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**PCEP Extension for SR-MPLS Entropy Label Position
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Abstract

This document proposes a set of extensions for PCEP to configure the entropy label position for SR-MPLS networks.

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Table of Contents

1.	Introduction	2
2.	Conventions used in this document	3
2.1.	Terminology	3
2.2.	Requirements Language	3
3.	PCEP Extensions	4
3.1.	The OPEN Object	4
3.2.	The LSP Object	4
3.2.1.	The LSP-EXTENDED-FLAG TLV	5
3.3.	The ERO Object	5
4.	Operations	6
5.	Security Considerations	6
6.	Acknowledgements	6
7.	IANA Considerations	6
7.1.	New SR PCE Capability Flag Registry	6
7.2.	New LSP Flag Registry	6
7.3.	New SR-ERO Flag Registry	7
8.	Normative References	7
	Authors' Addresses	8

[1.](#) Introduction

[RFC5440] describes the Path Computation Element Protocol (PCEP) which is used between a Path Computation Element (PCE) and a Path Computation Client (PCC) (or other PCE) to enable computation of Multi-protocol Label Switching (MPLS) for Traffic Engineering Label Switched Path (TE LSP). PCEP Extensions for the Stateful PCE Model [RFC8231] describes a set of extensions to PCEP to enable active control of MPLS-TE and Generalized MPLS (GMPLS) tunnels. [RFC8281] describes the setup and teardown of PCE-initiated LSPs under the active stateful PCE model, without the need for local configuration on the PCC, thus allowing for dynamic centralized control of a network.

Segment Routing (SR) leverages the source routing paradigm. Segment Routing can be instantiated on MPLS data plane which is referred to as SR-MPLS [I-D.ietf-spring-segment-routing-mpls]. SR-MPLS leverages the MPLS label stack to construct the SR path. PCEP Extensions for Segment Routing [I-D.ietf-pce-segment-routing] specifies extensions to the PCEP that allow a stateful PCE to compute and initiate TE paths, as well as a PCC to request a path subject to certain constraint(s) and optimization criteria in SR networks.

Entropy label (EL) [RFC6790] is a technique used in the MPLS data plane to provide entropy for load-balancing. Entropy Label Indicator (ELI) can be immediately preceding an EL in the MPLS label stack. The idea behind the EL is that the ingress router computes a hash

based on several fields from a given packet and places the result in an additional label, named "entropy label". Then, this entropy label can be used as part of the hash keys used by an LSR. Using the entropy label as part of the hash keys reduces the need for deep packet inspection in the LSR while keeping a good level of entropy in the load-balancing. When the entropy label is used, the keys used in the hashing functions are still a local configuration matter and an LSR may use solely the entropy label or a combination of multiple fields from the incoming packet.

[I-D.ietf-mpls-spring-entropy-label] proposes to use entropy labels for SR-MPLS networks. The Entropy Readable Label Depth (ERLD) is defined as the number of labels which means that the router will perform load-balancing using the ELI/EL. An appropriate algorithm would consider the following goals:

- o a limited number of <ELI, EL> pairs should be inserted deeper in the label-stack.
- o the inserted position should be within the ERLD of most transit nodes.
- o a minimum number of <ELI, EL> to satisfy the above criteria.

In some cases, It is required for the controller (e.g. PCE) to perform the TE path computation as well as the Entropy Label Position (ELP), because the controller has the ERLD information of all nodes, especially for inter-domain scenarios. This document proposes a set of extensions for PCEP to configure the ELP information for SR-MPLS networks.

2. Conventions used in this document

2.1. Terminology

The terminology is defined as [RFC5440], [RFC6790], [I-D.ietf-pce-segment-routing] and [I-D.ietf-mpls-spring-entropy-label].

2.2. Requirements Language

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "NOT RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in BCP 14 [RFC2119] [RFC8174] when, and only when, they appear in all capitals, as shown here.

3. PCEP Extensions

3.1. The OPEN Object

As defined in [[I-D.ietf-pce-segment-routing](#)], PCEP speakers use SR PCE Capability sub-TLV to exchange information about their SR capability when PST=1 in the PST List of the PATH-SETUP-TYPE-CAPABILITY TLV carried in Open object. This document defined a new flag (E-flag) for SR PCE Capability sub-TLV as shown in Figure 1.

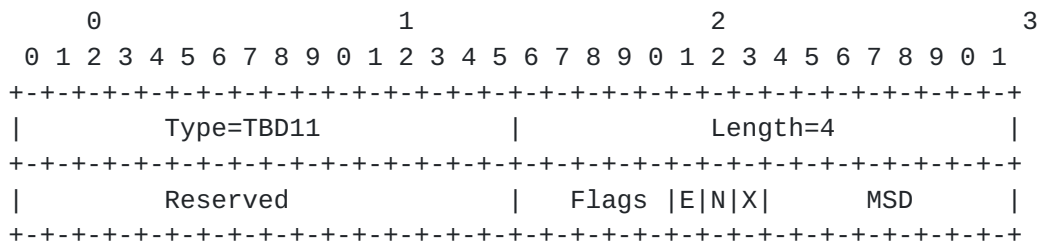


Figure 1: E-flag in SR-PCE-CAPABILITY sub-TLV

E (ELP Configuration is supported) : A PCC or PCE sets this flag bit to 1 carried in Open message to indicate that it supports the SR path with ELP configuration.

3.2. The LSP Object

The LSP Object is defined in [Section 7.3 of \[RFC8231\]](#). This document defined a new flag (E-flag) for the LSP Object as Figure 2 shown:

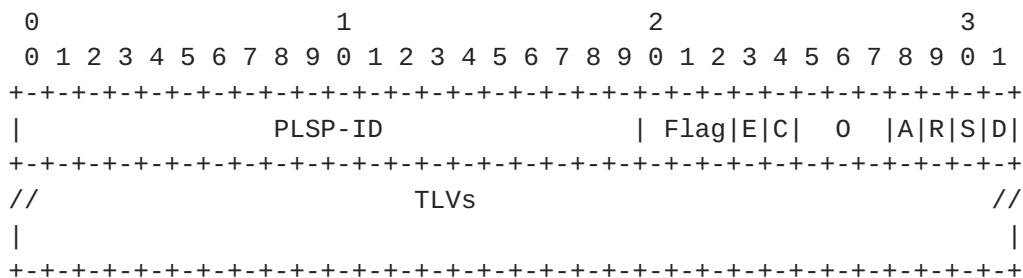


Figure 2: E-flag in LSP Object

E (Request for ELP Configuration) : If the bit is set to 1, it indicates that the PCC requests PCE to compute the SR path with ELP information. A PCE would also set this bit to 1 to indicate that the

ELP information is included by PCE and encoded in the PCRep, PCUpd or PCInitiate message.

3.2.1. The LSP-EXTENDED-FLAG TLV

As defined in [RFC8231], the length of LSP Object Flag field is 12 bits and it defined the value from bit 5 to bit 11. The bits from 1 to 3 are defined in [RFC8623], the bit value 4 is used in [RFC8281]. So all bits of the flag has been used and this document proposes to define a new LSP-EXTENDED-FLAG TLV for LSP object to extend the length of the flag as the Figure 3 shown.

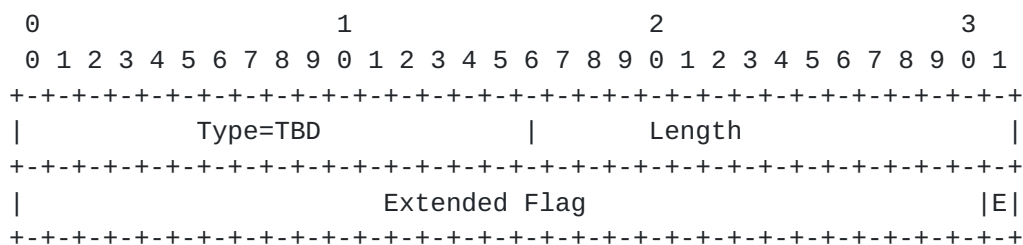


Figure 3: LSP-EXTENDED-FLAG TLV Format

The bit E has the same definition with [section 3.2](#) and the other bits of the Extended flag can be used for other drafts in the future.

3.3. The ERO Object

SR-ERO subobject is used for SR-TE path which consists of one or more SIDs as defined in [I-D.ietf-pce-segment-routing]. This document defines a new flag (E-flag) for the SR-ERO subobject as Figure 4 shown:

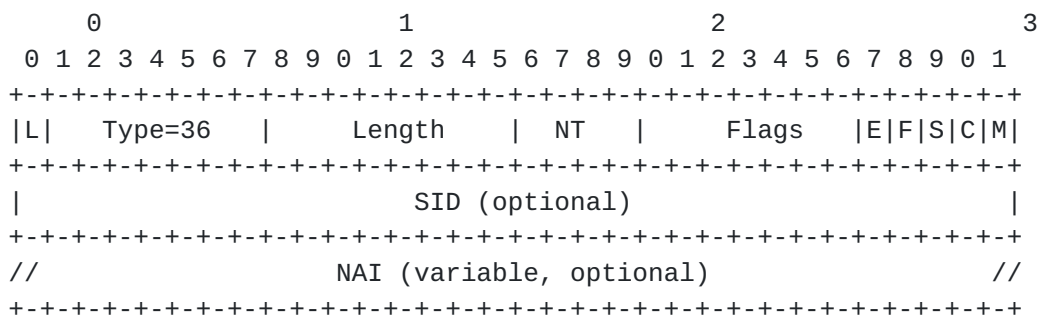


Figure 4: E-flag in SR-ERO subobject

E (ELP Configuration) : If this flag is set, it means that the position after this SR-ERO subobject is the position to insert <ELI, EL>, otherwise it cannot insert <ELI, EL> after this segment.

4. Operations

The SR path is initiated by PCE or PCC with PCReq, PCInitiated or PCUpd messages and the E bit is set to 1 in LSP object to request the ELP configuration. The SR-TE path being received by PCC with SR-ERO segment list, for example, <S1, S2, S3, S4, S5, S6>, especially S3 and S6 with E-flag set. It indicates that two <ELI, EL> pairs MUST be inserted into the label stack of the SR-TE forwarding entry, respectively after the label for S3 and label for S6. With EL information, the label stack for SR-MPLS would be <label1, label2, label3, ELI, EL, label4, label5, label6, ELI, EL>.

5. Security Considerations

TBA

6. Acknowledgements

TBA

7. IANA Considerations

7.1. New SR PCE Capability Flag Registry

SR PCE Capability TLV is defined in [[I-D.ietf-pce-segment-routing](#)], and the registry to manage the Flag field of the SR PCE Capability TLV is requested in [[I-D.ietf-pce-segment-routing](#)]. IANA is requested to make allocations from the registry, as follows:

Value	Name	Reference
TBD11	ELP Configuration is supported (E)	[this document]

Table 1

7.2. New LSP Flag Registry

[RFC8231] defines the LSP object; per that RFC, IANA created a registry to manage the value of the LSP object's Flag field. IANA is requested to make allocations from the registry, as follows:

Value	Name	Reference
TBD	Request for ELP Configuration (E)	[this document]
TBD	LSP-EXTENDED-FLAG TLV	[this document]

Table 2

7.3. New SR-ERO Flag Registry

SR-ERO subobject is defined in [I-D.ietf-pce-segment-routing], and the registry to manage the Flag field of SR-ERO is requested in [I-D.ietf-pce-segment-routing]. IANA is requested to make allocations from the registry, as follows:

Value	Name	Reference
36	ELP Configuration (E)	[this document]

Table 3

8. Normative References

- [I-D.ietf-mpls-spring-entropy-label]
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- [RFC8623] Palle, U., Dhody, D., Tanaka, Y., and V. Beeram, "Stateful Path Computation Element (PCE) Protocol Extensions for Usage with Point-to-Multipoint TE Label Switched Paths (LSPs)", [RFC 8623](#), DOI 10.17487/RFC8623, June 2019, <<https://www.rfc-editor.org/info/rfc8623>>.

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