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                                                        J. L. Le Roux
                                                        France Telecom

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                 MPLS Upstream Label Assignment for RSVP-TE

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Status of this Memo

Abstract

   This document describes procedures for distributing upstream-assigned
   labels for Resource Reservation Protocol - Traffic Engineering (RSVP-
   TE). It also describes how these procedures can be used for avoiding
   branch LSR traffic replication on a LAN for RSVP-TE point-to-
   multipoint (P2MP)LSPs.

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[1](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](RFC2119)].

[2](2). Introduction

   This document describes procedures for distributing upstream-assigned
   labels [MPLS-UPSTREAM] for Resource Reservation Protocol with Traffic
   Engineering (RSVP-TE). These procedures follow the architecture for
   MPLS Upstream Label Assignment described in [MPLS-UPSTREAM].

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

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

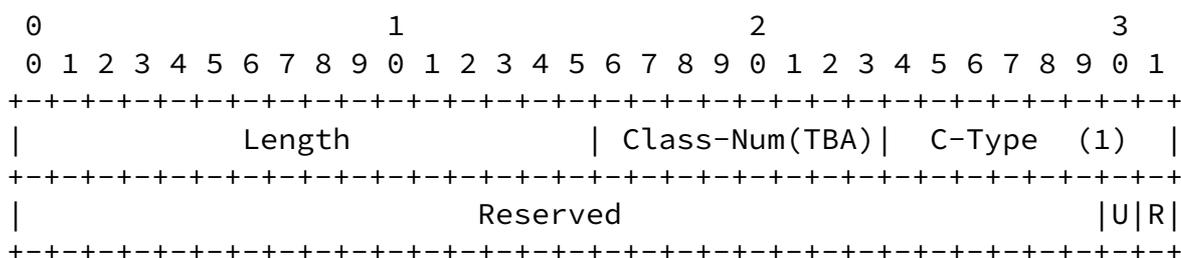The usage of MPLS upstream label assignment using RSVP-TE for

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avoiding branch LSR [RSVP-P2MP] traffic replication on a LAN for RSVP-TE P2MP TE LSPs [RFC4875] is also described.

3. RSVP-TE 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 RSVP-TE neighbor LSR(s) its support of upstream-assigned labels.

[RSVP-RESTART] defines a CAPABILITY object to be carried within Hello messages, and used to indicate the set of capabilities supported by a node. Currently one flag is defined, the R flag indicating the support for RecoveryPath Srefresh. This document defines a new flag, the U flag, to signal a LSR's support of upstream label assignment to its RSVP-TE neighbors.

The format of a Capability object 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
    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
    |            Length             | Class-Num(TBA)| C-Type  (1)   |
    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
    |                        Reserved                          |U|R|
    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```


Recovery Path Srefresh Capable (R): 1 bit, defined in [RSVP-RESTART].

Upstream Label Assignement Capable (U): 1 bit When set this means 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.

The usage of RSVP-TE Hello messages for exchanging upstream label

assignment capability implies that a LSR MAY exchange RSVP-TE Hellos
with a neighbor before sending/receiving any other RSVP-TE messages
to/from that neighbor.

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4. Distributing Upstream-Assigned Labels in RSVP-TE

   An optional RSVP-TE object, the UPSTREAM_ASSIGNED_LABEL object is
   introduced to signal an upstream-assigned label. The Class-Num for
   this object comes from the 0bbbbbbb space and is to be determined by
   IANA.

   UPSTREAM_ASSIGNED_LABEL C-Num = TBD

```
      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
     +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
     |                           Reserved                            |
     +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
     |                           Label                               |
     |                           ....                                |
     +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```


   The label can be encoded as in [RFC3209] when the C-Type is 1 or as a
   Generalized Label [RFC3473] when the C-Type is 2 or 3.

4.1. Procedures

   A RSVP-TE LSR that assigns Upstream-Assigned Labels, distributes them
   to the downstream LSRs by including them in RSVP-TE Path messages.

   A RSVP-TE LSR MUST NOT distribute the UPSTREAM_ASSIGNED_LABEL Object
   to a downstream LSR if the downstream LSR had not previously
   advertised the CAPABILITY object with the U bit set in its RSVP-TE
   Hello messages.

If a downstream RSVP-TE LSR receives a Path message that carries an
UPSTREAM_ASSIGNED_LABEL Object and the LSR does not support the
object C-Num/C-Type it will return an "Unknown Object C-Num/C-Type"
error. If the LSR does support the object, but is unable to process
the upstream-assigned label as described in [MPLS-UPSTREAM] it SHOULD
send a PathErr with the error code "Routing problem" and the error
value "MPLS Upstream Assigned Label Processing Failure". If the LSR
successfully processes the Path message and the upstream-assigned
label it MUST send a Resv message upstream as per [RFC3209] but it
MUST NOT include the LABEL object with a downstream assigned label in
the Resv Message. This is because as described in [MPLS-UPSTREAM] two
LSRs Ru and Rd for a LSP that is bound to FEC F, MUST use either
downstream-assigned label distribution or upstream-assigned label
distribution,for FEC F, but NOT both, for packets that are to be
transmitted on the LSP from Ru to Rd.

5. RSVP-TE 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 RSVP-TE is used for upstream label assignment, the IF_ID
   RSVP_HOP object 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 IF_ID RSVP_HOP object
   [RFC3473] in Path messages along with the UPSTREAM_ASSIGNED_LABEL
   Object.

   Three new TLVs are introduced in the IF_ID RSVP_HOP object [RFC3471]
   to support RSVP-TE P2MP LSPs, IP Multicast Tunnels and context
   labels. 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
   [RFC4875]. The TLV value identifies the RSVP-TE P2MP LSP. This
   mechanism extends RSVP-TE P2P Hierarchy [LSP-HIER] to RSVP-TE P2MP

Hierarchy. It allows Ru to tunnel an "inner" P2MP LSP, the label for
which is upstream assigned, over an "outer" 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 P2MP LSP to the outer P2MP LSP.
The control plane signaling between Ru and <Rd1...Rdn> for the inner
P2MP LSP uses directed RSVP-TE signaling messages as in [LSP-HIER].

2. IP Multicast Tunnel TLV. Type = TBD. In this case the TLV value is
a <Source Address, Multicast Group Address> tuple. Source Address is
the IP address of the root of the tunnel i.e. Ru, and Multicast Group
Address is the Multicast Group Address used by the tunnel.

3. MPLS Context Label TLV. Type = TBD. In this case the TLV value is
a <Source Address, MPLS Context Label> tuple. The Source Address
belongs to Ru and the MPLS Context Label is an upstream assigned
label, assigned by Ru. This allows Ru to tunnel an "inner" RSVP-TE
P2MP LSP, the label of which is upstream assigned, over an "outer"
MPLS LSP, where the outer LSP has the following property:

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  + The label pushed by Ru for the outer MPLS LSP is an upstream
    assigned context label, assigned by Ru. When <Rd1...Rdn> perform
    a MPLS label lookup on this label a combination of this label and
    the incoming interface MUST be sufficient for <Rd1...Rdn> to
    uniquely determine Ru's context specific label space to lookup
    the next label on the stack in. <Rd1...Rdn> MUST receive the data
    sent by Ru with the context specific label assigned by Ru being
    the top label on the label stack.

Currently the usage of the context label TLV is limited only to RSVP-
TE P2MP LSPs on a LAN as specified in the next section. The context
label TLV MUST NOT be used for any other purposes.

[6](6). RSVP-TE Point-to-Multipoint LSPs on a LAN

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

[RFC4875] describes how to setup RSVP-TE P2MP LSPs. On a LAN the
solution described in [RFC4875] relies on "ingress replication". A
LSR on a LAN (say Il), 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.

In order to increase efficiency of bandwidth utilization, it is
desirable for Ru to send a single copy of the packet for the P2MP LSP
on the LAN, when there are multiple downstream routers on the LAN
that are adjacent in that 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 RSVP-TE upstream-assigned labels
with the following procedures. Assume that Ru and <Rd1...Rdn> support
upstream label assignment.

Ru sends a Path message for the P2MP LSP to each of <Rd1...Rdn> that
is adjacent on the P2MP LSP, with the same UPSTREAM_ASSIGNED_LABEL
object. This object carries an upstream assigned label, L. This
message also carries a MPLS Context Label TLV, as described in the
previous section, with the value of the MPLS label set to a value
assigned by Ru on inteface I1 as specified in [MPLS-UPSTREAM].
<Rd1...Rdn> "reserve" the upstream assigned label in the separate
Upstream Neighbor Label Space that they maintain for Ru [MPLS-
UPSTREAM].

Ru can then transmit a single packet for the P2MP LSP to <Rd1..Rdn>

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with a top label L using procedures defined in [MPLS-UPSTREAM] and
[MPLS-MCAST-ENCAPS]. The MPLS packet transmitted by Ru contains as
the top label the context label assigned by Ru on the LAN interface,
I1. The bottom label is the upstream label assigned by Ru to the
RSVP-TE P2MP LSP. The top label is looked up in the context of the
LAN interface, I1, [MPLS-UPSTREAM] by a downstream LSR on the LAN.
This lookup enables the downstream LSR to determine the context
specific label space to lookup the inner label in.

If a subset of <Rd1...Rdn> do not support upstream label assignment
these procedures can still be used between Ru and the remaining
subset of <Rd1...Rdn>. 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.

8. References

8.1. Normative References

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9. Author's Address

   Rahul Aggarwal
   Juniper Networks
   1194 North Mathilda Ave.
   Sunnyvale, CA 94089
   Phone: +1-408-936-2720
   Email: rahul@juniper.net

   Jean-Louis Le Roux
   France Telecom
   2, avenue Pierre-Marzin
   22307 Lannion Cedex
   France
   E-mail: jeanlouis.leroux@orange-ftgroup.com

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