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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.

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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

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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 Survey Result		RFC 3036 Section(s)
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 Component	3.5.3
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 Component	3.5.3
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 Message Id TLV	3.5.7	
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	
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