                 Signaling LDP Label Advertisement Completion

Abstract

   There are situations following Label Distribution Protocol (LDP)
   session establishment where it would be useful for an LDP speaker to
   know when its peer has advertised all of its labels. The LDP
   specification provides no mechanism for an LDP speaker to notify a
   peer when it has completed its initial label advertisements to that
   peer. This document specifies means for an LDP speaker to signal
   completion of its initial label advertisements following session
   establishment.

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Table of Contents

1. Introduction

   There are situations following LDP session establishment where it
   would be useful for an LDP speaker to know when its peer has
   advertised all of the labels from its Label Information Base (LIB).
   For example, when an LDP speaker is using LDP-IGP synchronization
   procedures [RFC5443], it would be useful for the speaker to know when
   its peer has completed advertisement of its IP label bindings.
   Similarly, after an LDP session is re-established when LDP Graceful
   Restart [RFC3478] is in effect, it would be helpful for each peer to
   signal the other after it has advertised all its label bindings.

   The LDP specification [RFC5036] provides no mechanism for an LDP
   speaker to notify a peer when it has completed its initial label
   advertisements to that peer.

   This document specifies use of a Notification message with the End-
   of-LIB Status Code for an LDP speaker to signal completion of its
   label advertisements following session establishment.

   RFC 5036 implicitly assumes that new Status Codes will be defined
   over the course of time. However, it does not explicitly define the
   behavior of an LDP speaker that does not understand the Status Code
   in a Notification message. To avoid backward compatibility issues,
   this document specifies use of the LDP capability mechanism [RFC5561]
   at session establishment time for informing a peer that an LDP
   speaker is capable of handling a Notification message that carries an
   unrecognized Status Code.

1.1. Applicability - Label Advertisement Mode

   The mechanisms specified in this document are deemed useful to LDP
   peering using the 'Downstream Unsolicited' label advertisement mode
   [RFC5036]. They are not deemed useful to any LDP peering using the
   'Downstream on Demand' label advertisement mode since the LDP speaker
   would request particular label binding(s) from the peer anyway and
   know when it has received them.

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. Unrecognized Notification Capability

   An LDP speaker MAY include a Capability Parameter [RFC5561] in the
   Initialization message to inform a peer that it ignores Notification
   Messages that carry a Status Type-Length-Value (TLV) with a non-fatal
   Status Code unknown to it.

   The Capability Parameter for the Unrecognized Notification capability
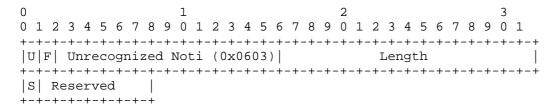   is a TLV with the following format:

```
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
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|U|F| Unrecognized Noti (0x0603)|           Length              |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|S| Reserved     |
+-+-+-+-+-+-+-+-+-+
```

           Figure 1: Unrecognized Notification Capability Format

   Where:

      U- and F-bits: MUST be 1 and 0, respectively, as per Section 3 of
         LDP Capabilities [RFC5561].

      Unrecognized Notif: 0x0603

      S-bit: MUST be 1 (indicates that capability is being advertised).

   Upon receiving a Notification with an unrecognized Status Code, an
   LDP speaker MAY generate a console or system log message for trouble
   shooting purposes.

4. Signaling Completion of Label Advertisement

   An LDP speaker that conforms to this specification SHOULD signal
   completion of its label advertisements to a peer by means of a
   Notification message, if its peer has advertised the Unrecognized
   Notification capability during session establishment. The LDP
   speaker SHOULD send the Notification message (per Forwarding
   Equivalence Class (FEC) Type) to a peer even if the LDP speaker has
   zero Label bindings to advertise to that peer.

   Such a Notification message MUST carry:

      - A status TLV (with TLV E- and F-bits set to zero) that carries
        an End-of-LIB Status Code (0x0000002F).

      - A FEC TLV with the Typed Wildcard FEC Element [RFC5918] that
        identifies the FEC type for which initial label advertisements
        have been completed. In terms of Section 3.5.1 of RFC 5036,
        this TLV is an "Optional Parameter" of the Notification message.

   An LDP speaker MUST NOT send a Notification that carries a Status TLV
   with the End-of-LIB Status Code to a peer unless the peer has
   advertised the Unrecognized Notification capability during session
   establishment.

   This applies to any LDP peers discovered via either basic discovery
   or extended discovery mechanisms (per Section 2.4 of [RFC5036]).

4.1. Missing Expected End-of-LIB Notifications

   There is no guarantee that an LDP speaker will receive (or send) an
   End-of-LIB Notification from (or to) a peer even if the LDP speaker
   has signaled the Unrecognized Notification capability (Section 3).

   Although it is expected that an LDP speaker supporting the
   Unrecognized Notification capability would support sending and
   receiving an End-of-LIB Notification, it is not mandatory by
   definition.

   Please note that this is not a concern since the LDP speaker would
   simply ignore the received Notification with an End-of-LIB status
   code (or any status code) that is not recognized or supported, by
   definition.

   To deal with the possibility of missing End-of-LIB Notifications
   after the LDP session establishment, an LDP speaker MAY time out
   receipt of an expected End-of-LIB Notification. An LDP speaker
   SHOULD start a per-peer internal timer, called 'EOL Notification'
   timer (the default value of 60 seconds is RECOMMENDED, though the
   value of this timer SHOULD be configurable) immediately following the
   LDP session establishment.

   This timer is reset by the subsequent label advertisement, and
   stopped by the End-of-LIB Notification message. Lacking any label
   advertisement from the peer, the timer would expire, causing the LDP
   speaker to behave as if it had received the End-of-LIB notification
   from the peer.

   If the End-of-LIB Notification message is received after the timer
   expires, then the message SHOULD be ignored.

5. Usage Guidelines

   The FECs known to an LDP speaker and the labels the speaker has bound
   to those FECs may change over the course of time. This makes it
   difficult to determine when an LDP speaker has advertised "all" of
   its label bindings for a given FEC type. Ultimately, this
   determination is a judgment call the LDP speaker makes. The
   following guidelines may be useful.

   An LDP speaker is assumed to "know" a set of FECs. Depending on a
   variety of criteria, such as:

      - the label distribution control mode in use (Independent or
        Ordered);

      - the set of FECs to which the speaker has bound local labels;

      - configuration settings that may constrain which label bindings
        the speaker may advertise to peers.

   The speaker can determine the set of bindings for a given FEC type
   that it is permitted to advertise to a given peer.

   LDP-IGP Sync, LDP Graceful Restart, and the response to a Wildcard
   Label Request [RFC5918] are situations that would benefit from End-
   of-LIB Notification. In these situations, after an LDP speaker
   completes its label binding advertisements to a peer, sending an End-
   of-LIB Notification to the peer makes their outcome deterministic.
   The following subsections further explain each of these situations
   one by one.

5.1. LDP-IGP Sync

   The LDP-IGP Synchronization [RFC5443] specifies a mechanism by which
   directly connected LDP speakers may delay the use of the link
   (between them) for transit IP traffic forwarding until the labels
   required to support IP-over-MPLS traffic forwarding have been
   distributed and installed.

   Without an End-of-LIB Notification, the speaker must rely on some
   heuristic to determine when it has received all of its peer's label
   bindings. The heuristic chosen could cause LDP to signal the IGP too
   soon (in which case, the likelihood that traffic will be dropped
   increases) or too late (in which case, traffic is kept on sub-optimal
   paths longer than necessary).

Following session establishment, with a directly connected peer that
has advertised the Unrecognized Notification capability, an LDP
speaker using LDP-IGP Sync may send the peer an End-of-LIB
Notification after it completes advertisement of its IP label
bindings to the peer. Similarly, the LDP speaker may use the End-of-
LIB Notification received from a directly connected peer to determine
when the peer has completed advertisement of its label bindings for
IP prefixes. After receiving the notification, the LDP speaker
should consider LDP to be fully operational for the link and should
signal the IGP to start advertising the link with normal cost.

5.2. LDP Graceful Restart

LDP Graceful Restart [RFC3478] helps to reduce the loss of MPLS
traffic caused by the restart of a router's LDP component. It
defines procedures that allow routers capable of preserving MPLS
forwarding state across the restart to continue forwarding MPLS
traffic using forwarding state installed prior to the restart for a
configured time period.

The current behavior without End-of-LIB Notification is as follows:
the restarting router and its peers consider the preserved forwarding
state to be usable but stale until it is refreshed by receipt of new
label advertisements following re-establishment of new LDP sessions
or until the time period expires. When the time period expires, any
remaining stale forwarding state is removed by the router.

Receiving End-of-LIB Notification from a peer in an LDP Graceful
Restart scenario enables an LDP speaker to stop using stale
forwarding information learned from that peer and to recover the
resources it requires without having to wait until the time period
expiry. The time period expiry can still be used if the End-of-LIB
Notification message is not received.

5.3. Wildcard Label Request

When an LDP speaker receives a Label Request message for a Typed
Wildcard FEC (e.g., a particular FEC Element Type) from a peer, the
LDP speaker determines the set of bindings (as per any local
filtering policy) to advertise to the peer for the FEC type specified
by the request. Assuming the peer had advertised the Unrecognized
Notification capability at session initialization time, the speaker
should send the peer an End-of-LIB Notification for the FEC type when
it completes advertisement of the permitted bindings.

As in the previous applications, receipt of the Notification
eliminates uncertainty as to when the peer has completed its
advertisements of label bindings for the requested Wildcard FEC
Element Type.

6. Security Considerations

No security considerations beyond those that apply to the base LDP
specification [RFC5036] and that are further described in [RFC5920]
apply to signaling the End-of-LIB condition as described in this
document.

7. IANA Considerations

This document introduces a new LDP Status Code and a new LDP
Capability.

IANA has assigned the 'End-of-LIB' status code (0x0000002F) from
the Status Code Name Space. [RFC5036] partitions the Status Code
Name Space into 3 regions: IETF Consensus region, First Come First
Served region, and Private Use region. The code point 0x0000002F
is from the IETF Consensus range.

IANA has assigned the 'Unrecognized Notification' capability
(0x0603) from the TLV Type name space. [RFC5036] partitions the
TLV Type name space into 3 regions: IETF Consensus region, Vendor
Private Use region, and Experimental Use region. The code point
0x0603 is from the IETF Consensus range.

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