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LDP Capabilities

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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. At present LDP has no
   guidelines for advertising such enhancements at LDP session
   initialization time. There is also no mechanism to enable and
   disable enhancements after the session is established. This document
   provides guidelines for advertising LDP enhancements at session
   initialization time. It also defines a mechanism to enable and
   disable enhancements after LDP session establishment.

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1. **Introduction**

A number of enhancements to LDP as specified in [RFC3036] 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 LSPs [IALDP]. Some have been implemented, and
some are advancing toward standardization. It is likely that
additional enhancements will be proposed in the future.

At present LDP has no guidelines for advertising such enhancements at
LDP session initialization time. There is also no mechanism to
enable and disable enhancements after the session is established.

This document provides guidelines for advertising LDP enhancements at
session initialization time. It also defines a mechanism to enable
and disable 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
[RFC3036]. 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 does but inbound label filtering,
where a speaker installs forwarding state for only certain FECs, does
not.

2. **Specification Language**

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].

3. **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 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 involve receiving and processing
    messages from a peer that the enhancement requires. 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 which an LDP speaker MAY advertise in its
    Initialization message to indicate that it is capable of
    processing capability announcements following 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.

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 notes that an IANA-
       assigned code point for the optional parameter corresponding to
       the enhancement is required.

4. **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 TLV that is a Capability Parameter 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
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |U|F| TLV Code Point            |              Length           |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |S| Reserved    |                                               |
   +-+-+-+-+-+-+-+-+-+       Capability Data                       |
   |                                       +-+-+-+-+-+-+-+-+-+      |
   |                                       |                       |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```
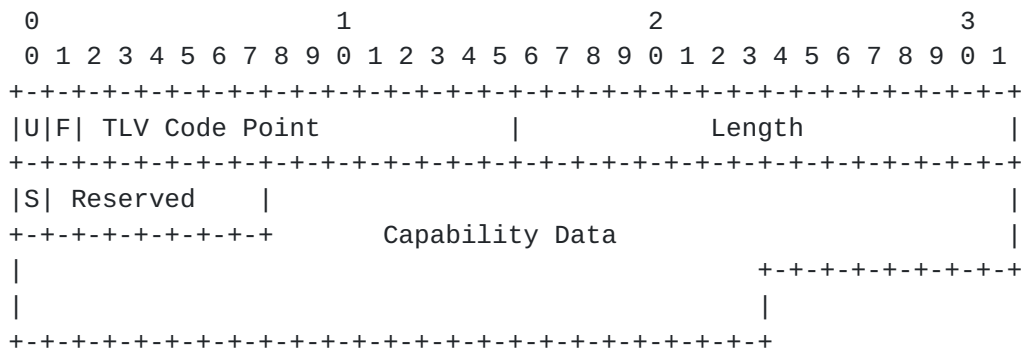
   where:
     U and F bits:
       As specified in [RFC3036].

     TLV Code Point:
       The TLV type which identifies a specific capability. The "IANA
       Considerations" section of [RFC3036] specifies the assignment of
       code points for LDP TLVs.

     S-bit:
       The State Bit indicates whether the sender is advertising or
       withdrawing the capability corresponding to the TLV Code Point.
       The State bit 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.

An LDP speaker MAY include more than one instance of a Capability
Parameter (as identified by the TLV Code Point) with different non-
empty Capability Data in an Initialization or Capability message.
The method for processing such Capability Parameters is specific to
the TLV Code Point and MUST be described in the document specifying
the capability.

To ensure backward compatibility with existing implementations the
following TLVs play the role of a Capability Parameter when included
in Initialization messages:

    - FT Session TLV [RFC3479]

This document refers to such TLVs as Backward Compatibility TLVs.

5. **Capability Message**

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

The format of the Capability message is:

```
    0                   1                   2                   3
    0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |0|    Capability (IANA)       |             Length            |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |                          Message ID                          |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |                           TLV_1                              |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |                          . . .                               |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |                           TLV_N                              |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

where TLV_1 through TLV_N are Capability Parameters. The S-bit of
each of the TLVs specifies the new state for the corresponding
capability.

Note that Backward Compatibility TLVs (see Section 4) MUST NOT be
included in Capability messages.

6. **Note on Terminology**

   The sections that follow talk of 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
   enabled or disabled and that it is the corresponding capability that
   is advertisted or withdrawn.

7. **Procedures for Capability Parameters in Initialization Messages**

   An LDP speaker SHOULD NOT include more than one instance of a
   Capability Parameter with the same type and value in an
   Initialization message. Note, however, that processing multiple
   instances of such a parameter does not require special handling, as
   additional instances do not change the meaning of an announced
   capability.

   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 enabled by a peer by
   examining the set of 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 A that advertises a specific
   LDP capability C to establish an LDP session with speaker B 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 A and B
   advertise C to one another then B could use it; that is, A's
   advertisement of C permits B to send messages to A 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
   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 SHOULD be Unsupported Capability, and the
message SHOULD contain the unsupported capabilities (see Section 9
for more details). In this case the session SHOULD NOT be re-
established automatically. How the session is re-established is
beyond the scope of this document. It depends on the LDP capability
and MUST be specified along with the procedures specifying the
capability.

An LDP speaker that supports capability advertisement and includes a
Capability Parameter in its Initialization message SHOULD set the TLV
U bit to 1. This ensures that an [RFC3036] compliant peer that does
not support the capability mechanism will ignore the Capability
Parameter and allow the session to be established.

8. Procedures for Capability Parameters in Capability Messages

An LDP speaker MUST NOT send a Capability message to a peer unless
its peer had advertised the Dynamic Capability Announcement
capability in its session Initialization message (see Section 10).

An LDP speaker MAY send a Capability message to a peer if its peer
had advertised the Dynamic Capability Announcement capability in its
session Initialization message (see Section 10).

An LDP speaker determines the capabilities enabled by a peer by
determining the set of capabilities enabled at session initialization
(as specified in Section 7) 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.

9. 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 SHOULD be set to 0.

In addition, this document defines a new LDP TLV named Returned TLVs
TLV that MAY be carried in a Notification message. 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 which includes each
   unsupported Capability Parameter. The Returned TLVs TLV MUST include
   only the Capability Parameters for unsupported capabilities. In
   addition, 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.

10. **Dynamic Capability Announcement TLV**

   The Dynamic Capability Announcement TLV is a Capability Parameter.
   Its format 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|0| DynCap Announcement (IANA)|           Length             |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |S| Reserved     |
   +-+-+-+-+-+-+-+-+-+
```

   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.

   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.

11. Backward Compatibility

From the point of view of the LDP capability advertisement mechanism an [RFC3036] compliant peer has label distribution for IPv4 enabled by default. To ensure compatibility with an [RFC3036] 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 identifies a set of Backward Compatibility TLVs that may appear in Initialization messages in the role of a Capability Parameter. This permits existing LDP enhancements that use an ad hoc mechanism for enabling capabilities at sesssion initialization time to continue to do so.

12. Security Considerations

The security considerations described in [RFC3036] that apply to the base LDP specification apply to the capability mechanism described in this document.

13. IANA Considerations

This document specifies the following which require code points assigned by IANA:

- LDP message code point for the Capability message. The authors request message type 0x0202 for the Capability message.

- LDP TLV code point for the Dynamic Capability Announcemnt TLV. The authors request TLV type code 0x0506.

- LDP TLV code point for the Returned TLVs TLV. The authors request TLV type 0x304.

- LDP Status Code code point for the Unsupported Capability Status Code. The authors request Status Code 0x0000002C.

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15. References

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