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Include Routes - Extension to Resource ReserVation Protocol-Traffic Engineering (RSVP-TE)

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Abstract

There are scenarios that require two or more LSPs or segments of LSPs to follow same route in the network. This document specifies methods to communicate route inclusions along the loose hops during path setup using the Resource ReserVation Protocol-Traffic Engineering (RSVP-TE) protocol.

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 RFC 2119 [RFC2119].

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1. Introduction

There are scenarios that require two or more Label Switched Paths (LSPs) to follow same route in the network. E.g., many deployments require member LSPs of a bundle/ aggregated link (or Forwarding Adjacency (FA))) follow the same route. Possible reasons for two or more LSPs to follow the same end-to-end or partial route include, but are not limited to:

- Fate sharing: an application may require that two or more LSP fail together. In the example of bundle link this would mean that if one component goes down, the entire bundle goes down.

- Homogeneous Attributes: it is often required that two or more LSPs have the same TE metrics like latency, delay variation, etc. In the example of a bundle/ aggregated link this would meet the requirement that all component links (FAs) of a bundle should have same latency and delay variation. As noted in [OSPF-TE-METRIC] and [ISIS-TE-METRIC], in certain networks, such as financial information networks, network performance (e.g. latency and latency variation) is becoming critical and hence having bundles with component links (FAs) with homogeneous delay and delay variation is important.

Similarly, there are scenarios where two or more LSPs need to follow a given resource in the network, e.g., two partially overlapping LSPs are required. In this case, inclusion of certain abstract nodes or resources between a specific pair of abstract nodes present in an ERO is required.

The RSVP-TE specification [RFC3209] and GMPLS extensions to RSVP-TE [RFC3473] allow abstract nodes and resources to be explicitly included in a path setup, e.g., using IPv4 prefix ERO subobject [RFC3209], IPv6 prefix ERO subobject [RFC3209] and Unnumbered Interface ID ERO subobject [RFC3477], etc. However, such inclusion may not be possible in the following scenarios:

- Inclusion of a LSP path which does not originate, terminate or traverse the source node, in which case the addresses of the path for which inclusion is required are unknown to the source node.

- Inclusion of a LSP path which, while known at the source node of the diverse LSP, has incomplete or unavailable route information, e.g. due to confidentiality of the path attributes. In these cases, the ingress node lacks sufficient knowledge about the loose hop. The ingress node, therefore, is not able to divide a loose hop into a proper sequence of strict or a sequence of finer-grained loose hops. Inter-domain and GMPLS overlay networks may present such restrictions.

The above-mentioned use cases require relevant path inclusion requirements to be communicated to the route expanding nodes. This document addresses these requirements and defines procedures to address them.

2. RSVP-TE signaling extensions

New IPv4 and IPv6 Point-to-Point (P2P) LSP ERO subobject types are defined in this document. These ERO subobjects are used to communicate path inclusion requirements to the ERO expanding node(s). For this purpose, the subobjects carry RSVP-TE Forwarding Equivalence Class (FEC) of the reference LSP who's Path is be used to expand the loose hop of the LSP being signaled. This document only defines the use of these objects for ERO loose hops.

2.1. IPv4 Point-to-Point LSP ERO subobject

The IPv4 Point-to-Point LSP ERO subobject is defined 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
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|L|    Type     |     Length    |Inclusion Flags|  Reserved     |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                 IPv4 tunnel end point address                 |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|   Reserved (MUST be zero)     |      Tunnel ID                |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                       Extended Tunnel ID                      |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                   IPv4 tunnel sender address                  |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|   Reserved (MUST be zero)     |             LSP ID            |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

L

The L bit is an attribute of the subobject. The L bit is set if the subobject represents a loose hop in the ERO. If the bit is not set, the subobject represents a strict hop in the explicit route.

This document only defines the use of the subobject in loose hopes in the ERO, i.e., L bit MUST of set to 1.

Type

IPv4 Point-to-Point LSP subobject
(to be assigned by IANA; suggested value: 38).

Length

The length contains the total length of the subobject in bytes, including the type and length fields. The length is always 24.

Inclusion Flags

The Inclusion-Flags are used to communicate desirable types of inclusion. The following flags are defined.

0x01 = Mandatory inclusion
This flag is used to indicate that the route of the LSP being signaled MUST follow the path specified by the LSP subobject.

0x02 = Best-effort inclusion
This flag is used to indicate that the route of the LSP being signaled SHOULD follow the path specified by the LSP subobject.

The remaining fields are used to specify RSVP-TE FEC of the reference LSP who's Path is be used to expand the route of the LSP being signaled. Specifically,

Tunnel ID

Tunnel ID of the reference LSP who's Path is be used to expand the route of the LSP being signaled.

Extended Tunnel ID

Extended Tunnel ID of the reference LSP who's Path is be used to expand the route of the LSP being signaled.

IPv4 tunnel sender address

IPv4 tunnel sender address of the reference LSP who's path is be used to expand the route of the LSP being signaled.

LSP ID

LSP ID of the reference LSP who's Path is be used to expand the route of the LSP being signaled.

2.2. IPv6 Point-to-Point LSP ERO subobject

The IPv6 Point-to-Point LSP ERO subobject is defined 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
 +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
 |L|    Type     |     Length    |Inclusion Flags|  Reserved     |
 +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                 IPv6 tunnel end point address                 |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|             IPv6 tunnel end point address (cont.)             |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|             IPv6 tunnel end point address (cont.)             |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|             IPv6 tunnel end point address (cont.)             |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|          Must Be Zero         |      Tunnel ID                |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                       Extended Tunnel ID                      |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                   Extended Tunnel ID (cont.)                  |
```

```
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                  Extended Tunnel ID (cont.)                   |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                  Extended Tunnel ID (cont.)                   |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                  IPv4 tunnel sender address                   |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|              IPv4 tunnel sender address (cont.)               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|              IPv4 tunnel sender address (cont.)               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|              IPv4 tunnel sender address (cont.)               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
 |   Reserved (MUST be zero)     |             LSP ID            |
 +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

L

The L bit is an attribute of the subobject. The L bit is set if the subobject represents a loose hop in the ERO.

If the bit is not set, the subobject represents a strict hop in the explicit route.

This document only defines the use of the subobject in loose hopes in the ERO, i.e., L bit MUST of set to 1.

Type

IPv6 Point-to-Point LSP subobject
(to be assigned by IANA; suggested value: 39).

Length

The length contains the total length of the subobject in bytes, including the type and length fields. The length is always 48.

Inclusion Flags

The Inclusion Flags are as defined for the IPv4 Point-to-Point LSP XRO subobject.

The remaining fields are used to specific RSVP-TE FEC of the reference LSP who's Path is be used to expand the route of the LSP being signaled.

2.3. Processing rules for LSP ERO subobjects

The basic processing rules of an ERO are not altered. Please refer to [RFC3209] for details.

If an LSR strips all local subobjects from an ERO carried in a Path message (according to the procedures in [RFC3209]) and finds that the next subobject is an IPv4 P2P LSP subobject or IPv6 P2P LSP subject, it MUST attempt to resolve the LSP subobject as described in the following.

If the L bit of the LSP subobject is not set, i.e., the subobject represents a strict hop in the explicit route, the processing node MUST respond with a PathErr message with the error code "Routing Problem" (24) and the error value "Bad initial subobject" (4).

If the inclusion flags of the LSP subobject is set to "mandatory inclusion", the processing node follows the following procedure:

- If the path taken by the LSP referenced in the LSP subobject is known to the processing node and the path contains the loose abstract node in the ERO hop, the processing node MUST ensure that loose hop expansion to the next abstract node follows the referenced path.

- If the path taken by the LSP referenced in the LSP subobject is unknown to the processing node or the referenced path does not contain the loose abstract node in the ERO hop, the processing node MUST sent a PathErr message with the error code "Routing Problem" (24) and the new error value "unknown or inconsistent LSP suboject" (value to be assigned by IANA) for the signaled LSP.

If the inclusion flags of the LSP subobject is set to "best-effort inclusion", the processing node follows the following procedure:

- If the path taken by the LSP referenced in the LSP subobject is known to the processing node and the path contains the loose abstract node in the ERO hop, the processing node SHOULD ensure that loose hop expansion to the next abstract node follows the referenced path.

- If the path taken by the LSP referenced in the LSP subobject is unknown to the processing node and/ or the referenced path does not contain the loose abstract node in the ERO hop, the processing node SHOULD ignore the route inclusion specified in the LSP subobject and SHOULD compute a suitable path to the loose abstract node in the ERO hop and proceed with the signaling request. After sending the Resv for the signaled LSP, the processing node SHOULD return a PathErr with the error code "Notify Error" (25) and error sub-code " unknown or inconsistent LSP suboject" (value to be assigned by IANA) for the signaled LSP.

3. Security Considerations

This document does not introduce any additional security issues above those identified in [RFC5920], [RFC2205], [RFC3209], and [RFC3473] and [RFC4874].

4. IANA Considerations

4.1. New ERO subobject types

This document adds the following new subobject of the existing entry for ERO (20, EXPLICIT_ROUTE):

Value	Description
TBA	IPv4 Point-to-Point LSP ERO subobject

TBA IPv6 Point-to-Point LSP ERO subobject

These subobject may be present in the Explicit Route Object, but not in the Route Record Object.

4.2. New RSVP error sub-codes

IANA registry: RSVP PARAMETERS
Subsection: Error Codes and Globally-Defined Error Value Sub-Codes

For Error Code "Routing Problem" (24) (see [RFC3209]) the following sub-codes are defined.

Sub-code	Value
Unknown or inconsistent LSP suboject	To be assigned by IANA.

For Error Code "Notify Error" (25) (see [RFC3209]) the following sub-codes are defined.

Sub-code	Value
Unknown or inconsistent LSP suboject	To be assigned by IANA.

5. Acknowledgments

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6. References

6.1. Normative References

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[RFC3473] Berger, L., "Generalized Multi-Protocol Label Switching (GMPLS) Signaling Resource ReserVation Protocol-Traffic Engineering (RSVP-TE) Extensions", RFC 3473, January 2003.

6.2. Informative References

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[RFC3477] Kompella, K. and Y. Rekhter, "Signalling Unnumbered Links in Resource ReSerVation Protocol - Traffic Engineering (RSVP-TE)", RFC 3477, January 2003.

[RFC2209] Braden, R. and L. Zhang, "Resource ReSerVation Protocol (RSVP) -- Version 1 Message Processing Rules", RFC 2209, September 1997.

[RFC5920] Fang, L., Ed., "Security Framework for MPLS and GMPLS Networks", RFC 5920, July 2010.

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