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MPLS Upstream Label Assignment for LDP

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Abstract

This document describes procedures for distributing upstream-assigned labels for Label Distribution Protocol (LDP). It also describes how these procedures can be used for avoiding branch LSR traffic replication on a LAN for LDP point-to-multipoint (P2MP)LSPs.

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[1. Specification of requirements](#)

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](#)].

[2. Introduction](#)

This document describes procedures for distributing upstream-assigned labels [[MPLS-UPSTREAM](#)] for Label Distribution Protocol (LDP). These procedures follow the architecture for MPLS Upstream Label Assignment described in [[MPLS-UPSTREAM](#)].

This document describes extensions to LDP that a LSR can use to advertise to its neighboring LSRs whether the LSR supports upstream label assignment.

This document also describes extensions to LDP to distribute upstream-assigned labels.

The usage of MPLS upstream label assignment using LDP for avoiding branch LSR traffic replication on a LAN for LDP P2MP LSPs [LDP-P2MP1, LDP-P2MP2] is also described.

3. LDP Upstream Label Assignment Capability

According to [MPLS-UPSTREAM], upstream-assigned label bindings MUST NOT be used unless it is known that a downstream LSR supports them. This implies that there MUST be a mechanism to enable a LSR to advertise to its LDP neighbor LSR(s) its support of upstream-assigned labels.

A new optional parameter, the LDP Capability TLV, is introduced to allow LDP peers to exchange capabilities as part of LDP Initialization messages. This TLV contains one or more sub-TLVs, each to signal a specific capability. LDP Capability TLV and detailed procedures for supporting LDP Capability signaling will be described in a separate document.

A Upstream Label Assignment Capability sub-TLV is introduced to signal a LSR's support of upstream label assignment, to its LDP peers. This sub-TLV is carried in the LDP Capability TLV.

Following is the format of the LDP Capability TLV:

```

      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| Capability TLV (TBD)          | Length (= 4)                    |
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
|                                     Sub-TLVs...                      |
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+

```

Following is the format of the Upstream Label Assignment Capability sub-TLV:

```

      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
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
|Upstream Lbl Ass Cap = 1          | Length (= 4)                    |
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
|                                     Reserved                          |
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+

```

If a LSR includes the Upstream Label Assignment Capability sub-TLV in LDP Initialization Messages it implies that the LSR is capable of both distributing upstream-assigned label bindings and receiving upstream-assigned label bindings. Reserved bits MUST be set to zero on transmission and MUST be ignored on receipt.

4. Distributing Upstream-Assigned Labels in LDP

An optional LDP TLV, Upstream-Assigned Label Request TLV, is introduced. This TLV MUST be carried in a Label Request message if an upstream-assigned label is being requested.

```

      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| Upstream Ass Lbl Req (TBD)|          Length          |
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
|                               Reserved                               |
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+

```

An optional LDP TLV, Upstream-Assigned Label TLV is introduced to signal an upstream-assigned label. Upstream-Assigned Label TLVs are carried by the messages used to advertise, release and withdraw upstream assigned label mappings.

```

      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| Upstream Ass Label (TBD) |          Length          |
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
|                               Reserved                               |
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
|                               Label                               |
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+

```

Label

This is a 20-bit label value as specified in RFC3032 represented as a 20-bit number in a 4 octet field.

4.1. Procedures

Procedures for Label Mapping, Label Request, Label Abort, Label Withdraw and Label Release follow RFC3036 other than the modifications pointed out in this section.

A LDP LSR MUST NOT distribute the Upstream Assigned Label TLV to a neighboring LSR if the neighboring LSR had not previously advertised the Upstream Label Assignment Capability in its LDP Initialization messages. A LDP LSR MUST NOT send the Upstream Assigned Label Request TLV to a neighboring LSR if the neighboring LSR had not previously advertised the Upstream Label Assignment Capability in its

LDP Initialization messages.

As described in [[MPLS-UPSTREAM](#)] the distribution of upstream-assigned labels is similar to either ordered LSP control or independent LSP control of the downstream assigned labels.

When the label distributed in a Label Mapping message is an upstream-assigned label, the Upstream Assigned Label TLV MUST be included in the Label Mapping message. When a LSR receives a Label Mapping message with an Upstream Assigned Label TLV and if it does not recognize the TLV, it MUST generate a Notification message with a status code of "Unknown TLV" [[RFC3036](#)]. If it does recognize the TLV but is unable to process the upstream label, it MUST generate a Notification message with a status code of "No Label Resources". If the Label Mapping message was generated in response to a Label Request message, the Label Request message MUST contain an Upstream Assigned Label Request TLV. A LSR that generates an upstream assigned label request to a neighbor LSR, for a given FEC, MUST NOT send a downstream label mapping to the neighbor LSR for that FEC unless it withdraws the upstream-assigned label binding. Similarly if a LSR generates a downstream assigned label request to a neighbor LSR, for a given FEC, it MUST NOT send an upstream label mapping to that LSR for that FEC, unless it aborts the downstream assigned label request.

The Upstream Assigned Label TLV may be optionally included in Label Withdraw and Label Release messages that withdraw/release a particular upstream assigned label binding.

5. LDP Tunnel Identifier Exchange

As described in [[MPLS-UPSTREAM](#)] an upstream LSR Ru MAY transmit a MPLS packet, the top label of which (L) is upstream-assigned, to a downstream LSR Rd, by encapsulating it in an IP or MPLS tunnel. In this case the fact that L is upstream-assigned is determined by Rd by the tunnel on which the packet is received. There must be a mechanism for Ru to inform Rd that a particular tunnel from Ru to Rd will be used by Ru for transmitting MPLS packets with upstream-assigned MPLS labels.

When LDP is used for upstream label assignment, the Interface ID TLV [[RFC3472](#)] is used for signaling the Tunnel Identifier. If Ru uses an IP or MPLS tunnel to transmit MPLS packets with upstream assigned labels to Rd, Ru MUST include the Interface ID TLV in the Label Mapping messages along with the Upstream Assigned Label TLV. Two new Interface ID TLVs are introduced to support RSVP-TE P2MP LSPs and IP Multicast Tunnels. The TLV value acts as the tunnel identifier.

1. RSVP-TE P2MP LSP TLV. Type = TBD. Value of the TLV is the RSVP-TE P2MP Session Object and optionally the P2MP Sender Template Object [[RSVP-TE-P2MP](#)]. The TLV value identifies the RSVP-TE P2MP LSP. It allows Ru to tunnel an "inner" LDP P2MP LSP, the label for which is upstream assigned, over an "outer" RSVP-TE P2MP LSP that has leaves <Rd1...Rdn>. The P2MP LSP IF_ID TLV allows Ru to signal to <Rd1...Rdn> the binding of the inner LDP P2MP LSP to the outer RSVP-TE P2MP LSP. The control plane signaling between Ru and <Rd1...Rdn> for the inner P2MP LSP uses targeted LDP signaling messages
2. IP Multicast Tunnel TLV. Type = TBD. In this case the TLV value is a <Source Address, Multicast Group Address> tuple.

6. LDP Point-to-Multipoint LSPs on a LAN

This section describes one application of upstream label assignment using LDP. Further applications are to be described in separate documents.

[[LDP-P2MP1](#), [LDP-P2MP2](#)] describe how to setup P2MP LSPs using LDP. On a LAN the solution relies on "ingress replication". A LSR on a LAN, that is a branch LSR for a P2MP LSP, (say Ru) sends a separate copy of a packet that it receives on the P2MP LSP to each of the downstream LSRs on the LAN (say <Rd1...Rdn> that are adjacent to it in the P2MP LSP.

It is desirable for Ru to send a single copy of the packet for the LDP P2MP LSP on the LAN, when there are multiple downstream routers on the LAN that are adjacent to Ru in that LDP P2MP LSP. This requires that each of <Rd1...Rdn> must be able to associate the label L, used by Ru to transmit packets for the P2MP LSP on the LAN, with that P2MP LSP. It is possible to achieve this using LDP upstream-assigned labels with the following procedures.

Consider a LSR Rd that receives the LDP P2MP FEC [[LDP-P2MP1](#), [LDP-P2MP2](#)] from its downstream LDP peer. Further the upstream interface to reach LSR Ru which is the next-hop to the P2MP LSP root address, Pr, in the LDP P2MP FEC, is a LAN interface. Further Rd and Ru support upstream-assigned labels. In this case Rd instead of sending a Label Mapping message as described in [[LDP-P2MP1](#), [LDP-P2MP2](#)] sends a Label Request message to Ru. This Label Request message MUST contain an Upstream Assigned Label Request TLV. Ru on receiving this message sends back a Label Mapping message to Rd with an upstream-assigned label. Processing of the Label Request and Label Mapping messages for LDP upstream-assigned labels is as described in [section 4.2](#). If Ru receives a Label Request for an upstream assigned label for the same P2MP FEC from multiple downstream LSRs on the LAN, <Rd1...Rdn>, it

MUST send the same upstream-assigned label to each of <Rd1...Rdn>. Ru transmits the MPLS packet with an upstream-assigned label on the LAN using the procedures defined in [[MPLS-UPSTREAM](#)] and [[MPLS-MCAST-ENCAPS](#)].

Note that <Rd1...Rdn> may have more than one equal cost next-hop on the LAN to reach Pr. In this case they MAY be configured to send the upstream assigned label request to the next-hop LSR with the lowest Router ID, if it is desirable for all of them to send the label request to the same upstream LSR. It is also to be noted that these procedures can still be used by Rd and Ru if other LSRs on the LAN do not support upstream label assignment. Ingress replication and downstream label assignment will continue to be used for LSRs that do not support upstream label assignment.

[7. Acknowledgements](#)

Thanks to Yakov Rekhter for his contribution. Thanks to Ina Minei and Thomas Morin for their comments.

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