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Reoptimization of Point-to-Multipoint Traffic Engineering Loosely Routed LSPs
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Abstract

For a Traffic Engineered (TE) point-to-multipoint (P2MP) Label Switched Path (LSP), it is preferable in some cases to re-evaluate and re-optimize the entire P2MP-TE LSP by re-signaling all its S2L sub-LSP(s). Existing mechanisms allow the path re-evaluation and the signaling of a the notification of preferred path exists for a single S2L sub-LSP only.

This document defines RSVP-TE signaling extensions to allow an ingress Label Switching Router (LSR) of a P2MP-TE LSP to trigger the re-evaluation of the entire LSP tree containing one or more S2L sub-LSPs whose paths are loose (or abstract) hop expanded, and for a mid-point LSR to signal to the ingress LSR that a better tree exists for the entire P2MP-TE LSP.

Status of this Memo

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1. Introduction

This document defines Resource Reservation Protocol - Traffic Engineering (RSVP-TE) [RFC2205] [RFC3209] signaling extensions for re-optimizing loosely routed Point-to-Multipoint (P2MP) Traffic Engineered (TE) Label Switched Paths (LSPs) [RFC4875] in an Multi-Protocol Label Switching (MPLS) and/or Generalized MPLS (GMPLS) networks.

A P2MP-TE LSP is comprised of one or more source-to-leaf (S2L) sub-LSPs. A loosely routed P2MP-TE S2L sub-LSP is defined as one whose path does not contain the full explicit route identifying each node along the path to the egress node at the time of its signaling by the ingress node. Such an S2L sub-LSP is signaled with no Explicit Route Object (ERO) [RFC3209], or with an ERO that contains at least one loose hop, or with an ERO that contains an abstract node that is not a simple abstract node (that is, an abstract node that identifies more than one node). This is often the case with inter-domain P2MP-TE LSPs where Path Computation Element (PCE) is not used [RFC5440].

As per [RFC4875], an ingress node may re-optimize the entire P2MP-TE LSP by re-signaling all its S2L sub-LSP(s) or may re-optimize individual S2L sub-LSP(s) i.e. individual destination(s).

[RFC4736] defines RSVP signaling extensions for re-optimizing loosely routed P2P TE LSP(s) as follows.

- A mid-point LSR that expands loose next-hop(s) MAY send a solicited or unsolicited PathErr with the Notify error code (25 as defined in [RFC3209]) with sub-code 6 to indicate "Preferable Path Exists" to the ingress node.

- An ingress node MAY trigger a path re-evaluation request at all mid-point LSR(s) that expands loose next-hop(s) by setting the "Path Re-evaluation Request" flag (0x20) in SESSION_ATTRIBUTES object in the Path message.

- The ingress node upon receiving this PathErr either solicited or unsolicited initiates re-optimization of the LSP.

[RFC4736] does not define signaling extensions specific for re-optimizing entire P2MP-TE LSP tree. Mechanisms defined in [RFC4736] can be used for signaling the re-optimization of individual S2L sub-LSP(s). However, to use [RFC4736] mechanisms for re-optimizing an entire P2MP-TE LSP tree, an ingress node needs to send the path re-evaluation requests on all (typically 100s of) S2L sub-LSPs and the

mid-point LSR to notify PathErrs for all S2L sub-LSPs. Such a procedure may lead to the following issues:

- A mid-point LSR that expands loose next-hop(s) may have to accumulate the received path re-evaluation request(s) for all S2L sub-LSPs (e.g, by using a wait timer) and interpret them as a re-optimization request for the whole P2MP-TE LSP tree. Otherwise, A mid-point LSR may prematurely notify "Preferable Path Exists" for one or a sub-set of S2L sub-LSPs.

- The ingress LSR that receives (un)solicited PathErr notification(s) for individual S2L sub-LSP(s), may prematurely start re-optimizing the sub-set of S2L sub-LSPs. However, as mentioned in [RFC4875] Section 14.2, such re-optimization procedure may result in data duplication that can be avoided if the entire P2MP-TE LSP tree is re-optimized, especially if the ingress node eventually receives PathErr notifications for all S2L sub-LSPs of the P2MP-TE LSP tree.

- The ingress node may have to heuristically determine when to perform entire P2MP-TE LSP tree re-optimization versus per S2L sub-LSP re-optimization, for example, to delay re-optimization long enough to allow all PathErr(s) to be received. Once all PathErr(s) are received, the ingress node has to accumulate them to see if re-optimization of the entire P2MP-TE is necessary. Such procedures may produce undesired results due to timing related issues. This may be easily avoided by the RSVP signaling messages defined in this document.

This document defines RSVP-TE signaling extensions for the head-end LSR of a P2MP-TE LSP to trigger the re-evaluation of the P2MP tree on every hop that has a next hop defined as a loose or abstract hop for one or more S2L sub-LSP path, and a mid-point LSR to signal to the head-end LSR that a better tree exists (compared to the current path) or that the whole P2MP-TE LSP must be re-optimized (because of maintenance required on the TE LSP path).

2. Terminology

2.1. Abbreviations

ABR: Area Border Router.

AS: Autonomous System.

ERO: Explicit Route Object.

TE LSP: Traffic Engineering Label Switched Path.

TE LSP ingress: head/source of the TE LSP.

TE LSP egress: tail/destination of the TE LSP.

2.2. Nomenclatures

Domain: Routing or administrative domain such as an IGP area and an autonomous system.

Interior Gateway Protocol Area (IGP Area): OSPF Area or IS-IS level.

Inter-area TE LSP: A TE LSP whose path transits across at least two different IGP areas.

Inter-AS MPLS TE LSP: A TE LSP whose path transits across at least two different Autonomous Systems (ASes) or sub-ASes (BGP confederations).

S2L sub-LSP: Source-to-leaf sub Label Switched Path.

2.3. 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 [RFC2119]. The reader is assumed to be familiar with the terminology in [RFC4875] and [RFC4736].

3. Signaling Procedure For Loosely Routed P2MP-TE LSP Re-Optimization

It might be preferable, as per [RFC4875], to re-optimize the entire P2MP-TE LSP by re-signaling all of its S2L sub-LSP(s) (Section 14.1, "Make-before- Break") or re-optimize individual S2L sub-LSP(s) i.e. individual destination(s) (Section 14.2 "Sub-Group-Based Re-Optimization"). This can be achieved by using the procedures defined in [RFC4736] to individually re-optimize the S2L sub-LSP(s) of a P2MP-TE LSP.

To evaluate an entire P2MP-TE LSP tree on mid-point LSRs that expand loose next-hop(s), an ingress node may send a Path message with "P2MP-TE Tree Re-evaluation Request" defined in this document. An ingress node may select one or more S2L sub-LSP of the P2MP-TE LSP tree to trigger the re-evaluation request(s).

A mid-point LSR that expands loose next-hop(s) for one or more S2L sub-LSP path(s), and that receives a Path message with the "P2MP-TE Tree Re-evaluation Request" bit set, checks for a preferable P2MP-TE LSP tree by re-evaluating all S2L sub-LSP(s) expanded paths of the P2MP-TE LSP. If a preferable P2MP-TE LSP tree is found, the mid-point LSR sends an RSVP PathErr to the ingress node with Error code 25 (Notify defined in [RFC3209] and Error sub-code defined in this document "Preferable P2MP-TE Tree Exists". The mid-point LSR, in

turn, does not propagate the "P2MP-TE Tree Re-evaluation Request" bit in subsequent RSVP Path messages sent downstream for the re-evaluated P2MP-TE LSP. The sending of an RSVP PathErr Notify message "Preferable P2MP-TE Tree Exists" to the ingress node will notify the ingress node of the existence of a preferable P2MP-TE LSP tree. In addition, a mid-point LSR may send an unsolicited PathErr message with "Preferable P2MP-TE Tree Exists" PathErr code 25 to the ingress node to notify of a preferred the P2MP-TE LSP tree when it determines it exists. In this case, the mid-point LSR that expands loose next-hop(s) for one or more S2L sub-LSP path(s) may select one or more S2L sub-LSP(s) of the P2MP-TE LSP tree to send this PathErr message to the ingress node.

If no preferable tree for P2MP-TE LSP can be found, the recommended mode is for the mid-point LSR that expands loose next-hop(s) for one or more S2L sub-LSP path(s) to propagate the request downstream by setting the "P2MP-TE Tree Re-evaluation Request" bit in the LSP_ATTRIBUTES object of RSVP Path message.

4. RSVP Signaling Extensions

4.1. P2MP-TE Tree Re-evaluation Request Flag

In order to trigger a tree re-evaluation request, a new flag is defined in Attributes Flags TLV of the LSP_ATTRIBUTES object [RFC5420] as follows:

Bit Number (to be assigned by IANA): P2MP-TE Tree Re-evaluation Request flag

The "P2MP-TE Tree Re-evaluation Request" flag is meaningful in a Path message of a P2MP-TE S2L sub-LSP and is inserted by the ingress node.

4.2. Preferable P2MP-TE Tree Exists Path Error sub-code

In order to indicate to an ingress node that a preferable P2MP-TE LSP tree exists, the following new sub-code for PathErr code 25 (Notify Error) [RFC3209] is defined:

Sub-code (to be assigned by IANA): Preferable P2MP-TE Tree Exists sub-code

When a preferable path for P2MP-TE LSP tree exists, the mid-point LSR sends a solicited or unsolicited "Preferable P2MP-TE Tree Exists" PathErr notification to the ingress node of the P2MP-TE LSP.

5. Compatibility

The LSP_ATTRIBUTES object has been defined in [RFC5420] with class numbers in the form 11bbbbbb, which ensures compatibility with non-supporting nodes. Per [RFC2205], nodes not supporting this extension will ignore the new flag defined in this document but forward it without modification.

6. Security Considerations

This document defines a mechanism for a mid-point LSR to notify the ingress node of a P2MP-TE LSP of the existence of a preferable tree. As per [RFC4736], in the case of a P2MP-TE LSP S2L sub-LSP spanning multiple domains, it may be desirable for a a mid-point LSR to modify the RSVP PathErr message defined in this document to maintain confidentiality across different domains. Furthermore, an ingress node may decide to ignore this PathErr message coming from a mid-point LSR residing in another domain. Similarly, an mid-point LSR may decide to ignore the tree re-evaluation request originating from another ingress domain.

7. IANA Considerations

IANA maintains a name space for RSVP-TE TE parameters "Resource Reservation Protocol-Traffic Engineering (RSVP-TE) Parameters". From the registries in this name space "Attribute Flags" allocation of new flag is requested (Section 4.1).

IANA also maintains a name space for RSVP protocol parameters "Resource Reservation Protocol (RSVP) Parameters". From the sub-registry "Sub-Codes - 25 Notify Error" in registry "Error Codes and Globally-Defined Error Value Sub-Codes" allocation of a new error code is requested (Section 4.2).

7.1. P2MP-TE Tree Re-evaluation Request Flag

The following new flag is defined for the Attributes Flags TLV in the LSP_ATTRIBUTES object [RFC5420]. The numeric value is to be assigned by IANA.

o P2MP-TE Tree Re-evaluation Request Flag:

Bit No	Attribute Flag Name	Carried in Path	Carried in Resv	Carried in RRO	Reference
TBA by IANA	P2MP-TE Tree Re-evaluation	Yes	No	No	This document

7.2. Preferable P2MP-TE Tree Exists Path Error sub-code

As defined in [RFC3209], the Error Code 25 in the ERROR SPEC object corresponds to a Notify Error PathErr. This document adds a new sub-code as follows for this PathErr:

o Preferable P2MP-TE Tree Exists sub-code:

Sub-code value	Sub-code Name	PathErr Code	PathErr Name	Reference
TBA by IANA	Preferable P2MP-TE Tree Exists	25	Notify error	This document

8. Acknowledgments

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9. References

9.1. Normative References

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