LDP Capabilities

Abstract

   A number of enhancements to the Label Distribution Protocol (LDP)
   have been proposed. Some have been implemented, and some are
   advancing toward standardization. It is likely that additional
   enhancements will be proposed in the future. This document defines a
   mechanism for advertising LDP enhancements at session initialization
   time, as well as a mechanism to enable and disable enhancements after
   LDP session establishment.

Status of This Memo

   This document specifies an Internet standards track protocol for the
   Internet community, and requests discussion and suggestions for
   improvements. Please refer to the current edition of the "Internet
   Official Protocol Standards" (STD 1) for the standardization state
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than English.

Table of Contents

1. Introduction

   A number of enhancements to LDP as specified in [RFC5036] have been
   proposed. These include LDP Graceful Restart [RFC3478], Fault
   Tolerant LDP [RFC3479], multicast extensions [MLDP], signaling for
   Layer 2 circuits [RFC4447], a method for learning labels advertised
   by next-next-hop routers in support of fast reroute node protection
   [NNHOP], upstream label allocation [UPSTREAM_LDP], and extensions for
   signaling inter-area Label Switched Paths (LSPs) [RFC5283]. Some
   have been implemented, and some are advancing toward standardization.
   It is also likely that additional enhancements will be implemented
   and deployed in the future.

   This document proposes and defines a mechanism for advertising LDP
   enhancements at session initialization time. It also defines a
   mechanism to enable and disable these enhancements after LDP session
   establishment.

LDP capability advertisement provides means for an LDP speaker to
announce what it can receive and process. It also provides means for
a speaker to inform peers of deviations from behavior specified by
[RFC5036]. An example of such a deviation is LDP Graceful Restart,
where a speaker retains MPLS forwarding state for LDP-signaled LSPs
when its LDP control plane goes down. It is important to point out
that not all LDP enhancements require capability advertisement. For
example, upstream label allocation requires capability advertisement,
but inbound label filtering, where a speaker installs forwarding
state for only certain Forwarding Equivalence Classes (FECs), does
not.

1.1. 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 [RFC2119].

This document uses the terms "LDP speaker" and "speaker"
interchangeably.

2. The LDP Capability Mechanism

Enhancements are likely to be announced during LDP session
establishment as each LDP speaker advertises capabilities
corresponding to the enhancements it desires.

Beyond that, capability advertisements may be used to dynamically
modify the characteristics of the session to suit the changing
conditions. For example, an LSR capable of a particular enhancement
in support of some "feature" may not have advertised the
corresponding capability to its peers at session establishment time
because the feature was disabled at that time. Later, an operator
may enable the feature, at which time the LSR would react by
advertising the corresponding capability to its peers. Similarly,
when an operator disables a feature associated with a capability, the
LSR reacts by withdrawing the capability advertisement from its
peers.

The LDP capability advertisement mechanism operates as follows:

- Each LDP speaker is assumed to implement a set of enhancements,
  each of which has an associated capability. At any time, a speaker
  may have none, one, or more of those enhancements "enabled". When
  an enhancement is enabled, the speaker advertises the associated
  capability to its peers. By advertising the capability to a peer,
  the speaker asserts that it shall perform the protocol actions
  specified for the associated enhancement. For example, the actions

may require the LDP speaker to receive and process enhancement-
specific messages from its peer. Unless the capability has been
advertised, the speaker will not perform protocol actions specified
for the corresponding enhancement.

   - At session establishment time, an LDP speaker MAY advertise a
     particular capability by including an optional parameter associated
     with the capability in its Initialization message.

   - There is a well-known capability called Dynamic Capability
     Announcement that an LDP speaker MAY advertise in its
     Initialization message to indicate that it is capable of processing
     capability announcements following a session establishment.

     If a peer had advertised the Dynamic Capability Announcement
     capability in its Initialization message, then at any time
     following session establishment, an LDP speaker MAY announce
     changes in its advertised capabilities to that peer. To do this,
     the LDP speaker sends the peer a Capability message that specifies
     the capabilities being advertised or withdrawn.

2.1. Capability Document

   When the capability advertisement mechanism is in place, an LDP
   enhancement requiring LDP capability advertisement will be specified
   by a document that:

      - Describes the motivation for the enhancement;

      - Specifies the behavior of LDP when the enhancement is enabled.
        This includes the procedures, parameters, messages, and TLVs
        required by the enhancement;

      - Includes an IANA considerations section that requests IANA
        assignment of a code point (from TLV Type namespace) for the
        optional capability parameter corresponding to the enhancement.

        The capability document MUST also describe the interpretation
        and processing of associated capability data, if present.

3. Specifying Capabilities in LDP Messages

   This document uses the term "Capability Parameter" to refer to an
   optional parameter that may be included in Initialization and
   Capability messages to advertise a capability.

The format of a "Capability Parameter" TLV is as follows:

```
 0                   1                   2                   3
 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|U|F| TLV Code Point            |              Length           |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|S| Reserved      |                                             |
+-+-+-+-+-+-+-+-+-+            Capability Data                  |
|                                         +-+-+-+-+-+-+-+-+-+-+-+
|                                         |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```
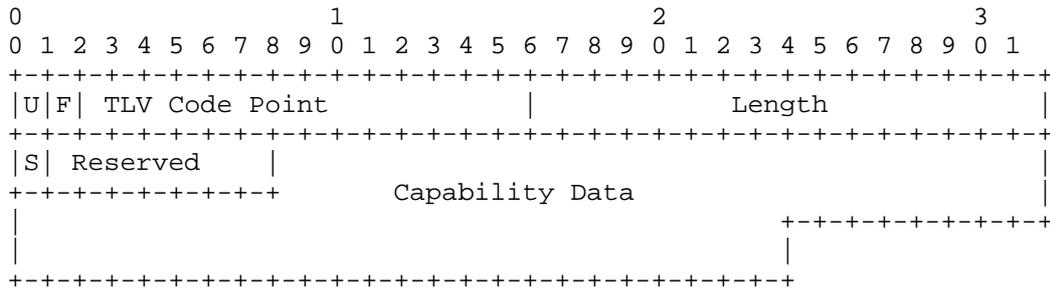
where:

   U-bit:
      Unknown TLV bit, as described in [RFC5036]. The value could be
      either 0 or 1 as specified in the Capability document associated
      with the given capability.

   F-bit:
      Forward unknown TLV bit, as described in [RFC5036]. The value
      of this bit MUST be 0 since a Capability Parameter TLV is sent
      only in Initialization and Capability messages, which are not
      forwarded.

   TLV Code Point:
      The TLV type that identifies a specific capability. This is an
      IANA-assigned code point (from TLV Type namespace) for a given
      capability as requested in the associated capability document.

   S-bit:
      The State Bit. It indicates whether the sender is advertising
      or withdrawing the capability corresponding to the TLV code
      point. The State Bit value is used as follows:

        1 - The TLV is advertising the capability specified by the TLV
            code point.

        0 - The TLV is withdrawing the capability specified by the TLV
            code point.

   Capability Data:
      Information, if any, about the capability in addition to the TLV
      code point required to fully specify the capability.

      The method for interpreting and processing this data is specific
      to the TLV code point and MUST be described in the document
      specifying the capability.

   An LDP speaker MUST NOT include more than one instance of a
   Capability Parameter (as identified by the same TLV code point) in an
   Initialization or Capability message. If an LDP speaker receives
   more than one instance of the same Capability Parameter type in a
   message, it SHOULD send a Notification message to the peer before
   terminating the session with the peer. The Status Code in the Status
   TLV of the Notification message MUST be Malformed TLV value, and the
   message SHOULD contain the second Capability Parameter TLV of the
   same type (code point) that is received in the message.

3.1. Backward Compatibility TLVs

   LDP extensions that require advertisement or negotiation of some
   capability at session establishment time typically use TLVs that are
   included in an Initialization message. To ensure backward
   compatibility with existing implementations, such TLVs continue to be
   supported in an Initialization message and are known in this document
   as "Backward Compatibility TLVs". A Backward Compatibility TLV plays
   the role of a "Capability Parameter" TLV; that is, the presence of a
   Backward Compatibility TLV has the same meaning as a Capability
   Parameter TLV with the S-bit set for the same capability.

   One example of a Backward Capability TLV is the "FT Session TLV" that
   is exchanged in an Initialization message between peers to announce
   LDP Fault Tolerance [RFC3479] capability.

4. Capability Message

   The LDP Capability message is used by an LDP speaker to announce
   changes in the state of one or more of its capabilities subsequent to
   session establishment.

The format of the Capability message is as follows:

```
 0                   1                   2                   3
 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|0|    Capability (0x0202)      |             Length            |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                           Message ID                          |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                             TLV_1                             |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                             . . .                             |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                             TLV_N                             |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```
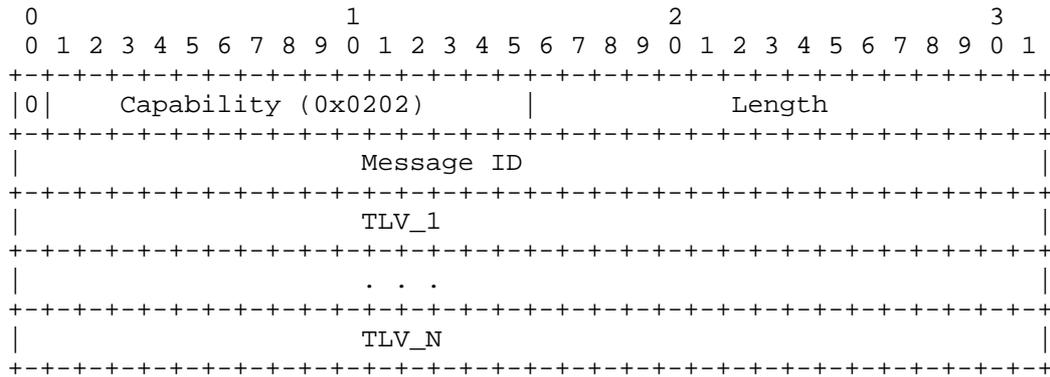
where TLV_1 through TLV_N are Capability Parameter TLVs. The S-bit
of each of the TLVs specifies the new state for the corresponding
capability.

Note that Backward Compatibility TLVs (see Section 3.1) MUST NOT be
included in Capability messages. An LDP speaker that receives a
Capability message from a peer that includes Backward Compatibility
TLVs SHOULD silently ignore these Backward Compatibility TLVs and
continue processing the rest of the message.

5. Note on Terminology

   The following sections in this document talk about enabling and
   disabling capabilities. The terminology "enabling (or disabling) a
   capability" is short hand for "advertising (or withdrawing) a
   capability associated with an enhancement". Bear in mind that it is
   an LDP enhancement that is being enabled or disabled, and that it is
   the corresponding capability that is being advertised or withdrawn.

6. Procedures for Capability Parameters in Initialization Messages

   The S-bit of a Capability Parameter in an Initialization message MUST
   be 1 and SHOULD be ignored on receipt. This ensures that any
   Capability Parameter in an Initialization message enables the
   corresponding capability.

   An LDP speaker determines the capabilities of a peer by examining the
   set of Capability Parameters present in the Initialization message
   received from the peer.

   An LDP speaker MAY use a particular capability with its peer after
   the speaker determines that the peer has enabled that capability.

These procedures enable an LDP speaker S1, that advertises a specific
LDP capability C, to establish an LDP session with speaker S2 that
does not advertise C. In this situation, whether or not capability C
may be used for the session depends on the semantics of the
enhancement associated with C. If the semantics do not require both
S1 and S2, advertise C to one another, then S2 could use it; i.e.,
S1's advertisement of C permits S2 to send messages to S1 used by the
enhancement.

It is the responsibility of the capability designer to specify the
behavior of an LDP speaker that has enabled a certain enhancement,
advertised its capability and determines that its peer has not
advertised the corresponding capability. The document specifying
procedures for the capability MUST describe the behavior in this
situation. If the specified procedure is to terminate the session,
then the LDP speaker SHOULD send a Notification message to the peer
before terminating the session. The Status Code in the Status TLV of
the Notification message MUST be Unsupported Capability, and the
message SHOULD contain the unsupported capability (see Section 8 for
more details).

An LDP speaker that supports capability advertisement and includes a
Capability Parameter in its Initialization message MUST set the TLV
U-bit to 0 or 1, as specified by Capability document. The LDP
speaker should set the U-bit to 1 if the capability document allows
it to continue with a peer that does not understand the enhancement,
and set the U-bit to 0 otherwise. If a speaker receives a message
containing unsupported capability, it responds according to the U-bit
setting in the TLV. If the U-bit is 1, then the speaker MUST
silently ignore the Capability Parameter and allow the session to be
established. However, if the U-bit is 0, then speaker SHOULD send a
Notification message to the peer before terminating the session. The
Status Code in the Status TLV of the Notification message MUST be
Unsupported Capability, and the message SHOULD contain the
unsupported capability (see Section 8 for more details).

7. Procedures for Capability Parameters in Capability Messages

An LDP speaker MUST NOT send a Capability message to a peer unless
its peer advertised the Dynamic Capability Announcement capability in
its session Initialization message. An LDP speaker MAY send a
Capability message to a peer if its peer advertised the Dynamic
Capability Announcement capability in its session Initialization
message (see Section 9).

An LDP speaker determines the capabilities enabled by a peer by
determining the set of capabilities enabled at session initialization
(as specified in Section 6) and tracking changes to that set made by
Capability messages from the peer.

An LDP speaker that has enabled a particular capability MAY use the
enhancement corresponding to the capability with a peer after the
speaker determines that the peer has enabled the capability.

8. Extensions to Error Handling

This document defines a new LDP status code named Unsupported
Capability. The E-bit of the Status TLV carried in a Notification
message that includes this status code MUST be set to 0.

In addition, this document defines a new LDP TLV, named Returned
TLVs, that MAY be carried in a Notification message as an Optional
Parameter. The U-bit setting for a Returned TLVs TLV in a
Notification message SHOULD be 1, and the F-bit setting SHOULD be 0.

When the Status Code in a Notification message is Unsupported
Capability, the message SHOULD specify the capabilities that are
unsupported. When the Notification message specifies the unsupported
capabilities, it MUST include a Returned TLVs TLV. The Returned TLVs
TLV MUST include only the Capability Parameters for unsupported
capabilities, and the Capability Parameter for each such capability
SHOULD be encoded as received from the peer.

When the Status Code in a Notification Message is Unknown TLV, the
message SHOULD specify the TLV that was unknown. When the
Notification message specifies the TLV that was unknown, it MUST
include the unknown TLV in a Returned TLVs TLV.

9. Dynamic Capability Announcement TLV

The Dynamic Capability Announcement TLV is a Capability Parameter
defined by this document with following format:

```
    0                   1                   2                   3
    0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |1|0| DynCap Ann. (0x0506)      |              Length (1)       |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |1| Reserved    |
   +-+-+-+-+-+-+-+-+
```
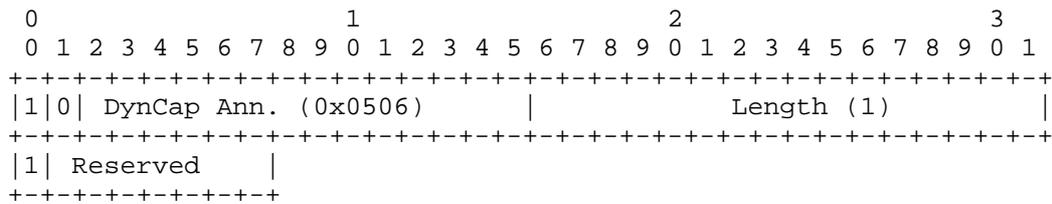
The value of the U-bit for the Dynamic Capability Announcement
Parameter TLV MUST be set to 1 so that a receiver MUST silently
ignore this TLV if unknown to it, and continue processing the rest of
the message. There is no "Capability Data" associated with this TLV
and hence the TLV length MUST be set to 1.

The Dynamic Capability Announcement Parameter MAY be included by an
LDP speaker in an Initialization message to signal its peer that the
speaker is capable of processing Capability messages.

An LDP speaker MUST NOT include the Dynamic Capability Announcement
Parameter in Capability messages sent to its peers. Once enabled
during session initialization, the Dynamic Capability Announcement
capability cannot be disabled. This implies that the S-bit is always
1 for the Dynamic Capability Announcement.

An LDP speaker that receives a Capability message from a peer that
includes the Dynamic Capability Announcement Parameter SHOULD
silently ignore the parameter and process any other Capability
Parameters in the message.

10. Backward Compatibility

From the point of view of the LDP capability advertisement mechanism,
an [RFC5036]-compliant peer has label distribution for IPv4 enabled
by default. To ensure compatibility with an [RFC5036]-compliant
peer, LDP implementations that support capability advertisement have
label distribution for IPv4 enabled until it is explicitly disabled
and MUST assume that their peers do as well.

Section 3.1 introduces the concept of Backward Compatibility TLVs
that may appear in an Initialization message in the role of a
Capability Parameter. This permits existing LDP enhancements that
use an ad hoc mechanism for enabling capabilities at session
initialization time to continue to do so.

11. Security Considerations

[MPLS_SEC] describes the security framework for MPLS networks,
whereas [RFC5036] describes the security considerations that apply to
the base LDP specification. The same security framework and
considerations apply to the capability mechanism described in this
document.

12. IANA Considerations

   This document specifies the following code points assigned by IANA:

      - LDP message code point for the Capability message (0x0202).

      - LDP TLV code point for the Dynamic Capability Announcement TLV
        (0x0506).

      - LDP TLV code point for the Returned TLVs TLV (0x0304).

      - LDP Status Code code point for the Unsupported Capability Status
        Code (0x0000002E).

13. Acknowledgments

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14.1. Normative References

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