        The Label Distribution Protocol (LDP) Implementation Survey Results

Status of This Memo

Abstract

   Multiprotocol Label Switching (MPLS), described in RFC 3031, is a
   method for forwarding packets that uses short, fixed-length values
   carried by packets, called labels, to determine packet next hops. A
   fundamental concept in MPLS is that two Label Switching Routers
   (LSRs) must agree on the meaning of the labels used to forward
   traffic between and through them. This common understanding is
   achieved by using a set of procedures, called a Label Distribution
   Protocol (as described in RFC 3036) , by which one LSR informs
   another of label bindings it has made. One such protocol, called
   LDP, is used by LSRs to distribute labels to support MPLS forwarding
   along normally routed paths. This document reports on a survey of
   LDP implementations conducted in August 2002 as part of the process
   of advancing LDP from Proposed to Draft Standard.

Table of Contents

1. Introduction

   Multiprotocol Label Switching (MPLS) is a method for forwarding
   packets that uses short fixed-length values carried by packets,
   called labels, to determine packet next hops [RFC3031]. A
   fundamental MPLS concept is that two Label Switching Routers (LSRs)
   must agree on the meaning of the labels used to forward traffic
   between and through them. This common understanding is achieved by
   using a set of procedures by which one LSR informs another of label
   bindings it has made.

   Label Distribution Protocol (LDP) specifies a set of procedures LSRs
   use to distribute labels to support MPLS forwarding along normally
   routed paths. LDP was specified originally by [RFC3036]. The
   current LDP specification is [RFC5036], which obsoletes [RFC3036].
   [RFC3037] describes the applicability of LDP.

   This document reports on a survey of LDP implementations conducted in
   August 2002 as part of the process of advancing LDP from Proposed to
   Draft standard.

   This section highlights some of the survey results. Section 2
   presents the survey results for LDP features, and Appendix A presents
   the survey results in full. Appendix B contains a copy of the survey
   form.

1.1. The LDP Survey Form

   The LDP implementation survey requested the following information
   about LDP implementation:

   - Responding organization. Provisions were made to accommodate
      organizations that wished to respond anonymously.

   - The status, availability, and origin of the LDP implementation.

   - The LDP features implemented and for each whether it was tested
      against an independent implementation. The survey form listed
      each LDP feature defined by [RFC3036] and requested one of the
      following as the status of the feature:

         t: Tested against another independent implementation
         y: Implemented but not tested against independent
            implementation
         n: Not implemented
         x: Not applicable to this type of implementation

      In addition, for the 'n' status, the responder could optionally
      provide the following additional information:

         s: RFC specification inadequate, unclear, or confusing
         u: Utility of feature unclear
         r: Feature not required for feature set implemented

   This document uses the following conventions for reporting survey
   results for a feature:

      At By Cn indicates:

      - A responders implemented the feature and tested it against
         another independent implementation (t)
      - B responders implemented the feature but have not tested it
         against an independent implemented (y)
      - C responders did not implement the feature (n)

      (Ds Eu Fr) indicates optional responses:

      - D responders thought the RFC 3036 specification of the feature
         inadequate, unclear, or confusing (s).
      - E responders thought the utility of the feature unclear (u).
      - F responders considered the feature not required for the
         feature set implemented (combines x and r).

1.2. LDP Survey Highlights

   This section presents some highlights from the implementation survey.

      - There were 12 responses to the survey, 2 of which were
         anonymous. At the time of the survey, 10 of the implementation
         were available as products and 2 were in beta test. Eleven of
         the implementations were available for sale; the remaining
         implementation had been done by a company no longer in
         business.

      - Seven implementations were independently written from the RFC
         3036 specification. Four implementations combined purchased or
         free code with code written by the responder.

         One of the implementations was fully purchased code ported to
         the vendor's platform.

      - Every LDP feature in the survey questionnaire was implemented
         by at least 2 respondents.

- Each of the 8 LDP Label Distribution Modes implemented and
  tested:

      8t 2y 2n   DU, Ord Cntl, Lib reten
      7t 1y 4n   DU, Ind Cntl, Lib reten
      7t 1y 4n   DoD Ord Cntl, Cons reten
      6t 1y 5n   DoD, Ind Cntl, Cons reten
      6t 1y 5n   DU, Ord Cntl, Cons reten
      6t 0y 6n   DU, Ind Cntl, Cons reten
      4t 3y 5n   DoD, Ord Cntl, Lib reten
      4t 2y 6n   DoD, Ind Cntl, Lib reten

- Platform and Interface Label Spaces were both widely supported.

      12t 0y 0n Per platform
       7t 1y 4n Per interface

- LDP Basic and Targeted Sessions were both widely supported.

      12t 0y 0n Basic/Directly Connected
      11t 1y 0n Targeted

- The TCP MD5 Option for LDP session TCP connections was not
  widely implemented.

      3t 1y 8n

2. Survey Results for LDP Features

   This section presents the survey results for LDP features using the
   notational convention described in Section 1.2. It omits the
   optional status responses (s, u, r); complete results may be found in
   Appendix A.

      Feature
         Survey Result

      Interface types
         12t 0y 0n   Packet
         2t 3y 7n   Frame Relay
         6t 2y 4n   ATM
      Label Spaces
         12t 0y 0n   Per platform
         7t 1y 4n   Per interface
      LDP Discovery
         12t 0y 0n   Basic
         11t 1y 0n   Targeted

```
    LDP Sessions
        12t 0y 0n       Directly Connected
        11t 1y 0n       Targeted
    LDP Modes
        7t 1y 4n        DU, Ind Cntl, Lib reten
        8t 2y 2n        DU, Ord Cntl, Lib reten
        6t 0y 6n        DU, Ind Cntl, Cons reten
        6t 1y 5n        DU, Ord Cntl Cons reten
        4t 2y 6n        DoD, Ind Cntl, Lib reten
        4t 3y 5n        DoD, Ord Cntl, Lib reten
        6t 1y 5n        DoD, Ind Cntl, Cons reten
        7t 1y 4n        DoD, Ord Cntl, Cons reten
    Loop Detection
        9t 2y 1n
    TCP MD5 Option
        3t 1y 8n
    LDP TLVs
        7t 4y 0n        U-bit
        7t 4y 0n        F-bit
        12t 0y 0n       FEC TLV
        6t 5y 1n          Wildcard
        12t 0y 0n         Prefix
        10t 0y 2n         Host
        12t 0y 0n       Address List TLV
        10t 1y 1n       Hop Count TLV
        9t 2y 1n        Path Vector TLV
        12t 0y 0n       Generic Label TLV
        6t 2y 4n        ATM Label TLV
        2t 3y 7n        Frame Relay Label TLV
        12t 0y 0n       Status TLV
        9t 3y 0n        Extended Status TLV
        6t 4y 2n        Returned PDU TLV
        6t 4y 2n        Returned Message TLV
        12t 0y 0n       Common Hello Param TLV
        12t 0y 0n         T-bit
        11t 0y 1n         R-bit
        11t 1y 0n         Hold Time
        12t 0y 0n       IPv4 Transport Addr TLV
        7t 2y 3n        Config Sequence Num TLV
        1t 1y 1n        IPv6 Transport Addr TLV
        12t 0y 0n       Common Session Param TLV
        12t 0y 0n         KeepAlive Time
        11t 0y 1n         PVLim
        11t 1y 0n         PDU Max Length
        6t 2y 2n        ATM Session Param TLV
                          M values
        5t 3y 4n            0 No Merge
        3t 3y 6n            1 VP Merge
```

```
   5t 3y 4n              2 VC Merge
   3t 3y 6n              3 VP & VC Merge
   6t 2y 4n           D-bit
   6t 2y 4n           ATM Label Range Component
   2t 3y 7n         FR Session Param TLV
                       M values
   2t 3y 7n              0 No Merge
   2t 3y 7n              1 Merge
   2t 3y 7n           D-bit
   2t 3y 7n           FR Label Range Component
  10t 0y 2n         Label Request Msg ID TLV
   2t 5y 5n         Vendor-Private TLV
   1t 5y 6n         Experimental TLV
 LDP Messages
  12t 0y 0n         Notification Msg
  12t 0y 0n         Hello Msg
  12t 0y 0n         Initialization Msg
  12t 0y 0n         KeepAlive Msg
  12t 0y 0n         Address Msg
  12t 0y 0n         Address Withdraw Msg
  12t 0y 0n         Label Mapping Msg
  10t 0y 2n            Label Request Msg Id TLV
  10t 1y 1n            Hop Count TLV
  10t 1y 1n            Path Vect TLV
   9t 0y 3n         Label Request Msg
   9t 0y 3n            Hop Count TLV
   9t 0y 3n            Path Vect TLV
  12t 0y 0n         Label Withdraw Msg
  12t 0y 0n            Label TLV
  11t 0y 1n         Label Release Msg
  10t 1y 1n            Label TLV
   9t 2y 1n         Label Abort Req Msg
   2t 5y 5n         Vendor-Private Msg
   1t 5y 6n         Experimental Msg
 LDP Status Codes
   9t 3y 0n         Success
   8t 4y 0n         Bad LDP Id
   7t 5y 0n         Bad Ptcl Version
   7t 5y 0n         Bad PDU Length
   7t 5y 0n         Unknown Message Type
   7t 5y 0n         Bad Message Length
   7t 4y 0n         Unknown TLV
   7t 5y 0n         Bad TLV length
   7t 5y 0n         Malformed TLV Value
  11t 1y 0n         Hold Timer Expired
  11t 1y 0n         Shutdown
  10t 1y 1n         Loop Detected
   7t 5y 0n         Unknown FEC
```

```
           11t 1y 0n        No Route
           9t 3y 0n         No Label Resources
           8t 3y 1n         Label Resources Available
                            Session Rejected
           7t 5y 0n           No Hello
           9t 2y 1n           Param Advert Mode
           9t 2y 1n           Param PDUMax Len
           8t 3y 1n           Param Label Range
           7t 5y 0n           Bad KA Time
           11t 1y 0n        KeepAlive Timer Expired
           9t 1y 2n         Label Request Aborted
           6t 5y 1n         Missing Message Params
           7t 5y 0n         Unsupported Addr Family
           7t 5y 0n         Internal Error
```

3. Security Considerations

   This document is a survey of existing LDP implementations; it does
   not specify any protocol behavior. Thus, security issues introduced
   by the document are not discussed.

4. Informative References

   [RFC3031] Rosen, E., Viswanathan, A., and R. Callon, "Multiprotocol
             Label Switching Architecture", RFC 3031, January 2001.

   [RFC3036] Andersson, L., Doolan, P., Feldman, N., Fredette, A., and
             B. Thomas, "LDP Specification", RFC 3036, January 2001.

   [RFC3037] Thomas, B. and E. Gray, "LDP Applicability", RFC 3037,
             January 2001.

   [RFC5036] Andersson, L., Ed., Minei, I., Ed., and B. Thomas, Ed.,
             "LDP Specification", RFC 5036, October 2007.

Appendix A. Full LDP Survey Results

LDP Implementation Survey Form (V 1.0)

==
A. General Information

Responders:

   Anonymous: 2
   Public: 10

      Agilent Technologies
      Celox Networks, Inc.
      Cisco Systems, Inc.
      Data Connection Ltd.
      NetPlane Systems, Inc
      Redback Networks
      Riverstone Networks
      Trillium, An Intel Company
      Vivace Networks, Inc.
      Wipro Technologies

===
B. LDP Implementation Status, Availability, Origin

Status:
      [ ] Development
      [ ] Alpha
      [2] Beta
      [10] Product
      [ ] Other (describe):

Availability:
      [ ] Public and free
      [ ] Only to selected organizations/companies but free
      [11] On sale
      [ ] For internal company use only
      [1] Other:

Implementation based on: (check all that apply)
      [1] Purchased code
            (please list source if possible)
      [ ] Free code
            (please list source if possible)
      [7] Internal implementation
            (no outside code, just from specs)
      [4] Internal implementation on top of purchased
            or free code

```
=======================================================================
C. LDP Feature Survey

For each feature listed, please indicate the status of the
implementation using one of the following:

    't'    tested against another independent implementation
    'y'    implemented but not tested against independent
           implementation
    'n'    not implemented
    'x'    not applicable to this type of implementation

  Optional: For 'n' status, indicate reason for not implementing
            using one of the following:

            's'  RFC specification inadequate, unclear, or confusing
            'u'  utility of feature unclear
            'r'  feature not required for feature set implemented

  Feature                                          RFC 3036 Section(s)
    Survey Result

  Interface types                                  2.2.1, 2.5.3,
                                                   2.8.2, 3.4.2
    12t 0y 0n            Packet
    2t 3y 7n(3r 1x)     Frame Relay
    6t 2y 4n(3r)        ATM
  Label Spaces                                     2.2.1, 2.2.2
    12t 0y 0n            Per platform
    7t 1y 4n(4r)        Per interface
  LDP Discovery                                    2.4
    12t 0y 0n            Basic                     2.4.1
    11t 1y 0n           Targeted                  2.4.2
  LDP Sessions                                     2.2.3
    12t 0y 0n            Directly Connected        --
    11t 1y 0n           Targeted                  2.3
  LDP Modes                                        2.6
    7t 1y 4n(2u 1r)     DU, Ind cntl, Lib reten   2.6
    8t 2y 2n(1r)        DU, Ord cntl, Lib reten   2.6
    6t 0y 6n(2u 2r)     DU, Ind cntl, Cons reten  2.6
    6t 1y 5n(1u 2r)     DU, Ord cntl, Cons reten  2.6
    4t 2y 6n(2u 2r)     DoD, Ind cntl, Lib reten  2.6
    4t 3y 5n(2r)        DoD, Ord cntl, Lib reten  2.6
    6t 1y 5n(2u 2r)     DoD, Ind cntl, Cons reten 2.6
    7t  1y 4n(1u 2r)    DoD, Ord cntl, Cons reten 2.6
  Loop Detection                                   2.8
    9t 2y 1n
```

```
     TCP MD5 Option                                     2.9
       3t 1y 8n(1u 1r 1x)
     LDP TLVs                                           3.3, 3.4, throughout
       7t 4y 0n(1 noreply)  U-bit                       3.3
       7t 4y 0n(1 noreply)  F-bit                       3.3
                            FEC TLV                     1, 2.1, 3.4.1
       6t 5y 1n(1r)            Wildcard                 3.4.1
       12t 0y 0n              Prefix                    3.4.1
       10t 0y 2n(s1 1u 1r)    Host                      2.1, 3.4.1
       12t 0y 0n           Address List TLV             3.4.3
       10t 1y 1n           Hop Count TLV                3.4.4
       9t 2y 1n            Path Vector TLV              3.4.5
       12t 0y 0n           Generic Label TLV            3.4.2.1
       6t 2y 4n(2r)        ATM Label TLV                3.4.2.2
       2t 3y 7n(1u 2r 1x)  Frame Relay Label TLV        3.4.2.3
       12t 0y 0n           Status TLV                   3.4.6
       9t 3y 0n            Extended Status TLV          3.5.1
       6t 4y 2n            Returned PDU TLV             3.5.1
       6t 4y 2n            Returned Message TLV         3.5.1
       12t 0y 0n           Common Hello Param TLV       3.5.2
       12t 0y 0n              T-bit                     3.5.2
       11t 0y 1n              R-bit                     3.5.2
       11t 1y 0n              Hold Time                 3.5.2
       12t 0y 0n           IPv4 Transport Addr TLV      3.5.2
       7t 2y 3n            Config Sequence Num TLV      3.5.2
       1t 1y 1n(1u 4r 1x)  IPv6 Transport Addr TLV      3.5.2
       12t 0y 0n           Common Session Param TLV     3.5.3
       12t 0y 0n             KeepAlive Time             3.5.3
       11t 0y 1n             PVLim                      3.5.3
       11t 1y 0n             PDU Max Length             3.5.3
       6t 2y 2n(1r 1x)     ATM Session Param TLV        3.5.3
                              M values
       5t 3y 4n(1r 1x)        0 No Merge                3.5.3
       3t 3y 6n(s 1 1r 1x)    1 VP Merge                3.5.3
       5t 3y 4n(1r 1x)        2 VC Merge                3.5.3
       3t 3y 6n(s1 1r 1x)     3 VP & VC Merge           3.5.3
       6t 2y 4n(1r 1x)      D-bit                       3.5.3
       6t 2y 4n(1r 1x)      ATM Label Range             3.5.3
                              Component
       2t 3y 7n(1u 1r 2x)   FR Session Param TLV        3.5.3
                              M values
       2t 3y 7n(1u 1r 2x)     0 No Merge                3.5.3
       2t 3y 7n               1 Merge                   3.5.3
       2t 3y 7n(1u 1r 2x)   D-bit                       3.5.3
       2t 3y 7n(1u 1r 2x)   FR Label Range              3.5.3
                              Component
       10t 0y 2n           Label Request Msg Id TLV     3.5.7
       2t 5y 5n(1u 1r)     Vendor-Private TLV           3.6.1.1
```

```
     1t 5y 6n(2r)        Experimental TLV           3.6.2
   LDP Messages                                     3.5, throughout
     12t 0y 0n           Notification Msg           3.5.1
     12t 0y 0n           Hello Msg                  3.5.2
     12t 0y 0n           Initialization Msg         3.5.3
     12t 0y 0n           KeepAlive Msg              3.5.4
     12t 0y 0n           Address Msg                3.5.5
     12t 0y 0n           Address Withdraw Msg       3.5.6
     12t 0y 0n           Label Mapping Msg          3.5.7
     10t 0y 2n(1r)         Label Request Msg Id TLV 3.5.7
     10t 1y 1n             Hop Count TLV            3.5.7
     10t 1y 1n             Path Vect TLV             3.5.7
     9t 0y 3n(1x)        Label Request Msg          3.5.8
     9t 0y 3n(1x)          Hop Count TLV            3.5.8
     9t 0y 3n(1x)          Path Vect TLV            3.5.8
     12t 0y 0n           Label Withdraw Msg         3.5.10
     12t 0y 0n             Label TLV                3.5.10
     11t 0y 1n           Label Release Msg          3.5.11
     10t 1y 1n             Label TLV                3.5.11
     9t 2y 1n            Label Abort Req Msg        3.5.9
     2t 5y 5n(1u 1r)     Vendor-Private Msg         3.6.1.2
     1t 5y 6n(2r)        Experimental Msg           3.6.2
   LDP Status Codes                                 3.4.6
     9t 3y 0n            Success                    3.4.6, 3.9
     8t 4y 0n            Bad LDP Id                 3.5.1.2.1
     7t 5y 0n            Bad Ptcl Version           3.5.1.2.1
     7t 5y 0n            Bad PDU Length             3.5.1.2.1
     7t 5y 0n            Unknown Message Type       3.5.1.2.1
     7t 5y 0n            Bad Message Length         3.5.1.2.1
     7t 4y 0n(1 noreply) Unknown TLV                3.5.1.2.2
     7t 5y 0n            Bad TLV Length             3.5.1.2.2
     7t 5y 0n            Malformed TLV Value        3.5.1.2.2
     11t 1y 0n           Hold Timer Expired         3.5.1.2.3
     11t 1y 0n           Shutdown                   3.5.1.2.4
     10t 1y 1n           Loop Detected              3.4.5.1.2, 3.5.8.1
     7t 5y 0n            Unknown FEC                3.4.1.1
     11t 1y 0n           No Route                   3.5.8.1
     9t 3y 0n            No Label Resources         3.5.8.1
     8t 3y 1n            Label Resources Available  3.5.8.1
                         Session Rejected           2.5.3, 3.5.3
     7t 5y 0n              No Hello                 2.5.3, 3.5.3
     9t 2y 1n              Param Advert Mode        2.5.3, 3.5.3
     9t 2y 1n              Param PDU Max Len        2.5.3, 3.5.3
     8t 3y 1n              Param Label Range        2.5.3, 3.5.3
     7t 5y 0n              Bad KA Time              3.5.1.2.5, 3.5.3
     11t 1y 0n           KeepAlive Timer Expired    2.5.6, 3.5.1.2.3
     9t 1y 2n            Label Request Aborted      3.5.9.1
     6t 5y 1n            Missing Message Params     3.5.1.2.1
```

```
   7t 5y 0n                 Unsupported Addr Family    3.4.1.1, 3.5.5.1
   7t 5y 0n                 Internal Error             3.5.1.2.7
```

Appendix B. LDP Implementation Survey Form

LDP Implementation Survey Form (V 1.0)

The purpose of this form is to gather information about implementations
of LDP as defined by RFC 3036. The information is being requested as
part of the process of advancing LDP from Proposed to Draft Standard.

The form is patterned after the implementation report form used for
HTTP/1.1; see:

http://www.ietf.org/IESG/Implementations/http1.1-implementations.txt

==
A. General Information

Please provide the following information.

Organization:

Organization url(s):

Product title(s):

Brief description(s):

Contact for LDP information
   Name:
   Title:
   E-mail:
   Organization/department:
   Postal address:
   Phone:
   Fax:

```
=======================================================================
B. LDP Implementation Status, Availability, Origin

Please check [x] the boxes that apply.
----------------------------------------------------------------


Status:
     [ ]   Development
     [ ]   Alpha
     [ ]   Beta
     [ ]   Product
     [ ]   Other (describe):

Availability
     [ ]   Public and free
     [ ]   Only to selected organizations/companies but free
     [ ]   On sale.
     [ ]   For internal company use only
     [ ]   Other:

Implementation based on:  (check all that apply)
     [ ]   Purchased code
           (please list source if possible)
     [ ]   Free code
           (please list source if possible)
     [ ]   Internal implementation
           (no outside code, just from specs)
     [ ]   Internal implementation on top of purchased
           or free code
           List portions from external source:
           List portions developed internally:
```

```
=======================================================================
C. LDP Feature Survey
```

For each feature listed, please indicate the status of the
implementation using one of the following:

```
    't'    tested against another independent implementation
    'y'    implemented but not tested against independent implementation
    'n'    not implemented
    '-'    not applicable to this type of implementation
```

  Optional: For 'n' status, indicate reason for not implementing using
            one of the following:

```
        's'  RFC specification inadequate, unclear, or confusing
        'u'  utility of feature unclear
        'r'  feature not required for feature set implemented
```

Feature	RFC 3036 Section(s)	Status (one of t, y, n, -; if n, optionally one of s, u, r)
Interface types	2.2.1, 2.5.3, 2.8.2, 3.4.2	
Packet		
Frame Relay		
ATM		
Label Spaces	2.2.1, 2.2.2	
Per platform		
Per interface		
LDP Discovery	2.4	
Basic	2.4.1	
Targeted	2.4.2	

LDP Sessions	2.2.3	
Directly Connected	--	
Targeted	2.3	
LDP Modes	2.6	
DU, Ind cntl, Lib retention	2.6	
DU, Ord cntl, Lib retention	2.6	
DU, Ind cntl, Cons retention	2.6	
DU, Ord cntl, Cons retention	2.6	
DoD, Ind cntl, Lib retention	2.6	
DoD, Ord cntl, Lib retention	2.6	
DoD, Ind cntl, Cons retention	2.6	
DoD, Ord cntl, Cons retention	2.6	
Loop Detection	2.8	
TCP MD5 Option	2.9	
LDP TLVs	3.3, 3.4, throughout	
U-bit	3.3	
F-bit	3.3	
FEC	1., 2.1, 3.4.1	

Wildcard	3.4.1	
Prefix	2.1, 3.4.1	
Host	2.1, 3.4.1	
Address List	3.4.3	
Hop Count	3.4.4	
Path Vector	3.4.5	
Generic Label	3.4.2.1	
ATM Label	3.4.2.2	
Frame Relay Label	3.4.2.3	
Status	3.4.6	
Extended Status	3.5.1	
Returned PDU	3.5.1	
Returned Message	3.5.1	
Common Hello Parameters	3.5.2	
T-bit	3.5.2	
R-bit	3.5.2	
Hold Time	3.5.2	
IPv4 Transport Address	3.5.2	
Configuration Sequence Number	3.5.2	
IPv6 Transport Address	3.5.2	
Common Session Parameters	3.5.3	

KeepAlive Time	3.5.3	
PVLim	3.5.3	
Max PDU Length	3.5.3	
ATM Session Parameters	3.5.3	
M values 0 No Merge	3.5.3	
1 VP Merge	3.5.3	
2 VC Merge	3.5.3	
3 VP & VC Merge	3.5.3	
D-bit	3.5.3	
ATM Label Range Component	3.5.3	
Frame Relay Session Parameters	3.5.3	
M values 0 No Merge	3.5.3	
1 Merge	3.5.3	
D-bit	3.5.3	
Frame Relay Label Range Component	3.5.3	
Label Request Message Id	3.5.7	
Vendor-Private	3.6.1.1	
Experimental	3.6.2	

```
===================+=============================+=======================
LDP Messages       | 3.5, throughout
-------------------+-----------------------------+-----------------------
  Notification     | 3.5.1                       |
-------------------+-----------------------------+-----------------------
  Hello            | 3.5.2                       |
-------------------+-----------------------------+-----------------------
  Initialization   | 3.5.3                       |
-------------------+-----------------------------+-----------------------
  KeepAlive        | 3.5.4                       |
-------------------+-----------------------------+-----------------------
  Address          | 3.5.5                       |
-------------------+-----------------------------+-----------------------
  Address Withdraw | 3.5.6                       |
-------------------+-----------------------------+-----------------------
  Label Mapping    | 3.5.7                       |
-------------------+-----------------------------+-----------------------
    Label Request  | 3.5.7                       |
    Message Id TLV |                             |
  -----------------+-----------------------------+-----------------------
    Hop Count TLV  | 3.5.7                       |
  -----------------+-----------------------------+-----------------------
    Path Vect TLV  | 3.5.7                       |
-------------------+-----------------------------+-----------------------
  Label Request    | 3.5.8                       |
  -----------------+-----------------------------+-----------------------
    Hop Count TLV  | 3.5.8                       |
  -----------------+-----------------------------+-----------------------
    Path Vect TLV  | 3.5.8                       |
-------------------+-----------------------------+-----------------------
  Label Withdraw   | 3.5.10                      |
  -----------------+-----------------------------+-----------------------
    Label TLV      | 3.5.10                      |
-------------------+-----------------------------+-----------------------
  Label Release    | 3.5.11                      |
  -----------------+-----------------------------+-----------------------
    Label TLV      | 3.5.11                      |
-------------------+-----------------------------+-----------------------
  Label Abort Req  | 3.5.9                       |
-------------------+-----------------------------+-----------------------
  Vendor-Private   | 3.6.1.2                     |
-------------------+-----------------------------+-----------------------
  Experimental     | 3.6.2                       |
```

LDP Status Codes	3.4.6	
Success	3.4.6, 3.9	
Bad LDP Id	3.5.1.2.1	
Bad Ptcl Version	3.5.1.2.1	
Bad PDU Length	3.5.1.2.1	
Unknown Message Type	3.5.1.2.1	
Bad Message Length	3.5.1.2.1	
Unknown TLV	3.5.1.2.2	
Bad TLV length	3.5.1.2.2	
Malformed TLV Value	3.5.1.2.2	
Hold Timer Expired	3.5.1.2.3	
Shutdown	3.5.1.2.4	
Loop Detected	3.4.5.1.2, 3.5.8.1	
Unknown FEC	3.4.1.1	
No Route	3.5.8.1	
No Label Resources	3.5.8.1	
Label Resources Available	3.5.8.1	
Session Rejected No Hello	2.5.3, 3.5.3	

Session Rejected Parameters Advert Mode	2.5.3, 3.5.3	
Session Rejected Parameters Max PDU Length	2.5.3, 3.5.3	
Session Rejected Parameters Label Range	2.5.3, 3.5.3	
KeepAlive Timer Expired	2.5.6, 3.5.1.2.3	
Label Request Aborted	3.5.9.1	
Missing Message Parameters	3.5.1.2.1	
Unsupported Address Family	3.4.1.1, 3.5.5.1	
Session Rejected Bad KeepAlive Time	3.5.1.2.5, 3.5.3	
Internal Error	3.5.1.2.7	

Author's Addresses

   Bob Thomas
   Cisco Systems, Inc.
   1414 Massachusetts Ave.
   Boxborough MA 01719

   EMail: rhthomas@cisco.com

   Loa Andersson
   Acreo AB
   Isafjordsgatan 22
   Kista, Sweden

   EMail: loa.andersson@acreo.se
          loa@pi.se