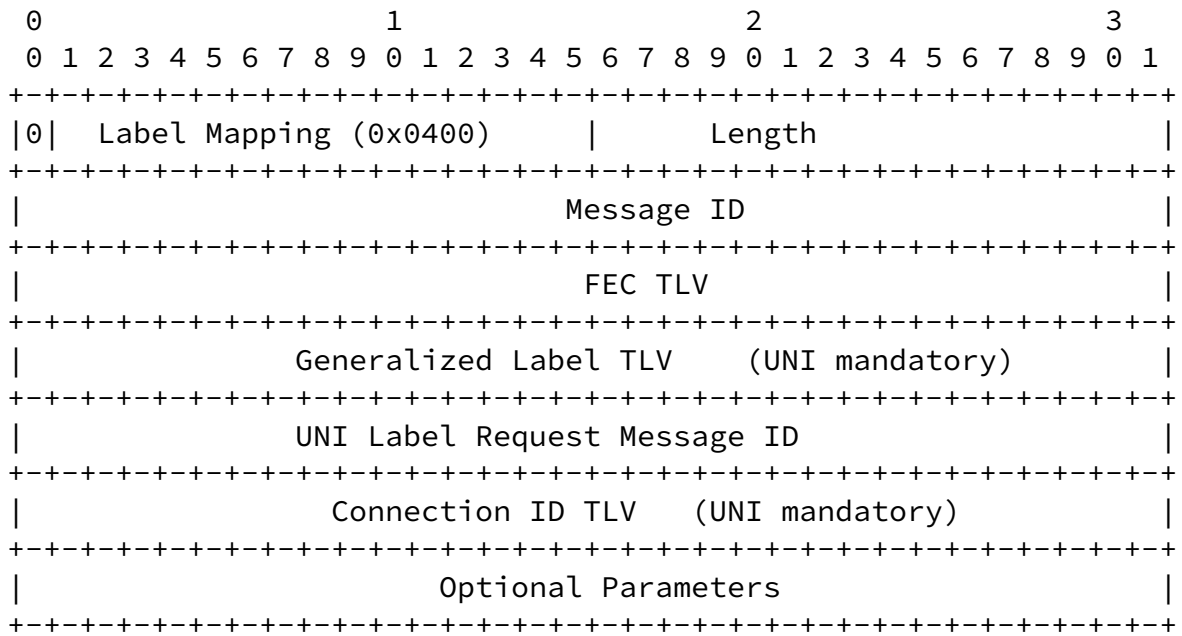
In the Label Request Message, the initiating UNI-C identifies the two connection termination points (Src and Dest ID TLVs). The UNI-N is expected to assign a Connection ID that is unique within the transport network. The Connection ID is passed to the terminating UNI-C in the Label Request Message by the destination UNI-N.

Upon the reception of the Label Request Message, the source UNI-N should verify that the signaled attributes (including the validity of the Source and the Destination IDs) can be supported. Failure to support one or more of the connection attributes triggers the generation of the Notification Message with the appropriate error code.

The Label Request message Message ID should be used as a local connection identifier, until such a time when the network-assigned Connection ID is sent back to the source client. As stated in [8], since LSRs use Label Request message IDs as transaction identifiers, an LSR SHOULD NOT reuse the Message ID of a Label Request message until the corresponding transaction completes. Thus the local connection identifier has a very limited lifespan.

[5.2.4 Label Mapping Message](#)

The format of the Label Mapping message for the 0-UNI is:



The Label Mapping message procedure for the 0-UNI is limited to downstream on demand ordered control mode. The UNI Label Mapping Message flows between:

- The destination UNI-C to destination UNI-N in response to a Label Request message;

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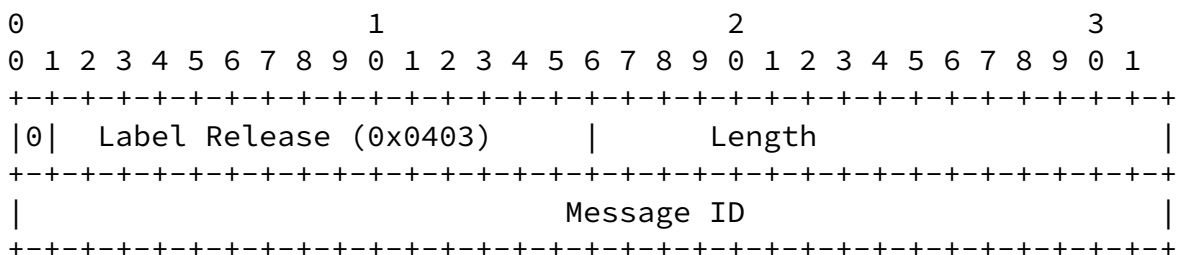
- The source UNI-N to the source UNI-C to indicate the successful establishment of a connection requested previously.

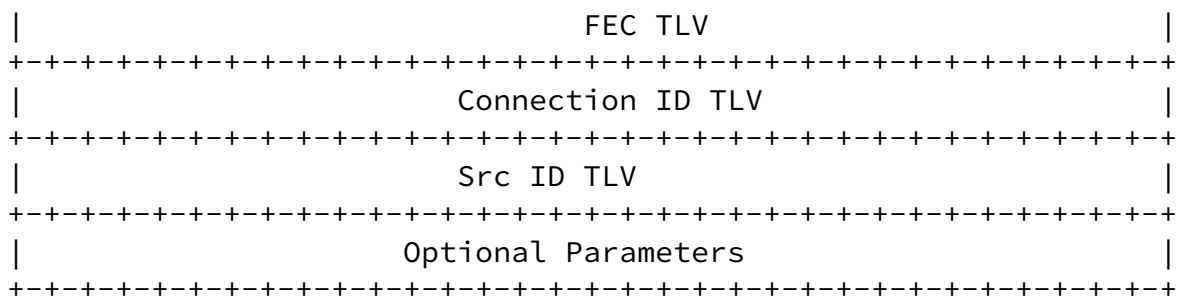
The network transports the assigned Connection ID to the calling client (source UNI-C) in the Label Mapping Message.

A terminating UNI-C that desires to receive a reservation confirmation from the initiating UNI-C MUST set the C-bit in the Connection ID TLV.

[5.2.5](#) Label Release Message

The encoding for the Label Release message at the 0-UNI is:





The LDP Label Release Message is used for connection deletion in the downstream direction, e.g. when the connection termination is initiated by the destination UNI-C (graceful OTN connection deletion) / source UNI-C (non-graceful OTN connection deletion). The O-UNI Label Release Message is sent by:

- The source UNI-C to source UNI-N to request the deletion a connection;
- The destination UNI-N to a destination UNI-C to indicate the deletion of a connection by the network.

For the optical UNI, the receiver of the Label Release Message must respond with a Notification Message with the appropriate status code indicating the success of the delete request.

Either the Connection ID TLV or the Src ID TLV MUST be included in the Label Release Message. When the Connection ID TLV is included, it is an indication that the connection identified by this ID is the one to be deleted. The Src ID TLV will only be present if a forced (i.e. non graceful) OTN connection deletion is to be performed.

When the Src ID TLV is included, it is an indication to the network that the source UNI-C requires deletion of all the connections

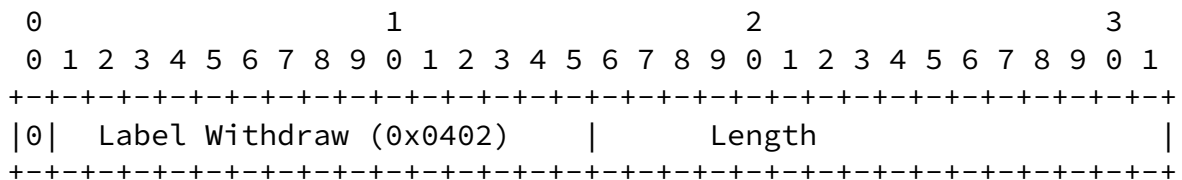
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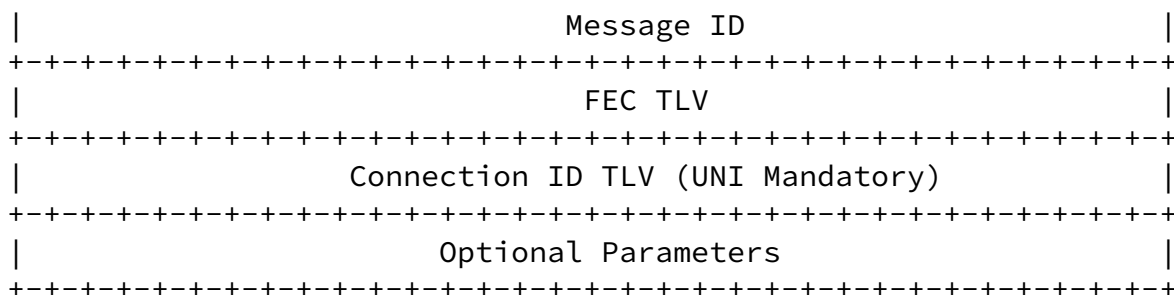
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associated with the specified logical link. This feature is primarily used for forced deletion of connections in failure recovery.

[5.2.6 Label Withdraw Message](#)

The encoding for the Label Withdraw message at the O-UNI is:





The LDP Label Withdraw message is used for connection deletion in the upstream direction, e.g. when the connection termination is initiated by the destination UNI-C (non-graceful OTN connection deletion) / source UNI-C (graceful OTN connection deletion). The UNI Label Withdraw Message is sent by:

- The destination UNI-C to destination UNI-N to request the deletion of a connection
- The source UNI-N to the source UNI-C to indicate the deletion of the connection by the network.

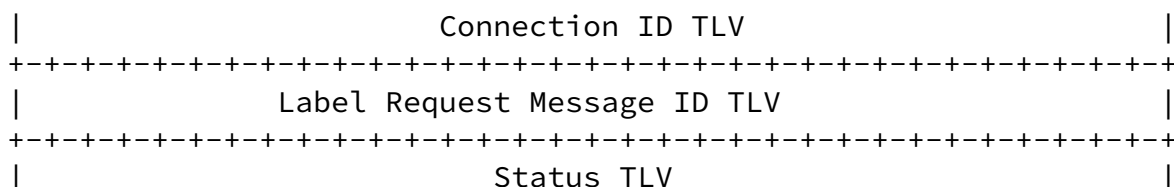
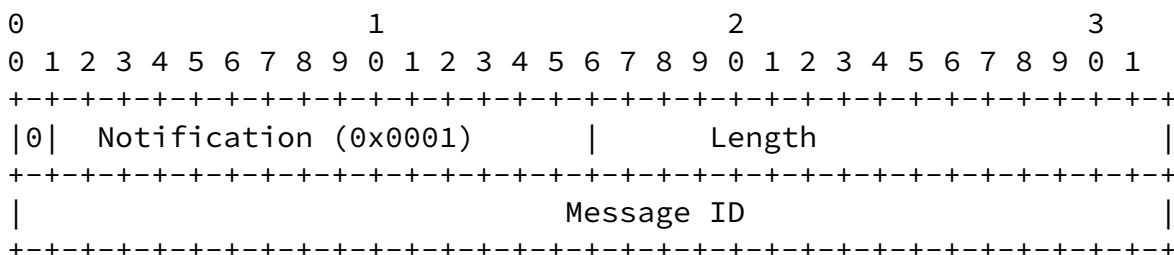
The procedure for the Label Withdraw Message is defined in [section 3.5.10](#) of [8]. The recipient of the Label Withdraw Message MUST respond with a Label Release message as in [8]. The Label Withdraw message for UNI carries a mandatory Connection ID.

5.2.7 Label Abort Message

The format and the procedure of the Label Abort message are as given in [section 3.5.9](#) of [8].

5.2.8 Notification Message

The format of the Notification for the O-UNI is:



```

+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
|                                     Optional Parameters                                     |
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+

```

The UNI Notification Message must be forwarded towards the entity originating the Label Request, Label Release, Status Enquiry, or Abort.

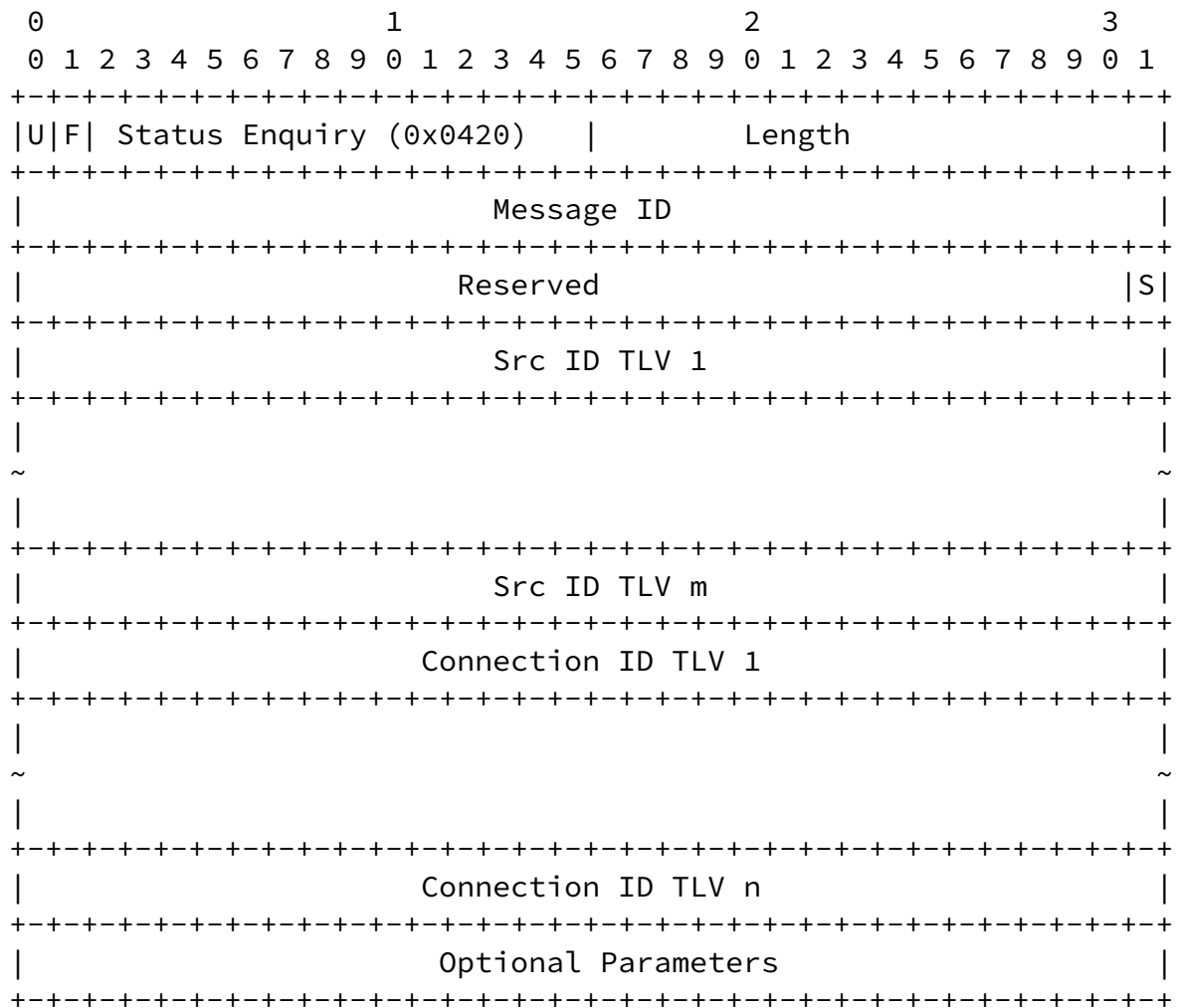
The Notification message plays a number of roles within the O-UNI:

- A failed connection setup event is indicated to the source UNI-C using a Notification message. In this case, the Notification message is generated in response to a Label Request message before the source client has been made aware of its associated Connection ID. Therefore, in this case, the Notification message MUST include the Label Request Message ID TLV that specifies the Message ID of the Label Request message of the failed setup (and which constitutes the source OTN client local connection identifier). The Status TLV MUST include the status code for the cause of the failed setup, e.g. "no_bandwidth_available".
- A Notification message is needed to initiate graceful deletion of a single OTN connection. In this case the Notification message MUST include the Connection ID of the connection to be deleted. The "delete_indication" status code must be included.
- A Notification message is sent in response to a connection deletion in the downstream direction, i.e. initiated by a Label Release message. In this case the Status TLV MUST include the status code for "delete_success". The Notification message can be sent in response to a single connection deletion or the deletion of all the connection associated with a source identification point (LDP session, logical link, or TNA address). For single connection deletion the Notification message MUST include the Connection ID of the deleted connection. When used to acknowledge the deletion of a group of connections, the Notification message MUST not contain IDs of any of the connections that were deleted.
- A Notification message is sent for those cases where the destination UNI-C requests a reservation confirmation indication from the source UNI-C. In this case the status TLV MUST include the "reserv_confirm" status code.
- A Notification message is sent for those cases where the source UNI-C attempts to abort a connection request after sending the Label Request Message. The Notification message is sent in response to an Abort message. In this case the Notification message MUST include the Label Request Message ID TLV.

The use of the Notification message for the O-UNI includes those procedures that are specified in [8].

5.2.9 Status Enquiry Message

The Status Enquiry is a new LDP message that is defined specifically for LDP applications for O-UNI signaling. The encoding for the Status Enquiry Message is:



The Status Enquiry message allows a client to enquire about the status of a connection or group of connections for which the client is an end point.

When a Src ID TLV is present in the Status Enquiry message, the client is in effect requesting the status of all connections associated with the specified logical link.

When a Connection ID TLV is present in the Status Enquiry message, the client is requesting the status of this particular connection.

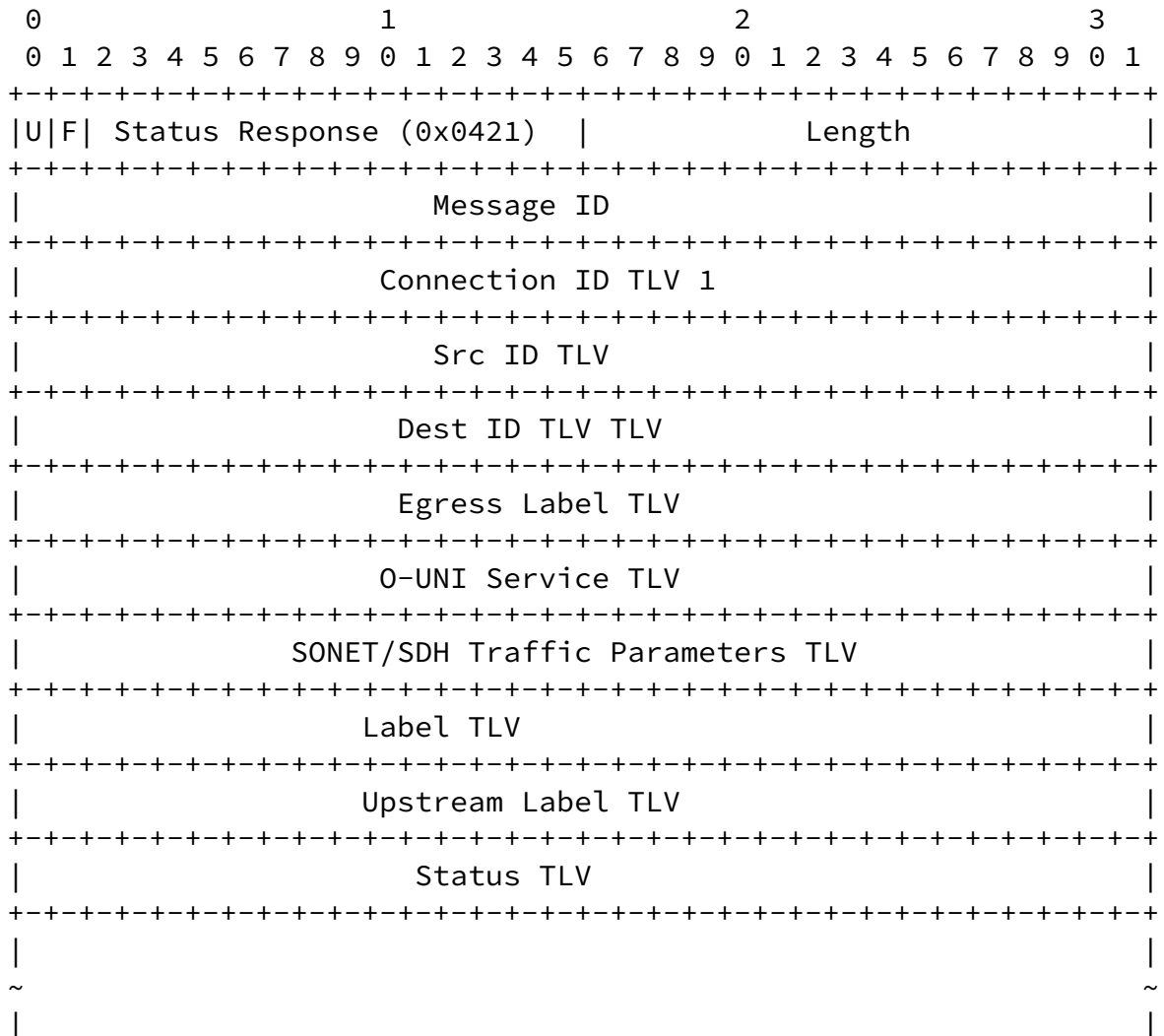
Status Enquiry can be generated by the client at any time. The Status Enquiry message is used to enquire about status of already existing connections.

S-bit:

Whenever the S bit is set, S=1, it indicates that the Status Enquiry message is for summary information. In that case the Status Response message contains summary information (Connection ID and connection Status) of the specified connections. Otherwise, S=0, detailed information is requested.

5.2.10 Status Response Message

The Status Response message is a new LDP message that is defined specifically for LDP applications for O-UNI. The encoding for the Status Response message is:




```

+-----+
|                               Connection ID TLV n                               |
+-----+
|                               Src ID TLV                                       |
+-----+
|                               Dest ID TLV TLV                                   |
+-----+
|                               Egress Label TLV                                 |
+-----+
|                               O-UNI Service TLV                               |
+-----+
|                               SONET/SDH Traffic Parameters TLV                 |
+-----+
|                               Label TLV                                       |
+-----+

```

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```

+-----+
|                               Upstream Label TLV                               |
+-----+
|                               Status TLV                                       |
+-----+
|                               Optional Parameters                               |
+-----+

```

The Status Response message is generated in response to a Status Enquiry message. The Status Response message contains information regarding the status of those connections (implicitly or explicitly) specified in the Status Enquiry message to which it is a response. The amount information included in the Status Response message depends on the whether the Status Enquiry is for summary or detailed information.

[6.0](#) Status Code Summary

The following are the status codes defined for this version of LDP O-UNI protocol.

```

0x000000xx = destination_not_reachable
0x000000xx = invalid_destination_TNA
0x000000xx = bandwidth_unavailable
0x000000xx = protection_mode_unavailable
0x000000xx = routing_directive_unavailable
0x000000xx = Failure_to_delete_connection
0x000000xx = Encoding_unavailable
0x000000xx = bad_egress_label
0x000000xx = delete_indication
0x000000xx = delete_success
0x000000xx = reserv_confirm

```

0x000000xx = abort_complete

0x000000xx = Connection active

0x000000xx = Connection doesn't exist

0x000000xx = Connection unavailable

0x000000xx = Connection dropped by far end

0x000000xx = Connection Pending

7. IANA Consideration

This draft requires the use of a number of new messages, TLVs, and status codes from the number spaces within the LDP protocol.

The two new messages (sections [5.2.9](#) and [5.2.10](#)) and the eight new TLVs (sections [5.1.1](#) to [5.1.8](#)) should be considered as part of LDP base protocol and be assigned message and TLV types accordingly as outlined in [8]. All the values given in this draft should be interpreted as advisory. There does not exist a preference to what values should be used.

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The authors' current understanding is that MPLS status codes are not sub-divided into specific ranges for different types of error. Hence, the numeric status code values assigned for this draft should simply be the next available values at the time of writing and may be substituted for other numeric values. See section "Status Codes" for details of the status codes defined in this draft.

8. Security Considerations

This draft doesn't introduce any new security issues other than those in [8].

9. References

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- 2 Bradner, S., "Key words for use in RFCs to Indicate Requirement Levels", [BCP 14](#), [RFC 2119](#), March 1997
- 3 B. Rajagopalan, "IP over Optical Networks: A Framework", [draft-](#)

- [ietf-ipo-framework-oo.txt](#), work in progress, July 2001.
- 4 Mayer, M. Ed., "Requirements for Automatic Switched Transport Networks (ASTN)", ITU G.807/Y.1301, V1.0, May 2001.
 - 5 Ashwood-Smith, P. et. al., "Generalized MPLS- Signaling Functional Description", [draft-ietf-mpls-generalized-signaling-04.txt](#), work in progress, May. 2001
 - 6 Ashoowd-Smith, P. et. al., "Generalized MPLS Signaling: CR-LDP Extensions", [draft-ietf-mpls-generalized-cr-ldp-03.txt](#), work in progress, May 2001
 - 7 Ashwood-Smith, P. et. al., "Generalized MPLS Signaling: RSVP-TE Extensions", [draft-ietf-mpls-generalized-rsvp-te-03.txt](#), work in progress, May 2000.
 - 8 Anderson, L., et. al., "LDP Specification", [RFC 3036](#), January 2001.
 - 9 Rajagopalan, B. Editor, "User Network Interface (UNI) 1.0 Signaling Specifications", OIF Contribution, OIF2000.125.5, June 2001
 - 10 Jamoussi, B., "Constraint-Based LSP Setup using LDP", [draft-ietf-mpls-cr-ldp-04.txt](#), work in progress, July 2000.

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10. Author's Addresses

Osama S. Aboul-Magd
Nortel Networks
P.O. Box 3511, Station ôCö
Ottawa, Ont, K1Y-4H7
Tel : 613-763-5827
e.mail : osama@nortelnetworks.com

Sandra Ballarte
Nortel Networks
P.O. Box 3511, Station C
Ottawa, Ontario, Canada
K1Y-4H7
Phone: 613-763-9510

Email: ballarte@nortelnetworks.com

Ewart Tempest
Nortel Networks
P.O. Box 3511, Station C
Ottawa, Ontario, Canada
K1Y-4H7
Phone: 613-768-0610
Email: ewart@nortelnetworks.com

Raj Jain
Nayna Networks, Inc.
157 Topaz St.
Milpitas, CA 95035
Phone: 408-956-8000x309
Fax: 408-956-8730
Email:raj@nayna.com

Liangyu Jia
ONI Systems Corp.
166 Baypoints Parkway
San Jose, CA 95134
Tel: 408-965-2743
Fax: 408-965-2660
e.mail:ljia@oni.com

Bala Rajagopalan
Tellium, Inc.
2 Crescent Place
Ocean Port, NJ 07757
Email :braja@tellium.com

Robert Rennison
Laurel Networks
2607 Nicholson Road
Sewickley, PA 15143, USA
Tel: +1 724-933-7330
Email:robren@laurelnetworks.com

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Yangguang Xu
Lucent Technologies Inc.
21-2A41
1600 Osgood St.
N. Anderson, MA 01845
Tel : 978-960-6105
e.mail :xuyg@Lucent.com

Zhensheng Zhang
Sorrento Networks
9990 Mesa Rim Road
San Diego, CA 92121
Tel: 858-646-7195
e.mail:zzhang@sorrentonet.com

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